WOODARD
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WATER SYSTEM CAPITAL IMPROVEMENT PLAN

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Vinalhaven Water District
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EXECUTIVE SUMMARY

In March 2006, Woodard & Curran completed a Master Plan for the Vinalhaven Water District to evaluate the entire system, including distribution, treatment, source, and future regulatory requirements, to understand the system's overall strengths and weaknesses and allow the District to plan improvements. The current plan serves as an update to that previously completed effort and captures changes in growth projections and projects that have been completed over the past 12 years. As a part of the development of this plan, the District's hydraulic model was updated, and a new list of recommended improvements was identified.

Water production data was reviewed from 2017. This data was used to develop updated system demands. Production decreased by approximately 25% between 2003 and 2017 due, in part, to water main improvements that decreased leaks and the reduction of bleeders throughout the distribution system. Round Pond continues to provide water to the Water District, and improvements should focus on accessibility and connectivity between the intake on Round Pond and the treatment system at Folly Pond.

As a part of this updated Master Plan, the prior hydraulic model was converted to Innovyze's InfoWater, a GIS-based software package that allows available GIS information to aid in the water distribution system mapping. The model was then updated to reflect completed distribution system projects and updated demands based on production data. Thirteen fire flow tests were completed to aid in the calibration of the model.

Most the recommended capital improvement projects aim to improve reliability within the system and replace aging infrastructure. Table ES-1 lists the projects and the anticipated cost for each project. These costs are high-level estimates and should be refined as each project moves into preliminary design.

Table ES-1: Recommended Capital Improvement Projects

Project	Anticipated Cost
Main Street Pipe Replacement	$710,000
Round Pond Pumping Arrangement	
Pump Improvements	$15,000
Round Pond Intake Improvements	$60,000
Transfer Line Pressure Testing	$5,000 - $10,000
Transfer Line Replacement	$160,000
Transmission Line Replacement	$1,800,000
Galvanized Main Replacement	$95,000
Improving Isolation of Mains	$5,000
Starr Street Main Replacement	$350,000

The total cost of these projects is approximately $3,205,000. These projects can be completed in conjunction with Town infrastructure improvements or spread out over several years as time and budget allow.

1. INTRODUCTION

1.1 Background

The Vinalhaven Water District ("the District") provides drinking water to the residents of Vinalhaven. Day-to-day operation and maintenance of the system is performed by Maine Water Company of Saco, under contract to the District. The District commissioned Woodard & Curran to update the existing Capital Improvement Plan, including a treatment and distribution system evaluation, system map, and hydraulic model, that was completed by Woodard & Curran in 2006. This new plan reflects the treatment and distribution system improvements completed by the District over the past twelve years and is intended to help guide the District's decision-making on upgrades, maintenance, rehabilitation, and replacement of the water system into the future.

The Vinalhaven Water Company constructed the public water system in 1910 and operated the system until 1979, when the Vinalhaven Water District was formed. The source for the water system is Round Pond. The treatment building is located adjacent to Folly Pond, a pond located directly adjacent to Round Pond, and utilizes filter bags and ultraviolet disinfection as well as pH and alkalinity control and chlorine disinfection. The distribution system includes 3.8 miles of transmission main, 4.7 miles of distribution main, and approximately 420 services.

1.2 Plan Objectives

The objective of this Water System Capital Improvement Plan is to create a working document that identifies and prioritizes existing and future system needs and allows the District to schedule recommended upgrades in a manner that minimizes the financial impact to the system's customers. In addition, this document can be used to help set expectations for equipment lifespan and regulatory driven changes.

The hydraulic model is a stand-alone tool that can be used to answer questions related to system growth, ability to serve new development, and to evaluate localized water quality issues within the distribution system that can result from changes in water age or flow direction. As future distribution system changes occur, it is important that the model be modified to reflect these changes.

2. PRESENT AND FUTURE WATER DEMAND

Anticipating population and water consumption patterns is critical for effective planning and asset management.

2.1 Current Demands

A detailed review of the produced water data from January 2017 to December 2017 was completed to develop a system demand baseline. There are three distinct demand periods in the Vinalhaven system: summer, winter, and non-summer non-freeze-up. Summer is generally categorized as July and August. This period has highest water-use due to a higher population during the summer and irrigation and watering activities associated with landscaping and house maintenance.

Vinalhaven operates several bleeders in the system during winter months, categorized as December through March, to prevent freeze-ups and move water in dead end sections that typically feed summer services. Several projects over the past ten years have increased looping in the system, decreasing the number of necessary bleeders and closing the gap between winter and the non-summer, non-freeze-up periods. Non-summer, non-freeze-up periods, categorized as April through June, October, and November, are typically the lowest demand times. Temperatures during these times do not typically necessitate the use of bleeders, and demands are not as high as the summer months. Table 2-1 lists the average production for each of these three demand periods in 2017.

Table 2-1: Existing Production

Demand Period	Average Production (gallons per day)
Summer	63,000
Winter	51,000
Non-Summer, Non-Freeze-Up	49,000

The peak day production in 2017 was 86,400 gallons, the result of a main break, and occurred on November 1, 2017.

Average demand has decreased by approximately 25% since 2002 and 2003. Demands from that period were evaluated for the 2006 CIP. This decrease is due, in part, to improvements made within the distribution system, which have decreased leaks, addressed leaky services, and added looping which allows for the reduction of bleeders.

2.2 Future Demands

Growth of the Vinalhaven water and wastewater systems would need to be approached with careful planning. The District is currently operating close to the safe yield of Round Pond, and significant capital investment would need to be made to the treatment system to allow for Folly Pond to be used as a source.

To prevent the cost of this treatment system falling on existing rate payers, a system development charge was put in place following PUC approval in 2003. This charge was based on the capital cost associated with the construction of a membrane filtration plant to treat water from Folly Pond. These development charges were updated in 2006 following the implementation of plans for cartridge filtration. The capital costs for this system, and the additional treatment that would be required to utilize Folly Pond water, were significantly less than envisioned when the original development charge was established. The 2006 system development charges are listed in Table 2-2.

Table 2-2: System Development Charge

Meter Size	Equivalent Factor	System Development Cost	Investment Amount Per Meter	System Development Charge
5/8-inch	1.0	$4,162.78	$1,535.08	$2,627.70
3/4-inch	1.3	$5,411.62	$1,642.71	$3,768.91
1-inch	2.19	$9,116.49	$2,830.57	$6,285.92
1 1/2-inch	2.97	$12,363.46	$3,855.49	$8,507.97
2-inch	8.0	$33,302.25	$6,157.54	$27,144.71

We have reviewed the current system development charges and believe the assumptions used in the 2006 update are still applicable. Therefore, we propose continuing to use the development charges approved by the PUC in 2006, and only updating them as necessary, should a change in the system require it.

The primary potential change to the distribution system is the conversion of summer properties to year-round residences. This change would be beneficial to the water system, as it does not increase the peak demand periods, but brings in additional revenue during lower demand time periods. Expansion of the water system service area is tied to wastewater service area expansion, which is also significantly limited by that system's treatment capacity.

Significant capital investment by the District would be necessary should demands increase considerably.

3. SUPPLY AND TREATMENT DESCRIPTION AND ASSESSMENT

3.1 Sources

3.1.1 Round Pond

The water source for the system is Round Pond. Round Pond is approximately 9.8 acres in size and is within an approximately 80-acre watershed. The outlet of the pond is controlled by a concrete dam and spillway. The spillway maintains the pond level at an elevation of 95.8 feet.

A small wood-frame building, supported by a concrete foundation, is located along the southern shore of the pond. Overhead electrical service is provided via a cross-country route, which is heavily wooded, making access for repairs difficult. The service is stepped down to 110 volts at a transformer on a utility pole just outside of the building. The building houses one ITT Marlow Model 2PL 1EC, 2 horsepower pump, SCADA equipment, and a propane fired generator attached to the outside of the building. A second pump is stored at the Folly Pond pump station and is available as a spare. It does not appear that this pump has been replaced since the 2006 Plan was developed.

The intake to the pump house consists of a 6-inch HDPE pipe. The intake extends approximately 125 feet into the pond. The flexible piping and intake support system allows the intake to be lifted from the pond into a boat for removal and cleaning of the screens. The intake is located approximately 7 feet off the bottom of the pond and approximately 16 feet below the spillway elevation.

The pump building floor elevation is reported as 96.28 feet, placing it approximately 6 inches above the normal full pond elevation. At full pond level, the building is surrounded by water and must be accessed by way of a plank walk.

The water level in the wetwell within the pump building responds directly to the pond level. During the winter months, when the pond level is high, the wetwell level rises to the underside of the floor slab. Although the building is electrically heated, the water in the wetwell may freeze to a depth of up to two feet. Freezing of water in the pump suction piping also occurs. As a result, the wetwell and pump suction piping have been surrounded with rigid foam board and supplemental heating has been added. This does not eliminate the risk of freezing, and this is a situation that must be closely monitored during periods of extended cold weather.

During dry months, the pond level may drop by up to six feet, leading to a comparable drop in the wetwell level. The lower water level not only impacts the intake (during drought years a visible whirlpool has been reported near the intake) but also alters the suction lift at the pump, reducing the pump output.

The deepest portion of Round Pond is approximately 23 feet below the spillway elevation. Based on a volumetric study performed by Snowden Consulting Engineers, Inc. in July 2001, the total volume of water stored in the pond is approximately 42 million gallons. With the top of the intake screen approximately 16 feet below the spillway control elevation, approximately 26 million gallons of water are available to the intake. The safe yield for the pond has been reported to be approximately 85 gallons per minute (gpm), which equates to approximately 122,400 gallons per day (gpd).

Round Pond also provides water to one private user, through a separate intake and pumping station. The user has rights to draw up to 175,000 gallons per year. The safe yield of the pond concerns many in that it ultimately limits and restricts growth throughout the community.

Water quality in Round Pond has historically been quite high, but there are some concerns. Active beaver colonies have not been identified in this watershed. Even with the heavy rains and high runoff experienced during 2005, turbidity in the pond averaged approximately 0.3 NTU and was always less than 1 NTU. During more typical, drier, years turbidity is typically as low as 0.18 NTU. Total organic carbon (TOC) in the pond water has historically been in the range of 2 to 3 mg/l, however, in wet years with high water conditions, TOC levels of 4 to 5 mg/l have been measured. Late in the fall of 2005, it was determined that the algae Synura was present in the pond. The establishment of this algae was likely due to the high runoff and water levels experienced within the watershed from that year's excessive precipitation. The Synura was undoubtedly responsible for at least a portion of the TOC increase. It led to taste and odor complaints by the District's customers and was likely responsible for a portion of the increases seen in the trihalomethane group of disinfection byproducts at that time.

Round Pond was issued a filtration waiver in 1992 and operated as a non-filtered surface water source for many years. A filtration system was installed at the Folly Pond pump station in 2007. The system was installed after an algae bloom in Round Pond resulted in excessive organic loads that caused an increase in disinfection byproducts and taste and odor complaints. This system is described in Section 3.2.

The District owns the lands around the entire perimeter of Round Pond except for the road and all but three parcels within the watershed. Based on an earlier application, it was noted that the District's total holdings within the watershed amounts to approximately 80 percent of the watershed. The District has use agreements within the watershed with the three private land owners.

Watershed protection is a primary concern on the island. The District has implemented a very successful public outreach program within the community. From an early age, residents of Vinalhaven are taught the importance of protecting the island's only source of drinking water. The District has partnered with the local elementary school and implemented educational programs to explain the importance of watershed protection. The pond is closed to fishing and motorized boats. There are no established trails located in the watershed near the pond other than the access road into the pump house. Vandalism at this location has not been a problem. All-terrain vehicles have been known to enter the watershed along its far western edge, away from the pond. The District is attempting to control this access through public education and has partnered with the Vinalhaven Land Trust on the posting of signs and trail markers.

The existing town road (North Haven Road) is very close to the pond and creates the potential for intentional and/or unintentional contamination or pollution of the water supply. Although the community is very well educated about the importance of watershed protection, the District should be prepared to address the worst-case scenario of an oil or gasoline spill resulting from a vehicular accident on this road.

It is impractical to consider the relocation or realignment of the road in this area, given the topography. In addition, the granite blocks placed along the shoulder of the road provide the best practical barricade to vehicles entering the pond. Still, it may be wise to focus public education on the potential drinking water impacts from accidents along this stretch, to post additional warning signs or speed reductions, and to possibly having spill containment booms readily available in this area.

3.1.2 Folly Pond

Folly Pond is located between Round Pond and the water distribution system. The Folly Pond Pump Station houses the District's treatment system. The pond is approximately 11 acres in size and its watershed is located directly adjacent to and downstream from the Round Pond watershed. Water levels in the pond are controlled by a culvert outlet under the North Haven Road, although beaver activity often limits flow from the pond.

Folly Pond is not currently used as a water source, and significant investment in treatment would be necessary if it were to be utilized. Limited water quality information on Folly Pond is available. Turbidity is generally in the 0.5 to 2.5 NTU range and water color is in the range of 30-50 in late summer. TOC typically ranges from 2-5 mg/l. Beavers and other mammals are known to be present in this watershed and fecal coliform levels are suspected to be of concern.

In 1997, the District began the search and development of a well field on the land adjacent to Folly Pond. The search was generally unsuccessful. One artesian well located on the Folly Pond property and developed during this period is connected to the wet well at Folly Pond. The artesian well contributes a negligible amount of water to the system.

3.2 Folly Pond Pump Station

Folly Pond Pump Station houses pumps, valves, bag filters, UV disinfection equipment, chemicals, and SCADA components. It is also used for office space. Raw water from Round Pond is pumped to the Folly Pond Pump Station where it is treated.

The pump station consists of a wet well, measuring 10 feet in diameter and 13 feet deep (total storage volume of 7,633 gallons) and two pumps. One pump is designed to deliver 231 feet of head at 60 gpm and was installed in 2017. The second pump is scheduled to be replaced in 2018. The wetwall was last cleaned in 2008.

Flow is measured by a 3-inch Sensus master meter, which also measures system pressure. This master meter was installed in 2001 to resolve conflicting readings from the original production meter and the newly installed service meters for each user.

The water then passes through a bag filter system. The system was installed in 2007 to improve water quality, meet LT2 requirements, and reduce DBPs in the system primarily through a reduction in the chlorine dose required. This system consists of bag filter units manufactured by Strainrite, classified by the Maine Drinking Water Program as an Alternative Filtration Technology capable of providing adequate removal and inactivation rates of *Giardia lamblia* and viruses. The water passes through Strainrite roughing and preliminary treatment bag filters followed by a final filtering step.

In 2011, treatment upgrades were completed. These upgrades included the installation of UV disinfection and the installation of a pipe loop to provide adequate chlorine contact time prior to the distribution system. The UV system consists of two Trojan B04 reactors and was designed to provide 3-log removal of *Cryptosporidium*.

Following UV treatment, sodium hypochlorite is added for virus removal. The pipe loop installed as a part of the 2011 consists of 12-inch ductile iron pipe and provides adequate contact time before the water leaves the Folly Pond site. The pipe loop allows the District to provide the full contact time necessary to achieve a 4-log virus removal using sodium hypochlorite. The addition of this contact loop in the immediate vicinity of the Folly Pond pump station building allows all chemical additions and all treated water analyses to be made at this one facility, eliminating the previous problems the system experienced using its long transmission line as a contactor resulting time offset, and need to overdose free chlorine to measure a residual at its remote monitoring station.

Water is chlorinated using a 12.5% solution of sodium hypochlorite pumped from a day tank. Hypochlorite is delivered in four 30-gallon drums per shipment, as needed. The sodium hypochlorite feed pumps were replaced as part of the 2011 upgrades.

After passing through the pipe loop, the free chlorine residual and pH are measured. Soda ash is added at this point for pH adjustment. The soda ash is delivered in 50-pound bags, typically ten at a time, with the sodium hypochlorite. Chemical feed systems are currently paced to flow and trimmed to residual setpoints.

As part of the 2011 upgrades, provisions were made to allow for the addition of ammonia to convert the system residual to chloramines to reduce DBPs. The District tried a conversion to chloramines prior to the installation of the pipe loop, but it was difficult to pace the chlorine dosing at the Folly Pond Pump Station based on readings at the remote chlorine monitoring station, while dosing ammonia at the monitoring station at the proper ratio. While the current combination of filtration, UV treatment, and chlorination is working for the District, there is potential to chloraminate in the future. The installation of the pipe loop and analyzers at the pump station would ease the chloramination process, allowing all chemicals to be dosed in close proximity and eliminating the time offset and residual decay that occurred in the transmission line. This remains a viable option should DBP levels rise. TTHM and HAA levels are discussed in greater detail in Section 6.

3.3 System Operation

The water system has been operated primarily the same way for the last 100 years. Water is pumped from Round Pond to Folly Pond pump station, disinfected, and then pumped from the pump station to the distribution system. Automation of the pumping and the installation of alternative methods of disinfection are the major operational differences when compared to earlier operation of the system. Automation is accomplished using the SCADA system, which was upgraded in 2017.

SCADA systems are typically defined as monitoring or control systems consisting of a central hose or master (usually called a master station, master terminal unit, or MTU); one or more field data gathering and control units or remotes (usually called remote stations, remote terminal units, or RTUs); and a collection or standard and/or custom software used to monitor, and control remotely located field data elements.

Collecting and processing data is accomplished with the use of Programmable Logic Controllers (PLCs). PLCs can gather specific operating information from devices, instruments, and components, and provide intelligent output. PLCs are required both at the RTUs and the MTU. PLCs at the RTU can be programmed to recognize each signal from various components independently and provide intelligent output to identify and define the signal. Output from the remote site PLCs is transferred to a PLC at the MTU. The PLC at the MTU can be programmed such that the data received can be provided to the operator through any monitoring or control device required. The MTU calls out to the remote stations as frequent as desired by the operator, to collect the information that has been gathered. Communication between the MTU and the remote sites can be accomplished by several methods. The two most commonly utilized forms of data transfer in the industry are telephone or radio telemetry. The communication method used in Vinalhaven is radio telemetry.

At the MTU site, several levels of monitoring or control are available. The signal that is received from each remote site can be used to notify status or condition solely or can be used to control the devices or take corrective action within each remote site from the MTU site. Graphical interfaces can be provided using a computer to observe the status at each remote site, such as pH levels or pump status. Each output from the PLC at the MTU can be connected to a dialer to notify others via telephone of the alarm condition. The SCADA system can be as simple or complex as the operator wishes. In Vinalhaven, the MTU, which is located at the Folly Pond pump station, is equipped with a graphical interface for local and remote users to monitor the status of the system.

The Round Pond pumping station is activated to operate when the level in the Folly Pond pumping station wet well is measured at 75 percent full. The Round Pond pumps run until the Folly Pond pumping station wet well reaches a full level.

As previously mentioned, the Folly Pond pumps are controlled by levels in the storage tank. When the tank reads 90 percent full, the Folly Pond pumping station will shut off. The pumping station will turn on when the tank level is measured at 80 percent and will pump until the full level of 90 percent is achieved. Pump rate is set by the operator and is then a constant value.

4. DISTRIBUTION SYSTEM DESCRIPTION AND ASSESSMENT

The piping network primarily consists of the transfer line between Round Pond and the Folly Pond Pump Station, the transmission main between the Folly Pond Pump Station and the distribution system at Pond Street, and the distribution system.

4.1 Transfer Line Between Round Pond and the Folly Pond Pump Station

The transfer line between Round Pond and Folly Pond is reportedly a 4-inch HDPE. The exact route of the main is unknown, but it is believed to be approximately 2,500 feet in length and is believed to run along the shore of the ponded areas between Round Pond and the pump station. The terrain between the two ponds is swampy.

There is a desire to pull water from Round Pond to Folly Pond, but if localized high points exist along the line, they would allow trapped air to collect, making it difficult to reliably maintain it as a suction line. In addition, the integrity of the transfer line is presently unknown and a reduction of the pressure in the line when used as a suction line could possibly draw Folly Pond or wetland area water into the suction. Pressure testing should be completed on the existing transfer line before eliminating the pumps at the Round Pond intake station and relocating them to the existing pump station at Folly Pond.

4.2 Transmission Main Between Folly Pond Pump Station and the Distribution System

The transmission main from the Folly Pond Pump Station to the distribution system consists of approximately 1.8 miles of 8-inch diameter cast iron pipe. The pipe was reportedly part of the original water system, which was constructed in the early 1900's. The main travels through areas of primarily wooded terrain, making access for maintenance and inspection difficult.

In 2005, District staff walked the length of the main and did not see any indications of leaks or compromised sections of pipe. They also isolated the line to measure leakage and determined that the amount of lost water along this section of pipe was relatively insignificant. It is unknown whether significant pipe degradation has occurred since these tests in 2005. There was at least one incident in recent years in which the line was inadvertently exposed in the area where it crosses the Mill's borrow pit.

4.3 Distribution System

This section will describe and evaluate conditions in the distribution system including the pipe network, the tank, and fire hydrants. Additional information regarding the distribution system can be found in Section 5, which covers the update, calibration, and evaluation of the hydraulic model.

4.3.1 Pipe Network

The water distribution system consists of approximately 6.5 miles of main ranging in size from 1-inch to 10-inch. This number excludes the transfer line and transmission main described above. Most of the pipe is unlined cast iron installed during the original construction of the system in the early 1900's. Hydraulic model results, described in greater detail in Section 5, indicate that this pipe is in relatively poor condition. Table 4-1 shows the distribution of pipe sizes and lengths within the system. Table 4-2 shows the distribution of pipe material types and lengths within the system. These numbers do not include the transfer line and transmission line described in the previous sections.

Table 4-1: Distribution System Pipe Sizes

Pipe Diameter (inches)	Length (miles)
4" or less	2.3
6"	2.7
8"	1.1
10"	0.4

Table 4-2: Distribution System Pipe Material Types

Pipe Material	Length (miles)
Cast Iron	2.8
Ductile Iron	1.4
Galvanized Iron	0.3
HDPE	0.4
PVC	1.6

Due to the physical constraints and rugged terrain that have impacted and shaped residential and commercial development in the Village portion of the island, the distribution system consists of several singular branches of piping servicing individual roads. Most of the water system has been developed within the road rights-of-ways or in feasible thruways throughout the residential and commercial areas of town. In addition, due to incremental growth, multiple properties are sometimes served from individual private lines or from significantly undersized lines. It appears that the construction of the system over the years has followed the growth of the community and expanded with the island population. There are currently 420 metered service connections to the system.

Several site features including ledge, undulating terrain, and ocean waters have made looping pipe segments very challenging and cost prohibitive. Looping of branched pipe segments is recommended in all water distribution systems where feasible. Looping is defined as the interconnection of branched and dead-ended pipe segments. It generally improves the water quality in dead end pipe segments, maintains water service to residents in the event of line breaks or maintenance activities, and provides operational and maintenance flexibility. In Vinalhaven, looping has already been accomplished in most areas where feasible, including the School Street, East Main Street, and East Boston Road area, the Pleasant Street and Carvers Street area, Clam Shell Lane, Mountain Street, and Sands Road.

There is currently only one main that connects the east side of the island to the source, treatment, and storage on the west side. The 10-inch cast iron main on Main Street includes a crossing of the Carvers Pond Spillway. The Town is currently developing plans for improvements on Main Street. These improvements include road rehabilitation, the replacement of the existing bridge, and aesthetic improvements to public facilities in the downtown area. The District should use this opportunity to replace the existing main to preserve the integrity of the main, improve reliability, and reduce the need to disturb the new infrastructure in the coming years.

4.3.2 Storage

The system has one storage tank. The glass-fused-to-steel tank was installed in 2002 by Aquastore Tanks. The tank holds 330,000 gallons and is approximately 89 feet tall and 25 feet in diameter. Water enters the tank through an existing 10-inch diameter cast-iron main with a fully open, manually-controlled gate valve. No altitude or other control valving is present. The tank level is measured by a pressure transducer at the gate valve located just outside the base of the storage tank. The measurement is transmitted back to the Folly Pond Pump Station via the system's Supervisory Control and Data Acquisition (SCADA) system. The signal sent to Folly Pond indicates the tank's water level expressed as a percentage of full. When the tank reads 90 percent full, the Folly Pond pumping station will shut off. The pumping station will turn on when the tank level is measured at 80 percent and will pump until the full level of 90 percent is achieved.

As noted, the tank has one single inlet/outlet pipe. In 2011, both active and passive mixing systems were installed in the tank to improve tank circulation, improve water quality, and decrease water age. The active mixer is a Kasco Marine unit that is suspended from the roof hatch. The passive mixing system consists of Tideflex nozzles that disperse water entering the tank. These installations were made to improve water aesthetics by reducing stratification in the tank.

4.3.3 Fire Hydrants

There are 31 fire hydrants in the Vinalhaven distribution system. Hydrants appear to be spaced adequately and are generally located to maximize service to various clusters of development throughout the Town.

Fire flow tests were conducted on ten hydrants on December 11, 2017. During these tests, flow rate was measure at each flowing hydrant, and static pressure and residual pressure were recorded for both the flow and at least one gauge hydrant. This information was used to calibrate the hydraulic model and the results of these tests are described in Section 5.

5. HYDRAULIC MODEL

5.1 Model Development and Calibration

The District contracted with Woodard & Curran in 2005 to provide a hydraulic model of the water distribution system. The hydraulic model was developed using WaterCAD, a software program which has since become obsolete. As a part of this project, the prior hydraulic model was converted to Innovyze's InfoWater, a GIS-based software package that allows available GIS information to aid in the water distribution system mapping.

5.1.1 Physical Model Development

The hydraulic computer model pipes are designated as "lines", pipe intersections as "nodes", storage facilities as "tanks" and supply sources as "reservoirs". Pumps are used to transfer water from the source to the distribution system. Each of these model components has properties or attributes that correspond to the actual physical properties of the distribution system facilities. The data used to develop the computer model includes pipe characteristics (diameter, length and friction coefficient C-value), node characteristics (elevation and demand), and storage facility characteristics (volume, geometry, typical operating levels and elevation).

For this hydraulic model update, many of the element characteristics including pipe diameter, length, and C-value and node elevation were imported from the previous model. Pipe length and node elevation were verified with available GIS information. C-values were adjusted during model calibration, which is described below. Tank and pump characteristics were compiled from available data and discussions with staff and incorporated into the model.

District staff provided information about system improvements and modifications that have occurred since the model was last updated; those updates were incorporated into the model. The updated model contains 186 junction nodes and 195 pipe segments, making up approximately 8.3 miles of distribution piping. This includes the approximately 1.8 mile 8-inch transmission main from Folly Pond Pump Station to the distribution system. The transfer line from Round Pond to Folly Pump Station is not included in the model since the only pumps impacting the distribution system are located at the Folly Pond Pump Station. The model also includes the one tank.

5.1.2 Demands

The existing average day demand was calculated based on the amount of water produced between January 2017 and December 2017. This average day demand, approximately 52,000 gallons per day, was distributed uniformly to nodes throughout the model. A standard residential diurnal pattern was applied to the demand to represent the variance of water usage throughout the day.

5.1.3 Model Calibration

After development of the physical model as described above, the model was calibrated using results derived from hydrant flow testing. In addition to piping modifications constructed since the model's development, it was important to conduct field testing to determine the current condition of the interior of the distribution system's pipes.

Corrosion and the deposition of sediment (tuberculation) on the interior of unlined iron mains is the chief cause of reduced carrying capacity. Corrosion and tuberculation greatly increase the roughness of the pipe's interior wall. The result is increased friction and a corresponding resistance to flow and a reduction in pressure.

The Hazen-Williams Coefficient, or C-value, is used to define the relative capacity of the water mains. For the Hazen-Williams formula, the lower the C-value, the lower the carrying capacity of a pipe. Typical C-values for new cement-lined ductile iron pipes are in the range of 120-140. Older, unlined cast iron pipes can have C-values ranging from 100 to lower than 40. Pipes with a C-value of 60 have a flow capacity of only half of a newer or lined pipe with a C-value of 120.

5.1.4 Fire Flow Testing

Hydrant flow tests were conducted to determine the availability of sufficient water for fire suppression (fire flow) and to assist in the assignment and adjustment of the pipe C-values throughout the system.

In December 2017, District staff, assisted by Maine Water Company staff, performed 10 hydrant flow tests. The locations of the flow tests were selected based on general uses in the area and system improvements completed since the model was developed. Two hydrants were selected for each test: one flow hydrant and one gauge hydrant, generally located immediately upstream or downstream of the flow hydrant. Three of the tests had two gauge hydrants. Residual pressures were recorded in the gauge hydrants, while a flow meter was attached to the flow hydrant, which was opened until system pressure stabilized. Figure 5-1 shows the location of the flow tests. This information provides the basis of model calibration.

Table 5-1: Fire Flow Test Data – December 2017

	Location	Flow Hydrant		Residual Hydrant		Calculated Flow Available @ 20 psi*
		Flow (gpm)	Static (psi)	Static (psi)	Residual (psi)	
1	Pond Street	568	45	57	23	481
2A	Lois Lane	568	40	35	21	688
2B	Lois Lane	568	40	42	26	640
3	Sands Road	712	62	60	33	903
4A	West Main Street	718	60	60	38	992
4B	West Main Street	718	60	64	44	1,044
5	Main Street	692	62	63	50	1,304
6	Atlantic Avenue	200	60	54	52	1,009
7A	Cross Street	384	52	53	13	340
7B	Cross Street	384	52	52	10	331
8	School	184	41	52	26	164
9	Pequot Road	131	42	44	21	128
10	East Boston Road	178	57	62	51	343

* Calculated flow available at 20 psi residual pressure is based on pressure drop measured at residual hydrant and adjusted for measured static pressure at the flow hydrant.

5.1.5 Final Calibration

To obtain an accurate representation of the distribution system, it was necessary to adjust model parameters, specifically C-values, to match results of field testing. The Innovyze Calibrator was used to run an initial calibration and determine Hazen-Williams C-factors for various pipe materials through several iterations. The existing water distribution system was divided into three calibration groups based on pipe material.

Hydrant flow tests were imported into the calibrator module for calculation. The correlation between the calculated C-values and the input data is expressed by the fitness value. The results below had a fitness value of 0.007, which indicates a strong correlation between the C-values and the fire flow data that was entered into the Calibrator. The average difference in pressure between measure fire flows and model results was 2.5%. Table 5-2 lists the C-factor range restrictions that were entered into the model for each pipe material and the results of calibration.

Table 5-2: Calibration Results

Pipe Material	C-factor Range	Calibrated C-factor
Cast Iron	30 – 80	35
Ductile Iron	80 – 130	105
HDPE/PVC	90 – 140	140

5.2 Model Evaluation

5.2.1 Model Scenarios

Once developed and calibrated, the model was evaluated under average day steady state conditions, average day 72-hour extended period simulation, and a special simulation to model the recovery of tank level after a high demand event like a main break or a fire. This scenario was modeled to identify restrictions between Folly Pond Pump Station and the water tank.

5.2.2 Evaluation Criteria

Typical and recommended operating standards, such as those listed by the American Water Works Association (AWWA), are used to ensure that an adequate level of service is provided to all customers at all times. These criteria were used to evaluate the results obtained from the hydraulic model. If the model indicates that evaluation criteria is not within the recommended range, alternatives are evaluated to determine improvements necessary to meet the standard. The evaluation criteria are listed below.

5.2.2.1 Fire Protection

The ability to provide required sufficient and sustained water flows and pressures during a fire emergency is a key goal for all water providers. Hydrants with less than 500 gpm of available fire flow were considered deficient. Figure 5-2 shows the available fire flow at hydrants throughout the system. These figures illustrate the available fire flow at junctions in the system while maintaining a pressure of 20 psi throughout the rest of the system.

5.2.2.2 System Pressure

The AWWA recommends maintaining a minimum pressure above 20 psi under normal operating conditions. Pressures above 20 psi should be available during all types of demand conditions and scenarios. When evaluating the hydraulic model, a safety factor of 5 psi is applied to the results to account for unknown conditions and inaccuracies. This factor provides an additional level of confidence in evaluating the model conditions. Figure 5-3 attached to this document illustrate the minimum pressures over a 72-hour period during current average day demand conditions.

5.2.2.3 Pipe Velocities

Establishing a recommended range for velocities within the piping network is related to maintaining system water quality. Pipes with inadequate velocities may result in decreased water quality, low chlorine residual, and/or bacterial growth. Excessive velocities, or changes in direction of flow, are also associated with headloss due to pipe friction and reduced water quality due to scouring of the pipe wall and resuspension of settled material. The AWWA recommends a maximum velocity of 5 feet per second (fps) at average day demand condition. Velocities throughout the system were well below this threshold for all scenarios.

5.2.2.4 Headloss

Pipes with high headloss generally cannot deliver optimum pressures to downstream customers. These pipes may be undersized for the amount of water flowing through them, have excessive velocities, or accumulated material within the pipe that increases roughness with the pipe. The AWWA recommends a maximum headloss of 10 feet per 1000 feet for distribution pipes. Headloss in all pipes were well below this level for all evaluated scenarios.

5.2.2.5 Water Age

The extended period simulation was used to track water age throughout the distribution system. Water age in the tank is high, approximately 20 days under average day conditions. Most of the system is fed from the tank, so it appears water age could be an issue throughout most of the system.

VINALHAVEN WATER SERVICE AREA
SCALE 1"=100'
F1
R2A
R2B
F2
F3
R3
R4A
F4
R4B
R5
F5
R6
F6
F7
R7B
R7A
R8
R9
F9
F8
R10
F10
PIPING PLAN A
PIPING PLAN B
PIPING PLAN C
PIPING PLAN D
LEGEND:
WATER SERVICES
2" OR LESS WATER MAINS
3" WATER MAIN
4" WATER MAIN
6" WATER MAIN
8" WATER MAIN
10" WATER MAIN
VALVE W/HYDRANT
VALVE
CURB STOP
LEAD/COPPER SAMPLING LOCATIONS
COMPLIANCE MONITORING LOCATIONS
HYDRANTS
REVISED DATE: 9/12/17

FIGURE 5-1

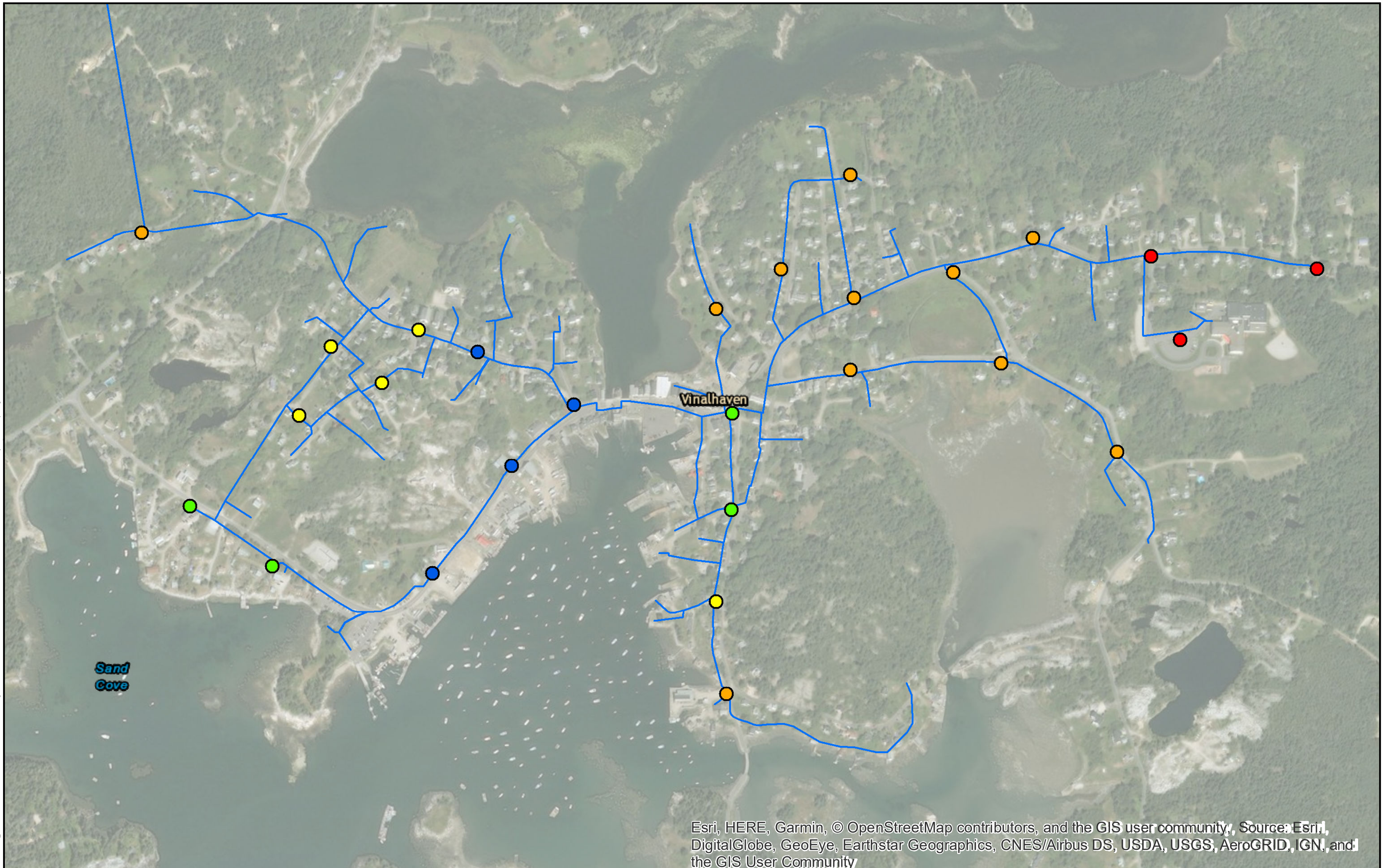


Figure 5-2

Available Fire Flow Analysis

Legend

Available Fire Flow (gpm)

- less than 250
- 250 - 500
- 500 - 750
- 750 - 1,000
- greater than 1,000

0 0.0375 0.075 0.15 Miles

N

WOODARD & CURRAN

Project #: 229180.01
Map Created: January 2018

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources:**

Figure Exported: 4/26/2018 By: mroper Using: \\woodardcurran.net\shared\Projects\0229180.01 Maine Water Co Vinalhaven Master Plan Update\wp\Hydraulic Model\Reference\GIS Figures\FireFlow.mxd

Figure 5-3

Minimum Pressure Analysis

Legend

Minimum Pressure (psi)

- less than 20
- 20 - 35
- 35 - 50
- greater than 50

0 0.0375 0.075 0.15 Miles

N

WOODARD & CURRAN

Project #: 229180.01
Map Created: January 2018

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources:**

Figure Exported: 4/26/2018 By: mroper Using: \\woodardcurran.net\shared\Projects\0229180.01 Maine Water Co Vinalhaven Master Plan Update\wip\Hydraulic Model\Reference\GIS Figures\MinPressure.mxd

6. REGULATORY COMPLAINCE REVIEW

The Safe Drinking Water Act was passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. There are numerous rules and regulations that have been promulgated since the Safe Drinking Water Act. Additionally, there have been several regulations enacted in recent years that are intended to improve the quality of finished water from a surface water source and to protect public health. The following section provides an overview of the regulations of greatest relevance to the District, as well as describes how the requirements impact system operations. The regulations discussed in this section include the following:

- System Classification
- Surface Water Treatment Rule (SWTR)
- Interim Enhanced Surface Water Treatment Rule (IESWTR)
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)
- Stage 1 Disinfectants and Disinfection By-Products Rule (Stage 1 DBPR)
- Stage 2 Disinfectants and Disinfection By-Products Rule (Stage 2 DBPR)
- Total Coliform Rule (TCR)
- Revised Total Coliform Rule (RTCR)
- Rules Related to Fluoridation
- Lead and Copper Rule (LCR)
- Chemical Phase I, II and V Rules

6.1 System Classification

The Vinalhaven Water District's system is classified as a Community Water System (CWS). As a CWS, Vinalhaven is regulated under the Federal Safe Drinking Water Act, which is administered by the Drinking Water Program (MDWP) of the Maine Department of Health and Human Services, Division of Human Health. The treatment plant has been classified as Class 2 and the distribution system has been classified as Class 1 by the MDWP. These classifications govern the license level requirements for the person in responsible charge of the system. The drinking water source is classified as surface water. This classification requires treatment according to the Federal Surface Water Treatment Rule, which requires the use of a filtration process (or a waiver from filtration) and full-time disinfection. The system utilizes bag filters, which are classified as alternative filtration. The system also utilizes UV and chlorine for disinfection.

6.2 Surface Water Treatment Rule (SWTR)

The SWTR, promulgated in 1989, requires public water systems to filter, or obtain a filtration waiver, and disinfect a surface source before it is transmitted to the public for consumption and other purposes. The purpose of the SWTR is to remove or inactivate viral, bacterial, and protozoan pathogens from the water, and more specifically, to ensure that the total treatment processes of the system achieve at least a 3-log removal/inactivation of Giardia cysts and a 4-log removal/inactivation of viruses. Several of the original provisions of the Rule have since been superseded by more recent regulations which are discussed herein.

The general requirements of the SWTR include:

- 3-log (99.9%) removal/inactivation of Giardia cysts;
- 4-log (99.99%) removal/inactivation of viruses;
- for filtered systems, turbidity of filtered water less than or equal to 0.5 NTU in 95% of the measurements taken each month, and not exceed 5 NTU at any time;
- disinfectant residual in the water entering the distribution system is never less than 0.2 mg/L for more than 4 hours;
- disinfectant residual in the distribution system is detectable (or heterotrophic plate count is less than 500/mL) in not less than 95% of the samples during a month, for any two consecutive months.

The 1996 amendments to Section 1453 of the Safe Drinking Water Act mandated that States develop and implement Source Water Assessment programs. The purpose of Source Water Assessment is to develop a basis for use in implementing, and improving a system's Source Water Protection Plan by:

- delineating and mapping protection areas for drinking water intakes;
- identifying and inventorying significant contaminants in the protection areas; and
- determining the susceptibility of public water supply systems to the entrance of contaminants released within the protection areas.

The Assessment serves to elevate the status of a hydrogeologically-defined geographic area for special consideration in the land use decision-making by federal, state, and local governments, as well as efforts of local land-use stakeholders. The Assessment reviews and recommends protection options for each source. Source protection allows reduced monitoring (waivers) from the Chemical Phase I, II, and V Rules (discussed later in this Section) for systems that can show that the threat of contamination from these chemicals is minimal and that a source water protection plan is in place.

Vinalhaven's primary source of drinking water is Round Pond, and they utilize bag filtration, UV treatment, and add sodium hypochlorite, which provides 3-log removal credits for Giardia and 4-log removal credits for viruses. Vinalhaven is compliant with the SWTR requirement for 4-log removal/inactivation for viruses and 3-log removal/inactivation of Giardia.

Vinalhaven's distribution disinfection residual is provided by chlorine. The District monitors for disinfectant residual at the entrance to the distribution system and is compliant with the SWTR requirement to provide a minimum of 0.2 mg/L and a maximum of 4 mg/L disinfection residuals entering the system. Vinalhaven also takes disinfection residual samples throughout the distribution system and is compliant with the SWTR requirement to have detectable disinfectant residual within the distribution system.

Vinalhaven meets the SWTR turbidity of filtered water requirements.

6.3 Interim Enhanced Surface Water Treatment Rule

The IESWTR, enacted on December 16, 1998, builds on the requirements of the Surface Water Treatment Rule and was designed to improve control of microbial pathogens, particularly for the protozoan Cryptosporidium, and to guard against increases in microbial risk which might occur when systems implement the Stage 1 DBPR. IESWTR applies to systems using surface water or groundwater under the direct influence of surface water. Initially, the provisions of IESWTR only apply to systems that serve 10,000 or more persons, except for the sanitary survey portions of the Rule which applied to all public water systems. However, as described in the following section, LT1SWTR extended all requirements of IESWTR to all public water systems. Some of the requirements only apply to filtered systems.

Major provisions of the IESWTR include:

- Disinfection profiling and benchmarking requirements;
- Unfiltered systems must include Cryptosporidium in watershed control program;
- Requirements for covers on new finished water storage facilities;
- Sanitary surveys by the primacy agency every 3 years for community water systems (CWS);
- Filtered system requirements:
    - 2-log (99%) Cryptosporidium removal requirement for systems that filter
    - Conventional and direct filtration systems are required to achieve a combined filter effluent <0.3 NTU in at least 95% of the measurements taken each month, with a maximum level of 1 NTU;
    - Combined filter effluent turbidity monitoring for compliance every 4 hours;
    - Individual filter turbidity monitoring for compliance every 15 minutes and required actions (filter profile) if an individual filter is out of compliance in 2 consecutive measurements. In addition, systems must report any individual filter with a turbidity level >1.0 NTU based on 2 consecutive measurements 15 minutes apart, and any individual filter with a turbidity level greater than 0.5 NTU at the end of the first 4 hours of filter operation based on 2 consecutive measurements 15 minutes apart. A filter profile must be produced within 7 days of the exceedance if no obvious reason for the abnormal filter performance can be identified.

As Vinalhaven serves less than 10,000 persons, their only IESWTR requirement was to have sanitary surveys performed by the primacy agency every three years. The system's most recent Sanitary Survey was conducted on May 1, 2018. Recommendations included cleaning the wetwell, replacing the chlorine analyzer at the pump station, and continuing to work on creating swing tie records, since the originals were burned in a fire years ago.

6.4 Long-Term 1 Enhanced Surface Water Treatment Rule

The LT1ESWTR was enacted January 14, 2002, to improve water quality though the control of Cryptosporidium and other microbial contaminants. LT1ESWTR builds on the requirements of the SWTR and extends the requirements of the IESWTR (described in the section above) to include water systems serving fewer than 10,000 people.

Systems are required to complete a disinfection profile, which is a graphical compilation of weekly inactivation of Giardia lambia, taken on the same calendar day each week of 12 consecutive months. The purpose of disinfection profiling is to allow systems and the State to assess whether a change in disinfection practices reduces microbial protection. Prior to making a significant change to disinfection practices, systems required to develop a profile must calculate a disinfection benchmark and consult with MDWP. The benchmark is the calculation of the lowest monthly average of inactivation based on the disinfection profile.

LT1ESWTR extended the requirements of IESWTR to include the Vinalhaven treatment system. The system is currently compliant with the requirements of LT1ESWTR.

6.5 Long-Term Enhanced Surface Water Treatment Rule

The LT2ESWTR was enacted on January 5, 2006, to reduce illness linked with the contaminant Cryptosporidium and other disease-causing microorganisms in drinking water. The rule supplemented existing regulations by targeting additional Cryptosporidium treatment requirements to higher risk systems. This rule also contains provisions to reduce risks from uncovered finished water reservoirs and to ensure that systems maintain microbial protection when they take steps to decrease the formation of disinfection by-products when systems implement the Stage 2 DBPR. The District installed UV treatment in 2010 to provide 3-log Cryptosporidium inactivation.

The system was required to begin conducting a second round of E. coli source water monitoring in October 2017 to redetermine bin classification. Due to a lack of notification, the DWP will not be treating this as a technical violation, but Vinalhaven should complete testing as soon as possible. The treatment at Folly Pond pump station is sufficient to provide Cryptosporidium treatment, so this test is simply a monitoring exercise for the District and will not result in any actionable outcome.

6.6 Stage 1 Disinfectants and Disinfection By-Products Rule

The Stage 1 DBPR was enacted in February 1999 and applies to all sizes of community water systems and non-transient, non-community systems that add a disinfectant to the drinking water during any part of the treatment process. The Stage 1 DBPR established limitations on the amount of disinfectant residual and disinfection by-products (DBPs) which can be present within the distribution system. While disinfectants are important and effective for controlling microorganisms, it was discovered that chlorine used in water treatment processes reacted with naturally occurring organic matter (NOM) to form chlorinated organic by-products. Disinfection by-products, such as haloacetic acids and trihalomethanes, were found to be harmful to humans. Some disinfectants and disinfection by-products have been shown to cause cancer and reproductive defects in lab animals and suggested to cause bladder cancer and reproductive defects in humans. The rule was designed to limit capital investments and avoid major shifts in disinfection technologies until additional information was available on the occurrence and health effects of DBPs.

The length of time that disinfectants are allowed to react with NOM and total organic carbon (TOC) also increases the formation of by-products. Therefore, it is important to have knowledge of and manage detention time within the distribution system and storage tanks to prevent or reduce the formation of these compounds.

Reduction of the formation of disinfection by-products within the treatment plant can be minimized by one of three primary practices:

1. Reducing the concentration of Natural Organic Matter (NOM) precursor (measured as Total Organic Carbon (TOC) and color) before the addition of disinfectant.

2. Reducing the concentration of disinfectant used to achieve the required Chlorine CT during the primary disinfection process.

3. Switching to a disinfectant that forms lower levels of regulated disinfection by-products.

The primary requirements of the Stage 1 DBPR rule include the following:

- Maximum Residual Disinfectant Level (MRDL) less than 4.0 mg/L for chlorine as Cl_2 and less than 4.0 mg/L for chloramines as Cl_2.
- Total Trihalomethanes (TTHM) Maximum Contaminant Level (MCL) less than 80 parts per billion (ppb) and haloacetic acids (HAA5) MCL less than 60 ppb in the distribution system.
- Bromate MCL less than 10 ppb at the entrance to the distribution system (systems using ozone).

Routine monitoring includes quarterly samples of TTHM and HAA5s. Compliance is determined by calculating the system-wide running annual average (RAA), which must be below the MCL. Systems are also required to monitor chlorine/chloramines at the same location and frequency as the Total Coliform Rule, and the RAA must be below the MRDL.

Systems are eligible for reduced TTHM and HAA5 monitoring if the TTHM RAA is less than 40 ppb and HAA5 RAA is less than 30 ppb and a TOC RAA of less than 4 mg/L.

6.7 Stage 2 Disinfectants and Disinfection By-Products Rule

The Stage 2 Disinfectants/Disinfection By-Products Rule was promulgated on January 4, 2006. The Rule applies to all community water systems that add a primary or residual disinfectant. The Rule builds on the Stage 1 DBPR to address high-risk public water systems for protection measures beyond those required by existing regulations. Stage 2 DBPR reduces potential cancer and reproductive and developmental health risks from DBPs in drinking water which form when disinfectants are used to control microbial pathogens.

Stage 2 DBPR required systems to complete an Initial Distribution System Evaluation to characterize DBP levels in their distribution system and identify locations to monitor DBPs for Stage 2 DBPR compliance. The Stage 2 DBPR bases TTHM and HAA5 compliance on a locational running annual average (LRAA) calculated at each monitoring location. The Stage 2 DBPR requires increased monitoring of TTHM and HAA5 in addition to the data being collected under Stage 1 DBPR. The TTHM and HAA5 thresholds must be met at each sampling location based on a locational running annual average (LRAA) instead of a blended average of all sampling sites as the previous rule had required. The current MCL's for TTHM and HAA5 are 80 ppb and 60 ppb respectively.

The rule did not change the MCL values for TTHMs and HAA5s that were established under Stage 1 DBPR, although it did establish maximum contaminant level goals (MCLGs) for the first time. The biggest impact of the Stage 2 DBPR is that it changed the way sampling results are averaged to determine compliance from system-wide running annual average (RAA) of all sampling sites to a Locational Running Annual Average (LRAA) using worst-case DBP sites. Under the Stage 2 DBPR, each individual site must be in compliance. This is not really an impact for Vinalhaven since they monitor only a single site each for TTHM and HAA and so the RAA and LRAA are the same.

The MCL requirements for Disinfection By-Products can be met with many approaches including the Best Available Technologies (BAT's) listed by EPA. Bench and pilot testing of preferred processes should be conducted to ensure that the final approach selected will enable the water system to meet the stricter Stage 2 Disinfection By-Product Rule.

Stage 2 DBPR also required calculation of operational evaluation levels (OEL), which is the locational summation of the previous two quarters results plus twice the current quarter's TTHM or HAA5 results divided by four. The OEL is exceeded if the results are greater than the TTHM or HAA5 MCL. If an OEL is exceeded, the system must conduct an operational evaluation and submit a written report to the state not later than 90 days after being notified of the analytical results that caused the exceedance. The operational evaluation must include an examination of the treatment and distribution system's operational practices that may contribute to TTHM and HAA5 formation and steps to minimize future exceedance. The OEL requirements went into effect when the system began compliance monitoring for Stage 2 DBPR.

Figure 6-1 shows the TTHM sample results and running annual average for 2010 through 2017. Figure 6-2 shows the HAA sample results and running annual average for 2010 through 2017.

Figure 6-1: TTHM Sample Results and Running Annual Average

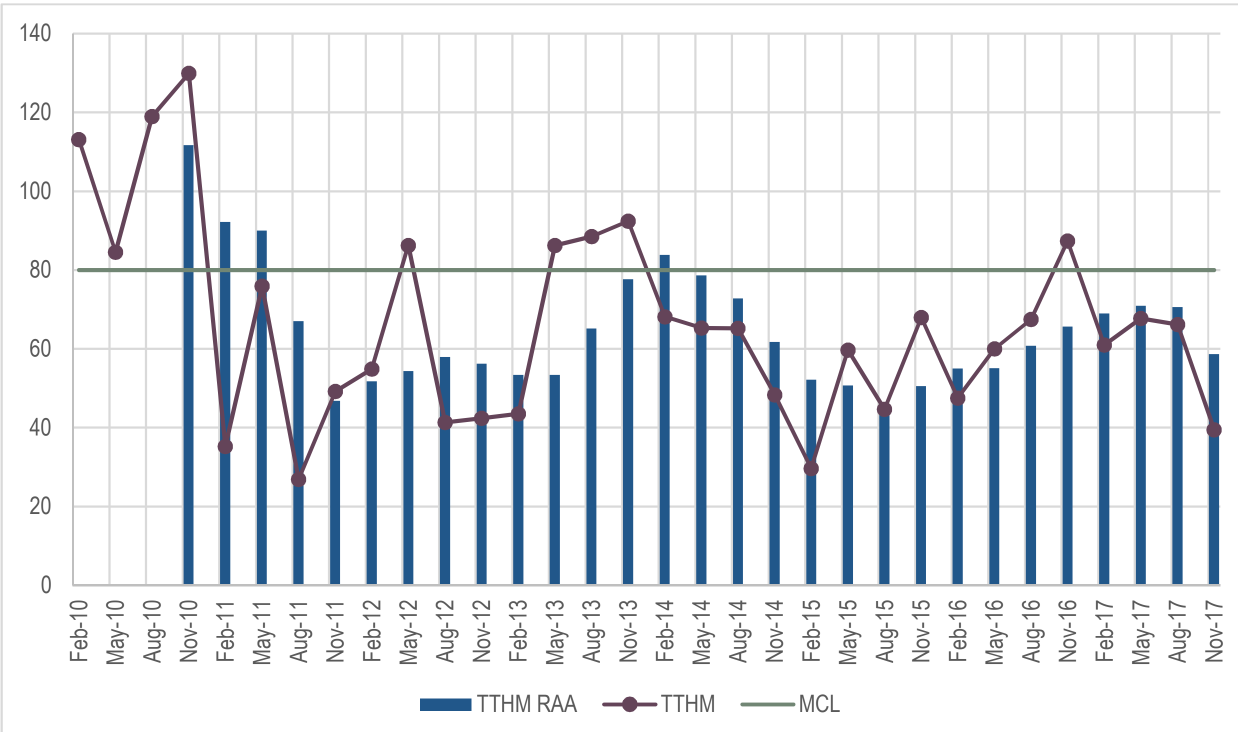
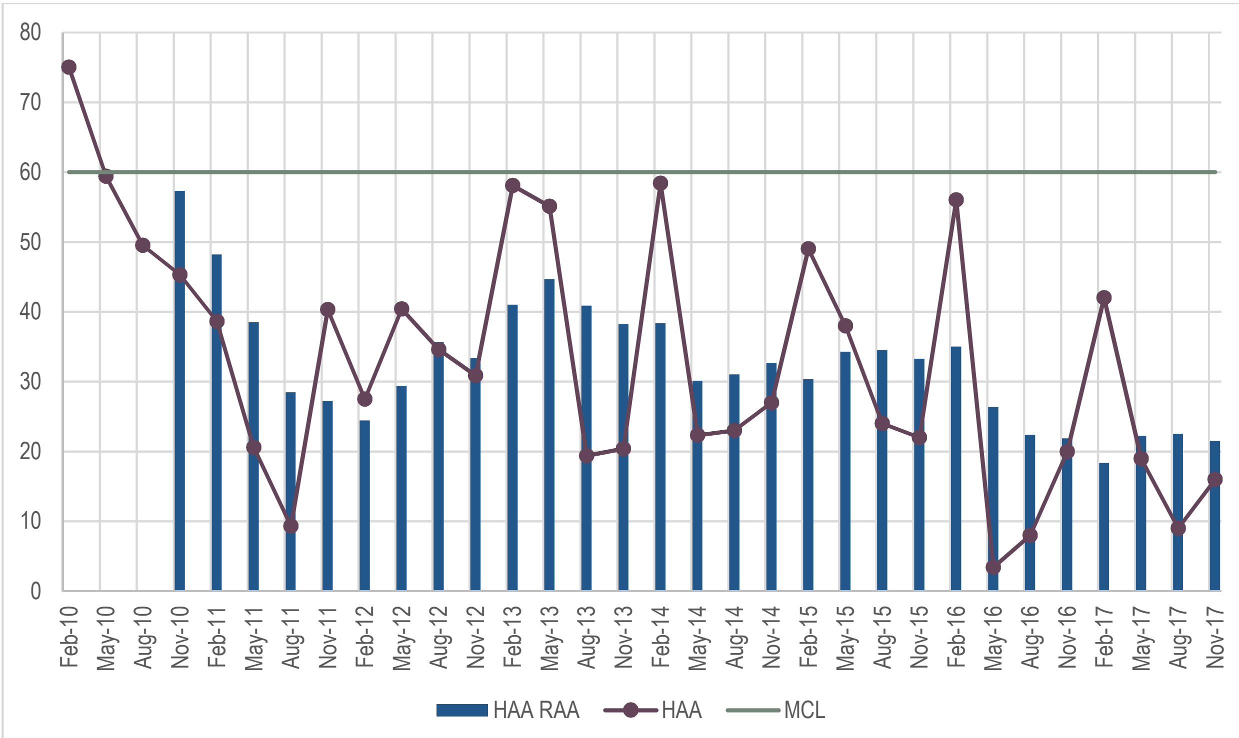


Figure 6-2: HAA Sample Results and Running Annual Average



The District saw a significant decrease in TTHM and HAA formation following the installation of the UV disinfection system. This treatment allowed the District to decrease the amount of chlorine they were adding to the water, thus decreasing a DBP precursor.

The District had previously converted to chloramines for a time prior to the installation of the pipe loop, but it was difficult to pace the dosing at the Folly Pond Pump Station based on readings at the remote chlorine monitoring station and matching to the correct ratio of ammonia, and this treatment was suspended. While the current combination of filtration, UV treatment, and chlorination is working for the District, there is potential to chloraminate in the future. The installation of the pipe loop and analyzers at the pump station would ease the chloramination process, and this remains a viable option should DBP levels rise.

6.8 Total Coliform Rule (TCR)

The Total Coliform Rule (TCR), promulgated in 1989, sets the maximum contaminant level goal for total coliforms at zero and sets a legal limit on total coliforms. There are a variety of bacteria, parasites, and viruses that can cause health problems when humans ingest them in drinking water. Testing water for each of these germs would be difficult and expensive. Instead, the industry measures for the presence of bacteria in drinking water using coliform bacteria as an indicator. The presence of any coliforms in drinking water suggests that there may be disease-causing agents in the water. Coliforms are a broad class of bacteria that live in soil, water, and the digestive tracts of humans and many animals. The presence of coliform bacteria in tap water suggests that the treatment system is not working properly or that there is a problem in the distribution system. Although many types of coliform bacteria are harmless, some can cause health problems.

Under the original TCR, a system the size of Vinalhaven's triggered a monthly maximum contaminant level violation if greater than 1 routine/repeat sample per month was total coliform-positive. The violation needed be reported to the

State by the end of the next business day and the public must be notified within 30 days. If a sample tested positive for coliforms, the system was required to collect a set of repeat samples within 24 hours. If any repeat sample was total coliform-positive, the system was required to analyze the sample for fecal coliforms or E. coli. If the system had any fecal coliform or E. coli-positive repeat samples, then an acute maximum contaminant level violation was triggered. The violation was required to be reported to the State by the end of the next business day and the public notified within 24 hours. These requirements were changed significantly under the Revised Total Coliform Rule, which is described in the next section.

Vinalhaven is required to take two samples monthly. This is done at the Town's fire station and at the Water District office.

6.9 Revised Total Coliform Rule

The Revised Total Coliform Rule, promulgated in February 2013, applies to all public water systems and establishes a maximum contaminant level for E. coli. The Rule uses E. coli and total coliforms to initiate an assessment to identify and correct sanitary defects. The rule replaced the total coliform MCL from the original TCR with treatment technique requirements. The major provisions of the Rule include requirements to test each coliform-positive test for the presence of E. coli and if positive, the results must be reported to the State and repeat samples must be taken. If there is an indication of coliform contamination, systems must perform an assessment to identify and correct defects that could provide a pathway of entry for microbial contamination. A Level 1 Assessment is to be completed by the water system owner or operator if two or more routine or repeat samples are total coliform positive in one month, or if repeat samples are not collected after a total coliform positive routine sample. A Level 2 Assessment is to be completed by the state or a state-approved entity following an E. coli MCL violation or after a second Level 1 Assessment within a 12-month rolling period. Public notification requirements vary based on the level of the assessment and conditions of the assessment. The Rule also required all public water systems to develop a written sample siting plan which adequately characterizes the water in the system.

6.10 Rules Related to Fluoridation

The MDWP regulates fluoride under a set of rules entitled, "Rules Relating to the Fluoridation of Public Water Systems". The Rule initially set the optimum level of fluoride for dental benefit at 1.2 mg/L, the optimum range at 1.0 to 2.0 mg/L, and the maximum contaminant level at 4.0 mg/L. In January 2011, the MDWP and the Environmental Protection Agency (EPA) issued a joint statement regarding fluoride in drinking water. The MDWP proposed that the recommended level of fluoride in drinking water be set at 0.7 mg/L. Vinalhaven does not fluoridate the water in their system.

6.11 Lead and Copper Rule

The Lead and Copper Rule (LCR) was promulgated on June 7, 1991 and applied to community water systems and non-transient non-community water systems. The purpose of the Rule was to protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. Lead and copper enter drinking water mainly from corrosion of lead and copper containing plumbing materials. Lead can cause damage to the brain, red blood cells, and kidneys, and copper can cause stomach and intestinal distress and liver or kidney damage. The Rule required systems to conduct routine water quality sampling at high -risk locations throughout the distribution system to determine lead and copper levels present at the taps of water users. The utility must calculate the 90th percentile value of all sample results and is in violation if the 90th percentile is above the established action levels of 0.015 mg/L for lead and 1.3 mg/L for copper. The Rule also requires systems that exceed the action levels to optimize corrosion control, provide public education as to the health implications of lead and copper, and replace lead service lines.

It is important to note that changes in water quality can affect finished water and compliance. Changes in water quality are most often attributed to changes in source water quality due to watershed activity, when new sources are introduced, or when changes to treatment are implemented for other water quality goals. Because lead and copper solubility are so sensitive to water quality, anytime a water system proposes changes to water chemistry it should be considered very carefully and be introduced very gradually. Future changes in treatment should only be made when they are assured of having no detrimental effects on the District's ability to remain in compliance with the LCR.

Vinalhaven is on reduced monitoring, and therefore samples at 10 locations throughout their system once every three years. Recent 90th percentile values for copper were 0.17 ppm (2012) and 0.19 ppm (2015), which is well below the MCL of 1.3 ppm. Recent 90th percentile values for lead were 5 ppb (2012) and 3.3 ppb (2015), well below the MCL of 15 ppb. The next round of sampling will be completed later this year.

6.12 Chemical Phase I, II, and V Rules

Chemical Phase I, II and V Rules were promulgated by the EPA between 1987 and 1992 and require monitoring of, and setting limits for, drinking water for several pesticides, herbicides, and chemicals used by industry and agriculture. Most regulated chemicals are organic in nature. Inorganic chemicals require annual analysis, while the organic chemicals require quarterly analysis for the first few years of treatment plant operation. If the chemicals are not present at levels above the limits, the system may request to sample less frequently. No regulated chemicals are present above the non-detect level in Vinalhaven water.

6.13 Radionuclide Rule

The Radionuclide Rule was promulgated by EPA on December 7, 2000. It required four consecutive quarters of initial monitoring for several contaminants or allowed the use of grandfathered data. One component of the rule set MCL for combined radium 226/228 at 5 pCi/l. If measurements of any regulated species of radionuclides was above the detection limit, but less than one half the MCL, systems could go to a reduced monitoring schedule of one sample every six years.

Vinalhaven source water is a surface water and, thus, would not ordinarily be expected to be subject to the levels of radionuclides that one might expect of a groundwater. Nonetheless, the island bedrock is granite, and soil cover is thin to nonexistent, so contamination of even surface water is a possibility. In 2012 the system measured a radium-228 level of 0.44 pCi/l, well below the 5 pCi/l MCL. The next round of sampling will be due in 2018.

6.14 Rules Relating to Licensure of Water System Operations

The Rules Relating to Licensure of Water System Operations are designed to regulate the licensing of operators of water treatment systems and water distribution systems serving the public. They are designed to protect the public health by insuring that operators of public water systems are qualified and have knowledge and ability to properly operate and maintain systems. The Vinalhaven treatment system is classified as Class 2 and the distribution system is classified as Class 1.

The MDWP requires all Community and Non-Transient, Non-Community water systems to place the direct supervision of their water system, including each treatment facility and/or distribution system, under the responsible charge of an operator holding a valid license with classification equal to or greater than the classification of the treatment facility and/or distribution system. Vinalhaven staff and Maine Water backup personnel on the mainland are licensed at or above these levels.

7. CAPITAL IMPROVEMENT PLAN

This section summarizes treatment facility and distribution system recommended improvements.

7.1 Recommendations

7.1.1 Main Street Pipe Replacement

There is currently only one connection between the water treatment plant and storage tank on the west side of the distribution system and the east side of the distribution system. This connection is located on Main Street and the existing line is 10-inch cast iron, believed to have been installed in 1908, and includes a 140-foot bridge crossing and approximately 15 services. The bridge crossing appears to consist of a main attached via brackets to the south side of the bridge abutments. We recommend replacing this section of water main due to the age, installation method, and criticality of the pipe.

We recommend replacing this section of water main with 12-inch ductile iron pipe with some modifications. The current alignment crosses to the north side of the street before and after the bridge crossing (bridge crossing is to the south or harbor side). We propose straightening the alignment to allow for ten feet of separation between the water and sewer mains, as well as installing a hydrant at the midpoint of Main Street aligned with future green space near the public parking area. Main line valves would be installed on either side of the 140-foot, dual bridge, stream crossing. This would provide a temporary connection point to the west side of the system (High Street hydrant) should the bridge crossing be damaged. The estimated cost of this project is approximately $710,000.

7.1.2 Round Pond Pumping Arrangement

Water is currently transferred from Round Pond to the Folly Pond pump station via a transfer pump at Round Pond. The building that houses the pumping equipment is deteriorating, and access is difficult. As a result, and in agreement with DWP sanitary survey recommendations, we recommend moving the transfer pumping equipment to the Folly Pond pump station.

This change would involve the installation of a vacuum priming system for pump priming and continuous pipeline air control, the installation of a new pump with a VFD, and an uninstalled spare. We estimate the cost of these improvements to be approximately $15,000.

Additionally, the intake and associated piping at Round Pond should be replaced. This includes approximately 500 feet of 4-inch pipe of unknown material from the intake to the concrete dam. A screened intake on a stainless-steel sled should be installed to improve raw water quality and ease of maintenance. The estimated cost of this replacement is approximately $60,000.

The transfer line between the concrete dam and the Folly Pond pump station is believed to be 4-inch HDPE and 2,500 feet in length, running along the shore of the ponded areas between Round Pond and Folly Pond. It is believed that this line is in relatively good shape, but it should be pressure tested to check for high points that would allow trapped air to collect, which would make it difficult to reliably pull water. This could add an additional $5,000 to $10,000 to the project cost. If the line needed replacement, costs of approximately $160,000 could be anticipated. A total project budget of $185,000 should be carried.

7.1.3 Transmission Line Replacement

The 8-inch cast iron transmission line that connects the Folly Pond pump station to the distribution system is approximately 1.8 miles in length. As described in Section 4, it is believed that this section of main is in relatively good condition, considering it is believed to be over one hundred years old. Due to the location of the main, inspection and maintenance are difficult, and this main is a critical connection point between the Folly Pond pump station and the distribution system. We recommend installing an 8-inch HDPE main parallel to the existing main to serve as a redundant connection. The estimated cost of this main on the mainland is approximately $1,200,000 but could reach $1,800,000 because of the premium price paid for construction on the island, the predominance of ledge and a lack of suitable cover material. This replacement could be carried out over several years, as time and budget allow.

7.1.4 Galvanized Main Replacement

The District should consider the replacement of the existing buried galvanized lines. Several of these sections of pipe have already been replaced as part of previously completed projects, but there is approximately 1,585 feet remaining in the system. The galvanized lines not only contribute to poor water quality along these runs but could also be one of the most frequent locations of leaks in the system. We recommend replacing these runs with 2-inch diameter HDPE pipe. The estimated cost of replacing the remaining galvanized main in the system is approximately $95,000.

7.1.5 Improving Isolation of Mains

The water distribution system historically contained several broken valves. Several of these valves were recently replaced in conjunction with pipe work performed in the eastern and western portions of the distribution system. Isolation of some service areas still cannot be performed due to a lack of isolation valves. We recommend replacing the remaining three broken wheel valves in the system. The cost of replacing these valves is approximately $5,000.

7.1.6 Starr Street Main Replacement

Water main replacement has taken place on the western side of Sands Road and within the Mountain Street neighborhood. Starr Street, including the cross-country section that connects Starr Street to Sands Road is currently served by a 6-inch cast iron main. We propose replacing this main with 8-inch ductile iron pipe between High Street and the end of Starr Street (approximately 680 feet) and replacing the cross-country run with 6-inch ductile iron pipe (approximately 720 feet). The estimated cost of this project is approximately $350,000. This work was originally included in the scope of the recently completed west side pipe replacement project but was cut from that project to reduce costs.

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