horizons Engineering Inc.

UPDATED SYSTEM EVALUATION FOR PRESSURE REDUCTION
Rosebrook Water System
Bretton Woods, New Hampshire

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UPDATED SYSTEM EVALUATION FOR PRESSURE REDUCTION
ROSEBROOK WATER SYSTEM
BRETTON WOODS, NEW HAMPSHIRE
FOR
ABENAKI WATER COMPANY
PLAINVILLE, CT

MAY 2021

(LAST UPDATED JUNE 22, 2021)

Project No. 21008
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System Overview/Components

The Abenaki Water Company, care of New England Service Company, operates the Rosebrook Water System (PWS ID 0382010) to provide domestic water supply and fire hydrant/sprinkler suppression to users in Bretton Woods, New Hampshire. The system serves the Mount Washington Hotel and Bretton Woods Ski Resort complex as well as single and multi-family residential and small commercial customers within the service area. The Rosebrook Water System is designated by the New Hampshire Department of Environmental Services (NHDES) as a Large Community Water System (a public water system serving a population greater than 1,000 or providing flow for fire suppression). NHDES records indicate the system serves a population of approximately 1,050 through 408 services connections. Major system components include two gravel packed production wells, a pump house, a 650,000-gallon atmospheric storage tank, and distribution piping and appurtenances.

Wells and Well Field

The system has two sand and gravel production wells located to the north of the Bretton Woods Base Lodge and to the south of Drummond Mountain Shop on Route 302.

Well #1 is a 43 foot deep gravel-packed production well with a reported yield of 322 gallons per minute and a static water level of approximately 6 feet below ground surface. Well #1 was installed in 1970 during the original construction of the water system and is located inside the pump station building. Currently Well #1 is equipped with an American Industrial 50 horsepower 10-stage vertical turbine pump. This pump has a reported pumping capacity of approximately 325 gallons per minute. As Well #1 was installed prior to adoption of NHDES Groundwater Withdrawal Rules Env-Ws 379 and 388, this well has not been assigned a permitted production volume.

Well #2 is a 52 foot deep gravel packed production well with a reported yield of 450 gallons per minute. The well is located approximately 90 feet to the southeast of the pump station. Well #2 was installed in the 1990s and received NHDES Conditional Approval in July of 2003. The well is currently equipped with a Goulds 60 horsepower, 480-volt, 3-phase pump set at 30 feet, with an estimated pumping capacity of 425 gallons per minute. NHDES has assigned Well #2 a daily permitted production volume of 540,000 gallons (375 gallons per minute based on continuous pumping).

Pump Station

The Rosebrook pump station consists of a single-story metal-framed building constructed on a concrete slab. The building is in fair condition, having been refurbished after a piping failure and flooding incident in 2008. The pump station does not contain any booster pumps or hydropneumatic storage. The well pumps are configured to operate based on water level in the atmospheric storage tank. These pumps provide the sole source of head for the system. The pump station building houses the Well #1 well head and drive motor along with a chemical feed pumps for water treatment, system controls and alarms for both wells, and various tools, spare parts, and supplies.

Atmospheric Storage Tank

Atmospheric storage consists of a single partially buried cast in place concrete storage tank with a metal truss roof, constructed in the early 1970s. The tank is ninety feet in diameter and has a capacity of 650,000 gallons. The tank is located within the Bretton Woods Ski Area at an approximate elevation of 2,010 feet. Within the last 15 years the tank has undergone repairs to address deterioration of the roof, including installation of a new roof covering system of polystyrene insulation and EPDM membrane in 2012.

Distribution System

The system consists primarily of cement-lined Ductile Iron and C900 PVC water mains. The system contains a total of approximately 32,600 feet of water main. Service connections consist primarily of type "K" copper with brass fittings. System pressures reportedly range from 50 to 190 pounds per square inch. Service connections at lower elevations are equipped with individual pressure reducing valves. The system is equipped with fire hydrants for fire suppression and water mains are adequately sized to provide fire flow. Some of the gate valves in the system are inoperable.

System Domestic Use Demands

Pumping records are maintained for the two water supply wells. Average daily demand over the 2015 calendar year was approximately 110,000 gallons. The peak month was January with an average daily demand of 131,616 gallons and a peak pumping day of 279,900 gallons on January 31, 2015. System demands for 2017 through March of 2021 are as follows:

2017	99,600 gallons per day
2018	119,800 gallons per day
2019	108,750 gallons per day
2020	91,430 gallons per day
2021	115,810 gallons per day

System Pressures

Due to the significant grade differential between the lower service areas and the operating level of the atmospheric storage tank, parts of the Rosebrook system have high static and working pressures. As noted earlier, the storage tank is located at elevation 2010+/-. Elevations along Route 302 and the Base Road near the intersection with Route 302 are approximately 1,575, resulting in static water system pressures in excess of 190 psi.

If system pressures can be effectively reduced, it may result in a system that is safer to operate, some operation and maintenance and pumping costs will be reduced, there will be less reliance on individual service pressure reducing valves (PRVs) for system control, and system leakage may be reduced.

Existing System Piping Flows/Hydraulic Modeling

On May 13, 2021 fire hydrant flow testing was performed in order to determine/confirm the flow characteristics of the existing system piping. Two different pressure gauges were used to confirm gauge accuracy before actual testing commenced. Three separate fire hydrant flow test diffusers were installed on the first hydrant in order to compare flow rates from each device. The newest flow test diffuser was selected for use as it provided a reasonable average of the three devices.

The hydrant flow testing showed that the existing piping network has a very high capacity to deliver water to all parts of the system, including the higher elevations of the system. This ability to deliver water is a function of the adequate size and interior condition of the water mains and the elevation of the exiting storage tank in relation to the hydrant locations. Based upon the hydrant flow testing, a pipe roughness coefficient C-value of 140 for cement lined Ductile Iron pipe and 150 for PVC pipe was determined to be appropriate and therefore utilized in the hydraulic modeling. Flow modeling assumed that a minimum residual pressure of 35 psi be maintained/provided at all locations in the system.

Available pipe water flows for the following locations are highlighted:

Hannah Loop (highest elevation, node J-64)	2,766 gpm
Dartmouth Ridge Homes (highest elevation, node J-66)	2,265 gpm
Crawford Ridge – Presidential Views (highest elevation, node J-19)	2,289 gpm
Rosebrook Townhomes (highest elevation, node J-31)	3,689 gpm
Mount Washington Hotel (node J-98)	1,990 gpm
Bretton Woods Base Lodge (node J-20)	9,070 gpm
Fairway Village (node J-88)	7,399 gpm

It is noted that water hammer was observed during fire flow testing on the north side of Route 302. Water hammer at the higher elevation locations was observed to be 10-12 psi and water hammer at the Mount Washington Hotel was observed to be 16 to 18 psi.

A copy of the modeling Plan and data output showing available flows at all junction nodes of the system can be found in Appendix B.

NHDES Letter of Deficiency DWGB 20-032

On December 1, 2020 the Abenaki Water Company received a Letter of Deficiency DWGB 20-032 (LOD) from the New Hampshire Department of Environmental Services. The LOD states that the Rosebrook Water System shall be modified such that the maximum normal working pressure is between 60 psi and 90 psi with a minimum working pressure of 35 psi at ground level under all conditions and a 100 psi maximum static pressure for the system. The LOD made reference to the "Recommended Standards for Water Works" as justification for the required pressure reduction.

Conceptual Improvements Options for Pressure Reduction

Three overall concepts have been considered for full and/or partial pressure reduction. The Overall Plan found in Appendix A generally shows the location of the proposed options infrastructure:

OPTION 1A assumes that the system will continue to utilize the existing 650,000 gallon water storage tank located at elevation 2,010 feet and that the existing pump station at the well site remains in use for chemical storage and injection. Under this option the well pumps will be replaced with pumps that provide the same outflow at a discharge pressure of 90 psi, and that new booster pump stations will be installed to fill the existing tank and provide service to the higher system users. A pressure reducing valve structure will be installed to allow water from the existing tank to flow back into the lower pressure zone.

OPTION 1B assumes that the system will continue to utilize the existing 650,000 gallon water storage tank located at elevation 2,010 feet and that a new pump station will be installed at the well site. Under this option the well pumps will provide the same outflow to the system but will pump into a 10,000 gallon +/- tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the 10,000 gallon +/- tank. New booster pumps will draw water out of the 10,000 gallon +/- tank, pumping at the same rate of flow from the well pump(s) at a discharge pressure of 90 psi, and that new booster pump stations will be installed to fill the existing tank and provide service to the higher system users. A pressure reducing valve structure will be installed to allow water from the existing tank to flow back into the lower pressure zone.

OPTION 1C assumes that the system will continue to utilize the existing 650,000 gallon water storage tank located at elevation 2,010 feet and that a new pump station will be installed at the well site. Under this option the well pumps will provide the same flow to the system but will pump into a 10,000 gallon +/- tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the 10,000 gallon +/- tank. New booster pumps will draw water out of the 10,000 gallon +/- tank, pumping at the same rate of flow from the well pump at a discharge pressure of approximately 190 psi to fill the existing storage tank without the need for new booster pump stations or pressure reducing valve structure (ie. pressure reduction to take place only for chemical injection piping).

OPTION 1D assumes that the system will continue to utilize the existing 650,000 gallon water storage tank located at elevation 2,010 feet and that a new pump station will be installed at the well site. Under this option the well pumps will provide the same flow to the system but will pump into a 10,000 gallon +/- tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the 10,000 gallon +/- tank. New booster pumps will draw water out of the 10,000 gallon +/- tank, pumping at the same rate of flow from the well pump at a discharge pressure of approximately 190 psi to fill the existing storage tank without the need for new booster pump stations. Multiple pressure reduction valve structures will be installed throughout the system to reduce pressure in the various legs of the distribution system. High pressure will remain in the 16 inch water main to the existing storage tank and also along Base Road. The existing 8 inch water main to the Mount Washington Hotel will also be kept under current high pressure in order to maintain the existing fire hydrant/sprinkler flows.

OPTION 2A assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located at the existing well site. Under this option the well pumps will provide the same outflow to the system but will pump into the 750,000 gallon tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the tank. New variable speed booster pumps at the well site will draw water out of the tank, pumping at the needed flow rate to serve the system at a discharge pressure of 90 psi, and new booster pump stations will be installed to service to the higher system users. A pressure reducing valve structure will not be needed under this option.

OPTION 2B assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located at the existing well site. Under this option the well pumps will provide the same outflow to the system but will pump into the 750,000 gallon tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the tank. New variable speed booster pumps at the well site will draw water out of the tank, pumping at the needed flow rate to serve the system at a discharge pressure of approximately 140 psi. Additional booster pump stations and pressure reducing valve structure will not be needed under this option.

OPTION 3A assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located on the north side of Route 302. Under this option the well pumps will be replaced with pumps that provide the same outflow at a discharge pressure of 90 psi to fill the new tank, and that new booster pump stations will be installed to service to the higher system users. A pressure reducing valve structure will not be needed under this option.

OPTION 1A

This Option maintains key components of the existing system such as the two gravel production wells, the existing pump station building, the transmission and distribution mains, and the 650,000 gallon atmospheric storage tank in the present locations. The key components of the improvements are outlined as follows:

- Replace existing well pumps in Well #1 and Well #2 with two new well pumps capable of the same flow rates (325 gpm for Well #1 and 425 gpm for Well #2) at a discharge pressure of 90 psi. This will reduce the system pressure at the pump station from approximately 190 psi to 90 psi. The well pumps will continue to be controlled by the water level(s) in the 650,000 gallon atmospheric storage tank.

- Install a new combined Rosebrook Booster Pump Station and Pressure Reducing Valve Structure in the vicinity of the existing 16 inch Ductile Iron pipe off of Rosebrook Lane on property owned by Omni/Rosebrook Townhomes Association. This pump station will be utilized to boost water flow/pressure from the well pump(s) to fill the existing storage tank. This pump station will have a slab elevation of approximately 1,700 feet. With an outlet pressure at the existing well pump(s) of 90 psi, this pump station will have an inlet pressure of approximately 35 psi and an outlet pressure of approximately 135 psi. This station will be outfitted with variable speed pumps that will operate in conjunction with the well pump to fill the tank with excess flow from the well pump in operation (pump outflow minus usage at the time of pump operation). This station will not need to provide fire flows, as fire flows for this area will continue to be delivered by the existing water storage tank. This pump station will have a maximum capacity of 425 gpm to match the design output of Well #2. Provisions for stand-by power (emergency generator) will need to be provided at this pump station. This pump station, as well as the well pump, would be controlled by water level in the existing atmospheric storage tank and would start and stop in conjunction with the well pump. The PRV structure will allow/throttle water flow from the existing tank back into the lower pressure zone. This PRV structure will need to operate under very low flow conditions and also high fire flow conditions. This PRV structure will need to be configured such that water hammer conditions are prevented/minimized. This PVR structure will have an inlet pressure of approximately 135 psi and an outlet pressure of approximately 35 psi.

- Install a new Crawford Ridge Booster Pump Station off of Crawford Ridge Drive on property owned by the Crawford Ridge Property Owners Association (at overflow parking area). This pump station will be utilized to boost water flow/pressure from the existing 12 inch water main on Crawford Ridge Drive. This booster pump station will have a slab elevation of approximately 1,670 feet. This pump station will have an inlet pressure of 50 psi and an outlet pressure 106 psi. This station will be outfitted with variable speed pumps drawing water from the storage tank and/or the existing well pump(s). This station will need to provide both domestic and fire hydrant flow to its service area. Provisions for stand-by power (emergency generator) will need to be provided at this pump station. This pump station will operate to maintain a constant outlet pressure of 35 psi minimum at ground level at the highest user in this area.

- Install a new Mount Washington Place Booster Pump Station off of Hartford Lane on property owned by the Mount Washington Place Owners Association (at intersection of Hartford Land and Hannah Loop). This pump station will be utilized to boost water flow/pressure from the existing 16 inch water main on Hannah Loop. This booster pump station will have a slab elevation of approximately 1,670 feet. This pump station will have an inlet pressure approximately of 50 psi and an outlet pressure of approximately 78 psi. This station will be outfitted with variable speed pumps drawing water from the storage tank and/or the existing well pump(s). This station will need to provide fire hydrant flows to its service area. Provisions for stand-by power (emergency generator) will need to be provided at this pump station. This pump station will operate to maintain a constant outlet pressure of 35 psi minimum at ground level at the highest user in this area.

Estimated Cost for OPTION 1A

Well Pump Replacement	$80,000
SCADA and Control Upgrade	$60,000
Chemical Feed/Storage Improvements	$30,000
Rosebrook Pump Station/PRV	$500,000
Crawford Ridge Booster Pump Station	$900,000
Mount Washington Booster Pump Station	$900,000
Subtotal – Construction Cost	$2,470,000
15% Contingency	$370,000
Subtotal – Construction Cost with Contingency	$2,840,000
Land/Easement	$200,000
Engineering @ 10% of Construction Cost	$247,000
Total	**$3,287,000**

OPTION 1B

This Option is similar to OPTION 1A except that the well pumps will pump into a 10,000 gallon +/- tank at the well site where chemical injection will take place and that a new pump station will be installed at the well site. Treated water will be pump into the system by new variable speed pumps in the new pump station drawing water from this 10,000 gallon +/- tank. The outlet pressure into the system from this pump station will 90 psi. The key components of the improvements are outlined as follows:

- Replace existing well pumps in Well #1 and Well #2 with two new well pumps capable of the same flow rates (325 gpm for Well #1 and 425 gpm for Well #2) at a discharge pressure of 20 psi. This will reduce the pressure for the chemical injection system from 190 psi to 20 psi. Install a 10,000 gallon +/- tank at the well site into which the treated well water will flow. Install a new pump station at the well site that will house the chemicals and chemical injection equipment as well as new variable speed pumps that will discharge into the system at 90 psi. The well pumps and booster pumps will continue to be controlled by the water level(s) in the 650,000 gallon atmospheric storage tank.

- Install a new combination Rosebrook Booster Pump Station and Pressure Reducing Valve Structure, a new Crawford Ridge Booster Pump Station, and a new Mount Washington Place Booster Pump Station as previously described.

Estimated Cost for OPTION 1B

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$700,000
Rosebrook Pump Station/PRV	$500,000
Crawford Ridge Booster Pump Station	$900,000
Mount Washington Booster Pump Station	$900,000
Subtotal – Construction Cost	$3,120,000
15% Contingency	$468,000
Subtotal – Construction Cost with Contingency	$3,588,000
Land/Easement	$200,000
Engineering @ 10% of Construction Cost	312,000
Total	**$4,100,000**

OPTION 1C

This Option is similar to OPTION 1B except that the treated water from the 10,000 gallon +/- tank will be pump into the system by variable speed pumps with an outlet pressure into the system of 190 psi to fill the existing storage tank without the need for new booster pump stations (ie. pressure reduction to take place only for chemical injection piping). This option includes a new pump station installed at the well site. The well pumps and booster pumps will continue to be controlled by the water level(s) in the 650,000 gallon atmospheric storage tank. The key components of the improvements are outlined as follows:

- Replace existing well pumps in Well #1 and Well #2 with two new well pumps capable of the same flow rates (325 gpm for Well #1 and 425 gpm for Well #2) at a discharge pressure of 20 psi. This will reduce the pressure for the chemical injection system from 190 psi to 20 psi. Install a 10,000 gallon +/- tank at the well site into which the treated well water will flow. Install a new pump station at the well site that will house the chemicals and chemical injection equipment as well as new variable speed pumps that will discharge into the system at 190 psi. The well pumps and booster pumps will continue to be controlled by the water level(s) in the 650,000 gallon atmospheric storage tank.

Estimated Cost for OPTION 1C

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$900,000
Subtotal – Construction Cost	$1,020,000
15% Contingency	$153,000
Subtotal – Construction Cost with Contingency	$1,173,000
Engineering @ 10% of Construction Cost	102,000
Total	**$1,275,000**

OPTION 1D

This Option is similar to OPTION 1C except that multiple pressure reducing valve structures will be installed throughout the system to reduce pressure in the various legs of the system. Under this option the 16 inch water main to the tank will operate under current pressure conditions as will the 16 inch water main located along Base Road, and also the 8 inch water main feeding the Mount Washington Hotel.

PRV1 will be installed to reduce pressure to Rivers Edge, Crawford Ridge, and the Presidential Views areas. PRV2, 3 and 4 will be installed to reduce pressure to the Forest Cottages, Rosebrook Townhomes, and the Mountain View areas. PRV5 will be installed to reduce pressure to the Mount Washington Place, Mount Washington Homes, and the Dartmouth Ridge Homes areas. And PRV6 will be installed to reduce pressure to the Stickney Circle and the Fairway Village areas. The Conceptual System Improvements for Pressure Reduction, Alternative 1D Overall Plan, found in Appendix A, shows the approximate locations, elevations, and inlet/outlet pressures for the noted PRV's.

As previously noted, the 8 inch water main along Base Road that feeds the Mount Washington Hotel will remain at its current pressure so that existing fire hydrant and sprinkler flow and pressure is not changed.

These six PRV structures will be located on main line piping that feeds existing fire hydrants. As such, the structures will be configured to pass high volume flows in order to approximately maintain existing fire hydrant flows. If found to be needed, additional "low volume" PRV structures could be installed on individual service line(s) at the point of service connection onto the main line piping.

Estimated Cost for OPTION 1D

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$900,000
Main Line PRV structures, 6 @ $160,000	$960,000
Service Line PRV structures, 6 @ $50,000	$300,000
Subtotal – Construction Cost	$2,280,000
15% Contingency	$342,000
Subtotal – Construction Cost with Contingency	$2,622,000
Engineering @ 10% of Construction Cost	228,000
Total	**$2,850,000**

OPTION 2A

This option assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located at the existing well site and that a new pump station will also be installed at the well site.. Under this option the well pumps will provide the same outflow to the system but will pump into the 750,000 gallon tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the tank. New variable speed booster pumps at the well site will draw water out of the tank, pumping at the needed flow rate to serve the system at a discharge pressure of 90 psi, and new booster pump stations will be installed to service to the higher system users. A pressure reducing valve structure will not be needed under this option. The Rosebrook Pump Station will need to provide fire flows under this option.

Estimated Cost for OPTION 2A

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$900,000
750,000 Gallon Water Storage Tank	$1,350,000
Rosebrook Pump Station	$900,000
Crawford Ridge Booster Pump Station	$900,000
Mount Washington Booster Pump Station	$900,000
Subtotal – Construction Cost	$5,070,000
15% Contingency	$760,000
Subtotal – Construction Cost with Contingency	$5,830,000
Land/Easement	$200,000
Engineering @ 10% of Construction Cost	$507,000
Total	**$6,537,000**

OPTION 2B

This option assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located at the existing well site and that a new pump station will be installed at the well site. Under this option the well pumps will provide the same outflow to the system but will pump into the 750,000 gallon tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the tank. New variable speed booster pumps at the new well site pump station will draw water out of the tank, pumping at the needed flow rate to serve the system at a discharge pressure of approximately 150 psi. No additional booster pump stations or PRV structure will be needed. Under this option the outlet pressure of the well site pump station will be reduced from 190 psi to approximately 150 psi to service the highest user in the system with 35 psi minimum at the service elevation.

Estimated Cost for OPTION 2B

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$1,200,000
750,000 Gallon Water Storage Tank	$1,350,000
Subtotal – Construction Cost	$2,670,000
15% Contingency	$400,000
Subtotal – Construction Cost with Contingency	$3,070,000
Engineering @ 10% of Construction Cost	$267,000
Total	**$3,337,000**

OPTION 3A

This option assumes that the existing water storage tank is replaced with a new 750,000 gallon water storage tank located on the north side of Route 302 and that a new pump station will be installed at the well site. Under this option the well pumps will provide the same outflow to the system but will pump into a 10,000 gallon +/- tank at the well site. Chemical injection will take place under low pressure when a well pump is filling the 10,000 gallon +/- tank. New booster pumps will draw water out of the 10,000 gallon +/- tank, pumping at the same rate of flow from the well pump(s) at a discharge pressure of 90 psi to fill the new tank and new booster pump stations will be installed to service to the higher system users. A pressure reducing valve structure will not be needed under this option. The Rosebrook Booster Pump Station will need to provide fire flow for this option

Estimated Cost for OPTION 3A

Well Pump Replacement	$60,000
SCADA and Control Upgrade	$60,000
Well Site Pump Station	$700,000
750,000 Gallon Water Storage Tank	$1,350,000
Rosebrook Pump Station	$900,000
Crawford Ridge Booster Pump Station	$900,000
Mount Washington Booster Pump Station	$900,000
Subtotal – Construction Cost	$4,870,000
15% Contingency	$730,000
Subtotal – Construction Cost with Contingency	$5,600,000
Land/Easement	$250,000
Engineering @ 10% of Construction Cost	$487,000
Total	**$6,337,000**

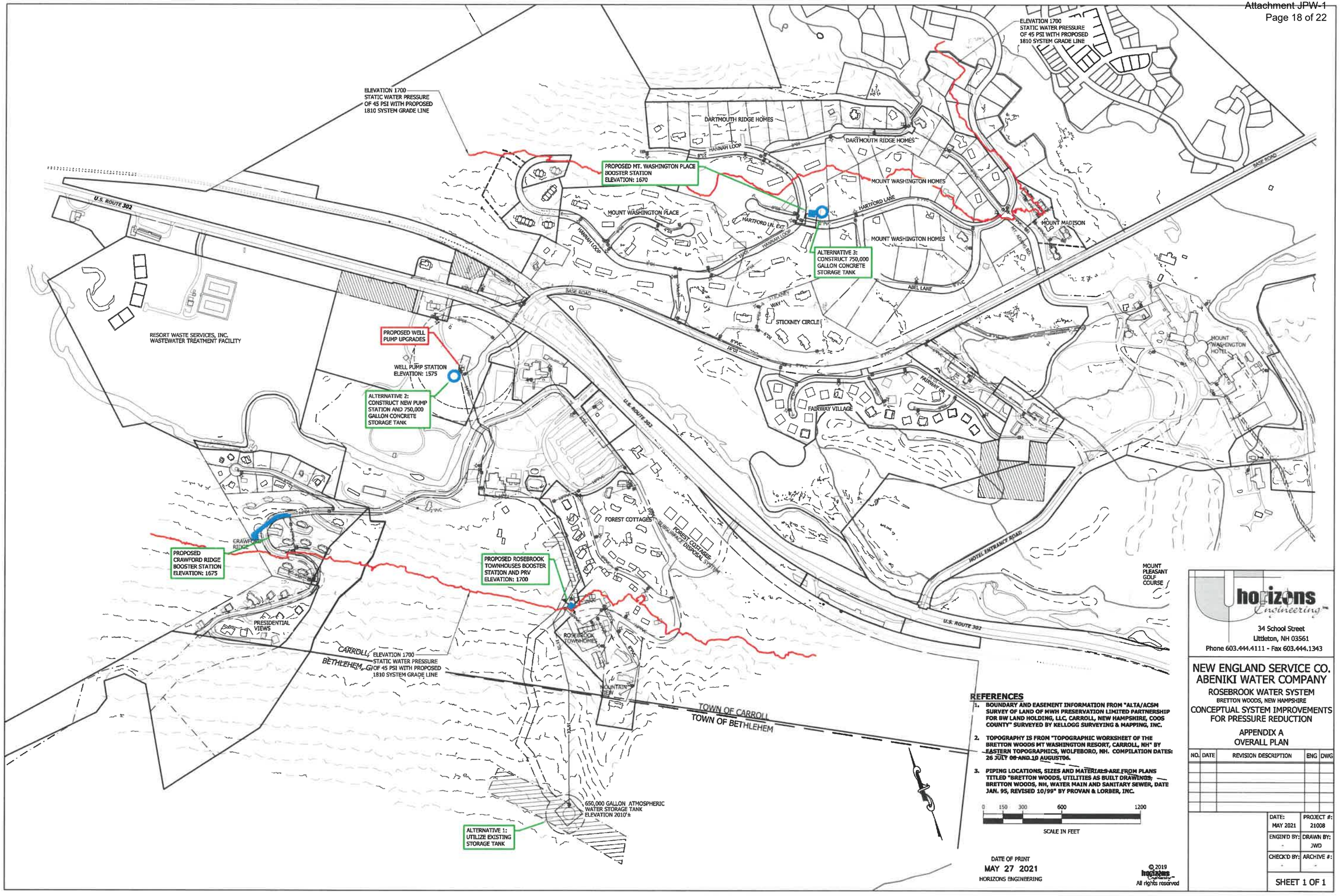
Summary Findings

- The Rosebrook Water System operates in excess of "recommended" pressure limits.
- The Rosebrook Water System has operated under these same conditions for approximately 50 years.
- Other public water systems in New Hampshire operate under similar pressure conditions.
- Pressure reduction will significantly reduce existing fire flows in the lower pressure zone.
- Existing fire flows in the lower elevation of the system are likely much greater than Needed Fire Flows (with the likely exception of the Mount Washington Hotel).
- Existing fire flows in the upper elevation of the system likely currently meet Needed Fire Flows.
- A Needed Fire Flow evaluation should be completed site wide for final design.
- Pressure reduction will reduce domestic water flow/pressure at properties at the higher system elevations. Some high value structures are up to 40 feet above the water service location at ground level and are three stories in height. A static pressure of 35 psi at the ground level of the service may not provide satisfactory pressure for the user.
- Pressure reduction may result in added liability to all parties involved in the project.
- Pressure reduction will improve operator safety at the existing pump station.
- Pressure reduction will improve operation and maintenance of the chemical injection system.
- Above grade piping within the existing pump station is believed to present the greatest hazard potential for the system operator.
- The existing pump station equipment is aged and will need to be upgraded within a relatively short period of time. The existing pump station was not designed for chemical storage and addition to the system.
- Chemical storage within the existing pump station creates a corrosive environment which will accelerate the deterioration of the existing equipment and piping within the building.
- Water hammer currently exists in the system on the north side of Route 302. This water hammer exasperates the high-pressure situation and should be addressed. One potential option to address this situation is the extension of the existing 16 inch water main at Fairway Village to the Mount Washington Hotel as has been previously identified.
- Piping and appurtenances in the system appear to be appropriately rated for the existing system pressures.
- Inoperable valves in the system will not be "fixed" by pressure reduction and should be replaced. Approximately 6 valves, in key system locations, are believed to be inoperable.

APPENDIX A

CONCEPTUAL IMPROVEMENTS OVERALL PLAN

CONCEPTUAL IMPROVEMENTS OPTION 1D



REFERENCES

1. BOUNDARY AND EASEMENT INFORMATION FROM "ALTA/ACSM SURVEY OF LAND OF MWH PRESERVATION LIMITED PARTNERSHIP FOR BW LAND HOLDING, LLC, CARROLL, NEW HAMPSHIRE, COOS COUNTY" SURVEYED BY KELLOGG SURVEYING & MAPPING, INC.
2. TOPOGRAPHY IS FROM "TOPOGRAPHIC WORKSHEET OF THE BRETTON WOODS MT WASHINGTON RESORT, CARROLL, NH" BY EASTERN TOPOGRAPHICS, WOLFEBORO, NH. COMPILATION DATES: 26 JULY 06 AND 10 AUGUST06.
3. PIPING LOCATIONS, SIZES AND MATERIALS ARE FROM PLANS TITLED "BRETTON WOODS, UTILITIES AS BUILT DRAWINGS; BRETTON WOODS, NH, WATER MAIN AND SANITARY SEWER, DATE JAN. 95, REVISED 10/99" BY PROVAN & LORBER, INC.

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SCALE IN FEET

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NEW ENGLAND SERVICE CO.
ABENIKI WATER COMPANY
ROSEBROOK WATER SYSTEM
BRETTON WOODS, NEW HAMPSHIRE
CONCEPTUAL SYSTEM IMPROVEMENTS FOR PRESSURE REDUCTION
APPENDIX A
OVERALL PLAN

NO.	DATE	REVISION DESCRIPTION	ENG	DWG

DATE: MAY 2021	PROJECT #: 21008
ENGIN'D BY: -	DRAWN BY: JWD
CHECK'D BY: -	ARCHIVE #: -

SHEET 1 OF 1

ELEVATION 1700
STATIC WATER PRESSURE
OF 45 PSI WITH PROPOSED
1810 SYSTEM GRADE LINE

ELEVATION 1700
STATIC WATER PRESSURE
OF 45 PSI WITH PROPOSED
1810 SYSTEM GRADE LINE

U.S. ROUTE 302

RESORT WASTE SERVICES, INC.
WASTEWATER TREATMENT FACILITY

PROPOSED WELL
PUMP UPGRADES

WELL PUMP STATION
ELEVATION: 1575

PRV 1:
CRAWFORD RIDGE
INLET PSI: 167 PSI
OUTLET PSI: 132 PSI
ELEVATION: 1625

PRV 2:
SKI AREA
INLET PSI: 172 PSI
OUTLET PSI: 70 PSI
ELEVATION: 1605

PRV 3:
ROSEBROOK TOWNHOMES
INLET PSI: 131 PSI
OUTLET PSI: 80 PSI
ELEVATION: 1700

PRV 4:
FOREST COTTAGES
INLET PSI: 90 PSI
OUTLET PSI: 40 PSI
ELEVATION: 1675

PRV 5:
STICKNEY & FAIRVIEW
INLET PSI: 182 PSI
OUTLET PSI: 98 PSI
ELEVATION: 1582

PRV 6:
MT WASHINGTON PLACE
INLET PSI: 183 PSI
OUTLET PSI: 128 PSI
ELEVATION: 1585

DARTMOUTH RIDGE HOMES
HANNAH LOOP
MOUNT WASHINGTON PLACE
HARTFORD LN. EXT.
HARTFORD LANE
MOUNT WASHINGTON HOMES
MOUNT MADISON
MT. CLARKE RD.
ABEL LANE
STICKNEY CIRCLE
RIDGE ROAD
FAIRWAY DR.
FAIRWAY VILLAGE
MOUNT WASHINGTON HOTEL
FOREST COTTAGES
FOREST COTTAGES SURFACE DISPOSAL SYSTEM
HOTEL ENTRANCE ROAD
MOUNT PLEASANT GOLF COURSE
CRAWFORD RIDGE
PRESIDENTIAL VIEWS
ROSEBROOK TOWNHOMES
MOUNTAIN VIEW
CARROLL, COOS COUNTY
BETHLEHEM, GRAFTON COUNTY
TOWN OF CARROLL
TOWN OF BETHLEHEM

650,000 GALLON ATMOSPHERIC
WATER STORAGE TANK
ELEVATION 2010'±

REFERENCES

1. BOUNDARY AND EASEMENT INFORMATION FROM "ALTA/ACSM SURVEY OF LAND OF NWH PRESERVATION LIMITED PARTNERSHIP FOR BW LAND HOLDING, LLC, CARROLL, NEW HAMPSHIRE, COOS COUNTY" SURVEYED BY KELLOGG SURVEYING & MAPPING, INC.
2. TOPOGRAPHY IS FROM "TOPOGRAPHIC WORKSHEET OF THE BRETTON WOODS MT WASHINGTON RESORT, CARROLL, NH" BY EASTERN TOPOGRAPHICS, WOLFEBORO, NH. COMPILATION DATES: 25 JULY 06 AND 10 AUGUST06.
3. PIPING LOCATIONS, SIZES AND MATERIALS ARE FROM PLANS TITLED "BRETTON WOODS, UTILITIES AS BUILT DRAWINGS, BRETTON WOODS, NH, WATER MAIN AND SANITARY SEWER, DATE JAN. 95, REVISED 10/99" BY PROVAN & LORBER, INC.

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SCALE IN FEET

DATE OF PRINT
JUNE 22 2021
HORIZONS ENGINEERING

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NEW ENGLAND SERVICE CO.
ABENIKI WATER COMPANY
ROSEBROOK WATER SYSTEM
BRETTON WOODS, NEW HAMPSHIRE
CONCEPTUAL SYSTEM IMPROVEMENTS
FOR PRESSURE REDUCTION
ALTERNATIVE 1D
OVERALL PLAN

NO.	DATE	REVISION DESCRIPTION	ENG	DWG

DATE: JUN 2021	PROJECT #: 21008
ENGIN'D BY: -	DRAWN BY: JWD
CHECK'D BY: -	ARCHIVE #: H-5292

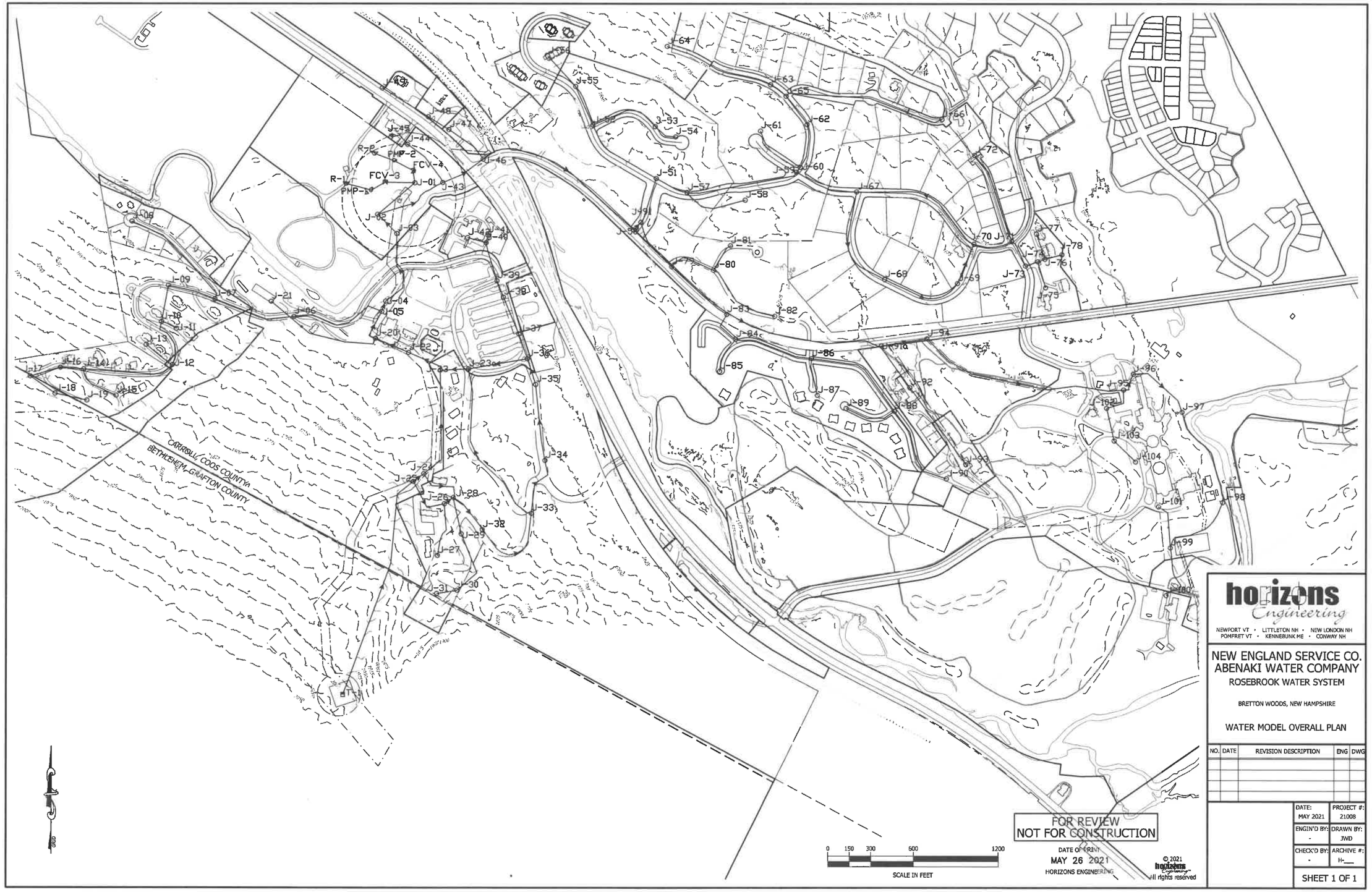
SHEET 1 OF 1

APPENDIX B

ROSEBROOK HYDRAULIC MODELING PLAN AND DATA OUTPUT

ROSEBROOK WATER SYSTEM
HYDRAULIC MODEL DATA
C-VALUES: DUCTILE IRON C=140, PVC C=150

Node Label	Available Flow (gpm)	Minimum Pressure (psi)	Calculated Pressure (psi)	Node Label	Available Flow (gpm)	Minimum Pressure (psi)	Calculated Pressure (psi)
J-01	4,135	35	35	J-55	4,271	35	48
J-02	8,672	35	131	J-56	3,771	35	35
J-03	8,672	35	145	J-57	7,029	35	119
J-04	8,672	35	141	J-59	6,609	35	87
J-05	8,672	35	142	J-60	6,525	35	85
J-06	6,105	35	140	J-61	3,088	35	35
J-07	5,068	35	127	J-62	4,241	35	70
J-08	4,943	35	35	J-63	3,489	35	49
J-09	4,657	35	118	J-64	2,766	35	35
J-10	4,430	35	94	J-65	3,489	35	59
J-12	4,162	35	75	J-66	2,265	35	35
J-14	3,734	35	51	J-67	6,609	35	76
J-15	3,306	35	35	J-68	5,621	35	64
J-16	3,643	35	47	J-69	5,046	35	58
J-17	3,001	35	35	J-70	4,775	35	57
J-18	2,408	35	35	J-71	3,987	35	55
J-19	2,289	35	35	J-72	3,001	35	35
J-20	9,070	35	138	J-73	3,987	35	44
J-22	9,552	35	136	J-74	3,927	35	35
J-23	10,000	35	134	J-75	3,726	35	35
J-23a	10,000	35	121	J-76	3,837	35	35
J-24	10,000	35	107	J-77	3,569	35	35
J-25	10,000	35	104	J-78	3,829	35	35
J-26	10,000	35	72	J-79	7,399	35	121
J-27	3,088	35	35	J-80	3,810	35	40
J-28	10,000	35	71	J-81	3,071	35	35
J-29	7,735	35	59	J-82	2,347	35	35
J-30	4,086	35	37	J-83	7,399	35	111
J-31	3,689	35	35	J-84	7,399	35	113
J-32	10,000	35	57	J-85	7,399	35	42
J-33	10,000	35	71	J-86	7,399	35	99
J-34	10,000	35	73	J-87	7,180	35	35
J-35	10,000	35	88	J-88	7,399	35	98
J-36	10,000	35	95	J-89	6,470	35	35
J-37	7,834	35	71	J-90	7,399	35	92
J-38	6,792	35	35	J-91	7,356	35	128
J-39	6,207	35	35	J-91a	3,159	35	50
J-40	5,264	35	35	J-92	2,618	35	35
J-41	5,119	35	35	J-93	1,989	35	35
J-42	4,179	35	35	J-94	2,939	35	41
J-43	8,672	35	133	J-95	2,300	35	38
J-44	7,559	35	37	J-96	2,277	35	35
J-45	6,606	35	35	J-97	2,150	35	46
J-46	8,419	35	126	J-98	1,990	35	46
J-47	7,834	35	47	J-99	1,892	35	50
J-48	7,048	35	35	J-100	1,892	35	48
J-49	5,569	35	35	J-101	1,838	35	35
J-50	7,399	35	128	J-102	2,236	35	37
J-51	7,172	35	124	J-103	2,173	35	37
J-52	5,048	35	50	J-104	2,120	35	35
J-53	4,131	35	35				



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NEW ENGLAND SERVICE CO.
ABENAKI WATER COMPANY
ROSEBROOK WATER SYSTEM

BRETTON WOODS, NEW HAMPSHIRE

WATER MODEL OVERALL PLAN

NO.	DATE	REVISION DESCRIPTION	ENG	DWG

DATE: MAY 2021	PROJECT #: 21008
ENGIN'D BY: -	DRAWN BY: JWD
CHECK'D BY: -	ARCHIVE #: H-___

SHEET 1 OF 1

Rosebrook Distribution System Evaluation for Treatment and Pressure Reduction Improvements

TO: Robert Gallo, PE, Manager, Engineering, Aquarion Water Company

FROM: Emily Balcom, EIT, Staff Engineer, Tighe & Bond
Amanda Keyes, PE, Project Manager, Tighe & Bond

COPY: Peter Galant, PE, Project Director, Tighe & Bond
Heather Doolittle, PE, Project Engineer, Tighe & Bond

DATE: June 16, 2022

This technical memorandum presents a summary of options for reducing distribution system pressure in the recently acquired Rosebrook Water System (PWS ID 0382010) in Carroll, New Hampshire. The evaluation included thirteen improvement options, each with preliminary cost estimates. A hydraulic model was developed and utilized to compare system pressures and available fire flow for the most feasible options.

1 Background

The Rosebrook System serves approximately 1,020 people in an area of Carroll, New Hampshire including the Bretton Woods Ski Resort, the Mount Washington Hotel, and single and multi-family residential and small commercial customers. The system includes two gravel-packed production wells, a treatment facility, a 650,000-gallon atmospheric storage tank, and distribution piping and associated appurtenances. The system is operated as one pressure zone and, due to its topography, has water pressure ranging from approximately 70 psi at its highest elevation customer to more than 190 psi at the lowest elevation. Much of the distribution system in the Valley exceeds the NH Public Utility Commission (NHPUC) standard (PUC 604.03) for systems to maintain normal operating pressure between 20 psi and 125 psi at each connection for services installed prior to 2013 and between 30 psi and 100 psi for services installed after that date.

The NH Department of Environmental Services' (NHDES's) 2019 Sanitary Survey of the system identified significant deficiencies including pressures that exceed the maximum allowable per New Hampshire Rules and Regulations, lack of chemical containment, and the need for chemical feed system improvements. The Rosebrook System received a Letter of Deficiency (LOD) from the NHDES on December 1, 2020 stating that the system should be modified to maintain a normal working pressure between 60 psi and 90 psi, with a minimum working pressure of 35 psi and a maximum static pressure of 100 psi. The LOD also requires the improvements at the wellfield to provide separate chemical storage, feed and containment systems for each treatment chemical.

The largest customer in the Rosebrook System is OMNI Hotels and Resorts (OMNI). OMNI owns several higher-occupancy, high-use buildings that utilize internal fire suppression systems, including the Mt. Washington Hotel & Resort, Bretton Arms Inn and multiple buildings at the Bretton Woods Ski Area. The water pressure at the Mt. Washington Resort is 150 – 175 psi, and the pressures at the Bretton Arms and Bretton Woods Ski Area are approximately 180 psi. OMNI has indicated that the service pressures to these facilities must be maintained for proper operation of their fire suppression systems. The planned pressure reduction project must balance these competing needs.

2 Options

In May 2021 Horizons Engineering completed an evaluation of seven Options (Options 1A-D, 2A & B, 3A) aimed at reducing pressures at the chemical injection point and in the distribution system as summarized in the memorandum titled *Updated System Evaluation For Pressure Reduction (updated June 22, 2021)*. Aquarion subsequently developed an additional six options (the 2022 options 4A through 4F)). The goal of options 4A through 4f was to reduce pressure to 150 psi or below for as many customers in the system as possible, except for the OMNI facilities. Choosing a pressure target lower than 150 psi would result in lower than acceptable pressures at high elevations in the system and would require either multiple Aquarion-owned booster stations or booster pumps in individual homes.

Altogether, the original 1,2, and 3 series, and the subsequent 4 series, result in a total of thirteen options summarized in this memorandum. The thirteen options consist of improvements aimed at reducing pressure in the system through a combination of new pump stations, pressure regulating valves (PRVs) and water main improvements to create reduced pressure zones within the Rosebrook distribution system. All options also include upgrades at the well facility to reduce the pressure at which chemicals are added, which is critical for worker safety, and to address the LOD requirements for chemical feed and storage improvements.

The options matrix in Attachment 1 describes each of the options considered, including estimates of probable capital cost and advantages and disadvantages of each. More detail regarding the 2021 options, of which many of the elements are repeated in the 2022 options, are provided in the above referenced System Evaluation report.

2.1 Capital Costs

Tighe & Bond reviewed the cost estimates included in Horizons Engineering's May 2021 memorandum and estimates prepared by Aquarion for the 2022 options, and compared them to recent construction bids received on similar projects. All costs were reviewed and updated for consistency to allow for a comparative analysis between the options.

Increases in the original cost estimates compared to previous reports result from a combination of modifying the conceptual designs to be more consistent with typical Aquarion standards and increases in material and labor costs since the original costs were developed. The ENR index has increased by 14% from June 2021 to May 2022 (from 11436 to 13004) and recent bidding results have suggested cost escalation even above that predicted by the ENR index.

Attachment 2 provides estimates for each option, incorporating a 20 percent contingency. Most of the options include replacement of the Treatment/Pump Station, so Tighe & Bond also developed a more detailed conceptual cost estimate for the replacement of the Rosebrook Treatment/Pump Station Replacement. A breakdown of the conceptual cost of the treatment facility is also included in Attachment 2.

The cost estimates for each option provided in Attachment 2 are considered Class 3 level construction cost estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International Recommended Practices and Standards. According to AACE International Recommended Practices and Standards, the estimate class designations are labeled Classes 1-5, where a Class 5 estimate is based upon the lowest level of project definition and a Class 1 estimate is closest to full project definition and maturity. A Class 3 estimate is appropriate for Planning Studies or a Preliminary Design Report. The expected accuracy range of a Class 3 estimate is between +30% to –20%. The level of project definition for a Class 3 estimate is between 10% and 40%. The Class 3 opinions of probable

construction costs presented here are considered appropriate for selecting between design Options and will be further refined as design progresses.

2.2 Operation & Maintenance (O&M) Costs

The quantity of water treated, and therefore annual treatment costs, is not expected to change with any of the options. Similarly, because the amount of water being pumped, and the change in elevation from the wellfield to the storage tank, are not expected to change, pumping costs are not anticipated to differ significantly for any of the options.

Water mains and pressure reducing valves are not expected to have a significant impact on system O&M costs. Incremental O&M costs are therefore expected to be limited to the operations labor and equipment maintenance for options with new pump stations. For this analysis it can be assumed that the options with new pump stations (see Attachment 1) will increase annual O&M costs by $10,000 per booster pump station per year.

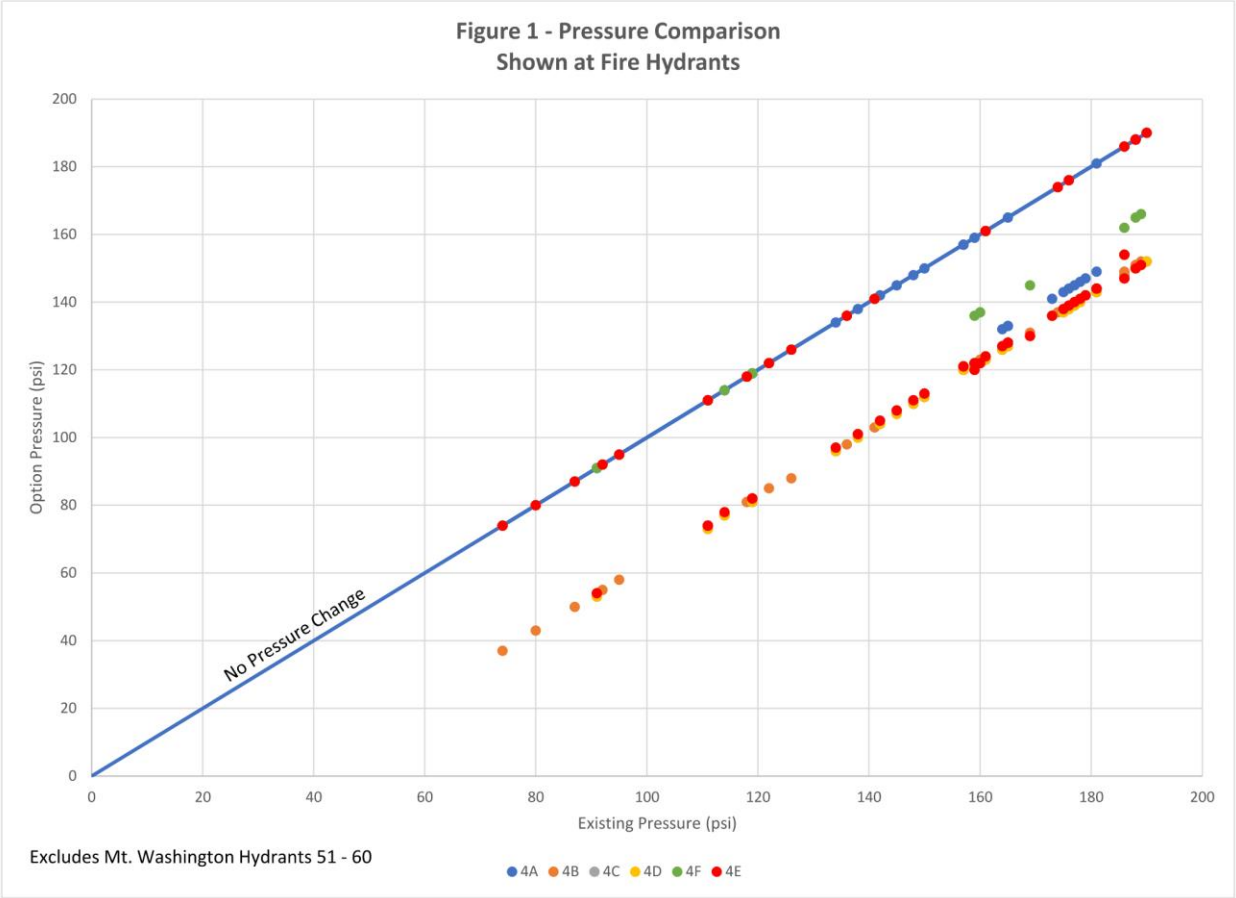
2.3 Pressure and Fire Flow

A hydraulic model of the Rosebrook Water System was developed to evaluate changes to system pressure and available fire flow (AFF) for the six 2022 options (4A – 4F). For purposes of this evaluation AFF was defined as the maximum flow that can be withdrawn from a single point in the system while maintaining at least 20 psi at all other points in the system, including the flowing location. The following system conditions were assumed for the hydraulic and AFF analysis:

- Water Storage Tank (WST) Water Level: 2,006.4 feet elevation (3.6 feet below overflow elevation)
- Rosebrook Treatment/Pump Station Status: Both well pumps off
- System Demand: 308,200 gpd (max day demand)

A comparison of available fire flow and pressure at each hydrant under each option is presented in Table 1 and Figure 1 of Attachment 3. As indicated in the attachment, Options 4A and 4B had the greatest reduction in AFF, but all hydrants had modeled AFF greater than 1,000 gpm under all options.

Modeled pressure reduction at hydrants is presented in Attachment 3 and in Figure 1 below. As shown, Options 4A and 4F had the least reduction in pressure, and pressure reduction with the other alternatives was similar and approximately 40 psi throughout the system (excluding OMNI properties).



3 Funding

The NH Drinking Water and Groundwater Advisory Commission has approved up to $2,500,00 in low-interest loan funds and $280,000 in grant funds for work related to the Rosebrook Pressure Reduction project through the Drinking Water and Groundwater Trust Fund (DWGTF) Program. Aquarion has applied for an additional $1,730,000 in funding for this project through the NHDES Drinking Water State Revolving Fund (DWSRF) program. The DWGTF funds and any additional DWSRF funds will help offset the cost of this project to the water system rate payers.

4 Discussion and Recommendations

Option 1C has the lowest estimated cost. However, this option only addresses the pressure issue at the treatment / pump station facility, leaving the pressure as-is throughout the distribution system.

Option 4E is the next lowest cost option, and achieves the targeted pressure (see Section 2) of 150 psi or less throughout the distribution system with the exception of the Omni facilities (see explanation in Section 1 – Background) and several commercial facilities on Route 302.

The primary components of Option 4E are a new building at the wellfield and three pressure reducing valve (PRV) vaults in the distribution system (see Attachment 3 Figure 2). The new wellfield building will house new chemical feed and storage systems, small water storage tanks (referred to as clearwells), and booster pumps. These new facilities will allow for the

three treatment chemicals to be injected into the water at a low pressure, thus improving safety. The booster pumps in the new wellfield building will boost pressure to the existing pressure of about 190 psi. For three areas in the distribution system, pressure will be reduced using the aforementioned three PRVs (see the ”reduced pressure zones” in Figure 2 of Attachment 3). With this arrangement of PRVs, the existing water main extending from the wellfield to the tank (on the south side of the valley) and the existing water main extending from the wellfield to the OMNI Hotel (on the north side of the valley) will remain at the current pressures, allowing the existing tank to continue to be utilized for water storage (instead of building a new tank at a lower elevation) and satisfying OMNI’s request that water pressure at their facilities on both sides of the valley remain as-is.

As referenced in Section 2, Option 4E will not provide for system-wide pressures less than 100 psi; however, it will reduce pressures to less than 150 psi throughout the system. This option will also allow for the continued use of the 650,000 gallon storage tank and maintain existing pressures for OMNI fire protection, as previously discussed.

Figures 4 and 5 of Attachment 3 present modeled available fire flow (AFF) and modeled pressure throughout the distribution system under Option 4E.

Attachments

Attachment 1 – Rosebrook Water System Options Matrix

Attachment 2 – Cost Summaries

Attachment 3 – Available Fire Flow Summary Table and System Improvement Maps (Option4E)

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Attachment 1

Rosebrook Water System Options Matrix

Rosebrook Water System – Treatment and Pressure Reduction Improvements Matrix - Options 1A-1D, 2A-2B & 3A (2021 Options)

Option	Description	Max. Pressure (excl. OMNI)	Discharge Pressure at Wellhouse	New Wellhouse?	Booster Pump Stations?	PRV Vaults?	Expected Capital Cost	Easement Costs (number)[1]	Advantages	Disadvantages
1A	Replace well pumps to reduce well station discharge pressure to 90 psi to reduce pressure in the entire system. This would allow chemical injection to take place at lower, safer pressures. A new pump station and PRV will be constructed in the vicinity of the Rosebrook Townhomes to fill the 650,000-gallon tank. Two additional pump stations would be constructed, one at Crawford Ridge to serve the south side of Route 302 and one at Mount Washington Place to boost pressures on the north side.	135 psi	90 psi	No	3	No	$6,345,800	$120,000 (3)	• Reduces pressure at point of chemical injection • Provides system-wide pressure reduction	• Does not address the deficiencies associated with the treatment plant, as identified in the NHDES's Letter of Deficiency. • Does not meet the requirement to keep the OMNI properties at existing pressures. • Three new pump stations will require backup power generation & more substantial easements vs. PRV options. • Higher potential for water outages due to risks associated with pumping/mechanical/instrumentation vs. passive PRV options. • Higher O&M and replacement costs vs. non-booster station options. • Portions of system will have pressures as low as 35 psi
1B	Three booster stations would be constructed as referenced in Option 1A. A new treatment building would be constructed, and the well pumps would discharge into a clearwell from which water would be pumped into the distribution system at 90 psi. This would allow chemical injection to take place at lower, safer pressures.	135 psi	90 psi	Yes	3	No	$8,618,000	$120,000 (3)	• Reduces pressure at point of chemical injection • Provides system-wide pressure reduction • Provides ample space for chemical storage and application to address NHDES LOD.	• Does not meet the requirement to keep the OMNI properties at existing pressures. • Three new pump stations will require backup power generation & more substantial easements vs. other options. • Pressures as low as 35 psi in several areas of the system. • Higher potential for water outages due to risks associated with pumping/mechanical/instrumentation vs. passive PRV options. • Higher O&M and replacement costs vs. non-booster station options • Portions of system will have pressures as low as 35 psi
1C	A new treatment building would be constructed, and the well pumps would discharge into a clearwell from which water would be pumped into the distribution system at 190 psi. This would allow chemical injection to take place at lower, safer pressures. No other pressure reduction would be provided.	190 psi	190 psi	Yes	No	No	$2,478,000	-	• Lowest cost option • Reduces pressure at point of chemical injection • Provides ample space for chemical storage and application to address NHDES LOD • Maintains existing pressures to OMNI properties	• Does not provide pressure reduction anywhere in distribution system
1D	A new treatment building would be constructed, and the well pumps would discharge into a clearwell from which water would be pumped into the distribution system at 190 psi. This would allow chemical injection to take place at lower, safer pressures. Six pressure reducing valves would be constructed to reduce pressures to the Rivers Edge, Crawford Ridge, Presidential Views, Forest Cottages Rosebrook Townhomes, Mountain View, Mount Washington Place, Mount Washington Homes, Stickney Circle and the Fairway Village areas.	132 psi	190 psi	Yes	No	6	$5,181,780	$180,000 (6)	• Reduces pressure at point of chemical injection • Provides ample space for chemical storage and application to address NHDES LOD • Maintains existing pressures to OMNI properties • Fewer points of mechanical/electrical failure vs. booster station options	• Reduces pressure to Bretton Woods Ski Area buildings • More easements required vs. other options
2A	Three booster stations will be constructed as referenced in Option 1A. The existing 650,000-gallon storage tank would be abandoned and replaced with a 750,000 –gallon tank at the wellfield. Chemical injection will take place under lower pressure prior to the tank. A new treatment/booster station would be constructed to address the NHDES LOD.	90 psi	90 psi	Yes	3	No	$12,118,000	$120,000 (3)	• Reduces pressure at point of chemical injection • Provides ample space for chemical storage and application to address NHDES LOD • Reduces pressure to regulatory limits throughout system	• Significant cost to construct tank • Three new pump stations will require backup power generation & more substantial easements vs. PRV options • Higher O&M and replacement costs vs. non-booster station options • Does not meet the requirement to keep the OMNI properties at existing pressures • Pressures as low as 35 psi in several areas of the system • Water service and fire fighting capacity would be lost in the event of a failure of the well pumps or wellfield booster station
2B	A new treatment/booster station would be constructed at the wellfield. The existing 650,000-gallon storage tank would be abandoned, and a 750,000-gallon tank constructed at the wellfield. The station would have a discharge pressure of 150 psi. No other booster stations or PRV systems would be constructed.	150 psi	150 psi	Yes	No	No	$5,978,000	-	• Reduces maximum pressure in the system from 190 psi to 150 psi, • No additional booster or PRV systems required	• Significant cost to construct tank • Reduces pressure down to 35 psi at higher elevations • Does not meet the requirement to keep the OMNI properties at existing pressures • Higher O&M Costs vs. non-booster options & higher replacement costs • Water service and fire fighting capacity would be lost in the event of a failure of the well pumps & wellfield booster station
3A	Three booster stations will be constructed as referenced in Option 1A. A new treatment building would be constructed, and the well pumps would discharge into a clearwell from which water would be pumped into the distribution system at 90 psi. This would allow chemical injection to take place at lower, safer pressures. A new 750,000-gallon storage tank would be constructed on the north side of Route 302 to replace the 650,000-gallon tank on the Bretton Wood Ski Resort at a hydraulic grade equivalent to the 90 psi discharge pressure at the wellfield.	135 psi	90 psi	Yes	3	No	$12,178,000	$180,000 (4)	• Reduces pressure at point of chemical injection • Provides ample space for chemical storage and application to address NHDES LOD.	• Significant cost to construct tank • Difficulty in siting new tank in developed areas • Does not meet the requirement to keep OMNI properties at existing pressures • Three new pump stations will require backup power generation & more substantial easements vs. PRV options • Higher O&M Costs vs. non-booster options & higher replacement costs • Areas above the booster stations would lose water service and fire fighting capacity in the event of a station failure. • The proposed 750,000-gallon tank could not serve the entire system in the event of a failure of the well pumps wellfield booster station.

1. Easement costs are estimated based on typical Aquarion easements in other systems. Easement costs are assumed at $40,000 for pump station easements, $20,000 for PRV vault easements, and $60,000 for an easement for a new water storage tank. The true costs of easements cannot be determined until the exact location of each facility is determined and then an easement agreement and fee is negotiated with the property owner of the locations identified.

Rosebrook Water System – Treatment and Pressure Reduction Improvements Matrix - Options 4A – 4F (2022 Options)

Option	Description	Target Max. Pressure (excl. OMNI)	Discharge Pressure at Wellhouse	New Wellhouse?	Booster Pump Stations?	PRV Vaults?	Expected Capital Cost	Easement Costs (number)[1]	Advantages	Disadvantages
4A	Option 4A would construct a new pumping and chemical treatment facility at the wellfield. The River's Edge and surrounding area will be served by a PRV to reduce pressures. Forest Cottages will be served by a PRV to reduce pressures in the lower portion of the area while isolation valving is used to maintain pressure in the higher elevations. New water mains would be installed from a proposed PRV at Stickney Circle to serve the Mt. Washington Place, Mt. Washington Homes and Fairway Village. Maintaining existing pressure in areas on the south side of Route 302 are necessary for filling the storage tank, and to maintain pressures in higher-elevation areas.	150 psi	190 psi	Yes	No	3	$7,218,200	$60,000 (3)	• Provides ample space for chemical storage and application to address NHDES LOD • Reduced pressure at the point of chemical addition • Existing pressures are maintained to OMNI properties • Existing pressures are maintained in the northern portions of Mt. Washington Place/Homes, and the Dartmouth Ridge area	• Existing high pressures maintained at Drummond's, Irving gas station and Fabyan's • Increased disturbance area compared to other options • Significant main extensions parallel to existing ones
4B	The discharge pressure from the wellfield station would be reduced to 150 psi. A booster station and PRV would be required near the Rosebrook Townhomes for continued operation of the storage tank. No other pressure reduction measures would be implemented in the system. Under this option, pressures to the Mount Washington Hotel, Bretton Arms and Bretton Woods Ski Area would be reduced.	150 psi	150 psi	Yes	1	No	$4,508,000	-	• Provides ample space for chemical storage and application to address NHDES LOD • Reduced pressure at the point of chemical addition • Limited easement requirements • Entire system pressure is reduced to a maximum of 150 psi	• Does not meet the requirement to keep the OMNI properties at the same pressures.
4C	A PRV would be installed at the wellfield & booster station to reduce the discharge pressure to the north side of Base Road to a maximum of 150 psi, excluding the Mt. Washington Hotel (MWH) and the Bretton Arms. A dedicated main would be extended from the wellfield at existing pressures to the 8-inch main that serves the Mount Washington Hotel and Bretton Arms. All other properties north of Base Road would be reduced to a maximum of 150 psi, as well as Fairway Village. The River's Edge and Forest Cottage area pressures would be reduced in the same manner as Option 4A. Portions of the mains south of Base Road will remain at existing pressures, as well as the ski lodge, alpine club and ski school. Drummond's ski shop, Fabyan's Restaurant and the Irving gas station, located on Route 302, would also remain at existing pressures. Maintaining existing pressure in several mains south of Route 302 are necessary for filling the storage tank, and to maintain pressures in higher-elevations.	150 psi	190/150 PRV at Station	Yes	No	2	$5,200,540	$40,000 (2)	• Provides ample space for chemical storage and application to address NHDES LOD • Potential for transmission main redundancy • Existing pressures are maintained to OMNI properties	• The main extension from the wellfield/station would have to cross Route 302 and a railroad right-of-way. There is the potential for significant additional cost if open cutting of the road and tracks are not permitted. • Delays due to crossing permits for Route 302 & railroad ROW. • Existing high pressures maintained at Drummond's, Irving gas station and Fabyan's.
4D	Same as 4C except a higher-pressure main would also be extended to the Dartmouth Ridge area to maintain existing pressures. Maintaining existing pressure in areas on the south side of Route 302 are necessary for filling the storage tank, and to maintain pressures in higher-elevation areas.	150 psi	190/150 PRV at Station	Yes	No	2	$5,943,240	$40,000 (2)	• Provides ample space for chemical storage and application to address NHDES LOD • Potential for transmission main redundancy • Existing pressures are maintained to OMNI properties	• The main extension from the wellfield/station would have to cross Route 302 and a railroad right-of-way. There is the potential for significant additional cost if open cutting of the road and tracks are not permitted. • Delays due to crossing permits for Route 302 & railroad ROW • Existing high pressures maintained at Drummond's, Irving gas station and Fabyan's. • 1,450 lf of parallel main required up to Dartmouth Ridge
4E	A 190 psi discharge pressure is maintained at the wellfield station. A PRV is placed near the intersection of Base Road and Hannah Loop, reducing pressures to all properties north of Route 302, and Fairway Village, to a maximum of 150 psi. Existing pressures are maintained to the Mount Washington Hotel and Bretton Arms via the 8-inch main on Base Road. The River's Edge and Forest Cottage area pressures would be reduced in the same manner as Option 4A. Portions of the mains south of Base Road will remain at existing pressures, as well as the ski lodge, alpine club and ski school at the Bretton Woods Ski Area. Drummond's ski shop, Fabyan's Restaurant and the Irving gas station will also remain at existing pressures. Maintaining existing pressure in areas on the south side of Route 302 are necessary for filling the storage tank, and to maintain pressures in higher-elevation areas.	150 psi	190 psi	Yes	No	3	$3,859,460	$60,000 (3)	• Provides ample space for chemical storage and application to address NHDES LOD • Can implement pressure reduction on north side of Base Road and Fairway Village utilizing one easement and connecting one pressure reducing facility to three mains (one in, two out). • Existing pressures are maintained to OMNI properties. • Limited disturbance areas.	• Existing high pressures maintained at Drummond's, Irving gas station and Fabyan's.
4F	Same as 4E, except that a dedicated main is extended from Base Road, under existing pressures, to serve the Dartmouth Ridge area. Maintaining existing pressure in areas on the south side of Route 302 are necessary for filling the storage tank, and to maintain pressures in higher-elevation areas.	190 psi	150 psi	Yes	No	3	$4,322,860	$60,000 (3)	• Provides ample space for chemical storage and application to address NHDES LOD • Avoids crossing Route 302 and a railroad ROW with a main extension. • Can implement pressure reduction on north side of Base Road and Fairway Village utilizing one easement and connecting one pressure reducing facility to three mains (one in, two out). • Maintains pressure to OMNI properties. • Maintains higher pressure to Dartmouth Ridge area.	• Existing high pressures maintained at Drummond's, Irving gas station and Fabyan's. • 1,450 lf of parallel main required up to Dartmouth Ridge

1. Easement costs are estimated based on typical Aquarion easements in other systems. Easement costs are assumed at $40,000 for pump station easements, $20,000 for PRV vault easements, and $60,000 for an easement for a new water storage tank. The true costs of easements cannot be determined until the exact location of each facility is determined and then an easement agreement and fee is negotiated with the property owner of the locations identified.

Attachment 2

Cost Summaries

Cost Comparison Tables

Aquarion Water Company Rosebrook Water System - Treatment & Pressure Reduction Options - 1 Series Options (2021)

Item	Unit Cost	Unit	Option #1A Qty	Option #1A (90 psi Well Station Discharge; Replace Well Pumps; Construct Booster PSs)	Option #1B Qty	Option #1B (90 psi Well Station Discharge; Replace Well Station & Pumps; Construct Booster PSs)	Option #1C Qty	Option #1C (190 psi Well Station Discharge; Replace Well Station & Pumps)	Option #1D Qty	Option #1D (190 psi Well Station Discharge; Replace Well Station & Pumps; Construct PRVs)
Rosebrook Treatment/Pump Station Replacement	$ 1,700,000	LS		$ -	1	$ 1,700,000	1	$ 1,700,000	1	$ 1,700,000
Well Pump Replacement	$ 70,000	LS	1	$ 70,000	1	$ 70,000	1	$ 70,000	1	$ 70,000
Chemical Feed/Storage Improvements	$ 77,000	LS	1	$ 77,000		$ -		$ -		$ -
Rosebrook Booster Pump Station/PRV	$ 1,450,000	LS	1	$ 1,450,000	1	$ 1,450,000		$ -		$ -
Crawford Ridge Booster Pump Station	$ 1,425,000	LS	1	$ 1,425,000	1	$ 1,425,000		$ -		$ -
Mount Washington Booster Pump Station	$ 1,425,000	LS	1	$ 1,425,000	1	$ 1,425,000		$ -		$ -
Main Line PRV Structures	$ 297,450	EA		$ -		$ -		$ -	6	$ 1,784,700
Service Line PRVs	$ 3,000	EA		$ -		$ -		$ -	6	$ 18,000
Subtotal Construction Cost				$ 4,447,000		$ 6,070,000		$ 1,770,000		$ 3,572,700
20% Contingency				$ 889,400		$ 1,214,000		$ 354,000		$ 714,540
Engineering & Construction (20%)				$ 889,400		$ 1,214,000		$ 354,000		$ 714,540
Easement Costs				$ 120,000		$ 120,000		$ -		$ 180,000
Total				**$ 6,345,800**		**$ 8,618,000**		**$ 2,478,000**		**$ 5,181,780**

Aquarion Water Company Rosebrook Water System - Treatment & Pressure Reduction Options - 2 and 3 Series Options (2021)

Item	Unit Cost	Unit	Option #2A Qty	Option #2A (90 psi Well Station Discharge; Replace Well Station & Pumps; Construct WST & Booster PSs)	Option #2B Qty	Option #2B (140 psi Well Station Discharge; Replace Well Station & Pumps; Construct WST)	Option #3A Qty	Option #3A Pumps; Construct WST along Rt302, Tanks, & Booster PSs)
Rosebrook Treatment/Pump Station Replacement	$ 1,700,000	LS	1	$ 1,700,000	1	$ 1,700,000	1	$ 1,700,000
Well Pump Replacement	$ 70,000	LS	1	$ 70,000	1	$ 70,000	1	$ 70,000
Rosebrook Booster Pump Station/PRV	$ 1,450,000	LS	1	$ 1,450,000		$ -	1	$ 1,450,000
Crawford Ridge Booster Pump Station	$ 1,425,000	LS	1	$ 1,425,000		$ -	1	$ 1,425,000
Mount Washington Booster Pump Station	$ 1,425,000	LS	1	$ 1,425,000		$ -	1	$ 1,425,000
750,000-Gallon Storage Tank	$ 2,500,000	LS	1	$ 2,500,000	1	$ 2,500,000	1	$ 2,500,000
Subtotal Construction Cost				$ 8,570,000		$ 4,270,000		$ 8,570,000
20% Contingency				$ 1,714,000		$ 854,000		$ 1,714,000
Engineering & Construction (20%)				$ 1,714,000		$ 854,000		$ 1,714,000
Easement Costs				$ 120,000		$ -		$ 180,000
Total				**$ 12,118,000**		**$ 5,978,000**		**$ 12,178,000**

Aquarion Water Company Rosebrook Water System - Treatment & Pressure Reduction Options - 4 Series Options (2022)

Item	Unit Cost	Unit	Option #4A Qty	Option #4A (190 psi Well Station Discharge & 150 psi Max Service Pressure)	Option #4B Qty	Option #4B (150 psi Well Station Discharge & Construct Rosebrook Booster/PRV)	Option #4C Qty	Option #4C (190 psi/150 psi Hybrid; Maintain OMNI Pressure)	Option #4D Qty	Option #4D (190 psi/150 psi Hybrid; Maintain OMNI & Dartmouth Ridge Pressure)	Option #4E Qty	Option #4E (190 psi; Maintain OMNI Pressure)	Option #4F Qty	Option #4F (190 psi; Maintain OMNI & Dartmouth Ridge Pressure)
Rosebrook Treatment/Pump Station Replacement	$ 1,700,000	LS	1	$ 1,700,000	1	$ 1,700,000	1	$ 1,725,000	1	$ 1,700,000	1	$ 1,700,000	1	$ 1,700,000
Well Pump Replacement	$ 70,000	LS	1	$ 70,000	1	$ 70,000	1	$ 70,000	1	$ 70,000	1	$ 70,000	1	$ 70,000
Gate Valve (closed position)	Varies	LS	1	$ 4,500			1	$ 4,500	1	$ 4,500	1	$ 4,500	2	$ 13,000
River's Edge 4" PRV	$ 150,000	LS	1	$ 150,000		$ -	1	$ 150,000	1	$ 150,000	1	$ 150,000	1	$ 150,000
Stickney Circle 8" PRV	$ 200,000	LS	1	$ 200,000		$ -		$ -		$ -		$ -		$ -
Forest Cottage 8" PRV	$ 200,000	LS	1	$ 200,000		$ -	1	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000
Hannah Loop 12" PRV	$ 298,000	LS		$ -		$ -		$ -		$ -	1	$ 298,000	1	$ 298,000
Water Main Extension (8")	$ 390	LF	7150	$ 2,788,500		$ -	240	$ 93,600	1,690	$ 659,100	240	$ 93,600	240	$ 93,600
Water Main Extension (12")	$ 430	LF		$ -		$ -	2100	$ 903,000	2,100	$ 903,000	460	$ 197,800	1210	$ 520,300
Jack & Bore Under Railroad (125')	$ 395,000	LS		$ -		$ -	1	$ 395,000	1	$ 395,000		$ -		$ -
Directional Drill Under Route 302 (150')	$ 135,000	LS		$ -		$ -	1	$ 135,000	1	$ 135,000		$ -		$ -
Rosebrook Booster/PRV Station	$ 1,450,000	LS		$ -	1	$ 1,450,000		$ -		$ -		$ -		$ -
16" Redundancy Valve	$ 10,000	LS		$ -		$ -	1	$ 10,000		$ -		$ -		$ -
Subtotal Construction Cost				$ 5,113,000		$ 3,220,000		$ 3,686,100		$ 4,216,600		$ 2,713,900		$ 3,044,900
20% Contingency				$ 1,022,600		$ 644,000		$ 737,220		$ 843,320		$ 542,780		$ 608,980
Engineering & Construction (20%)				$ 1,022,600		$ 644,000		$ 737,220		$ 843,320		$ 542,780		$ 608,980
Easement Costs				$ 60,000		$ -		$ 40,000		$ 40,000		$ 60,000		$ 60,000
Total				**$ 7,218,200**		**$ 4,508,000**		**$ 5,200,540**		**$ 5,943,240**		**$ 3,859,460**		**$ 4,322,860**

Conceptual Cost for Rosebrook Treatment/Pump Station Facility

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

Tighe&Bond

Project: **Rosebroook Treatment and Booster Facility**
Location: **Carroll, NH**

Prepared By: APK/JP/EB/JC

Estimate Type: **CONCEPTUAL**

Date Updated: 5/6/2022
T&B Project No.: A1000-113A

Spec. Section	Description	Qty	Units	Material/Installed Cost $/Unit	Material/Installed Cost Total	Installation $/Unit	Installation Total	Total
DIVISION 2 - SITE WORK								
	WTP Site Clearing	10,000	SF	$2	$20,000		$0	$20,000
	8" DI Pipe - From Existing Well Building	75	LF	$300	$22,500		$0	$22,500
	16" DI Pipe to Existing Distribution Pipin	125	LF	$400	$50,000		$0	$50,000
	Haybales and Siltation Fence	375	LF	$7	$2,625		$0	$2,625
	Site Grading	1	LS	$12,000	$12,000		$0	$12,000
	Loam and Seed	10,000	SF	$1	$10,000		$0	$10,000
	Access Drive/Parking	1	LS	$18,000	$18,000		$0	$18,000
	Tight Tank	1	LS	$15,000	$15,000		$0	$15,000
SUBTOTAL - DIVISION 2					**$150,125**		**$0**	**$150,125**
DIVISION 3 - CONCRETE								
03300	Cast-in-Place Concrete							
	Centralized Building							
	Foundation walls	37	CY	$1,000	$37,000			$37,000
	Slab on grade	17	CY	$1,000	$17,000			$17,000
	Interior walls	1	CY	$1,000	$1,000			$1,000
	Chemical Storage Containment area (interior) and eqiupment pads	5	CY	$1,000	$5,000			$5,000
	Chemical Storage Containment area (exterior)	0	CY	$1,000	$0			$0
	Generator pad	5	CY	$800	$4,000			$4,000
SUBTOTAL - DIVISION 3					**$64,000**		**$0**	**$64,000**
DIVISION 4 - MASONRY/BUILDINGS								
04810	8" CMU with Split Face block veneer	1,000	SF	$75	$75,000			$75,000
SUBTOTAL - DIVISION 4					**$75,000**		**$0**	**$75,000**
DIVISION 5 - METALS								
05500	Miscellaneous Metals - door lintels	500	LB	$6	$3,000			$3,000
SUBTOTAL - DIVISION 5					**$3,000**		**$0**	**$3,000**
DIVISION 6 - WOOD & PLASTICS								
	Prefabricated Roof Trusses	1	LS	$60,000	$60,000			$60,000
	Rough Carpentry: Gable Ends, Blocking, Sheathing, Interior Wall	1	LS	$28,000	$28,000			$28,000
SUBTOTAL - DIVISION 6					**$88,000**		**$0**	**$88,000**
DIVISION 7 - THERMAL & MOISTURE PROTECTION								
	Standing seam Metal Roof	2,000	SF	$18	$36,000			$36,000
	Composite Wall/Ceiling covering, Wall Insulation, Air/Vapor Barrier	1,500	SF	$8	$12,000			$12,000
	Attic and Foundation Insulation	1	LS	$20,000	$20,000			$20,000
	Additional wall insulation	1	LS	$10,000	$10,000			$10,000
SUBTOTAL - DIVISION 7					**$78,000**		**$0**	**$78,000**
DIVISION 8 - DOORS & WINDOWS								
08110	Steel Door and Frames							
	Exterior Insulated Door & Frame - single	1	EA	$2,000	$2,000			$2,000
	Exterior Insulated Door & Frame - double	1	EA	$2,500	$2,500			$2,500
	Interior Door & Frame - single	1	EA	$1,500	$1,500			$1,500
	Interior Door & Frame - double	0	EA	$1,800	$0			$0
SUBTOTAL - DIVISION 8					**$6,000**		**$0**	**$6,000**
DIVISION 9 - FINISHES								
09900	Painting							
	New Building							
	Miscellaneous painting	1,500	SF	$10	$15,000			$15,000
	Wellhouse 2							
	Clean and Paint Door	0	EA	$1,000	$0			$0
	Interior walls and ceiling	0	SF	$11	$0			$0
	Miscellaneous painting	0	SF	$10	$0			$0
09960	Chemical Resistant Coatings	300	SF	$60	$18,000			$18,000
SUBTOTAL - DIVISION 9					**$33,000**		**$0**	**$33,000**
DIVISION 10 - SPECIALTIES								
	Interior Signage	1	LS	$1,000	$1,000		$0	$1,000
SUBTOTAL - DIVISION 10					**$1,000**		**$0**	**$1,000**
DIVISION 11 - EQUIPMENT								
	Booster Pumps	3	EA	$32,465	$97,394	$12,985.8	$38,957	$136,351
	Sodium Hypochlorite Metering Pumps	2	EA	$1,824	$3,647	$1,459	$2,918	$6,565
	Phosphate Metering Pumps	2	EA	$1,800	$3,600	$1,440	$2,880	$6,480
	Soda Ash Metering Pumps	1	EA	$1,824	$1,824	$729	$729	$2,553
SUBTOTAL - DIVISION 11					**$106,465**	**$16,614**	**$45,485**	**$151,949**
DIVISION 12 - FURNISHINGS								
	Shelf and Cabinet	1	EA	$1,000	$1,000			$1,000
SUBTOTAL - DIVISION 12					**$1,000**			**$1,000**
DIVISION 13 - SPECIAL CONSTRUCTION								
	Chlorine Analyzer	1	EA	$5,000	$5,000		$0	$5,000
	pH Analyzer	1	EA	$5,000	$5,000		$0	$5,000
	(2) 1,150 Gal Linear PE Tanks for Potable Water, IMFO	1	LS	$15,000	$15,000	$6,000	$6,000	$21,000
	(1) 500 gallon HDPE Tank	1	LS	$6,900	$6,900	$2,760	$2,760	$9,660
	Instrumentation							
	8" Mag Meter	3	EA	$5,500	$16,500	$2,200	$6,600	$23,100
	Level Transmitter	3	EA	$2,750	$8,250		$0	$8,250
	PLC Programmming and SCADA Integration	1	ALLOW	$30,000	$30,000		$0	$30,000
SUBTOTAL - DIVISION 13					**$86,650**		**$15,360**	**$102,010**
DIVISION 14 - CONVEYING SYSTEMS								
	NOT USED							
SUBTOTAL - DIVISION 14								
DIVISION 15 - MECHANICAL								

Spec. Section	Description	Qty	Units	Material/Installed Cost		Installation		Total
				$/Unit	Total	$/Unit	Total	
	8" Water Main Flanged	30	LF	$100	$3,000	$0	$0	$3,000
	12" Water Main Flanged	30	LF	$120	$3,600		$0	$3,600
	8" Static Mixer with Injector	2	EA	$3,352	$6,705	$1,341	$2,682	$9,386
	8" 90 Degree Bends	4	EA	$1,000	$4,000	$400	$1,600	$5,600
	8" Dresser Coupling	2	EA	$2,000	$4,000	$800	$1,600	$5,600
	8" Butterfly valve	3	EA	$600	$1,800		$0	$1,800
	12" Butterfly Valve	2	EA	$900	$1,800		$0	$1,800
	8" x 8" Tee	2	EA	$800	$1,600		$0	$1,600
	2" Air release valve	1	EA	$942	$942		$0	$942
	12" 90 Degree Bend	2	EA	$1,102	$2,203		$0	$2,203
					$0		$0	$0
	1/2" Tubing to injection point	150	LF	$50	$7,500		$0	$7,500
	PVC Piping to Injection Point	150	LF	$100	$15,000		$0	$15,000
	Sodium Hypochlorite							
	2" PVC Vented Ball Valve	4	EA	$375	$1,500		$0	$1,500
	PVC 4 Function Valve	3	EA	$350	$1,050		$0	$1,050
	1" Y Strainer	2	EA	$450	$900		$0	$900
	1" Flushing Connection with 5/8" Hose Connection	2	EA	$100	$200		$0	$200
	1/2" Flexible Tubing Metering Pump Discharge	4	EA	$100	$400		$0	$400
	2" PVC Unions	2	EA	$50	$100		$0	$100
	1/2" PVC Unions	3	EA	$40	$120		$0	$120
	Calibration Column	1	EA	$700	$700		$0	$700
	Pressure Gauges	1	EA	$700	$700		$0	$700
	Phosphate System							
	2" PVC Vented Ball Valve	4	EA	$375	$1,500		$0	$1,500
	PVC 4 Function Valve	3	EA	$350	$1,050		$0	$1,050
	1" Y Strainer	2	EA	$450	$900		$0	$900
	1" Flushing Connection with 5/8" Hose Connection	4	EA	$100	$400		$0	$400
	1/2" Flexible Tubing Metering Pump Discharge and Day Tank Reliefe Line	5	EA	$100	$500		$0	$500
	2" PVC Unions	2	EA	$50	$100		$0	$100
	1/2" PVC Unions	3	EA	$40	$120		$0	$120
	Calibration Column	1	EA	$700	$700		$0	$700
	Pressure Gauges	1	EA	$700	$700		$0	$700
	Soda Ash System							
	2" PVC Vented Ball Valve	4	EA	$375	$1,500		$0	$1,500
	PVC 4 Function Valve	3	EA	$350	$1,050		$0	$1,050
	1" Y Strainer	2	EA	$450	$900		$0	$900
	1" Flushing Connection with 5/8" Hose Connection	4	EA	$100	$400		$0	$400
	1/2" Flexible Tubing Metering Pump Discharge and Day Tank Reliefe Line	5	EA	$100	$500		$0	$500
	2" PVC Unions	2	EA	$50	$100		$0	$100
	1/2" PVC Unions	3	EA	$40	$120		$0	$120
	Calibration Column	1	EA	$700	$700		$0	$700
	Pressure Gauges	1	EA	$700	$700		$0	$700
	HVAC							
	Exhaust Fans	2	EA	$2,500	$5,000	$0	$0	$5,000
	Louvers	3	EA	$1,150	$3,450	$0	$0	$3,450
	EUH	2	LS	$2,000	$4,000	$0	$0	$4,000
	Controls	1	LS	$6,000	$6,000	$0	$0	$6,000
	Plumbing							
15110	Valves							
	2" Backflow Preventer	1	EA	$1,000	$1,000	$300	$300	$1,300
	3/4" Backflow Preventer	2	LS	$750	$1,500	$300	$600	$2,100
	Valves	1	LS	$2,500	$2,500	$750	$750	$3,250
15140	Domestic Piping and Fittings							
	1/2" Type L Copper Pipe	75	LF	$8	$600	$12	$900	$1,500
	3/4" Type L Copper Pipe	100	LF	$11	$1,100	$12	$1,200	$2,300
	1" Type L Copper Pipe	200	LF	$13	$2,600	$12	$2,400	$5,000
	1 1/4" Type L Copper Pipe	75	LF	$18	$1,350	$15	$1,125	$2,475
	2" Type L Copper Pipe	175	LF	$28	$4,900	$15	$2,625	$7,525
15150	Sanitary Waste/Vent Piping and Fittings							
	2" PVC Pipe	150	LF	$17	$2,550	$20	$3,000	$5,550
	3" PVC Pipe	75	LF	$20	$1,500	$20	$1,500	$3,000
	4" PVC Pipe	200	LF	$30	$6,000	$25	$5,000	$11,000
15410	Plumbing Fixtures							
	Sink	1	EA	$350	$350	$150	$150	$500
	Hose Bibbs	2	EA	$350	$700	$75	$150	$850
	Floor Drain	1	EA	$750	$750	$200	$200	$950
	Cleanout	3	EA	$500	$1,500	$150	$450	$1,950
15411	Emergency Plumbing Fixtures							
	Emergency Shower w/ Eyewash	1	EA	$1,500	$1,500	$225	$225	$1,725
	Emergency Thermostatic Mixing Valve	1	EA	$950	$950	$175	$175	$1,125
15480	Water Heaters	1	EA	$7,000	$7,000	$2,000	$2,000	$9,000
	Fire Protection							
	4" Backflow Preventer	1	EA	$3,600	$3,600	$400	$400	$4,000
15313	Wet system riser and trim	1	EA	$4,000	$4,000		$0	$4,000
	Wet sprinkler system	3,200	SF	$5	$16,000		$0	$16,000
15316	Dry system riser and trim	1	EA	$7,000	$7,000		$0	$7,000
	Dry sprinkler system	3,200	SF	$6	$19,200		$0	$19,200
	Engineering and Design - Allowance	1	EA	$2,500	$2,500		$0	$2,500
SUBTOTAL - DIVISION 15					**$126,560**		**$28,632**	**$207,892**
DIVISION 16 - ELECTRICAL								
	Booster Pump Control Panels	1	LS	$109,394	$109,394		$0	$109,394
	Chemical Feed Pump Control Panels	1	LS	$8,625	$8,625		$0	$8,625
	Well Pump Control Panels	1	LS	$29,613	$29,613		$0	$29,613
	Miscellaneous Pump Controls & Instrumentation	1	LS	$39,675	$39,675		$0	$39,675
	Communications from Old Building	1	LS	$31,646	$31,646		$0	$31,646
16500	Lighting	1	LS	$16,664	$16,664		$0	$16,664
	Generator	1	LS	$119,600	$119,600		$0	$119,600
	Electric Service	1	LS	$51,088	$51,088		$0	$51,088

Spec. Section	Description	Qty	Units	Material/Installed Cost		Installation		Total
				$/Unit	Total	$/Unit	Total	
	Power Distribution Equipment	1	LS	$91,428	$91,428		$0	$91,428
	Pump Power	1	LS	$16,457	$16,457		$0	$16,457
	Soda Ash Electrical	1	LS	$5,750	$5,750		$0	$5,750
SUBTOTAL - DIVISION 16					**$519,940**		**$0**	**$519,940**
SUBTOTAL								**$1,477,916**
General Conditions - Division 1 (15%)								$221,700
Anticipated Bid Price (to nearest thousand)								**$1,700,000**
Contingency (20%)								$340,000
Total Construction Cost								**$2,040,000**
Engineering and Construction Phase Services (20%)								$340,000
Total Project Cost								**$2,380,000**
							Say	**$2,380,000**

Attachment 3

Available Fire Flow Summary Table and Maps (Option 4E)

TABLE 1

Model Predicted Pressure and Available Fire Flow for Various Alternative Water System Pressure Zone Layouts

Hydrant Facility Number	Existing		Option 4A		Option 4B		Option 4C		Option 4D		Option 4E		Option 4F	
	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)	Pressure (psi)	AFF (gpm)
1	111	3,700	111	3,600	74	2,800	111	3,600	111	3,600	111	3,600	111	3,600
2	122	>5,000	122	>5,000	85	>5,000	122	>5,000	122	>5,000	122	>5,000	122	>5,000
3	95	>5,000	95	4,850	58	3,850	95	4,850	95	4,850	95	4,850	95	4,850
4	118	5,000	118	5,000	81	5,000	118	5,000	118	5,000	118	5,000	118	5,000
5	126	>5,000	126	>5,000	88	>5,000	126	>5,000	126	>5,000	126	>5,000	126	>5,000
6	159	5,000	65	4,200	121	5,000	65	4,200	65	4,200	65	4,200	65	4,200
7	141	>5,000	141	>5,000	103	>5,000	141	>5,000	141	>5,000	141	>5,000	141	>5,000
8	160	5,000	67	4,450	123	5,000	67	4,450	67	4,450	67	4,450	67	4,450
9	169	>5,000	75	>5,000	131	>5,000	75	>5,000	75	>5,000	75	>5,000	75	>5,000
10	186	>5,000	92	4,050	148	>5,000	92	4,050	92	4,050	92	4,050	92	4,050
11	80	2,200	80	2,200	43	1,150	80	2,200	80	2,200	80	2,200	80	2,200
11A	74	2,050	74	2,050	37	1,100	74	2,050	74	2,050	74	2,050	74	2,050
12	92	2,550	92	2,550	55	1,350	92	2,550	92	2,550	92	2,550	92	2,550
12A	87	2,450	87	2,450	50	1,350	87	2,450	87	2,450	87	2,450	87	2,450
13	118	4,050	118	4,050	81	2,250	118	4,050	118	4,050	118	4,050	118	4,050
14	136	4,350	136	4,300	98	2,450	136	4,300	136	4,300	136	4,300	136	4,300
15	161	4,800	161	4,750	123	2,700	161	4,750	161	4,750	161	4,750	161	4,750
16	186	4,400	94	1,750	148	2,900	94	1,750	94	1,750	94	1,750	94	1,750
17	186	5,000	186	5,000	149	5,000	186	5,000	186	5,000	186	5,000	186	5,000
18	176	>5,000	176	>5,000	138	>5,000	176	>5,000	176	>5,000	176	>5,000	176	>5,000
19	188	4,600	95	2,950	151	4,100	95	2,950	95	2,950	95	2,950	95	2,950
20	189	4,800	96	3,150	152	4,350	96	3,150	96	3,150	96	3,150	96	3,150
21A	190	>5,000	190	>5,000	152	>5,000	152	>5,000	152	>5,000	190	>5,000	190	>5,000
22	181	>5,000	181	>5,000	144	>5,000	144	>5,000	144	>5,000	144	>5,000	144	>5,000
23	165	4,900	165	4,900	128	4,300	128	4,550	128	4,550	128	4,600	128	4,600
24	157	3,850	157	3,850	120	3,350	120	3,450	120	3,450	121	3,550	121	3,550
25	157	3,850	157	3,850	120	3,350	120	3,450	120	3,450	121	3,550	121	3,550
26	164	3,800	132	2,750	126	3,300	126	3,400	126	3,400	127	3,500	127	3,500
27	176	5,000	144	3,200	138	5,000	138	5,000	138	5,000	139	5,000	139	5,000
28	145	>5,000	145	>5,000	108	>5,000	107	>5,000	107	>5,000	108	>5,000	108	>5,000
29	119	3,350	119	3,300	81	2,300	81	2,450	118	1,400	82	2,550	119	3,050
30	114	2,600	114	2,600	77	2,000	77	2,100	114	1,400	78	2,150	114	2,500
31	111	2,550	111	2,550	74	1,750	74	1,800	111	1,300	74	1,850	111	2,400
32	91	2,050	91	2,050	54	1,400	53	1,450	91	1,200	54	1,450	91	2,000
33	150	>5,000	150	>5,000	112	>5,000	112	>5,000	112	>5,000	113	>5,000	113	>5,000
34	142	>5,000	142	>5,000	104	4,550	104	>5,000	104	>5,000	105	4,950	105	5,000
35	134	4,850	134	4,800	96	3,850	96	4,200	96	4,200	97	4,400	97	4,400
36	148	5,000	148	5,000	110	4,200	110	4,650	110	4,650	111	4,700	111	4,700
37	159	5,000	159	5,000	122	4,550	121	5,000	121	5,000	122	5,000	122	5,000
38	111	3,100	111	3,050	73	2,350	73	2,450	73	2,450	74	2,550	74	2,550
39	119	3,350	119	3,350	82	2,600	82	2,700	82	2,700	82	2,800	82	2,800
40	138	3,800	138	3,750	101	3,150	100	3,300	100	3,300	101	3,400	101	3,400
41	173	2,850	141	3,450	136	2,500	136	2,550	136	2,550	136	2,550	136	2,550
42	165	2,150	133	3,750	128	1,850	128	1,850	128	1,850	128	1,850	128	1,850
44	181	>5,000	149	3,200	143	>5,000	143	>5,000	143	>5,000	144	>5,000	144	>5,000
45	177	5,000	145	3,250	140	5,000	139	5,000	139	5,000	140	5,000	140	5,000
46	175	>5,000	143	3,100	137	>5,000	137	>5,000	137	>5,000	138	>5,000	138	>5,000
47	165	5,000	133	3,250	127	5,000	127	5,000	127	5,000	128	5,000	128	5,000
48	179	>5,000	147	3,050	142	>5,000	142	>5,000	142	>5,000	142	>5,000	142	>5,000
49	178	>5,000	146	3,250	140	>5,000	140	>5,000	140	>5,000	141	>5,000	141	>5,000
50	174	1,750	174	1,750	137	1,500	174	1,700	174	1,500	174	1,750	174	1,750
51	164	2,150	164	2,150	127	1,850	164	2,100	164	1,750	164	2,150	164	2,150
52	162	2,200	162	2,200	124	1,850	162	2,200	161	1,750	162	2,200	162	2,200
53	152	2,300	152	2,300	114	1,950	152	2,250	152	1,800	152	2,300	152	2,300
54	153	1,950	153	1,950	115	1,600	153	1,900	153	1,600	153	1,950	153	1,950
55	153	1,850	153	1,850	116	1,550	153	1,800	153	1,500	153	1,850	153	1,850
56	152	1,650	152	1,650	114	1,400	152	1,650	152	1,400	152	1,650	152	1,650
57	154	1,550	154	1,550	116	1,300	154	1,550	153	1,350	154	1,550	154	1,550
58	165	1,950	165	1,950	128	1,700	165	1,950	165	1,650	165	1,950	165	1,950
59	175	1,950	175	1,950	138	1,700	175	1,950	175	1,650	175	1,950	175	1,950
60	169	2,000	169	2,000	132	1,700	169	2,000	169	1,650	169	2,000	169	2,000
61	188	5,000	188	5,000	150	5,000	150	5,000	150	5,000	188	5,000	188	5,000
62	188	5,000	188	5,000	150	5,000	150	5,000	150	5,000	188	5,000	188	5,000
Unknown	161	5,000	161	5,000	124	5,000	123	5,000	123	5,000	124	5,000	124	5,000

1. Predicted results for pressure and available fire flow were calculated using a hydraulic model of Aquarion Water Company's Rosebook water distribution system. The results shown are based on the results calculated at the nearest model node located within at least 500 ft and 12 ft elevation from the hydrant lateral connection point. Predicted pressure and flow are based on various assumptions in the model as to pump status, tank level, water main condition, and demand distribution. As actual field conditions may vary from those assumed in the model, field measurements may differ from the calculated values shown here. Differences between the model and field-observed values may result in the need to alter pressure reducing valve set points in order to achieve target pressures and available fire flow.

2. Available Fire Flow (AFF) was calculated using a 20-psi minimum pressure constraint at the flowing node, and a 20-psi minimum pressure constraint at all other nodes in the system.

FIGURE 1
ROSEBROOK WATER SYSTEM HYDRANT ID

Legend

- Well
- Water Tank
- Hydrant

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

LOCUS MAP

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)

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Rosebrook Water System
Carroll, NH
Aquarion Water Company

May 2022

Tighe&Bond

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Hannah Loop PRV
Reduced Pressure Zone

River's Edge PRV
Reduced Pressure Zone

Forest Cottage PRV
Reduced Pressure Zone

Hannah Loop PRV
Reduced Pressure Zone

FIGURE 2
OPTION 4E
PRESSURE ZONE LAYOUT

Legend

- Well
- Water Tank
- Hydrant
- Alternative PRV
- New 8-in Low Pressure Main
- New 12-in Low Pressure Main
- Reduced Pressure Zone

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

LOCUS MAP

N

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)

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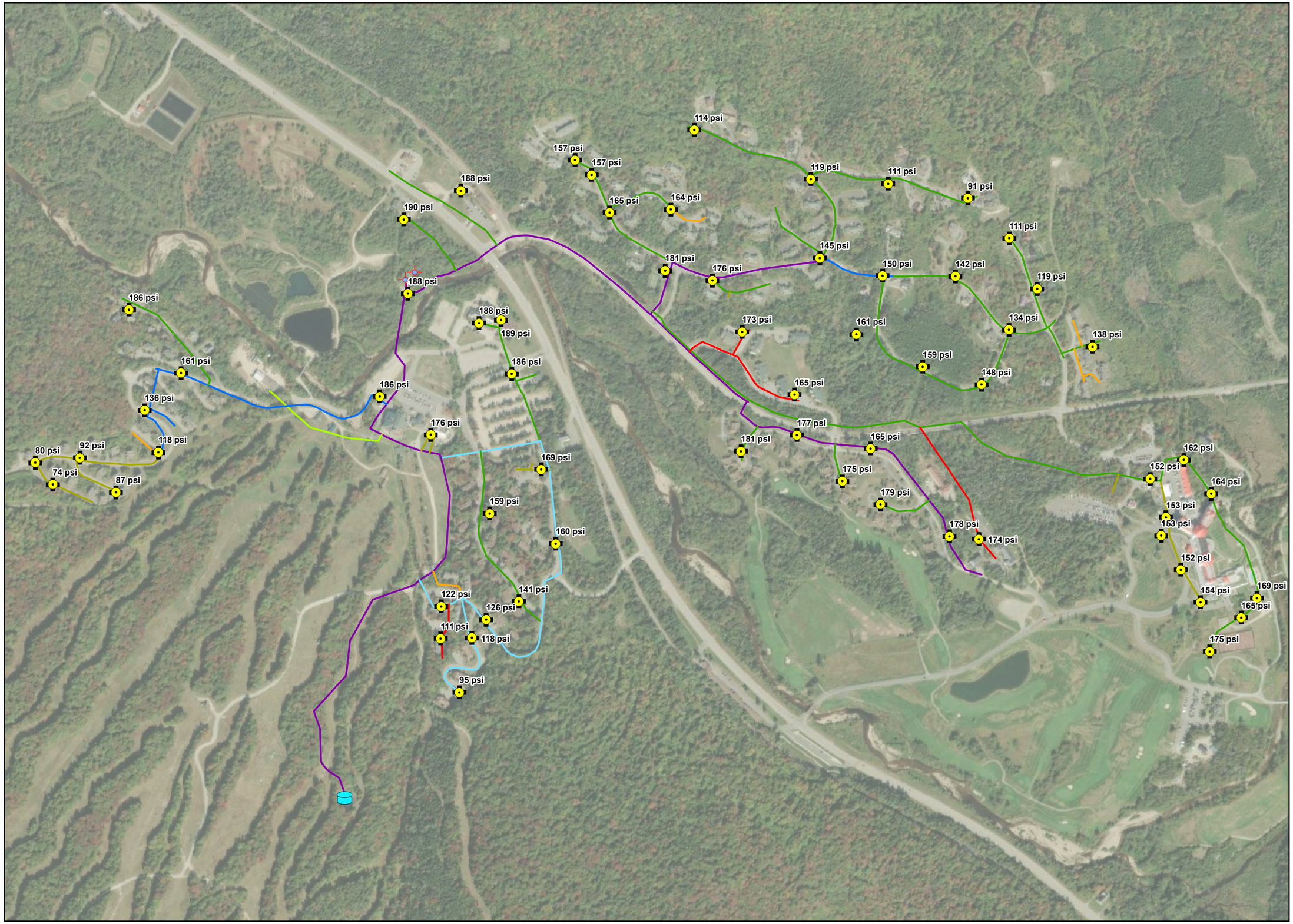
R-1000

FIGURE 3
MODELED EXISTING SYSTEM PRESSURE



Legend

- Well
- Water Tank
- Hydrant

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

LOCUS MAP

N

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)
3. Pressure and AFF results based on model assumptions and may differ from actual field conditions.

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Aquarion Water Company

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FIGURE 4
MODELED EXISTING AVAILABLE FIRE FLOW

Legend

- Well
- Water Tank

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

Modeled AFF (gpm)

- ≤500
- >500 and ≤1,000
- >1,000 and ≤1,500
- >1,500 and ≤3,500
- >3,500

LOCUS MAP

N

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)
3. Pressure and AFF results based on model assumptions and may differ from actual field conditions.

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Carroll, NH
Aquarion Water Company

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FIGURE 5
MODELED PRESSURE
OPTION 4E

Hannah Loop 12-in PRV
150 psi Outlet

River's Edge 4-in PRV
80 psi Outlet

Forest Cottage 8-in PRV
80 psi Outlet

78 psi
121 psi
121 psi
188 psi
190 psi
128 psi
127 psi
82 psi
74 psi
54 psi
74 psi
144 psi
139 psi
108 psi
113 psi
105 psi
82 psi
188 psi
94 psi
95 psi
96 psi
136 psi
124 psi
97 psi
101 psi
161 psi
92 psi
122 psi
111 psi
186 psi
128 psi
136 psi
176 psi
140 psi
144 psi
128 psi
118 psi
92 psi
80 psi
74 psi
87 psi
75 psi
138 psi
142 psi
65 psi
67 psi
141 psi
174 psi
162 psi
152 psi
164 psi
153 psi
153 psi
152 psi
169 psi
154 psi
165 psi
122 psi
126 psi
141 psi
111 psi
118 psi
175 psi
95 psi

Legend

- Well
- Water Tank
- Hydrant
- Alternative PRV
- New 8-in Low Pressure Main
- New 12-in Low Pressure Main
- Alternative Pressure Zone

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

LOCUS MAP

N

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)
3. Pressure and AFF results based on model assumptions and may differ from actual field conditions.

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N-1000

Hannah Loop 12-in PRV
150 psi Outlet

River's Edge 4-in PRV
80 psi Outlet

Forest Cottage 8-in PRV
80 psi Outlet

2,131 gpm
3,562 gpm
3,562 gpm
2,573 gpm
1,855 gpm
1,466 gpm
4,602 gpm
3,509 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
2,541 gpm
4,974 gpm
2,809 gpm
1,740 gpm
2,964 gpm
3,134 gpm
2,559 gpm
≥5,000 gpm
4,416 gpm
3,418 gpm
4,726 gpm
4,052 gpm
≥5,000 gpm
≥5,000 gpm
4,692 gpm
1,873 gpm
4,313 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
1,727 gpm
4,029 gpm
2,525 gpm
2,216 gpm
2,059 gpm
2,444 gpm
2,212 gpm
2,302 gpm
2,151 gpm
1,938 gpm
1,833 gpm
1,672 gpm
1,556 gpm
2,000 gpm
1,967 gpm
1,970 gpm
≥5,000 gpm
4,206 gpm
4,434 gpm
≥5,000 gpm
≥5,000 gpm
≥5,000 gpm
3,616 gpm
≥5,000 gpm
4,861 gpm

FIGURE 6
MODELED AVAILABLE FIRE FLOW OPTION 4E

Legend

- Well
- Water Tank
- Alternative PRV
- New 8-in Low Pressure Main
- New 12-in Low Pressure Main
- Alternative Pressure Zone

Water Mains Size (in)

2, 4, 6, 8, 10, 12, 16, Unknown

Modeled AFF (gpm)

- ≤500
- >500 and ≤1,000
- >1,000 and ≤1,500
- >1,500 and ≤3,500
- >3,500

LOCUS MAP

N

0 300 600
Feet
1:7,200 1 in = 600 ft

NOTES

1. Orthophotography courtesy of ESRI
2. Water system GIS provided by Aquarion Water Company (2022)
3. Pressure and AFF results based on model assumptions and may differ from actual field conditions.

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Carroll, NH
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2023 Financing with NH DWGTF - Rosebrook Pressure Reduction Project (Phase I)

Plant / Accumulated Depreciation / Depreciation Expense

PUC Account	Item	Total Estimated Costs	Depr Rate	Annual Depr Exp	One-Half Year Depr	Net Book Value	Tax Value as Percent NetUtilPlant	Combined Property Tax Rate	Annual Prop Tax Expense
304	Building Structure	$ 567,680	2.50%	$ 14,192	$ 7,096	$ 560,584	100.00%	12.12	$ 6,794
304	Site Work/Gravel Drive	$ 125,533	2.50%	$ 3,138	$ 1,569	$ 123,964	100.00%	12.12	$ 1,502
304	Electrical	$ 943,679	2.50%	$ 23,592	$ 11,796	$ 931,883	100.00%	12.12	$ 11,294
304	HVAC/Mechanical	$ 544,228	2.50%	$ 13,606	$ 6,803	$ 537,425	100.00%	12.12	$ 6,514
304	Control Equipment & Integration	$ 86,445	2.50%	$ 2,161	$ 1,081	$ 85,364	100.00%	12.12	$ 1,035
311	Pumping Equipment	$ 326,837	10.00%	$ 32,684	$ 16,342	$ 310,495	100.00%	12.12	$ 3,763
311	Station Piping & Valves	$ 197,245	10.00%	$ 19,724	$ 9,862	$ 187,383	100.00%	12.12	$ 2,271
320	Chemical Feed Equipment/Piping	$ 210,324	10.00%	$ 21,032	$ 10,516	$ 199,808	100.00%	12.12	$ 2,422
331	Water Mains	$ 194,839	2.00%	$ 3,897	$ 1,948	$ 192,891	100.00%	12.12	$ 2,338
335	Hydrants & Valves	$ 114,859	2.00%	$ 2,297	$ 1,149	$ 113,710	100.00%	12.12	$ 1,378
	Total Construction Costs	$ 3,311,670		$ 136,324	$ 68,162	$ 3,243,508			$ 39,311
	NHDWGTF Grant	$ (280,000)							
	Total Project Costs	$ 3,031,670		$ 136,324	$ 68,162	$ 3,243,508			$ 39,311

2023 Financing with NH DWGTF - Rosebrook Pressure Reduction Project (Phase I)

Preliminary Calculation of Revenue Requirement

Total Plant Additions	$	3,311,670
Less: 1/2 Year Depreciation		(68,162)
Total Net Plant	$	3,243,508
Total CIAC	$	(280,000)
Less: 1/2 Accum Amort of CIAC		5,763
Total Net CIAC	$	(274,237)
Total Net Addition of Rate Base	$	2,969,271
Rate of Return		3.17%
Increase in Net Operating Income Requirement	$	94,126
Increase in Operating Expenses:		
Operating & Maintenance		
Depreciation Expense		136,324
Amorization of CIAC		(11,526)
Taxes other than Income		39,311
Increase in Revenue Requirement	$	258,235
2022 Billed Rosebrook Water Revenues	$	333,351
% Increase in Annual Water Revenues		77.47%

2023 Financing with NH DWGTF - Rosebrook Pressure Reduction Project (Phase I)

CIAC / Accumulated Amortization / Amortization of CIAC

PUC Account	Item	Total Estimated Costs	Depr Rate	Annual Depr Exp	One-Half Year Depr	Net Book Value
304	Building Structure	$ 47,997	2.50%	$ 1,200	$ 600	$ 47,397
304	Site Work/Gravel Drive	$ 10,614	2.50%	$ 265	$ 133	$ 10,481
304	Electrical	$ 79,788	2.50%	$ 1,995	$ 997	$ 78,790
304	HVAC/Mechanical	$ 46,014	2.50%	$ 1,150	$ 575	$ 45,439
304	Control Equipment & Integration	$ 7,309	2.50%	$ 183	$ 91	$ 7,218
311	Pumping Equipment	$ 27,634	10.00%	$ 2,763	$ 1,382	$ 26,252
311	Station Piping & Valves	$ 16,677	10.00%	$ 1,668	$ 834	$ 15,843
320	Chemical Feed Equipment/Piping	$ 17,783	10.00%	$ 1,778	$ 889	$ 16,894
331	Water Mains	$ 16,474	2.00%	$ 329	$ 165	$ 16,309
335	Hydrants & Valves	$ 9,711	2.00%	$ 194	$ 97	$ 9,614
	Total CIAC/NH Drinking Water Groundwater Trust Fund Grant	$ 280,000		$ 11,526	$ 5,763	$ 274,237

NH Drinking Water Groundwater Trust Fund Grant	$ 280,000

2023 Financing with NH DWGTF - Rosebrook Pressure Reduction Project (Phase I)

Estimated Cost and Cost Allocation for Phase 1

Item	Total Esimated Costs	Indirect Cost Allocation Percentage	Allocation of Indirect Costs	Total Adjusted Costs
Building Structure	$ 377,600	17.1%	$ 190,080	$ 567,680
Site Work/Gravel Drive	$ 83,500	3.8%	$ 42,033	$ 125,533
Electrical	$ 627,700	28.5%	$ 315,979	$ 943,679
HVAC/Mechanical	$ 362,000	16.4%	$ 182,228	$ 544,228
Control Equipment & Integration	$ 57,500	2.6%	$ 28,945	$ 86,445
Pumping Equipment	$ 217,400	9.9%	$ 109,437	$ 326,837
Station Piping & Valves	$ 131,200	6.0%	$ 66,045	$ 197,245
Chemical Feed Equipment/Piping	$ 139,900	6.4%	$ 70,424	$ 210,324
Water Mains	$ 129,600	5.9%	$ 65,239	$ 194,839
Hydrants & Valves	$ 76,400	3.5%	$ 38,459	$ 114,859
Total Direct Costs	**$ 2,202,800**		**$ 1,108,870**	**$ 3,311,670**
Contractor General Conditions/Mobilization/Insurance & Bonds	$ 564,900		$ (564,900)	$ -
Incurred to date	$ 254,770		$ (254,770)	$ -
Construction Administration & Inspection	$ 180,000		$ (180,000)	$ -
Aquarion Labor & Overhead	$ 109,200		$ (109,200)	$ -
Total Indirect Costs	**$ 1,108,870**		**$ (1,108,870)**	**$ -**
Total Project Cost	**$ 3,311,670**		**$ -**	**$ 3,311,670**
Less: NH Drinking Water Groundwater Trust Fund Grant	$ (280,000)			$ (280,000)
Net Project Cost	**$ 3,031,670**			**$ 3,031,670**

The State of New Hampshire
Department of Environmental Services

Robert R. Scott, Commissioner

July 26, 2022

Amanda Keyes, PE
Tighe & Bond
177 Corporate Drive
Portsmouth, NH 03801
via email: apkeyes@tighebond.com

Subject: Rosebrook Water Company PWS 0382010
Wellfield Improvements (Phase 1 of the Pressure Reduction Project)
Design Review #170093

Dear Ms. Keyes:

The New Hampshire Department of Environmental Services Drinking Water and Groundwater Bureau (DWGB) has reviewed the preliminary design documents dated July 2022 for the subject project. I performed a review of the project in accordance with the design standards for large public water systems listed under Env-Dw 404 and referencing the Recommended Standard for Water Works. DWGB offers the following comments.

1. Provide an argument that the costs of Option 1A exceeds the benefit of reducing the pressures within the system to 100 psi, or other reasoning that Option 1A should not be selected over 4E, apart from maintaining existing pressure along the base road water service main.
2. Has the option of providing dedicated fire flow pumps at the well treatment station for services to the Omni properties been considered?
3. The flow meters on Drawings M-100 and M-101 are specified to have straight pipe runs before and after. However, I do not believe that reducers placed within the straight run are allowed, as shown.
4. The Water System Improvements Notes:
    a. Drawing G-003 indicate under note 9 that less than 10-feet horizontal separation between water and storm or sewer drains “will be allowed”. This is not allowed without an approved waiver from DES. Recommend submitting a waiver request or changing the wording to "will be considered".
    b. Note 4 indicates 5 feet of cover, which contradicts with the site details on drawing C-501 which indicates 4-feet and 6-inches of cover.
5. The AWWA disinfecting of water mains procedure requires a minimum flushing velocity of 3 ft/sec. Recommend changing the specifications to match the latest AWWA procedures.
6. Not mentioned in the Notes or specifications is the plugging of hydrant drains, which is required unless a waiver is submitted for approval and contains evidence of the high-groundwater elevation below the hydrant drain.

7. The design flows for each of the pumps are as follows, please provide design calculations for the flow rate of the booster pumps.
    a. Well pump No. 1 design flow is 300 gpm.
    b. Well pump No. 2 design flow is 350 gpm.
    c. Three booster pumps are sized for 125 gpm.
8. Submit electronic copies of the engineered stamped final design Plans and Specifications to this department for review prior to bidding this project, which should include all required documentation for the funding source(s), which at this time is the Drinking Water and Groundwater Trust Fund (DWGTF).

Upon satisfactory response to these comments, DES approves this project for construction by meeting drinking water design review requirements. If you have any questions or comments please contact me at 603-271-1746 or Randal.A.Suozzo@des.nh.gov.

Sincerely,

Randal A. Suozzo, P.E.
Drinking Water and Groundwater Bureau

ec: Robert Gallo, John Walsh, Daniel Lawrence, Carl McMorran; Aquarion Water Company
Peter Galant; Tighe & Bond