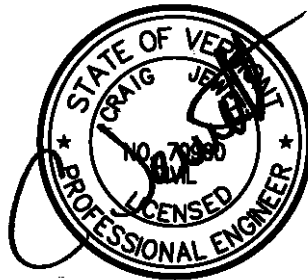




WOODSTOCK AQUEDUCT COMPANY

WATER SYSTEM HYDRAULIC MODEL DEVELOPMENT, EVALUATION, AND REPORT

WOODSTOCK, VERMONT



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WATER SYSTEM HYDRAULIC MODEL DEVELOPMENT, EVALUATION, AND REPORT
EXECUTIVE SUMMARY**

**WOODSTOCK, VT
2023**

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1.0 BACKGROUND/EXISTING CONDITIONS

- a. **Statement of Purpose:** The purpose of this hydraulic model is to accurately depict how the water system hydraulically operates, characterize the current fire flow availability throughout the system, and to use as a planning tool for future water distribution system improvements.
- b. **Previously Completed:** This hydraulic model is an update to the most current model which was completed in 2009.
- c. **General System Description:** The Woodstock Aqueduct Company's (WAC) primary water supply comes from two separate wells, located north of the village and off of Route 12. These wells are identified as Well 001 and Well 005. Though the system has three permitted sources, these are the only two currently in use.

From these wells, water is pumped into the system and to the 948,000 gallon tank which floats within the system. The level in the tank is controlled through timers to fit with daily usage, so their run times are constantly adjusted. Based on current demands, this means that Well 001 is run from 4 am to 10 pm, and Well 005 is run from 5 pm to 11 am. The finished water tank establishes the hydraulic grade line for the entire water system, though, the system has been recently operating with the well pumps running more frequently (up to 18 hours a day) to increase system pressures and flow availability. The water system is comprised of a single pressure zone.

The distribution system's general makeup of the piping type, size, and part of the whole system is outlined below in **Table 1**. Refer to **PER Figure 1 and 2** for further information on the water system.

Table 1 Distribution Piping Summary

Diameter	Material	Length (ft)	% of System
1	Copper	372	0.40%
1.5	Ductile Iron	134	0.15%
	Galvanized Iron	584	0.64%
2	Ductile Iron	2,270	2.47%
	Galvanized Iron	1,553	1.69%
4	Ductile Iron	30,309	32.94%
6	PVC	2,412	2.62%
	Ductile Iron	6,688	7.27%
	Asbestos Concrete	414	0.45%
8	PVC	10,185	11.07%
	Ductile Iron	29,473	32.03%
	Steel	1,503	1.63%
12	Ductile Iron	6,115	6.65%

- d. **System Demands:** The Vermont Water Supply Rule states that public water systems should have the ability to meet the average day demand (ADD) over a 12-hour period. WAC's water

sources have a combined permitted source capacity of 474 gallons per minute (gpm), which when pumped for 12 hours equals 341,280 gallons, and is the system Maximum Daily Demand (MDD). The sources that the system use currently only account for 353 gpm of the MDD, which equals 254,160 gpd. This exceeds the current system demand (based on the master meter data of the last three years) of 235,794 gpd by 8%.

- e. **Current Water Storage and Configuration:** As outlined above in the system description, the system operates a single water storage tank. Water is pumped from the wells, through chlorine injection points at each well, and into the finished water tank which has a volume of 948,000 gallons. Water elevations and related storage volumes for the finished water storage tank are shown below in **Table 2**.

Table 2 Finished Water Tank Elevations and Volumes

Unit	Elevation (ft)	Height Above Finished Floor (ft)	Volume (gal)
Overflow	955.5	31.5	905,203
Outlet Pipe	924	N/A	0
Finished Floor	924	N/A	0
Over 20 PSI at Highest Elev. in Distribution System	925	1	28,737
Low Level	952	28	804,625

The minimum for fire flow capacity is the ability to flow 3,000 gpm for 3 hours, while also holding one day's worth of water storage. The 3,000 gpm for 3 hours aspect comes from the systems ISO report, which is included in **PER Appendix F**. These storage values equate to 540,000 gallons for fire flow and the systems permitted ADD of 341,280 gallons.

The system currently operates the storage tank to maintain a level of at least 28' above the finished floor, and will typically keep that level between 28'-31.'

- f. **System Pressures:** There is a single pressure zone for the WAC's water system. This pressure is directly related to the water elevation in the finished water storage tank, and the well pump's when active. With the tank at its low operating level of 28' the pressures in this zone range from 123 pounds per square inch (psi), down to 38 psi. These generally correspond to the lowest and highest service locations. The highest pressure is at the sewer plant on Maxham Meadow Way, at an elevation of 668'. The lowest pressure is at the intersection of Shurtleff Lane and Prospect Street, at an elevation of 865'.
- g. **Fire Flow Requirements:** The water system was given the Public Protection Classification of 07/7X in the most recent Insurance Services Office (ISO) report, which was produced July 2016. The ISO is an organization which evaluates a community's ability to combat structure fire and is used for rate setting by insurance companies. The report set a basic fire flow for the system of 3,000 gpm. During their investigation, thirteen (13) hydrants in differing locations of the system were analyzed for needed and available fire flows at a residual of 20 psi at that particular hydrant. The highest of these needed flows was 4,000 gpm near Pleasant Street. A summary of these hydrant tests and their needed and available fire flows are shown in **Table 3** below. It is assumed

that these tests were done while the wells were on, and likely when all three sources were being operated (as opposed to just the two as they operate now).

Table 3 ISO Report Fire Flow Test Results

Test No.	Test Location	Flow (GPM)		Flow at 20 psi		Pressure	
		Individual Hydrants	Total	Needed	Avail.	Static	Resid.
1	Taftsville Near Pleasant Rd	500	500	4,000	800	115	73
10	Pleasant Near Central	820	820	1,750	1,100	115	62
10A	Pleasant Near Central	820	820	1,000	1,100	115	62
1A	Taftsville Near Pleasant Rd	500	500	1,750	800	115	73
2	Central Near Elm	1,010	1,010	3,500	1,300	117	59
3	Elm St near Billings Mus.	1,060	1,060	3,000	1,200	115	40
4	High St Near Cross	530	530	1,750	1,200	115	95
5	South St Near C.C.	400	400	2,250	1,100	108	94
6	Church St Near St. James	820	820	2,500	1,000	110	52
7	Rte4 West Near High School	890	890	4,000	1,100	100	50
7A	Rte4 West Near High School	890	890	3,000	1,100	100	50
8	River St Near Union	480	480	1,000	700	120	68
9	School St South St	950	950	2,250	1,100	113	42

For flows equal to or greater than 3,000 gpm, ISO recommends a fire flow duration of three (3) hours. **Table 4** below shows water storage volume requirements for a range of required fire flows in the system.

Table 4 Fire Flow Volumes

Recommended Fire Flow (gpm)	3,000	2,000	1,000	500
Minimum Recommended Flow Duration (hours)	3	2	1	0.5
Required Fire Storage Volume (gallons)	540,000	240,000	60,000	15,000

Considering the need to hold 1 day of storage for use and 540,000 gallons for a 3,000 gpm 3-hour fire, the minimum required overall storage for the system (including ADD) is 775,794 gallons, which is more than covered by what the system currently has for storage.

2.0 EVALUATION

- a. **Modeling Basics:** The modeling program used for this evaluation is the KYPipe Pipe 2022 program (Developed by KY Pipe LLC). This software requires initial conditions, such as demands on the system (water use), pumps (well and booster pumps), water storage tanks and reservoirs, valves and their status (open, closed, check valve etc.), and pipes with their type, diameter, age, and roughness. The points at which pipes connect are junctions, and demands are assigned at these junctions.

For modeling, a reservoir or tank is needed as there must be input water to the system. Once this is connected to the pipe network, the model can be run in a steady-state scenario. This means that the results are based on a single moment in time. This is useful for determining best-case scenarios for pressure and fire flow availability. A more accurate representation of the system requires demands be applied, and further, an Extended Period Simulation (EPS) would need to be run.

An EPS would simulate the system over a predetermined amount of time, using real usage info over the course of days, months, or seasons. This allows for altering input demands to account for peak usage times (say mornings and afternoons), and low usage times (late night to early morning). This can also be adjusted by season as water usage/demands change from summer to winter.

The model produced for this report only applied demands, which were then analyzed in a steady-state scenario.

- b. **Existing Demand Modeling:** To best represent the water system as it operates currently, demands were applied to over 125 junction nodes within the model. The demand was based on the highest usage year from the last three years of master meter data (water leaving the finished water tank and entering the system). This data was equal to an MDD of 342 gpm. Dividing demand by the total number of junctions, yields approximately 2.74 gpm per junction. This demand was applied to all the junctions evenly. Since higher use areas (think building and road intersection density) would have more junctions, this was thought to accurately represent the system's demands. The existing demand's MDD was used only to calibrate the model, as this would be necessary to most accurately represent the system as it currently operates.
- c. **Demand Projections:** Although Woodstock's population in general has trended downward, potential expansion of the water system to unserved areas and incoming population not reflected by the census due to the Covid-19 Pandemic is being considered for the projection of future demands.
- d. **Existing Water System Service Area:** The existing service area is shown in **PER Figure 1**.
- e. **Storage Requirements:**
- i. **System Demand Storage and Peak Flow Equalization:** For the past three years the system has had a metered ADD value of 235,794 gallons and an MDD value of 300,330 gallons. This MDD is based off reported monthly flows and corresponds to February

2021. This peak value occurred during a month in which the water system reported three separate water main leak repairs, so this value likely isn't indicative of actual usage numbers but should be considered a conservative estimate of peak usage in the system. Negating months with documents leak repairs, the peak month is generally July-September 2021 with an MDD of 269,844. The peak value of 300,330 translates to a water system peaking factor of 1.3.

For development of the existing model, the water level in the tank was set at the lowest point of its operational range, which translated to a water height of 28' and volume storage value of 804,625 gallons.

- ii. **Emergency Storage:** The Water Supply Rule requires that public water systems with hydrants maintain at least a minimum of one day's average daily water use plus the required volume to fight the largest fire to be fought through the entire water system. With an average ADD of 235,794 gallons and 540,000 gallons needed to supply 3,000 gpm for 3 hours, this total comes to 775,794 gallons. The finished water tank at 948,000 gallons supplies 122% of what is required.
- iii. **Fire Flow Protection:** The system currently has 96 fire hydrants spread throughout the system, while most are centered along the Woodstock Village core which corresponds to the most densely populated part of the system. Shown below in **Tables 5 and 6** is the fire flow availability breakdown of the hydrants when the well pumps are on. This is important to note as the system currently operates with well pumps running 18 hours a day to meet demand. The fire flow values represent the highest gpm you can pull out of any given hydrant while maintaining at least 20 psi throughout the distribution system.

Table 5 Hydrant Fire Flow Highlights with Well Pumps On

		Note
Max gpm	1,272	
Max gpm Hydrant	H-60	Below Water Tank
Min gpm	187	
Min gpm Hydrant	H-32	South Street at Dead End
Average Fireflow (gpm)	562	

Table 6 Fire Flow Availability with Well Pumps On

NFPA Color	Red	Orange	Green	Blue
GPM	(<500)	(500 - 1,000)	(1,000 - 1,500)	(1,500<)
Hydrants	23	72	1	0
% of Total	24.0%	75.0%	1.0%	0.0%

The hydrant that can provide the highest flow is located just below the finished water storage tank on the 8-inch water main and can provide 1,272 gpm while maintaining 20 psi throughout the system. The least flowable hydrant is located in the Village on South Street at the dead end of the 4-inch line with a high roughness value providing only 207 gpm. In total, 23 hydrants on the system provide less than 500 gpm. Of these 23 hydrants, most are on mains which are less than 8-inches in diameter.

Shown in **Tables 7 and 8** are the fire flow results when the well pumps are off. This would represent a worst case scenario situation when the available water is only from the storage tank. As can be seen, almost none of the hydrants can provide 500 gpm while maintaining at least 20 psi throughout the system in this scenario.

Table 7 Hydrant Fire Flow Highlights with Well Pumps Off

		Note
Max gpm	760	
Max gpm Hydrant	H-60	Below Water Tank
Min gpm	150	
Min gpm Hydrant	H-32	South Street at Dead End
Average Fireflow (gpm)	335	

Table 8 Hydrant Flow Availability with Well Pumps Off

NFPA Color	Red	Orange	Green	Blue
GPM	(<500)	(500 - 1,000)	(1,000 - 1,500)	(1,500<)
Hydrants	95	1	0	0
% of Total	99.0%	1.0%	0.0%	0.0%

Refer to **Appendix A** for a complete table of the hydrants which cannot provide at least 500 gpm while maintaining 20 psi throughout the system. This table also shows what the available fire flow is at those hydrants with both the well pumps on and off. It would be our recommendation these hydrants be made aware to the Fire Department, and if any of these hydrants are to be used for any reason that the Division be notified and a boil water notice be given.

- iv. **Dead Storage/Unusable Volumes:** While not necessarily a dead storage or unusable volume, there is a height of water which must be maintained in the tank to keep a pressure of 35 psi throughout the distribution system. This height is 21.9' and is equivalent to a storage value of 629,332 gallons, or 66% of the tanks total volume.
- f. **Distribution System Development:** The hydraulic model was built by exporting the older WaterCAD model and updating it based on the most recent projects and information from the water system operators. The updates mostly consisted of the 8-inch loop which was constructed on Carlton Hill Road and College Hill Road.

Pipe roughness values were assigned to pipes based on their installation year as described by the water system. The dates of installation were given as ballpark values but should generally represent when pipes were installed +/- 10 years for the older pipes. This variation is acceptable as the pipes at 100+ years old will have a similarly low C factor value.
- g. **Data Collection:** In order to calibrate the model, hydrant flow testing was conducted throughout the system. In conjunction with the hydrant flow testing, five pressure recorders were placed throughout the system. The locations of these recorders, and of the hydrant tests

themselves, can be found in **PER Figure 3**. These locations were generally chosen as they were evenly distributed throughout the system and were in areas where hydrant flushing could be easily done without hindering the public.

Before the pressure recorders were placed, they were programmed to begin recording at a determined time and to record values at 2-second intervals. Once programmed, the pressure recorders were attached to the hydrants but not before they had been flushed to ensure any particles that were in the hydrant could not enter the pressure recorder and hinder its measurements. Once the recorders were attached to the hydrants, those specific hydrants were opened and left open until all the hydrant flow tests had been completed.

The tests were done over the course of two days, with the first day of tests done with the well pumps manually turned off, and the second with the pumps on. For each of the two days once all pressure recorders were placed, the finished water storage tank level was noted along with the time. Before conducting the hydrant flow test, the flow hydrant flowed for a few moments until it flowed clear. The pitometer was then placed, and the hydrant was fully opened. The value on the pressure gauge was then noted as this represented the static pressure before the test was conducted. Next, the flowing hydrant was opened fully, and its flow rate was recorded. At the same time, the measuring hydrant's residual pressure was noted, along with the time, so that the data from each hydrant test could be matched to the data from the pressure recorders. For the days with the well pumps running, their corresponding pumping rates were noted at the time of the tests as well.

The outlet orifice was examined to determine its type, in which all hydrants were found to have smooth and flush orifices. Once all 14 tests had been completed, the pressure recorders were collected, and all of their corresponding hydrants were closed and drained.

The full results of the hydrant flow tests and the fire flow calculations can be found in **Appendix B**. These results represent a summary of the tests with the static, residuals, and pressure logger data from the specific times of the tests. A summary of the testing is below in **Table 9**.

Table 9 Hydrant Flow Testing Results Summary

Wells On		Wells Off	
Average Measured Flow Rate (gpm)	702	Average Measured Flow Rate (gpm)	599
Average Calculated Flow Rate (gpm)	850	Average Calculated Flow Rate (gpm)	669
Average Static Pressure (psi)	96	Average Static Pressure (psi)	91
Average Residual Pressure (psi)	43	Average Residual Pressure (psi)	34
Tests Where <20 PSI Measured	3	Tests Where <20 PSI Measured	12

Important to note with the hydrant testing is that while they are a measure of what the hydrant can flow, it is not a measure of what the hydrant can flow while maintaining 20 psi throughout the system, and several tests dropped the pressure elsewhere in the system below 20 psi.

The results show the significant effect of running the wells, in both the flow rates and the pressures. Also of note is the number of tests where a pressure within the system (at either a hydrant or pressure recorder) was measured to be below 20 psi. These were found with both the wells on and off, with 12 out of the 15 tests with a reading below 20 psi originating at

Hydrant H-96 roughly at the middle point of College Hill Road. This points to a weak spot in the system, and it is unsurprisingly at one of the higher elevations in the distribution.

Another reason that it may be more susceptible to lower pressures and flows is that it sits in the middle of the system and is either fed by small diameter lines in the downtown on the east or water has to travel all the way to the west before the river crossing loop and finally reaching the College Hill Road area.

Any hydrant flow testing in the future should be done only when the tank is full and the well pumps are on. There should also be the requirement to issue a boil water notice in the area of College Hill Road to prevent any negative effects of low pressure.

- h. **Model Calibration:** The KYPipe program was used to develop and calibrate the model of Pittsford's water distribution system.

After inputting the results from the 14 hydrant flow tests, two additional pressure recorder readings were input for each test. The 14 tests were then input again using information from two of the remaining pressure recorders which were used. The pressure recorder readings were able to be used as the time of those tests were noted and then matched up with the corresponding hydrant flow test.

Following calibration, the fire flow results from the hydrant tests were favorably matched to the calculated values. It is important to note that the calculated field value is the flow strictly of that particular hydrant at 20 psi (and doesn't consider other hydrants in the system that drop below 20 psi). This same idea was applied to the model hydrants, so that they may be compared. After comparing them, the pipes roughness values were further adjusted around each test and the system to bring the model values as close as possible to the field calculated ones.

Results from the Calibrated Models (well pumps on and off) are shown below.

Table 10 Calibrated Model Results with Well Pumps On

Test Name	Static Hydrant Name	Field Static Pressure (psi)	Model Static Pressure (psi)	Difference	Field Calculated Fire Flow (gpm)	Model Calculated Fire Flow (gpm)	Difference
Test 1	H-89	96	89	7%	1,129	1,140	1%
Test 2*	H-44	110	105	5%	1,175	1,233	5%
Test 3	H-80	101	94	7%	738	743	1%
Test 4*	H-95	79	69	13%	877	874	0%
Test 5*	H-37	64	65	1%	579	555	4%
Test 6*	H-29	112	110	2%	1,039	829	20%
Test 7	H-31	118	108	9%	300	293	2%
Test 8	H-53	113	110	2%	899	858	5%
Test 9*	H-66	94	89	6%	748	751	0%

* - These tests were two-part tests where hydrants on either side of the static hydrant were flowed, the field calculated fire flow represents an average calculated fire flow value from the two tests.

Table 11 Calibrated Model Results with Well Pumps Off

Test Name	Static Hydrant Name	Field Static Pressure (psi)	Model Static Pressure (psi)	Difference	Field Calculated Fire Flow (gpm)	Model Calculated Fire Flow (gpm)	Difference
Test 1	H-89	92	84	8%	941	933	1%
Test 2*	H-44	104	99	5%	916	917	0%
Test 3	H-80	96	89	7%	717	716	0%
Test 4*	H-95	76	64	16%	657	643	2%
Test 5*	H-37	60	58	3%	385	391	2%
Test 6*	H-29	108	103	5%	901	696	23%
Test 7	H-31	110	99	10%	230	233	1%
Test 8	H-53	107	102	5%	606	627	3%
Test 9*	H-66	84	80	4%	576	551	4%

* - These tests were two-part tests where hydrants on either side of the static hydrant were flowed, the field calculated fire flow represents an average calculated fire flow value from the two tests.

The calibrated model's static pressures average to be within 6% of the field measured values. The model's fire flows average to be within 4% of the field values for the well pumps are on and off.

The only test that could not achieve a difference of 5% or lower was that of test 6. This test should likely be omitted since the hydrants which were planned to be flowed versus the hydrants that actually were do not line up. Different hydrants were picked due to convenience of flowing, and so the hydrants which were flowed were vastly further apart.

It was found during calibration that the pipes around Test 7 had to be given extremely low C factor values in order for the data to align. This would suggest that there is some sort of unknown element in this area which is restricting the flow in some way.

- i. **Theoretical Water System Service Areas:** The theoretical service area would include potential connections below 873' elevation. This elevation correlates to the elevation below the finished water tank level which would produce 35 psi of water pressure, based on the minimum level in the tank for fire flow and ADD, which comes out to 730.7' (see **PER Figure 9**). As can be seen, there are areas at or below that elevation that currently are not within the existing service area.

- j. **Water Age Analysis:** In reviewing Disinfection Byproducts (DBP) sampling for the system, there are no identified DBP issues associated with the WAC system. This is typical for a groundwater supplied water system. Water loss associated with this system makes calculating accurate water age throughout the distribution system difficult, unless the water loss area locations are known and to what extent.

Based on these factors, the water age was not determined for this model because it would not be accurate or useful.

3.0 IMPROVEMENT ALTERNATIVES MODELED

- a. **Scenarios Modeled:** In order to fully analyze the alternatives proposed in the PER, alternatives 1A, 1B, and 2 were modeled and are described below. These Alternatives were modeled at the WAC's total permitted MDD of 474 gpm spread throughout the system. This represents the highest possible usage the system should experience.
- Alternative 1A: Upgraded transmission main (8-inch to 12-inch) coming down from the tank, down Cox District Road, and to Route 4.
 - Alternative 1B: Same as Alt 1A with the addition of 12-inch main extended down Route 4 to just before Woodstock Downtown.
 - Alternative 2: Addition of another water storage tank on the eastern side of the water system, with 12-inch main connecting to rest of distribution.
- b. **Data Gaps and Assumptions:** The only known data gaps for the model are from the hydrants that were not flow tested. While this is certainly something to consider, it would be unrealistic and frankly unnecessary to flow all of the hydrants. Just as too little input data can be detrimental to a model, too much can be as well. KYPipe allows modeling of 40 scenarios and our 14 tests and 56 other data points utilizing the pressure recorders are more than sufficient to develop a fully calibrated model.
- The water level in the water storage tank (or tanks as it relates to Alternative 2) was assumed to be at the low tank level operating point. This is required by the DWGPD in regards to their Draft Hydraulic Evaluations Guidance, and it is good practice as this represents the typical low level in the tank and subsequent lower level of water pressure for the system.
- c. **Summary of Deficiencies:** Deficiencies from State fire flow regulatory requirements exist throughout the system, mostly on undersized lines or dead end mains. The deficiencies are exasperated when the model is run with the well pumps off. Refer to **Figures 1 and 2** for a visualization of deficient hydrants across the system.
- d. **Considerations for Improvement and Capital Planning:** The following tables summarize the Alternatives and their benefit to the system. It should be noted that all of these alternative scenarios were run assuming that the well pumps were off, so this represents a worst case scenario for flows.

Table 12 Alternative 1A Fire Flow Highlights

		Note
Max gpm	2,907	
Max gpm Hydrant	H-57	Route 4 Below Upgraded Main
Min gpm	162	
Min gpm Hydrant	H-32	South Street at Dead End
Average Fireflow (gpm)	822	
Fireflow Increase from Existing (gpm)	145%	

Table 13 Alternative 1A Fire Flow Availability

NFPA Color	Red	Orange	Green	Blue
GPM	(<500)	(500 - 1,000)	(1,000 - 1,500)	(1,500<)
Hydrants	17	58	14	7
Difference from Existing	-78	+57	+14	+7
% of Total	17.7%	60.4%	14.6%	7.3%

This alternative, while only involving 3,800 feet of 12-inch main, has a massive benefit to the system as a whole. The fire flows across the system were more than doubled, and 78 of the deficient hydrants were brought into compliance (from a fire flow standpoint).

Table 14 Alternative 1B Fire Flow Highlights

		Note
Max gpm	3,441	
Max gpm Hydrant	H-44	Route 4 East of Prosper Road
Min gpm	168	
Min gpm Hydrant	H-32	South Street at Dead End
Average Fireflow (gpm)	1,216	
Fireflow Increase from Existing (gpm)	263%	

Table 15 Alternative 1B Fire Flow Availability

NFPA Color	Red	Orange	Green	Blue
GPM	(<500)	(500 - 1,000)	(1,000 - 1,500)	(1,500<)
Hydrants	12	35	27	22
Difference from Existing	-83	+34	+27	+22
% of Total	12.5%	36.5%	28.1%	22.9%

Alternative 1B includes Alternative 1A, and the additional piping down Route 4 triples the existing fire flow for the system. The additional piping, though, only brings 5 additional hydrants into compliance.

Table 16 Alternative 2 Fire Flow Highlights

		Note
Max gpm	6,299	
Max gpm Hydrant	H-7	Below New Tank within National Park
Min gpm	171	
Min gpm Hydrant	H-32	South Street before Dead End Line
Average Fireflow (gpm)	1,352	
Fireflow Increase from Existing (gpm)	303%	

Table 17 Alternative 2 Fire Flow Availability

NFPA Color	Red	Orange	Green	Blue
GPM	(<500)	(500 - 1,000)	(1,000 - 1,500)	(1,500<)
Hydrants	11	30	31	24
Difference from Existing	-84	+29	+31	+24
% of Total	11.5%	31.3%	32.3%	25.0%

The addition of a new tank on the Mount Peg Marsh-Billings-Rockefeller property would nearly quadruple the existing fire flow available to the system, as well as leave only 11 hydrants out of compliance with the WSR. The remaining uncompliant hydrants are on 4-inch diameter mains or less and on dead end sections of the system. It's likely the only way to attain complete compliance would be to either replace all of these lines with 8-inch diameter mains, or to remove these hydrants completely. Refer to **Figure 3** for a visualization of the hydrant fire flows from **Table 17**.






4.0 CONCLUSIONS, RECOMMENDATIONS, AND NEXT STEPS

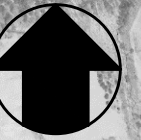
The purpose of this Hydraulic Model Report was to produce and analyze a model that best represented the system as it operated today, so that the model can be used to analyze the effects of a given system improvement. In this report, the model was used to analyze 3 different improvement alternatives.

Conclusions:

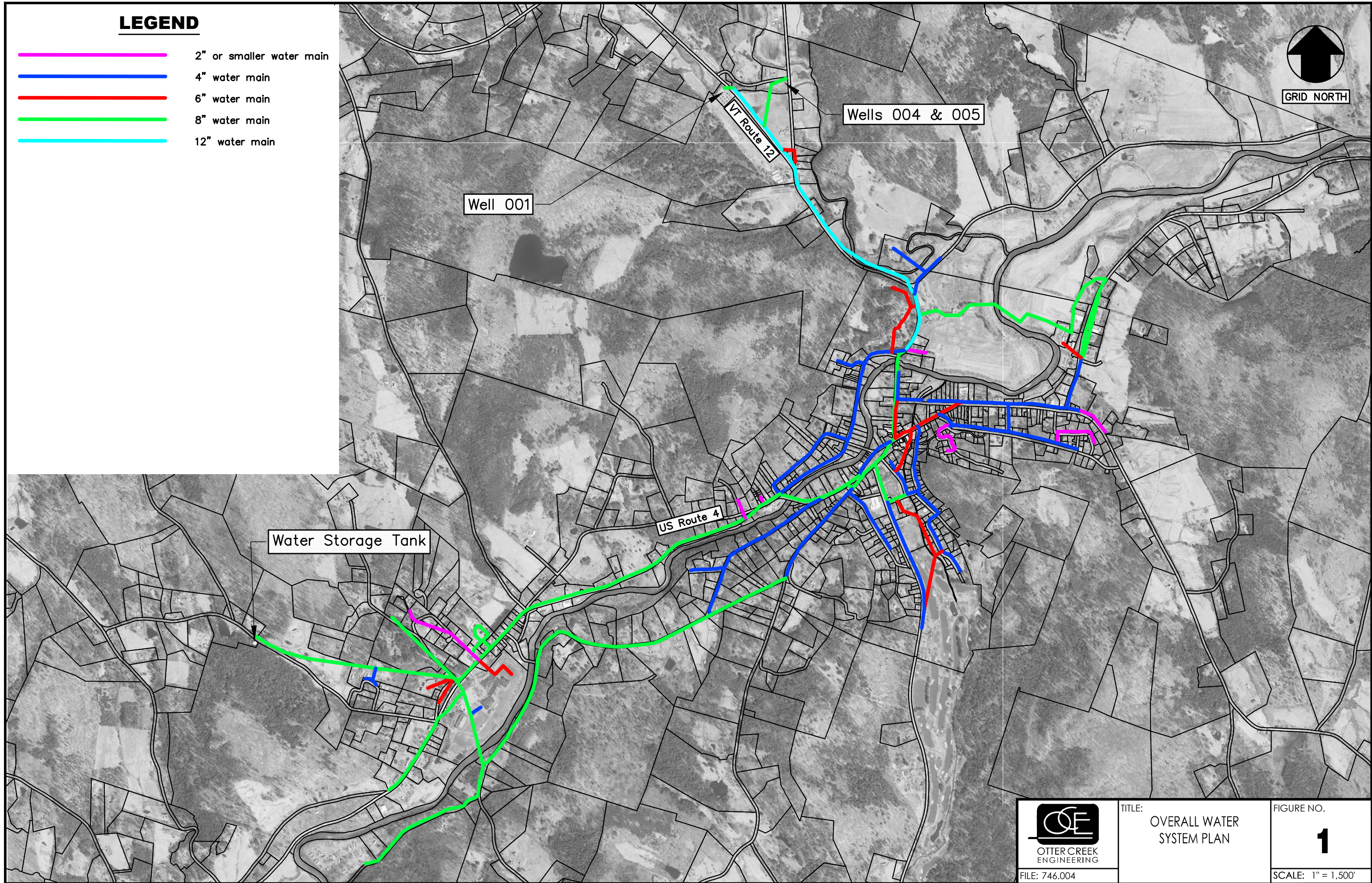
- The system's two active well sources do not produce sufficient water to meet current and future system demands. The Town, though, is in the process of adding an additional source to attempt to remediate this.
- The system has adequate water storage to meet State and ISO standards.
- 49% of the distribution mains are under 8-inches in diameter, which is the State required minimum diameter of mains which have fire hydrants on them.
- The system currently has 23 hydrants which cannot produce 500 gpm while the well pumps are on and maintaining 20 psi throughout the rest of the system. This number increases dramatically with the well pumps off, at 95 hydrants under 500 gpm.
- Upsizing the main which conveys water from the water storage tank down to the distribution at Route 4 doubles the available fire flow throughout the system and eliminates a substantial number of uncompliant hydrants.
- No Alternative proposed will eliminate all deficient hydrants, as the only likely way to do this would be to upsize all mains to at least 8-inch in diameter.
- Alternative 2 has the greatest hydraulic impact on the system and is the recommended alternative of this report.

LEGEND

-  2" or smaller water main
-  4" water main
-  6" water main
-  8" water main
-  12" water main



GRID NORTH



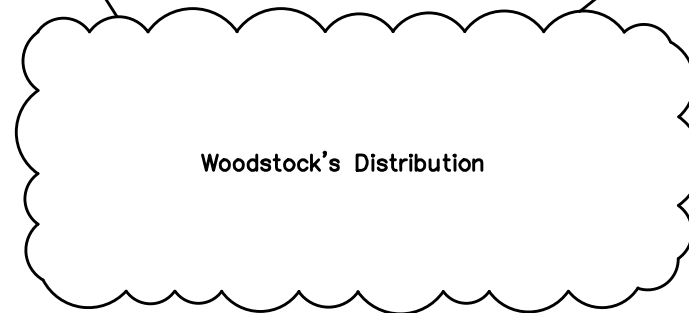
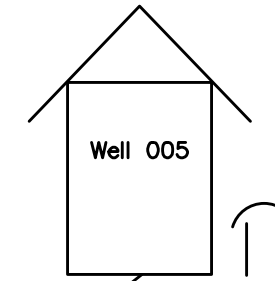
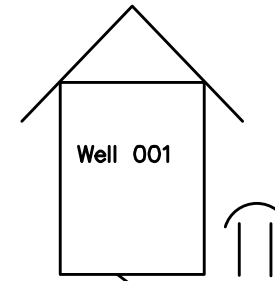
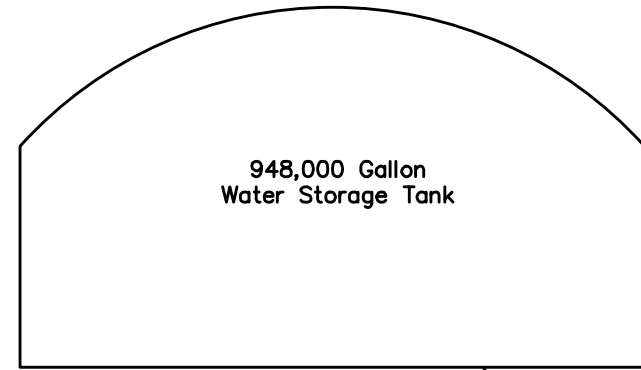
FILE: 746.004

TITLE:
OVERALL WATER
SYSTEM PLAN







FIGURE NO.

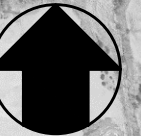
1

SCALE: 1" = 1,500'

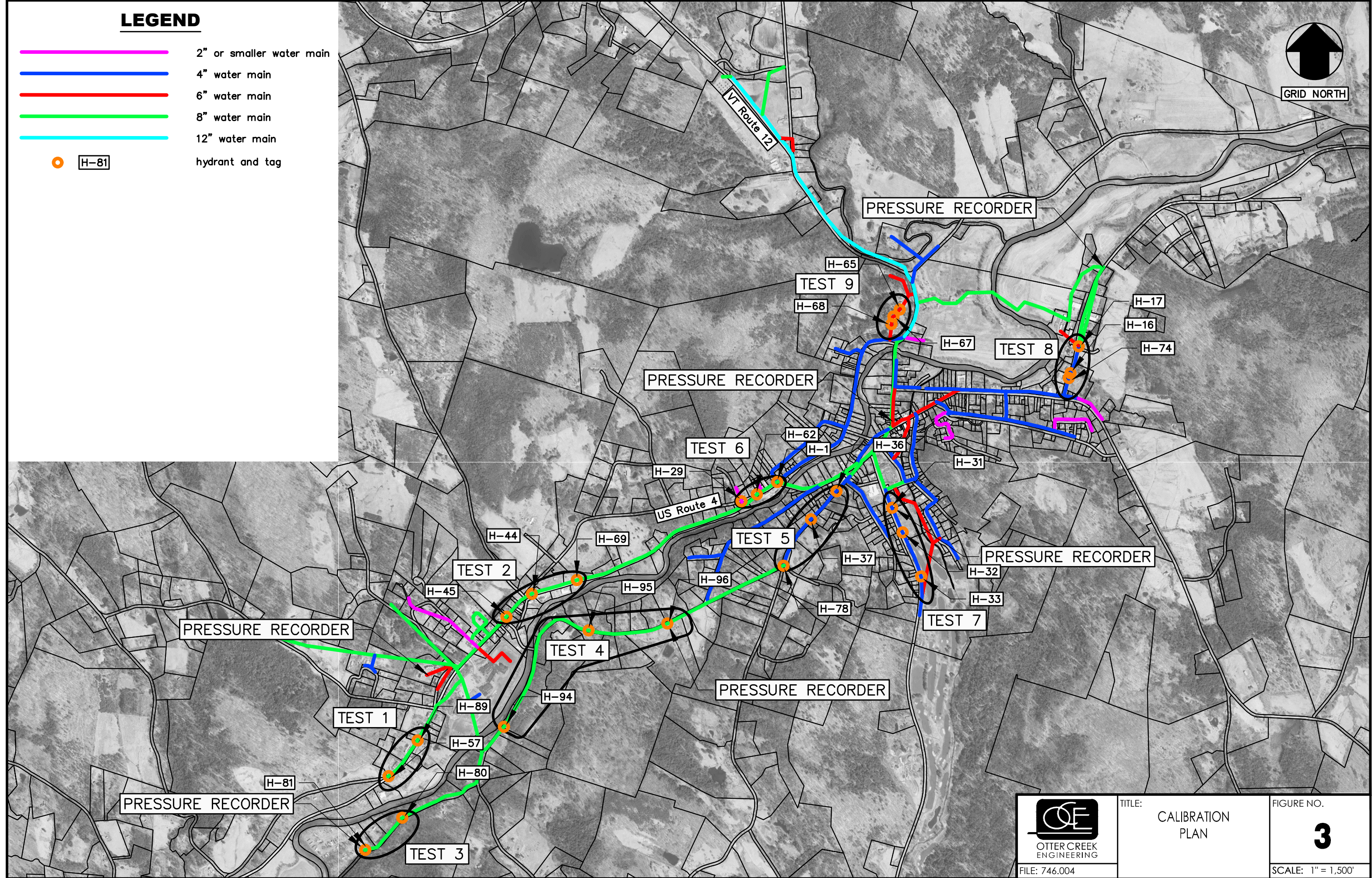


LEGEND

-  2" or smaller water main
-  4" water main
-  6" water main
-  8" water main
-  12" water main
-  hydrant and tag



GRID NORTH





OTTER CREEK
ENGINEERING

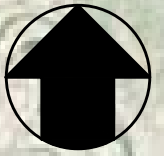
FILE: 746.004

TITLE:
CALIBRATION
PLAN

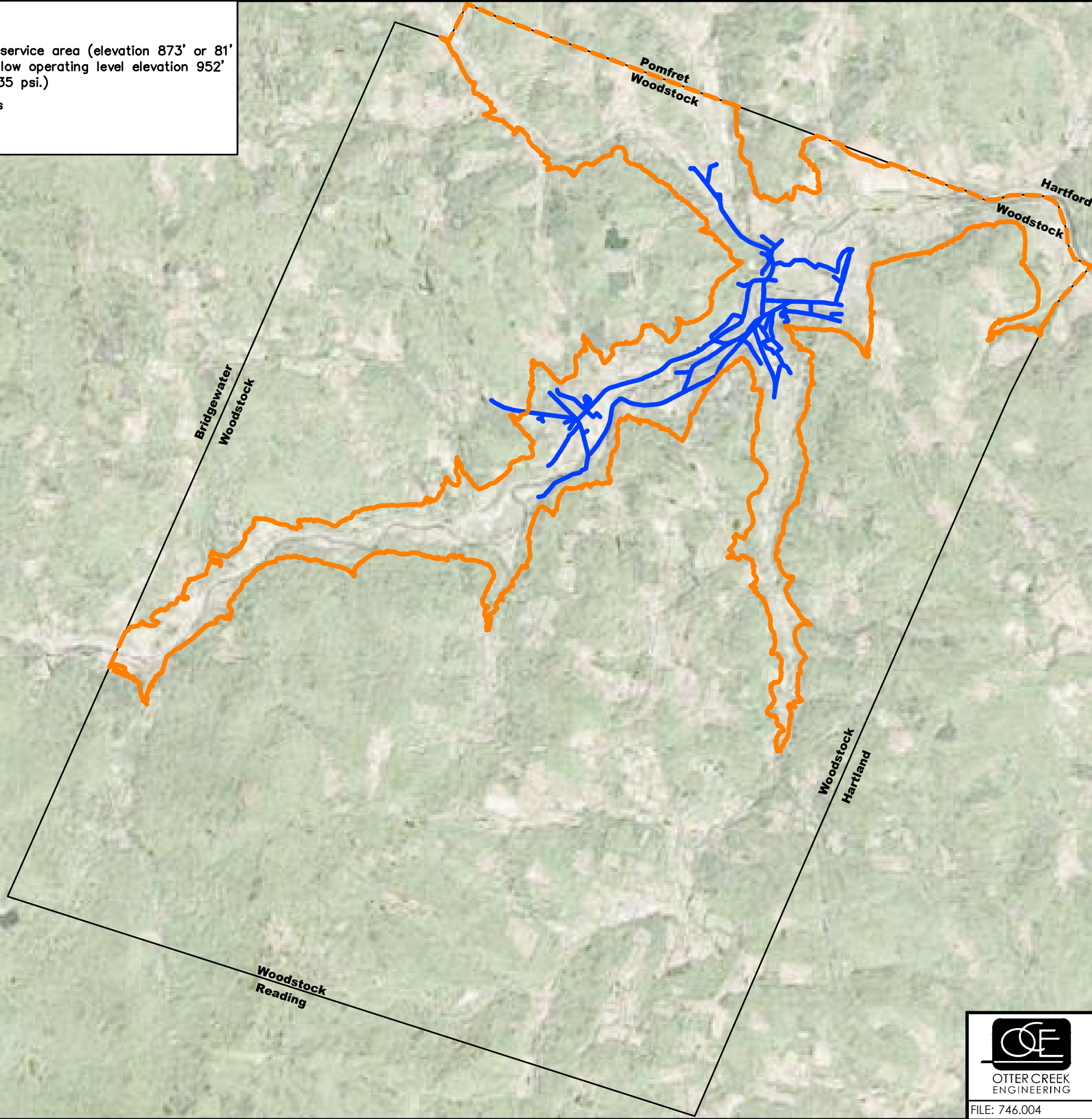
FIGURE NO.
3
SCALE: 1" = 1,500'

LEGEND

-  Theoretical service area (elevation 873' or 81' below tank low operating level elevation 952' to provide 35 psi.)
-  water mains



GRID NORTH

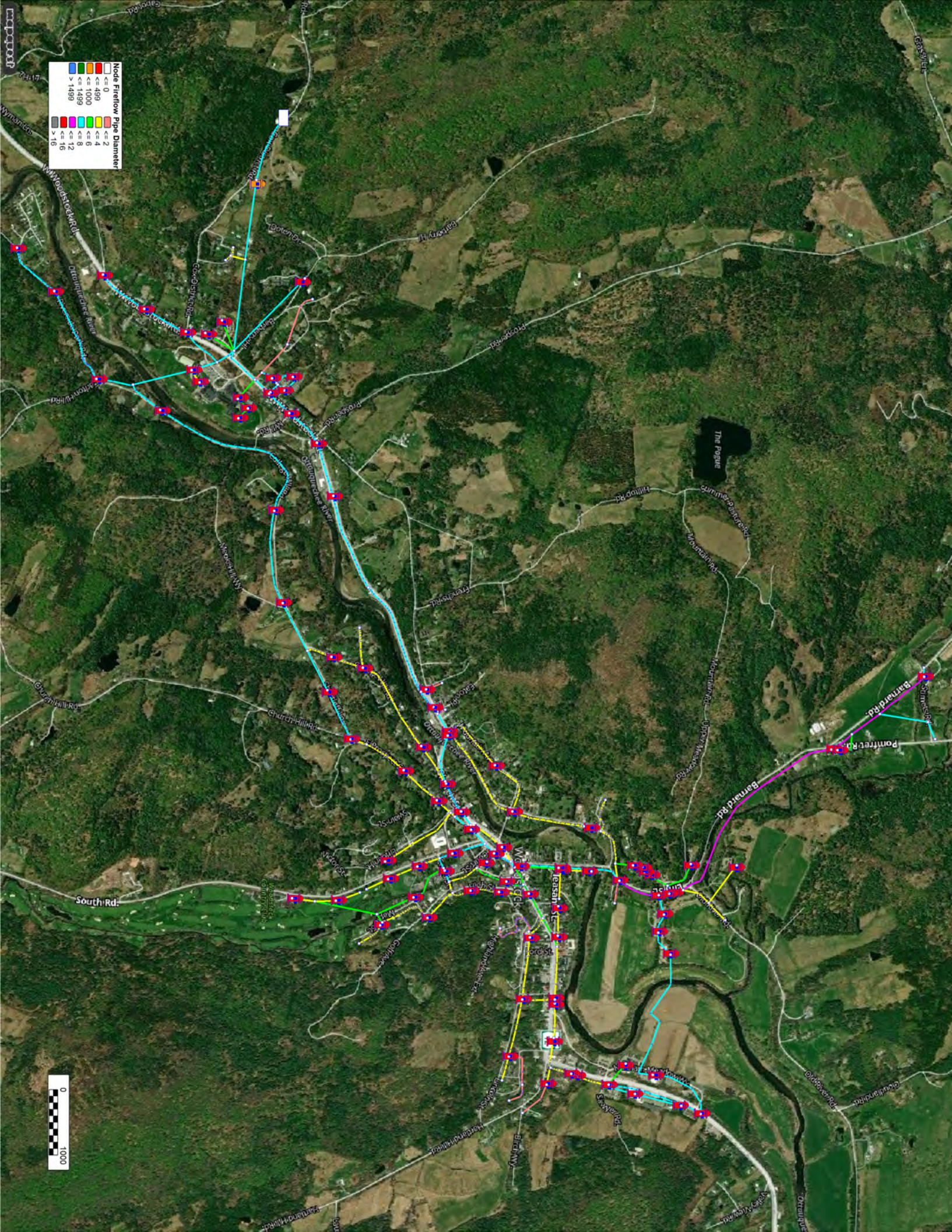


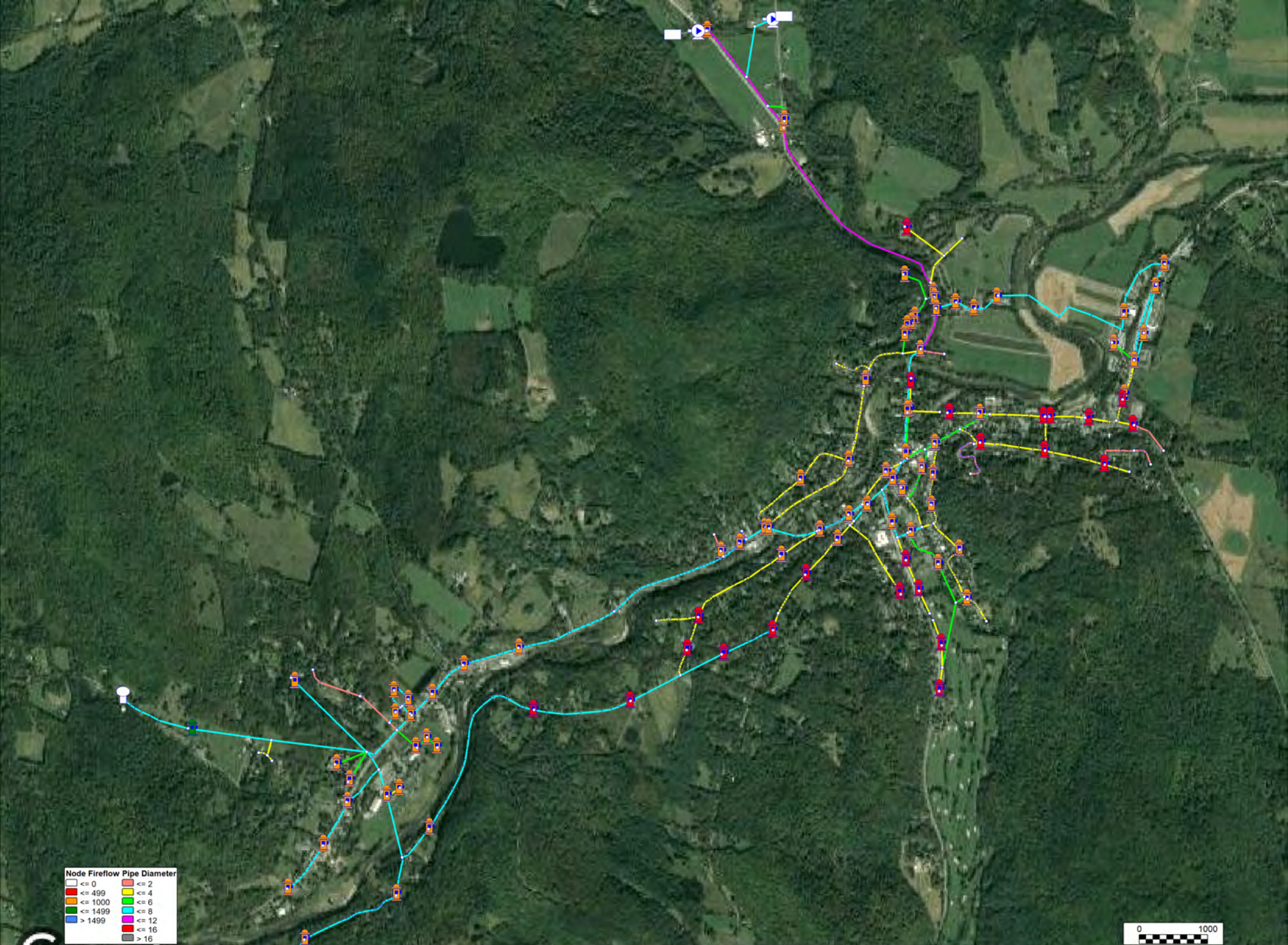
OTTER CREEK
ENGINEERING

FILE: 746.004

TITLE:
WOODSTOCK
AQUEDUCT COMPANY
THEORETICAL
SERVICE AREA

FIGURE NO.
9
SCALE: 1" = 4,500'

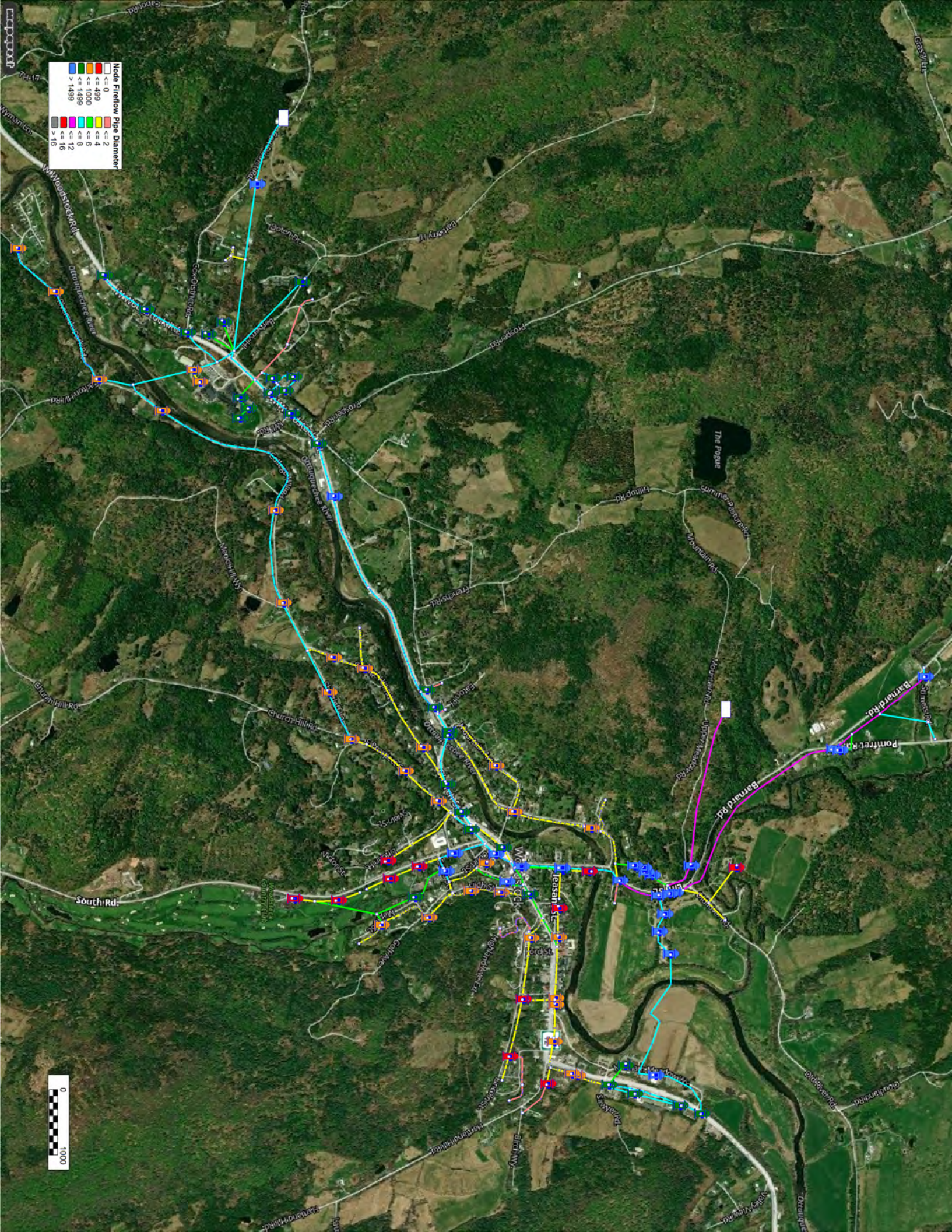




Node Fireflow Pipe Diameter

White	<= 0	Red	<= 2
Orange	<= 499	Yellow	<= 4
Light Blue	<= 1000	Green	<= 6
Dark Blue	<= 1499	Cyan	<= 8
Light Purple	> 1499	Magenta	<= 12
Dark Purple	> 1499	Dark Red	<= 16
Grey	> 1499	Dark Grey	> 16





Node Fireflow Pipe Diameter
<= 0
<= 489
<= 1000
<= 1499
> 1499
<= 2
<= 4
<= 6
<= 8
<= 12
<= 16
> 16



Wells On Hydrants Below 500 gpm		Wells Off Hydrants Below 500 gpm	
Hydrant	Available Fire Flow	Hydrant	Available Fire Flow
H-11	428.3	H-1	498.6
H-12	373.6	H-10	456.4
H-14	476.1	H-11	331.6
H-15	457.9	H-12	324.9
H-16	472.9	H-13	382.8
H-18	314	H-14	344.7
H-20	386.7	H-15	338.3
H-21	414.9	H-16	346.8
H-31	312.3	H-17	421.1
H-32	206.6	H-18	247.5
H-33	391.5	H-19	423.5
H-34	392.9	H-2	335.1
H-35	213.6	H-20	291.8
H-37	457.3	H-21	305.1
H-58	463.2	H-22	411.1
H-6	350.1	H-23	439.6
H-74	455.8	H-24	446.2
H-75	224	H-25	449.9
H-76	494.5	H-26	473.6
H-78	424.2	H-27	473.1
H-82	481.1	H-28	485.5
H-85	438.9	H-3	334.7
H-95	481.1	H-30	444.4
H-96	463.1	H-31	273.8
		H-32	185.9
		H-33	336.5
		H-34	335.7
		H-35	183
		H-36	318.1
		H-37	298.3
		H-38	318.6
		H-39	424.3
		H-4	453.4
		H-40	331.6
		H-41	331.6
		H-42	331.6
		H-43	331.6
		H-44	357.4
		H-45	363.6
		H-46	353.2
		H-47	439.7
		H-48	372.2
		H-49	372.2
		H-5	438.9
		H-50	380.7

H-51	380.7
H-52	437.4
H-53	431.3
H-54	438.8
H-55	438.8
H-56	367.7
H-57	367.7
H-58	295.5
H-59	438.8
H-6	304.7
H-61	425.2
H-63	327.2
H-64	438.8
H-65	440.2
H-66	440.4
H-67	331.9
H-68	332
H-7	439.2
H-70	439.1
H-71	438.8
H-72	372.2
H-73	380.7
H-74	336.8
H-75	182.2
H-76	286.4
H-77	453.2
H-78	256
H-79	423.5
H-8	438.8
H-80	327.2
H-81	327.2
H-82	347.6
H-83	441.5
H-84	423.5
H-85	262.4
H-86	353.9
H-87	497.1
H-88	441.4
H-89	367.7
H-9	438.3
H-90	368.6
H-91	368.6
H-92	368.7
H-93	368.6
H-94	318.6
H-95	287.6
H-96	276

Hydrant Flow Tests with Well Pumps Off

Test	Date/Time	Tank Level	Flowing Hydrant			Static Hydrant			Logger ID					Nozzle Coefficient	Calculated Fire Flow (gpm)	
			Name	Residual Pitot Reading (psi)	Flow Rate (gpm)	Name	Static Pressure (psi)	Residual Pressure (psi)	M OCE 1 H-53	M OCE 2 H-96	M OCE 3 H-56	M OCE 4 H-81	Telog H-23			
	7/6/2022	ft		psi	gpm		psi	psi	psi	psi	psi	psi	psi			
	7/7/2022 9:30:00 AM	31.95							107.80	65.30	89.00	91.80	107.20	Baseline		
Test 1	7/7/2022 11:24:34 AM	30.63	H-57	24	822	H-89	92	36	55.60	13.70	32.30	40.00	56.56		1	941
Test 2A	7/7/2022 11:06:06 AM	30.68	H-69	21	768	H-44	104	54	41.40	17.10	40.90	43.80	40.98		1	1,016
Test 2B	7/7/2022 11:15:30 AM	30.68	H-45	14	626	H-44	108	54	51.00	17.40	41.20	44.10	50.84		1	815
Test 3	7/7/2022 9:19:16 AM	31.95	H-81	LF ¹	620	H-80	96	38	61.30	14.70	45.00	19.20	60.61		1	717
Test 4A	7/7/2022 9:33:20 AM	31.69	H-94	24	822	H-95	76	18	56.00	7.90	38.10	33.30	55.04		0.95	766
Test 4B	7/7/2022 9:42:28 AM	31.59	H-96	10	530	H-95	76	28	62.20	11.70	47.10	44.00	61.34		0.95	547
Test 5A	7/7/2022 9:54:08 AM	31.41	H-78	LF ¹	340	H-37	60	30	78.50	35.60	63.40	63.50	78.29		1	397
Test 5B	7/7/2022 10:00:20 AM	31.41	H-36	LF ¹	340	H-37	58	26	71.80	37.20	63.50	65.10	70.48		1	373
Test 6A	7/7/2022 10:46:36 AM	31.09	H-87	23	804	H-29	108	36	31.30	19.70	44.10	46.50	30.96		1	896
Test 6B	7/7/2022 10:54:40 AM	30.85	H-69	20	750	H-29	108	46	43.50	18.80	42.40	45.40	44.20		1	906
Test 7	7/7/2022 10:08:50 AM	31.24	H-32	LF ¹	180	H-31	110	58	87.40	48.90	73.50	76.00	83.52		0.95	230
Test 8	7/7/2022 10:18:54 AM	31.21	H-17	13	602	H-53	107	21	20.80	23.70	49.70	51.10	36.00		1	606
Test 9A	7/7/2022 10:30:20 AM	31.31	H-65	13	602	H-66	84	18	37.70	26.60	51.50	53.80	40.49		1	592
Test 9B	7/7/2022 10:34:20 AM	31.09	H-67	12	578	H-66	84	16	39.40	27.00	52.50	54.70	42.78		1	559

1. LF = Low Flow gauge used to determine flow, no residual pitot reading given.



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	11:24 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-89	
Location (draw map on back): Test Area 1	Elevation: 743
Static Pressure (psi): 92	
Residual Pressure (psi): 36	

Flowing Hydrant No: H-57	
Location: Test Area 1	Elevation: 742
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 24	

Calculations: 822 gpm * 1.0 = 822 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 822 gpm
Calculate available Fire Flow using formula: $(822 \times (92-20)^{0.54}) / (92-36)^{0.54} = 941$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	11:06 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-44	
Location (draw map on back): Test Area 2A	Elevation: 712
Static Pressure (psi): 104	
Residual Pressure (psi): 54	

Flowing Hydrant No: H-69	
Location: Test Area 2A	Elevation: 708
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 21	

Calculations: 768 gpm * 1.0 = 768 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 768 gpm
Calculate available Fire Flow using formula: $(768 \times (104-20)^{0.54}) / (104-54)^{0.54} = 1,016$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	11:16 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-44	
Location (draw map on back): Test Area 2B	Elevation: 712
Static Pressure (psi): 108	
Residual Pressure (psi): 54	

Flowing Hydrant No: H-45	
Location: Test Area 2B	Elevation: 727
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 14	

Calculations: 626 gpm * 1.0 = 626 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 626 gpm
Calculate available Fire Flow using formula: $(626 \times (108-20)^{0.54}) / (108-54)^{0.54} = 815$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	9:19 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-80	
Location (draw map on back): Test Area 3	Elevation: 736
Static Pressure (psi): 96	
Residual Pressure (psi): 38	

Flowing Hydrant No: H-81	
Location: Test Area 3	Elevation: 739
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 620 gpm * 1.0 = 620 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 620 gpm
Calculate available Fire Flow using formula: $(620 \times (96-20)^{0.54}) / (96-38)^{0.54} = 717 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	9:33 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-95	
Location (draw map on back): Test Area 4A	Elevation: 789
Static Pressure (psi): 76	
Residual Pressure (psi): 18	

Flowing Hydrant No: H-94	
Location: Test Area 4A	Elevation: 739
Outlet Diameter: 2.5 in	
Outlet Coefficient: 0.95	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 24	

Calculations: 822 gpm * 0.95 = 781 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 781 gpm
Calculate available Fire Flow using formula: $(781 \times (76-20)^{0.54}) / (76-18)^{0.54} = 766$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	9:42 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-95	
Location (draw map on back): Test Area 4B	Elevation: 789
Static Pressure (psi): 76	
Residual Pressure (psi): 28	

Flowing Hydrant No: H-96	
Location: Test Area 4B	Elevation: 799
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 10	

Calculations: 530 gpm * 0.95 = 504 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 504 gpm
Calculate available Fire Flow using formula: $(504 \times (76-20)^{0.54}) / (76-28)^{0.54} = 547 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	9:54 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-37	
Location (draw map on back): Test Area 5A	Elevation: 801
Static Pressure (psi): 60	
Residual Pressure (psi): 30	

Flowing Hydrant No: H-78	
Location: Test Area 5A	Elevation: 861
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 340 gpm * 1.0 = 340 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 340 gpm
Calculate available Fire Flow using formula: $(340 \times (60-20)^{0.54}) / (60-30)^{0.54} = 397 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:00 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-37	
Location (draw map on back): Test Area 5B	Elevation: 801
Static Pressure (psi): 58	
Residual Pressure (psi): 26	

Flowing Hydrant No: H-36	
Location: Test Area 5B	Elevation: 761
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 340 gpm * 1.0 = 340 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 340 gpm
Calculate available Fire Flow using formula: $(340 \times (58-20)^{0.54}) / (58-26)^{0.54} = 373 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:47 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-29	
Location (draw map on back): Test Area 6A	Elevation: 709
Static Pressure (psi): 108	
Residual Pressure (psi): 36	

Flowing Hydrant No: H-87	
Location: Test Area 6A	Elevation: 704
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 23	

Calculations: 804 gpm * 1.0 = 804 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 804 gpm
Calculate available Fire Flow using formula: $(804 \times (108-20)^{0.54}) / (108-36)^{0.54} = 896$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:55 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-29	
Location (draw map on back): Test Area 6B	Elevation: 709
Static Pressure (psi): 108	
Residual Pressure (psi): 46	

Flowing Hydrant No: H-69	
Location: Test Area 6B	Elevation: 708
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 20	

Calculations: 750 gpm * 1.0 = 750 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 750 gpm
Calculate available Fire Flow using formula: $(750 \times (108-20)^{0.54}) / (108-46)^{0.54} = 906$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:09 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-31	
Location (draw map on back): Test Area 7	Elevation: 699
Static Pressure (psi): 110	
Residual Pressure (psi): 58	

Flowing Hydrant No: H-32	
Location: Test Area 7	Elevation: 709
Outlet Diameter: 2.5 in	
Outlet Coefficient: 0.95	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 180 gpm * 0.95 = 171 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 171 gpm
Calculate available Fire Flow using formula: $(171 \times (110-20)^{0.54}) / (110-58)^{0.54} = 230$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:19 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-53	
Location (draw map on back): Test Area 8	Elevation: 699
Static Pressure (psi): 107	
Residual Pressure (psi): 21	

Flowing Hydrant No: H-17	
Location: Test Area 8	Elevation: 702
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 13	

Calculations: 602 gpm * 1.0 = 602 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 602 gpm
Calculate available Fire Flow using formula: $(602 \times (107-20)^{0.54}) / (107-21)^{0.54} = 606$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:30 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-66	
Location (draw map on back): Test Area 9A	Elevation: 757
Static Pressure (psi): 84	
Residual Pressure (psi): 18	

Flowing Hydrant No: H-65	
Location: Test Area 9A	Elevation: 747
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 13	

Calculations: 602 gpm * 1.0 = 602 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 602 gpm
Calculate available Fire Flow using formula: $(602 \times (84-20)^{0.54}) / (84-18)^{0.54} = 592 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-07-2022	Time:	10:34 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-66	
Location (draw map on back): Test Area 9B	Elevation: 757
Static Pressure (psi): 84	
Residual Pressure (psi): 16	

Flowing Hydrant No: H-68	
Location: Test Area 9B	Elevation: 747
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 12	

Calculations: 578 gpm * 1.0 = 578 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 578 gpm
Calculate available Fire Flow using formula: $(578 \times (84-20)^{0.54}) / (84-16)^{0.54} = 559$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Hydrant Flow Tests with Well Pumps On

Test	Date/Time	Tank Level	Flowing Hydrant					Static Hydrant			Logger ID					Nozzle Coefficient	Calculated Fire Flow (gpm)		
			Well 1	Well 2	Name	Residual Pitot Reading	Flow Rate	Name	Static Pressure	Residual Pressure	M OCE 1	M OCE 2	M OCE 3	M OCE 4	Telog				
			ft	gpm	gpm	psi	gpm		psi	psi	psi	psi	psi	psi	psi			psi	
	7/6/2022 11:40:30 AM	30.24										113.00	67.90	92.00	94.40	112.48	Baseline		
Test 1	7/6/2022 3:16:50 PM	30.08	204.91	27.17	H-57	30	920	H-89	96	44	71.80	21.90	39.90	47.90	67.84			1	1,129
Test 2A	7/6/2022 2:55:20 PM	30.12	221.90	27.23	H-69	23	804	H-44	110	60	62.40	24.20	49.60	51.60	61.59			1	1,104
Test 2B	7/6/2022 3:06:20 PM	30.15	206.41	26.71	H-45	23	804	H-44	110	70	75.90	30.10	55.00	57.40	75.85			1	1,246
Test 3	7/6/2022 11:50:30 AM	30.36	202.62	26.72	H-81	15	650	H-80	101	37	76.30	18.70	52.90	21.90	74.68			1	738
Test 4A	7/6/2022 12:13:04 PM	30.35	205.16	26.92	H-94	35	1,000	H-95	79	30	72.30	12.60	49.40	38.60	71.89			0.95	1,050
Test 4B	7/6/2022 12:23:06 PM	30.03	206.09	22.97	H-96	15	650	H-95	80	33	81.20	17.90	60.00	51.90	80.00			0.95	705
Test 5A	7/6/2022 3:28:20 PM	30.14	210.04	26.77	H-78	LF ¹	445	H-37	64	40	96.70	44.70	75.80	74.40	96.36			1	617
Test 5B	7/6/2022 3:38:10 PM	30.17	166.99	27.53	H-36	LF ¹	390	H-37	64	40	94.10	53.80	78.50	81.20	95.82			1	541
Test 6A	7/6/2022 2:29:48 PM	30.11	210.47	27.05	H-87	27	872	H-29	112	44	47.70	23.80	48.70	50.40	44.79			1	1,027
Test 6B	7/6/2022 2:41:40 PM	30.03	203.85	26.56	H-69	23	804	H-29	112	56	59.80	22.70	46.70	49.80	55.82			1	1,051
Test 7	7/6/2022 3:44:46 PM	30.05	202.03	26.11	H-32	LF ¹	210	H-31	118	72	102.20	62.20	86.60	88.20	104.81			0.95	300
Test 8	7/6/2022 1:45:52 PM	30.29	214.42	27.53	H-17	25	840	H-53	113	31	31.00	30.50	55.60	57.60	47.33			1	899
Test 9A	7/6/2022 2:06:50 PM	30.03	187.18	25.57	H-65	20	750	H-66	94	24	50.70	33.50	58.00	60.60	51.92			1	773
Test 9B	7/6/2022 2:11:24 PM	30.15	199.89	25.81	H-67	17	690	H-66	94	26	52.00	30.80	58.00	58.50	68.52			1	722

1. LF = Low Flow gauge used to determine flow, no residual pitot reading given.



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	3:16 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-89	
Location (draw map on back): Test Area 1	Elevation: 743
Static Pressure (psi): 96	
Residual Pressure (psi): 44	

Flowing Hydrant No: H-57	
Location: Test Area 1	Elevation: 742
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 30	

Calculations: 920 gpm * 1.0 = 920 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 920 gpm
Calculate available Fire Flow using formula: $(920 \times (96-20)^{0.54}) / (96-44)^{0.54} = 1,129$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	2:55 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-44	
Location (draw map on back): Test Area 2A	Elevation: 712
Static Pressure (psi): 110	
Residual Pressure (psi): 60	

Flowing Hydrant No: H-69	
Location: Test Area 2A	Elevation: 708
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 23	

Calculations: 804 gpm * 1.0 = 804 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 804 gpm
Calculate available Fire Flow using formula: $(804 \times (110-20)^{0.54}) / (110-60)^{0.54} = 1,104$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	3:06 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-44	
Location (draw map on back): Test Area 2B	Elevation: 712
Static Pressure (psi): 110	
Residual Pressure (psi): 70	

Flowing Hydrant No: H-45	
Location: Test Area 2B	Elevation: 727
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 23	

Calculations: 804 gpm * 1.0 = 804 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 804 gpm
Calculate available Fire Flow using formula: $(804 \times (110-20)^{0.54}) / (110-70)^{0.54} = 1,246$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	11:50 a.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-80	
Location (draw map on back): Test Area 3	Elevation: 736
Static Pressure (psi): 101	
Residual Pressure (psi): 37	

Flowing Hydrant No: H-81	
Location: Test Area 3	Elevation: 739
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 15	

Calculations: 650 gpm * 1.0 = 650 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 650 gpm
Calculate available Fire Flow using formula: $(650 \times (101-20)^{0.54}) / (101-37)^{0.54} = 738$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	12:13 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-95	
Location (draw map on back): Test Area 4A	Elevation: 789
Static Pressure (psi): 79	
Residual Pressure (psi): 30	

Flowing Hydrant No: H-94	
Location: Test Area 4A	Elevation: 739
Outlet Diameter: 2.5 in	
Outlet Coefficient: 0.95	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 35	

Calculations: 1000 gpm * 0.95 = 950 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 950 gpm
Calculate available Fire Flow using formula: $(950 \times (79-20)^{0.54}) / (79-30)^{0.54} = 1,050$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	12:23 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-95	
Location (draw map on back): Test Area 4B	Elevation: 789
Static Pressure (psi): 80	
Residual Pressure (psi): 33	

Flowing Hydrant No: H-96	
Location: Test Area 4B	Elevation: 799
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 15	

Calculations: 650 gpm * 0.95 = 618 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 618 gpm
Calculate available Fire Flow using formula: $(618 \times (80-20)^{0.54}) / (80-33)^{0.54} = 705 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	3:28 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-37	
Location (draw map on back): Test Area 5A	Elevation: 801
Static Pressure (psi): 64	
Residual Pressure (psi): 40	

Flowing Hydrant No: H-78	
Location: Test Area 5A	Elevation: 861
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 445 gpm * 1.0 = 445 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 445 gpm
Calculate available Fire Flow using formula: $(445 \times (64-20)^{0.54}) / (64-40)^{0.54} = 617$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	3:38 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-37	
Location (draw map on back): Test Area 5B	Elevation: 801
Static Pressure (psi): 64	
Residual Pressure (psi): 40	

Flowing Hydrant No: H-36	
Location: Test Area 5B	Elevation: 761
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 390 gpm * 1.0 = 390 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 390 gpm
Calculate available Fire Flow using formula: $(390 \times (64-20)^{0.54}) / (64-40)^{0.54} = 541 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	2:29 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-29	
Location (draw map on back): Test Area 6A	Elevation: 709
Static Pressure (psi): 112	
Residual Pressure (psi): 44	

Flowing Hydrant No: H-87	
Location: Test Area 6A	Elevation: 704
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 27	

Calculations: 872 gpm * 1.0 = 872 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 872 gpm
Calculate available Fire Flow using formula: $(872 \times (112-20)^{0.54}) / (112-44)^{0.54} = 1,027$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	2:41 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-29	
Location (draw map on back): Test Area 6B	Elevation: 709
Static Pressure (psi): 112	
Residual Pressure (psi): 56	

Flowing Hydrant No: H-69	
Location: Test Area 6B	Elevation: 708
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 23	

Calculations: 804 gpm * 1.0 = 804 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 804 gpm
Calculate available Fire Flow using formula: $(804 \times (112-20)^{0.54}) / (112-56)^{0.54} = 1,051$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	3:44 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-31	
Location (draw map on back): Test Area 7	Elevation: 699
Static Pressure (psi): 118	
Residual Pressure (psi): 72	

Flowing Hydrant No: H-32	
Location: Test Area 7	Elevation: 709
Outlet Diameter: 2.5 in	
Outlet Coefficient: 0.95	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): N/A	

Calculations: 210 gpm * 0.95 = 200 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 200 gpm
Calculate available Fire Flow using formula: $(200 \times (118-20)^{0.54}) / (118-72)^{0.54} = 300$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	1:46 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-53	
Location (draw map on back): Test Area 8	Elevation: 699
Static Pressure (psi): 113	
Residual Pressure (psi): 31	

Flowing Hydrant No: H-17	
Location: Test Area 1	Elevation: 702
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 25	

Calculations: 840 gpm * 1.0 = 840 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 840 gpm
Calculate available Fire Flow using formula: $(840 \times (113-20)^{0.54}) / (113-31)^{0.54} = 899$ gpm
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>

Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	2:06 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-66	
Location (draw map on back): Test Area 9A	Elevation: 757
Static Pressure (psi): 94	
Residual Pressure (psi): 24	

Flowing Hydrant No: H-65	
Location: Test Area 9A	Elevation: 747
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel: Smooth & Rounded = 1.0 Square & Sharp = 0.88 Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 20	

Calculations: 750 gpm * 1.0 = 750 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 920 gpm
Calculate available Fire Flow using formula: $(750 \times (94-20)^{0.54}) / (94-24)^{0.54} = 773 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>



Fire Hydrant Flow Test Field Data

Project:	Water CAD	Project Number:	746-003
Client:	Woodstock Aqueduct		
Date:	07-06-2022	Time:	2:11 p.m.
Static Readings by:	Bill/Mike	Flow Readings by:	ED
Water System Owner: Woodstock Aqueduct			

Static Hydrant No: H-66	
Location (draw map on back): Test Area 9B	Elevation: 757
Static Pressure (psi): 94	
Residual Pressure (psi): 26	

Flowing Hydrant No: H-68	
Location: Test Area 9B	Elevation: 747
Outlet Diameter: 2.5 in	
Outlet Coefficient: 1.0	<i>Inside Corner of nozzle at barrel:</i> Smooth & Rounded = 1.0 <i>Square & Sharp = 0.88</i> <i>Square & Projecting into barrel = 0.77</i>
Pitot Pressure during full flow (psi): 17	

Calculations: 690 gpm * 1.0 = 690 gpm
Determine Flowing Hydrant Discharge (gpm) from Pollard table, multiply by Outlet Coefficient: 690 gpm
Calculate available Fire Flow using formula: $(690 \times (94-20)^{0.54}) / (94-26)^{0.54} = 722 \text{ gpm}$
$Q_R = \frac{Q_F \times h_R^{0.54}}{h_F^{0.54}}$
<p>Q_R is the calculated Fire Flow available at the desired residual pressure (gpm) Q_F is the Flowing Hydrant Discharge (gpm) h_R is the difference between the static pressure and the desired residual pressure (psi) h_F is the actual drop in pressure observed during flow test, from static to residual (psi)</p>