WATER SYSTEM MASTER PLAN

FINAL REPORT

TOWN OF SCITUATE

November 2020

Revised January 2021

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Executive Summary

EXECUTIVE SUMMARY

Executive Summary

This plan addresses the three primary water related concerns of the Town of Scituate

1. Ability to meet future demands
2. Water quality
3. System reliability

Ability to Meet Future Demands

Determining whether the Town's available water supply is sufficient to meet the projected demands in the future requires projecting future demands and comparing them to the total effective capacity of all sources.

Effective Capacity of Sources

The Town of Scituate's water system is supplied by a reservoir system consisting of three reservoirs (Tack Factory Pond, Main Reservoir, and Old Oaken Bucket Pond) treated at the Old Oaken Bucket Water Treatment Plant (OOB WTP) and six groundwater wells (Wells 10, 11, 17A, 19, 22, and 18B).. These sources are used in varying combinations to meet the total water demand. The Humarock area is maintained and managed by the Scituate Water Department but it is served by the Town of Marshfield sources, which accounts for about 10% of the annual usage.

The amount of water available from each source is dictated by the Town's Water Management Act (WMA) permit. The WMA permit covers three five-year periods from 2016 to 2030 and includes:

- Total annual for each of the three periods and maximum day withdrawal amount for each source.
- Incremental increases in the daily average and total annual usage for each of the three periods.
- Increased capacity if the Town incorporates mitigation measures.
- Additional capacity if Scituate decides to serve the Humarock area from its own sources.

This information is presented in Tables ES-1 and ES-2 and graphically below in Figure ES-1.

TABLE ES-1
Maximum Authorized Annual Average Withdrawal – Total Raw Water Withdrawal Volumes

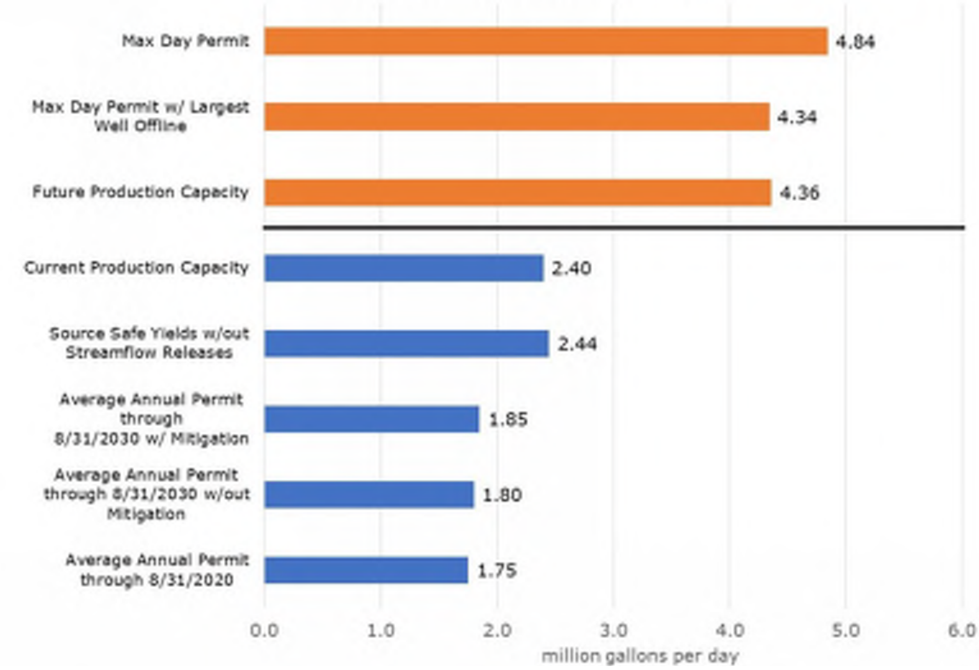
Without Humarock: Permit Periods	**Daily Average (mgd)**	**Total Annual (MGY)**
9/16/2016 – 8/31/2020	1.75	638.75
9/1/2020 – 8/31/2025	1.77	646.05
9/1/2025 – 8/31/2030 – w/out Mitigation	1.80	657.00
Prior to making withdrawals greater than the baseline of 1.80 mgd, a mitigation plan must be incorporated into the permit and required mitigation activities must be implemented.		
9/1/2025 – 8/31/2030 – with Mitigation	1.85	675.25
With Humarock: Permit Periods	**Daily Average (mgd)**	**Total Annual (MGY)**
9/16/2016 – 8/31/2020	1.80	657.00
Prior to making withdrawals greater than the baseline of 1.80 mgd, a mitigation plan must be incorporate into the permit and required mitigation activities must be implemented.		
9/1/2020 – 8/31/2025	1.85	675.25
9/1/2025 – 8/31/2030 – w/out Mitigation	1.87	682.55
9/1/2025 – 8/31/2030 – with Mitigation	1.97	719.05

TABLE ES-2
Maximum Permitted Withdrawals

Maximum Daily Withdrawals Rates from the Authorized Groundwater Withdrawal Points:	Maximum Daily Rate
Well #10	0.20 mgd (138 gpm)
Well #11	0.12 mgd (81 gpm)
Well #17A	0.39 mgd (270 gpm)
Well #19	0.41 mgd (288 gpm)
Well #22	0.50 mgd (350 gpm)
Well #18B	0.22 mgd (153 gpm)

Maximum Withdrawals from Old Oaken Bucket Pond	Maximum Rate
Maximum Daily Withdrawal	3.0 mgd
Maximum Annual Average Daily Withdrawals	0.79 mgd
Maximum Annual Withdrawal	288.35 mg

Figure ES-1
Total Permitted and Effective Supply



Note that the current production capacity is less than the total permitted maximum for a combination of reasons related to equipment condition, staffing and loss of well capacity over time. The future production capacity assumes that issues related to treatment capacity restrictions (at Wells 17A and 18B and OOB WTP) are addressed following planned and ongoing improvements.

Future Demands

Future demands were determined by examining both usage and population trends. Population growth projections from the Metropolitan Area Planning Council (MAPC) and the UMass Donahue Institute were compared and vetted with the Town Planner. The MAPC evaluates growth under a 'status quo' and a 'strong region' scenario. The MAPC strong region scenario projected the highest growth and was used in the interest of conservatism. Figure ES-2 shows the various projections.

The 2014 MAPC Economic Development Study included projections for commercial growth in Scituate. These data were combined with population projections and were used to develop projected demands by customer type for the years 2030, 2040 and 2050. These values can be found in Table 3-9 in the report.

Figure ES-3 summarizes the current and projected max day demands and available source capacity.

Figure ES-2
Population projections by source

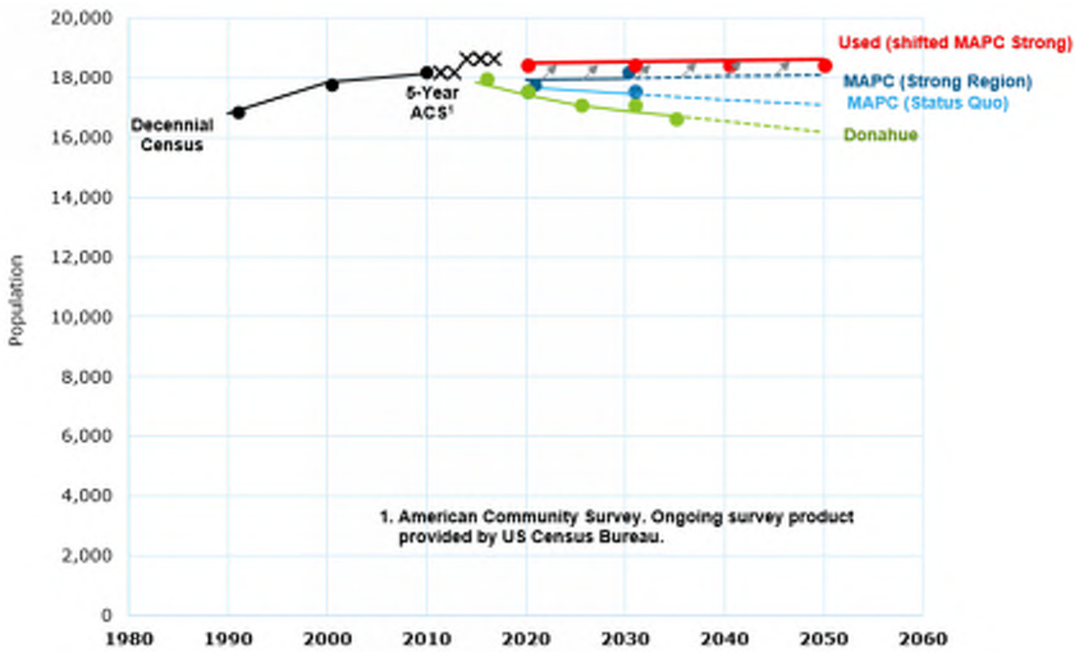
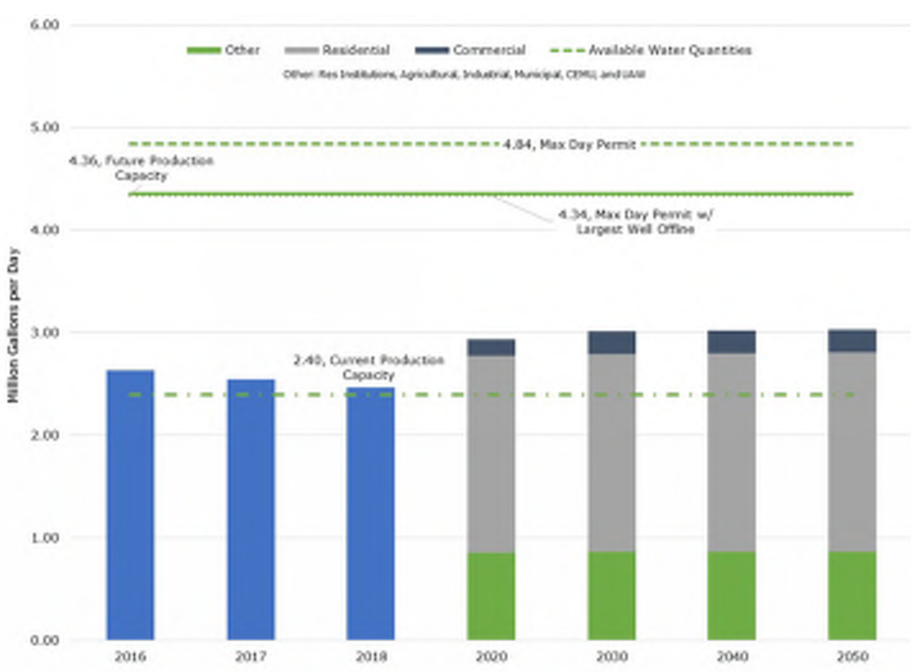


Figure ES-3
Projected Demand vs. Supply (Excludes Humarock)



Based upon the analysis conducted, the Town's water supplies are not sufficient for meeting projected demands if improvements to increase production from the sources are not implemented, such as treatment improvements to allow increased production from Wells 17A and 18B and from the OOB WTP. If the reliability and treatment capacity from these sources are improved, then the existing supplies appear to be sufficient to meet projected demands. The Town should continue to monitor usage and growth annually to track against the projections.

Water Quality

Scituate has been plagued by discolored water for decades due to the precipitation of iron and manganese. Manganese is a secondary contaminant primarily found in ground water sources, and is present in Wells 17A, 18B, 19 and 22.

System Reliability

The water system consists of three primary elements: Source/Treatment, Distribution, and Storage. Maintaining the desired level of service to Scituate's water customers depends upon all of them. Monitoring and control capabilities are also important for the overall operation of the system. The prioritized capital improvement program described in Section 5 of the report includes improvements or repairs aimed at each element. These needs are summarized below:

Source / Treatment: The Town relies on the Old Oaken Bucket Water Treatment Plant for up to 50% of its supply during the summer and could not meet peak demands without it. Emergency repairs had to be made to the existing facility during the winter of 2018-2019, and in order to take the plant offline, temporary filtration had to be added to Wells 17A and 18B, which underscores the significance of the facility. The emergency repairs will only extend the service life of the plant by five years at most. After the emergency repairs were completed, an evaluation of the existing plant was conducted (see Section 2.3.4), which found significant deficiencies in terms of redundancy and condition. Our recommendation is to proceed with the design of a replacement facility immediately.

Well 18B was fitted with greensand filters as part of the emergency repairs. The additional improvements are required to add sustainable residuals disposal capabilities, improve operability overall, and increase production from the facility. The treatment facility for Well 17A is under construction and completion is expected in 2021. Historically, production from this well has been limited due to water quality concerns related to high manganese; the new treatment facilities will allow operating Well 17A to its full capability. The CIP includes $41M of improvements not including the Well 17A filtration plant.

Storage: The Pincin Hill water tank was slated for rehabilitation in 2016; however, the project had to be postponed indefinitely because the Town could not operate with only one tank during the summer. The CIP includes rehabilitation for the two existing storage tanks as well as costs for a third new tank for redundancy. The CIP includes $5.5M for tank rehabilitation and construction.

Distribution: The Town has made significant investments in the distribution system over the last ten years, having replaced most of the unlined cast iron pipe. This improved water quality and hydraulic performance of the system. The CIP includes

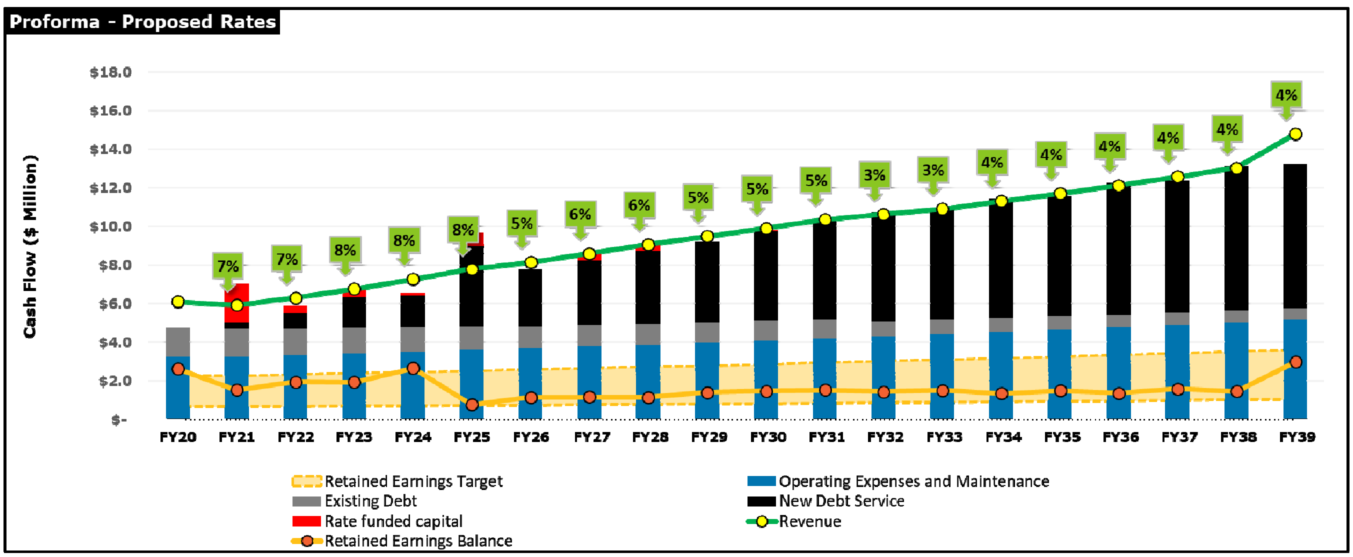
$46M of distribution system improvements, including the current phase IV improvements under design, which will replace the remaining cast-iron pipe and undersized galvanized iron pipes. Future phases include the Humarock area, which is prone to breakage and high unaccounted water loss, and replacement or rehabilitation of the asbestos cement pipe that constitutes almost half of the remaining distribution system. The CIP includes $46M for pipe replacement.

SCADA and metering. The water system is outdated in terms of instrumentation and controls. The wells are all run in manual (on / off) mode and the controls at the OOB plant are minimal. The addition of a modern SCADA system will greatly increase efficiency and reliability by allowing the Water Department to operate sources in response to demands. The CIP includes continuation of the existing meter replacement program plus the addition of Advanced Meter Infrastructure (AMI), which will provide the Town with a significant increase in its ability to measure and manage water usage.

Cost Impacts

The total capital improvement program totals $114M over the next 20 years. In order to determine the cost impacts on customers, estimated rate increases were developed for the 20-year planning period and costs for a typical residential user were estimated. The most recent recommended affordability metrics were then applied to assess the financial burden associated with the future rate increases.

Figure ES-4
Projected Water Rate Increases



The annual cost of water for a typical residential customer was determined to increase from the current cost of $864 to $2,286 in 2039. While this is a considerable increase, the economic burden, which is based upon Scituate's lowest quintile income, results in a determination of "low burden" in 2020 and a "low-moderate" burden in 2039. While this is considered acceptable, the Town can also consider a customer assistance program in the future.

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SECTION 1

Section 1
Introduction

The Town of Scituate owns and operates a public water system to provide water to its residents and businesses. Scituate obtains its drinking water from a combination of groundwater wells and surface water sources. The Town's distribution system in the Humarock Village Area is served by the Marshfield water system.

1.1 Plan Purpose and Goals

The purpose of this Water System Master Plan is to present a strategic and sustainable 20-year capital improvement plan that will guide the Town of Scituate in meeting its water quantity, water quality, and operations and maintenance goals while simultaneously addressing economic needs and environmental requirements. The plan is meant to allow the Town to continue to:

- Provide a sustainable, high-quality drinking water source for residents, businesses, and industry.
- Operate and maintain the Town's drinking water system, which includes one surface water treatment plant, six water supply wells and three associated treatment buildings, two water storage tanks, two booster pump stations, and over 120 miles of water distribution system piping and associated valves, hydrants, services, and meters.
- Comply with Federal and State environmental regulations such as the Safe Drinking Water Act, Drinking Water Regulations, the Water Management Act (WMA) Regulations and the Town's WMA permit requirements, and the Sustainable Water Management Initiative (SWMI).
- Identify annual capital plans, budgets, and spending recommendations.

1.2 Water System Overview

The Scituate water system serves approximately 7,889 residential, commercial, industrial, agricultural, and municipal customers, based on the Town's billed usage records. According to billing data provided by the Town , approximately 96% of customers are residential. In 2018, the system had an average daily demand of 1.553 mgd (including water purchased for the Humarock region).

Figure 1-1 presents a static hydraulic profile of the water system, and Figure 1-2 presents a distribution system map illustrating the facilities and infrastructure.

1.2.1 Water Management Act

The Water Management Act (M.G.L. c. 21G) became effective in March 1986. The Act authorizes the Massachusetts Department of Environmental Protection (MassDEP) to regulate the quantity of water withdrawn from both surface and groundwater supplies. The purpose of these regulations (310 CMR 36.00) is to ensure adequate water supplies for current and future water needs.

1.2.1.1 Maximum Authorized Withdrawals

The amount of water that may be withdrawn from each source of supply in terms of both total annual volume and maximum daily volume is defined in the Town's Water Management Act (WMA) permit. The WMA permitting process is dependent on the impact to the sub-basins from which water is withdrawn. The impact focuses on the "Biological Category" and the "Groundwater Withdrawal Category" of the sub-basin. The majority of Scituate's water supplies are in sub-basin 22132, which is a Category 5 (most impacted) for both categories. The sub-basin is also 94.3% August net groundwater depleted. One groundwater source is in sub-basin 22091, which is not assessed for Biological Category, Groundwater Withdrawal Category, or August net groundwater depletion.

The permit authorizes the Town to withdraw water from the South Coastal Basin at the rates described in Table 1-1. The maximum authorized annual average withdrawals are provided for each five-year period of the permit term. As mentioned above, the Humarock area of Scituate is served by the Town of Marshfield. Should Scituate connect Humarock to the distribution system, the maximum authorized withdrawal volumes would change as summarized in Table 1-1[1].

TABLE 1-1
Maximum Authorized Annual Average Withdrawal – Total Raw Water Withdrawal Volumes

Without Humarock: Permit Periods	**Daily Average (mgd)**	**Total Annual (MGY)**
9/16/2016 – 8/31/2020	1.75	638.75
9/1/2020 – 8/31/2025	1.77	646.05
9/1/2025 – 8/31/2030 – w/out Mitigation	1.80	657.00
Prior to making withdrawals greater than the baseline of 1.80 mgd, a mitigation plan must be incorporated into the permit and required mitigation activities must be implemented.		
9/1/2025 – 8/31/2030 – with Mitigation	1.85	675.25
With Humarock: Permit Periods	**Daily Average (mgd)**	**Total Annual (MGY)**
9/16/2016 – 8/31/2020	1.80	657.00
Prior to making withdrawals greater than the baseline of 1.80 mgd, a mitigation plan must be incorporate into the permit and required mitigation activities must be implemented.		
9/1/2020 – 8/31/2025	1.85	675.25
9/1/2025 – 8/31/2030 – w/out Mitigation	1.87	682.55
9/1/2025 – 8/31/2030 – with Mitigation	1.97	719.05

[1] Note that the Town of Marshfield would presumably experience a decrease in their WMA permit, thus this represents a transfer of capacity versus an increase.

The maximum authorized annual average withdrawal rate without mitigation is the previously approved baseline withdrawal rate of 1.80 mgd. The permit notes that prior to making withdrawals greater than the 1.80 mgd baseline, Scituate is required to develop a mitigation plan for review and approval by MADEP, incorporate the approved mitigation plan into the WMA permit by permit amendment, and implement required mitigation activities. Thereafter, withdrawals cannot exceed the lesser of either the maximum withdrawal volume authorized in the expiring permit or the water needs forecasts developed for Scituate by the Department of Conservation and Recreation (DCR), as summarized in Table 1-2 below (volumes authorized in the permit are highlighted in bold print).

TABLE 1-2
Maximum Authorized Average Annual Withdrawals (in **bold**), with Mitigation Plan

	Maximum Authorized in Scituate's Expiring Permit	DCR 2030 Water Needs Projection + 5% Buffer
Without Humarock on the Supply System	**1.85 mgd**	1.78 mgd + 0.09 mgd = 1.87 mgd
With Humarock on the Supply System	2.01 mgd	1.88 mgd + 0.09 mgd = **1.97 mgd**

The permit "authorizes Scituate to withdraw water in five-year increments (permit periods) up to the maximum authorized, 1.85 mgd without supply to Humarock or 1.97 mgd if Humarock is connected to the system. If Scituate's water demand increases more quickly than anticipated in the DCR water needs forecasts, Scituate may withdraw volumes authorized for later permit periods provided that all other conditions of this permit are met. If water needs are expected to exceed the maximum authorized in this permit, Scituate may apply for additional volume at any time by submitting a new WMA Permit application BRPWM03."

Authorized use is compared to actual use and projected use in Section 2.4. As discussed further in that section, the analysis presented in this plan does not indicate that withdrawals greater than the baseline will be required.

1.2.1.2 Maximum Authorized Withdrawals by Source

Maximum withdrawals from groundwater withdrawal points and Old Oaken Bucket (OOB) Pond are as summarized in Table 1-3 and are not be exceeded without advance approval from the department.

The Town's permit was issued under the safe yield methodology adopted by MADEP on November 7, 2014 and described in the regulations at 310 CMR 36.13. A brief discussion on safe yield methodologies is provided below.

- **Wellfields:** Max permitted withdrawals for the wells reflect the MADEP approved Zone II maximum daily pumping rate for each of Scituate's permitted wells based on prolonged pumping tests.

  As stated in 310 CMR 22.02, a Zone II is "that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation)."

- **Reservoirs:** The MADEP approved maximum daily withdrawal rate from Scituate's Reservoir System (described in Section 1.2.2) reflects the capacity of the intake structure at Old Oaken Bucket Pond (it is noted the plant's nominal design capacity is the same as the max daily withdrawal rate). This max daily withdrawal rate of 3.0 mgd cannot be exceeded without advance approval from MADEP.

  The permitted annual daily average withdrawal rate and total annual withdrawal volume reflect the reservoir firm yield approved by MADEP in 2004, which was determined to be 0.79 mgd under the drought of record (1960's drought) for Massachusetts with no downstream releases. The reservoir firm yield is the maximum average daily withdrawal that can be extracted from a reservoir without risk of failure during an extended drought period. A reservoir failure occurs when a reservoir is unable to provide sufficient water to meet demand.

  As noted in the WMA permit, Scituate's Water Conservation Plan (discussed further in Section 3.3.) and Drought Management Plan include shut-off of downstream releases when the reservoir reaches specified levels that are expected to provide sufficient protection for water supply purposes with a firm yield of 0.79 mgd. Impacts to firm yield are discussed further below (and in Section 3.3.) in light of anticipated minimum streamflow releases to restore aquatic habitat in First Herring Brook.

TABLE 1-3
Maximum Permitted Withdrawals

Maximum Daily Withdrawals Rates from the Authorized Groundwater Withdrawal Points:	Maximum Daily Rate
Well #10	0.20 mgd (138 gpm)
Well #11	0.12 mgd (81 gpm)
Well #17A	0.39 mgd (270 gpm)
Well #19	0.41 mgd (288 gpm)
Well #22	0.50 mgd (350 gpm)
Well #18B	0.22 mgd (153 gpm)

Maximum Withdrawals from Old Oaken Bucket Pond	Maximum Rate
Maximum Daily Withdrawal	3.0 mgd
Maximum Annual Average Daily Withdrawals	0.79 mgd
Maximum Annual Withdrawal	288.35 mg

1.2.1.3 Performance Standard for Residential Per Capita Use and Unaccounted for Water

Scituate's permit also includes a requirement for residential gallons per capita day water use (rgpcd) of 65 gallons or less (changed from 80 rgpcd) and an unaccounted-for water (UAW) target of 10% of total production (changed from 15%). The rgcpd and UAW requirements are applicable to all public water system permittees. Permittees that cannot comply with the targets within the time frame in their permit must meet Functional Equivalence requirements (outlined in the WMA permit attachments).

As discussed further in later sections of this plan, the Town is generally meeting the performance standard of residential use of 65 gpcd. However, unaccounted for water has been above the performance standard of 10% in previous years. This is in large part a reflection of the fact that much of Scituate's soils are sandy which makes leaks harder to detect as the water is immediately absorbed rather than coming to the surface. Recommendations provided in this plan for the distribution system are aimed at mitigating water losses.

1.2.1.4 Mitigation of Impacts for Withdrawals Exceeding the Baseline Withdrawal

Withdrawals above the baseline withdrawal rate of 1.80 mgd require mitigating impacts, which can be through direct mitigation that result in enhanced streamflow including surface water releases, stormwater recharge, and projects to remove infiltration/inflow from wastewater collection systems. Direct mitigation credits are based on per gallons of related direct mitigation (for example, per gallon credit for reservoir releases). The direct credit is based on a calculated rate of water returned within the basin and is calculated volumetrically.

Indirect mitigation activities that result in streamflow and habitat improvements may be required if additional mitigation is required after direction mitigation measures are implemented. One indirect credit is equivalent to 10,000 gpd, and include: Habitat Restoration Fund, Septic System Maintenance Fund, MS4 Implementation, Innovative Projects, Land Protection credits, Fertilizer Bylaw, Infiltration/Inflow Removal Program (up to 5 credits, separate from direct credits), dam removal, culvert replacements, installing and maintaining a fishway, Stormwater Bylaw, Stormwater Utility, other stream restoration for habitat improvement, wetlands bylaw, and stream buffer restoration.

As described in the WMA permit, Scituate's mitigation requirement is 24,500 gpd without supplying Humarock and 83,300 gpd if Humarock is added to the distribution system (these quantities assume that future withdrawals will be discharged to on-site septic systems at the same rate of 60% as current water withdrawals).

1.2.2 Supply Sources

The water system is supplied by a reservoir system consisting of three reservoirs (Tack Factory Pond, Main Reservoir, and Old Oaken Bucket Pond) and six groundwater wells (Wells 10, 11, 17A, 19, 22, and 18B). As mentioned, the Humarock area is served by Marshfield. Table 1-4 presents operating characteristics of each source.

Water from Wells 10 and 11 is combined and treated[2] prior to entering the distribution system, as is water from Wells 19 and 22. Well 18B is a replacement well for abandoned Well 18A and it is treated at the Well 18B corrosion control facility. Water from Well 17A was historically discharged to Old Oaken Bucket Pond and treated at the surface water treatment plant. Construction of a treatment plant for Well 17A is anticipated to be completed in 2021, at which point treated water from Well 17A will be discharged directly into the distribution system. Water from Old Oaken Bucket Pond is treated at the surface water treatment plant (OOB WTP).

TABLE 1-4
Sources of Supply

Source	Pump Rating (gpm)	Reservoir Firm Yield (gpm) (1)	Max Authorized Daily Withdrawal (gpm) (2)	Current Production Capacity (gpm) (3)	Notes
Well #10	160		138	90	
Well #11	104		81	50	
Well #19	350		288	213	
Well #22R	350		350	166	
Well #17A	360		270	0	
Well #18B	350		153	0	
Old Oaken Bucket Pond	--	549 (0.79 mgd)	2,083 (3.0 mgd)	1,528	OOB firm yield with no streamflow releases
Old Oaken Bucket Pond	--	389 (0.56 mgd)			Roughly estimated firm yield after streamflow releases

(1) Corresponds to the annual daily average withdrawal rate and total annual withdrawal volume in the Town's WMA permit; the firm yield was approved by MADEP on May 13, 2004 and is based on the drought of record (1960's) for Massachusetts with no downstream releases.
(2) The max authorized withdrawal rates reflect the MADEP approved Zone II maximum daily pumping rate for each well based on prolonged pumping tests. For Old Oaken Bucket Pond, the max authorized withdrawal rate reflects the capacity of the intake structure and the nominal capacity of the water treatment plant.
(3) The production for wells is dependent on seasonal conditions (e.g., drought conditions vs. wet weather). The well production rates shown above are considered to be reliable production rates observed by operators during recent drought conditions.

[2] The Environmental Protection Agency introduced the Lead and Copper rule in 1991 to address the public health threat posed by exposure to lead leaching out of household plumbing. In 2000, revisions to the lead and copper rule required public water systems to install the best available corrosion control treatment. In response, Scituate constructed corrosion control facilities at all of its wells. To minimize expenses where wells were in relatively close proximity to each other, joint facilities were constructed.

Due to high iron and manganese concentrations, wells 17A and 18B are not in service. Well 17A was pumped to Old Oaken Bucket Pond until recently, the well is currently offline while a new water treatment plant is under construction. Well 18B was fitted with greensand filters in 2019 and was operated during the summer of 2019, it is currently offline while a permanent residual disposal system is being designed.

The OOB treatment plant output is constrained by process limitations and available staff. The plant is normally operated during one shift per day. The plant can be run for two shifts per day for approximately two weeks due to solids overload and operation staffing.

1.2.2.1 Impact to Old Oaken Bucket Pond under Minimum Streamflow Releases

The firm yield for Old Oaken Bucket Pond is based on the drought of record (1960's) for Massachusetts with no downstream releases. Recent efforts to restore stream flow and aquatic habitat to First Herring Brook are based on an analysis of the reservoir using the Water Evaluation and Planning (WEAP) integrated water resources planning tool. The analysis examined different scenarios to evaluate the effect of management options on environmental and water system objectives. The reservoir model and subsequent reports examine the effect of increasing the full storage capacity of the Main Reservoir by 1.5 feet, as well as operational changes to meet both the Town's water needs and provide stream flow for aquatic habitat maintenance and seasonal fish ladder operation.

Although refinements to the model are still being made (for example, the model needs to be revised to reflect flow from Well 17A discharging directly to the distribution system rather than to Old Oaken Bucket Pond), the latest model update (September 2019) provides estimates of aquatic habitat release goals by bioperiod, as well as fish ladder flow goals for the fall and spring migratory periods.

Since Main Reservoir flows into Old Oaken Bucket Pond, the habitat release goals from Old Oaken Bucket Pond would reduce the firm yield available from the reservoir system for the treatment plant (although each reservoir has separate release requirements):

Bioperiod	Aquatic Habitat Release Goal from Old Oaken Bucket Pond (mgd)
Dec - Feb	1.84
Mar - May	2.13
Jun – Aug	0.23
Sep – Nov	0.28

The model does not provide an updated calculation of the reservoir firm yield subsequent to streamflow releases.

The WEAP report also provides fish ladder flow goals for the ladders at each reservoir. However, because fish migration occurs in the spring and fall, the estimate of the reservoir firm yield does not consider the fish ladder goals.

Reservoir Fish Ladder Goal (mgd)		Old Oaken Bucket Pond Fish Ladder Goal (mgd)	
Arp-May	Sep-Oct	Apr-May	Sep-Oct
1.65	0.39	1.65	0.29

Scituate's Water Conservation Plan and Drought Management Plan include shut-off of downstream releases when the reservoir reaches specified levels that are expected to provide sufficient protection for water supply purposes with a firm yield of 0.79 mgd. We recommend that the Town conduct a study to evaluate the impact to firm yield based on the operational management plan shown in Table 1-5 that includes drought triggers based on the streamflow releases to be implemented. This will help determine the extent to which releases should be limited during drought conditions.

1.2.2.2 Reservoir Trigger Levels and Storage

The Town monitors water levels in the reservoir in order to balance streamflow releases, reservoir storage, and outdoor watering bans, according to the reservoir storage model summarized in Table 1-5.

TABLE 1-5
Reservoir Trigger Levels – Normal Conditions

Reservoir Level (ft)	Reservoir Storage (MG)	Reservoir % Full	Estimated Supply Remaining (days) (1)	Operations Notes
40	155	100%	158	
39	134	87%	137	
38	114	73%	116	
37	95	61%	96	
36	76	49%	77	Outdoor watering (irrigation) ban automatically enacted
35	60	39%	61	
34	44	28%	45	Total water ban (no handheld)
33	31	20%	31	Curtail downstream flow releases (resume at WL = 34 ft)
32	18	11%	18	
31	10	6%	10	
30	2	1%	1	
29	1	1%	1	
28	0.5	0%	0	
27	0	0%	0	

(1) Based on average June – August pumping of 1.85 mgd, 53% of supply from surface water, and no inflow.

1.2.2.3 Alternatives for Increasing Surface Water Supply

Prior master plans conducted in the early 2000's evaluated different options for increasing the capacity of the reservoir system and the surface water supply treated at the OOB WTP, including dredging the reservoirs to expand storage or a new transmission main from Reservoir Dam to the plant.

A 2003 study conducted by CEI concluded that dredging 2 feet of sediment on average from Main Reservoir could potentially yield an additional 40 MG of storage, and that dredging 3 feet of sediment from Old Oaken Bucket Pond could potentially yield an additional 8 MG of storage. Dredging Main Reservoir would require taking the source off-line for the duration of dredging activities, which could last from 2 to 3 years according to the 2003 study. This project was not recommended because there would be inadequate supply for the Town during this time, unless available raw water storage was increased first by dredging Old Oaken Bucket Pond (dredging Tack Factory Pond was not recommended). Dredging Old Oaken Bucket Pond would also require taking the source off-line as well as temporary piping to supply the plant directly from Main Reservoir.

Overall, dredging Old Oaken Bucket Pond followed by dredging Main Reservoir would require bypass piping, modifications to the intake, and potentially 5 years to complete including time to obtain necessary permits. Construction costs estimated at the time ranged from (converted to 2020 dollars) $3.3M to $9.8M, depending on the value of the dredge material removed.

Based on prior experience, a dredging project would first require a preliminary design report to evaluate options for dredging, dewatering, and disposal of dredged material, a survey of the site consisting of hydrographic and geophysical surveys and sediment probing, sampling to characterize materials for chemical composition and dewaterability, and evaluation of construction feasibility. Possible dredging methods include mechanical dredging (using a backhoe or clam shell dredger to dig/gather sediment and transport it to a barge for transport), hydraulic dredging (boats suck up a mixture of sediment and water from the bottom surface and transfer the mixture through a pipeline to a desired location), and diver-assisted dredging (similar to hydraulic dredging but involves divers using a flexible suction hose connected to a pump on land or on a barge). Dredging methods vary in terms of costs, production rate (volume removed per hour), space and access requirements, and solids concentration of the material to be removed. An alternatives evaluation should first be conducted to determine the extent of material that can be dredged and additional storage that can be obtained, and to evaluate if the cost of dredging will be worth the benefit of the increased storage.

A new raw water transmission main from Main Reservoir directly to the OOB WTP would require approximately 3,800 linear feet of transmission main along the existing diversion channel or approximately 4,800 linear feet along Route 3A. Pumping could be required to maintain minimum scour velocities if there is not an adequate change in slope. Costs for a new main could range from $1M to $3M, depending on the need for pumping.

As discussed in detail in Section 2.3.4, this master plan focused on improvements to the OOB WTP as the most feasible alternative to increasing the Town's water supply, because the overall reliability of the existing facility is significantly compromised by the lack of redundancy and age and condition of key process components. Additionally, dredging and/or construction of a new raw water main would incur additional costs without eliminating the need to provide treatment or to upgrade the aging plant. Therefore, these alternatives are not recommended at this time, but could be evaluated further in the future to improve system redundancy and reliability.

1.2.2.4 Alternatives for using Reclaimed Wastewater

The use of reclaimed wastewater for aquifer recharge by discharging within a Zone II, Interim Wellhead Protection Area, or Private Water Supply Area is permitted under 314 CMR 20.00. Evaluation of this alternative is outside the scope of this Master Plan but is a possibility the Town may wish to evaluate further. However, per 314 CMR 20.00, discharge of treated wastewater to an existing surface water or wetland requires a Surface Water Discharge Permit issued by the Department pursuant to 314 CMR 3.00 and does not involve the reuse of reclaimed water in accordance with 314 CMR 20.00. MADEP reviews special permit conditions on a case-by-case basis.

1.2.2.5 Potential Future Supply Sources – Dolan Wellfield

The Dolan Wellfield is in an unconfined aquifer located in a bedrock valley. According to previous master plans prepared for the Town, the Town owns approximately 9 acres of land surrounding the Dolan Wellfield, which covers most of the required Zone 1 land. The Town has indicated the wellfield could likely reliably yield approximately 200 gpm based on prior pump tests, and that the wellfield could be permitted for a max withdrawal rate of 400 gpm.

A 1983 study that reviewed the site and the groundwater investigation study conducted in the early 1980s cautioned that there was potential for saltwater intrusion, high color, and iron.

As discussed elsewhere in this plan, withdrawals from the South Coastal Basin, in which the Dolan Wellfield is located, that exceed the authorized baseline of 1.80 mgd will require a permit amendment and mitigation plan.

1.2.3 Treatment

All of the system's sources of supply are treated, as summarized in Table 1-6. As noted, the treatment facility for Well 17A is anticipated to be completed in 2021. A disposal lagoon for Well 18B is anticipated to be constructed in 2021.

1.2.4 Pumping Facilities

All wells have submersible pumps, except Well 19 is equipped with a vertical turbine pump.

There are two booster pumping stations in the distribution system that boost pressure to two separate zones (Table 1-7). The Mann Lot Road Pump Station supplies the western corner of Town, and the Walnut Tree Hill Station supplies a small area around Woodworth Lane and Walnut Hill Drive.

1.2.5 Storage Facilities

Two storage tanks provide atmospheric storage to the system, as summarized in Table 1-8: the Pincin Hill Tank on Maple Street and the Creelman Tank on Mann Lot Road. Both storage tanks are standpipes. The overflow elevation of the Pincin Hill Tank is lower than the overflow of the Creelman tank. Therefore, for the purposes of this plan, it is assumed the overflow elevation of the Pincin Hill tank sets the hydraulic grade of the Main Service pressure zone.

1.2.6 Standby Power

Table 1-9 list the availability of standby power equipment at each of the system's facilities. Backup power is not available at Wells 10 and 11 or the treatment building. Backup power is available at the other facilities.

1.2.7 Distribution System

The distribution system consists of approximately 122 miles of water mains, as listed in Table 1-10 by material and diameter. The system is designed for fire protection and includes approximately 726 fire hydrants located throughout Town (based on the Town's GIS database). As shown in the hydraulic profile in Figure 1-1, the water system consists of the Main Service pressure zone and two high service pressure zones. The Main Service pressure zone is supplied by the groundwater wells and the surface water treatment plant. Two atmospheric storage tanks set the hydraulic gradeline elevation for the Main Service area and provide storage. The two High Service pressure zones are supplied from the Main Service zone by the system's booster pumping stations.

TABLE 1-6
Summary of Treatment

Location	Treatment Objective	Treatment Process	Chemical Addition
OOB WTP	Corrosion Control	pH Adjustment	Potassium Hydroxide
	Disinfection	Chemical Injection	Chlorine Dioxide
	Organic Removal	Powdered Activated Carbon	
	Dental Health	Fluoridation	Sodium Fluoride
	Particulate Removal	Rapid Mix	Aluminum Sulfate
		Coagulation	
		Flocculation	
		Rapid Sand Filtration	
		Sedimentation	
	Taste and Odor Control	Algae Control	Copper Sulfate
Wells 10 / 11	Corrosion Control	pH Adjustment	Potassium Hydroxide
	Disinfection	4-log treatment of viruses	Sodium Hypochlorite
	Other	Fluoridation	Sodium Fluoride
Wells 19 / 22	Corrosion Control	pH Adjustment	Potassium Hydroxide
	Disinfection	Chemical Injection	Sodium Hypochlorite
	Other	Fluoridation	Sodium Fluoride
	Organics Removal	Diffused Aeration	(Well 19 Only)
Well 18B	Corrosion Control	pH Adjustment	Potassium Hydroxide
	Disinfection	Chemical Injection	Sodium Hypochlorite
	Other	Fluoridation	Sodium Fluoride
	Fe/Mn Removal	Greensand Filtration	Sodium Hypochlorite pre-oxidation
Well 17A	Corrosion Control	pH Adjustment	Potassium Hydroxide
	Disinfection	Chemical Injection	Sodium Hypochlorite
	Other	Fluoridation	Sodium Fluoride
	Fe/Mn Removal	Greensand Filtration	Sodium Hypochlorite and Potassium Permanganate pre-oxidation

TABLE 1-7

List of Booster Pumping Facilities

Pump	Motive Power	Purpose	Capacity (gpm)	Motor Size (hp)
		Mann Lot Road Pump Station		
Pump #1	Electric	Boost Pressure	1,050	25
Pump #2	Electric	Boost Pressure	1,050	25
		Walnut Tree Hill Pump Station		
Pump #1	Electric	Boost Pressure	200	3
Pump #2	Electric	Boost Pressure	200	3
Pump #3	Electric	Boost Pressure / Increase Flow	950	75

TABLE 1-8

List of Storage Facilities

Storage Tank	Location	Type	Volume (MG) (1)	Diameter (ft)	Base Elevation (ft)	Overflow Elevation (ft)	Hydraulic Grade Elevation (ft) (2)
Pincin Hill	Maple Street	Standpipe	1.268	54	126	201	200
Creelman	Mann Lot Road	Standpipe	1.013	50	131	203	200

(1) Measured to hydraulic grade elevation.
(2) Based on Pincin Hill overflow elevation minus 1-ft freeboard/safety factor.
(3) Both tanks supply the low service area.

TABLE 1-9

List of Standby Power Facilities

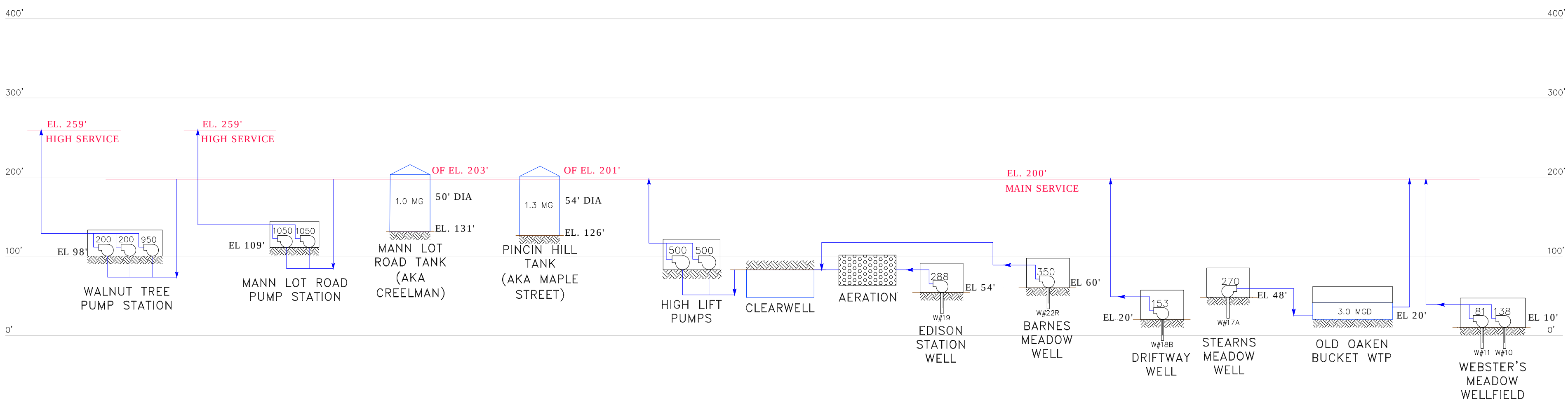
Facility	Standby Power
Well 18B Treatment Building	Yes
Well 10/11 Treatment Building	No
Well 19/22 Treatment Building	Yes
Well 17A	Yes
Old Oaken Bucket WTP	Yes
Walnut Tree Booster Pump Station	Yes
Mann Lot Road Booster Pump Station	Yes

TABLE 1-10

Length of Distribution Mains (feet)

	AC	CI	CU	DI	GAL	PVC	UNK	Total
1"			511			489	975	**1,974**
1-1/4"					414	336		**751**
2"	664	676	308		7,335	6,642	3,254	**18,880**
4"	1,263	339					121	**1,724**
6"	139,798	28,471	506	197	507	11,651	3,795	**184,926**
8"	91,877	25,624		74,231	792	60,854	4,119	**257,497**
10"	31,643	21,221		2,103		2,639	45	**57,651**
12"	30,889	8,647		62,425		10,907	1,136	**114,003**
14"	2,654							**2,654**
16"	178							**178**
UNK		15	1,530				96	**1,641**
Total (ft)	**298,966**	**84,994**	**2,855**	**138,957**	**9,049**	**93,518**	**13,541**	**641,878**
Total (miles)	**56.6**	**16.1**	**0.5**	**26.3**	**1.7**	**17.7**	**2.6**	**121.6**

AC – Asbestos Cement; CI – Cast Iron; CU – Copper; DI – Ductile Iron; GAL – Galvanized; PVC – Polyvinyl Chloride; UNK – Unknown



NOTES:

1. VERTICAL DATUM NGVD88.
2. PUMP CAPACITIES ARE IN GALLONS PER MINUTE (GPM)
3. WELL PUMP AND OOB WTP CAPACITIES EQUAL TO MAX DAILY AUTHORIZED WITHDRAWAL.RATES.
4. HGL BASED ON FACILITY ELEVATIONS AND REPORTED DISCHARGE PRESSURES. VERIFY PRIOR TO USE.
5. WATER WITHDRAWN FROM WELL 17A DISCHARGES INTO OLD OAKEN BUCKET POND.

SCITUATE SYSTEM
2019 WATER MASTER PLAN

FIGURE 1-1
STATIC HYDRAULIC PROFILE

Scituate Water Division

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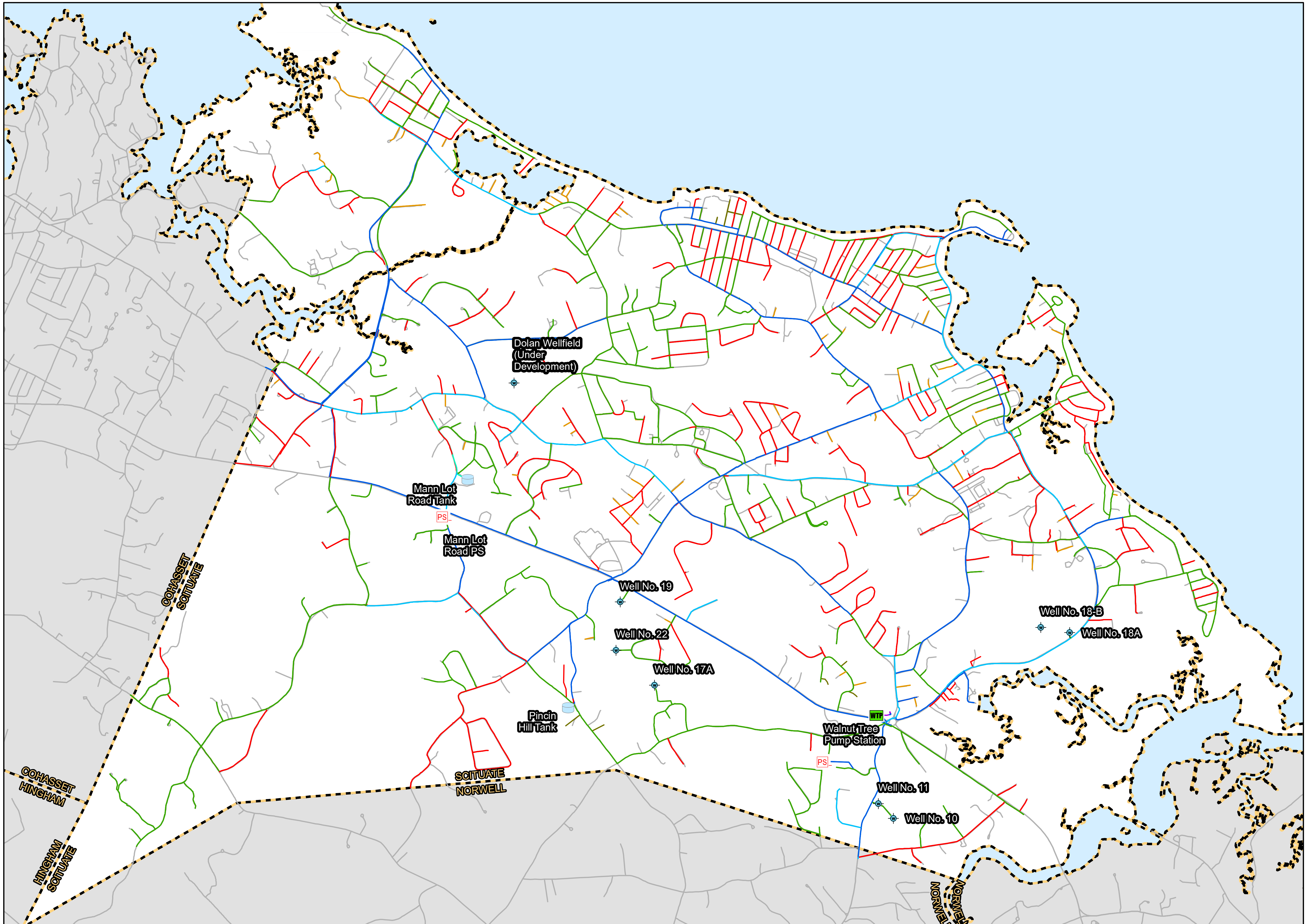

FIGURE 1-2
Scituate Water Distribution System

Legend

- WTP Water Treatment Plant
- Water Storage Tank
- Well
- PS Pump Station
- Street
- Town Boundary

Water Main Diameter

≤4 inch	12 inch
6 inch	14 inch
8 inch	16 inch
10 inch	Unknown

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

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Scituate, Massachusetts
October 2020

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SECTION 2

Section 2
Baseline Assessment

2.1 Design Basis

The purpose of this task is to identify and document the minimum levels of service for the water system. These minimum levels of service will be used to identify and prioritize capital improvements going forward. Minimum levels of service typically include regulatory, safety, environmental, and economic considerations. A public meeting was held on December 18, 2019 to seek input from stakeholders. The following items were identified at the meeting as stakeholder concerns:

- Determine how much supply capacity is available. Is the capacity sufficient to meet future demands?
- Consider streamflow releases in determining supply capacity.
- Ensure that the water quality standards used for current and future treatment plants are adequate to prevent future discolored water events.
- What is the status of colored water issues? Is there a metric for assessing the success of cleaning?

We developed the following minimum levels of service based on regulations, standard industry practice, and stakeholder input.

1. Provide appropriate available fire flow throughout the system with the goal of provide ISO needed fire flow at all ISO test locations
2. Provide adequate pressure – all customers between 35 and 100 psi
3. Minimize disruptions in service with a goal of no disruptions
4. Meet all water quality regulatory requirements
    a. Safe Drinking Water Act
    b. Lead & Copper Rule
    c. Manganese action level (0.3 mg/L)
5. Additional water quality objectives
    a. Maintain treated water manganese concentration <0.015 mg/L
    b. Minimize colored water events with the goal of having no colored water complaints
6. Supply
    a. Provide adequate supply to meet current and future demands

b. Optimize system operation to provide for streamflow releases

7. Safety

   a. All water system facilities should meet industry guidelines for operator safety

   b. All water system facilities should meet building/electrical/fire code requirements for operator and public safety

2.2 Hydraulic Evaluation

2.2.1 Model Construction

A hydraulic model of the water distribution system was constructed in InfoWater 10.4.2 (Innovyze, Monrovia, CA) using existing water system GIS data. Water system data imported into the model included pipes, tanks, pump stations, wells, and treatment plants. The GIS database included information on pipe diameter, material, and age that was imported into the model database.

Nodes were added at the ends of pipes, breaks between pipe segments, and tees, and at hydrant lateral connections. The creation of nodes at hydrant lateral connections will allow for greater flexibility of the model for future development of a Unidirectional Flushing (UDF) program, if desired.

The hydraulic model consists of 1,745 nodes and 1,924 pipes.

Elevation data was applied to all model nodes from 2015 LiDAR data available from MassGIS. All model elevations are reported in NGVD 1988.

Additional system information was obtained from the 2001 Water System Master Plan prepared by Weston & Sampson Engineers, Inc. This information includes water storage tank elevations and diameters, and the limits of the high service area boundary served by the Mann Lot Booster Pump Station.

The Scituate water distribution system layout is shown in Figure 1-2 at the end of Section 1.

2.2.2 System Operation

The Scituate water system is composed of two atmospheric storage tanks, a booster pump station, six groundwater wells, a surface water reservoir, and a surface water treatment plant (WTP). The Town currently has three active points of entry where water enters the distribution system. Production at each point of entry was determined using average monthly production records from 2010 through 2016, and daily production for July 2018. Table 2-1 summarizes Scituate's water distribution system facilities.

TABLE 2-1

Distribution System Facilities Summary

Storage	Volume	Elevation (NGVD 88)	Diameter
Creelman Tank	1.0 MG	Base: 131 ft Overflow: 203 ft	50 ft
Pincin Hill Tank	1.3 MG	Base: 126 ft Overflow: 201 ft	54 ft

Pump Station	No. Pumps	Rated Capacity	VFD Control
Mann Lot Road Booster Station	2	1,050 gpm @ 62 ft TDH	70 psi discharge
Walnut Tree Hill Booster Station (hydropneumatic)	3	2 – 200 gpm 1 – 950 gpm	Discharge pressure control

Source of Supply	Average Winter Production (mgd)	Average Summer Production (mgd)	Max Day Demand Production (mgd)
Old Oaken Bucket WTP (incl. Well 17A)	0.24	1.06	1.45
Wells 10 & 11 (combined point of entry)	0.25	0.21	0.27
Wells 19 & 22 (combined point of entry)	0.76	0.66	0.64
Well 18	Inactive due to high Mn		

The Scituate water system is controlled manually, with wells and the WTP operating 24 hours per day. Production is simulated as fixed negative demands at the various points of entry.

2.2.3 Demand Allocation

System demand was allocated using quarterly customer billing data for fiscal year 2017. Quarterly usage at each water meter was georeferenced by joining property parcel ID numbers associated with each meter to a parcel data layer. Customer accounts that did not contain a Parcel ID or did not find a Parcel ID match in the data join were georeferenced using the street address associated with the water meter.

The spatially referenced meter data were joined to model nodes using a closest match criterion. Water usage in Scituate varies seasonally, with some properties occupied only during the summer months. To account for seasonal residents, average winter demand (January – March) and average summer demand (June – August) scenarios were both programmed into the model. The base demands from these billing periods were scaled based on total system production to reflect the unmetered water demand, such as from leaks. Table 2-2 summarizes the total system demand during Average Winter Day, Average Summer Day, and Maximum Demand Day (MDD). The MDD demand scenario used global scaling of the Average Summer Day demand allocation to match total system production during the documented 2017 MDD.

TABLE 2-2

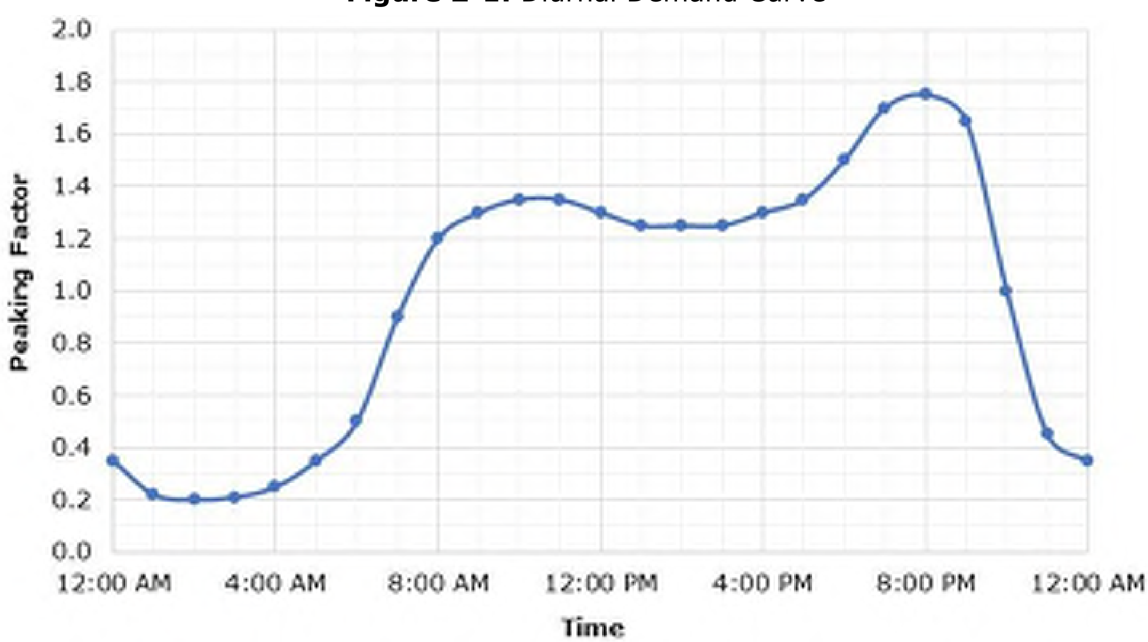
Summary of Model Demand Scenarios

Scenario	Total System Demand (mgd)
Average Winter Day	1.24
Average Summer Day	1.93
Maximum Demand Day	2.36

2.2.4 Extended Period Simulation

Extended period simulation (EPS) scenarios were developed to analyze source contribution and variations in flow over the course of a day. The diurnal demand pattern represents the system-wide variation in demand experienced over the course of the day. The diurnal demand pattern used is shown in Figure 2-1.

Figure 2-1: Diurnal Demand Curve



source: AWWA Manual M32 Computer Modeling of Water Distribution Systems

2.2.5 Model Calibration

Hydrant flow testing could not be performed during development of the model due to supply capacity limitations. In lieu of hydrant flow testing records, pipe friction coefficients were determined based on pipe characteristics including age, material, diameter, and relative condition based on correspondence with water system personnel.

To aid calibration efforts, pressure loggers were deployed at five hydrants in Scituate from 9/17/2018 through 9/25/2018 (Figure 2-2). The pressures recorded at these locations were used to check that the model captures daily patterns and is reasonably well calibrated.

Friction headlosses in heavily tuberculated pipes are caused by a combination of roughness of the pipe wall and a decrease in the interior diameter of the pipe due to accumulated corrosion deposits. The Scituate model was first calibrated assuming nominal interior diameters of all pipes. Then unlined cast iron pipes were corrected by assigning a minimum C-factor and then reducing the interior diameter to result in the same headloss. This procedure allows for more accurate predictions of flow velocity and retention time in heavily tuberculated pipes. Table 2-3 shows the pipe C-factors applied to pipe characteristic groupings.

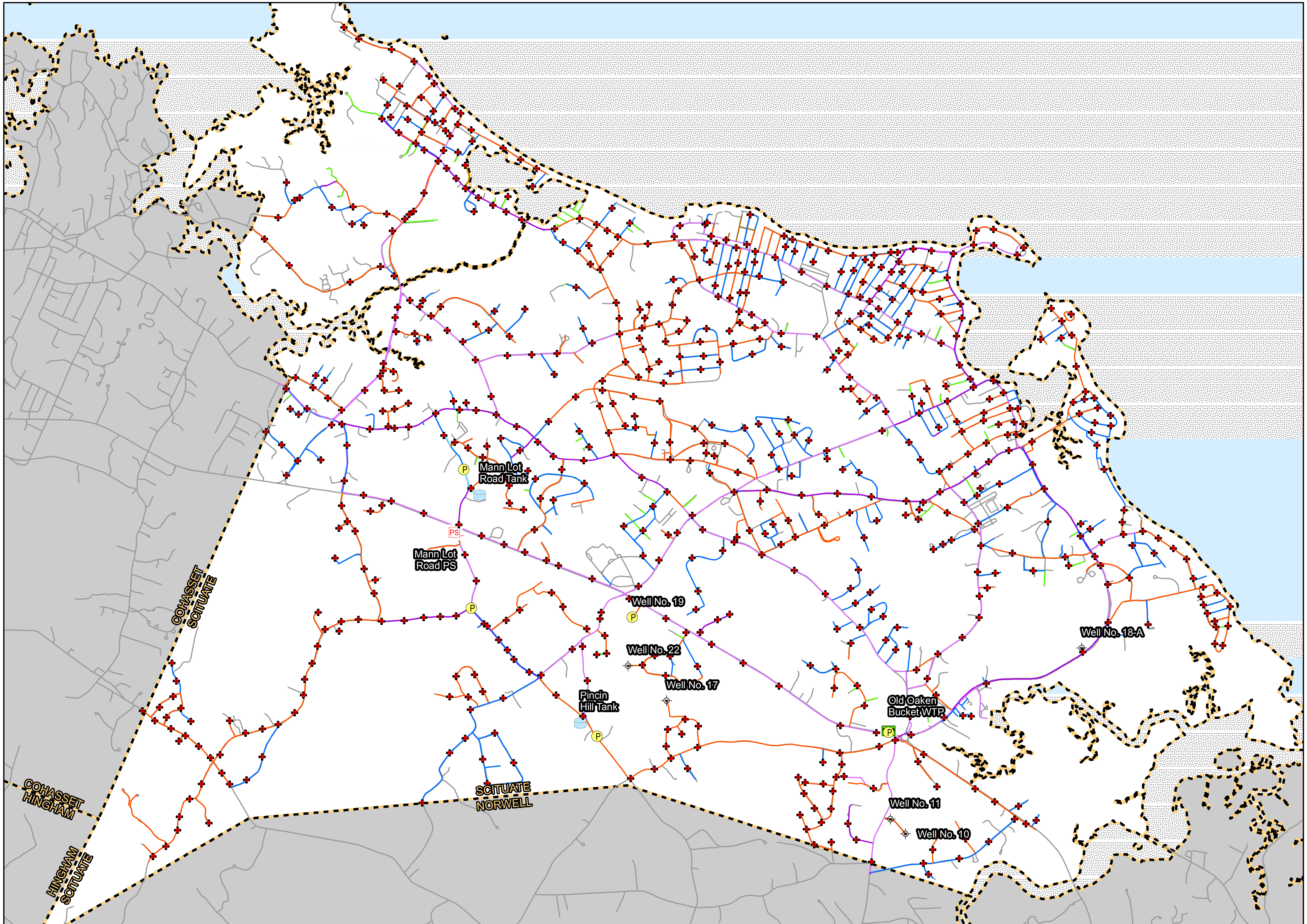


FIGURE 2-2 Pressure Logger Locations

Legend

- Pressure Logger
- Hydrant
- Water Treatment Plant
- Water Storage Tank
- Well
- Pump Station

Water Main Diameter, in

- ≤ 4
- 6
- 8
- 10
- 12
- 14
- 16
- Unknown
- Street
- Town Boundary

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

Scituate Water Distribution System
Scituate, Massachusetts
January 2020

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TABLE 2-3
C-factors assigned based on pipe characteristics

Material	Year Installed	Nominal Diameter (in)	Initial C-Factor	Adjusted Diameter (in)	Adjusted C-factor
Cast Iron (Cleaned & Lined)	-	-	130	-	-
Asbestos Cement	-	-	120	-	-
Plastic/PVC	-	-	140	-	-
Cast Iron	< 1918 & Unknown	4	30	2.75	80.00
		6		4.13	
		8		5.51	
		10		6.89	
		12	50	9.56	90.90
	1918 to 1937	4	35	2.88	82.73
		6		4.33	
		8		5.77	
		10		7.21	
		12	55	9.80	93.63
	1938 to 1957	6	40	4.50	85.45
		8		6.00	
		10		7.49	
	1958 to 1978	8	45	6.20	88.18
		12	65	10.22	99.09
	> 1978	-	85	-	-
Ductile Iron	< 2000 & Unknown	-	110	-	-
Ductile Iron	> 2000	-	130	-	-
Galvanized Steel	-	-	45	-	-
Unknown	-	-	55	-	-
Copper	-	-	80	-	-

2.2.6 Results

Extended Period Simulations (EPSs) were prepared for MDD and ADD conditions to assess flows and pressures throughout the system identify area with high or low pressure and excessive flow velocities. Pressure and typical flow rates are presented in Figures 2-3 and 2-4 for ADD and MDD conditions, respectively. As indicated in the figures, there are a few areas in the system where the pressure can drop below 35 psi, but pressures are generally within the desired range of 35 to 100 psi throughout the system. No excessive flow velocities were predicted.

System-wide available fire flow (AFF) analysis was conducted under MDD conditions. AFF is defined as the maximum flow that can be extracted at a given hydrant while maintaining >20 psi pressure at all points in the system. The Insurance Service Office (ISO) has determined "needed fire flow" (NFF) values for 14 locations throughout the system. Table 2-4 shows ISO Test locations, NFF, and model predicted AFF.

TABLE 2-4

Comparison of ISO Needed Fire Flow and Modeled Available Fire Flow

ISO Site No.	Location	GIS Hydrant ID	ISO Needed Fire Flow (gpm)	Modeled Available Fire Flow (gpm)
1	Country Road @ Gannett Road	HYD-0438	5,500/2,200/2,250	2,450
2	Route 3A @ 1st Parish Road	HYD-0537	5,000/6,000/1,250	2,450
3	1st Parish Road @ Middle School	HYD-0538	4,500/1,500/3,000	2,250
4	Front Street @ Otis Place	HYD-0218	4,500/2,300/3,000	1,850
5	Driftway @ Old Driftway	HYD-0561	2,000	2,000
6	Glades @ Bailey's Causeway	HYD-0007	3,000	1,400
7	(Hatherly @ Marion) Pershing @ Short	HYD-0080	1,750	1,850
8	Hewes Road @ Kent Street	HYD-0419	2,000	1,850
9	Summer @ Clapp Road	HYD-0606	500	200
10	Vernon & First Parish	HYD-0682	500	550
11	Old Oaken @ Marilyn	HYD-0658	500	900
12	Vinal Avenue @ School	HYD-0300	2,500	1,500
13	Hatherly Road @ Country Club	HYD-0012	2,250	1,400
14	Hatherly Road @ Egypt	HYD-0050	750	1,900

1. ISO Locations and Needed Fire Flows were determined from the 1994 ISO Survey for Scituate.

2. Modeled available fire flows shown were determined using a hydraulic model of the Scituate water distribution system. The model assumes 2019 maximum day demand conditions.

3. Locations where more than one needed fire flow is shown reflect the ISO-determined fire protection needs at various structures. Needed fire flows in excess of 3,500 gpm are expected to be provided by building-specific fire protection systems.

4. Boxed results ISO locations where available fire flows are <90% of needed fire flows

As indicated in the table, 5 of the 14 ISO locations have model-predicted flows less than 90% of the ISO NFF. Water main improvements aimed at improving the AFF at deficient ISO test locations receive increased priority. For locations other than the ISO test locations, NFF is determined based on materials of construction, use, density, and other considerations. For one-and-two-family dwellings not exceeding 2 stories in height, the NFF is determined based on density as indicated in Table 2-5.

TABLE 2-5

ISO NFF for 1 and 2 family dwellings not exceeding 2 stories

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
More than 100	500
31-100	750
11-30	1,000
10 or less	1,500

Much of the Town fits into categories indicated in Table 2-5 with ISO NFF of 1,000 gpm or less. Figure 2-5 show model predicted AFF under MDD conditions. As indicated in the figure, there is an area in the high-pressure zone in the south west area of Town with AFF <500 gpm. Similarly to the ISO locations with deficient flow, water main improvements aimed at improving AFF in this area receive increased priority.

Much of the Town has AFF between 1,500 and 2,500 gpm that is comfortably above the recommended minimum flows for residential neighborhoods.

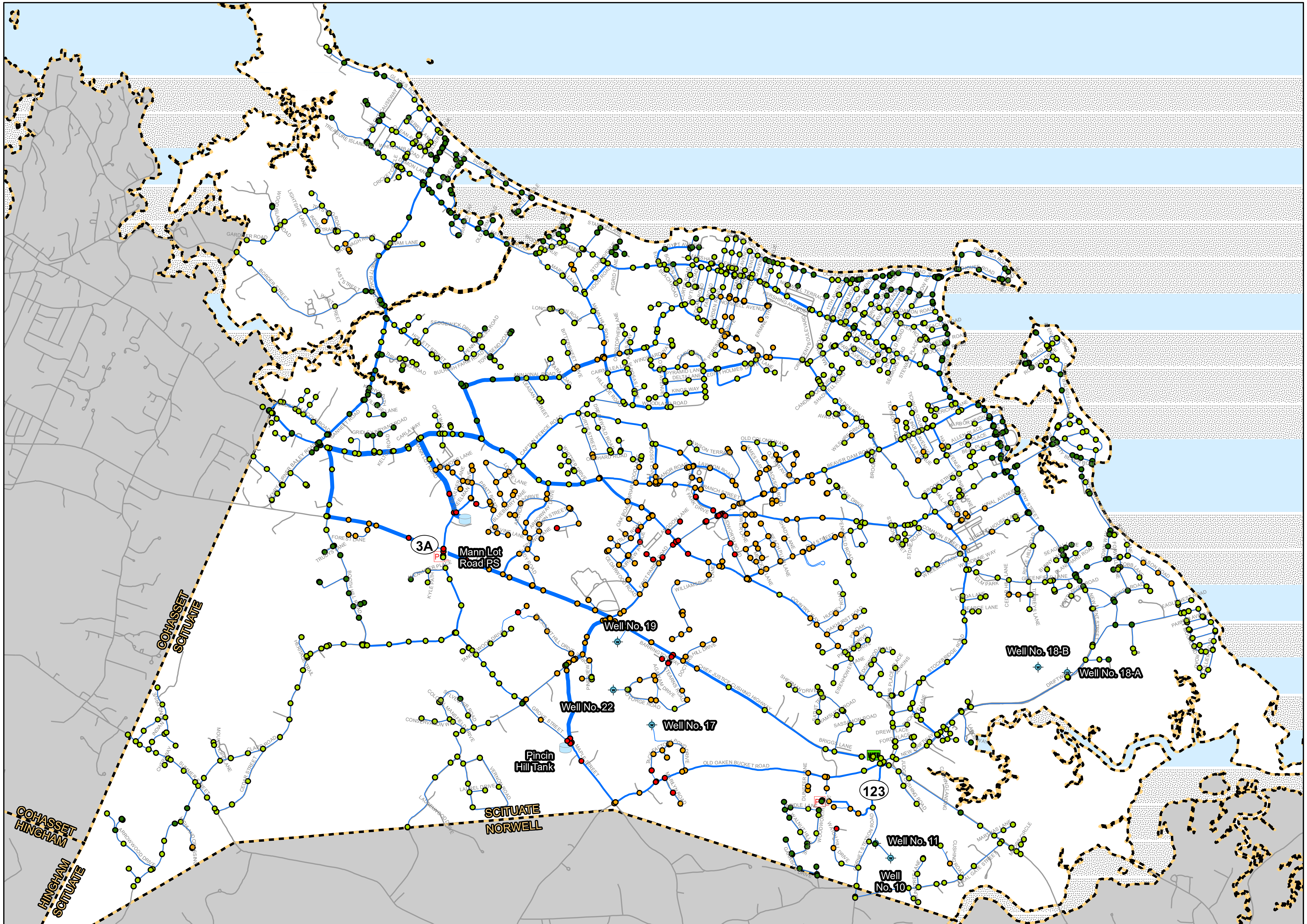

FIGURE 2-3
Average Day Demand System Hydraulics

Legend

- Water Treatment Plant
- Water Storage Tank
- Well
- Pump Station
- Street
- Town Boundary

Average Day Pressure

- ≤35 psi
- >35 psi and ≤55 psi
- >55 psi and ≤75 psi
- >75 psi

Average Day Flow Rate

- ≤30 gpm
- >30 gpm and ≤90 gpm
- >90 gpm and ≤200 gpm
- >200 gpm and ≤450 gpm
- >450 gpm

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

1. Pressure and flow modeled during 2019 average winter day demand conditions

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Scituate, Massachusetts
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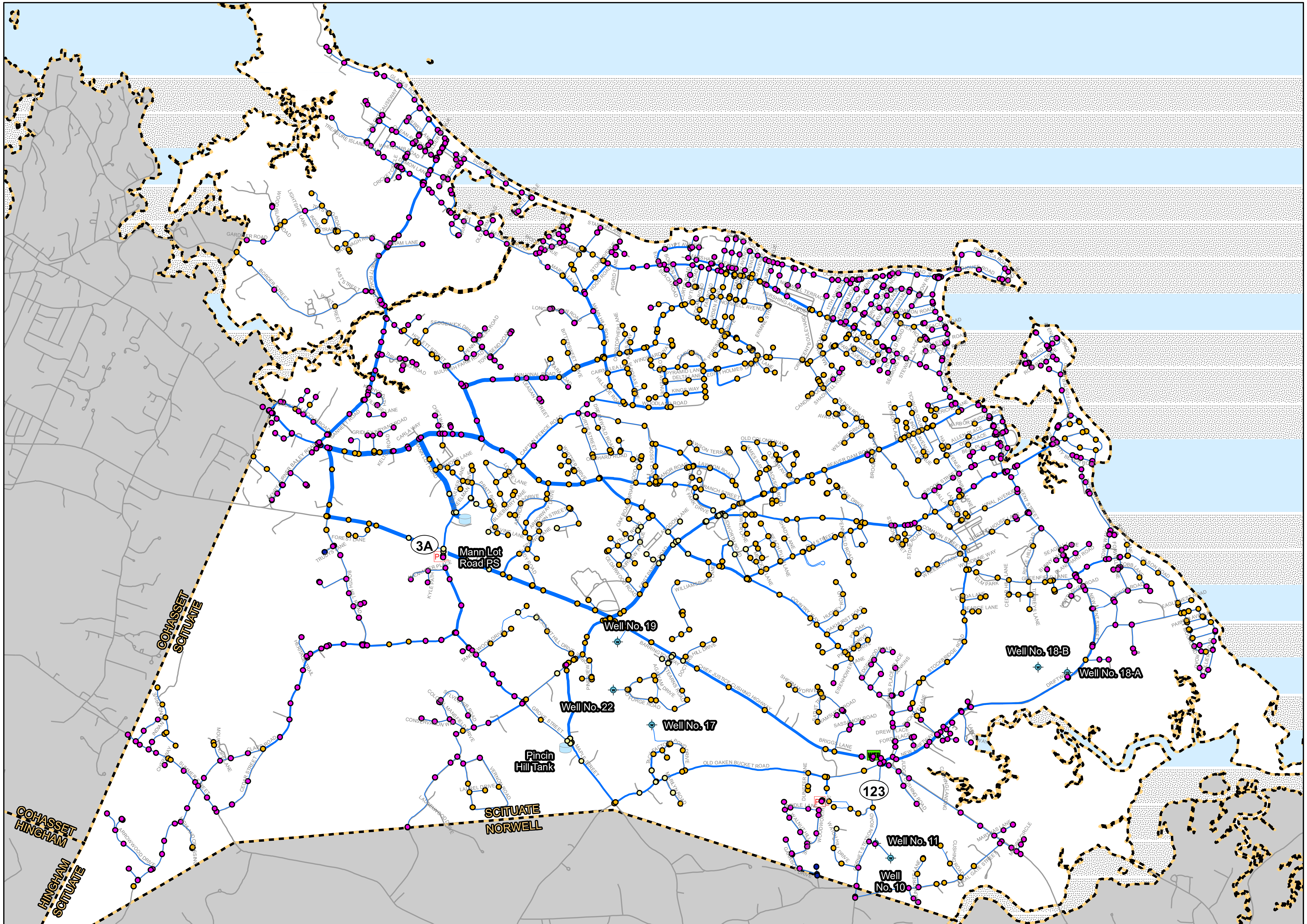
FIGURE 2-4
Max Day Demand System Hydraulics



Legend

- WTP Water Treatment Plant
- Water Storage Tank
- Well
- PS Pump Station
- Street
- Town Boundary

Max Day Pressure

- ≤35 psi
- >35 psi and ≤65 psi
- >65 psi and ≤85 psi
- >85 psi

Max Day Flow Rate

- ≤30 gpm
- >30 gpm and ≤90 gpm
- >90 gpm and ≤200 gpm
- >200 gpm and ≤450 gpm
- >450 gpm

LOCUS MAP

N

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

1. Pressure and flow modeled during 2019 maximum day demand conditions

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Scituate, Massachusetts

January 2020

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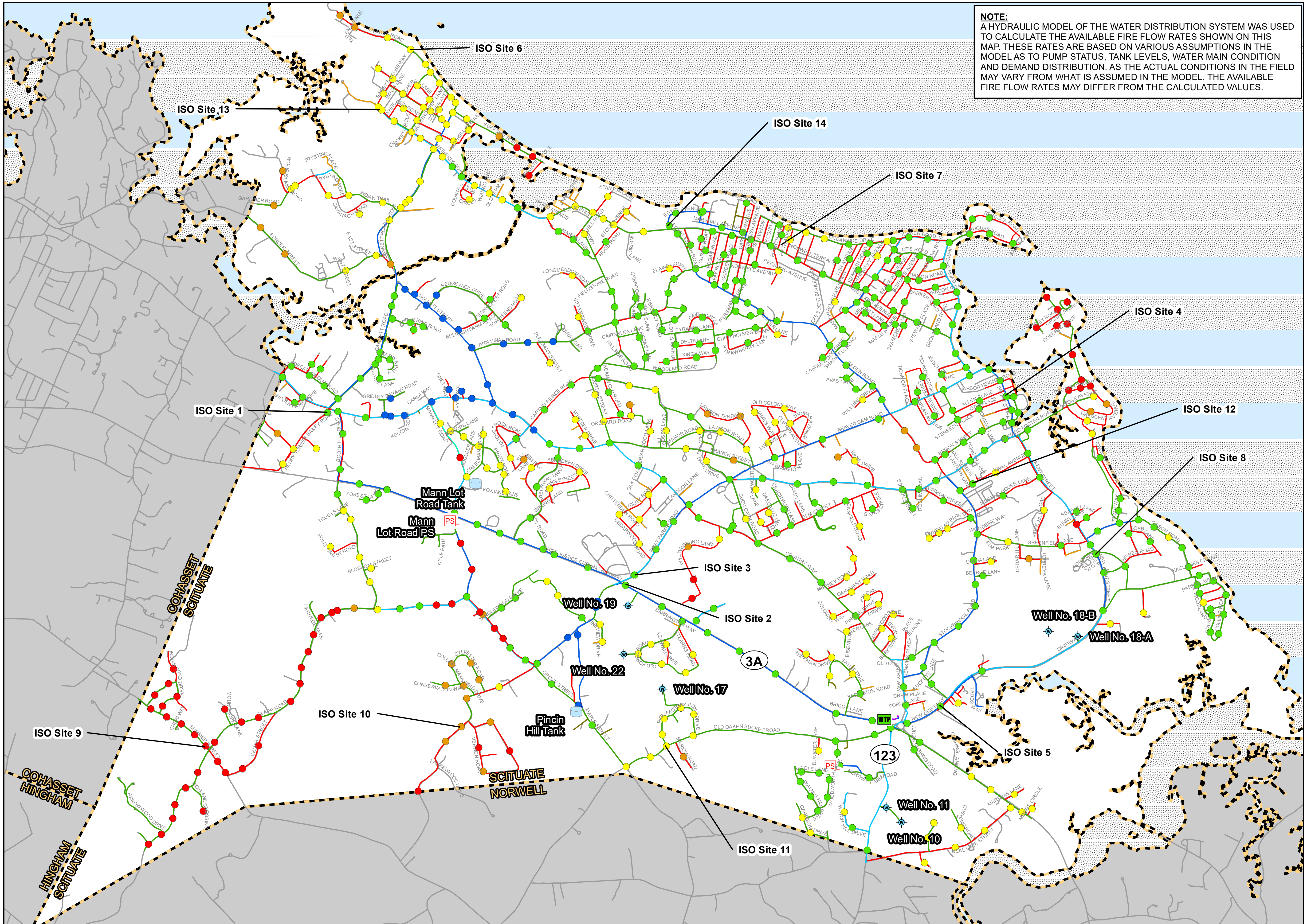

NOTE:
A HYDRAULIC MODEL OF THE WATER DISTRIBUTION SYSTEM WAS USED TO CALCULATE THE AVAILABLE FIRE FLOW RATES SHOWN ON THIS MAP. THESE RATES ARE BASED ON VARIOUS ASSUMPTIONS IN THE MODEL AS TO PUMP STATUS, TANK LEVELS, WATER MAIN CONDITION AND DEMAND DISTRIBUTION. AS THE ACTUAL CONDITIONS IN THE FIELD MAY VARY FROM WHAT IS ASSUMED IN THE MODEL, THE AVAILABLE FIRE FLOW RATES MAY DIFFER FROM THE CALCULATED VALUES.

FIGURE 2-5
Model Predicted Available Fire Flow

Legend

- WTP Water Treatment Plant
- Water Storage Tank
- Well
- PS Pump Station
- Street
- Town Boundary

Water Main Diameter

- ≤4 inch
- 6 inch
- 8 inch
- 10 inch
- 12 inch
- 14 inch
- 16 inch
- Unknown

Available Fire Flow

- ≤500 gpm
- >500 gpm and ≤750 gpm
- >750 gpm and ≤1,500 gpm
- >1,500 gpm and ≤2,500 gpm
- >2,500 gpm and ≤3,500 gpm
- >3,500 gpm

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

1. Available flow modeled during 2019 maximum day demand conditions

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Scituate, Massachusetts

January 2020

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2.3 Condition Evaluation

2.3.1 Distribution System

Treated drinking water is delivered to customers through a distribution system that consists of a 120-mile pipe network. The distribution system impacts fire protection, service continuity, pressure and water quality. Like most water systems in New England, Scituate's system consists of a variety of ages and materials as shown in Table 2-6.

TABLE 2-6

Length of water main by age and material (ft)

	Age (years)						
Material	**UNK**	**>120**	**90-120**	**60-90**	**30-60**	**<30**	**Total**
DI	1,300	0	0	0	2,000	135,600	138,900
AC	15,900	0	0	173,800	109,100	0	298,800
CI	16,600	19,600	6,800	19,700	2,300	0	65,000
PVC	31,700	1,100	600	400	38,000	20,900	92,700
GAL	2,600	1,600	2,000	1,700	1,300	0	9,200
CIC&L	6,700	12,500	0	800	0	0	20,000
Other	12,500	600	0	600	300	0	14,000
All	87,300	35,400	9,400	197,000	153,000	156,500	638,600

AC – Asbestos Cement; CI – Cast Iron; CU – Copper; DI – Ductile Iron; GAL – Galvanized; PVC – Polyvinyl Chloride; CIC&L – cast iron cleaned and lined; UNK – Unknown

2.3.1.1 Fire Protection

Several deficiencies in available fire flow were noted in Section 2.2. Most available fire flow deficiencies result from undersized and/or heavily tuberculated cast iron and galvanized steel water mains. The ongoing water main replacement program includes replacing all cast iron and galvanized steel mains, which is expected to remedy most available fire flow deficiencies as undersized and tuberculated pipes will be replaced.

2.3.1.2 Service Continuity

Water main breaks are the primary distribution system related cause of service disruptions. Water main breaks are caused by a number of factors or conditions; however, the likelihood of a failure depends on the underlying condition of the pipe which in turn depends on material and age. Each type of pipe construction material has an inherent service life. Table 2-7 shows the estimated remaining service life of water mains with remaining service life less than 30 years, and the estimated replacement cost

TABLE 2-7

Summary of Watermain by Remaining Service Life

Material	Estimated Service Life	Amount of pipe with indicated years of remaining service life (ft)			
		<0	0-10	10-20	20-30
Asbestos Cement	85	-	39,000	89,000	76,000
Cast Iron	115	14,000	5,000	6,000	16,000
Galvanized	100	2,000	1,000	1,000	1,000
Total to be replaced		14,000	44,000	95,000	92,000
Budget Replacement cost[1]		$3,850,000	$12,100,000	$26,125,000	$25,300,000

(1) Estimated as $275/LF

Watermain break data from 2016-2018 was reviewed to determine which materials experienced the most breaks or leaks. Asbestos Cement, cast iron and galvanized steel were found to be breakage-prone. The majority of the asbestos-cement (AC) pipe will reach the end of its service life within the next 20 years, and replacement of this pipe represents the most significant buried infrastructure need.

2.3.2 MADEP Sanitary Survey

The DEP conducted a sanitary survey of the system in 2019. Sanitary surveys are periodic inspections conducted by the DEP to identify any deficiencies with respect to regulatory requirements and to provide recommendations for improvements. The survey identified one violation and two deficiencies and provided two recommendations, which the Town has fully addressed:

- Violation regarding lack of chlorine analyzer at the Well 19/22 treatment plant.
- Deficiency regarding the requirement to register the drywells with the Department's Underground Injection Control program.
- Deficiency regarding the online chlorine analyzer at the OOB WTP and configuration of pH and chlorine alarms.
- Recommendation to paint the two distribution system storage tanks. Improvements for the storage tanks, including painting, are discussed in this plan.
- Recommendation to continue managerial, operational, and infrastructure improvements.

2.3.3 Communications and Control Systems

Modern water systems are controlled by a collection of sensors and software collectively referred to as a Supervisory Control and Data Acquisition System (SCADA). SCADA allows a water system to control sources based upon tank levels, assign hierarchy of operations in terms of which sources come on line first and set operating parameters by volume, rate of flow or run time. Alarms can be set for a variety of conditions from parameters that have strayed out of range to significant failure, fire or intrusion conditions.

The Town's water system is currently controlled through a rudimentary system consisting primarily of general alarms. The wells are run exclusively in "Hand" mode (the opposite of automatic) and there is no distinguishing between minor and major alarm conditions. As a result, it is difficult to optimize system operations, to allow wells to rest and during storms allow operators to focus on priority tasks rather than driving to a well station to determine if an alarm is minor or major in nature. Obtaining a modern SCADA is a key goal.

A SCADA Assessment Summary Report was prepared for the Town in 2013 to outline a potential design and costs for extending the SCADA system from the treatment plant to the remote sites, including six wells, two booster pump stations, and two storage tanks.

According to the report, the water treatment plant was the only facility at the time with a SCADA system consisting of a GE Proficy iFIX-HMI system with an unlimited tag use license, an Ethernet local area network for communications to plant controllers, and Bristol Babcock PLC units located in the plant. The report indicates that the Town was upgrading the plant system and that equipment was partially installed the day of the site visit in December 2012. Since a detailed investigation or analysis of the WTP SCADA system was not performed, the recommendations and associated costs identified in the study may not fully reflect all potential improvements for the treatment plant.

The study provided recommendations for:

- Replacing existing control panels with standardized SCADA control panels
- Wiring instruments and equipment to the new panels
- Installing cellular communications links to enable remote site monitoring and control
- Installing new online analyzers and other instrumentation (e.g. fluoride analyzer, ambient temperature sensors, pressure sensors, flood sensors, magnetic flowmeters)
- Installing intrusion monitoring sensors and security systems
- Integrating new control panels with the SCADA system at the Old Oaken Bucket WTP for monitoring, control, alarming, and data archiving; this would also allow for integration of related controls, for example tank level data to control the well pump operations
- New GE iFIX Proficy for the WTP, as well as a new computer with 22-inch monitor and large LED flat panel TV display

The ongoing Well 17A project includes a modern SCADA system that will control the equipment at the new treatment plant and also communicate with the OOBWTP. The cost estimates for replacing and rehabilitating the OOBWTP also include a modern SCADA system.

2.3.4 Old Oaken Bucket Water Treatment Plant

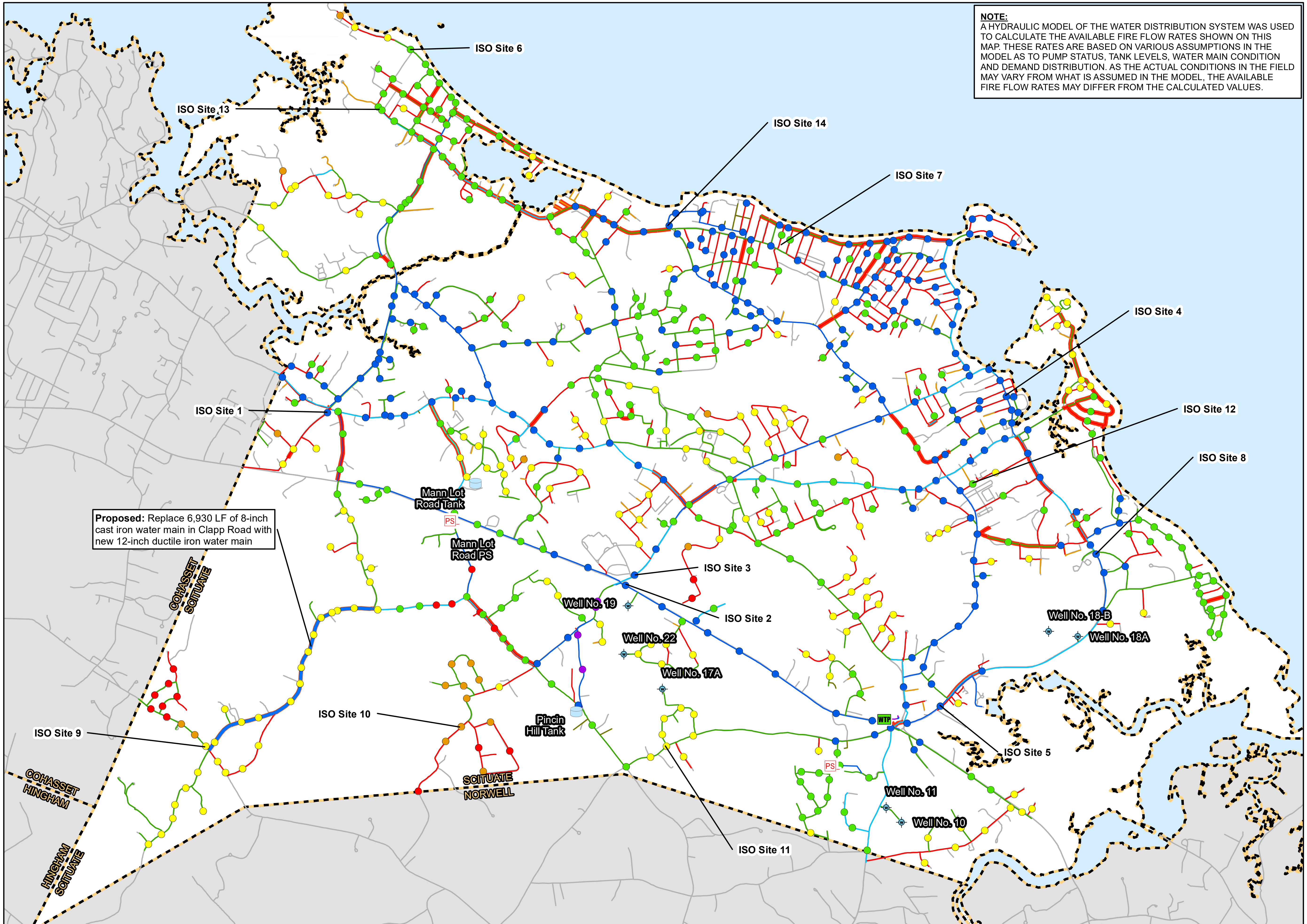
The OOBWTP was originally constructed in 1967 and was last upgraded in 1988 prior to the recent emergency repairs. The 1988 upgrade included an expansion of the sedimentation basins as well as a GAC filter for additional polishing of the finished water. The OOBWTP is rated for a maximum production rate of 3.0 mgd. The current plant process includes an influent low lift pumping station with three raw water pumps which provide water to the headworks of the plant. Prior to the headworks of the plant, the water is chemically pretreated with alum for flocculation of total suspended solids (TSS) as well as potassium hydroxide (KOH) for pH adjustment. The chemical injection station is in an underground vault outside of the main building and chemicals are injected into a 16-inch ductile iron raw water line to the headworks of the plant.

After chemical pretreatment, the water flows to the rapid mix station located outside of the main water treatment plant. There are two rapid mixers which can be isolated or operated in parallel. The water is then sent to one of two flocculation basins which provide slow mixing to generate large flocculated particles.

Suspended solids settling occurs in the two sedimentation basins which provide enough residence time for settling to take place. Chlorine dioxide injection also occurs at the sedimentation basins for disinfection. According to the Scituate Water Department, chlorine dioxide injection at the sedimentation basins provides adequate disinfectant contact time (CT) to meet Massachusetts Department of Environmental Protection's requirements under 310 CMR 22.00.

Each sedimentation basin is equipped with a "Trac Vac" residuals collection system manufactured by Ovivo. The Trac Vac system collects the residuals that settle to the bottom of the sedimentation basins. The collected residuals can either be sent to the existing residual lagoon or a set of three 15,000-gallon fiberglass underground residuals storage tanks located onsite. Residuals from tanks are then pumped to sewer via an ejector pump station located on the OOBWTP property to be treated at the Scituate WWTF. Residuals in the lagoon settle over time and should be removed and hauled off site periodically.

After the sedimentation process, the water is filtered using an Aqua Aerobics sand filtration system followed by a granular activated carbon (GAC) filter also manufactured by Aqua Aerobics. The current facility only has a single train of filters with no redundancy. Post caustic and chlorine dioxide disinfection chemical injection occur after the filters. Fluoridation also occurs after the GAC filter and then treated water flows to the clearwell from where it is pumped to the distribution system. A site plan of the OOBWTP is provided in Figure 2-6.



J:\S\S5001 Scituate DPW\018 Water Master Plan\Model\Figures\Scituate_2050MaxDayAFF_w_improvements.mxd

FIGURE 2-6
Projected 2050 Max Day Available Fire Flow with Improvements

Legend

- Water Treatment Plant
- Water Storage Tank
- Well
- Pump Station
- Proposed Clapp Rd Improvement
- Cast Iron to be Replaced
- Street
- Town Boundary

Water Main Diameter

- ≤4 inch
- 6 inch
- 8 inch
- 10 inch
- 12 inch
- 14 inch
- 16 inch
- Unknown

Available Fire Flow

- ≤500 gpm
- >500 gpm and ≤750 gpm
- >750 gpm and ≤1,500 gpm
- >1,500 gpm and ≤2,500 gpm
- >2,500 gpm and ≤3,500 gpm
- >3,500 gpm

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

1. Available flow modeled during projected 2050 maximum day demand conditions.
2. Results assume all remaining cast iron pipe is replaced.

Scituate Water Distribution System
Scituate, Massachusetts
October 2020

Tighe&Bond
Engineers | Environmental Specialists

S-5001

2.3.4.1 Evaluation Scope and Methodology

Tighe & Bond conducted several site visits and interviews with Sean Anderson, Water Superintendent and Eric Langlan, the Town's Chief Operator as part of the existing conditions evaluation of the OOBWTP. Members of Tighe & Bond's Process/Mechanical, Electrical and Structural disciplines were on site to evaluate the plant from a visual standpoint to determine the scope of upgrades required at the OOBWTP.

The evaluation was broken down into several categories for repair or upgrade considerations including:

- **Equipment Redundancy and Compliance** which include upgrades or replacement of existing process equipment units that are beyond their useful lives as well as additional process equipment required to provide fully redundant systems to allow for plant repairs without having to shut down the plant

- **Structural** which include repairs identified during the visual inspection of the OOBWTP.

- **Electrical** which includes replacement of electrical systems beyond their useful lives or repairs within the OOBWTP.

- **General Safety Concerns** which include items that were visually investigated and identified by plant personnel and Tighe & Bond which could result in hazardous scenarios. It should be noted that a site-specific OSHA review of the OOBWTP was not considered in this evaluation.

Table 2-8 provides a list of deficiencies that were observed during the site visits.

TABLE 2-8

Old Oaken Bucket Observed Deficiencies

Category - Plant Reliability and Compliance

Deficiency #	Deficiency Description	Comments	Recommended Improvement
1	Plant does not have redundant filtration system	If the sand or carbon filters become compromised, the plant must be shut down to conduct repairs.	Expand the facility to accommodate a back up prepackaged clarfication/filtration system independent of existing filters
2	Plant does not have redundant Sedimentation Basin	Plant is rated for a max day flow of 3.0 mgd. To achieve 3.0 mgd, both sedimentation basins must be fully operational. If a sedimentation is down for repairs, the plant cannot achieve its maximum capacity output.	Consider prepackaged clarification and filtration systems sized for 3 MGD for redudant sedimentation and filtration redundancy.
3	Backwash volumes are high and increase solids loading at the head of the plant. Backwash volume should be monitored with a permanent flow meter per the Backwash Rule.	Backwash rates can be measured up to 400-600 gpm. Full backwash volume is directed to the rapid mixing station at the headworks of the plant. This recycle rate is significantly higher than typical and compromises the filter system.	Install a new backwash tank and appropriately sized pumping system for proper recycle of backwash. Add new backwash flow meter.
4	Insufficient residual disposal capacity	Sewer Department has significantly limited the amount of sludge that can be sent to sewer on a daily basis. During summer months, sludge builds up in the sedimentation basins, which can lead to carryover into the downstream filtration system.	Plant should consider alternative means to handle sludge. Options include increasing storage, decanting and hauling offsite
5	Rapid Mixer #2 is not operable	Based on conversations with the plant staff the Rapid Mixer for Sedimentation Train #1 is no longer in service	Rapid Mixer #1 and #2 should be replaced due to age (1991 vintage)

TABLE 2-8

Old Oaken Bucket Observed Deficiencies

Category - Structural

Deficiency #	Deficiency Description	Comments	Recommended Improvement
6	Roof Failure: Low Lift Pump Station	Operators have experienced standing water inside the low lift pump station and have seen roof leaks. Water intrusion from the roof can lead to equipment failure and electrical safety issues	Replace roof with tar and gravel built up roof.
7	Roof Failure: Main Treatment Process Building	Operators have experienced roof leaks in several areas of the plant	Replace roof with tar and gravel built up roof.
8	Structural concrete repairs throughout plant basin structures - spalled concrete and cracks	Multiple areas identified within flocculation, sedimentation and carbon and sand filter basins	Selective repair/ restoration of Sedimentation Basin and Floc Basin Walls
9	Deteriorating concrete stair / loading dock repairs	Cementitious skim coat along the loading dock walls located on the east side of the building is in poor condition and delaminating from the concrete surfaces.	Repair concrete surfaces along the loading dock.
10	Visible delamination throughout glazed CMU walls	Visible delamination throughout CMU walls in Pump and Filtration rooms	Selective repair of delaminated CMU sections
11	Treated Water Channels covered with open grates	Treated water could be susceptible to contamination	Replace existing grates with FRP Grating with Hinged Covers
12	Visual deterioration of exterior doors and frames at WTP and Low Lift Pump Station	All the exterior metal doors have visible deterioration. Corrosion was observed along the bottom of doors and frames.	All exteriors door and frames should be replaced.
13	Exterior windows along south elevation at the main entrance at the pump room are in poor condition. Glass is not insulated and the sealant is deteriorating.	Current windows are plexiglass and in poor condition.	Replace plexiglass panes with new energy efficient windows and storefront.

TABLE 2-8
Old Oaken Bucket Observed Deficiencies

14	Joint sealant deterioration between masonry and concrete building columns as well as metal frames for doors and louvers - WTP and Low Lift Pump Station	Noticeable joint sealant deterioration throughout	Remove and replace elastomeric joint sealant
15	Aluminum Roof Hatch Replacement - Low Lift Pump Station	Existing roof hatches are original and in poor conditions - noticeable areas of leakage	Replace existising hatches
16	Backwash pump station experiences possible groundwater leakage	Groundwater leakage could be a point of contamination to treated water	Install water tight seal coat to the interior of the pump station, install fall protection for hatch
17	Hatch Failure - meter/chemical vault water instrusion	Operators have seen inches of water collected inside this meter/chemical vault	Replace hatch over existing access panel and replace link seals around pipe penetrations

Category - General Safety Concerns

Deficiency #	Deficiency Description	Comments	Recommended Improvement
18	Chlorine gas system safety concerns. Currently required to conduct an Risk Management Plan for storage and handling of chlorine gas on site. Threshold for storage is 1,500 lbs.	Scituate Fire Department and Water Department do not have the appropriate equipment to handle chlorine dioxide leaks. Fire Department has indicated that they would wait for State Task force to take action. Plant is also located next to a Little League Baseball Field.	Consider replacing chlorine gas with hydrochloric acid for chlorine dioxide generation
19	Fire Suppression and Smoke / Heat Detection Alarms	The plant currently has no fire protection, smoke, or heat detection alarms throughout the plant to meet building code	Install new fire protection and heat detection systems
20	Liquid Chemical Feed Location Hazard	Chemical feed lines are located overhead and may be susceptible to leakage on operations personnel	Relocate chemical feed lines to a more appropriate height
21	Loading Dock and Chemical Delivery System Hazard	Loading dock and exterior walkways do not have hand and guard rails, possible falls could occur. Limited space for maneuvering chemicals makes it difficult for operators.	Install guardrails along loading dock where appropriate

TABLE 2-8

Old Oaken Bucket Observed Deficiencies

Category - Electrical and SCADA

22	Existing fire alarm system and associated wiring reported to be unreliable	Fire alarm system panel and wiring are aged and require replacement, conduit is in good condition and can be reused	Replace fire alarm system panels, devices and wiring
23	Existing generator is near 30 years old and beyond useful life	New generator will require significantly more cooling air, therefore new larger intake/exhaust louvers will be required.	Replace generator with new indoor, gas fired generator. Install new larger louvers for generator ventilation and provide remote radiator to be mounted outside
24	Main Plant has insufficient/outdated instrumentation and controls (SCADA)	PLC panel is beyond useful life. New Instrumentation, controls and SCADA recommended to improve performance and reliability	Provide new main PLC panel, PLC/SCADA software, programming and new SCADA computer. Replace existing instrumentation throughout the facility and provide additional instrumentation to improve monitoriing
25	Low Lift Station has insufficient/outdated instrumentation and controls (SCADA)	PLC panel is aged and due for replacement. The Low Lift Station does not have SCADA capability currently	Provide new remove PLC panel in Low Lift Station
26	Electrical code violations - Low Lift Station	Low Lift Station currently has several electrical circuits that are sourced from equipment in the remote treatment building, which is a code violation.	Provide new single power circuit from the remote treatment building to bring the facility up to code; this includes new high voltage and low voltage panelboards.
27	Main Plant power distribution beyond useful life, reliability unknown	Main plant power distribution equipment including the main circuit breaker, main distribution switchboard, transfer switch and wiring is nearly 30 years old and beyond its useful life.	Replace existing power distribution equipment including the main circuit breaker, main distribution switch board, transfer switch and wiring.
28	Miscellaneous eletrical items at the Low Lift Station	Existing VFDs are not equipped with harmonic filtering and do not meet the IEEE 519 harmonics requirements. Air compressor control panel is aged.	Install new NEMA 12 VFDs with low harmonics filters along with new conduit and wire. Install new air compressor control panel.

TABLE 2-8
Old Oaken Bucket Observed Deficiencies

29	Miscellaneous electrical items at the Main Plant Rapid Mix Station	Electrical equipment and conduit for the rapid mix station is in visibly poor condition	Replace existing electrical equipment and conduit at the Rapid Mix Station including new signal and power conduits and wire, new electrical boxes, switches and strut
30	Miscellaneous electrical items at the Main Plant	Most electrical components in the building are at the end of their useful life. Some conduit can be reused.	Replace flocculator VFDs and wall mounted starters, replace 480V power wiring and 120V process-related power wiring. Replace filter control panel
31	Motor Control Centers (MCCs) are beyond their useful life	Existing MCCs have reached the end of their useful life.	Replace MCCs and reconnect ciricuits and electrical loads as required.
32	Utility service is beyond its useful life and its reliability is unknown	Utility service has reached the end of its useful life.	Replace the existing utility service with a new utility transformer, wiring and conduit
33	Panelboards are aged and have reached the end of their useful life	Panelboards have reached the end of their useful life.	Replace existing panelboards and reconnect circuits as required.
Category - Mechanical / HVAC Systems			
34	HVAC equipment is original from the 1991 plant expansion and functionality is suspect	HVAC system functionality is reportably unreliable	Replace existing louvers, duct work, AHU, gas heaters in its entirety and install dehumdification systems

2.3.4.2 Alternatives Analysis

The alternatives analyzed as part of this study are 1) rehabilitation and expansion of the existing facility and 2) construction of a new water treatment plant.

Alternative 1 - Rehabilitation and Expansion of the Existing OOBWTP

The overall reliability of the existing facility is significantly compromised by the lack of redundancy and age and condition of key process components. Planned shut downs for repairs can only be scheduled during low demand periods.

Redundancy Upgrades - The current plant is rated for a maximum daily flow of 3.0 mgd; however, the plant only has a single set of filters and does not have a redundant sedimentation basin to effectively obtain this maximum flow rate if a sedimentation basin or one of the filters requires maintenance. After the initial lift pumps, which discharge to the rapid mixers, the remainder of the plant flows via gravity, which makes it difficult to retrofit an additional set of filters without significant mechanical process changes to the existing plant operation. The addition of a third underground sedimentation basin will require significant space and will affect the normal operation of the plant during construction.

Improving redundancy at the existing plant by adding duplicate equipment is not feasible due to the size and layout of the facility. As an alternative, the addition of an independent prepackaged clarification and filtration system was evaluated. This system would be inserted into the process after the rapid mixers and initial pH adjustment and alum coagulation steps. In the proposed prepackaged system, the coagulated water would flow through distribution laterals which are located on the clarifier floor. After the clarification process, the pretreated water will enter the anthracite and sand filter. The system will consist of 3 treatment units, each sized for 1 mgd and would be housed in a new extension to the existing plant. Information on the prepackaged equipment assumed for this analysis is provided in Appendix D.

Residuals Processing/Disposal Upgrades - The current residuals handling process utilizes a vacuum system (Trac-Vac) which pulls sludge from the sedimentation basin floor and discharges either to the existing lagoon or three 15,000 gallon underground fiberglass tanks. The residuals are then discharged to the Town sewer system via an ejector pump system and treated at the Scituate WWTF.

Alum residuals can be difficult to treat at the WWTF; therefore, the WWTF maintains significant restrictions on the time and the flow of residuals sent to the WWTF. Additionally, the WWTF has limited capacity to receive additional flow from the plant during peak hours. Currently, the OOBWTP can discharge residuals from the hours of 8 PM to 4 AM and at a rate of 8 GPM. These restrictions allow for significant accumulation of residual solids within the sedimentation basins which can lead to carryover into the downstream processes which degrades finished water quality. Therefore, alternative means for residuals processing are recommended. The goals of the upgrades will be to limit the reliance on the Scituate WWTF to handle the alum residuals. It should be noted that is becoming increasingly more difficult to find locations that will accept low solids content alum residuals for treatment. It would be beneficial to provide a system that will be able to process residuals on a more regular basis with the ability to generate alum residuals with higher solids content. Several mechanical and non-mechanical technologies are available for residuals management. Some mechanical means includes belt presses and centrifuges. Non-mechanical means consist of lagoons and residuals drying beds.

Due to space constraints at the existing site, residual thickening via a gravity thickener and dewatering via centrifuge was evaluated for alum residuals processing. Residuals from both the existing Trac-Vac and new package treatment process would be pumped to a holding tank. Residuals would then be pumped to a residuals thickener where polymer will be added to aid in the dewatering process. From the thickener, residuals would be processed in a centrifuge. The dewatered residuals will be hauled offsite as a solid to a landfill and the liquid component will be discharged to sewer.

Disinfection Upgrades - The plant currently utilizes chlorine dioxide gas as to meet disinfection requirements. Chlorine dioxide is generated on site by reacting chlorine gas (150 lb cylinders) with sodium chlorite which is provided in 270-gallon totes. As discussed in Table 2-8, the use of chlorine gas can be a considerable safety concern, especially in the proximity of nearby neighborhoods and the Little League field adjacent to the OOBWTP.

To eliminate the inherent risks associated with chlorine gas, two options were evaluated: converting to sodium hypochlorite or using hydrochloric acid to generate chlorine dioxide.

<u>Conversion to Sodium Hypochlorite</u>

Pros:

- The Town currently uses sodium hypochlorite to treat all of its groundwater, staff is familiar with handling and dosing
- Less handling risk than chlorine gas and hydrochloric acid
- The Town purchases sodium hypochlorite through a chemical consortium which results in favorable pricing

Cons:

- May not be feasible because it could generate more disinfection byproducts (DPBs)
- May require significant storage space

<u>Converting to Hydrochloric Acid for Chlorine Dioxide Generation</u>

Pros:

- Powerful disinfectant that does not generate DBPs
- Reasonable cost for disinfection

Some of the limitations for using hydrochloric acid include:

- HCl is highly corrosive and difficult to handle

For the purposes of this study, the conversion to hydrochloric acid was considered as the basis for the plant upgrade as the use of sodium hypochlorite could lead to the generation of DBPs; however, this is subject to change during design.

Backwash Storage Upgrades - The plant currently recycles 100% of the filter backwash flow to the beginning of the treatment process (rapid mixers). The filter backwash flow should be metered per the EPA's Filter Backwash Recycling Rule. This amount of backwash can also significantly increase solids loading collected at the flocculation and sedimentation basins, which could result in carryover of solids to the filters over time. As part of the upgrade of the facility, an additional backwash equalization tank with recycle pumps that meter flow to the beginning of the plant so that reduced recycle rates (approximately 10%) should be considered.

For purposes of this analysis, a backwash equalization tank sized for 3 filter backwashes was assumed. The size of the backwash tank is subject to change during design.

Construction Sequence Considerations - Much of the work listed in Table 2-8 consists of adding process equipment to the existing facility to accommodate additional treatment capacity for redundancy and reliability. Most of this new process equipment would be housed in a new building extension. Additional tankage will also be required to allow for more backwash storage capacity to reduce excessive backwash recycle rates.

These additions to the existing plant can possibly be completed without taking the OOBWTP offline as the current process will not have to be disturbed and can remain operational during construction. The structural repairs within the existing concrete structures can occur while the new treatment train is online allowing for old treatment train to be taken offline and drained. The remaining structural, electrical, mechanical and general safety concerns identified can also be upgraded while the plant is online to avoid a complete shutdown of the plant.

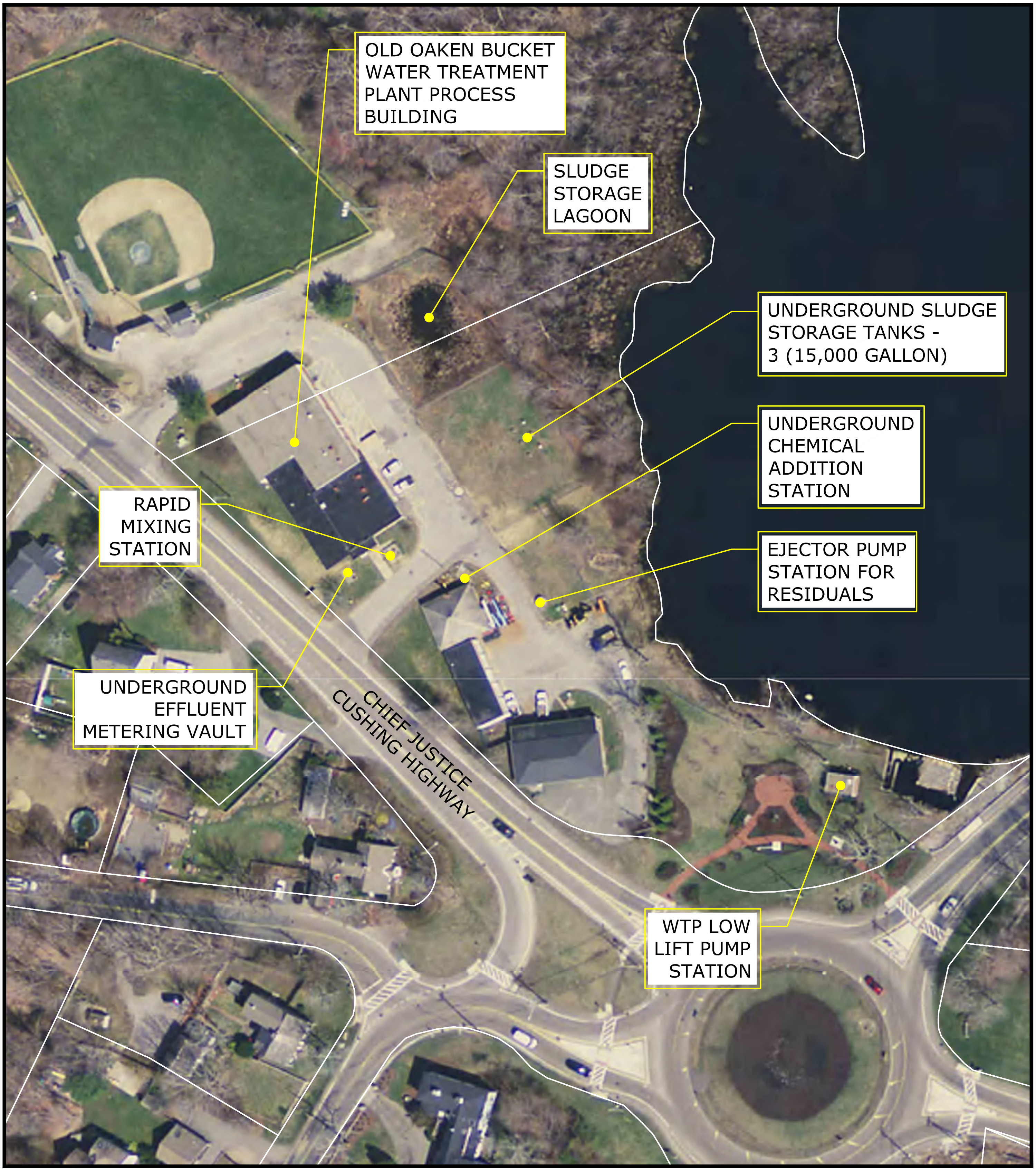
Chemical feed systems may need to shut down for periods, and this will most likely need to occur during the winter when the plant can be offline without causing system demand deficiencies.

The additional process equipment required will extend the building further and limit driveway access during construction. An extension to the building will most likely require land from the adjacent baseball field, which will need to be relocated to another site. A conceptual layout of the new process building expansion is shown on Figure 2-7. This layout assumes that a 10,000 square foot building extension is required. This layout and building area are subject to change during design.

Anticipated Schedule for Implementation - Table 2-9 provides and anticipated schedule to complete the rehabilitation of the existing water treatment plant for design through commissioning of the upgrades.

TABLE 2-9
Anticipated Implementation Schedule - OOBWTP Upgrades

Task	Estimated Schedule
Planning & Treatment Piloting	6 to 9 months
Design & Permitting	6 to 9 months
Bidding & Contracts	3 to 4 months
Construction, Startup & Commissioning	9 to 14 months
Estimated Total Timeline	***24 to 36 months***



Tighe&Bond
Engineers | Environmental Specialists

Data Reference:
Bureau of Geographic Information (MassGIS),
Commonwealth of Massachusetts, Executive
Office of Technology and Security Services

0 50' 100'
Feet

N

Figure 2-7

Old Oaken Bucket Water Treatment Plant

Site Plan

Scituate, Massachusetts

January 2020

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S-5001-015

Alternative 2 – Replace Existing Facility with a New 3 mgd Treatment Plant

The replacement alternative provides significant increases in performance, efficiency and reliability. Several types of treatment options exist for surface water treatment including conventional system similar to the existing plant process, dissolved air flotation (DAF) or ultrafiltration (UF). For the purposes of this analysis, DAF technology was used to determine an opinion of cost for the new plant due to its moderate costs compared to the other alternatives.

DAF Technology Overview - DAF treatment can be provided in packaged systems. An overview of a packaged DAF system is provided in Appendix D. The DAF system consists of a rapid mix zone, followed by a flocculation tank similar to a conventional treatment process. After flocculation, the water flows to the DAF tank where the floc particles attach to microbubbles. The floc becomes entrained to the bubbles which allows them to rise to the surface. The clarified water then passes through a perforated collection system where it leaves the system over a weir plate and into an effluent channel.

The floc particles collect at the surface where a residuals layer is formed. Periodic removal of the residuals is required via hydraulic means by causing the basin to overflow into a residuals trough for collection.

Based on the AquaPak technology, a 3 mgd facility will require 3 DAF trains (2 duty, 1 standby).

Design Considerations - Like the considerations made for Alternative 1, the new plant will require a new means for residuals disposal and backwash equalization. Sodium hypochlorite may be more suitable for disinfection in this application. For purposes of the cost analysis, a similar approach was taken for the aforementioned design considerations as to those described for Alternative 1. Selected technologies are subject to pilot testing and may change during design.

Construction Sequence Considerations - A new water treatment facility can be constructed while the existing plant is fully operational. The new plant could be located to property adjacent to the existing OOBWTP, where the current administrative and garage buildings are located. During construction, the Water Department will need to be temporarily relocated.

Once the new facility is fully functional, demolition of the OOBWTP can commence. A hazardous waste survey is highly recommended prior to demolition to ensure that hazardous waste is properly identified and disposed of in a safe and legal manner. A general layout of the new 3 mgd water treatment is provided on Figure 2-8. This layout assumes that a 15,000 square foot building is required. This layout and building area are subject to change during design.

Anticipated Schedule for Implementation - Table 2-10 provides and anticipated schedule to construct a new 3.0 mgd water treatment plant through design, commissioning and demolition of the current plant.

TABLE 2-10
Anticipated Implementation Schedule - New Plant Construction

Task	Anticipated Schedule Range
Planning & Piloting	6 to 9 months to complete
Design & Permitting	9 to 12 months to complete
Bidding & Contracts	2 to 3 months to complete
Construction, Startup & Commissioning	18 to 24 months to complete
Demolition of the Existing OOBWTP	3 to 6 months to complete
Anticipated Completion Timeline	***38 to 54 months to complete***

NOTES:

1. ASSUMED BUILDING EXPANSION TO BE 10,000 SF TO HOUSE (3) 1 MGD FILTER UNITS, SODIUM HYPOCHLORITE TANK AND SOLIDS HANDLING.
2. LAYOUT FOR THE BUILDING EXPANSION IS CONCEPTUAL AND SUBJECT TO CHANGE.

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Engineers | Environmental Specialists

Data Reference:
Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

0 50' 100'
Feet

N

Figure 2-8

Old Oaken Bucket Water Treatment Plant

Existing Plant Expansion

Scituate, Massachusetts

January 2020

Opinion of Probable Cost - Table 2-11 provides a summary of the Opinion of Probable Cost for each of the alternatives including:

- A new 3.0 mgd Water Treatment Plant using DAF technology
- A new 3.0 mgd Building Extension to the existing OOBWTP using packaged conventional treatment
- Restoration of the existing OOBWTP footprint including process equipment, electrical, HVAC and structural repairs

Opinion of Probable Cost breakdown for each of the alternatives are in Appendix C.

Additional Considerations and Recommendations-The existing facility is located on a Town-owned parcel which also contains the Water Division headquarters and a small vehicle maintenance garage. In addition, a portion of the site is used as a Little League baseball field. The existing administration building was not evaluated as part of this project; however, it is generally considered to be in poor condition. Alternative #1 will most likely require the removal of the existing baseball field to house the necessary building expansion.

The new treatment plant alternative consists of demolishing the existing Water Division headquarters and maintenance garage area to allow for the construction of the new WTP. Once the new WTP is online, the OOBWTP can be demolished providing opportunity for municipal uses such as a replacement Water Division headquarters, vehicle and equipment storage garage, additional parking for the ballfield, or a small park. The Town should review the overall needs of the Department of Public Works in evaluating these options.

Land reuse cost considerations have not been factored into the opinions of probable cost at this time.

Based on the ease of constructability, costs, improvements in water treatment technology, and the potential to revitalize the subject area, it is recommended that the Town seek funding to construct a new 3.0 mgd water treatment plant. The opinion of cost differential between expanding the existing facility and constructing a new plant is approximately 10%; however, the maintenance and operation of the existing plant during construction of the expansion may prove to be difficult and could add variability in the construction costs. Additionally, the plant expansion will need to take space away from the Little League Field, which could generate some additional public resistance to the project. The new plant would also be more reliable and easier to operate, ultimately providing a higher level of service compared to expanding and rehabilitating the existing facility.

TABLE 2-11

Opinion of Probable Cost Summary

Alternative	Opinion of Probable Cost
Alternative 1A – Existing Plant Upgrade and Expansion for Redundancy	$17,367,100
Alternative 1B – Existing Plant Repair	$6,873,000
TOTAL FOR ALTERNATIVE 1 (1A + 1B)	**$24,240,100**
Alternative 2 – New 3.0 mgd Plant	**$26,198,900**

Project OPC Notes:

1. Includes an allowance of 30% for contractor mobilization, bonds, insurance, general conditions and overhead and profit

2. Includes contractor submittals, installation, startup, testing and warranty costs ranging from 25% to 100% of equipment purchase price depending on the equipment complexity

3. Includes a 30% contingency.

4. Includes as allowance of 8% design and 12% construction phase engineering services

5. Concept level anticipated accuracy range: -25% to +40%.

Assumptions:

1. Sludge disposal will be required for the new facility.

2. Sufficient Town owned land is available for a new WTP on adjacent land near the existing OOBWTP.

3. The treatment system used for the new plant will be the Aquapak, dissolved air flotation (DAF) system.

4. The treatment system used for the plant expansion will be the PulsaPak clarification and multimedia filtration system.

2.3.5 Well Facilities, Pump Stations, and Storage Tanks

On September 12, 2019, Tighe & Bond, accompanied by the Water Department operators, conducted site visits of the treatment plants, wells, pump stations, and storage tanks to document the existing condition of, and develop prioritized improvement recommendations for, the system facilities. The assessments discussed below are based on visual checks of the facility components as well as information provided by the operators. Detailed inspections of electrical, mechanical, structural, or architectural components were not conducted.

Refer to Appendix A for inspection photographs from the site visits that illustrate the issues and deficiencies identified. Recommended improvements to address deficiencies at each facility are listed below.

Items reviewed during the facility inspections for the purposes of identifying improvements include:

- <u>Civil</u> – Roads, sidewalks, fencing, gates, and drainage structures
- <u>Security</u> – Physical protection systems such as entrance gates, perimeter fencing, and intrusion detection systems
- <u>Process/Mechanical</u> – Major mechanical equipment, chemical feed systems, process valves and actuators, equipment accessibility, compliance with MassDEP standards, other regulations, and recommended design guidelines (e.g., *Recommended Standards for Water Works*, also known as *The 10 State Standards*), potential safety concerns (chemical containment and spill prevention)
- <u>Structural/Architectural</u> – General structural integrity (e.g., concrete cracks) and condition of painted surfaces
- <u>Electrical</u> – Overall condition and age of electrical equipment
- <u>HVAC</u> – Availability and overall condition of mechanical equipment (e.g., intake louvers, exhaust fans, boilers, radiators, unit heaters, dehumidifiers, and sump pumps)
- <u>Instrumentation and Controls</u> – Availability and overall condition of pressure transmitters, turbidimeters, water quality analyzers, flow meters, and other process instrumentation and control equipment

The equipment condition is assessed using the following general definitions:

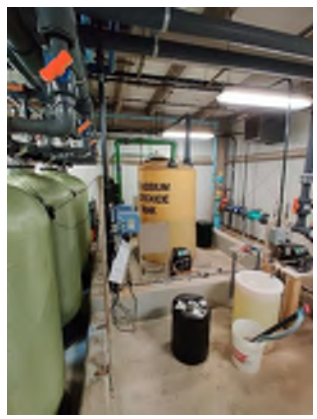
- *Very Good Condition* – less than 10 years old, little to no outward signs of aging or corrosion, operating within expected parameters
- *Good Condition* – approximately halfway through its life expectancy, noticeable signs of aging or corrosion, generally operating within expected parameters with some maintenance issues
- *Fair Condition* - nearing the end of its life expectancy, significant signs of aging or corrosion, periodic maintenance issues or repair
- *Poor Condition* – in need of replacement

A Conditions Summary Table is presented in Appendix C summarizing field observations and recommended improvements for each facility. This table is used to aid the discussion of major observations noted during the site visits and includes references to CIP item numbers. Table 2-12 at the end of this section summarizes the total estimates for each facility.

Recommended improvements are discussed and organized using the following abbreviations:

- Civil/Site/Security—C1, C2, etc.
- Process and Instrumentation—PI1, PI2, etc.
- Structural/Architectural—S1, S2, etc.
- Electrical—E1, E2, etc.
- Mechanical—M1, M2, etc.

2.3.5.1 Well 18B


This facility was built in approximately the 1990's. The onsite yard is shared with the transportation department. Sodium hypochlorite is added to disinfect the raw water and potassium hydroxide is added to adjust pH for corrosion control. A fluoride system is in place but is currently inoperable and in need of repair or replacement.

Raw water is also treated to remove iron and manganese using three greensand filters, which were installed in 2019. The wellhouse is experiencing issues related to disposal of the spent filter backwash. The Town is currently using a Rain-For-Rent frac tank located in the garage adjacent to the wellhouse to store backwash flows. The greensand filtration system needs to be backwashed more frequently than initially anticipated, about three times per day as opposed to once per day. The rental frac tank is undersized for this amount of backwash. In order to return the well to permanent, seasonal use, a disposal lagoon is under design, consisting of the traditional combination of lined and unlined lagoons. This effort is underway.

Well 18B is in the golf course driving range located approximately 0.25 miles to the wellhouse site. The Well is in the middle of the driving range with no easy access and the Well is consistently bombarded by golf balls. DPW staff access to the Well is restricted by the golf course management and can only perform maintenance during a certain time of the day.

Recommended improvements for the site include:

- Civil, Site, Security
  - Provide intrusion detection security system, with alarms wired for remote transmission
  - Provide chain link fence around the well house and a gate across the access road: the site is shared with the transfer station and there does not appear to be a gate preventing access to the water treatment facility
  - Improve access road and building layout for receiving bulk chemical delivery
  - Clear vegetation and debris (e.g., CMU blocks) surrounding the building
  - Provide wall penetrations for hoses/piping that are currently run underneath the roll-up door (in order to properly close the roll-up door)
  - Provide shed or similar plastic enclosure around wellhead to protect casing: negotiate with golf course for enclosure
- Process and Instrumentation
  - Provide automatic well level instrumentation
  - Construct disposal lagoon for spent filter backwash
  - Replace fluoride system with new fluoride saturator for sodium fluoride, pumps, and instrumentation; provide redundant saturator to assure continuity of supply while servicing a solution tank
  - Provide separate containment area (or other means for secondary chemical containment, such as drum spill containment pallets) for fluoride feed system; containment must be 110% of total volume stored
  - Provide bulk tank for sodium hypochlorite, would allow for bulk deliveries like potassium hydroxide
  - Replace potassium hydroxide bulk tank and day tank, replace leaking piping, replace transfer pump
  - Provide redundant metering pumps for each chemical feed system
  - Provide level sensors for all chemical storage tanks
  - Provide chemical resistant coating for containment areas
  - Replace aging PLC system and implement SCADA recommendations (see SCADA discussion)

  - Install built-in bypass system to allow maintenance or repair work during operation
  - Repair or replace chlorine analyzer
  - Clean and repaint rusted ductile iron pipe and fittings, or replace pipe/fittings
  - Provide NFPA diamonds on bulk tanks and day tanks
  - Provide enclosure for chemical fill delivery line and spill bucket under fitting
  - Provide exterior tank level alarm panel including display readout for tank levels

- Electrical
  - Verify surge protection is installed and it is adequate to protect the electrical equipment
  - Verify panels have enough working space/front clearances per code (NFPA 70, 3’ to 4’ depending on voltages and layout)
  - Upgrade electrical panels and service equipment in conjunction with SCADA-related improvements; based on a visual inspection, the estimated age of the equipment, and typical life expectancies for similar equipment under similar service conditions, replacement in kind of electrical equipment is recommended.
- Structural
  - Replace roof that is approaching end of service life
  - Clean and repaint exterior double door
- Mechanical
  - Replace dehumidifier with adequately sized unit, as the existing portable dehumidifier is inadequate in regulating room humidity and there is condensation on piping and the polyethylene greensand tanks
  - Improve heating, ventilation, and climate control system
  - Replace existing louver that is inoperable

2.3.5.2 Well 10/11 Treatment Building and Wells 10 and 11 (Webster's Meadow)

Well 10/11 Treatment Building

Well 10

Well 11

This site consists of Wells 10 and 11 and a wellhouse to treat both wells. There is a gate across the access road to the site and signs are provided warning against unauthorized entry. The rest of the site is surrounded by trees and dense vegetation. The wellheads are enclosed by chain link fences with barbed wire.

Both wells are artesian wells, with Well 10 having been redeveloped in 2017. The gate (isolation) valves and flow meters for each well are inside an above-grade metal enclosure equipped with a small unit heater.

Sodium hypochlorite is added to disinfect the raw water, potassium hydroxide is added to adjust pH for corrosion control, and sodium fluoride is added for dental health. The disinfection system is designed to provided 4-log inactivation of viruses. There is a pipe loop approximately 200 feet long to sample the finished water prior to the first customer.

The entire site is in the 100-Year flood zone according to the FEMA National Flood Hazard Layer, with a base flood elevation of 15 feet (referenced to NAVD88). Reportedly, the Tree-Berry Farm located west of Well 10 has flooded before.

The electrical enclosures for Wells 10 and 11 are located several feet above grade on top of metal platforms with stairs, and the well casings are located inside concrete enclosures with the top of concrete several feet above grade.

Recommended improvements for the site include:

- Civil, Site, Security
    - Provide intrusion detection security system, with alarms wired for remote transmission
    - Improve access road and building layout for receiving bulk chemical delivery
    - Test fire suppression system and bring it online: system is in place but has not been tested, wellhouse is equipped with smoke detectors
    - Clear vegetation surrounding the wellhouse: tree lines are on or within 10 feet of the building
    - Clear vegetation surrounding Well 10 and Well 11, including vegetation growing on the platforms, stairs, and fences
    - Repair barbed wire along fence lines
- Process and Instrumentation
    - Provide automatic well level instrumentation
    - Provide level sensors for all chemical storage tanks
    - Provide bulk tank for sodium hypochlorite: would allow for bulk deliveries like potassium hydroxide
    - Replace potassium hydroxide bulk tanks, replace leaking piping, replace transfer pump
    - Provide redundant metering pumps for each chemical feed system

  - Provide separate containment area (or other means for secondary chemical containment, such as drum spill containment pallets) for fluoride feed system; containment must be 110% of total volume stored
  - Provide chemical resistant coating for containment areas
  - Replace aging PLC system and implement SCADA recommendations (see SCADA discussion)
  - Clean and repaint rusted ductile iron pipe and fittings, or replace pipe/fittings
  - Provide NFPA diamonds on bulk tanks and day tanks, where missing
  - Identify source of chemical feed system leaks and repair leaks
  - Provide low level alarm for chlorine (a new chlorine analyzer was recently installed)
  - Provide enclosure for chemical fill delivery line and spill bucket under fitting
  - Provide exterior tank level alarm panel including display readout for tank levels

- Electrical
  - Verify surge protection is installed and it is adequate to protect the electrical equipment
  - Verify panels have enough working space/front clearances per code (NFPA 70, 3’ to 4’ depending on voltages and layout)
  - Upgrade electrical panels and service equipment in conjunction with SCADA-related improvements; based on a visual inspection, the estimated age of the equipment, and typical life expectancies for similar equipment under similar service conditions, replacement in kind of electrical equipment is recommended.
  - Provide power redundancy, such as a backup generator and connect the facilities to a single electric service: reportedly, the wellhouse regularly experiences loss of power and there are three separate electric meters/services for the facilities (one for each well and one for the wellhouse)
  - Provide poles or underground conduit for communication wire from Well 10 to wellhouse
  - Provide emergency lights and exit signs

- Structural

  - Clean and repaint exterior double door at the Wellhouse
  - Clean roof gutters: brushes and vegetation observed growing on roof gutters
  - Repair deteriorating concrete structure around Well 10 casing and failing railing; the bases of the railing cast into concrete are corroding; replace the railing with top-mounted railing if possible; or clean, galvanize, and paint the sleeves and rail posts and place a cone of grout to shed water away from the base; repair concrete spalling and cracking
  - Repair insulation at wellhouse: insulation is detached from roof in some areas
  - Clean and paint interior floor

- Mechanical
  - Replace dehumidifier with adequately sized unit, as the existing portable dehumidifier appears small for the interior space and there is condensation on piping
  - Improve heating, ventilation, and climate control system: the wellhouse exhibits evidence of metal corrosion of the building walls, hangers/supports, and other metal surfaces
  - Replace existing louver system that is inoperable
  - Propane tank should be cleaned/repainted or replaced by utility

2.3.5.3 Well 19/22 Treatment Building and Wells 19 (Edison Station) and 22R (Barnes Meadow)



Well 19/22 Treatment Building

Well 19 (inside)



Well 22 Building and Well 22R

This site consists of Wells 19 and 22 and a wellhouse to treat both wells. There is a gate across the access road to the treatment building site and signs are provided warning against unauthorized entry. The rest of the site is surrounded by trees and dense vegetation. Well 19 is inside the treatment building. The original Well 22 is in a wellhouse located on the same property but some distance away south-west from the treatment building through dense vegetation and trees. The replacement Well 22R is located outside Wellhouse 22. The original Well 22 is not currently in use but could be used as an emergency source.

Sodium hypochlorite is added to disinfect the raw water, potassium hydroxide is added to adjust pH for corrosion control, and sodium fluoride is added for fluoridation. There is a diffused aeration unit for removal of volatile organic compounds from Well 19. Following aeration, water from Well 19 is discharged to a below-grade clearwell at the Well 19/22 treatment building. Raw water from Well 22 is also discharged to the clearwell. Two high-lift booster pumps draw suction from the clearwell to supply the distribution system.

Part of the site is in the 100-Year flood zone according to the FEMA National Flood Hazard Layer, but in an area where the base flood elevation is not determined. Well 22 is in the 100-year flood zone, while the Wellhouse 19/22 treatment building is not.

Backup generators are located adjacent to the Wellhouse 19/22 treatment building and adjacent to Wellhouse 22.

Recommended improvements for the site include:

- Civil, Site, Security
    - Provide intrusion detection security system, with alarms wired for remote transmission at Wellhouse 22 (treatment building has intrusion alarm and fire alarm, confirm these are wired for remote transmission)
    - Provide heat/smoke detectors at Wellhouse 22 with alarms wired for remote transmission
    - Consider reinstalling chain link fence that was removed at Wellhouse 22
    - Consider removing abandoned gear drive at Wellhouse 22
    - Repave driveway up to Wellhouse 22, and pave around building or restore gravel
    - Provide building flood sensor at Wellhouse 22 wired for remote transmission: the wellhouse is in the 100-yr flood zone (base flood elevation not established); this site should be monitored during rain events
    - Verify top of casing for Well 22 is above the highest flood of record, since the well is in the 100-yr flood zone but a base flood elevation is not established
    - Clear debris and vegetation surrounding Wellhouse 22, and clear trees overhanging the Wellhouse
- Process and Instrumentation
    - Provide automatic well level instrumentation
    - Provide level sensors for all chemical storage tanks
    - Provide bulk tank for sodium hypochlorite: would allow for bulk deliveries like potassium hydroxide

  - Replace sodium hypochlorite and potassium hydroxide bulk tanks and day tanks, replace leaking piping, replace transfer pump
  - Provide redundant metering pumps for each chemical feed system
  - Provide separate containment area (or other means for secondary chemical containment, such as drum spill containment pallets) for fluoride feed system; containment must be 110% of total volume stored
  - Provide chemical resistant coating for containment areas
  - Replace aging PLC system and implement SCADA recommendations (see SCADA discussion)
  - Clean and repaint rusted ductile iron pipe and fittings, or replace pipe/fittings, at both buildings (Wellhouse 22 and Well 19/22 treatment building)
  - Provide NFPA diamonds on bulk tanks and day tanks, where missing
  - Identify source of water leaks and repair leaks; at Well 19/22 treatment building, water leaks into the potassium hydroxide containment area and into the trench below the process piping
  - Separate chemicals into their respective containment areas (a potassium hydroxide drum was inside the sodium hypochlorite area)
  - Resolve communication issues with service provider
  - Provide enclosure for chemical fill delivery line and spill bucket under fitting
  - Provide exterior tank level alarm panel including display readout for tank levels
  - Sandblast, clean, and recoat the pump bases for the high lift pumps inside the treatment building, the steel plate supports for the recirculation pumps located above the clearwell, and the steel plates for the aeration vents
  - Replace the aeration system recirculation pumps, if needed; reportedly these pumps are not used

- Electrical

  - Verify existing surge protectors are adequate to protect the electrical equipment
  - Verify panels have enough working space/front clearances per code (NFPA 70, 3’ to 4’ depending on voltages and layout)
  - Upgrade electrical panels and service equipment in conjunction with SCADA-related improvements; based on a visual inspection, the estimated

age of the equipment, and typical life expectancies for similar equipment under similar service conditions, replacement in kind of electrical equipment is recommended.

- Provide emergency lights and exit signs at Wellhouse 22 and at the Well 19/22 treatment building, where missing
- Reprogram VFD for Well 22: if the automatic transfer switch is triggered, the VFD is reset to 40 Hz, which results in a decrease in well production
- Provide covers for junction boxes at Wellhouse 22: some junction boxes have exposed wiring

- Structural
  - Repair insulation at Well 19/22 treatment building: insulation is detached from roof in some areas
  - Clean and paint exterior CMU walls at Wellhouse 22
  - Repair cracks in exterior CMU walls at Wellhouse 22 (above rear louver next to generator), seal masonry joints; cracks may have occurred due to steel lintel above the louver rusting from water exposure and expanding the mortar joint, therefore should also seal around the window to limit moisture getting to the lintel
  - Replace exterior door at Wellhouse 22
  - Clean and repaint exterior double door at Well 19/22 treatment building
  - Clean and paint interior floor at Wellhouse 22 and Well 19/22 treatment building
- Mechanical
  - Replace dehumidifier with adequately sized unit, as the existing portable dehumidifier appears small for the interior space and there is condensation on piping (pipe condensation seeps into containment area)
  - Replace exterior vent cap that is dented and rusted at Wellhouse 22
  - Remove older unit heater at Wellhouse 22, if not needed and recently installed Modine heater is adequate for the space
  - Improve heating, ventilation, and climate control system: the treatment building exhibits evidence of metal corrosion of the building walls, hangers/supports, and other metal surfaces

2.3.5.4 Wellhouse 17A

Wellhouse 17A was not visited because a new treatment plant will be constructed in 2021. The new plant will be rated for a maximum flow of 360 gpm and average flow of 270 gpm (max authorized daily withdrawal). Treatment will consist of three greensand filters used to treat iron and manganese along with a backwash water storage tank and a backwash residuals storage tank. Chemical treatment will consist of sodium hypochlorite for disinfection, potassium hydroxide for pH adjustment, fluoride, and potassium permanganate as an oxidant for the greensand filtration system. The well pump was replaced in recent years and is not being replaced as part of the upgrade.

2.3.5.5 Walnut Tree Booster Pump Station (Woodworth Lane)



This site consists of a booster pump station on Woodworth Lane that serves a small portion of the distribution system on Woodworth Lane, Bridle Lane, Walnut Hill Drive, Garrison Drive, and Greenbriar Way. The facility is in a wooded parcel located behind 23 Woodworth Lane and is accessible from a paved driveway.

The pump station consists of a Flowtronex packaged pumping system with two 3 hp pumps and one 75 hp pump, with a rated flow range of 200 gpm to 1,350 gpm. A bladder tank on the pump station discharge provides pressure equalization when the pumps are off. According to the on-site control panel, the station operates to maintain a pressure setpoint of 70 psi.

The station is equipped with an interior natural-gas fired generator with exhaust fan, as well as smoke detectors, louvers with motorized actuators, exhaust fans, a unit heater, and a dehumidifier. The building is enclosed by a chain link fence.

Recommended improvements for the site include:

- Civil, Site, Security
    - Provide intrusion detection security system, with alarms wired for remote transmission
    - Provide heat/smoke detectors with alarms wired for remote transmission

  - Clear dense vegetation surrounding building and overtopping fence; vegetation is also growing on the building (ivy growing on walls); large trees are located within 10 feet of the building
  - Provide signs on doors warning against unauthorized entry
- Process and Instrumentation
  - Identify whether wet environment may be attributed to water leaks and repair leaks, replace dehumidifier with larger unit, and provide sump pump; the pump room was observed to be very wet, most likely due to condensation from the process piping but the possibility of leaks should also be investigated
  - Replace flow meter that is not working
  - Replace aging PLC system and implement SCADA recommendations (see SCADA discussion)
  - Clean and repaint rusted ductile iron pipe and fittings, or replace pipe/fittings
  - Restore communications at facility and resolve communications issues with service provider: station used to have a point of communication but is no longer functioning due to issue with communication provider
- Electrical
  - Verify there is a surge protector that is adequate to protect the electrical equipment
  - Verify panels have enough working space/front clearances per code (NFPA 70, 3' to 4' depending on voltages and layout)
  - Upgrade electrical panels and service equipment in conjunction with SCADA-related improvements; based on a visual inspection, the estimated age of the equipment, and typical life expectancies for similar equipment under similar service conditions, replacement in kind of electrical equipment is recommended.
- Structural
  - Clear moss off roof
  - Clean and repaint exterior doors
  - Clean and paint floor
- Mechanical

- Replace dehumidifier with adequately sized unit, as the existing portable dehumidifier appears small for the interior space and there is condensation on piping (pump room was very wet)
- Unit heater may need to be replaced due to age

2.3.5.6 Mann Lot Road Booster Pump Station (100 Mann Lot Road)

This site consists of a booster pump station on Mann Lot Road that serves the western corner of the distribution system, up to the Town boundaries with Norwell, Cohasset, and Hingham. The facility is in a wooded parcel, and the building is less than 30 feet from the edge of the road. Three wooden bollards protect the building frontage.

The pump station consists of two 25 hp pumps equipped with variable frequency drives, each with a rated flow of 1,050 gpm. According to the on-site pump control panel, the pumps are set to operate to maintain a pressure setpoint of 66 psi. Reportedly the pumps were rebuilt in the last three years and operate continuously 24 hours per day. An ultrasonic flow meter was recently installed to monitor flow.

The station is equipped with an interior natural-gas fired generator, generator exhaust fan, louvers with motorized actuators, and a unit heater.

Recommended improvements for the site include:

- Civil, Site, Security
  - Provide intrusion detection security system, with alarms wired for remote transmission
  - Provide heat/smoke detectors with alarms wired for remote transmission
  - Clear dense vegetation surrounding building; vegetation is also growing on the building (ivy growing on walls); large trees are located within 10 feet of the building
  - Provide chain link fence around building
- Process and Instrumentation
  - Identify whether wet environment may be attributed to water leaks and repair leaks, replace dehumidifier with larger unit, and provide sump pump; the pump room was observed to be slightly wet, most likely due to condensation from the process piping but the possibility of leaks should also be investigated

  - Replace aging PLC system and implement SCADA recommendations (see SCADA discussion)
  - Clean and repaint rusted ductile iron pipe and fittings, or replace pipe/fittings
  - Restore communications at facility and resolve communications issues with service provider: station used to have a point of communication but is no longer functioning due to issue with communication provider
  - Sandblast and repaint pump bases that are heavily rusted, investigate source of water leaks
  - Replace guard for motor shaft on pump 1 that is heavily rusted (green-colored motor)
  - Repaint concrete housekeeping pads
- Electrical
  - Verify there is a surge protector that is adequate to protect the electrical equipment
  - Verify panels have enough working space/front clearances per code (NFPA 70, 3’ to 4’ depending on voltages and layout)
  - Upgrade electrical panels and service equipment in conjunction with SCADA-related improvements; based on a visual inspection, the estimated age of the equipment, and typical life expectancies for similar equipment under similar service conditions, replacement in kind of electrical equipment is recommended.
- Structural
  - Replace roof
  - Clean and repaint gable end boards
  - Clean and paint floor
  - Consider boarding up window
- Mechanical
  - Replace dehumidifier with adequately sized unit for the space; condensation observed on piping and floor was wet
  - Unit heater may need to be replaced due to age
  - Provide exhaust fan

2.3.5.7 Mann Lot Road Tank (aka Creelman)

This site consists of the Mann Lot Road standpipe located in a wooded parcel. The tank is enclosed by a chain link fence with a double-leaf gate and barbed wire. A pressure transducer was recently installed.

Access to the site is through a residential driveway, and there is no land available to build a proprietary driveway to the tank. However, according to the Town's records, there is a 10-foot easement from Creelman Drive to the standpipe, likely corresponding to the distribution main. The Town should evaluate whether it is possible to clear this easement and use it for access.

Recommended improvements for the site include:

- Civil, Site, Security
    - Provide surveillance cameras/motion sensors for security system, with alarms wired for remote transmission; there is evidence of prior vandalism and graffiti
    - Clear dense vegetation surrounding tank; large trees are located within 10 feet of the tank
    - Evaluate if existing easement can be cleared and used as an access road
- Process and Instrumentation
    - Relocate tank overflow and provide swale (or similar shallow channel) to direct and manage tank overflows and promote infiltration; the tank's overflow is pointed towards residential areas, such that flushing the tank (to clean out sedimentation build-up) floods nearby residential yards; it may be possible to relocate the tank overflow to direct flows to the south and west of the tank away from residences; tank level instrumentation discussed below is also recommended

- Implement SCADA recommendations (see SCADA discussion); includes providing tank level instrumentation
- Repair communications at facility; reportedly, a radio path to this tank was successful; the Town is experiencing communications issues with the service provider (cannot switch between analog and digital)

- Structural
  - Repair areas of spalling/deterioration on concrete foundation
  - Provide anchor bolts; tank is not bolted down into the supporting concrete foundation
  - Repaint tank exterior

2.3.5.8 Pincin Hill Tank (aka Maple Street)

This site consists of the Pincin Hill standpipe located in a wooded parcel in Town forest land. The tank is enclosed by a chain link fence with a double-leaf gate and barbed wire. Access to the site is from Grove Street.

This tank has a lower overflow elevation than the Mann Lot Road Tank and would therefore overflow first. The Town can continuously monitor water level for this tank. Overflows from this tank are discharged into/towards the surrounding woods.

Recommended improvements for the site include:

- Civil, Site, Security
  - Provide surveillance cameras/motion sensors for security system, with alarms wired for remote transmission; there is evidence of prior vandalism and graffiti
  - Clear dense vegetation surrounding tank; large trees are located within 10 feet of the tank
  - Maintain a clear access path to the tank (clear leaves and debris) to perform maintenance on the tank
- Process and Instrumentation
  - Implement SCADA recommendations (see SCADA discussion); includes providing tank level instrumentation
  - Repair communications at facility, consider installing underground conduit for communication wires; there is one low-lying communication line that could be easily damaged during a rain/snow storm because wires are fastened to trees
- Structural

- Provide anchor bolts; tank is not bolted down into the supporting concrete foundation
- Repaint tank exterior

TABLE 2-12
Summary of Well Facilities, Pump Stations, and Storage Tank Improvements Costs

Facility / System Component	Estimated Cost by Priority Score					Total
	1	2	3	4	5	
Well 19/22	$1,000	$133,500	$79,500	$35,000	$10,000	$259,000
Well 10/11	$0	$121,500	$337,000	$20,500	$10,000	$489,000
Well 18B	$0	$121,000	$90,000	$380,000	$10,000	$601,000
Mann Lot Road PS	$0	$43,000	$67,000	$11,000	$0	$121,000
Walnut Tree PS	$0	$22,500	$79,500	$5,000	$0	$107,000
Mann Lot Rd Tank	$0	$2,000	$425,000	$115,000	$0	$542,000
Pincin Hill Tank	$0	$6,000	$455,000	$19,000	$0	$480,000
All facilities	$0	$0	$0	$694,000	$0	$694,000
Total	$1,000	$449,500	$1,533,000	$1,279,500	$30,000	$3,293,000

Scoring Factors

Priority = 1 - Low, 5 - High

2.4 Quantity and Storage Evaluation

2.4.1 Quantity Assessment

This section presents water demand trends. Historical demand data are compared to available water to determine the adequacy of supplies to meet current needs. Demand projections are discussed in Section 3.

2.4.1.1 Historical Demands

Water demands by customer category were obtained from the Annual Statistical Reports submitted to MADEP. These categories, as reported in the ASRs, include:

- **Total Finished Water Entering Distribution System:** includes finished water from own sources (determined as the raw water volume minus treatment process losses) plus finished water provided by the Marshfield water system

- **Metered Use**

  - **Residential demand:** water sold to single and multi-family residential dwellings including homes, condominiums, and apartments

  - **Residential institutions:** water sold to institutions with fluctuating residential populations and non-residential uses, including colleges and prisons

  - **Commercial:** water sold to local businesses and restaurant

  - **Agricultural:** water used mainly to grow food, raise animals, or run a garden center

  - **Industrial:** water used mainly for industrial purposes

  - **Municipal / Institutional / Non-Profit:** water used mainly for municipal purposes, including schools, playing fields, municipal buildings, treatment plants, non-profits such as churches, and non-residential institutions such as private schools

  - **Other Services:** water used for purposes not included in above categories. According to the ASRs, this includes seasonal beach showers

- **Confidently Estimated Municipal Use (CEMU):** consists of unmetered uses of water for municipal purposes, such as fire protection and training, hydrant and water main flushing and construction, flow testing, bleeders and blow-offs, tank overflow and drainage, sewer and storm water system flushing, street cleaning, source meter calibrations, and water lost to major water main breaks. Losses of water due to ongoing leaks discovered during leak detection surveys are not included. All water volumes reported in ASRs under this category must have accompanying calculations and documentation of how the volumes were calculated.

- **Unaccounted for Water (UAW):** water equal to the total volume of finished water entering the distribution system minus the total metered use and confidently estimated municipal use. This may include apparent losses from sources such as meter inaccuracies and data handling errors, and real losses such as leakage from water mains and service lines. Unaccounted for Water is often expressed as a percentage of total water delivered to the system.

2.4.1.2 Total Finished Water Entering Distribution System

Historical demand data of total finished water entering the Scituate distribution system, consisting of water from local sources and purchases from Marshfield, are shown on Figure 2-9, including total gallons per year and the ratio of summer usage (May through September) to winter usage (January through March and November through December). Monthly data is summarized in Table 2-13. These data were obtained from Scituate's Annual Statistical Reports (ASRs) to MADEP.

As shown on Figure 2-9, annual demands have decreased slightly since 2009 from a high of 681.5 MG to a range of 543-610 MG in the previous five years (2014-2018). As expected, demands are highest in the summer, on average approximately 1.5 times the winter usage in the previous five years.

Total finished water entering the distribution system is the sum of total finished water that originates from local (or own) sources (summarized on Figure 2-10) and the total finished water that is purchased (summarized on Figure 2-11). Only a small portion of water is purchased, approximately 40 to 70 MG/year, which has been on a generally increasing trend since 2009. Most of the finished water entering the distribution system is from the Town's groundwater wells and surface water treatment plant.

Average day, maximum month, and maximum day demand data are presented in Figure 2-12 and Table 2-14 for the total finished water entering the distribution system. Max day demand data are based on daily records of production from each local source provided by the Town plus purchased water. Purchases from Marshfield are not metered daily. Therefore, max day demand data are based on the daily average amount purchased during the same month as the max day of the local sources (generally in June, July, or August).

Max month demands were 1.40 times the average day demands, while max day demands were 1.85 times the average day demands (based on the average max month and max day peaking factors for the previous five years). Demand projections discussed in Section 3 are based on the projected average day demands times the projected peaking factors presented in Table 2-15.

Figure 2-9: Total Finished Water Entering Distribution System (Own Sources Plus Purchased)

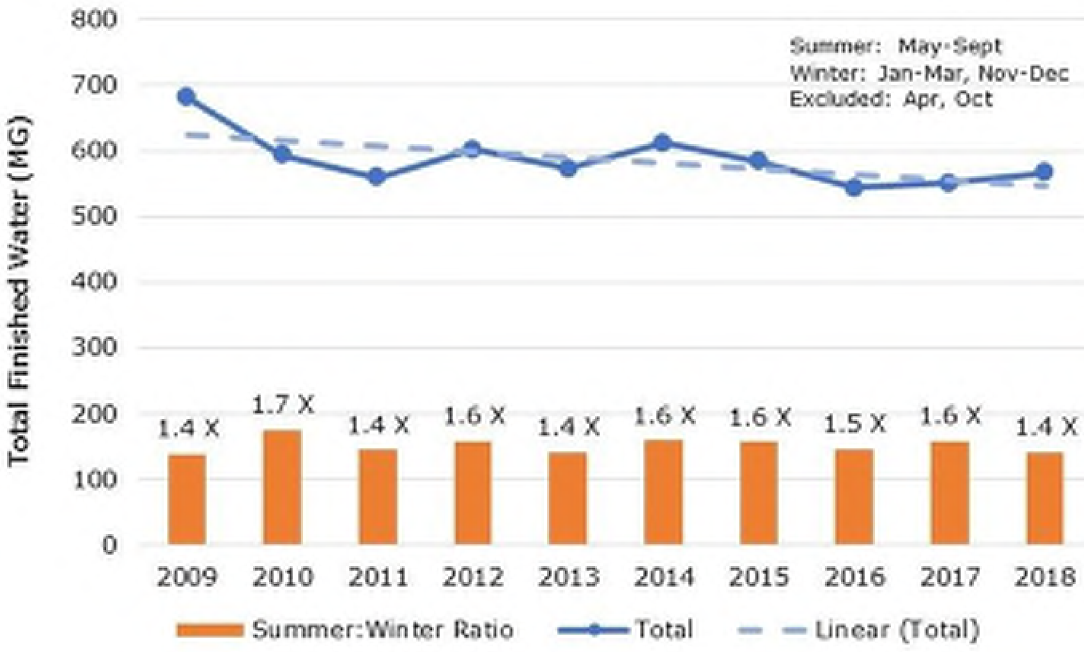


Figure 2-10: Total Finished Water from Own Sources

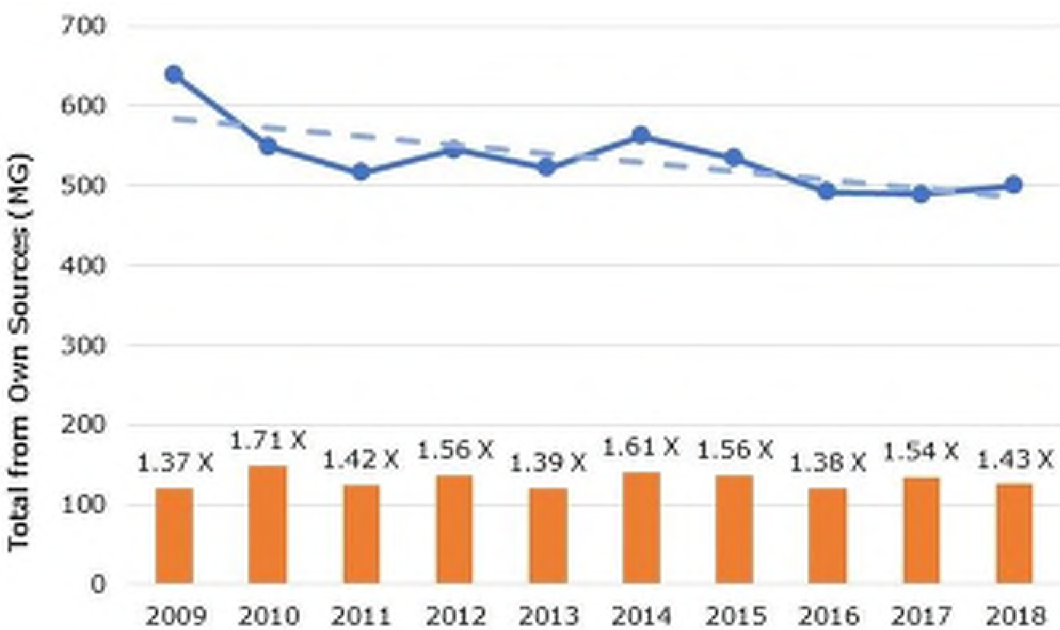


Figure 2-11: Total Finished Water Purchased

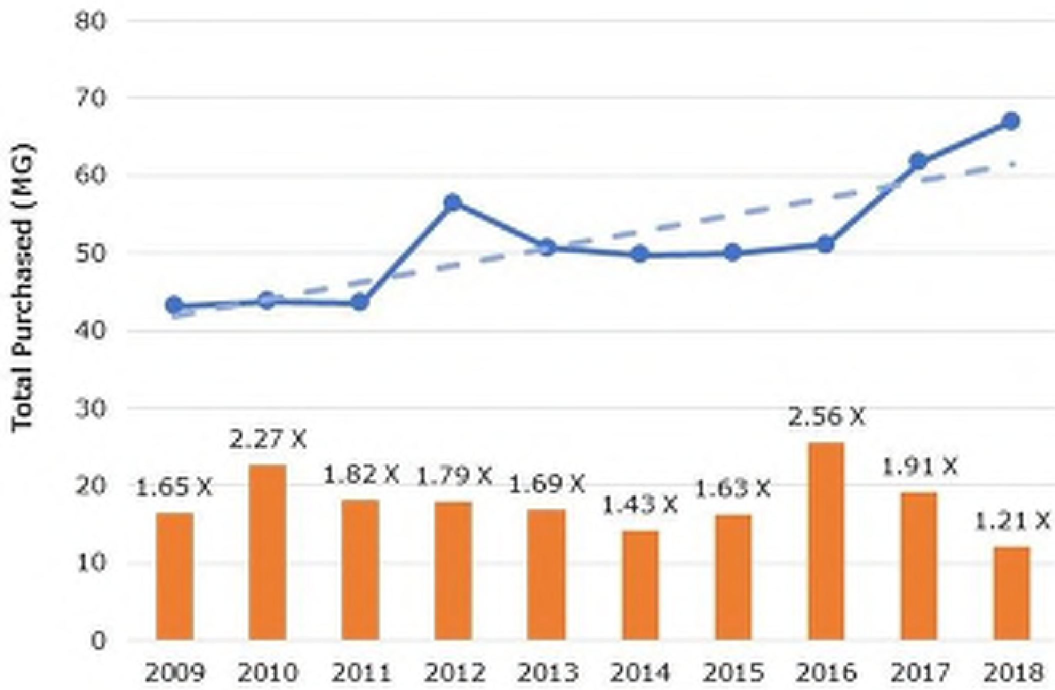


TABLE 2-13
Total Finished Water Entering Distribution System (Own Sources Plus Purchased, Million Gallons)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Summer to Winter Ratio
2009	52.34	46.28	50.28	50.07	64.18	64.06	69.10	78.61	61.51	51.15	45.57	48.36	681.50	1.39
2010	41.79	33.20	36.44	40.84	55.71	69.92	83.66	65.82	49.75	40.75	36.35	38.64	592.86	1.74
2011	36.78	33.67	44.73	38.70	48.22	56.82	73.74	54.86	48.97	42.72	39.76	40.21	559.18	1.45
2012	40.15	36.33	42.01	52.09	59.22	58.40	75.35	65.97	51.73	41.99	39.02	39.55	601.81	1.58
2013	40.37	40.58	42.69	42.32	57.27	51.81	61.48	61.25	51.93	45.09	37.60	40.00	572.36	1.41
2014	44.32	36.30	42.55	43.00	52.93	63.99	76.53	71.65	58.29	42.28	39.42	40.50	611.76	1.59
2015	40.84	40.01	44.03	39.80	61.37	59.09	66.53	62.60	55.47	44.15	35.31	34.58	583.77	1.57
2016	38.42	38.76	37.10	38.68	50.50	64.30	68.04	51.94	41.02	39.76	35.92	38.56	543.01	1.46
2017	33.19	28.78	38.07	39.79	47.63	57.24	62.56	62.24	53.68	48.19	38.83	40.82	551.03	1.58
2018	47.09	34.09	40.63	40.45	49.72	61.45	66.08	61.66	44.05	42.10	40.02	39.36	566.69	1.41
Five-Year Average	40.77	35.59	40.48	40.34	52.43	61.22	67.95	62.02	50.50	43.30	37.90	38.76	571.25	1.52

Figure 2-12: Average Day, Max Month, and Max Day Demands

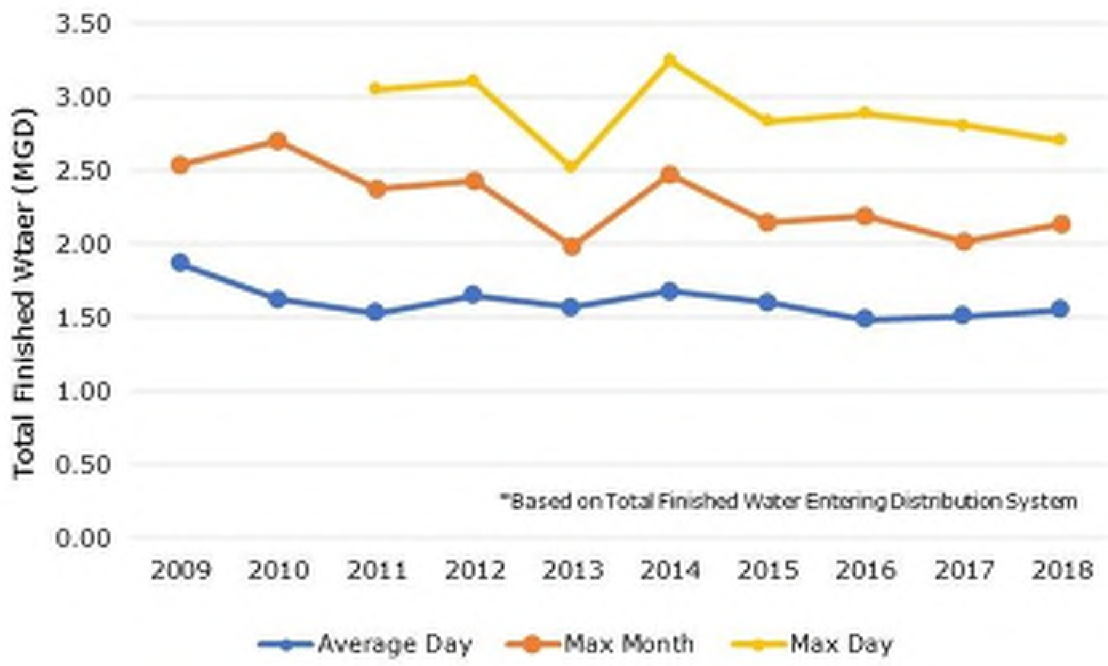


TABLE 2-14
Peaking Factor Summary [1]

	Average Day Demand (mgd)	Max Month Demand (mgd)	Max Day Demand (mgd)	Max Month Peaking Factor [2]	Max Day Peaking Factor [3]
2009	1.867	2.536	--	1.36	--
2010	1.624	2.699	--	1.66	--
2011	1.532	2.379	3.053	1.55	1.99
2012	1.649	2.431	3.106	1.47	1.88
2013	1.568	1.983	2.521	1.26	1.61
2014	1.676	2.469	3.246	1.47	1.94
2015	1.599	2.146	2.838	1.34	1.77
2016	1.488	2.195	2.890	1.48	1.94
2017	1.510	2.018	2.806	1.34	1.86
2018	1.553	2.132	2.705	1.37	1.74
			Five-Year Average	1.40	1.85
			Projected	**1.50**	**1.95**

[1] Based on Total Finished Water Entering Distribution System (Own Sources plus Purchased)
[2] Max Month Demand/Average Day Demand
[3] Max Day Demand/Average Day Demand

2.4.1.3 Demand Supplied from Local (Own) Sources

For the purposes of evaluating the capacity of local sources to supply the Scituate distribution system excluding the Humarock region, historical demands without purchases from Marshfield were also evaluated (as shown on Figure 2-10).

Table 2-15 summarizes the average day, maximum month, and maximum day demands for finished water entering the distribution system from Scituate's local sources, and related peaking factors. The area of the distribution system served by the local sources has a slightly lower max month peaking factor and a slightly higher max day peaking factor than for the entire distribution system including the Humarock region. However, the projected peaking factors presented in Table 2-14 appear appropriate for determining future demands, and they are repeated in Table 2-15.

TABLE 2-15

Demand Supplied from Local Sources and Peaking Factor Summary (1)

	Average Day Demand (mgd)	Max Month Demand (mgd)	Max Day Demand (mgd)	Max Month Peaking Factor (2)	Max Day Peaking Factor (3)
2009	1.749	2.353	--	1.35	--
2010	1.504	2.480	--	1.65	--
2011	1.413	2.129	2.803	1.51	1.98
2012	1.494	2.202	2.878	1.47	1.93
2013	1.429	1.790	2.328	1.25	1.63
2014	1.540	2.251	3.141	1.46	2.04
2015	1.462	1.917	2.659	1.31	1.82
2016	1.348	1.940	2.635	1.44	1.96
2017	1.341	1.768	2.550	1.32	1.90
2018	1.369	1.900	2.467	1.39	1.80
		Five-Year Average		1.38	1.90
			Projected	**1.50**	**1.95**

(1) Based on Total Finished Water Entering Distribution System from Own Sources
(2) Max Month Demand/Average Day Demand
(3) Max Day Demand/Average Day Demand

2.4.1.4 Metered Use, Confidently Estimated Municipal Use, and Unaccounted for Water

Number of Service Connections by Category

Table 2-16 summarizes the number of customers in each demand category. This includes all service connections, including services that may not have had any consumption billed or metered in that year.

The number of customers in most of the customer categories has remained relatively stable. Residential customers, and therefore total customers, have generally increased.

Most customers in the system are Residential (not including Residential Institutions), accounting for 96% of all service connections since 2010. The second largest group of customers are Commercial accounting for 2-3% of all services, followed by Municipal/Institutional/Non-Profits accounting for 1% or less of all services.

TABLE 2-16
Number of Service Connections by Customer Category (from ASRs)

	Residential	Residential Institutions	Commercial / Business	Agricultural	Industrial	Municipal / Institutional / Non-profits	Other	Total Connections
2010	7,332	3	221	3	6	58	1	7,624
2011	7,339	3	219	3	5	72		7,641
2012	7,338	2	213	3	3	76	1	7,636
2013	7,364	2	213	2	3	74	1	7,659
2014	7,396	2	213	2	3	73	1	7,690
2015	7,438	2	209	2	3	73	1	7,728
2016	7,461	2	199	3	3	83	2	7,753
2017	7,364	2	189	3	3	80	3	7,644
2018	7,556	2	262	4	4	64		7,892

Baseline Demands – Entire Service Area

Table 2-17 summarizes the average daily demand for the consumption categories described, in million gallons per day. This includes consumption in the Humarock Village. The total metered use consists of the sum of all metered customer categories. Total CEMU, UAW, and total finished demands (including finished water from own sources and purchased) are also presented. Figure 2-13 presents the total metered, total CEMU, total UAW, and total finished demands.

Total metered use and total finished water entering the system have remained relatively stable since 2009, with indications of a slightly declining trend. Total CEMU and UAW are generally stable and represent a small portion of the overall consumption.

Figure 2-14 presents the percentage of the total consumption by customer class, and Figure 2-15 presents the average day consumption by customer class. Most of the total consumption is in the Residential category, averaging 85% of the total consumption since 2009. As expected, the second largest users are those with the most customers, Commercial and Municipal/Institutional/Non-Profit, which account for 5-9% and 1-15% of the total consumption respectively.

TABLE 2-17
Historical Average Demands by Customer Class (mgd)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	Residential	**Residential Institution**	**Commercial / Business**	**Agricultural**	**Industrial**	**Municipal / Institutional / Non-profits**	**Other Services**	**Total Metered Use (sum a through g)**	**Total CEMU**	**UAW**	**% UAW (j / l)**	**Total Finished Water Entering System (h+i+j)**	**Percent Change in Total Finished Water**
2009	1.345	0.014	0.110	0.003	0.005	0.041	0.003	1.521	0.099	0.248	13%	1.867	
2010	1.279	0.014	0.077	0.003	0.003	0.014	0.003	1.392	0.089	0.143	9%	1.624	-13%
2011	1.224	0.016	0.101	0.003	0.004	0.148	0.000	1.495	0.025	0.012	1%	1.532	-6%
2012	1.146	0.015	0.081	0.003	0.003	0.059	0.000	1.306	0.013	0.325	20%	1.644	7%
2013	1.148	0.017	0.076	0.003	0.003	0.062	0.000	1.309	0.030	0.229	15%	1.568	-5%
2014	1.143	0.014	0.122	0.003	0.002	0.086	0.000	1.370	0.137	0.169	10%	1.676	7%
2015	1.102	0.013	0.077	0.003	0.002	0.047	0.000	1.246	0.040	0.313	20%	1.599	-5%
2016	1.045	0.015	0.068	0.003	0.003	0.116	0.002	1.251	0.013	0.220	15%	1.484	-7%
2017	1.039	0.014	0.078	0.003	0.003	0.076	0.003	1.216	0.118	0.176	12%	1.510	2%
2018	1.019	0.011	0.105	0.015	0.003	0.211	0.000	1.363	0.176	0.014	1%	1.553	3%
Five-Year Average	**1.070**	**0.013**	**0.090**	**0.005**	**0.002**	**0.107**	**0.001**	**1.289**	**0.097**	**0.178**	**11%**	**1.564**	

Figure 2-13: Metered, CEMU and UAW Totals

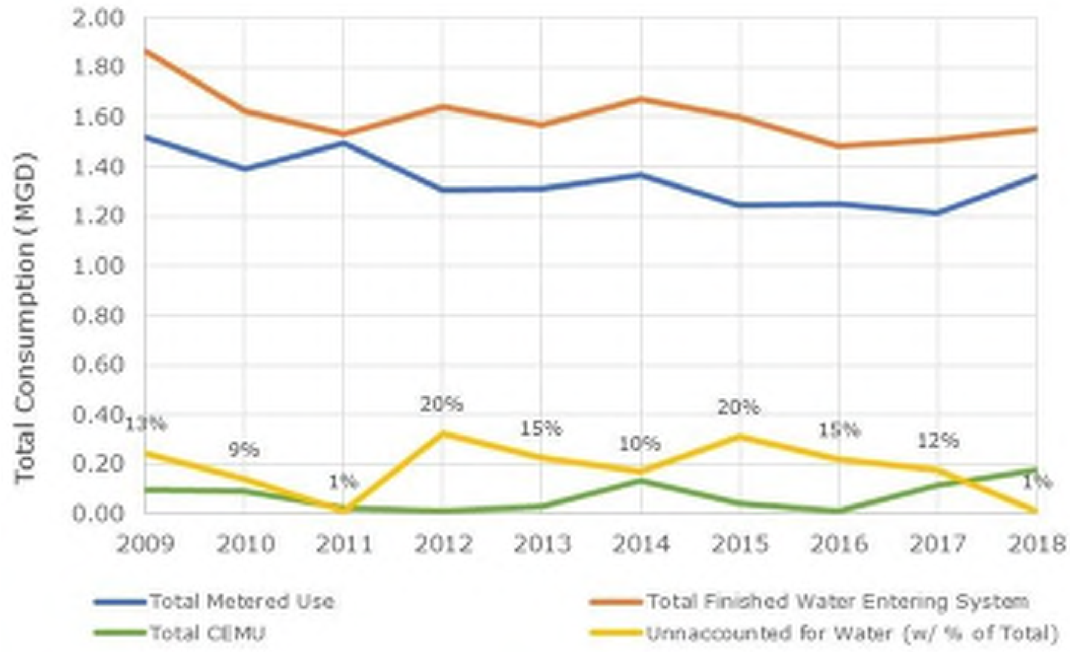


Figure 2-14: Percentage of Total Consumption by Customer Class

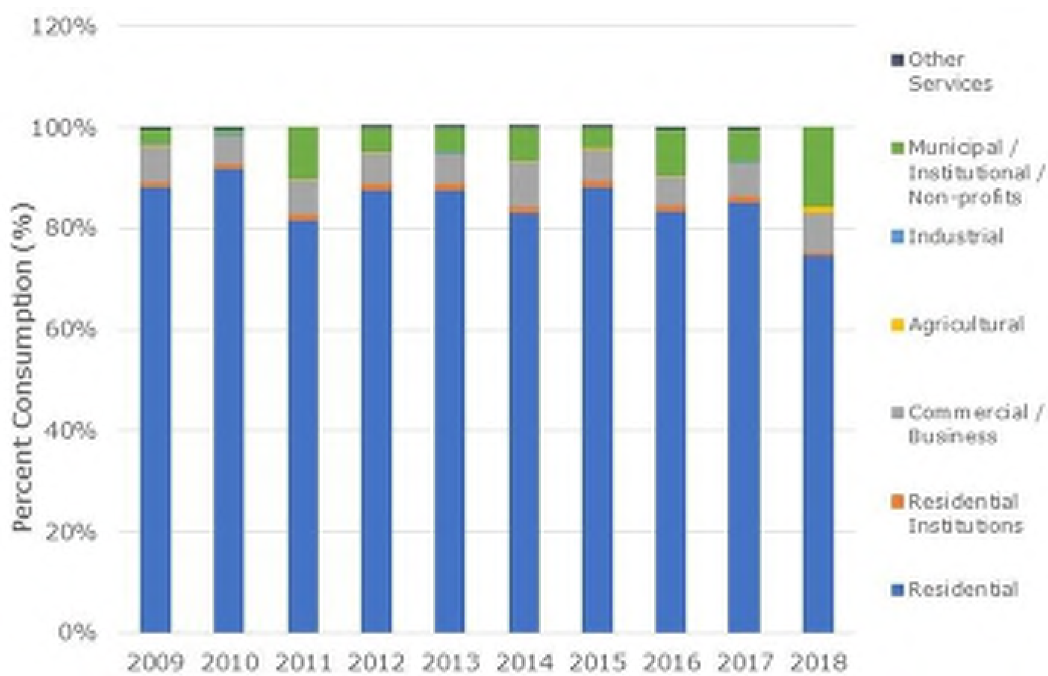
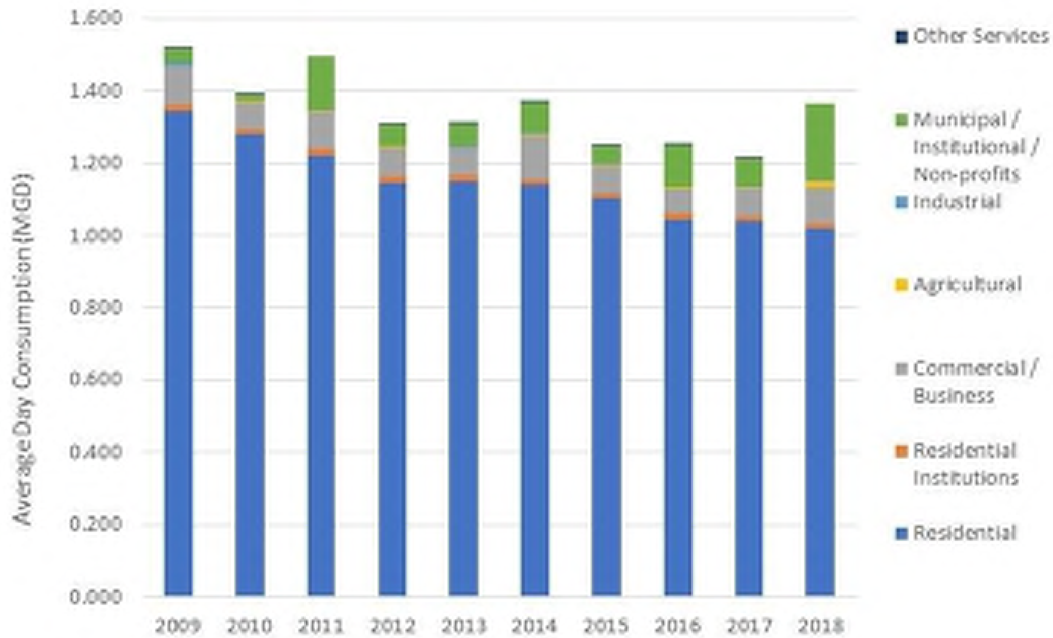


Figure 2-15: Average Day Consumption by Customer Class



<u>Baseline Demand Projections – Humarock Village Demands and System-Wide Demands Excluding Humarock Village</u>

For the purposes of evaluating the capacity of the local sources and for determining projected demands for the Town if connecting Humarock, demands were separated into system-wide demands excluding Humarock and demands for Humarock only. The historical demand trends for these respective service areas form the basis for establishing baseline demand projections assuming no growth or other changes to demands. The projected demands discussed in Section 3 are then based on the baseline demand projections plus projected demands for system growth and expansion.

The average daily demands for the consumption categories are summarized in Table 2-18 for the system excluding Humarock, and in Table 2-19 for the Humarock area only. Consumption data distinguishing the Humarock customers was provided by the Town from 2013 through 2018.

As shown in Table 2-18, there appears to be a data error with the consumption data for 2018, resulting in negative UAW (these values were not used to determine the baseline projections). The baseline projections are based on the average of the previous three years for the metered use categories and CEMU. An allocation of 10% for UAW is based on the target goal in the Town's WMA permit. Total Finished Water from Local Sources is calculated as the sum of the total metered use, CEMU, and UAW. The baseline projection of 1.506 mgd assumes no growth or system expansion; this is discussed in Section 3.

As shown in Table 2-19, UAW in the Humarock Area is high, ranging from 58-78%. The baseline projections are based on the average of the previous three years for the metered use categories. The projected UAW in mgd is also based on the three-year average, which conservatively assumes that UAW losses are not mitigated. However, the Town has improved, and continues to improve, the distribution system in this area to control water losses. For comparison, Table 2-19 also presents the baseline projections assuming UAW is decreased to 10%.

TABLE 2-18
Historical Average Demands by Customer Class – System-Wide Demands Excluding Humarock Area (mgd)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	Residential	**Residential Institution**	**Commercial / Business**	**Agricultural**	**Industrial**	**Municipal / Institutional / Non-profits**	**Other Services**	**Total Metered Use (sum a through g)**	**Total CEMU**	**UAW**	**% UAW (j / l)**	**Total Finished Water from Local Sources (h+i+j)**	**Percent Change in Total Finished Water**
2013	1.105	0.017	0.074	0.003	0.003	0.062	0.000	1.263	0.030	0.14	9%	1.429	
2014	1.081	0.014	0.120	0.003	0.002	0.086	0.0002	1.307	0.137	0.10	6%	1.540	8%
2015	1.041	0.013	0.076	0.003	0.002	0.047	0.0003	1.183	0.040	0.24	16%	1.462	-5%
2016	0.989	0.015	0.066	0.003	0.003	0.116	0.0015	1.193	0.013	0.14	10%	1.344	-8%
2017	0.987	0.014	0.076	0.003	0.003	0.076	0.0028	1.162	0.118	0.06	5%	1.341	-0.2%
2018	0.979	0.011	0.104	0.015	0.003	0.211	0.0000	1.322	0.176	*-0.13*	*-9%*	1.369	2%
Baseline Projections for Scituate Excluding Humarock	**0.985**	**0.013**	**0.082**	**0.007**	**0.003**	**0.144**	**0.001**	**1.236**	**0.120**	**0.15**	**10%**	**1.506**	

(1) Data in italics not used to determine baseline projections.

TABLE 2-19
Historical Average Demands by Customer Class – Humarock Area Demands (mgd)

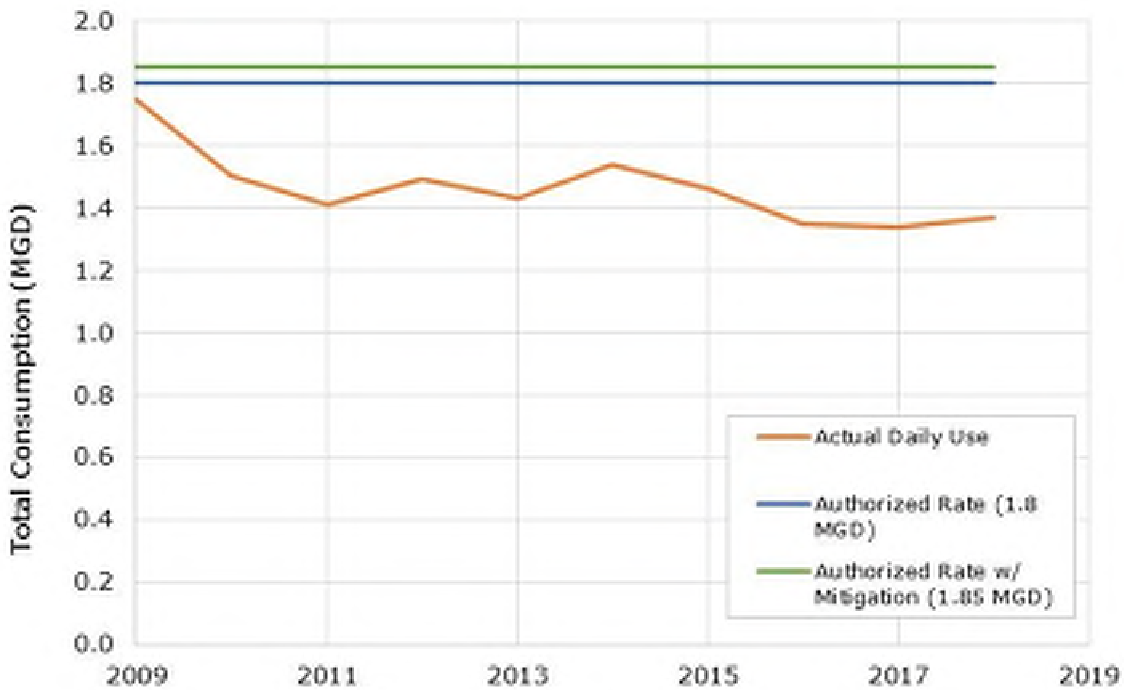
	(a) Residential	(b) Residential Institution	(c) Commercial / Business	(d) Agricultural	(e) Industrial	(f) Municipal / Institutional / Non-profits	(g) Other Services	(h) Total Metered Use (sum a through g)	(i) Total CEMU	(j) UAW	(k) % UAW (j / l)	(l) Total Purchased Water (h+i+j)	(m) Percent Change in Total Finished Water
2013	0.044		0.0016			0.00010		0.045		0.093	67%	0.139	
2014	0.061		0.0015			0.00016		0.063		0.074	54%	0.136	-2%
2015	0.061		0.0014			0.00021		0.063		0.074	54%	0.137	0%
2016	0.056		0.0023			0.00014		0.058		0.082	58%	0.140	2%
2017	0.052		0.0015			0.00009		0.054		0.115	68%	0.169	21%
2018	0.040		0.0011			0.00009		0.041		0.142	78%	0.184	9%
Baseline Projections for Humarock Area	**0.050**		**0.0020**			**0.00020**		**0.052**		**0.120**	70%	**0.172**	
Baseline Projections with Decrease in UAW	**0.050**		**0.0020**			**0.00020**		**0.052**		**0.006**	10%	**0.058**	

2.4.1.5 Authorized vs. Actual Use

Figure 2-16 compares the Actual Daily Use (the average day demand based on the total finished water from the local sources), to the Authorized Rate from the Town's WMA permit, excluding Humarock. Actual Daily Use has ranged from 71% to 97% of the Authorized Rate and averaged 81% since 2009.

The difference between the Actual Daily Use and the Authorized Rate could represent the additional demand that is available to the Town after meeting current average needs: about 0.35 mgd on average or 20% of the Authorized Rate.

Figure 2-16: Authorized Use vs. Actual Use



2.4.1.6 Available Water from Local Sources

The capacity of Scituate's local sources to meet current needs were evaluated under different source production scenarios and compared to historical demands (comparisons to projected demands are discussed in Section 3). The need for potential future sources of supply is also considered.

Table 2-20 summarizes the Town's local sources and production capacities (from Table 1-4), as well as different available water withdrawal scenarios. Figure 2-17 presents the quantities for the different withdrawal scenarios. The quantities available from these scenarios are compared to average day demands (representative of year-round conditions) and maximum day demands (representative of peak demand conditions) on Figures 2-18 and 2-19, respectively. As noted in Table 2-20:

- Production from the Old Oaken Bucket Pond WTP is based on the current reservoir firm yield as well as an estimate of the firm yield following aquatic habitat release goals, as discussed in Section 1.2.2.

- Max withdrawal rates for the groundwater wells reflect the MADEP approved Zone II maximum daily pumping rates based on prolonged pumping tests. For Old Oaken Bucket Pond, the max withdrawal rate reflects the capacity of the intake structure and the nominal capacity of the treatment plant.

- Typical production rates are based on 2018-2020 operating data (refer to Table 1-4 and accompanying discussion in Section 1.2.2).

The analysis on Figure 2-18 indicates the Town's supply sources are adequate for meeting average (year-round) demand conditions, at current production capacities (i.e., prior to improvements to Well 17A, Well 18B, and OOB WTP).

However, the analysis on Figure 2-19 indicates that, at current production rates with Wells 17A and 18B offline, restricted capacity from OOB WTP due to existing treatment processes and redundancy, and reduced production rates from other wells due to seasonal (drought) impacts, the Town's supply sources cannot meet maximum day demands. Figure 2-19 also shows the potential Future Production Capacity, which is based on the potential production following upgrades to the treatment facility at Well 18B and new treatment plants at Well 17A and OOB. This highlights the importance of upgrading the treatment facilities to alleviate restrictions in source production that are due to water quality and operational concerns, rather than available water supply.

Scituate's WMA permit indicates that: 1) prior to making withdrawals greater than the 1.80 mgd baseline, Scituate is required to develop a mitigation plan for review and approval by MADEP, incorporate the approved mitigation plan into the WMA permit by permit amendment, and implement required mitigation activities; and, 2) maximum withdrawals from groundwater withdrawal points and Old Oaken Bucket Pond are not be exceeded without advance approval from the department.

The evaluation shows that Scituate has sufficient water to meet demands if all sources can be used at their permitted rates or if treatment restrictions at Wells 17A and 18B and at the OOB WTP are addressed. The analysis shows that at current production rates and limited production capacities, the Town does not have sufficient water to meet peak demands. Other measures such as water conservation and water use restrictions during drought conditions are recommended, as the Town is currently practicing.

TABLE 2-20
Sources of Supply - Available Water from Local Sources

Source	Pump Rating	Reservoir Firm Yield (1)	Max Authorized Daily Withdrawal (2)		Current Production Capacity (3)
	gpm	gpm	mgd	gpm	gpm
Well #10	160		0.20	138	90
Well #11	104		0.12	81	50
Well #19	350		0.41	288	213
Well #22R	350		0.50	350	166
Well #17A	360		0.39	270	Offline
Well #18B	350		0.22	153	Offline
Old Oaken Bucket WTP (4)	--	549 (0.79 mgd)	3.0	2,083	1,528 (1.65 mgd for 18-hours)
Old Oaken Bucket WTP w/ Streamflow Releases (5)	--	389 (0.56 mgd)			

Available Water Withdrawal Scenarios

Average Day Supply Scenarios:	Total (mgd)	Description
Current Production Capacity	2.40	Sources operating at their current production capacity
Source Safe Yields w/out Streamflow Releases	2.44	Wellfield safe yield and reservoir firm yield before minimum streamflow releases
Average Annual Permit, excluding Humarock	1.75	Through 8/31/2020
	1.80	Through 8/31/2030 without Mitigation
	1.85	Through 8/31/2030 with Mitigation (6)
Max Day Supply Scenarios:		
Current Production Capacity	2.40	Sources operating at their current rates
Future Production Capacity	4.36	Wells 17A and 18B and OOB WTP at max authorized withdrawal rates following upgrades, other sources operating at their current rates
Max Day Permit	4.84	Max daily authorized withdrawal for wells and OOB WTP
Max Day Permit with Largest Well Offline	4.34	Assumes largest well is offline

(1) Corresponds to the annual daily average withdrawal rate and total annual withdrawal volume in the Town's WMA permit; the firm yield was approved by MADEP on May 13, 2004 and is based on the drought of record (1960's) for Massachusetts with no downstream releases.
(2) For the groundwater wells, the max withdrawal rates reflect the MADEP approved Zone II maximum daily pumping rate for each well based on prolonged pumping tests. For Old Oaken Bucket Pond, this reflects the capacity of the intake structure and the nominal capacity of the water treatment plant.
(3) Well 18B currently offline due to water quality and backwash processing capacity. Well 17A offline during construction of new treatment plant. Typical OOB and well production rates observed in 2018-2020. OOB rate corresponds to max sustainable rate with existing processes and redundancy. Production shown is for 18 hours and is only sustainable for short periods (<2 weeks).
(4) OOB treatment capacity is rated for 3 mgd, does not limit production. Current production capacity based on operating the plant through two 9-hour shifts.
(5) Equal to current Firm Yield minus release goal of 0.23 mgd for Jun-Aug Bio Period (from *Reservoir Dam Water Storage Modeling Report, September 2019*). This subtraction is an approximation and revised firm yield should be corroborated with the reservoir model.
(6) With mitigation plan incorporated into permit and mitigation activities implemented.

Figure 2-17: Available Water Scenarios

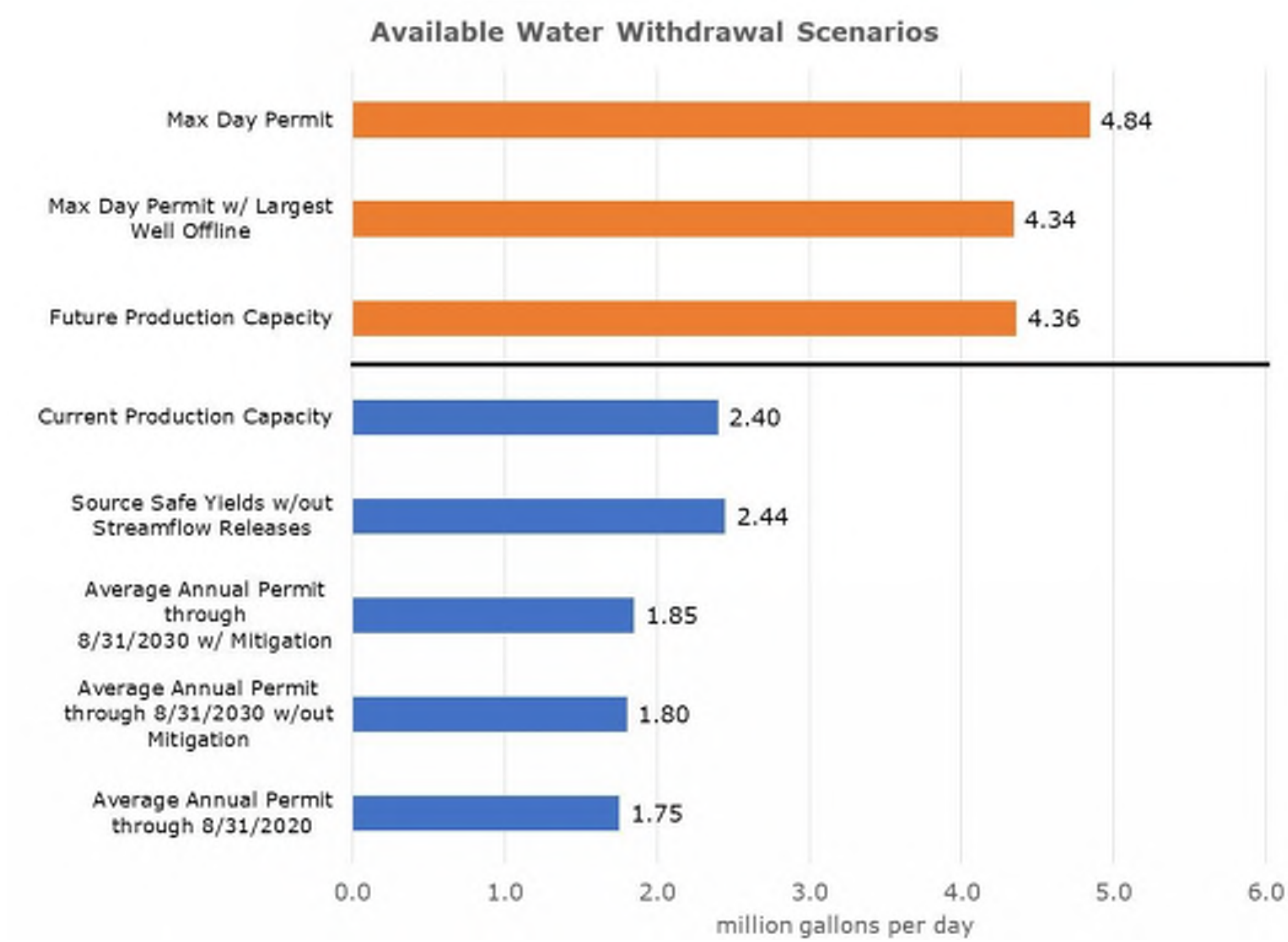


Figure 2-18: Supply Assessment under Average Day Baseline Demands (Excludes Humarock)

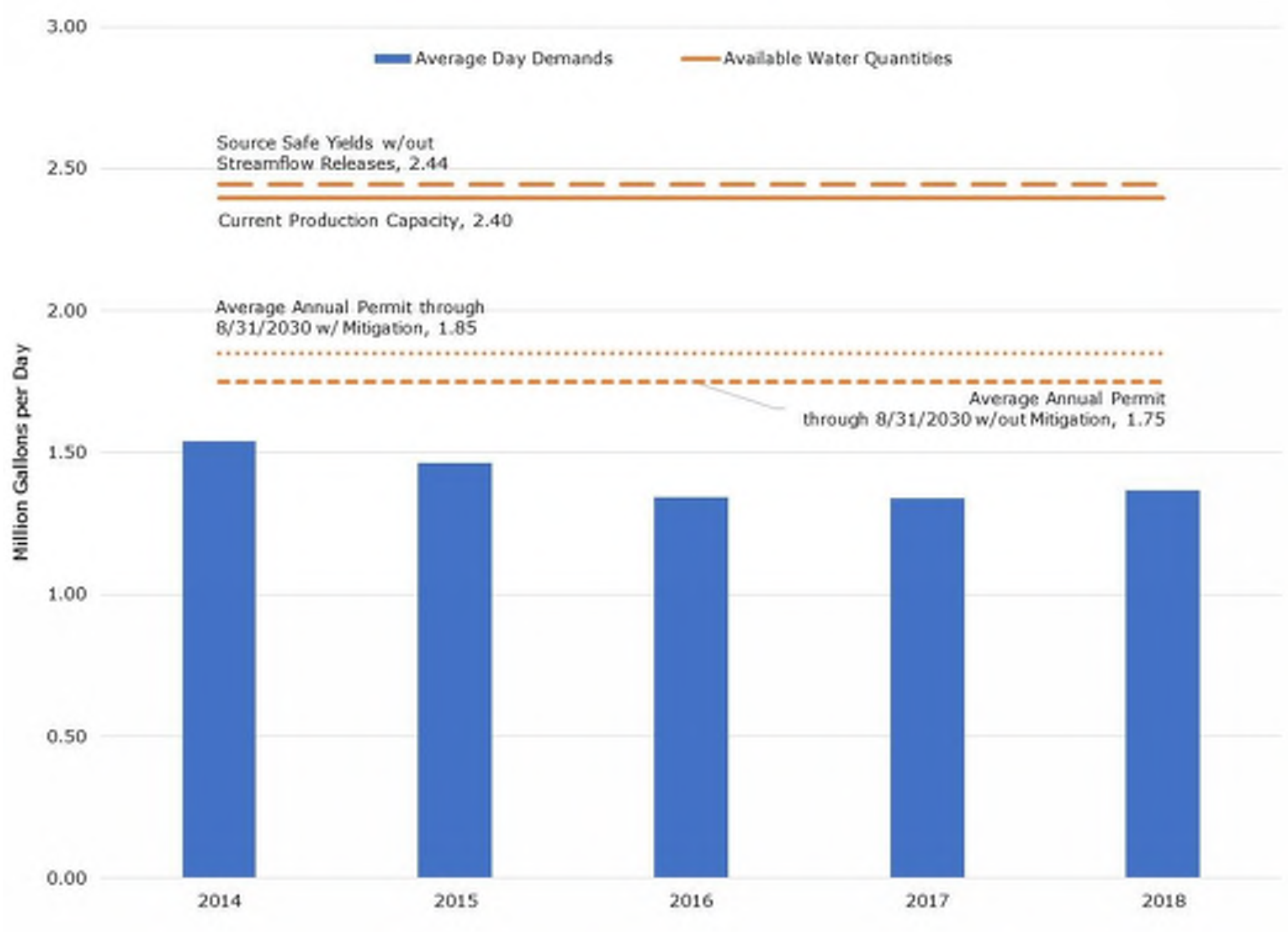
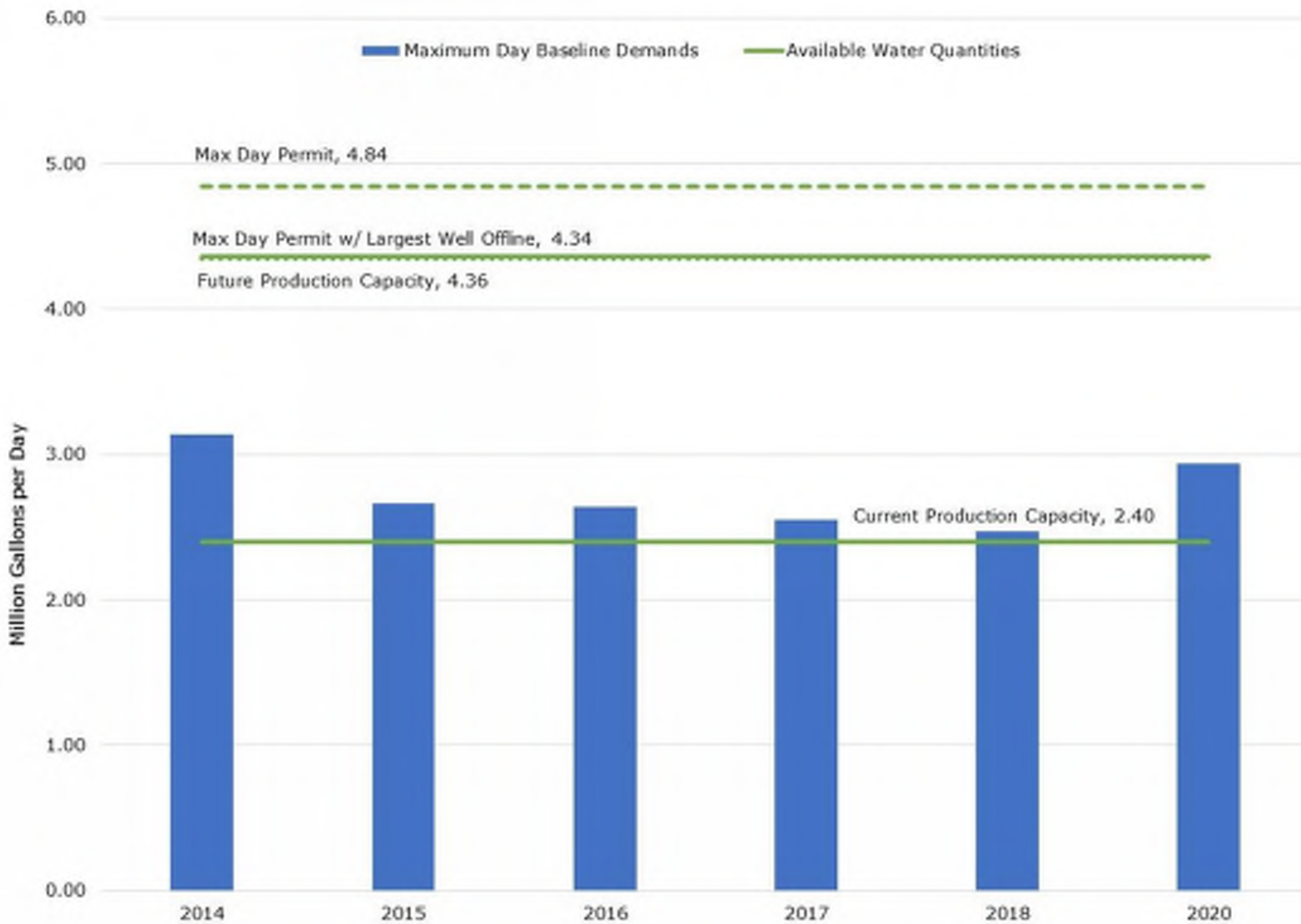


Figure 2-19: Supply Assessment Under Maximum Day Baseline Demands (Excludes Humarock)



2.4.1.7 Source Redundancy and Pumping Capacity Evaluation

The Massachusetts Guidelines for Public Water Systems (April 2014) indicate that pumping facilities should be provided with at least two pumping units. The guidelines further state: "with any pump out of service, the remaining pump(s) shall be capable of providing the maximum daily pumping demand of the system," and "each booster pumping station contains not less than two pumps with capacities such that peak demand can be satisfied with the largest pump out of service."

The following evaluation considers the pumping capacity available from the system's supply sources to meet the overall demands of the system (Table 2-21), as well as the level of redundancy available if sources are offline. Peak hour demands in Table 2-21 are based on applying a peaking factor of 1.75 to the average day demands, like the peaking factor used in the hydraulic model.

Table 2-21 compares maximum day and peak hour demands for the entire system (excluding Humarock) against the supply capacity available under two scenarios: 1) all sources producing up to the maximum daily withdrawal rates from the WMA permit; and, 2) all sources producing at their current production capacity (that is, Wells 17A and 18B currently offline and prior to improvements that would allow production up to the permitted rates for Wells 17A and 18B and for the OOB WTP). The total supply capacity is determined with all sources in service as well as with the largest well (Well #22R in Scenario 1 and Well #19 in Scenario 2) out of service and with OOB WTP out of service. The analysis also summarizes the percentage of max day demands that each source could meet on its own (for example, at its permitted rate, Well #11 can meet 5% of max day demands, while the treatment plant could meet 122% of max day demands at its permitted rate).

Figures 2-20, 2-21, and 2-22 present the results of this analysis. Under Scenario 1 (sources at max permitted rates), max day demands and peak hour demands are met even with the largest well out of service, but demands are not met if OOB WTP is out of service. Under Scenario 2 (sources at current production capacities and Wells 17A and 18B offline), max day demands are met with available sources in service and with the largest well out of service but not with OOB WTP out of service, and peak hour demands cannot be met. The analysis indicates that all sources are important and OOB WTP is critical for meeting high demands.

The recommendations included in this master plan are intended to provide operational flexibility to meet demand conditions during any season (for example, max day demands represent peak summer use). However, the decision of which sources to operate at particular times of the year or under seasonal conditions is a Water Department operational decision that depends on many factors that are beyond the scope of a Master Plan. The analysis highlights the importance of the upgrades at Wells 17A and 18B and replacing the OOB WTP.

TABLE 2-21

Supply Capacity Evaluation - Scituate Water System (Excluding Humarock)

Facility Name	Scenario 1: Maximum Daily Withdrawal Rates from WMA Permit		Scenario 2: Sources at Current Production Capacity	
	gpm	% of MDD	gpm	% of MDD
Old Oaken Bucket WTP	2,083	122%	1,528	89%
Well #19	288	17%	213	12%
Well #17A	270	16%	0	0%
Well #22R	350	20%	166	10%
Well #18B	153	9%	0	0%
Well #10	138	8%	90	5%
Well #11	81	5%	50	3%
Total with OOB out of service	1,280	75%	519	30%
Total with largest well out of service	3,013	176%	1,834	107%
Total with all sources in service	3,363	196%	2,047	119%

2018 Max Day Demand (MDD)	1,713 gpm
Peak Hour Demand (PHD=1.75X ADD)	2,198 gpm
Fire Flow	From storage

ADD based on average summer day (max month demand).

Figure 2-20: Current Production Capacity (Wells 17A and 18B Offline)

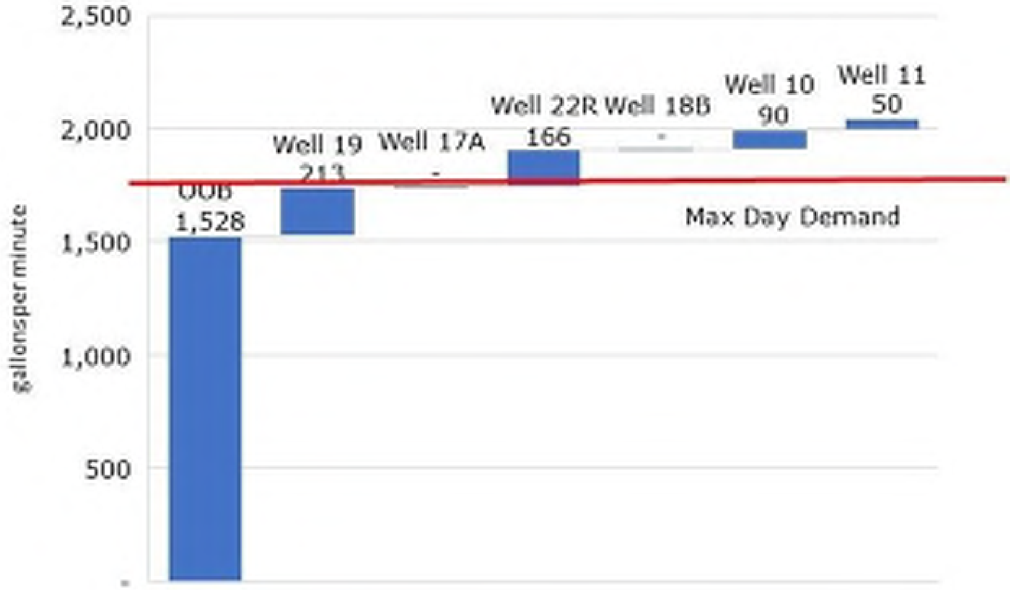


Figure 2-21: Current Production Capacity with Largest Well Offline (#19) and Wells 17A and 18B Online (at Max Permitted Rate)

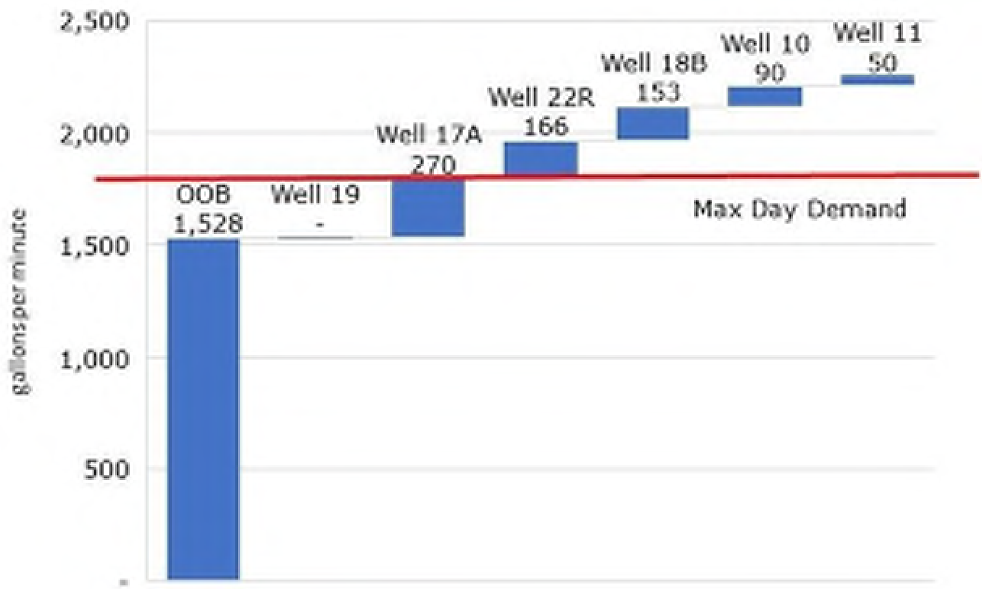
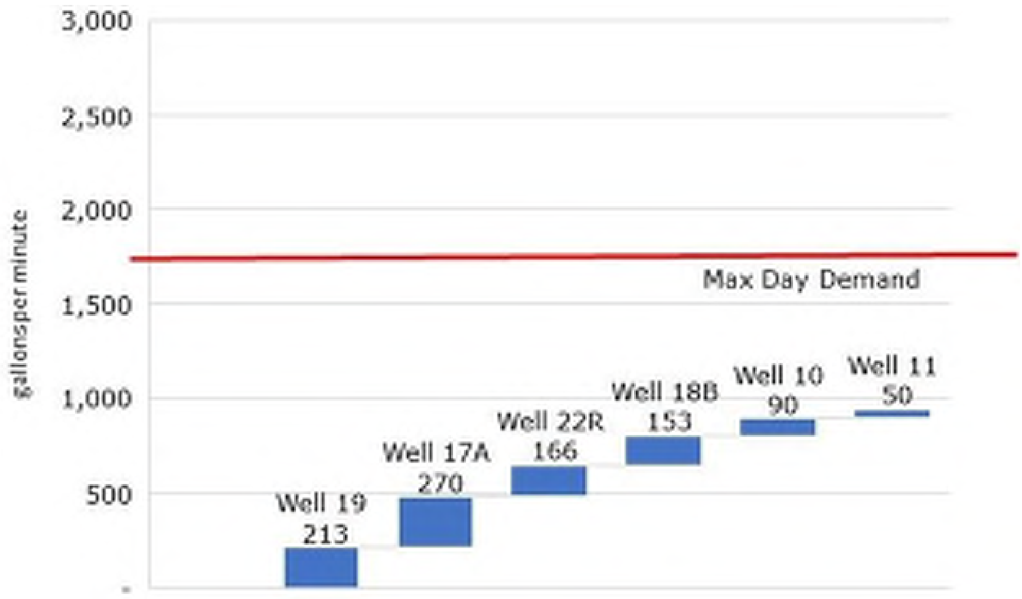


Figure 2-22: Current Production Capacity with OOB WTP Offline and Wells 17A and 18B Online (at Max Permitted Rate)



In addition to evaluating source redundancy and pumping capacity available to meet max day demands, consideration was given to the amount of time over which max day demands must be met. Figures 2-23, 2-24, 2-25 and 2-26 present daily demands during the peak demand periods for 2015, 2016, 2017, and 2018, respectively.

The daily data show that demands will peak for a day and subsequently decrease, and not remain at the same peak demand for multiple days, except for 2018 which did experience 3 days of high demands following the max day.

Figure 2-23: 2015 Max Day Demand Period

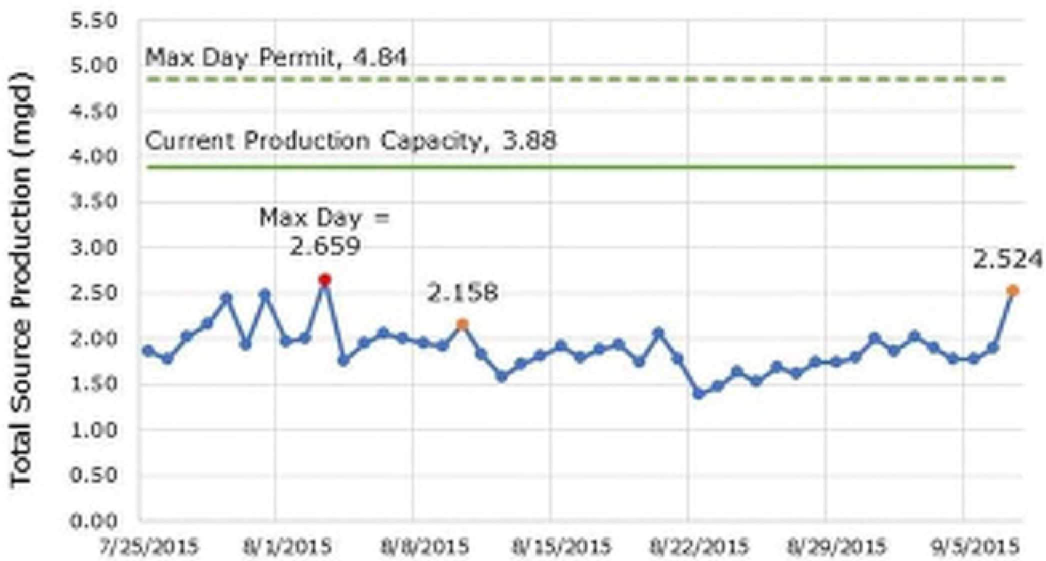


Figure 2-24: 2016 Max Day Demand Period

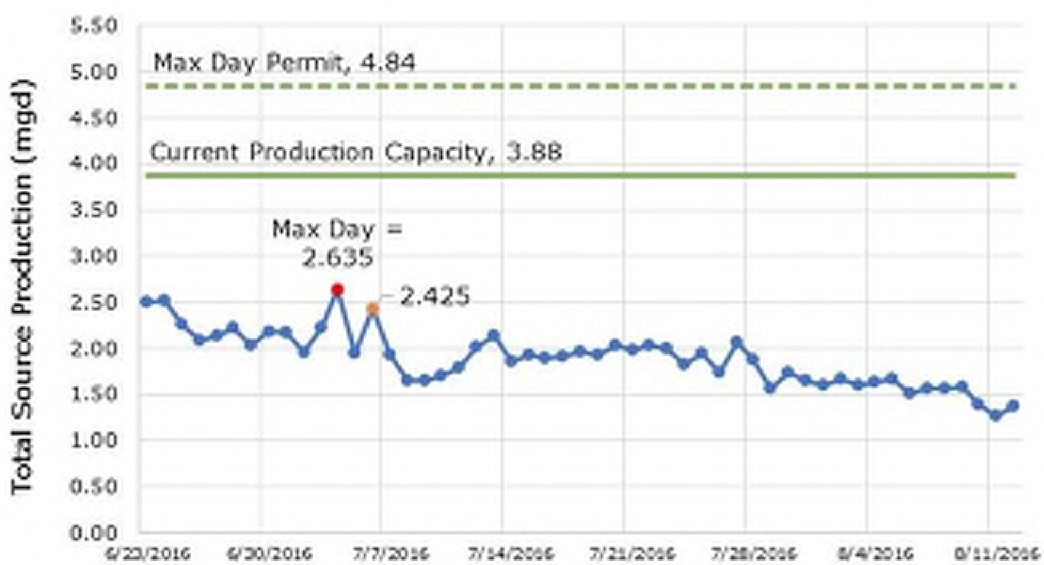


Figure 2-25: 2017 Max Day Demand Period

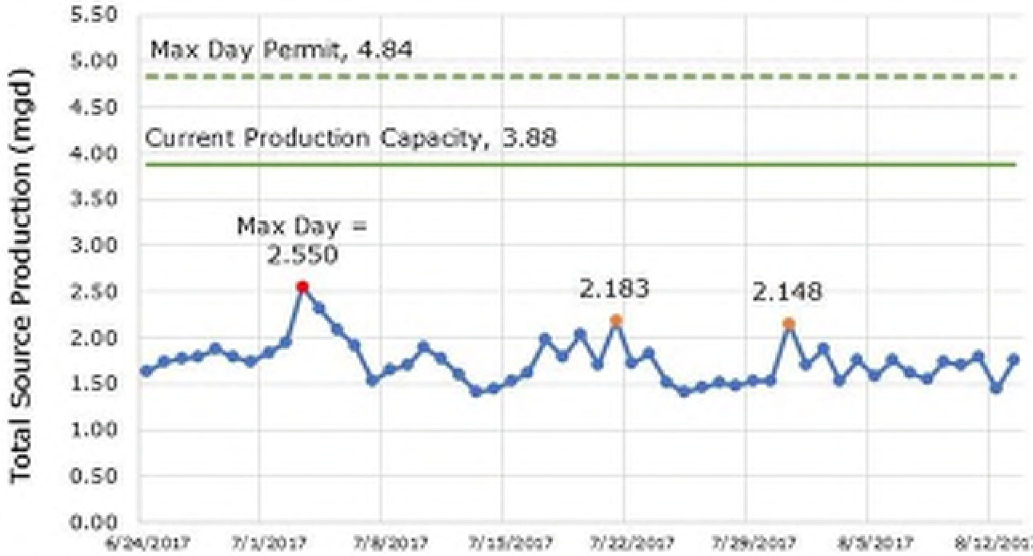
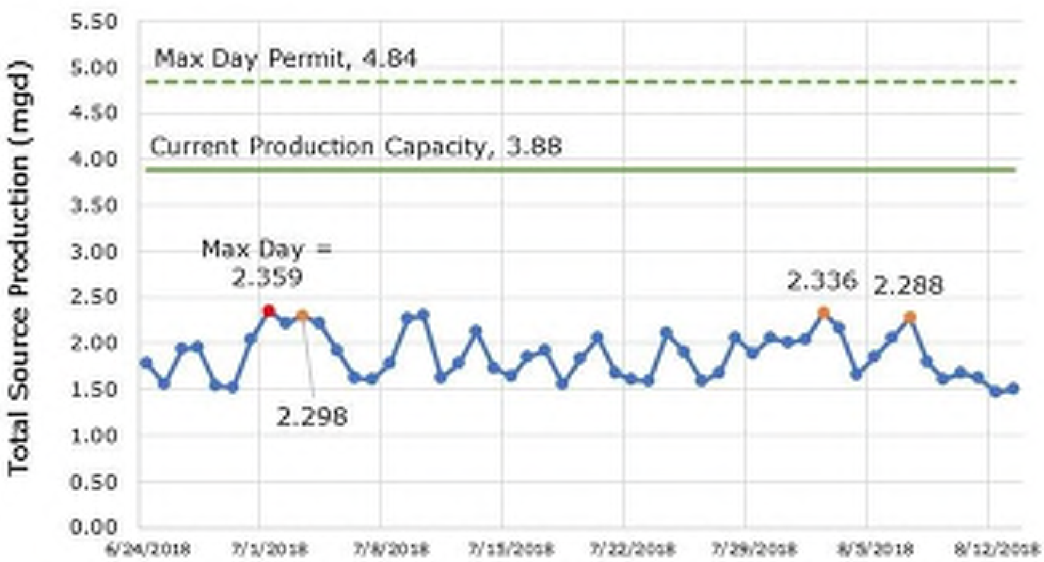


Figure 2-26: 2018 Max Day Demand Period



The remaining evaluation below considers the pumping capacities of the different booster pump stations that supply the two individual high-pressure zones in the system (Tables 2-22 and 2-23). Average and max day demands for the pressure zones are based on the demands assigned in the distribution system hydraulic model based on customer billing data. Peak hour demands are based on applying a peaking factor of 1.75 to the average day demands, like the peaking factor used in the hydraulic model.

The Mann Lot Road High Service Area is served by the Mann Lot Road Pump Station. There is no atmospheric storage at this water level. Table 2-22 compares maximum day demands and peak hour demands against the station's pumping capacity with the largest pump out of service. This area of the distribution system provides fire protection.

The Mann Lot Road Pump Station meets the pumping capacity criteria but cannot provide fire flows in excess of 2,100 gpm.

TABLE 2-22

Pumping Capacity Baseline Evaluation – Mann Lot Road High Service Area

Facility Name	Pump No.	Demand / Capacity (gpm)	Standby Power
2018 Max Day Demand (MDD)		130	
Peak Hour Demand (PHD=1.75X ADD)		186	
Fire Flow		3,500	
Mann Lot Road Pump Station	1	1,050	Yes
	2	1,050	Yes

Comparison Criteria		
Criterion #1: Pumping Capacity Minus Largest Pump > MDD	1,050	Criterion Met
Criterion #2: Pumping Capacity Minus Largest Pump > PHD	1,050	Criterion Met
Ability to meet fire flow	2,100	Not met with all pumps in service

The Walnut Tree Hill High Service Area is served by the Walnut Tree Hill Pump Station. There is no atmospheric storage at this water level. Table 2-23 compares maximum day demands and peak hour demands against the station's pumping capacity with the largest pump out of service. This area of the distribution system provides fire protection.

The Walnut Tree Hill Pump Station meets the pumping capacity criteria but cannot provide fire flows in excess of 1,350 gpm.

TABLE 2-23

Pumping Capacity Baseline Evaluation – Walnut Tree Hill High Service Area

Facility Name	Pump No.	Demand / Capacity (gpm)	Standby Power
2018 Max Day Demand (MDD)			
Peak Hour Demand (PHD=1.75X ADD)			
Fire Flow		3,500	
Walnut Tree Hill Pump Station	1	200	Yes
	2	200	
	3	950	Yes

Comparison Criteria		
Criterion #1: Pumping Capacity Minus Largest Pump > MDD	400	Criterion Met
Criterion #2: Pumping Capacity Minus Largest Pump > PHD	400	Criterion Met
Ability to meet fire flow	1,350	Not met with all pumps in service

2.4.2 Storage Assessment

The Massachusetts Guidelines for Public Water Systems (April 2014) indicate that "storage facilities should have sufficient capacity, as determined from engineering studies, to meet domestic demands, and fire flow demands where fire protection is provided. Fire flow requirements established by the National Fire Protection Association (NFPA) should be satisfied where fire protection is provided. The minimum storage capacity (or equivalent capacity) for systems not providing fire protection shall be equal to the average daily consumption. This requirement may be reduced when the source and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system. Excessive storage capacity should be avoided to prevent potential water quality deterioration problems."

Regarding pressure in the distribution system related to storage, the guidelines note "all service connections shall have a minimum residual water pressure at street level of at least 20 psi under all design conditions of flow," and "the minimum working pressure in the distribution system should be 35 psi and the normal working pressure should be approximately 60-80 psi."

Because the storage tanks provide pressure to the main service area, the storage tanks were evaluated as follows:

- Available usable storage compared to total required storage (the larger of required turnover equalization storage or required peaking equalization storage, plus the required fire storage).
    - Usable equalization storage is defined as storage above the elevation that provides 35 psi static pressure at the high point in the system. Required equalization storage is based on the greater of 20% of the maximum day demand (peaking equalization) or 20% of the total useable volume (equalization volume that provides a 5-day turnover).
    - Usable fire storage is defined as storage above the elevation that provides 20 psi static pressure at the high point in the system. Required fire storage is determined based on the highest ISO identified needed fire flow in the system multiplied by the ISO recommended flow duration.

The system's storage tanks are illustrated in Figure 2-27. Table 2-24 compares the available usable storage to the required storage. The characteristics of the storage tanks are:

- The Pincin Hill Tank (also known as the Maple Street Tank) is a standpipe with a diameter of 54 feet and total height of 75 feet. The tank's overflow elevation is at an elevation of 201 feet. The operating overflow is 200 feet, therefore the tank has an operating volume of 1.268 MG.
- The Mann Lot Road Tank (also known as the Creelman Tank) is a standpipe with a diameter of 50 feet and total height of 72 feet. The tank's overflow elevation is at an elevation of 203 feet. The operating overflow is 200 feet, therefore the tank has an operating volume of 1.013 MG.

The required equalization storage of 0.493 MG is based on the peaking equalization to meet peak demands (20% of max day demand) and corresponds to a required equalization depth of 16 feet and elevation of 184 feet at the bottom of the equalization storage, including 1 foot of freeboard. At this water level elevation, approximately 225 of the highest customers in the system receive less than 35 psi of static pressure. The highest customer in the system receives 24 psi.

Figure 2-28 illustrates the location of the high services that receive less than 35 psi with the tanks drawdown to the required equalization depth. At the bottom of the required equalization elevation, these services, ranging in elevation from 104 feet to 128 feet, receive 24 to 34 psi of static pressure.

The elevation that provides 20 psi of static pressure for the highest customer is at 174 feet. Therefore, the volume below the required equalization storage (at 184 feet) and above 174 feet is usable for fire protection and emergencies, or a combined volume of 0.327 MG. The remaining volume below 174 feet and to the bottom of the storage tanks is considered unusable, or a combined volume of 1.460 MG.

The required emergency storage is based on providing a fire flow of 3,500 gpm for 3 hours, or 0.630 MG. This corresponds to a required emergency depth of 20 feet to an elevation of 165 feet at the bottom of the required emergency storage. At this water elevation approximately 21 customers receive less than 20 psi of static pressure. The highest customer in the system receives 16 psi.

As shown in Figure 2-27 and in Table 2-24, although the total storage is greater than the required storage, the tanks do not provide the required pressures for all customers in the system. For the highest customer, the tanks can provide static pressures in the range of 0 psi (at a max drawdown of 2 feet above the base elevation of the Pincin Hill Tank) to 31 psi (at the operating overflow of 200 feet). Approximately 225 customers receive less than 35 psi with the tanks drawn down to the bottom of required equalization, and 21 customers receive less than 20 psi with the tanks drawn down to the bottom of the required fire storage. These limited areas of low pressure are also identified in the hydraulic model.

If the Pincin Hill tank needs to be removed from service for maintenance or repairs, then the remaining volume provided by the Mann Lot Rd Tank is less than the required storage volume. However, if the Mann Lot Rd Tank is removed from service, the volume provided by the Pincin Hill Tank is greater than the required storage volume.

We recommend providing a new storage tank to improve operational flexibility when a tank needs to be offline for maintenance. The property where the existing tanks are located appear to have space available for a new tank, such that a third tank could be constructed while the existing tanks remain in service. Due to its location with respect to the distribution system, a tank located next to the Mann Lot Rd Tank would provide greater hydraulic benefit.

However, providing excessive storage is not recommended due to water quality concerns. Excessive storage leads to stagnation which can result in loss of disinfectant residual and increase in disinfection byproducts. Therefore, we recommend providing no more storage than required to meet the criteria for equalization, fire, and emergency storage as discussed. Therefore, the recommendation to add a third tank is accompanied by a recommendation to reduce the storage provided in the lower service area by the existing tanks. This could be accomplished by replacing one of the tanks with two smaller tanks. Providing a new tank and reducing storage in an existing tank would be a major undertaking that we view as lower priority compared to the treatment plant upgrades.

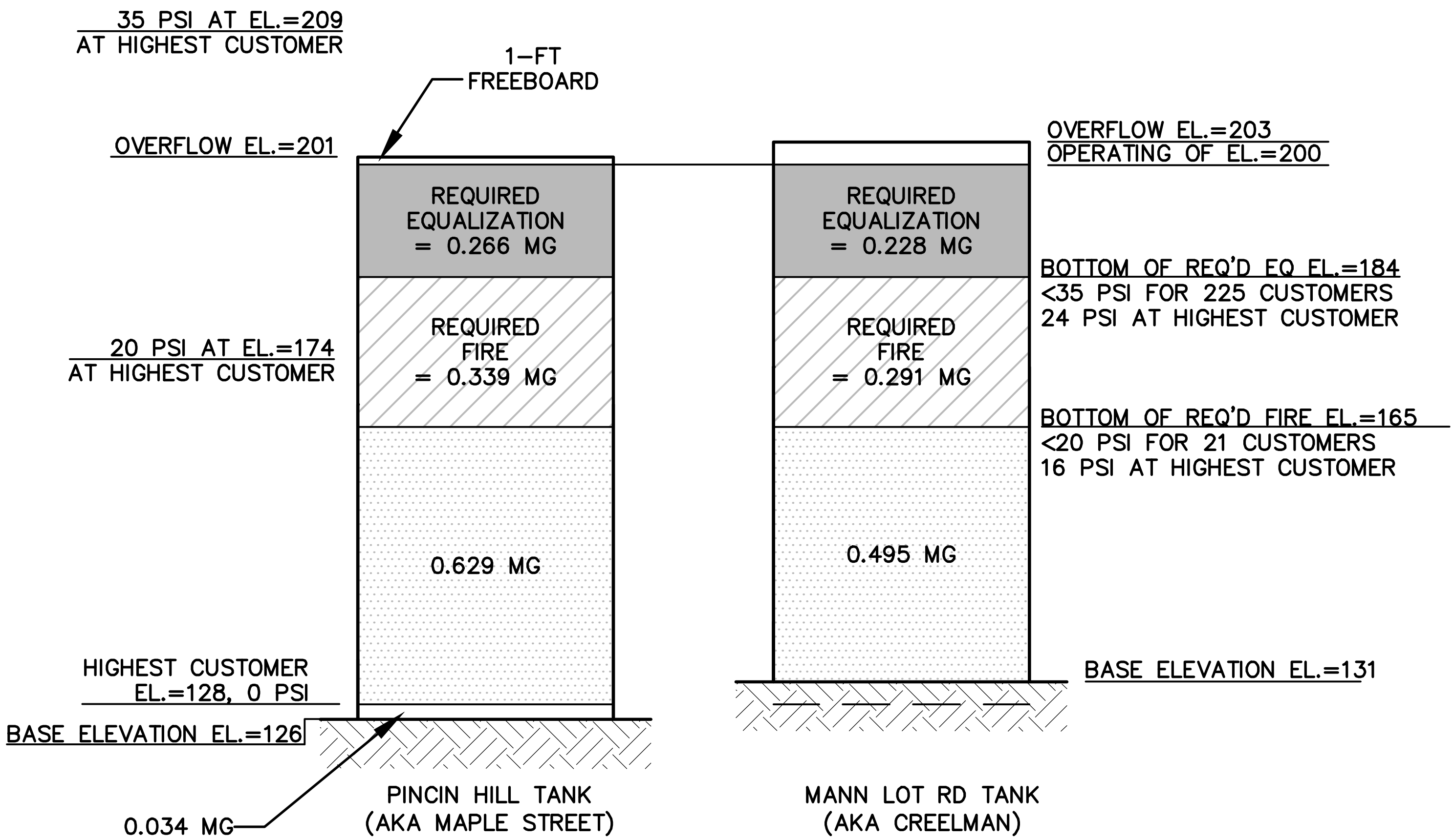
TABLE 2-24

Scituate – Baseline Storage Capacity Evaluation Data (million gallons)

	Required	Usable
Equalization Storage	0.493 (1)	0 (3)
Emergency/Fire Storage	0.630 (2)	0.327 (4)
Volume below Usable	--	1.460 (5)
Total	1.123	2.281 (6)

(1) At bottom of the required EQ storage, highest 225 customers in the Main (Low) Service Area receive less than 35 psi; highest customer receives 24 psi.
(2) Required fire storage of 3,500 gpm for 3 hours.
(3) Water elevation that provides 35 psi at the highest customer is above the tank overflow elevation.
(4) Equivalent to volume above elevation that provides 20 psi of static pressure at high point in the system minus required equalization storage.
(5) Volume below the elevation that provides 20 psi to the bottom of the storage tanks.
(6) Usable fire plus volume below usable plus required equalization.

REQUIRED TANK LEVELS



TOTAL CAPACITY TO OPERATING OVERFLOW
PINCIN HILL TANK = 1.268 MG (17,131 GAL/FT)
MANN LOT RD TANK = 1.013 MG (14,687 GAL/FT)

DIAMETER
PINCIN HILL TANK = 54 FT
MANN LOT RD TANK = 50 FT

NOTES:
1. STORAGE EVALUATION DOES NOT INCLUDE DEMANDS OR CUSTOMERS IN HUMAROCK.
2. REQUIRED EQUALIZATION STORAGE BASED ON PEAKING EQUALIZATION (20% OF MAX DAY DEMAND).
3. REQUIRED FIRE STORAGE BASED ON 3500 GPM FIRE FLOW AND 3 HOUR DURATION.
4. STORAGE BELOW REQUIRED FIRE AND ABOVE ELEVATION THAT PROVIDES 0 PSI AT HIGHEST CUSTOMER PROVIDES AVERAGE DAY CONSUMPTION FOR 15 HOURS.
5. HIGHEST CUSTOMER LOCATED ON TACK FACTORY POND DRIVE.

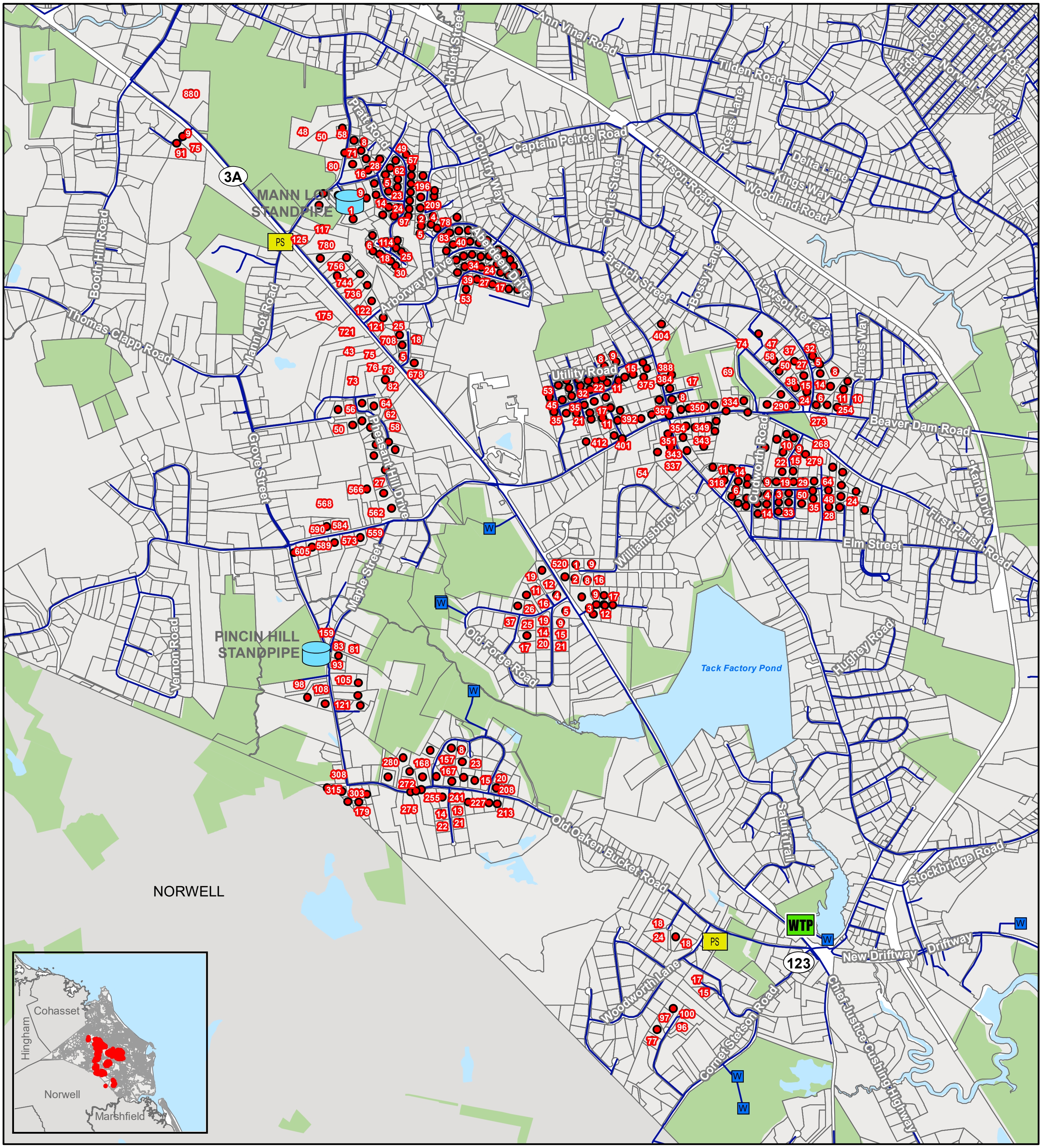
FIGURE 2-27
2019 WATER MASTER PLAN

SCITUATE STORAGE TANK EVALUATION
BASELINE ASSESSMENT

Scituate Water Division

Tighe&Bond
www.tighebond.com

10/04/2019



- Service Point with High Elevation
- PS Pumping Station
- WTP Treatment Plant
- W Well
- WaterTank
- Water Main
- Parcels
- Waterbody
- Protected Open Space Land

N

1:24,000

0 1,000 2,000
Feet

January 2020

FIGURE 2-28
Scituate Service Points at High Elevations

(receive <35 psi at bottom of required equalization)

Scituate System
2019 Water Master Plan
Scituate Water Division

Tighe&Bond
Engineers | Environmental Specialists

Based on data provided by Scituate MA.
Parcels obtained through MassGIS

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S-5001

2.4.3 Consolidation of Sources Assessment

Consolidation of sources of supply and individual treatment facilities was considered in this master plan.

The main advantage when consolidating sources is a potential cost savings where multiple sources require the same type of treatment because consolidating sources also consolidates treatment facilities.

However, the inherent disadvantage with consolidating sources to a single treatment facility is that the loss of the single facility would result in the loss of multiple sources. Thus, retaining multiple separate sources provides greater system resiliency.

Additionally, not all the supply sources in Town require the same type of treatment. For example, neither Well 19 nor Well 22 require treatment for manganese (discussed further in Section 4). Considering there is a new treatment plant already under construction at Well 17A for manganese removal, consolidating Wells 17A, 19, and 22 would not provide benefit.

Similarly, connecting Well 17A to the OOBWTP would reduce the overall production capacity, as both sources would be limited by the permitted capacity of the OOBWTP. A higher total finished water production capacity is possible if both sources remain separate.

As noted, a treatment plant is under construction at Well 17A; therefore, connecting Well 17A to the OOBWTP is not advantageous at this point. The decision for a new treatment plant at Well 17A was made by the Town (prior to this Master Plan Study) due to the urgent need for additional production capacity independent of the OOBWTP. This need was underscored by the emergency in the winter of 2018-2019. In addition to improving system resiliency and finished water production capacity, the Well 17A treatment plant will be completed and in service several years sooner than a new or upgraded OOBWTP due to the substantially longer planning, design, and construction periods required for a surface water treatment plant.

SECTION 3

Section 3
Supply System Evaluation

3.1 Future System Assessment

This section builds upon the previous analysis by evaluating the existing system's ability to provide future demands in 2030, 2040, and 2050. The following evaluation consists of two basic elements: developing future demands and evaluating the system's performance under those demands.

3.2 Estimating Future Population

Projections of the number of people to be served by the Town's system provide the basis for projecting future water demands and assessing the adequacy of the system's supply sources. This sub-section presents population trends since 1990 and projections for 2030, 2040, and 2050 planning periods. Projected demands are discussed in Section 3.3.

3.2.1 Historical and Projected Populations

Historical population data, annual estimates, and population projections were obtained for the Town of Scituate. Table 3-1 and Figure 3-1 show the historical and projected populations.

Historical population data were obtained for the Town for 1990, 2000, and 2010 from the Decennial Census U.S. Census Bureau. Annual estimates were obtained for 2011 through 2017 from the American Community Survey's (ACS) 5-year estimates.

3.2.1.1 Regional Population Projections

Population projections were obtained from the Metropolitan Area Planning Council (MAPC), which were developed in 2014 for the 2020 and 2030 periods, and from the University of Massachusetts Donahue Institute, which were developed in 2015 for the 2020, 2025, 2030, and 2035 periods. The executive summary from the MAPC 2014 evaluation is included in Appendix B. The UMASS Donahue projections can be found under the Massachusetts Population Estimates Program at http://www.donahue.umassp.edu/.

- The MAPC developed projections based on two scenarios for regional growth. The Status Quo Scenario is based on continuation of existing rates of births, deaths, migration, and housing occupancy. Alternatively, the Stronger Region scenario explores how changing trends could result in higher population growth, greater housing demand, and a substantially larger workforce. Projections for 2040 and 2050 were extrapolated from the 2020 and 2030 projections.

  The MAPC characterizes Scituate as an Established Suburb. These communities are characterized by owner-occupied single-family homes on lots less than one acre. They contain scattered parcels of vacant developable land and new growth takes the form of infill and some redevelopment. Their population is relatively stable.

- The Donahue Institute used a component-of-change method based on trends observed in Town-level fertility and mortality from 2000 through 2010, and regional, gross migration-by-age trends observed in data from the 2005-2012 American Community Survey. Projections for 2040 and 2050 were extrapolated from the 2030 and 2035 projections.

The data suggest the following:

- Scituate experienced an increase in population from 1990 to 2010.

- The ACS estimates indicate very slight increases in population from 2010 through 2017, of 0.5% or less per year, whereas the MAPC and Donahue projections both estimated a decline in population from 2010 to 2020.

- The MAPC and Donahue projections for 2020 are lower than the 2010 U.S. Census. A slight population decrease of -1.1% is projected from 2020 to 2030 under the Status Quo scenario, whereas a slight increase of 0.3% is projected from 2020 to 2030 under the Stronger Region scenario, or about 4.6 ppl/yr (although the MACP's 2020 population estimate is lower than the actual 2010 US Census). A larger decrease of -3.1% is projected from 2020 to 2030 by the Donahue Institute.

- The MAPC 2014 projections also include housing demand projections and estimates of the total household change and housing unit demand. Under the Stronger Region scenario, approximately 623 additional housing units are expected from 2010 to 2030, or an increase in number of households of 9%. The projected population, however, is expected to increase by only 0.3% as noted above. Overall, the MAPC population and household projections suggest that household sizes will continue to shrink and that demand for multi-family housing alternatives will increase; in particular, the MAPC attributes an increase in elderly housing, as elderly residents comprise the fastest growing segment of the population according to the MAPC.

3.2.1.2 Scituate 2004 Master Plan and Planning Board Comments

2004 Master Plan

The Town is preparing an update to its Master Plan and anticipates having a draft in the Spring of 2020. The 2004 Master Plan includes a buildout analysis, which is a calculation of the potential maximum level of development of the Town showing the total future potential residential and commercial development based on the zoning regulations present at the time.

Approximately 2,099 acres, or 19% of the Town, were viewed as remaining developable land under current zoning regulations. This remaining developable land would result in 2,890 additional homes in Residential Zoning Districts, based on densities allowed at current zoning. Approximately 320,000 additional square feet of space could be accommodated in the Business and Commercial Zoning District.

A conservative estimate of the rate of future residential development was based on the average of 44 building permits per year issued from 1990 to 2000. Therefore, it was projected that each year an additional 44 new homes could be expected to be built. At the assumed rate of 44 homes per year, buildout was estimated to be reached in the year 2066 (implying the calculations were determined in 2000 to 2001).

At the average household size for Scituate (2.65 people per household, according to the 2013-2017 American Community Survey (ACS) estimate), the additional homes could represent approximately 7,659 additional people.

This estimate of the future population is very conservative and significantly different to the MAPC and Donahue projections. The potential number of households from the buildout analysis is based on zoning regulations and available open land but does not consider potential population changes resulting from births, deaths, and migration, or changes in household characteristics whereby households may decrease in size (the same population number spread out across more housing units).

Town of Scituate Planning Board Information (from 2020)

Scituate's planning office was contacted to discuss current or future projects that may impact the population served by the Town and require public water supply.

Descriptions of identified new developments are summarized in Appendix B, including the planned number of housing units, estimated population served for each project, and anticipated planning period for the development. The estimated number of housing units listed for each development is based on discussion with the Town planners. Information on non-residential development projects was also provided, as listed in Appendix B.

Overall, based on the projects identified, an estimated 664 potential units are planned, with approximately half (331 units) either in construction or soon to be in construction in 2020, and the remainder (333 units) projected for further out (it is assumed the remainder would be developed by 2030). Projects consists of a mixture of Chapter 40B affordable housing developments, single-family homes, elderly housing complexes, duplexes, and one- and two-bedroom units, as well as some mixed-use (commercial/retail) projects.

The following conclusions are drawn from this data:

- The number of units for the residential projects is consistent with the 2014 MAPC projections. The types of planned units are also consistent with smaller household sizes (e.g., elderly housing, one- and two- bedroom units, and duplexes).
- The mixed-use and non-residential developments appear to be consistent with developments identified in the market analysis summarized in the 2014 MACP Scituate Economic Development Study. These are discussed further in the section below (and in Appendix B) and form the basis for estimating water demand projections.
- Overall, the Town's upcoming projects appear to be consistent with the 2014 MAPC projections that form the basis for the population and water demand projections presented in this master plan.

3.2.1.3 Scituate 2014 Economic Development Study

An Economic Development Study prepared in 2014 for Scituate's Economic Development Commission by the Metropolitan Area Planning Council included a market analysis, which identified market trends and the segments with potential for growth in Scituate. The study identified several potential developments as summarized in detail in Appendix B and listed briefly below. As detailed in Appendix B and described in Section 3.3 below, these developments form the basis for estimating future commercial growth in this master plan.

- Potential for approximately 80,000 square feet of additional retail space (specialty and convenience retail, and food service establishments).

- Opportunities to increase seasonal tourism include adding boat tours, fishing excursions, a dinghy dock, more support services for boaters, expanding beach access, and increasing promotion of existing recreational amenities. Overall, the goal would be to make for a more attractive and desirable tourist destination, thereby increasing seasonal tourists and related water demands.

- Opportunity to support additional lodging space, up to 30,000 square feet for hotels.

- Additional small office space could likely be supported in each of the existing village areas, of approximately 10,000 square feet in total, with the greatest potential in Greenbush.

- The study utilized the MAPC projections available at the time, which were developed in 2008. Those projections suggested Scituate would grow by approximately 700 households by 2030, many of which would be smaller households than average single-family households. While the number of households was projected to grow by 12% between 2010 and 2035, the projected population growth rate was only 4%, implying household size would shrink (a similar trend is observed based on the 2014 MAPC Stronger Region projections, as discussed above). The study suggests the housing market could support higher density rental housing in North Scituate (if sewer can be extended) and Greenbush, and additional luxury condominiums in Scituate Harbor.

- The study discusses development considerations, or constraints that generally influence the market potential for commercial and residential development. One such significant constraint is the lack of sewer infrastructure and the feasibility of extending sewers to unsewered areas. The Harbor Village and Greenbush areas have sewer, whereas North Scituate and portions of Route 3A do not. The study noted that North Scituate is unlikely to see any significant development without a sewer system, despite market conditions that could support higher density residential and neighborhood commercial. Similarly, the study suggests there is limited potential for commercial development along Route 3A, given substantial protected open space, environmental constraints, and lack of sewer infrastructure.

- At the time of the study, the Town had completed three phases of a six-phase sewer extension plan. According to the DPW Sewer Division, the wastewater treatment plant's capacity at the time of the study was adequate for expansion of the sewer system through all phases of sewer extension. North Scituate was to be included in Phase V.

3.2.1.4 Conclusions on Population Projections

Overall, the Town's population has remained relatively stable in the previous decades and is projected to change minimally. The information provided by the Town's planning board, the MAPC projections, and the 2014 MAPC Economic Development Study suggest that, although residential development may occur resulting in an increase in the number of households, the population is not anticipated to increase at the same rate as potential new households, implying household sizes will decrease.

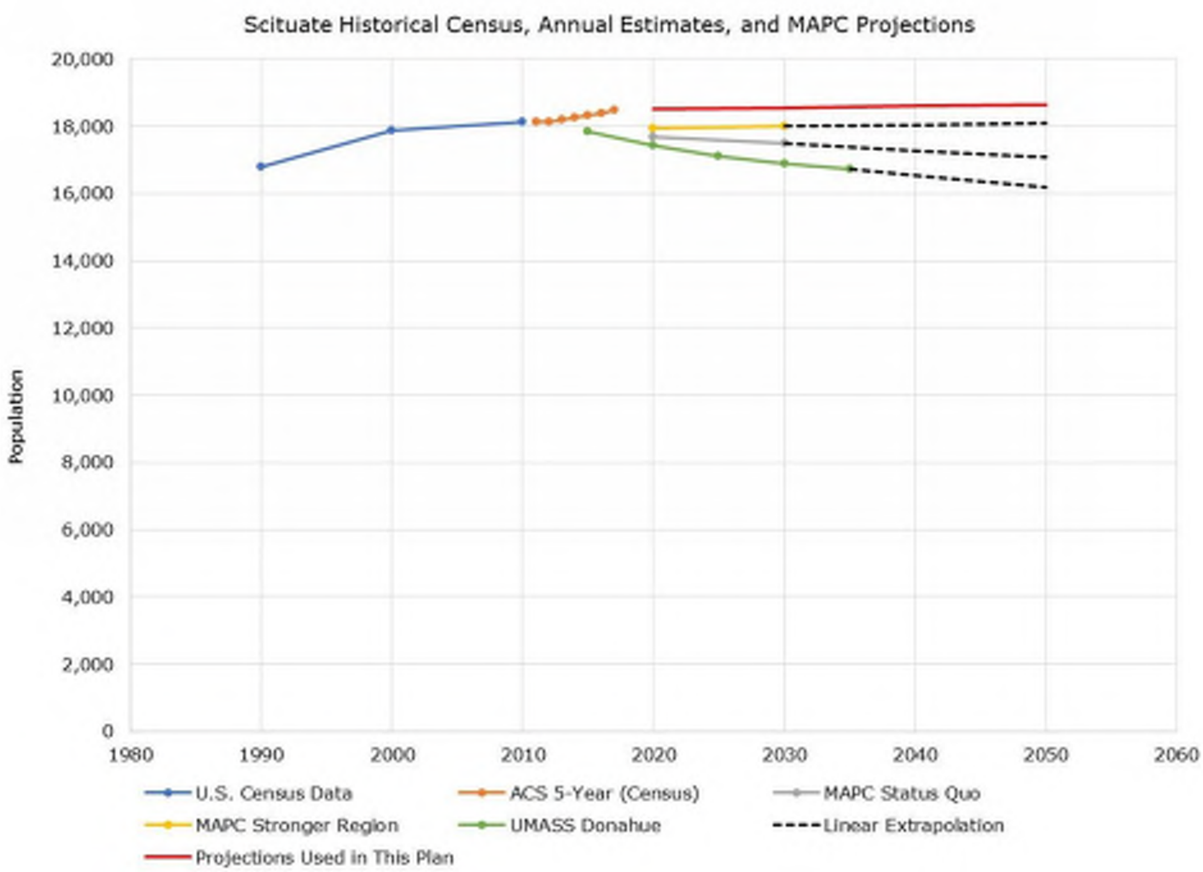
For purposes of this plan, population projections are based on a linear increase like the MAPC Stronger Region scenario, or 4.6 ppl/yr through the 2050 planning period but shifted up to be consistent with the 2017 ACS Estimate, as shown on Figure 3-1.

TABLE 3-1
Historical Population and Metropolitan Area Planning Council Projections for Scituate

	Historical U.S. Census	ACS 5-Year Population Estimates	% Change	MAPC Status Quo Projections (2)	MAPC Stronger Region Projections (2)	UMASS Donahue Institute Projections (3)	Projections Used in this Plan (4)
1990	16,786						
2000	17,863		6.4%				
2010	18,133		1.5%				
2011		18,115	-0.1%				
2012		18,128	0.1%				
2013		18,181	0.3%				
2014		18,240	0.3%				
2015		18,312	0.4%			17,838	
2016		18,390	0.4%				
2017		18,491	0.5%				
2020				17,683	17,948	17,434	**18,505**
2025						17,102	
2030				17,482	17,994	16,900	**18,551**
2035						16,724	
2040 (1)				*17,281*	*18,040*	*16,548*	**18,597**
2050 (1)				*17,080*	*18,086*	*16,196*	**18,643**

(1) 2040 and 2050 extrapolated assuming same percent change from 2020 to 2030.
(2) MAPC Projections developed in 2014.
  a. Status Quo: based on continuation of existing rates of births, deaths, migration, and housing occupancy.
  b. Stronger Region: explores how changing trends could result in higher population growth, greater housing demand, and a substantially larger workforce.
(3) Donahue Institute projections developed in 2015. Component-of-change method based on trends observed in town-level fertility and mortality from 2000 through 2010, and regional, gross migration-by-age trends observed in data from the 2005-2012 American Community Survey.
(4) Based on MAPC Stronger Region Trend but shifted to be consistent with 2017 ACS Estimate.

Figure 3-1: Historical and Projected Populations for Town of Scituate



3.2.2 Historical Population Served

The historical population served by the Town was evaluated in different ways, as described below. For the different methodologies, the reasonableness of the estimated population served was verified by determining the per capita residential consumption (gallons per capita per day, or gpcd). These values are compared to previously reported values and industry standards to determine the reasonableness of the population served estimates. Historical per capita consumption is also utilized to determine consumption projections.

The performance standard for residential gallons per capita per day is 65 gpcd in Scituate's Water Management Act Permit, which is required for all public water system permittees. Industry standards range from 50 to 75 gpcd. Based on our experience in other communities, per capita consumption can be as low as 45 gpcd and as high as 100 gpcd.

The estimates presented below are based on demands and number of customers for the entire service area, including Humarock.

3.2.2.1 Estimate #1: Annual Statistical Reports

The Town reports residential consumption and population served estimates yearly to MADEP as part of the Public Water System Annual Statistical Reporting. Table 3-2 presents a summary of the reported data and the resulting per capita consumption. It appears that 2016 and 2017 population served estimates have not been adjusted since the estimate reported for 2015. The reported population served estimate is also higher than the U.S. Census and ACS annual estimates for the entire Town. The resultant per capita consumption ranges from 55 to 63 gpcd, indicating a reasonable estimate of the population served.

Based on the data reported by the Town, total residential consumption appears to be on a decreasing trend as shown on Table 3-2. The per capita consumption also appears to be on a decreasing trend, but this is also impacted by the static population served estimates.

TABLE 3-2
Per Capita Estimate Based on Population Served and Residential Use Reported in ASRs

	Reported Total Residential Consumption (mg)	Total Residential Consumption (mgd)	Population Served Reported in ASRs	Estimated gpcd
2014	417.1	1.14	19,186	60
2015	402.4	1.10	19,018	58
2016	382.5	1.05	19,018	55
2017	379.3	1.04	19,018	55
2018	371.8	1.02	19,018	54

3.2.2.2 Estimate #2: ACS Annual Estimates of Town Population

Table 3-3 summarizes per capita consumption based on the total residential consumption from the Town's billing records and the ACS annual estimates of the Town's population from Table 3-1. The following is noted regarding the billing records provided by the Town:

- Billed usage data was provided by the Town for June 2013 through September 2019. The records were missing billed usage data for September, November, and December 2018.
- All categories of customers are metered and billed quarterly, with customers billed at different cycles based on Section:
  - Section A customers are billed at the end of January, April, July, and October
  - Section B customers are billed at the end of February, May, August, and November
  - Section C customers are billed at the end of March, June, September, and December
- In order to adjust the quarterly data to obtain monthly usage estimates for each customer, the quarterly data was apportioned to each month in the respective quarter based on the five-year average monthly trends of the Finished Water Entering the Distribution System.
  - For example, if the five-year monthly averages of Finished Water Entering the Distribution System in June, July, and August are 60 MG, 66 MG, and 62 MG, respectively, for a total quarterly amount distributed of 188 MG, then the percentages distributed each month were 32%, 35%, and 33%, respectively.
  - These same percentages were then applied to amounts billed in August to estimate the monthly usage for June, July and August.
- Customer accounts in the Town's billing records are assigned Use Description categories, of which there are 52 different categories. For the purposes of this analysis, accounts were assigned either Residential, Commercial, or Municipal categories.
- It is noted that the total consumption obtained from the billing records (for the sum of all categories) is slightly different from the total Metered Finished Water Use reported in the ASRs for any given year, which may be attributed to corrections made for the ASRs, data rounding, or differences in how particular quarters were assigned (for example if usage billed in January is assigned to the current or to the prior year).
- Residential consumption in the tables presented below is based on the calendar year associated with the end of the billing cycle. For example, consumption billed at the end of January 2016 is included in Year 2016, although some consumption occurred in November and December 2015.

Table 3-3 presents the total residential consumption from the Town's billing records and the ACS population estimates. The resultant per capita consumption ranges from 55 to 63 gpcd, indicating the ACS population estimates could be a reasonable basis for the population served. As noted above, total residential consumption appears to be decreasing.

TABLE 3-3
Per Capita Estimate Based on Town's Billing Records and ACS Population Estimates

	Total Residential Consumption (mg)	Total Residential Consumption (mgd)	ACS Population Estimate	Estimated gpcd
2014	432.5	1.185	18,240	65
2015	412.8	1.131	18,312	62
2016	392.9	1.074	18,390	58
2017	392.7	1.076	18,491	58
2018 (1)	371.8	1.019	18,491	55

(1) 2018 ACS population estimate was not available as of December 2019. Residential consumption for 2018 is based on the ASR data, as the billing records are missing billed usage for September, November, and December 2018.

3.2.2.3 Estimate #3: Seasonal Number of Customers

As a desirable summer destination, the Town experiences a seasonal increase in population due to vacationers and seasonal residents, compared to the population of year-round residents. The historical population served by the Town was evaluated further beyond the U.S. Census population and the ACS annual estimates, to evaluate the seasonal change in the population served and the impact on water usage.

The summer and winter populations were estimated by determining from the Town's records the number of residential customers that had usage in July (summer) and in April (winter) and multiplying those numbers by the ACS annual estimates of the Town's average household size (people per household, or ppl/hh). This estimate assumes that residential connections serve one single-family housing unit and that average household size does not vary seasonally. Furthermore, the number of people per housing unit within different areas in Town may be different than the Town-wide average, leading to inaccuracies in population served estimates, and ultimately in residential water consumption per person per day (gpcd).

This analysis is based on the number of residential customers that had actual usage billed greater than 15 gallons per day, to eliminate usage that may be due to unattended leaks or other losses. This total number of residential customers with consumption is different than the number of residential customers reported in the ASRs (Table 2-16), most likely because the annual reports include counts of all services in the system regardless of consumption quantity.

Based on the Town's billing records and the number of customers with reported consumption, most residential customers are single-family households. For example, in 2017, single-family households accounted for 91% of all residential service connections, with the remaining 9% consisting of multi-family type categories such as multi-decker units, apartments, condominiums, duplexes, single-family with commercial, and senior housing. However, many customers classified in multi-family categories (such as apartments, condominiums, and senior housing) are metered and billed separately. Therefore, even a portion of the 9% of multi-family customers represent single-family units.

Table 3-4 summarizes the results by season. The analysis shows that number of customers, total consumption, per capita consumption, and per customer (service connection) consumption are all highest during summer (July). In comparison to winter (April), the number of residential customers increases by about 550 to 1,100 services, the estimated summer population increases by about 1,500 to 3,000 people, daily residential consumption increases by about 0.7 mgd to 0.9 mgd, per capita consumption increases by about 34 gpcd to 43 gpcd, and per customer consumption increases by about 90 gpd to 115 gpd.

Regarding the increase in summer vs. winter population shown on Table 3-4, it is important to note that this is based on the population with metered connections and does not capture the entire influx of potential transient visitors (for example, those visiting individual households, staying in hotels, or visiting for a day).

Water use peaks in the summer when the seasonal population peaks and demand for irrigation water is at its maximum. The increase in per capita usage during the summer indicates a large component of water usage is related to seasonal activities such as irrigation and potentially other outdoor uses that would not be expected to occur during winter.

Further analysis of customer water usage is presented in Section 3.3.

TABLE 3-4
Seasonal Population Served and Per Capita Estimates from Number of Seasonal Customers

	Seasonal Residential Customers	Seasonal Residential Use (mg)	Seasonal Residential Use (mgd)	Average Household Size (ppl/hh) (1)	Estimated Population Served	Estimated gpd per person	Estimated gpd per customer
SUMMER = July							
2014	7,162	53.8	1.735	2.69	19,266	90	242
2015	7,073	50.8	1.639	2.68	18,956	86	232
2016	7,115	51.1	1.647	2.70	19,211	86	232
2017	7,137	46.1	1.489	2.65	18,913	79	209
2018	7,197	47.9	1.544	2.65	19,072	81	215
Average						**84**	**226**
WINTER = April							
2014	6,608	25.9	0.863	2.69	17,776	49	131
2015	5,956	20.9	0.696	2.68	15,962	44	117
2016	6,488	23.7	0.790	2.70	17,518	45	122
2017	6,571	23.5	0.782	2.65	17,413	45	119
2018	6,463	23.4	0.780	2.65	17,127	46	121
Average						**46**	**122**

(1) 2018 ACS population estimate was not available as of December 2019.

3.2.2.4 Results of Population Served Estimates

Table 3-5 summarizes the population served estimates and per capita consumption rates observed in recent years.

TABLE 3-5
Summary of Average, Summer, and Winter Population Served and Per Capita Consumption Estimates

	ACS Town Population Estimate	Average Annual GPCD	Summer Population Served	Summer GPCD	Winter Population Served	Winter GPCD
2014	18,240	65	19,266	90	17,776	49
2015	18,312	62	18,956	86	15,962	44
2016	18,390	58	19,211	86	17,518	45
2017	18,491	58	18,913	79	17,413	45
2018	18,491	55	19,072	81	17,127	46
Average		60		84		46

3.2.3 Projected Population Served

The projected population to be served by the Town, on an average basis, was determined by using the methodology described below. As discussed above, the population fluctuates over the course of a year, peaking in the summer and decreasing in winter. Water demand projections are discussed in Section 3.3.

The Town's population has remained relatively stable in the previous decades and is projected to change minimally. Increases to the number of people to be served by the Town water system may generally come from the following sources:

- **System Growth to Serve New Town Residents:** refers to new people moving into Town and/or new births.

  For the Town of Scituate, Town-wide population projections generally indicate a stable population with possibility for a slight decrease in population. As discussed previously, the population projections developed by the MAPC under the Stronger Region Scenario indicate a slight increase of 0.3% from 2020 to 2030, or about 4.6 ppl/yr (although the MACP's 2020 population estimate is lower than the actual 2010 US Census). The projected population growth in Table 3-6 is based on this trend but the MACP projections have been shifted up to be consistent with the 2017 ACS estimate.

  As discussed previously, the Scituate Economic Development Study, dated December 2014, prepared by the Metropolitan Area Planning Council concluded that the number of households is projected to increase and outpace the population growth rate, implying that household size will shrink.

- **System Growth to Serve the Village of Humarock:** this area of Town is geographically separate from the rest of the Town and is currently served by the Marshfield Water District. However, the population served estimates and residential consumption presented previously include this service area.

- **System Growth to Serve Existing Town Residents:** refers to system service area expansion to serve more of a Town's existing population. This often includes residents currently served by private wells or by other public community water systems. This is generally not applicable to the Town of Scituate since the water system serves most of the Town.

- **Other:** System growth can also occur due to service area expansion to serve new non-residential developments, which is not strictly dependent on changes in the population served. Projected demands for non-residential growth are discussed in Section 3.3.

The Town's WMA permit indicates that mitigation is required for increases in withdrawals above 1.80 mgd. The amount of mitigation required is dependent on the nature of the areas served, with less mitigation required for areas served by on-site septic systems (due to an allowance for groundwater recharge from on-site systems). Given the small population growth projected for the Town (152 people through 2050 based on the MACP Stronger Region projections), it is conservatively assumed that this growth will occur in sewered areas. However, water demand projections for non-residential growth discussed in Section 3.3. are evaluated for sewered and non-sewered areas.

TABLE 3-6
Projected Population Served

	Annual Population Served	Projected Population Growth (1)	Total Population Served
2014	18,240		
2015	18,312		
2016	18,390		
2017	18,491		
2018	N/A		
2020		14	18,505
2030	18,505	46	18,551
2040	18,551	46	18,597
2050	18,597	46	18,643

(1) Assumes linear increase like MAPC Stronger Region scenario, at a rate of 4.6 ppl/yr.

3.3 Estimating Future Demands

The results of the population projections form the basis for estimating future demands, as well as customer usage patterns that describe seasonal demand changes due to fluctuating winter vs. summer populations and increased outdoor water usage during summer.

Similar to the baseline assessment where historical demands were evaluated separately for the Town excluding the Humarock Area as well as for Humarock, the following analysis is based on estimating future demands for each service area separately. This allows for determining the adequacy of the local sources of supply to meet the Town’s demand projections should the Humarock area remain unconnected to the rest of the system.

3.3.1 Customer Water Usage Analysis

Overall historical consumption is reviewed in detail in Section 2.4.1. That analysis indicated that max month demands (representative of summer conditions) are generally 1.50 times the annual average day demands and that max day demands (peak summer conditions) are generally 1.95 times the annual average day demands. The max day peaking factor is comparable to the summer to winter ratio, which averaged 1.54 in 2014-2018 (ranged from 1.4 to 1.6). The max day peaking factor is slightly higher because it compares the highest daily use over a full year to an average day, whereas the summer to winter ratio compares an average summer day to an average winter day.

The overall historical demands also show that residential consumption accounts for over 83% of the Town’s overall consumption (including the Humarock area). The bulk of water usage is residential, with commercial a distant second (about 7%), and all other usage classes accounting for the remaining 10%.

The following analysis examines how the largest customer class uses water and how usage patterns vary seasonally. Table 3-7 below summarizes yearly (MG/year) and average daily (mgd) residential customer usage by comparing the following:

- Baseline use: this represents water used for stable, essential needs such as drinking, cooking, cleaning, and bathing, which are also generally indoor uses. A reasonable proxy for baseline use is winter-time usage. Baseline use can be reduced through efficiency upgrades but tends to be more difficult to reduce than discretionary use.

- Discretionary use: this represents water use that tends to be more discretionary (i.e. less essential), such as for watering lawns, landscaping, swimming pools, washing cars, and other generally outdoor uses, which tend to be more variable by month and year.

Baseline use in Table 3-7 is estimated based on the average daily residential usage for April (from Table 3-4) and multiplying it by 365 days, and discretionary use is estimated as the difference between the actual use (Table 3-3) and the baseline use.

As will be examined more fully below, the increase in actual usage from baseline usage indicates higher water use in the summer. This is generally a result of the increase in the summer population and increased outdoor water use during warmer months, which coincides with low rainfall. Figure 3-2 shows total yearly consumption for 2016 (when much of the state experienced drought conditions) and for 2018 (consumption shown as curves), as well as total precipitation (shown as bars). As noted, usage peaks opposite to available rainfall.

TABLE 3-7
Residential Baseline and Discretionary Use

	Baseline Usage (MG)	Actual Usage (MG)	Discretionary Usage (MG)
2014	314.8	432.5	118
2015	253.9	412.8	159
2016	289.1	392.9	104
2017	285.6	392.7	107
2018	284.8	371.8	87

	Baseline Usage (mgd)	Actual Usage (mgd)	Discretionary Usage (mgd)
2014	0.863	1.185	0.322
2015	0.696	1.131	0.435
2016	0.790	1.074	0.284
2017	0.782	1.076	0.293
2018	0.780	1.019	0.238

Figure 3-2: Scituate Monthly Precipitation and Water Usage

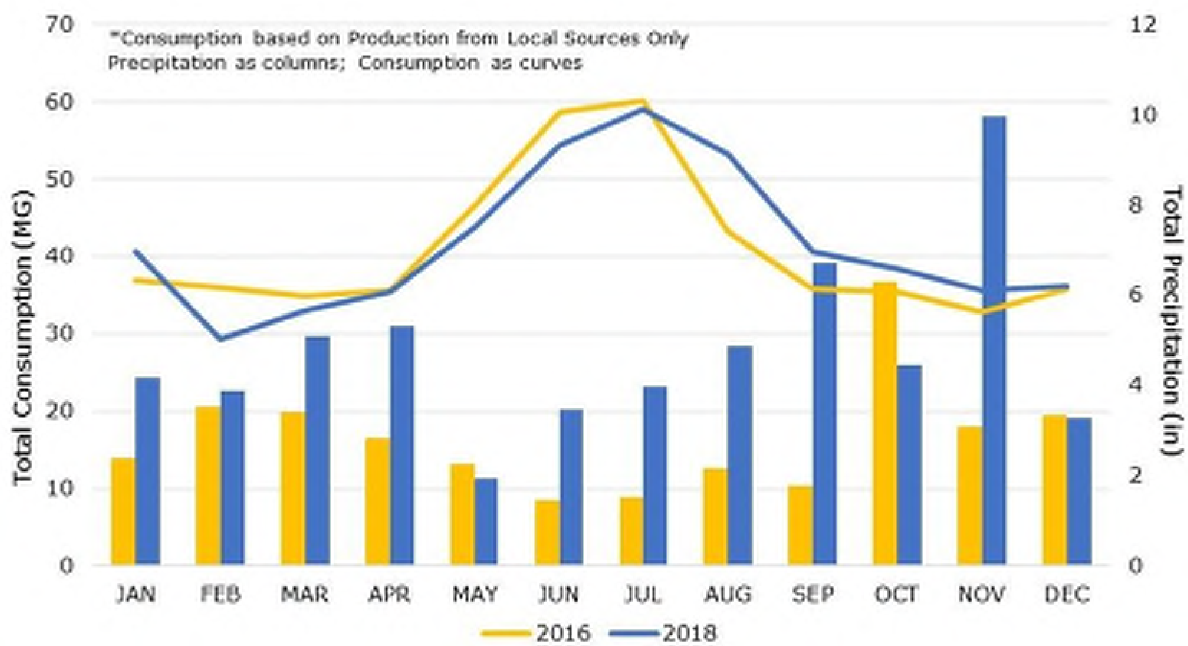
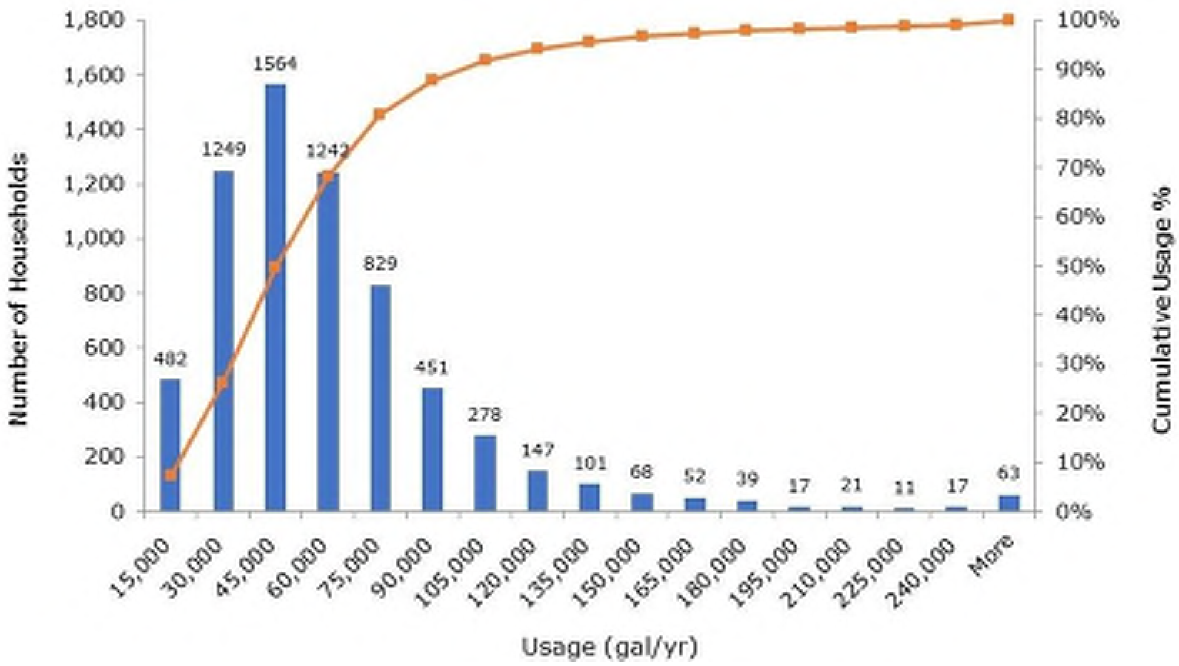


Figure 3-3: Total Annual Residential Water Use in 2017



For all graphs in this section, the x-axis values represent the max value for that data bar; for example, 482 households in Figure 3-3 had annual usage of 15,000 gal/yr or less, 1,249 households had annual usage in the range of 15,000 to 30,000 gal/yr, etc. The curves represent cumulative usage.

Figure 3-3 shows that the variability of total annual use among residential customers ranges from less than 15,000 gallons to more than 240,000 gallons per year. The most typical annual usage, as shown by the tallest three bars, is between 15,000 and 60,000 gallons. The data are somewhat clustered between 15,000 and 75,000 gallons per year (the tallest four bars). The cumulative percent line shows that approximately 50% of total usage is accounted for by households using 45,000 gal/yr or less.

Figure 3-4: Annual Baseline Residential Water Use in 2017

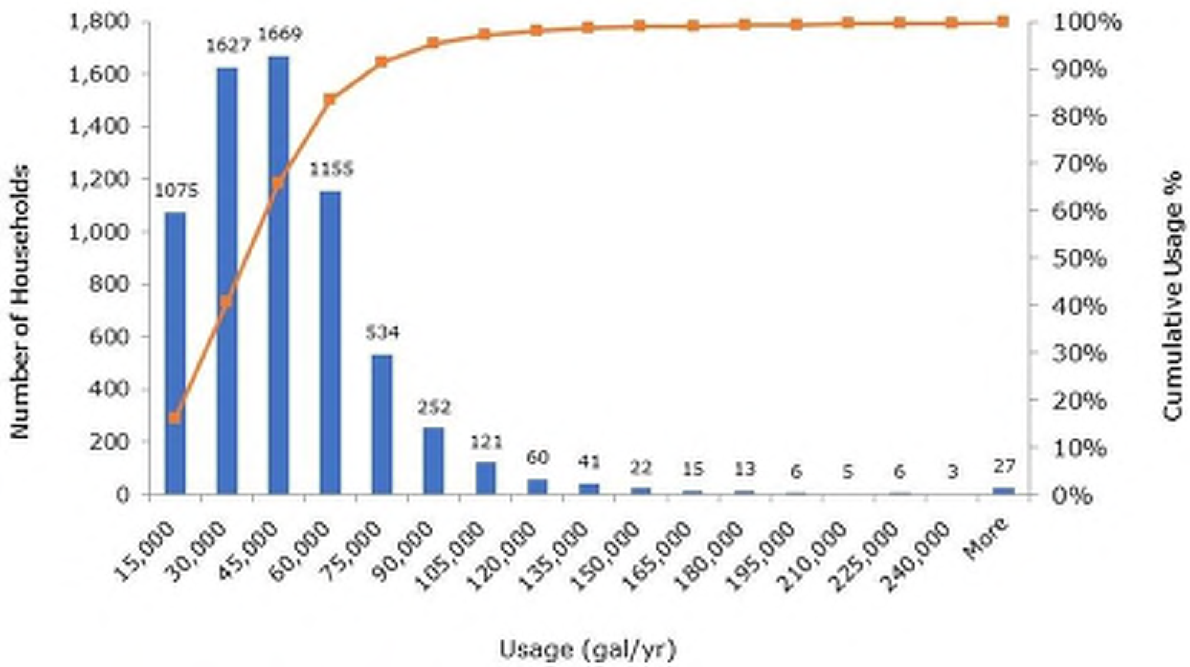


Figure 3-4 shows annual baseline use, which is calculated as the usage in April times 12 to represent a full year at this rate. This shows that most residential customers use 75,000 gallons per year or less, and that several households use 15,000 gallons per year or less. The cumulative percent line shows that almost 85% of total usage is from households using 60,000 gallons per year or less (the four tallest bars).

Figure 3-5: Annual Discretionary Residential Water Use in 2017

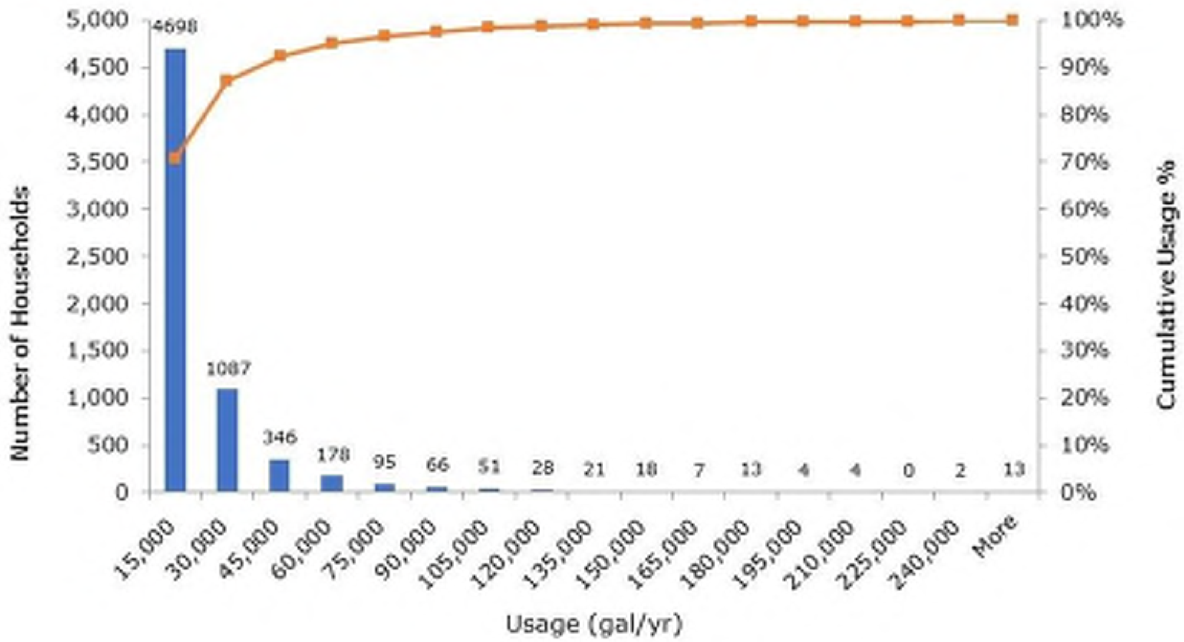


Figure 3-5 shows annual discretionary usage, which is calculated as the difference between actual usage (Figure 3-3) and baseline usage (Figure 3-4). The first column includes customers with zero-use, or customers who showed no seasonal increase in use. Households are clustered at very low levels, showing that most households have discretionary usage of less than 15,000 gallons per household per year.

Figure 3-6: Percentile of Discretionary Residential Water Use in 2017

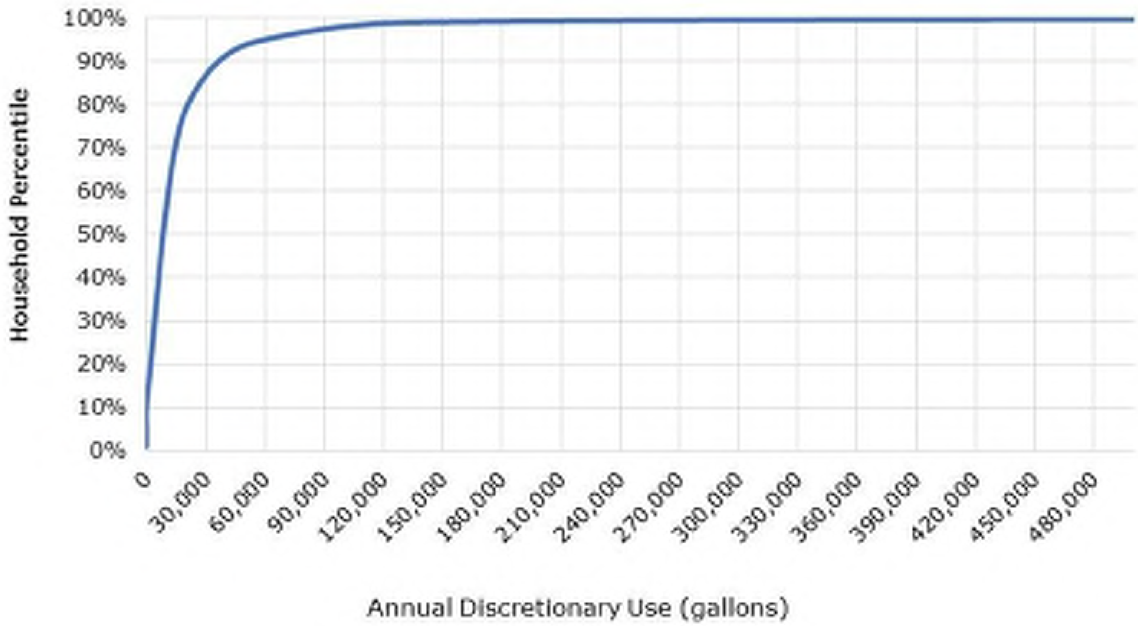


Figure 3-6 presents annual household discretionary use along the x-axis (i.e., the data from Figure 3-5) and household percentile rank on the y-axis. This function is created by ranking the annual discretionary use for each residential household from lowest to highest and then calculating each household's percentile rank. Percentile rank refers to the percentage of all residential customers that use the same amount or less discretionary water than that household.

For example, in Scituate, the 50th percentile household uses 8,442 gallons or less of discretionary water in a year, while the 90th percentile household uses 36,468 gallons; this represents over a four-fold increase from the 50th percentile household.

Figure 3-7: Cumulative Percent of Discretionary Residential Water Use by Customer Percentile in 2017

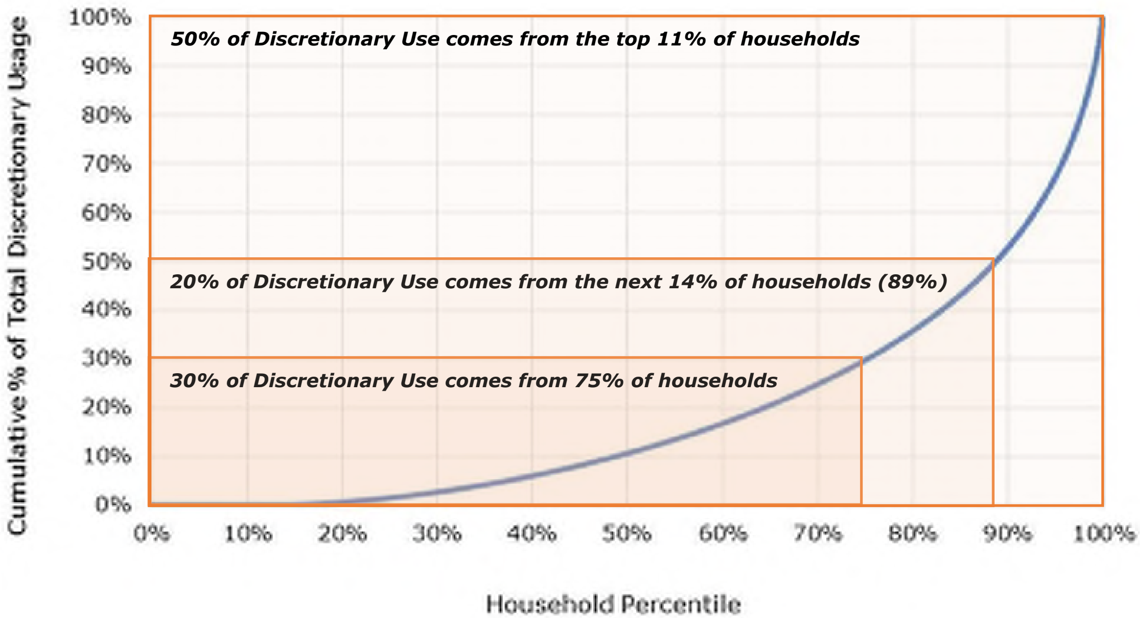


Figure 3-7 shows the percentile rank of customers based on their discretionary use (i.e., the value that was shown on the y-axis in Figure 3-6) and shows the cumulative percent of all discretionary use accounted for on the y-axis. The x-axis shows the customer's percentile rank for discretionary usage, where each percentile rank is associated with a total annual discretionary volume. As we move along the x-axis from left to right, the cumulative total of this underlying discretionary use increases. The y-axis shows what percent of all discretionary use that running total represents.

For example, 30% of discretionary usage comes from 75% of households, while the next 14% of households (the 89th household percentile) account for the next 20% of discretionary usage (i.e., 89% of households account for 50% of discretionary usage overall). Overall, 50% of the remaining discretionary usage comes from the top 11% of households (household percentiles from 89% to 100%).

Scituate Water Resources Commission 2016 Conservation Plan

The analysis above shows that conservation strategies targeting the top percent of discretionary users should help mitigate peak demands and alleviate related system stresses, but such strategies must be balanced with rate strategies to avoid sharp revenue losses that may occur as a result of restricting discretionary usage. The Town's 2016 Conservation Plan was reviewed to further examine this balance and the Town's proactive approach.

The plan notes that water rates are set annually by the Board of Water Commissioners. Because peak demands are driven predominantly by residential customers, the Town chose to charge higher rates for higher usage (commercial customers are charged more for water initially, but their rates increase by less as they use more water). The plan indicates that this structure allows the Town to target the outdoor, non-essential water use (discretionary usage) and reward those who use less water. Customers are metered and billed quarterly but, as discussed elsewhere in this plan, it is recommended that customers be metered monthly to better track seasonal use across all customers.

The Town's 2016 Conservation Plan describes the Code of General Bylaws adopted in April 2013 that authorizes the Board of Selectmen to take measures to conserve and manage the Town's public water supply, including ordering mandatory restrictions (e.g., restrictions on outdoor water usage, filling of swimming pools, and use of automatic and other hose mounted sprinklers).

Based upon the research conducted by the North and South River Watershed Association (NSRWA) and MADEP for restoring herring passage to First Herring Brook (based on the Water Evaluation and Planning (WEAP) integrated water resources model discussed previously), a revised policy was adopted in May 2015 stating that watering bans will be based on the water levels in Scituate's surface water reservoir, to be implemented by the Water Division (summarized previously in Section 1.2). The ban includes all non-essential use, defined as uses that are not required for health and safety reasons, or by regulation, or to produce food and fiber, or for the maintenance of livestock. Non-essential uses would include irrigation of lawns or landscaping, and washing vehicles, parking lots, driveways and/or sidewalks. The Town's irrigation restrictions allow the use of in-ground sprinklers one day per week between Memorial Day and Labor Day.

The NSRWA study and WEAP model adjustments are ongoing efforts that continually provide recommendations for operational management strategies, such as refining the triggers that lead to implementing a Total Outdoor Water Ban.

Additionally, the Town's Conservation Plan outlines recommendations for new developments and new and renovated buildings, such as using Best Available Technology (BAT) for water conservation, using water efficient fixtures and equipment, and promoting reuse of treated wastewater especially for irrigation purposes.

The plan also recommends the Town give serious consideration to "water banking" for integration into the Town's subdivision bylaws and building property requirements for property rehabilitation. As an example, the plan supposes that new demands made upon the water system by a developer should be offset by the developer through the support of water conservation strategies elsewhere.

Impact of Outdoor Water Bans

Usage data for all metered customers was reviewed to quantify the impact of outdoor water bans before, during, and after the declared drought of 2016 (usage data presented do not include CEMU or UAW).

Figure 3-8 compares total usage in 2015, a non-drought year, to 2016. Usage peaked in August 2016 and was followed by a decrease in total usage below 2015 levels, indicating the impact of the outdoor water ban. Figure 3-9 compares total usage in 2016 to 2017, showing lower usage in 2017 overall.

Figure 3-10 compares changes in usage from month to month for each year. Generally, 2016 showed the most decrease in usage during the summer from month to month.

Figure 3-8: Change in Total Usage
from 2015 (non-Drought Year) to 2016 (declared Drought)

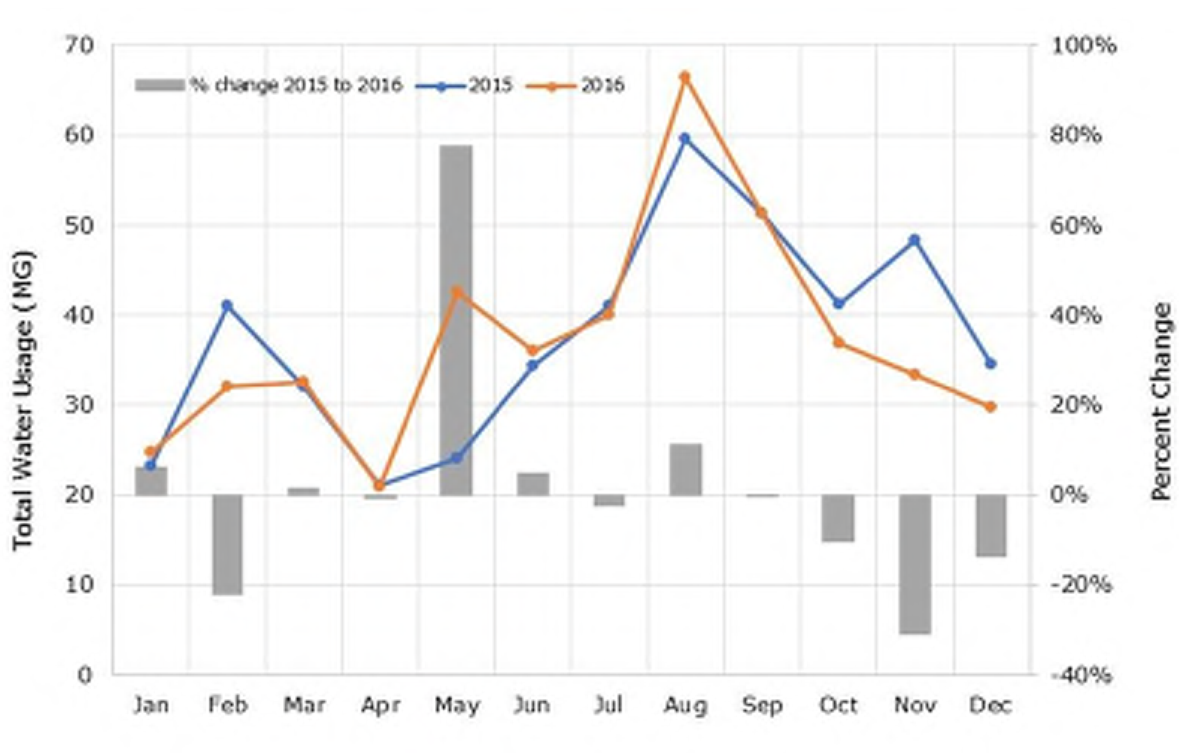


Figure 3-9: Change in Total Usage
from 2016 (declared Drought) to 2017 (non-Drought Year)

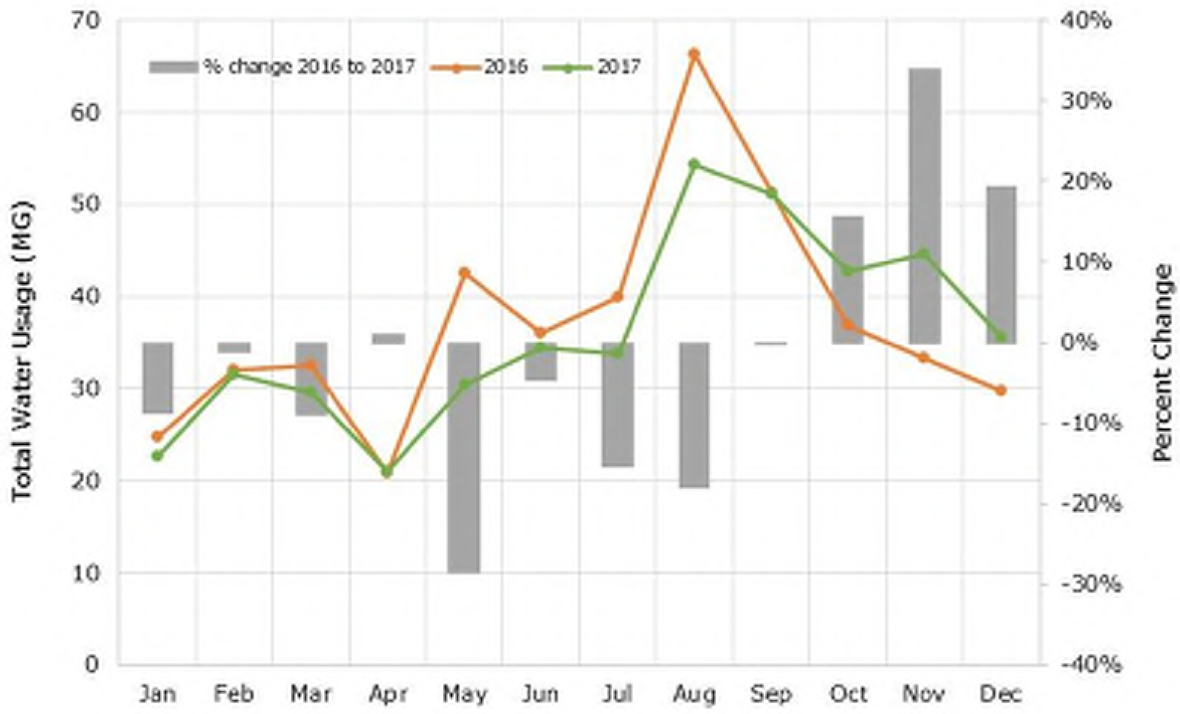
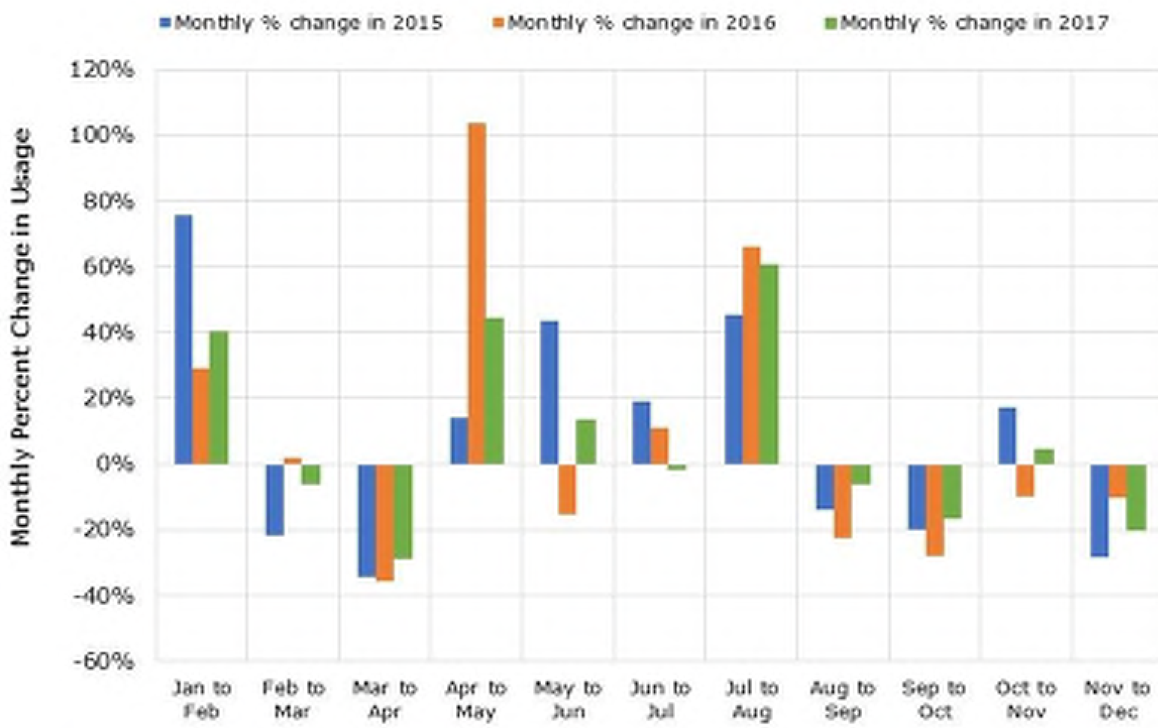


Figure 3-10: Change in Total Monthly Usage



3.3.2 Demand Projections - System-Wide Excluding Humarock

Average day demands for the Scituate water system were projected by demand category. Maximum month and maximum day demands are based on applying the projected peaking factors to the average day demands (peaking factors determined previously of 1.50 and 1.95 for max month and max day, respectively).

Average day demand projections were calculated as follows:

Residential Growth: Minimal residential growth is projected for the Town, as summarized in Table 3-6. Residential demand projections were calculated as the sum of the following:

- Current (2020) Projections for the system assuming no growth and excluding Humarock (Table 2-18)
- Residential demands from population growth (Table 3-6) and an assumed per capita consumption rate of 50 gpd per person

Commercial Growth: The 2014 MAPC Economic Development Study provided an estimate of potential demand for new commercial square footage by subarea. The analysis provided a rough estimate of what could potentially be built over the next 10-15 years based on findings from a retail gap analysis, growth in tourism, additional professional office workers, and need for accommodations in the area. The study cautioned that, due to Scituate's location away from highways, combined with regional competition, there is little potential to expand the commercial base beyond what can be supported by the local market (residents, tourists, and commuters).

The analysis identified potential commercial developments by type and size for different subareas of Town including: Greenbush, North Scituate, Scituate Harbor, Route 3A corridor, and Humarock (of these areas, it is noted that North Scituate and Route 3A are unsewered). Although some of this potential development may be infeasible due to lack of sewer infrastructure, water demands were determined based on the square footage identified in the MAPC study for each potential development and system sewage flow design criteria from 310 CMR 15.000 (Title V), as described below.

Projected demands for non-residential customers are based on the peak wastewater flow projections from the Massachusetts Title V code. The wastewater flow projections are assumed to represent peak flows and were divided in half to obtain an average flow. The average wastewater flow projections are then divided by 0.85 because water discharged into a wastewater system excludes consumption, which is typically 15%. This 15% water consumption component is thereby added back in to the average wastewater flow projections to determine the total average water demand. Detailed calculations of commercial demand projections are included in Appendix B.

Demands were estimated separately for sewered areas, unsewered areas, and for Humarock (sewered). Of the total potential demands in Scituate (not including Humarock), approximately 21% are estimated for unsewered areas and 79% in sewered areas. Less mitigation is required under the WMA permit for areas served by on-site septic systems.

Commercial demand projections were calculated as the sum of the following:

- Current (2020) Projections for the system assuming no growth and excluding Humarock (Table 2-18)

- Demands for potential new developments (Appendix B) in Greenbush, Scituate Harbor, North Scituate, and the Route 3A corridor

- An increase in commercial demands proportional to the anticipated increase in residential demands (for example, a 0.2% increase in commercial demands was included from 2030 to 2040 to match the same projected increase in residential demand)

Residential Institutions, Agricultural, Industrial, Municipal, Institutional, Non-Profit, Other, and CEMU: It is assumed that demand projections for these categories will remain consistent with the Current (2020) Projections for the system excluding Humarock (Table 2-18).

Unaccounted for Water: A target of 10% UAW is assumed for the demand projections, consistent with the Current (2020) Projections for the system excluding Humarock (Table 2-18).

Table 3-8 summarizes the average day, max month, and max day demand projections for the system (excluding Humarock) for current (2020) year, 2030, 2040, and 2050, and Table 3-9 summarizes the demand projections by category.

TABLE 3-8
Projected Demands for Scituate (Excluding Humarock) (mgd)

	Avg Day	Max Month	Max Day
2020	1.506	2.259	2.937
2030	1.544	2.316	3.010
2040	1.548	2.322	3.018
2050	1.551	2.327	3.025

TABLE 3-9
Projected Demands by Category for Scituate (Excluding Humarock) (mgd)

	Residential	Residential Institutions	Commercial / Business	Agricultural	Industrial	Municipal / Institutional / Non-profits	Other Services	Total Metered Use	Total CEMU	UAW	% UAW	Total
2020	0.985	0.013	0.082	0.007	0.003	0.144	0.001	1.236	0.120	0.151	10%	1.506
2030	0.988	0.013	0.113	0.007	0.003	0.144	0.001	1.269	0.120	0.154	10%	1.544
2040	0.990	0.013	0.114	0.007	0.003	0.144	0.001	1.273	0.120	0.155	10%	1.548
2050	0.993	0.013	0.115	0.007	0.003	0.144	0.001	1.276	0.120	0.155	10%	1.551

3.3.3 Demand Projections – Humarock Region

Projections for Humarock were calculated as discussed above for the rest of the system. Average day demands were projected by demand category and max month and max day demands were calculated by applying the projected peaking factors to the average day demands (1.50 and 1.95, respectively).

Current (2020) projections for Humarock are summarized in Table 2-G, and include Residential, Commercial/Business, and Municipal/Institutional/Non-Profits categories. Average day demand projections were calculated as follows:

Residential Growth: It was assumed that the residential growth projected for the Town would not impact the population in the Humarock region. Therefore, residential demands are based on the Current (2020) Projections for Humarock.

Commercial Growth: Commercial demands were estimated as described above and as summarized in Appendix B, based on the potential developments identified in the 2014 MAPC Economic Development Study and the design flows from the Title V code.

Municipal, Institutional, and Non-Profit: It is assumed that demand projections for these categories will remain consistent with the Current (2020) Projections for Humarock (Table 2-19).

Unaccounted for Water: Although the Town continues to address high UAW in this region, it was conservatively assumed that UAW amounts in mgd would remain consistent in the region at approximately 0.120 mgd, as indicated in Table 2-19.

Table 3-10 summarizes the average day, max month, and max day demand projections for Humarock for current (2020) year, 2030, 2040, and 2050, and Table 3-11 summarizes the demand projections by category.

TABLE 3-10
Projected Demands for Humarock (mgd)

	Avg Day	Max Month	Max Day
2020	0.172	0.258	0.336
2030	0.175	0.263	0.342
2040	0.175	0.263	0.342
2050	0.175	0.263	0.342

TABLE 3-11
Projected Demands by Category for Humarock (mgd)

	Residential	Residential Institutions	Commercial / Business	Agricultural	Industrial	Municipal / Institutional / Non-profits	Other Services	Total Metered Use	Total CEMU	UAW	% UAW	Total
2020	0.050		0.0020			0.00020		0.052		0.120	70%	0.172
2030	0.050		0.005			0.00020		0.055		0.120	68%	0.175
2040	0.050		0.005			0.00020		0.055		0.120	68%	0.175
2050	0.050		0.005			0.00020		0.055		0.120	68%	0.175

3.4 System Performance Evaluation under Future Demands

3.4.1 Quantity Assessment

This section compares the water demand projections to available water to determine the adequacy of supplies to meet future needs. Withdrawal scenarios for available water from local sources are discussed in Section 2.4.1.6 and summarized in Table 2-20 and on Figure 2-17.

Figures 3-11 and 3-12 present the projected demands (excluding Humarock) under average day and max day conditions, respectively, against the withdrawal scenarios.

Figure 3-11: Supply Assessment under Average Day Future Demands (Excludes Humarock)

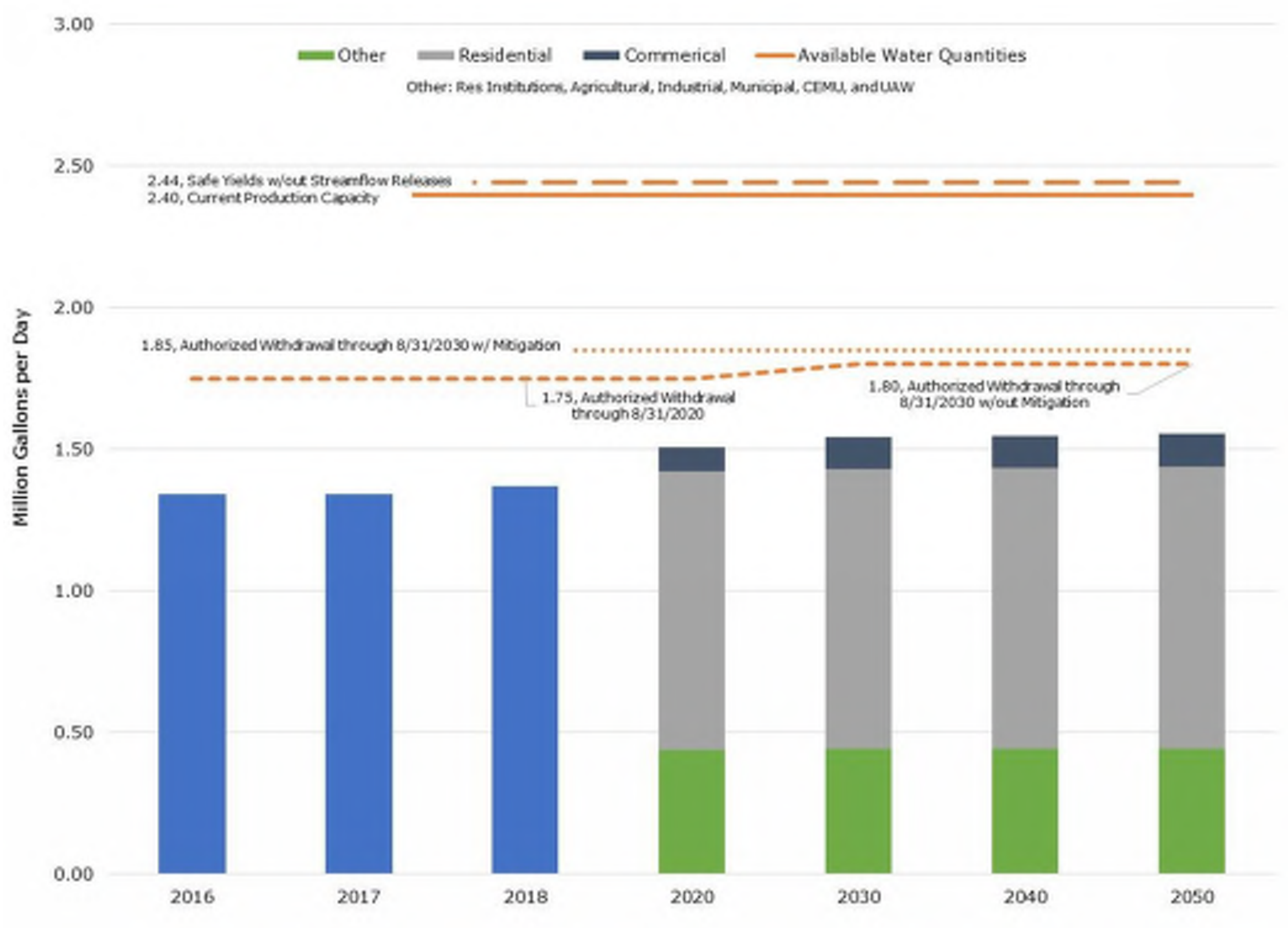


Figure 3-12: Supply Assessment Under Maximum Day Future Demands (Excludes Humarock)

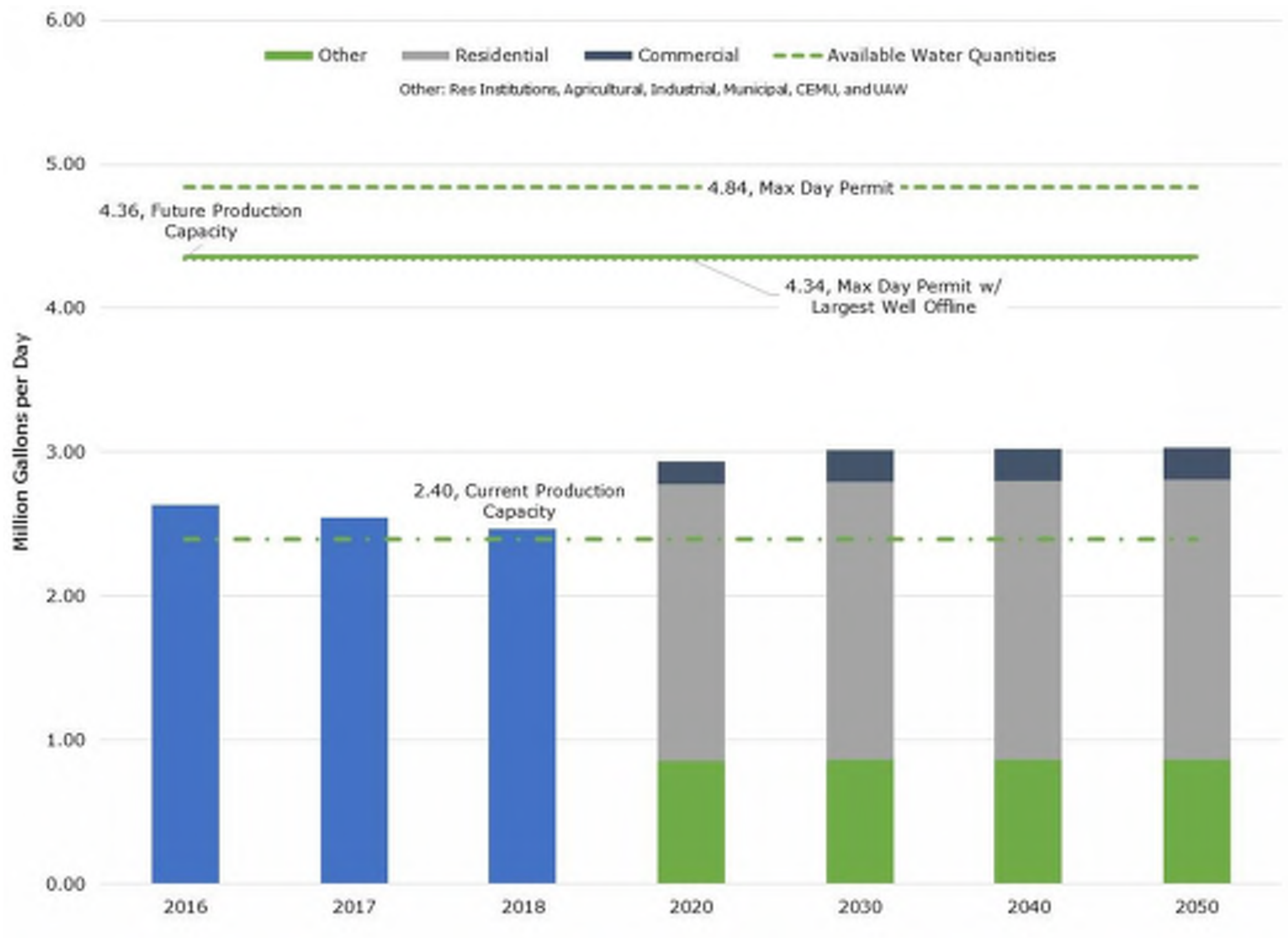


Table 3-12 presents the supply capacity evaluation from Section 2.4.1 with respect to 2050 projected demands. The analysis indicates a deficiency to meet projected max day demands with all wells in service and OOB WTP out of service.

Increasing the treatment capacity of the OOB WTP and increasing the reliable production from the wells (i.e., returning Wells 17A and 18B to service with treatment upgrades) will enable the system to meet sustained peak demands that may occur for longer than the max day (although as discussed in Section 2.4.1, peak demands are generally not sustained for several days at a time).

TABLE 3-12

Supply Capacity Evaluation - Scituate Water System (Excluding Humarock)

Facility Name	Scenario 1: Maximum Daily Withdrawal Rates from WMA Permit		Scenario 2: Sources at Current Production Capacity	
	gpm	% of MDD	gpm	% of MDD
Old Oaken Bucket WTP	2,083	99%	1,528	73%
Well #19	288	14%	213	10%
Well #17A	270	13%	0	0%
Well #22R	350	17%	166	8%
Well #18B	153	7%	0	0%
Well #10	138	7%	90	4%
Well #11	81	4%	50	2%
Total with OOB out of service	1,280	61%	519	25%
Total with largest well out of service	3,013	143%	1,834	87%
Total with all sources in service	3,363	160%	2,047	97%
2050 Max Day Demand (MDD)		2,101 gpm		
Peak Hour Demand (PHD=1.75X ADD)		2,828 gpm		
Fire Flow		From storage		

ADD based on average summer day (max month demand).

3.4.2 Storage Assessment

Table 3-13 presents the storage capacity evaluation under future demands, which suggests the following:

- At the bottom of the required equalization storage, 325 of the highest customers in the system would receive less than 35 psi of static pressure, which is 100 more customers than in the baseline assessment. The highest customer in the system receives 23 psi.

- The increase in the required equalization storage (equivalent to 20% of max day demands) results in a decrease in the available fire storage (equivalent to the volume below the required equalization and above the water level that provides 20 psi of static pressure). The unusable volume is unchanged, as it is equivalent to the volume below the water level that provides 20 psi.

- The increase in the required equalization storage results in an overall increase in the required storage, for a total of 1.235 MG.

- As determined previously, the total required storage is less than the total storage of both tanks. However, neither tank can provide the required storage if one tank must be removed from service for maintenance or repairs. We recommend providing a third tank to improve operational flexibility when a tank needs to be offline for maintenance (refer to Section 2.4.2 for additional discussion).

TABLE 3-13

Scituate – Future Storage Capacity Evaluation Data (million gallons)

	Required	**Usable**
Equalization Storage	0.605 (1)	0 (3)
Emergency/Fire Storage	0.630 (2)	0.216 (4)
Volume below Usable	--	1.460 (5)
Total	1.235	2.281 (6)

(1) At bottom of the required EQ storage, highest 325 customers in the Main (Low) Service Area receive less than 35 psi; highest customer receives 23 psi.
(2) Required fire storage of 3,500 gpm for 3 hours.
(3) Water elevation that provides 35 psi at the highest customer is above the tank overflow elevation.
(4) Equivalent to volume above elevation that provides 20 psi of static pressure at high point in the system minus required equalization storage.
(5) Volume below the elevation that provides 20 psi to the bottom of the storage tanks.
(6) Usable fire plus volume below usable plus required equalization.

SECTION 4

Section 4
Water Quality Evaluation

Water Quality Monitoring Reports submitted to the Department of Environmental Protection were obtained for 2014-2019 to evaluate water quality issues at each supply source and in the distribution system. Trends are discussed below.

A review of the Environmental Protection Agency's (EPA's) Safe Drinking Water Information System (SDWIS) database was conducted to identify any water quality violations in the water supply system for the previous ten years (2010 – 2019). The system reported two health-based violations to the EPA that occurred in July and August 2015, both related to a violation of the Maximum Contaminant Level under the Total Coliform Rule. Compliance was achieved in November 2015. No other health based, monitoring and reporting, or other violations were reported.

Available Consumer Confidence Reports (CCRs) (2016 through 2018) were also reviewed. The Scituate Water System did not have any water quality parameters out of compliance.

Source water quality data were reviewed to identify trends in water quality over time which may indicate source degradation. Observations noted in the following sub-sections are summarized in Section 4.1.4.

4.1 Regulatory Compliance Review

The regulatory compliance review presented below summarizes the U.S. Environmental Protection Agency's (U.S. EPA) Primary and Secondary drinking water quality standards, as well major drinking water regulations promulgated to date that pertain to Scituate.

- **National Primary Drinking Water Regulations (NPDWR)**: are legally enforceable primary standards and treatment techniques that apply to public water systems. Primary standards and treatment techniques protect public health by limiting the levels of contaminants in drinking water and establishing "maximum contaminant levels" (MCLs). The regulations encompass the following rules and standards:
    - Surface Water Treatment Rule, Groundwater Rule, and Total Coliform Rule for microorganisms
    - Chemical Contaminant Rule, Lead and Copper Rule, and Arsenic Rule for organic and inorganic chemicals
    - Radionuclides Rule
    - Stage 1 and Stage 2 Disinfectant and Disinfection By-Products Rule (DBPR) – additional information provided below
- **National Secondary Drinking Water Regulations (NSDWRs)**: set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these "secondary maximum contaminant levels" (SMCLs). They are established as guidelines to assist public water systems in managing their drinking water for

aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the SMCL.

- **Proposed, Unregulated and Other Substances**: includes substances without maximum contaminant levels and for which drinking water standards have not been established, but which are monitored to determine if future regulation may be warranted.
- **Health Advisories**: EPA has established health advisories for PFOA and PFOS, which are fluorinated organic chemicals that are part of a larger group of chemicals referred to as perfluoroalkyl substances (PFASs). Health advisories provide information on contaminants that can cause human health effects and are known or anticipated to occur in drinking water. EPA's health advisories are non-enforceable and non-regulatory and provide technical information to states agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. On October 2, 2020, MassDEP published its PFAS public drinking water standard, called a Massachusetts Maximum Contamination Level (MMCL), of 20 nanograms per liter (ng/L) (or parts per trillion (ppt)) – individually or for the sum of the concentrations of six specific PFAS.

Additional information on the **Stage 1 and Stage 2 Disinfectant and Disinfection By-Products Rule (DBPR)** is provided below:

- Stage 1 of the Disinfectants and Disinfection By-Products Rule (DBPR) established MCLs of 80 µg/L for total trihalomethanes (TTHMs, including chloroform, bromodichloromethane, dibromochloromethane, and bromoform) and 60 µg/L for five haloacetic acids (HAA5, including monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, bromoacetic acid, and dibromoacetic acid).
- Under the Stage 1 DBPR, most systems were required to collect quarterly DBP samples at four distribution system locations per water source. Compliance with the DBP MCLs was based on a system-wide running annual average of the quarterly monitoring results. EPA also established a maximum contaminant level goal (MCLG) of zero for disinfection by-products.
- The Stage 2 DBPR final rule set forth a phased approach to implementing the Stage 2 DBPR requirements. The Stage 2 DBPR targets public water systems (PWSs) with the greatest risk.
- Completion of an initial distribution system evaluation (IDSE) was required to locate high-DBP sites within the distribution system. Water systems proposed new or revised Stage 2 monitoring sites based on the IDSE study. Under the Stage 2 DBPR, MCLs for TTHMs and HAA5 remain the same as the Stage 1 running annual averages of 80 and 60 µg/L. Instead of reducing the MCLs, the Stage 2 DBPR is intended to reduce DBP occurrence peaks in the distribution system by changing the compliance monitoring provisions. Compliance with the MCLs is determined based on a locational running annual average (LRAA) at each sample location identified under the IDSE.

4.1.1 Primary Water Quality Standards

Table 4-1 summarizes observations and compliance issues with Scituate's water quality relative to the primary water quality standards.

TABLE 4-1
Evaluation of Primary Water Quality Standards

Standard	Comment / Observation
Microorganisms	No Total Coliform hits in distribution system
	All raw water sources are adequately disinfected
	Turbidity in Old Oaken Bucket WTP finished water in compliance with standard
Disinfectants	Total Chlorine Residuals reported in CCRs
	Measured at less than MCL of 4 mg/L in distribution system
Disinfection By-Products	MCL compliance is calculated using the Locational Running Annual Average (LRAA) for each monitoring location in the distribution system
	4 monitoring locations established in Scituate
	Total Trihalomethanes (Figure 4-1): LRAAs are below the MCL, but some sites are approaching the MCL
	Haloacetic Acids (Figure 4-2): LRAAs are below the MCL
Organic Chemicals	Tetrachloroethylene: reported in CCRs, occasionally detected in the distribution system at levels below the MCL of 5 ug/L, at a range (low-high) of non-detect to 2.0 ug/L. Not detected at the individual sources.
	No other organic chemicals detected
Inorganic Chemicals	Contaminants with levels above detection levels are reported in CCRs
	Lead and Copper: no sites in the distribution system were above the action levels of 15 ug/L for lead and 1.3 mg/L for copper. 90th percentiles were calculated at 4 ug/L for lead and 0.12 mg/L for copper
	Barium: reported in CCRs, occasionally detected at levels well below the MCL of 2 mg/L, at a range (low-high) of non-detect to 0.018 mg/L. Detected at OOB WTP, Wells 19/22 WTP, and Wells 10/11 WTP (not detected at Well 18B) (Figure 4-3).
	Fluoride: reported in CCRs, occasionally detected at levels below the MCL of 4 mg/L, at a range (low-high) of 0.3 to 0.6 mg/L. Detected at Wells 19/22 WTP, Wells 10/11 WTP, Well 18B, and OOB WTP in 2018 (other years not available).
	Nitrate: reported in CCRs, occasionally detected at levels well below the MCL of 10 mg/L, at a range (low-high) of non-detect to 2.5 mg/L. Detected at Wells 19/22 WTP, Wells 10/11 WTP, Well 18B, and OOB WTP (Figure 4-4).
	Other contaminants have not been detected

Figure 4-1: Total Trihalomethanes

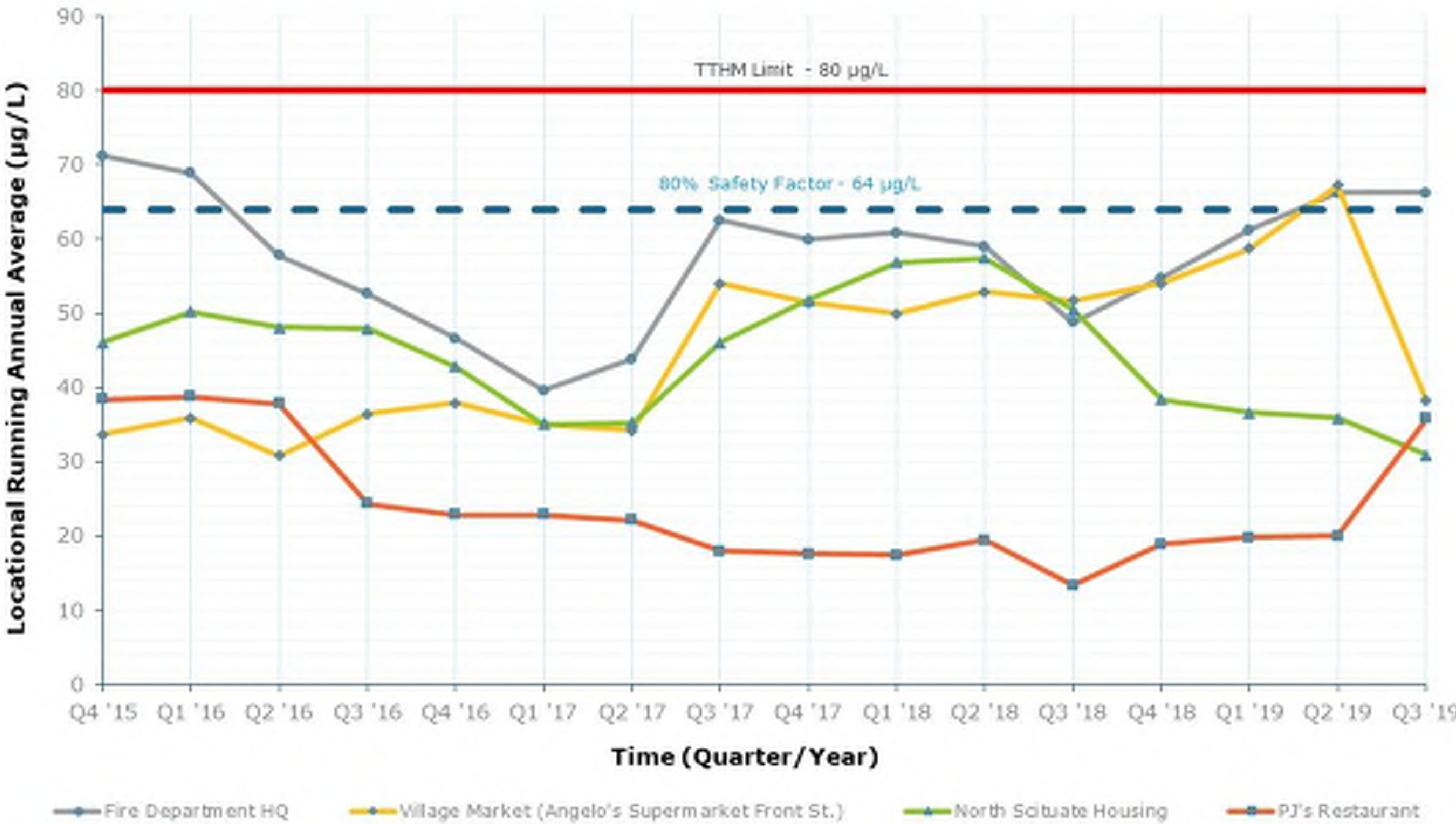


Figure 4-2: Haloacetic Acids

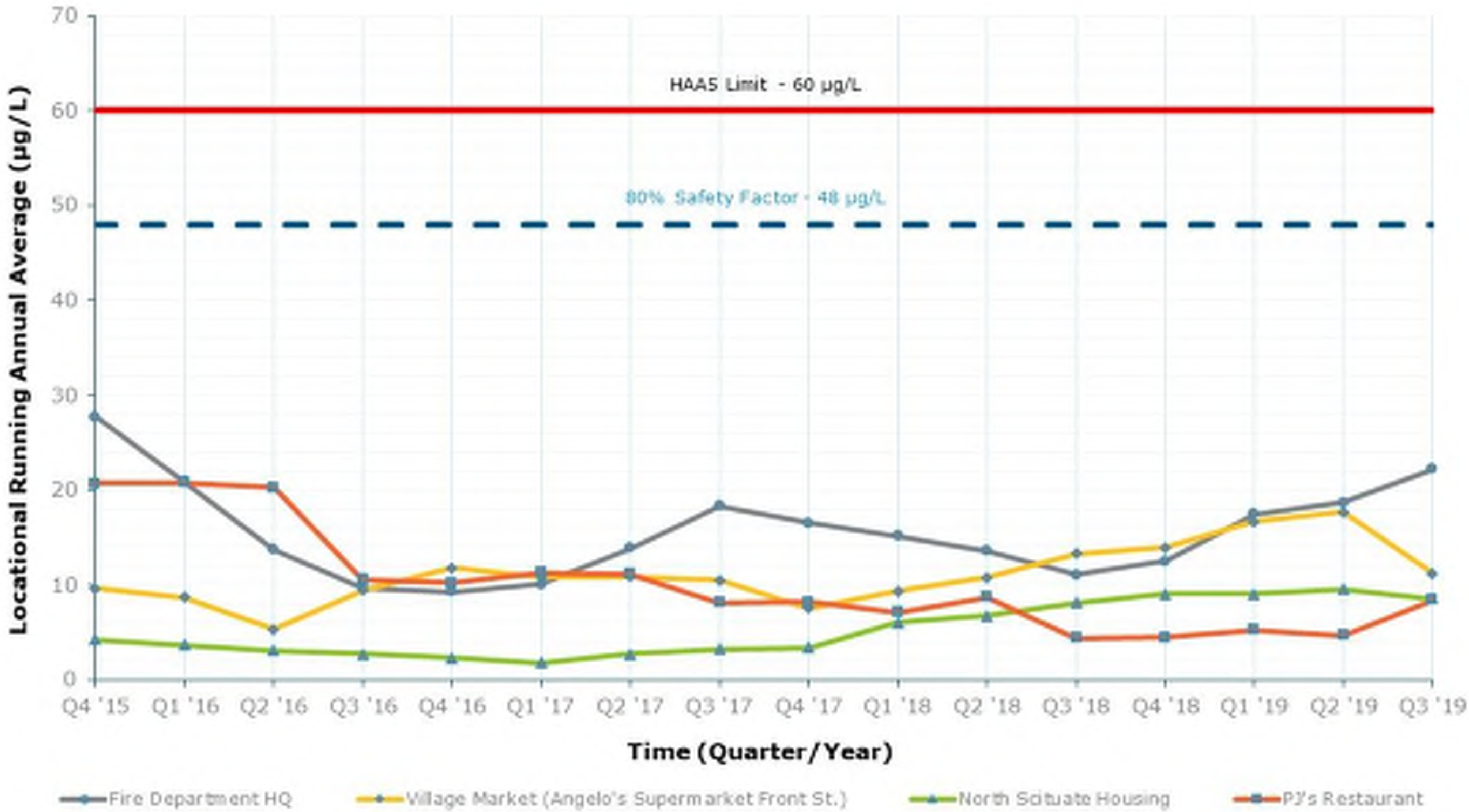


Figure 4-3: Barium Concentrations by Source
(not detected in Well 18B WTP)

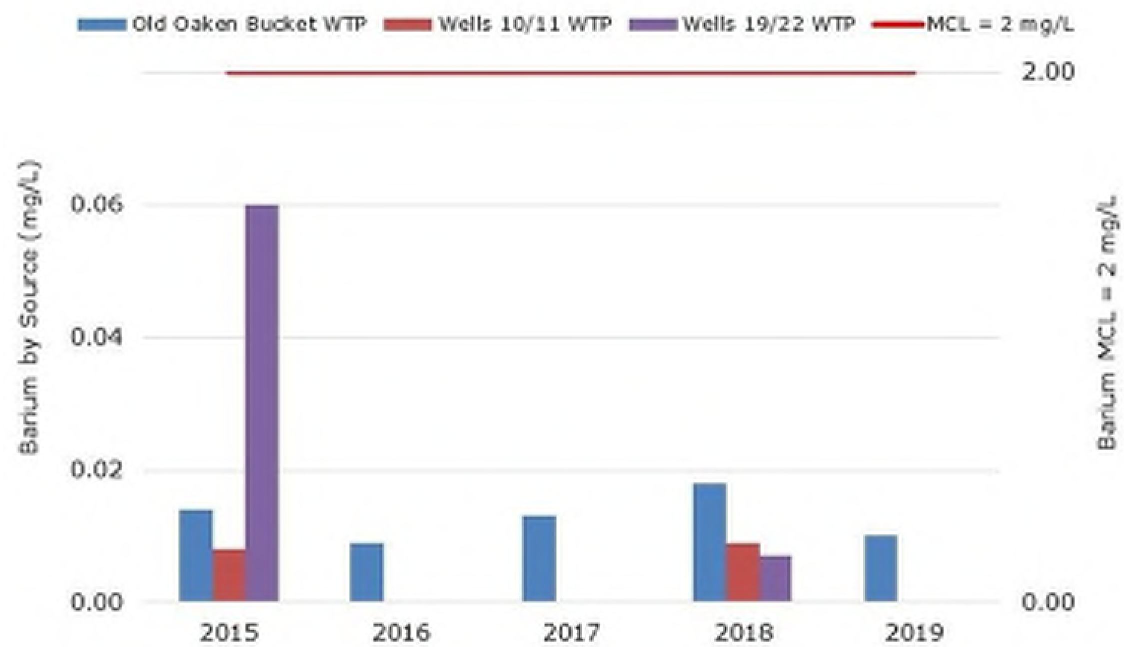
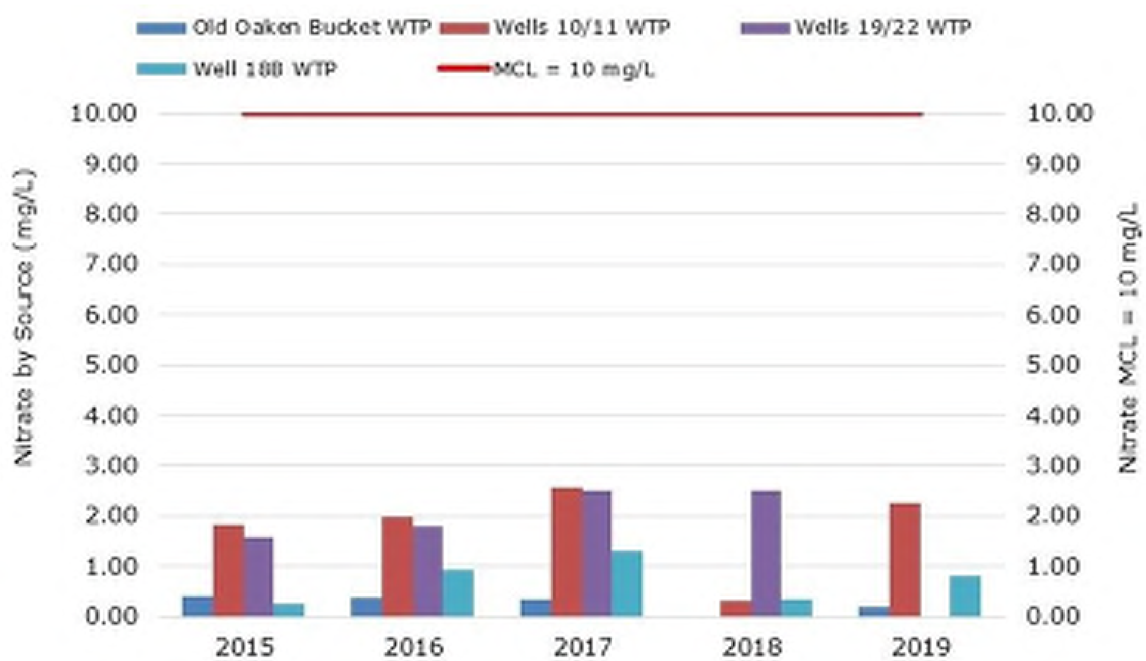


Figure 4-4: Nitrate Concentrations by Source



4.1.2 Secondary Water Quality Standards

Table 4-2 summarizes observations and compliance issues with Scituate's water quality relative to the secondary water quality standards.

TABLE 4-2
Evaluation of Secondary Water Quality Standards

Standard	Comment / Observation
Iron	Secondary MCL = 0.3 mg/L
	Iron was below detection levels in the finished water from Wells 10/11, Wells 19/22, Well 18B, and OOB WTP
	Iron was below the MCL in the distribution system (Figure 4-5)
Manganese	Secondary MCL = 0.05 mg/L
	Below detection levels in the finished water from Wells 10/11 WTP
	Generally above SMCL in finished water from other sources (Figures 4-6, 4-7, and 4-8)
	Occasionally above the SMCL in the distribution system (Figure 4-9)
Aluminum	Can cause colored water above the SMCL of 0.2 mg/L
	Two distribution system sites and one source above SMCL (Figure 4-10)
	Reported in Consumer Confidence Reports
Other Contaminants	Contaminants with levels above detection levels are reported in CCRs
	Chloride: reported in CCRs, occasionally detected at levels below the SMCL of 250 mg/L, at a range (low-high) of 60 to 129 mg/L.
	Copper: reported in CCRs, occasionally detected at levels below the SMCL of 1.0 mg/L, at a range (low-high) of non-detect to 0.09 mg/L.
	Fluoride: reported in CCRs, occasionally detected at levels below the SMCL of 2 mg/L, at a range (low-high) of 0.3 to 0.6 mg/L.
	pH: reported in CCRs, generally ranges from 6.4 to 7.4 in the distribution system, compared to the SMCL of 6.5 to 8.5.
	Sulfate: reported in CCRs, occasionally detected at levels below the SMCL of 250 mg/L, at a range (low-high) of 4 to 36 mg/L.
	Total Dissolved Solids: reported in CCRs, occasionally detected at levels below the SMCL of 500 mg/L, at a range (low-high) of 60 to 216 mg/L.
	Other contaminants not detected – silver, zinc

Figure 4-5: Iron Concentrations in Distribution System

Figure 4-6: Manganese in Old Oaken Bucket WTP Finished Water

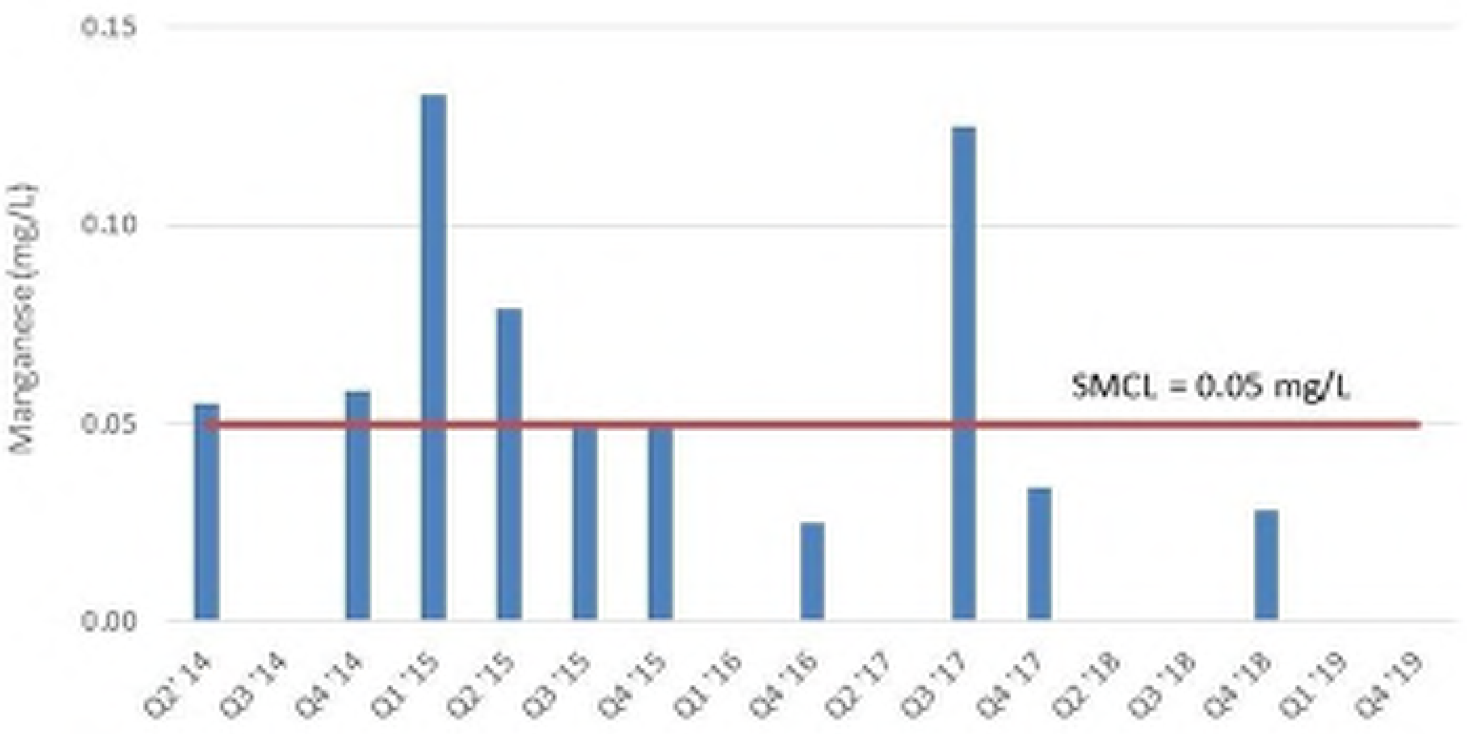


Figure 4-7: Manganese in Well 18B Finished Water

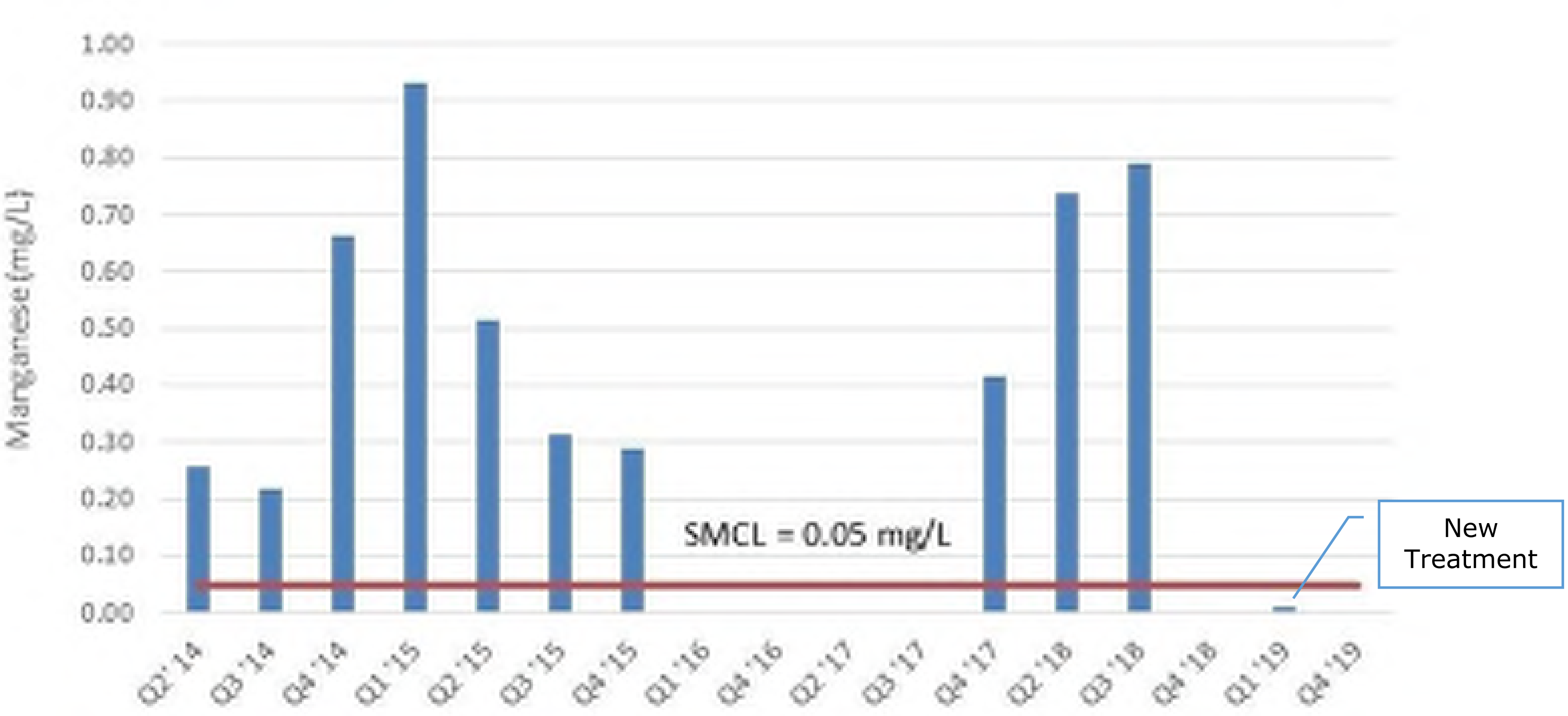


Figure 4-8: Manganese in Wells 19/22 Finished Water

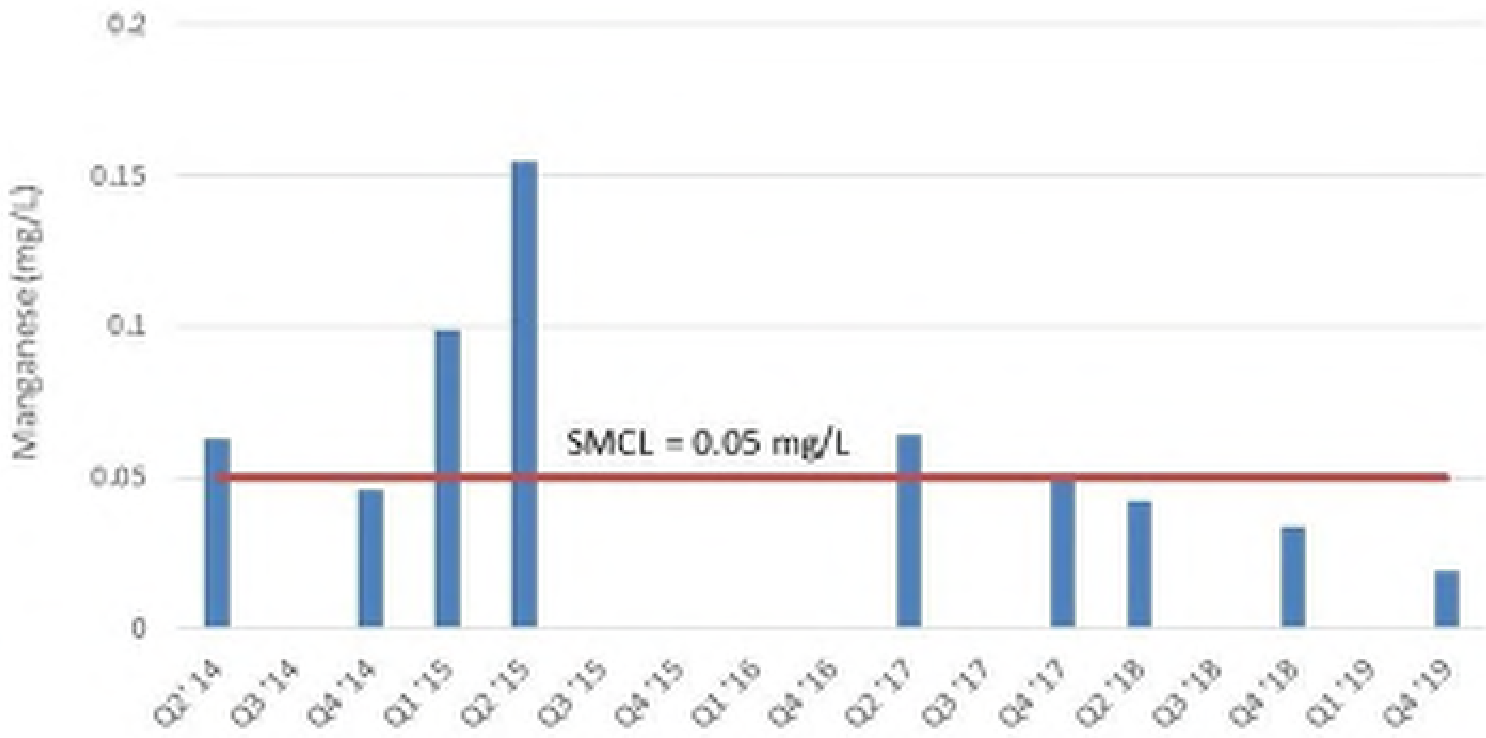


Figure 4-9: Manganese in the Distribution System

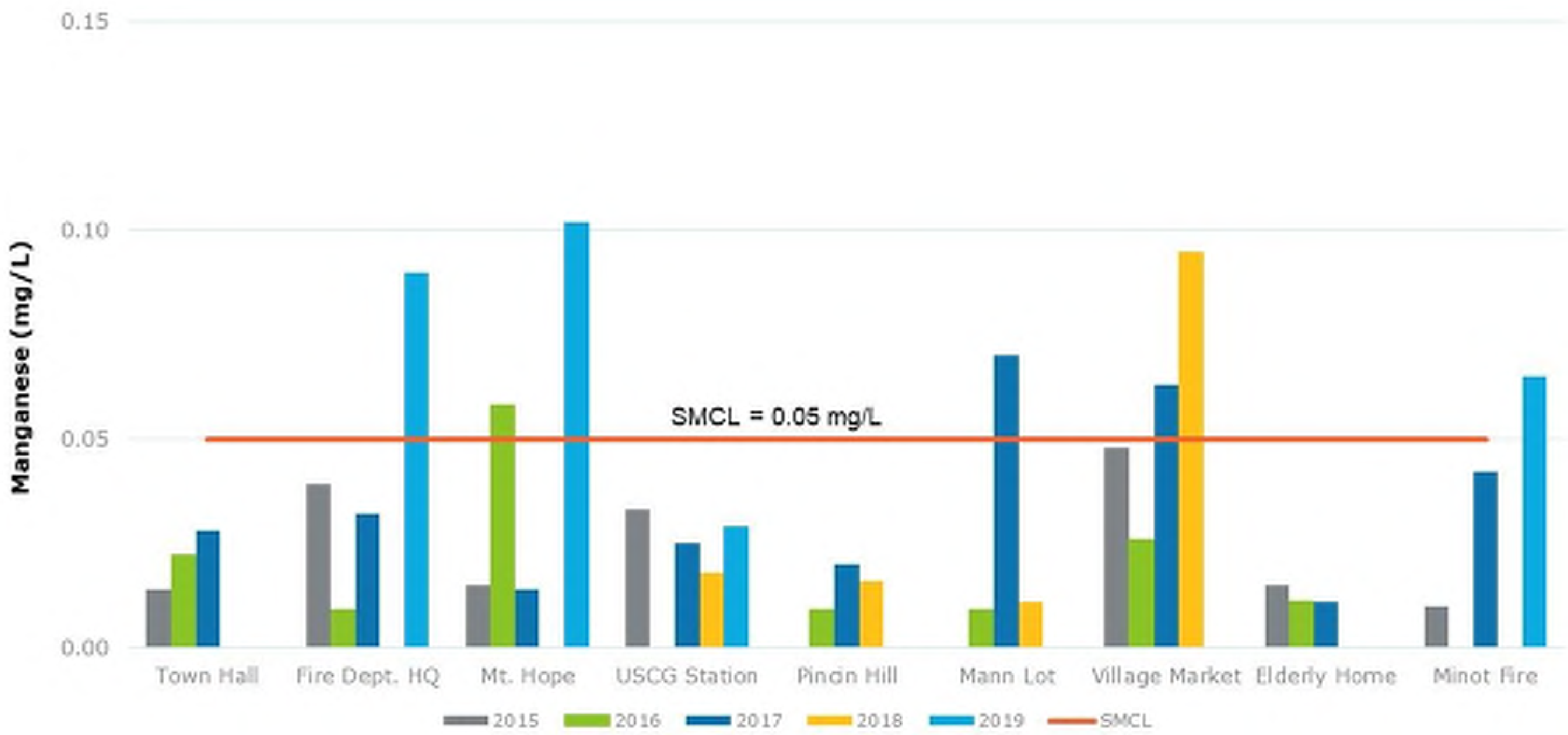
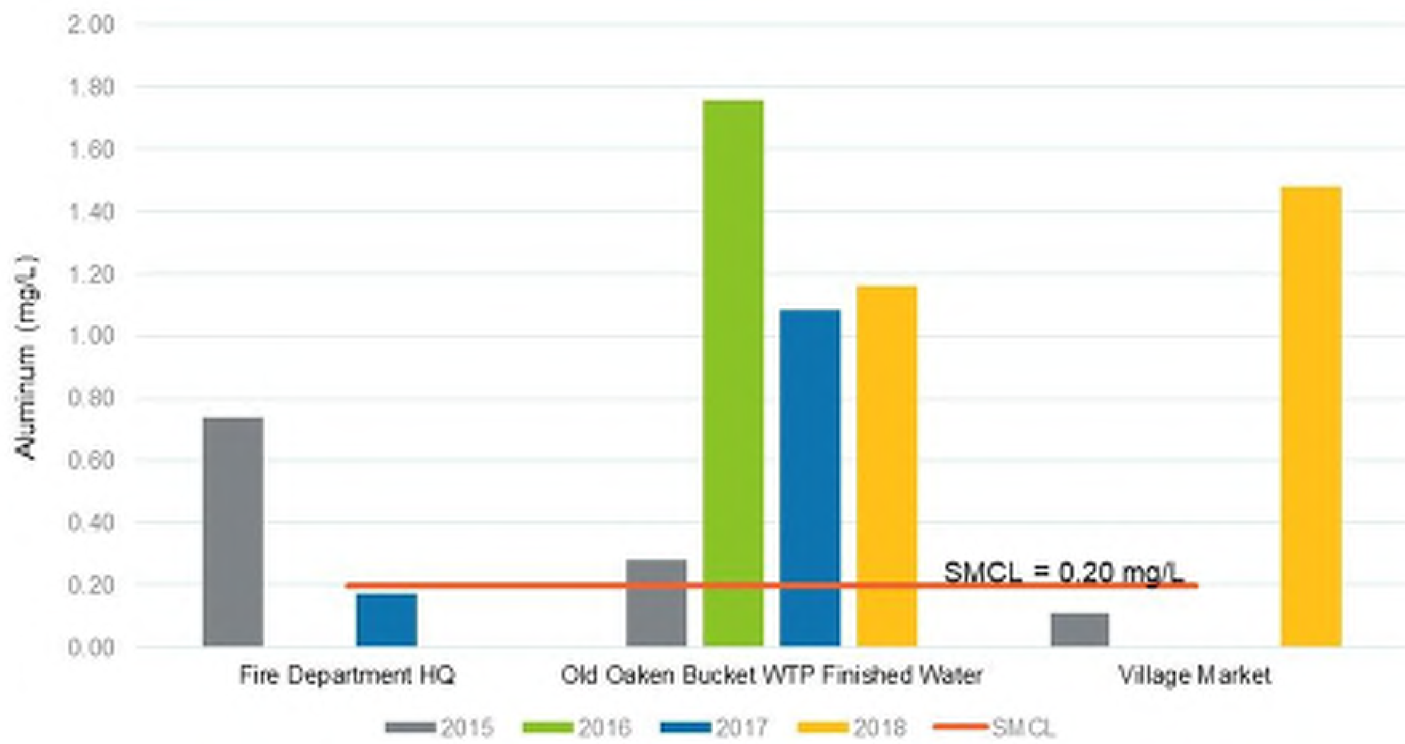


Figure 4-10: Aluminum in the Distribution System



4.1.3 Proposed, Unregulated, and Other Substances

Table 4-3 summarizes observations relative to proposed and potential regulations.

TABLE 4-3
Evaluation of Proposed, Unregulated, and Other Substances

Parameter	Comment / Observation
Perchlorate	Reported in Consumer Confidence Reports
	Occasionally detected at a range (low-high) from non-detect to 0.13 ug/L
	Proposed Maximum Contaminant Level Goal of 56 ug/L
Unregulated and Other Substances	Drinking water standards have not been established by EPA
	Monitored to assist EPA in determining their occurrence in drinking water and whether future regulation is warranted
	Substances reported in CCR and Range: Calcium (4.9-20.2 mg/L) Magnesium (2.8-10.2 mg/L) Sodium (20-64 mg/L)
Unregulated Contaminant Monitoring Rule – Part 4 (UCMR4)	Once every 5 years EPA issues a new list of unregulated contaminants to be monitored by public water systems
	UCMR4 was published on December 20, 2016
	Substances reported in CCR and Range: Chlorodibromoacetic acid (0.37-2 ug/L) Dibromoacetic acid (0.5-1.75 ug/L) Quinoline (0.0449 ug/L)

4.1.4 Conclusions on Source Water Quality

- Barium, fluoride, and nitrate have been detected at the sources at levels well below the MCLs. As shown on Figures 4-3 and 4-4, barium is on a potentially increasing trend at OOB WTP, and nitrate is potentially increasing at Wells 10/11 and Wells 19/22. Nitrate should continue to be monitored and trended, and treatment considered if concentrations approach the MCL. Fluoride data were only available for 2018 and were not graphed.

- As shown on Figures 4-6, 4-7, and 4-8, manganese can be above the SMCL at OOB WTP, Well 18B, and Wells 19/22. There are no discernible trends regarding manganese at OOB WTP or at Wells 19/22. Manganese appears to be on an increasing trend at Well 18B, where a new treatment system is installed. Treatment for manganese removal at Wells 19/22 should be considered because these are the largest producing wells in the system.

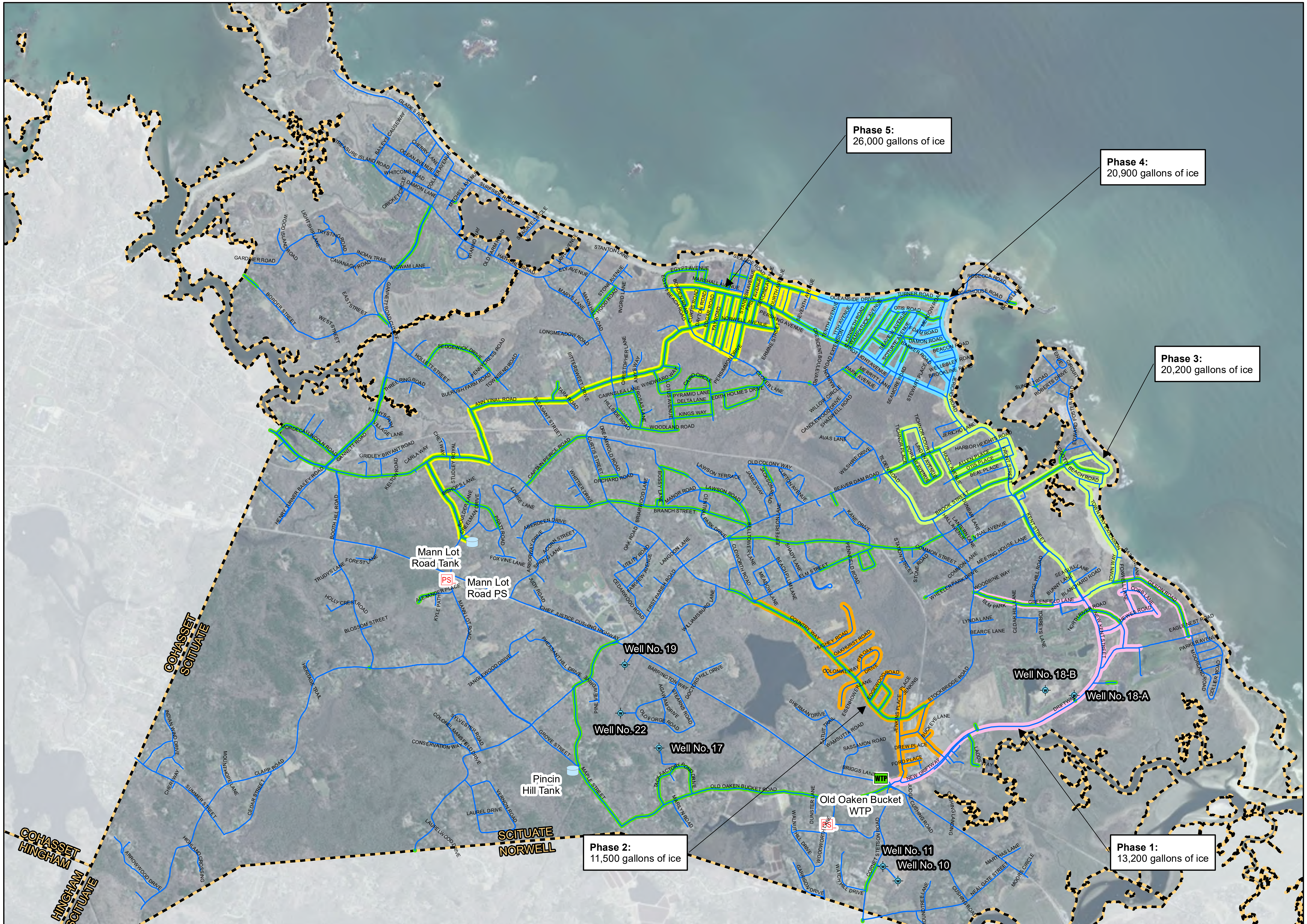
4.2 Discolored Water

The most important distribution system issue in the eyes of most customers is the presence of accumulated sediments (primarily iron and manganese) that cause discolored water events. Discolored water episodes typically occur during the summer when demand is high due to increased population and outdoor water use. Discolored water has caused numerous complaints during the summers of 2018 and 2019. The Town has initiated a program to remove accumulated sediments from the distribution system consisting of ice-pigging and unidirectional flushing.

The most common method of cleaning water mains is hydrant flushing. Unidirectional Flushing (UDF) is an enhanced method of hydrant flushing that maximizes flow velocities in the pipes being cleaned and minimizes water use. Ice pigging is a process of scouring the interior of pipes with an ice slurry. Ice pigging is a more effective means of removing sediments from pipes compared to UDF but is also more expensive. Ice pigging programs were conducted in the fall of 2018 and spring of 2019. Approximately 128,000 feet of water main were cleaned during these programs. Figure 4-11 shows the scope of the ice pigging program.

The UDF program was designed and initiated in 2019. The UDF program consists of a series of sequences in which valves are operated and hydrants are flowed to sequentially flush watermains. The objectives of the UDF program design are to maximize the flow velocity in each main, minimize the amount of water used, and move sequentially from sources or storage facilities outward in the system to avoid introducing sediments from pipes that have not been flushed into pipes that have been flushed. Figure 4-12 shows an overview of the UDF program. As indicated in the figure, the Town's distribution system is divided into 10 flushing zones, with each zone consisting of multiple individual sequences. During the fall of 2019, the Water Division completed 9 out of 10 zones. Based on visual observation, both the ice pigging and UDF programs have been successful in removing sediment, as can be seen in the photograph. Distribution system testing for manganese also suggests an improvement: in the October 2019 sampling, no manganese was detected at 4 out of 7 sample locations and was reduced from 40% to 80% compared to June 2019 (before the flushing program) in the other 3 samples.

FIGURE 4-11
Recommended Ice Pigging



Legend

- WTP
- WaterTank
- Well
- BoosterPump
- Town Boundary
- Water Main
- Pipes with Reverse Flow
- Phase 1 Ice Pigging
- Phase 2 Ice Pigging
- Phase 3 Ice Pigging
- Phase 4 Ice Pigging
- Phase 5 Ice Pigging

LOCUS MAP

0 1,250 2,500
Feet
1:30,000 1 in = 2,500 ft

NOTES

1. Ice quantities shown are based on vendor provided ice usage by pipe material and diameter. Actual ice volumes may vary based on field conditions.

Scituate Water Distribution System
Scituate, Massachusetts
January 2020

Tighe&Bond
Engineers | Environmental Specialists

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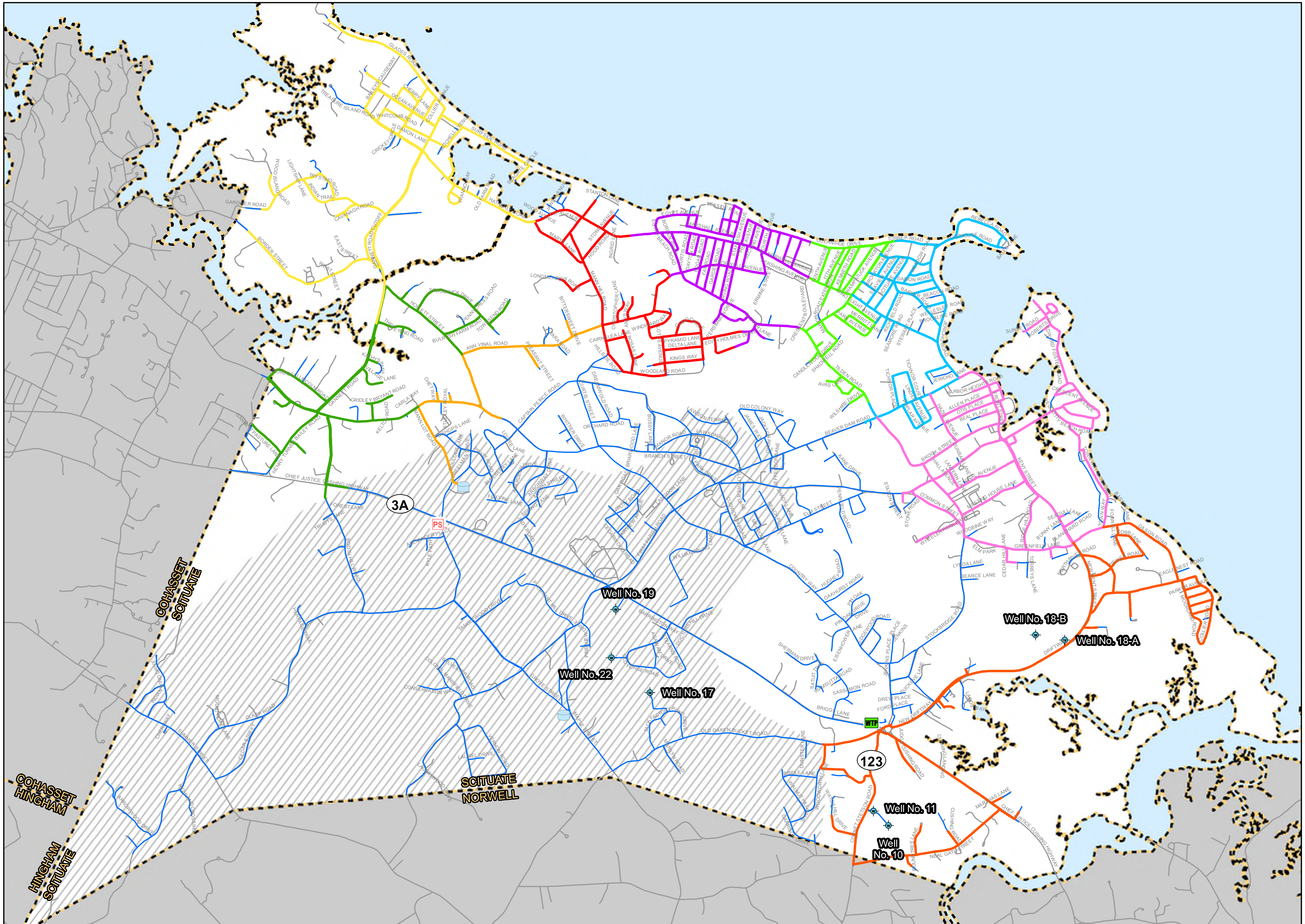
S-5001

FIGURE 4-12
Overview of UDF Program Progress



Legend

- WTP Water Treatment Plant
- Water Storage Tank
- Well
- PS Pump Station
- WaterMain
- Street
- Area Excluded from UDF Program
- Town Boundary

Zone

1, 2, 3, 4, 5, 6, 7, 8, 9

LOCUS MAP

0 1,250 2,500

Feet

1:30,000 1 in = 2,500 ft

NOTES

Scituate Water Distribution System
Scituate, Massachusetts

January 2020

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SECTION 5

Section 5
Phased Capital Improvements Program

5.1 Program Development

The Capital Improvement Program reflects the recommendations developed from the condition assessments described in Section 2.3 combined with ongoing repair and maintenance programs. Projects were ordered in terms of priority based upon our evaluation and discussions with the Town.

5.2 Program Cost Summary

Table 5-1 summarizes the capital improvements

TABLE 5-1

Capital Improvement Summary

System Component	Description	Funding Source	Budgetary Cost		Year
Meters	Water Meter Replacements	Rate	$	210,000	2021
Treatment	Wells 10 & 11 upgrades	Rate	$	489,000	2021
Treatment	Well 18B Upgrades	Debt	$	850,000	2021
Source	New Treatment Plant Prelim. Design & Permitting	Debt	$	2,800,000	2021
Source	Well 17A Construction	SRF	$	8,000,000	2021
Treatment	Repairs to Water Treatment Plant	Rate	$	100,000	2022
Source	Well Redevelopment Program	Rate	$	125,000	2022
Storage	Repair Mann Lot Standpipe- Construction	Debt	$	550,000	2022
Treatment	New Surface Water Treatment Plant Design	Debt	$	2,500,000	2022
Pipes	Water Main Replacement Phase 4	Debt	$	2,500,000	2022
Distribution	Mann Lot Road Pump Station Improvements	Rate	$	150,000	2023
Meters	Water Meter Replacements	Rate	$	200,000	2023
Meters	Advanced Meter Infrastructure (AMI) Upgrade	Debt	$	1,100,000	2023
Source	Dolan Field Well Construction	Debt	$	2,500,000	2023
Pipes	Water Main Replacement Phase 5 (Humarock)	Debt	$	5,000,000	2023
Distribution	Walnut Tree Pump Station Repairs	Rate	$	107,000	2024

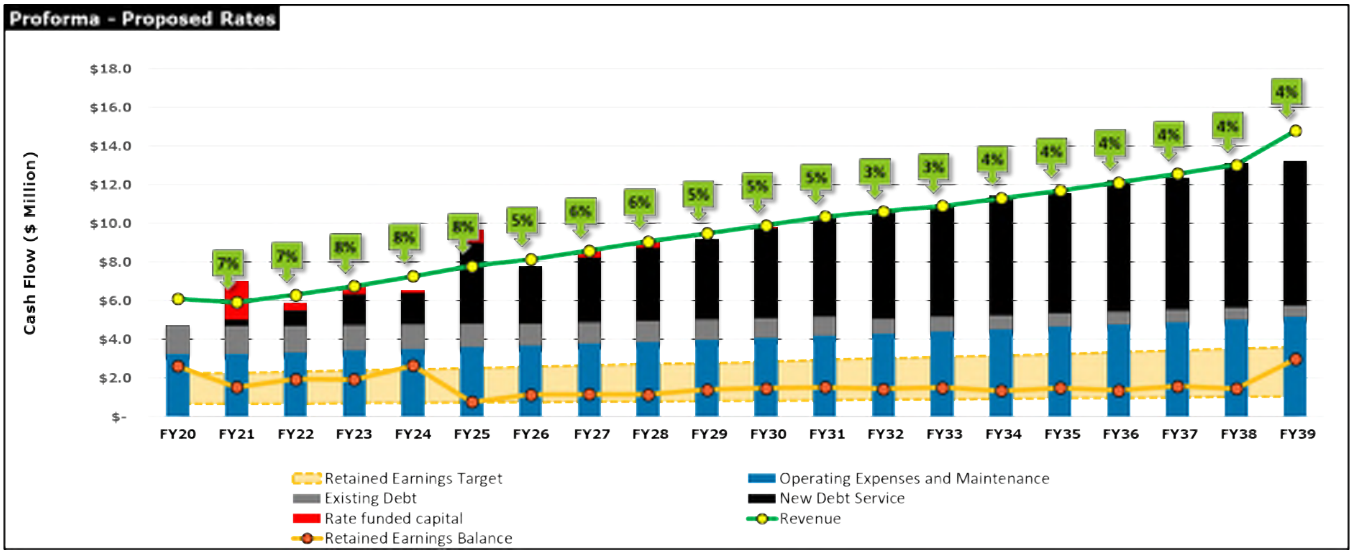
System Component	Description	Funding Source		Budgetary Cost	Year
Storage	New Storage Tank (two smaller tanks to replace one existing)	Debt	$	2,500,000	2025
Meters	Water Meter Replacements	Rate	$	220,000	2025
Source	West End Well Investigation	Rate	$	300,000	2025
Enterprise	SCADA	Debt	$	700,000	2025
Storage	Pincin Hill Tank Upgrades	Debt	$	1,500,000	2025
Pipes	Water Main Replacement Phase 6	Debt	$	3,500,000	2025
Treatment	New Surface Water Treatment Plant	SRF	$	40,000,000	2025
Source	Reservoir Expansion	Debt	$	1,790,000	2026
Source	West End Well Construction	Debt	$	3,000,000	2026
Pipes	Water Main Replacement Phase 7	Debt	$	3,500,000	2026
Meters	Water Meter Replacements	Rate	$	230,000	2027
Pipes	Water Main Replacement Phase 8	Debt	$	3,500,000	2027
Meters	Water Meter Replacements	Rate	$	240,000	2028
Pipes	Water Main Replacement Phase 9	Debt	$	3,500,000	2028
Pipes	Water Main Replacement Phase 10	Debt	$	3,500,000	2029
Pipes	Water Main Replacement Phase 11	Debt	$	3,500,000	2030
Pipes	Water Main Replacement Phase 12	Debt	$	3,500,000	2031
Pipes	Water Main Replacement Phase 13	Debt	$	3,500,000	2032
Pipes	Water Main Replacement Phase 14	Debt	$	3,500,000	2034
Pipes	Water Main Replacement Phase 15	Debt	$	3,500,000	2036
Pipes	Water Main Replacement Phase 16	Debt	$	3,500,000	2038
		TOTAL		**$114,920,000**	

5.3 Water Rate Impacts

The Scituate water department is operated as a municipal enterprise fund under MGL c. 44, § 53F½. Enterprise funds are intended to provide financial separation between the utility and the General Fund by segregating the utility associated costs and recovering those costs by billing water customers.

The water rate model prepared under a previous project was updated through FY19. Expenses were projected through FY39 including the capital improvement program shown above. Percentage increases were applied to the existing rate structure to provide revenue sufficient to support the projected expenses plus a minimum fund reserve equal to 20% of operating costs. Figure 5-1 shows the required rate increases for each year.

Figure 5-1: Projected Water Enterprise Fund Proforma



5.4 Customer Cost Impacts and Affordability

The most meaningful way to evaluate water rates is by determining customer costs and then evaluating the economic impact of that cost. Since the 1990's the water industry has used the EPA Financial Capability Analysis (FCA) approach which used the residential indicator (residential water cost divided by the median household income) to measure cost impact. This methodology was developed for evaluating cost impacts of sewer separation projects on a community wide basis.

In April 17, 2019 a report entitled "Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector" was released that describes an approach that is more suitable for measuring the economic impact on a household level. This report was commissioned by the American Water Works Association, the National Association of Clean Water Agencies and the Water Environment Federation.

This new methodology uses two indicators to determine financial impact, the Household Burden Indicator (HBI) and the Propensity of Poverty Index (PPI). HBI is similar to the residential indicator, however instead of dividing the total cost of water by the median household income, it is divided by the upper limit of the Lowest Quintile Income (LQI). The PPI is defined as the percentage of the community at or below 200% of the Federal Poverty Level (FPL).

The total annual water cost for a residential water customer was calculated for each year of the analysis period. The HBI is intended to be based upon the combined cost of water, sewer and stormwater. Currently the cost of sewer is less than the cost of water in

Scituate, in the interest of conservatism, the future cost of sewer was assumed to be equal to the cost of water.

Table 5-2 contains the estimated cost of water, sewer, the LQI and the resultant HBI for each year of the analysis period. Water costs are based upon a four-person household using 60 gallons per capita per day and the LQI is based upon the 2017 value obtained from the 2017 American Community Survey projected at an annual increase of 1.1%.

TABLE 5-2

Annual Water Cost for Typical Residential User

Year	Annual Water Cost	Assumed Sewer Cost	LQI	HBI
FY20	$864	$864	$42,989	4.0%
FY21	$925	$925	$43,441	4.3%
FY22	$990	$990	$43,897	4.5%
FY23	$1,069	$1,069	$44,358	4.8%
FY24	$1,154	$1,154	$44,823	5.2%
FY25	$1,247	$1,247	$45,294	5.5%
FY26	$1,309	$1,309	$45,770	5.7%
FY27	$1,388	$1,388	$46,250	6.0%
FY28	$1,471	$1,471	$46,736	6.3%
FY29	$1,544	$1,544	$47,227	6.5%
FY30	$1,622	$1,622	$47,722	6.8%
FY31	$1,703	$1,703	$48,224	7.1%
FY32	$1,754	$1,754	$48,730	7.2%
FY33	$1,806	$1,806	$49,242	7.3%
FY34	$1,879	$1,879	$49,759	7.6%
FY35	$1,954	$1,954	$50,281	7.8%
FY36	$2,032	$2,032	$50,809	8.0%
FY37	$2,113	$2,113	$51,342	8.2%
FY38	$2,198	$2,198	$51,882	8.5%
FY39	$2,286	$2,286	$52,426	8.7%

The PPI for Scituate, based upon 2017 values was 9%, to determine the economic impact the two values are entered into the Figure 5-2. The resulting economic burden is a "Low" in FY20 and a "Moderate to Low" in FY39.

Figure 5-2: Economic Burden Matrix

HBI – Water Costs as a percent of income at LQI	PPI Percent of Households below 200% of FPL		
	>=35%	20% to 35%	< 20%
>= 10%	Very High Burden	High Burden	Moderate - High Burden
7% to 10%	High Burden	Moderate - High Burden	Moderate - Low Burden
< 7%	Moderate - High Burden	Moderate - Low Burden	Low Burden

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