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Water System Master Plan Report

Hazen Project No. 31238-002
June 2017

Hendersonville Water Sewer

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Executive Summary

The City of Hendersonville authorized Hazen to develop a water system master plan that identifies capital improvements to eliminate low pressures, remedy deficient fire flows and supply future water demands.

The project included evaluating water age and developing unidirectional flushing (UDF) plans in water quality problem areas. This report summarizes the project.

This project supplements a 2014/2015 project that built a new hydraulic model from the city's GIS and customer billing records. The water system master plan envisions expanding the service area into both the urban service area and the rural transition area by 2040. The service area was defined through meetings with city staff and the county planning department. Population estimates for the service area were based on projections developed by the French Broad River Metropolitan Planning Organization for traffic analysis zones (TAZs). These projections show the water system will supply an additional population of 74,000 people by 2040.

Projected maximum day demands are shown in Figure E-1. This figure also shows the water treatment plant expansions that will be needed to meet projected demands.

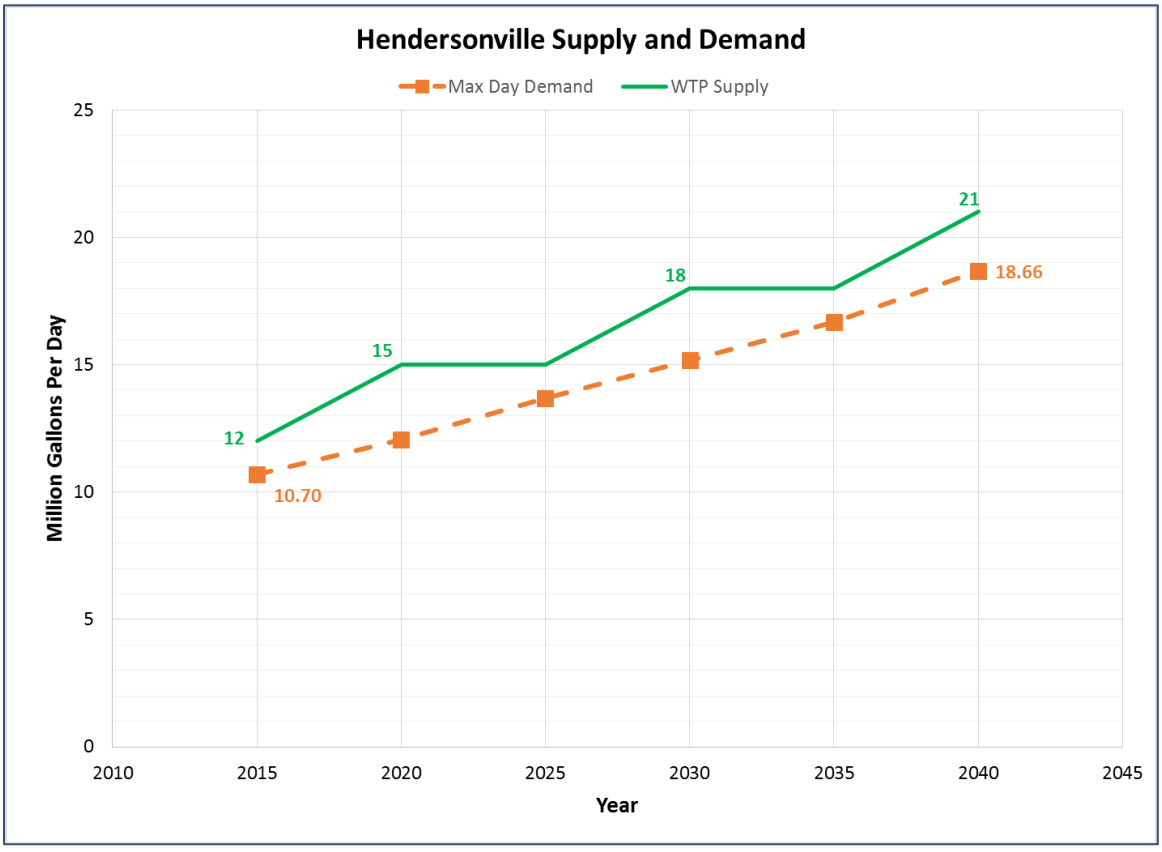


Figure E-1: Water System Supply and Demand

Future demand conditions were simulated with the model to check for deficiencies in storage, pumping and distribution capacity. Subsequent modeling tested alternatives that eliminate deficiencies.

To accommodate the projected growth, 22 new pump stations and 9 new storage tanks are recommended. The most important improvements include:

- Replace the existing 24-inch transmission main leaving the WTP with a new 36-inch from WTP to NC 191 then a new 30 inch pipe to the intersection of Blythe St & 5th Ave W. The first phase will occur as part of a NC DOT improvement project starting in 2025. The second phase will be installed by 2030 so the WTP can supply the maximum day demand.
- Install a 24-inch transmission main along Balfour Parkway from NC 191 to Ashville Hwy. This model shows this pipe will carry 5.3 mgd to Fletcher and the Eastside area.
- Extend 16-inch pipe along Balfour Parkway from Asheville Highway to Interstate 26.
- Build a new 2 mgd booster pump station on Balfour Parkway to meet projected demands in the Eastside Pressure Zone.
- Create Southside- Crail Farm Pressure Zone in the south part of the existing main zone to eliminate low pressures. The new pressure zone will include a new 2 mgd pump station and a proposed 0.5 MG tank.
- Implement Long John Mountain Pressure Zone to serve customers along NC 191 and US 64. This new pressure zone will include a new pump station and storage tank, along with a series of pressure reducing valves and two existing pump stations.
- Install other smaller pipes to improve available fire flows.

The attached maps show the capital improvement projects.

The total opinion of probable costs for larger projects, tanks and pump stations shown below is **$50.1 million**.

CIP Phase	Number of Large Projects	Number of New Tanks	Number of New Pumps	Number of New Pressure Zones	Opinion of Probable Construction Cost ($)[1]
2020	3	2	4	7	9,625,000
2025	8	6	5	7	28,839,000
2030	1	0	0	0	7,070,000
2035	0	1	2	3	1,140,000
2040	0	0	9	9	3,456,000
Total	$36,559,000	$5,291,000	$8,280,000		$50,130,000

1. 2017$ (Construction + 20% Engineering + 20% Contingencies)

1. Introduction

1.1 Authorization

Hazen and Sawyer was authorized by the City of Hendersonville to develop a water system master plan in January 2016.

1.2 Purpose

The purpose of the study was to recommend capital improvements for eliminating existing deficiencies and supplying future growth. Our analysis used the new hydraulic model from a previous project to analyze existing problems and to simulate future conditions.

1.3 Scope of Work

The scope of work outlined in a proposal dated October 27, 2015, included the following tasks:

1. **Meet with city staff**

   This task included an initial meeting, three progress meetings or webcasts and a final presentation to City Council.

2. **Field tests**

   We proposed a field test to resolve a model calibration discrepancy on the discharge side of Eastside Pump Station. The test consisted of flow and pressure measurements.

3. **Evaluate water age**

   This task mapped water age for existing system operation. The model predicted water age based on a 30-day simulation of existing average daily demand using current pump controls and operating procedures. The map highlighted areas where water age was excessive. Disinfection by Products (DBP) sampling sites were plotted on the map to estimate water age at each site.

   Recommendations were made to improve operations and reduce water age in problem areas. Possible recommendations included automatic flushing, bleeding water at zone boundaries, increasing tank turnover, improving circulation and changing operating methods.

   This task also included planning unidirectional flushing (UDF) for approximately 50 miles of water main in water quality problem areas.

4. **Identify existing deficiencies**

   The calibrated model simulated peak hour demand for existing maximum day conditions to identify low pressure areas. Areas with deficient fire flows were identified by comparing the fire flow map from previous projects with zoning maps and information provided by local fire departments. Pump and storage deficiencies were identified by comparing existing pump and tank capacity in each pressure zone to existing maximum day demand and requirements for equalizing and fire storage. Recommendations were developed for eliminating existing deficiencies.

5. Estimate future demands

This task included projecting water demands to the year 2040. Hazen worked with utility staff and the Hendersonville and Henderson County planning departments to delineate the extent of the future service area. Using population projections for traffic analysis zones (TAZs) developed by the French Broad River Metropolitan Planning Organization, we estimated the future population of the water system service area. Per capita demands were estimated using past production and census records, as well as billing data from previous modeling projects. Using this information, we tabulated future water demands in 5-year increments to 2040, for the system as a whole and in each pressure zone

Demand projections included average day, maximum day, maximum day plus fire, and peak hour demands. Average day projections reflected population growth projected for Traffic Analysis Zones (TAZs) within the service area and per capita usage trends, with allowances for commercial demand and non-revenue water. We worked with city staff to develop allowances for future industrial development.

Maximum day projections considered recent peaking factors and irrigation trends. Peak hour projections were based on diurnal patterns developed in previous modeling projects.

6. Evaluate pump and tank capacity

This task included evaluating future pump and storage capacity in each pressure zone. We evaluated the pumps supplying each pressure zone by comparing existing firm capacity with projected maximum day demands. The storage evaluation compared existing tank capacities to future requirements for equalizing diurnal demands, sustaining fire flows and meeting state guidelines for emergency storage.

7. Test improvements to eliminate deficiencies

Hydraulic modeling simulated future demand conditions. Predicted pressures without improvements were compared with design criteria agreed upon by city staff. After identifying deficiencies, the model tested improvement alternatives and identified cost-effective methods of supplying future demands, meeting design criteria and maintaining water quality. Zone boundaries were expanded and adjusted as needed to provide satisfactory pressures. Proposed improvements took full advantage of the existing system to minimize costs.

8. Develop CIP

The city's existing capital improvements plan was reviewed and adjusted based on modeling results and discussions with city staff. Proposed improvements were reviewed for constructability and coordinated with paving schedules and other planning information. This task included tabulating descriptions of CIP projects including demand triggers and links to other projects where appropriate; color-coded mapping summarizing each phase of the proposed program of construction; preparing detailed project sheets for the first phase of improvements; and estimating planning level cost estimates for long range improvements.

9. Prepare final report

Hazen prepared this report that summarizes the field test and documents existing deficiencies. The report tabulates past, present and future demands and summarizes the findings from computer simulations. Proposed pumps, tanks and pipelines are justified. This draft report summarizes the recommended CIP in table and maps. Hazen will respond to review comments by city staff and prepare five paper copies and an electronic version of the final report.

1.4 General Information

Hendersonville's water system supplies more than 65,000 customers. The distribution system includes over 650 miles of water mains, 53 pump stations, and 24 water storage tanks. Several of the pump stations have small hydropneumatic storage tanks.

The water treatment plant (WTP) currently can treat up to 12 million gallons per day (mgd). The water flows through two transmission mains, a 16-inch pipe and a 24-inch pipe, to the central part of the system.

Hazen created a hydraulic model of the distribution system in a previous project as shown in Figure 1. The model includes all water mains in the city's GIS, as well as Laurel Park. Calibration included checking the model using extensive field tests and SCADA records. Table 1 lists current pump station characteristics. Table 2 summarizes information about the tanks. Table 3 list the PRV information included in the model.

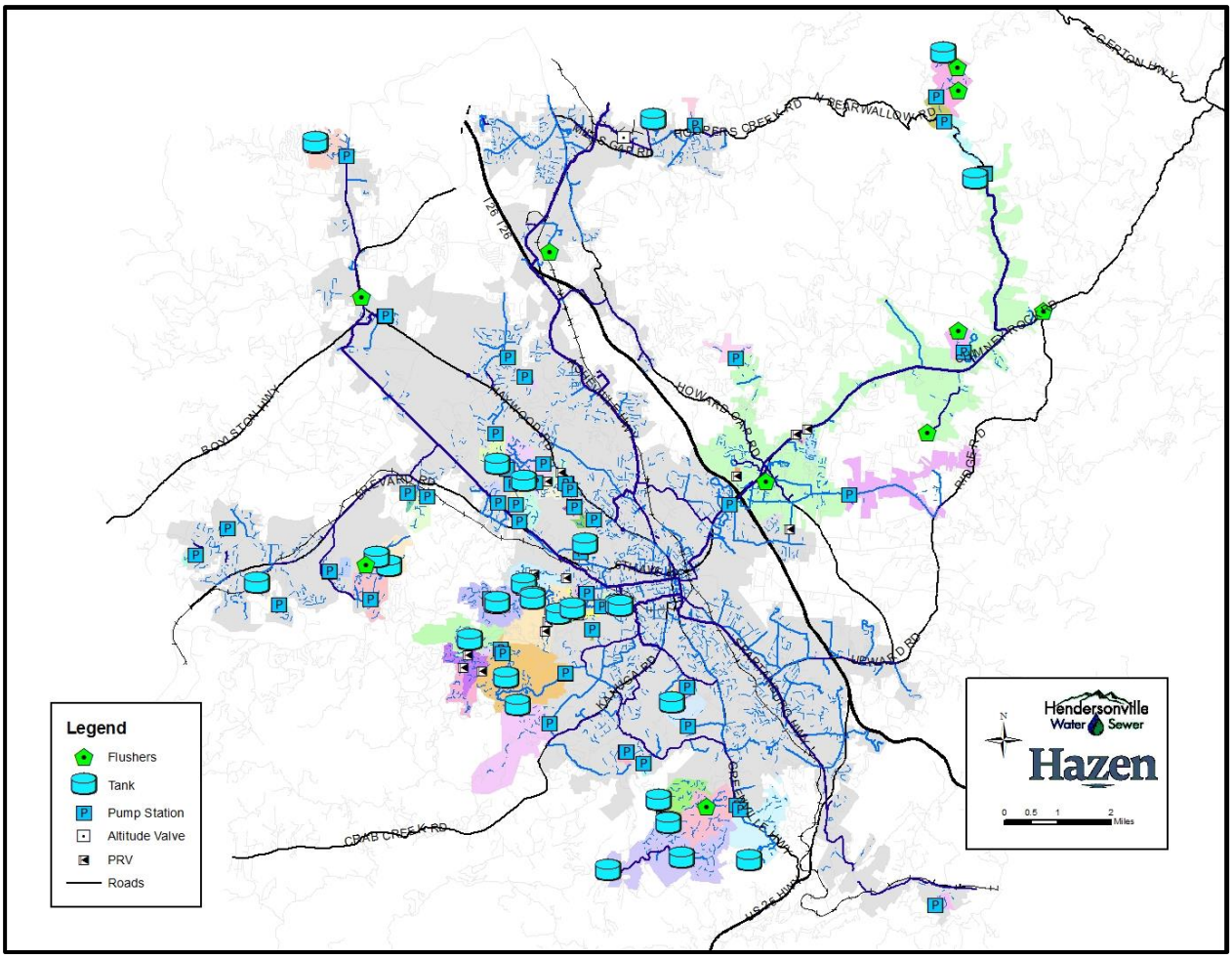


Figure 1: Existing Hydraulic Model of Hendersonville's System

Table 1: Pump Summary

Location	Inlet Zone	Outlet Zone	Pump Number	Capacity		TDH	HP
				mgd	gpm		
WTP Pump	Clearwell	Main	1-Electric 2-Electric 3-Electric 4-Electric	4.0 4.0 3.5 3.5	2,800 2,800 2,431 2,431	450 450 450 450	450 450 350 350
Eastside Booster	Main	Eastside Booster	1-VFD 2-VFD	2.09 2.09	1,450 1,450	250 250	125
Carriage Park Main	Main	Carriage Park Main	1-Electric 2-Electric	0.23 0.23	158 158	400 400	25
Champions Hill-Willow Rd	Main	Champions Hill-Willow Rd	1-Electric 2-Electric	0.40 0.40	280 280	580 580	60
Claremont (Main)	Main	Claremont (Main)	1-Electric 2-Electric	0.77 0.77	535 535	462 462	40
Cummings Cove	Main	Cummings Cove	1-Electric 2-Electric	0.12 0.12	80 80	323 323	15
Cummings Cove (New)	Cummings Cove	Cummings Cove	1-Electric 2-Electric	0.23 0.23	158 158	180 180	10
Dunroy	Main	Dunroy	1-Electric 2-Electric	0.34 0.47	237 325	341 375	30
Grand Highlands No. 1	Eastside	Grand Highlands No. 1	1-Electric 2-Electric	0.23 0.23	159 159	558 558	30
Grand Highlands No. 2	Grand Highlands No.1	Grand Highlands No. 2	1-Electric 2-Electric	0.23 0.23	159 159	475 475	25
Grand Highlands No. 3	Main	Grand Highlands No. 3	1-Electric 2-Electric	0.23 0.23	159 159	430 430	25
Haywood Knolls	Main	Haywood Knolls	1-Electric 2-Electric	0.12 0.12	84 84	342	15
High Vista	Main	High Vista	1-Electric 2-Electric	0.43 0.49	300 339	176 177	25
Kenmure-Greenleaf Dr.	Kenmure-Greenville Hwy	Kenmure-Greenleaf Dr.	1-Electric 2-Electric	0.46 0.46	320 320	392 392	40
Kenmure-Greenville Hwy	Main	Kenmure-Greenville Hwy	1-Electric 2-Electric	0.44 0.44	305 305	504 504	100 75
Kenmure-Railpen Gap	Kenmure-Greenville Hwy	Kenmure-Railpen Gap	1-Electric 2-Electric	0.12 0.12	84 84	290 290	10
Laurel Park Place	Main	Laurel Park Place	1-Electric 2-Electric	0.34 0.29	237 200	247 210	20
Solomon Jones	Champions Hill- Willow Rd	Solomon Jones	1-Electric 2-Electric	0.34 0.34	237 237	281 281	15
Sugar Hollow	Main	Sugar Hollow	1-Electric 2-Electric	0.34 0.34	237 237	341 341	30

Location	Inlet Zone	Outlet Zone	Pump Number	Capacity		TDH	HP
				mgd	gpm		
Addison Creek	Main	Addison Creek	1-Electric 2-Electric	0.16 0.16	111 111	104 104	5
Blacksmith Run	Eastside	Blacksmith Run	1-Electric 2-Electric	0.08 0.08	53 53	305 305	7.5
Brightwater	Main	Brightwater	1-Electric 2-Electric	0.09 0.09	60 60	120 120	5
Carriage Park Lane	Carriage Park Main	Carriage Park Lane	1-Electric 2-Electric	0.13 0.13	90 90	151 151	5
Carriage Park-Grapevine	Carriage Park Lane	Carriage Park-Grapevine	1-Electric 2-Electric	0.70 0.70	50 50	168 168	7.5
Champion Hills-Haden Dr.	Champion Hills-Willow Rd	Champion Hills-Haden Dr.	1-Electric 2-Electric	0.13 0.13	90 90	103 103	5.0
Champion Hills-Indian Cave	Champion Hills-Willow Rd	Champion Hills-Indian Cave	1-Electric 2-Electric	0.06 0.06	42 42	449 449	7.5
Cummings Cove (136)	New Cummings Cove	Cummings Cove	1-Electric 2-Electric	0.08 0.08	53 53	114 114	3
Dellwood	Main	Dellwood	1-Electric 2-Electric	0.26 0.26	180 180	340 340	20
Dunroy Hydro	Dunroy	Dunroy Hydro	1-Electric 2-Electric	0.06 0.06	42 42	224 224	3
Enchanted Forest	Main	Enchanted Forest	1-Electric 2-Electric	0.02 0.02	16 16	202 202	1.5
Golf Mountain Estates	Main	Golf Mountain Estates	1-Electric 2-Electric	0.02 0.02	15 15	225 225	2
Grand Highlands No. 4	Grand Highlands No.3	Grand Highlands No. 4	1-Electric 2-Electric	0.13 0.13	90 90	266 266	7.5
Hawthorne Hills	Main	Hawthorne Hills	1-Electric 2-Electric	0.19 0.22	130 150	496 260	25
Hearth Stone	Main	Hearth Stone	1-Electric 2-Electric	0.08 0.08	53 53	376 376	7.5
Highlander Woods	Eastside	Highlander Woods	1-Electric 2-Electric	0.16 0.16	111 111	210 210	7.5
Hunters Crossing - Surrey Lane	Main	Hunters Crossing - Surrey Lane	1-Electric 2-Electric	0.08 0.08	53 53	376 376	7.5
Hunters Crossing – Hunters Lane	Hunters Crossing-Surrey Lane	Hunters Crossing – Hunters Lane	1-Electric 2-Electric	0.06 0.06	42 42	465 465	7.5

Location	Inlet Zone	Outlet Zone	Pump Number	Capacity		TDH	HP
				mgd	gpm		
Hunters Glen	Main	Hunters Glen	1-Electric 2-Electric	0.17 0.17	117 117	340 340	30
Indian Hills	Main	Indian Hills	1-Electric 2-Electric	0.08 0.08	53 53	175 175	5
Kenmure-Poplar Loop	Kenmure-Railpen Gap	Kenmure-Poplar Loop	1-Electric 2-Electric	0.08 0.08	53 53	306 306	7.5
Long John	Main	Long John	1-Electric 2-Electric	0.23 0.23	158 158	557 557	30
Middleton Place	Main	Middleton Place	1-Electric 2-Electric	0.04 0.04	30 30	205 205	3
Mountain Valley	Main	Mountain Valley	1-Electric 2-Electric	0.08 0.08	53 53	350 376	7.5
Mountain Vista	Main	Mountain Vista	1-Electric 2-Electric	0.22 0.22	150 150	252 252	15
Overlook Terrace	Main	Overlook Terrace	1-Electric 2-Electric	0.13 0.13	92 92	225 225	10
Park Knolls	Main	Park Knolls	1-Electric 2-Electric	0.03 0.03	22 22	180 180	2
Rugby Hollow	Main	Rugby Hollow	1-Electric 2-Electric	0.03 0.03	22 22	186 137	3 2
Stonebridge	Main	Stonebridge	1-Electric 2-Electric	0.04 0.04	30 30	384 384	5
Sugarloaf School	Eastside	Sugarloaf School	1-Electric 2-Electric	0.10 0.10	69 69	362 362	15
Sweetwater Hills	Main	Sweetwater Hills	1-Electric 2-Electric	0.05 0.05	38 38	255 255	5
Tennerriffee	Main	Tennerriffee	1-Electric 2-Electric	0.04 0.04	30 30	206 205	3
Trenholm	Main	Tranholm	1-Electric 2-Electric	0.33 0.33	230 230	496 496	25
Twelfth Fairway	Main	Twelfth Fairway	1-Electric 2-Electric	0.07 0.07	50 50	40 40	5
Portable #140				0.04	30	205	3

Town of Laurel Park: Pump Summary

Location	Inlet Zone	Outlet Zone	Number of Pumps	Capacity		TDH feet	HP
				mgd	gpm		
Laurel Park	Main	Hebron	2	0.55	381	163	25
Hebron	Hebron	Echo	2	0.50	347	277	40
Echo	Echo	Apple	2	0.23	160	200	15
Apple	Apple	Sky	2	0.23	160	200	15
Sky Village	Sky	Fleetwood	2	0.23	160	200	15
Fleetwood	Fleetwood	Fleetwood Hydro	2	0.06	46	275	5

Table 2: Tank Summary

Tank	Zone	Overflow Elevation (feet)	Bowl Elevation (feet)	Range (feet)	Diameter (feet)	Capacity (MG)	SCADA
Etowah Elevated	Main Zone	2,328	2,306	32	28	0.1	Y
Ewart Hills-1	Main Zone	2,336	2,323	13	256	5.0	Y
Ewart Hills-2	Main Zone	2,336	2,321	15	238	5.0	Y
Fletcher	Main Zone	2,303	2,280	23	86	1.0	Y
Carriage Park	Carriage Park Main	2,738	2,706	32	33	0.2	Y
Champion Hills	Ch Willow	2,830	2,798	32	33	0.2	Y
Cobblestone	Claremont Main	2,790	2,766	24	31	0.1	Y
Cumming Cove	Cummingscove	2,525	2,501	24	27	0.1	N
Cummings Cove-Sanctuary	New Cummingscove	2,727	2,718.3	8'-8"	50	0.125	N
Dunroy	Dunroy	2,528	2,504	24	27	0.1	N
Eastside	Eastside	2,474	2,441	33	90	1.5	Y
Grand Highlands	Grand Highlands No 3	3,839	3,820	19	31	0.1	Y
Haywood Knolls	Haywood Knolls	2,613	2,589	24	27	0.1	Y
High Vista-A	High Vista	2,460	2,445	15	26	0.06	Y
High Vista-B	High Vista	2,460	2,445	15	25	0.05	Y
Kanuga Conference Center Private	Sugar Hollow	2,477	2,453	23	27	0.1	N
Kenmure Greenleaf-A	Kenmure Greenville Hwy	2,674	2,650	24	27	0.1	Y
Kenmure Greenleaf-B	Kenmure Greenville Hwy	2,674	2,650	24	27	0.1	Y
Kenmure Poplar Loop	Kenmure Railpengap	2,834	2,810	24	27	0.1	Y
Laurel Park	Laurel Park	2,466	2,442	24	27	0.1	N
Pinnacle Falls-	Kenmure Greenleaf	3,072	3,030	42	31	0.2	Y
Pinnacle Mountain	Kenmure Greenleaf	2,913	2,894	19	30	0.1	Y
Solomon Jones	Solomon Jones	2,962	2,937	25	28	0.1	N
Sugar Hollow	Sugar Hollow	2,625	2,601	24	24	0.08	Y

Town of Laurel Park: Tank Summary

Tank	Zone	Overflow Elevation (feet)*	Bowl Elevation (feet)*	Range (feet)	Diameter (feet)	Capacity (MG)
Hebron 1	Hebron	2506	2487	19	31	0.1
Hebron 2	Hebron	2506	2490	17	32	.095
Echo	Echo	2730	2690	40	30	0.2
Apple 1	Apple	2840	2821	19	30	0.1
Apple 2	Apple	2840	2813	28	25	0.1
Sky Village	Sky	3033	3015	18	30	.095
Fleetwood 1	Fleetwood	3114	3093	20	30	0.1
Fleetwood 2	Fleetwood	3114	3097	17	48	0.264

Table 3: PRV Summary

PRV Name	Diameter (in)	Elevation (ft)	Setting (psi)	HGL (ft)
Allen	8	2,183	70	2345
Bowen Terrace	6	2,255	90	2463
Brittany	2	2,125	85	2321
	6	2,125	85	2321
Cedar Bluffs	2	2,157	70	2319
	6	2,157	65	2307
Chattooga Run (Prickly Briar Rd)	6	2,366	60	2505
Chattooga Run 6	6	2,413	50	2529
Falls Summit	6	2,674	80	2859
Mistletoe	6	2,285	90	2493
Shaws Farm	6	2,334	60	2473
Wolf Pen	6	2,154	90	2362

1.5 Meetings with City Staff

Throughout the course of this master plan study, there were meetings with city staff to discuss progress, request data needs and agree on projections. Below is a brief description of each meeting.

The kickoff meeting took place on January 28, 2016. Previous projects from 2014 and 2015 were summarized. Next, the scope of the project was reviewed in detail.

The first progress meeting was March 17, 2016. The first part of the meeting included the planning department for discussion of future growth. The second part of the meeting focused on storage requirements, field test results, uni-directional flushing areas, pressure design criteria, and the city's current CIP.

The second progress meeting was April 19, 2016. This meeting reviewed demand projection methodology.

The third progress meeting took place September 13, 2016. This meeting reviewed the draft uni-directional flushing plan and finalized future demands and 2040 pressure zone boundaries.

A meeting on November 3, 2016, included a presentation to the Water and Sewer Technical Advisory Committee summarizing the current project and a separate meeting to review proposed improvements.

2. Field Test

2.1 Background

Hydraulic gradient (HGL) tests were conducted during a 2014 project to calibrate the model. However, the model could not match the measured flow north of the Eastside pump station during one of these tests unless we assumed a partly closed valve in the model.

The city later found a closed valve near the intersection of US 64 and Sugarloaf. However, closing this valve in the model did not produce flow and pressure predictions that matched the previous test results. Therefore, a new HGL test was conducted.

The new test included a Pitotube flow measurement using a tap the city installed downstream of Eastside pump station, which is not equipped with a meter.

The HGL test was run again.

2.2 HGL Test Results

Table 4 and Figure 2 show the results of the new HGL test. For this test, the recorded speed of the pump was 82% when operating at 48.7 Hz.

Table 4: HGL Test Results

HGL No.	Date Time	Location	Flow mgd	Head feet	Elevation feet	HGL feet	Distance feet
3B	4/27/2016	Ewart Hills Reservoirs		14	2321	2335	-
		5th Ave W -E- N Main		179	2152	2331	7,500
	12:40	Ashe & Jonas		200	2128	2328	10,300
	to	US 64 & Linda Vista		209	2117	2326	15,600
	13:00	Eastside PS - Suction	1.64	146	2177	2323	18,300
		Eastside PS - Discharge		311	2177	2488	18,300
		US 64 -N- Howard Gap		327	2160	2487	24,400
		US 64 & Pace		252	2226	2478	46,200
		Bearwallow & Old Cannon		227	2247	2474	58,900
		Eastside Tank		84	2381	2465	71,700

Eastside Pump 2 averaged 48.7 Hz.

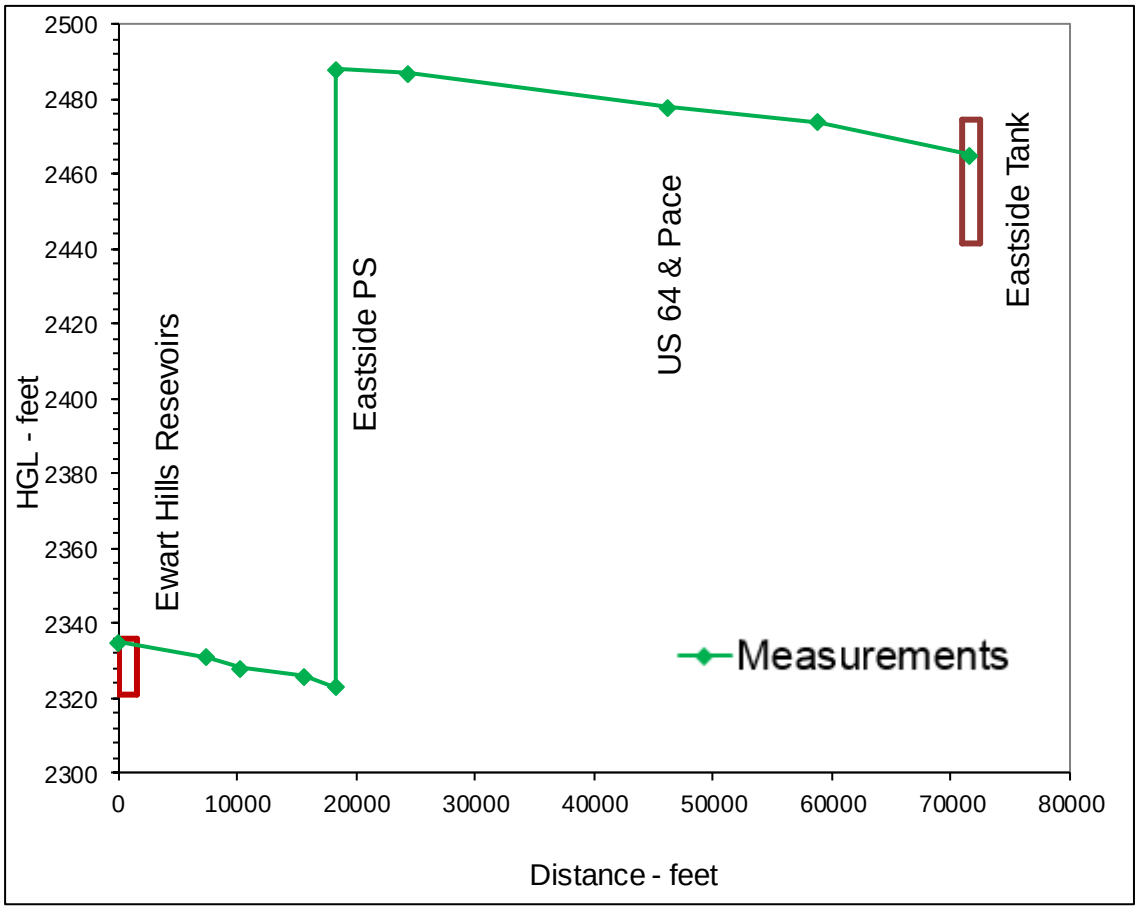


Figure 2: Measured HGLs Plotted Against Distance

2.3 Model Calibration using New HGL Test

The next step was to compare the model's predictions to the measurements. For this simulation, tanks in the model were set to levels from SCADA and Pump 2 at Eastside pump station was set to 82% speed. Figure 3 shows the results. The flow matched within 1% and all HGL predictions were within 4 feet of the measurements.

This field test documented that the model accurately calculates flows and HGLs in an important part of the system.

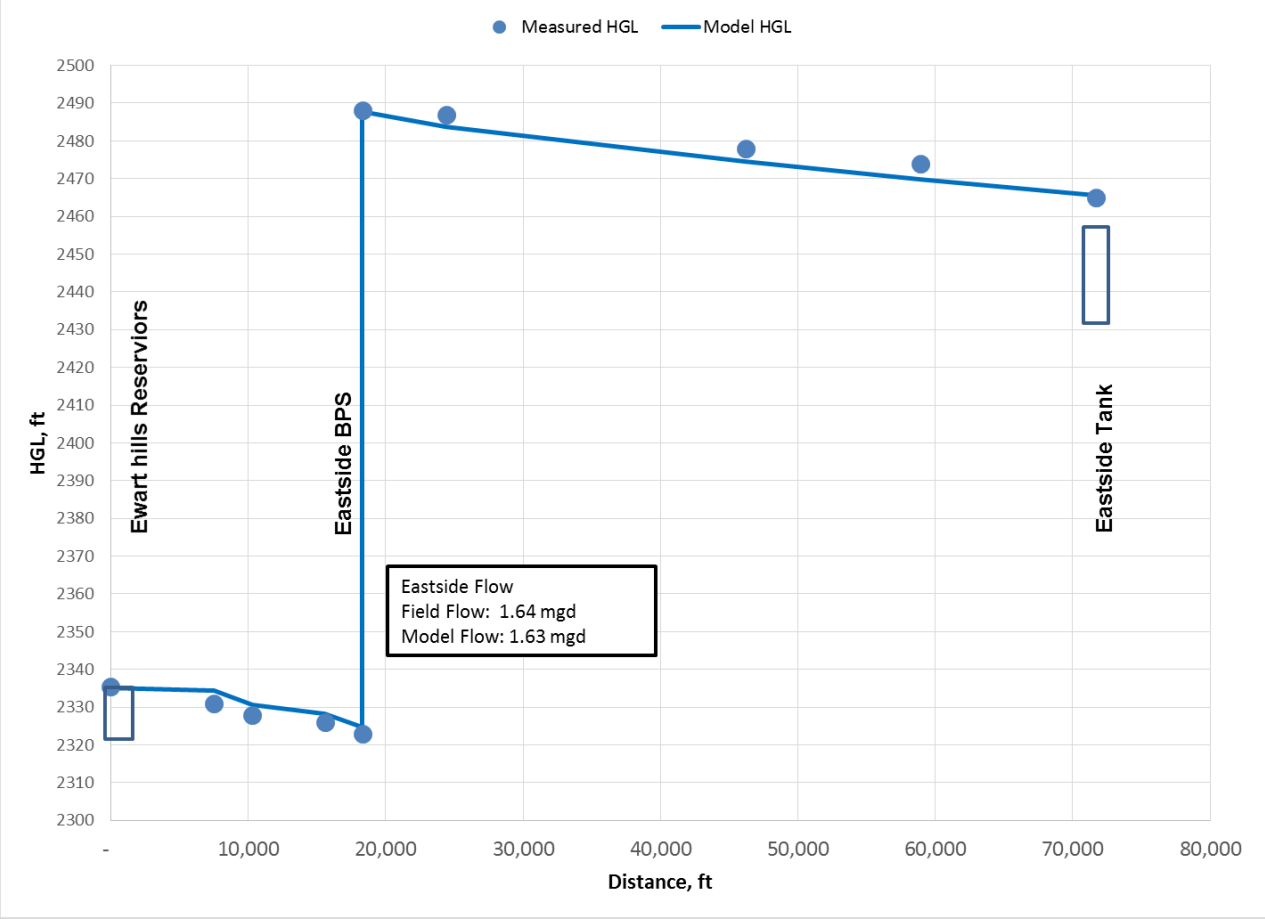


Figure 3: Model vs. Measurements

3. Evaluate Water Age

3.1 Background

Water age, which reflects travel time through a distribution system, is a general indicator of water quality. As water age increases, water quality deteriorates due to disinfectant decay and production of disinfection byproducts (DBPs). The city must sample for DBPs at approved sites to comply with EPA's Stage 2 DBP Rule.

3.2 Water Age Simulations

The model ran a 30-day simulation of existing average daily demand using current pump controls and operating procedures to map water age. Results are shown in Figure 4.

Water age greater than 1 week is generally considered excessive. Figure 4 shows areas with excessive water age in red. Figure 4 also shows the locations of the city's DBP sampling sites.

The model predicted excessive water age in many of the system's storage tanks, as shown in Figure 5.

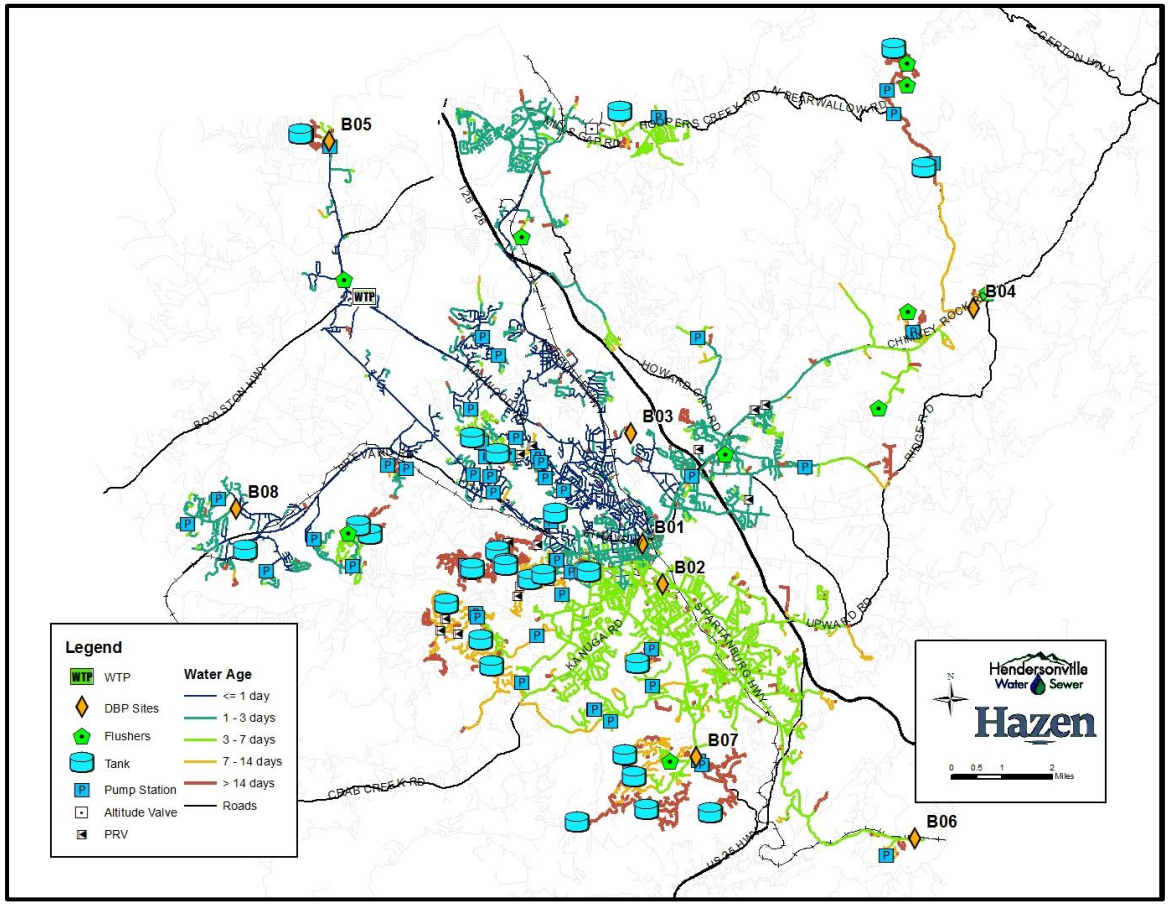


Figure 4: Average Day Water Age Predictions and DBP Sites

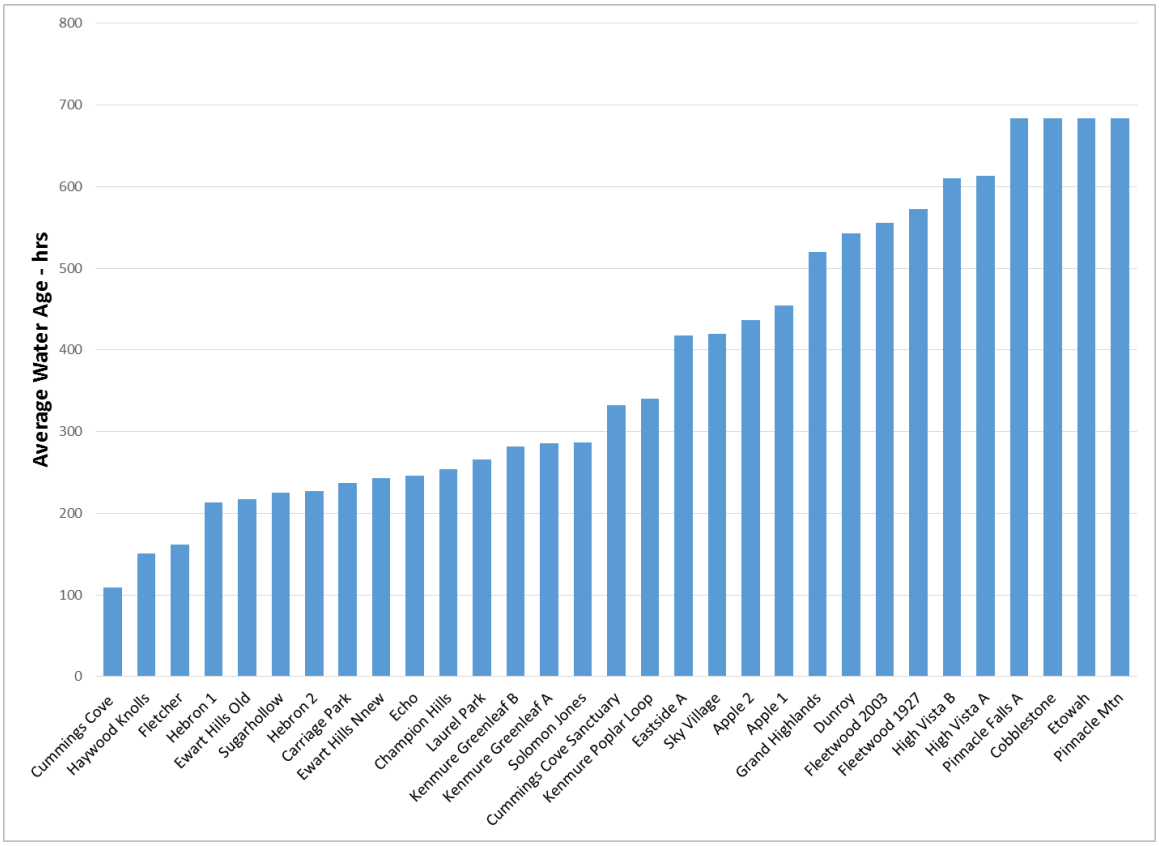


Figure 5: Existing System Average Water Age in Storage Tanks

3.3 Unidirectional Flushing

Using the water age map, seven areas with excessive water age were chosen for Unidirectional Flushing (UDF) as shown on Figure 6. These seven areas cover approximately 53 miles of pipe.

UDF is a systematic method of closing valves and opening hydrants to direct water through targeted segments of pipe. Flushing begins near sources such as water plants, trunk mains, and tanks. Closing certain valves in a prescribed sequence creates one-way flow into each segment from other pipes that have been flushed previously. Flowing hydrants induce velocities high enough to scour sediment and biofilm from the walls of the pipes. Pipes 16-inch and larger cannot be included in a UDF program because flows from hydrants cannot achieve sufficient scouring velocities.

The goals of unidirectional flushing are:

- Minimum velocity = 3 fps (removes sediment)
- Desired velocity = 5 fps (promotes scouring)
- Minimum pressure = 20 psi
- Pipe Volume Turnovers = 3

Hazen used specialized software to plan the flushing sequences. The UDF software used the hydraulic model and shapefiles describing valve and hydrant locations. The software created a field journal that was delivered to city staff for conducting the UDF program (included as Appendix B). The journal shows:

- Pipes to be flushed
- Length of flushed pipes
- Valves to be opened or closed
- Hydrants to be flushed
- Amount of flow to flush
- Amount of time to flush
- Flushing volume
- Pressures while flushing

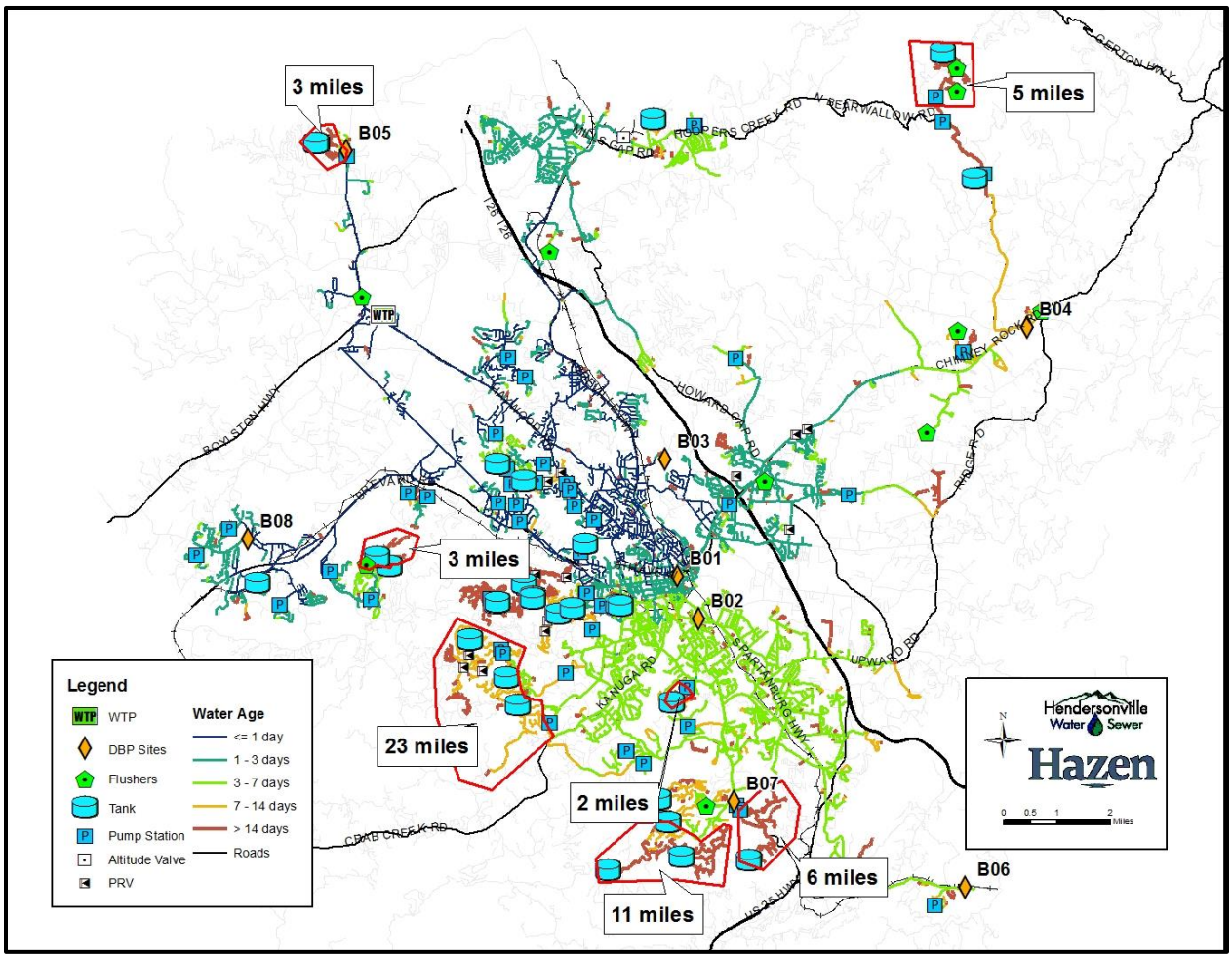


Figure 6: Unidirectional Flushing Areas

4. Existing Deficiencies

4.1 Existing Pressures

Identifying existing deficiencies included checking service pressures, available fire flows, storage capacity and pump capacity. The model simulated existing peak hour demand of 13.7 mgd and mapped pressures as shown in Figure 7.

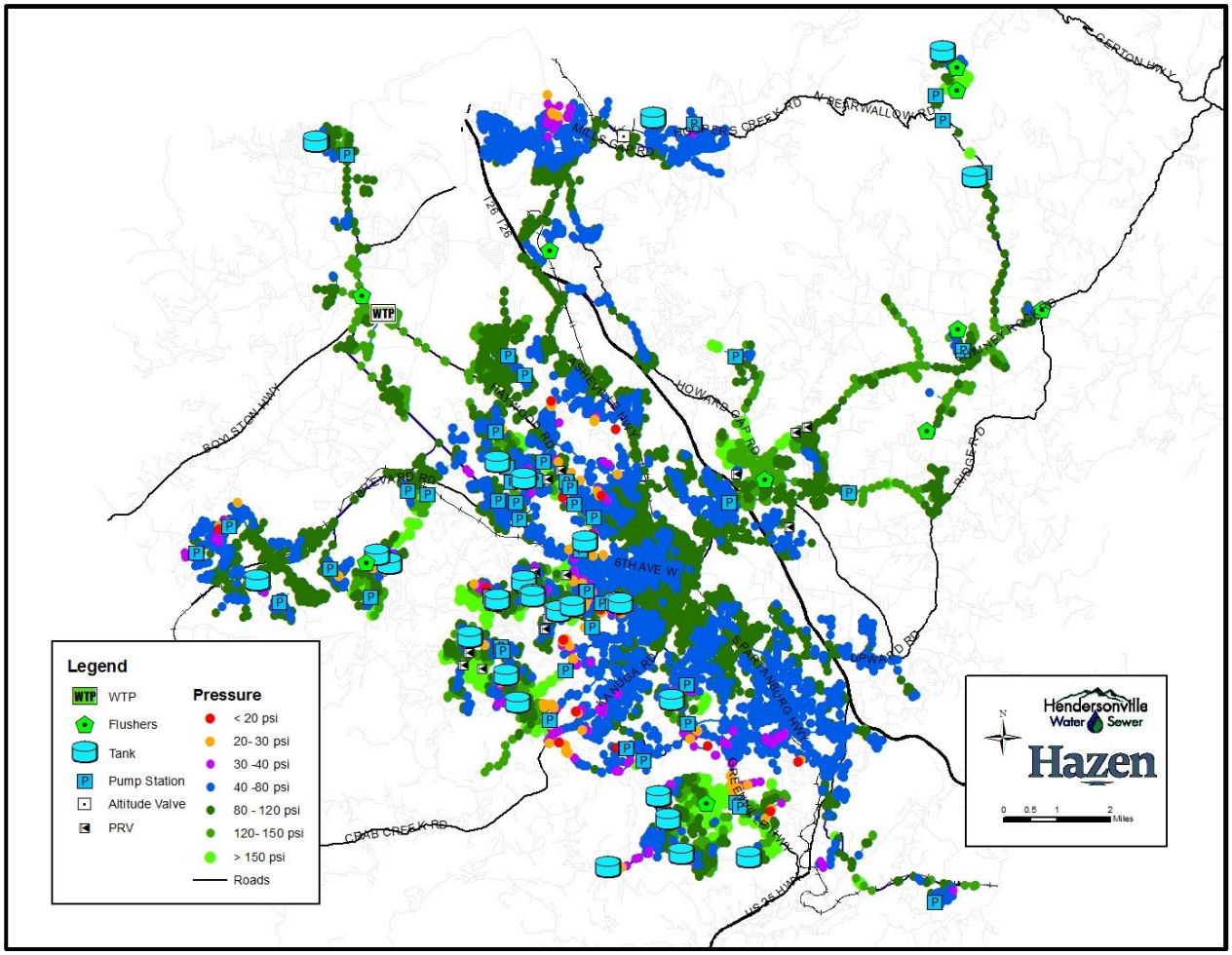


Figure 7: Existing Peak Hour Pressures

4.2 Existing Fire Flows

Figure 8 maps available fire flows predicted by the model for maximum day demand with low tank levels. The map uses the color-coding scheme recommended by the Office of the State Fire Marshal (OSFM). Hydrants shown in red have deficient fire flows less than 500 gpm. summarizes available fire flows in each OFSM category. Fire flow deficiencies were considered in the routing of improvements in a subsequent section of this report.

Most of the low pressures are related to elevations issues. The only way to improve was to move these areas into a higher pressures zone. This was done as much as possible. The low available fire flows were mostly due to elevations except for those on 4-inch or smaller water mains. It is recommended that all hydrants be moved to 6-inch water mains or larger.

Table 5: Existing Available Fire Flows

< 500 gpm	**65**
500 – 1,000 gpm	532
1,000 – 1,500 gpm	777
> 1,500 gpm	1367

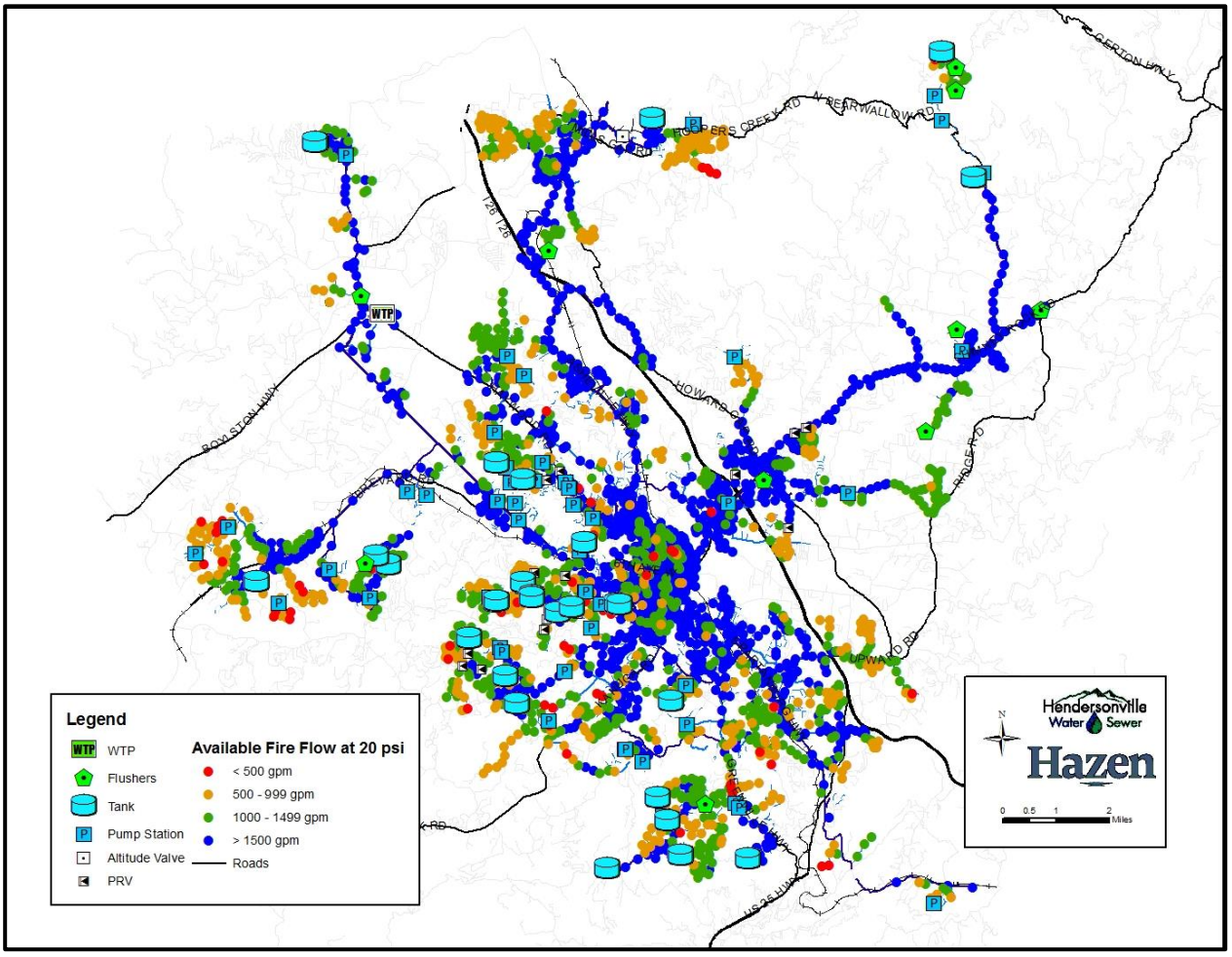


Figure 8: Existing Available Fire Flow

4.3 Existing Storage Evaluation

Our desk top storage evaluation compared an existing storage capacity to required equalizing and fire storage needs.

Equalizing storage requirements were calculated by multiplying maximum day demand in each zone by a percentage that was determined from the shape of the diurnal demand curve. Fire storage was calculated by multiplying the largest needed flow in each zone by the duration recommended by the American Water Works Association (AWWA). Table 6 shows the existing storage evaluation. Four pressures zones are deficient in meeting the equalizing and fire storage requirements. They are Cummings Cove, Sugar Hollow, Laurel Park and Solomon Jones. These storage deficiencies were taken into consideration in the design of improvements.

Table 6: Existing Storage Analysis

Existing System	Main Zone	Carriage Park Main	Haywood Knolls	Champion Hills Willow Rd	Sugar Hollow	Claremont Main	Cummings Cove	New Cummings Cove	Dunroy	Eastside	Grand Highlands	High Vista	Kenmure Greenville Hwy	Kenmure Railpengap	Laurel Park	Kenmure Greenleaf	Solomon Jones	Town of Laurel Park	TOTAL
STORAGE NEEDED																			
AVERAGE DAY DEMAND - MGD	5.75	0.077	0.022	0.046	0.058	0.025	0.045	0.009	0.005	0.678	0.02	0.035	0.053	0.037	0.016	0.063	0.058	0.13	7.13
Max Day Factor	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	
MAXIMUM DAY DEMAND - MGD	8.63	0.12	0.03	0.07	0.09	0.04	0.07	0.01	0.01	1.02	0.03	0.05	0.08	0.06	0.02	0.09	0.09	0.20	10.70
EQUALIZING STORAGE																			
EQUALIZING PERCENTAGE	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
EQUALIZING VOLUME -MG	0.86	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.10	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	1.07
FIRE STORAGE																			
NEEDED FIRE FLOW - GPM	3500	750	750	1000	1000	750	1000	750	750	2500	750	750	1500	750	1000	750	1000	1400	3500
DURATION - HOURS	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
FIRE STORAGE VOLUME - MG	0.63	0.09	0.09	0.12	0.12	0.09	0.12	0.09	0.09	0.30	0.09	0.09	0.18	0.09	0.12	0.09	0.12	0.25	0.63
EQUALIZING + FIRE STORAGE REQUIRED - MG	1.49	0.10	0.09	0.13	0.13	0.09	0.13	0.09	0.09	0.40	0.09	0.10	0.19	0.10	0.12	0.10	0.13	0.27	1.70
EXISTING STORAGE	11.10	0.20	0.10	0.20	0.08	0.10	0.10	0.13	0.10	1.50	0.10	0.11	0.20	0.10	0.10	0.30	0.10	1.10	15.72
EQ + FIRE EXCESS STORAGE SURPLUS/DEFICIT - MG	9.61	0.10	0.01	0.07	**-0.05**	0.01	**-0.03**	0.03	0.01	1.10	0.01	0.01	0.01	0.00	**-0.02**	0.20	**-0.03**	0.83	14.02
PWS STORAGE REQUIRED (1/2 ADD) - MG																			3.57
EXISTING STORAGE																			15.72
PWS STORAGE SURPLUS/DEFICIT - MG																			12.15

4.4 Existing Pump Evaluation

Table 7 evaluated existing pumping capacity by pressure zone comparing current demands to existing firm capacity with the largest pump in each pump station out of service. Maximum day demands apply to stations that supply zones with floating storage. Peak hour demands apply for zones without storage using the NC Rules Governing Public Water Supply Systems as shown in Figure 9. The table identifies several pump capacity deficiencies that are addressed in subsequent sections of this report.

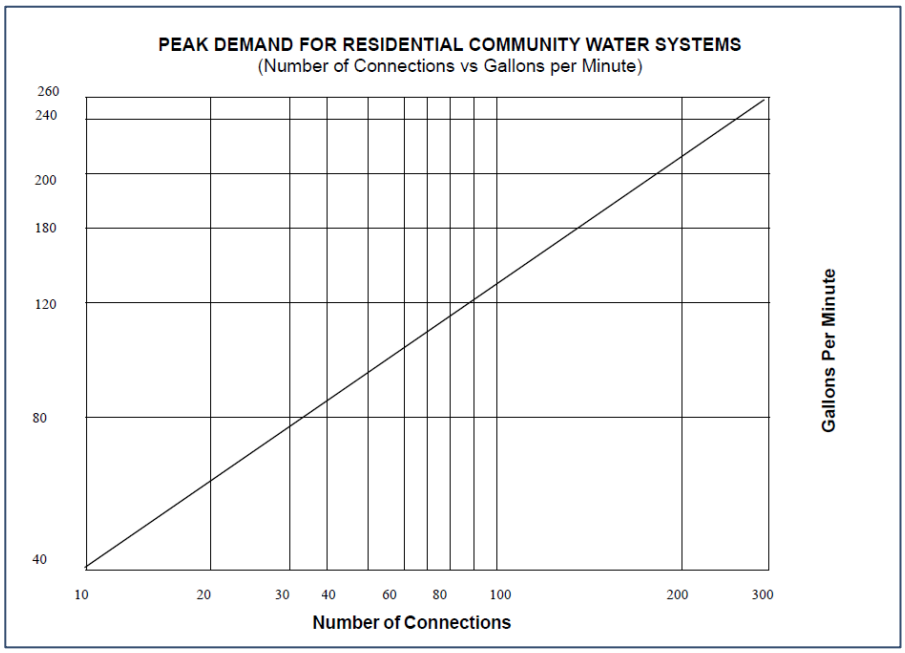


Figure 9: Chart for Determining Peak Demand from NC Rules Governing Public Water Supply

Table 7: Existing Pump Capacity

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Maximum Day Demand, mgd	Status
New WTP Pump	Clearwell	Main	21.00	10.69	OK
Eastside Booster	Main	Eastside	4.00	1.05	OK
Carriage Park Main	Main	Carriage Park Main	0.23	0.01	OK
Champions Hill-Willow Rd	Main	Champions Hill-Willow Rd	0.4	0.16	OK
Claremont (Main)	Crail Farm	Claremont (Main)	0.77	0.04	OK
Cummings Cove	Main	Cummings Cove	0.12	0.08	OK
Cummings Cove (New)	Cummings Cove	Cummings Cove	0.23	0.01	OK
Dunroy	Main	Dunroy	0.34	0.01	OK
Grand Highlands No. 1	Eastside	Grand Highlands No. 1	0.23	0.03	OK
Grand Highlands No. 2	Grand Highlands No.1	Grand Highlands No. 2	0.23	0.03	OK
Grand Highlands No. 3	Main	Grand Highlands No. 3	0.23	0.03	OK
Haywood Knolls	Main	Haywood Knolls	0.12	0.03	OK
High Vista	Main	High Vista	0.43	0.05	OK
Kenmure-Greenleaf Dr.	Kenmure-Greenville Hwy	Kenmure-Greenleaf Dr.	0.46	0.09	OK
Kenmure-Greenville Hwy	Main	Kenmure-Greenville Hwy	0.44	0.23	OK
Kenmure-Railpen Gap	Kenmure-Greenville Hwy	Kenmure-Railpen Gap	0.12	0.06	OK
Laurel Park Place	Main	Laurel Park Place	0.29	0.02	OK
Solomon Jones	Champions Hill- Willow Rd	Solomon Jones	0.34	0.08	OK
Sugar Hollow	Main	Sugar Hollow	0.34	0.09	OK
Town of Laurel Park – Laurel Park	Main	Hebron	0.55	0.19	OK

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Maximum Day Demand, mgd	Status
Town of Laurel Park -Hebron	Hebron	Echo	0.50	0.18	OK
Town of Laurel Park -Echo	Echo	Apple	0.23	0.15	OK
Town of Laurel Park -Apple	Apple	Sky	0.23	0.11	OK
Town of Laurel Park -Sky Village	Sky	Fleetwood	0.23	0.06	OK
Town of Laurel Park -Fleetwood	Fleetwood	Fleetwood Hydro	0.06	0.02	OK

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Peak Hour Demand, mgd	Status
Addison Creek	Main	Addison Creek	0.16	0.144	OK
Blacksmith Run	Eastside	Blacksmith Run	0.08	0.151	Deficient
Brightwater	Main	Brightwater	0.09	0.089	OK
Carriage Park Lane	Carriage Park Main	Carriage Park Lane	0.13	0.144	Deficient
Carriage Park-Grapevine	Carriage Park Lane	Carriage Park-Grapevine	0.70	0.115	OK
Champion Hills-Haden Dr.	Champion Hills-Willow Rd	Champion Hills-Haden Dr.	0.13	0.089	OK
Champion Hills-Indian Cave	Champion Hills-Willow Rd	Champion Hills-Indian Cave	0.06	0.122	Deficient
Cummings Cove (new)	New Cummings Cove	Cummings Cove	0.08	0.374	Deficient
Dellwood	Main	Dellwood	0.26	0.144	OK
Dunroy Hydro	Dunroy	Dunroy Hydro	0.06	0.059	OK
Enchanted Forest	Main	Enchanted Forest	0.02	0.058	Deficient
Golf Mountain Estates	Main	Golf Mountain Estates	0.02	0.058	Deficient
Grand Highlands No. 4	Grand Highlands No.3	Grand Highlands No. 4	0.13	0.058	OK
Hawthorne Hills	Main	Hawthorne Hills	0.19	0.202	Deficient

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Peak Hour Demand, mgd	Status
Hearth Stone	Main	Hearth Stone	0.08	0.091	Deficient
Highlander Woods	Eastside	Highlander Woods	0.16	0.271	Deficient
Hunters Crossing - Surrey Lane	Main	Hunters Crossing - Surrey Lane	0.08	0.144	Deficient
Hunters Crossing – Hunters Lane	Hunters Crossing- Surrey Lane	Hunters Crossing – Hunters Lane	0.06	0.058	OK
Hunters Glen	Main	Hunters Glen	0.17	0.216	Deficient
Indian Hills	Main	Indian Hills	0.08	0.089	Deficient
Kenmure-Poplar Loop	Kenmure-Railpen Gap	Kenmure-Poplar Loop	0.08	0.079	OK
Long John	Main	Long John	0.23	0.187	OK
Middleton Place	Main	Middleton Place	0.04	0.130	Deficient
Mountain Valley	Main	Mountain Valley	0.08	0.170	Deficient
Mountain Vista	Main	Mountain Vista	0.22	0.086	OK
Overlook Terrace	Main	Overlook Terrace	0.13	0.202	Deficient
Park Knolls	Main	Park Knolls	0.03	0.079	Deficient
Rugby Hollow	Main	Rugby Hollow	0.03	0.060	Deficient
Stonebridge	Main	Stonebridge	0.04	0.088	Deficient
Sugarloaf School	Eastside	Sugarloaf School	0.10	0.268	Deficient
Sweetwater Hills	Main	Sweetwater Hills	0.05	0.084	Deficient
Tennerriffee	Main	Tennerriffee	0.04	0.062	Deficient
Trenholm	Main	Tranholm	0.33	0.144	OK
Twelfth Fairway	Main	Twelfth Fairway	0.07	0.062	OK

5. Water Demand Projections

5.1 Overview

The water system master plan included projecting future water demands through the year 2040 in the current service areas and in the surrounding urban and rural transition areas. Demand projections were based on population projections for traffic analysis zones (TAZs) within the 2040 service area. The extent of the future service area was based on discussions with city staff and input from the city and county planning departments.

New demands were estimated by multiplying new population supplied by current average per capita use with a 10% percent non-revenue water. This assumes that the city will reduce its existing non-revenue water. New demands were combined with existing demands to estimate the total future demand in the study area. Peaking factors were then applied based on WTP production records and current diurnal demand patterns.

5.2 Population Projections

Hazen met with the city and county planning departments to define the future service area. This area includes the exisiting service area, urban service area and rural transistion area, defined by City with input from County staff. A portion of this area that is likely to be supplied by Asheville was removed from the Hendersonville service area. Figure 10 shows the final future service area used for this study.

The French Broad River Metropolitan Planning Organization (FBRMPO) has developed TAZ population estimates for 2010 and 2040. The 2040 population estimates for TAZs within the existing service area included the current population served, and the hydraulic model already includes the demand for these customers based on billing records current population. Therefore, the current population supplied for TAZs in the existing service area was subtracted from the 2040 TAZ population estimates. For TAZs outside the the existing service area, the 2040 TAZ total polulation was used to calculate the new population supplied.

An adjustment was made to allow for additional growth beyond the TAZ projections in the Etowah area. According to the Etowah and Horse Shoe Communities Plan, there are several locations where residential development will be turned into commercial districts. The City also provided us information regarding several larger residential developments that may occur. Based on these plans, this growth was projected to be equivalent to approximately 4,300 people.

5.3 Per Capita Use

In order to estimate the additional water demand to be supplied, the projected increase in the population of the service area was multiplied by the current per capita water usage calculated from billing records. From the 2015 Hydraulic Modeling Study, residential and small commercial customers use an average of 4.28 mgd. The current population served is approximately 56,000. The corresponding average per capita demand is approximately 76 gpd. After discussion with city staff, it was agreed to add 10% to the per capita water usage to allow for non-revenue water. Therefore, the per capita demand used to project new water demand is 84 gpd.

Based on these assumptions, we estimated an additional population of 74,000 people will be supplied by the water system by 2040.

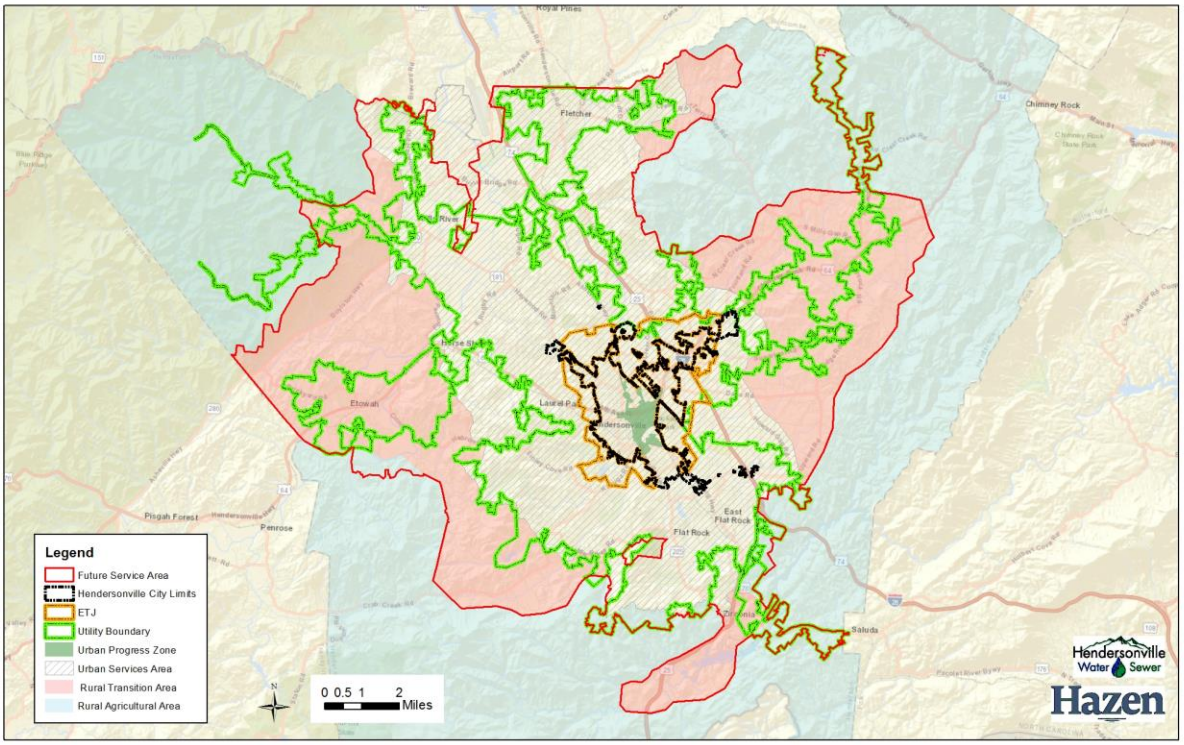


Figure 10: Future Service Area

5.4 Nonrevenue Water

The 2015 Hydraulic Modeling Project showed that non-revenue water was approximatley 30% of the total production of the water plant. The city has implemented a leakage control program with the goal of decreasing non-revenue water to 10%. We included this goal in the model by adjusting the per capita consumption by 10% for new population supplied, and by decreasing the non-revenue water in the existing service area by overtime 5% per year until 2035, when we assumed it would hold at 10%. This

implies that non-revenue water in the existing service area will drop for 2.16 mgd in 2014 to 0.55 mgd in 2040, a decrease of 0.61 mgd.

5.5 New Industrial Demand

Hazen interviewed staff from the Henderson County Partnership for Economic Development to discuss the possible industrial growth. It was agreed that by 2040 average daily industrial demand of 0.6 mgd could occur in the service area. The consultant working on improvements for the Fletcher Zone estimated industrial average daily demand of 0.21 mgd could occur in this zone. The remaining 0.39 mgd of new industrial use was distributed to the remaining industrial sites.

5.6 Wholesale Allowance

The city currently sells water to Laurel Park and Saluda. The Laurel Park water system is now included in the city's model, and the potential growth for this area was included in the TAZ population projections. The contractual maximum rate to Saluda is 0.2 mgd and they currently use 0.10 mgd, so an allowance for an additional 0.10 mgd was included in the demand projections.

5.7 Maximum Day Peaking Factor

Average day demand is the best basis for projecting future demand; however, maximum day demand is the critical requirement for production capacity and pump stations. Maximum day demand is the highest daily demand in a year and it varies in most water systems due to rainfall .

The record flow from the WTP was 12.79 mgd in 2009, as shown in Figure 11. Based on conversations with the city staff, there were flow meter issues in 2009. During the last 20 years, excluding 2009, the highest maximum day peaking factor was 148%. City staff agreed to use 150% as the maximum day factor for estimating future demands.

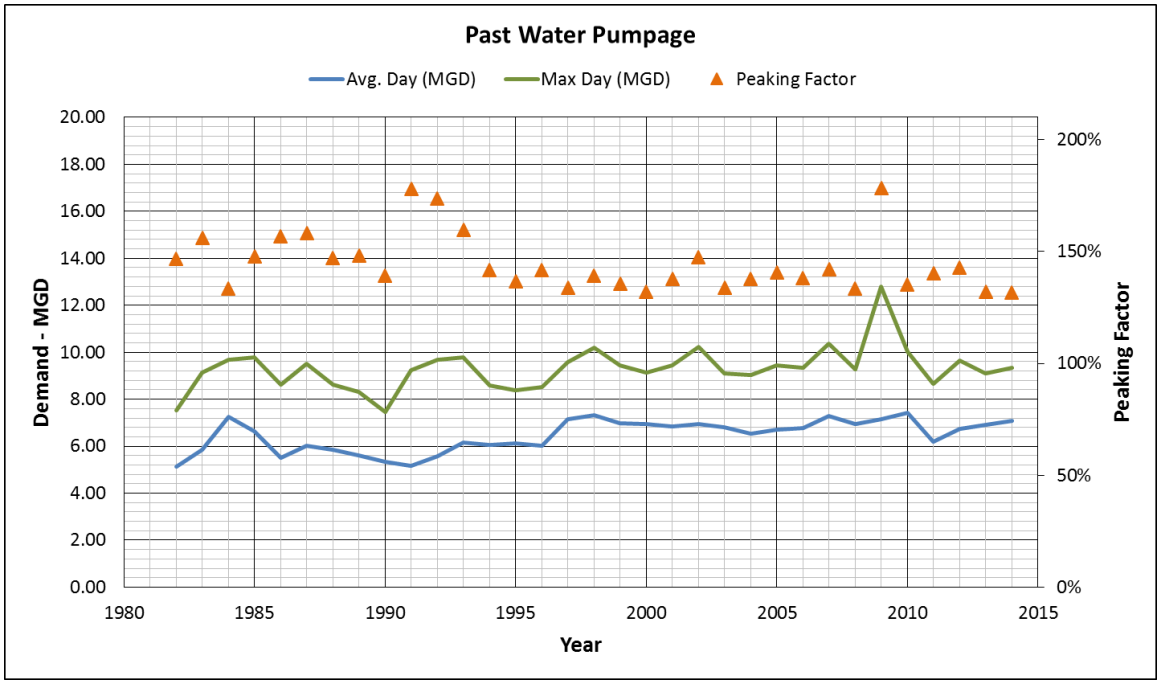


Figure 11: Hendersonville Maximum Day Peaking Factor

5.8 Demand Projection Summary

Table 8 summarizes the average day demand projection for 2040. Table 9 shows projected demands in 5-year increments. The peak hour estimates assume a peaking factor of 130%, which was determined from system diurnal pattern, as shown in Figure 12.

Table 8: 2040 Average Day Water Demand Summary

	AVERAGE DAY MGD
2014 Annual Average Production	7.13 mgd
2014-2040 Residential and Commercial Growth from TAZ (includes Laurel Park)	**6.22** mgd
2040 Additional Wholesale (Saluda)	0.10 mgd
2040 Industrial Allowance	0.60 mgd
Reduction in NRW (to 0.55 mgd)	-1.61 mgd
Total Average Day Water Demand by 2040	**12.44 mgd**
Maximum Day Demand Projection	**18.66 mgd**

Table 9: Demand Projections

MGD	2015	2020	2025	2030	2035	2040
ADD	7.13	8.04	9.12	10.11	11.11	12.44
MDD	10.70	12.07	13.68	15.17	16.67	18.66
Peak Hour	13.69	15.69	17.78	19.72	21.67	24.26
MDD & 3500 gpm Fire	11.33	12.70	14.31	15.80	17.30	19.29

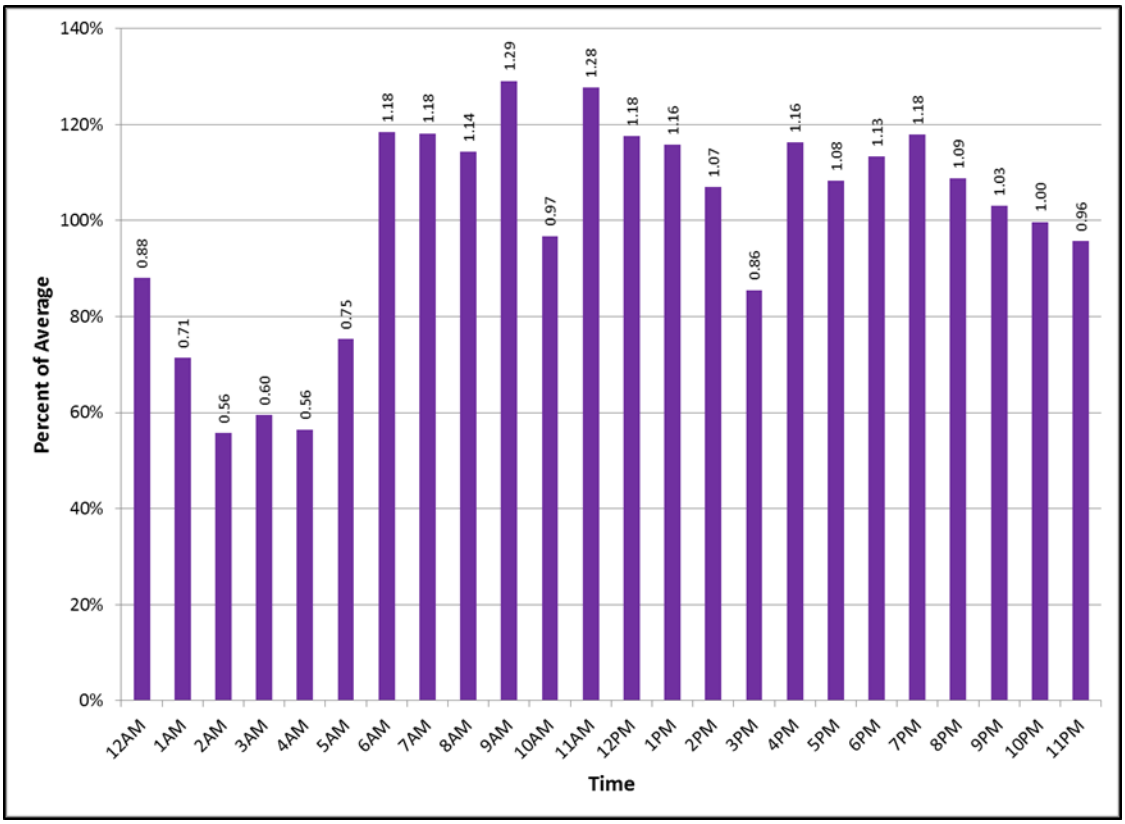


Figure 12: Diurnal Pattern

6. Evaluate Pump and Tank Capacity

Table 10 evaluated existing storage capacity for project water demands in 2040. The table calculates equalizing and fire storage in each pressure zone for comparison with existing storage capacity. Equalizing storage to allow constant pumping rates was calculated by multiplying maximum day demand in each pressure zone by a percentage that was derived from the system diurnal demand pattern. Fire storage requirements were calculated by multiplying the maximum needed fire flow in each pressure zone by the duration recommended by the AWWA. The table then adds equalizing and fire storage requirements and compares with the existing floating storage capacity in each pressure zone.

- Pressure Zone changes from the existing system are as follows:
- The main zone is broken into four different zones: Main, Etowah, Fletcher and Southside
- Carriage Park Main and Haywood Knolls zones will become part of the new Long John Mountain Zone
- Sugar Hollow Zone will be combined with Champion Hills Willow Rd Zone
- Three additional zones were added to growth areas
- 6 tanks were abandoned: Etowah Elevated (Main Zone), Fletcher (Main Zone) Carriage Park and Haywood Knolls (Long John Mountain Zone), Pinnacle Mountain (Kenmure Greenleaf Zone), Sugar Hollow (Champion Hills Willow Rd Zone)

Table 10 identifies several storage deficiencies that are addressed by proposed tanks in subsequent sections of this report. The table also checks total system storage (including WTP clearwells) with the PWS requirement of half the average day demand. The requirement for 2040 is 6.21 mg and the existing storage is sufficient. The City has plenty of storage and may want to consider removing one of the Ewart Hill Reservoirs.

Table 11 evaluated 2040 pumping capacity by pressure zone by comparing projected demands to existing firm capacity with the largest pump in each pump station out of service. Maximum day demands apply to stations that supply zones with floating storage. Peak hour demands apply for zones without storage using the NC Rules Governing Public Water Supply Systems, as shown in Figure 9. The pump capacity table shows which stations will be abandoned and lists several new stations. The table identifies several pump capacity deficiencies that are addressed by proposed pumps in subsequent sections of this report.

Table 10: 2040 Storage Evaluation

2040 System	Main Zone	Etowah	Fletcher	Southside	Long John Mountain	Champion Hills Willow Rd	Claremont Main	Cummings Cove	New Cummings Cove	Dunroy	Eastside	Grand Highlands	High Vista	Kenmure Greenville Hwy	Kenmure Railpengap	Laurel Park	Kenmure Greenleaf	Solomon Jones	Town of Laurel Park	Red Top	Summit Landing	Crab Creek	TOTAL
STORAGE NEEDED																							
AVERAGE DAY DEMAND - MGD	6.26	0.67	1.15	0.31	0.23	0.15	0.08	0.04	0.01	0.03	2.46	0.02	0.04	0.05	0.05	0.01	0.06	0.10	0.29	0.19	0.12	0.10	12.42
Max Day Factor	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	150%	
MAXIMUM DAY DEMAND - MGD	9.40	1.01	1.73	0.47	0.34	0.22	0.11	0.06	0.02	0.05	3.69	0.03	0.05	0.08	0.08	0.02	0.09	0.14	0.44	0.29	0.18	0.15	18.64
EQUALIZING STORAGE																							
EQUALIZING PERCENTAGE	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
EQUALIZING VOLUME -MG	0.94	0.10	0.17	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.37	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.04	0.03	0.02	0.01	1.86
FIRE STORAGE																							
NEEDED FIRE FLOW - GPM	3500	2500	3000	2500	1000	1000	750	1000	750	750	2500	750	750	1500	750	1000	750	700	1400	1000	1500	1000	3500
DURATION - HOURS	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	3
FIRE STORAGE VOLUME - MG	0.63	0.30	0.54	0.30	0.12	0.12	0.09	0.12	0.09	0.09	0.30	0.09	0.09	0.18	0.09	0.12	0.09	0.08	0.25	0.12	0.18	0.12	0.63
EQUALIZING + FIRE STORAGE REQUIRED - MG	1.57	0.40	0.71	0.35	0.15	0.14	0.10	0.13	0.09	0.09	0.67	0.09	0.10	0.19	0.10	0.12	0.10	0.10	0.30	0.15	0.20	0.13	2.49
EXISTING STORAGE	10.00					0.20	0.10	0.10	0.13	0.10	1.50	0.10	0.11	0.20	0.10	0.10	0.20	0.10	1.10				14.14
EQ + FIRE EXCESS STORAGE SURPLUS/DEFICIT - MG	8.43	-0.40	-0.71	-0.35	-0.15	0.06	0.00	-0.03	0.03	0.01	0.83	0.01	0.01	0.01	0.00	-0.02	0.10	0.00	0.81	-0.15	-0.20	-0.13	11.64
PWS STORAGE REQUIRED (1/2 ADD) - MG																							6.21
EXISTING STORAGE																							14.14
PWS STORAGE SURPLUS/DEFICIT - MG																							7.93

Table 11: 2040 Pumping Capacity

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	2040 Maximum Day Demand, mgd	Status
New WTP Pump	Clearwell	Main	21.00	18.65	OK
Balfour (2025)	Main	Eastside	4.00	3.71	OK
Eastside Booster					
Etowah (2017)	Main	Etowah	Design by others	1.01	OK
Carriage Park Main	Main	Carriage Park Main	0.23	0.15	OK
Champions Hill-Willow Rd	Main	Champions Hill-Willow Rd	0.4	0.36	OK
Claremont (Main)	Crail Farm	Claremont (Main)	0.77	0.29	OK
Crab Creek (2025)	Crail Farm	Crab Creek	0.15	0.15	OK
Crail Farm (2025)	Main	Crail Farm	2.00	2.00	OK
Cummings Cove	Main	Cummings Cove	0.12	0.08	OK
Cummings Cove (New)	Cummings Cove	Cummings Cove	0.23	0.02	OK
Dunroy	Main	Dunroy	0.34	0.05	OK
Fletcher (2025)	Main	Fletcher	Design by others	1.73	OK
Grand Highlands No. 1	Eastside	Grand Highlands No. 1	0.23	0.03	OK
Grand Highlands No. 2	Grand Highlands No.1	Grand Highlands No. 2	0.23	0.03	OK
Grand Highlands No. 3	Main	Grand Highlands No. 3	0.23	0.03	OK
Haywood Knolls	Main	Haywood Knolls	0.12	ABANDON	
High Vista	Main	High Vista	0.43	0.05	OK
Hunters (2020)	Main	Hunters	0.35	0.34	OK

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	2040 Maximum Day Demand, mgd	Status
Kenmure-Greenleaf Dr.	Kenmure-Greenville Hwy	Kenmure-Greenleaf Dr.	0.46	0.12	OK
Kenmure-Greenville Hwy	Crail Farm	Kenmure-Greenville Hwy	0.44	0.26	OK
Kenmure-Railpen Gap	Kenmure-Greenville Hwy	Kenmure-Railpen Gap	0.12	0.07	OK
Laurel Park Place	Main	Laurel Park Place	0.29	0.02	OK
Red Top (2035)			0.30	0.29	OK
Solomon Jones	Champions Hill- Willow Rd	Solomon Jones	0.34	0.14	OK
Sugar Hollow	Main	Sugar Hollow	0.34	ABANDON	
Town of Laurel Park (2030)	Main	Hebron	0.55	0.44	OK
Town of Laurel Park -Hebron	Hebron	Echo	0.50	0.34	OK
Town of Laurel Park -Echo	Echo	Apple	0.23	0.29	Deficient
Town of Laurel Park -Apple	Apple	Sky	0.23	0.21	OK
Town of Laurel Park -Sky Village	Sky	Fleetwood	0.23	0.12	OK
Town of Laurel Park -Fleetwood	Fleetwood	Fleetwood Hydro	0.06	0.08	Deficient

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Peak Hour Demand, mgd	Status
Addison Creek	Main	Addison Creek	0.16	0.14	OK
Bay Laurel (2020)	Hunters	Bay Laurel	0.13	0.13	OK
Blacksmith Run	Eastside	Blacksmith Run	0.08	0.15	Deficient
Brightwater	Main	Brightwater	0.09	ABANDON	
Brookside (2040)	Main	Brookside	0.37	0.37	OK
Burge Mountain (2040)	Brookside	Burge Mountain	0.32	0.32	OK
Carriage Park Lane	Carriage Park Main	Carriage Park Lane	0.13	ABANDON	
Carriage Park-Grapevine	Carriage Park Lane	Carriage Park-Grapevine	0.70	ABANDON	
Champion Hills-Haden Dr.	Champion Hills-Willow Rd	Champion Hills-Haden Dr.	0.13	0.089	OK
Champion Hills-Indian Cave	Champion Hills-Willow Rd	Champion Hills-Indian Cave	0.06	0.122	Deficient
Crab Creek BPS (2040)	Crab Creek	Crab Creek BPS	0.144	0.14	OK
Cummings Cove	New Cummings Cove	Cummings Cove	0.08	0.374	Deficient
Davis Mountain (2040)	Red Top	Davis Mountain	0.33	0.33	OK
Dellwood	Main	Dellwood	0.26	0.144	OK
Dunroy Hydro	Dunroy	Dunroy Hydro	0.06	0.059	OK
Enchanted Forest	Main	Enchanted Forest	0.02	ABANDON	
Evans Rd (2040)	Red Top	Evans	0.17	0.17	OK
Golf Mountain Estates	Main	Golf Mountain Estates	0.02	ABANDON	
Grand Highlands No. 4	Grand Highlands No.3	Grand Highlands No. 4	0.13	0.058	OK
Hawthorne Hills	Main	Hawthorne Hills	0.19	ABANDON	
Hearth Stone	Main	Hearth Stone	0.08	0.091	Deficient

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Peak Hour Demand, mgd	Status
Highlander Woods	Eastside	Highlander Woods	0.16	0.271	Deficient
Holiday Dr (2040)	Crab Creek	Holiday Dr	0.14	0.14	OK
Hunters Crossing - Surrey Lane	Main	Hunters Crossing - Surrey Lane	0.08	ABANDON	
Hunters Crossing – Hunters Lane	Hunters Crossing- Surrey Lane	Hunters Crossing – Hunters Lane	0.06	ABANDON	
Hunters Glen	Main	Hunters Glen	0.17	0.22	Deficient
Hutch Mountain (2040)	Fletcher	Hutch Mountain	0.20	0.20	OK
Indian Hills	Main	Indian Hills	0.08	0.09	Deficient
Kanuga Ridge (2040)	Evans	Kanuga Ridge	0.13	0.13	OK
Kenmure-Poplar Loop	Kenmure-Railpen Gap	Kenmure-Poplar Loop	0.08	0.08	OK
Long John	Main	Long John	0.23	ABANDON	
Mailey Dr (2025)	Main	Mailey	0.32	0.32	OK
Middleton Place	Main	Middleton Place	0.04	ABANDON	
Mountain Valley	Main	Mountain Valley	0.08	0.170	Deficient
Mountain Vista	Main	Mountain Vista	0.22	0.086	OK
Old Distillery (2040)	Crail Farm	Old Distillery	0.12	0.12	OK
Old Timey (2040)	Hutch Mountain	Old Timey	0.06	0.06	OK
Overlook Terrace	Main	Overlook Terrace	0.13	ABANDON	
Park Knolls	Main	Park Knolls	0.03	ABANDON	
Rugby Hollow	Main	Rugby Hollow	0.03	0.06	Deficient
Stonebridge	Main	Stonebridge	0.04	0.088	Deficient
Sugarloaf School	Eastside	Sugarloaf School	0.10	ABANDON	

Location	Inlet Zone	Outlet Zone	Firm Pumping Capacity, mgd	Peak Hour Demand, mgd	Status
Sweetwater Hills	Main	Sweetwater Hills	0.05	0.08	Deficient
Tall Pines (2020)	Main	Tall Pines	0.13	0.13	OK
Tennerriffee	Main	Tennerriffee	0.04	0.062	Deficient
Trenholm	Main	Tranholm	0.33	ABANDON	
Twelfth Fairway	Main	Twelfth Fairway	0.07	0.062	OK
Laurel Park	Main	Hebron	0.24	ABANDON	

7. Recommended Improvements

7.1 Background

The calibrated model was used to simulate projected demands in the study area to the year 2040. Predicted results were compared with design criteria to identify areas where improvements are needed. After discussions with city staff, we used the following design criteria to judge system performance:

- Minimum Pressure- 20 psi for fire flows; 40 psi for peak hour as a goal, 30 psi to meet PWS Rules
- Maximum Pressure- 150 psi
- Maximum Velocities- 5 fps during peak hour
- Pump stations supplying pressure zones with floating storage tanks should have firm capacity exceeding maximum day demand
- Pump stations with variable speed pumps supplying pressure zones without floating storage must have firm capacity exceeding peak hour demand and comply with NC Rules Governing Public Water Supply Systems (section 0.0801 & 0.0802)
- Storage in each pressure zone should supply the difference between peak hour and maximum day demand with a reserve for fire supply
- The minimum fire flow in any pressure zone is 500 gpm with a goal of 1,000 gpm, where possible. For industrial areas, the goal was 2,500 to 3,000 gpm.

Initial modeling identified problem areas by simulating future demands with the existing pipe system and new 8-inch water mains to serve growth areas. This simulation showed major pressure problems, as shown in Figure 13. Improvement alternatives were tested in subsequent simulations.

In choosing between viable alternatives, consideration was given to hydraulic performance, capital cost, and input from city staff. Most of the recommended water mains are 8-inch pipes to provide fire flows; however, 12-inch pipes were recommended to supply higher fire flows for industies. We recommend 6-inch pipes when connecting to existing 6-inch pipes.

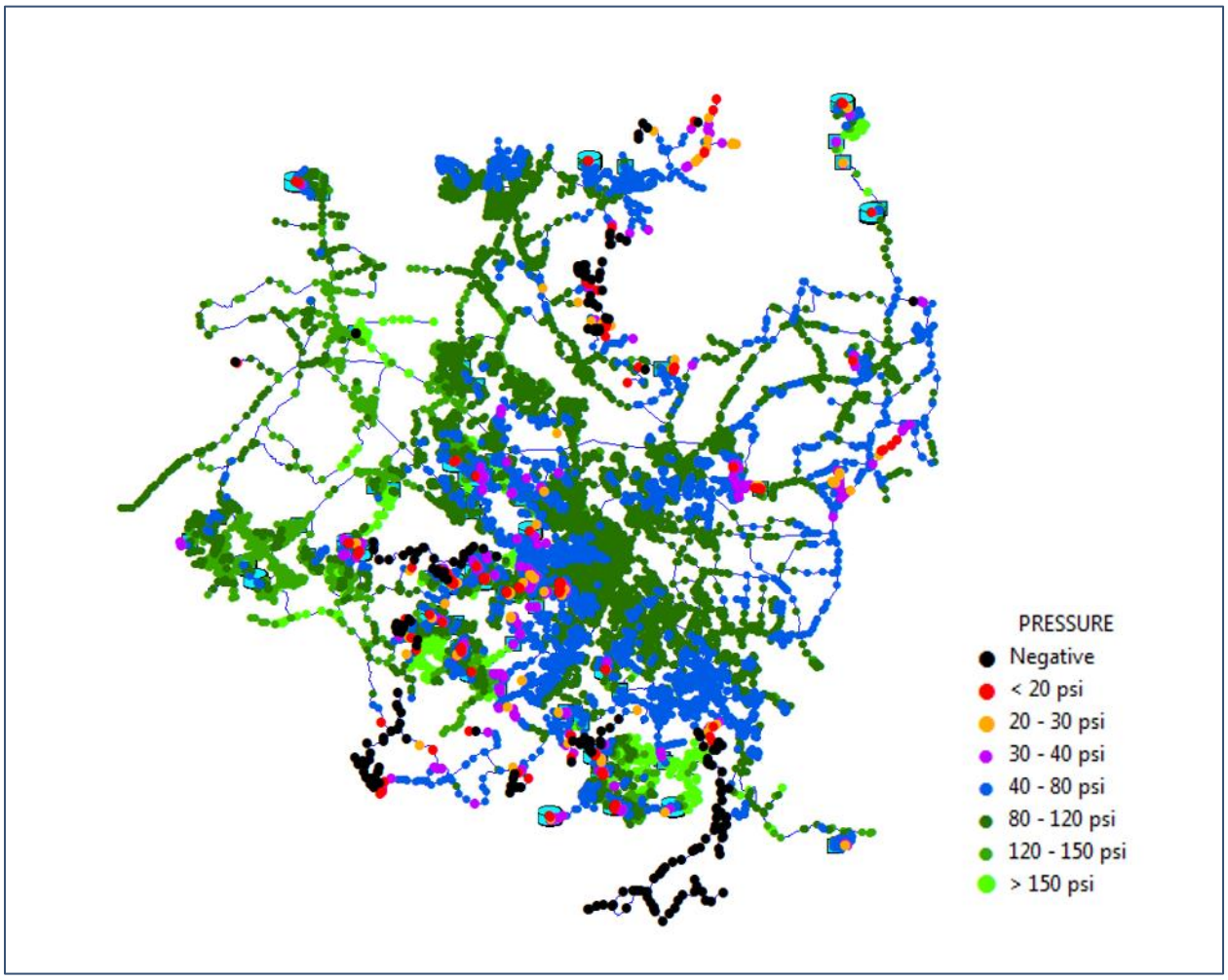


Figure 13: Predicted Pressures Supplying 2040 MDD Demand with Existing System

Given the expansive growth of the system, a major portion of the study focused on defining future pressure zones to meet design criteria. Fire flow issues were also addressed.

The city's capital improvement plans for 2016 to 2021 were incorporated in the recommended improvements as much as possible. Consideration was also given to planned NC DOT projects, especially the Balfour Parkway.

The Henderson County Department of Public Health requested consideration of summer camps when routing improvements so that city water could be provided. Community plans for Dana, Edneyville, Etowah and Horse Shoe, Green River-Tuxedo-Zirconia were also reviewed.

7.2 Model Results with Proposed Improvements

The proposed improvements address not only low pressures and fire flows but also supply future growth. Figure 14 shows predicted pressures for 2040 at peak hour demand. The figure identifies areas where pressures exceed 150 psi and future piping must be designed accordingly.

Pressure below 30 psi occurred at intermediate high elevations within the Main Zone, near storage tanks were customers are not served, and at high elevations on the edges of Fletcher Zone. Addressing pressures issues within the Town of Laurel Park was not part of this study.

Table 12 compares current, 2020 and 2040 available fire flows. Proposed improvements decrease the number of hydrants with available flows less than 1500 gm and increase hydrants with flows greater than 1500 gpm. Figure 15 maps predicted fire flows for 2040 using the ISO color scheme.

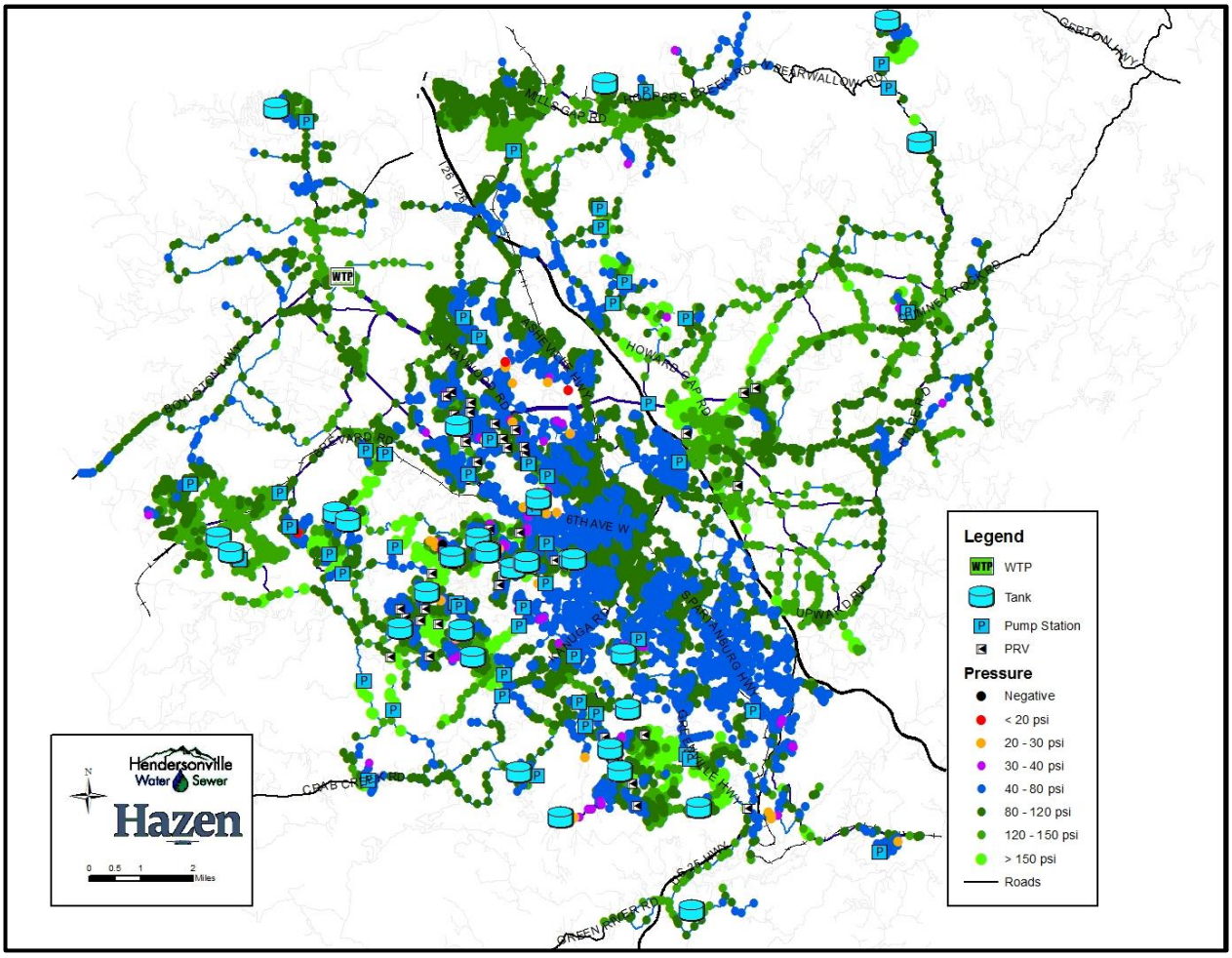


Figure 14: 2040 Peak Hour Pressures with Proposed Improvements

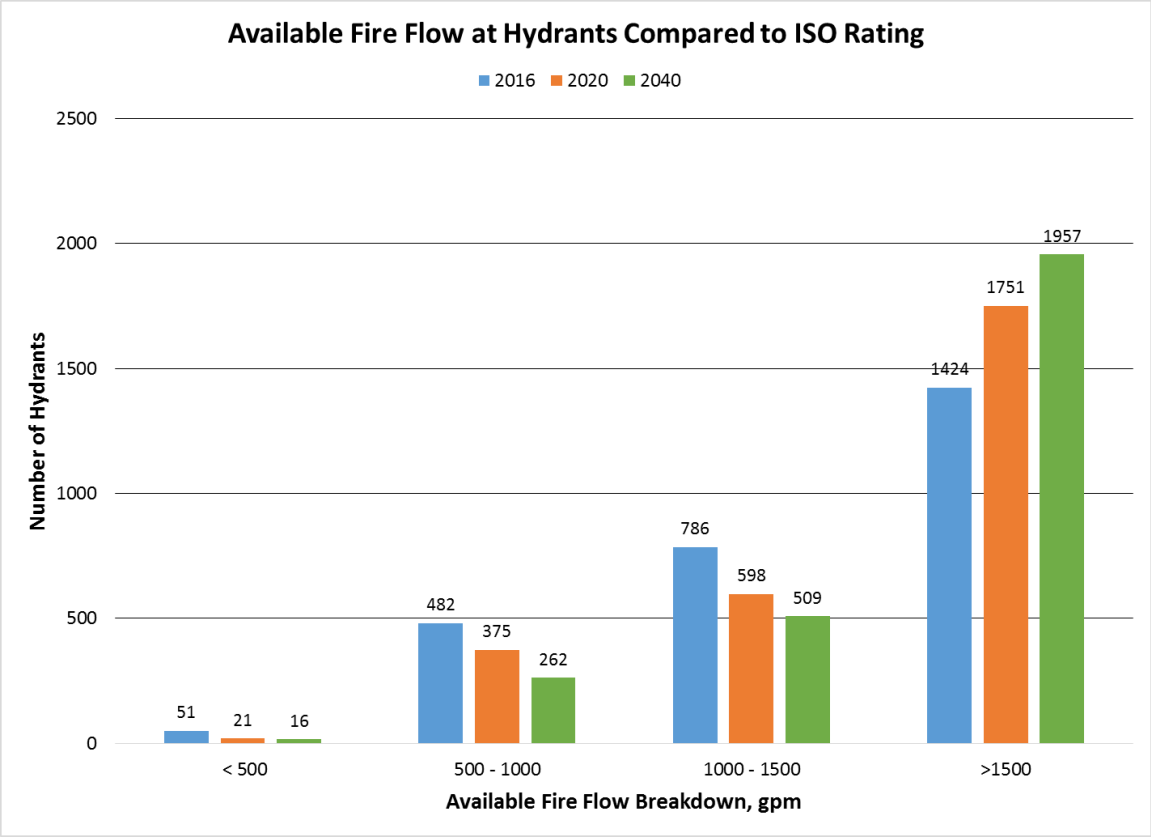


Table 12: Available Fire Flows with Proposed Improvements

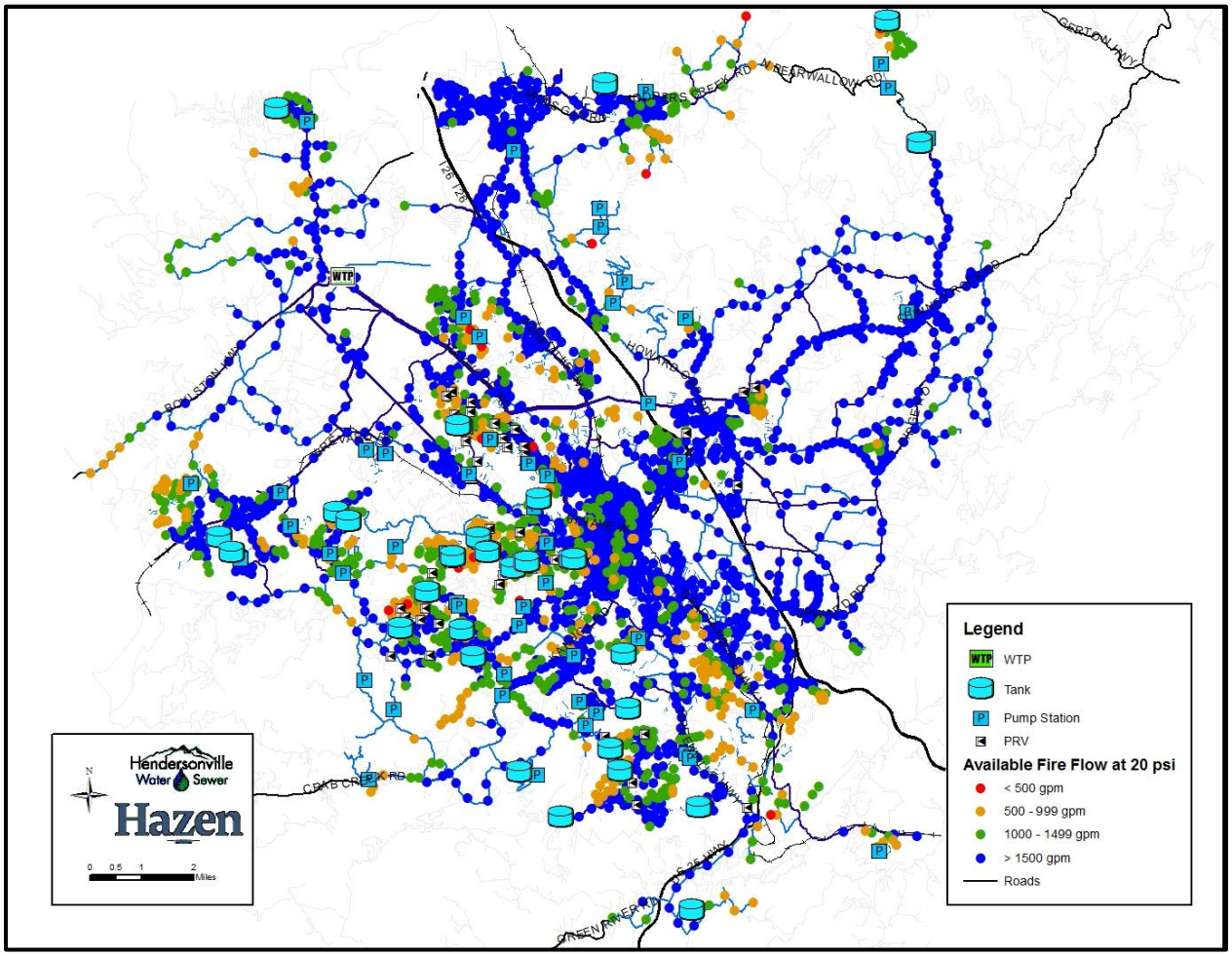


Figure 15: Map for 2040 with Proposed Improvements for Fire Flow

7.3 Transmission Main Capacity at the Water Treatment Plant

The water plant capacity was evaluated by comparing treatment and finished water pumping capacity to maximum day demand projections. The current treatment and pumping capacity is 12 mgd. Maximum day demand will exceed 12 mgd by 2020, as show in Figure 16. The city is currently making plans to upgrade treatment capacity to 15 mgd and increase firm pumping capacity to 18 mgd. We recommend expanding treatment capacity to 18 mgd by 2030 and to 21 mgd by 2040. Firm pump capacity of 18 mgd will be sufficient until 2030, when we propose replacing one of the 5 mgd pumps with a new 8 mgd pump.

The model showed that to convey 2040 maximum day demand, additional transmission main capacity will be needed leaving the water plant. We recommend replacing the existing 24-inch transmission main

leaving the WTP with a new 36-inch pipe from WTP to NC 191. This pipe replacement will coincide with the NC DOT improvements planned in 2025 and 2030.

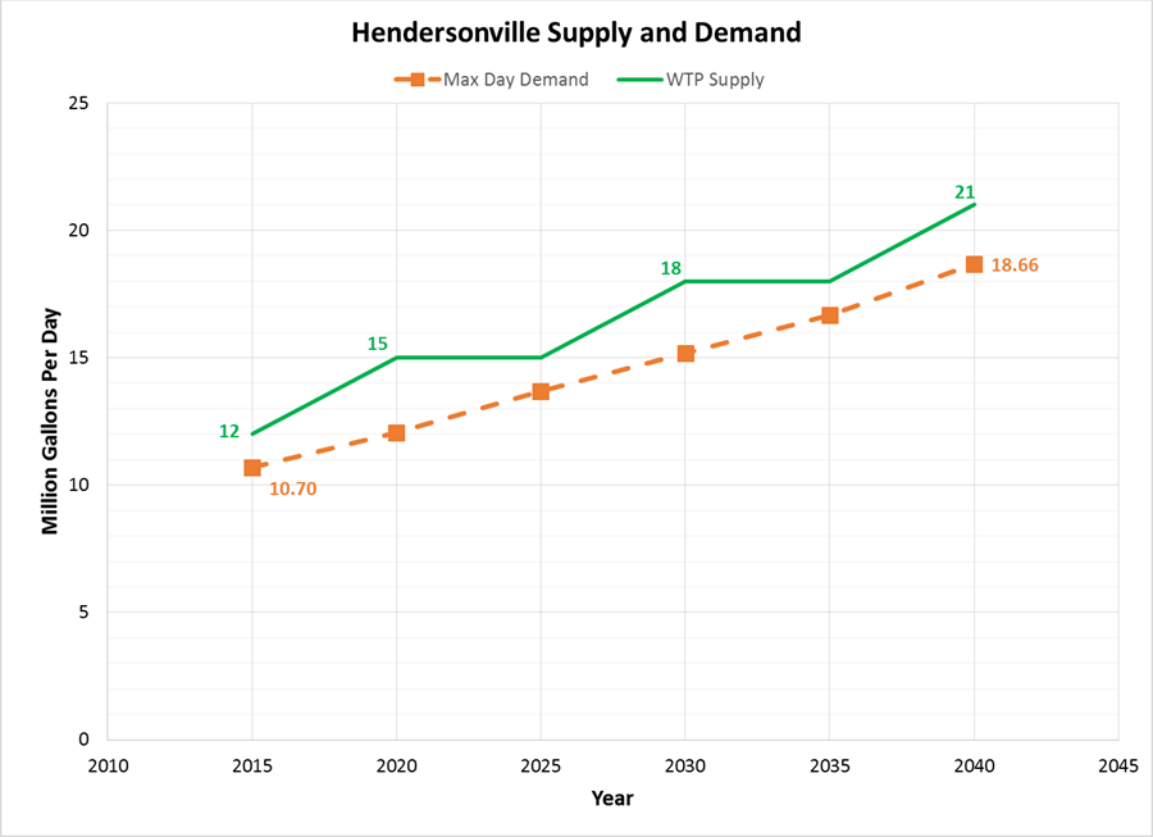


Figure 16: Hendersonville Supply and Demand

7.4 Improvements by Pressure Zone

Main Pressure Zone

Figure 17, Figure 18 and Figure 19, and Figure 20 shows the proposed improvements in the Main Zone. The improvements are color coded by installation year: red for 2020, orange for 2025, green for 2030, purple for 2035, pink for 2040. Each group of improvements are labeled in the format as ZZZ-NNN where ZZZ is the "zone" name and NNN is the group number.

Most of these improvements are to extend service to new areas and the details (size, length, location and cost) are described in Appendix A.

Major improvements are described below.

Balfour Parkway

NC DOT is planning a new connector, Balfour Parkway, from NC 191 to US 64 on the north side of Hendersonville. The project is currently in the planning stages and the purchase of property right of ways is scheduled to begin in 2022.

Modeling showed that a water main along this route is very beneficial to supply new demands in Fletcher and the Eastside Pressure Zone. We recommend installing a new 24-inch water main along Balfour Parkway from NC 191 to Asheville Hwy (BF-1). This 24-inch pipe will be supply three 16-inch pipes that carry water north, south and east. The 24-inch pipe will reduce headloss between the WTP and Fletcher by approximately 30 ft. The water main along Balfour Parkway should continue eastward as a 16-inch pipe to Interstate 26 where it supply the proposed Balfour Parkway Pump Station (BF-2) and the Eastside Pressure Zone.

Town of Mills River

The main zone is also expected to expand into the Town of Mills River. The suggested phasing is shown in Figure 20. To provide adequate fire flow down Boylston Hwy in the future a 12-inch pipe is recommended from Clement Dr and Boyston Hwy down to Gash Rd and Boyston Hwy. A 16-inch pipe is recommended on Landson Rd and Banner Farm Rd, modeling showed that this main wanted to carry more flow then the current City's CIP-Rugby main. The 16-inch pipe reduces headloss between the two main transmission mains and provides a second feed to the Etowah Zone. We recommended reducing the city's CIP-Rugby 16-inch pipe to a 12-inch pipe.

Fire Flow Improvements

Table 13 lists the fire flow improvements in the Main Zone.

Table 13: Main Zone Fire Flow Improvements

M1-3: 6” pipe	M1-5: 12” pipe	M1-6: 8” pipe,	M1-7: 16” pipe
M1-8: 16” pipe	M1-9: 8” pipe	M1-10: 8” pipe	M2-2: 6” pipe
M2-4: 6” pipe	M2-5: 6” pipe	M2-6: 8” pipe	M2-7: 8” pipe
M2-10; 8” pipe	M2-13: 12” pipe	M2-14: 8” pipe	M2-15: 8” pipe
M2-16: 8” pipe	M2-17: 6” pipe		

Improvements to Supply Future Growth

CIP M2-13 includes a portion of the city’s current CIP named N. Highland Lake Rd Interconnection. The remaining portion had no hydraulic benefits.

CIP M2-12a includes a portion of the city’s current CIP named Rutledge Rd Water System Improvements. The remaining portion was no longer required because of the recommendation to the Dunroy Zone described in a later section.

In the main zone two small areas Tall Pines and Marley Dr had low pressures. We recommend a 90 gpm pump station with TDH of 20 ft to maintain a discharge HGL of 2380 ft for Tall Pines (Figure 18) and a 220 gpm pump station with a TDH of 180 ft to maintain a discharge HGL of 2550 ft for Marley Dr (Figure 19).

There are many current city’s CIP projects within the Main zone that were included in the CIP year 2020 and are included in Appendix A and shown in the following figures.

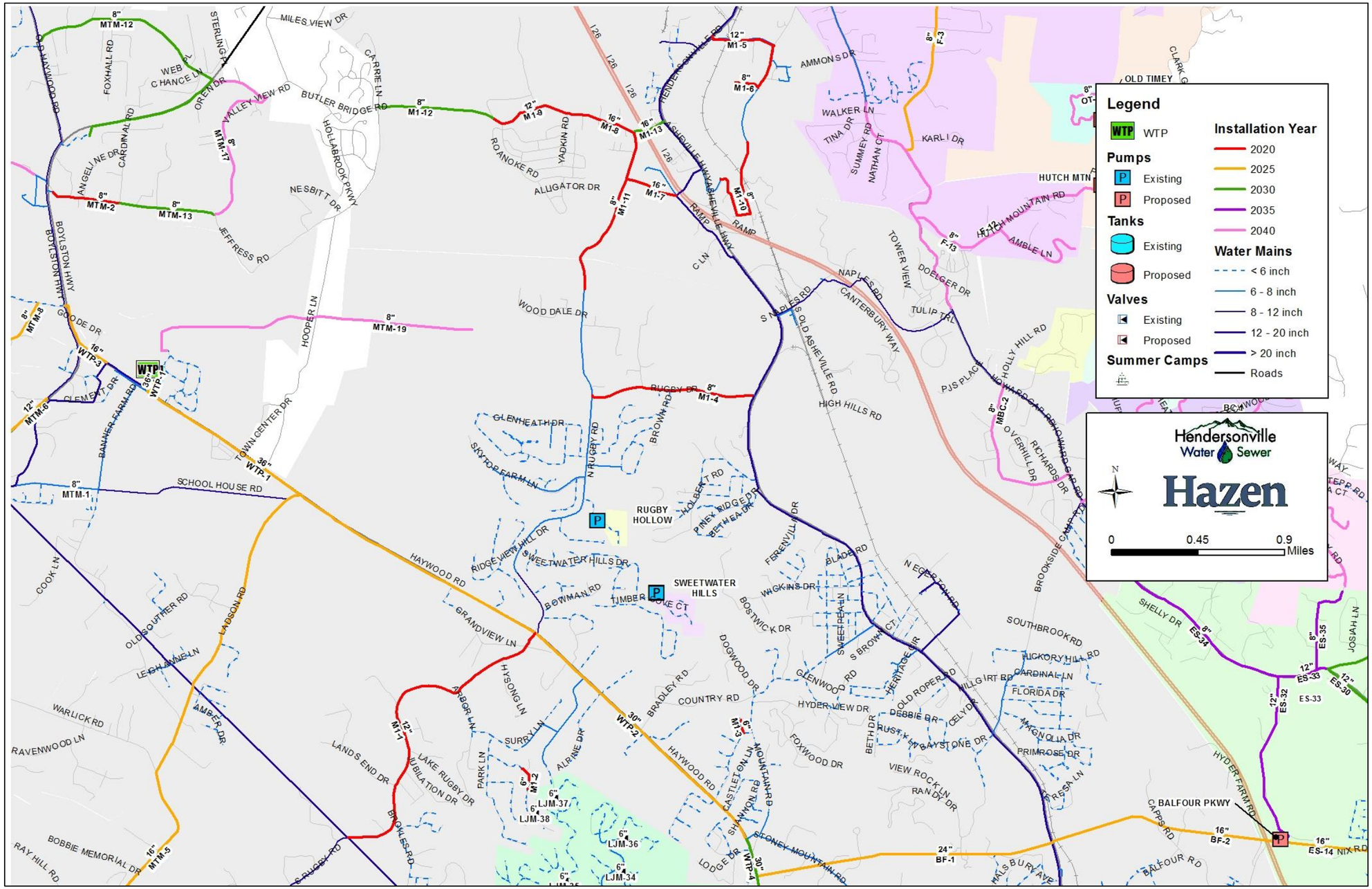
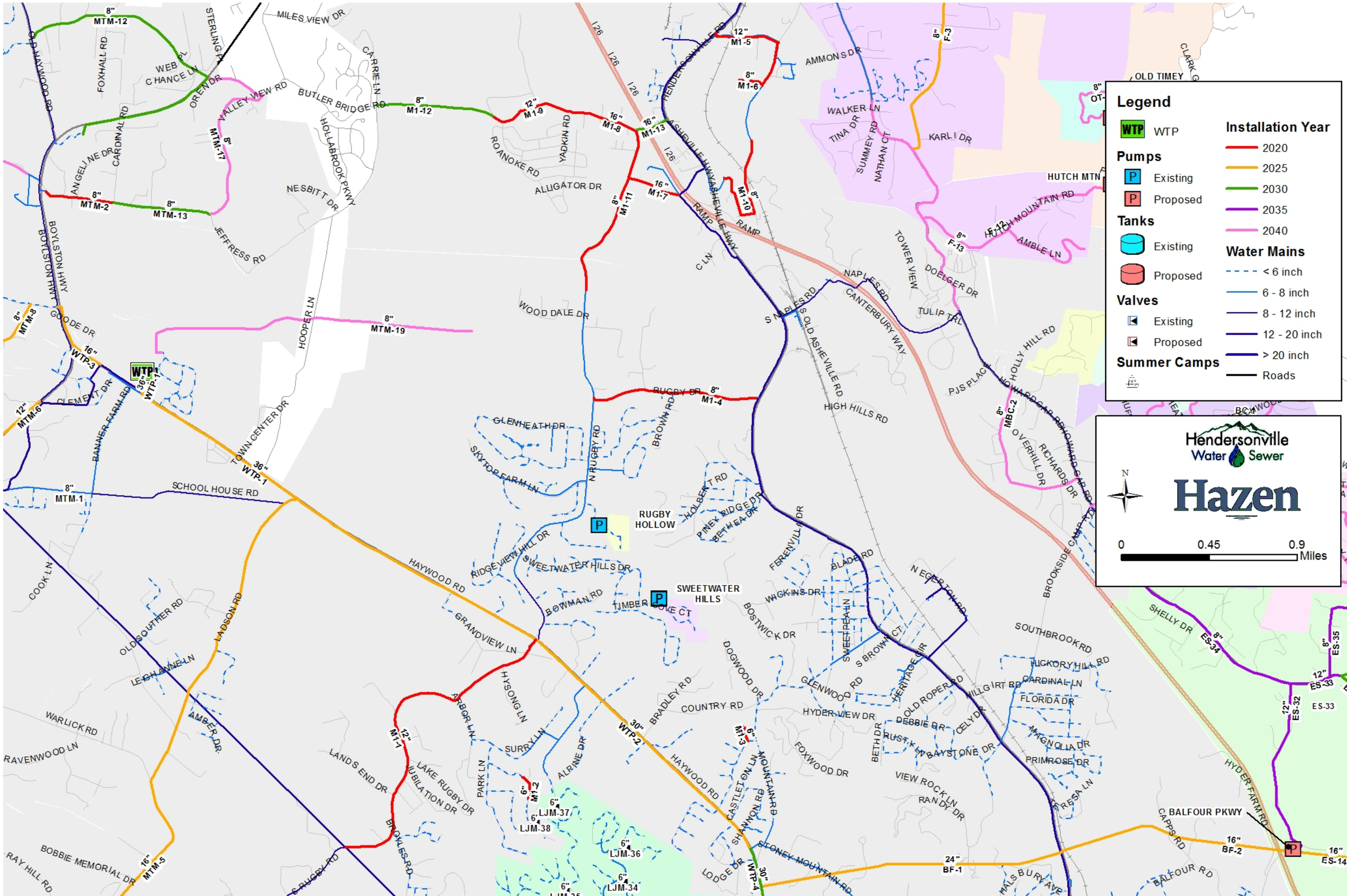


Figure 17: Recommendation for Main Zone Area 1


Legend
WTP
WTP
Pumps
P
Existing
P
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville Water & Sewer
Hazen
N
0
0.45
0.9
Miles
WTP-1
WTP-2
WTP-3
WTP-4
MTM-1
MTM-2
MTM-5
MTM-6
MTM-8
MTM-11
MTM-12
MTM-13
MTM-17
MTM-19
M1-1
M1-2
M1-3
M1-4
M1-5
M1-6
M1-7
M1-8
M1-9
M1-10
M1-11
M1-12
M1-13
BF-1
BF-2
F-3
F-12
F-13
MBC-2
ES-14
ES-30
ES-32
ES-33
ES-34
ES-35
LJM-34
LJM-36
LJM-37
LJM-38
I-26
RAMP
BUTLER BRIDGE RD
HAYWOOD RD
SCHOOL HOUSE RD
BALFOUR PKWY
BALFOUR RD
SWEETWATER HILLS
RUGBY HOLLOW
SWEETWATER HILLS DR
RUGBY DR
WOOD DALE DR
ALLIGATOR DR
ROANOKE RD
YADKIN RD
HOLLABROOK PKWY
NESBITT DR
JEFFRESS RD
HOOPER LN
BOYLSTON HWY
GOODE DR
CLEMENT DR
BANNER FARM RD
TOWN CENTER DR
OLD HAYWOOD RD
FOXHALL RD
WEB CHANCE LN
ORENDR
VALLEY VIEW RD
CARRIE LN
MILES VIEW DR
STERLING PL
ANGELINE DR
CARDINAL RD
HENDERSONVILLE RD
ASHEVILLE HWY
C LN
S OLD ASHEVILLE RD
S NAPLES RD
NAPLES RD
CANTERBURY WAY
TOWER VIEW
DOELGER DR
TULIP TRL
HIGH HILLS RD
PJS PLACE
HOLLY HILL RD
HOWARD GAP RD
OVERHILL DR
RICHARDS DR
BROOKSIDE CAMP RD
AMMONS DR
WALKER LN
TINA DR
SUMMEY RD
NATHAN CT
KARLI DR
HUTCH MTN
HUTCH MOUNTAIN RD
AMBLE LN
OLD TIMEY
CLARK G
BROWN RD
N RUGBY RD
GLENHEATH DR
SKYTOP FARM LN
HOLBERT RD
PINEY RIDGE DR
BETHEA DR
FERENVILL DR
BLADE RD
WICKINS DR
N EGERTON RD
BOSTWICK DR
SWEETPEA LN
S BROWN CT
DOGWOOD DR
GLENWOOD RD
HERITAGE DR
OLD ROPER RD
HILLGIRT RD
HYDER VIEW DR
DEBBIE DR
JOELY DR
RUSTY LN
BAYSTONE DR
FOXWOOD DR
VIEW ROCK LN
RANDY DR
TERESA LN
MAGNOLIA DR
PRIMROSE DR
FLORIDA DR
CARDINAL LN
HICKORY HILL RD
SOUTHBROOK RD
HYDER FARM RD
CAPPS RD
SHELLY DR
JOSHUA LN
NIX
BC-1
TEPP RD
A CT
WAY
CASTLETON LN
MOUNTAIN RD
SHANNON RD
STONEY MOUNTAIN RD
LODGE DR
COUNTRY RD
BRADLEY RD
ARBOR LN
SURRY LN
ALPINE DR
PARK LN
LANDS END DR
JUBILATION DR
LAKE RUGBY DR
BROYLES RD
S RUGBY RD
RAVENWOOD LN
WARLICK RD
AMBER DR
LADSON RD
OLD SOUTHER RD
LEIGH ANNE LN
COOK LN
BOBBIE MEMORIAL DR
RAY HILL RD
TIMBER COVE CT
HALSBURY AVE

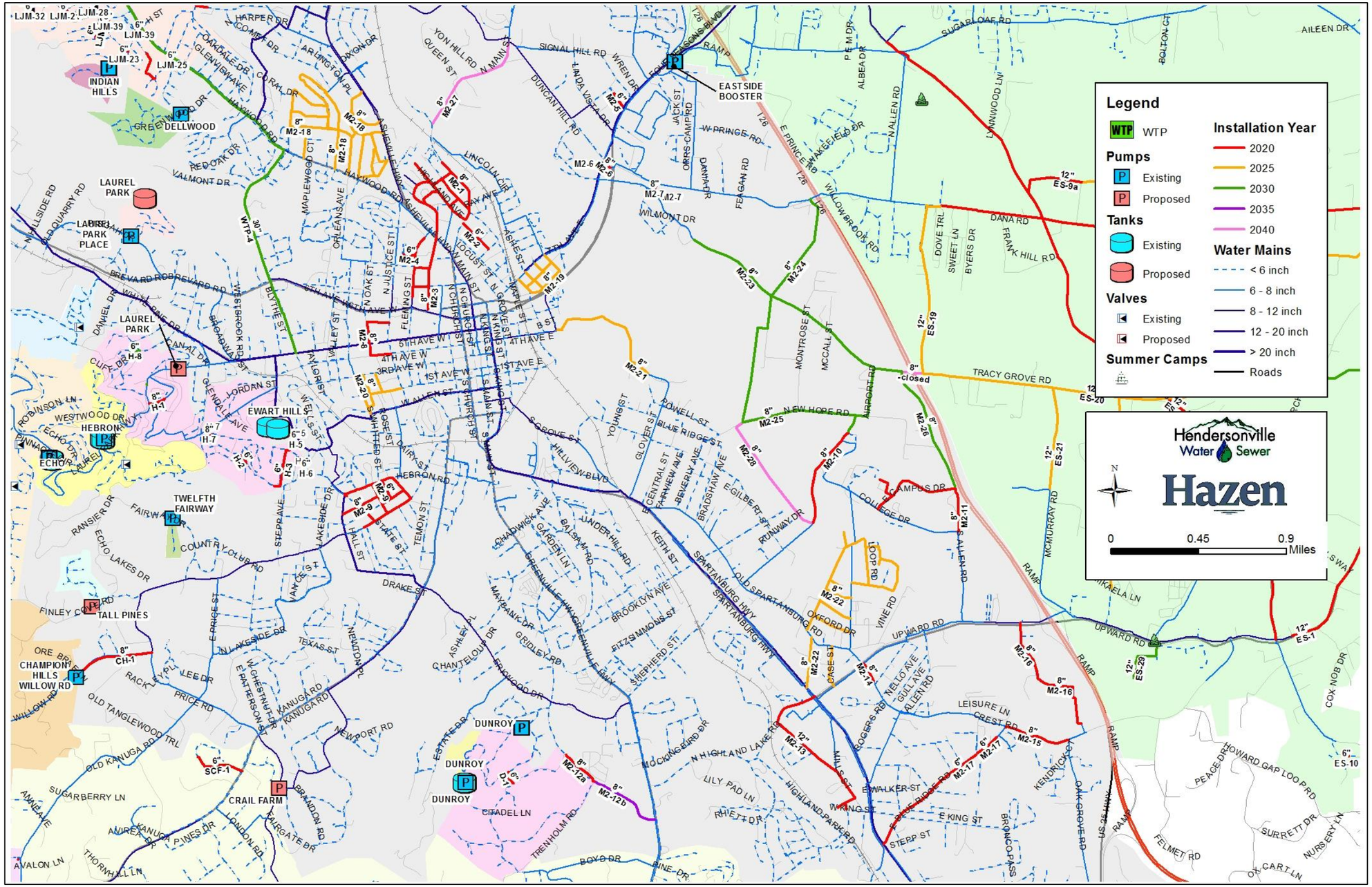
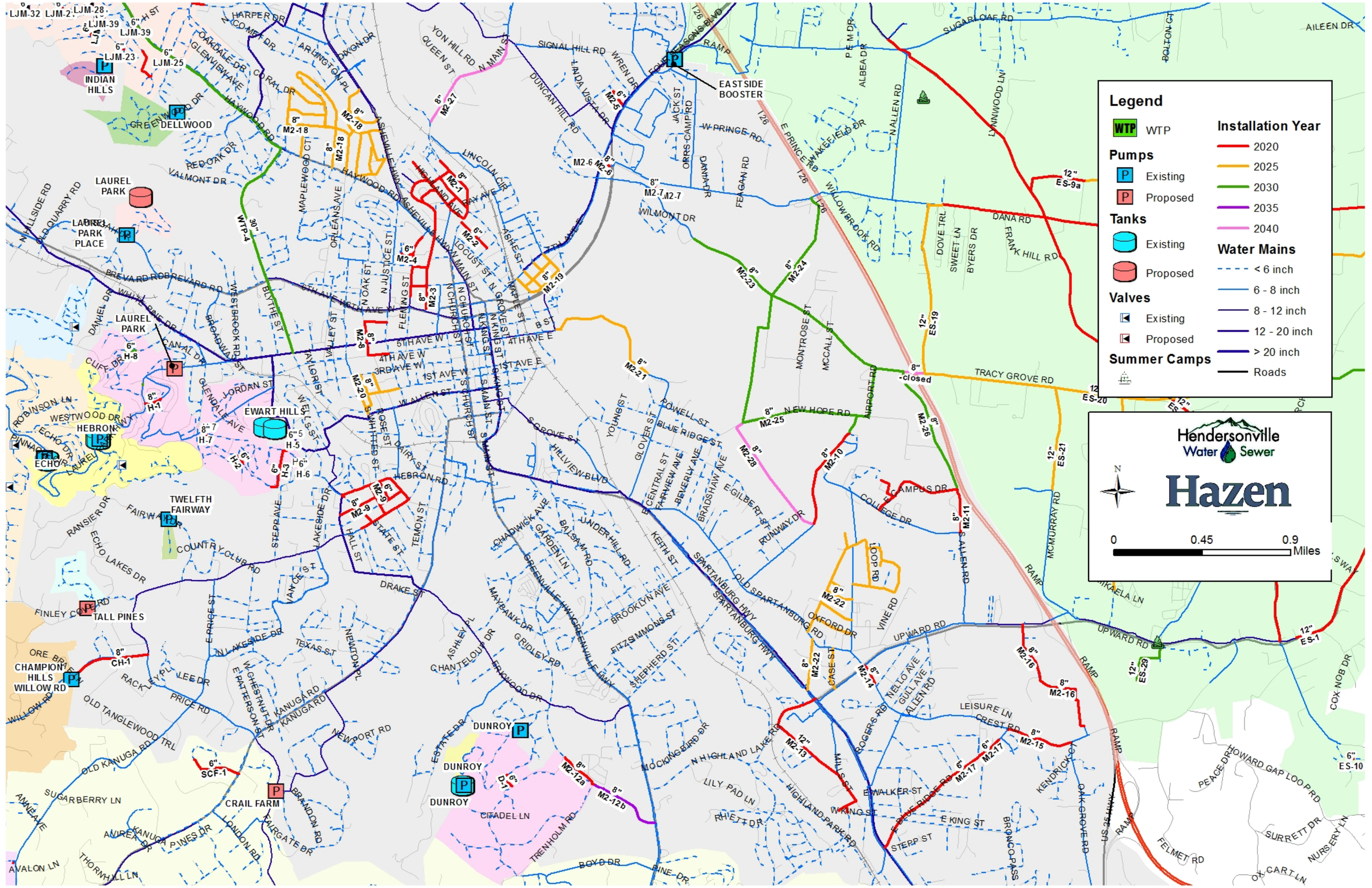


Figure 18: Recommendation for Main Zone Area 2


Legend
WTP
WTP
Pumps
Existing
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville Water Sewer
Hazen
0
0.45
0.9
Miles
EAST SIDE BOOSTER
INDIAN HILLS
DELLWOOD
LAUREL PARK
LAUREL PARK PLACE
LAUREL PARK
EWART HILLS
HEBRON
ECHO
TWELFTH FAIRWAY
TALL PINES
CHAMPION HILLS
CRAIL FARM
DUNROY
DUNROY
DUNROY
LJM-32
LJM-28
LJM-39
LJM-23
LJM-25
WTP-4
M2-18
M2-1
M2-2
M2-4
M2-3
M2-19
M2-8
M2-20
M2-9
M2-6
M2-5
M2-27
M2-7
M2-23
M2-24
M2-21
M2-25
M2-26
M2-28
M2-10
M2-11
M2-22
M2-14
M2-16
M2-15
M2-17
M2-13
M2-12a
M2-12b
ES-9a
ES-19
ES-20
ES-21
ES-1
ES-29
ES-10
H-1
H-2
H-3
H-5
H-6
H-7
H-8
CH-1
SCF-1
D-1
8-closed
SUGARLOAF RD
AILEEN DR
DANA RD
TRACY GROVE RD
NEW HOPE RD
WILMONT DR
W PRINCE RD
E PRINCE RD
SIGNAL HILL RD
DUNCAN HILL RD
HAYWOOD RD
ASHEVILLE HWY
SPARTANBURG HWY
OLD SPARTANBURG RD
HEBRON RD
UPWARD RD
LEISURE LN
CAMPUS DR
COLLEGE DR
RUNWAY DR
HIGHLAND LAKE RD
OLD KANUGA RD
KANUGA RD
TRENHOLM RD
CITADEL LN
LILY PAD LN
RHETT DR
BOYD DR
PINE DR
MOCKINGBIRD DR
ESTATE DR
NEWPORT RD
DRAKE ST
HALL ST
STATE ST
TEMON ST
ASHLEY PL
CHANTELOUP DR
GRIDLEY RD
MAYBANK DR
BROOKLYN AVE
FITZSIMMONS ST
SHEPHERD ST
KEITH ST
CHADWICK AVE
GARDEN LN
BALSAM RD
UNDERHILL RD
GREENVILLE HWY
TEXAS ST
NEWTON PL
LAKESIDE DR
STEPP AVE
VANCE ST
E PRICE ST
W LAKESIDE DR
PRICE RD
LEE DR
RACKLEY PL
FINLEY COVE RD
ECHO LAKES DR
COUNTRY CLUB RD
FAIRWAY DR
RANSIER DR
ANNIE AVE
SUGARBERRY LN
AVALON LN
THORNHILL LN
ANDREA DR
KANUGA PINES DR
LONDON RD
FAIRGATE DR
BRANDON RD
OLD TANGLEWOOD TRL
ROBINSON LN
WESTWOOD DR
ECHO DR
LAUREL WAY
PINNACLE VIEW DR
CLIFF DR
CANAL DR
DANIEL DR
WHITE PINE DR
BREVARD RD
OLD QUARRY RD
MILLSIDE RD
RED OAK DR
VALMONT DR
GREENWOOD DR
OAKDALE DR
GLENVIEW AVE
CORAL DR
ARLINGTON PL
DIXON DR
HARPER DR
NICOMEY DR
YON HILL RD
QUEEN ST
N MAIN ST
LINCOLN CIR
MAPLEWOOD CT
ORLEANS AVE
HIGHLAND AVE
BAY AVE
ASHE ST
ELM AVE
MAPLE ST
N CHURCH ST
S CHURCH ST
N KING ST
S KING ST
N GROVE ST
S GROVE ST
N MAIN ST
S MAIN ST
N OAK ST
N JUSTICE ST
FLEMING ST
LOCUST ST
6TH AVE W
5TH AVE W
4TH AVE W
3RD AVE W
1ST AVE W
4TH AVE E
1ST AVE E
W ALLEN ST
S WHITNER ST
ROSE ST
DAIRY ST
VALLEY ST
TAYLOR ST
WELLS ST
BLYTHE ST
WESTBROOK RD
BROADWAY ST
JORDAN ST
GLENDALE AVE
W CHESTNUT ST
E PATTERSON ST
YOUNG ST
GLOVER ST
CENTRAL ST
FAIRVIEW AVE
BEVERLY AVE
BRADSHAW AVE
POWELL ST
BLUE RIDGE ST
E GILBERT ST
E WALKER ST
W KING ST
E KING ST
STEPP ST
BRONCO PASS
OAK GROVE RD
KENDRICK ST
MILLS ST
ROGERS RD
NELTO AVE
GULL AVE
ALLEN RD
CASE ST
OXFORD DR
LOOP RD
VINE RD
S ALLEN RD
MONTROSE ST
MCCALL ST
AIRPORT RD
JACK ST
ORRS CAMP RD
DANA DR
FEAGAN RD
ALBEA DR
P E M DR
NALLEN RD
LYNNWOOD LN
BOLTON CT
WILLOWBROOK RD
DOVE TRL
SWEET LN
BYERS DR
FRANK HILL RD
MCMURRAY RD
MIKAELA LN
COX NOB DR
PEACE DR
HOWARD GAP LOOP RD
SURRETT DR
NURSERY LN
FELMET RD
OX CART LN
US 25 HWY
RAMP

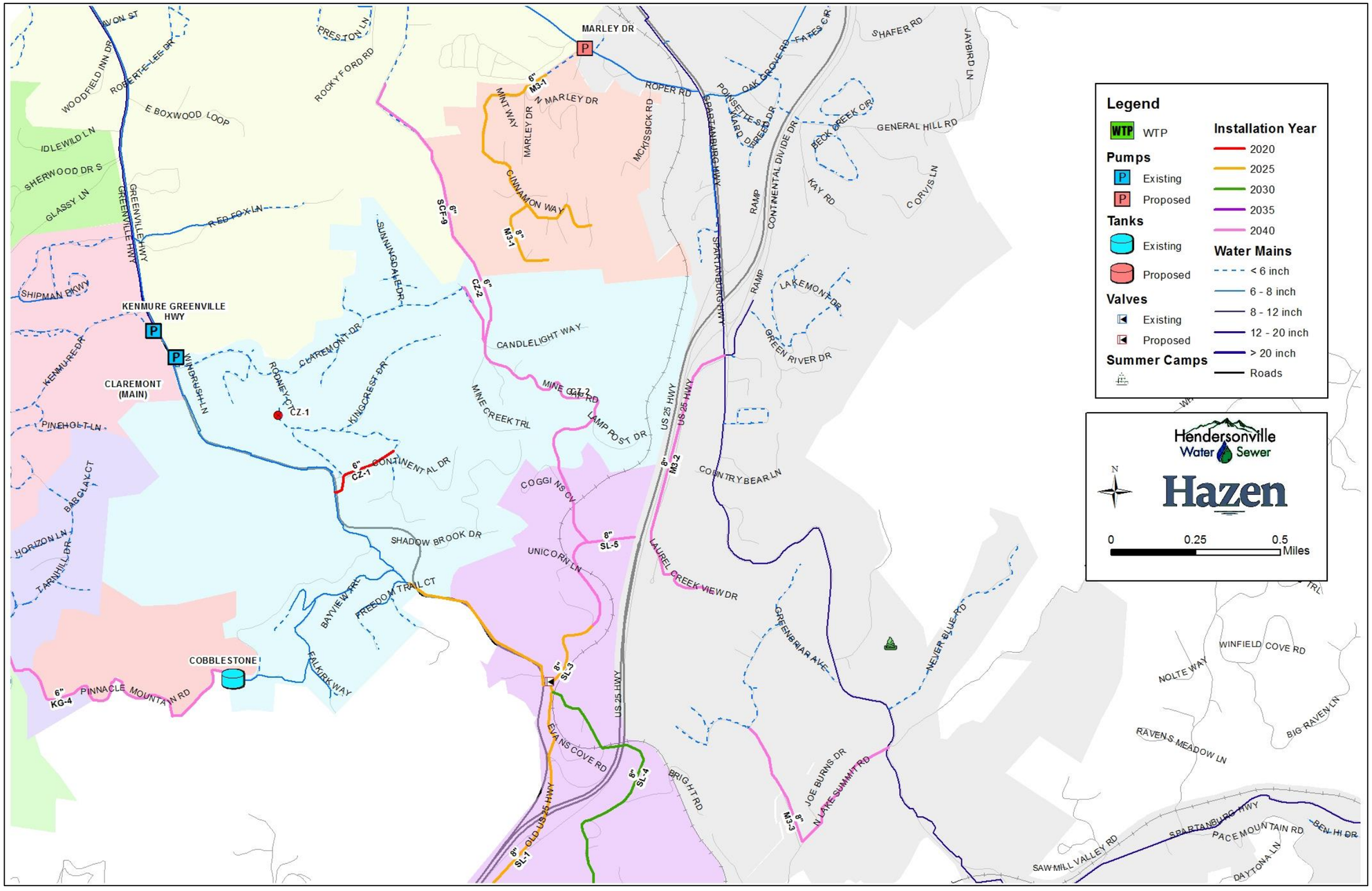
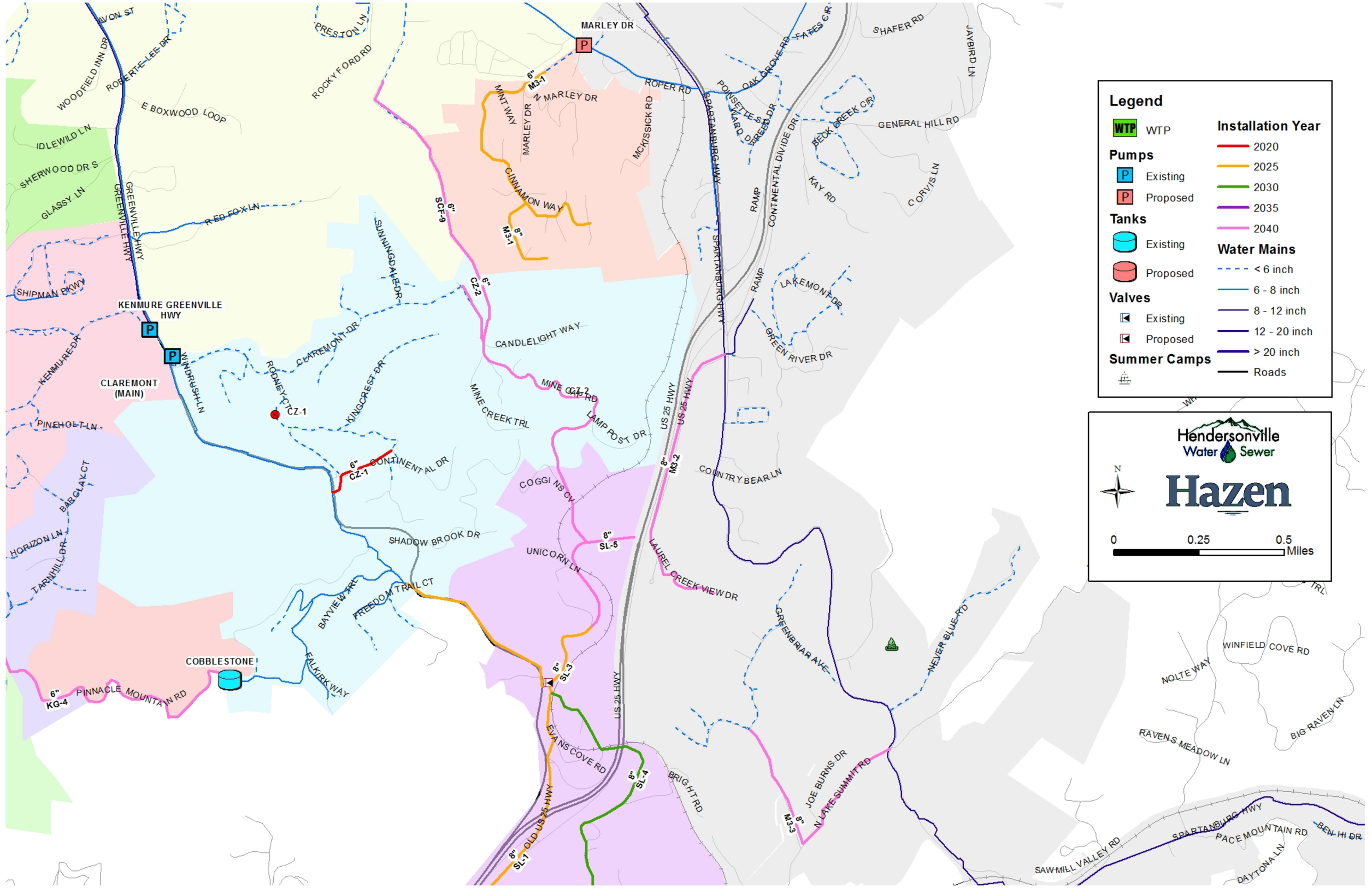


Figure 19: Recommendation for Main Zone Area 3


MARLEY DR
P
6"
M3-1
N MARLEY DR
MARLEY DR
MINT WAY
CINNAMON WAY
8"
M3-1
6"
SCF-9
ROPER RD
MCKISSICK RD
POINSETTE SQUARE DR
OAK GROVE RD
FAITES CIR
SHAFER RD
JAYBIRD LN
SPARTANBURG HWY
CONTINENTAL DIVIDE DR
RAMP
BECK CREEK CIR
GENERAL HILL RD
KAY RD
CORVIS LN
WOODFIELD INN DR
AVON ST
ROBERT E LEE DR
E BOXWOOD LOOP
PRESTON LN
ROCKY FORD RD
IDLEWILD LN
SHERWOOD DR S
GLASSY LN
GREENVILLE HWY
RED FOX LN
SUNNINGDALE DR
6"
CZ-2
SHIPMAN PKWY
KENMURE GREENVILLE HWY
P
P
KENMURE DR
CLAREMONT (MAIN)
WINDRUSH LN
CLAREMONT DR
RODNEY CT
CZ-1
KINGCREST DR
CANDLELIGHT WAY
MINE CREEK TRL
MINE GAP RD
CZ-2
LAMP POST DR
US 25 HWY
US 25 HWY
LAKEMONT DR
GREEN RIVER DR
PINEHOLT LN
BABCLAY CT
HORIZON LN
TARNHILL DR
6"
CZ-1
CONTINENTAL DR
SHADOW BROOK DR
COGGINS CV
UNICORN LN
8"
SL-5
8"
M3-2
COUNTRY BEAR LN
LAUREL CREEK VIEW DR
BAYVIEW TR
FREEDOM TRL
CT
FALKIRK WAY
COBBLESTONE
6"
KG-4
PINNACLE MOUNTAIN RD
8"
SL-3
US 25 HWY
EVANS COVE RD
8"
SL-4
8"
SL-1
OLD US 25 HWY
BRIGHT RD
GREENBRIAR AVE
NEVER BLUE RD
JOE BURNS DR
N LAKE SUMMIT RD
8"
M3-3
WINFIELD COVE RD
NOLTE WAY
BIG RAVEN LN
RAVENS MEADOW LN
SAW MILL VALLEY RD
SPARTANBURG HWY
PACE MOUNTAIN RD
BEN HI DR
DAYTONA LN
Legend
WTP
WTP
Pumps
P
Existing
P
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville
Water Sewer
N
Hazen
0
0.25
0.5
Miles

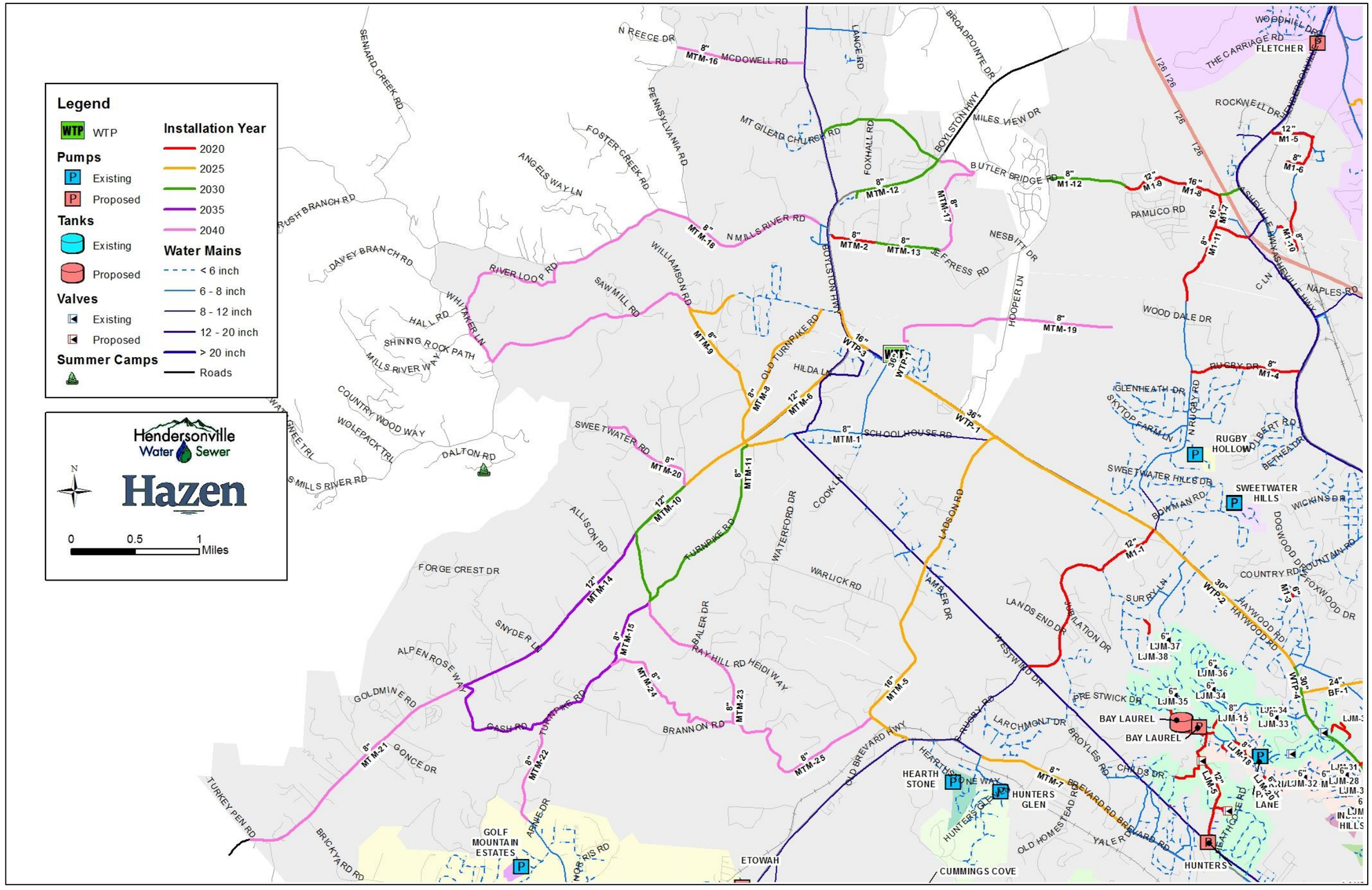


Figure 20: Recommendation for Main Zone Town Mills River

Legend

WTP WTP

Pumps
- P Existing
- P Proposed

Tanks
- Existing
- Proposed

Valves
- Existing
- Proposed

Summer Camps

Installation Year
- 2020
- 2025
- 2030
- 2035
- 2040

Water Mains
- < 6 inch
- 6 - 8 inch
- 8 - 12 inch
- 12 - 20 inch
- > 20 inch
- Roads

Hendersonville Water Sewer

Hazen

N

0 0.5 1 Miles

N REECE DR
8" MTM-16
MCDOWELL RD
LANCE RD
BROADPOINTE DR
WOODHILL DR
THE CARRIAGE RD
FLETCHER
ROCKWELL DR
HENDERSONVILLE RD
12" M1-5
8" M1-6
SENARD CREEK RD
PENNSYLVANIA RD
MT GILEAD CHURCH RD
FOXHALL RD
BOYLSTON HWY
MILES VIEW DR
126
FOSTER CREEK RD
ANGELS WAY LN
8" MTM-12
BUTLER BRIDGE RD
8" M1-12
12" M1-9
16" M1-8
PAMLICO RD
16" M1-7
8" M1-11
8" M1-10
ASHEVILLE HWY
RUSH BRANCH RD
8" MTM-18
N MILLS RIVER RD
8" MTM-17
8" MTM-2
8" MTM-13
JEFFRESS RD
NESBITT DR
DAVEY BRANCH RD
RIVER LOOP RD
WILLIAMSON RD
SAWMILL RD
HOOPER LN
8" MTM-19
C LN
NAPLES RD
WOOD DALE DR
WHITAKER LN
HALL RD
SHINING ROCK PATH
MILLS RIVER WAY
8" MTM-9
OLD TURNPIKE RD
16" WTP-3
36" WTP-1
HILDA LN
RUGBY DR
8" M1-4
GLENHEATH DR
SKYTOP FARM LN
RUGBY RD
COUNTRY WOOD WAY
WOLFPACK TRL
DALTON RD
S MILLS RIVER RD
8" MTM-8
12" MTM-6
SCHOOLHOUSE RD
8" MTM-1
SWEETWATER RD
8" MTM-20
8" MTM-11
12" MTM-10
SWEETWATER HILLS DR
SWEETWATER HILLS
BOWMAN RD
WICKINS DR
DOGWOOD DR
MOUNTAIN RD
ALLISON RD
TURNPIKE RD
WATERFORD DR
COOK LN
WARLICK RD
LADSON RD
12" M1-1
FORGE CREST DR
12" MTM-14
AMBER DR
30" WTP-2
COUNTRY RD
FOXWOOD DR
SURREY LN
HAYWOOD RD
6" M1-3
LANDS END DR
JUBILATION DR
6" LJM-37
LJM-38
6" LJM-36
6" LJM-35
6" LJM-34
PRE STWICK DR
WESTWIND DR
30" WTP-4
24" BF-1
SNYDER LN
8" MTM-15
BALER DR
RAY HILL RD
HEIDI WAY
ALPENROSE WAY
8" MTM-24
8" MTM-23
16" MTM-5
BAY LAUREL
8" LJM-15
LJM-34
LJM-33
GOLDMINE RD
CASH RD
TURNPIKE RD
BRANNON RD
8" MTM-25
OLD BREVARD HWY
LARCHMONT DR
BROYLES RD
CHILDS DR
8" MTM-21
GONCE DR
8" MTM-22
8" MTM-7
BREVARD RD
HEARTHSTONE WAY
HEARTHSTONE
HUNTERS GLEN
HUNTERS GLEN
OLD HOMESTEAD RD
YALE RD
12" LJM-5
LJM-20
LANE
HEATHCOTE RD
TURKEY PEN RD
BRICKYARD RD
ARROWDR
NORRIS RD
GOLF MOUNTAIN ESTATES
ETOWAH
CUMMINGS COVE
HUNTERS

Long John Mountain Pressure Zone

The city's CIP plan for 2018-2019 includes Long John Mountain water main interconnections, pump station and tank. The goal of this project is to connect the valley along NC 191 with the valley along US 64 and in the process eliminate several existing pump stations. After modeling several alternatives and discussing with city staff, the recommended improvements are shown in Figure 21. The figure shows tanks and pumps to be abandoned in yellow. We recommend abandoning eight existing pump stations and two storage tanks.

The new pump station (LJM-1: Hunters BPS) located at Hunters Ln on an existing 16" tranmission main should be designed for 250 gpm with a TDH of 370 ft to maintian discharge HGl of 2711 ft.

The new 0.16 MG storage tank (LJM-11) should be located near Bay Laurel with an overflow elevation of 2721 ft.

The new tank will improve existing low pressures.

Higher HGLs will be needed in the area currently served by the Carriage Park Grapevine PS (Pink shaded area). We recommend expanding this area slightly and moving the pump station, (LJM-10-renamed to Bay Laurel Pump Station).

To maintain pressures within the range customers currently experience, a series of PRVs will be required, as shown in the figure.

Carriage Park Pump Station will still be utilized, but dedicated suction piping (LJM-18) will be needed to supply a larger service area. (Purple shaded area). Maximum day demand in this area is 104 gpm. The pump curve for this pump station is not available, so we recommend testing the existing pumps to ensure they will perform properly after pressure and flow requirements have changed.

We recommend several check valves to improve fire protection, as shown in Figure 21. Several of these check valves allow flow into the Long John Mountain Zone from the main zone in the event of a fire.

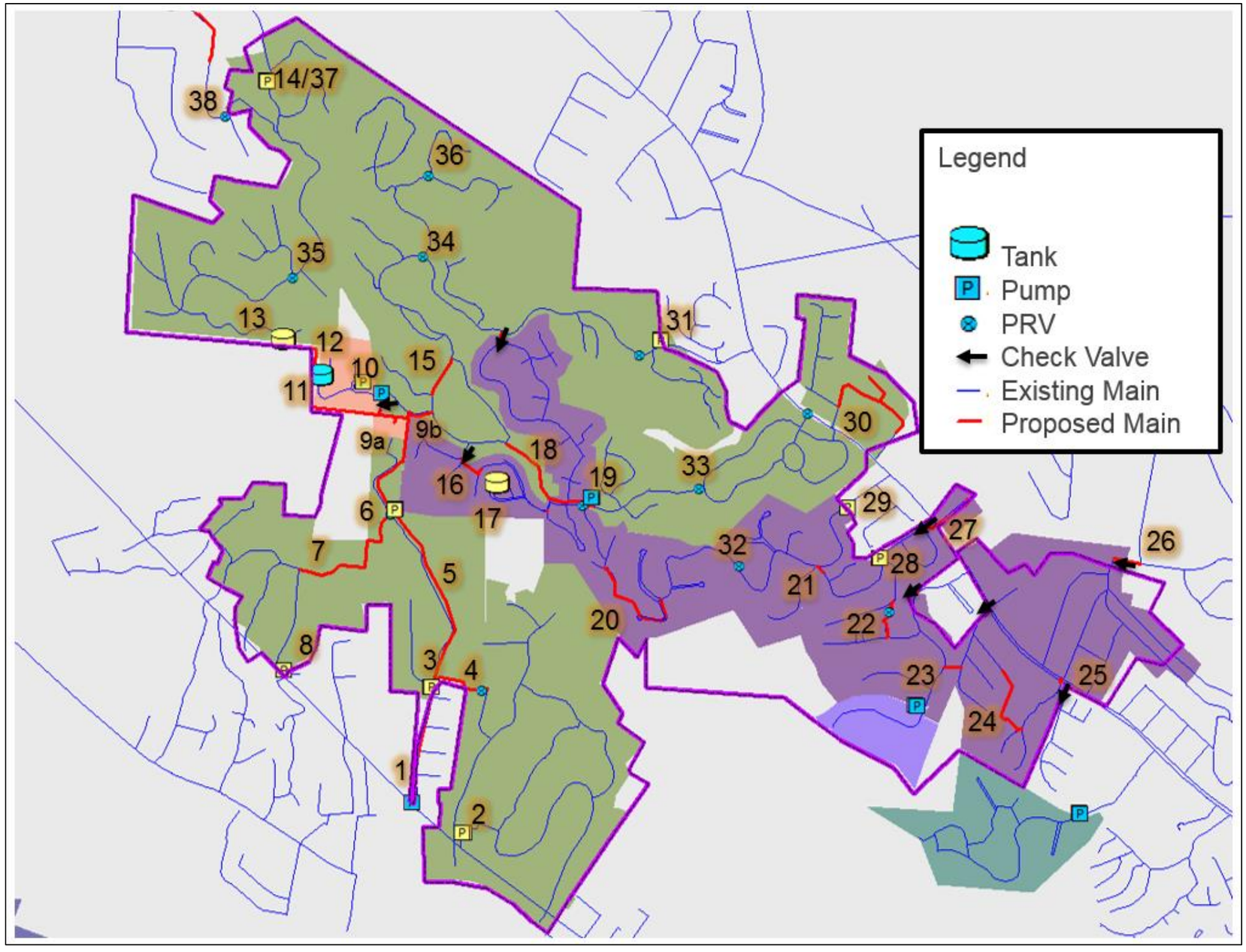


Figure 21: Recommended Improvements for Long John Mountain

Town of Laurel Park- Hebron Zone

Improvements in the Town of Laurel Park – Hebron Zone area address low pressures and provide for growth. A two phase approach is recommended. Phase 1 address low pressures west of Ewart Hills Reservoirs. Phase 2 will address low pressures upstream of Town of Laurel Park pump station.

The first recommendations shifts city customers west of Ewart Hills reservoirs into the Town of Laurel Park's Hebron pressure zone. The new zone boundary shown as a dashed gray line in **Figure 22**, includes several closed valves and check valves. The new pipes required to implement this project are:

- H-1: 8-inch pipe on Woodbyne Ave will connect the Hebron Zone to the expanded area
- H-7: 8-inch pipe on Davis Mountain Rd allows for the abandonment of Overlook Terr PS
- H-2, H-3 & H-4 are 6-inch pipes that improve fire flow
- H-5 & H-6 are check valves from Main zone into Hebron Zone.

The second phase of improvements further expands Laurel Park's Hebron pressure zone by moving Laurel Park BPS eastward. The new boundary is shaded light pink in **Figure 22**. The new pipes required for this shift are:

- CIP H-8: 6-inch pipe on David Mountain Rd
- The reopen closed valve on Woodbyne Ave (directly north of H-1 on **Figure 22**)

The 2040 maximum day demand that would be supplied by the relocated Laurel Park PS is approximately 350 gpm at a TDH of 175 ft. We currently only know the design point for Laurel Park PS which is 380 gpm at 163 ft TDH. The model indicates that the existing pump can meet the future demand.

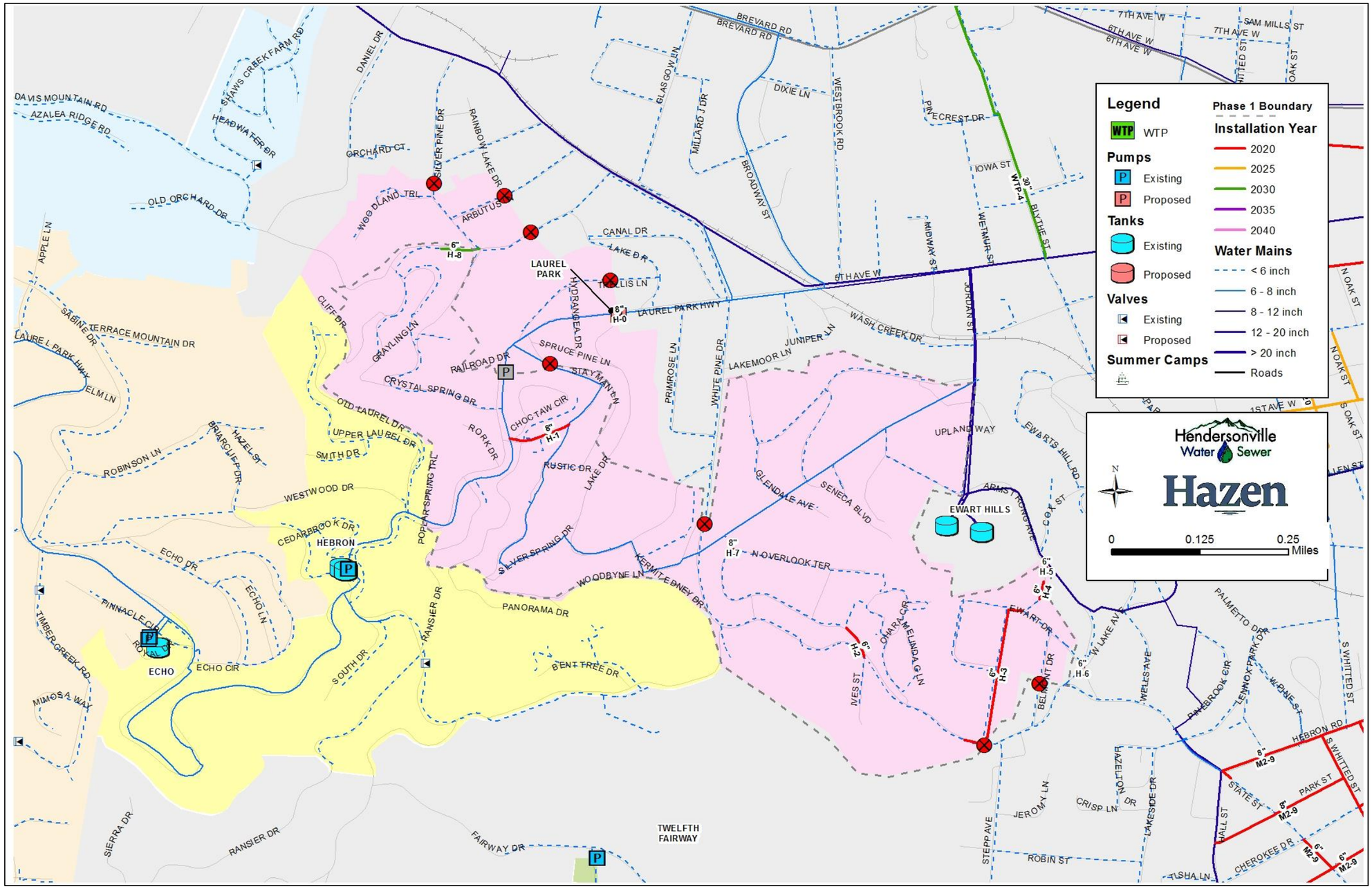
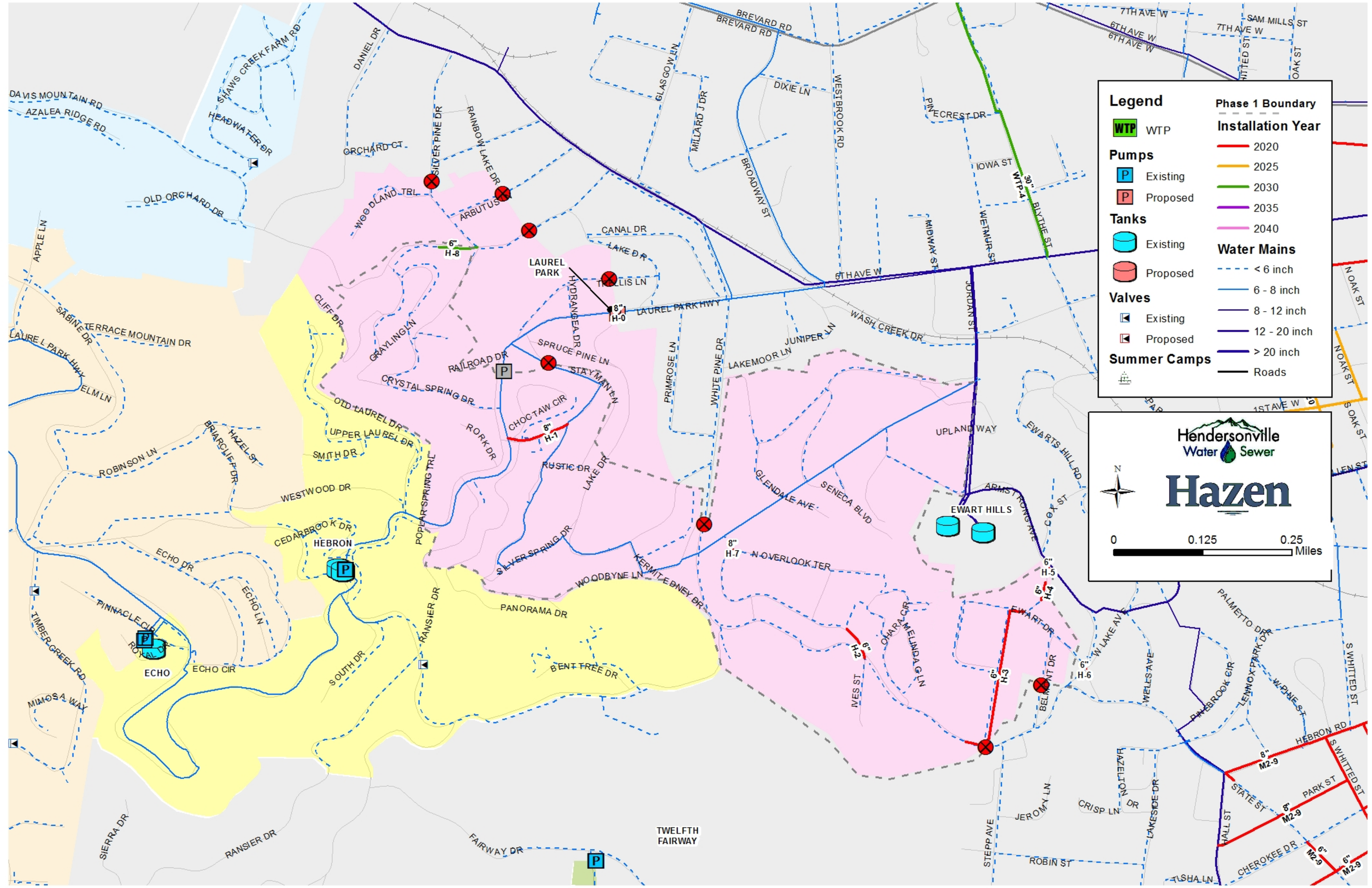


Figure 22: Recommended Improvements for Town of Laurel Park – Hebron Pressure Zone


Legend
WTP
WTP
Pumps
P
Existing
P
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Phase 1 Boundary
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville Water & Sewer
Hazen
0
0.125
0.25
Miles
LAUREL PARK
EWART HILLS
HEBRON
ECHO
TWELFTH FAIRWAY
WTP-4
H-0
H-1
H-2
H-3
H-4
H-5
H-6
H-7
H-8
M2-9
DAVIS MOUNTAIN RD
AZALEA RIDGE RD
SHAWS CREEK FARM RD
HEADWATER DR
OLD ORCHARD DR
DANIEL DR
ORCHARD CT
SILVER PINE DR
RAINBOW LAKE DR
WOODLAND TRL
ARBUTUS CT
CANAL DR
LAKE DR
TRELLIS LN
HYDRANGEA DR
SPRUCE PINE LN
STAYMAN LN
RAILROAD DR
CRYSTAL SPRING DR
CHOCTAW CIR
OLD LAUREL DR
UPPER LAUREL DR
SMITH DR
RORK DR
RUSTIC DR
LAKE DR
SILVER SPRING DR
WOODBYNE LN
KERMIT EDNEY DR
PANORAMA DR
BENT TREE DR
SOUTH DR
RANSIER DR
POPLAR SPRING TRL
WESTWOOD DR
CEDARBROOK DR
ECHO DR
ECHO LN
ECHO CIR
PINNACLE CIR
ROYAL DR
TIMBER CREEK RD
MIMOSA WAY
ROBINSON LN
BRIARCLIFF DR
HAZEL ST
SIERRA DR
RANSIER DR
FAIRWAY DR
APPLE LN
SABINE DR
TERRACE MOUNTAIN DR
LAUREL PARK HWY
ELM LN
CLIFF DR
GRAYLING LN
BREVARD RD
GLASGOW LN
MILLARD J DR
DIXIE LN
WESTBROOK RD
BROADWAY ST
PINECREST DR
IOWA ST
7TH AVE W
6TH AVE W
SAM MILLS ST
WHITTED ST
OAK ST
N OAK ST
BLYTHE ST
MIDWAY ST
WETMUR ST
JORDAN ST
5TH AVE W
LAUREL PARK HWY
WASH CREEK DR
JUNIPER LN
LAKEMOOR LN
PRIMROSE LN
WHITE PINE DR
UPLAND WAY
EWARTS HILL RD
ARMSTRONG AVE
COX ST
GLENDALE AVE
SENECA BLVD
OVERLOOK TER
IVES ST
O'HARA CIR
MELINDA GLN
EWART DR
BELMONT DR
W LAKE AVE
WELLS AVE
PALMETTO DR
PINEBROOK CIR
LENNOX PARK DR
W PINE ST
S WHITTED ST
HEBRON RD
STATE ST
PARK ST
HALL ST
CHEROKEE DR
TUSHA LN
LAKESIDE DR
HAZELTON DR
CRISP LN
JEROMY LN
STEPP AVE
ROBIN ST
1ST AVE W
N OAK ST
S OAK ST

Eastside Pressure Zone

By 2040 significant growth in Eastside Pressure Zone will increase maximum day demand to 3.71 mgd. The existing Eastside BPS has firm capacity of 2 mgd and cannot meet the future demand. We recommended installing a new pump station supplied by the Balfour transmision main. The new Balfour BPS should be the same size as Eastside BPS. Most of the future water mains in Eastside Pressure Zone are already included in the city's existing CIP. These pipes serve potential industrial development growth areas. Recommended improvments are shown in **Figure 23**.

The city's Eastside Phase 2 CIP Project includes a 16-inch water main in Laycock, Ridge and Upward roads. However, the model shows that a 12-inch pipe (ES-1) can provide available fire flows greater than 2,700 gpm.

Figure 23 shows many other improvements to supply new development in the Eastside Pressure Zone. The colors in the figure indicate proposed phasing, but the pipes should be installed as development occurs.

Sugarloaf School PS can be abandoned once the north section of the Eastside Phase 2 Project (ES-1) comes online. The N Allen Rd PRV can be abandoned once the city's Dana Rd CIP project (ES-3) comes online.

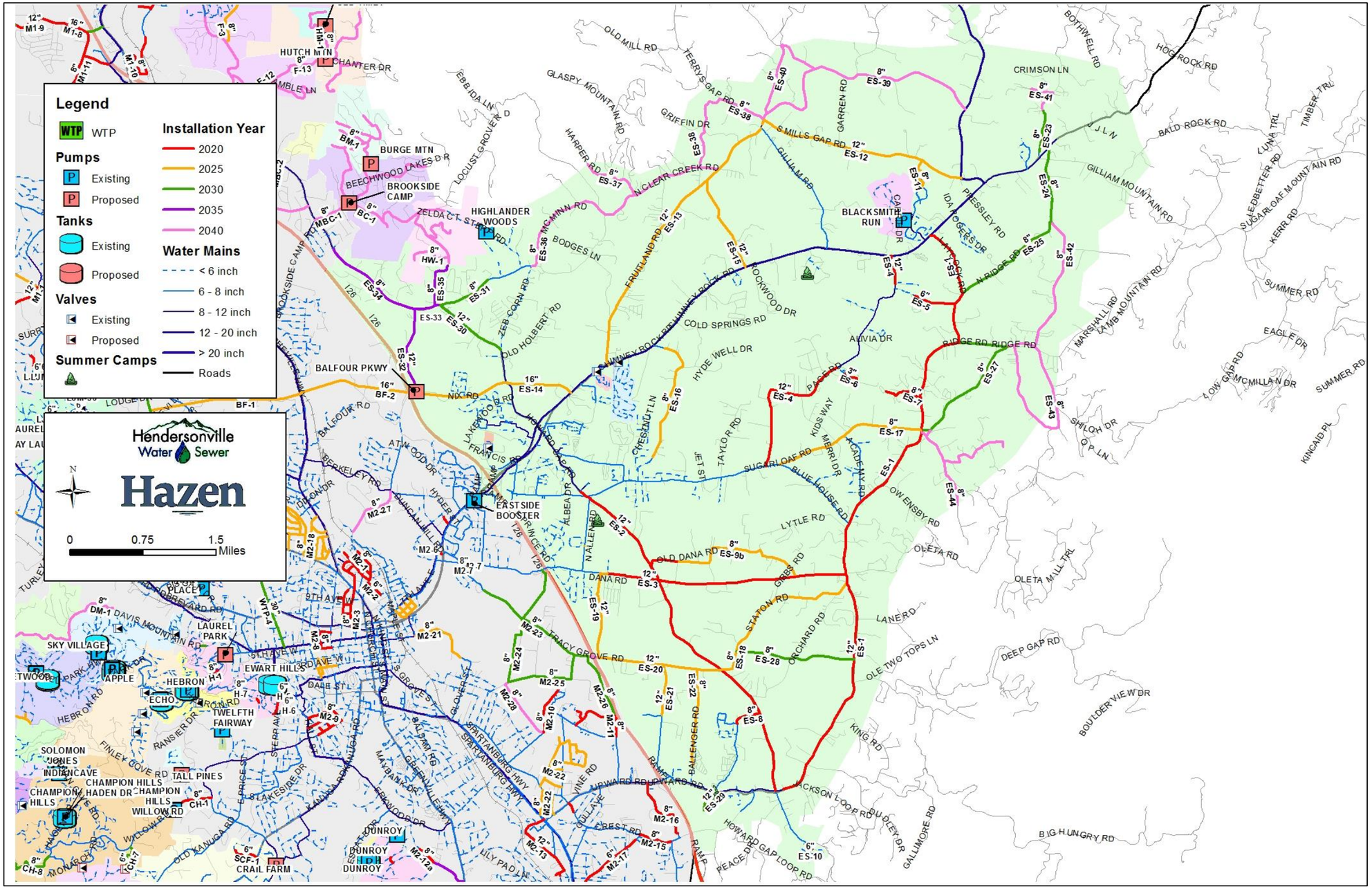


Figure 23: Proposed Improvements to Eastside

Legend

WTP WTP

Pumps
- P Existing
- P Proposed

Tanks
- Existing
- Proposed

Valves
- Existing
- Proposed

Summer Camps

Installation Year
- 2020
- 2025
- 2030
- 2035
- 2040

Water Mains
- < 6 inch
- 6 - 8 inch
- 8 - 12 inch
- 12 - 20 inch
- > 20 inch
- Roads

Hendersonville Water Sewer

Hazen

N

0 0.75 1.5 Miles

HUTCH MTN
BURGE MTN
BEECHWOOD LAKES DR
BROOKSIDE CAMP
BROOKSIDE CAMP RD
HIGHLANDER WOODS
ZELDA CT
STARR RD
MCMINN RD
BODGES LN
ZEB CORN RD
OLD HOLBERT RD
BALFOUR PKWY
NIX RD
BALFOUR RD
LODGE DR
OLD MILL RD
TERRYS GAP RD
GLASPY MOUNTAIN RD
EBB IDA LN
LOCUST GROVE RD
GRIFFIN DR
HARPER RD
N CLEAR CREEK RD
S MILLS GAP RD
GARREN RD
GILLIAM RD
CRIMSON LN
BOTHWELL RD
HOG ROCK RD
BALD ROCK RD
J J LN
TIMBER TRL
LUNA TRL
LEDBETTER RD
SUGARLOAF MOUNTAIN RD
GILLIAM MOUNTAIN RD
KERR RD
BLACKSMITH RUN
CARDIN DR
IDA ROGERS DR
PIESSLEY RD
N RIDGE RD
HITCH RACK RD
FRUITLAND RD
ROCKWOOD DR
CHIMNEY ROCK RD
COLD SPRINGS RD
HYDE WELL DR
ALIVIA DR
PAGE RD
RIDGE RD
MARSHALL RD
LAMB MOUNTAIN RD
SUMMER RD
EAGLE DR
LOW GAP RD
MCMILLAN DR
SHILOH DR
O P LN
KINGAID PL
I26
I26
I26

Fletcher Pressure Zone

The Fletcher area is currently supplied from the Main Zone. However, the city has retained another consultant to study shifting this area into a new zone supplied by a proposed pump station and storage tank as shown in Figure 24. The pump station will be located on Hendersonville Rd near Woodhill Dr and the pumps will be designed point of 1750 gpm at 110 ft total dynamic head. The new 1.0 MG tank will be located near the existing tank but the overflow elevation will be higher at 2,420 ft.

There are several industrial areas in this area and therefore the proposed pipes were sized to provide fire flow of 2,500 gpm. We recommend a 6-inch pipe from Winding Ivy Ct along parcel lines to Stone Hollow Rd (F-1) to increase fire flows in the first phase of improvements.

Figure 24 shows several other improvements to supply growth areas. The colors in the figure indicate phasing but improvements should be installed as development occurs.

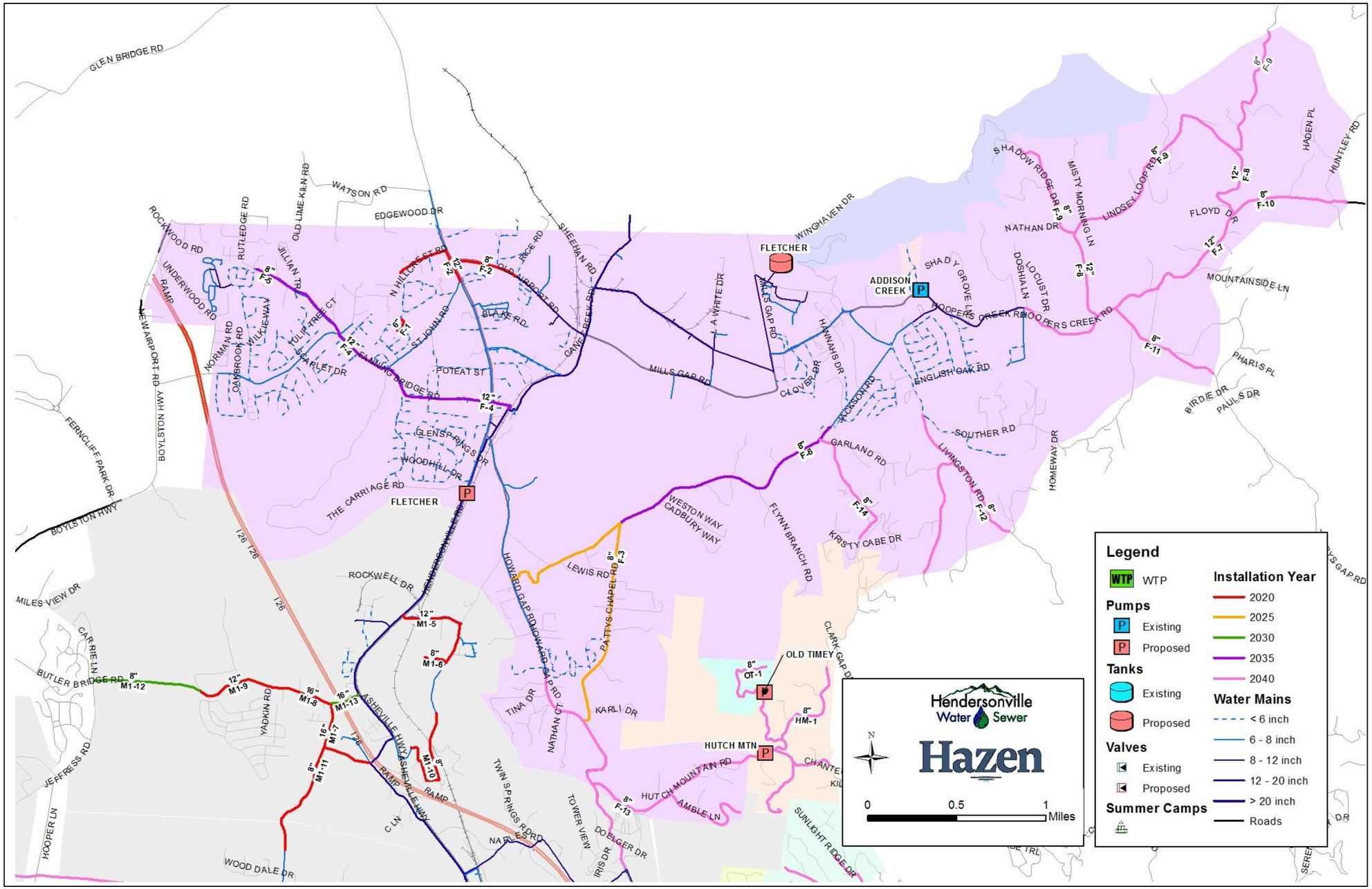


Figure 24: Recommendation for Fletcher

GLEN BRIDGE RD
ROCKWOOD RD
UNDERWOOD RD
RAMP
NE AIRPORT RD
RUTLEDGE RD
OLD LIME KILN RD
JILLIAN TRL
WATSON RD
EDGEWOOD DR
N HILLCREST ST RD
8" F-5
12" F-2
8" F-2
OLD AIRPORT RD
RICE RD
SHEEHAN RD
CANE CREEK RD
WINGHAVEN DR
FLETCHER
MILLS GAP RD
L A WHITE DR
HANNAHS DR
CLOVER DR
ADDISON CREEK
P
SHADY GROVE LN
DOSHIA LN
LOCUST DR
HOOPERS CREEK RD
SHADOW RIDGE DR F-9
MISTY MORNING LN
NATHAN DR
LINDSEY LOOP RD
8" F-9
12" F-8
8" F-10
FLOYD DR
12" F-7
8" F-11
HADEN PL
HUNTLEY RD
MOUNTAINSIDE LN
PHARIS PL
BIRDIE DR
PAUL S DR
ENGLISH OAK RD
SOUTHER RD
LIVINGSTON RD F-12
HOMEWAY DR
JACKSON RD
GARLAND RD
8" F-14
KRISTY CABE DR
FLYNN BRANCH RD
WESTON WAY
CADBURY WAY
LEWIS RD
8" F-3
PATTYS CHAPEL RD F-3
HOWARD GAP RD
CLARK GAP RD
OLD TIMEY
8" OT-1
8" HM-1
HUTCH MTN
P
HUTCH MOUNTAIN RD
AMBLE LN
8" F-13
SUNLIGHT RIDGE DR
TOWER VIEW
DOELGER DR
IRIS DR
TWIN SPRINGS RD
NAPLES RD
ASHEVILLE HWY
RAMP
I26
I26 I26
ROCKWELL DR
HENDERSONVILLE RD
GLENSPRINGS DR
WOODHILL DR
THE CARRIAGE RD
FLETCHER
P
BOYLSTON HWY
FERNCLIFF PARK DR
BOYLSTON HWY
MILES VIEW DR
CARRIE LN
BUTLER BRIDGE RD
8" M1-12
12" M1-9
16" M1-8
16" M1-13
16" M1-7
8" M1-11
8" M1-10
12" M1 -5
8" M1-6
YADKIN RD
JEFFRESS RD
HOOPER LN
C LN
WOOD DALE DR
NORMAN RD
OAKBROOK RD
WILKIE WAY
TULIP TREE CT
SCARLET DR
6" F-1
12" F-4
FANNING BRIDGE RD
ST JOHN RD
BLAKE RD
POTEAT ST
12" F-4
GLENSPRINGS DR
OLD TIMEY
8" OT-1
8" HM-1
HUTCH MTN
P
HUTCH MOUNTAIN RD
AMBLE LN
8" F-13
KARLI DR
TINA DR
NATHAN CT
HOWARD GAP RD
PATTYS CHAPEL RD F-3
LEWIS RD
8" F-3
WESTON WAY
CADBURY WAY
FLYNN BRANCH RD
KRISTY CABE DR
8" F-14
GARLAND RD
8" F-6
LIVINGSTON RD F-12
SOUTHER RD
ENGLISH OAK RD
HOOPERS CREEK RD
HOOPERS CREEK RD
8" F-11
ADDISON CREEK
P
SHADY GROVE LN
DOSHIA LN
LOCUST DR
HANNAHS DR
CLOVER DR
MILLS GAP RD
L A WHITE DR
WINGHAVEN DR
FLETCHER
SHADOW RIDGE DR F-9
MISTY MORNING LN
NATHAN DR
LINDSEY LOOP RD
8" F-9
12" F-8
8" F-10
FLOYD DR
12" F-7
HADEN PL
HUNTLEY RD
MOUNTAINSIDE LN
PHARIS PL
BIRDIE DR
PAUL S DR
HOMEWAY DR
JACKSON RD
SUNLIGHT RIDGE DR
CLARK GAP RD
GAP RD

Hendersonville Water Sewer
Hazen
N
0 0.5 1 Miles

Legend

WTP WTP

Pumps
- P Existing
- P Proposed

Tanks
- Existing
- Proposed

Valves
- Existing
- Proposed

Summer Camps

Installation Year
- 2020
- 2025
- 2030
- 2035
- 2040

Water Mains
- < 6 inch
- 6 - 8 inch
- 8 - 12 inch
- 12 - 20 inch
- > 20 inch
- Roads

Etowah Pressure Zone

The Etowah area is currently served from the Main Pressure Zone. A new Etowah Pump Station, transmission main and new storage tank are currently under design and review by the city. The proposed BPS will be located at Morgan Rd and Epona Trace. The existing Etowah elevated tank will be abandoned and the new 0.5 MG tank with an overflow of 2440 ft will be constructed at the end of Oak Knoll Dr. These improvements are shown in Figure 25.

To provide adequate fire flow for potential commercial development at the end of Brevard Rd, we recommend a 12-inch water main along Brevard Rd from Sunset Hill Drive to Old Highway 64. We also recommend a new 8-inch pipe in Old Hwy 64 (E-2) to improve fire flows.

Park Knoll PS, Golf Mountain PS and Enchanted Forest PS can be abandoned.

Figure 25 also shows several other improvements to supply future development, with color coding to indicate phasing. Again, improvements should be installed as development occurs.

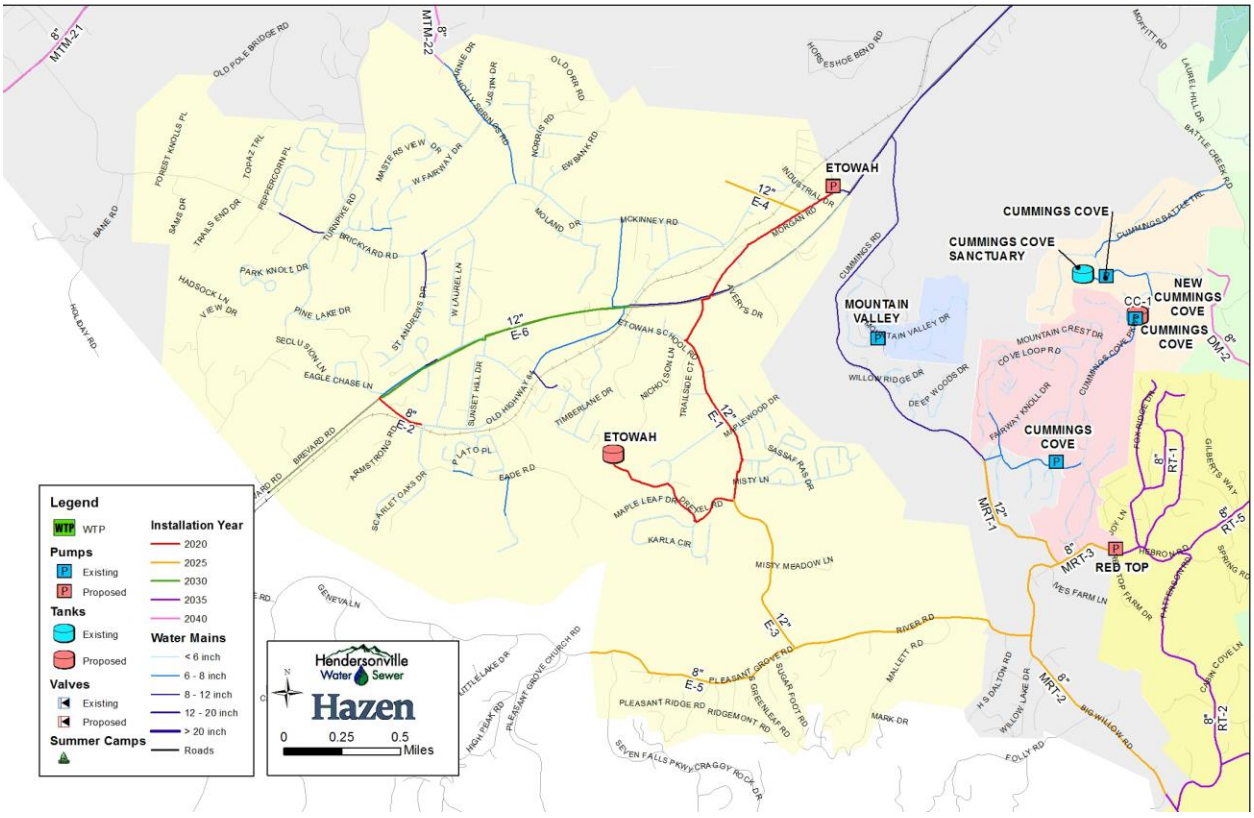
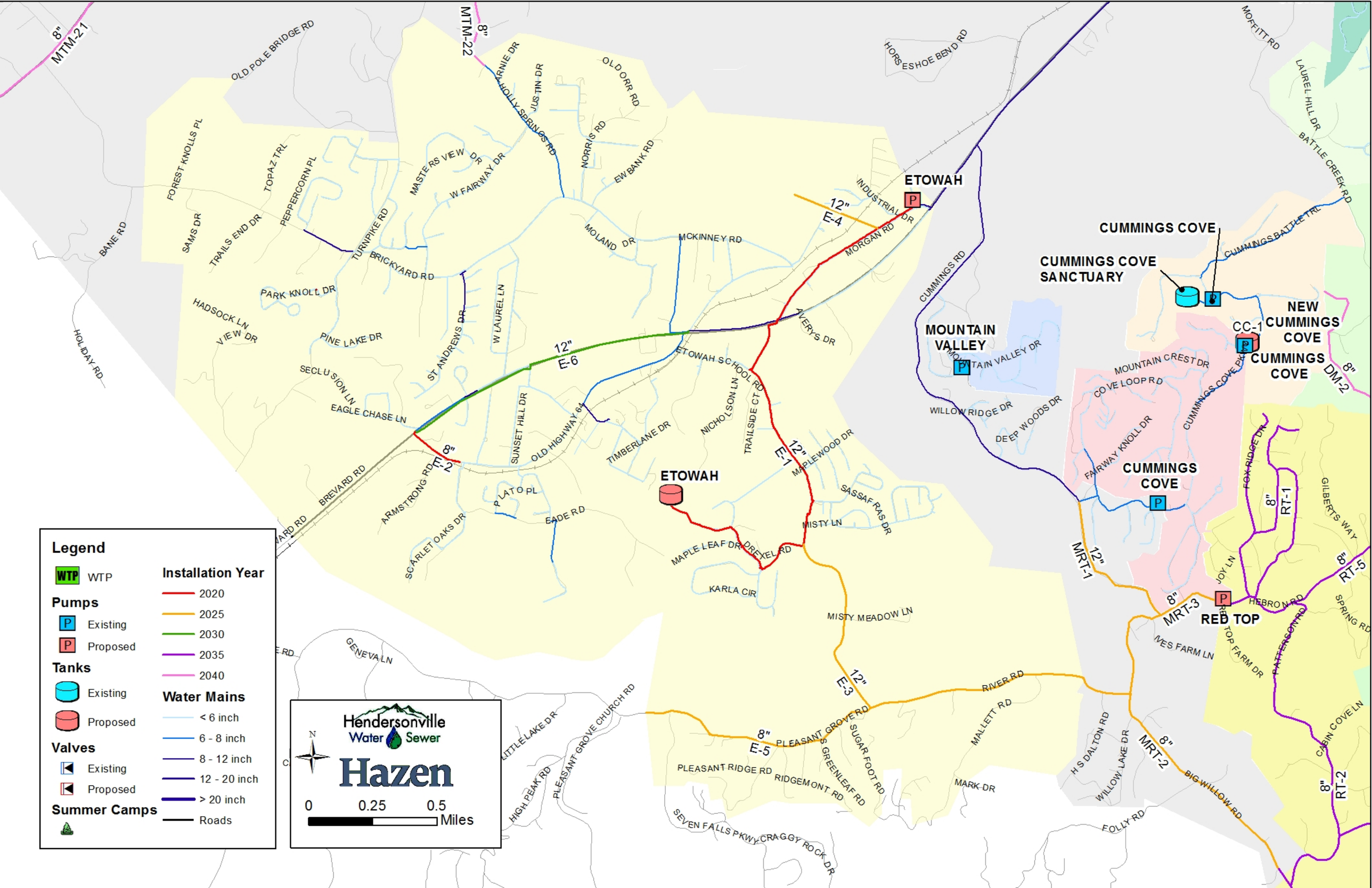


Figure 25: Recommendation for Etowah


8" MTM-21
OLD POLE BRIDGE RD
8" MTM-22
HOLLY SPRINGS RD
JUSTIN DR
OLD ORR RD
NORRIS RD
EWBANK RD
HORSESHOE BEND RD
MOFFITT RD
LAUREL HILL DR
BATTLE CREEK RD
FOREST KNOLLS PL
TOPAZ TRL
PEPPERCORN PL
MASTERS VIEW DR
W FAIRWAY DR
SAMS DR
TRAILS END DR
TURNPIKE RD
BRICKYARD RD
BANE RD
MOLAND DR
MCKINNEY RD
ETOWAH
INDUSTRIAL DR
MORGAN RD
12" E-4
CUMMINGS RD
CUMMINGS BATTLE TRL
CUMMINGS COVE
CUMMINGS COVE SANCTUARY
NEW CUMMINGS COVE
CC-1
CUMMINGS COVE
8" DM-2
PARK KNOLL DR
HADSOCK LN
VIEW DR
PINE LAKE DR
ST ANDREWS DR
W LAUREL LN
AVERYS DR
MOUNTAIN VALLEY
MOUNTAIN VALLEY DR
MOUNTAIN CREST DR
COVE LOOP RD
CUMMINGS COVE DR
HOLIDAY RD
SECLUSION LN
EAGLE CHASE LN
12" E-6
ETOWAH SCHOOL RD
NICHOLSON LN
TRAILSIDE CT
WILLOW RIDGE DR
DEEP WOODS DR
FAIRWAY KNOLL DR
8" E-2
ARMSTRONG RD
BREVARD RD
SUNSET HILL DR
OLD HIGHWAY 64
TIMBERLANE DR
P LATO PL
EADE RD
SCARLET OAKS DR
ETOWAH
12" E-1
MAPLEWOOD DR
SASSAFRAS DR
MISTY LN
MAPLE LEAF DR
DREXEL RD
KARLA CIR
CUMMINGS
FOX RIDGE DR
8" RT-1
GILBERTS WAY
12" MRT-1
JOY LN
8" RT-5
8" MRT-3
RED TOP
HEBRON RD
SPRING RD
RED TOP FARM DR
PATTERSON RD
MISTY MEADOW LN
12" E-3
RIVER RD
MALLETT RD
CABIN COVE LN
GENEVA LN
LITTLE LAKE DR
PLEASANT GROVE CHURCH RD
HIGH PEAK RD
8" E-5
PLEASANT GROVE RD
S GREENLEAF RD
SUGAR FOOT RD
PLEASANT RIDGE RD
RIDGEMONT RD
MARK DR
H S DALTON RD
WILLOW LAKE DR
8" MRT-2
BIG WILLOW RD
8" RT-2
FOLLY RD
SEVEN FALLS PKWY
CRAGGY ROCK DR
Legend
WTP WTP
Pumps
P Existing
P Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
N
Hendersonville Water Sewer
Hazen
0 0.25 0.5 Miles

Southside- Crail Farm Pressure Zone

The Crail Farm area is currently supplied from the Main Zone. The model shows several low pressure areas including the suction side of Kenmure Greensville Hwy BPS and Claremont BPS. We recommend creating a new Southside Pressure Zone supplied by a proposed pump station on the existing 12-inch pipe on Crail Farm Road. This pump station will supply Kenmure Greenville Hwy BPS and Claremont BPS as well as the proposed pump stations on Crab Creek Road and on Old Distillery Road. The proposed Crail Farm Pump Station should be designed for 2.0 mgd with a TDH of 132 feet for a discharge HGL of approximately 2420 feet. A 0.5 MG storage tank with an overflow of 2404 ft is proposed at the end of Glassy Mountain Dr., as shown in **Figure 26**.

To improve available fire flows, we recommend a 6-inch pipe on Jearl Ln (SF-1) and an 8-inch pipe on W Blue Rige Rd and Preston Ln (SCF-2).

We recommend merging Trenhom and Dunroy pressure zones by installing a 6-inch pipe from Kalimar Hts to Dunroy Dr (D-1) and abandoning Trenhom PS. This eliminates the need for part of the Rutledge Road project in the city's CIP. The Dunroy pump station and tank are adequate to meet the demand.

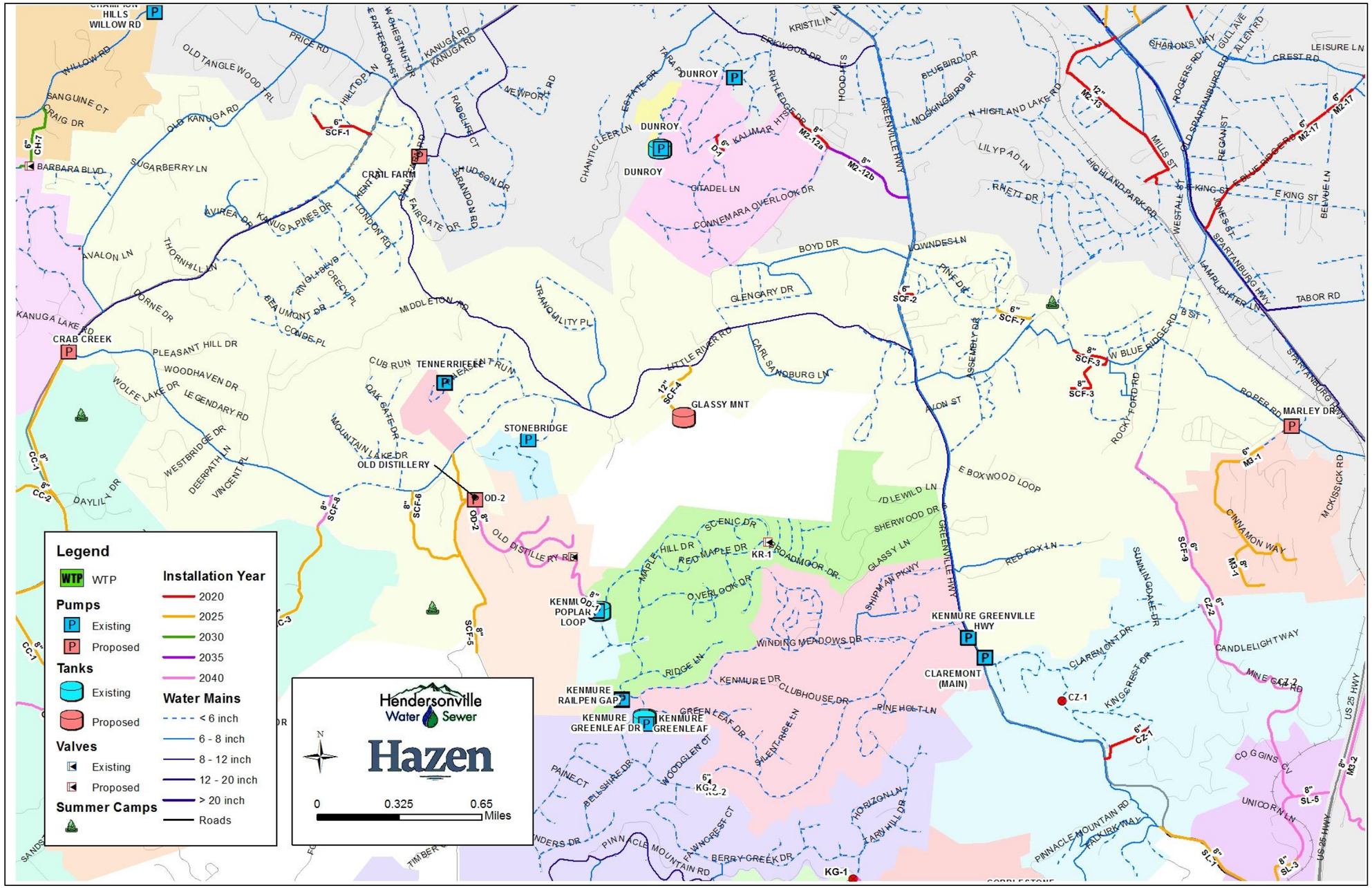
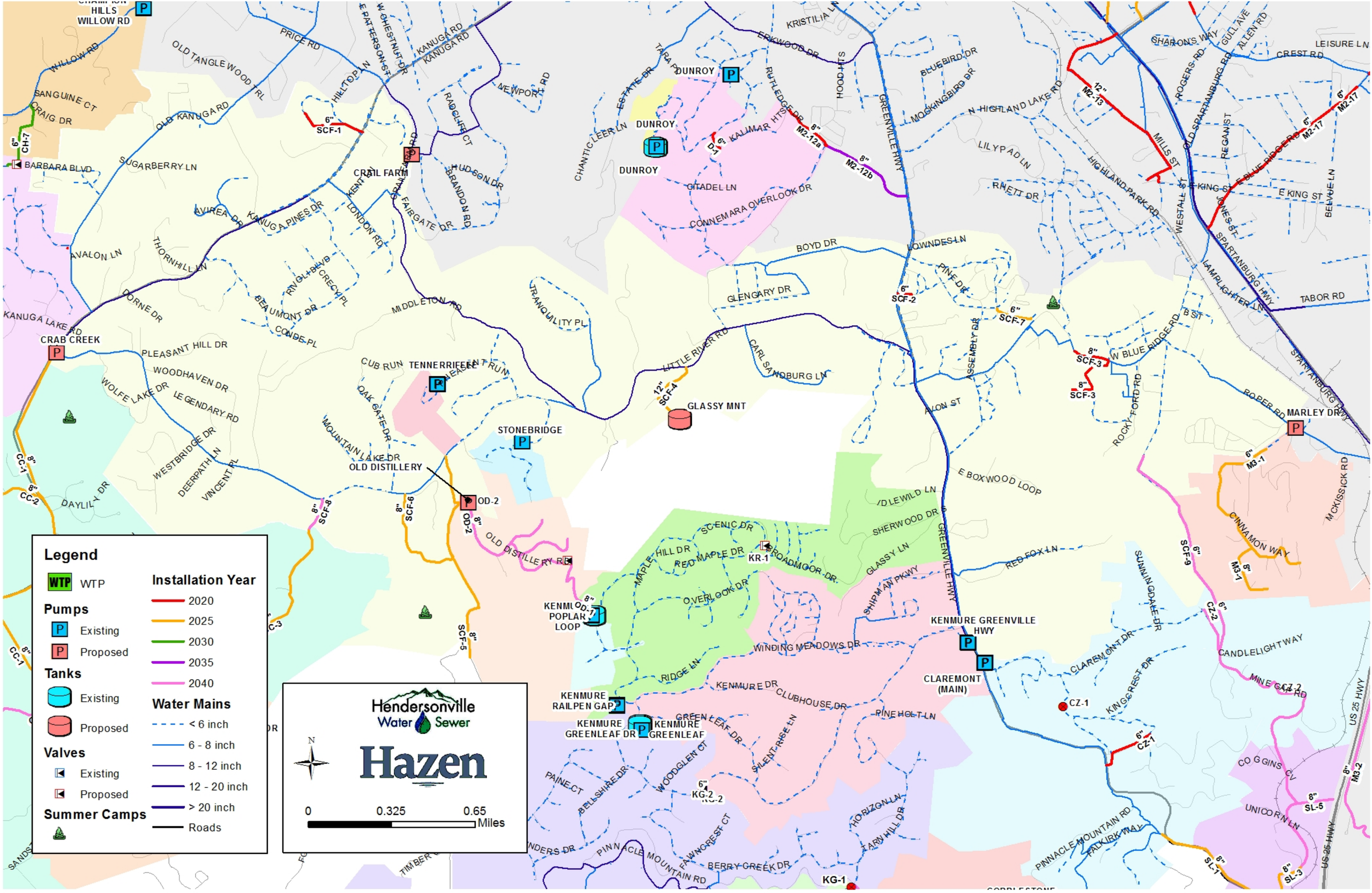


Figure 26: Recommendation for South Crail Farm


Legend
WTP
WTP
Pumps
Existing
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville Water Sewer
Hazen
N
0
0.325
0.65
Miles
HILLS
WILLOW RD
PRICE RD
OLD TANGLEWOOD TRL
WILLOW RD
SANGUINE CT
CRAIG DR
CH-7
BARBARA BLVD
SUGARBERRY LN
OLD KANUGA RD
HILLTOP LN
E PATTERSON ST
W CHESTNUT ST
KANUGA RD
KANUGA RD
SCF-1
RADCLIFFE CT
NEWPORT RD
CRAIG FARM
FAIRGATE DR
HUDSON DR
BRANDON RD
KENT RD
LONDON RD
AVIREA DR
KANUGA PINES DR
AVALON LN
THORNHILL LN
DORNE DR
RIVOLI BLVD
CRECY PL
BEAUMONT DR
CONDE PL
KANUGA LAKE RD
CRAB CREEK
PLEASANT HILL DR
WOODHAVEN DR
WOLFE LAKE DR
LEGENDARY RD
WESTBRIDGE DR
DEERPATH LN
VINCENT RL
DAYLILY DR
CC-1
CC-2
CC-3
MIDDLETON RD
TRANQUILITY PL
CUB RUN
TENNERRIFFE
PLEASANT RUN
OAK GATE DR
MOUNTAIN LAKE DR
OLD DISTILLERY
STONEBRIDGE
OD-2
OLD DISTILLERY RD
SCF-8
SCF-6
SCF-5
TARA PL
DUNROY
ESTATE DR
CHANTICLEER LN
DUNROY
DUNROY
D-1
KALMAR HTS
CITADEL LN
CONNEMARA OVERLOOK DR
KRISTILIA LN
ERKWOOD DR
RUTLEDGE DR
M2-12a
M2-12b
HOOD HTS
GREENVILLE HWY
BLUEBIRD DR
MOCKINGBIRD DR
LILYPAD LN
RNETT DR
N HIGHLAND LAKE RD
HIGHLAND PARK RD
M2-13
MILLS ST
SHARONS WAY
GUILL AVE
ALLEN RD
LEISURE LN
CREST RD
ROGERS RD
OLD SPARTANBURG RD
REGAN ST
E BLUE RIDGE DR
M2-17
W KING ST
E KING ST
JONES ST
WESTALL ST
BELVUE LN
SPARTANBURG HWY
LAMPLIGHTER LN
TABOR RD
BOYD DR
GLENGARY DR
LOWNDES LN
PINE DR
SCF-2
SCF-7
ASSEMBLY DR
ALON ST
B ST
W BLUE RIDGE DR
SCF-3
ROCKY FORD RD
ROPER RD
MARLEY DR
SPARTANBURG HWY
LITTLE RIVER RD
CARL SANDBURG LN
12"
SCF-4
GLASSY MNT
E BOXWOOD LOOP
OLDE WILD LN
SHERWOOD DR
GLASSY LN
SCENIC DR
MAPLE HILL DR
RED MAPLE DR
KR-1
BROADMOOR DR
OVERLOOK DR
RED FOX LN
SUNNINGDALE DR
SCF-9
M3-1
CINNAMON WAY
MCKISSICK RD
M3-2
CANDLELIGHT WAY
MINE GAP RD
CZ-2
CZ-1
KING CREST DR
CLAREMONT DR
CLAREMONT (MAIN)
KENMURE GREENVILLE HWY
SHIPMAN PKWY
WINDING MEADOWS DR
KENMURE DR
CLUBHOUSE DR
PINE HOLT LN
KENMURE RAILPEN GAP
KENMURE GREENLEAF DR
KENMURE GREENLEAF
GREEN LEAF DR
SILENT RISE LN
KENMOOR POPLAR LOOP
KG-1
KG-2
WOODGLEN CT
PAINE CT
BELLSHIRE DR
FAWNCREST CT
BERRY CREEK DR
PINNACLE MOUNTAIN RD
HORIZON LN
FARM HILL DR
RIDGE LN
SCF-10
SL-1
SL-3
SL-5
US 25 HWY
US-25 HWY
COGGINS CV
UNICORN LN
FALKIRK WAY

Claremont Pressure Zone

Currently the lower elevations in the Claremont area are supplied through a PRV on the discharge side of Claremont BPS. However, some of the customers this PRV supplies have low pressures. We recommend supplying these customers from the main Claremont zone by installing a new 6-inch water main (CZ-1) from Greenville Hwy along Continental Dr to Southview Ln and closing a valve between Claremont Dr and Kingcrest Dr.

Development along Mine Gap Rd can be supplied from existing water mains by replacing the replacing the existing 2-inch pipe at the end of Claremont Dr with a 6-inch pipe (CZ-2) and extending it to Mine Gap Rd to meet future growth. Figure 27 shows the proposed improvements.

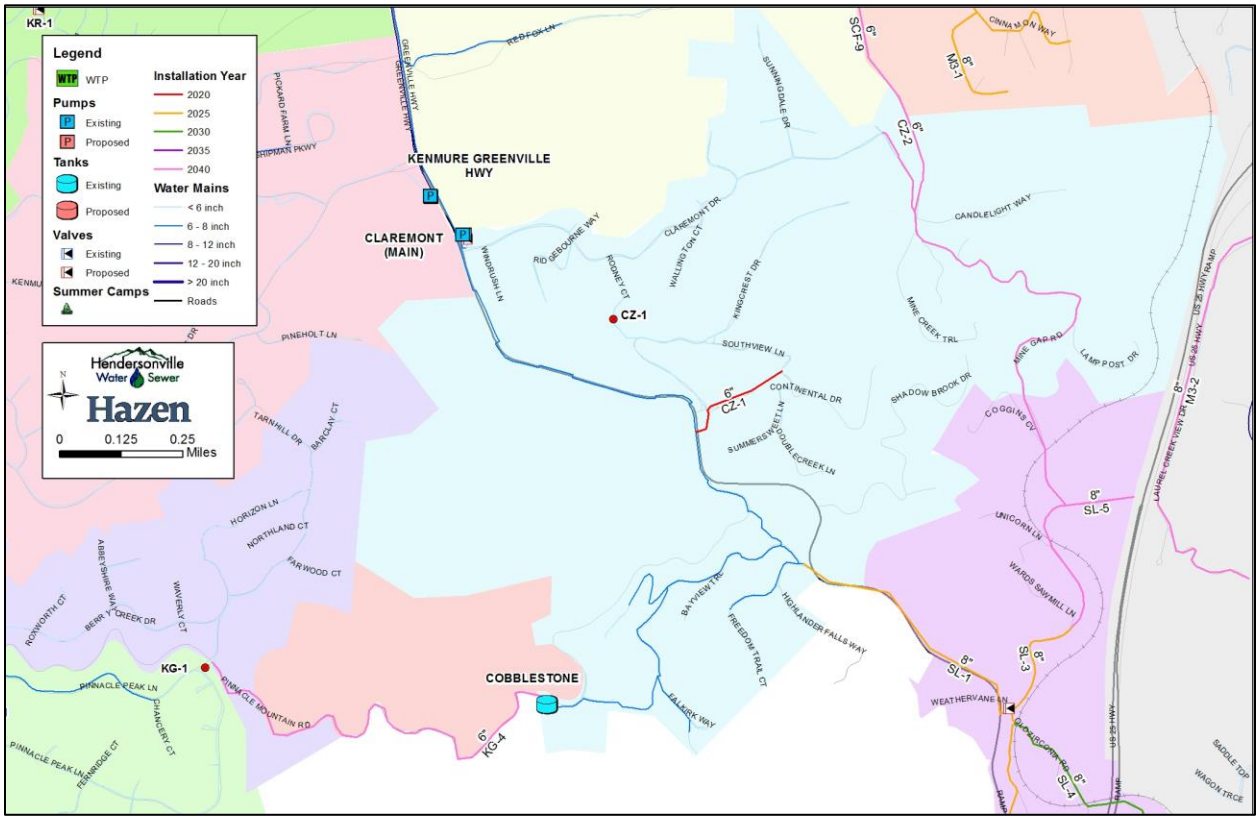


Figure 27: Recommendation for Claremont

Legend

WTP — WTP

Pumps

P — Existing

P — Proposed

Tanks

Existing

Proposed

Valves

Existing

Proposed

Summer Camps

Installation Year

2020

2025

2030

2035

2040

Water Mains

< 6 inch

6 - 8 inch

8 - 12 inch

12 - 20 inch

> 20 inch

Roads

Hendersonville Water & Sewer

Hazen

N

0 0.125 0.25 Miles

KR-1

KENMURE GREENVILLE HWY

CLAREMONT (MAIN)

CZ-1

COBBLESTONE

KG-1

SCF-9 6"

M3-1 8"

CZ-2 6"

CZ-1 6"

KG-4 6"

SL-1 8"

SL-3 8"

SL-4 8"

SL-5 8"

M3-2 8"

GREENVILLE HWY

RED FOX LN

PICKARD FARM LN

SHIPMAN PKWY

SUNNINGDALE DR

CINNAMON WAY

CANDLELIGHT WAY

CLAREMONT DR

WALLINGTON CT

RIDGEBOURNE WAY

RODNEY CT

WINDRUSH LN

KINGCREST DR

SOUTHVIEW LN

MINE CREEK TRL

MINE GAP RD

LAMP POST DR

CONTINENTAL DR

SHADOW BROOK DR

COGGINS CV

SUMMERSWEET DOUBLECREEK LN

PINEHOLT LN

TARNHILL DR

BARCLAY CT

HORIZON LN

NORTHLAND CT

FARWOOD CT

ABBEYSHIRE WAY

BERRY CREEK DR

WAVERLY CT

ROXWORTH CT

PINNACLE PEAK LN

CHANCERY CT

FERNRIDGE CT

PINNACLE MOUNTAIN RD

BAYVIEW TRL

FREEDOM TRAIL CT

FALKIRK WAY

HIGHLANDER FALLS WAY

WARDS SAWMILL LN

UNICORN LN

WEATHERVANE LN

OLD ZIRCONIA RD

US 25 HWY

US 25 HWY RAMP

LAUREL CREEK VIEW DR

SADDLE TOP

WAGON TRCE

Summit Landing Pressure Zone

We propose a new Summit Landing Pressure Zone to meet future demand in an area not currently served by the city. The zone would be supplied by the current Claremont Main Zone. The new zone will include a new 0.2 MG tank with an overflow elevation of 2350 ft. We propose a pressure reducing control valve that opens and closes in response to the water level in the new zone. The control valve will insure tank turnover. Figure 28 depicts several other improvements in the proposed Summit Landing Zone.

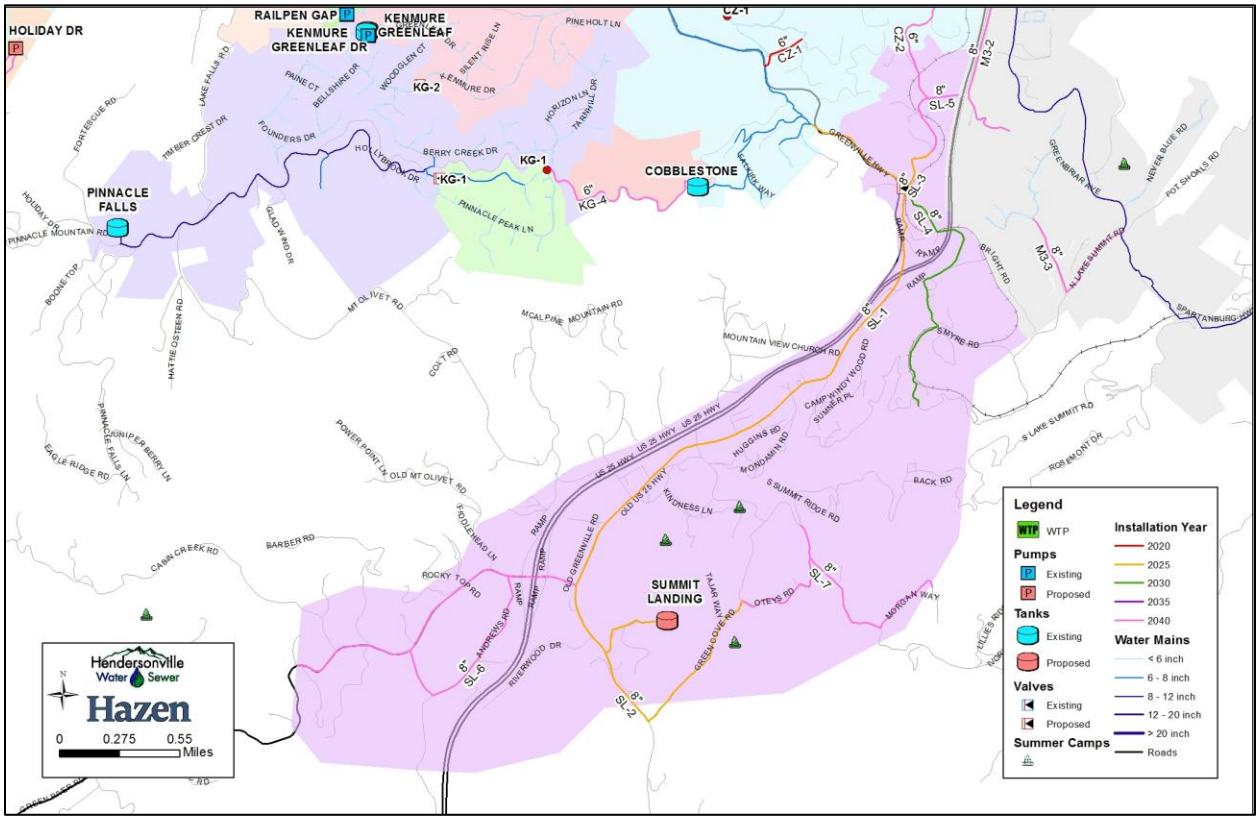
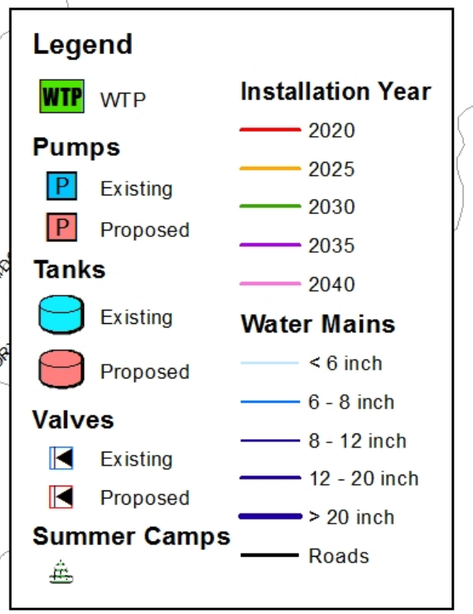


Figure 28: Recommendation for Summit Landing

HOLIDAY DR
RAILPEN GAP
KENMURE GREENLEAF
KENMURE GREENLEAF DR
PINE HOLT LN
CZ-1
6" CZ-1
CZ-2
6"
8" M3-2
8" SL-5
LAKE FALLS RD
FORTESCUE RD
TIMBER CREST DR
PAINE CT
BELLSHIRE DR
WOODGLEN CT
GREENLEAF DR
SILENT RISE LN
KENMURE DR
KG-2
HORIZON LN
TARNHILL DR
FOUNDERS DR
HOLLYBROOK DR
BERRY CREEK DR
KG-1
KG-1
PINNACLE PEAK LN
6" KG-4
COBBLESTONE
EATKIRK WAY
GREENVILLE HWY
8" SL-3
8" SL-4
RAMP
RAMP
RAMP
RAMP
BRIGHT RD
GREENBRIAR AVE
NEVER BLUE RD
POT SHOALS RD
8" M3-3
N LAKE SUMMIT RD
SPARTANBURG HWY
PINNACLE FALLS
HOLIDAY DR
PINNACLE MOUNTAIN RD
BOONE TOP
GLADWIND DR
HATTIE OSTEEN RD
MT OLIVET RD
MCALPINE MOUNTAIN RD
COLT RD
MOUNTAIN VIEW CHURCH RD
8" SL-1
WINDY WOOD RD
S MYRE RD
S LAKE SUMMIT RD
ROSEMONT DR
PINNACLE FALLS LN
JUNIPER BERRY LN
EAGLE RIDGE RD
POWER POINT LN
OLD MT OLIVET RD
FIDDLEHEAD LN
BARBER RD
CABIN CREEK RD
ROCKY TOP RD
RAMP
RAMP
RAMP
OLD GREENVILLE RD
US 25 HWY
US 25 HWY
US 25 HWY
OLD US 25 HWY
HUGGINS RD
MONDAMIN RD
CAMP WINDY WOOD SUMNER PL
KINDNESS LN
S SUMMIT RIDGE RD
BACK RD
SUMMIT LANDING
TAJAR WAY
GREEN GROVE RD
OTEYS RD
8" SL-7
MORGAN WAY
8" ANDREWS RD
8" SL-6
RIVERWOOD DR
8" SL-2
LILLIES RIDGE
IVORY





Kenmure Greenleaf Pressure Zone

The model shows the existing Pinnacle Falls and Pinnacle Mountain tanks are incompatible and the storage analysis table indicates that Pinnacle Mountain tank is not needed. We recommend abandoning Pinnacle Mountain Tank, which will reduce water age and improve water quality in this zone.

A proposed pressure reducing valve will eliminate excessive (KG-1) pressures for customers along Pinnacle Peak Ln loop. A valve near Pinnacle Peak Ln near Pinnacle Mountain Rd must be closed to create this reduced pressure zone within the Kenmure Greenleaf Zone, as shown in Figure 29.

To improve fire flows in the Kenmure Greenville Hwy Zone, we recommend installing a PRV (KG-2) between zones on Kenmure Dr.

Developments at higher elevations near Pinnacle Falls Tank and north of Pinnacle Mountain Rd (KG-4) will require a booster pump.

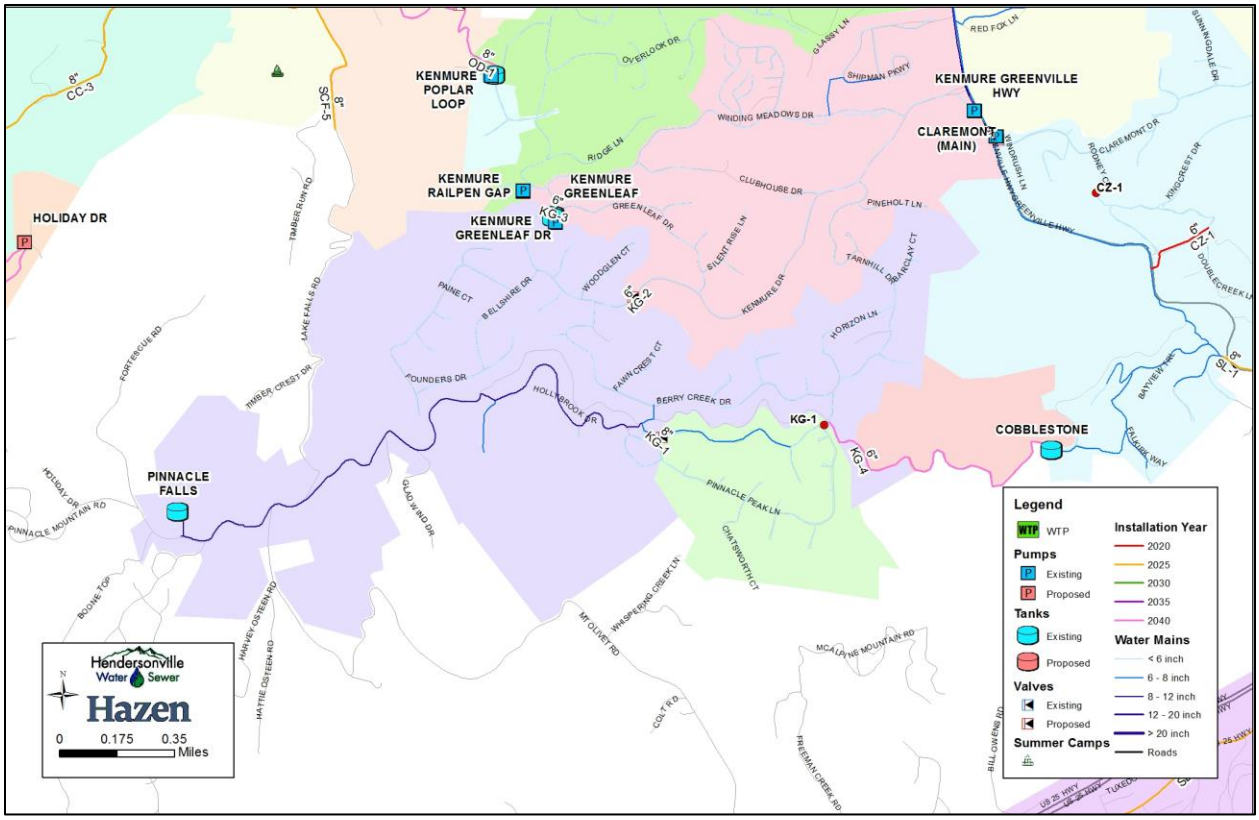
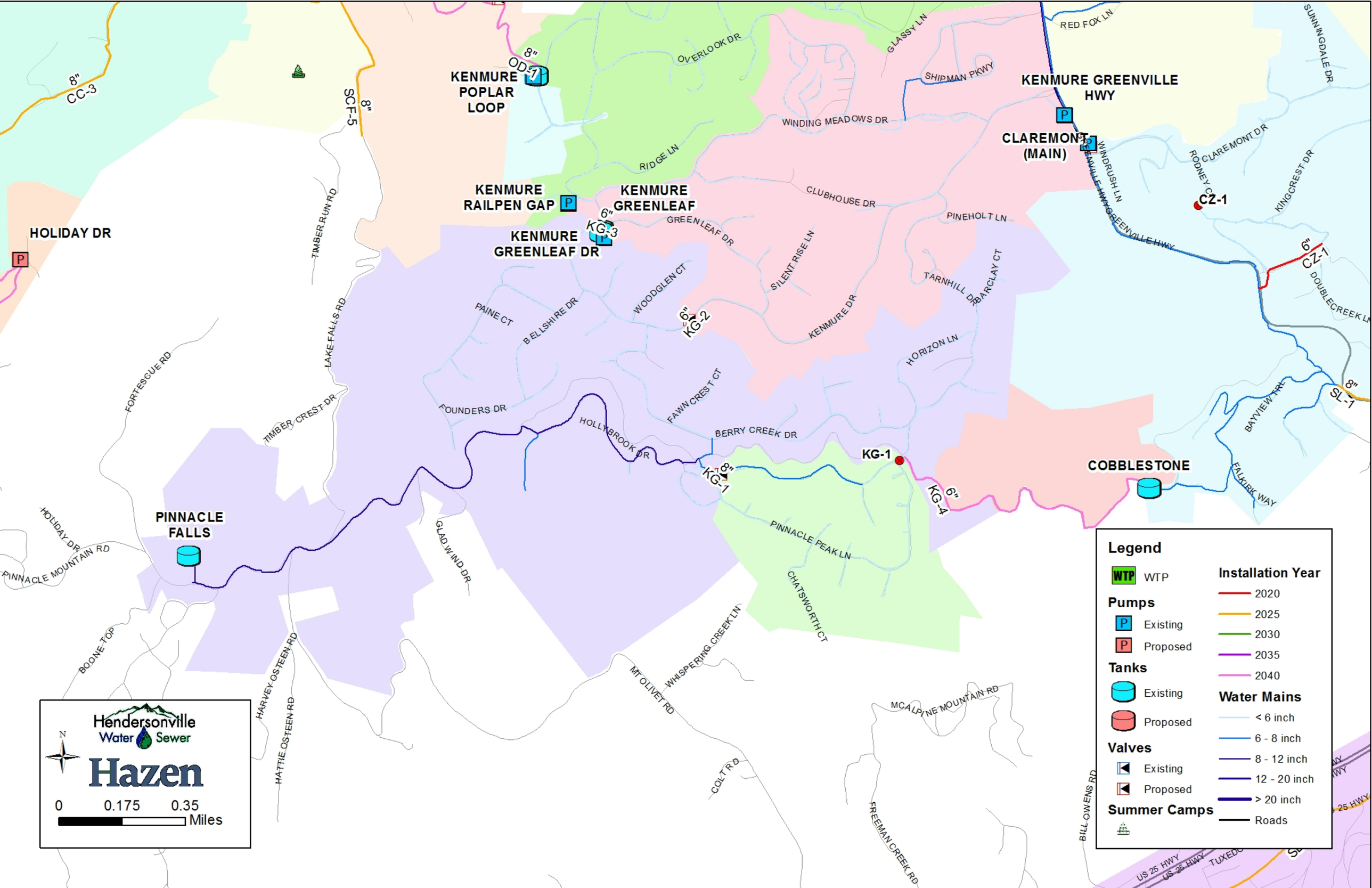


Figure 29: Proposed Improvements for Kenmure Greenleaf Pressure Zone


KENMURE POPLAR LOOP
OD-1
8"
CC-3
SCF-5
OVERLOOK DR
GLASSY LN
SHIPMAN PKWY
RED FOX LN
SUNNINGDALE DR
KENMURE GREENVILLE HWY
CLAREMONT (MAIN)
WINDING MEADOWS DR
RIDGE LN
RODNEY CLAREMONT DR
KINGCREST DR
WINDRUSH LN
GREENVILLE HWY
CZ-1
KENMURE RAILPEN GAP
KENMURE GREENLEAF
KENMURE GREENLEAF DR
KG-3
6"
CLUBHOUSE DR
PINEHOLT LN
GREENLEAF DR
HOLIDAY DR
TIMBER RUN RD
SILENT RISE LN
TARNHILL DR
BARCLAY CT
KENMURE DR
WOODGLEN CT
PAINE CT
BELLSHIRE DR
KG-2
LAKE FALLS RD
FORTESCUE RD
HORIZON LN
FOUNDERS DR
TIMBER CREST DR
FAWN CREST CT
HOLLYBROOK DR
BERRY CREEK DR
KG-1
KG-4
COBBLESTONE
FALKIRK WAY
BAYVIEW TRL
SL-1
DOUBLECREEK LN
PINNACLE FALLS
HOLIDAY DR
PINNACLE MOUNTAIN RD
GLADWIND DR
PINNACLE PEAK LN
CHATSWORTH CT
BOONE TOP
HARVEY OSTEEN RD
HATTIE OSTEEN RD
WHISPERING CREEK LN
MT OLIVET RD
COLT RD
MCALPINE MOUNTAIN RD
FREEMAN CREEK RD
BILL OWENS RD
US 25 HWY
TUXEDO
Hendersonville Water Sewer
Hazen
N
0 0.175 0.35 Miles
Legend
WTP WTP
Pumps
Existing
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads

Kenmure Railpengap & Old Distillery Pressure Zone

We recommend creating a new zone to reduce pressures in the Kenmore Railpengap area. The new zone should be supplied by a PRV (KR-1) on Pinnacle Peak Ln, as shown in Figure 30.

We modeled two alternatives for supplying the area west of this zone, along Old Distillery Rd. The first alternative included a pipe near the Kenmure Poplar loop (OD-1), with a PRV on Old Distillery Dr to reduce pressures. This option relies on the constructability of OD-1, which is through a ridge line.

The second option uses a variable speed pump station at Lake Falls Rd & Old Distillery Rd, designed for 30 gpm at a TDH of 190 ft. to maintain a discharge HGL of 2740 ft. In order for the pump to meet the pressures at the higher elevations along Old Distillery Rd, the discharge pressure would be over 200 psi. Therefore, if the existing homes at the end of Old Distillery Rd wish to be served by the city a jockey pump would be required. Both options are shown in Figure 30.

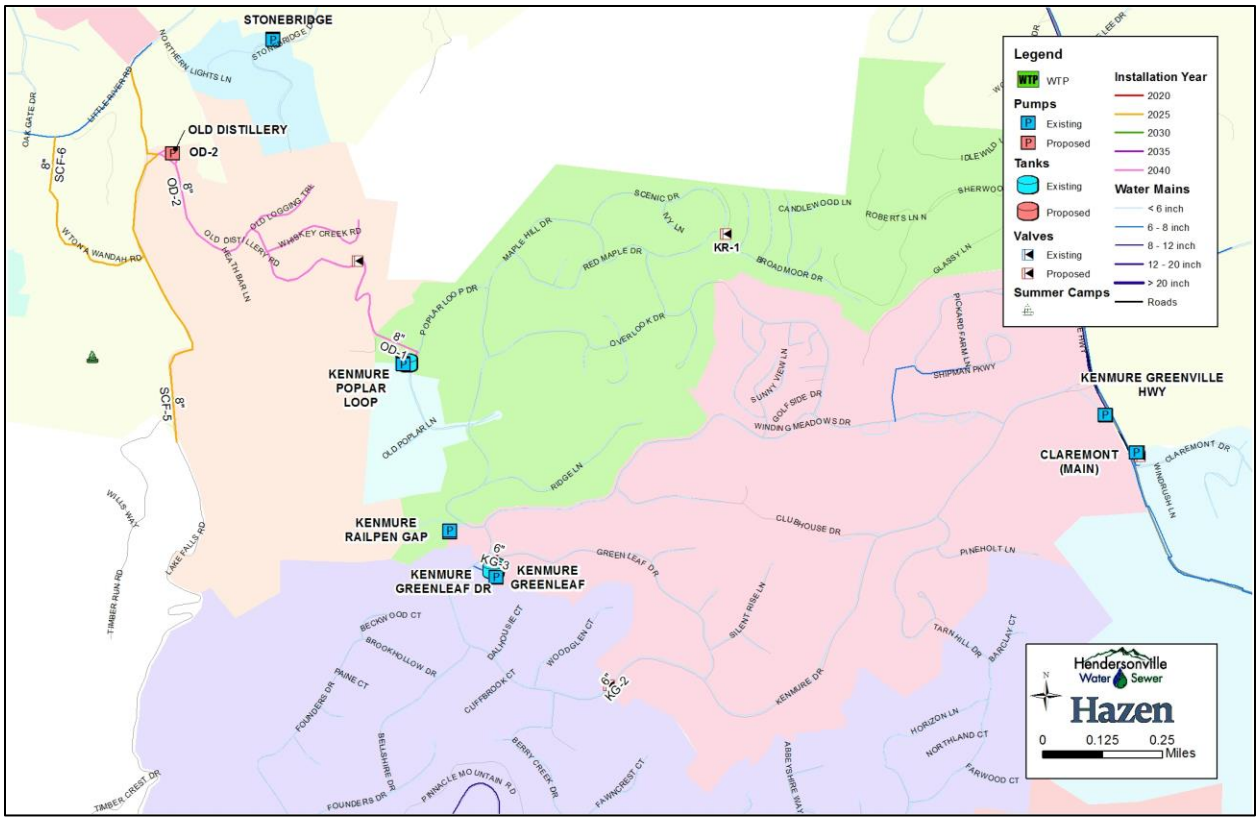


Figure 30: Proposed Improvements for Kenmure Railpen Gap / Old Distillery Pressure Zone

STONEBRIDGE
STONEBRIDGE DR
NORTHERN LIGHTS LN
LITTLE RIVER RD
OAK GATE DR
OLD DISTILLERY
OD-2
8"
SCF-6
OD-2
8"
OLD LOGGING TRL
OLD DISTILLERY RD
WHISKEY CREEK RD
HEATHBAR LN
WTONA WANDAH RD
SCF-5
8"
KENMURE POPLAR LOOP
OLD POPLAR LN
8"
OD-1
POPLAR LOOP DR
MAPLE HILL DR
RED MAPLE DR
SCENIC DR
IVY LN
KR-1
CANDLEWOOD LN
ROBERTS LN N
BROADMOOR DR
GLASSY LN
OVERLOOK DR
SUNNY VIEW LN
GOLFSIDE DR
WINDING MEADOWS DR
PICKARD FARM LN
SHIPMAN PKWY
KENMURE GREENVILLE HWY
CLAREMONT (MAIN)
CLAREMONT DR
WINDRUSH LN
RIDGE LN
KENMURE RAILPEN GAP
6"
KG-3
KENMURE GREENLEAF DR
KENMURE GREENLEAF
GREEN LEAF DR
CLUBHOUSE DR
PINEHOLT LN
SILENT RISE LN
KENMURE DR
6"
KG-2
WILLS WAY
LAKE FALLS RD
TIMBER RUN RD
TIMBER CREST DR
BECKWOOD CT
BROOKHOLLOW DR
PAINE CT
FOUNDERS DR
DALHOUSIE CT
CLIFFBROOK CT
WOODGLEN CT
BELLSHIRE DR
FOUNDERS DR
PINNACLE MOUNTAIN RD
BERRY CREEK DR
FAWNCREST CT
ABBEYSHIRE WAY
TARN HILL DR
BARCLAY CT
HORIZON LN
NORTHLAND CT
FARWOOD CT

Legend

WTP WTP

Pumps
- Existing
- Proposed

Tanks
- Existing
- Proposed

Valves
- Existing
- Proposed

Summer Camps

Installation Year
- 2020
- 2025
- 2030
- 2035
- 2040

Water Mains
- < 6 inch
- 6 - 8 inch
- 8 - 12 inch
- 12 - 20 inch
- > 20 inch
- Roads

N

Hendersonville Water Sewer

Hazen

0 0.125 0.25 Miles

Crab Creek / Evans Road Pressure Zone

The city currently does not serve the Crab Creek/Evans Road area. The recommended improvements to provide service for future growth are shown in Figure 31. We recommend supplying the main Crab Creek zone using a BPS designed for 104 gpm and a TDH of 80 ft. to maintain a discharge HGL of 2480 ft. Figure 27 shows a proposed 0.15 MG storage tank with an overflow elevation of 2477 ft. on Foster Hill Road. We recommend two variable speed pump stations to supply the higher elevations within the Crab Creek Zone.

- Holiday Dr VPS: 95 gpm @ 140 ft. to maintain discharge HGL of 2655 ft.
- Crab Creek 2 VPS: 100 gpm @ 220 ft. to maintain discharge HGL of 2760 ft.

The area north of Crab Creek along Evans Rd will be split between Crab Creek Zone and Evans Zone. Two VPS will supply Evan zone:

- Evens Rd VPS: 120 gpm @ 180 ft. to maintain a discharge HGL of 2650 ft.
- Kanuga Ridge VPS: 100 gpm @ 85 ft. to maintain a discharge HGL of 2760 ft.

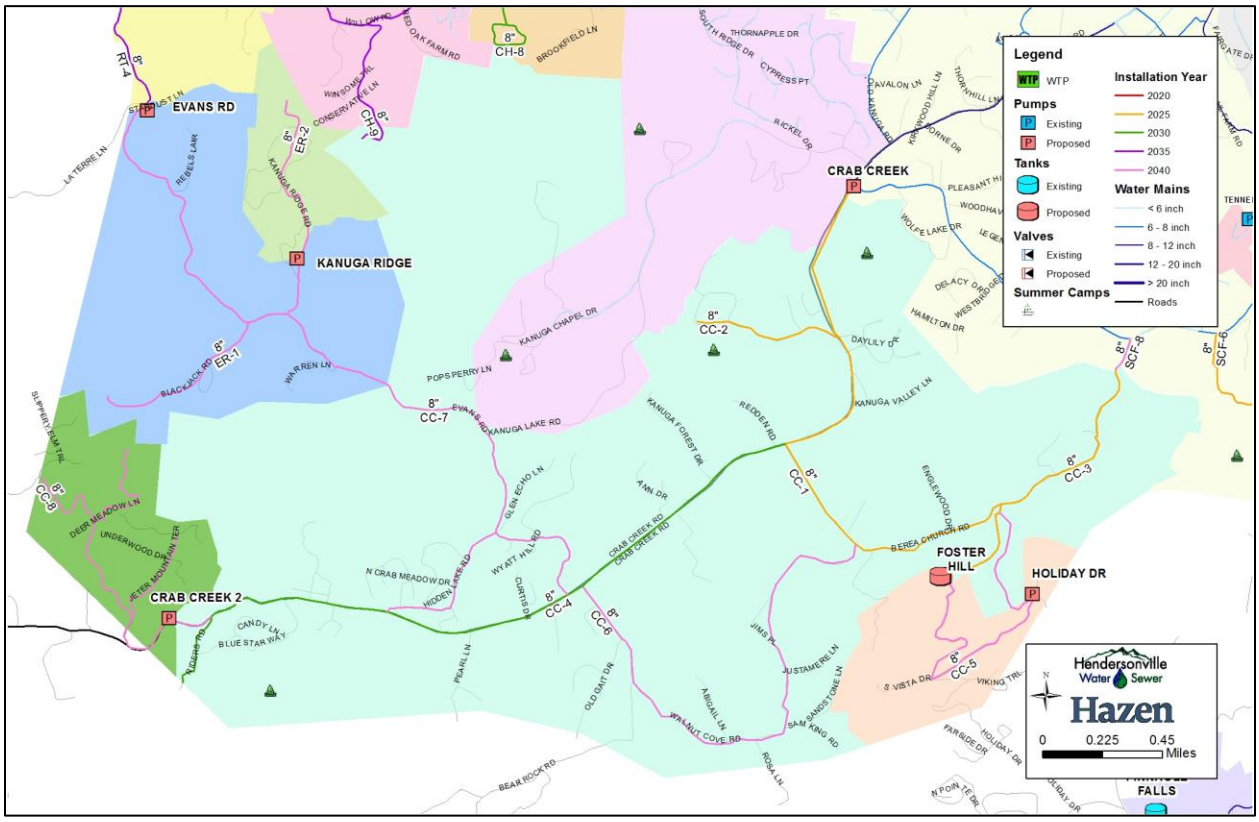
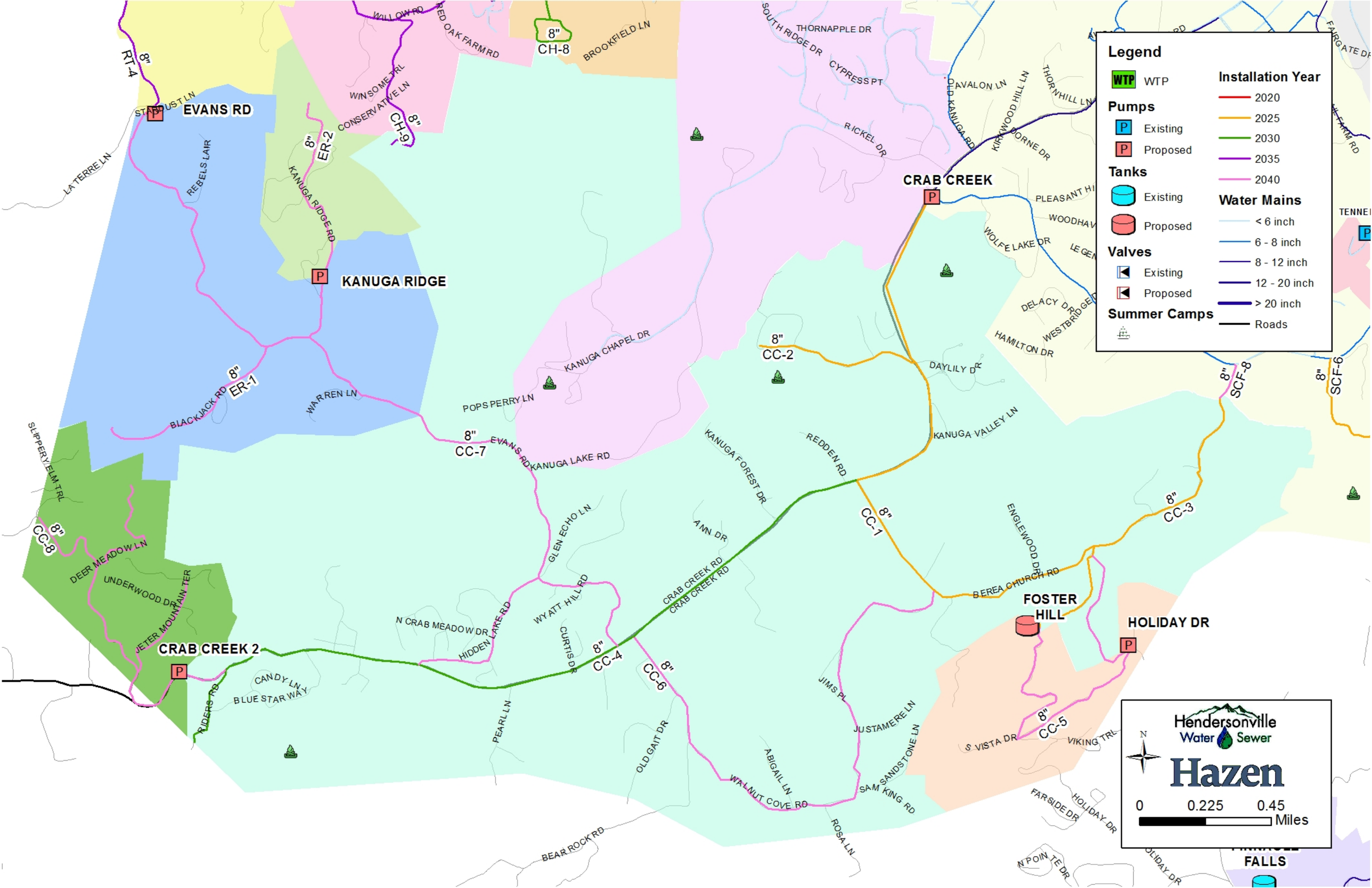


Figure 31: Recommendation for Crab Creek / Evans


Legend
WTP
WTP
Pumps
Existing
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
EVANS RD
KANUGA RIDGE
CRAB CREEK
CRAB CREEK 2
FOSTER HILL
HOLIDAY DR
FALLS
RT-4
ER-1
ER-2
CH-8
CH-9
CC-1
CC-2
CC-3
CC-4
CC-5
CC-6
CC-7
CC-8
SCF-6
SCF-8
8"
LA TERRE LN
STARDUST LN
REBELS LAIR
KANUGA RIDGE RD
WILLOW RD
RED OAK FARM RD
WINSOME TRL
CONSERVATIVE LN
BROOKFIELD LN
SOUTH RIDGE DR
THORNAPPLE DR
CYPRESS PT
RICKEL DR
DAVALON LN
OLD KANUGA RD
KIRKWOOD HILL LN
THORNHILL LN
KIRKWOOD DORNE DR
PLEASANT HI
WOODHAV
WOLFE LAKE DR
LEGEN
DELACY DR
WESTBRIDGE
HAMILTON DR
DAYLILY DR
KANUGA CHAPEL DR
POPS PERRY LN
BLACKJACK RD
WARREN LN
SLIPPERY ELM TRL
DEER MEADOW LN
UNDERWOOD DR
JETER MOUNTAIN TER
EVANS RD
KANUGA LAKE RD
KANUGA FOREST DR
REDDEN RD
KANUGA VALLEY LN
GLEN ECHO LN
ANN DR
ENGLEWOOD DR
BEREA CHURCH RD
N CRAB MEADOW DR
HIDDEN LAKE RD
WYATT HILL RD
CURTIS DR
CRAB CREEK RD
CRAB CREEK RD
CANDY LN
BLUE STAR WAY
RIDERS RD
PEARL LN
OLD GAIT DR
JIMS PL
JUSTAMERE LN
SANDSTONE LN
ABIGAIL LN
WALNUT COVE RD
SAM KING RD
ROSA LN
BEAR ROCK RD
S VISTA DR
VIKING TRL
FARSIDE DR
HOLIDAY DR
N POINTE DR
Hendersonville Water Sewer
Hazen
N
0
0.225
0.45
Miles

Champion Hills Pressure Zone

The Champion Hills Pump Station supplies the Champion Hill Pressure Zone, which in turn supplies Solomon Jones, Indian Cave, Falls Ln Chattooga Run and Chattooga Run zones. We propose connecting the current Sugar Hollow Zone to the Champion Hills Zone with new 8-inch pipe from Monarch Rd along parcel boundary to South Ridge Dr (CH-2) and 6-inch from Summery Farms Ln, Bliss Dr, along parcel property to Rickel Dr (CH-7).

The existing Champion Hills Tank has adequate volume to meet the maximum day demands and fire flow for both Champion Hills and current Sugar Hollow zones. This eliminates the need for a larger tank in the Sugar Hollow Zone.

The model shows low pressures on the suction side of Champion Hill Pump Station. To resolve these pressures, we recommend installing an 8-inch pipe to supply the pump station (CH-1) and connecting the existing suction pipe to the discharge side of the pumps with a PRV (CH-1) to resolve low pressures. Proposed improvements are shown in Figure 32.

Champion Hills Zone supplies several PRVs to prevent excessive pressure at lower elevations. To supply future development, we recommend two additional PRVs to supply future CH-6 water mains. One will be on Loggers Run and the other on Rambling Tr. To meet future demand along Willow Rd, CH-8 and CH-9 water mains are needed with a PRV separating the two segments.

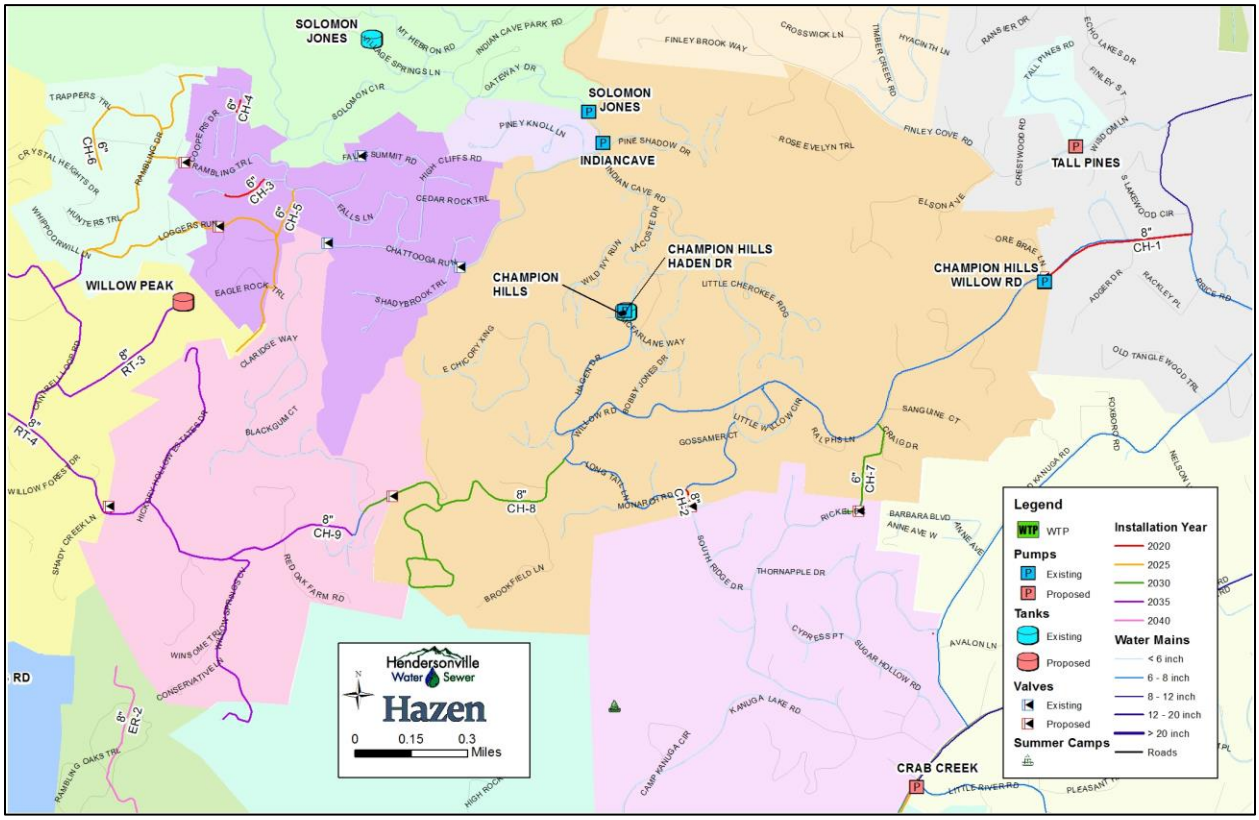
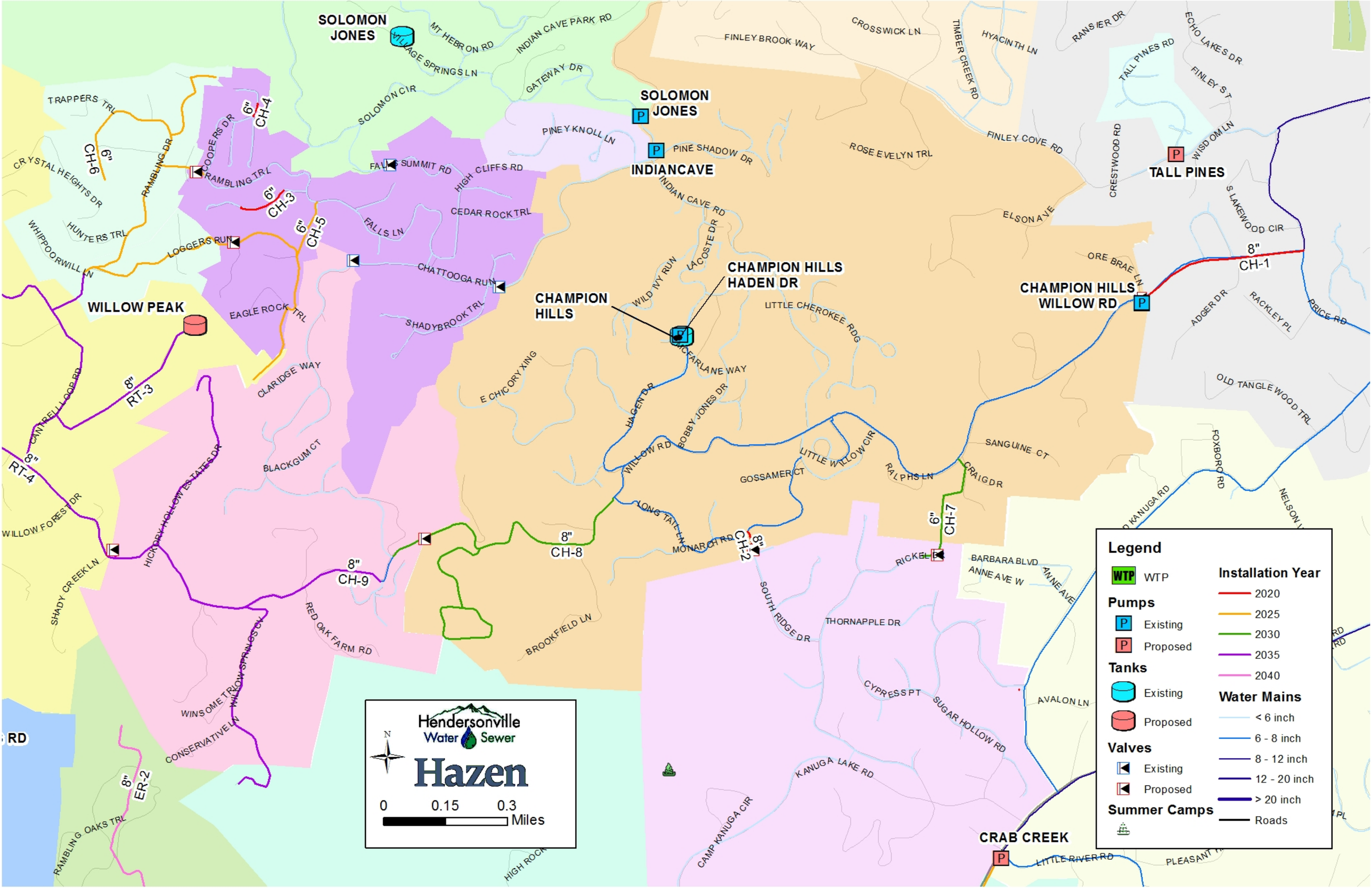


Figure 32: Proposed Improvements for Champion Hills Pressure Zone


SOLOMON JONES
MT HEBRON RD
INDIAN CAVE PARK RD
VILLAGE SPRINGS LN
GATEWAY DR
SOLOMON CIR
TRAPPERS TRL
CH-6
6"
RAMBLING DR
CRYSTAL HEIGHTS DR
COOPERS DR
CH-4
6"
RAMBLING TRL
CH-3
6"
HUNTERS TRL
WHIPPOORWILL LN
LOGGERS RUN
CH-5
6"
WILLOW PEAK
EAGLE ROCK TRL
CLARIDGE WAY
8"
RT-3
8"
RT-4
CANTRELL LOOP RD
WILLOW FOREST DR
BLACKGUM CT
HICKORY HOLLOW ESTATES DR
SHADY CREEK LN
WINSOME TRL
WILLOW SPRINGS CV
CONSERVATIVE LN
RED OAK FARM RD
8"
CH-9
FALLS SUMMIT RD
HIGH CLIFFS RD
CEDAR ROCK TRL
FALLS LN
CHATTOOGA RUN
SHADYBROOK TRL
PINEY KNOLL LN
SOLOMON JONES
PINE SHADOW DR
INDIANCAVE
INDIAN CAVE RD
LACOSTE DR
WILD IVY RUN
CHAMPION HILLS
CHAMPION HILLS HADEN DR
LITTLE CHEROKEE RDG
MCFARLANE WAY
E CHICORY XING
HAGEN DR
BOBBY JONES DR
8"
CH-8
WILLOW RD
LONG TAIL LN
MONARCH RD
8"
CH-2
BROOKFIELD LN
SOUTH RIDGE DR
THORNAPPLE DR
CYPRESS PT
SUGAR HOLLOW RD
AVALON LN
KANUGA LAKE RD
CAMP KANUGA CIR
HIGH ROCK
8"
ER-2
RAMBLING OAKS TRL
RD
FINLEY BROOK WAY
CROSSWICK LN
TIMBER CREEK RD
HYACINTH LN
RANSIER DR
ECHO LAKES DR
TALL PINES RD
FINLEY ST
FINLEY COVE RD
ROSE EVELYN TRL
CRESTWOOD RD
WISDOM LN
TALL PINES
ELSON AVE
S LAKEWOOD CIR
8"
CH-1
ORE BRAE LN
CHAMPION HILLS WILLOW RD
ADGER DR
RACKLEY PL
PRICE RD
OLD TANGLEWOOD TRL
GOSSAMER CT
LITTLE WILLOW CIR
RALPHS LN
CRAIG DR
SANGUINE CT
6"
CH-7
RICKEL
BARBARA BLVD
ANNE AVE W
ANNE AVE
FOXBORO RD
NELSON
KANUGA RD
CRAB CREEK
LITTLE RIVER RD
PLEASANT
Hendersonville Water Sewer
Hazen
N
0 0.15 0.3 Miles
Legend
WTP WTP
Pumps
Existing
Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads

Red Top Pressure Zone

We recommend extending a 12-inch water main to the intersection of Cummings Rd & Lacey Ln (MRT-1). We also recommend installing a check valve on River Rd to separate the Etowah Pressure Zone from the Main Zone. This will allow flow into the Etowah Zone when pressures drop for any reason, such as a fire flow. Future water mains along Big Willow Rd will remain in the Main Zone until Patterson Rd intersection (MRT-2).

As growth occurs along Fox Ridge Road, a new BPS will be needed near Hebron Rd & Red Top Farm Dr. The new pump station (Red Top BPS) should have a capacity of 210 gpm at a TDH of 90 ft. to maintain a discharge HGL of 2420 ft. This proposed pump station will eventually supply a new 0.15 MG Tank, with an overflow elevation 2420 ft. at the end of Willow Peak Rd. The tank will provide fire flows and supply two future variable speed pumps on Evans Rd and Davis Mountain Rd. Evans Rd pump design information was listed above. Davis Mountain pump design is 230 gpm @ TDH of 300 ft. to maintain an HGL of 2800 ft. New developments on Hebron Rd should be served through a PRV (FW-2). Proposed improvements are shown in Figure 33.

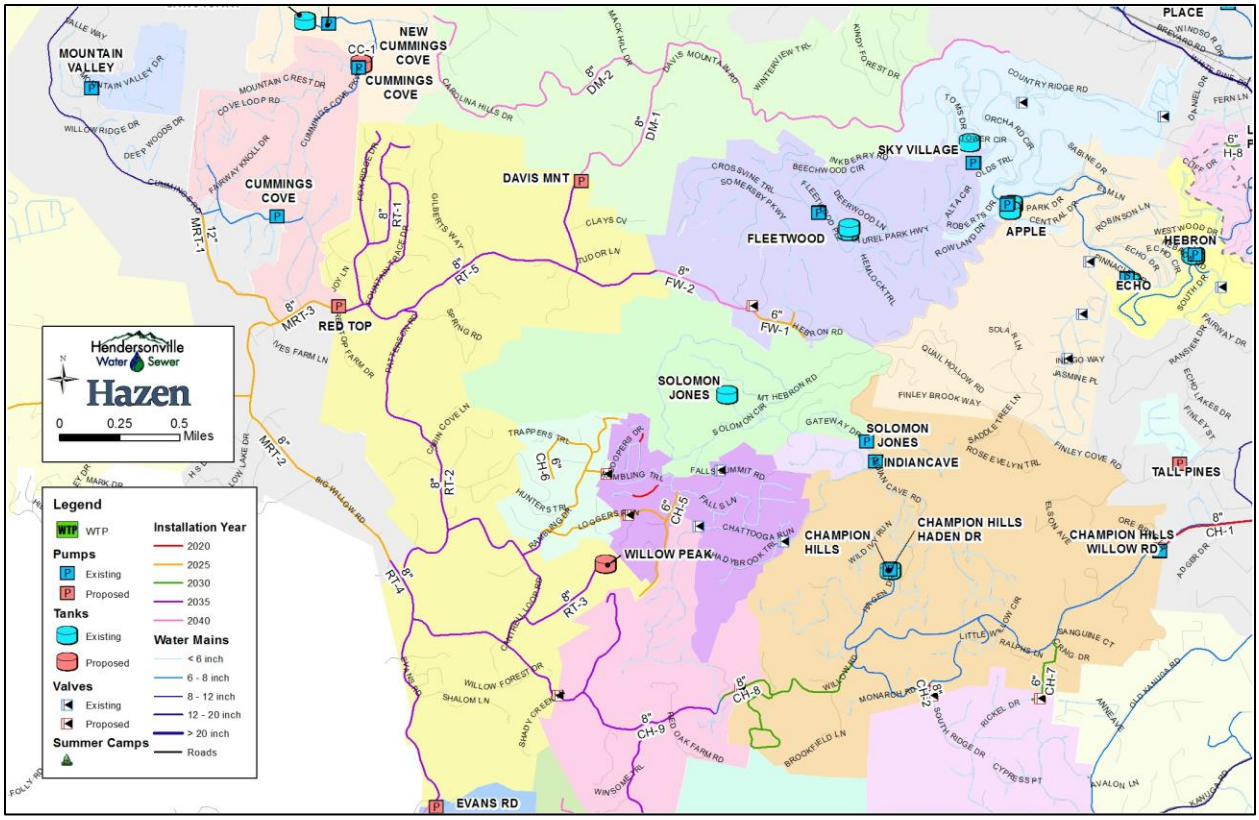


Figure 33: Proposed Improvements for Red Top Pressure Zone

Hendersonville Water Sewer

Hazen

N

0 0.25 0.5 Miles

Legend

WTP — WTP

Pumps
- Existing
- Proposed

Tanks
- Existing
- Proposed

Valves
- Existing
- Proposed

Summer Camps

Installation Year
- 2020
- 2025
- 2030
- 2035
- 2040

Water Mains
- < 6 inch
- 6 - 8 inch
- 8 - 12 inch
- 12 - 20 inch
- > 20 inch
- Roads

MOUNTAIN VALLEY
VALLE WAY
MOUNTAIN VALLEY DR
WILLOW RIDGE DR
DEEP WOODS DR
CUMMINGS RD
MOUNTAIN CREST DR
COVE LOOP RD
FAIRWAY KNOLL DR
CUMMINGS COVE
CUMMINGS COVE PKWY
CC-1
NEW CUMMINGS COVE
CUMMINGS COVE
MRT-1
12"
FOX RIDGE DR
8"
RT-1
GILBERTS WAY
JOY LN
FOUNTAIN TRACE DR
8"
MRT-3
RED TOP
RED TOP FARM DR
IVES FARM LN
PATTERSON RD
SPRING RD
8"
RT-5
DAVIS MNT
CLAYS CV
TUDOR LN
MACK HILL DR
CAROLINA HILLS DR
8"
DM-2
8"
DM-1
DAVIS MOUNTAIN RD
WINTERVIEW TRL
KINDY FOREST DR
8"
FW-2
6"
FW-1
HEBRON RD
FLEETWOOD
CROSSVINE TRL
SOMERSBY PKWY
FLEETWOOD PKWY
DEERWOOD LN
LAUREL PARK HWY
HEMLOCK TRL
SKY VILLAGE
INKBERRY RD
BEECHWOOD CIR
TOMS DR
TOWER CIR
OLDS TRL
ORCHARD CIR
COUNTRY RIDGE RD
ALTA CIR
ROBERTS DR
ROWLAND DR
APPLE
PARK DR
CENTRAL DR
SABINE DR
ELM LN
ROBINSON LN
WESTWOOD DR
HEBRON
ECHO DR
ECHO CIR
PINNACLE DR
ECHO
SOUTH DR
CLIFF DR
DANIEL DR
FERN LN
WINDSOR DR
BREVARD RD
WHITE PINE DR
PLACE
6"
H-8
SOLA LN
QUAIL HOLLOW RD
FINLEY BROOK WAY
INDIGO WAY
JASMINE PL
RANSIER DR
FAIRWAY DR
ECHO LAKES DR
FINLEY ST
SOLOMON JONES
MT HEBRON RD
SOLOMON CIR
GATEWAY DR
SOLOMON JONES
INDIANCAVE
SADDLETREE LN
ROSEEVELYN TRL
FINLEY COVE RD
TALL PINES
INDIAN CAVE RD
ELSON AVE
ORE BRANCH RD
8"
CH-1
ADGER DR
CHAMPION HILLS
WILD IVY RUN
HADEN DR
CHAMPION HILLS
HAGEN DR
CHAMPION HILLS WILLOW RD
LITTLE WILLOW CIR
RALPHS LN
SANGUINE CT
CRAIG DR
6"
CH-7
8"
CH-2
SOUTH RIDGE DR
RICKEL DR
CYPRESS PT
AVALON LN
ANNE AVE
OLD KANUGA RD
KANUGA RD
8"
CH-8
WILLOW RD
MONAROH RD
8"
CH-9
RED OAK FARM RD
BROOKFIELD LN
WINSOME TRL
WILLOW FOREST DR
SHALOM LN
SHADY CREEK
EVANS RD
EVANS RD
CWTRL LOOP RD
8"
RT-3
8"
RT-4
8"
MRT-2
BIG WILLOW RD
8"
RT-2
6"
CH-6
TRAPPERS TRL
HUNTERS TRL
RAMBLING DR
RAMBLING TRL
LOOPERS DR
LOGGERS RUN
6"
CH-5
FALLS SUMMIT RD
FALLS LN
CHATTOOGA RUN
SHADYBROOK TRL
WILLOW PEAK
CABIN COVE LN
COVE LN
MARK DR
FOLLY RD
LOW LAKE DR
HS L
EY DR
HI

Cummings Cove Pressure Zone

The existing Cummings Cove Tank cannot meet current equalizing storage and fire requirements. In addition, the model shows very low pressures (near zero) along Cumming Cove Prk near the tank and on the suction side of the New Cummings Cove BPS. We recommended a new 0.14 mg tank near the existing tank but at a site where the elevation is higher by 34 feet, allowing an overflow elevation of 2572 ft., which would increase pressures by 14 psi. This improvement is labeled CC-1 in Figure 33.

Solomon Jones Pressure Zone

Solomon Jones Tank is too small to provide a 1000 gpm fire flow. Using a 750 gpm fire requirement, the storage analysis for the 2040 showed no deficiency. This assumes a pump operates during the fire, so we recommend backup power at the pump station.

Laurel Park Pressure Zone

The existing Laurel Park Tank cannot meet the current equalizing and fire storage requirements and the model shows low pressures near the tank. We recommend a new 0.15 MG tank at a higher overflow elevation of 2517 feet. This improvement is shown as LP-1 on Figure 16.

Small Dead-End System Zones

As noted in Table 11 several deficient pump stations supplying dead-end systems design point are less than the peak demand. They should be checked against their pump curve to see if the peak demand falls within the curve.

Highlander/ Brookside/ Hutch

The eastern edge of the 2040 service area has very high ground elevations. To serve future development in the Highlander, Brookside and Hutch areas, we recommend four variable spend pump stations:

- Hutch Mnt VSP (140 gpm @ 175 ft. TDH to maintain 2640 ft. HGL) – Suction is the Fletcher Zone
- Old Timey VPS (40 gpm @ 100 ft. TDH to maintain 2765 ft. HGL)
- Brookside Camp VSP (260 gpm @ 80ft. TDH to maintain 2410 ft. HGL) – Suction is the Main Zone
- Burge Mtn VPS (220 gpm @ 175ft. TDH to maintain 2640 ft. HGL)

These pump stations and other improvements are shown in Figure 15.

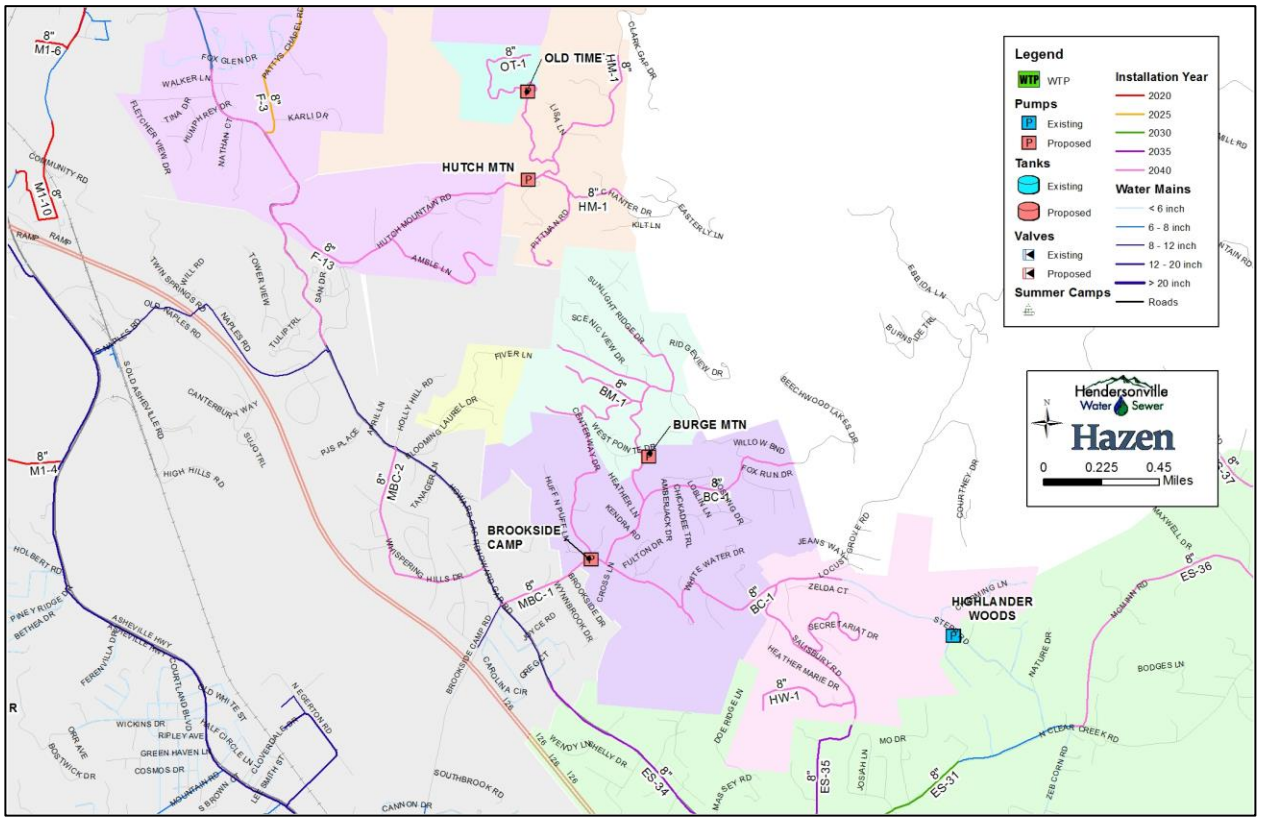
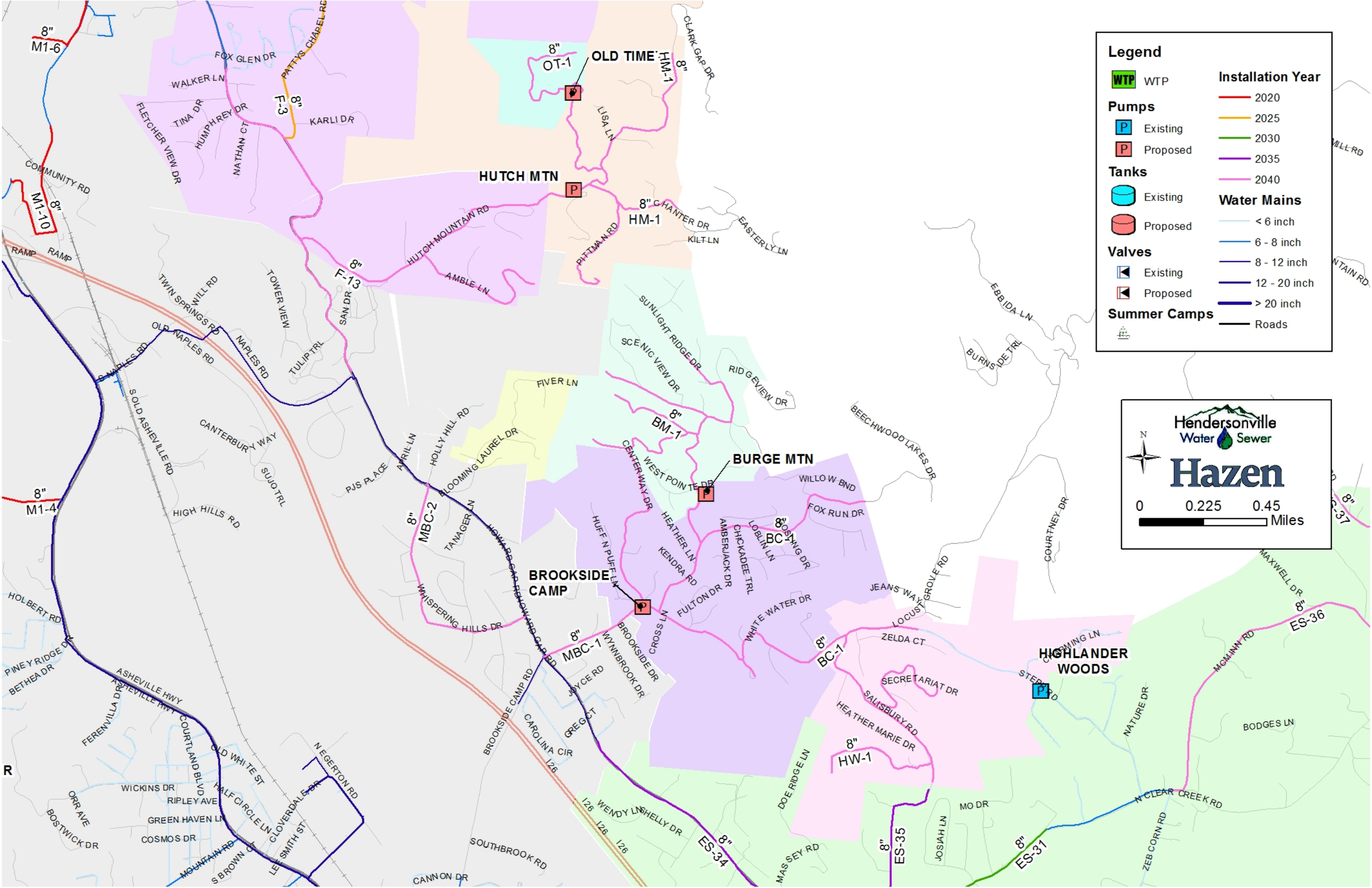


Figure 34: Proposed Improvements for Highlander / Brookside / Hutch Pressure Zones


Legend
WTP WTP
Pumps
P Existing
P Proposed
Tanks
Existing
Proposed
Valves
Existing
Proposed
Summer Camps
Installation Year
2020
2025
2030
2035
2040
Water Mains
< 6 inch
6 - 8 inch
8 - 12 inch
12 - 20 inch
> 20 inch
Roads
Hendersonville Water Sewer
Hazen
0 0.225 0.45 Miles
OLD TIME
OT-1
HM-1
HUTCH MTN
BURGE MTN
BM-1
BROOKSIDE CAMP
MBC-1
MBC-2
BC-1
HIGHLANDER WOODS
HW-1
M1-6
M1-10
M1-4
F-3
F-13
ES-34
ES-35
ES-31
ES-36
8"
FOX GLEN DR
PATTYS CHAPEL RD
WALKER LN
TINA DR
HUMPHREY DR
NATHAN CT
KARLI DR
FLETCHER VIEW DR
COMMUNITY RD
RAMP
CLARK GAP DR
LISA LN
CHANTER DR
KILT LN
EASTERLY LN
PITTMAN RD
HUTCH MOUNTAIN RD
AMBLE LN
SAN DR
TOWER VIEW
TWIN SPRINGS RD
WILL RD
OLD NAPLES RD
NAPLES RD
TULIP TRL
SUNLIGHT RIDGE DR
SCENIC VIEW DR
RIDGEVIEW DR
FIVER LN
EBBIDA LN
BURNSIDE TRL
BEECHWOOD LAKES DR
SOLD ASHEVILLE RD
CANTERBURY WAY
HOLLY HILL RD
BLOOMING LAUREL DR
APRIL LN
PJS PLACE
HIGH HILLS RD
SUJO TRL
TANAGER LN
HOWARD GAP ROUND GAP RD
WHISPERING HILLS DR
CENTER WAY DR
WEST POINTE DR
WILLOW BND
FOX RUN DR
HEATHER LN
KENDRA RD
HUFF N PUFF LN
AMBERJACK DR
CHICKADEE TRL
LOBLIN LN
BOSWING DR
FULTON DR
CROSS LN
WHITE WATER DR
COURTNEY DR
JEANS WAY
LOCUST GROVE RD
ZELDA CT
SECRETARIAT DR
SALISBURY RD
HEATHER MARIE DR
STERLING LN
NATURE DR
MAXWELL DR
MCMINN RD
BODGES LN
N CLEAR CREEK RD
ZEB CORN RD
MO DR
JOSIAH LN
DOE RIDGE LN
MASSEY RD
WENDY LN
SHELLY DR
I26
BROOKSIDE CAMP RD
CAROLINA CIR
GREG CT
JOYCE RD
WYNNBROOK DR
ASHEVILLE HWY
FERENVILLA DR
COURTLAND BLVD
OLD WHITE ST
HALF CIRCLE LN
GLOVERDALE DR
N EGERTON RD
WICKINS DR
RIPLEY AVE
GREEN HAVEN LN
COSMOS DR
ORR AVE
BOSTWICK DR
MOUNTAIN RD
S BROWN CT
LEE SMITH ST
SOUTHBROOK RD
CANNON DR
BETHEA DR
PINEY RIDGE DR
HOLBERT RD

8. Capital Improvement Plan Cost Estimates

Recommended improvements were incorporated into a capital improvement plan that includes opinions of probable costs for each construction project.

The larger projects included 16-inch piping and above, and included Long John Mountain. The total probable construction cost for larger projects, tanks and pump stations shown in Table 14 is **$50.1 million**.

For smaller projects, costs were estimated using the unit costs shown in Table 15, which assumes working in rocky soil with many stream crossings. The cost for the smaller projects can be found in the Appendix. These costs were not included in Table 14 because they may be paid by developers.

Table 14: Summary of Capital Improvements by CIP Phase

CIP Phase	Number of Large Projects	Number of New Tanks	Number of New Pumps	Number of New Pressure Zones	Opinion of Probable Construction Cost ($)[1]
2020	3	2	4	7	$9,625,000
2025	8	6	5	7	$28,839,000
2030	1	0	0	0	$7,070,000
2035	0	1	2	3	$1,140,000
2040	0	0	9	9	$3,456,000
Total	$36,559,000	$5,291,000	$8,280,000		**$50,130,000**

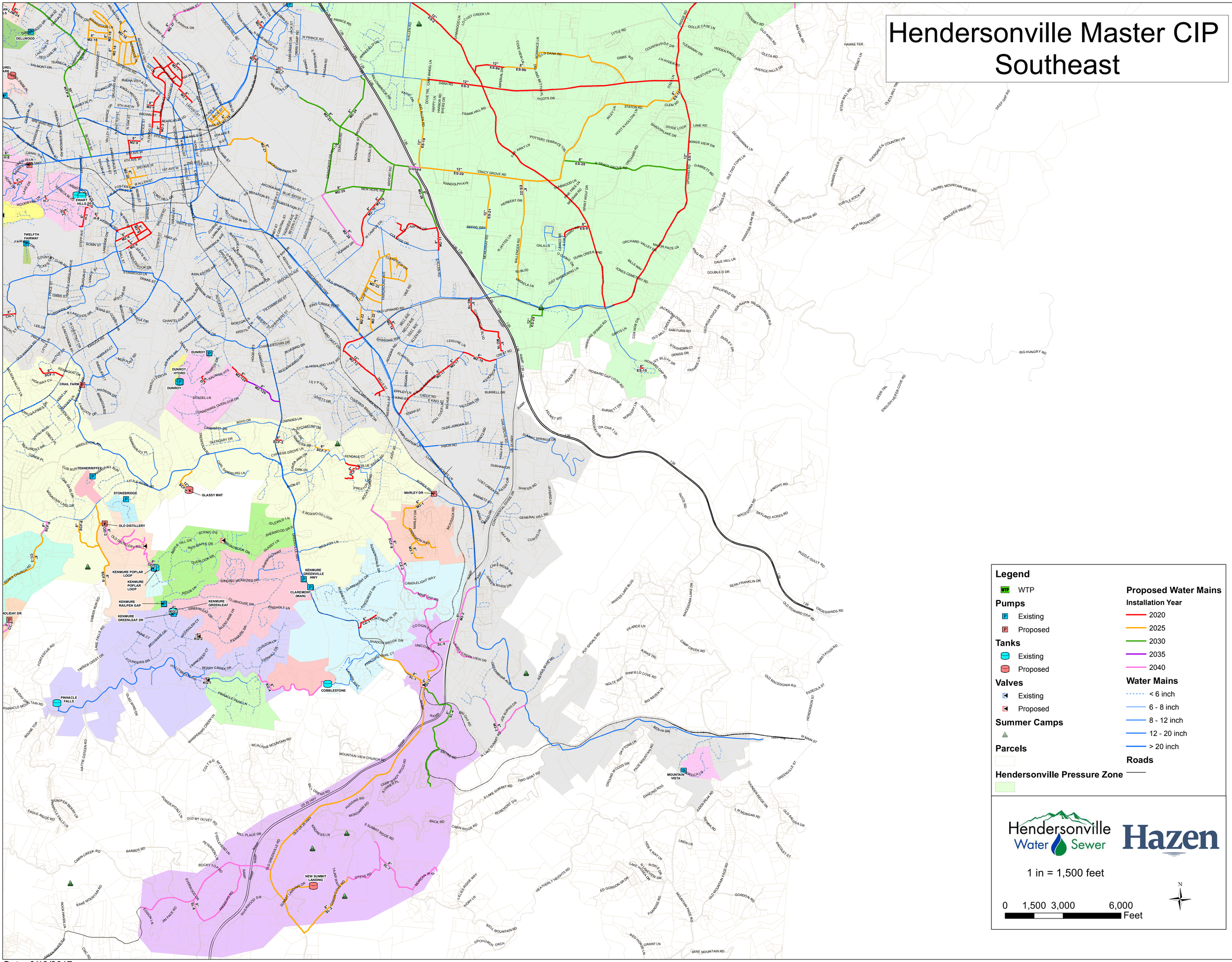
1. 2017$ (Construction + 20% Engineering + 20% Contingencies)

Table 15: Unit Cost of Construction per Diameter

Pipe Diameter, in	Unit Cost of Construction ($/ft)	Unit Cost of Construction + Engineering ($/ft)	Unit Cost of Construction + Engineering + Contingencies ($/ft)
< 6	**50**	**60**	**72**
6	**100**	**120**	**144**
8	**120**	**144**	**173**
12	**140**	**168**	**202**

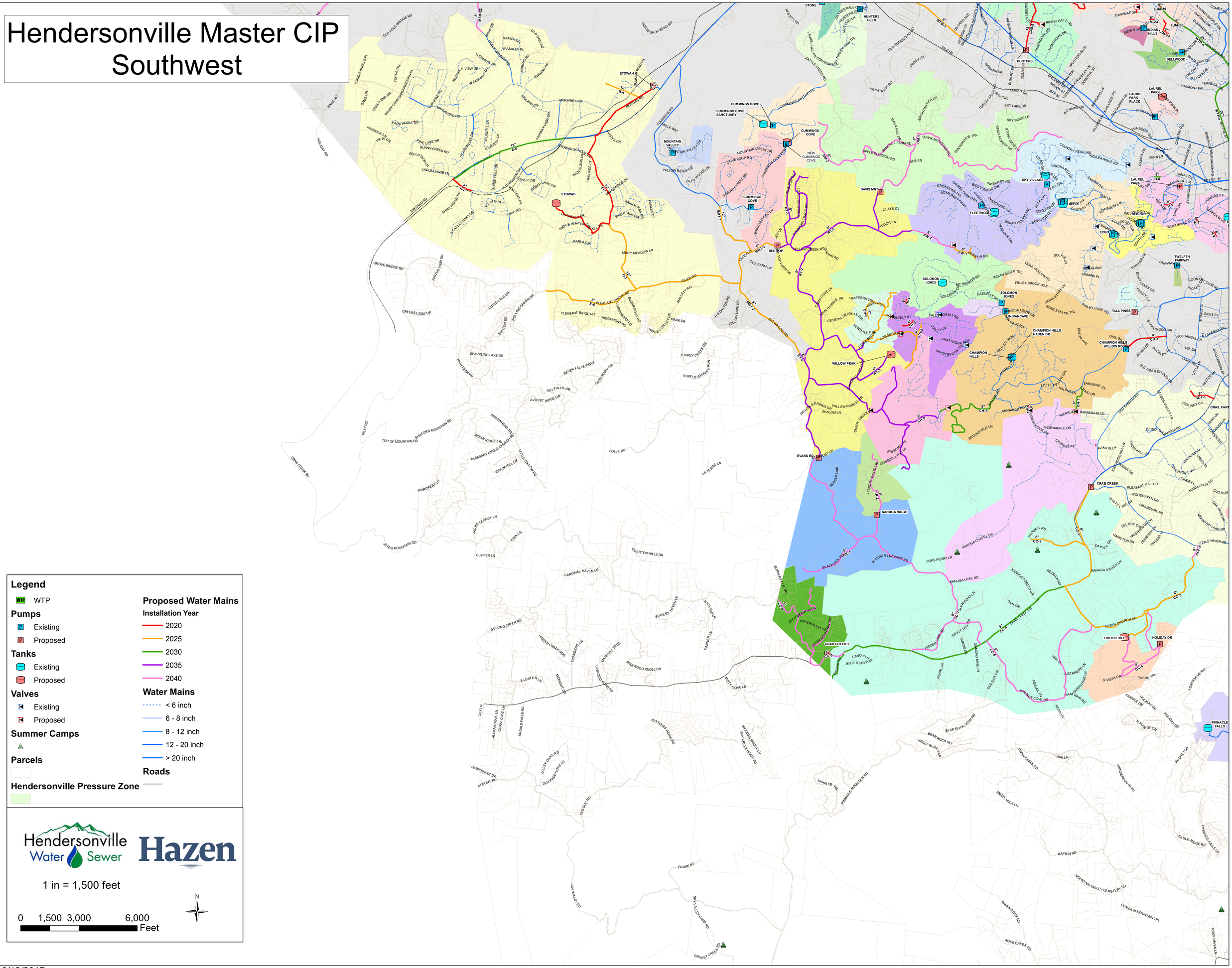
1. 2017$ (Construction + 20% Engineering + 20% Contingencies)

Hendersonville Master CIP
Southeast

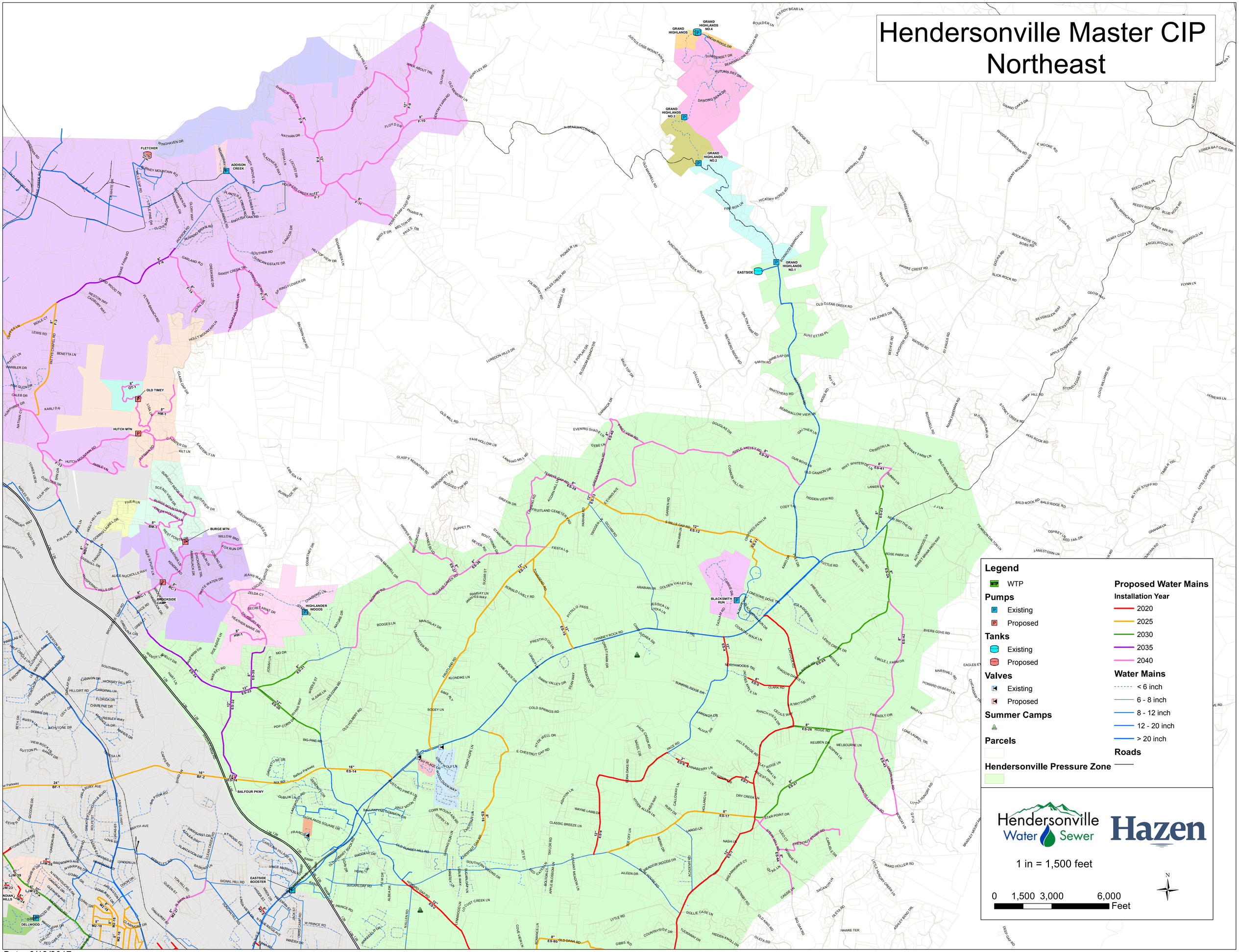


Date: 6/13/2017

Hendersonville Master CIP
Southwest

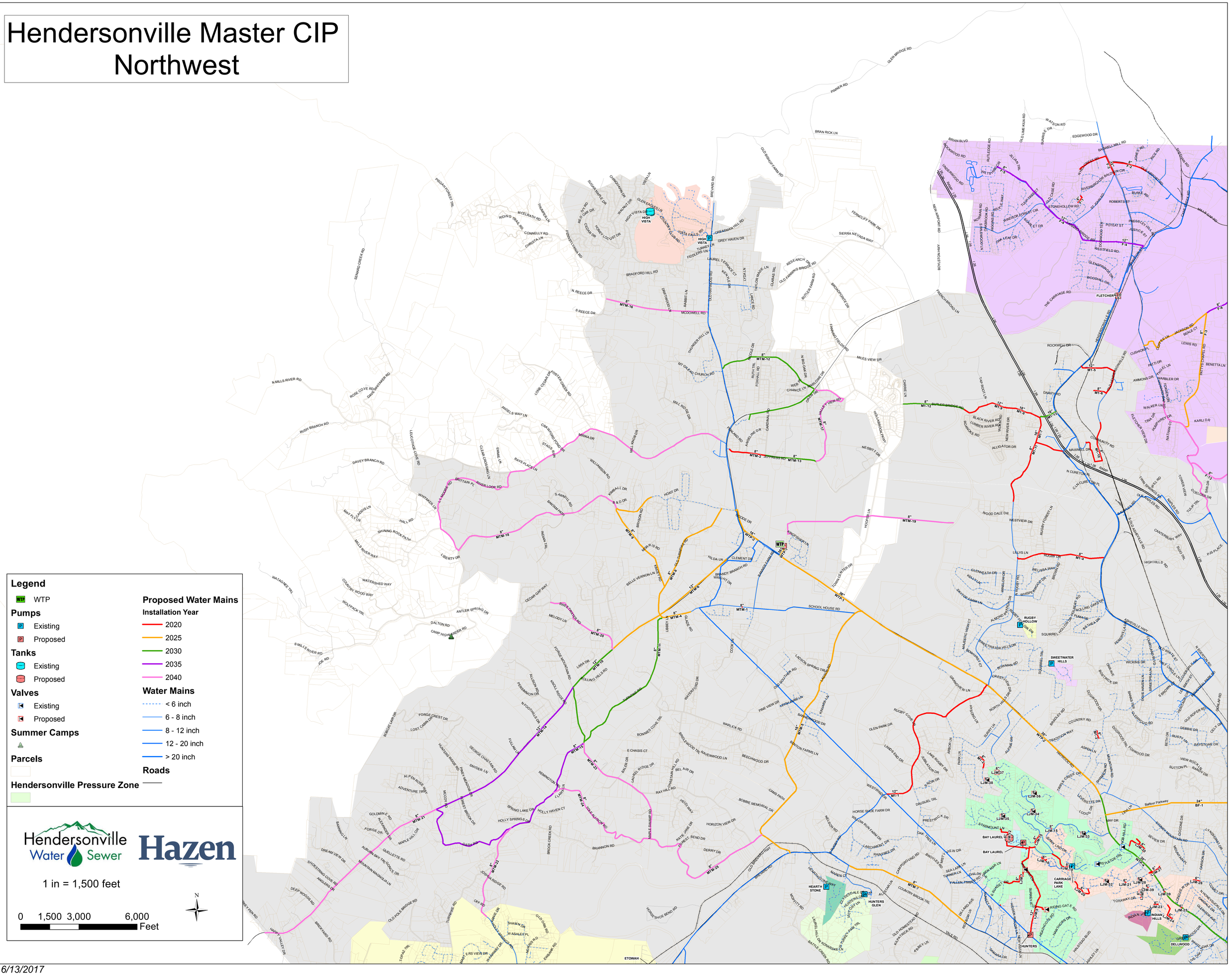


Hendersonville Master CIP
Northeast



Date: 6/13/2017

Hendersonville Master CIP
Northwest



Date: 6/13/2017

Table A-1: Larger Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
M1-7/M1-8	2020	16	From existing main just north of Cureton Pl to N Rugby Rd to Butler Bridge Rd ending at Yadkin Rd	4700	$1,019,000	$1,222,800	$1,467,000
M1-13	2020	16	N Rugby & Butler Bridge Rd crossing 1-26 to Ashville HWY	900	$324,000	$388,800	$467,000
WTP-1	2025	36	WTP Site along Haywood Rd (NC191) to School House Rd	5600	$1,906,000	$2,287,200	$2,745,000
WTP-2	2025	30	From School House Rd along Haywood Rd (NC191) to Stoney Mountain	15700	$4,798,000	$5,757,600	$6,909,000
WTP-3	2025	16	WTP north NC 191 / Boylston Hwy	2100	$437,000	$524,400	$629,000
MTM-5	2025	16	Ladson Rd switching to Banner Farm Rd to Brevard Rd	15500	$2,734,000	$3,280,800	$3,937,000
ES-3	2025	12	Etowah School Rd from Drexel Rd to River Rd (crosses the French Broad River)	13000	$617,000	$740,400	$888,000
BF-1	2025	16	Haywood Rd along new Balfour Parkway to Ashville Hwy	8200	$2,091,000	$2,509,200	$3,011,000
BF-2	2025	16	Ashville Hwy along new Balfour Parkway to new Balfour Parkway BPS	6400	$1,289,000	$1,546,800	$1,856,000
ES-14	2025	16	BPS along new Balfour Parkway to Chimney Rock Rd	9200	$1,595,000	$1,914,000	$2,297,000
WTP-4	2030	30	Stoney Mountain along Haywood Rd (NC 191) to Blythe St south to 5th Ave	17600	$4,910,000	$5,892,000	$7,070,000

1. 2017 $$
2. 20% Engineering; 20% Contingencies

Table A-2: Long John Mountain Probable Cost

Project ID	Description	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
LJM-1	Hunters PS	$400,000	$480,000	$576,000
LJM-2	Abandon Hawthorne PS			
LJM-3	Abandon HC Surrey PS			
LJM-4	6" Hunters Lane to Gregory Way	$97,000	$116,400	$140,000
LJM-5	12" Hunters Lane	$913,000	$1,095,600	$1,315,000
LJM-6	Abandon Hunters Crossing PS			
LJM-7	6" Hunters Lane & Chariot Ct to E. Sunset Dr.	$191,000	$229,200	$275,000
LJM-8	Abandon Brightwater PS	$19,000	$22,800	$27,000
LJM-9a	2" to Bay Magnolia Ct.	$18,000	$21,600	$26,000
LJM-9b	8" Bay Laurel to Carriage Parkway	$42,000	$50,400	$60,000
LJM-10	Bay Laurel VPS	$300,000	$360,000	$432,000
LJM-11	Bay Laurel Tank	$320,000	$384,000	$461,000
LJM-12	6" from Tank to water main on Starmount Lane	$99,000	$118,800	$143,000
LJM-13	Abandon Kaywood Knolls Tank			
LJM-14	Abandon Haywood Knolls PS			
LJM-15	6" along Carriage Park Way	$53,000	$63,600	$76,000
LJM-16	6" Carriage West to Fire Hydrant on Carriage Summit	$39,000	$46,800	$56,000
LJM-17	Abandon Carriage Park Tank			
LJM-18	8" Carriage Park Way	$173,000	$207,600	$249,000
LJM-19	Possible New pumps			
LJM-20	6" W. Highpoint Lane to Long John Drive	$166,000	$199,200	$239,000
LJM-21	6" Long John Dr & Turtle Lane to Middleton Place	$26,000	$31,200	$37,000
LJM-22	6" Kalmia Lane to Toxaway Ct to intersection of Toxaway Drive	$77,000	$92,400	$111,000
LJM-23	6" Indian Hill Road to Essex Path	$31,000	$37,200	$45,000
LJM-24	6" Forest Drive along easement to Winding Trail to Walden Pond Drive to Waterside Drive	$113,000	$135,600	$163,000
LJM-25	6" Waterside Drive to Browning Ave & Haywood Road and check valve	$36,000	$43,200	$52,000
LJM-26	6" Check valve on Ex 6" on Browning Ave. west of Carson Drive	$8,000	$9,600	$12,000
LJM-27	6" Middleton Placed to end of Carleton Terrace and 6" check valve	$109,000	$130,800	$157,000

Table A-2: Long John Mountain Probable Cost

Project ID	Description	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
LJM-28	Abandon Middleton Place, 6" PRV at Middleton Place	$15,000	$18,000	$22,000
LJM-29	Abandon Long John PS			
LJM-30	6" Hampton Drive & Holly Hill Drive along Holly Hill Drive East and Hilltop Circle N.	$214,000	$256,800	$308,000
LJM-31	Abandon Long John PS			
LJM-32	6" PRV at Long John Drive west of Peachtree	$15,000	$18,000	$22,000
LJM-33	8" PRV at Carriage Park Way west of Carriage Springs Way	$19,000	$22,800	$27,000
LJM-34	8" PRV at Carriage Park Way at Summit Hill Road	$19,000	$22,800	$27,000
LJM-35	6" PRV at Haywood Knoll Drive & Crown Lane	$15,000	$18,000	$22,000
LJM-36	6" PRV at Carriage Crest Drive & High Fields Court	$15,000	$18,000	$22,000
LJM-37	6" PRV at Haywood Knoll Drive & Oakwilde Drive	$15,000	$18,000	$22,000
LJM-38	6" PRV at Fawnview Lane & Deer Haven Lane	$15,000	$18,000	$22,000
LJM-39	5 additional Check valves	$95,000	$114,000	$137,000
Total				**$5,283,000**

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
M1-1	2020	12	CIP-Rugby Rd	9,614	$1,346,000	$1,615,000	$1,938,000
M1-2	2020	6	Required with Long John Mountain Changes Deerhaven Ln	653	$65,000	$78,000	$94,000
M1-3	2020	6	AFF Improve: White Cedar Ln	385	$38,000	$46,000	$55,000
M1-4	2020	8	Rugby Dr	4,406	$529,000	$634,000	$761,000
M1-5	2020	12	AFF Improve: Old Brickyard Rd	1,824	$255,000	$306,000	$368,000
M1-6	2020	8	AFF Improve: parallel pipe: Old Hendersonville	1,990	$239,000	$287,000	$344,000
M1-9	2020	12	Butler Bridge Rd from Yadkin Rd to haw River Rd	2,283	$320,000	$384,000	$460,000
M1-10	2020	8	AFF Improve: Connecting Maxwell Dr down Hickory Flats Dr through parcel to Old Hendersonville Rd	3,693	$443,000	$532,000	$638,000
M1-11	2020	8	N Rugby Rd	3,513	$422,000	$506,000	$607,000
M2-1	2020	8	CIP- N Main St Sanitary	8,794	$1,055,000	$1,266,000	$1,519,000
M2-2	2020	6	AFF Improve: Highland Ave	1,022	$102,000	$123,000	$147,000
M2-3	2020	8	CIP- Oakland St & Fleming St	4,485	$538,000	$646,000	$775,000
M2-4	2020	6	AFF Improve: Fassifern Ct	332	$33,000	$40,000	$48,000
M2-5	2020	6	AFF Improve: Coolridge St	432	$43,000	$52,000	$62,000
M2-6	2020	8	AFF Improve: Duncan Hill Rd	228	$27,000	$33,000	$39,000
M2-7	2020	8	AFF Improve: Tracy Grove Rd	221	$27,000	$32,000	$38,000
M2-8	2020	8	CIP-Florida Ave	2,120	$254,000	$305,000	$366,000
M2-9	2020	8	CIP-Willow Cherokee Park	7,230	$836,000	$1,004,000	$1,204,000
M2-10	2020	8	AFF Improve: Airport Rd	2,808	$337,000	$404,000	$485,000
M2-11	2020	8	E Campus Dr	4,476	$537,000	$644,000	$773,000
M2-12a	2020	8	Rutledge Rd	1,127	$135,000	$162,000	$195,000
M3-1	2020	8	Marley Dr	5,908	$695,000	$834,000	$1,001,000
MTM-1	2020	8	Improve AFF: Off Schoolhouse Rd near Banner Farm Rd	10	$1,000	$1,000	$2,000
MTM-2	2020	8	Jeffress Rd	1,899	$228,000	$273,000	$328,000
H-1	2020	8	Woodbyne Ave between Laurel Park Hwy and Woodbyne Ln	469	$56,000	$68,000	$81,000
H-2	2020	6	N Overlook Terr	259	$26,000	$31,000	$37,000
H-3	2020	6	Parallel 2-inch on Chariton Ave to Robleigh Dr	1,263	$126,000	$152,000	$182,000
H-4	2020	6	Robleigh to connect water mains from Ewart to Hydrant 10-3250	137	$14,000	$16,000	$20,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
H-5	2020	6	Place Check valve in existing pipe Robleigh Dr, from Main zone to Hebron zone	29	$3,000	$3,000	$4,000
H-6	2020	6	Place Check valve in existing pipe Ewart Dr, from Main zone to Hebron zone	26	$3,000	$3,000	$4,000
H-7	2020	8	Abandon and bypass Overlook Terr PS	96	$12,000	$14,000	$17,000
ES-1	2020	12	CIP – Eastside Phase 2	35,381	$4,953,000	$5,944,000	$7,133,000
ES-2	2020	12	CIP- Howard Gap Rd Ext PH2 plus Across Sugarloaf to existing 10-inch	20,397	$2,856,000	$3,427,000	$4,112,000
ES-3	2020	12	CIP – Dana Rd	13,005	$1,821,000	$2,185,000	$2,622,000
ES-4	2020	12	CIP- Pace Rd	10,118	$1,417,000	$1,700,000	$2,040,000
ES-5	2020	6	Clark Rd	2,283	$228,000	$274,000	$329,000
ES-6	2020	3	Dixie Blvd	874	$44,000	$52,000	$63,000
ES-7	2020	8	W Blackwell Dr	2,139	$257,000	$308,000	$370,000
ES-8	2020	8	AFF Improve;	1,501	$180,000	$216,000	$259,000
ES-9a	2020	12	Old Dana Rd	1,806	$253,000	$303,000	$364,000
ES-10	2020	8	AFF Improve; Wisdom Cove Rd	151	$15,000	$18,000	$22,000
ES-11	2020	8	Redundancy: S Mills Gap Across Parcel to existing 8-inch loop	1,831	$220,000	$264,000	$316,000
F-1	2020	6	AFF Improve: from Winding Ivy Ct along parcel lines to Stone Hollow Rd	444	$44,000	$53,000	$64,000
F-2	2020	12	Old Airport Rd (DOT Project)	4,542	$596,000	$716,000	$859,000
E-1	2020	12 (6-inch tie-ins)	New PS along Morgan Rd, Etowah Park Rd, Etowah School Rd, Oak Knoll Dr to Tank	13,741	$1,911,000	$2,293,000	$2,751,000
E-2	2020	8	Improve AFF, Old Highway 64 & Eade Rd to Brevard Rd	1,187	$142,000	$171,000	$205,000
E-4	2020	12	Supply new development	1,857	$260,000	$312,000	$374,000
SCF-1	2020	6	Improve AFF: Jearl Ln	1,396	$140,000	$168,000	$201,000
SCF-2	2020	6	Bonclarken Ln	305	$30,000	$37,000	$44,000
SCF-3	2020	8	Improve AFF: W Blue Ridge Rd; Preston Ln	2,156	$259,000	$310,000	$373,000
D-1	2020	6	From Kalimar Hts to Dunroy Dr	402	$40,000	$48,000	$58,000
M2-13	2020	12	AFF Improve: Highland Lake Rd down street to Industry	5,109	$714,000	$857,000	$1,028,000
M2-14	2020	8	AFF Improve: Old Spartanburg Rd	569	$68,000	$82,000	$98,000
M2-15	2020	8	AFF Improve: Crest Rd	1,822	$219,000	$262,000	$315,000
M2-16	2020	8	AFF Improve: Commercial Blvd	3,801	$456,000	$547,000	$657,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
CZ-1	2020	6	Close Valve; From Greenville Hwy to along Continental Dr to Southview Ln	1,224	$122,000	$147,000	$176,000
SL-1	2020	8	From Clermont Zone to New Tank; Control PRV	20,430	$2,471,000	$2,965,000	$3,557,000
SI-2	2020	8	From connection to Tank to Camp Green Cove	5,807	$697,000	$836,000	$1,003,000
SL-3	2020	8	From PRV along Zirconia Rd north	1,358	$182,000	$218,000	$262,000
KG-1	2020	8	PRV and closed valve, isolating Pinnacle Peak Ln loop		$19,000	$22,800	$27,000
KG-2	2020	6	AFF Improve PRV on Kenmure Dr between zone	109	$11,000	$13,000	$16,000
KG-3	2020	6	AFF Improve: Greenleaf Dr	10	$1,000	$1,000	$1,000
KR-1	2020	8	PRV Pinnacle Peak Ln		$19,000	$22,800	$27,000
CC-1	2020	8	From Crab Creek BPS to Tank	14,696	$1,764,000	$2,117,000	$2,540,000
CC-2	2020	8	From Crab Creek to Camp Tekoa	3,041	$365,000	$438,000	$525,000
CC-3	2020	8	From Holiday Dr along Berea Church Rd to end of pressure zone	4,114	$494,000	$592,000	$711,000
CH-1	2020	8	Parallel existing pip along Willow Rd from Price Rd / PRV bypass at Champion Hills BPS	2,308	$296,000	$355,000	$426,000
CH-2	2020	8	Connect from Monarch Rd along parcel boundary to South Ridge Dr	308	$37,000	$44,000	$53,000
CH-3	2020	6	Parallel 2-inch water line on Green Pine Ct for improved fire flow	643	$64,000	$77,000	$93,000
CH-4	2020	6	Parallel 2-inch water line on Coopers Dr for improved fire flow	195	$19,000	$23,000	$28,000
MTM-4	2025	8	School House Rd from Boylston Hwy	1,663	$200,000	$240,000	$287,000
MTM-5	2025	16	Ladson Rd / Banner Farm Rd	15,460	$0	$0	$0
MTM-6	2025	12	Boylston HWY	7,482	$1,047,000	$1,257,000	$1,508,000
MTM-7	2025	8	Brevard Rd	6,828	$819,000	$983,000	$1,180,000
MTM-8	2025	8	Old Turnpike Rd	6,814	$818,000	$981,000	$1,177,000
MTM-9	2025	8	Kimzey / S Mills River Rd	7,049	$846,000	$1,015,000	$1,218,000
ES-9b	2025	8	Old Dana Rd	7,715	$926,000	$1,111,000	$1,333,000
ES-12	2025	12	CIP- Mills Gap Road	11,411	$1,597,000	$1,917,000	$2,300,000
ES-13	2025	12	CIP-Fruitland Road	16,288	$2,280,000	$2,736,000	$3,284,000
ES-14	2025	16	Balfour BPS; Balfour Parkway	9,211	$45,000	$54,000	$65,000
ES-15	2025	12	Townsend Rd	5,349	$749,000	$899,000	$1,078,000
ES-16	2025	8	Chestnut Gap Rd	7,025	$843,000	$1,012,000	$1,214,000
ES-17	2025	8	Sugarloaf Rd	8,321	$999,000	$1,198,000	$1,438,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
ES-18	2025	8	Staton Rd	9,666	$1,160,000	$1,392,000	$1,670,000
ES-19	2025	12	Mid Allen Rd	5,095	$713,000	$856,000	$1,027,000
ES-20	2025	12	Tracy Grove Rd	6,657	$932,000	$1,118,000	$1,342,000
ES-21	2025	12	McMurray Rd	2,794	$391,000	$469,000	$563,000
ES-22	2025	8	Ballenger Rd	5,234	$628,000	$754,000	$904,000
F-3	2025	8	Coffee Ln, Jackson Rd and Pattys Chapel	10,539	$1,265,000	$1,518,000	$1,821,000
E-3	2025	12	Etowah School Rd to River Rd	4,110	$575,000	$690,000	$829,000
E-5	2025	8	River Rd	9,675	$1,161,000	$1,393,000	$1,672,000
SCF-4	2025	12	Glassy Mnt	1,567	$219,000	$263,000	$316,000
SCF-5	2025	8	Lake Fall Rd	4,864	$584,000	$700,000	$841,000
SCF-6	2025	8	W Ton A Wandah Rd	2,362	$283,000	$340,000	$408,000
SCF-7	2025	6	Kinross Dr	783	$78,000	$94,000	$113,000
M2-17	2025	6	AFF Improve E Blue Ridge Rd	4,280	$428,000	$514,000	$616,000
M2-18	2025	8	CIP-Druid Hills	19,451	$2,334,000	$2,801,000	$3,361,000
M2-19	2025	8	CIP- 7th Ave	4,363	$524,000	$628,000	$754,000
M2-20	2025	8	CIP- 1st Ave & Oak St	3,236	$388,000	$466,000	$559,000
M2-21	2025	8	From 4th to Jackson Park	3,636	$436,000	$524,000	$628,000
CH-5	2025	6	Along Loggers Run	3,641	$365,000	$438,000	$526,000
CH-6	2025	6	Expand into Rambling Dr & Trail. Two PRV to provide redundancy	8,102	$843,000	$1,011,000	$1,214,000
MRT-1	2025	12	From existing 12-inch water line to end of Lacy Ln	3,255	$456,000	$547,000	$656,000
MRT-2	2025	8	Big Willow Rd	8,244	$989,000	$1,187,000	$1,425,000
MRT-3	2025	8	From Lacy Ln to Red Top BPS	1,510	$181,000	$217,000	$261,000
FW-1	2025	6	Hebron Rd	1,549	$155,000	$186,000	$223,000
FW-2	2025	6	PRV along Hebron Rd	2,635	$335,000	$402,000	$482,000
M1-12	2030	8	Butler Bridge Rd	3,184	$382,000	$459,000	$550,000
MTM-10	2030	12	Boylston HWY	2,868	$401,000	$482,000	$578,000
MTM-11	2030	8	Turnpike Rd	11,238	$1,349,000	$1,618,000	$1,942,000
MTM-12	2030	8	Butler Bridge Rd / Boylston Hwy	9,528	$1,143,000	$1,372,000	$1,646,000
MTM-13	2030	8	Jeffress Rd	2,657	$319,000	$383,000	$459,000
H-8	2030	6	Davis Mountain Rd	286	$29,000	$34,000	$41,000
ES-23	2030	8	S Pauls Rd	2,282	$274,000	$329,000	$394,000
ES-24	2030	8	Pilot Mountain Rd	4,117	$494,000	$593,000	$712,000
ES-25	2030	8	N Ridge Rd	6,530	$784,000	$940,000	$1,128,000
ES-26	2030	8	Ridge Rd	2,633	$316,000	$379,000	$455,000
ES-27	2030	8	Sugarloaf Rd	6,914	$830,000	$996,000	$1,195,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
ES-28	2030	8	E Tracy Grove Rd	6,512	$781,000	$938,000	$1,125,000
ES-29	2030	12	Education Dr	1,527	$214,000	$256,000	$308,000
ES-30	2030	12	Howard Gap Rd	4,133	$579,000	$694,000	$833,000
ES-31	2030	8	N Clear Creek Rd	3,018	$362,000	$435,000	$521,000
E-6	2030	12	Brevard Rd from Sunset Hill Dr to Old Highway 64	6,195	$867,000	$1,041,000	$1,249,000
M2-22	2030	8	CIP- Fairgrounds Ave	13,562	$1,627,000	$1,953,000	$2,343,000
M2-23	2030	8	Tracy Grove Rd	6,872	$825,000	$990,000	$1,187,000
M2-24	2030	8	Grand Kids Haven Ln north to Dana Rd	6,929	$831,000	$998,000	$1,197,000
M2-25	2030	8	New Hope Rd / Airport Rd	5,297	$636,000	$763,000	$915,000
SL-4	2030	8	From PRV along Old Zirconia Rd across US 25 Hwy east	7,088	$851,000	$1,021,000	$1,225,000
CC-4	2030	8	Along Crab Creek from Berea Church Rd to Riders Rd to service Camp Blue Star	14,366	$1,724,000	$2,069,000	$2,483,000
CH-7	2030	6	Second supply to Sugar Hollow along Summey Farm Ln, Bliss Dr along parcel property to Rickel Dr	1,666	$167,000	$200,000	$240,000
CH-8	2030	8	Willow Rd & Thrashing Rock area to new zone with PRV	7,114	$873,000	$1,047,000	$1,256,000
M2-12b	2035	8	Rutledge Rd	2,052	$246,000	$295,000	$355,000
MTM-14	2035	12	Boylston HWY	9,672	$1,354,000	$1,625,000	$1,950,000
MTM-15	2035	8	Turnpike Rd / Gash Rd	12,447	$1,494,000	$1,792,000	$2,151,000
ES-32	2035	12	Clear Creed Rd	4,957	$694,000	$833,000	$999,000
ES-33	2035	12	Howard Gap Rd	1,392	$195,000	$234,000	$281,000
ES-34	2035	8	Howard Gap Rd	5,649	$678,000	$813,000	$976,000
ES-35	2035	8	Salisbury Rd	2,694	$323,000	$388,000	$465,000
F-4	2035	12	Fannin Bridge Rd to Fanning Bridge Rd	6,081	$851,000	$1,022,000	$1,226,000
F-5	2035	8	Rutledge Rd	3,281	$394,000	$472,000	$567,000
F-6	2035	8	Jackson Rd	7,499	$900,000	$1,080,000	$1,296,000
CH-9	2035	8	Growth area for Willow Rd, Willow Springs, Hickory Hollow Estates	10,199	$1,224,000	$1,469,000	$1,762,000
RT-1	2035	8	Red Top BPS to Fox Ridge development	11,388	$1,367,000	$1,640,000	$1,968,000
RT-2	2035	8	Along Patterson Rd	8,702	$1,044,000	$1,253,000	$1,504,000
RT-3	2035	8	Cantrell Loop Rd to Tank on Willow Peak	7,748	$930,000	$1,116,000	$1,339,000
RT-5	2035	8	East on Hebron Rd	8,245	$989,000	$1,187,000	$1,425,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
RT-4	2035	8	Willow Rd and Evans	9,974	$1,197,000	$1,436,000	$1,723,000
M3-2	2040	8	Laurel Creek View Dr	4,864	$584,000	$700,000	$841,000
M3-3	2040	8	Strawberry Fields Rd	4,071	$488,000	$586,000	$703,000
MTM-16	2040	8	McDowell Rd	5,227	$627,000	$753,000	$903,000
MTM-17	2040	8	Valley View Rd / Butler Bridge Rd	6,039	$725,000	$870,000	$1,044,000
MTM-18	2040	8	N Mills River Rd, Whitaker Ln/ A Mills River Rd	30,005	$3,601,000	$4,321,000	$5,185,000
MTM-19	2040	8	Above the WTP	9,349	$1,122,000	$1,346,000	$1,615,000
MTM-20	2040	8	Sweetwater Rd	4,518	$542,000	$651,000	$781,000
MTM-21	2040	8	Boylston HWY	11,192	$1,343,000	$1,612,000	$1,934,000
MTM-22	2040	8	Holly Springs Rd	5,134	$616,000	$739,000	$887,000
MTM-23	2040	8	Maple Swamp Rd	6,690	$803,000	$963,000	$1,156,000
MTM-24	2040	8	Tole Allison Rd	7,202	$864,000	$1,037,000	$1,244,000
MTM-25	2040	8	Brannon Rd	8,281	$994,000	$1,193,000	$1,431,000
ES-36	2040	8	McMinn Rd / N Clear Creek Rd	13,657	$1,639,000	$1,967,000	$2,360,000
ES-37	2040	8	Harper Rd	3,447	$414,000	$496,000	$596,000
ES-38	2040	8	Lanning Rd / Terrys Gap Rd	7,263	$872,000	$1,046,000	$1,255,000
ES-39	2040	8	Old Clear Creek Rd/ Apple Valley Rd	14,589	$1,751,000	$2,101,000	$2,521,000
ES-40	2040	8	Green Mountain Rd / Piney View Rd	6,296	$756,000	$907,000	$1,088,000
ES-41	2040	8	Sleepy Hollow Ln	2,479	$298,000	$357,000	$428,000
ES-42	2040	8	Pilot Mountain Rd / Ridge Rd	9,198	$1,104,000	$1,324,000	$1,589,000
ES-43	2040	8	Union Hill Rd / Union Hill Church Rd	10,396	$1,247,000	$1,497,000	$1,796,000
ES-44	2040	8	Stepp Mill Rd/ Big Oak Rd / Chestnut Stump Rd	9,341	$1,121,000	$1,345,000	$1,614,000
F-7	2040	12	Hoopers Creed Rd	8,329	$1,166,000	$1,399,000	$1,679,000
F-8	2040	12	Lindsey Loop Rd	5,342	$748,000	$897,000	$1,077,000
F-9	2040	8	Lindsey Loop and North	14,907	$1,789,000	$2,147,000	$2,576,000
F-10	2040	8	Hoopers Creek Rd	3,545	$425,000	$511,000	$613,000
F-11	2040	8	Terrys Gap Rd	3,620	$434,000	$521,000	$626,000
F-12	2040	8	Livingston Rd / Mountain Laurel Ln	8,511	$1,021,000	$1,226,000	$1,471,000
F-13	2040	8	Howard Gap Rd / Hutch Mountain Rd	16,701	$2,004,000	$2,405,000	$2,886,000
F-14	2040	8	Hutch Mountain Rd	3,885	$466,000	$559,000	$671,000
SCF-8	2040	8	Berea Church Rd	705	$85,000	$101,000	$122,000
SCF-9	2040	6	Mine Gap Rd	2,826	$283,000	$339,000	$407,000
M2-26	2040	8	S Allen Rd	3,555	$427,000	$512,000	$614,000
M2-27	2040	8	N Main St	3,031	$364,000	$436,000	$524,000
M2-28	2040		DOT future greenway between Shepherd St & New Hope Rd	3,625	$435,000	$522,000	$626,000

Table A-3: Smaller Projects Probable Cost

ID	CIP Year	Size, in	Location	Length, ft.	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
CZ-2	2040	6	From Claremont Dr to Mine Gap, north and south on Mine Gap	6,834	$683,000	$820,000	$984,000
SL-5	2040	8	Zirconia Rd North to end of pressures zone	3,596	$432,000	$518,000	$621,000
SL-6	2040	8	From Huggins across US 25 Hwy west	13,058	$1,567,000	$1,880,000	$2,256,000
SL-7	2040	8	Little Man Lodger Dr / Bell Mountain Rd	8,159	$979,000	$1,175,000	$1,410,000
KG-4	2040	6	Pinnacle Mountain Rd	5,551	$555,000	$666,000	$799,000
OD-1	2040	8	Connection from Kenmure Railpen Gap to Old Distillery to PRV	1,869	$243,000	$292,000	$350,000
OD-2	2040	8	From Lake Falls Rd & Old Distillery Rd to PRV	5,868	$723,000	$868,000	$1,041,000
CC-5	2040	8	Holiday Dr Loop	8,797	$1,056,000	$1,267,000	$1,520,000
CC-6	2040	8	Walnut Cove Rd loop	11,101	$1,332,000	$1,598,000	$1,918,000
CC-7	2040	8	Evans Rd from Crab Creek to boundary with Evans	9,798	$1,176,000	$1,411,000	$1,693,000
CC-8	2040	8	From CC-3 to Jeter Mountain Rd	11,983	$1,432,000	$1,718,000	$2,061,000
ER-1	2040	8	Evans HSP to boundary with Crab Creek	15,229	$1,827,000	$2,193,000	$2,632,000
ER-2	2040	8	Kanuga Ridge	3,911	$469,000	$563,000	$676,000
DM-1	2040	8	Davis Mountain Rd	15,345	$1,841,000	$2,210,000	$2,652,000
DM-2	2040	8	Apple Blossom Rd	8,764	$1,052,000	$1,262,000	$1,514,000
HW-1	2040	8	Extend Highlander Woods Zone along Brookside Camp Rd to Salisbury Rd	10,180	$1,222,000	$1,466,000	$1,759,000
MBC-1	2040	8	Brookside Camp Rd	2,129	$255,000	$307,000	$368,000
MBC-2	2040	8	Whispering Hills Dr	4,613	$554,000	$664,000	$797,000
BC-1	2040	8	Brookside / Centerway / Burge Mtn/ Beechwood Lakes	15,105	$1,813,000	$2,175,000	$2,610,000
BM-1	2040	8	Burge Mtn / Sunlight Ridge	10,549	$1,266,000	$1,519,000	$1,823,000
HM-1	2040	8	Hutch Mountain Rd	10,764	$1,292,000	$1,550,000	$1,860,000
OT-1	2040	8	Old Timey Pl	3,225	$387,000	$464,000	$557,000

1. 2017 $$
2. 20% Engineering; 20% Contingencies

Table A-4: New Storage Tank

Name	Volume (MG)	Ground Elevation (ft.)	Height (ft.)	Diameter (ft.)	Overflow (ft.)	CIP Year	Unit Cost of Construction[1] ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
BAY LAUREL	0.16	2679	42	25	2721	2020	$320,000	$384,000	$461,000
ETOWAH	0.5	2407	33	50	2440	2020	$552,000	$662,400	$795,000
CUMMINGSCOVE	0.14	2535	37	25	2572	2025	$288,000	$345,600	$415,000
FLETCHER	1	2390	30	75	2420	2025	$900,000	$1,080,000	$1,296,000
FOSTER HILL	0.15	2435	42	25	2477	2025	$320,000	$384,000	$461,000
GLASSY MNT	0.5	2372	33	50	2404	2025	$368,000	$441,600	$530,000
LAUREL PARK	0.15	2484	33	25	2517	2025	$266,000	$319,200	$383,000
SUMMIT LANDING	0.2	2318	32	33	2350	2025	$368,000	$441,600	$530,000
WILLOW PEAK	0.15	2388	32	28	2420	2035	$292,000	$350,400	$420,000

1. 2017 $$ Tank, Foundation, Piping and Sales Tax on Materials; added 10% to account for land purchase, road access and grading; 20% Engineering; 20% Contingencies

2. 20% Engineering; 20% Contingencies

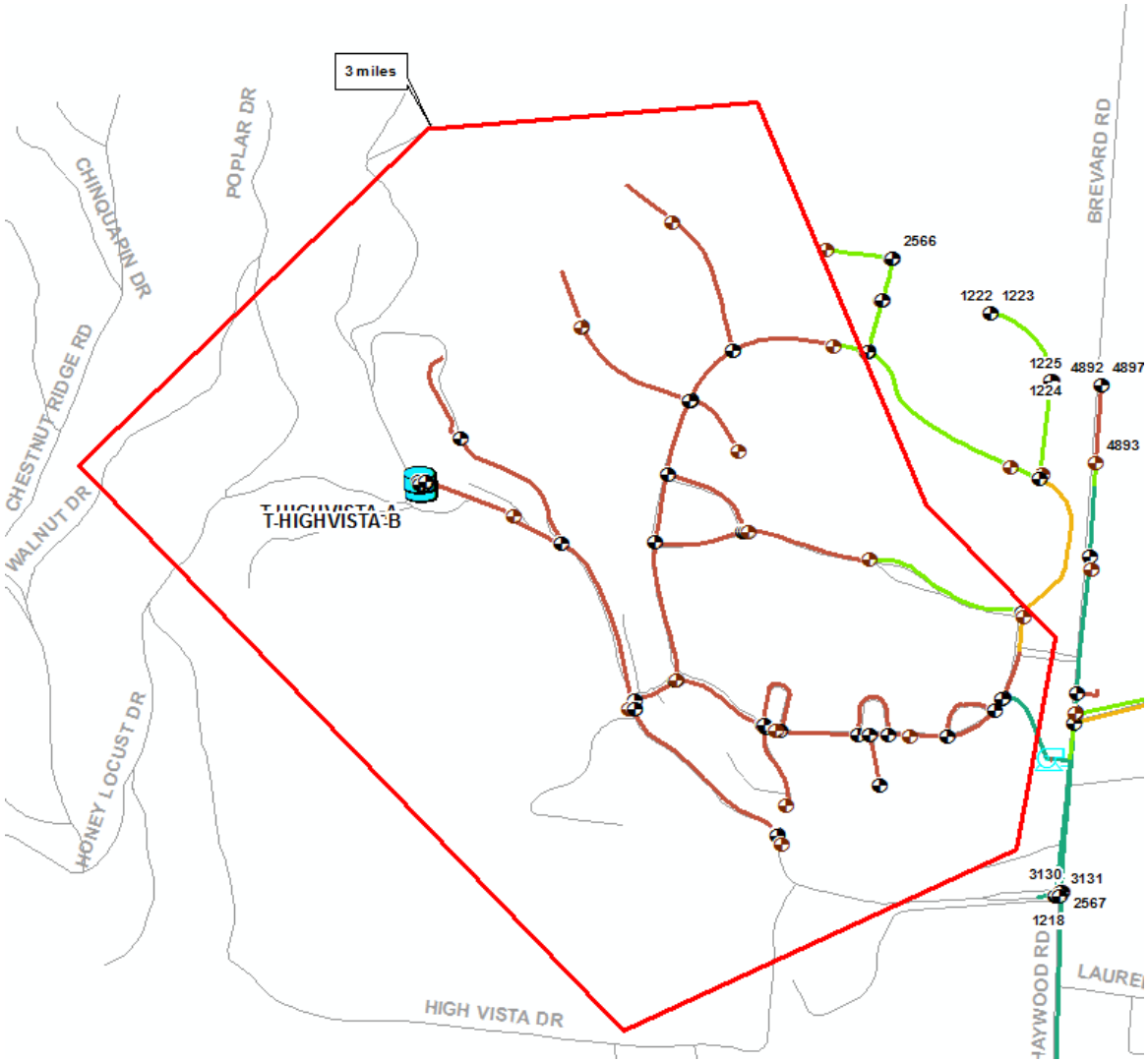
Table A-5: New Pump Stations

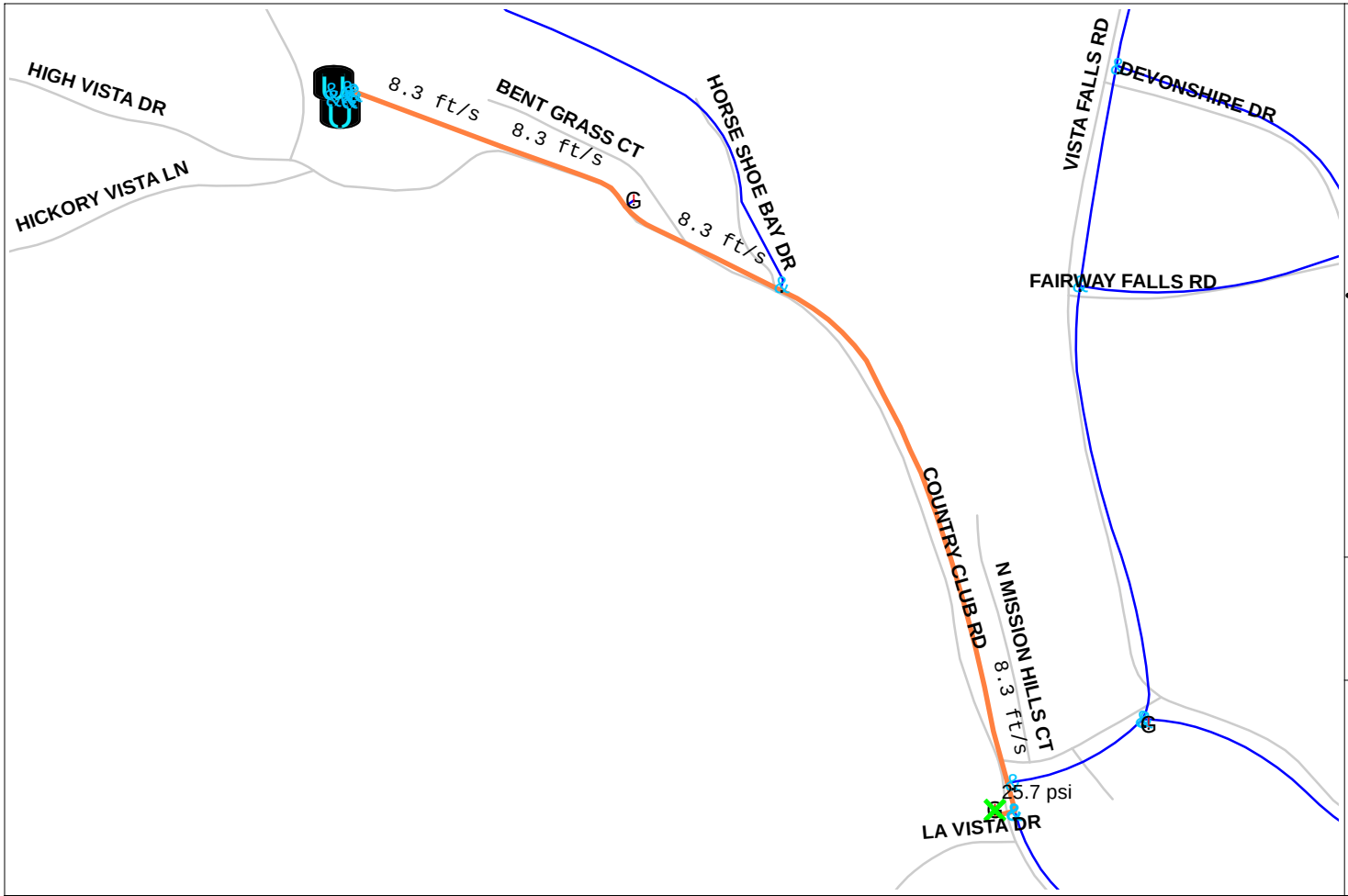
Name	Design Flow (gpm)	Design Head (ft.)	Pumps to Tank	CIP Year	Unit Cost of Construction ($)	Unit Cost of Construction + Engineering ($)	Unit Cost of Construction + Engineering + Contingencies ($)
BAY LAUREL	90	168	yes	2020	$250,000	$300,000	$360,000
ETOWAH			yes	2020			By others
HUNTERS	250	370	yes	2020	$300,000	$360,000	$432,000
TALL PINES	90	20	no	2020	$250,000	$300,000	$360,000
FLETCHER	1750	110	yes	2025			By others
BALFOUR	1400	253	yes	2025	$750,000	$900,000	$1,080,000
CRAB CREEK	104	80	yes	2025	$250,000	$300,000	$360,000
CRAIL FARM	1400	132	yes	2025	$750,000	$900,000	$1,080,000
MARLEY DR	220	180	no	2025	$300,000	$360,000	$432,000
EVANS RD	120	180	no	2035	$250,000	$300,000	$360,000
RED TOP	210	90	yes	2035	$250,000	$300,000	$360,000
BROOKSIDE	260	80	no	2040	$300,000	$360,000	$432,000
BURGE MNT	220	175	no	2040	$300,000	$360,000	$432,000
CRAB CREEK 2	100	220	no	2040	$250,000	$300,000	$360,000
DAVIS MNT	230	300	no	2040	$300,000	$360,000	$432,000
HOLIDAY DR	95	140	no	2040	$250,000	$300,000	$360,000
HUTCH MNT	140	175	no	2040	$250,000	$300,000	$360,000
KANUGA RIDGE	100	85	no	2040	$250,000	$300,000	$360,000
OLD DISTILLERY	30	190	no	2040	$250,000	$300,000	$360,000
OLD TIMEY	40	100	no	2040	$250,000	$300,000	$360,000

1. 2017 $$ Building include two pumps, VFD's, meter, manual transfer switch, valving, vinyl siding and a seamed metal roof

2. 20% Engineering; 20% Contingencies

Zone 1


3 miles
POPLAR DR
CHINQUAPIN DR
CHESTNUT RIDGE RD
WALNUT DR
HONEY LOCUST DR
HIGH VISTA DR
BREVARD RD
T-HIGHVISTA-B
2566
1222
1223
1225
1224
4892
4897
4893
3130
3131
2567
1218
HAYWOOD RD
LAUREL



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

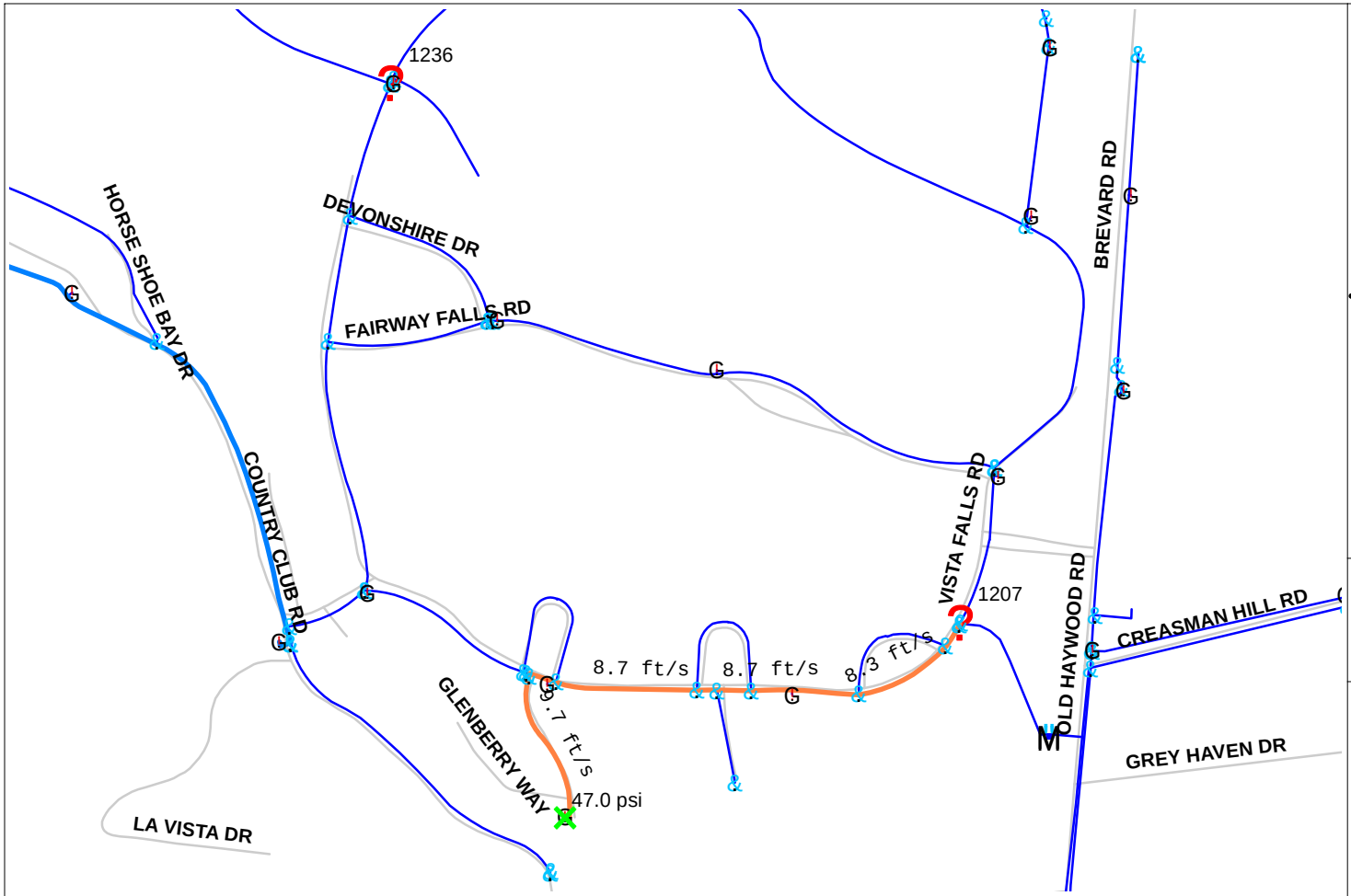
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps off

Zone	ZONE1	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	49.35720 psi				
Duration	10 min.	Open Hydrant	13-0686	Res. Pressure	25.70640 psi		Turbidity		
Valves to Open				Discharge Flow	710.16288		Disinf. Res.		
				Available Flow	796.40736		pH		
Valves to Close				Total Pipe Len.	1,690.0 ft		Iron		
				Min Flushing Vol	321.59430		Odor		
Pipes to Flush	P-10255,P-10261,P-3105,P-3107,P-HIGHVISTA-A,P-HIGHVISTA-B,PI-1669,PI-3359,PI-3361,PLATFH-13-0686			Desired Flushing Vol	964.78280		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

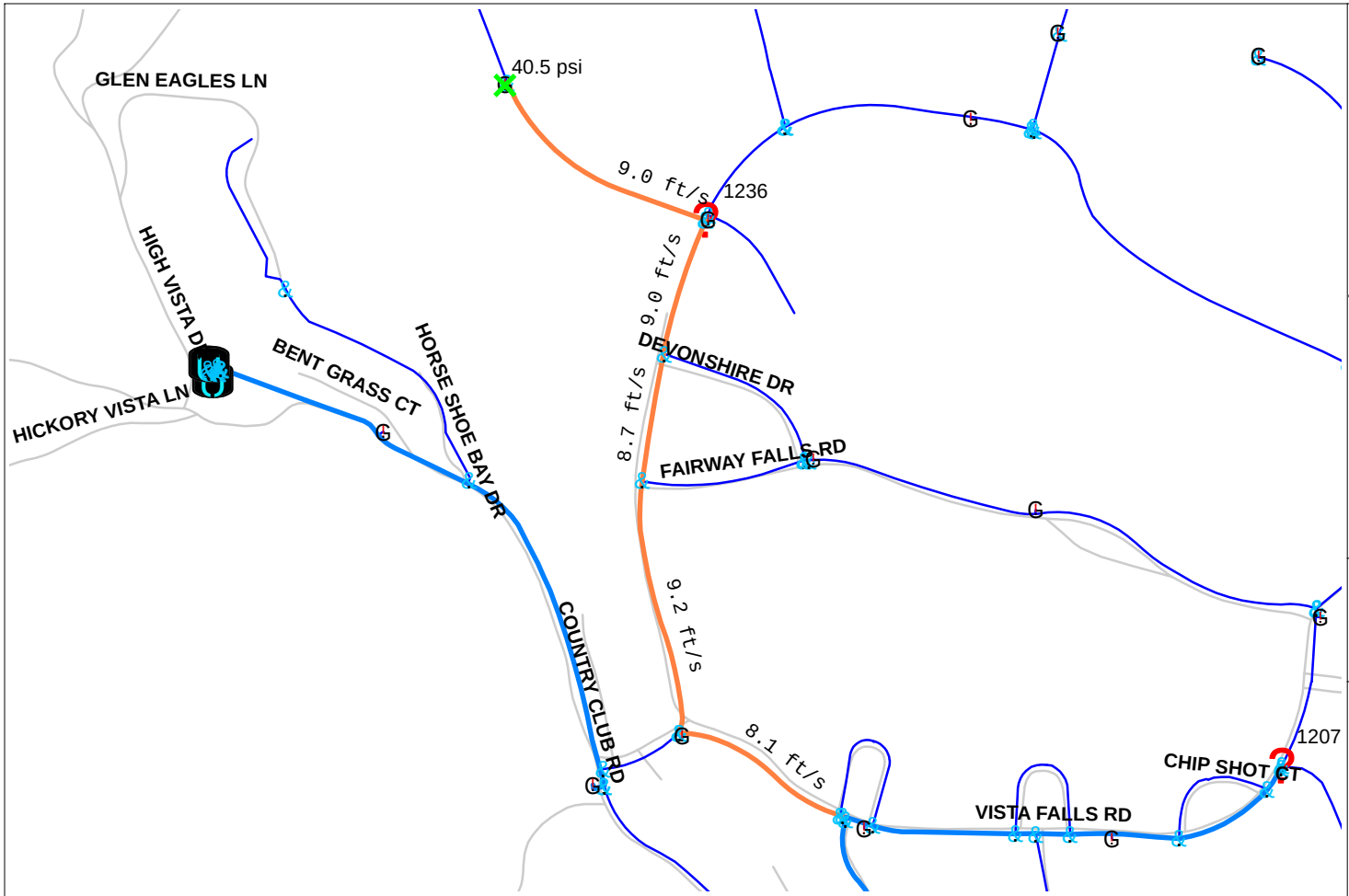
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps on

Zone	ZONE1	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	81.25130 psi				
Duration	9 min.	Open Hydrant	13-0660	Res. Pressure	47.02430 psi		Turbidity		
Valves to Open				Discharge Flow	857.16736		Disinf. Res.		
				Available Flow	1,331.78976		pH		
Valves to Close	1236, 1207			Total Pipe Len.	1,641.5 ft		Iron		
				Min Flushing Vol	355.02580		Odor		
Pipes to Flush	P-11781,P-12795,P-1301,P-1305,P-1325,PI-1643,PI-1647,PI-1649,PI-1651,PI-1657,PI-1659,PI-1661,PLATFH-13-0660			Desired Flushing Vol	1,065.07750		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps on

Zone	ZONE1	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	101.60890				
Duration	14 min.	Open Hydrant	13-0674	Res. Pressure	40.47620 psi		Turbidity		
Valves to Open				Discharge Flow	795.22688		Disinf. Res.		
				Available Flow	960.98016		pH		
Valves to Close	(1236,1207)			Total Pipe Len.	2,539.7 ft		Iron		
				Min Flushing Vol	509.70280		Odor		
Pipes to Flush	P-1307,P-1311,P-1317,P-1335,PI-1663,PI-1677,PI-1691,PLATFH-13-0674			Desired Flushing Vol	1,529.10830		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	14 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

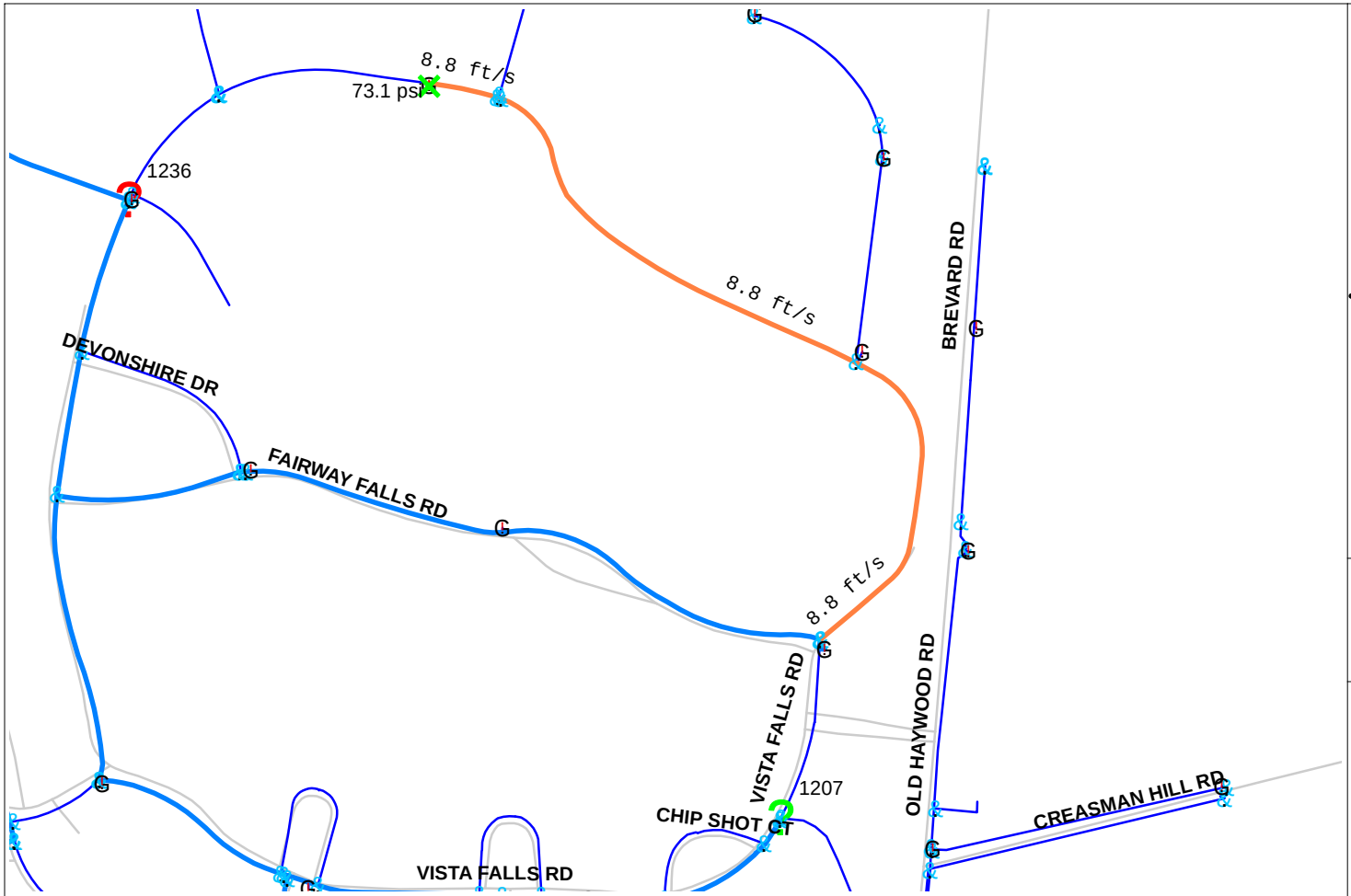
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE1	Sequence	4	Static Pressure	139.74790				
Date of Flush		Start Time		Res. Pressure	59.14060 psi		Turbidity		
Duration	10 min.	Open Hydrant	13-0664	Discharge Flow	854.45920		Disinf. Res.		
Valves to Open				Available Flow	1,087.29152		pH		
Valves to Close	(1236,1207)			Total Pipe Len.	1,894.6 ft		Iron		
				Min Flushing Vol	372.63680		Odor		
Pipes to Flush	P-1327,P-1329,P-1331,P-1337,PI-1671,PI-1675,PI-1681,PLATFH-13-0664			Desired Flushing Vol	1,117.91040		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

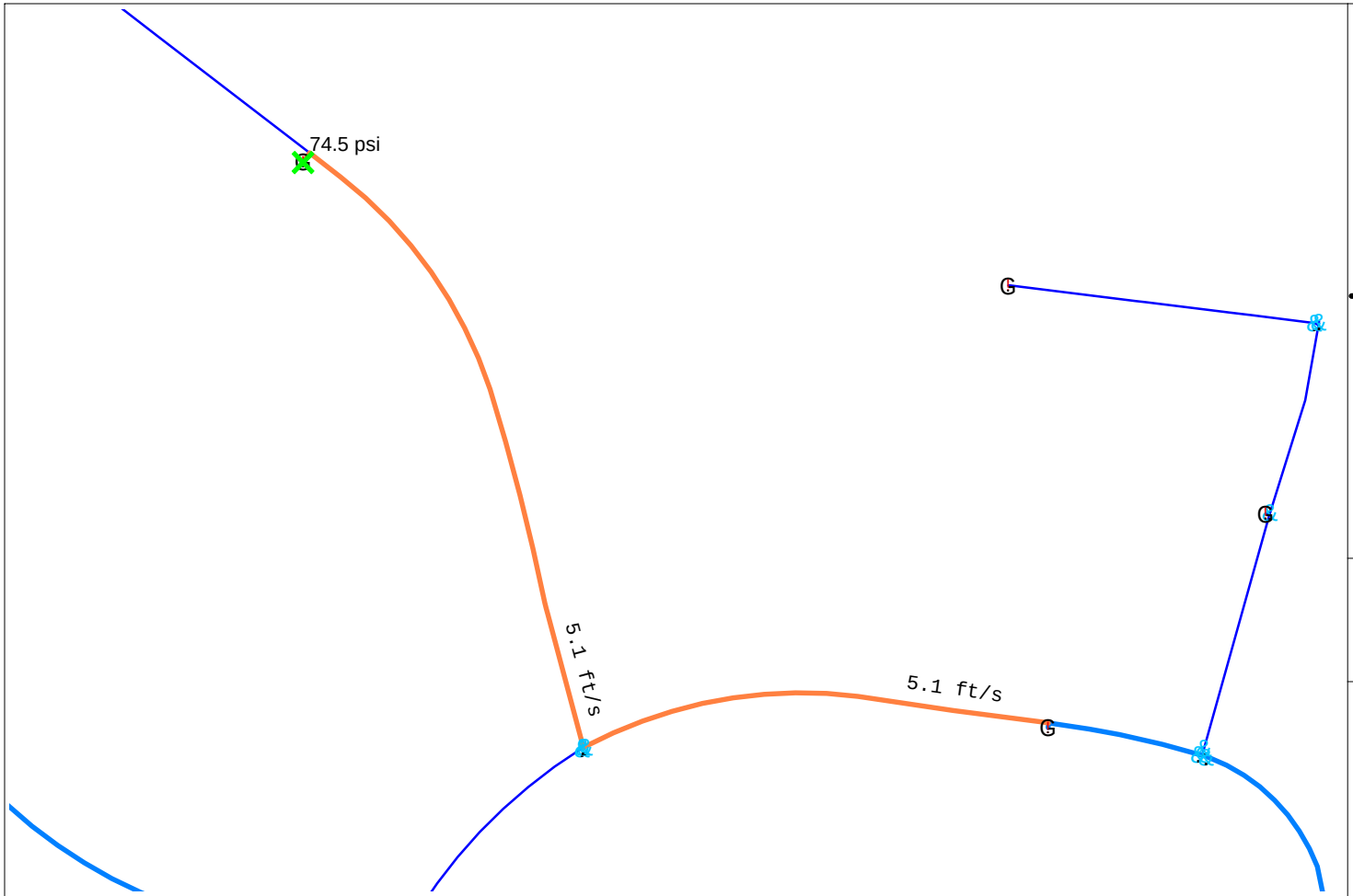
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps on

Zone	ZONE1	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	137.07500				
Duration	12 min.	Open Hydrant	13-0658	Res. Pressure	73.13260 psi		Turbidity		
Valves to Open	1207			Discharge Flow	771.96448		Disinf. Res.		
				Available Flow	1,198.04832		pH		
Valves to Close	(1236)			Total Pipe Len.	2,039.2 ft		Iron		
				Min Flushing Vol	397.45900		Odor		
Pipes to Flush	P-1343,P-13873,P-8149,PI-1687,PI-1689,P-1345,PLATFH-13-0658			Desired Flushing Vol	1,192.37700		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

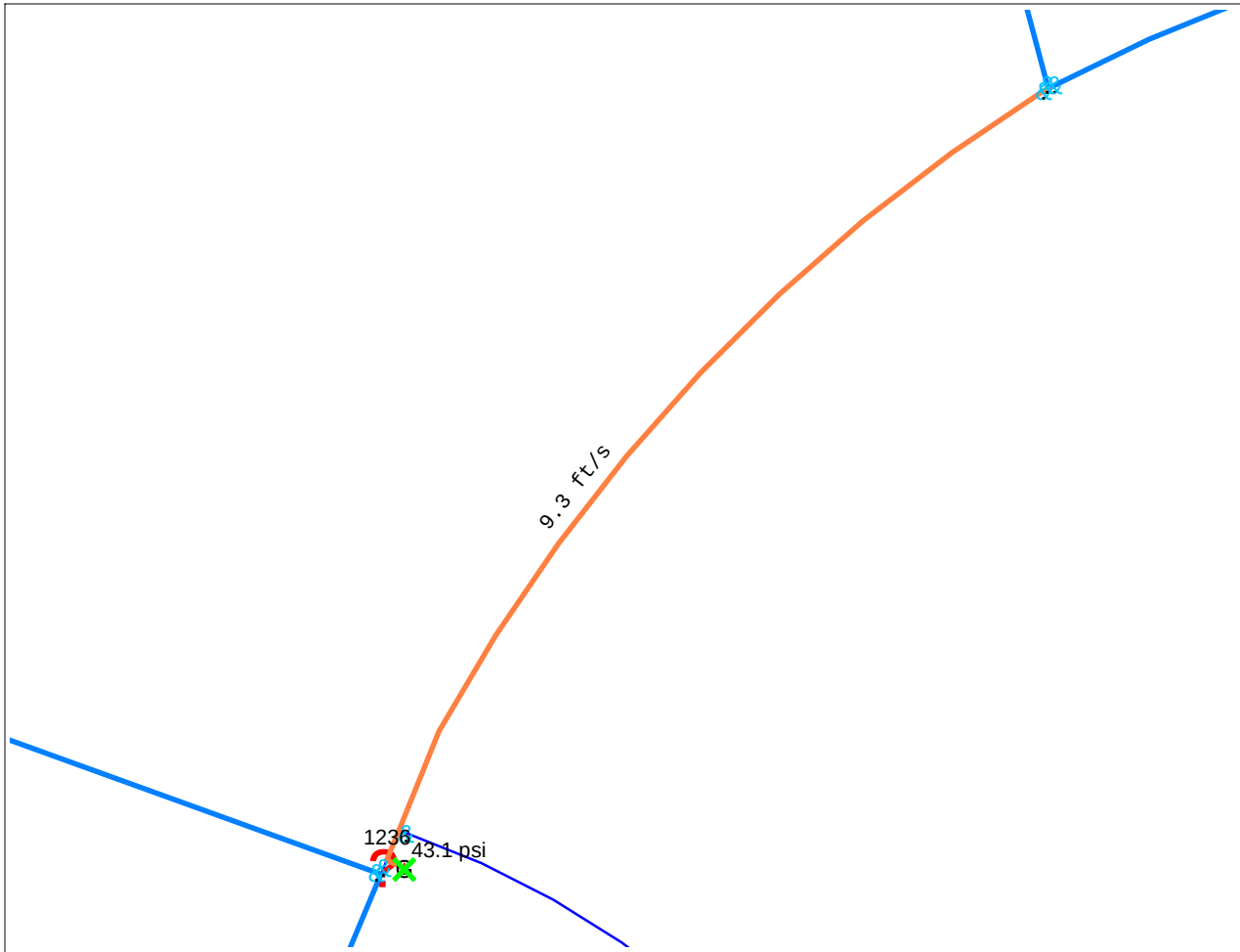
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both High Vista pumps on

Zone	ZONE1	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	117.93190				
Duration	12 min.	Open Hydrant	13-0676	Res. Pressure	74.46600 psi		Turbidity		
Valves to Open				Discharge Flow	449.41568		Disinf. Res.		
				Available Flow	828.76640		pH		
Valves to Close	(1236)			Total Pipe Len.	1,214.3 ft		Iron		
				Min Flushing Vol	236.50690		Odor		
Pipes to Flush	P-8143,PI-1695,PI-8503,PLATFH-13-0676			Desired Flushing Vol	709.52060		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

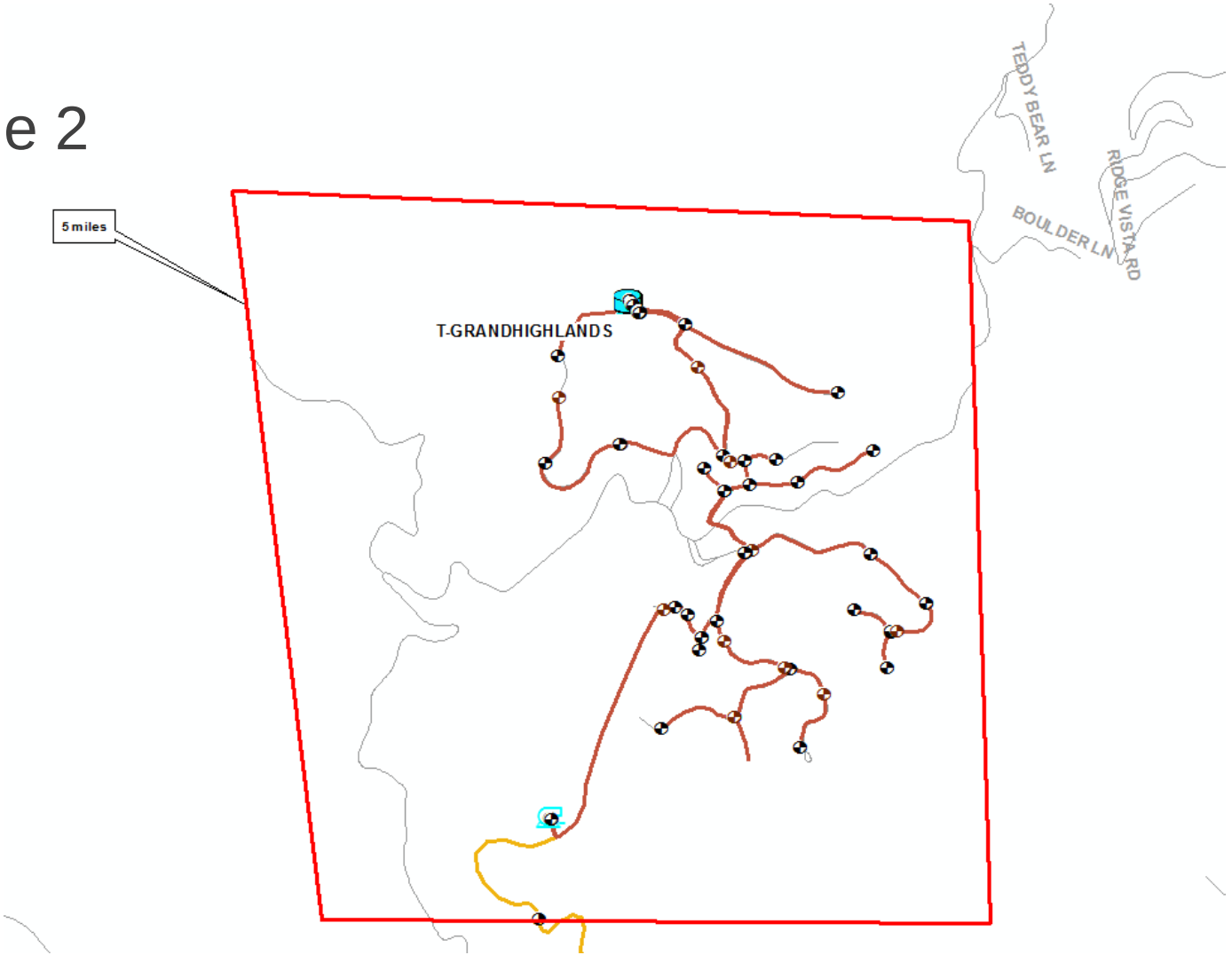
Note: Both High Vista pumps on
Open valve 1236 after Sequence 7

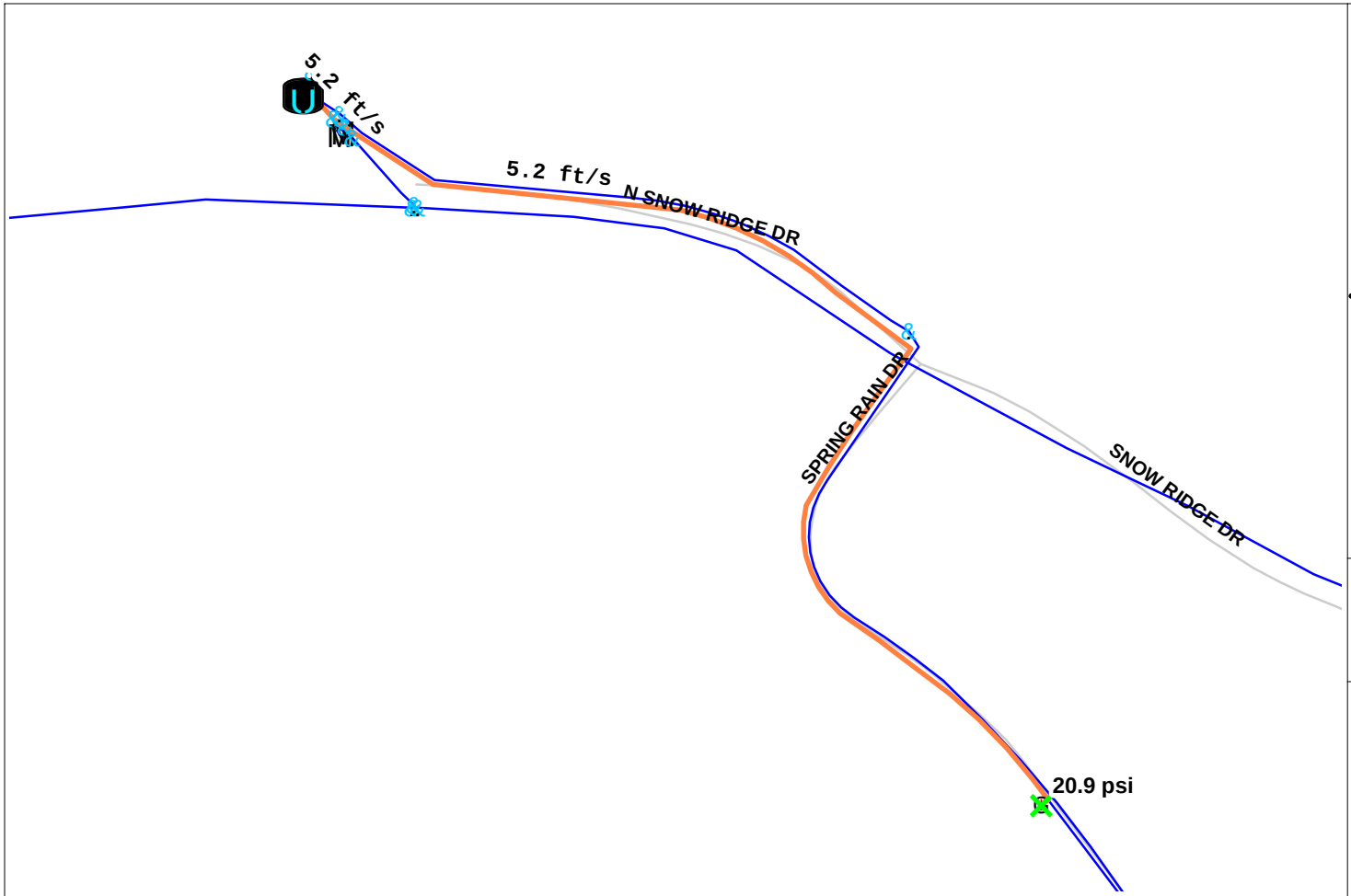
Zone	ZONE1	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	129.85180				
Duration	2 min.	Open Hydrant	13-0672	Res. Pressure	43.06210 psi		Turbidity		
Valves to Open				Discharge Flow	820.22528		Disinf. Res.		
				Available Flow	970.56288		pH		
Valves to Close	(1236)			Total Pipe Len.	328.4 ft		Iron		
				Min Flushing Vol	64.40510 ft^3		Odor		
Pipes to Flush	P-1339,P-1341,PLATFH-13-0672			Desired Flushing Vol	193.21520		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	2 min.		Other		

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Zone 2


5 miles
T-GRANDHIGHLANDS
TEDDY BEAR LN
RIDGE VISTA RD
BOULDER LN



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

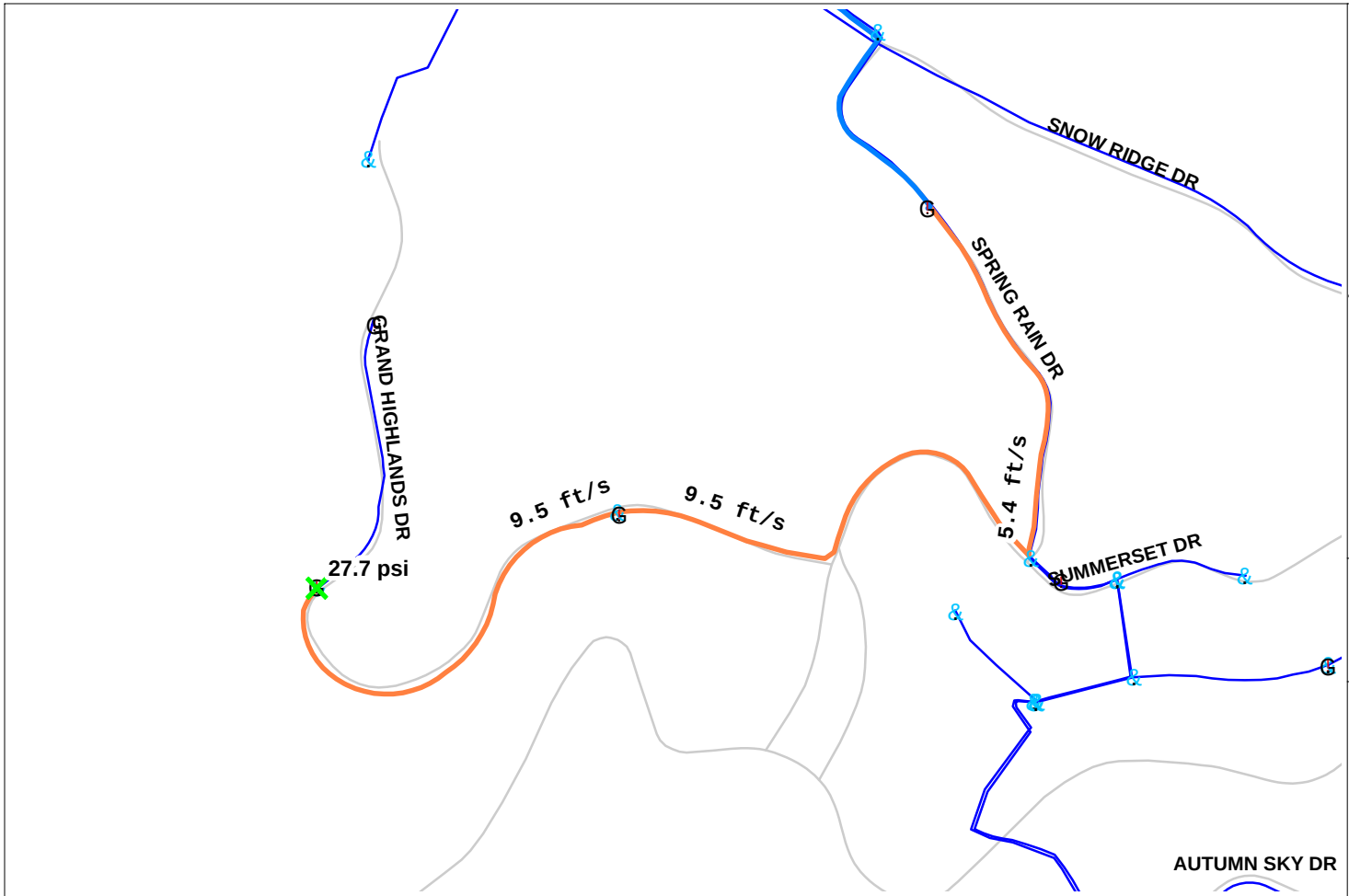
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	26.51470 psi				
Duration	9.8 min.	Open Hydrant	14-0002	Res. Pressure	20.92770 psi		Turbidity		
Valves to Open				Discharge Flow	795.15744		Disinf. Res.		
				Available Flow	874.11072		pH		
Valves to Close				Total Pipe Len.	1,017.9 ft		Iron		
				Min Flushing Vol	347.86620		Odor		
Pipes to Flush	P-15023,P-GRANDHIGHLANDS,PI-5021,PLATFH-14-0002			Desired Flushing Vol	1,043.59870		HPC		
				Min Flushing Time	3.3 min.		Color		
				Desired Flushing	9.8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

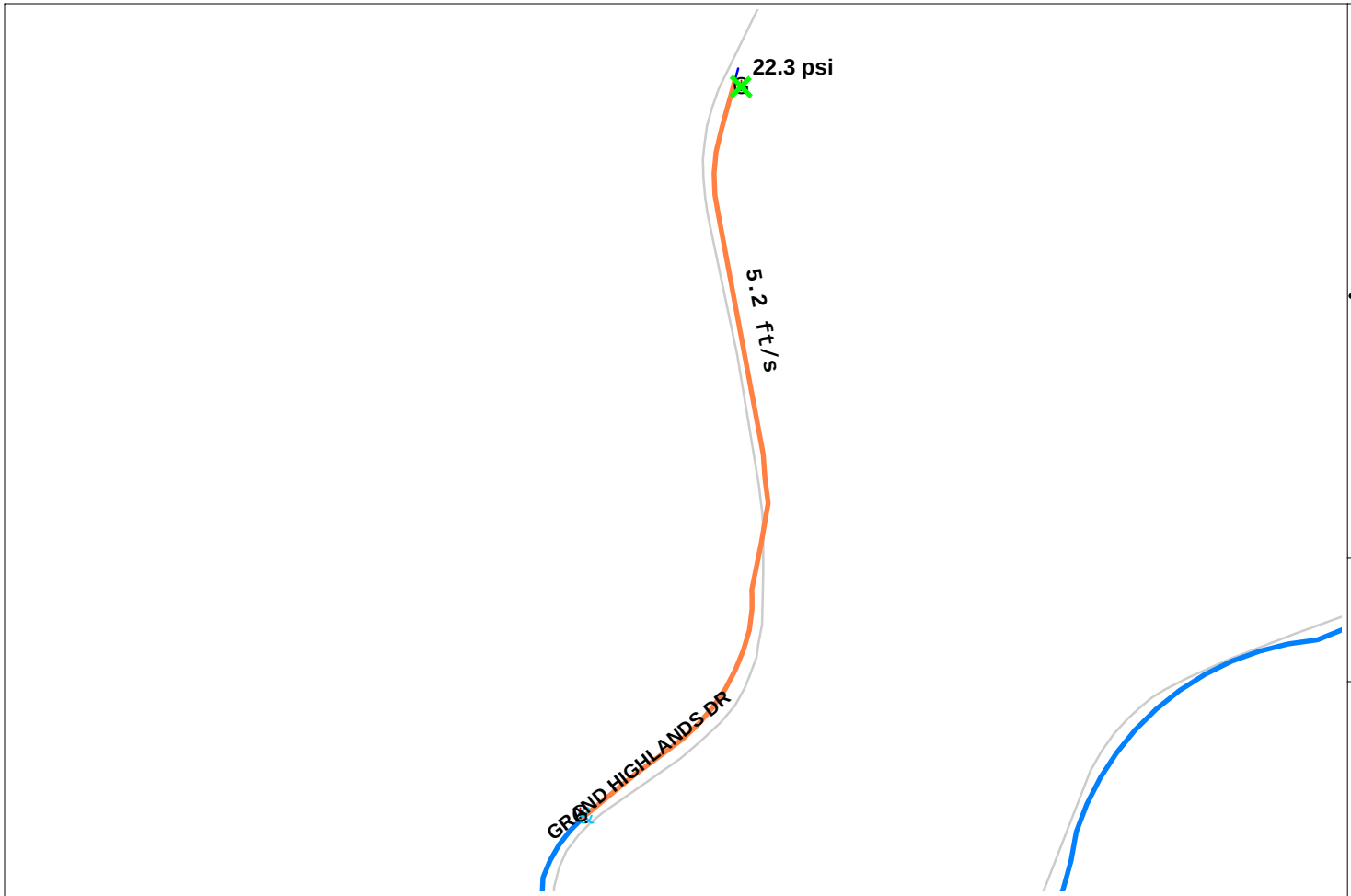
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	84.14160 psi				
Duration	18.9 min.	Open Hydrant	14-0010	Res. Pressure	27.67870 psi		Turbidity		
Valves to Open				Discharge Flow	838.41856		Disinf. Res.		
				Available Flow	894.17888		pH		
Valves to Close				Total Pipe Len.	2,970.3 ft		Iron		
				Min Flushing Vol	704.84200		Odor		
Pipes to Flush	P-4773,P-4775,PI-5023,PLATFH-14-0010			Desired Flushing Vol	2,114.52610		HPC		
				Min Flushing Time	6.3 min.		Color		
				Desired Flushing	18.9 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

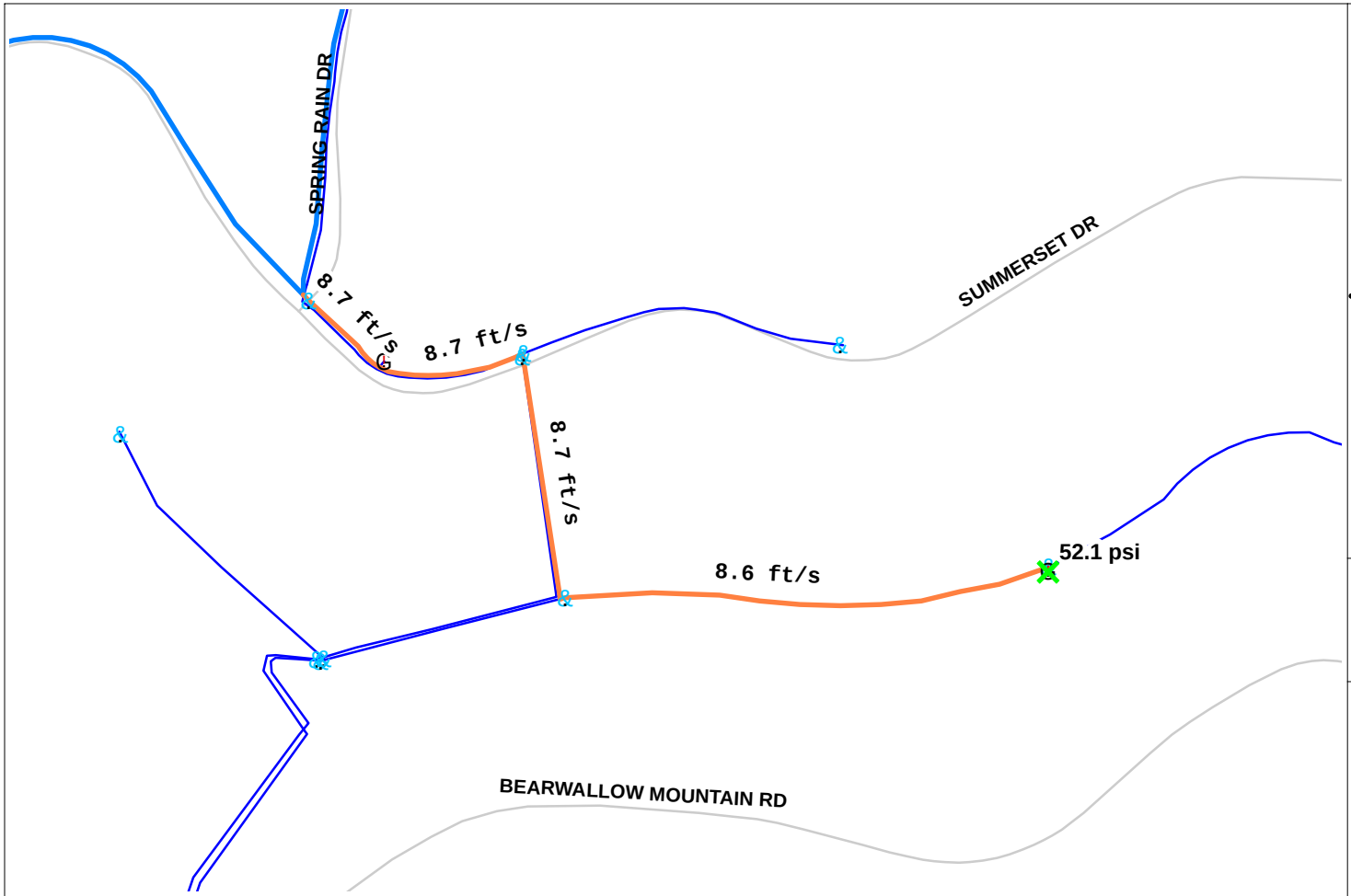
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	45.57790 psi				
Duration	6.0 min.	Open Hydrant	14-0012	Res. Pressure	22.33160 psi		Turbidity		
Valves to Open				Discharge Flow	460.87328		Disinf. Res.		
				Available Flow	485.80224		pH		
Valves to Close				Total Pipe Len.	630.6 ft		Iron		
				Min Flushing Vol	123.81880		Odor		
Pipes to Flush	PI-5025,PLATFH-14-0012			Desired Flushing Vol	371.45640		HPC		
				Min Flushing Time	2.0 min.		Color		
				Desired Flushing	6.0 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

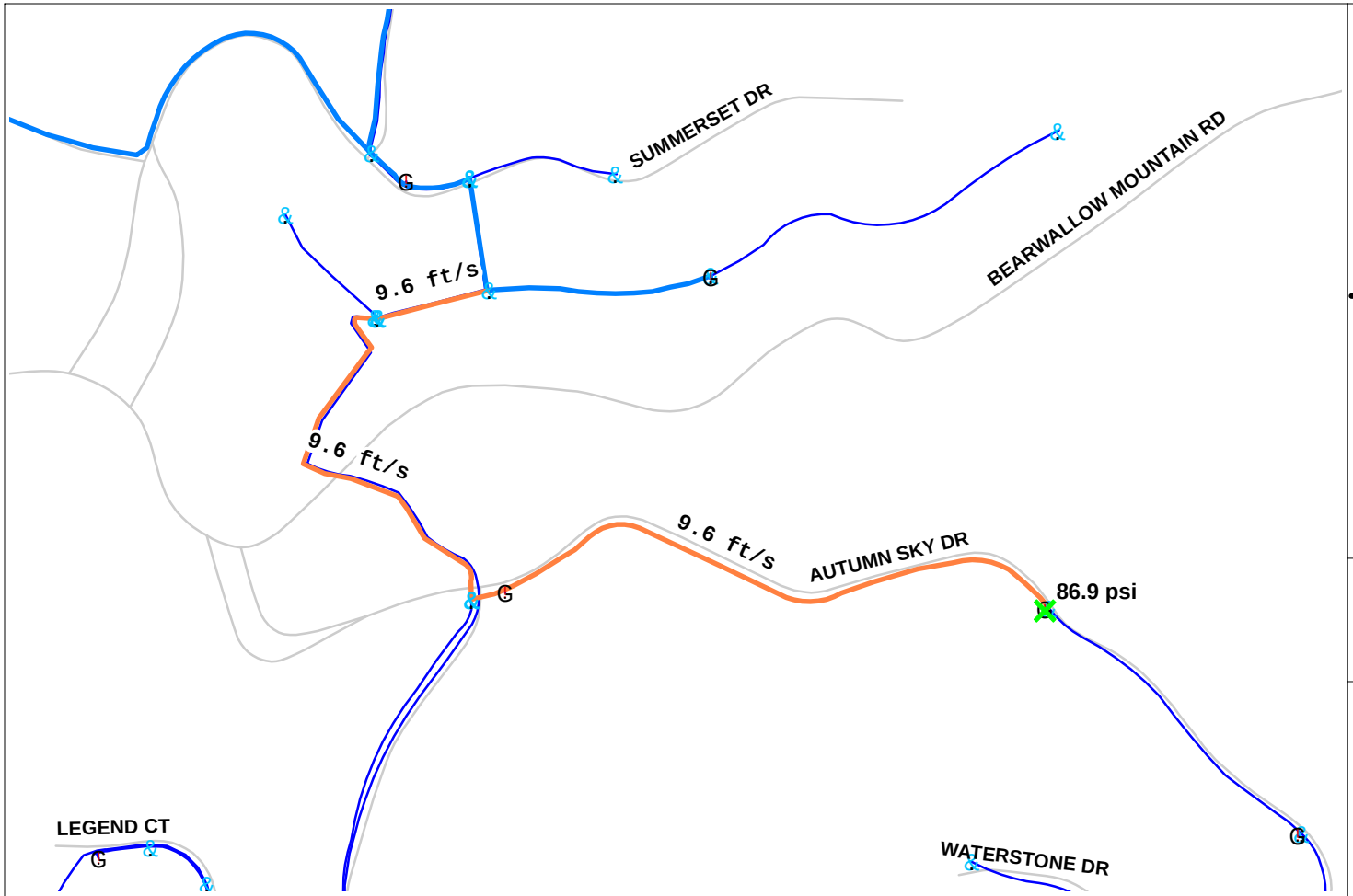
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	76.33730 psi				
Duration	5.0 min.	Open Hydrant	14-0006	Res. Pressure	52.13080 psi		Turbidity		
Valves to Open				Discharge Flow	754.25728		Disinf. Res.		
				Available Flow	1,197.49280		pH		
Valves to Close				Total Pipe Len.	859.3 ft		Iron		
				Min Flushing Vol	166.75490		Odor		
Pipes to Flush	P-13395,P-15161,P-15163,P-4791,PLATFH-14-0006			Desired Flushing Vol	500.26470		HPC		
				Min Flushing Time	1.7 min.		Color		
				Desired Flushing	5.0 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

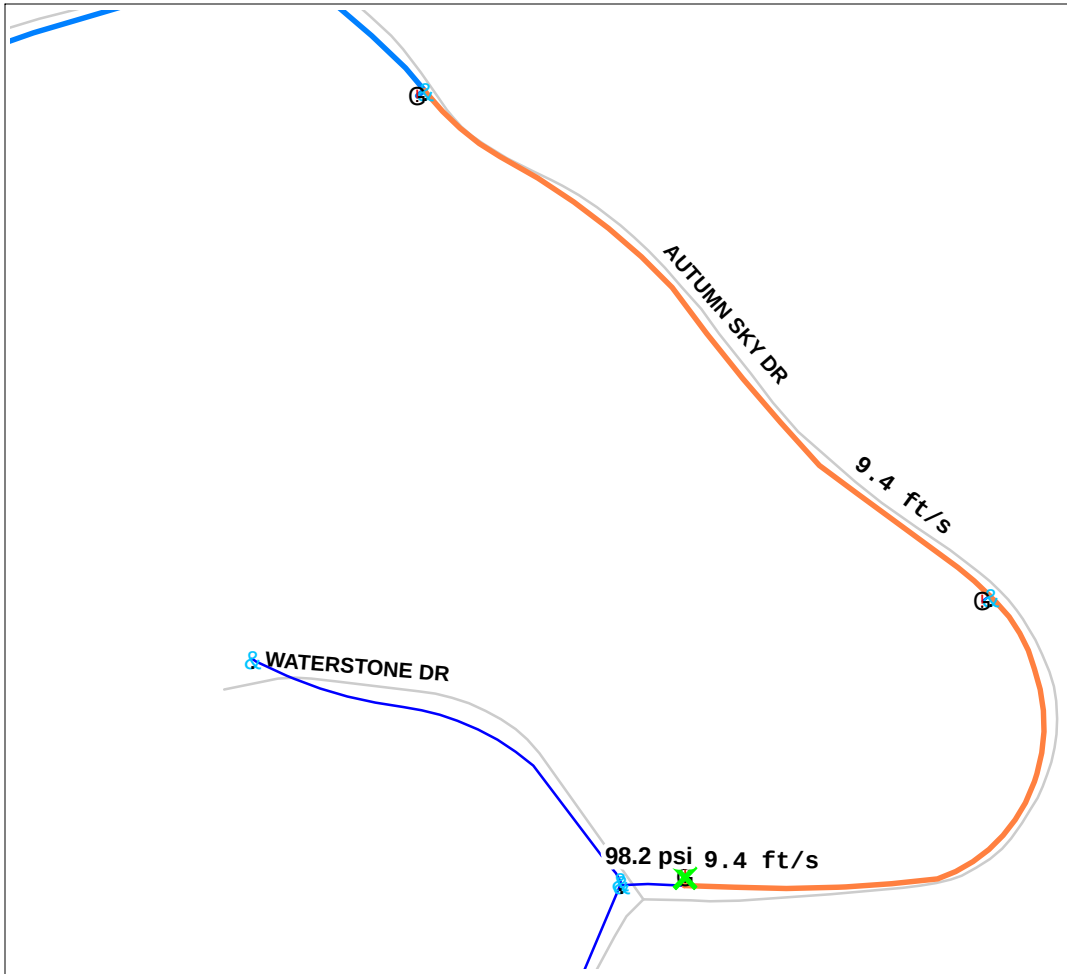
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	156.06180				
Duration	11.6 min.	Open Hydrant	14-0022	Res. Pressure	86.92330 psi		Turbidity		
Valves to Open				Discharge Flow	841.75168		Disinf. Res.		
				Available Flow	1,216.65824		pH		
Valves to Close				Total Pipe Len.	2,224.3 ft		Iron		
				Min Flushing Vol	434.94480		Odor		
Pipes to Flush	P-10635,P-4749,P-4761,P-4785,PI-5003,PLATFH-14-0022			Desired Flushing Vol	1,304.83450		HPC		
				Min Flushing Time	3.9 min.		Color		
				Desired Flushing	11.6 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

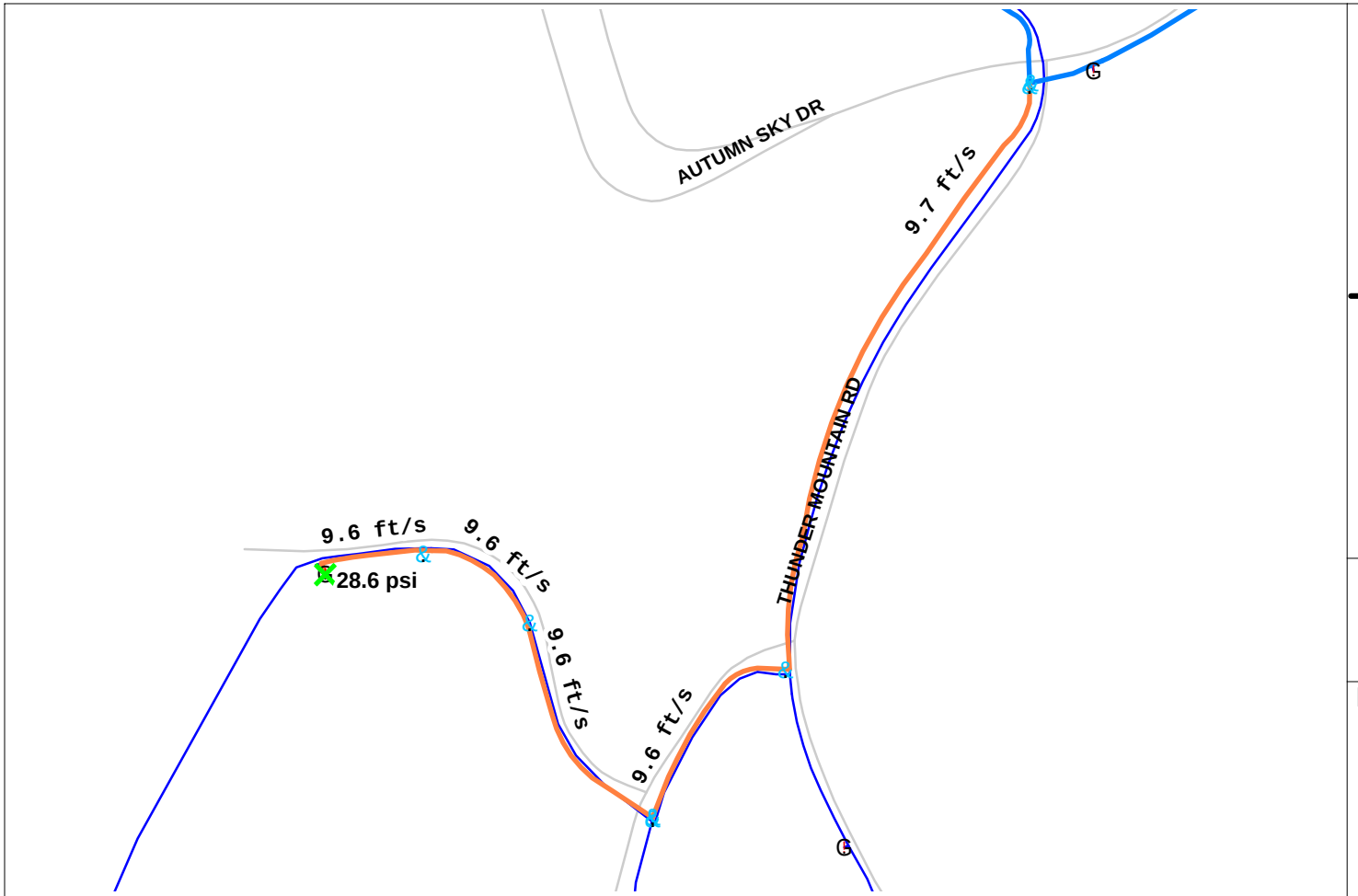
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	188.99260				
Duration	6.1 min.	Open Hydrant	14-0018	Res. Pressure	98.18800 psi		Turbidity		
Valves to Open				Discharge Flow	825.91936		Disinf. Res.		
				Available Flow	1,156.52320		pH		
Valves to Close				Total Pipe Len.	1,150.6 ft		Iron		
				Min Flushing Vol	225.91010		Odor		
Pipes to Flush	P-4759,PI-5039,PLATFH-14-0018			Desired Flushing Vol	677.73020		HPC		
				Min Flushing Time	2.0 min.		Color		
				Desired Flushing	6.1 min.		Other		

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Date: 7/18/2016 5:04:43 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

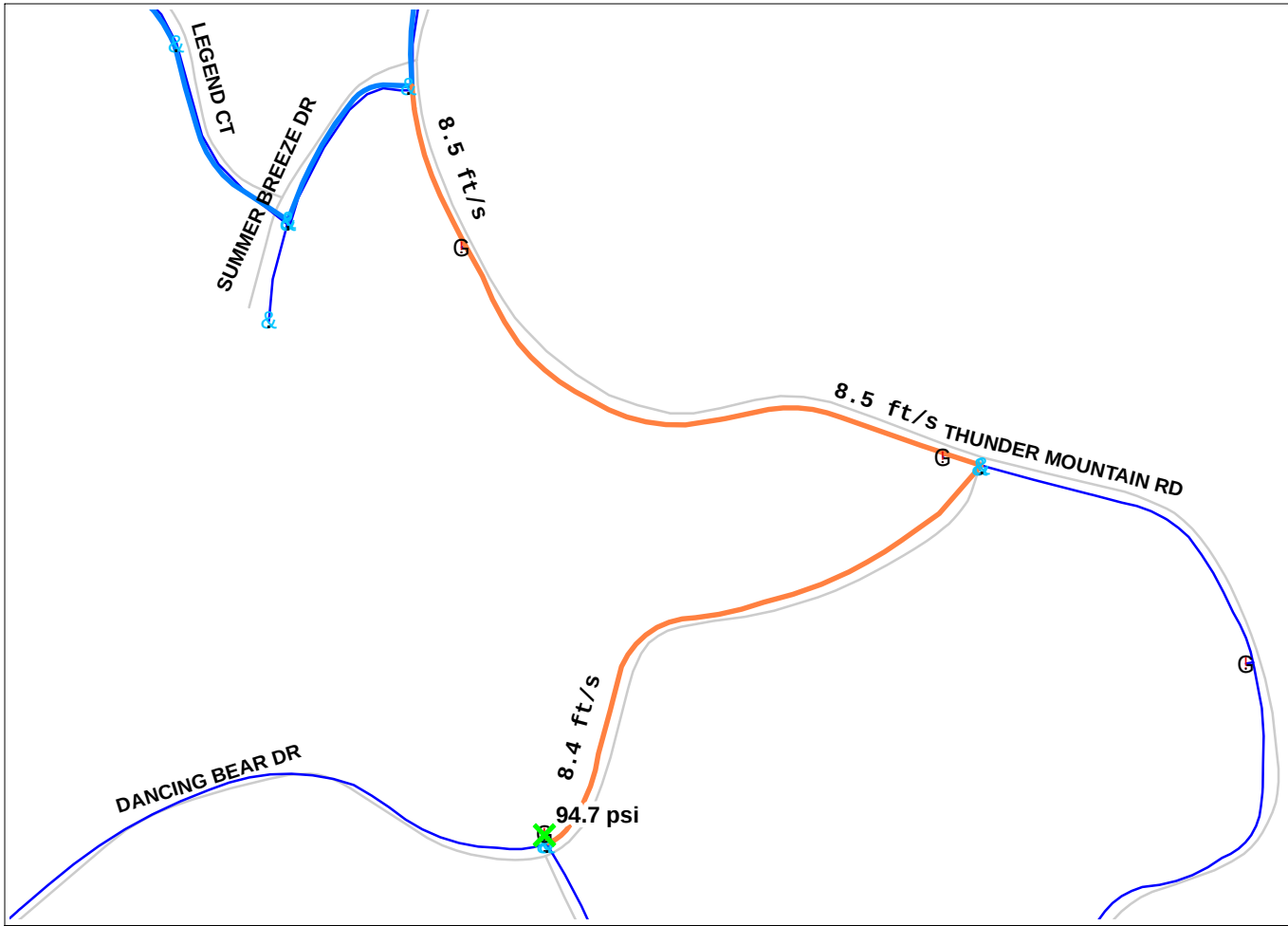
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	102.33030				
Duration	7.0 min.	Open Hydrant	14-0014	Res. Pressure	28.63580 psi		Turbidity		
Valves to Open				Discharge Flow	848.00128		Disinf. Res.		
				Available Flow	900.63680		pH		
Valves to Close				Total Pipe Len.	1,356.1 ft		Iron		
				Min Flushing Vol	265.14850		Odor		
Pipes to Flush	P-10639,P-4747,PI-4987,PI-4991,PI-4995,PLATFH-14-0014			Desired Flushing Vol	795.44560		HPC		
				Min Flushing Time	2.3 min.		Color		
				Desired Flushing	7.0 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

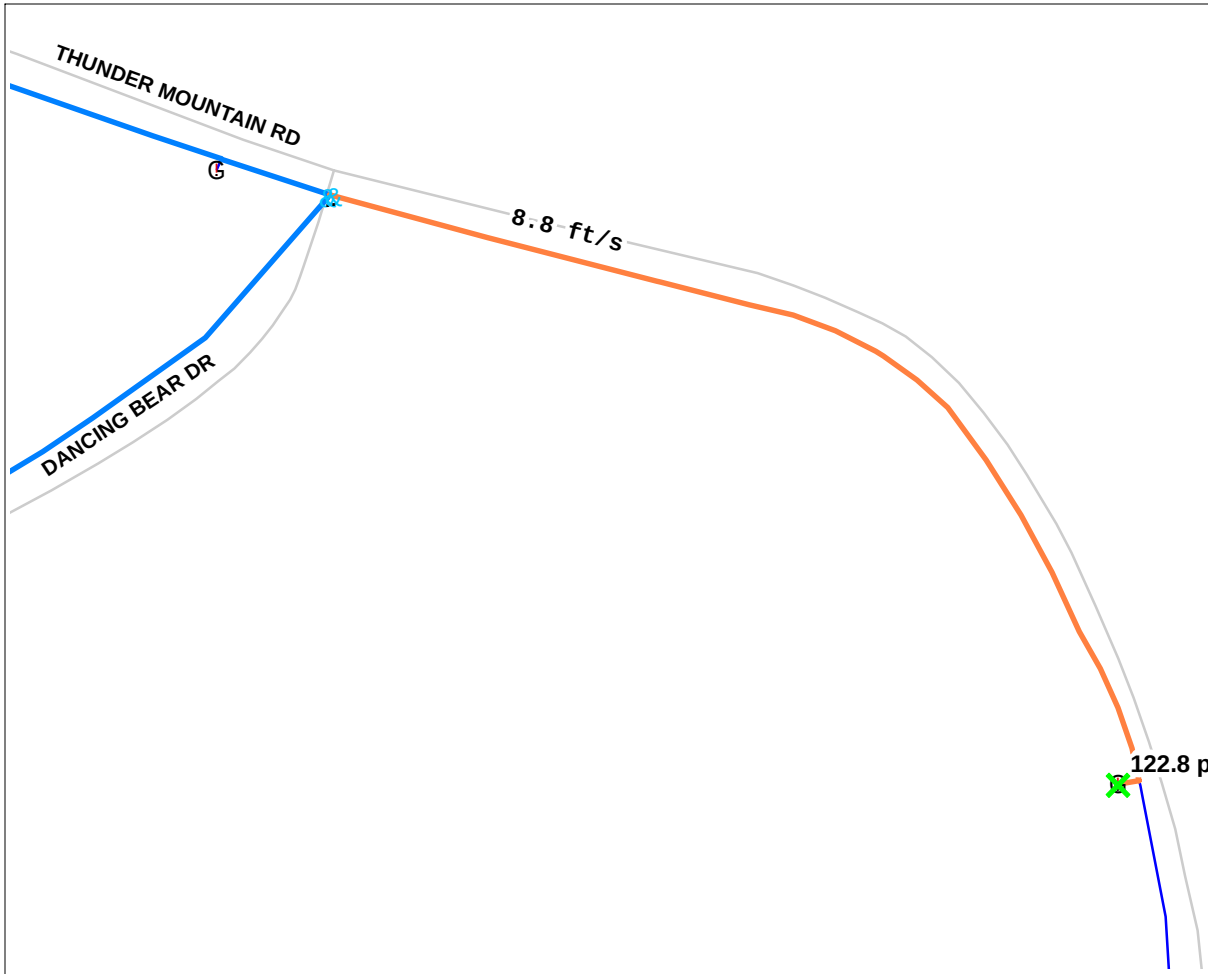
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE2	Sequence	8	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	167.32230				
Duration	9.1 min.	Open Hydrant	14-0024	Res. Pressure	94.70280 psi		Turbidity		
Valves to Open				Discharge Flow	743.35520		Disinf. Res.		
				Available Flow	1,092.49952		pH		
Valves to Close				Total Pipe Len.	1,545.9 ft		Iron		
				Min Flushing Vol	301.86210		Odor		
Pipes to Flush	P-10641,P-10643,P-4763,P-4765,PI-4997,PLATFH-14-0024			Desired Flushing Vol	905.58640		HPC		
				Min Flushing Time	3.0 min.		Color		
				Desired Flushing	9.1 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note:

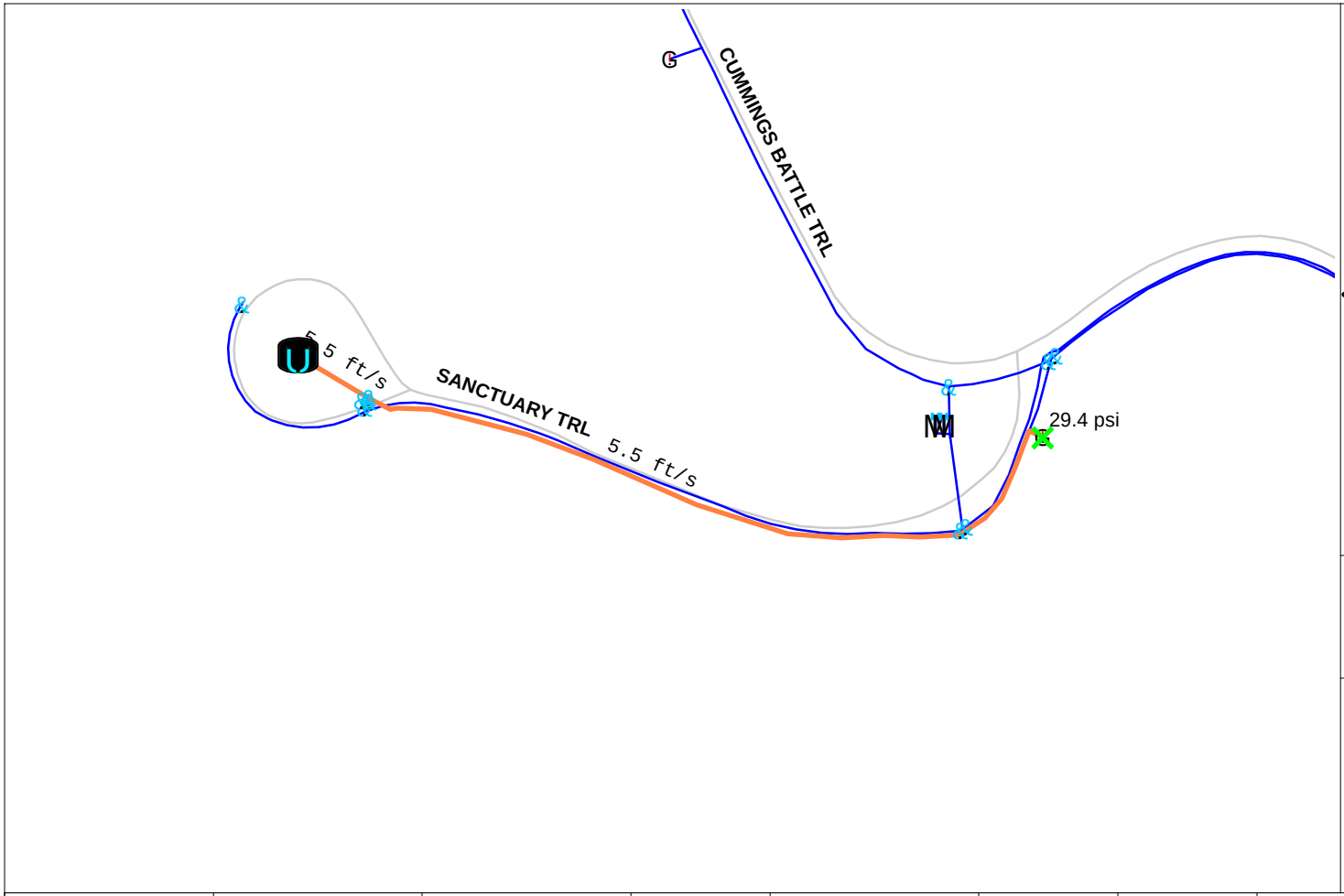
Zone	ZONE2	Sequence	9	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	195.05230				
Duration	2.3 min.	Open Hydrant	14-0026	Res. Pressure	122.80370		Turbidity		
Valves to Open				Discharge Flow	769.53408		Disinf. Res.		
				Available Flow	1,246.10080		pH		
Valves to Close				Total Pipe Len.	406.1 ft		Iron		
				Min Flushing Vol	78.98690 ft^3		Odor		
Pipes to Flush	PI-5041,PLATFH-14-0026			Desired Flushing Vol	236.96060		HPC		
				Min Flushing Time	0.8 min.		Color		
				Desired Flushing	2.3 min.		Other		

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Zone 3


3 miles
T-CUMMING SCOVE - SANCTUARY
T-CUMMING SCOVE
1292
2016
2014
2011
2004
2017
2015
8264
8263
8255
1973
1971
ROCKY TRAIL RD
CAROLINA HILLS DR



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

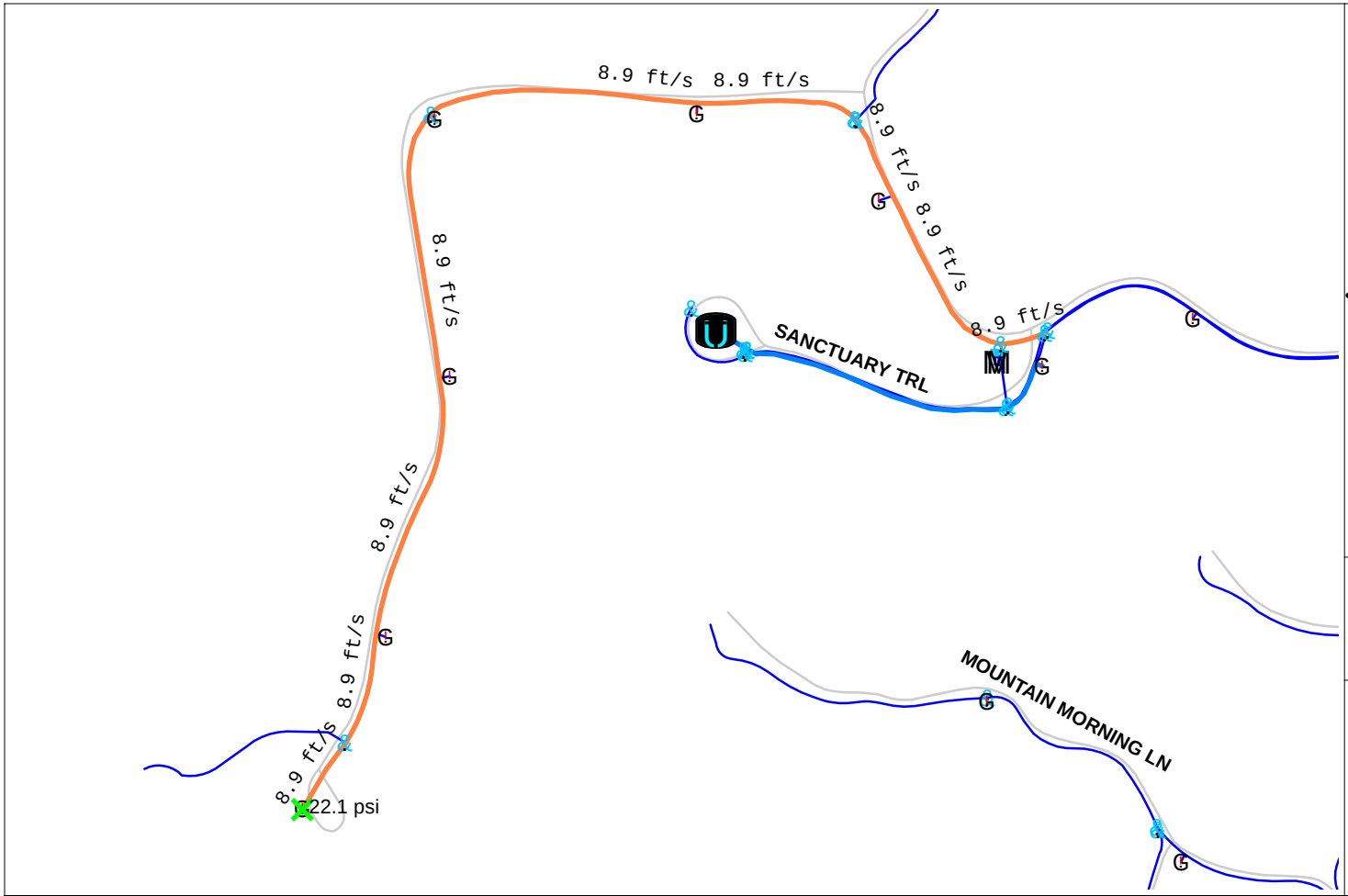
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	33.79710 psi				
Duration	6 min.	Open Hydrant	11-0904	Res. Pressure	29.35650 psi		Turbidity		
Valves to Open				Discharge Flow	859.45888		Disinf. Res.		
				Available Flow	1,598.16160		pH		
Valves to Close				Total Pipe Len.	673.0 ft		Iron		
				Min Flushing Vol	231.52270		Odor		
Pipes to Flush	P-1431,PI-1763,PLATFH-11-0904			Desired Flushing Vol	694.56800		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

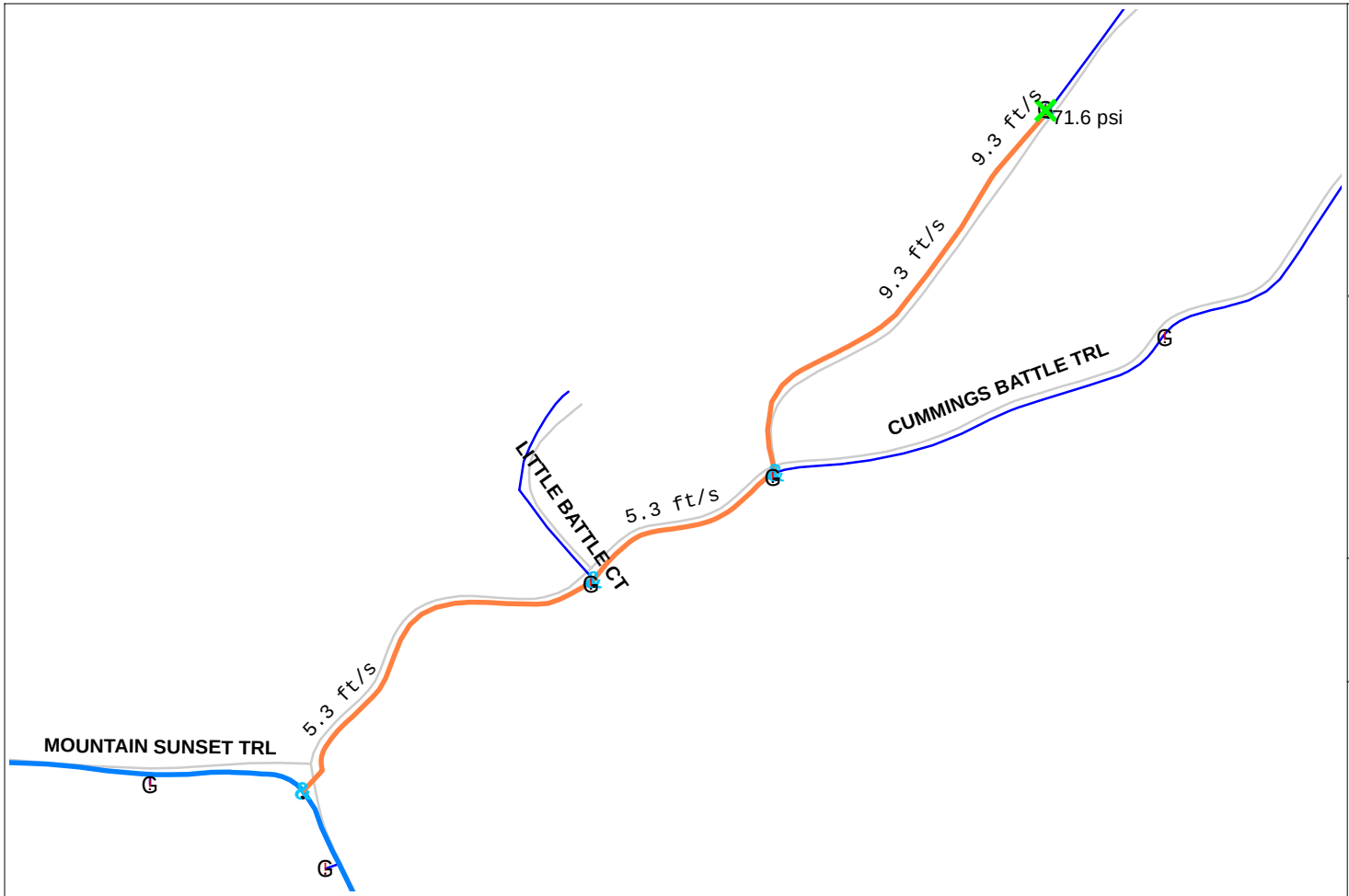
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	78.42520 psi				
Duration	15 min.	Open Hydrant	11-0892	Res. Pressure	22.09950 psi		Turbidity		
Valves to Open				Discharge Flow	783.49152		Disinf. Res.		
				Available Flow	799.18496		pH		
Valves to Close				Total Pipe Len.	2,735.1 ft		Iron		
				Min Flushing Vol	535.70350		Odor		
Pipes to Flush	P-12323,P-1399,P-1403,P-1429,PI-1749,PI-1751,PI-1753,PI-1801,P-1401,P-12801,P-1393,P-1395			Desired Flushing Vol	1,607.11060		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	15 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

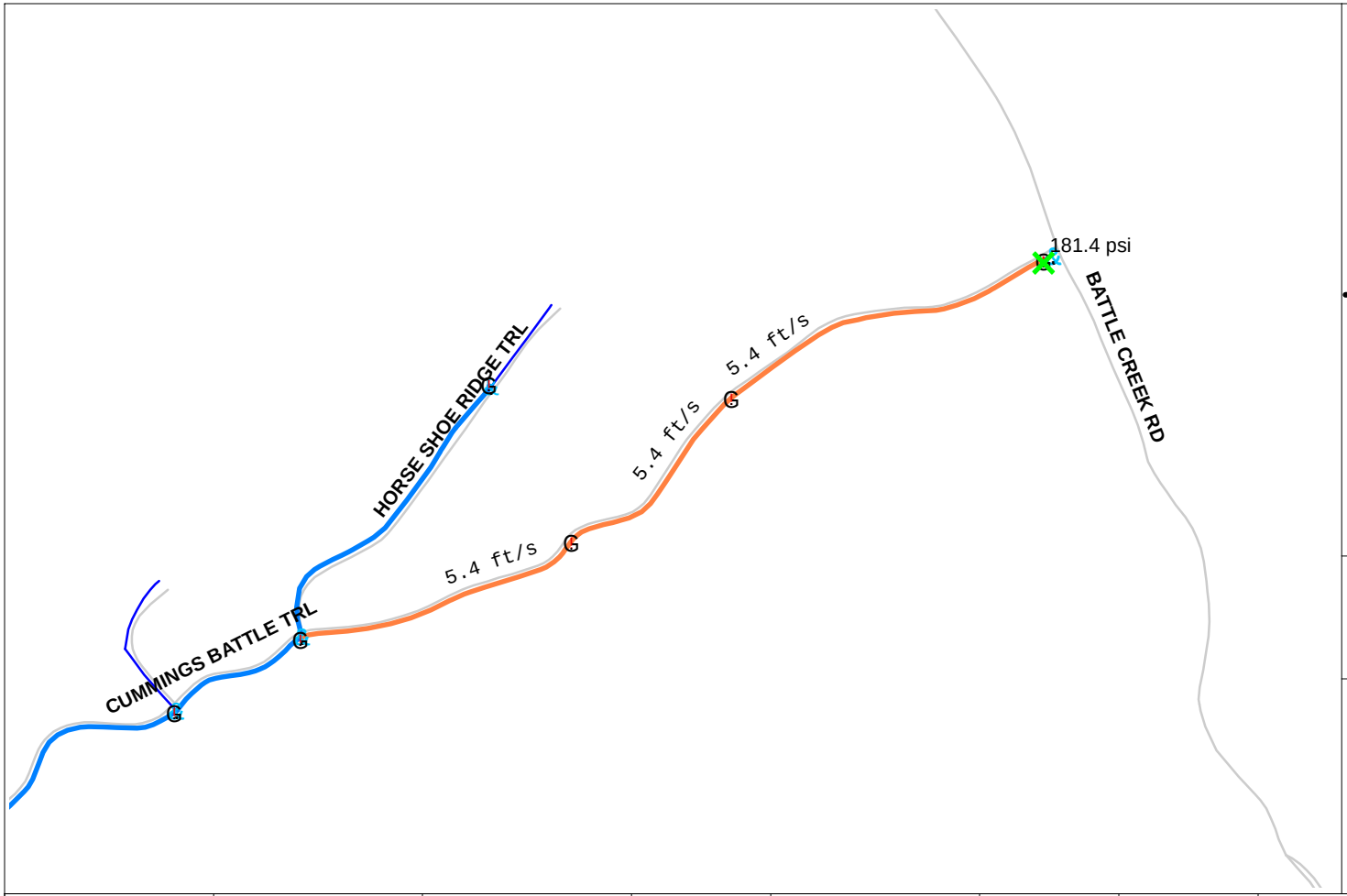
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	113.52350				
Duration	16 min.	Open Hydrant	11-0924	Res. Pressure	71.64980 psi		Turbidity		
Valves to Open				Discharge Flow	822.93344		Disinf. Res.		
				Available Flow	1,270.89088		pH		
Valves to Close				Total Pipe Len.	2,095.5 ft		Iron		
				Min Flushing Vol	590.72530		Odor		
Pipes to Flush	PLATFH-11-0924,P-7695,PI-8007,P-7705,PI-8013,P-7701,P-7699,PI-8011			Desired Flushing Vol	1,772.17600		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

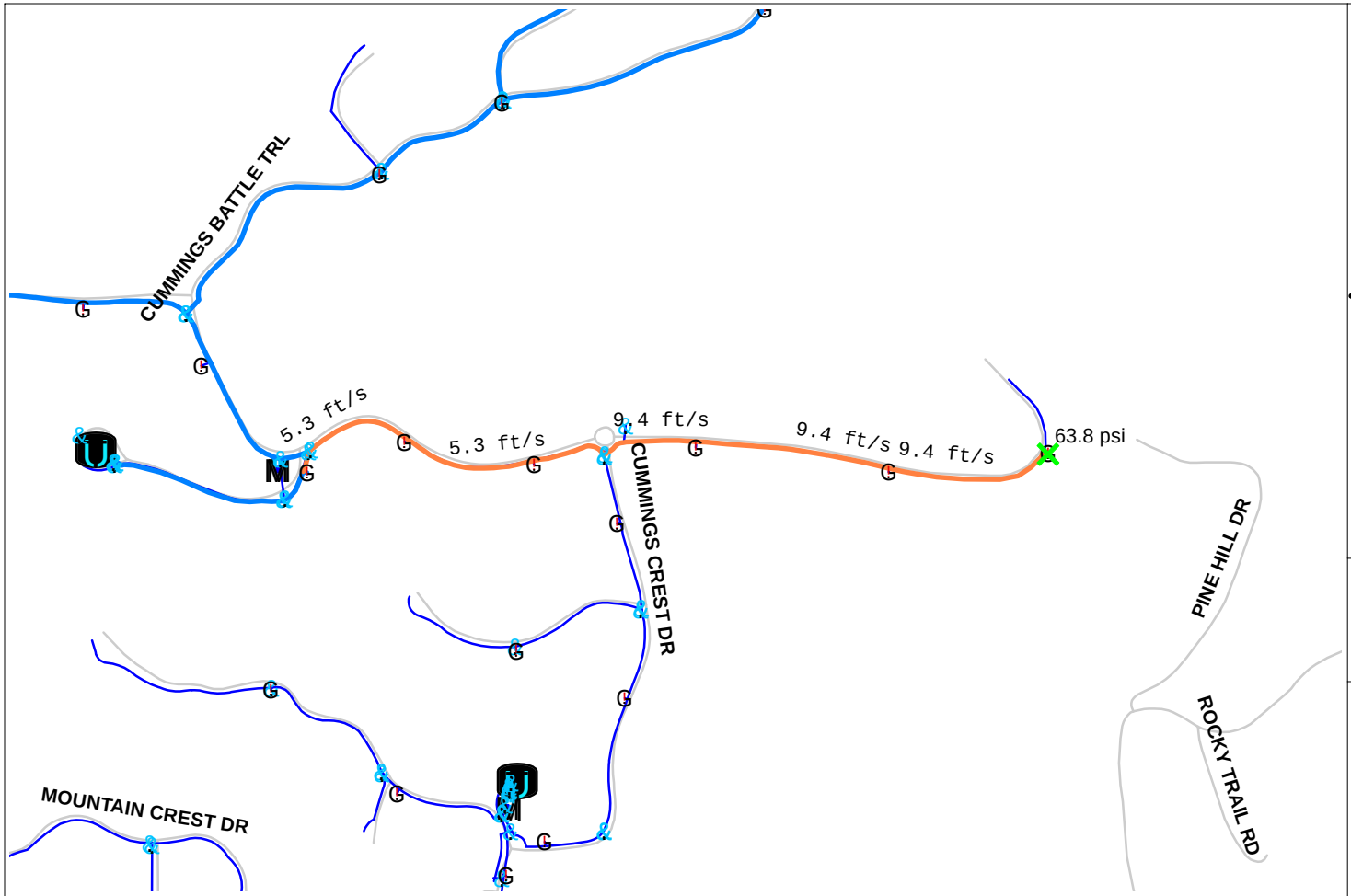
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	217.94900				
Duration	22 min.	Open Hydrant	11-0916	Res. Pressure	181.43610		Turbidity		
Valves to Open				Discharge Flow	842.93216		Disinf. Res.		
				Available Flow	2,100.07392		pH		
Valves to Close				Total Pipe Len.	2,384.1 ft		Iron		
				Min Flushing Vol	831.26100		Odor		
Pipes to Flush	PLATFH-11-0916,P-1445,P-1441,PI-1811,P-7703			Desired Flushing Vol	2,493.78300		HPC		
				Min Flushing Time	7 min.		Color		
				Desired Flushing	22 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

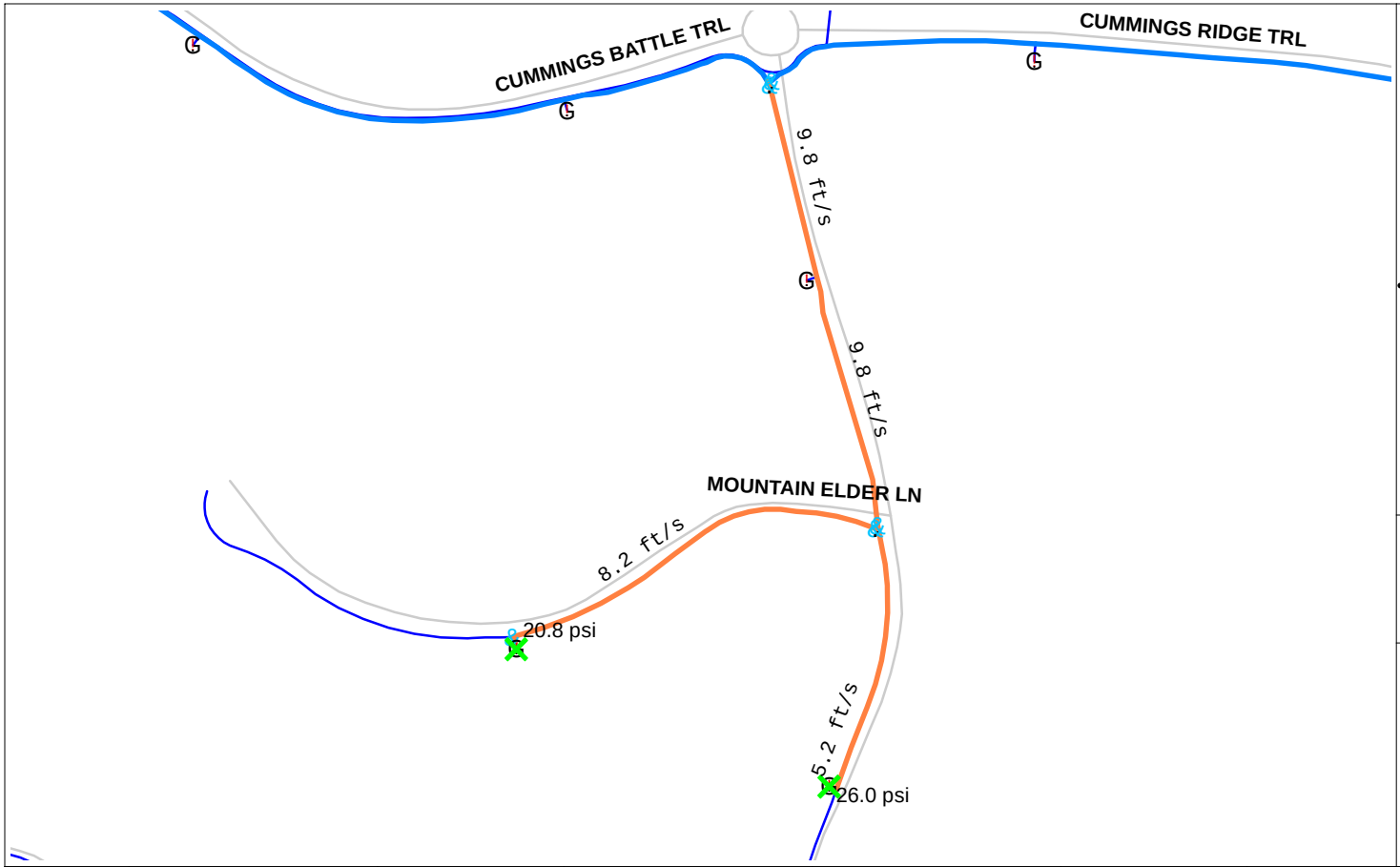
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	100.95860				
Duration	16 min.	Open Hydrant	11-0914	Res. Pressure	63.81630 psi		Turbidity		
Valves to Open				Discharge Flow	832.09952		Disinf. Res.		
				Available Flow	1,269.84928		pH		
Valves to Close				Total Pipe Len.	2,285.4 ft		Iron		
				Min Flushing Vol	595.48000		Odor		
Pipes to Flush	P-1423,P-1427,PI-1787,PI-1789,P-12803,P-1425,P-1435,PI-1781,PI-1783,PLATFH-11-0914			Desired Flushing Vol	1,786.44010		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

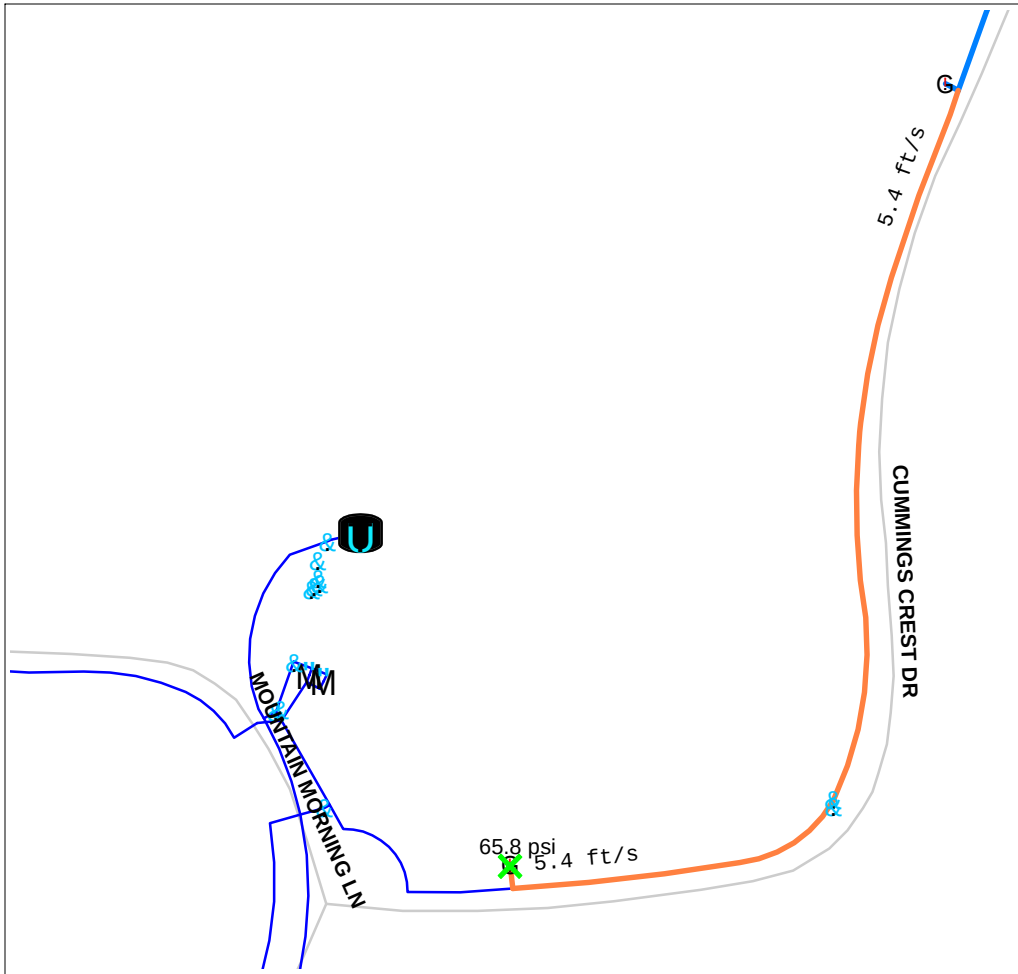
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

			Hydrant 1		Hydrant 2			Hydrant 1		Hydrant 2	
Zone	ZONE3										
Sequence	6	**Hydraulics**	**Model**	**Field**	**Model**	**Field**	Water Quality	Initial Value	Final Value	Initial Value	Final Value
Date of Flush		Static Pressure	61.96110		61.96120						
Start Time		Res. Pressure	20.83600		25.99070		Turbidity				
Duration	7 min.	Discharge Flow	723.35648		807.86496		Disinfectant Res.				
Open Hyd.	11-0866,11-0874	Available Flow	495.38496		1,139.3020		pH				
Valves to Open		Total Pipe Len.	1,129.2 ft		1,129.2 ft		Iron				
		Min Flushing Vol	237.46850		265.22030		Odor				
Valves to Close		Desired Flushing	712.40540		795.66080		HPC				
		Min Flushing Time	2 min.		2 min.		Color				
Pipes to Flush	P-12401,P-1407,P-1409,P-1411,PI-1761,PI-1767,PI-1785,PLATFH-11-0866,PLATFH-	Desired Flushing	7 min.		7 min.		Other				

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Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

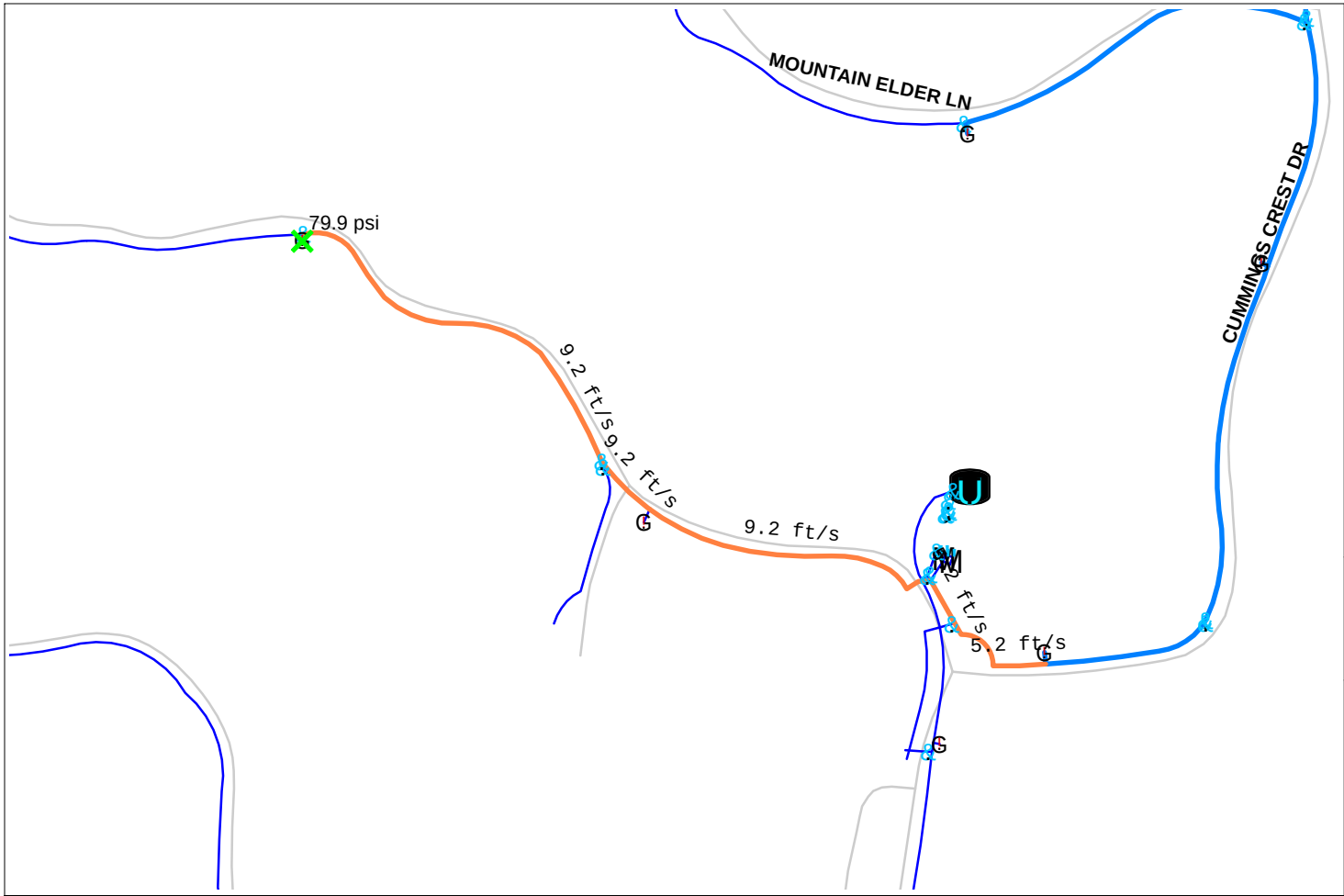
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Cummings Cove (New) pumps off

Zone	ZONE3	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	82.32680 psi				
Duration	5 min.	Open Hydrant	11-0872	Res. Pressure	65.80550 psi		Turbidity		
Valves to Open				Discharge Flow	846.61248		Disinf. Res.		
				Available Flow	1,734.12512		pH		
Valves to Close				Total Pipe Len.	571.8 ft		Iron		
				Min Flushing Vol	197.86290		Odor		
Pipes to Flush	P-1405,PI-1759,PLATFH-11-0874,PLATFH-11-0872			Desired Flushing Vol	593.58860		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Date: 7/26/2016 2:50:54 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

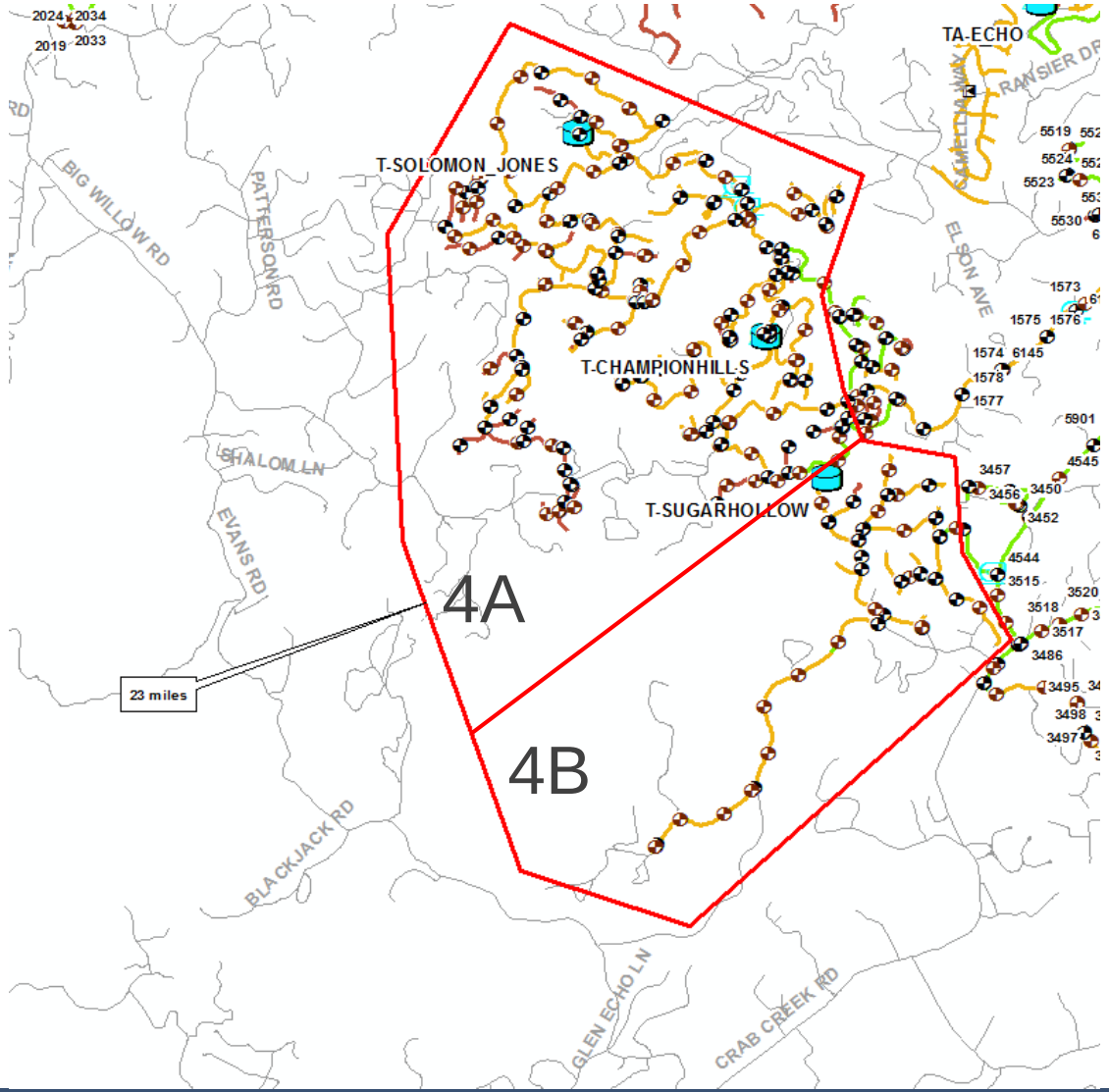
Note: Both Cummings Cove (New) pumps off

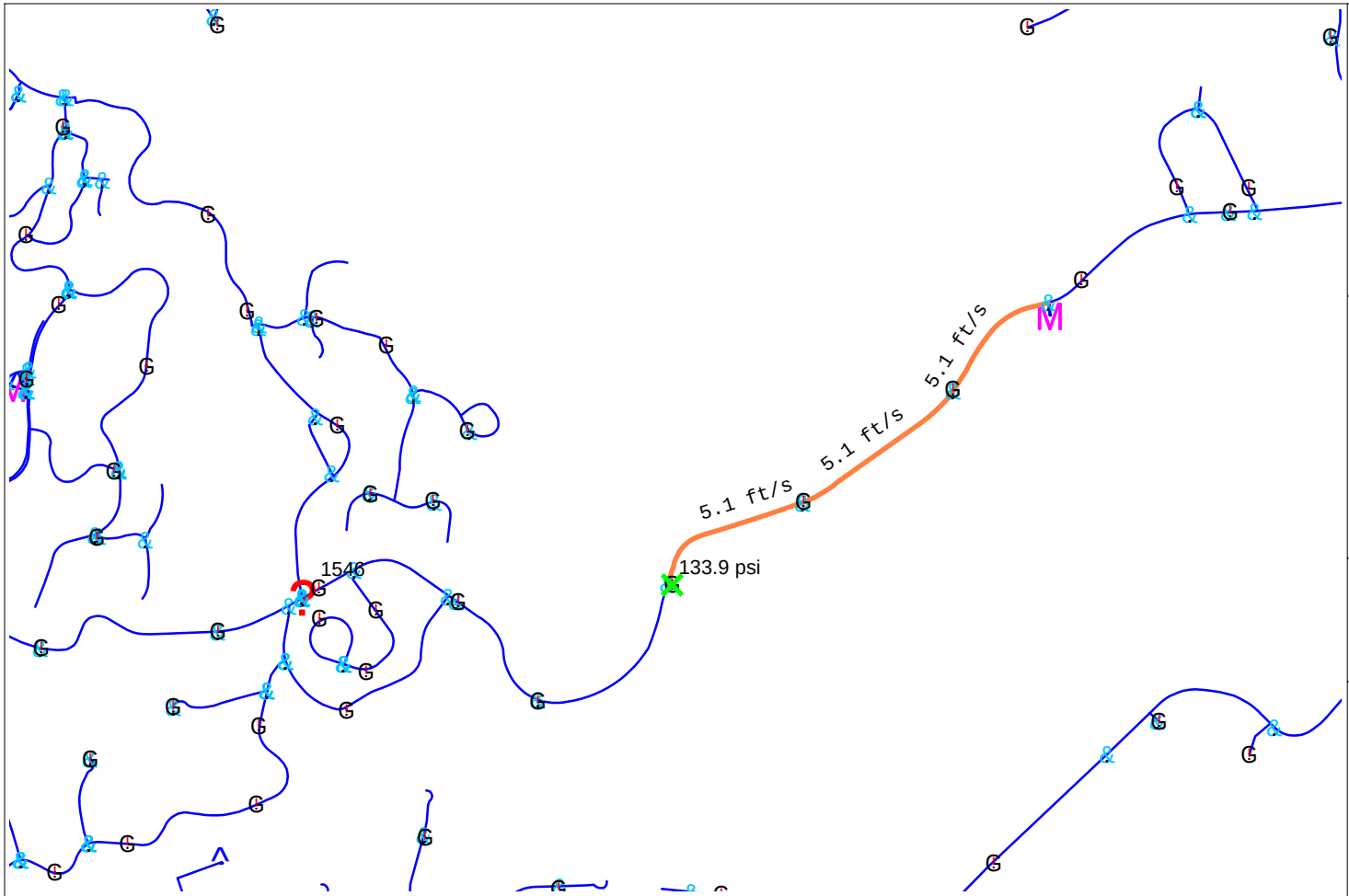
Zone	ZONE3	Sequence	8	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	112.22350				
Duration	6 min.	Open Hydrant	11-0868	Res. Pressure	79.94780 psi		Turbidity		
Valves to Open				Discharge Flow	807.17056		Disinf. Res.		
				Available Flow	1,423.86720		pH		
Valves to Close				Total Pipe Len.	990.0 ft		Iron		
				Min Flushing Vol	220.72520		Odor		
Pipes to Flush	P-12327,P-1415,P-1417,P-1439,P-14499,P-17097,PI-1777,PI-1805,PLATFH-11-0868,PLATFH-11-0894,P-14659,P-14647,PI-1757			Desired Flushing Vol	662.17570		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Date: 7/26/2016 2:50:54 PM

Zone 4


T-SOLOMON_JONES
T-CHAMPIONHILL-S
T-SUGARHOLLOW
TA-ECHO
4A
4B
23 miles
BIG WILLOW RD
PATTERSON RD
SHALOM LN
EVANS RD
BLACKJACK RD
GLEN ECHO LN
CRAB CREEK RD
ELSON AVE
RANSIER DR
2024
2034
2019
2033



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

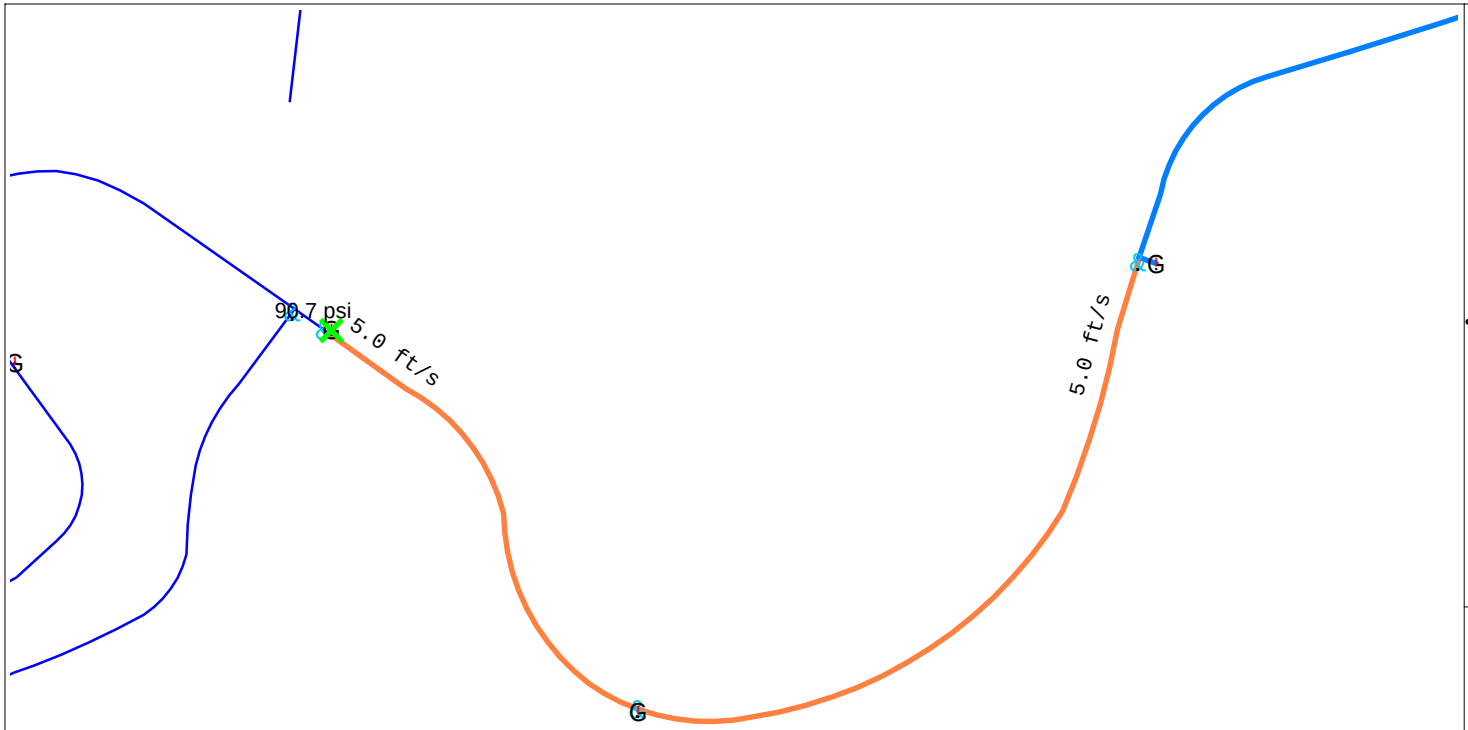
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE4A	Sequence	1	Static Pressure	236.53180				
Date of Flush		Start Time		Res. Pressure	133.93670		Turbidity		
Duration	28 min.	Open Hydrant	10-2121	Discharge Flow	1,768.01184		Disinf. Res.		
Valves to Open				Available Flow	2,604.20832		pH		
Valves to Close	1546			Total Pipe Len.	2,816.2 ft		Iron		
				Min Flushing Vol	2,169.96450		Odor		
Pipes to Flush	P-1793,P-1795,PI-2127,PLATFH-10-2121			Desired Flushing Vol	6,509.89340		HPC		
				Min Flushing Time	9 min.		Color		
				Desired Flushing	28 min.		Other		

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Date: 7/29/2016 2:55:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

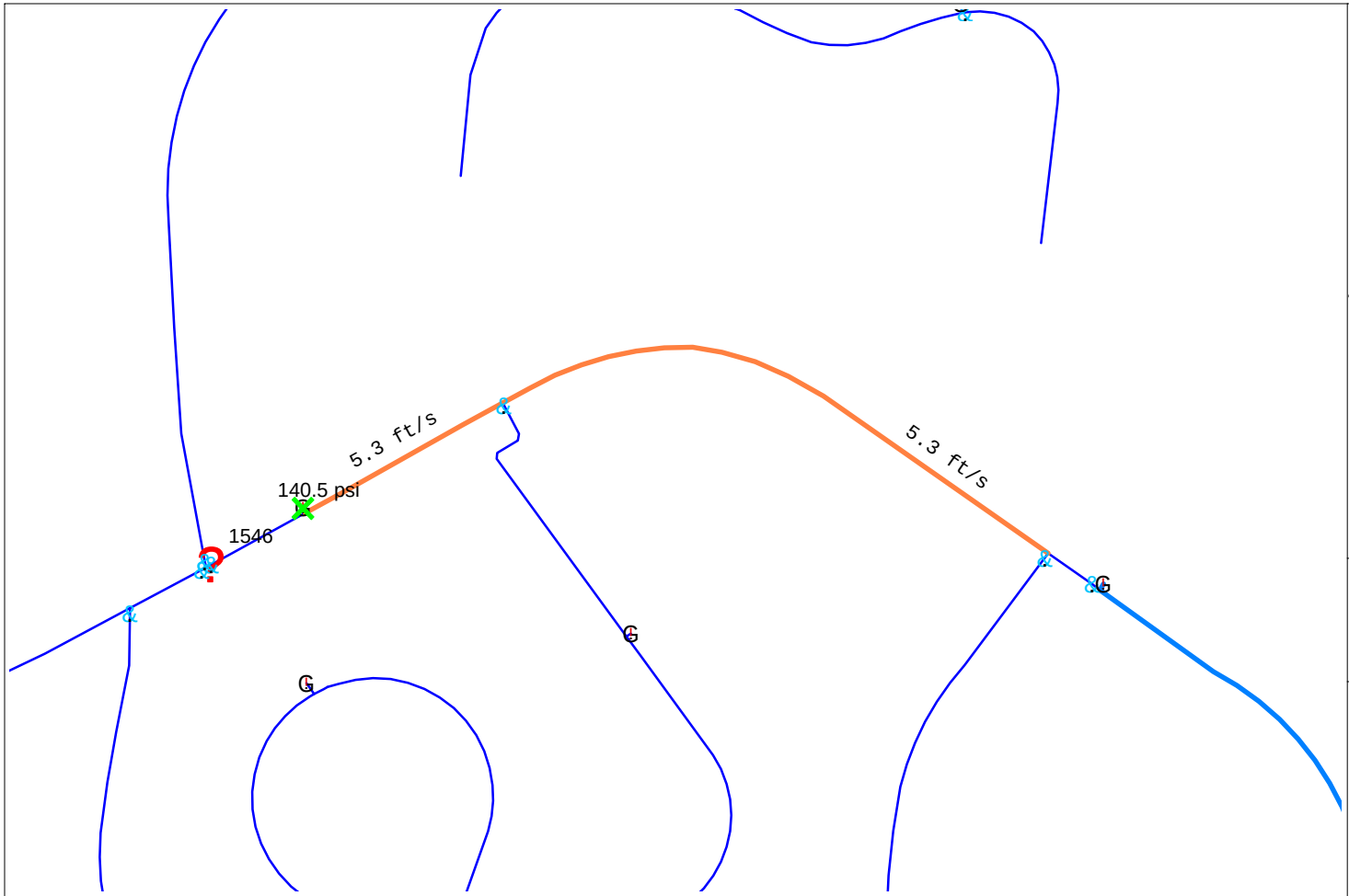
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

Zone	ZONE4A	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	192.42480				
Duration	19 min.	Open Hydrant	10-2131	Res. Pressure	90.65890 psi		Turbidity		
Valves to Open				Discharge Flow	1,917.37728		Disinf. Res.		
				Available Flow	2,512.82528		pH		
Valves to Close	(1546)			Total Pipe Len.	1,889.5 ft		Iron		
				Min Flushing Vol	1,605.63730		Odor		
Pipes to Flush	P-1797,P-1799,PI-2129,PI-2131,PLATFH-10-2131			Desired Flushing Vol	4,816.91190		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	19 min.		Other		

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Date: 7/29/2016 2:55:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

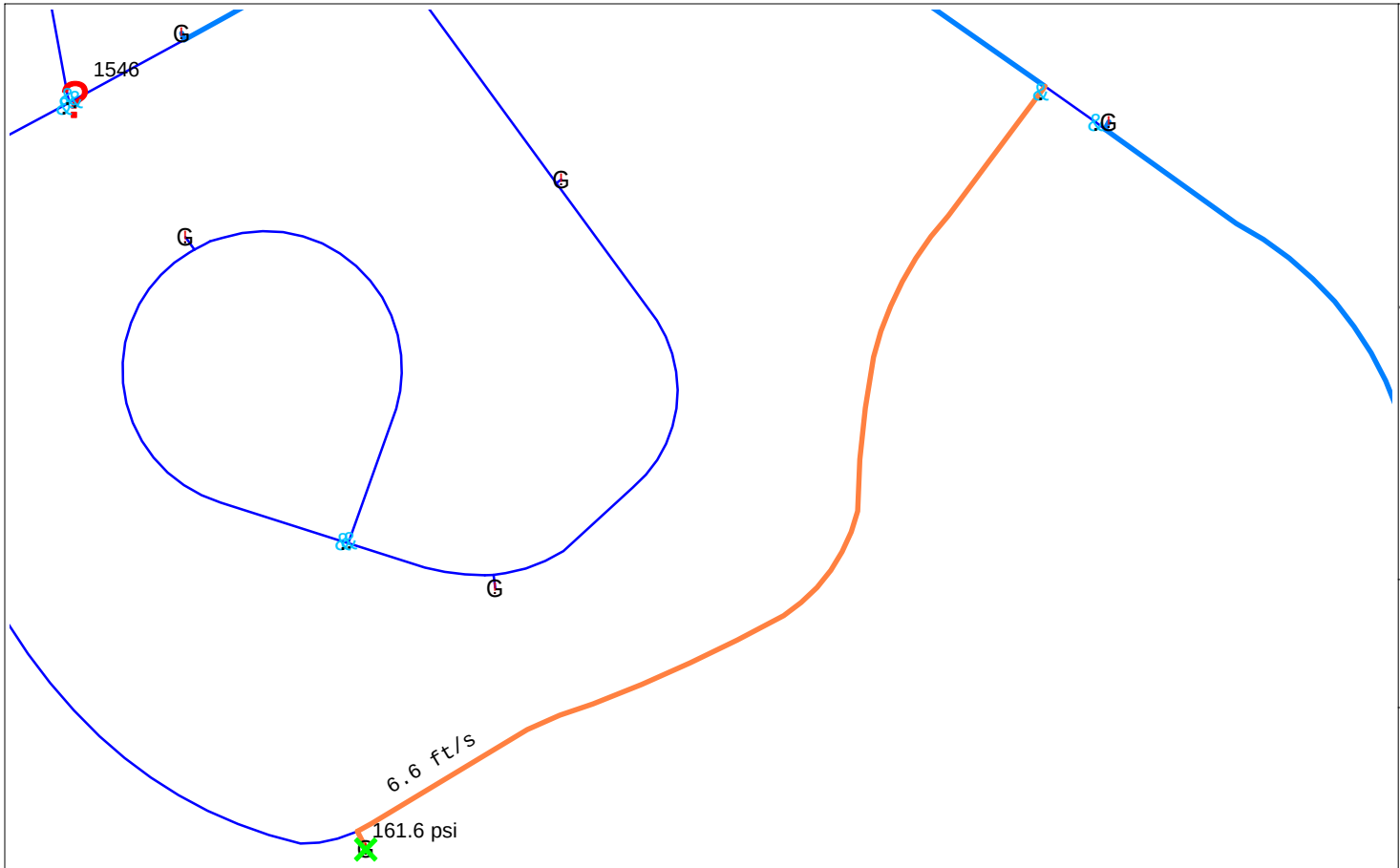
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE4A	Sequence	3	Static Pressure	169.30220				
Date of Flush		Start Time		Res. Pressure	140.46950		Turbidity		
Duration	8 min.	Open Hydrant	10-2136	Discharge Flow	823.00288		Disinf. Res.		
Valves to Open				Available Flow	2,132.15520		pH		
Valves to Close	(1546)			Total Pipe Len.	837.5 ft		Iron		
				Min Flushing Vol	291.57080		Odor		
Pipes to Flush	P-1767,P-1765,PLATFH-10-2136			Desired Flushing Vol	874.71240		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

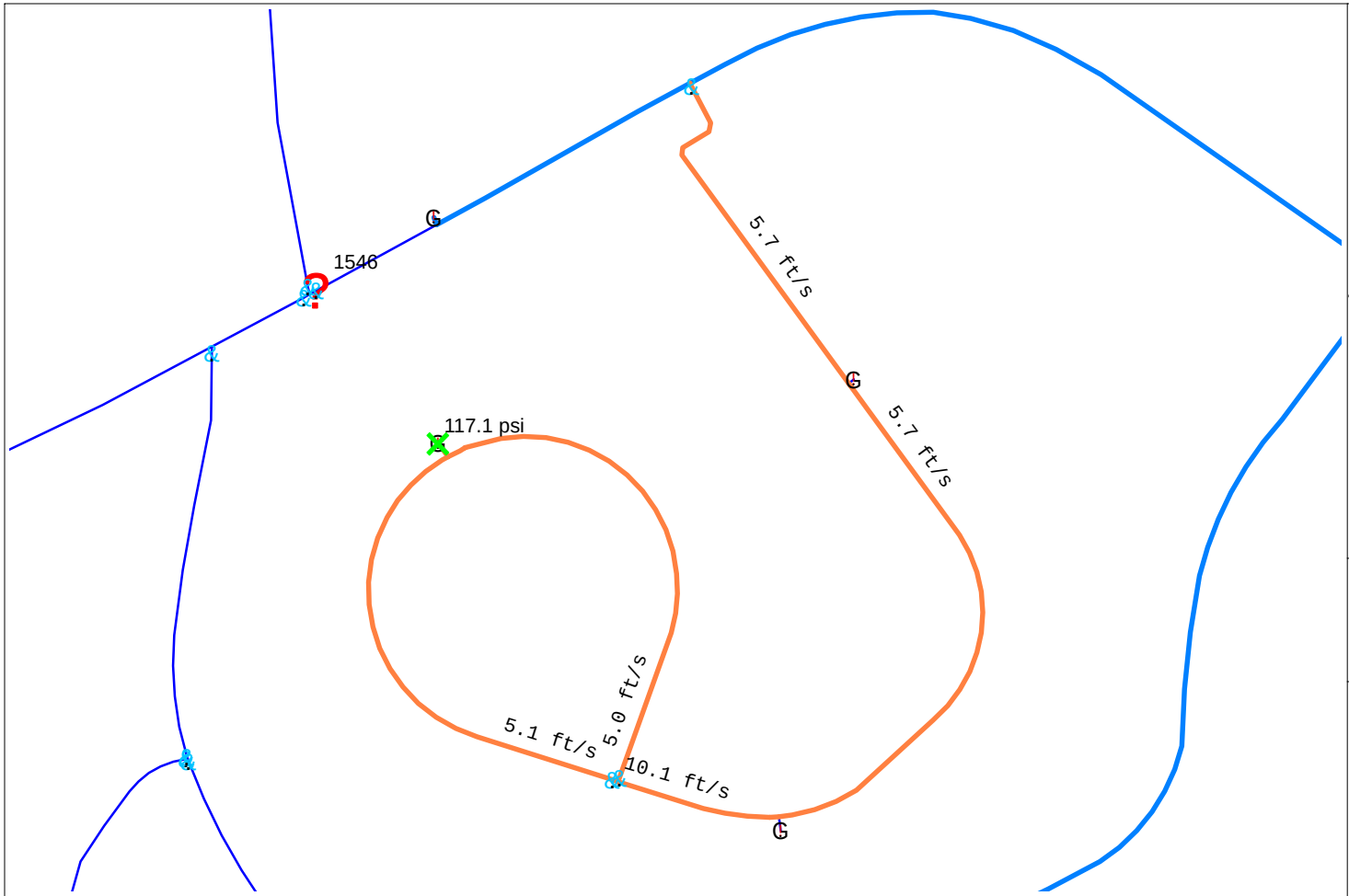
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

Zone	ZONE4A	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	173.42970				
Duration	7 min.	Open Hydrant	10-2924	Res. Pressure	161.58140		Turbidity		
Valves to Open				Discharge Flow	706.13536		Disinf. Res.		
				Available Flow	3,026.75072		pH		
Valves to Close	(1546)			Total Pipe Len.	943.5 ft		Iron		
				Min Flushing Vol	223.80490		Odor		
Pipes to Flush	P-9973,PLATFH-10-2924			Desired Flushing Vol	671.41460		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

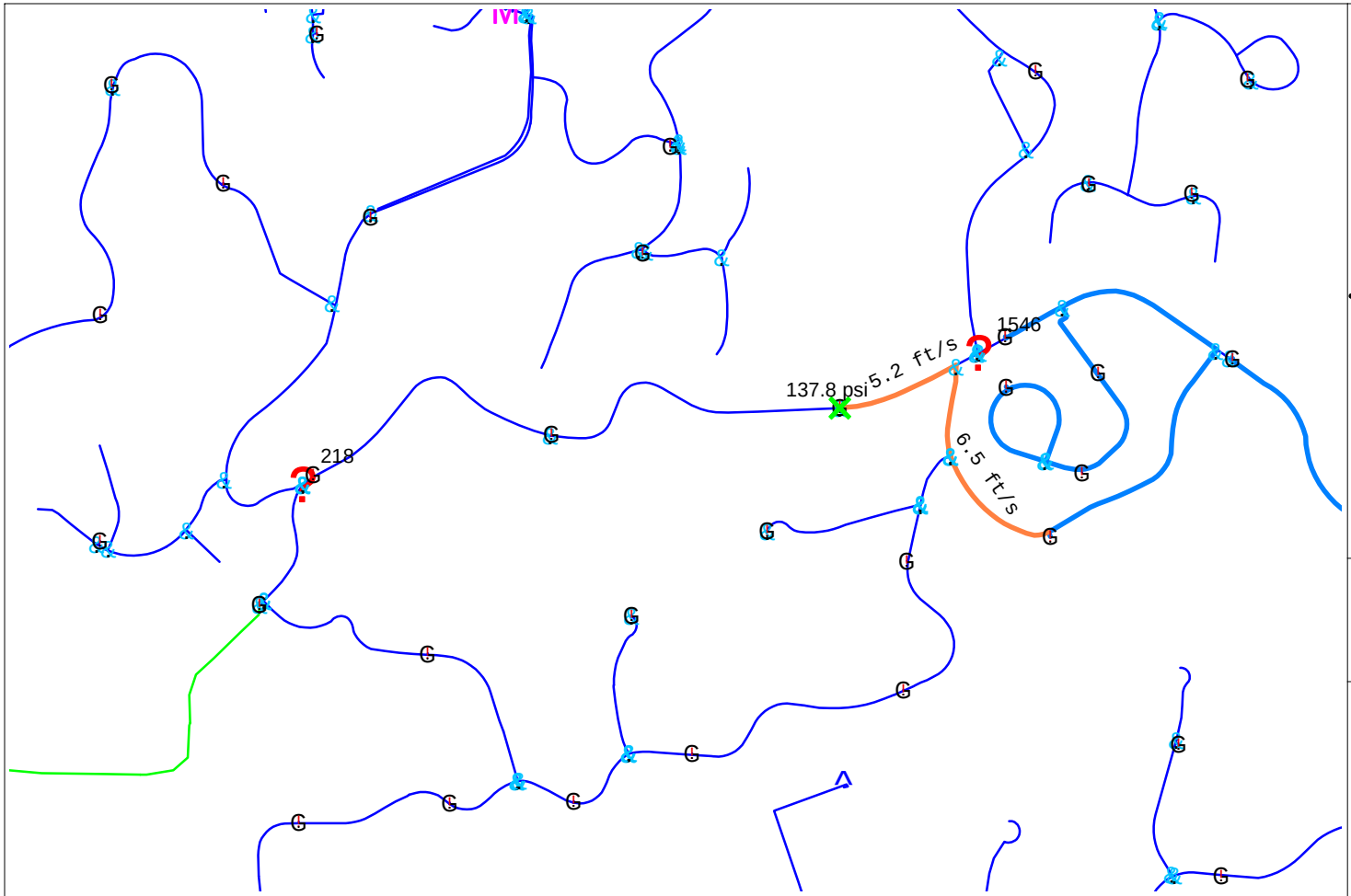
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

Zone	ZONE4A	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	158.03700				
Duration	15 min.	Open Hydrant	10-3279	Res. Pressure	117.13590		Turbidity		
Valves to Open				Discharge Flow	892.85952		Disinf. Res.		
				Available Flow	1,785.37184		pH		
Valves to Close	(1546)			Total Pipe Len.	1,668.8 ft		Iron		
				Min Flushing Vol	596.93430		Odor		
Pipes to Flush	P-9843,P-9845,PI-10609,PI-10611,PI-10613,PLATFH-10-3279,P-12221,P-9847,P-9841			Desired Flushing Vol	1,790.80300		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	15 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

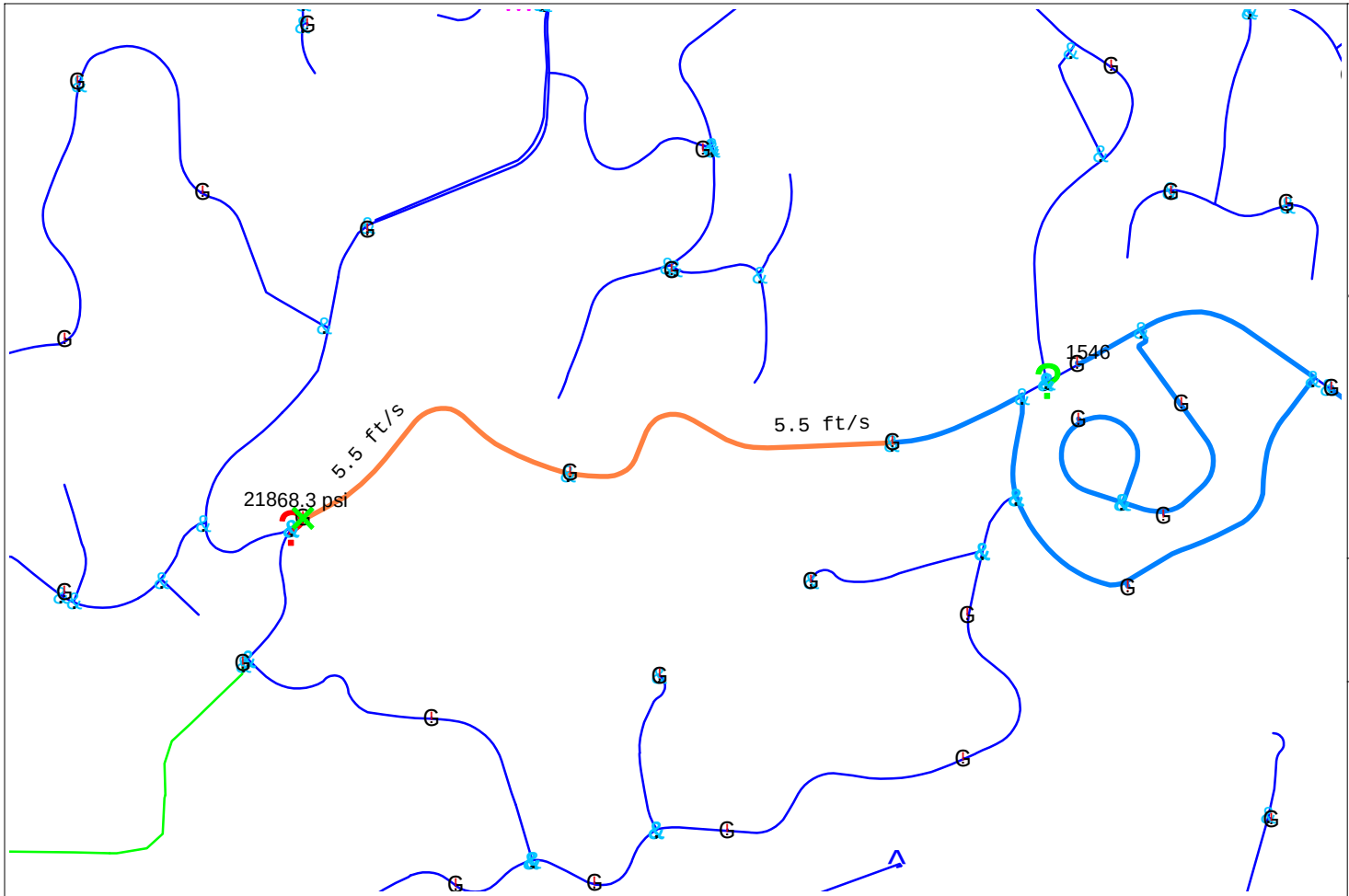
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

Zone	ZONE4A	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	154.34600				
Duration	10 min.	Open Hydrant	10-2141	Res. Pressure	137.82140		Turbidity		
Valves to Open				Discharge Flow	815.22560		Disinf. Res.		
				Available Flow	2,663.02400		pH		
Valves to Close	218(1546)			Total Pipe Len.	1,225.6 ft		Iron		
				Min Flushing Vol	350.87930		Odor		
Pipes to Flush	P-9849,P-9971,PI-10817,PI-10819,PLATFH-10-2141,PLATFH-10-2151			Desired Flushing Vol	1,052.63800		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

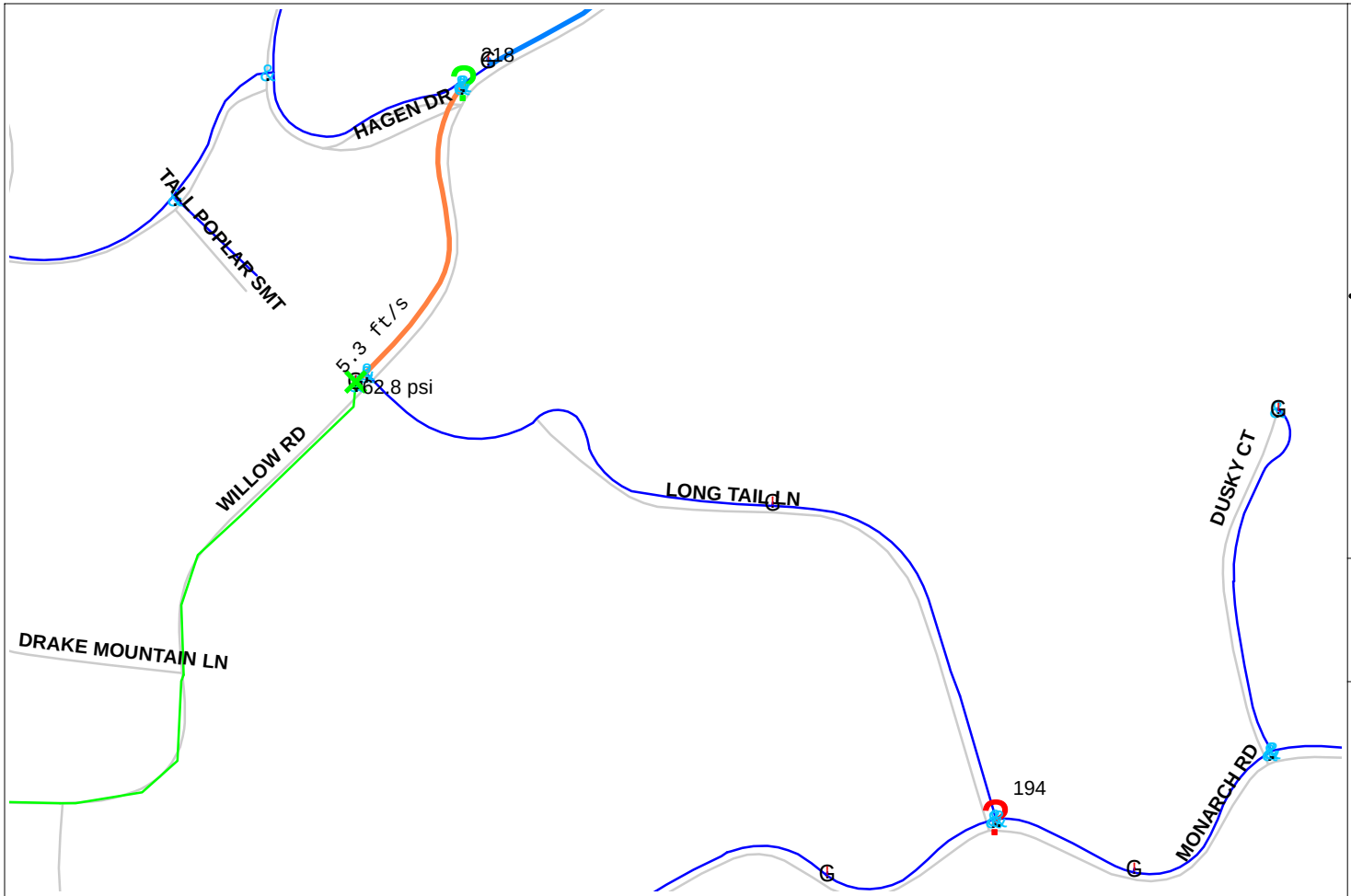
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Champions Hill Willow Rd pumps on

Zone	ZONE4A	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	93.77640 psi				
Duration	20 min.	Open Hydrant	10-2151	Res. Pressure	68.30020 psi		Turbidity		
Valves to Open	1546			Discharge Flow	861.05600		Disinf. Res.		
				Available Flow	1,582.32928		pH		
Valves to Close	(218)			Total Pipe Len.	2,152.6 ft		Iron		
				Min Flushing Vol	750.18870		Odor		
Pipes to Flush	P-1813,P-9851,PI-2133,PI-2137,PLATFH-10-2151			Desired Flushing Vol	2,250.56620		HPC		
				Min Flushing Time	7 min.		Color		
				Desired Flushing	20 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

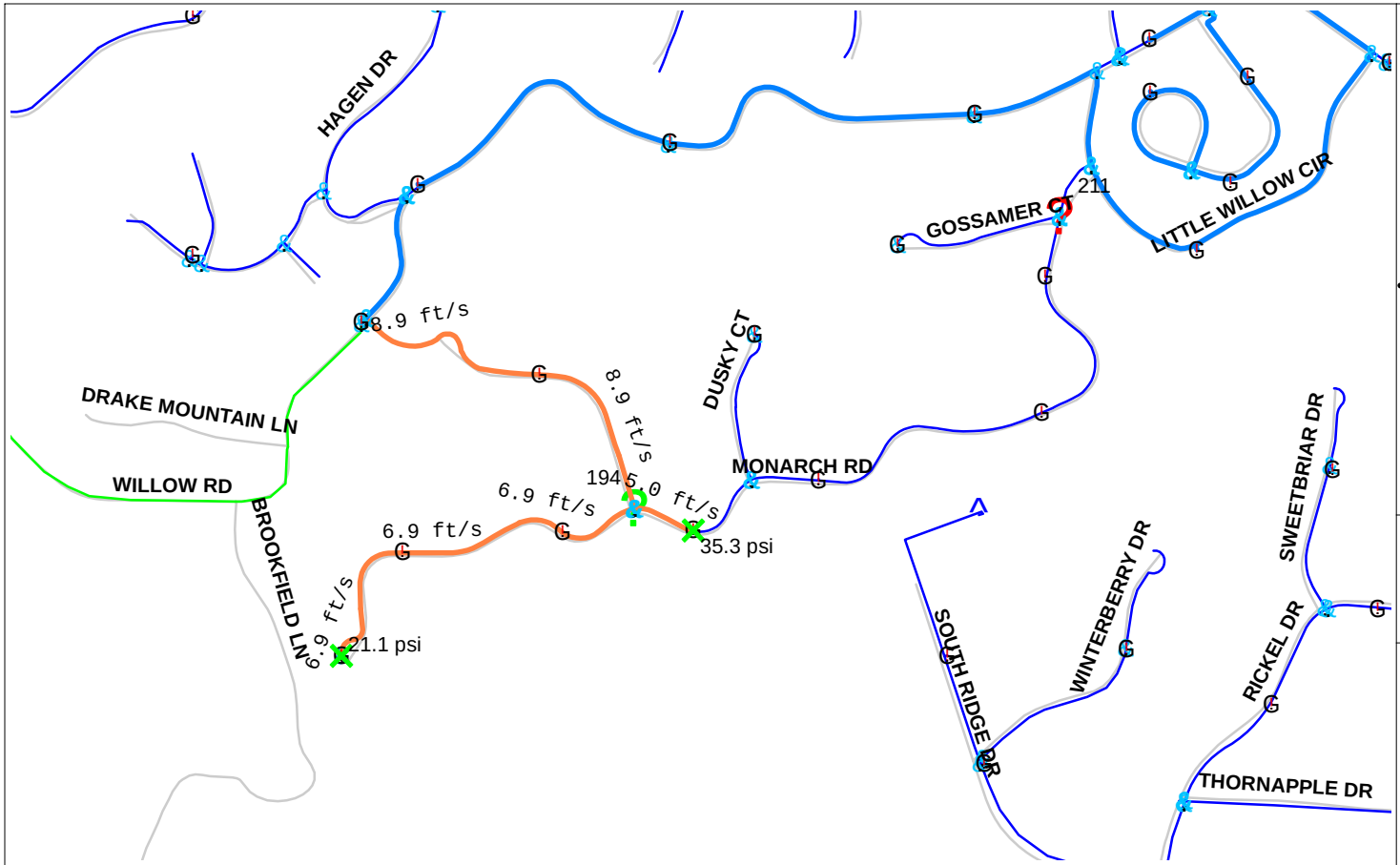
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	8	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	72.43230 psi				
Duration	4 min.	Open Hydrant	10-3156	Res. Pressure	62.84450 psi		Turbidity		
Valves to Open	218			Discharge Flow	825.98880		Disinf. Res.		
				Available Flow	2,078.13088		pH		
Valves to Close	194			Total Pipe Len.	473.7 ft		Iron		
				Min Flushing Vol	164.99980		Odor		
Pipes to Flush	P-179,P-1805,P-183,PI-83,PLATFH-10-3156			Desired Flushing Vol	494.99940		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

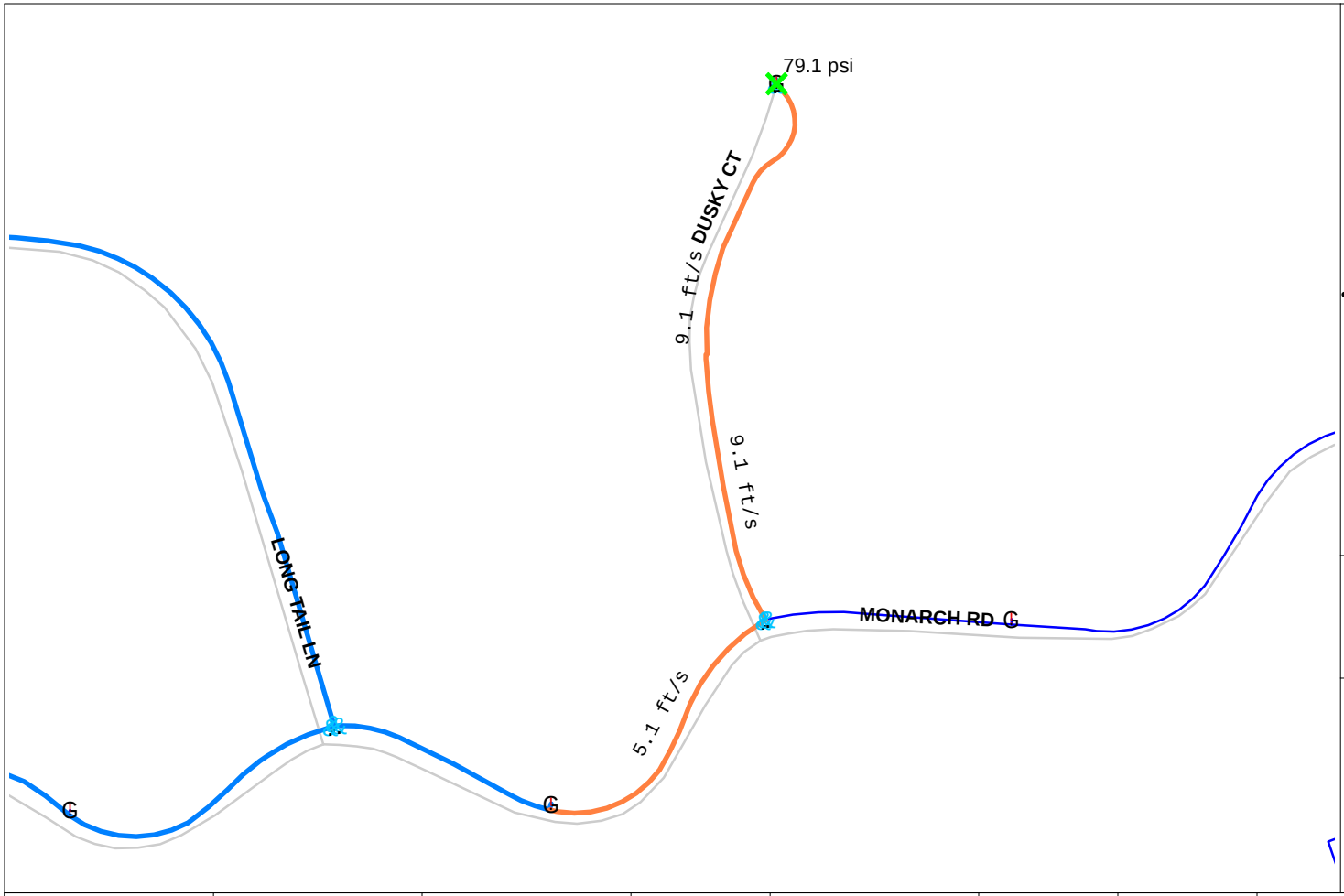
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

			Hydrant 1		Hydrant 2			Hydrant 1		Hydrant 2	
Zone	ZONE4A										
Sequence	9	**Hydraulics**	**Model**	**Field**	**Model**	**Field**	Water Quality	Initial Value	Final Value	Initial Value	Final Value
Date of Flush		Static Pressure	77.19830		77.19830						
Start Time		Res. Pressure	21.05800		35.27100		Turbidity				
Duration	19 min.	Discharge Flow	606.00288		783.63040		Disinfectant Res.				
Open Hyd.	10-3150,10-3158	Available Flow	284.07904		1,326.6512		pH				
Valves to Open	194	Total Pipe Len.	2,793.0 ft		2,793.0 ft		Iron				
		Min Flushing Vol	507.38760		656.08560		Odor				
Valves to Close	211	Desired Flushing	1,522.1629		1,968.2568		HPC				
		Min Flushing Time	6 min.		6 min.		Color				
Pipes to Flush	P-11257,P-11259,P-11261,P-163,P-165,P-167,PI-69,PI-71,PI-73,PLATFH-10-3150	Desired Flushing	19 min.		19 min.		Other				

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

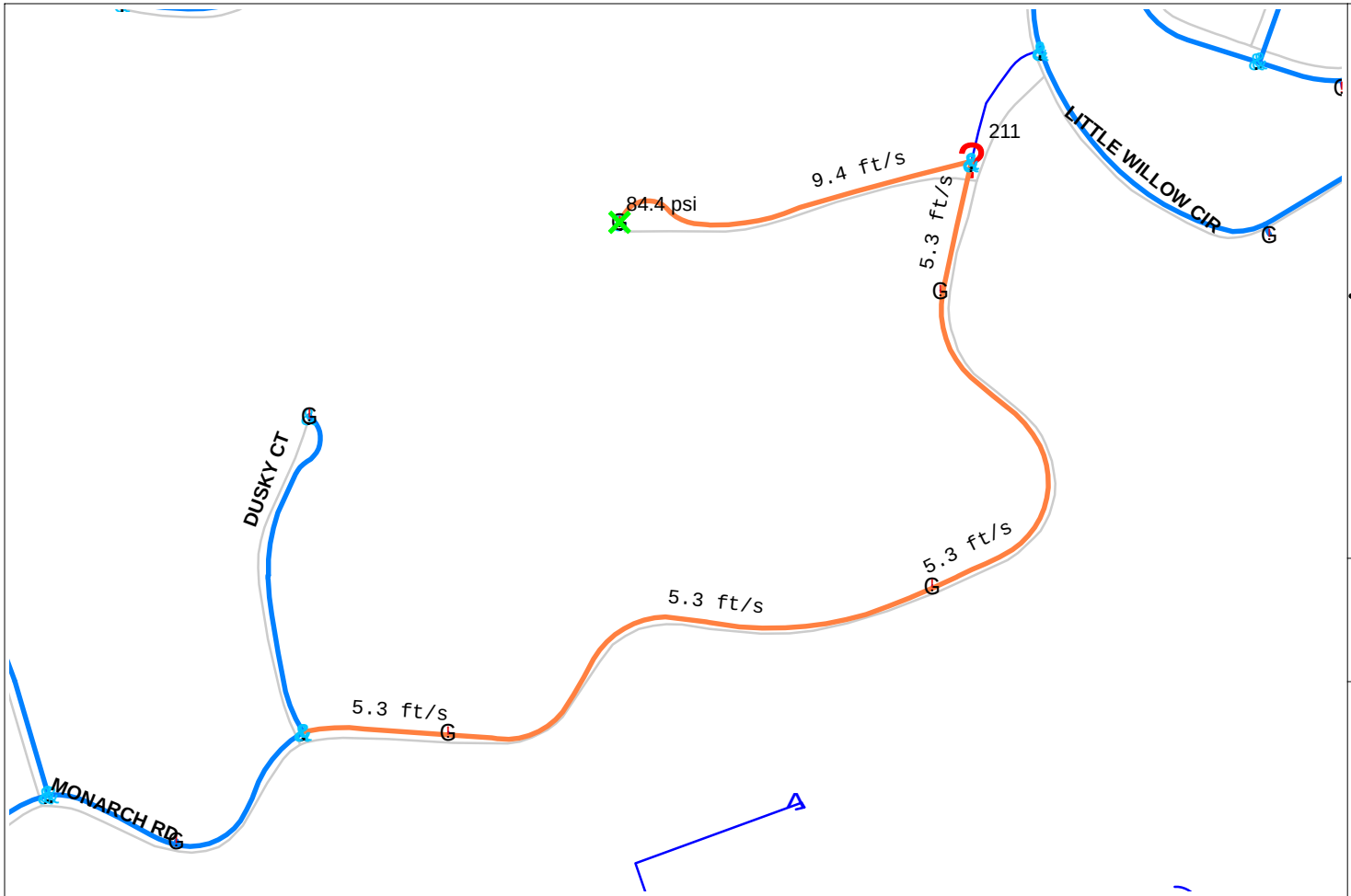
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	10	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	107.09610				
Duration	6 min.	Open Hydrant	10-3168	Res. Pressure	79.11700 psi		Turbidity		
Valves to Open				Discharge Flow	804.32352		Disinf. Res.		
				Available Flow	1,488.02976		pH		
Valves to Close	(211)			Total Pipe Len.	796.9 ft		Iron		
				Min Flushing Vol	199.14920		Odor		
Pipes to Flush	P-169,P-171,PI-75,PLATFH-10-3168			Desired Flushing Vol	597.44750		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

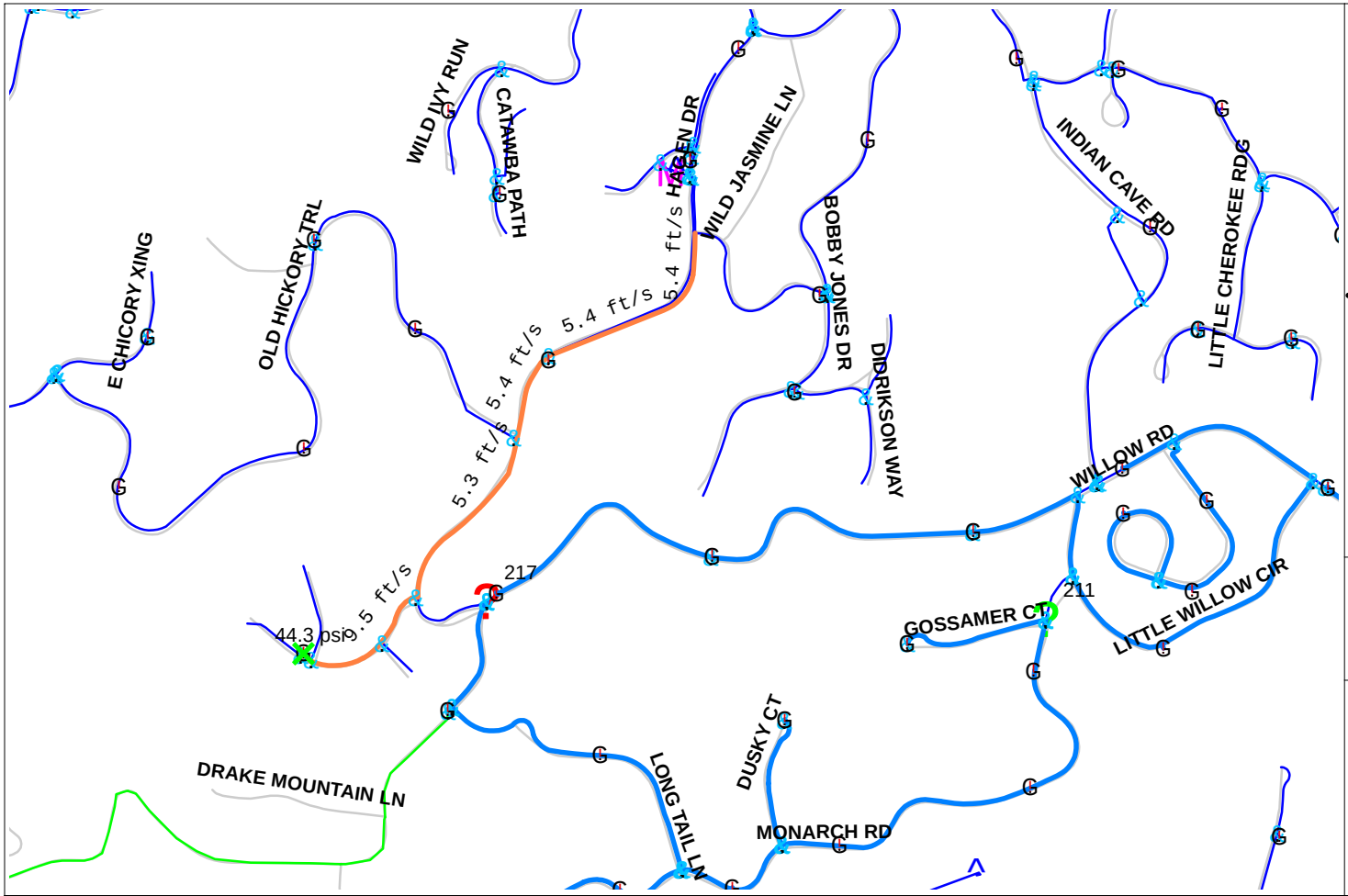
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	11	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	124.86160				
Duration	21 min.	Open Hydrant	10-3166	Res. Pressure	84.35580 psi		Turbidity		
Valves to Open				Discharge Flow	829.11360		Disinf. Res.		
				Available Flow	1,389.56384		pH		
Valves to Close	(211)			Total Pipe Len.	2,427.6 ft		Iron		
				Min Flushing Vol	760.13010		Odor		
Pipes to Flush	P-173,P-175,P-177,PI-77,PI-79,PLATFH-10-3166			Desired Flushing Vol	2,280.39040		HPC		
				Min Flushing Time	7 min.		Color		
				Desired Flushing	21 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

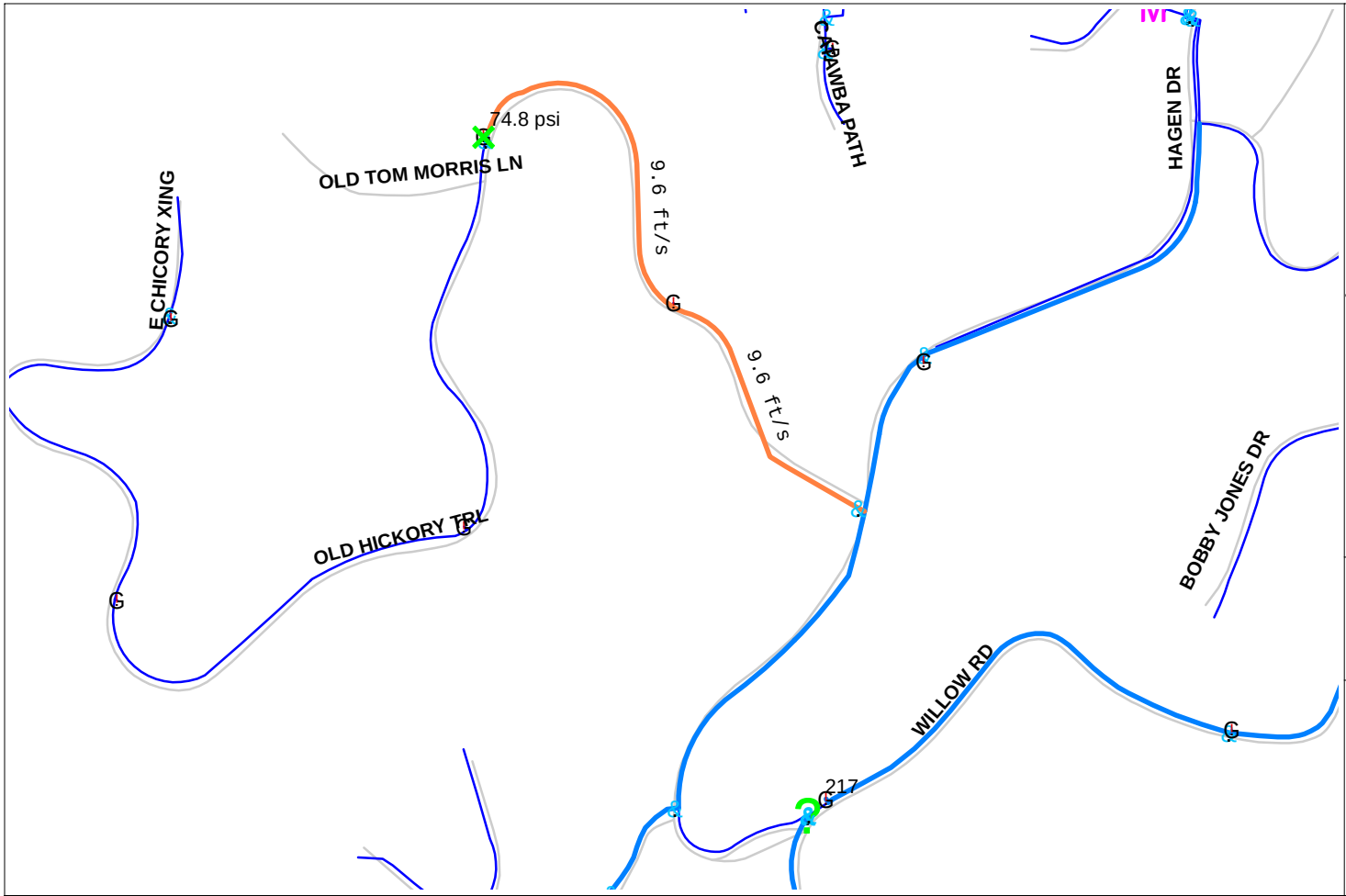
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	12	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	65.85580 psi				
Duration	21 min.	Open Hydrant	10-2271	Res. Pressure	44.25680 psi		Turbidity		
Valves to Open	211			Discharge Flow	831.54400		Disinf. Res.		
				Available Flow	1,251.16992		pH		
Valves to Close	217			Total Pipe Len.	2,500.2 ft		Iron		
				Min Flushing Vol	777.78410		Odor		
Pipes to Flush	P-11263,P-1817,P-1819,PI-2139,PLATFH-10-2271,P-11267,P-1811,P-14137,P-1809,P-1825,PI-2143			Desired Flushing Vol	2,333.35220		HPC		
				Min Flushing Time	7 min.		Color		
				Desired Flushing	21 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

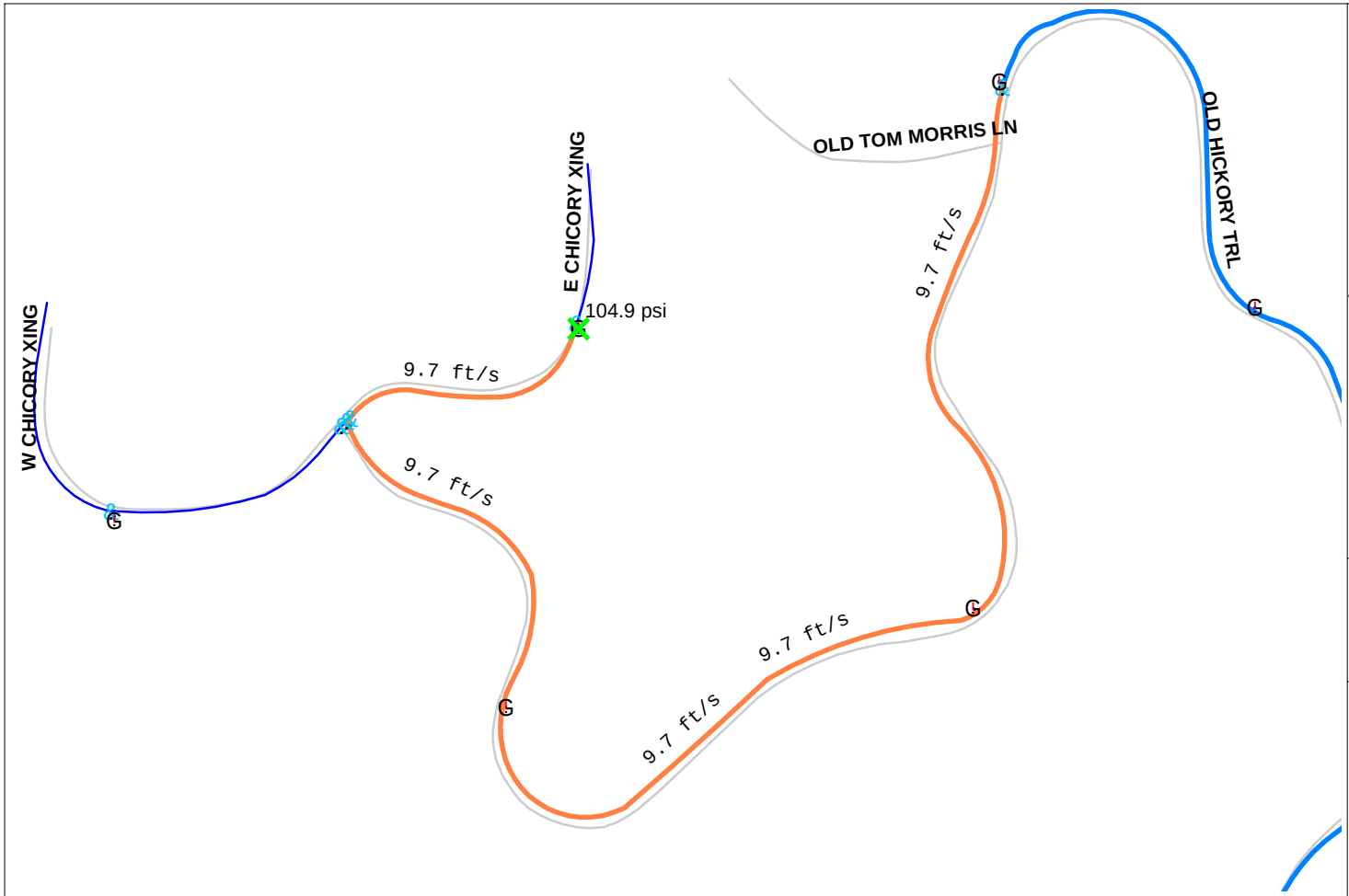
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	13	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	105.15820				
Duration	7 min.	Open Hydrant	10-2246	Res. Pressure	74.80000 psi		Turbidity		
Valves to Open	217			Discharge Flow	843.62656		Disinf. Res.		
				Available Flow	1,473.37792		pH		
Valves to Close				Total Pipe Len.	1,387.4 ft		Iron		
				Min Flushing Vol	270.72580		Odor		
Pipes to Flush	P-1823,PI-2141,PLATFH-10-2246			Desired Flushing Vol	812.17750		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

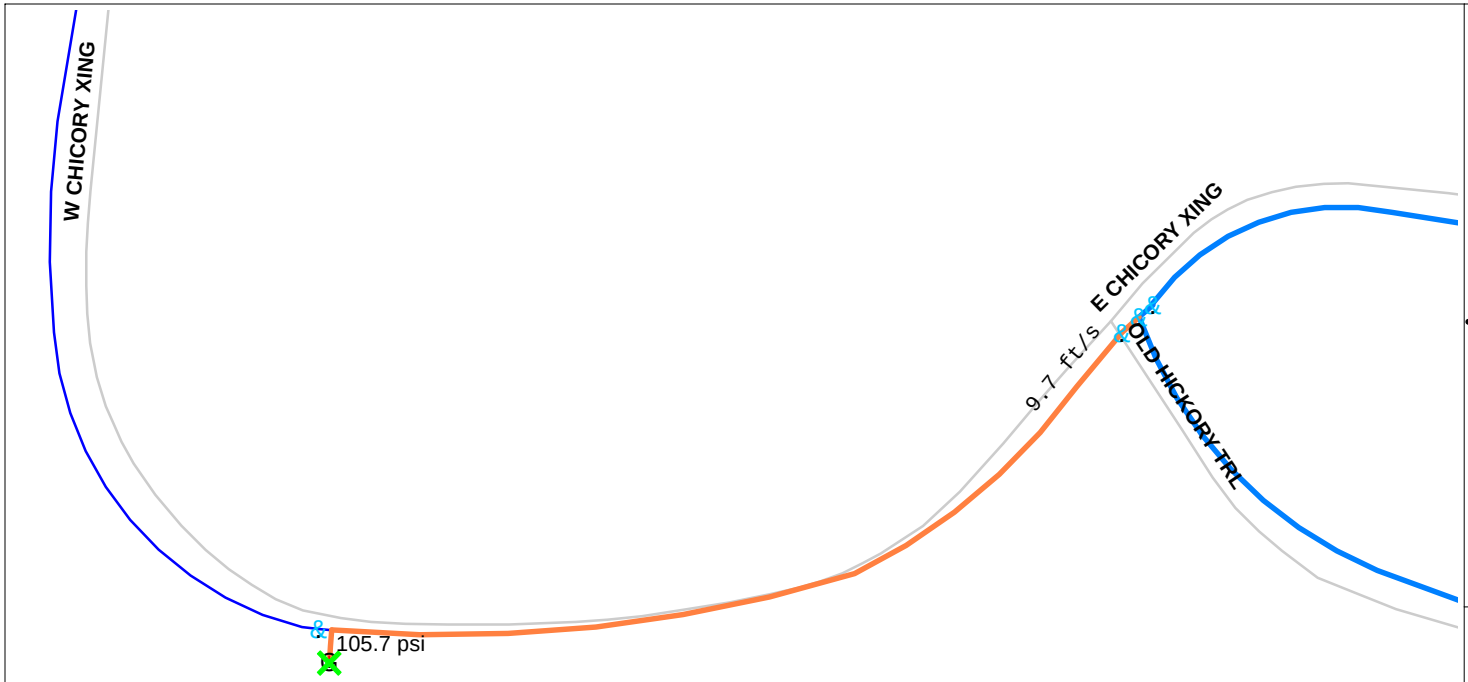
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	14	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	187.91730				
Duration	14 min.	Open Hydrant	10-2266	Res. Pressure	104.86130		Turbidity		
Valves to Open				Discharge Flow	853.41760		Disinf. Res.		
				Available Flow	1,249.85056		pH		
Valves to Close				Total Pipe Len.	2,814.1 ft		Iron		
				Min Flushing Vol	550.99660		Odor		
Pipes to Flush	P-11271,P-12867,P-1821,P-1877,P-1879,PI-2203,PI-2209,PLATFH-10-2266			Desired Flushing Vol	1,652.98970		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	14 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

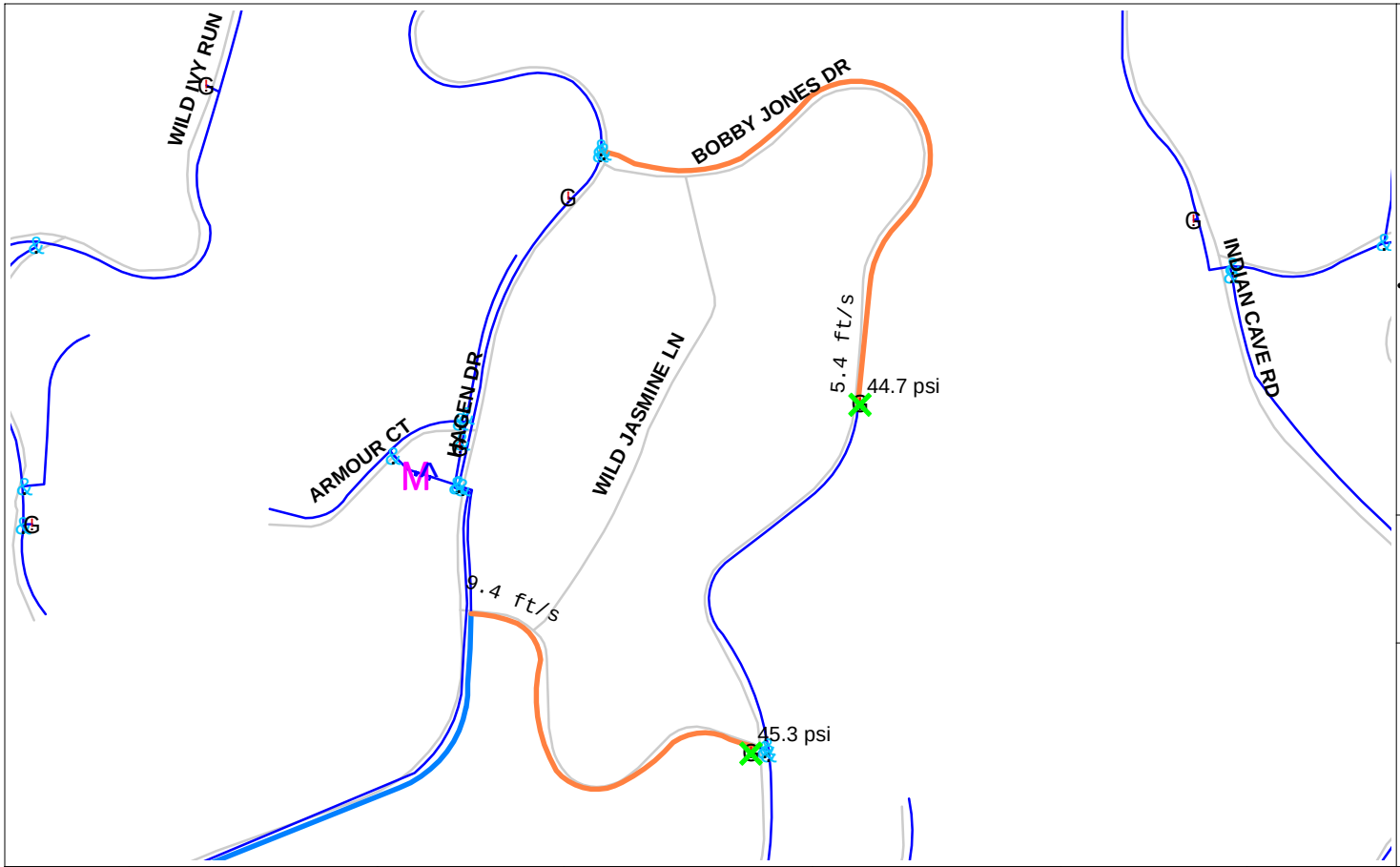
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	15	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	189.21710				
Duration	2 min.	Open Hydrant	10-3216	Res. Pressure	105.69870		Turbidity		
Valves to Open				Discharge Flow	856.82016		Disinf. Res.		
				Available Flow	1,256.30848		pH		
Valves to Close				Total Pipe Len.	412.5 ft		Iron		
				Min Flushing Vol	80.95770 ft^3		Odor		
Pipes to Flush	PI-2205,PLATFH-10-3216			Desired Flushing Vol	242.87320		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	2 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

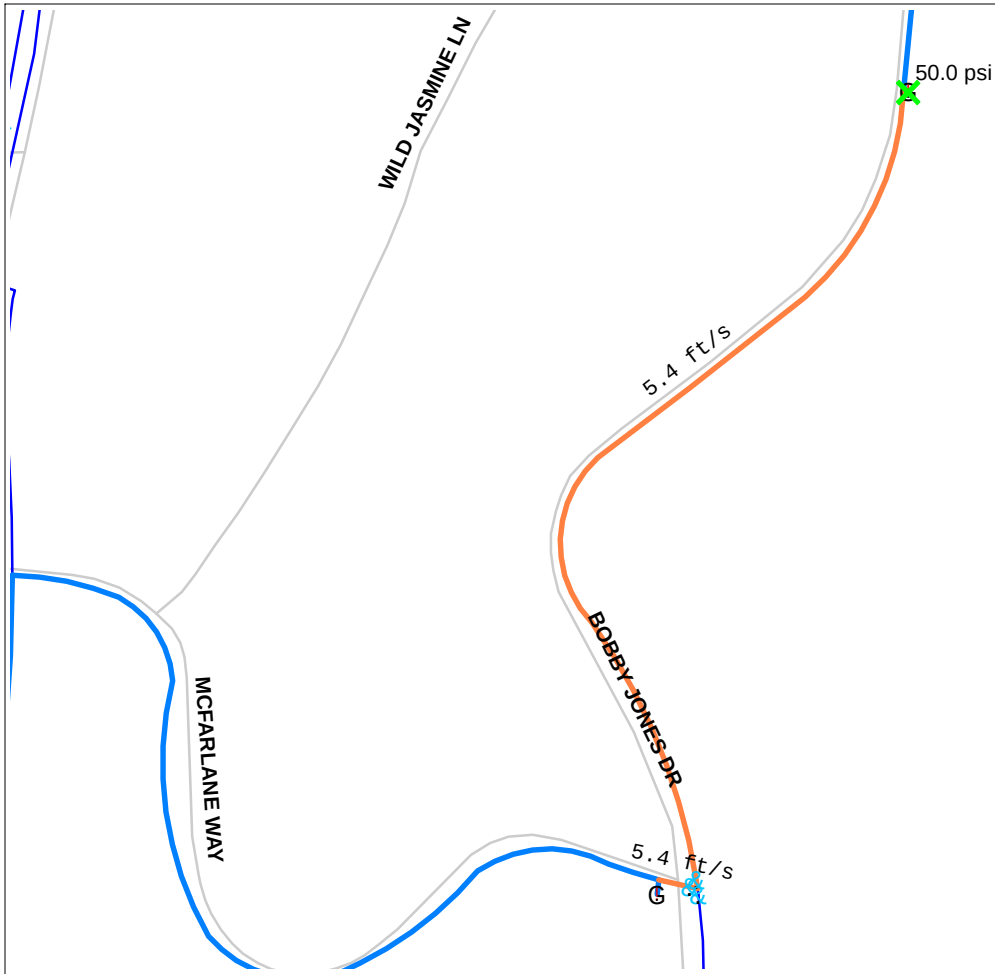
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A		Hydrant 1		Hydrant 2			Hydrant 1		Hydrant 2	
Sequence	16	Hydraulics	Model	Field	Model	Field	Water Quality	Initial Value	Final Value	Initial Value	Final Value
Date of Flush		Static Pressure	60.11450		59.98230						
Start Time		Res. Pressure	45.33310		44.73270		Turbidity				
Duration	15 min.	Discharge Flow	654.74976		650.44448		Disinfectant Res.				
Open Hyd.	10-2226,10-2221	Available Flow	1,240.8233		1,029.6563		pH				
Valves to Open		Total Pipe Len.	1,889.4 ft		1,889.4 ft		Iron				
		Min Flushing Vol	423.31040		420.50890		Odor				
Valves to Close		Desired Flushing	1,269.9313		1,261.5266		HPC				
		Min Flushing Time	5 min.		5 min.		Color				
Pipes to Flush	PI-2151,PLATFH-10-2226,PI-2147,PLATFH-10-2221	Desired Flushing	15 min.		15 min.		Other				

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

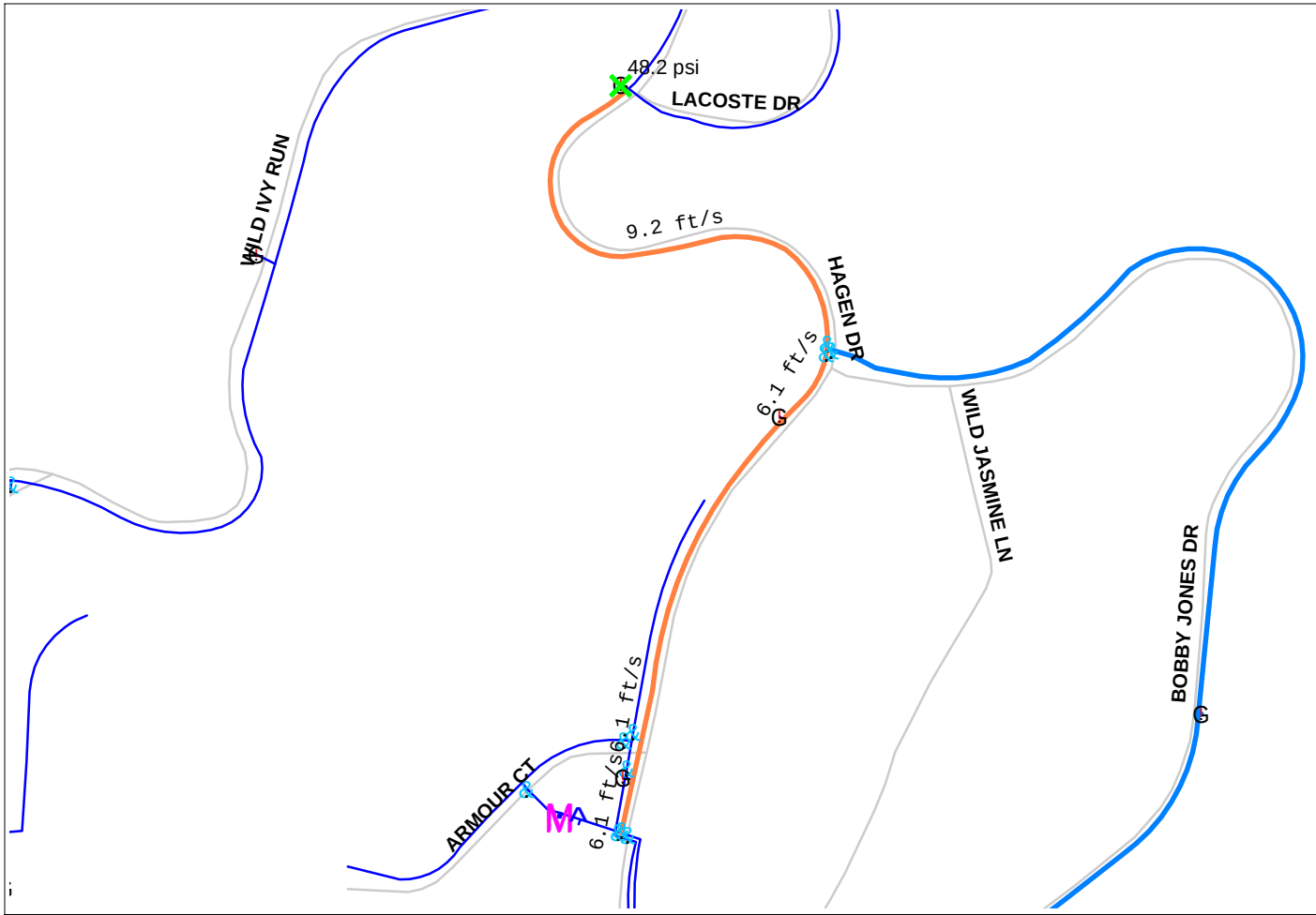
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	17	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	59.98240 psi				
Duration	7 min.	Open Hydrant	10-2221	Res. Pressure	49.97050 psi		Turbidity		
Valves to Open				Discharge Flow	834.94656		Disinf. Res.		
				Available Flow	1,849.74272		pH		
Valves to Close				Total Pipe Len.	752.5 ft		Iron		
				Min Flushing Vol	259.83150		Odor		
Pipes to Flush	P-1833,P-1839,PLATFH-10-2221			Desired Flushing Vol	779.49440		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

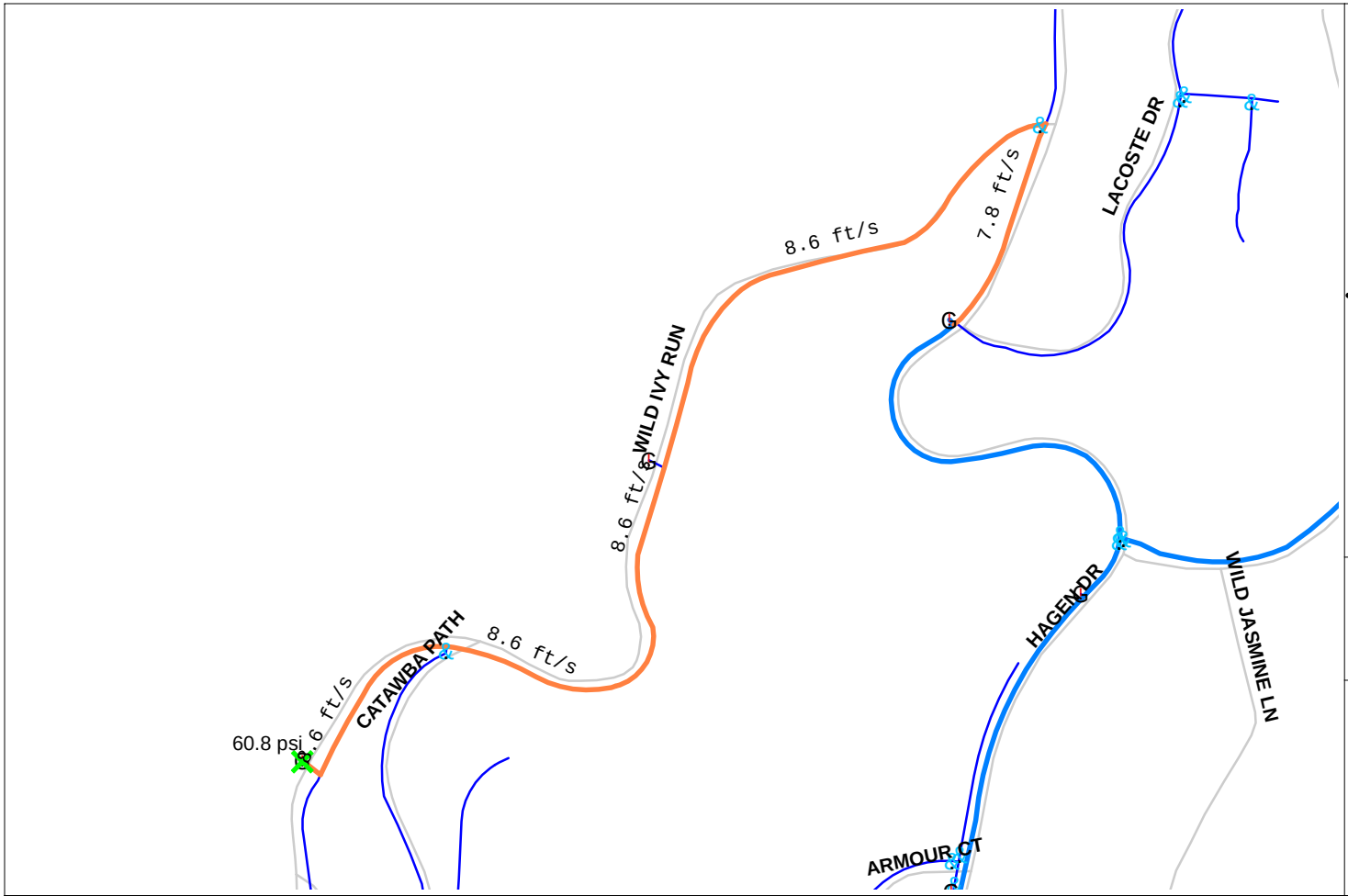
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	18	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	64.66710 psi				
Duration	9 min.	Open Hydrant	10-2196	Res. Pressure	48.21470 psi		Turbidity		
Valves to Open				Discharge Flow	868.69440		Disinf. Res.		
				Available Flow	1,664.61568		pH		
Valves to Close				Total Pipe Len.	1,263.0 ft		Iron		
				Min Flushing Vol	333.27080		Odor		
Pipes to Flush	P-1829,P-1831,PI-2051,PI-2145,PLATFH-10-2196			Desired Flushing Vol	999.81250		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

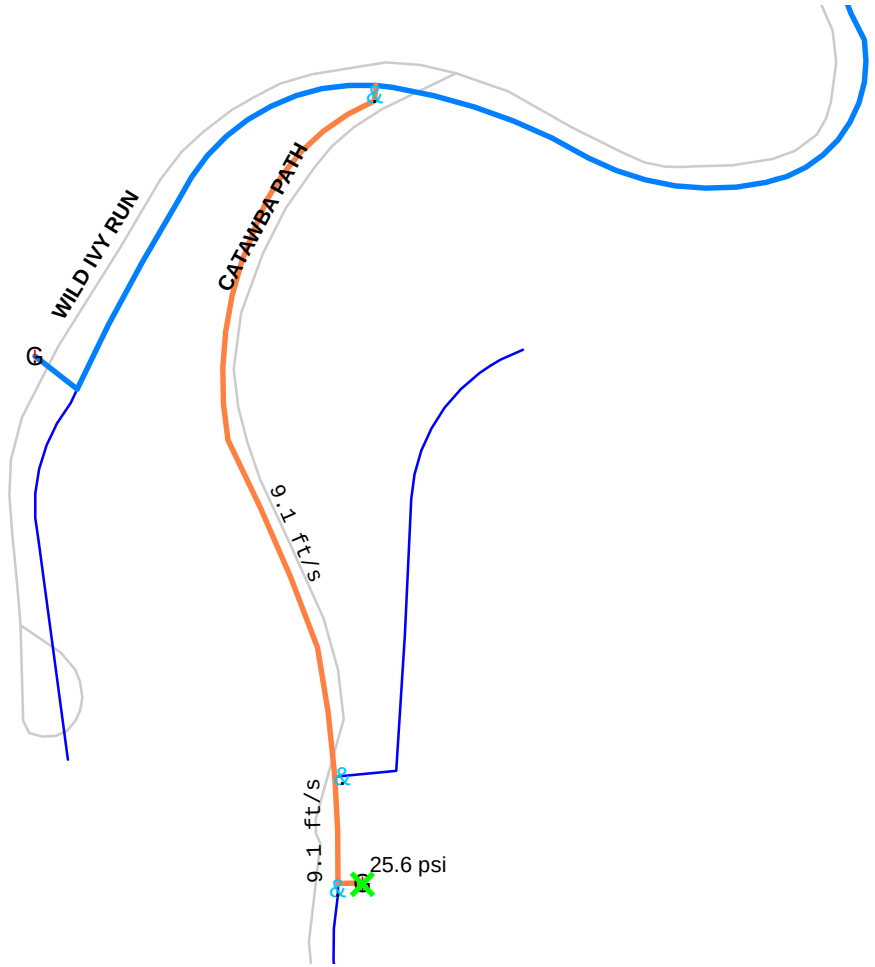
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	19	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	102.00900				
Duration	12 min.	Open Hydrant	10-2896	Res. Pressure	60.82540 psi		Turbidity		
Valves to Open				Discharge Flow	760.78464		Disinf. Res.		
				Available Flow	1,134.23296		pH		
Valves to Close				Total Pipe Len.	2,031.7 ft		Iron		
				Min Flushing Vol	405.54400		Odor		
Pipes to Flush	P-12229,P-12233,P-1707,P-1709,P-1851,P-1855,PI-2171,PLATFH-10-2896			Desired Flushing Vol	1,216.63190		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

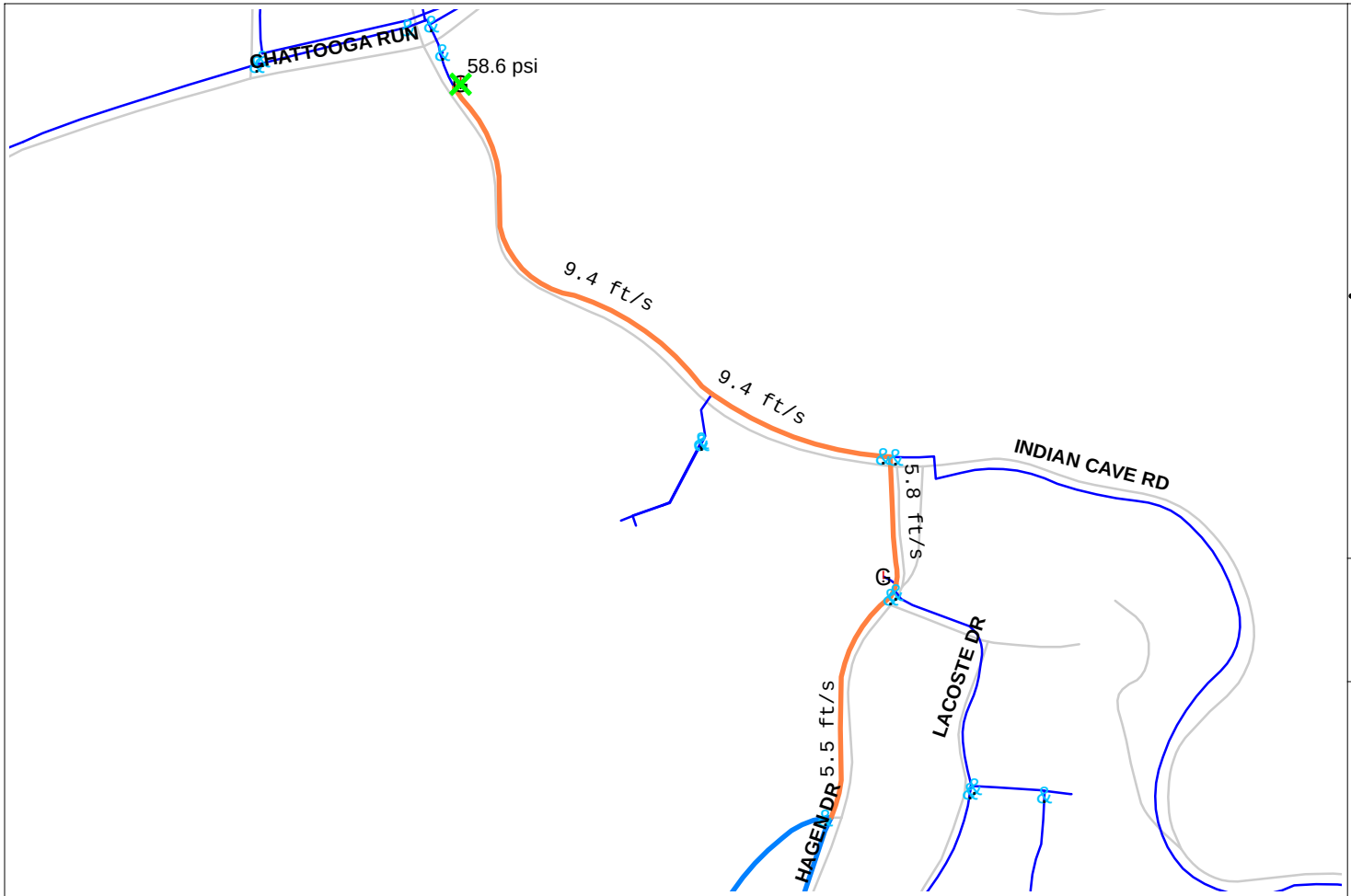
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	20	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	74.71130 psi				
Duration	3 min.	Open Hydrant	10-2897	Res. Pressure	25.63530 psi		Turbidity		
Valves to Open				Discharge Flow	802.65696		Disinf. Res.		
				Available Flow	856.05632		pH		
Valves to Close				Total Pipe Len.	543.9 ft		Iron		
				Min Flushing Vol	106.73260		Odor		
Pipes to Flush	P-1859,PI-2173,PLATFH-10-2897			Desired Flushing Vol	320.19770		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	3 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

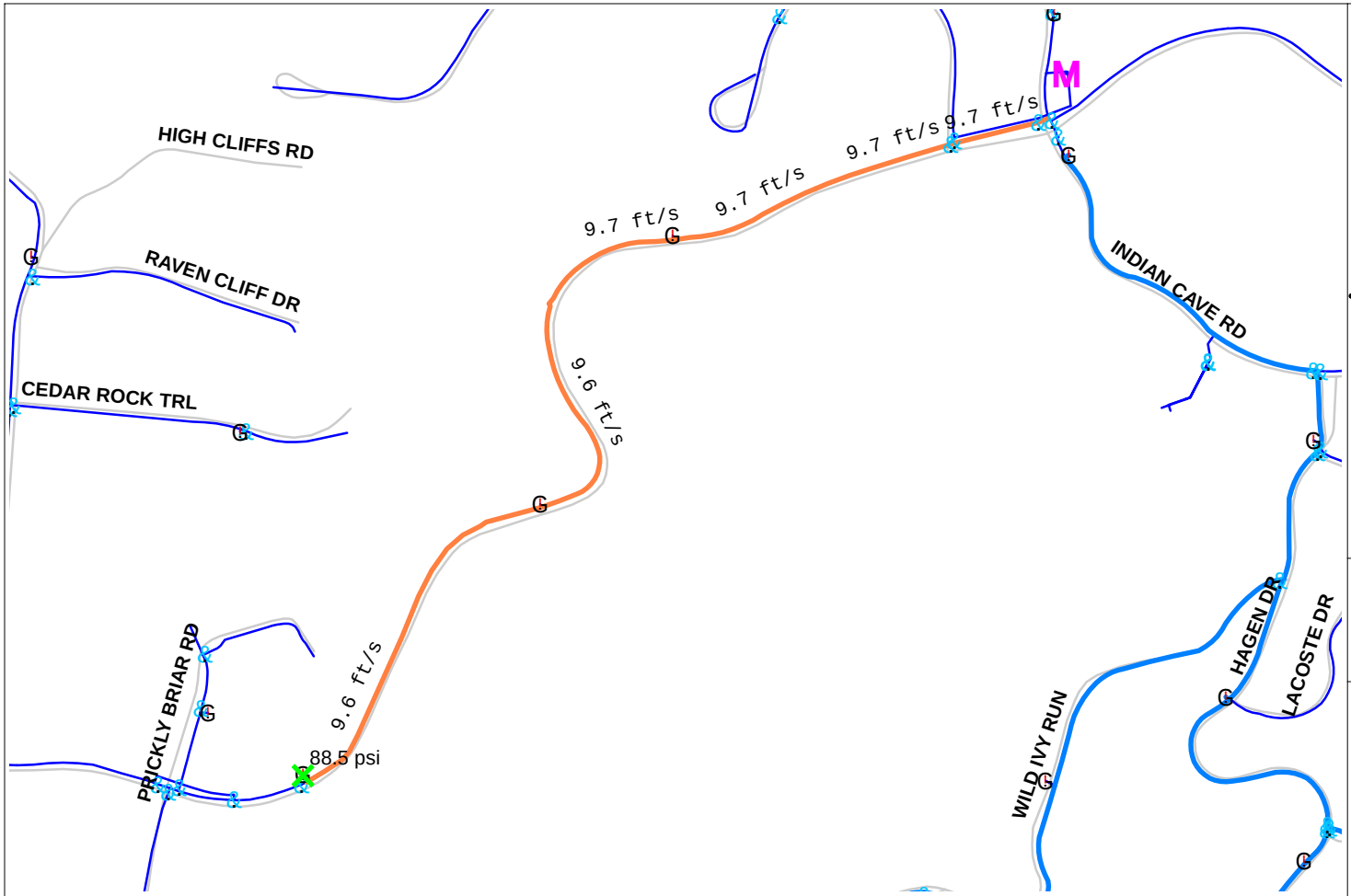
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	21	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	81.66050 psi				
Duration	9 min.	Open Hydrant	10-2792	Res. Pressure	58.62730 psi		Turbidity		
Valves to Open				Discharge Flow	531.70208		Disinf. Res.		
				Available Flow	1,100.97120		pH		
Valves to Close				Total Pipe Len.	1,397.4 ft		Iron		
				Min Flushing Vol	221.84000		Odor		
Pipes to Flush	P-12847,P-12849,P-1711,P-1713,P-1721,P-1733,PI-2053,PLATFH-10-2792			Desired Flushing Vol	665.52000		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

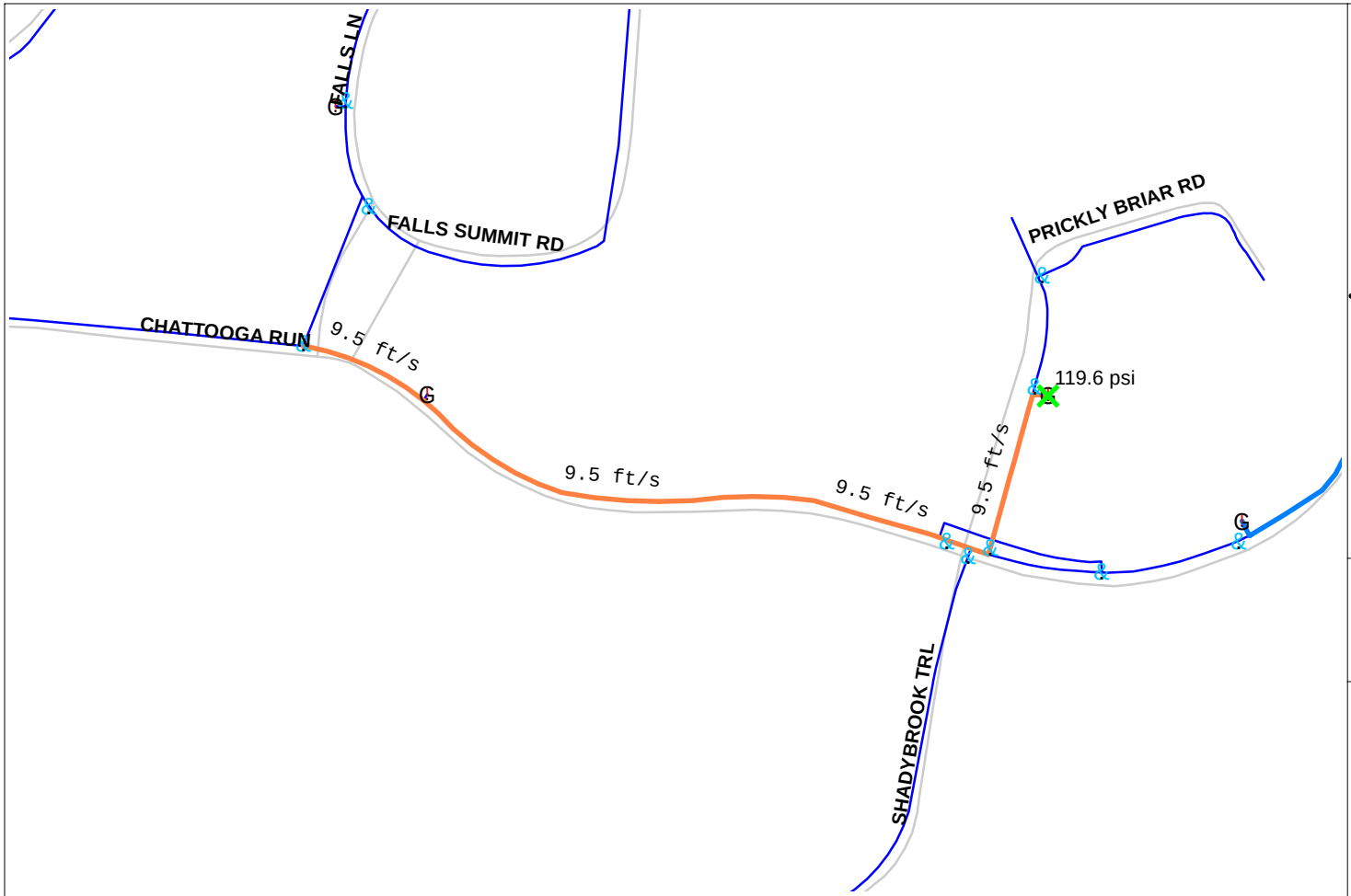
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	22	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	185.74100				
Duration	15 min.	Open Hydrant	10-2900	Res. Pressure	88.51170 psi		Turbidity		
Valves to Open				Discharge Flow	849.32064		Disinf. Res.		
				Available Flow	1,178.88288		pH		
Valves to Close				Total Pipe Len.	2,841.2 ft		Iron		
				Min Flushing Vol	557.24470		Odor		
Pipes to Flush	P-12259,P-12309,P-15169,P-1885,P-1891,PI-2063,PI-2213,PI-2221,PLATFH-10-2900			Desired Flushing Vol	1,671.73420		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	15 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

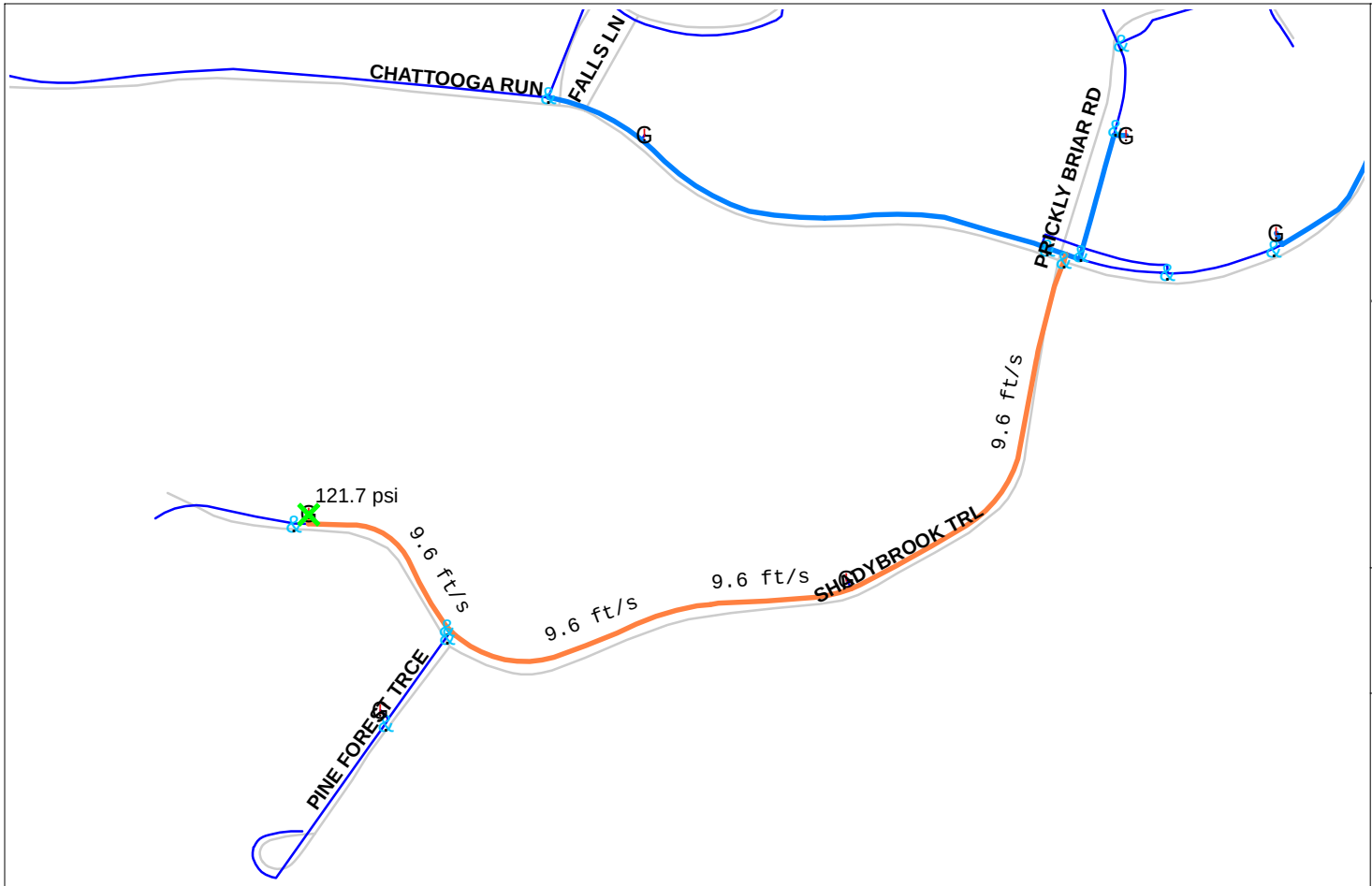
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	23	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	204.69300				
Duration	6 min.	Open Hydrant	10-2904	Res. Pressure	119.60250		Turbidity		
Valves to Open				Discharge Flow	835.36320		Disinf. Res.		
				Available Flow	2,076.18656		pH		
Valves to Close				Total Pipe Len.	1,079.9 ft		Iron		
				Min Flushing Vol	211.45510		Odor		
Pipes to Flush	P-11285,P-12871,P-135,P-137,P-1895,P-1905,PI-39,PLATFH-10-2904			Desired Flushing Vol	634.36530		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

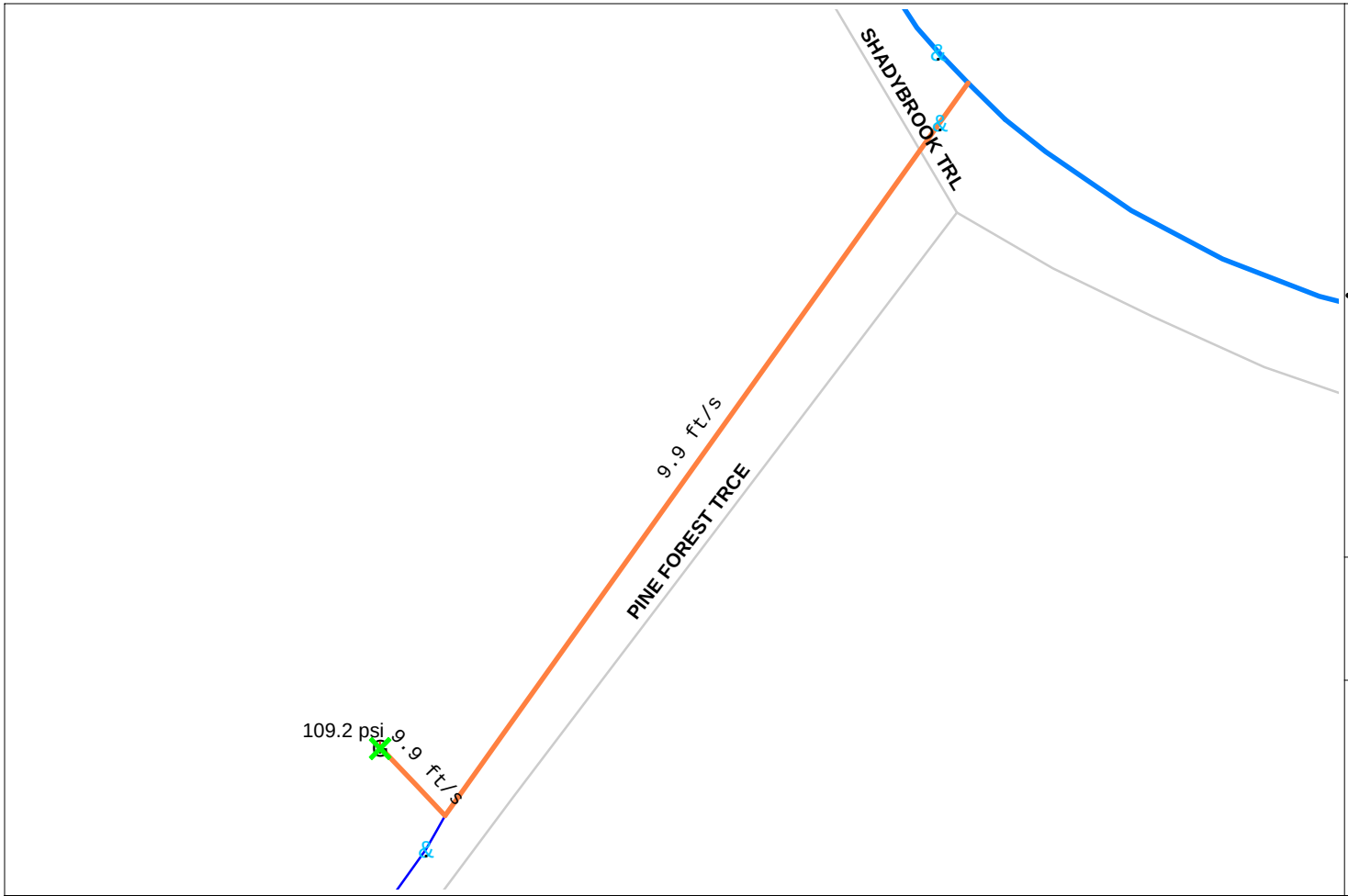
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	24	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	233.29070				
Duration	8 min.	Open Hydrant	10-2902	Res. Pressure	121.67020		Turbidity		
Valves to Open				Discharge Flow	842.51552		Disinf. Res.		
				Available Flow	1,239.29568		pH		
Valves to Close				Total Pipe Len.	1,599.1 ft		Iron		
				Min Flushing Vol	313.51210		Odor		
Pipes to Flush	P-11275,P-129,P-131,P-133,PI-2231,PI-41,PLATFH-10-2902			Desired Flushing Vol	940.53630		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

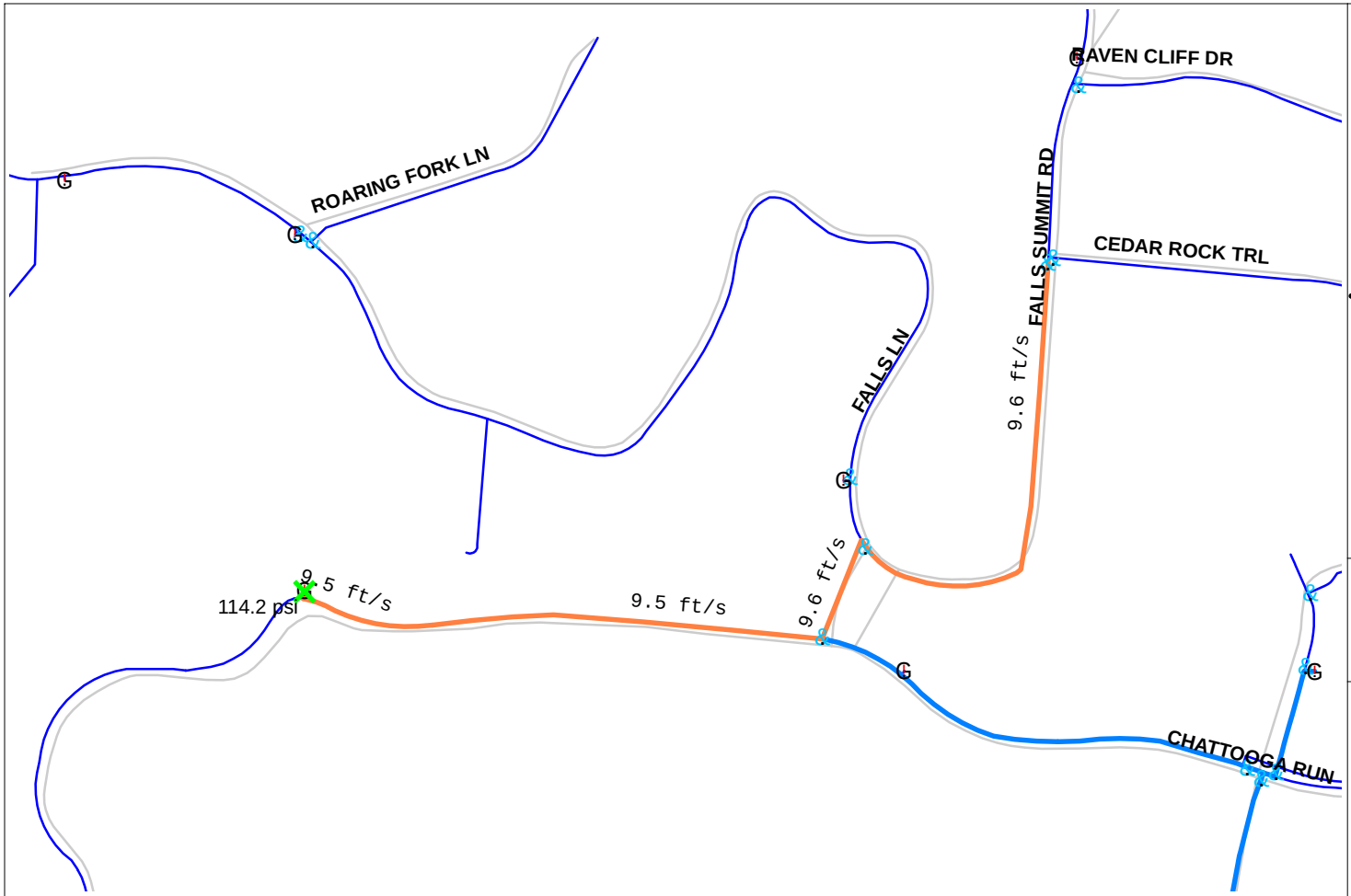
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	25	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	228.09110				
Duration	1 min.	Open Hydrant	10-2903	Res. Pressure	109.18730		Turbidity		
Valves to Open				Discharge Flow	870.70816		Disinf. Res.		
				Available Flow	1,235.68480		pH		
Valves to Close				Total Pipe Len.	179.4 ft		Iron		
				Min Flushing Vol	35.20640 ft^3		Odor		
Pipes to Flush	PI-2235,PLATFH-10-2903			Desired Flushing Vol	105.61930		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	1 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

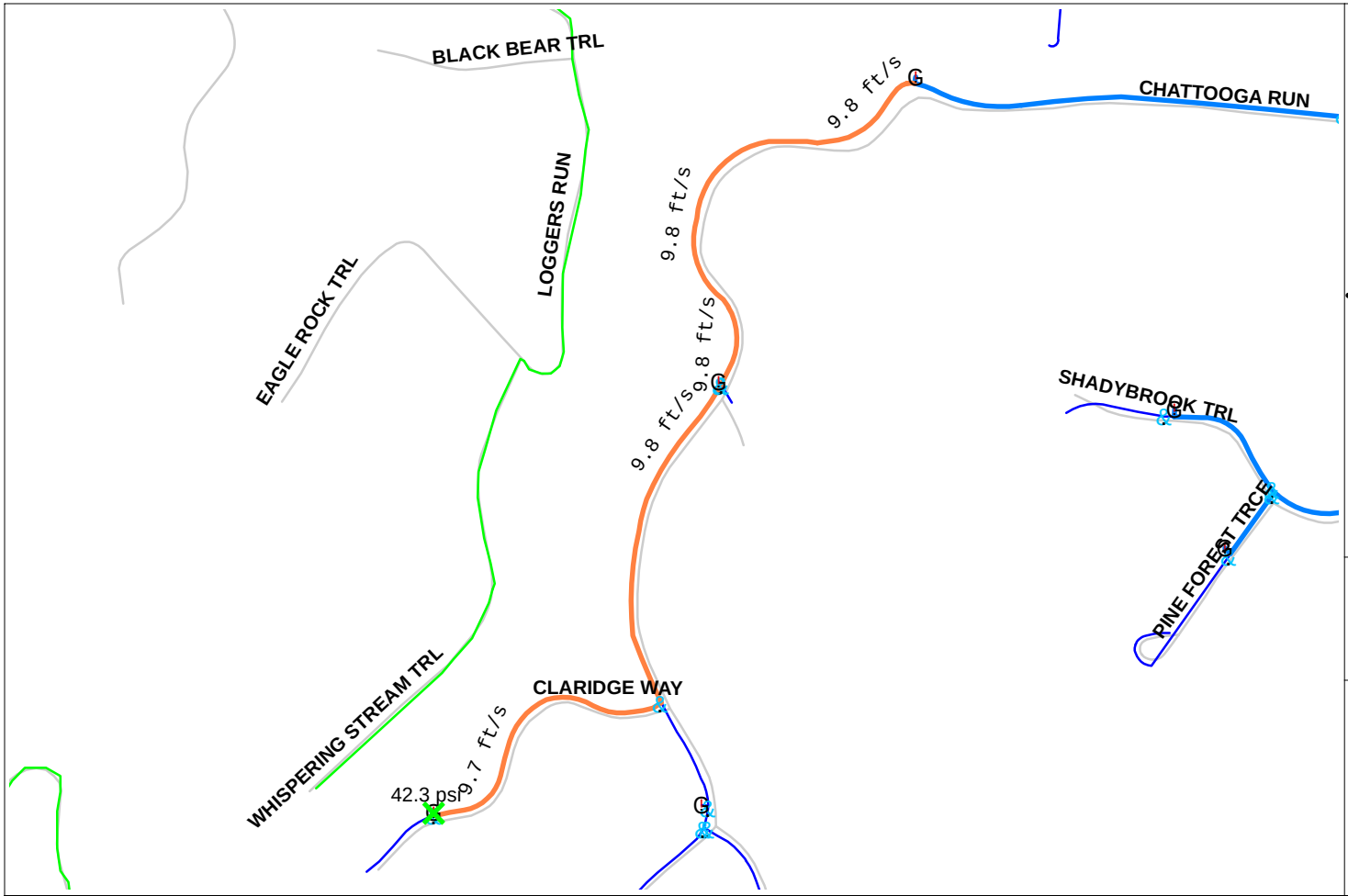
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	26	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	192.10650				
Duration	10 min.	Open Hydrant	10-2913	Res. Pressure	114.20600		Turbidity		
Valves to Open				Discharge Flow	816.26720		Disinf. Res.		
				Available Flow	1,110.83168		pH		
Valves to Close				Total Pipe Len.	2,006.1 ft		Iron		
				Min Flushing Vol	381.89950		Odor		
Pipes to Flush	P-11291,P-1903,PI-2271,PI-2273,PI-2285,PLATFH-10-2913			Desired Flushing Vol	1,145.69840		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

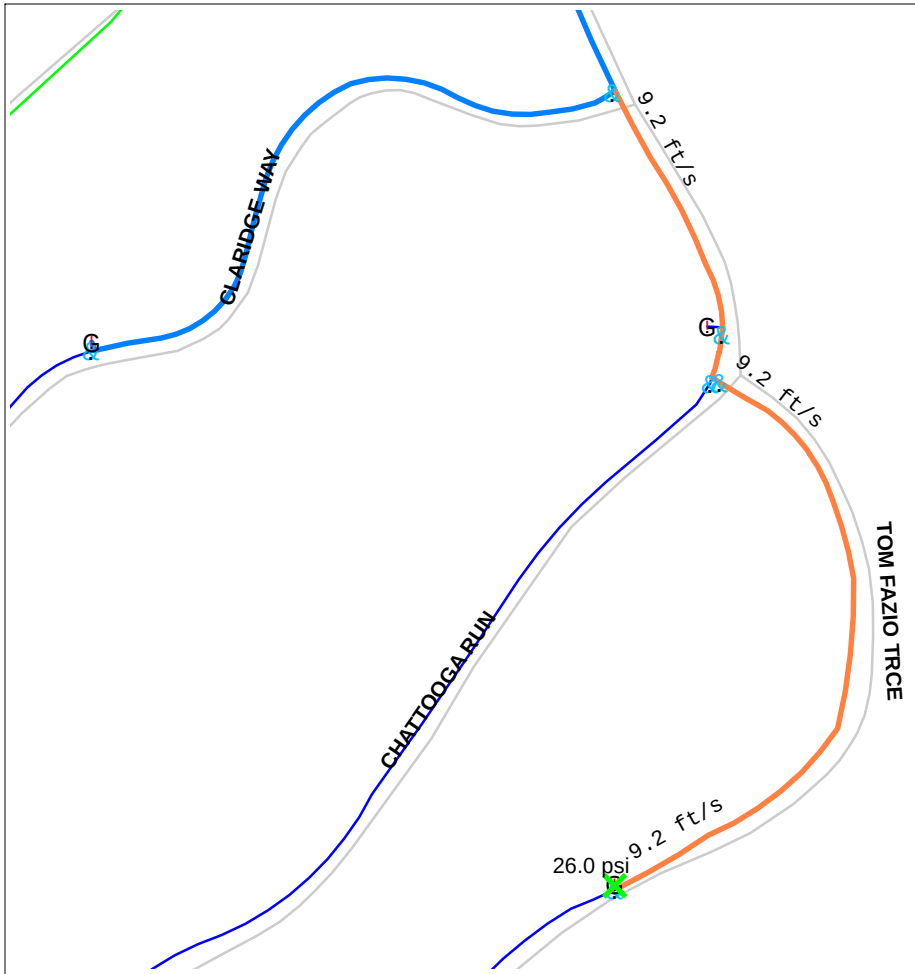
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	27	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	87.26270 psi				
Duration	12 min.	Open Hydrant	10-2915	Res. Pressure	42.30690 psi		Turbidity		
Valves to Open				Discharge Flow	858.13952		Disinf. Res.		
				Available Flow	1,038.82240		pH		
Valves to Close				Total Pipe Len.	2,398.2 ft		Iron		
				Min Flushing Vol	469.40570		Odor		
Pipes to Flush	P-10391,P-10393,P-10395,P-11289,P-11295,P-1897,P-1899,P-1901,PI-2239,PI-2241,PLATFH-10-2915			Desired Flushing Vol	1,408.21710		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

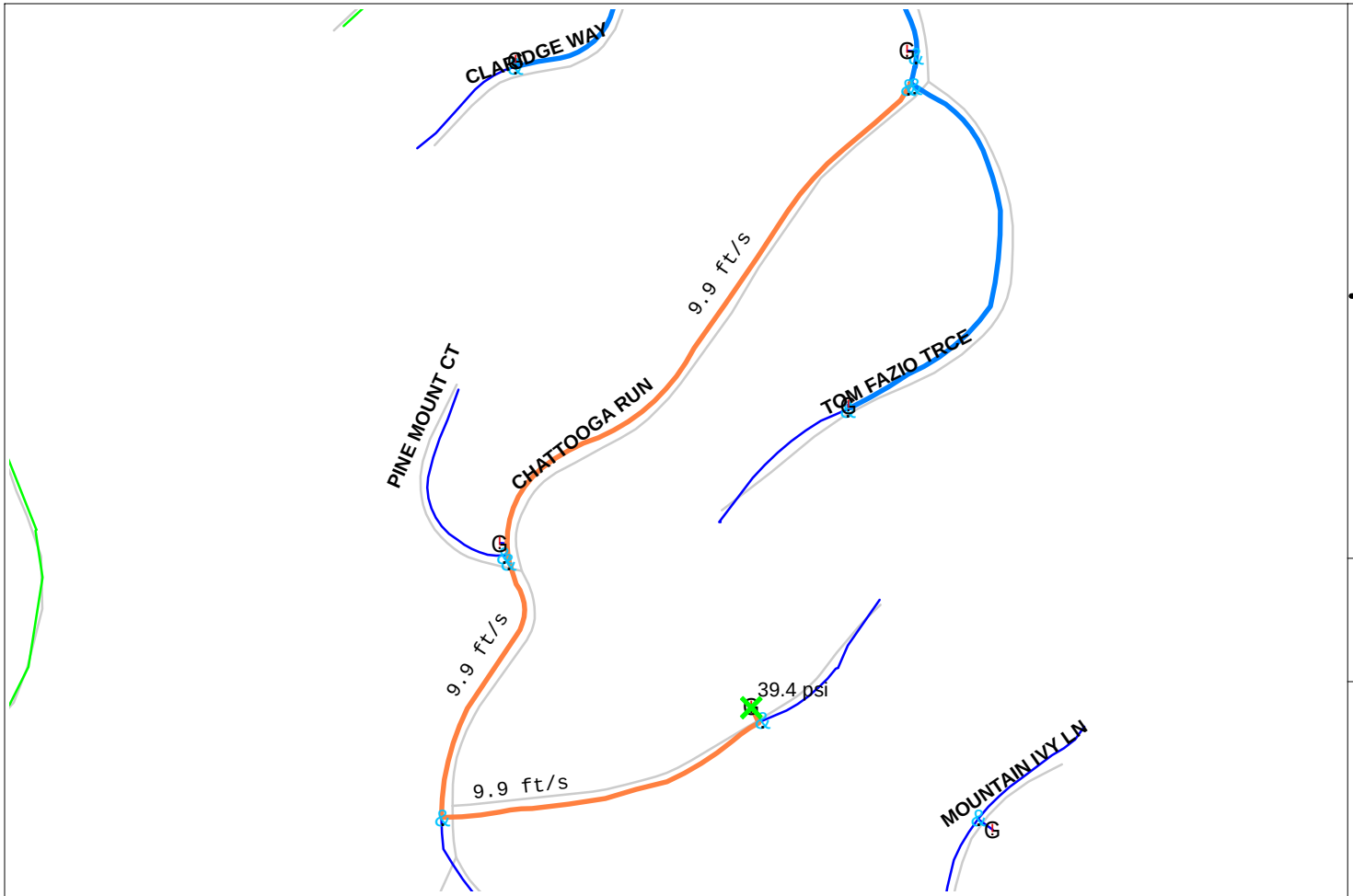
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	28	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	71.23030 psi				
Duration	5 min.	Open Hydrant	10-2917	Res. Pressure	26.02620 psi		Turbidity		
Valves to Open				Discharge Flow	808.42048		Disinf. Res.		
				Available Flow	865.08352		pH		
Valves to Close				Total Pipe Len.	940.1 ft		Iron		
				Min Flushing Vol	184.30500		Odor		
Pipes to Flush	P-11299,P-1913,P-1915,PI-2245,PI-2249,PLATFH-10-2917			Desired Flushing Vol	552.91510		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

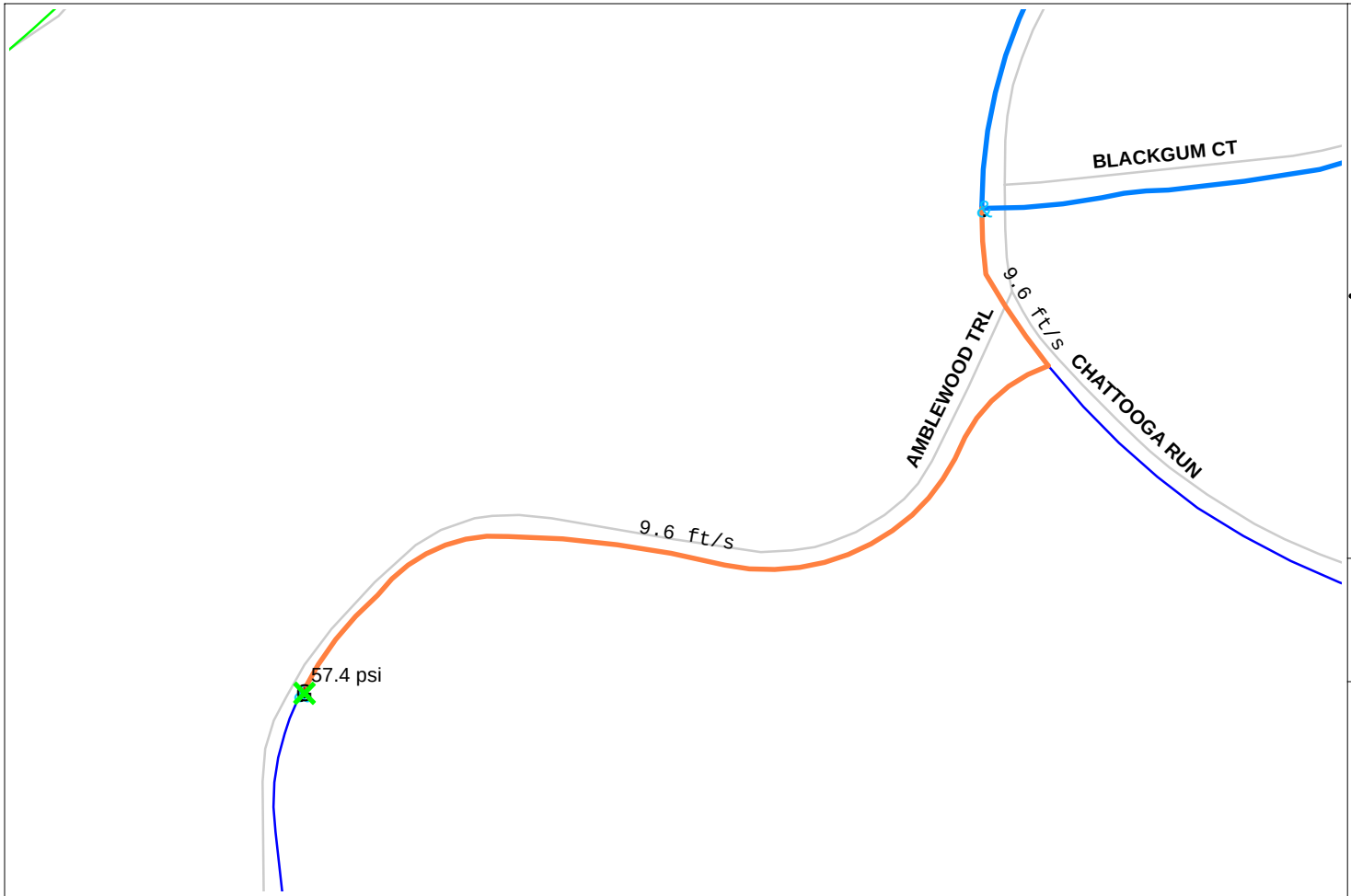
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	29	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	115.42690				
Duration	10 min.	Open Hydrant	10-2919	Res. Pressure	39.44200 psi		Turbidity		
Valves to Open				Discharge Flow	872.23584		Disinf. Res.		
				Available Flow	986.67296		pH		
Valves to Close				Total Pipe Len.	1,889.8 ft		Iron		
				Min Flushing Vol	370.67370		Odor		
Pipes to Flush	P-1917,P-1919,P-1921,PI-2247,PI-2253,PI-2257,PLATFH-10-2919			Desired Flushing Vol	1,112.02110		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

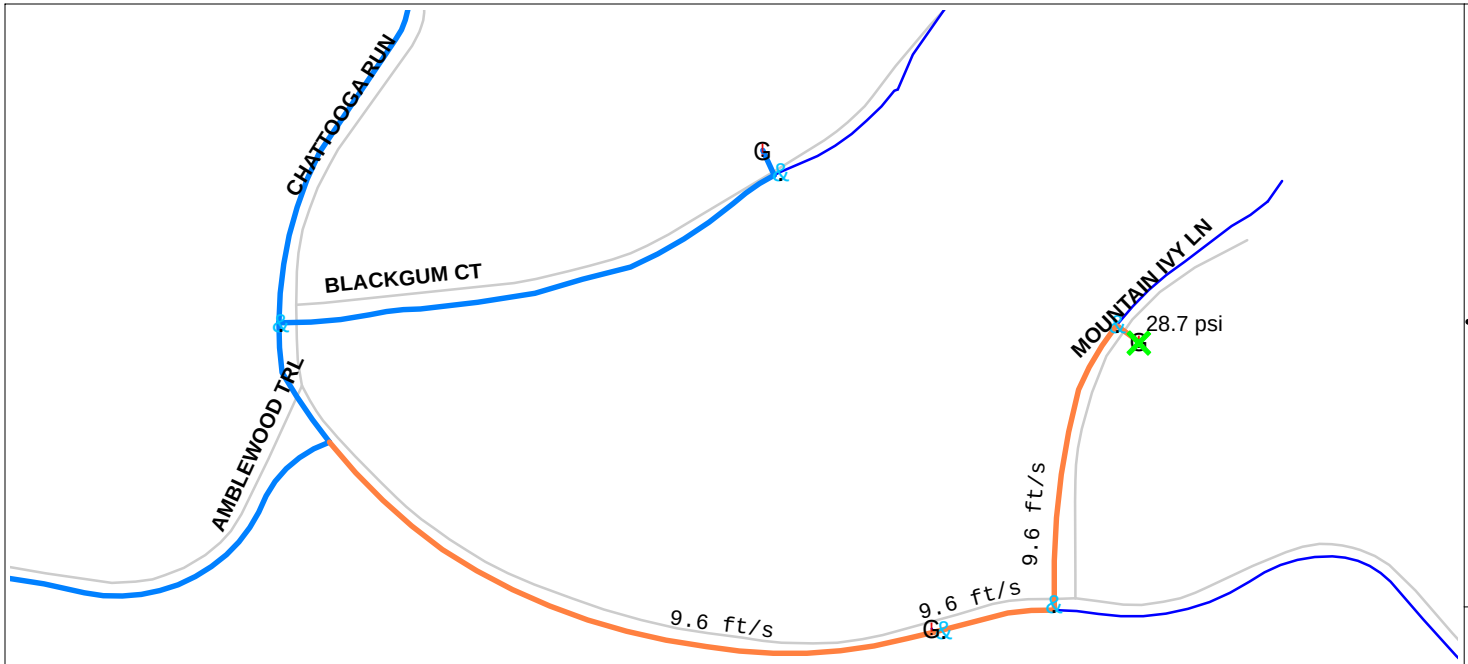
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	30	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	132.75880				
Duration	4 min.	Open Hydrant	10-2920	Res. Pressure	57.35910 psi		Turbidity		
Valves to Open				Discharge Flow	841.47392		Disinf. Res.		
				Available Flow	1,035.41984		pH		
Valves to Close				Total Pipe Len.	769.4 ft		Iron		
				Min Flushing Vol	150.98650		Odor		
Pipes to Flush	P-1929,PI-2259,PLATFH-10-2920			Desired Flushing Vol	452.95940		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

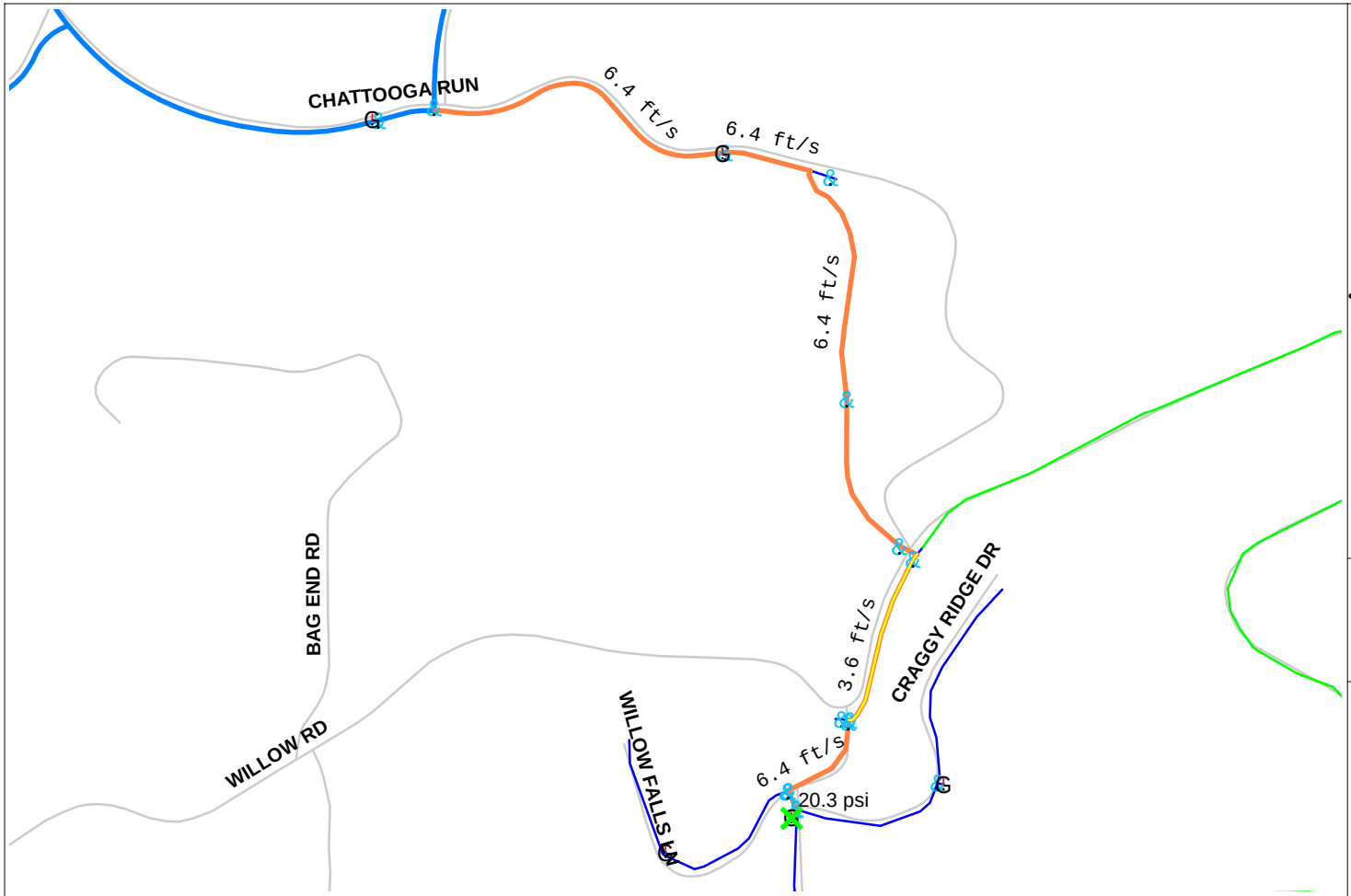
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	31	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	112.82720				
Duration	5 min.	Open Hydrant	10-2922	Res. Pressure	28.65830 psi		Turbidity		
Valves to Open				Discharge Flow	848.27904		Disinf. Res.		
				Available Flow	894.45664		pH		
Valves to Close				Total Pipe Len.	1,056.0 ft		Iron		
				Min Flushing Vol	207.27760		Odor		
Pipes to Flush	P-1925,P-1927,PI-2263,PI-2265,PLATFH-10-2922			Desired Flushing Vol	621.83280		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

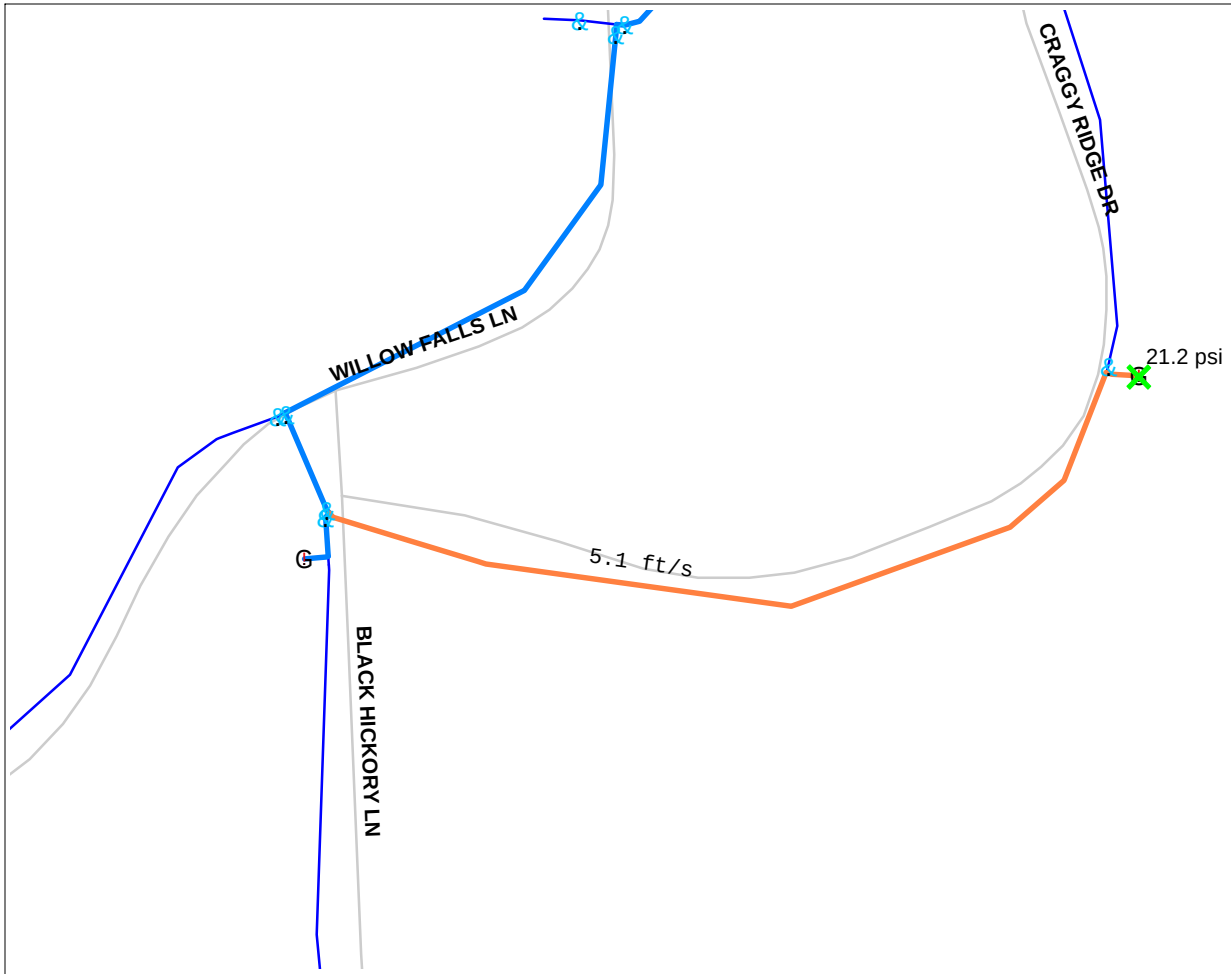
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	32	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	75.99640 psi				
Duration	19 min.	Open Hydrant	10-3269	Res. Pressure	20.33230 psi		Turbidity		
Valves to Open				Discharge Flow	563.57504		Disinf. Res.		
				Available Flow	565.44992		pH		
Valves to Close				Total Pipe Len.	2,169.7 ft		Iron		
				Min Flushing Vol	478.19580		Odor		
Pipes to Flush	P-1931,P-1933,P-7837,P-7841,PI-8175,PI-8177,PI-8181,PI-8185,PI-8191,PLATFH-10-3269			Desired Flushing Vol	1,434.58750		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	19 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

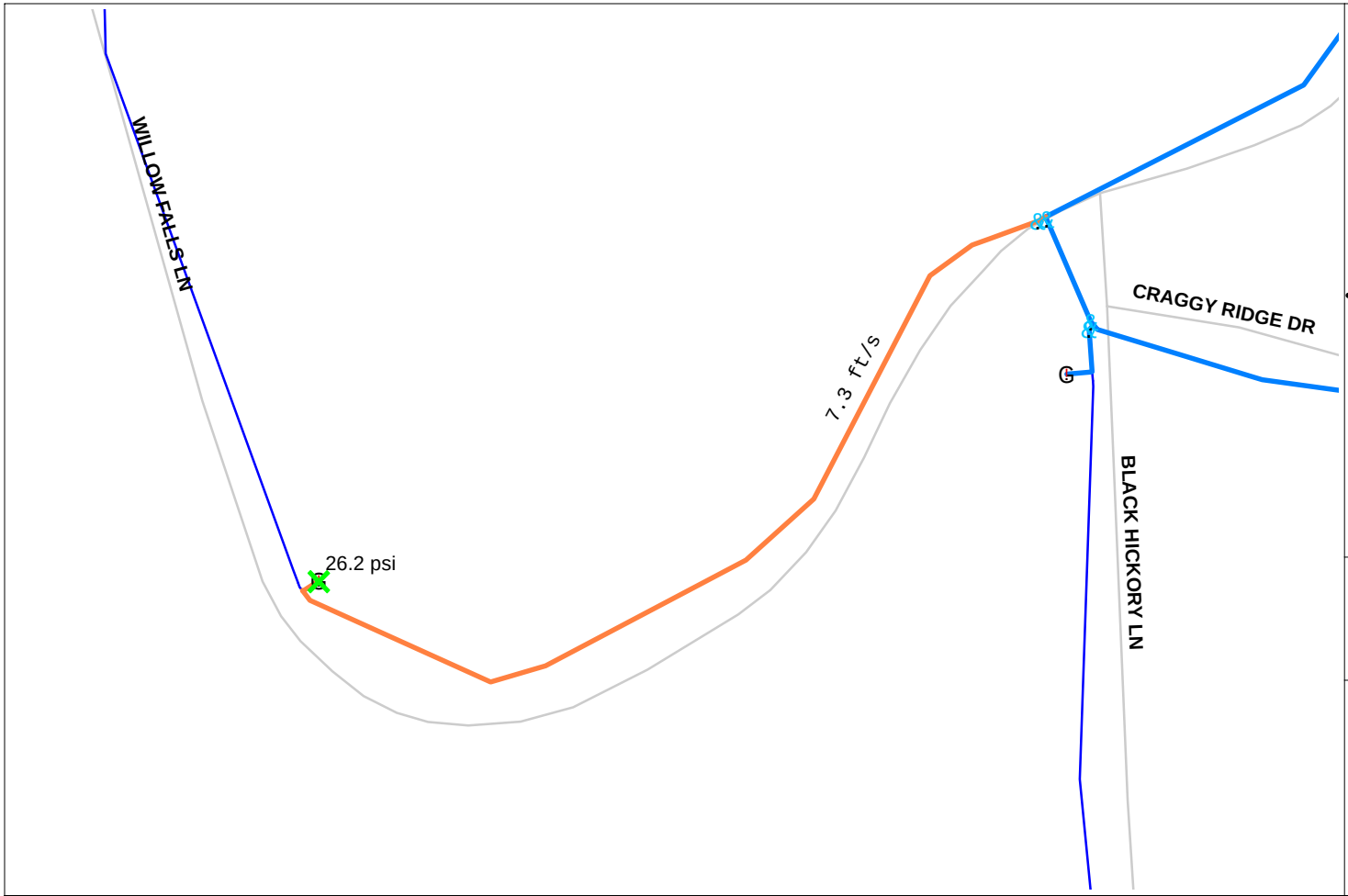
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	33	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	59.53110 psi				
Duration	3 min.	Open Hydrant	10-3270	Res. Pressure	21.19440 psi		Turbidity		
Valves to Open				Discharge Flow	447.54080		Disinf. Res.		
				Available Flow	455.04032		pH		
Valves to Close				Total Pipe Len.	314.2 ft		Iron		
				Min Flushing Vol	61.68860 ft^3		Odor		
Pipes to Flush	P-7847,PLATFH-10-3270			Desired Flushing Vol	185.06590		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	3 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	34	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	99.82800 psi				
Duration	2 min.	Open Hydrant	10-3268	Res. Pressure	26.19440 psi		Turbidity		
Valves to Open				Discharge Flow	639.68128		Disinf. Res.		
				Available Flow	668.29056		pH		
Valves to Close				Total Pipe Len.	310.8 ft		Iron		
				Min Flushing Vol	61.03130 ft^3		Odor		
Pipes to Flush	P-7843,PLATFH-10-3268			Desired Flushing Vol	183.09380		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	2 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

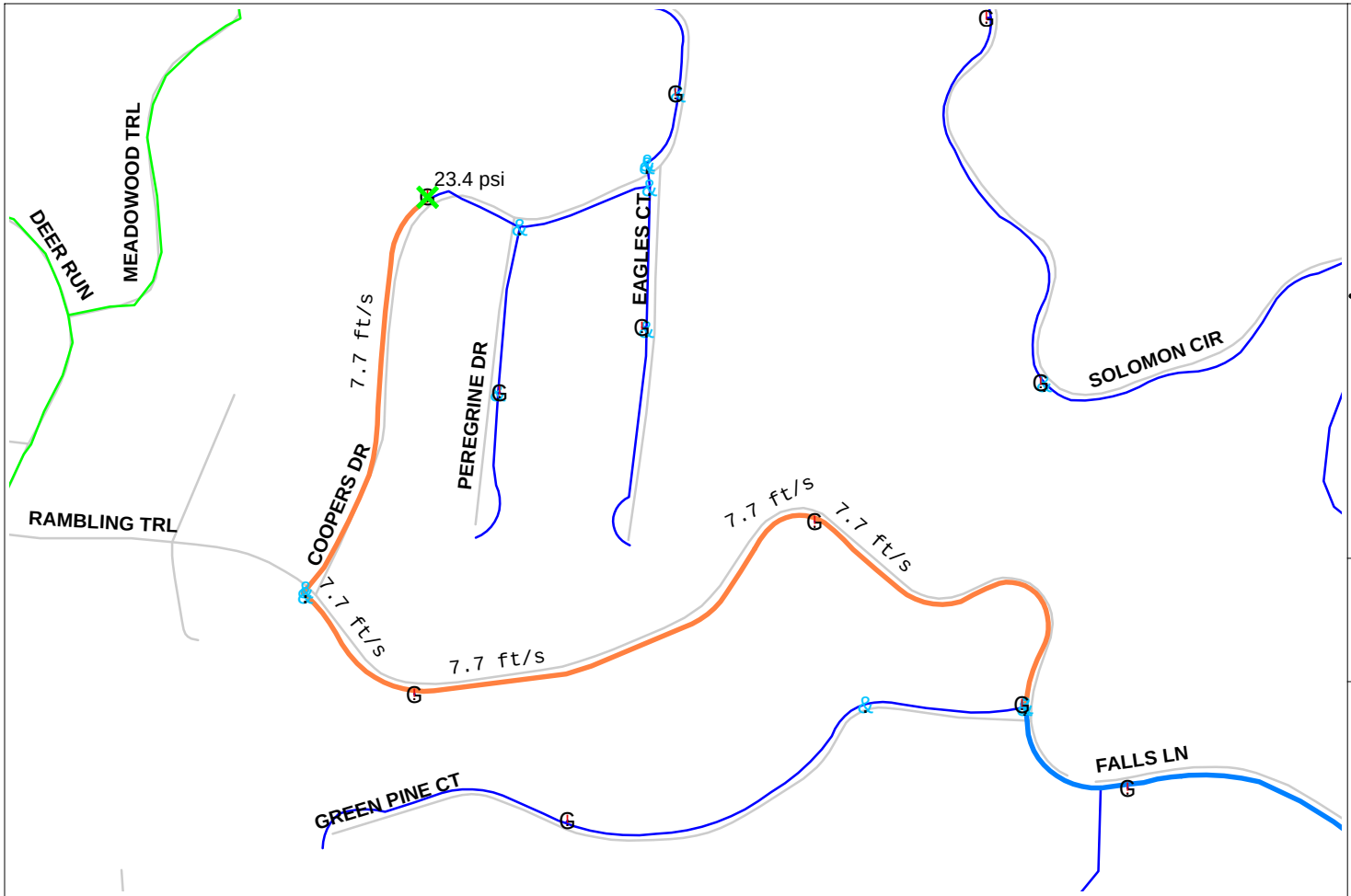
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	35	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	120.20450				
Duration	16 min.	Open Hydrant	10-3288	Res. Pressure	24.51600 psi		Turbidity		
Valves to Open				Discharge Flow	785.08864		Disinf. Res.		
				Available Flow	798.21280		pH		
Valves to Close				Total Pipe Len.	2,867.1 ft		Iron		
				Min Flushing Vol	561.34070		Odor		
Pipes to Flush	P-12303,P-1943,P-1945,P-1947,P-1949,P-1951,P-1953,P-1955,PI-2283,PI-2289,PI-6423,PLATFH-10-3288			Desired Flushing Vol	1,684.02200		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	36	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	120.63740				
Duration	17 min.	Open Hydrant	10-3283	Res. Pressure	23.44950 psi		Turbidity		
Valves to Open				Discharge Flow	673.01248		Disinf. Res.		
				Available Flow	685.72000		pH		
Valves to Close				Total Pipe Len.	2,586.4 ft		Iron		
				Min Flushing Vol	506.79290		Odor		
Pipes to Flush	P-12291,P-12299,P-6151,P-6153,PI-6425,PLATFH-10-3283			Desired Flushing Vol	1,520.37860		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	17 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

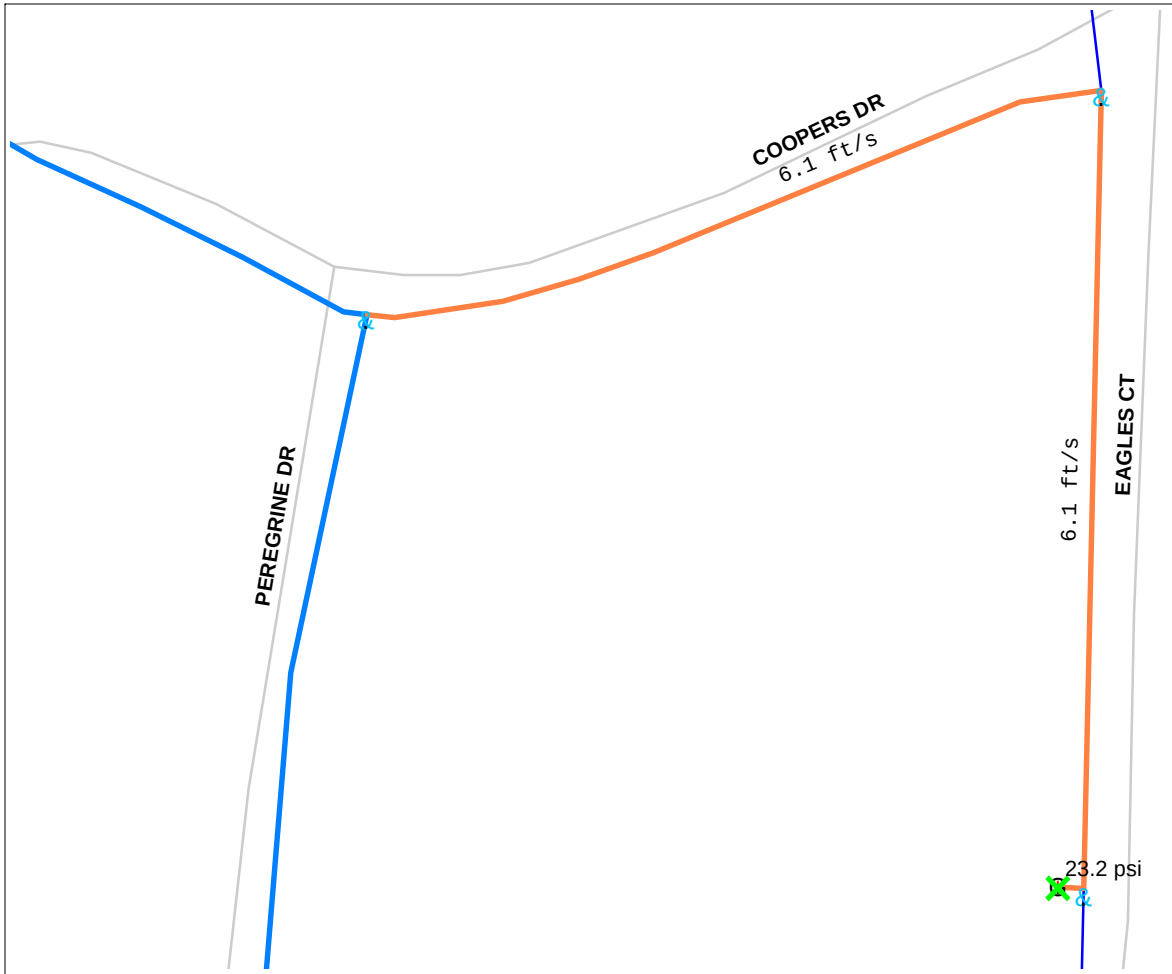
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	37	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	108.50500				
Duration	4 min.	Open Hydrant	10-3282	Res. Pressure	23.48070 psi		Turbidity		
Valves to Open				Discharge Flow	606.55840		Disinf. Res.		
				Available Flow	619.96032		pH		
Valves to Close				Total Pipe Len.	487.7 ft		Iron		
				Min Flushing Vol	95.63800 ft^3		Odor		
Pipes to Flush	P-6157,PI-6427,PLATFH-10-3282			Desired Flushing Vol	286.91400		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

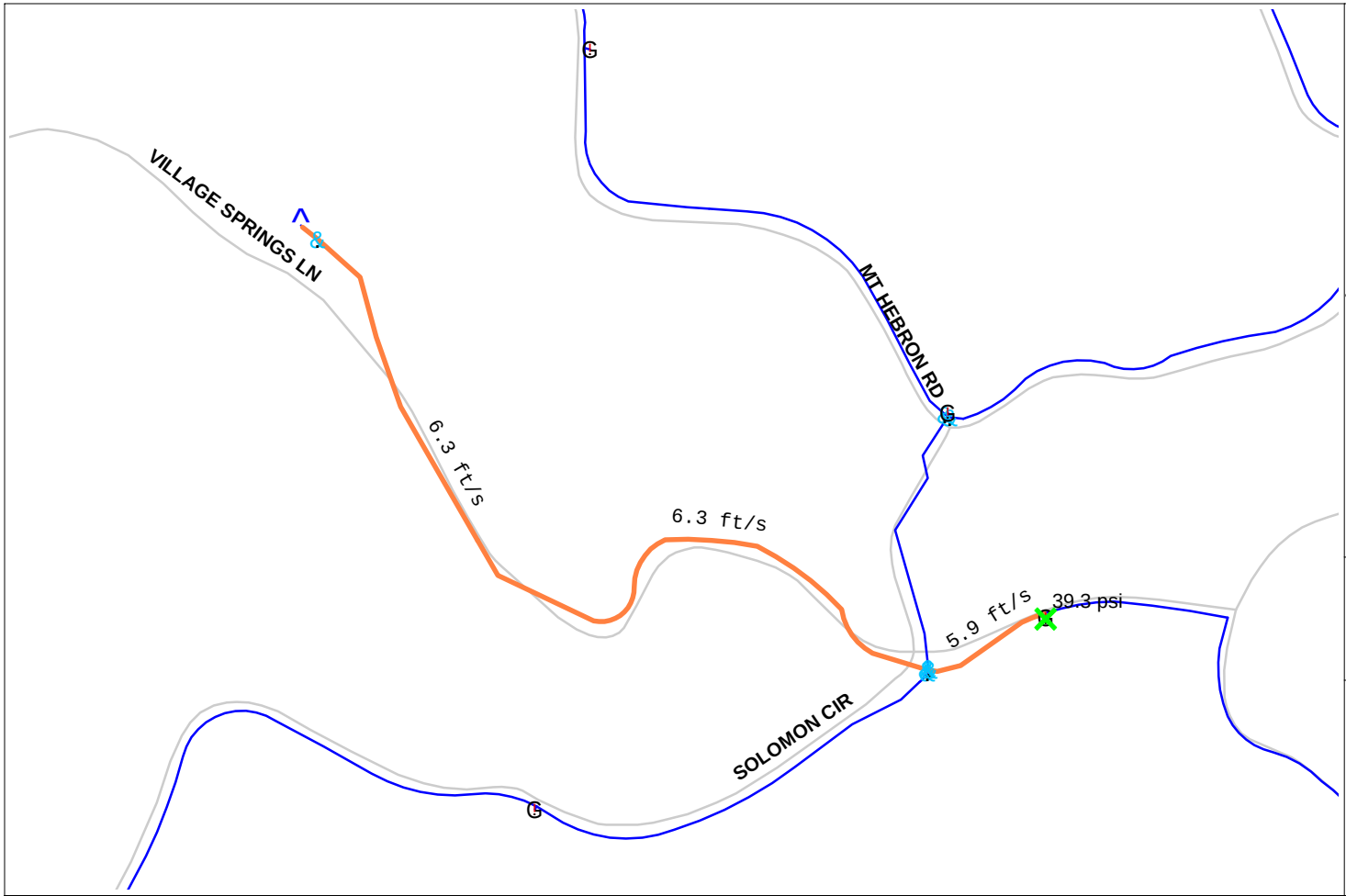
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	38	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	92.47290 psi				
Duration	4 min.	Open Hydrant	10-3284	Res. Pressure	23.15500 psi		Turbidity		
Valves to Open				Discharge Flow	534.61856		Disinf. Res.		
				Available Flow	547.88160		pH		
Valves to Close				Total Pipe Len.	511.8 ft		Iron		
				Min Flushing Vol	100.39700		Odor		
Pipes to Flush	P-6159,PI-6429,PLATFH-10-3284			Desired Flushing Vol	301.19090		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

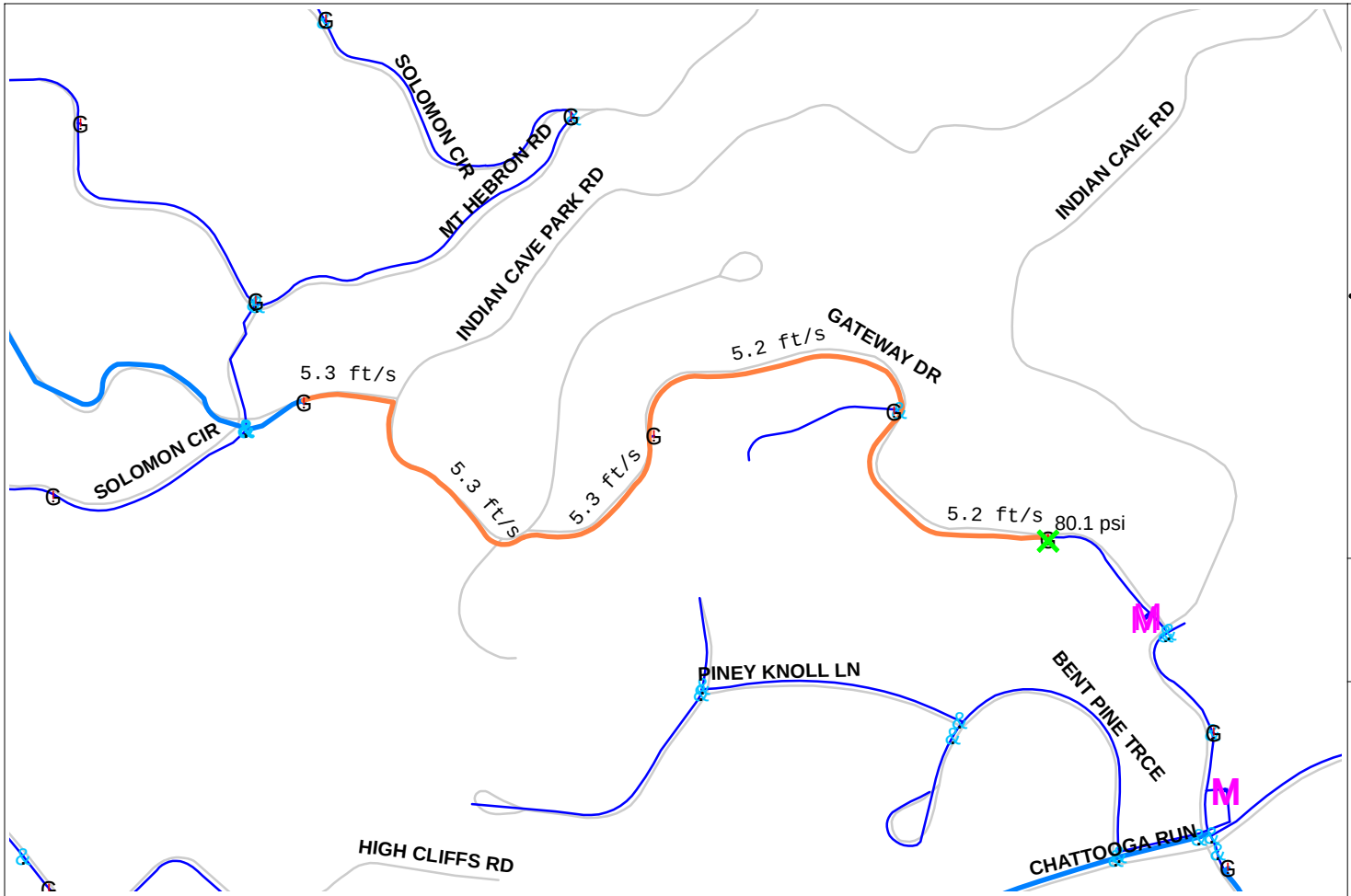
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	39	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	57.68230 psi				
Duration	11 min.	Open Hydrant	10-3214	Res. Pressure	39.28290 psi		Turbidity		
Valves to Open				Discharge Flow	872.86080		Disinf. Res.		
				Available Flow	1,227.14368		pH		
Valves to Close				Total Pipe Len.	1,335.9 ft		Iron		
				Min Flushing Vol	418.48310		Odor		
Pipes to Flush	P-12271,PI-6311,PI-6325,PLATFH-10-3214			Desired Flushing Vol	1,255.44930		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	40	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	127.42460				
Duration	26 min.	Open Hydrant	10-3192	Res. Pressure	80.05060 psi		Turbidity		
Valves to Open				Discharge Flow	869.80544		Disinf. Res.		
				Available Flow	1,316.37408		pH		
Valves to Close				Total Pipe Len.	2,768.2 ft		Iron		
				Min Flushing Vol	1,020.91340		Odor		
Pipes to Flush	P-12263,P-13615,P-6049,P-6051,P-6053,PI-6327,PLATFH-10-3192			Desired Flushing Vol	3,062.74010		HPC		
				Min Flushing Time	9 min.		Color		
				Desired Flushing	26 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

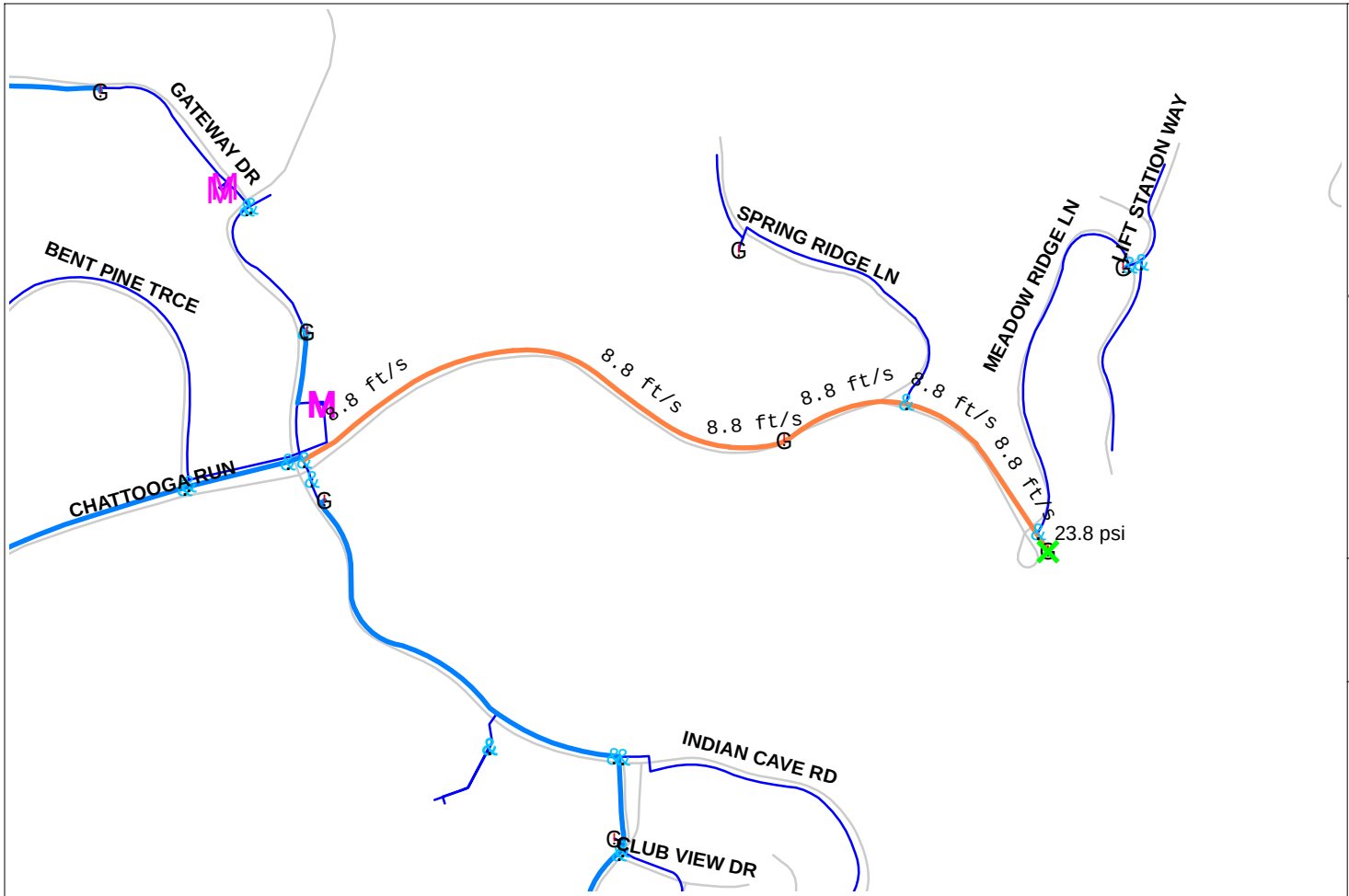
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	41	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	77.68350 psi				
Duration	1 min.	Open Hydrant	10-3194	Res. Pressure	53.51380 psi		Turbidity		
Valves to Open				Discharge Flow	472.40032		Disinf. Res.		
				Available Flow	918.55232		pH		
Valves to Close				Total Pipe Len.	148.0 ft		Iron		
				Min Flushing Vol	18.28240 ft^3		Odor		
Pipes to Flush	P-15247,PLATFH-10-3194			Desired Flushing Vol	54.84720 ft^3		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	1 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

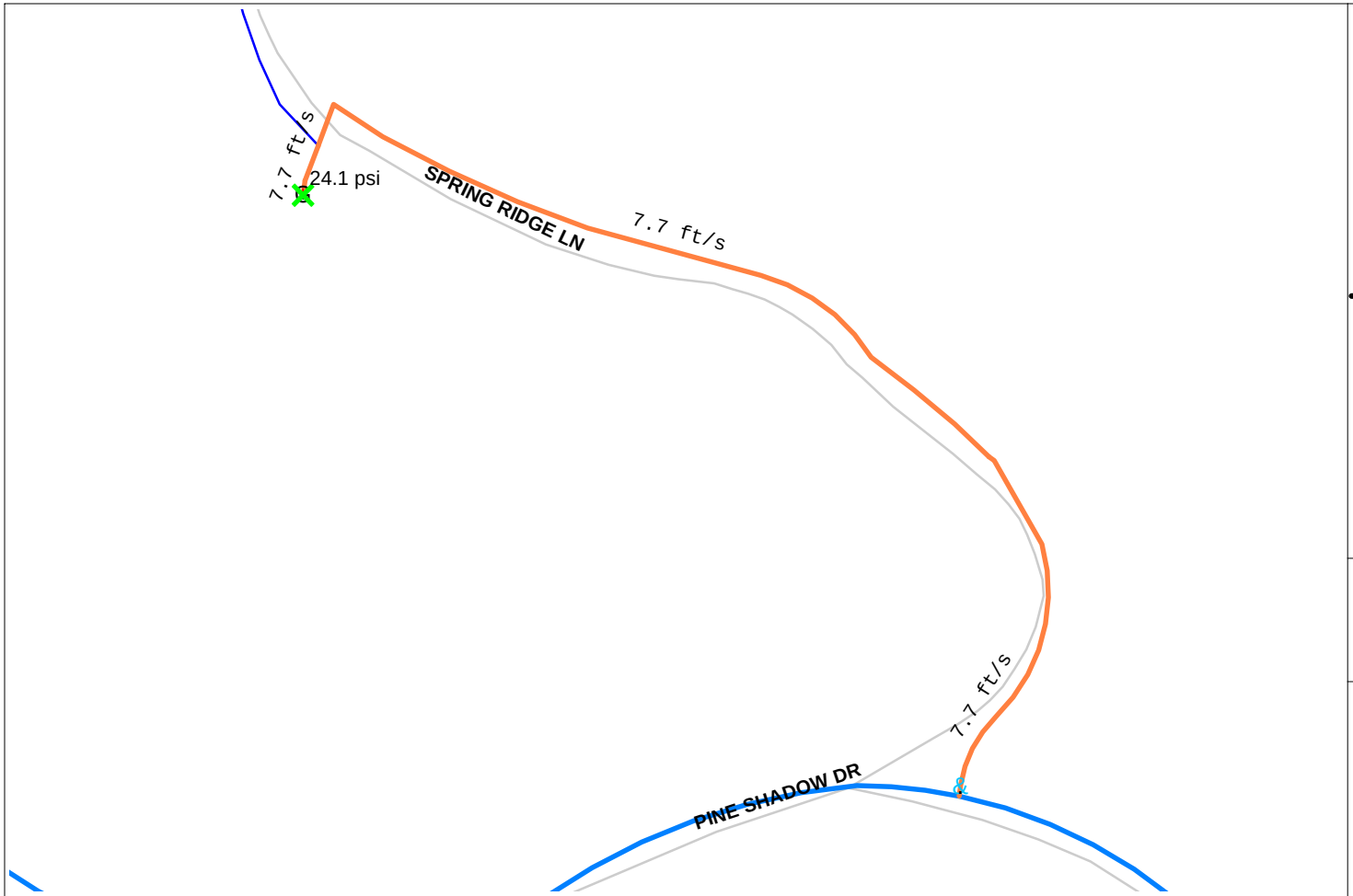
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	42	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	90.88120 psi				
Duration	10 min.	Open Hydrant	10-2186	Res. Pressure	23.79170 psi		Turbidity		
Valves to Open				Discharge Flow	773.00608		Disinf. Res.		
				Available Flow	800.78208		pH		
Valves to Close				Total Pipe Len.	1,781.8 ft		Iron		
				Min Flushing Vol	348.74700		Odor		
Pipes to Flush	P-12239,P-12243,P-12251,P-1735,P-1737,P-1739,PI-2067,PLATFH-10-2186			Desired Flushing Vol	1,046.24090		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

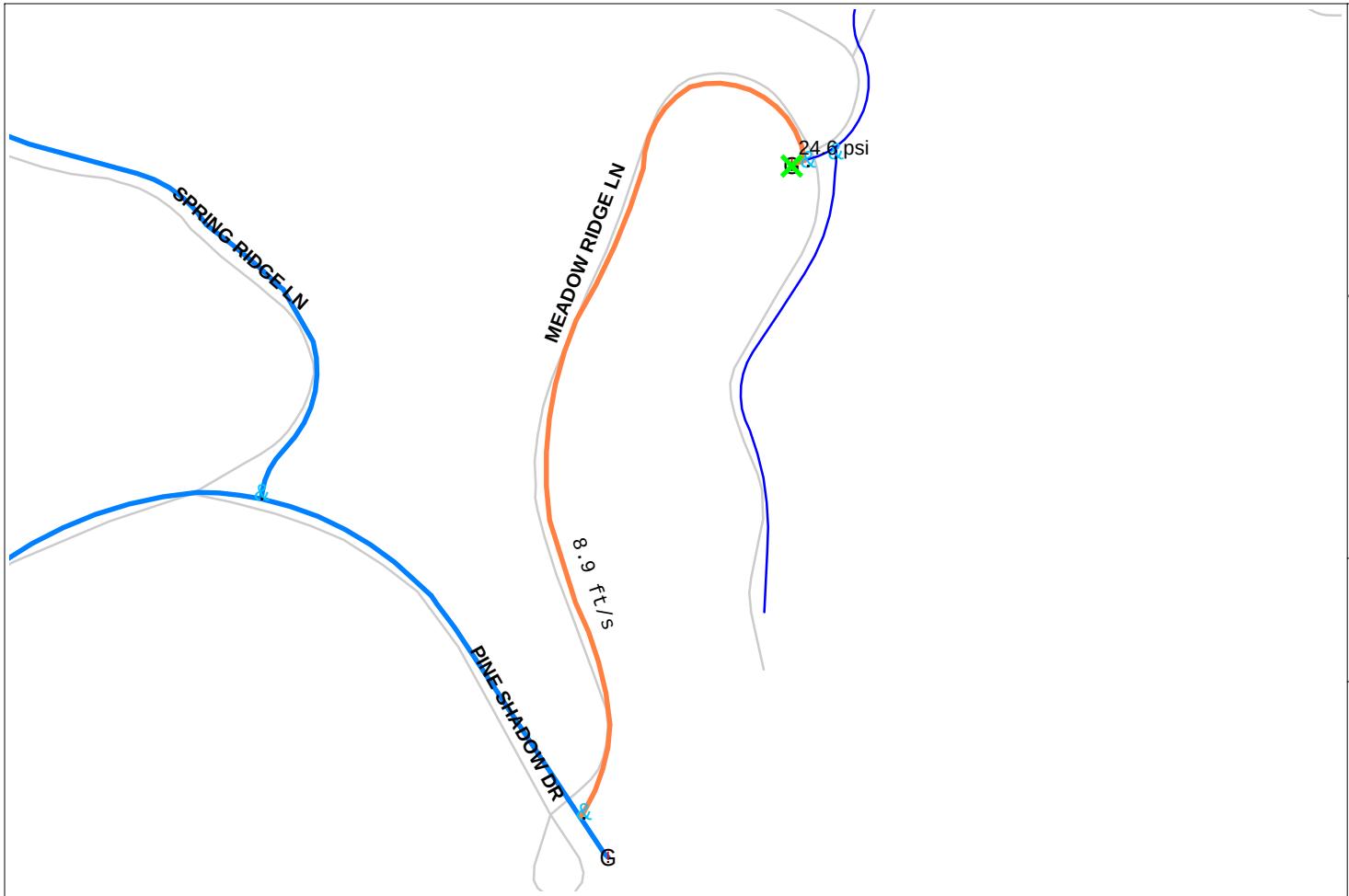
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	43	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	81.78170 psi				
Duration	4 min.	Open Hydrant	10-2894	Res. Pressure	24.05460 psi		Turbidity		
Valves to Open				Discharge Flow	681.13696		Disinf. Res.		
				Available Flow	711.55168		pH		
Valves to Close				Total Pipe Len.	634.9 ft		Iron		
				Min Flushing Vol	124.58990		Odor		
Pipes to Flush	P-12247,P-1871,PI-2187,PLATFH-10-2894			Desired Flushing Vol	373.76980		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

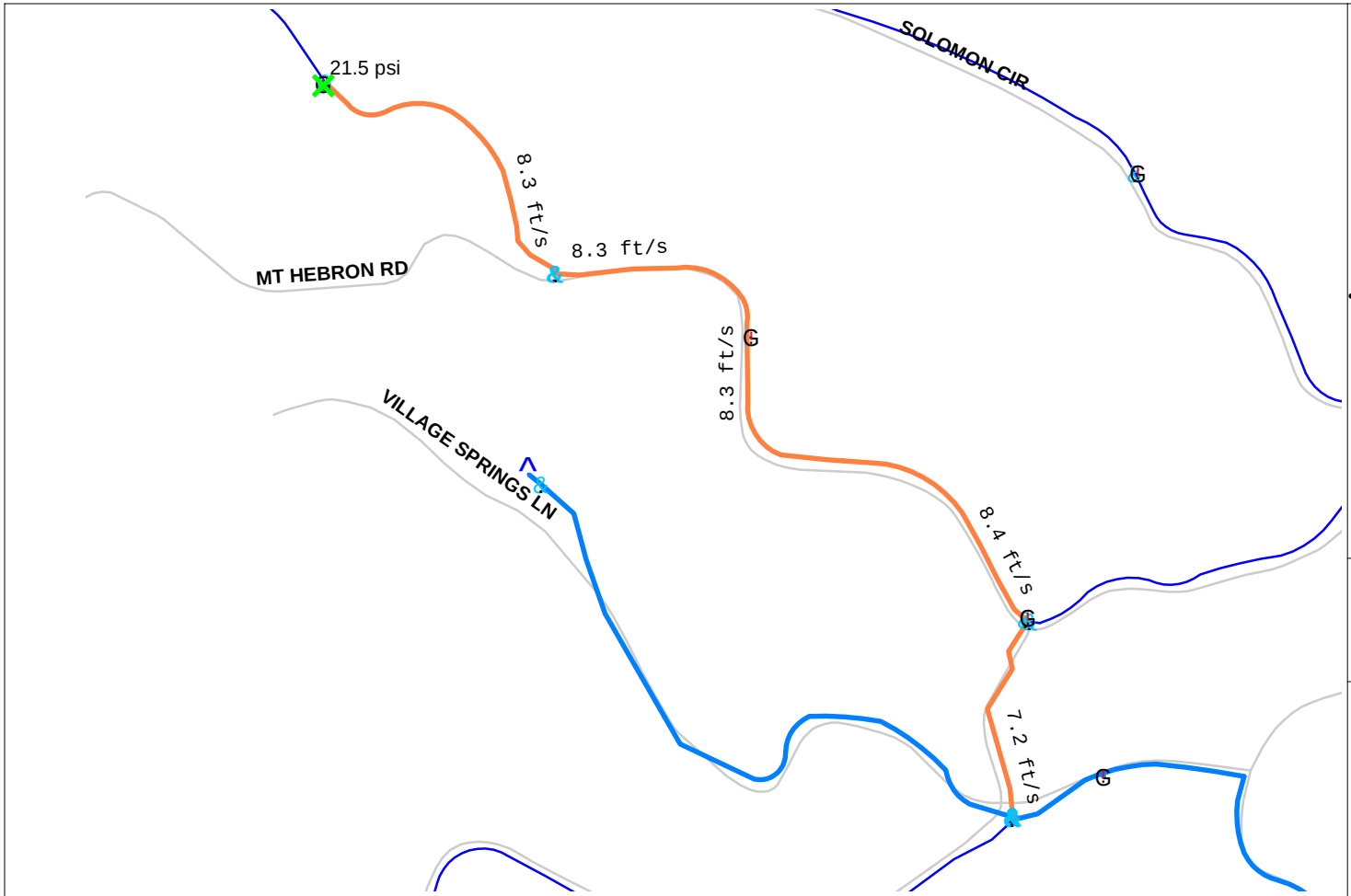
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	44	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	105.18040				
Duration	4 min.	Open Hydrant	10-2796	Res. Pressure	24.57960 psi		Turbidity		
Valves to Open				Discharge Flow	785.85248		Disinf. Res.		
				Available Flow	813.28128		pH		
Valves to Close				Total Pipe Len.	783.3 ft		Iron		
				Min Flushing Vol	153.64570		Odor		
Pipes to Flush	PI-2189,PLATFH-10-2796			Desired Flushing Vol	460.93710		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

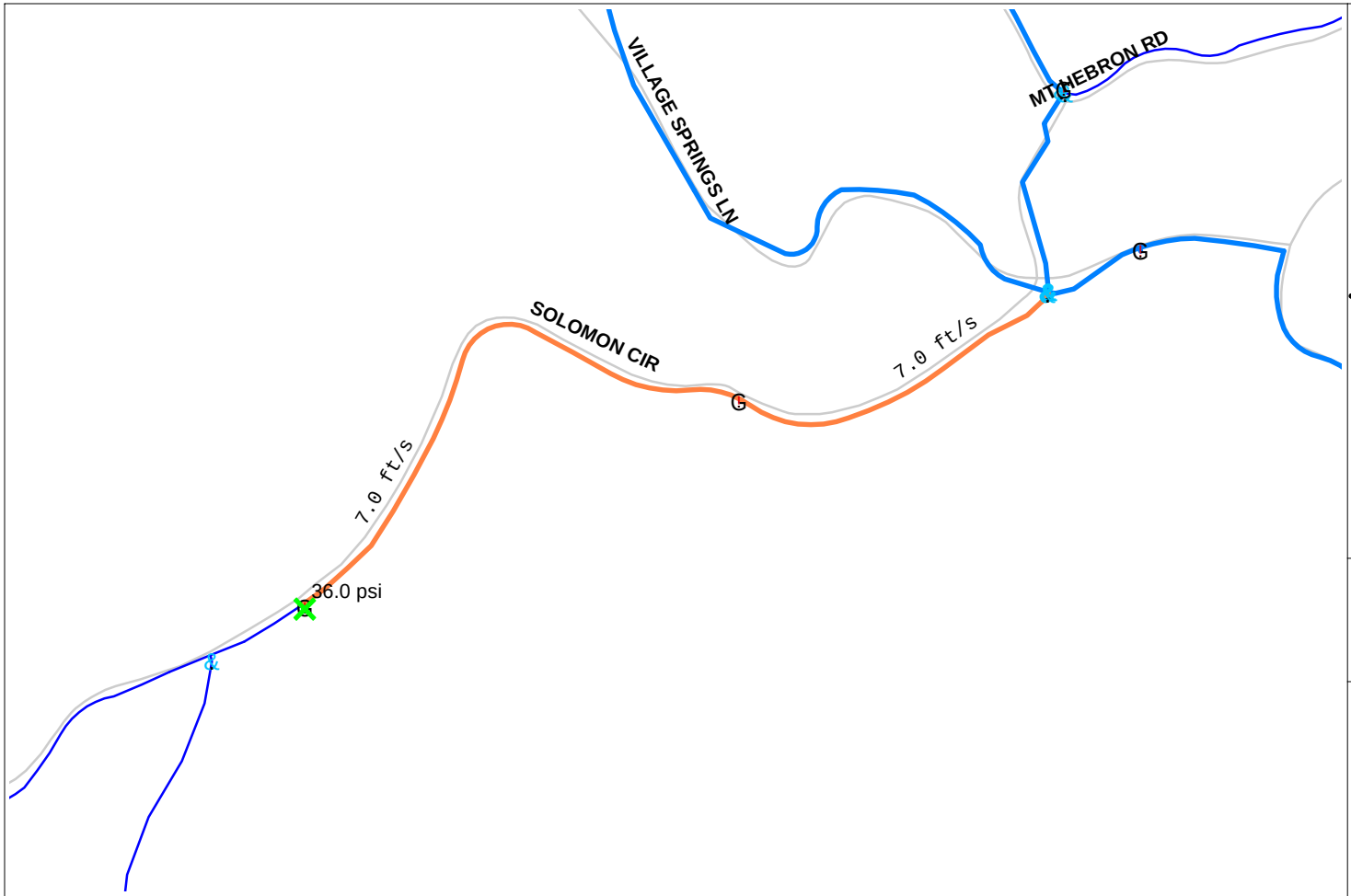
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	45	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	60.95930 psi				
Duration	12 min.	Open Hydrant	10-3188	Res. Pressure	21.53060 psi		Turbidity		
Valves to Open				Discharge Flow	735.30016		Disinf. Res.		
				Available Flow	750.99360		pH		
Valves to Close				Total Pipe Len.	2,004.8 ft		Iron		
				Min Flushing Vol	403.69520		Odor		
Pipes to Flush	P-12275,P-13617,P-14179,P-6055,P-6059,PI-6309,PI-6315,PLATFH-10-3188			Desired Flushing Vol	1,211.08570		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

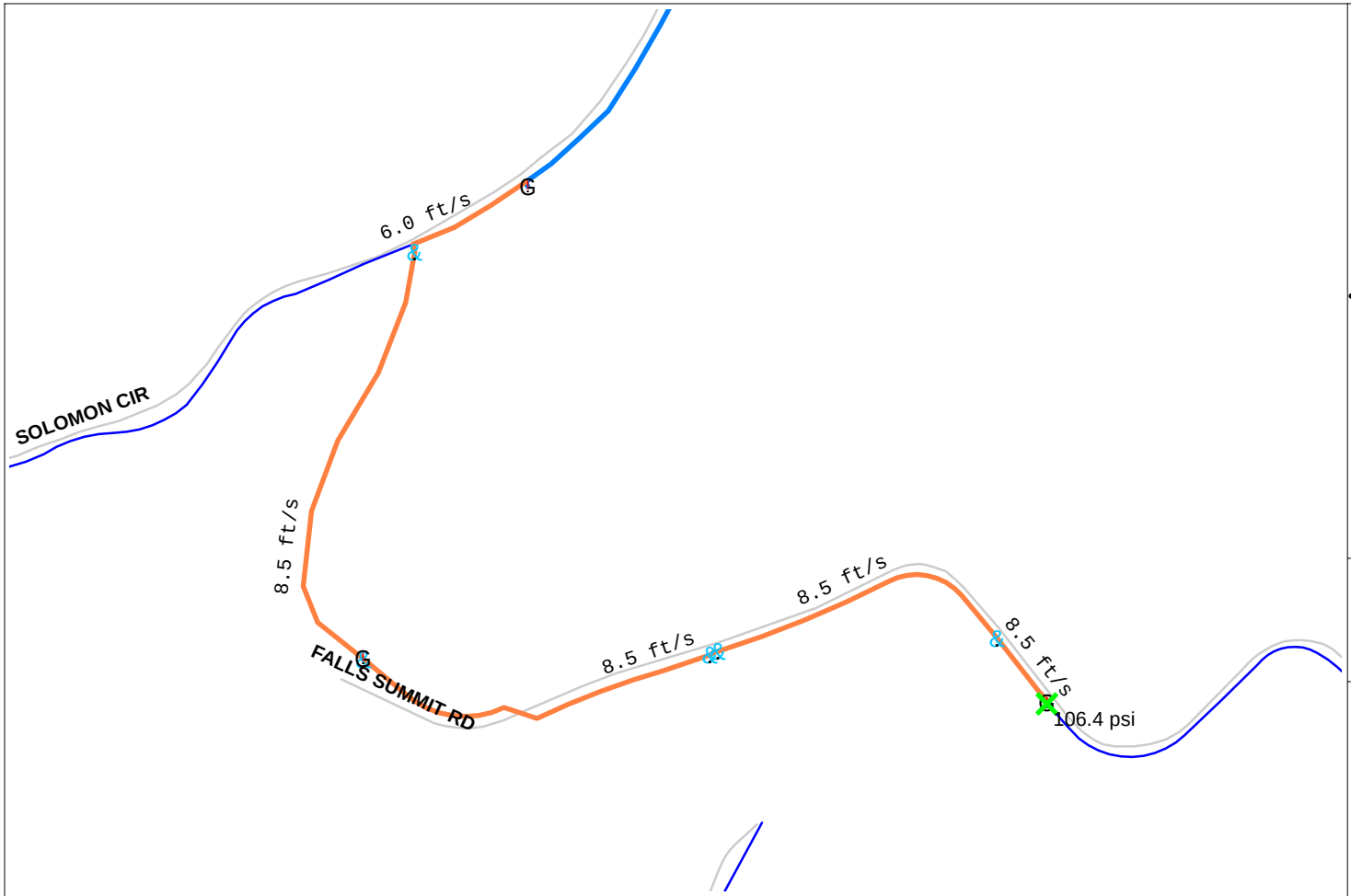
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	46	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	70.45040 psi				
Duration	11 min.	Open Hydrant	10-3198	Res. Pressure	35.98760 psi		Turbidity		
Valves to Open				Discharge Flow	833.90496		Disinf. Res.		
				Available Flow	1,015.42112		pH		
Valves to Close				Total Pipe Len.	1,516.9 ft		Iron		
				Min Flushing Vol	400.09960		Odor		
Pipes to Flush	P-12267,P-6073,P-6075,PLATFH-10-3198			Desired Flushing Vol	1,200.29890		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

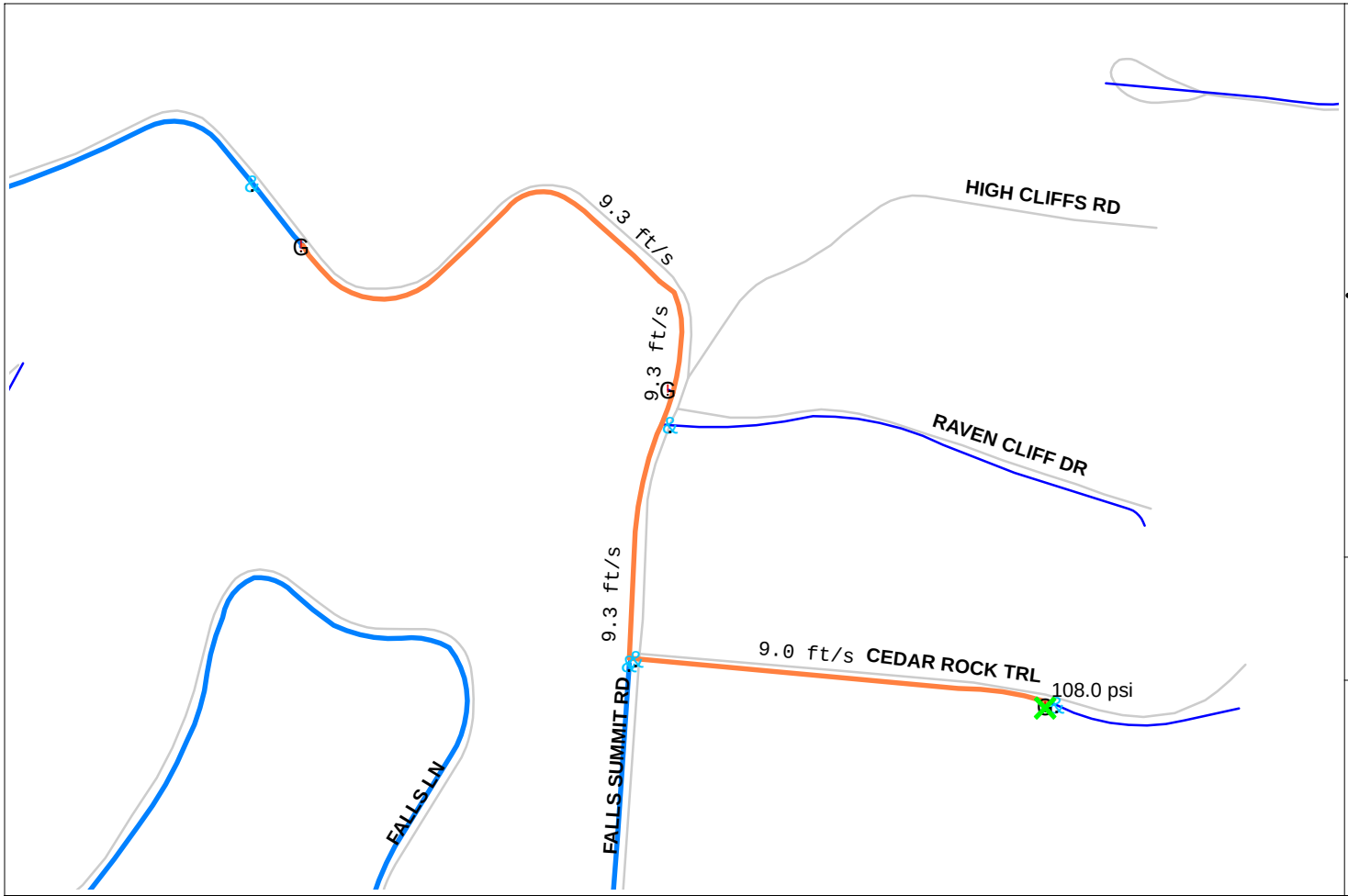
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	47	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	114.21030				
Duration	11 min.	Open Hydrant	10-2908	Res. Pressure	106.35200		Turbidity		
Valves to Open				Discharge Flow	716.13472		Disinf. Res.		
				Available Flow	1,205.20064		pH		
Valves to Close				Total Pipe Len.	1,785.7 ft		Iron		
				Min Flushing Vol	349.27460		Odor		
Pipes to Flush	P-10381,P-10383,P-1691,PI-2033,PI-2035,PI-2275,PI-2281,PI-6323,PLATFH-10-2908			Desired Flushing Vol	1,047.82380		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

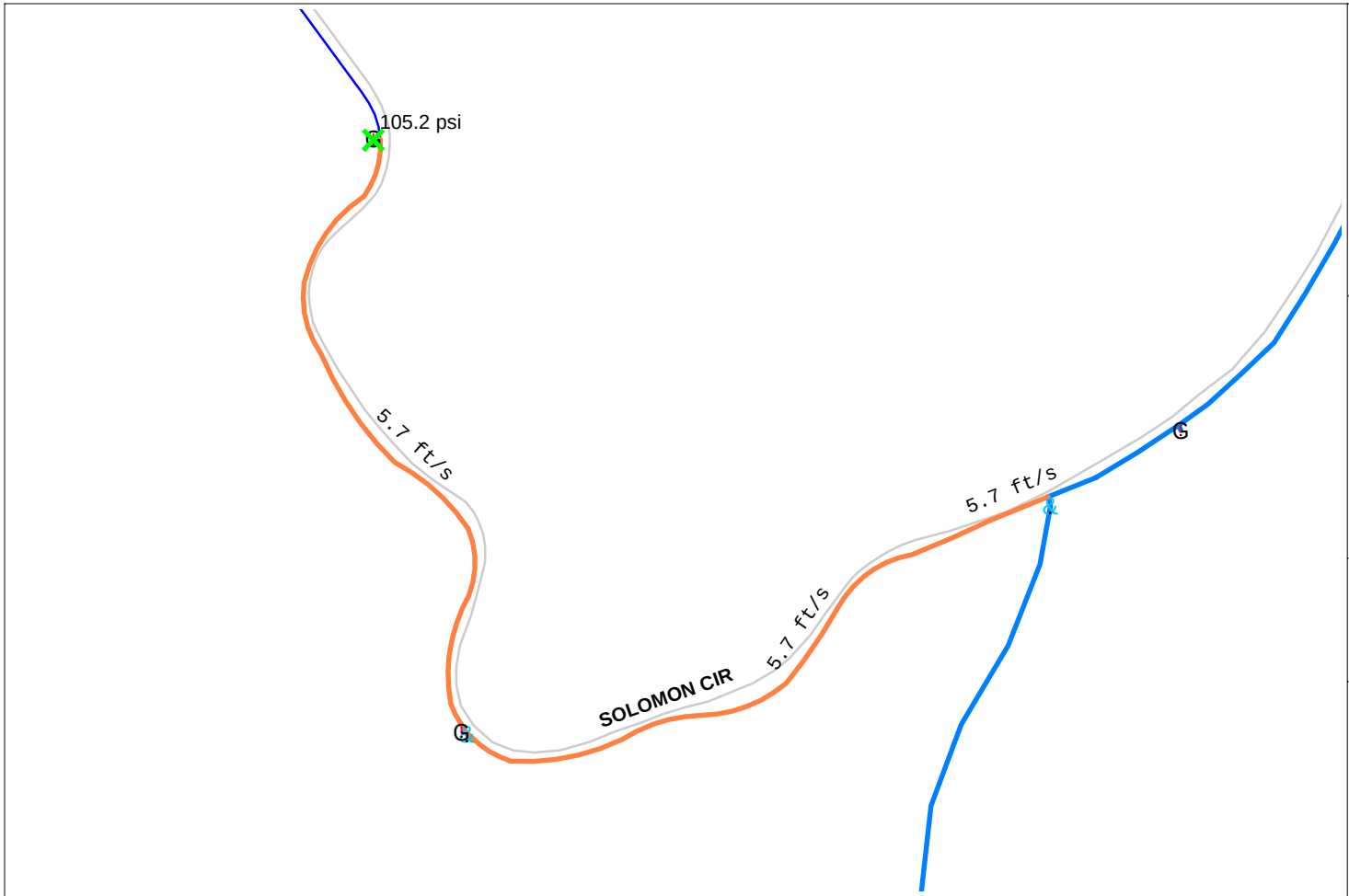
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	48	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	154.46640				
Duration	9 min.	Open Hydrant	10-2906	Res. Pressure	108.01330		Turbidity		
Valves to Open				Discharge Flow	793.83808		Disinf. Res.		
				Available Flow	1,139.51040		pH		
Valves to Close				Total Pipe Len.	1,675.6 ft		Iron		
				Min Flushing Vol	321.10020		Odor		
Pipes to Flush	P-12307,P-1935,P-1937,P-1941,PI-2277,PLATFH-10-2906			Desired Flushing Vol	963.30070		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

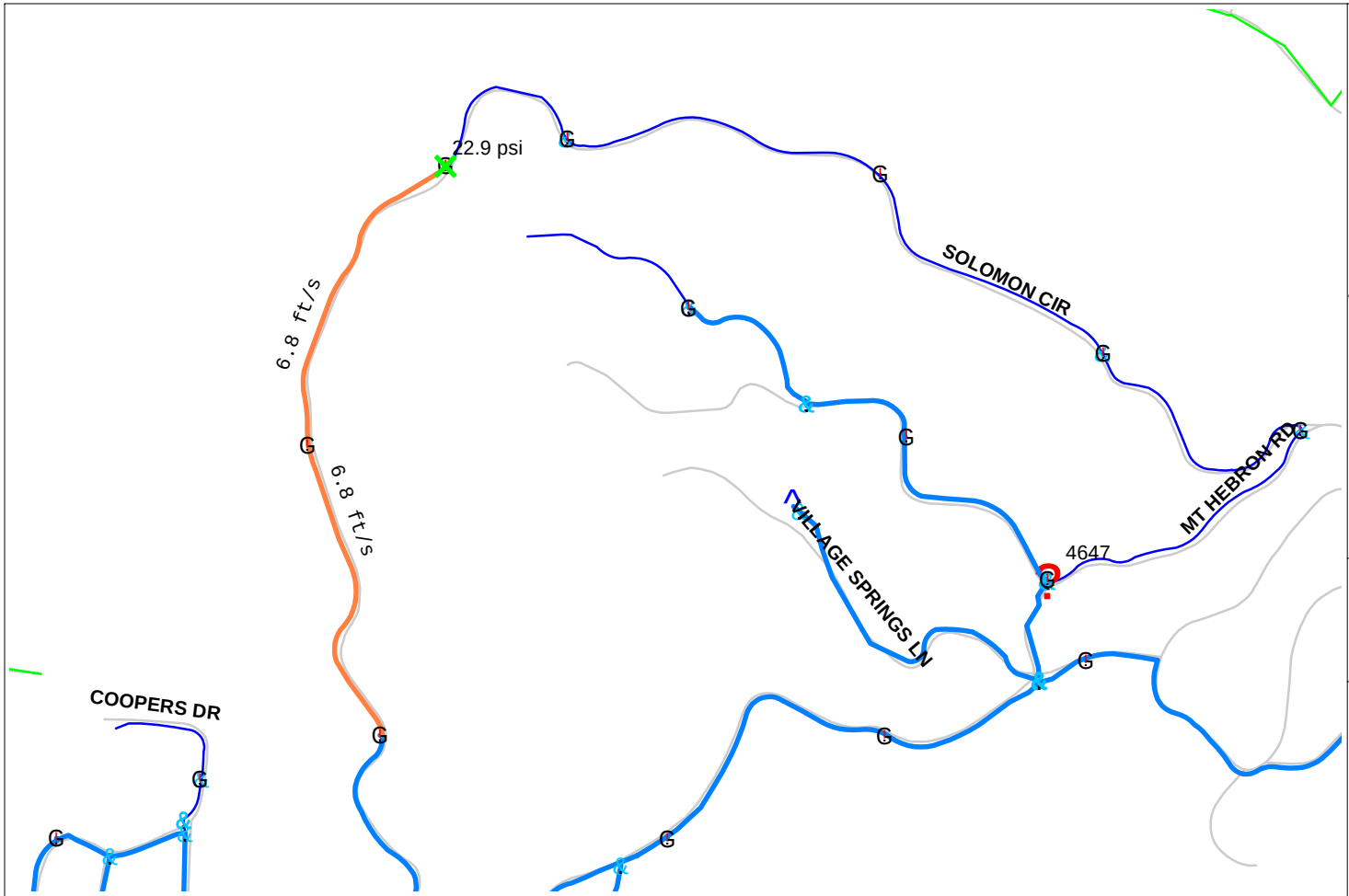
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	49	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	151.04730				
Duration	13 min.	Open Hydrant	10-3202	Res. Pressure	105.18710		Turbidity		
Valves to Open				Discharge Flow	855.50080		Disinf. Res.		
				Available Flow	1,476.84992		pH		
Valves to Close				Total Pipe Len.	1,532.2 ft		Iron		
				Min Flushing Vol	508.56370		Odor		
Pipes to Flush	P-1693,P-6067,P-6069,PI-6333,PLATFH-10-3202			Desired Flushing Vol	1,525.69120		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	13 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

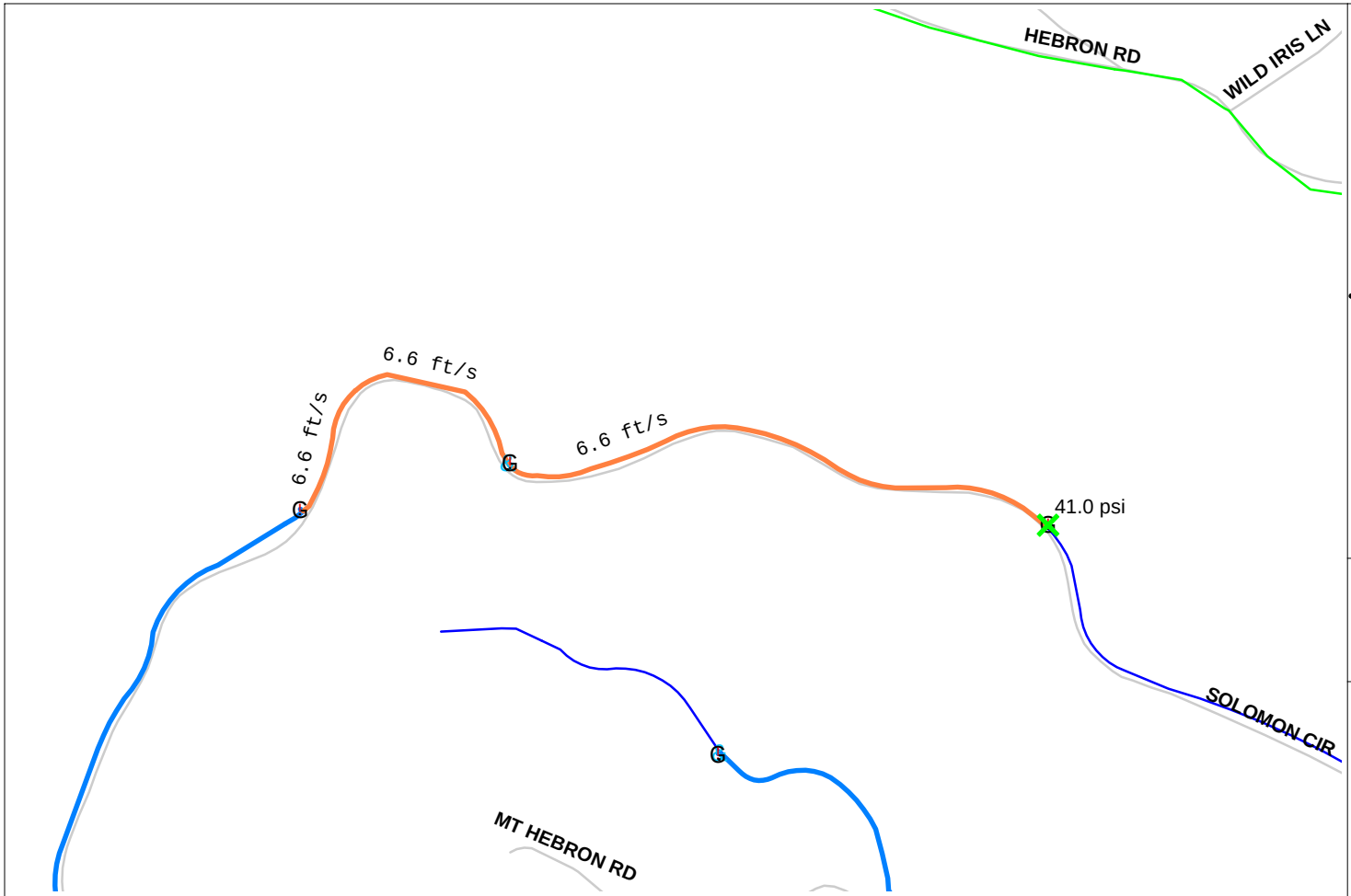
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	50	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	96.39180 psi				
Duration	15 min.	Open Hydrant	10-3206	Res. Pressure	22.89590 psi		Turbidity		
Valves to Open				Discharge Flow	598.29504		Disinf. Res.		
				Available Flow	611.14144		pH		
Valves to Close	4647			Total Pipe Len.	2,055.2 ft		Iron		
				Min Flushing Vol	402.40230		Odor		
Pipes to Flush	P-12285,P-6063,P-6071,PLATFH-10-3206			Desired Flushing Vol	1,207.20680		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	15 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

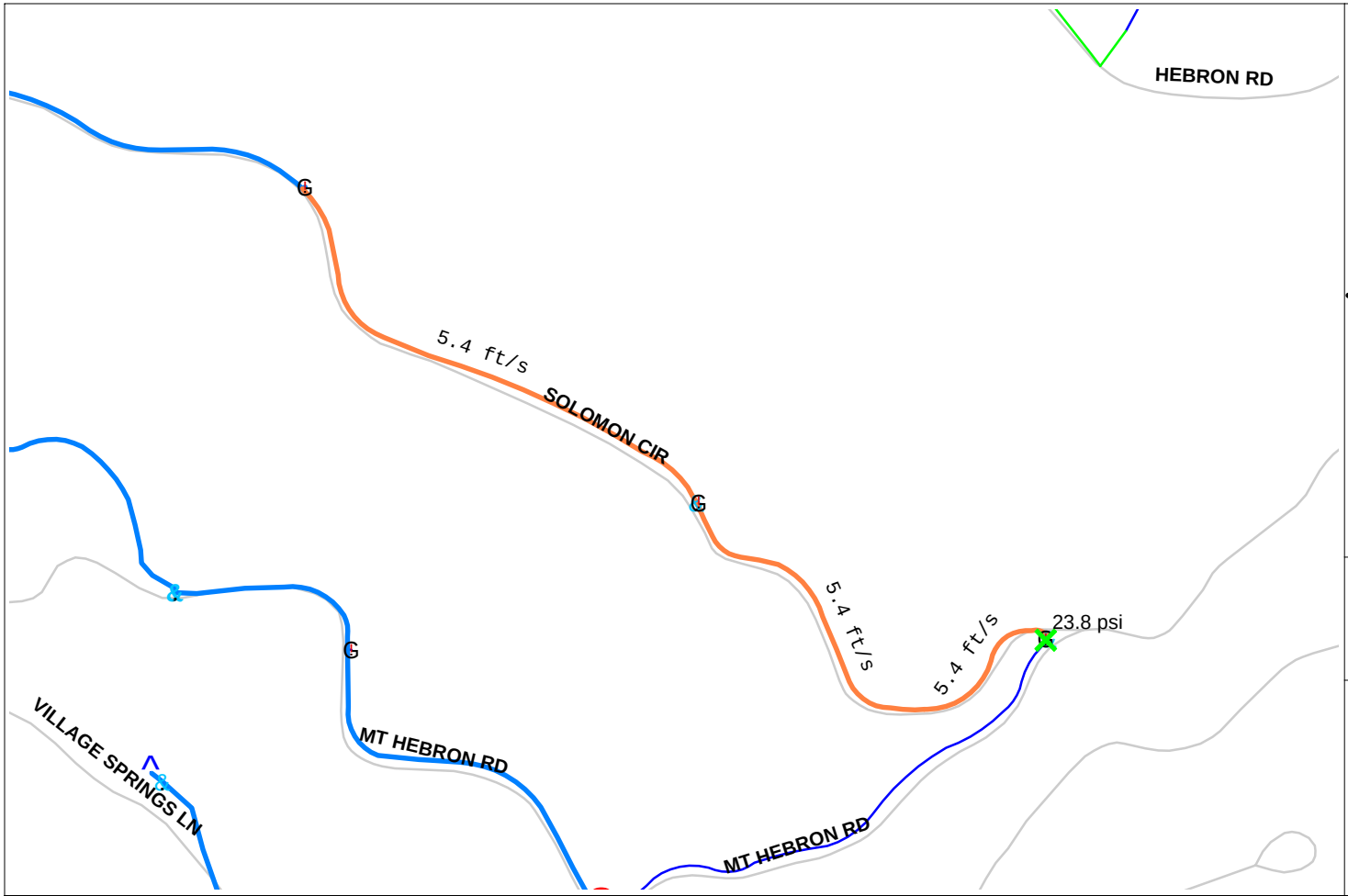
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	51	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	128.88910				
Duration	13 min.	Open Hydrant	10-3210	Res. Pressure	40.99870 psi		Turbidity		
Valves to Open				Discharge Flow	578.08800		Disinf. Res.		
				Available Flow	651.48608		pH		
Valves to Close	(4647)			Total Pipe Len.	1,661.5 ft		Iron		
				Min Flushing Vol	325.67510		Odor		
Pipes to Flush	P-14183,P-6065,P-6079,PI-6321,PLATFH-10-3210			Desired Flushing Vol	977.02540		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	13 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

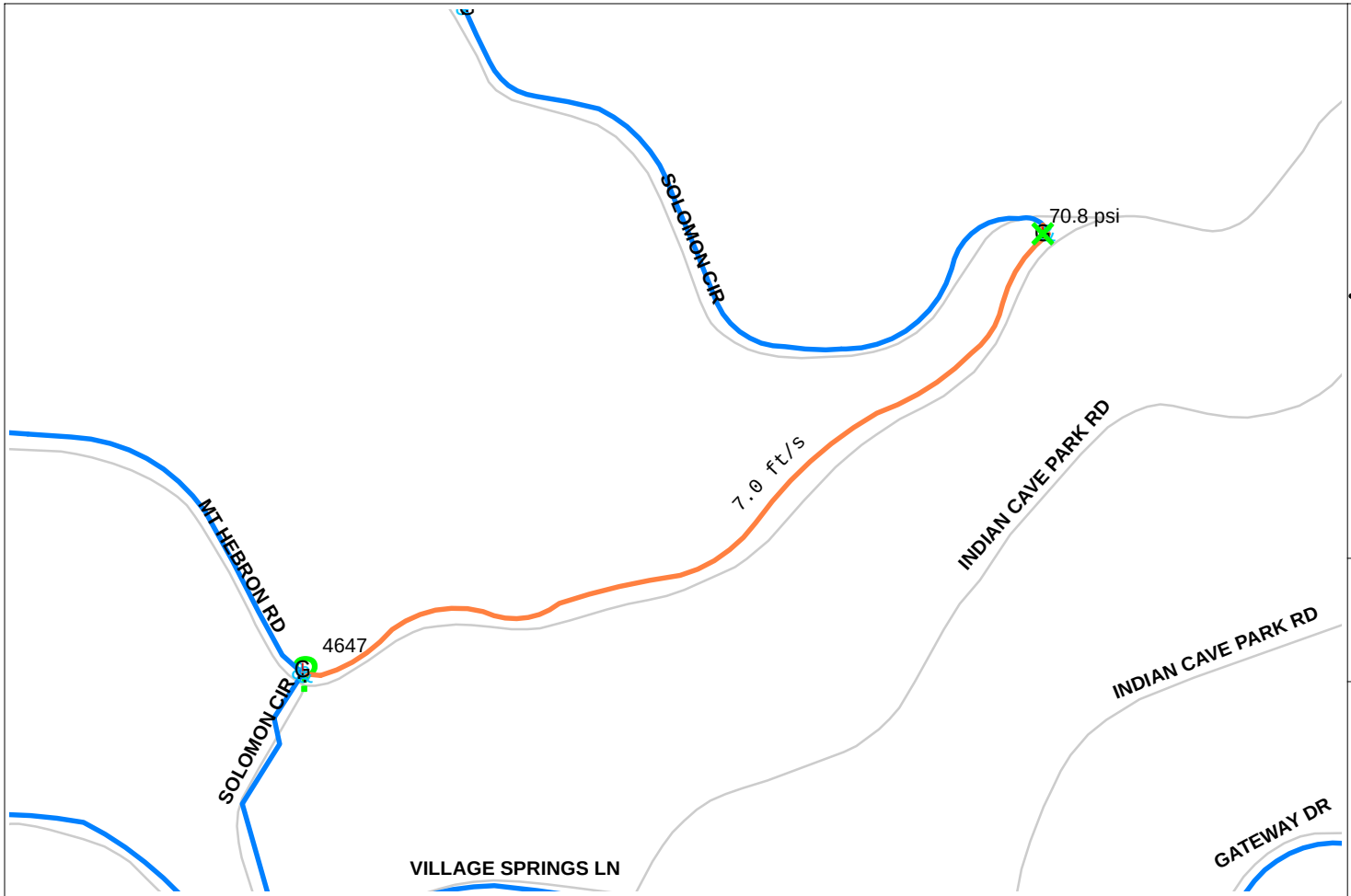
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	52	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	99.85800 psi				
Duration	17 min.	Open Hydrant	10-3222	Res. Pressure	23.79670 psi		Turbidity		
Valves to Open				Discharge Flow	474.34464		Disinf. Res.		
				Available Flow	488.30208		pH		
Valves to Close	(4647)			Total Pipe Len.	1,850.1 ft		Iron		
				Min Flushing Vol	362.77290		Odor		
Pipes to Flush	P-12319,P-14181,P-6081,PLATFH-10-3222			Desired Flushing Vol	1,088.31860		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	17 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

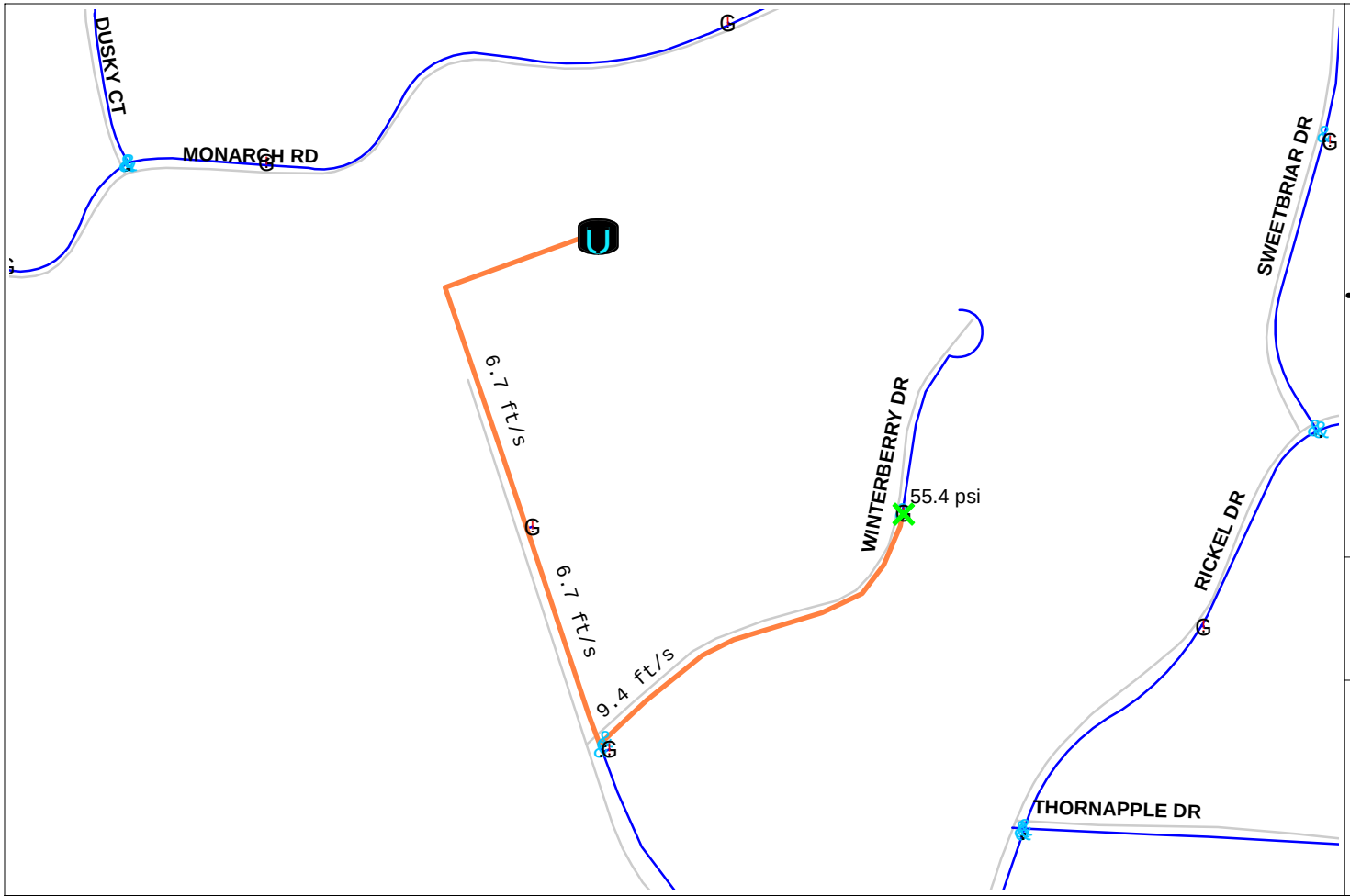
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4A	Sequence	53	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	99.95090 psi				
Duration	7 min.	Open Hydrant	10-3222	Res. Pressure	70.80420 psi		Turbidity		
Valves to Open	4647			Discharge Flow	818.41984		Disinf. Res.		
				Available Flow	1,368.52352		pH		
Valves to Close				Total Pipe Len.	1,007.3 ft		Iron		
				Min Flushing Vol	260.39110		Odor		
Pipes to Flush	P-6057,P-6077,PI-6319,PLATFH-10-3222			Desired Flushing Vol	781.17320		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Date: 7/29/2016 3:22:56 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

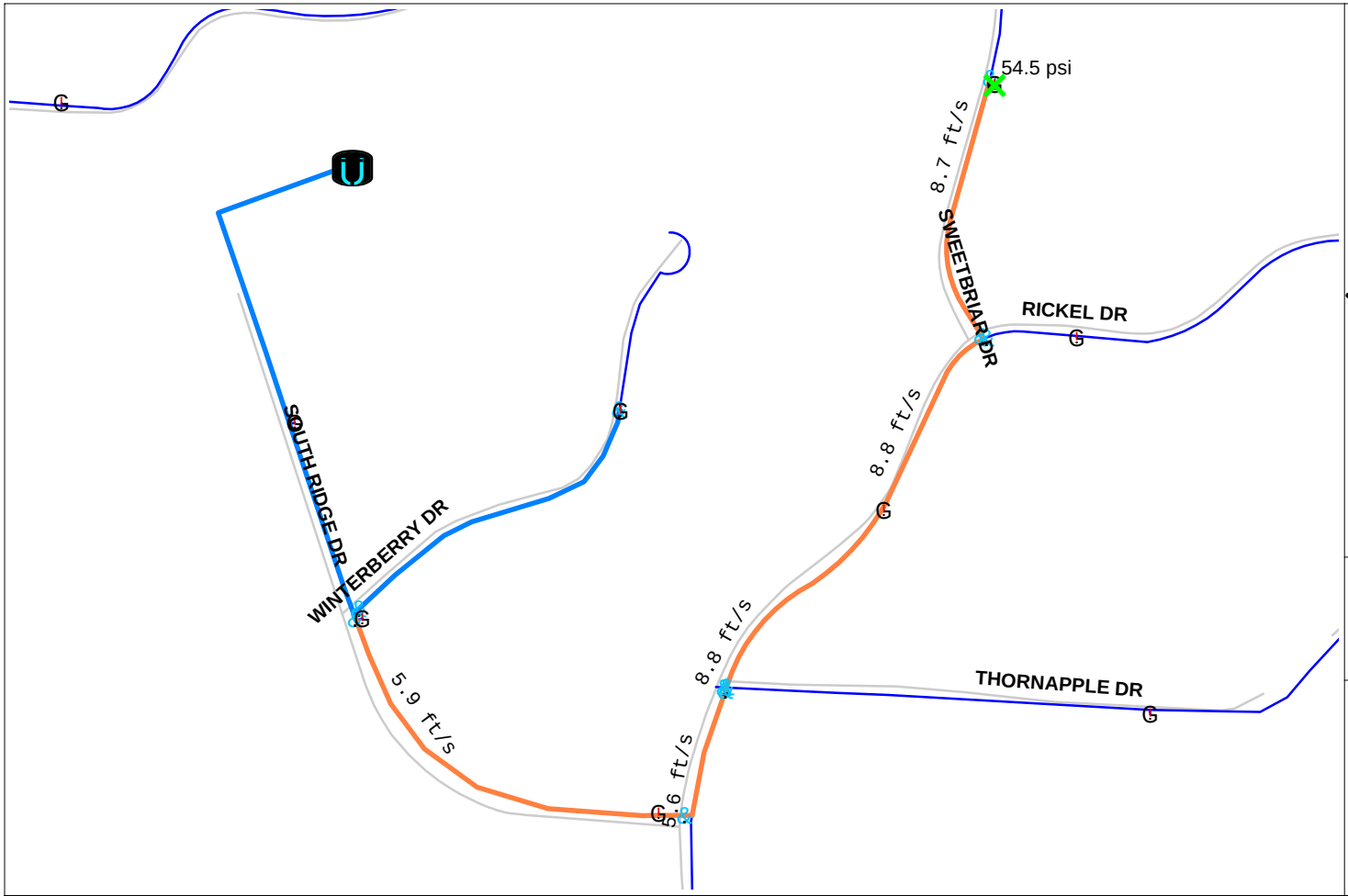
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	78.23810 psi				
Duration	11 min.	Open Hydrant	10-2306	Res. Pressure	55.39770 psi		Turbidity		
Valves to Open				Discharge Flow	827.65536		Disinf. Res.		
				Available Flow	1,328.45664		pH		
Valves to Close				Total Pipe Len.	1,681.1 ft		Iron		
				Min Flushing Vol	412.40090		Odor		
Pipes to Flush	P-6869,P-6871,PI-8361,PLATFH-10-2306			Desired Flushing Vol	1,237.20280		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Date: 7/27/2016 5:26:17 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

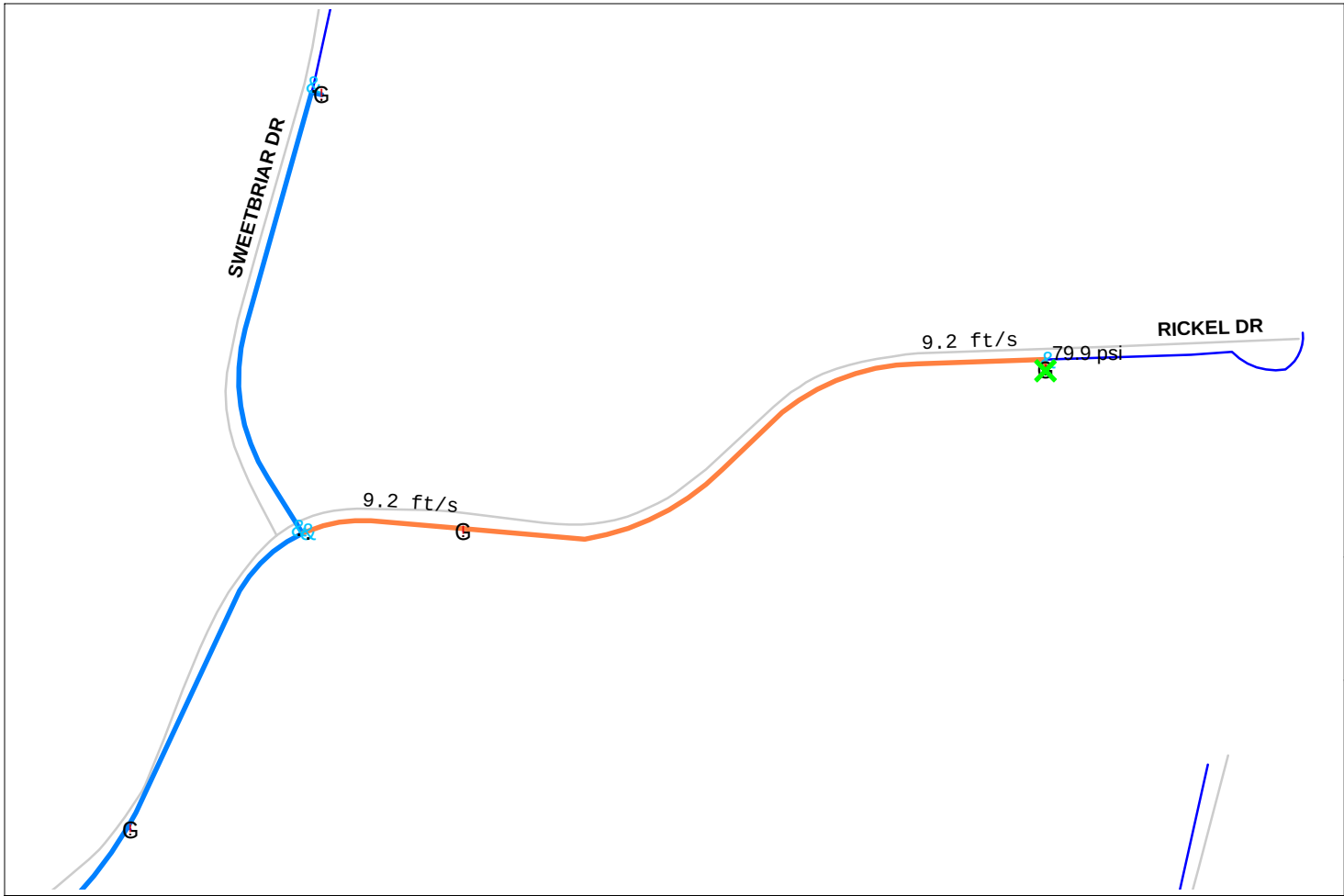
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	93.35590 psi				
Duration	16 min.	Open Hydrant	10-2321	Res. Pressure	54.45830 psi		Turbidity		
Valves to Open				Discharge Flow	769.32576		Disinf. Res.		
				Available Flow	1,065.07072		pH		
Valves to Close				Total Pipe Len.	2,337.8 ft		Iron		
				Min Flushing Vol	560.47550		Odor		
Pipes to Flush	P-13711,P-13865,P-6873,P-6875,P-8055,PI-7207,PI-8367,PLATFH-10-2321			Desired Flushing Vol	1,681.42650		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Date: 7/27/2016 5:26:17 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

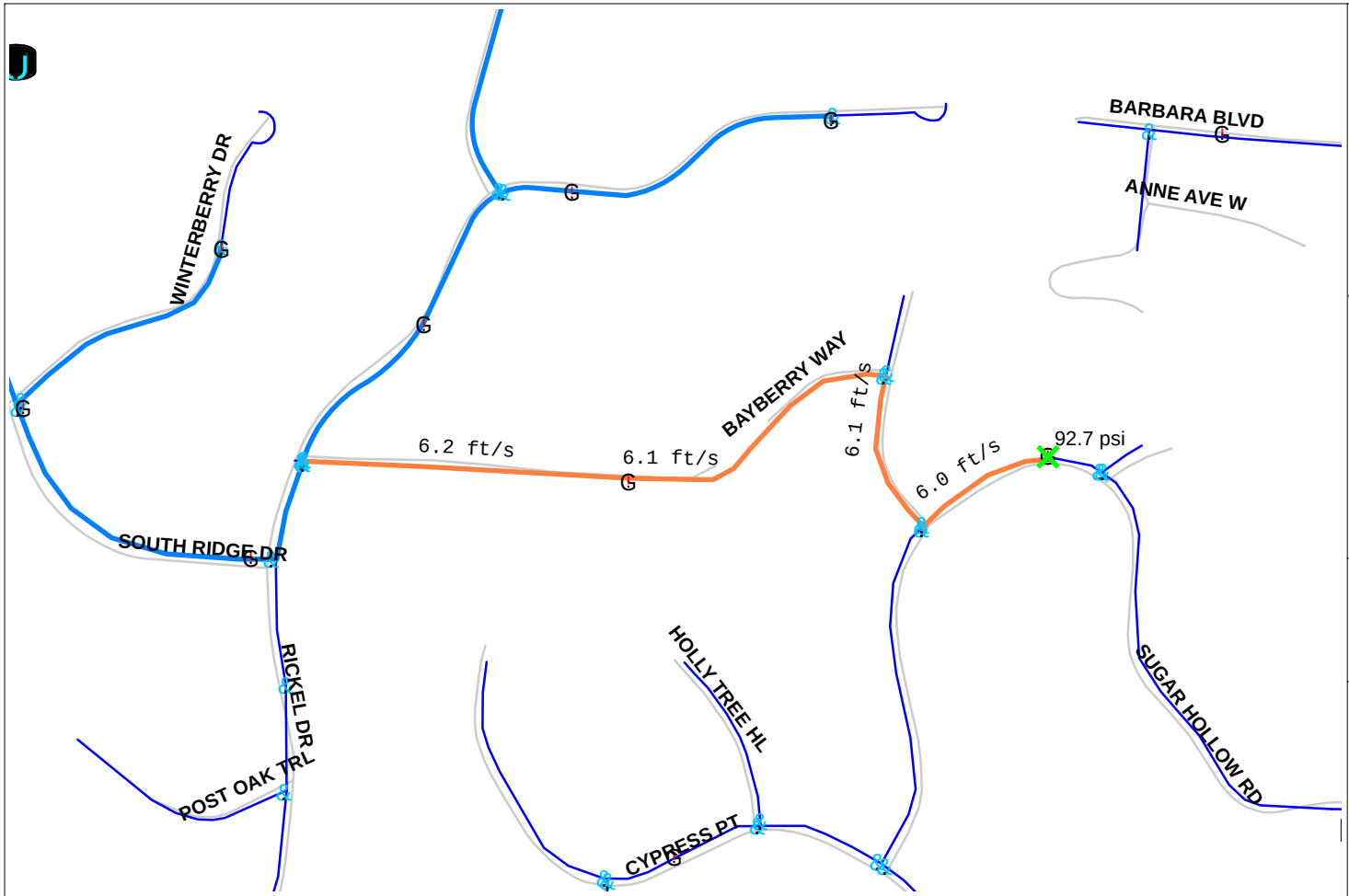
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	128.45280				
Duration	5 min.	Open Hydrant	10-2331	Res. Pressure	79.87910 psi		Turbidity		
Valves to Open				Discharge Flow	807.93440		Disinf. Res.		
				Available Flow	1,220.06080		pH		
Valves to Close				Total Pipe Len.	849.3 ft		Iron		
				Min Flushing Vol	166.61870		Odor		
Pipes to Flush	P-13867,P-8053,PLATFH-10-2331			Desired Flushing Vol	499.85600		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

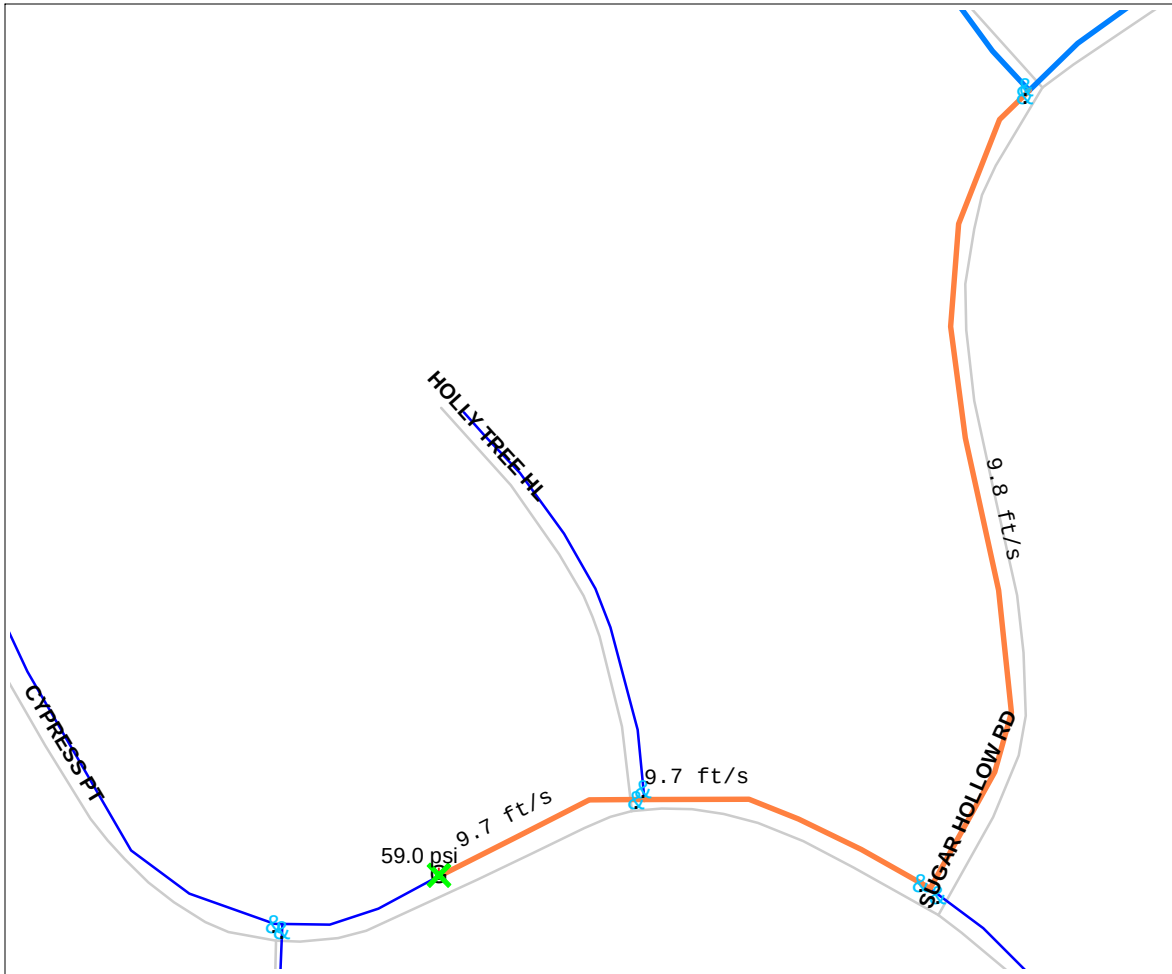
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	139.63960				
Duration	18 min.	Open Hydrant	10-3228	Res. Pressure	92.68940 psi		Turbidity		
Valves to Open				Discharge Flow	869.11104		Disinf. Res.		
				Available Flow	1,390.60544		pH		
Valves to Close				Total Pipe Len.	2,212.9 ft		Iron		
				Min Flushing Vol	698.01570		Odor		
Pipes to Flush	P-6865,P-6881,PI-7183,PI-7185,PLATFH-10-3228			Desired Flushing Vol	2,094.04720		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	18 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

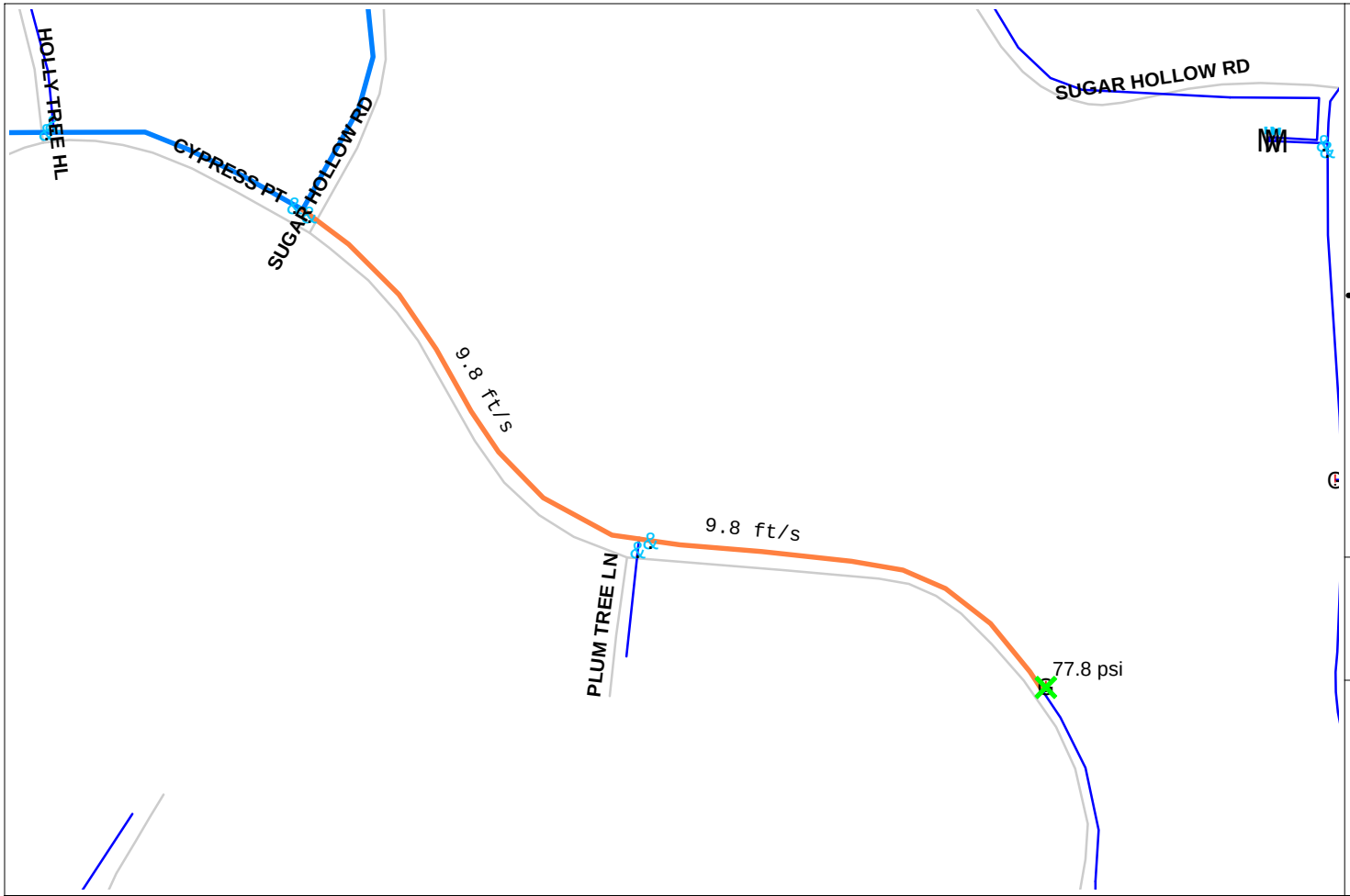
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	131.87890				
Duration	7 min.	Open Hydrant	10-3230	Res. Pressure	58.97560 psi		Turbidity		
Valves to Open				Discharge Flow	854.45920		Disinf. Res.		
				Available Flow	1,064.16800		pH		
Valves to Close				Total Pipe Len.	1,369.4 ft		Iron		
				Min Flushing Vol	266.86960		Odor		
Pipes to Flush	P-6857,P-6879,PI-7181,PI-7191,PI-7213,PLATFH-10-3230			Desired Flushing Vol	800.60890		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

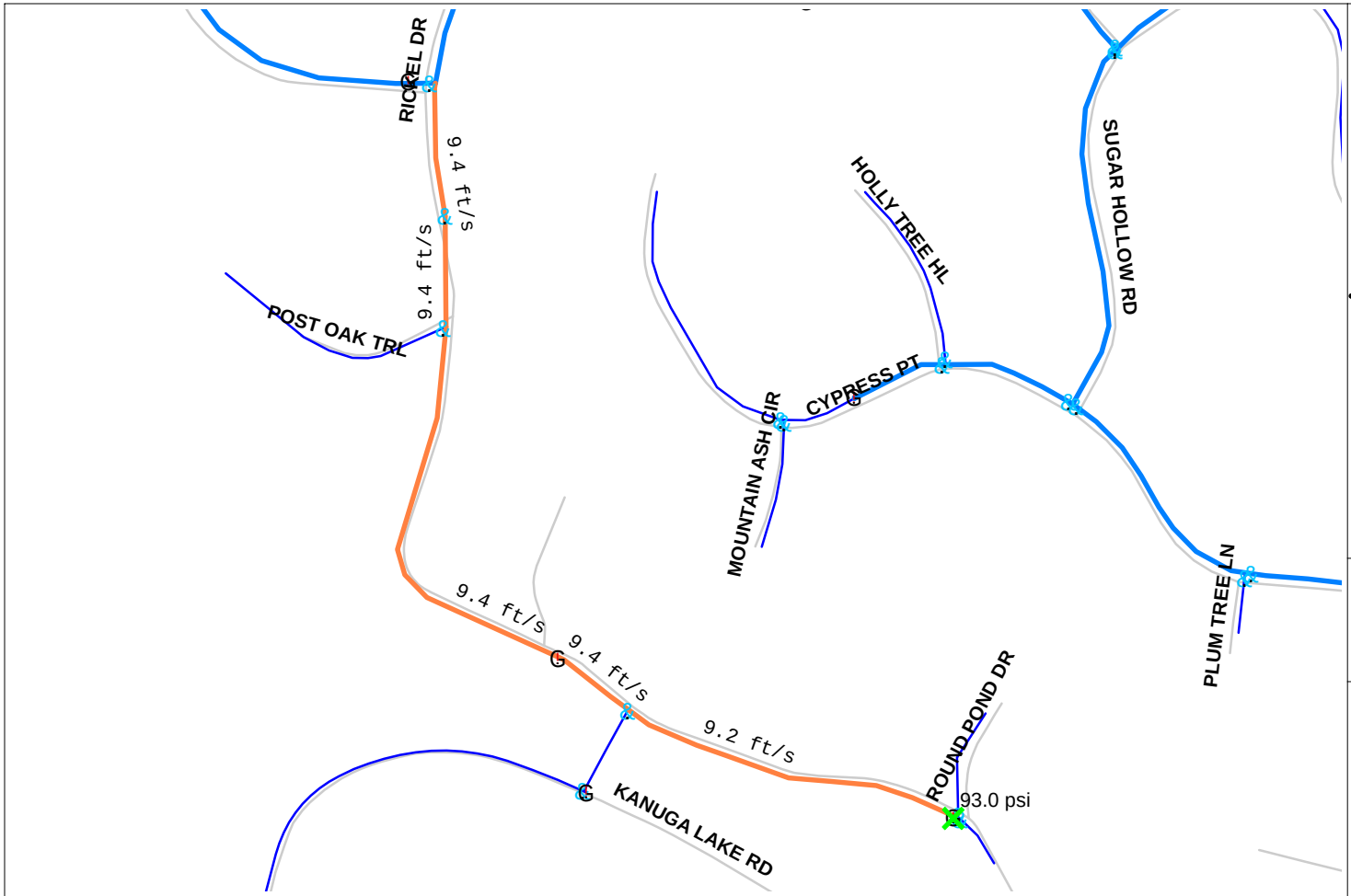
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	163.94290				
Duration	6 min.	Open Hydrant	10-3232	Res. Pressure	77.81670 psi		Turbidity		
Valves to Open				Discharge Flow	857.58400		Disinf. Res.		
				Available Flow	1,121.38656		pH		
Valves to Close				Total Pipe Len.	1,080.1 ft		Iron		
				Min Flushing Vol	211.38480		Odor		
Pipes to Flush	P-6883,PI-7199,PI-7215,PLATFH-10-3232			Desired Flushing Vol	634.15440		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

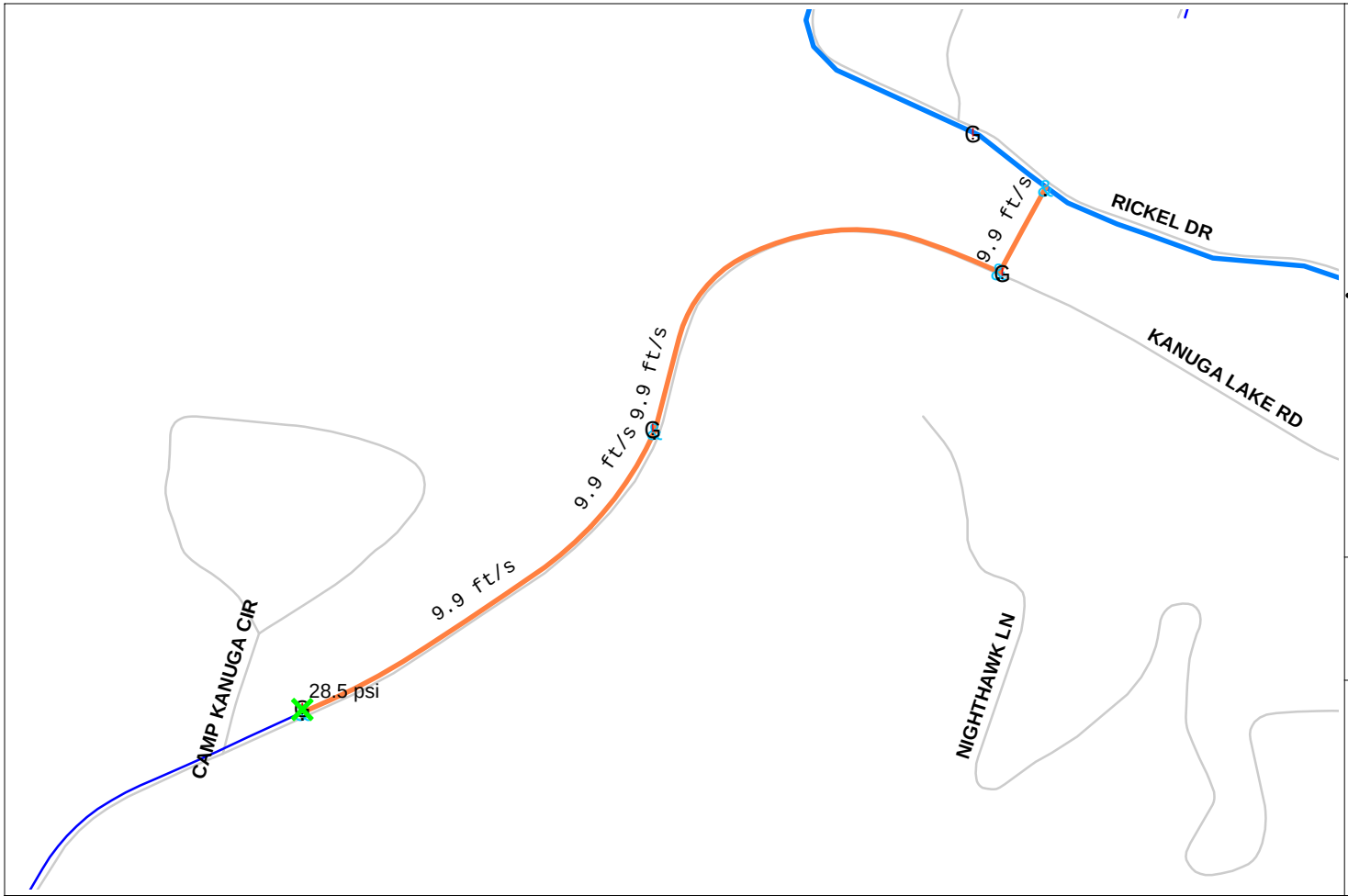
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	162.98560				
Duration	13 min.	Open Hydrant	10-2281	Res. Pressure	93.00580 psi		Turbidity		
Valves to Open				Discharge Flow	806.68448		Disinf. Res.		
				Available Flow	1,173.81376		pH		
Valves to Close				Total Pipe Len.	2,489.9 ft		Iron		
				Min Flushing Vol	479.69810		Odor		
Pipes to Flush	P-10000,P-13853,P-13859,P-13861,P-6867,PLATFH-10-2281			Desired Flushing Vol	1,439.09430		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	13 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

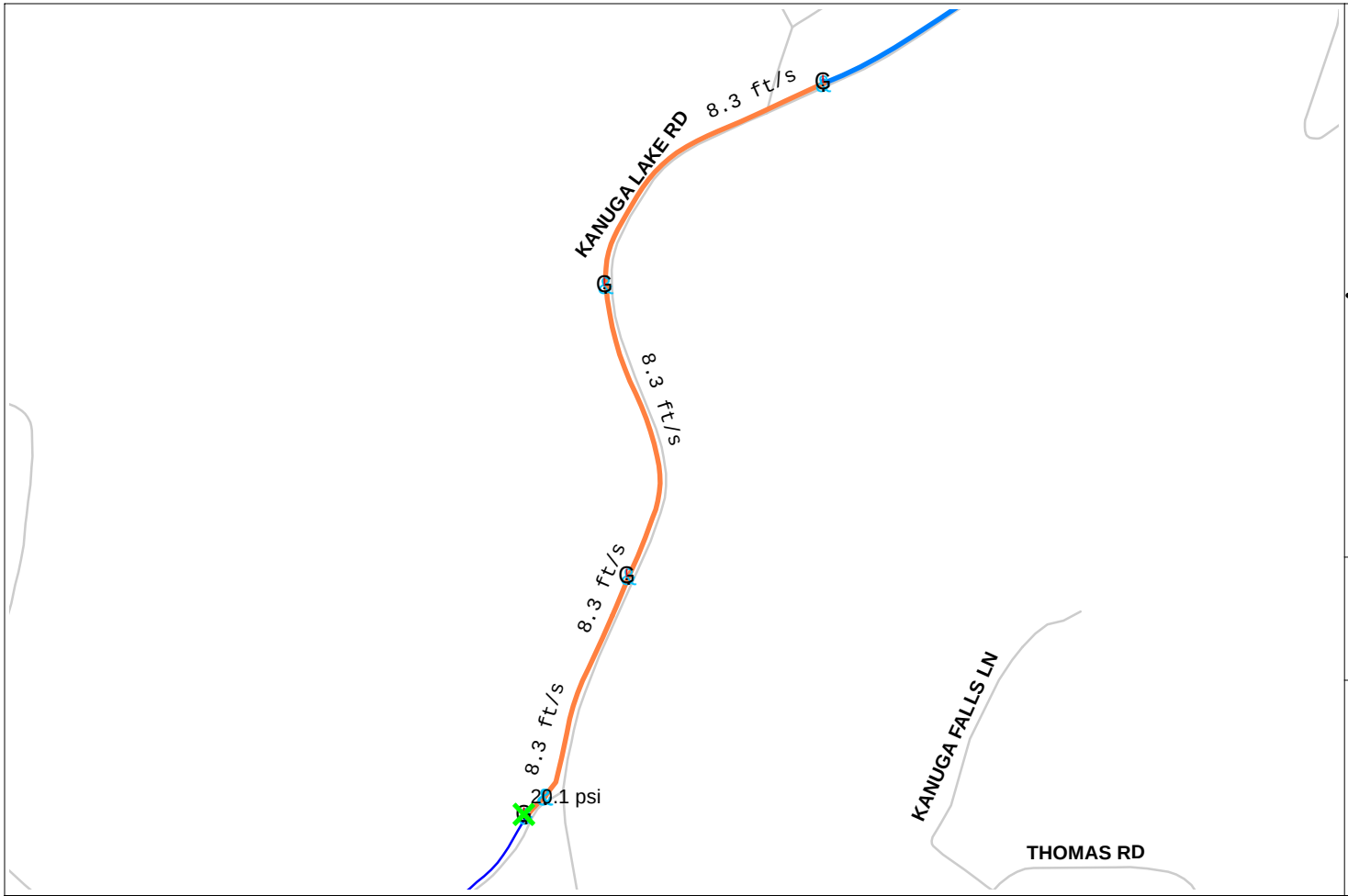
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	8	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	130.44480				
Duration	11 min.	Open Hydrant	10-3182	Res. Pressure	28.51040 psi		Turbidity		
Valves to Open				Discharge Flow	847.37632		Disinf. Res.		
				Available Flow	883.62400		pH		
Valves to Close				Total Pipe Len.	2,215.1 ft		Iron		
				Min Flushing Vol	424.34030		Odor		
Pipes to Flush	P-11323,P-17065,P-939,P-941,PI-1299,PI-1301,PLATFH-10-3182			Desired Flushing Vol	1,273.02100		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

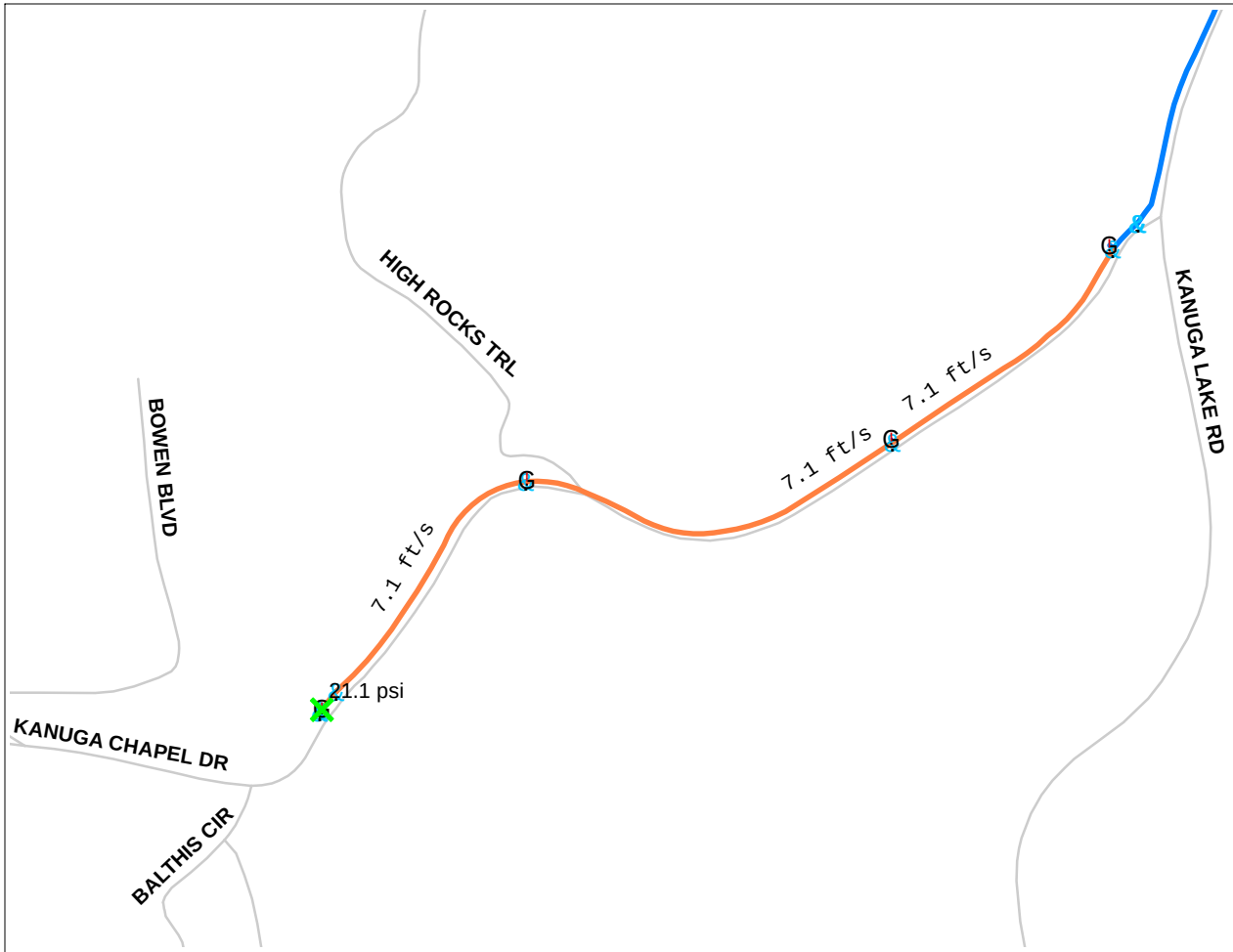
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE4B	Sequence	9	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	130.82630				
Duration	16 min.	Open Hydrant	10-3176	Res. Pressure	20.12600 psi		Turbidity		
Valves to Open				Discharge Flow	710.92672		Disinf. Res.		
				Available Flow	711.69056		pH		
Valves to Close				Total Pipe Len.	2,684.6 ft		Iron		
				Min Flushing Vol	512.02430		Odor		
Pipes to Flush	P-11317,P-943,P-945,P-947,P-949,PI-1303,PI-1305,PI-1307,PI-1309,PLATFH-10-3176			Desired Flushing Vol	1,536.07300		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Date: 7/27/2016 5:26:17 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

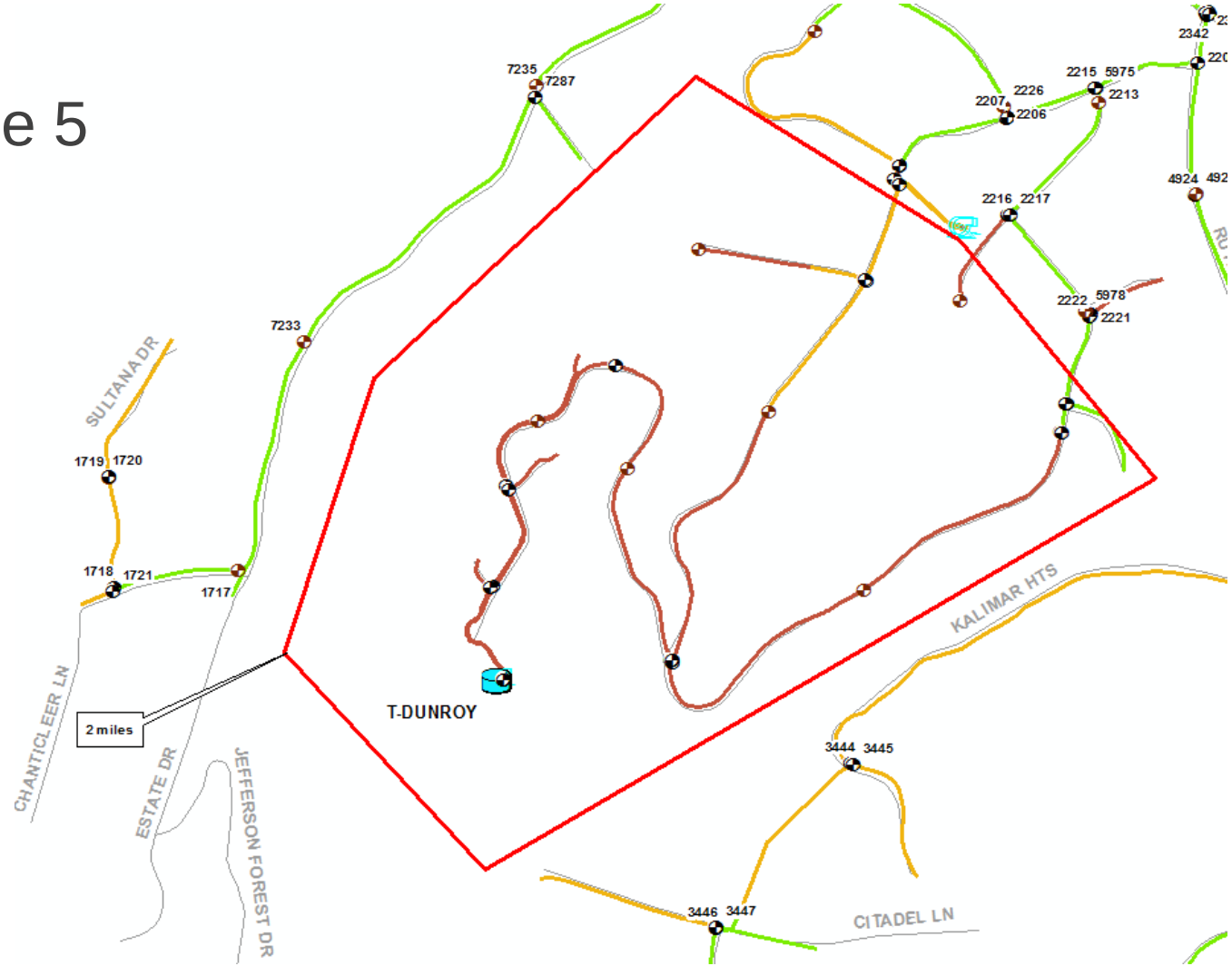
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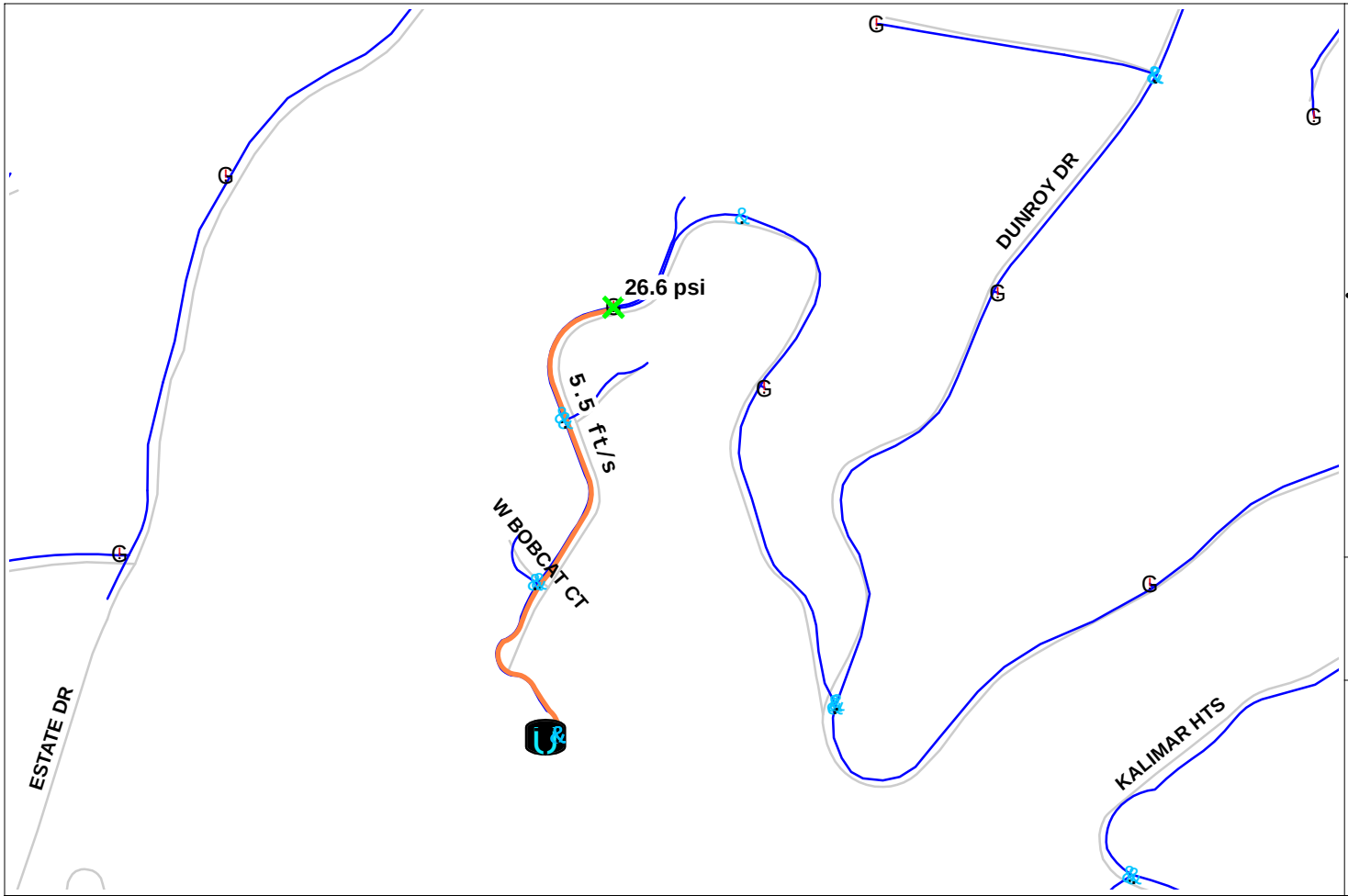
Zone	ZONE4B	Sequence	10	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	127.74920				
Duration	16 min.	Open Hydrant	10-3234	Res. Pressure	21.11160 psi		Turbidity		
Valves to Open				Discharge Flow	606.21120		Disinf. Res.		
				Available Flow	610.03040		pH		
Valves to Close				Total Pipe Len.	2,325.4 ft		Iron		
				Min Flushing Vol	441.60180		Odor		
Pipes to Flush	P-951,P-953,P-955,PI-1311,PI-1313,PI-1315,PI-1317,PLATFH-10-3234			Desired Flushing Vol	1,324.80540		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Zone 5


7235
7287
2342
2215
5975
2207
2226
2213
2206
4924
2216
2217
7233
2222
5978
2221
SULTANA DR
1719
1720
1718
1721
1717
KALIMAR HTS
T-DUNROY
2 miles
CHANTICLEER LN
ESTATE DR
JEFFERSON FOREST DR
3444
3445
3446
3447
CITADEL LN



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

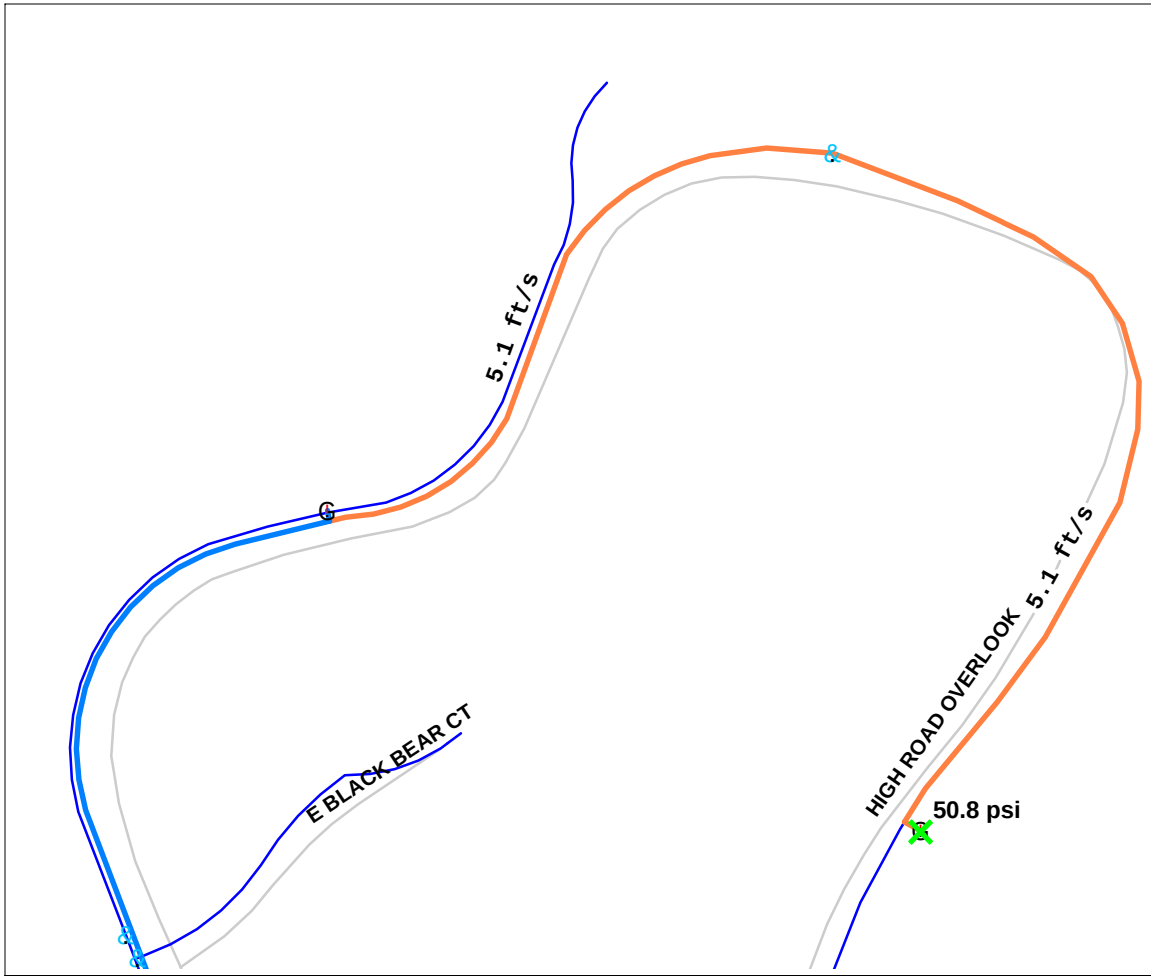
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE5	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	39.32500 psi				
Duration	9.8 min.	Open Hydrant	10-3236	Res. Pressure	26.59690 psi		Turbidity		
Valves to Open				Discharge Flow	817.23936		Disinf. Res.		
				Available Flow	1,006.67168		pH		
Valves to Close				Total Pipe Len.	1,081.8 ft		Iron		
				Min Flushing Vol	357.57640		Odor		
Pipes to Flush	P-11001,P-2665,P-DUNROY,PI-2981,PLATFH-10-3236			Desired Flushing Vol	1,072.72930		HPC		
				Min Flushing Time	3.3 min.		Color		
				Desired Flushing	9.8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

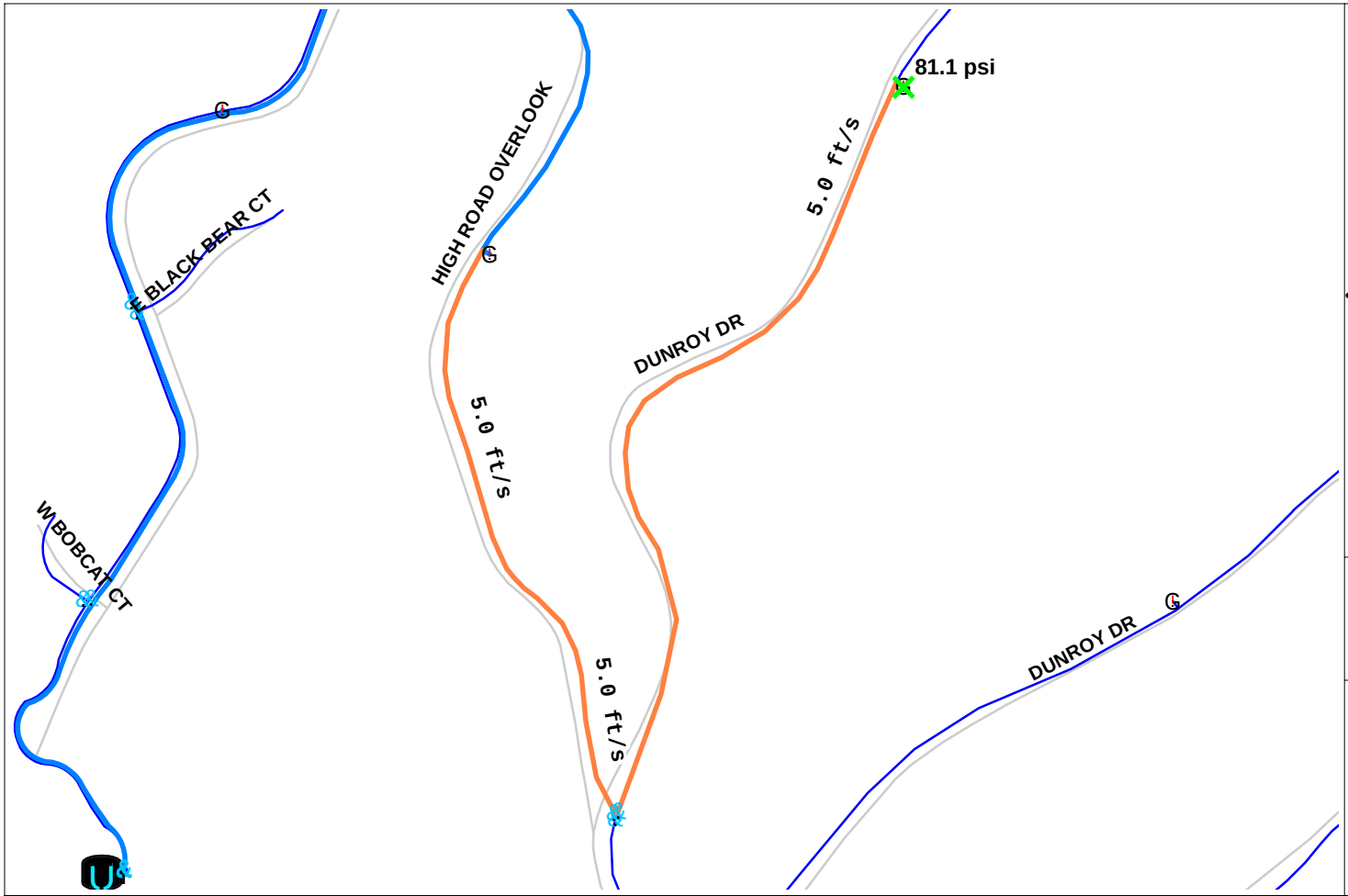
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE5	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	70.78980 psi				
Duration	8.0 min.	Open Hydrant	10-2823	Res. Pressure	50.77310 psi		Turbidity		
Valves to Open				Discharge Flow	791.68544		Disinf. Res.		
				Available Flow	1,244.29536		pH		
Valves to Close				Total Pipe Len.	820.8 ft		Iron		
				Min Flushing Vol	283.44400		Odor		
Pipes to Flush	P-7717,PI-2973,PLATFH-10-2823			Desired Flushing Vol	850.33210		HPC		
				Min Flushing Time	2.7 min.		Color		
				Desired Flushing	8.0 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/18/2016 5:24:44 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

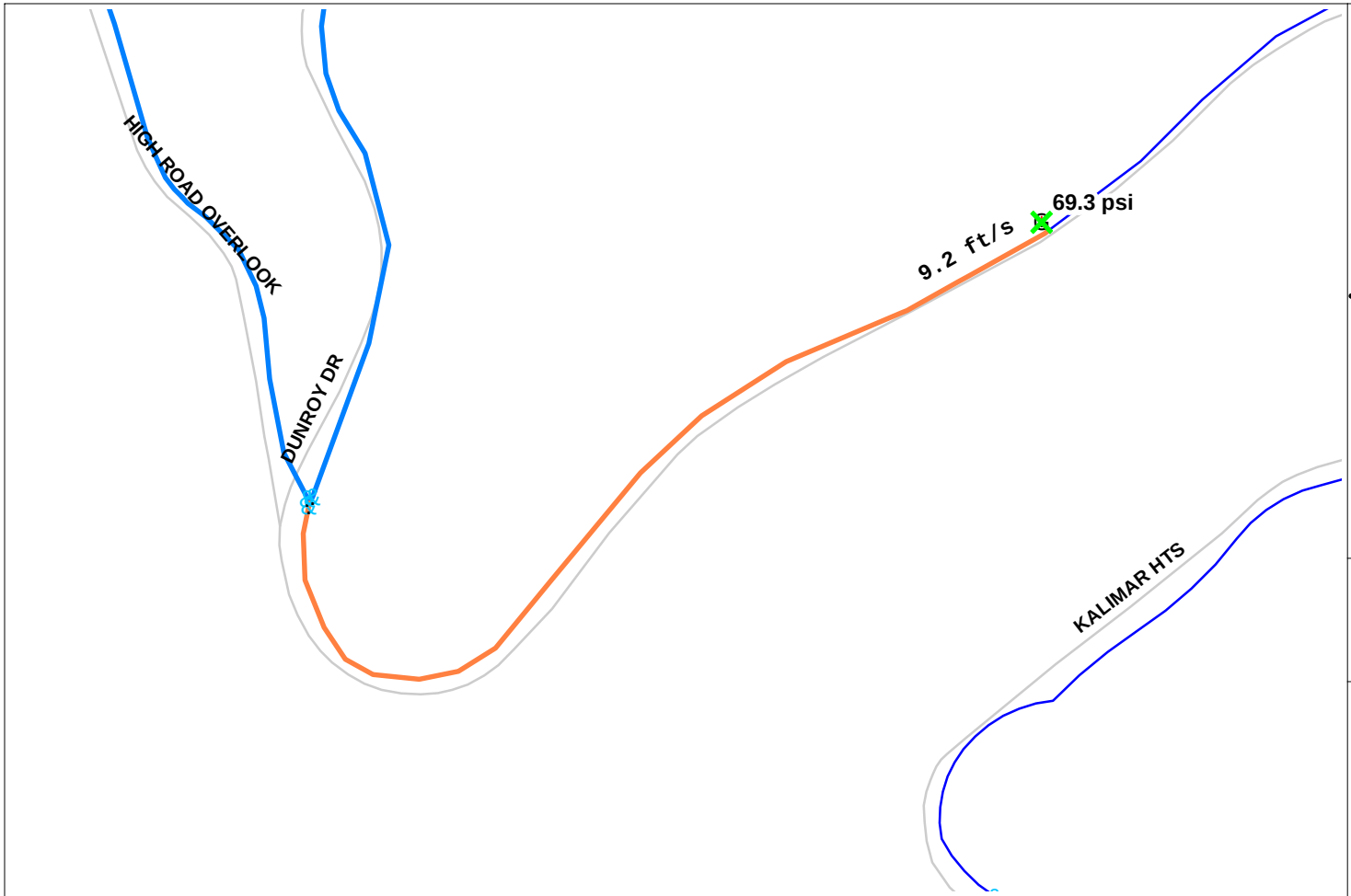
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE5	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	117.84670				
Duration	16.6 min.	Open Hydrant	10-2822	Res. Pressure	81.14210 psi		Turbidity		
Valves to Open				Discharge Flow	813.14240		Disinf. Res.		
				Available Flow	1,326.09568		pH		
Valves to Close				Total Pipe Len.	1,669.6 ft		Iron		
				Min Flushing Vol	600.77290		Odor		
Pipes to Flush	P-10987,P-10989,P-7709,PI-8025,PLATFH-10-2822			Desired Flushing Vol	1,802.31880		HPC		
				Min Flushing Time	5.5 min.		Color		
				Desired Flushing	16.6 min.		Other		

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Date: 7/18/2016 5:24:44 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

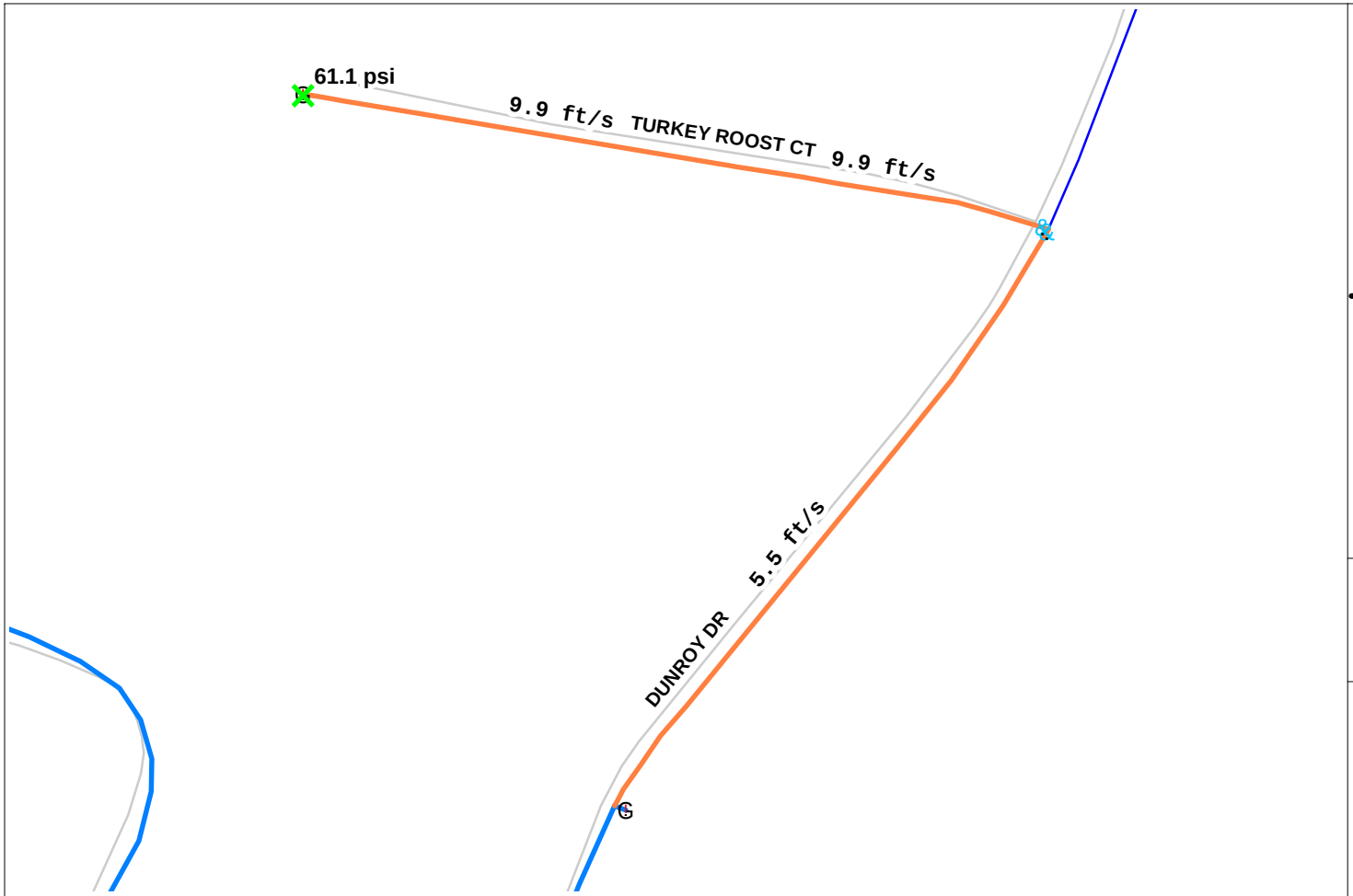
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE5	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	114.83080				
Duration	4.9 min.	Open Hydrant	10-2824	Res. Pressure	69.26050 psi		Turbidity		
Valves to Open				Discharge Flow	809.11488		Disinf. Res.		
				Available Flow	1,175.34144		pH		
Valves to Close				Total Pipe Len.	893.6 ft		Iron		
				Min Flushing Vol	175.13060		Odor		
Pipes to Flush	P-7711,PI-8023,PLATFH-10-2824			Desired Flushing Vol	525.39180		HPC		
				Min Flushing Time	1.6 min.		Color		
				Desired Flushing	4.9 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/18/2016 5:24:44 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

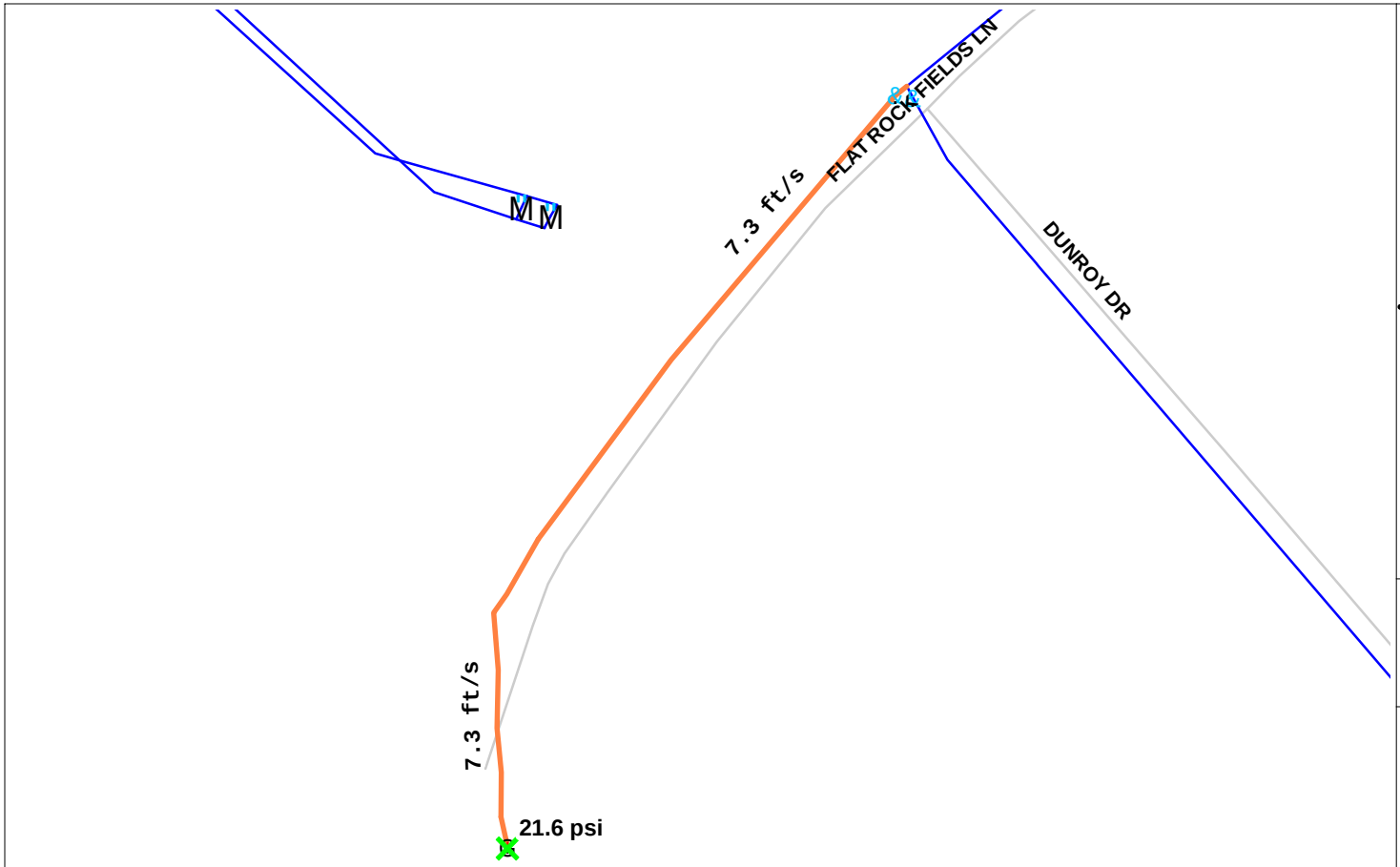
UNIDIRECTIONAL FLUSHING PROGRAM

Note:

Zone	ZONE5	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	121.07510				
Duration	7.8 min.	Open Hydrant	10-2821	Res. Pressure	61.14630 psi		Turbidity		
Valves to Open				Discharge Flow	868.76384		Disinf. Res.		
				Available Flow	1,134.16352		pH		
Valves to Close				Total Pipe Len.	1,106.9 ft		Iron		
				Min Flushing Vol	302.45310		Odor		
Pipes to Flush	P-11013,P-7719,PI-8021,PI-8029,PLATFH-10-2821			Desired Flushing Vol	907.35930		HPC		
				Min Flushing Time	2.6 min.		Color		
				Desired Flushing	7.8 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/18/2016 5:24:44 PM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

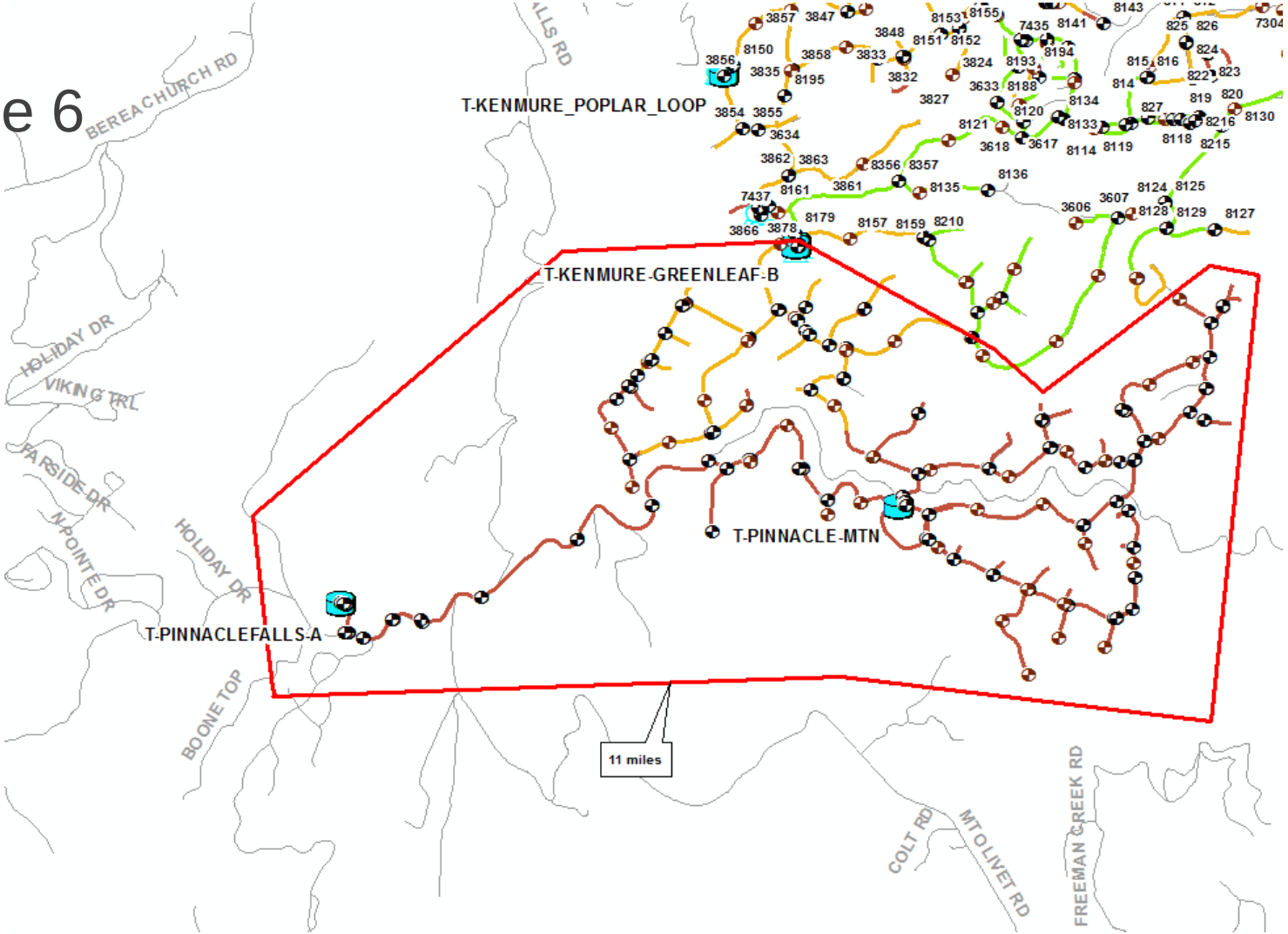
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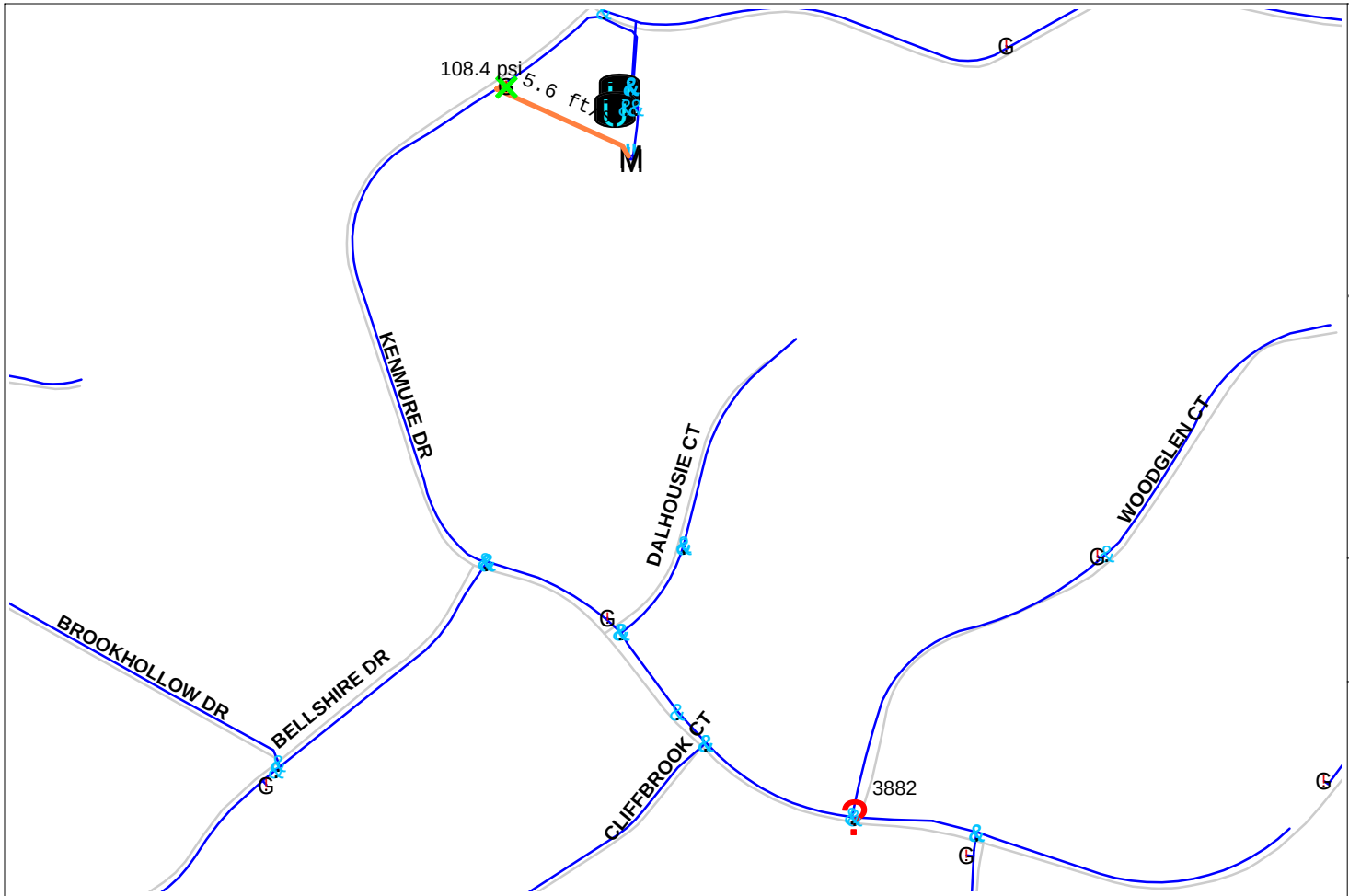
Zone	ZONE5	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	45.99980 psi				
Duration	2.4 min.	Open Hydrant	01-0514	Res. Pressure	21.55500 psi		Turbidity		
Valves to Open				Discharge Flow	644.75040		Disinf. Res.		
				Available Flow	670.99872		pH		
Valves to Close				Total Pipe Len.	355.0 ft		Iron		
				Min Flushing Vol	69.69510 ft^3		Odor		
Pipes to Flush	P-11015,P-2657,PLATFH-01-0514			Desired Flushing Vol	209.08530		HPC		
				Min Flushing Time	0.8 min.		Color		
				Desired Flushing	2.4 min.		Other		

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Zone 6


T-KENMURE_POPLAR_LOOP
T-KENMURE-GREENLEAF-B
T-PINNACLE-MTN
T-PINNACLEFALLS-A
11 miles
BEREA CHURCH RD
HOLIDAY DR
VIKING TRL
PARSIDE DR
N POINTE DR
HOLIDAY DR
BOONE TOP
COLT RD
MT OLIVET RD
FREEMAN CREEK RD



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

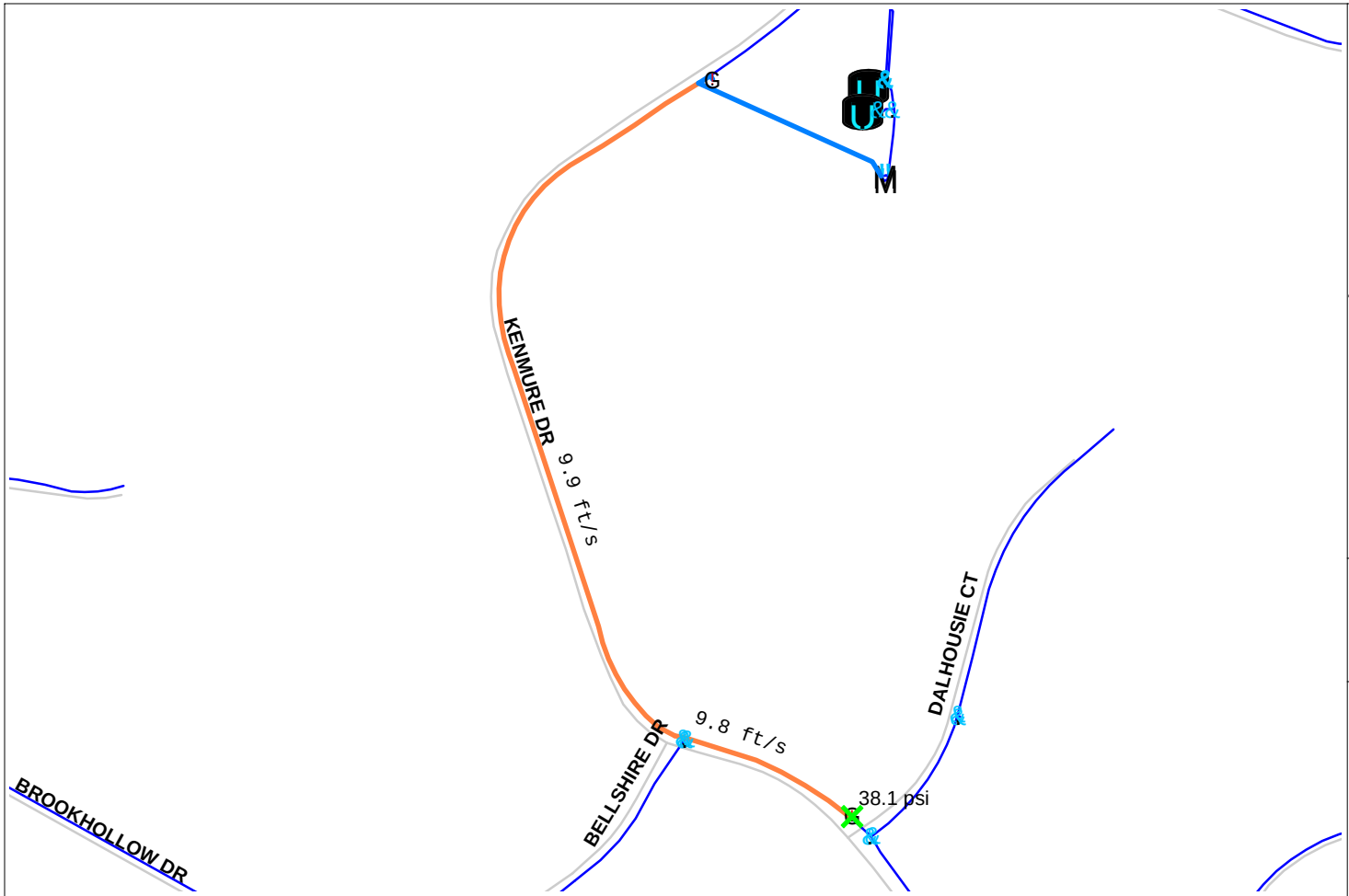
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	221.68050				
Duration	3 min.	Open Hydrant	07-1002	Res. Pressure	108.41060		Turbidity		
Valves to Open				Discharge Flow	868.13888		Disinf. Res.		
				Available Flow	1,163.88384		pH		
Valves to Close	3882			Total Pipe Len.	299.8 ft		Iron		
				Min Flushing Vol	99.29570 ft^3		Odor		
Pipes to Flush	PI-4819,PI-5245,PLATFH-07-1002			Desired Flushing Vol	297.88720		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	3 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

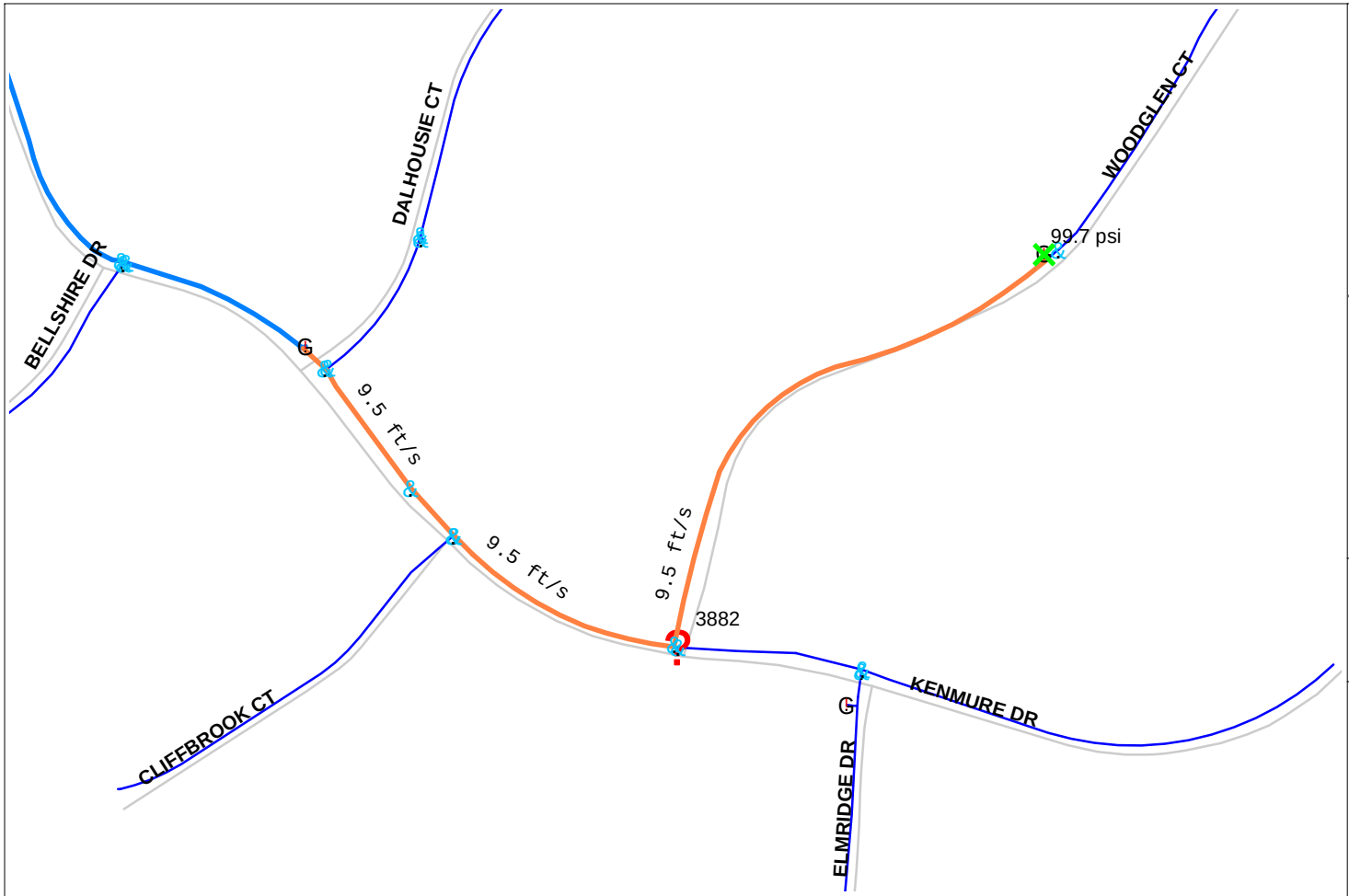
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	173.14020				
Duration	7 min.	Open Hydrant	07-1001	Res. Pressure	38.06680 psi		Turbidity		
Valves to Open				Discharge Flow	857.30624		Disinf. Res.		
				Available Flow	916.74688		pH		
Valves to Close	(3882)			Total Pipe Len.	1,313.7 ft		Iron		
				Min Flushing Vol	254.21800		Odor		
Pipes to Flush	P-4997,P-4999,PI-5253,PLATFH-07-1001			Desired Flushing Vol	762.65410		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

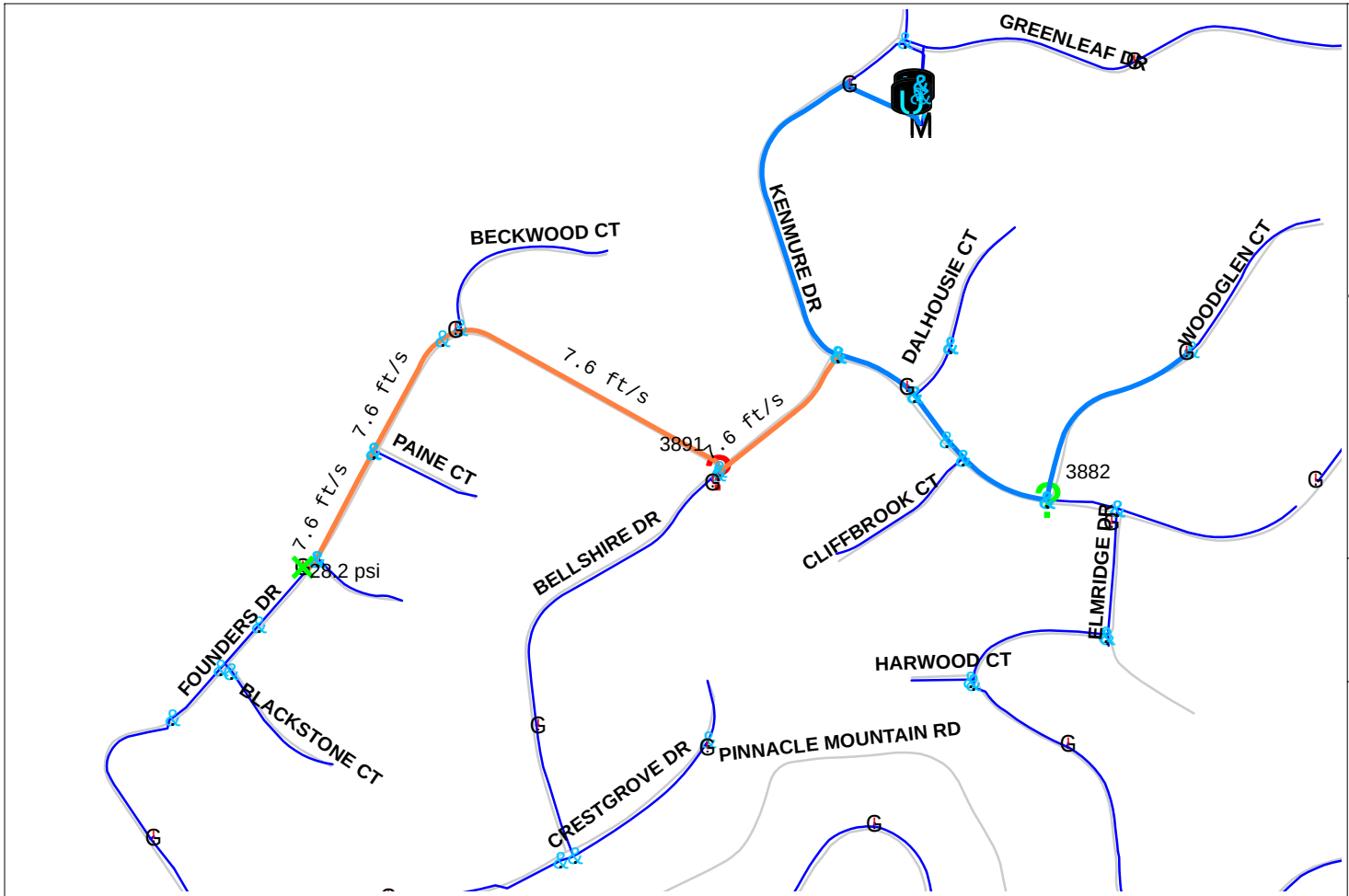
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	250.70010				
Duration	7 min.	Open Hydrant	07-3218	Res. Pressure	99.73550 psi		Turbidity		
Valves to Open				Discharge Flow	833.69664		Disinf. Res.		
				Available Flow	1,037.64192		pH		
Valves to Close	(3882)			Total Pipe Len.	1,320.1 ft		Iron		
				Min Flushing Vol	258.26580		Odor		
Pipes to Flush	P-5003,P-5005,P-5007,PI-5257,PI-5259,PI-5265,PLATFH-07-3218			Desired Flushing Vol	774.79730		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

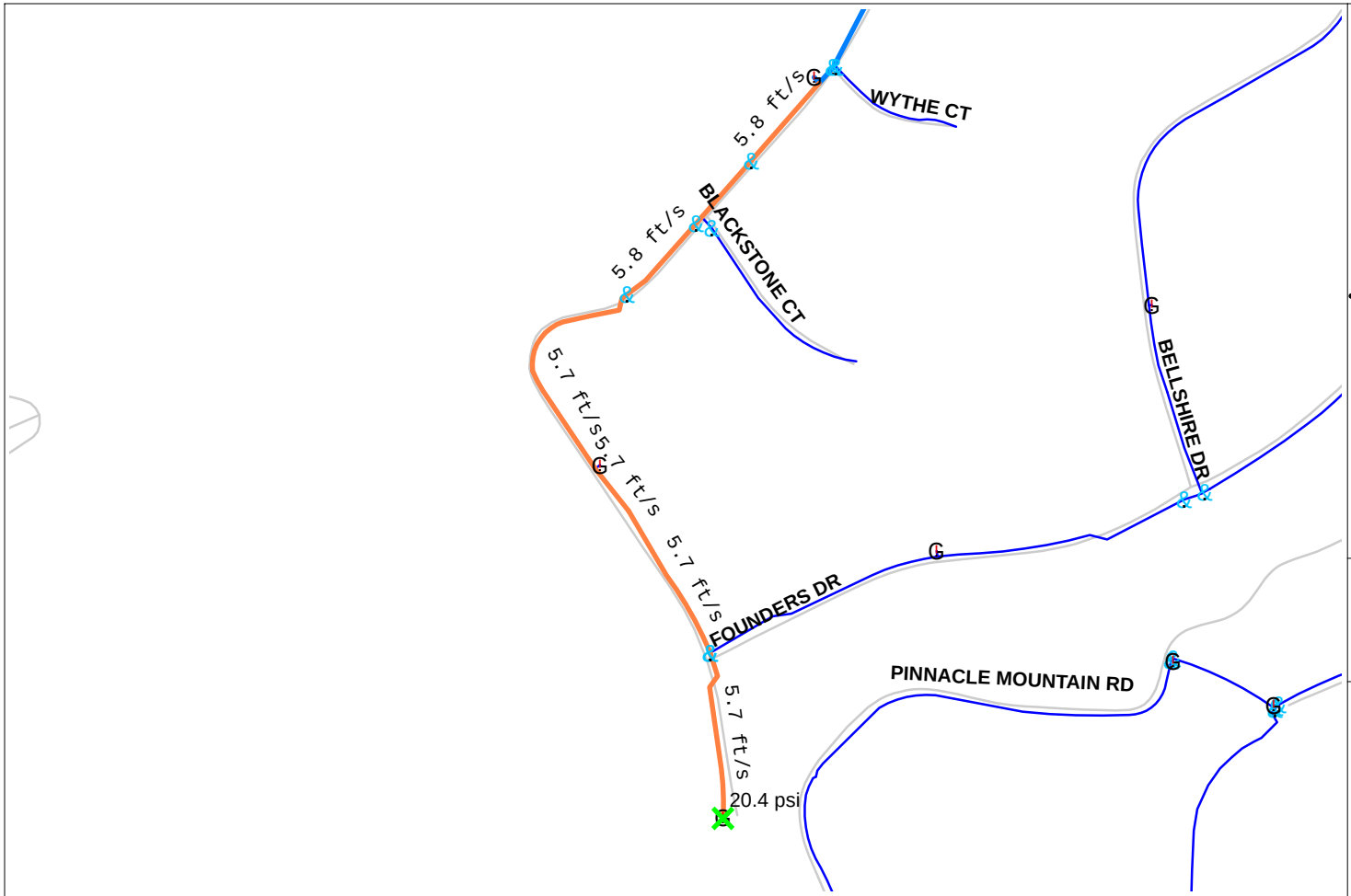
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	82.94520 psi				
Duration	16 min.	Open Hydrant	07-3230	Res. Pressure	28.18000 psi		Turbidity		
Valves to Open	3882			Discharge Flow	663.63808		Disinf. Res.		
				Available Flow	736.34176		pH		
Valves to Close	3891			Total Pipe Len.	2,462.3 ft		Iron		
				Min Flushing Vol	477.95540		Odor		
Pipes to Flush	P-4677,P-5019,P-5021,P-5025,PI-4895,PI-5251,PI-5273,PI-5275,PI-5277,PI-5285,PLATFH-07-3230			Desired Flushing Vol	1,433.86620		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

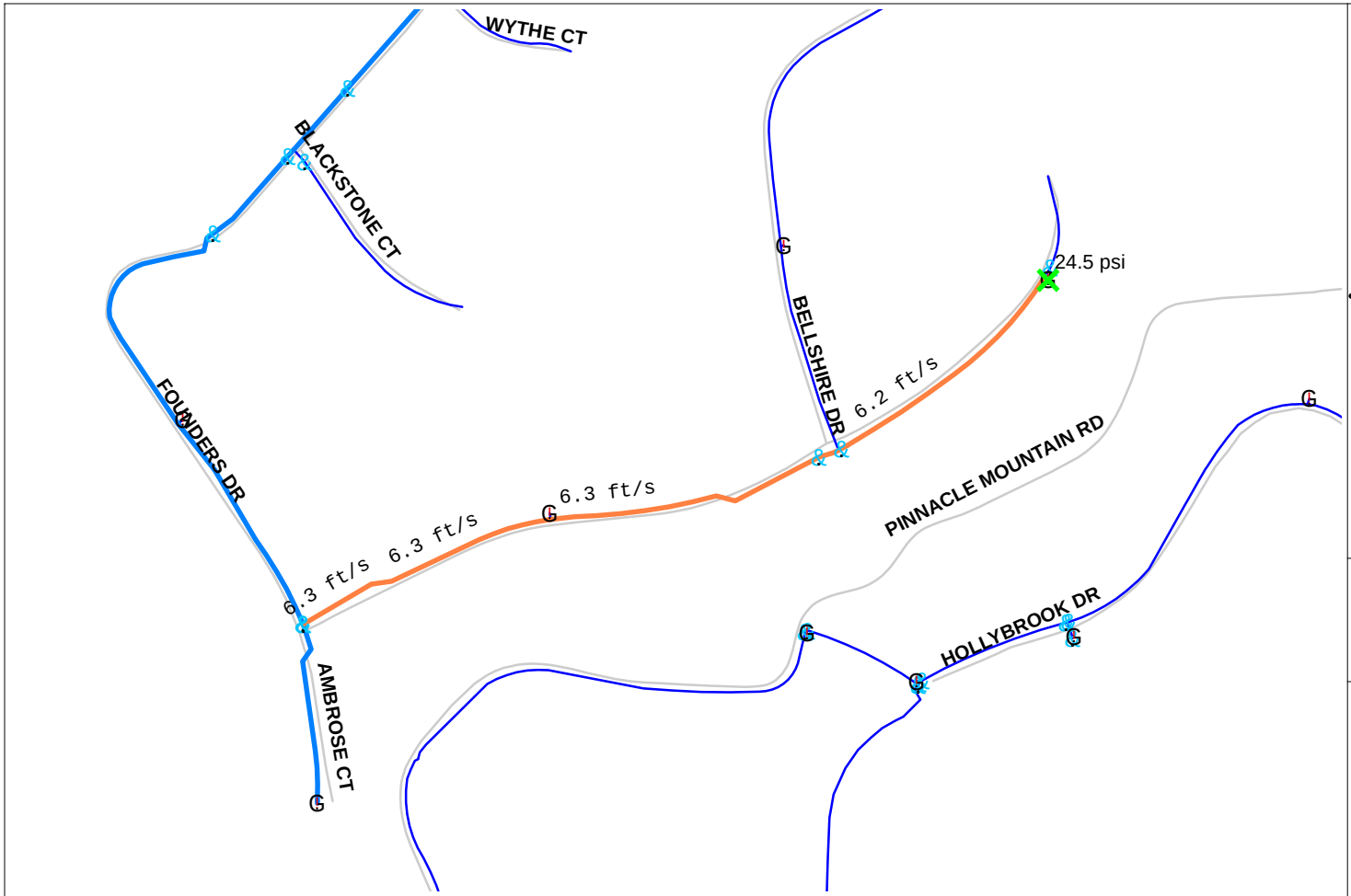
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	76.01100 psi				
Duration	18 min.	Open Hydrant	07-1008	Res. Pressure	20.44710 psi		Turbidity		
Valves to Open				Discharge Flow	502.74560		Disinf. Res.		
				Available Flow	505.80096		pH		
Valves to Close	(3891)			Total Pipe Len.	2,085.2 ft		Iron		
				Min Flushing Vol	406.95740		Odor		
Pipes to Flush	P-4675,P-4679,P-5027,P-5029,P-5031,PI-4897,PI-5291,PLATFH-07-1008			Desired Flushing Vol	1,220.87210		HPC		
				Min Flushing Time	6 min.		Color		
				Desired Flushing	18 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

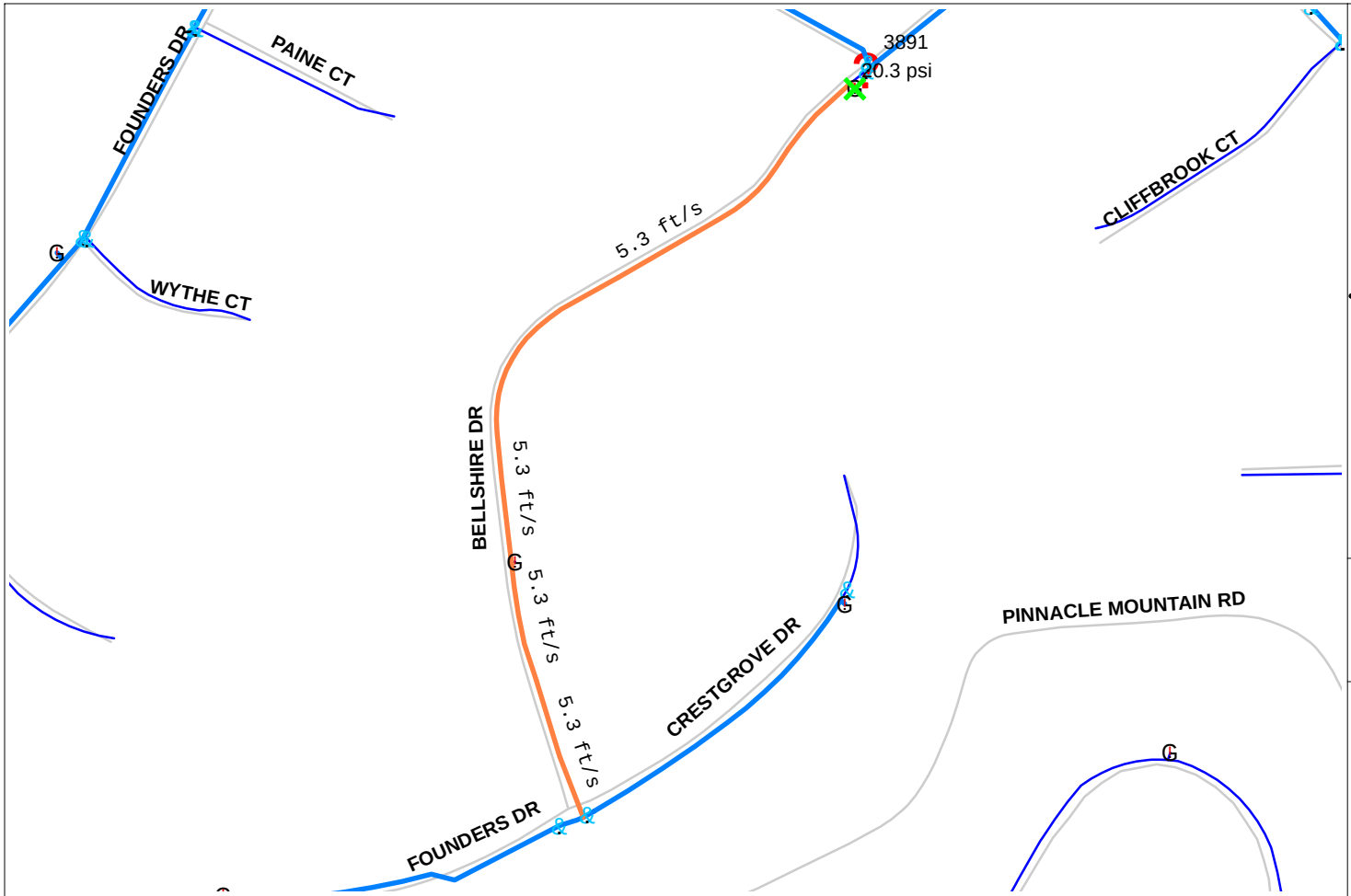
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	98.97550 psi				
Duration	14 min.	Open Hydrant	07-3228	Res. Pressure	24.50170 psi		Turbidity		
Valves to Open				Discharge Flow	549.96480		Disinf. Res.		
				Available Flow	575.58816		pH		
Valves to Close	(3891)			Total Pipe Len.	1,755.9 ft		Iron		
				Min Flushing Vol	343.61810		Odor		
Pipes to Flush	P-4669,P-5033,P-5035,PI-4891,PI-5281,PI-5293,PLATFH-07-3228			Desired Flushing Vol	1,030.85430		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	14 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

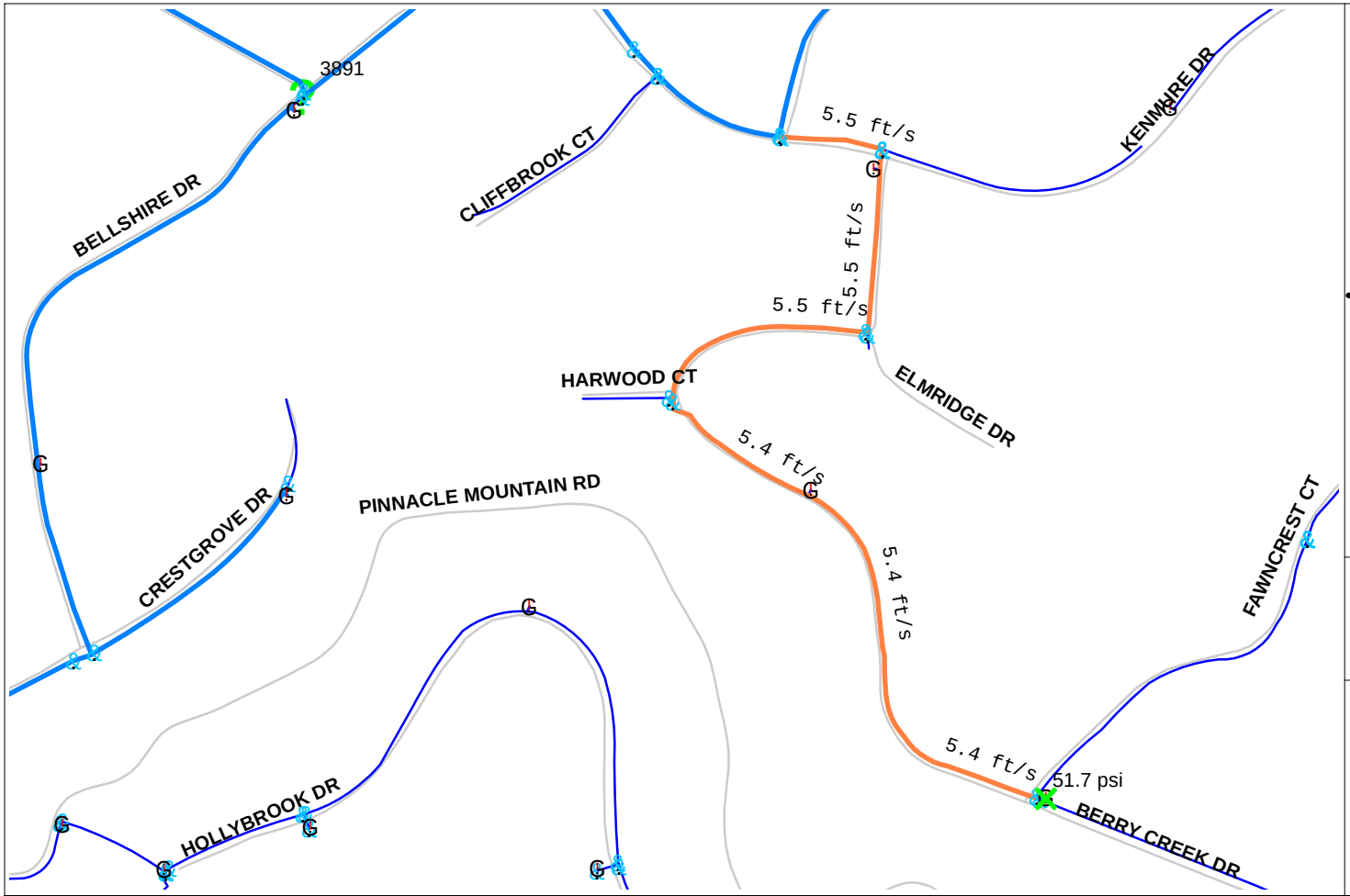
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	85.54370 psi				
Duration	14 min.	Open Hydrant	07-1010	Res. Pressure	20.27160 psi		Turbidity		
Valves to Open				Discharge Flow	468.99776		Disinf. Res.		
				Available Flow	470.38656		pH		
Valves to Close	(3891)			Total Pipe Len.	1,527.6 ft		Iron		
				Min Flushing Vol	299.62330		Odor		
Pipes to Flush	P-10907,P-10911,P-4671,PI-4893,PLATFH-07-1010			Desired Flushing Vol	898.86980		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	14 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

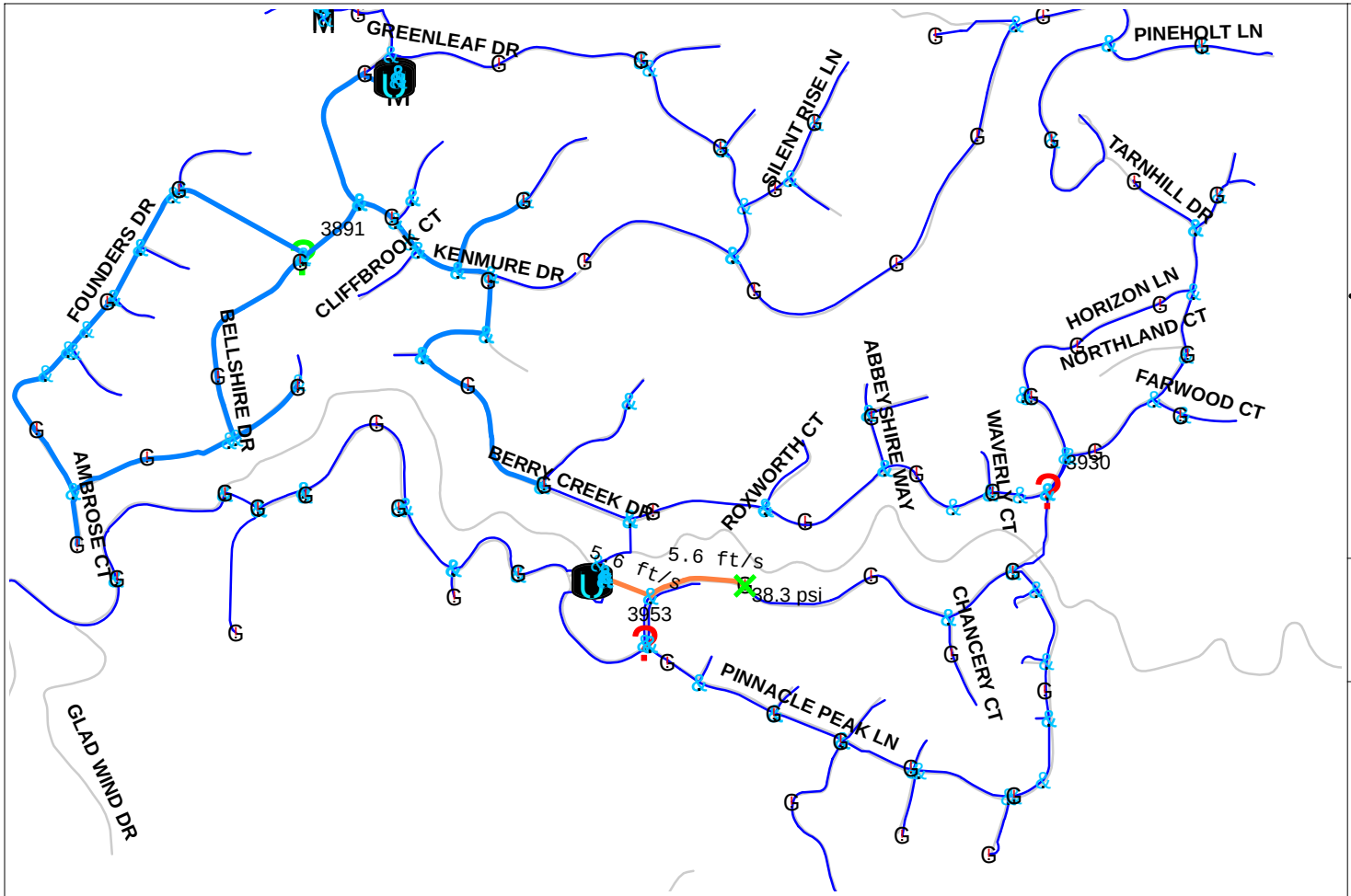
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE6	Sequence	8	Static Pressure	62.38060 psi				
Date of Flush		Start Time		Res. Pressure	51.74230 psi		Turbidity		
Duration	23 min.	Open Hydrant	07-1011	Discharge Flow	799.18496		Disinf. Res.		
Valves to Open	3891			Available Flow	1,650.10272		pH		
Valves to Close				Total Pipe Len.	2,499.5 ft		Iron		
				Min Flushing Vol	815.87260		Odor		
Pipes to Flush	P-10925,P-5009,P-5013,P-5037,P-5041,P-5043,P-5045,PI-5261,PI-5271,PI-5295,PI-5297,PI-5301,PI-5311,PLATFH-07-1011			Desired Flushing Vol	2,447.61780		HPC		
				Min Flushing Time	8 min.		Color		
				Desired Flushing	23 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

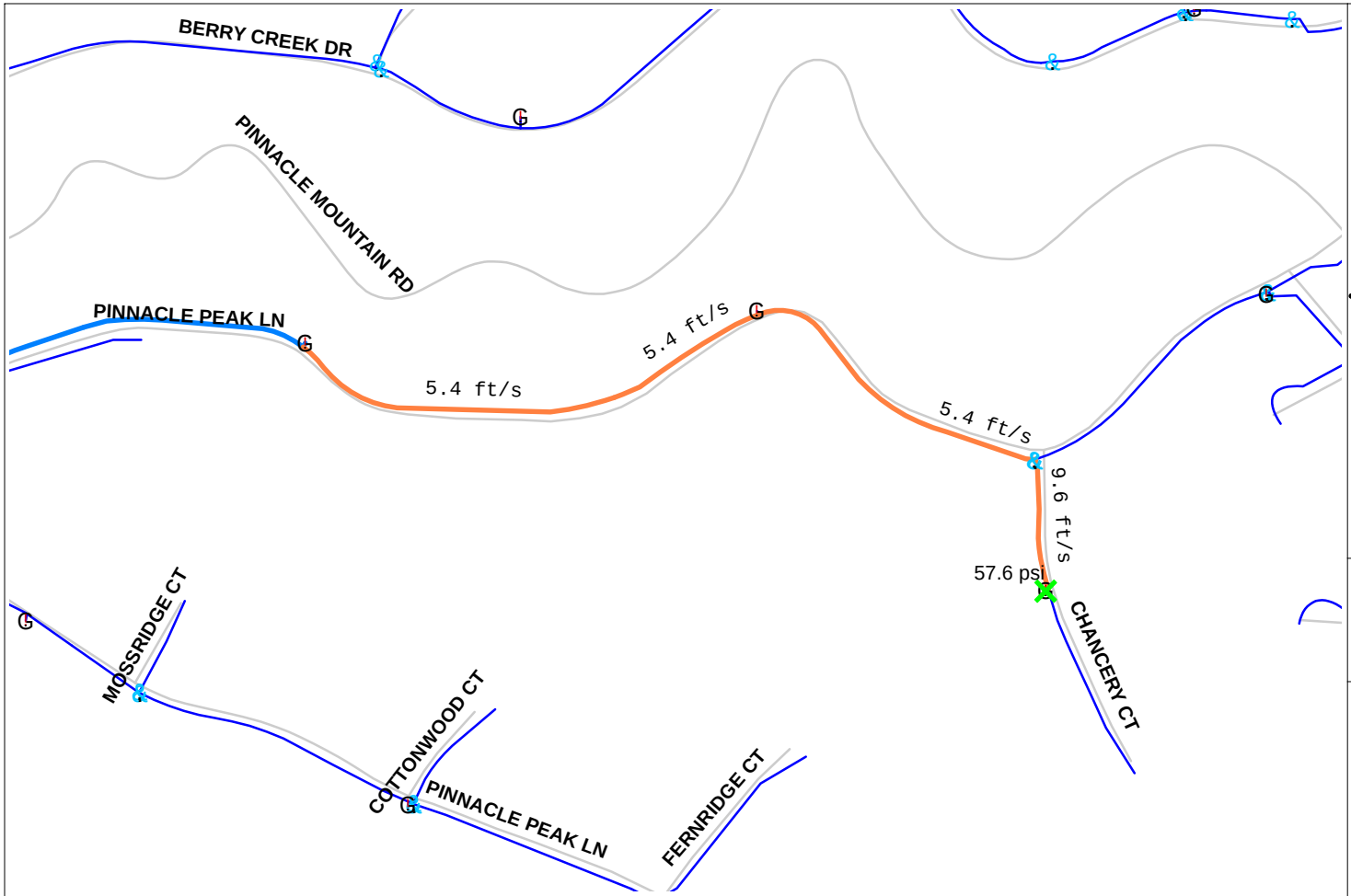
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE6	Sequence	9						
Date of Flush		Start Time		Static Pressure	60.43930 psi				
Duration	9 min.	Open Hydrant	07-3186	Res. Pressure	38.29850 psi		Turbidity		
Valves to Open	3891			Discharge Flow	867.72224		Disinf. Res.		
				Available Flow	1,202.00640		pH		
Valves to Close	3953, 3930			Total Pipe Len.	1,024.3 ft		Iron		
				Min Flushing Vol	352.31960		Odor		
Pipes to Flush	P-5129,P-5131,PI-10067,PI-5359,PLATFH-07-3186			Desired Flushing Vol	1,056.95890		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

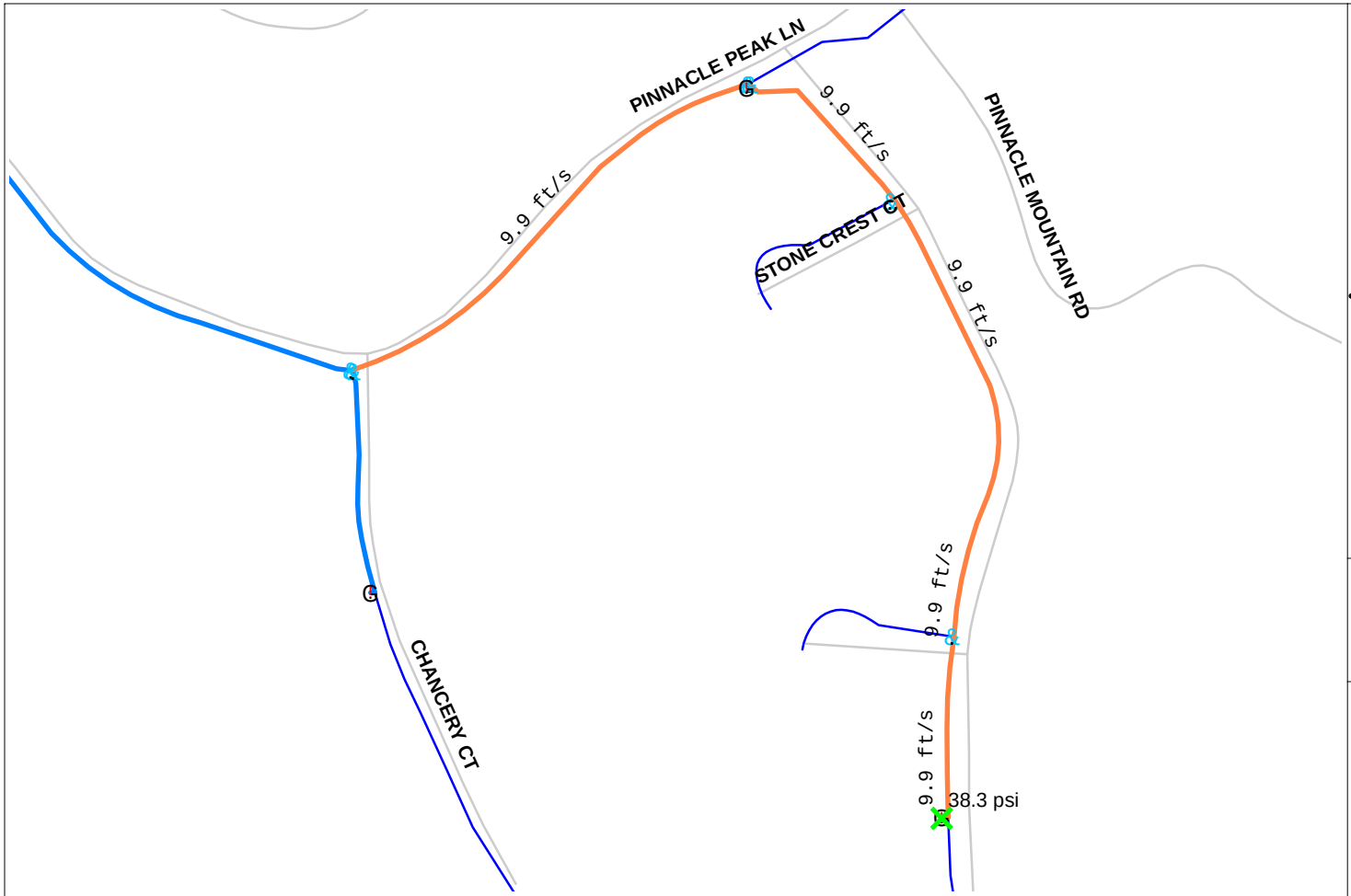
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	10	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	93.36780 psi				
Duration	16 min.	Open Hydrant	07-1018	Res. Pressure	57.64290 psi		Turbidity		
Valves to Open				Discharge Flow	843.55712		Disinf. Res.		
				Available Flow	1,248.25344		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	1,836.0 ft		Iron		
				Min Flushing Vol	595.22780		Odor		
Pipes to Flush	P-11581,P-14153,P-5133,PI-10901,PI-5365,PLATFH-07-1018			Desired Flushing Vol	1,785.68350		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

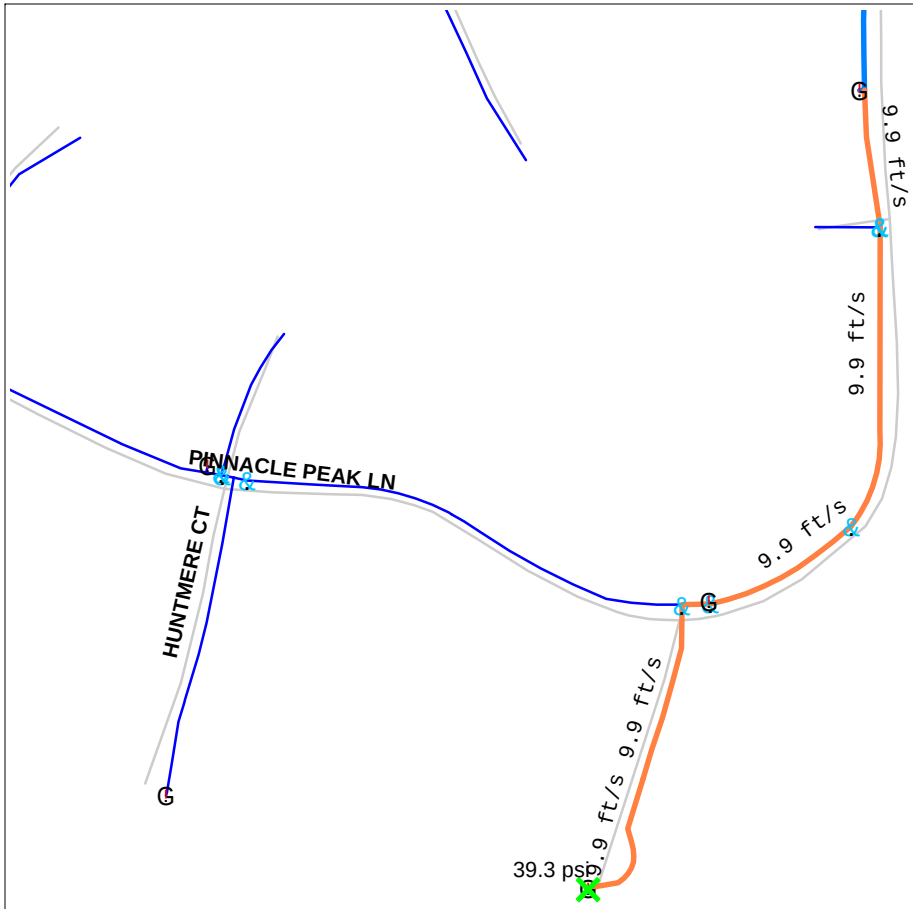
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	11	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	100.72910				
Duration	8 min.	Open Hydrant	07-3206	Res. Pressure	38.31620 psi		Turbidity		
Valves to Open				Discharge Flow	861.61152		Disinf. Res.		
				Available Flow	989.45056		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	1,508.9 ft		Iron		
				Min Flushing Vol	293.73430		Odor		
Pipes to Flush	P-10943,P-5109,P-5111,P-5113,P-5135,PI-5353,PLATFH-07-3206			Desired Flushing Vol	881.20280		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

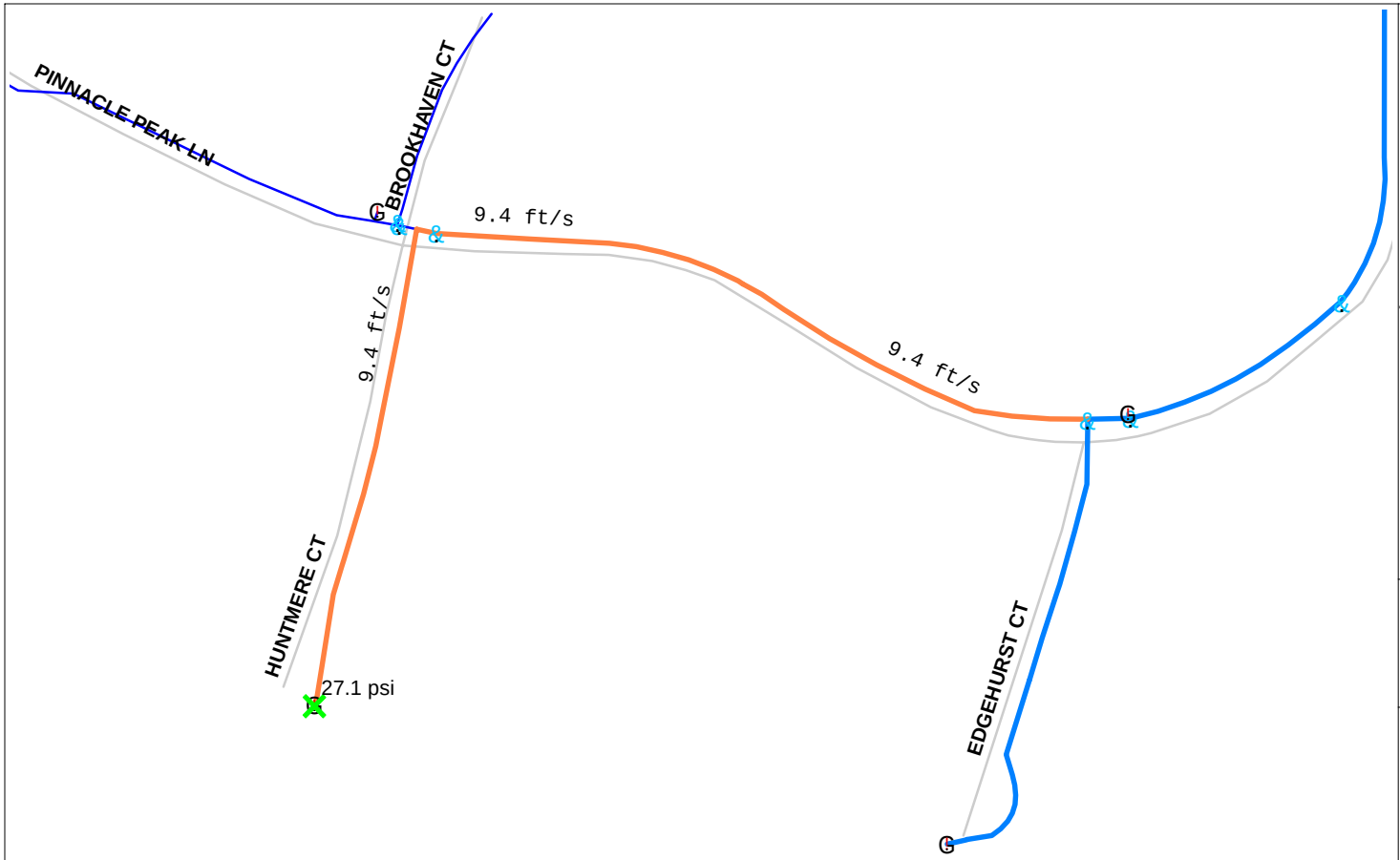
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE6	Sequence	12	Static Pressure	128.89170				
Date of Flush		Start Time		Res. Pressure	39.26080 psi		Turbidity		
Duration	7 min.	Open Hydrant	07-3202	Discharge Flow	870.22208		Disinf. Res.		
Valves to Open				Available Flow	967.50752		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	1,346.2 ft		Iron		
				Min Flushing Vol	262.97560		Odor		
Pipes to Flush	P-10937,P-13387,P-4705,P-5105,P-5107,PI-4925,PLATFH-07-3202			Desired Flushing Vol	788.92690		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

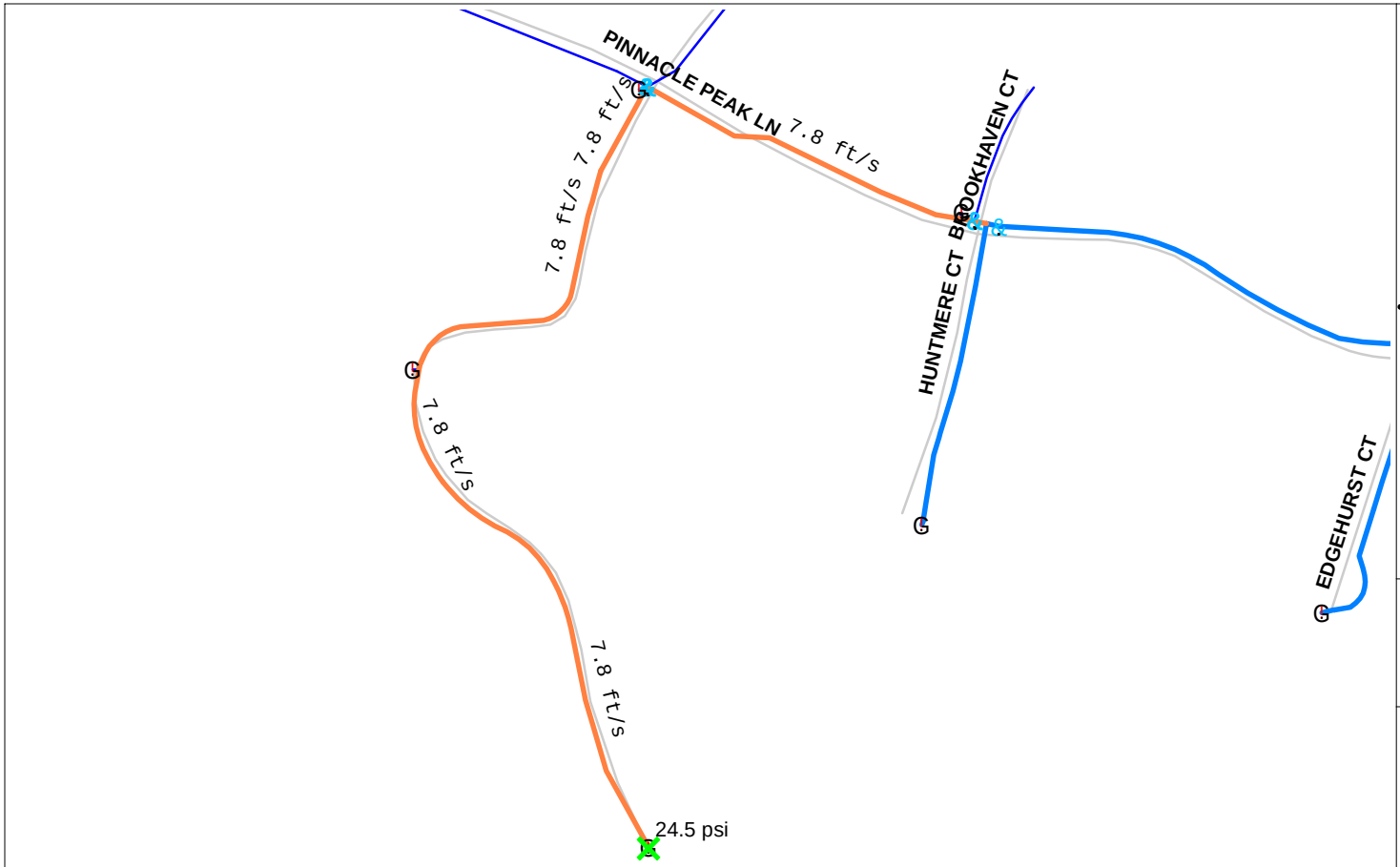
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	13	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	120.22500				
Duration	6 min.	Open Hydrant	07-3200	Res. Pressure	27.14980 psi		Turbidity		
Valves to Open				Discharge Flow	825.84992		Disinf. Res.		
				Available Flow	859.66720		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	1,126.4 ft		Iron		
				Min Flushing Vol	220.43230		Odor		
Pipes to Flush	P-10935,P-4703,PI-4921,PLATFH-07-3200			Desired Flushing Vol	661.29680		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

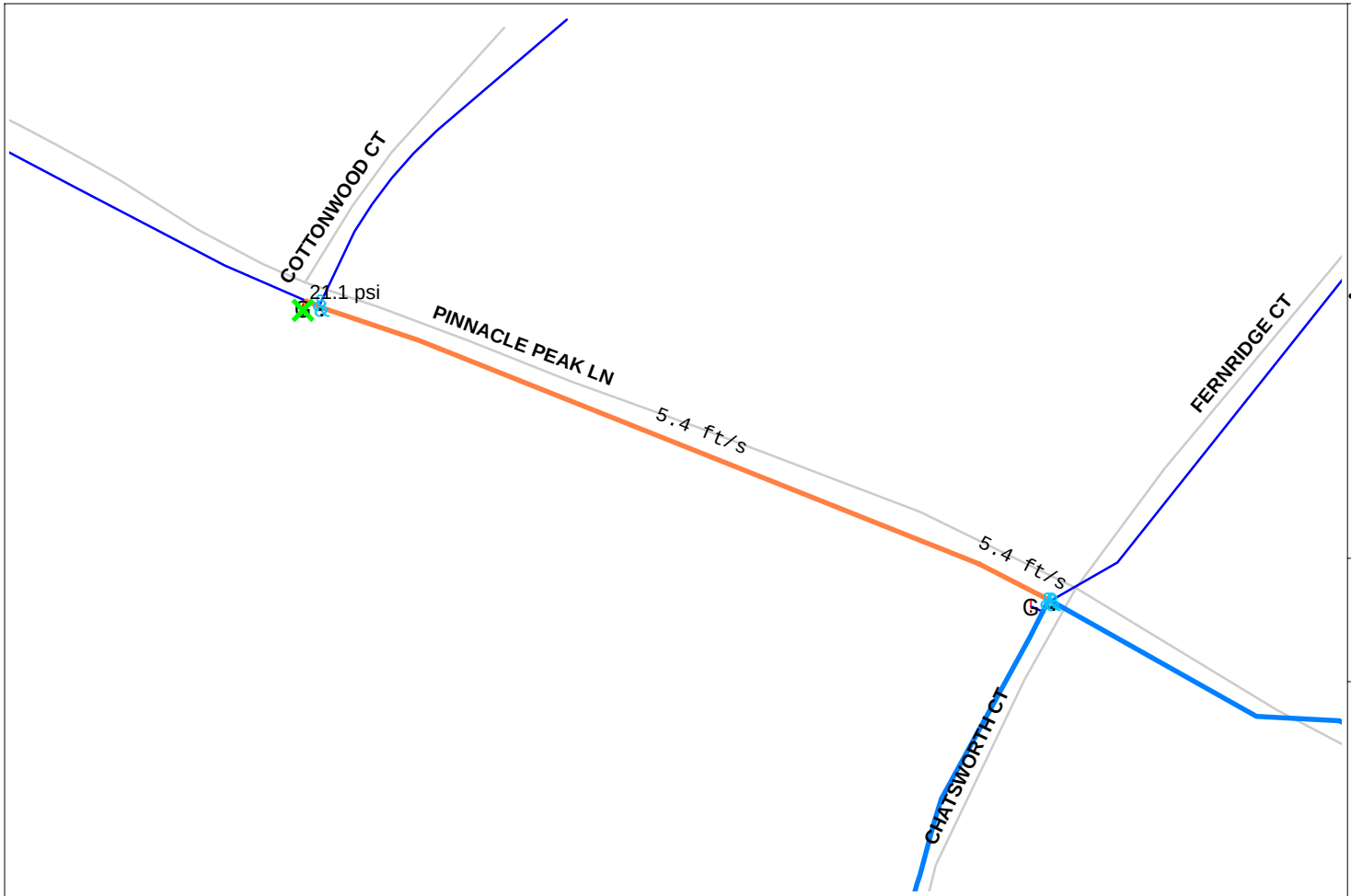
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	14	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	109.82530				
Duration	13 min.	Open Hydrant	07-3194	Res. Pressure	24.48830 psi		Turbidity		
Valves to Open				Discharge Flow	687.31712		Disinf. Res.		
				Available Flow	706.69088		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	1,983.0 ft		Iron		
				Min Flushing Vol	388.50380		Odor		
Pipes to Flush	P-10927,P-10931,P-13385,P-4693,P-4695,P-4697,P-4699,P-4701,PI-4917,PI-4923,PLATFH-07-3194			Desired Flushing Vol	1,165.51130		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	13 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

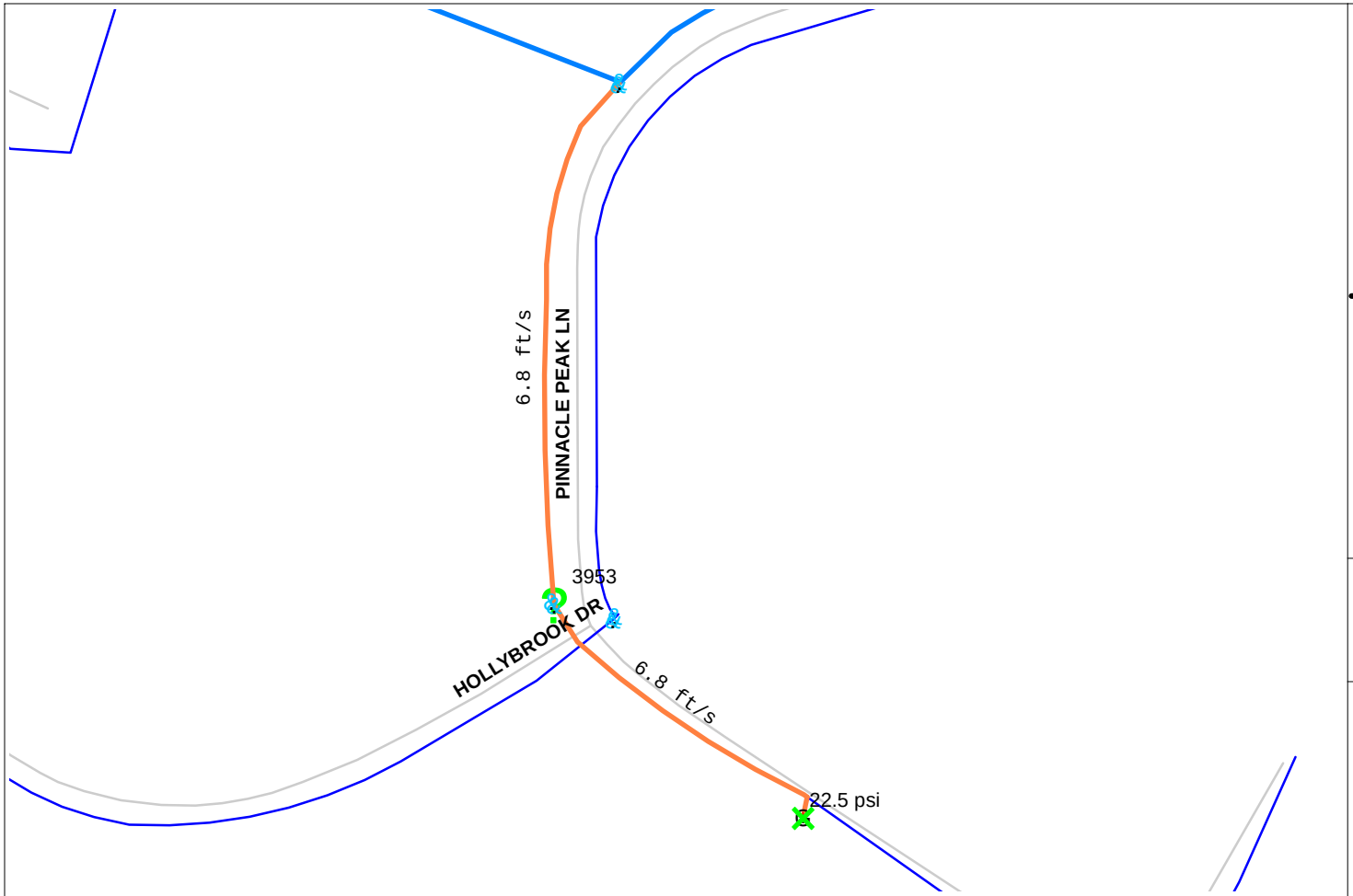
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	15	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	59.12920 psi				
Duration	5 min.	Open Hydrant	07-3190	Res. Pressure	21.06650 psi		Turbidity		
Valves to Open				Discharge Flow	478.09440		Disinf. Res.		
				Available Flow	485.52448		pH		
Valves to Close	(3953,3930)			Total Pipe Len.	508.2 ft		Iron		
				Min Flushing Vol	99.47420 ft^3		Odor		
Pipes to Flush	P-5121,PI-4913,PI-5355,PLATFH-07-3190			Desired Flushing Vol	298.42250		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

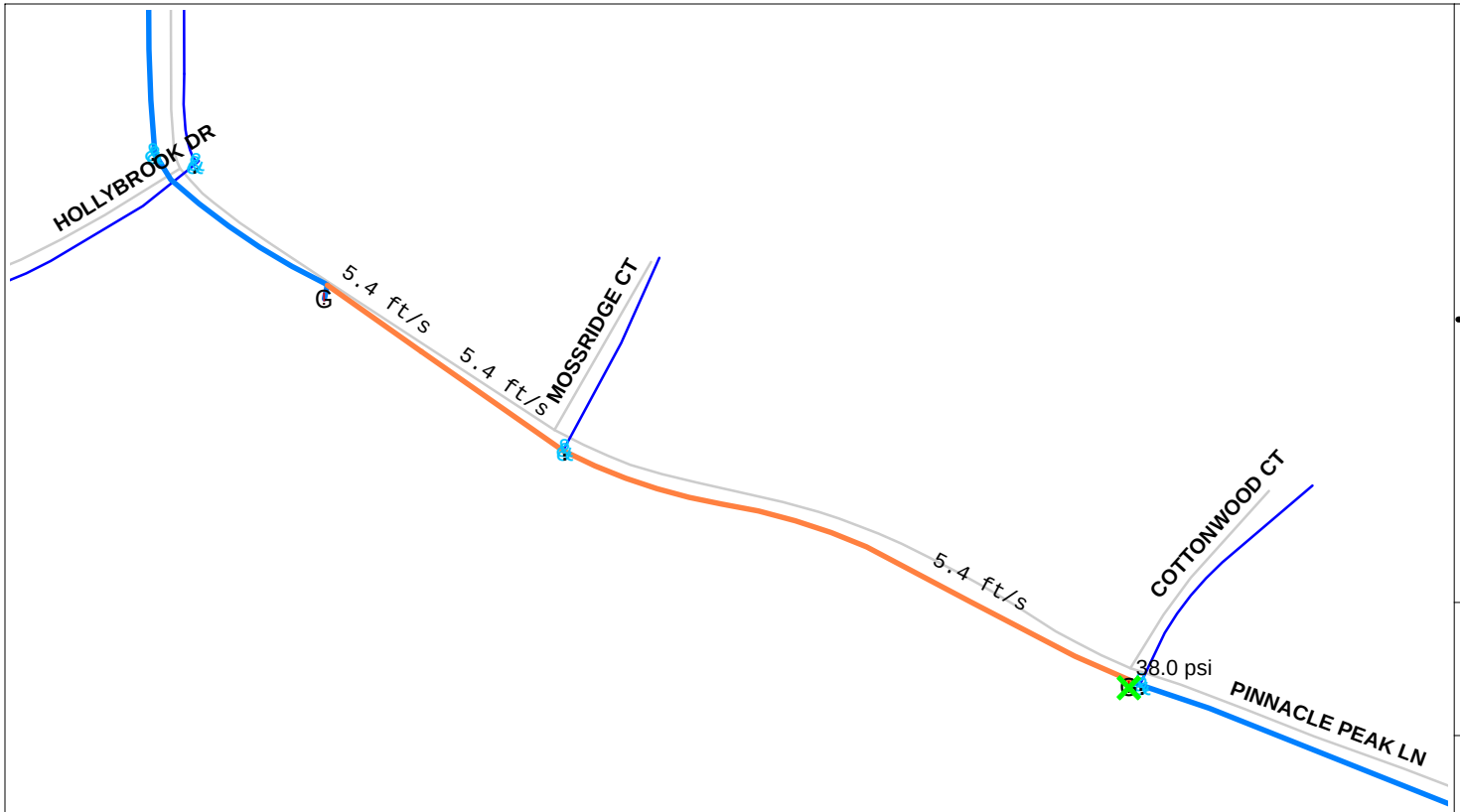
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	16	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	41.80750 psi				
Duration	4 min.	Open Hydrant	07-3188	Res. Pressure	22.46560 psi		Turbidity		
Valves to Open	3953			Discharge Flow	760.36800		Disinf. Res.		
				Available Flow	804.11520		pH		
Valves to Close	(3930)			Total Pipe Len.	544.2 ft		Iron		
				Min Flushing Vol	134.34830		Odor		
Pipes to Flush	P-5117,PI-5363,PLATFH-07-3188			Desired Flushing Vol	403.04480		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

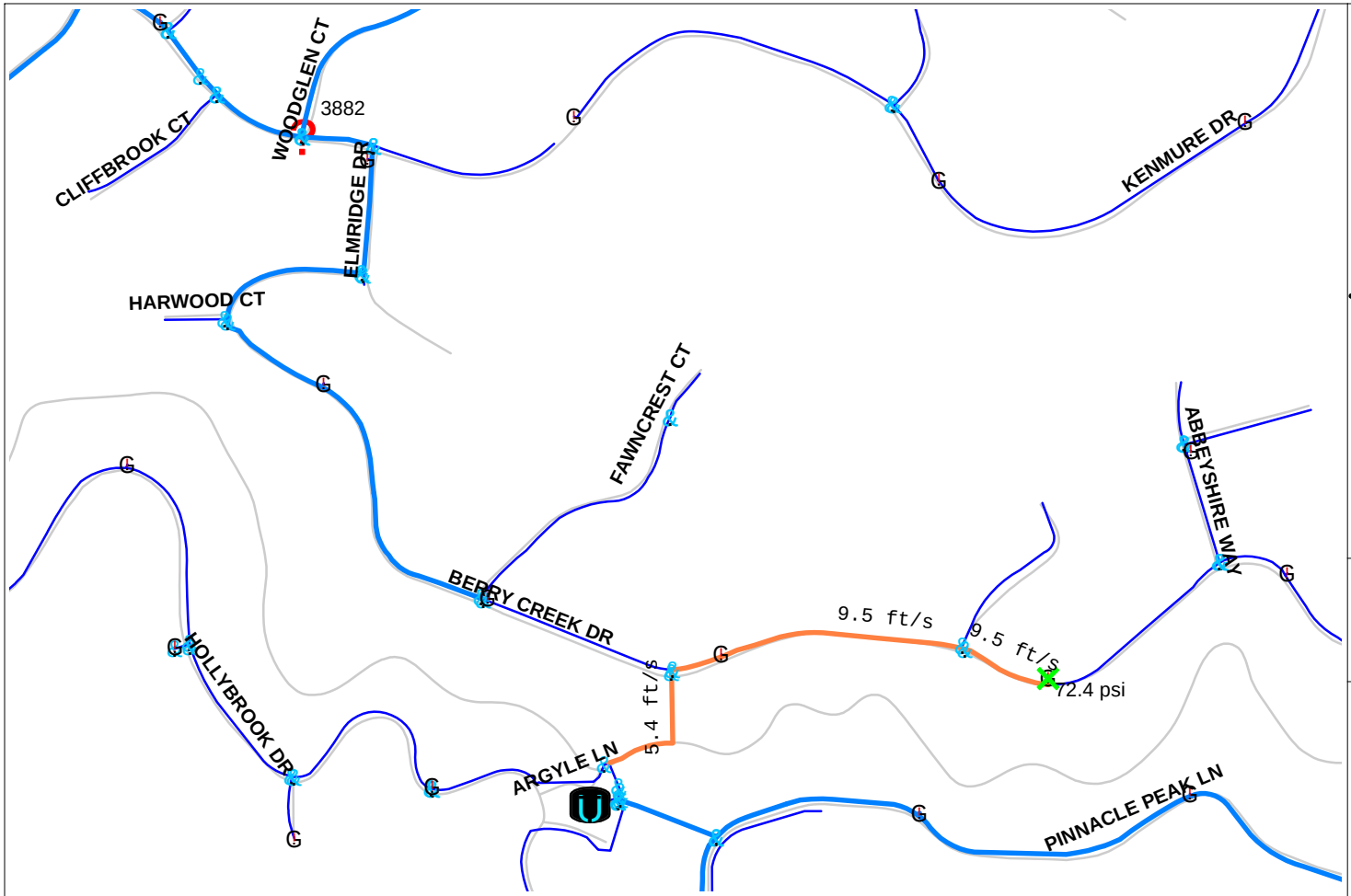
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	17	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	59.13890 psi				
Duration	8 min.	Open Hydrant	07-3190	Res. Pressure	38.01650 psi		Turbidity		
Valves to Open				Discharge Flow	708.70464		Disinf. Res.		
				Available Flow	989.45056		pH		
Valves to Close	(3930)			Total Pipe Len.	824.3 ft		Iron		
				Min Flushing Vol	239.88110		Odor		
Pipes to Flush	P-5115,P-5119,P-5123,PLATFH-07-3190			Desired Flushing Vol	719.64320		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	8 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

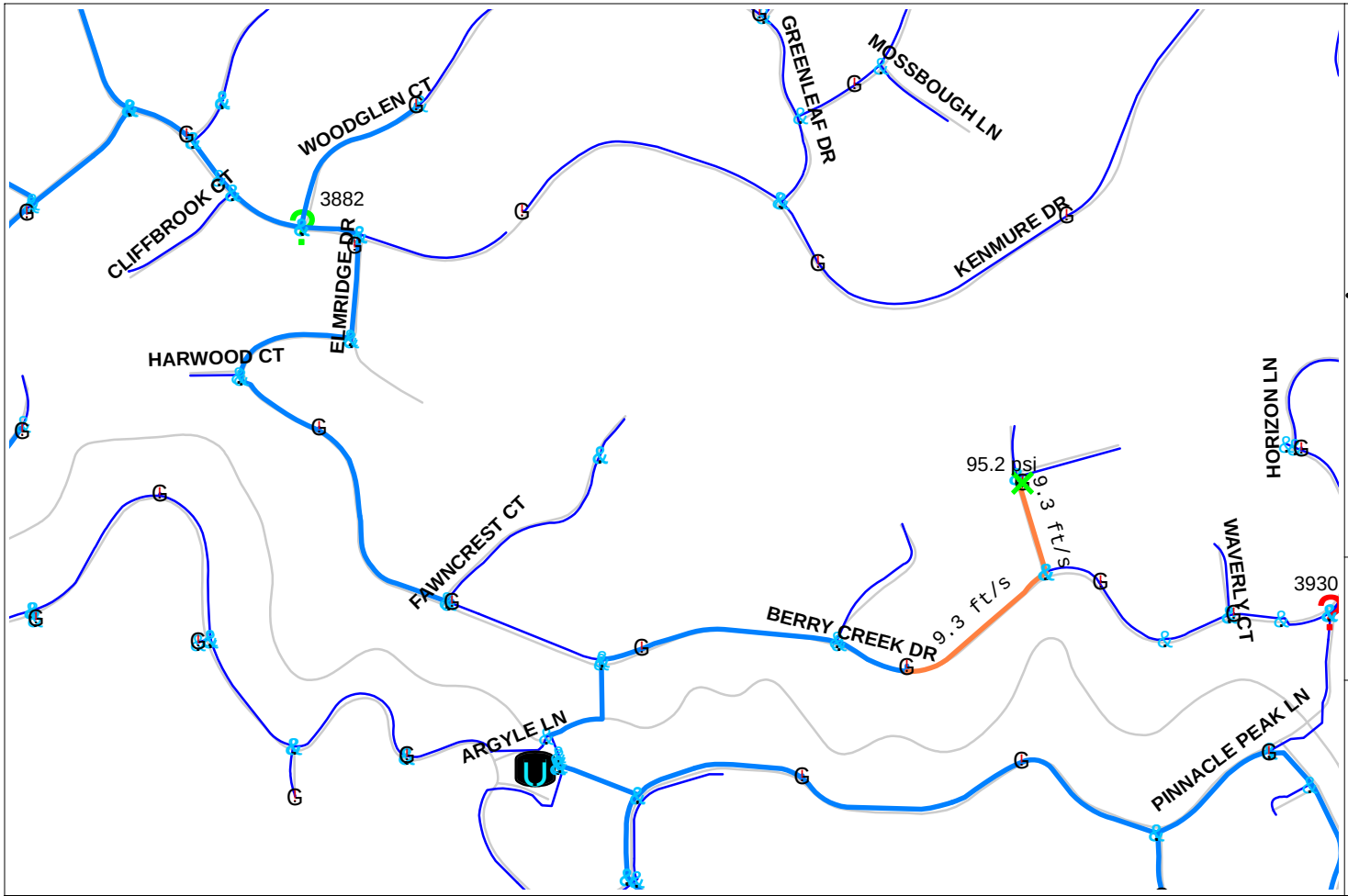
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	18	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	105.88710				
Duration	11 min.	Open Hydrant	07-1013	Res. Pressure	72.36630 psi		Turbidity		
Valves to Open				Discharge Flow	827.03040		Disinf. Res.		
				Available Flow	1,381.50880		pH		
Valves to Close	3882(3930)			Total Pipe Len.	1,721.1 ft		Iron		
				Min Flushing Vol	401.56140		Odor		
Pipes to Flush	P-15291,P-15293,P-5047,P-5049,P-5053,PI-4821,PI-5303,PI-5313,PLATFH-07-1013			Desired Flushing Vol	1,204.68430		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	11 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

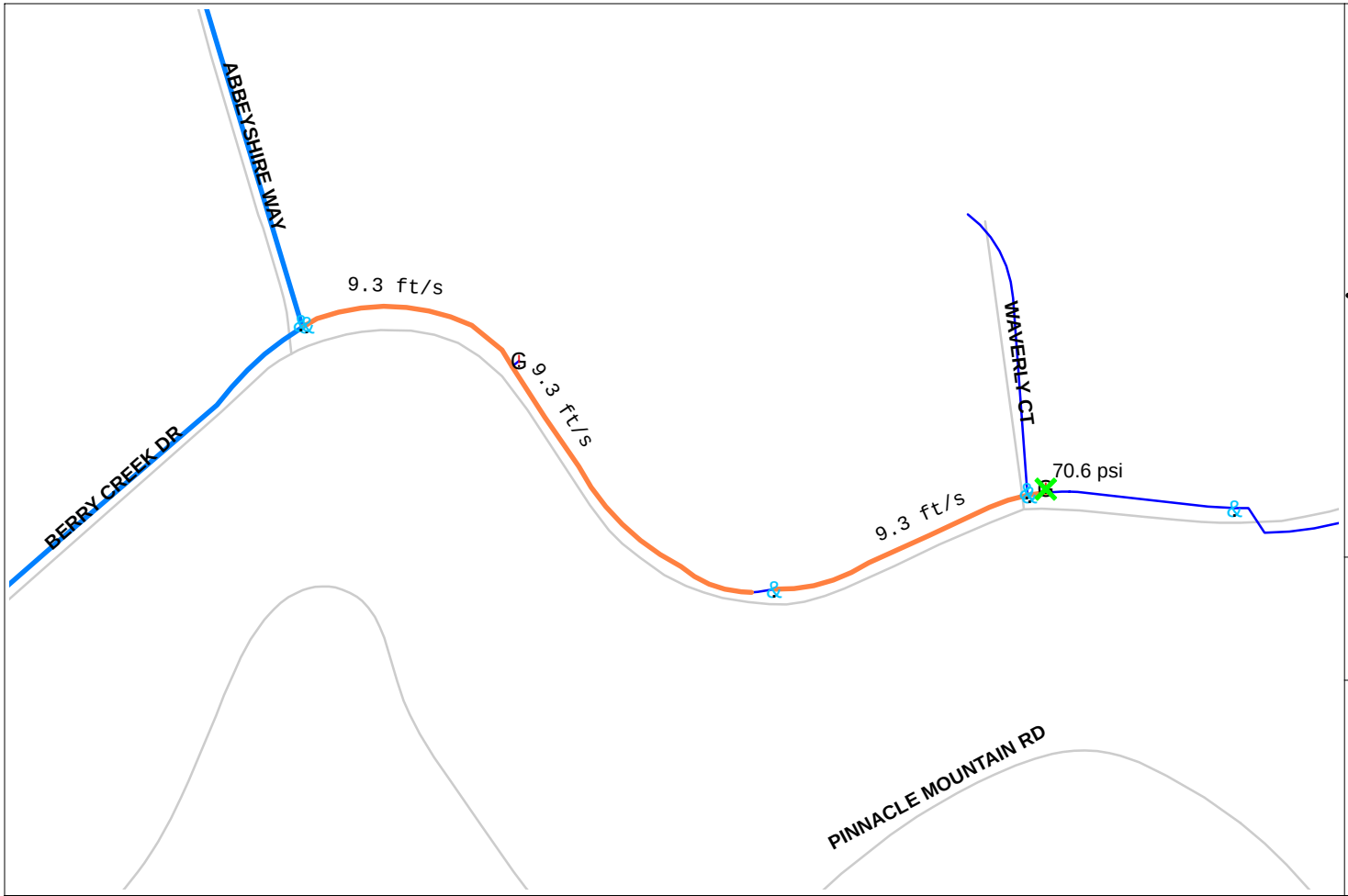
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	19	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	140.50520				
Duration	6 min.	Open Hydrant	07-1014	Res. Pressure	95.20870 psi		Turbidity		
Valves to Open	3882			Discharge Flow	813.07296		Disinf. Res.		
				Available Flow	1,378.10624		pH		
Valves to Close	(3930)			Total Pipe Len.	1,067.2 ft		Iron		
				Min Flushing Vol	208.03290		Odor		
Pipes to Flush	P-5055,PI-5317,PLATFH-07-1014			Desired Flushing Vol	624.09870		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

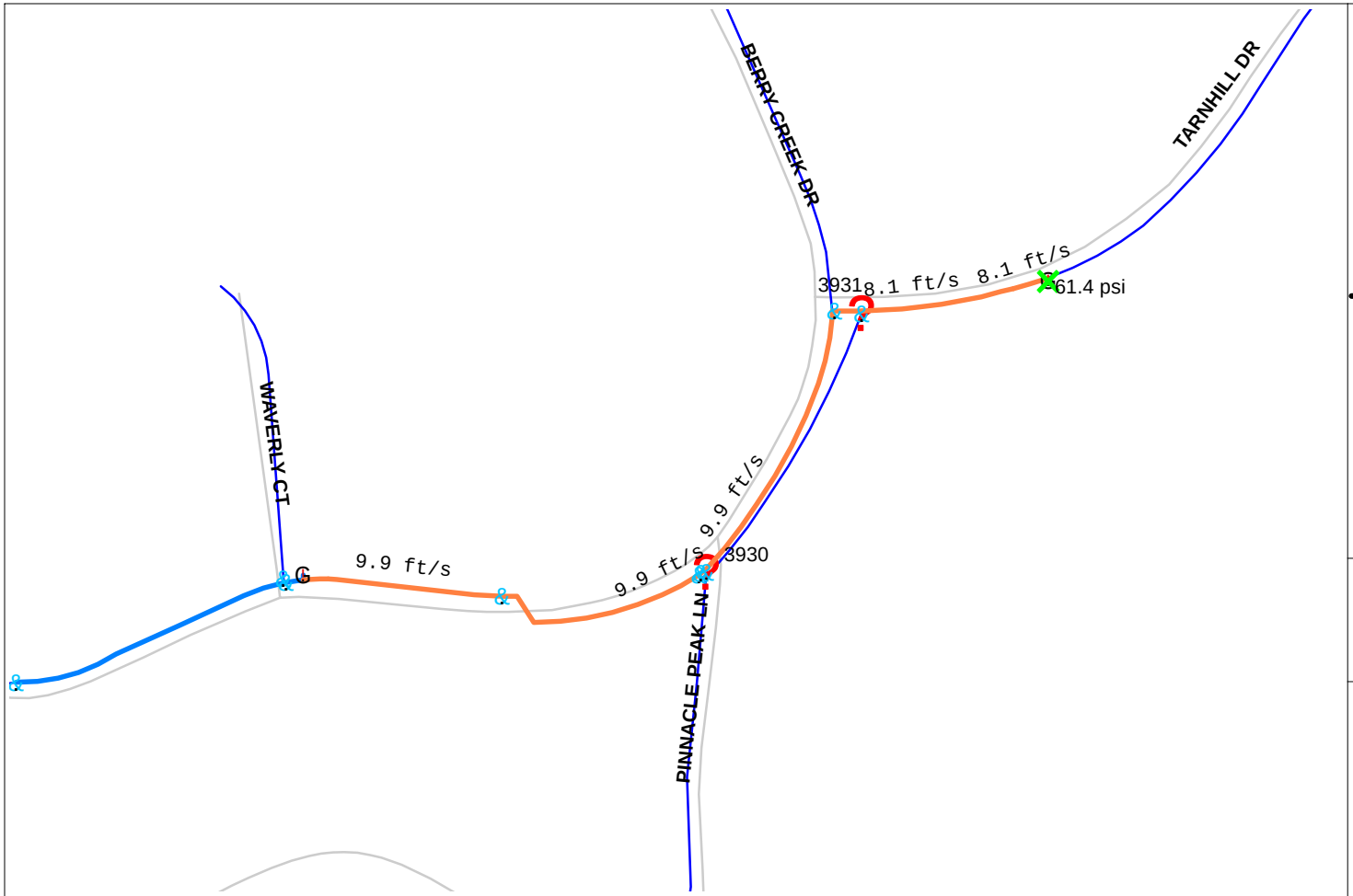
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	20	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	124.90540				
Duration	5 min.	Open Hydrant	07-1016	Res. Pressure	70.57800 psi		Turbidity		
Valves to Open				Discharge Flow	816.75328		Disinf. Res.		
				Available Flow	1,166.52256		pH		
Valves to Close	(3930)			Total Pipe Len.	864.5 ft		Iron		
				Min Flushing Vol	168.66010		Odor		
Pipes to Flush	P-5057,P-5059,P-5065,PI-5315,PI-5321,PLATFH-07-1016			Desired Flushing Vol	505.98030		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

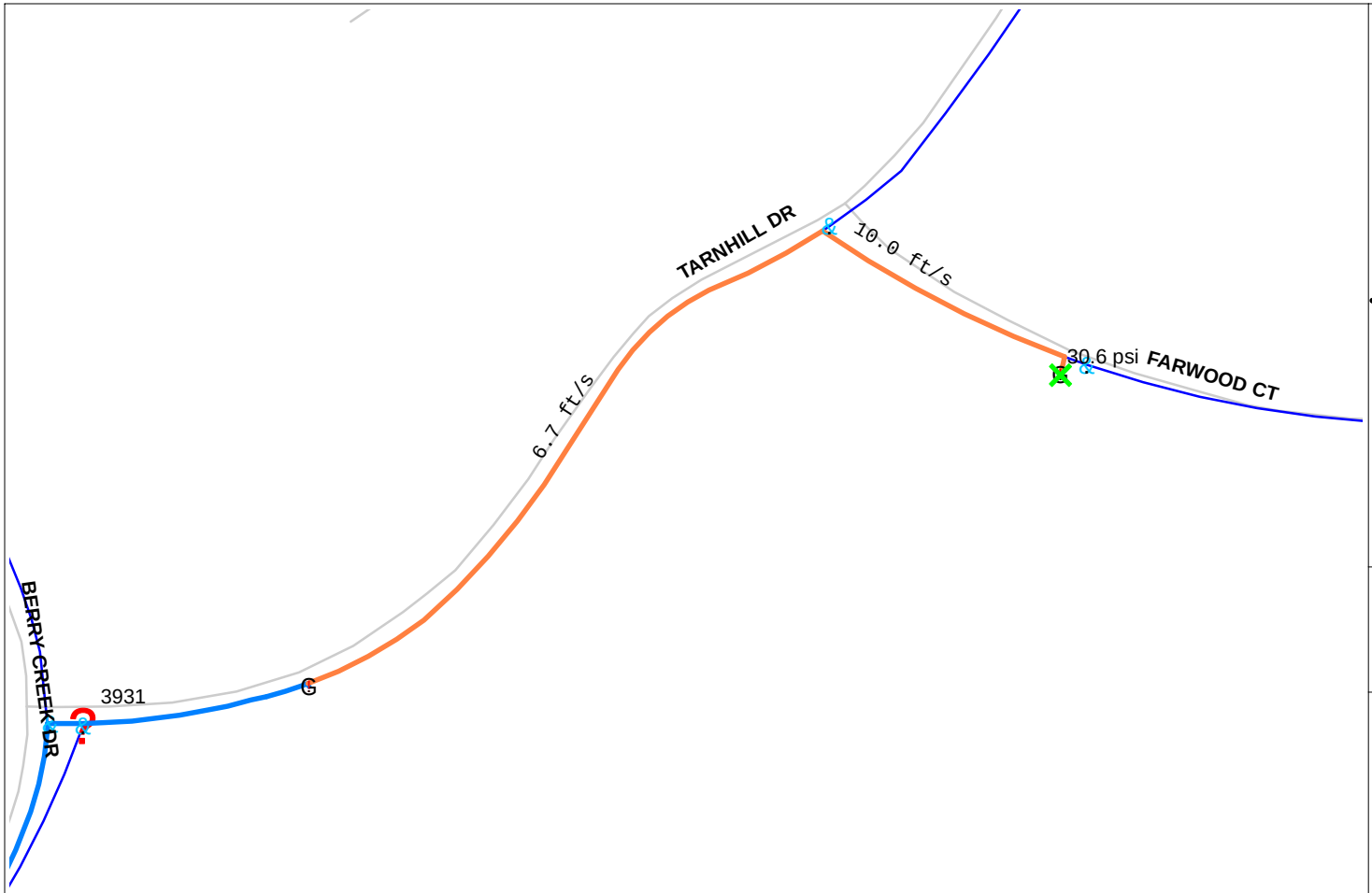
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	21	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	138.33650				
Duration	5 min.	Open Hydrant	07-1023	Res. Pressure	61.44850 psi		Turbidity		
Valves to Open				Discharge Flow	871.19424		Disinf. Res.		
				Available Flow	1,100.06848		pH		
Valves to Close	3931(3930)			Total Pipe Len.	886.4 ft		Iron		
				Min Flushing Vol	182.00830		Odor		
Pipes to Flush	P-10949,P-5063,P-5071,PI-5325,P-5069,P-5097,P-5101,PI-5329,PLATFH-07-1023			Desired Flushing Vol	546.02490		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

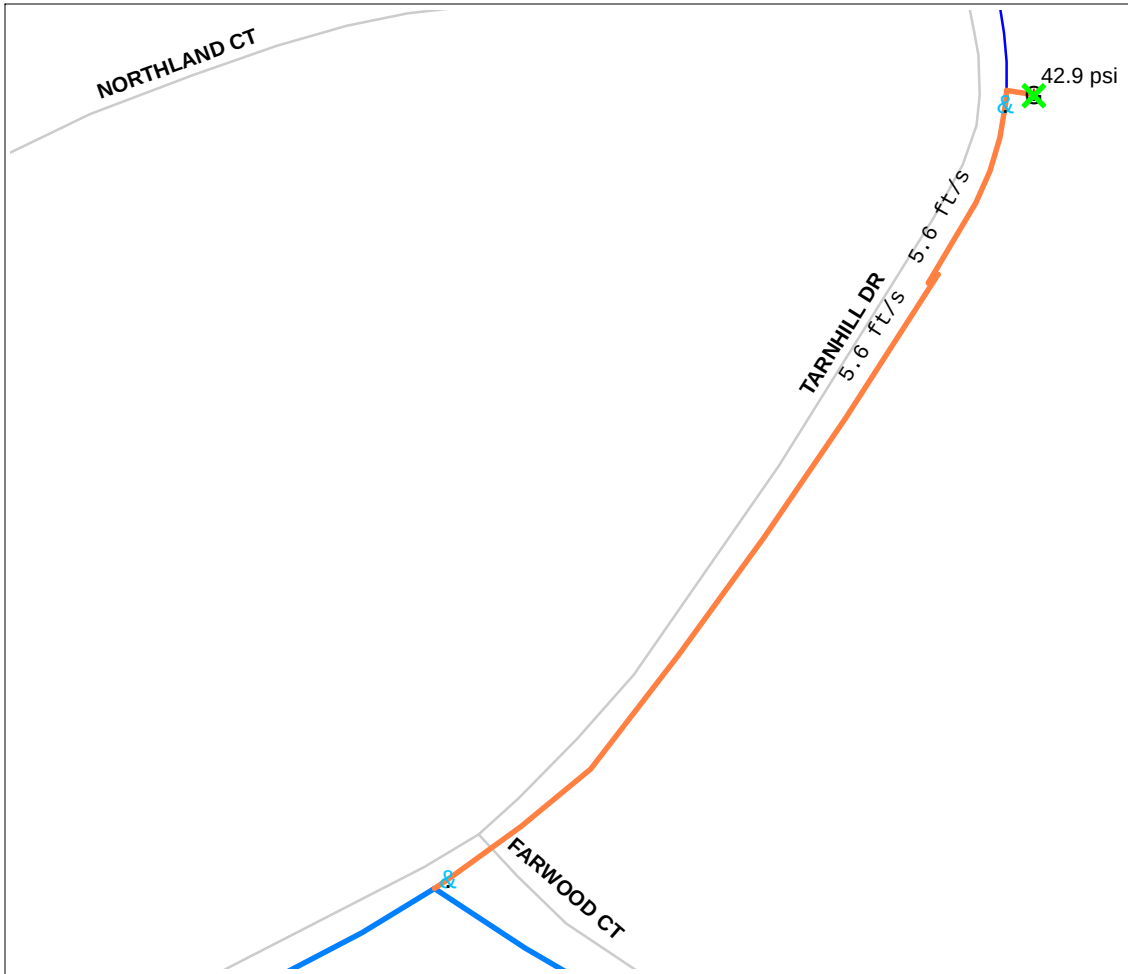
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	22	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	117.10480				
Duration	5 min.	Open Hydrant	07-1024	Res. Pressure	30.60980 psi		Turbidity		
Valves to Open				Discharge Flow	876.74944		Disinf. Res.		
				Available Flow	933.62080		pH		
Valves to Close	(3930,3931)			Total Pipe Len.	770.5 ft		Iron		
				Min Flushing Vol	202.23280		Odor		
Pipes to Flush	P-5095,PI-5351,PLATFH-07-1024			Desired Flushing Vol	606.69830		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	5 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

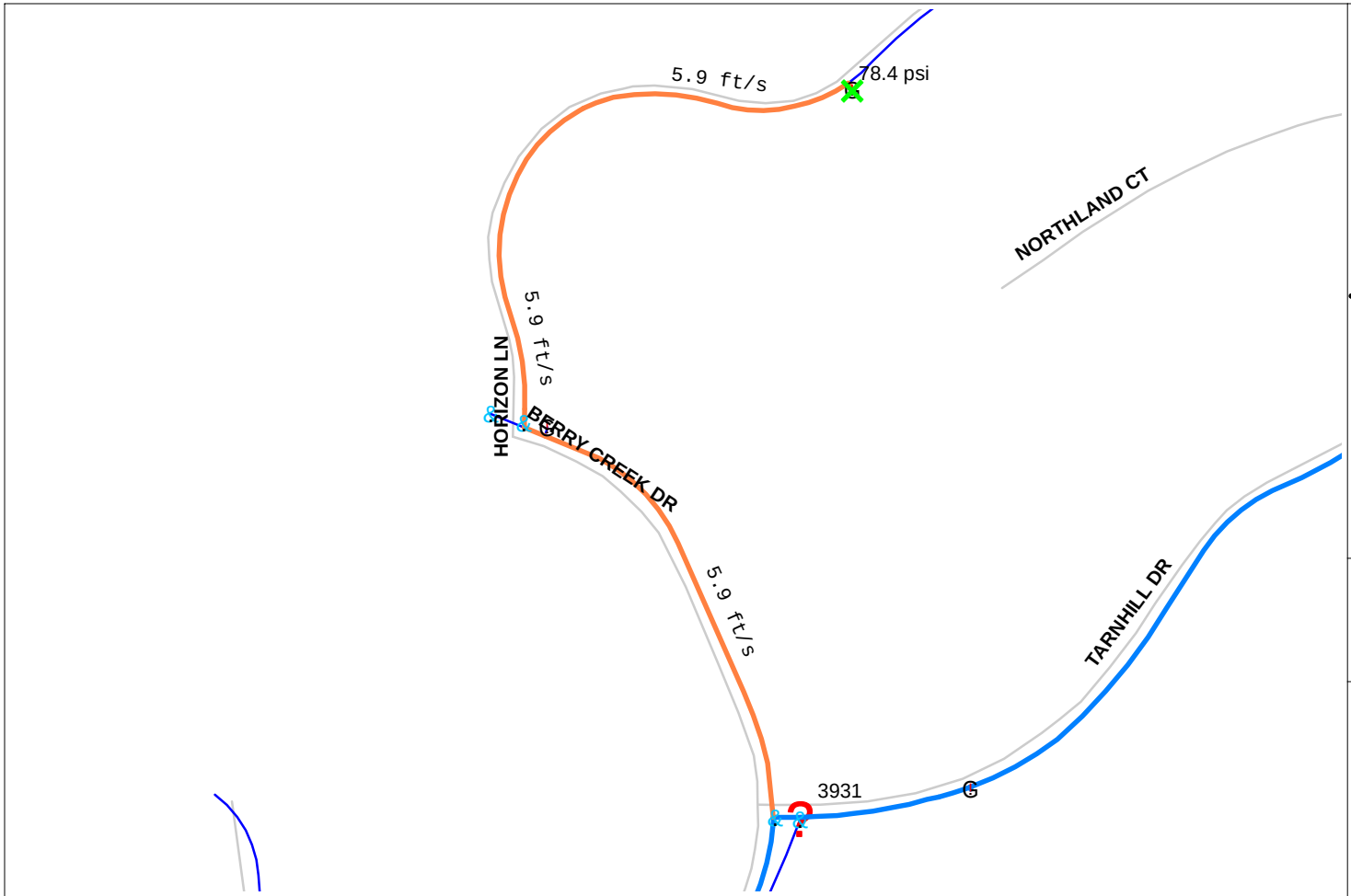
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	23	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	117.10460				
Duration	4 min.	Open Hydrant	07-1022	Res. Pressure	42.92860 psi		Turbidity		
Valves to Open				Discharge Flow	818.97536		Disinf. Res.		
				Available Flow	948.27264		pH		
Valves to Close	(3930,3931)			Total Pipe Len.	411.5 ft		Iron		
				Min Flushing Vol	132.29080		Odor		
Pipes to Flush	P-5081,P-5099,PI-5335,PLATFH-07-1022			Desired Flushing Vol	396.87250		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	4 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

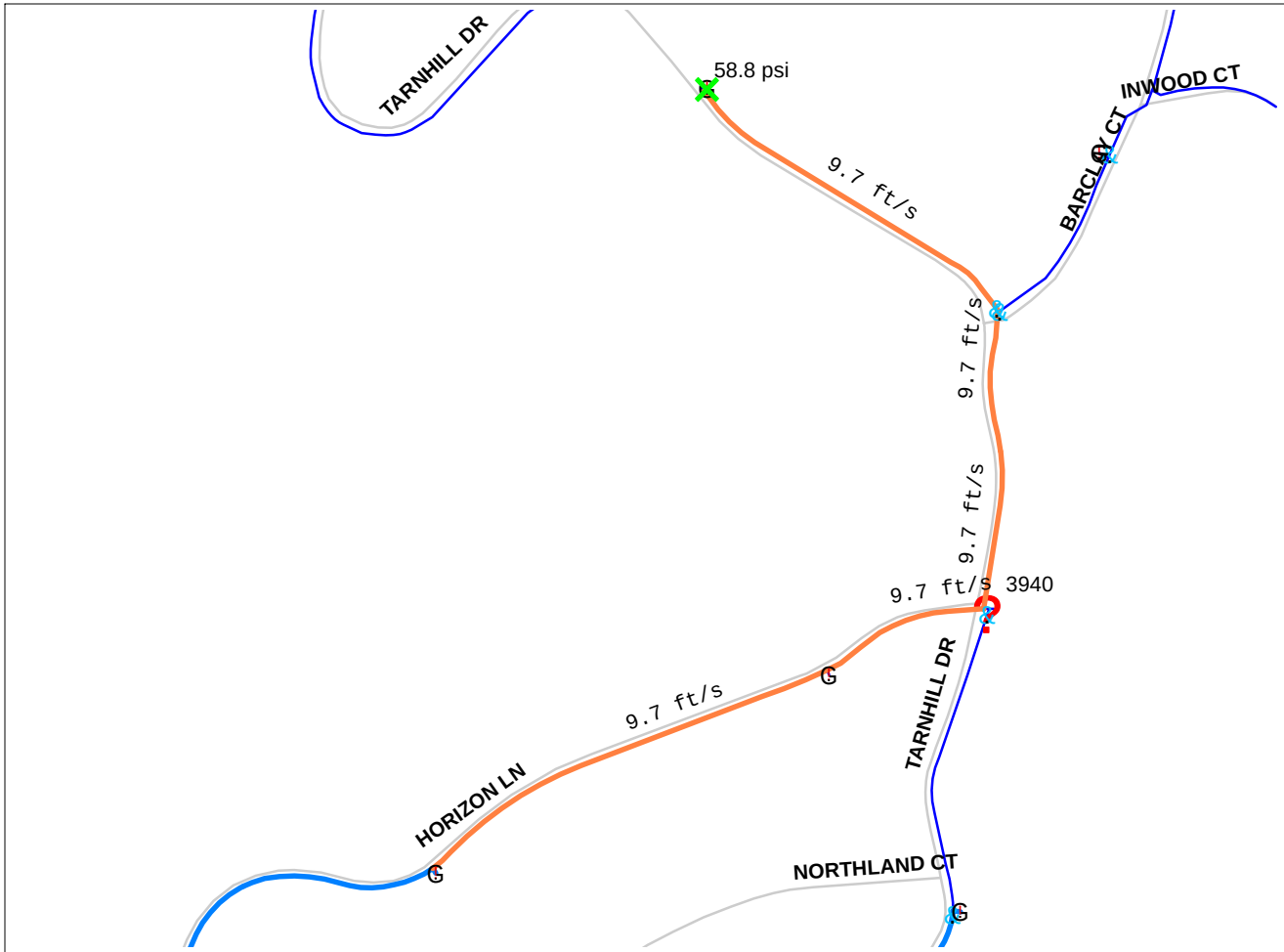
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	24	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	159.56820				
Duration	10 min.	Open Hydrant	07-1020	Res. Pressure	78.38690 psi		Turbidity		
Valves to Open				Discharge Flow	860.84768		Disinf. Res.		
				Available Flow	1,154.16224		pH		
Valves to Close	(3930,3931)			Total Pipe Len.	1,160.0 ft		Iron		
				Min Flushing Vol	375.49100		Odor		
Pipes to Flush	P-10957,P-13441,P-5067,P-5083,PI-5331,PLATFH-07-1020			Desired Flushing Vol	1,126.47300		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

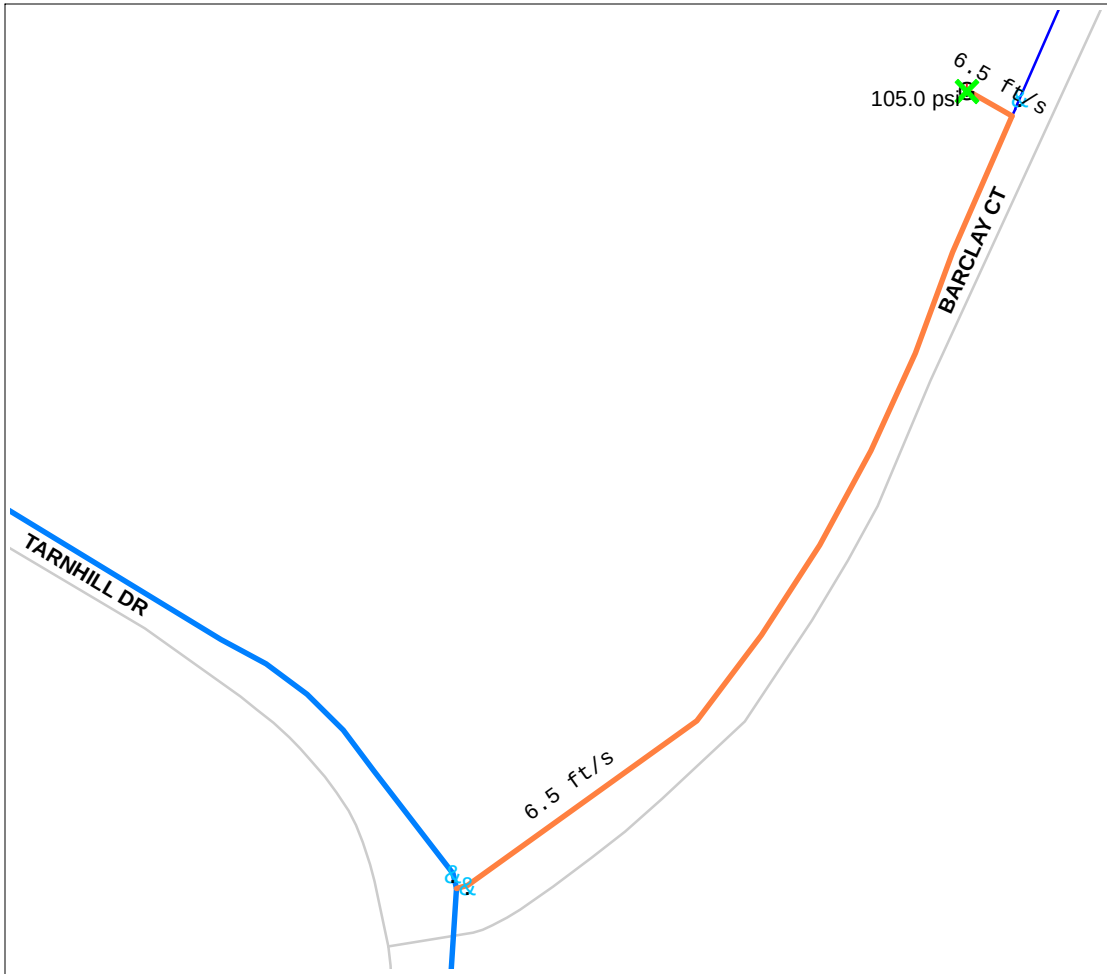
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	25	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	185.56530				
Duration	10 min.	Open Hydrant	07-1026	Res. Pressure	58.80180 psi		Turbidity		
Valves to Open				Discharge Flow	851.95936		Disinf. Res.		
				Available Flow	984.79808		pH		
Valves to Close	3940(3930,3931)			Total Pipe Len.	1,863.1 ft		Iron		
				Min Flushing Vol	365.00290		Odor		
Pipes to Flush	P-13443,P-10961,P-13445,PI-5339,P-5089			Desired Flushing Vol	1,095.00870		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

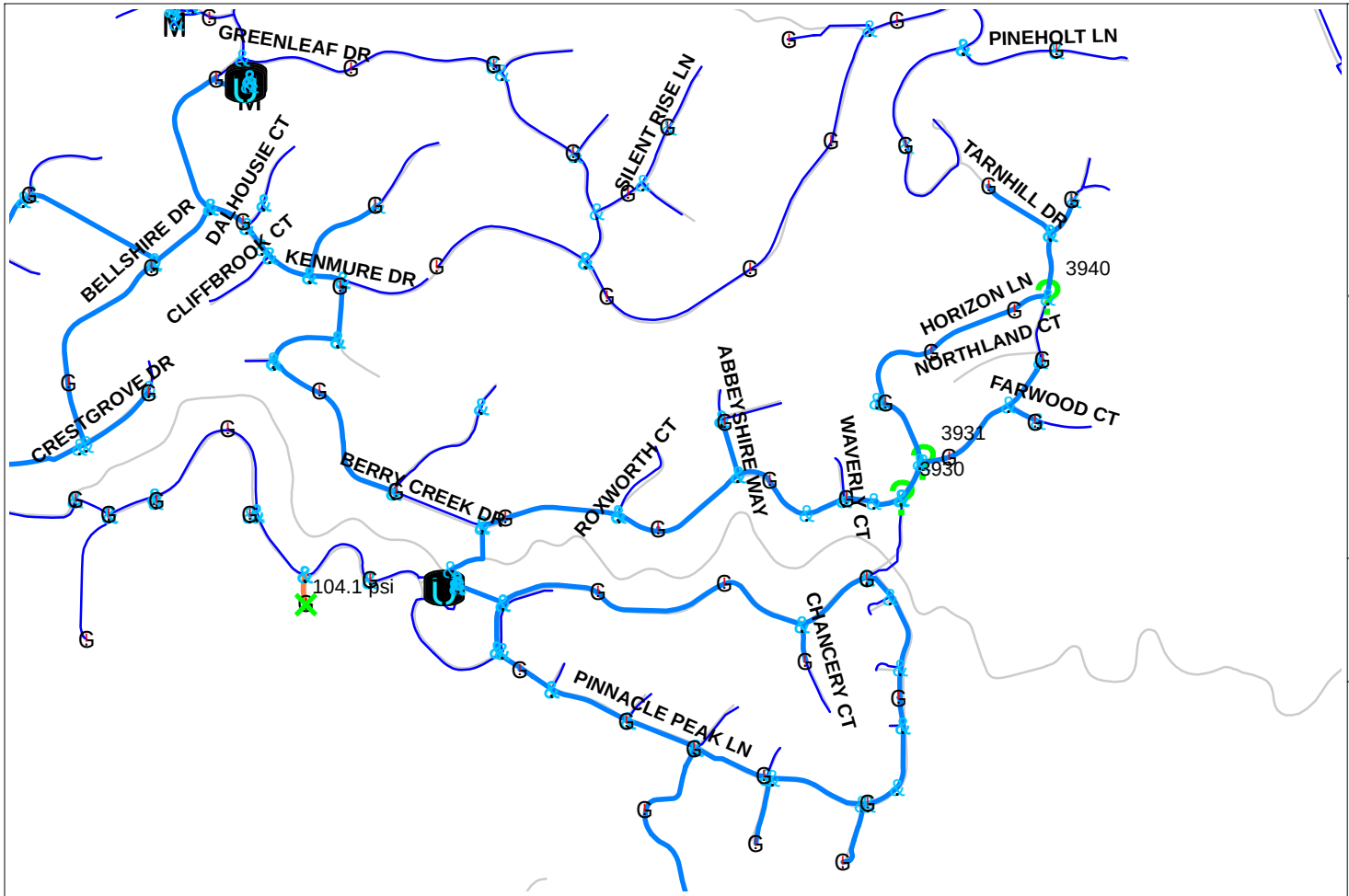
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	26	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	163.90050				
Duration	2 min.	Open Hydrant	07-1025	Res. Pressure	105.01050		Turbidity		
Valves to Open				Discharge Flow	569.61632		Disinf. Res.		
				Available Flow	930.56544		pH		
Valves to Close	(3930,3931,3940)			Total Pipe Len.	294.6 ft		Iron		
				Min Flushing Vol	57.69410 ft^3		Odor		
Pipes to Flush	PI-5345,PLATFH-07-1025			Desired Flushing Vol	173.08240		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	2 min.		Other		

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Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

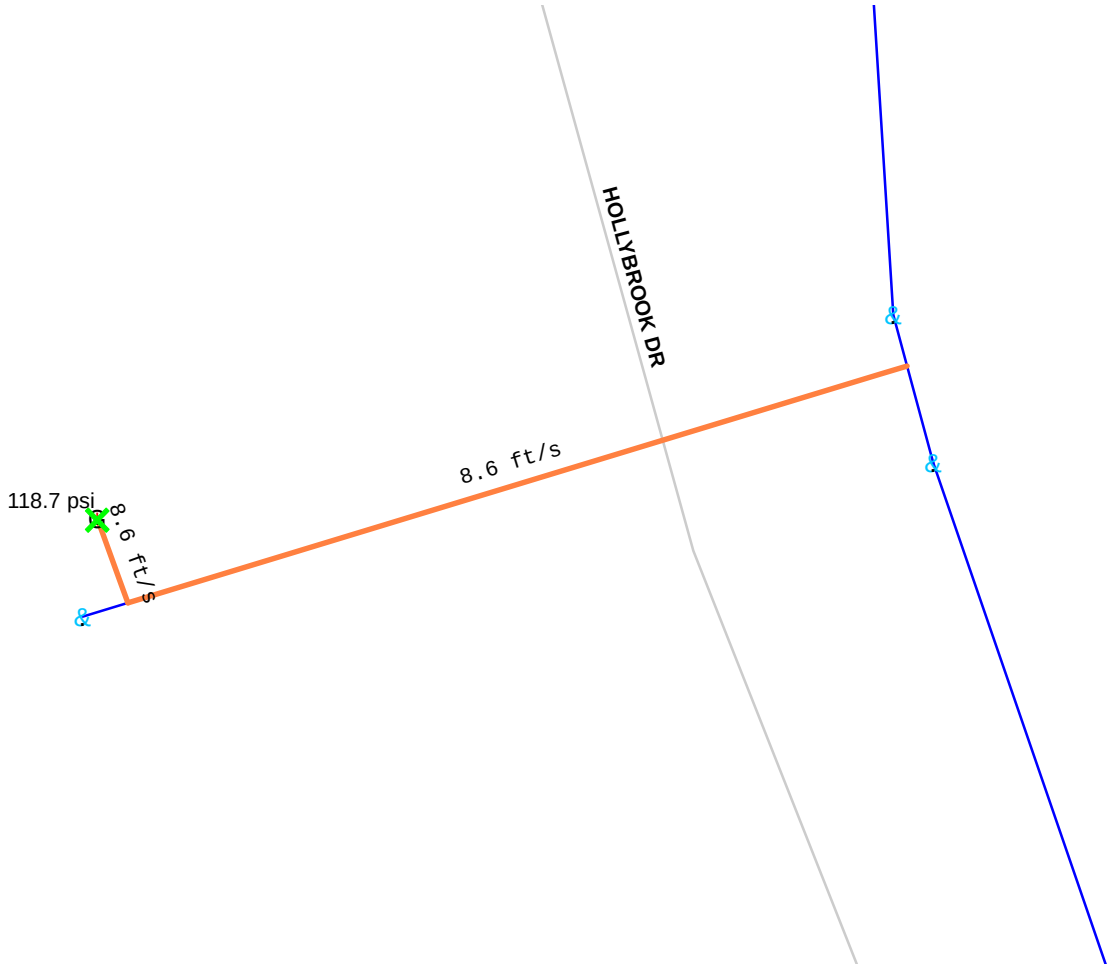
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE6	Sequence	27	Static Pressure	110.51670				
Date of Flush		Start Time		Res. Pressure	104.13030		Turbidity		
Duration	1 min.	Open Hydrant	07-3154	Discharge Flow	708.63520		Disinf. Res.		
Valves to Open	3940, 3931, 3930			Available Flow	2,816.06976		pH		
Valves to Close				Total Pipe Len.	201.0 ft		Iron		
				Min Flushing Vol	39.46670 ft^3		Odor		
Pipes to Flush	PI-11			Desired Flushing Vol	118.40000		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	1 min.		Other		

Prepared By: Hazen and Sawyer

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

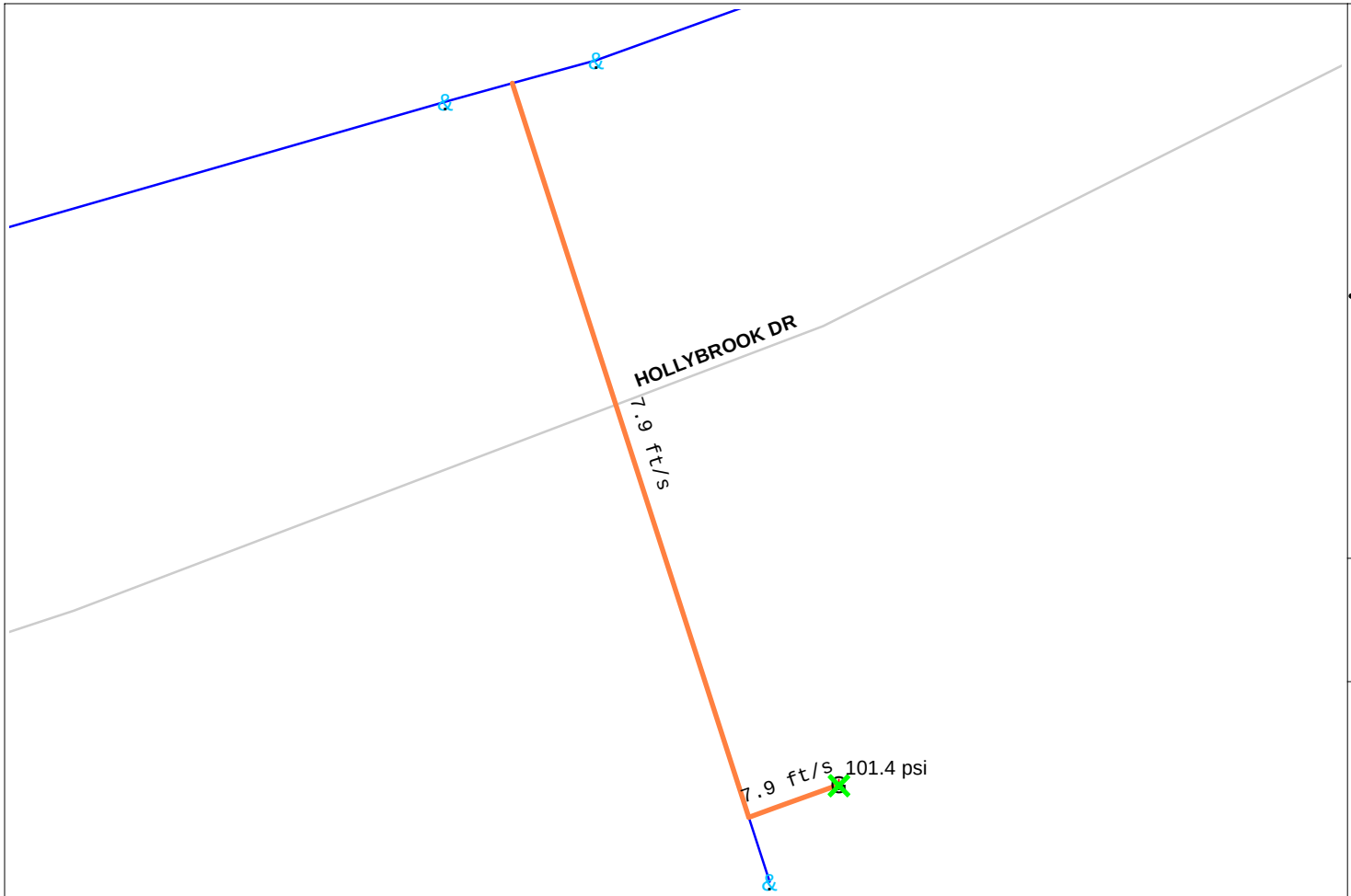
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	28	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	122.96690				
Duration	0 min.	Open Hydrant	07-3160	Res. Pressure	118.69020		Turbidity		
Valves to Open				Discharge Flow	756.54880		Disinf. Res.		
				Available Flow	3,791.97952		pH		
Valves to Close				Total Pipe Len.	51.0 ft		Iron		
				Min Flushing Vol	10.02200 ft^3		Odor		
Pipes to Flush	PI-925,PLATFH-07-3160			Desired Flushing Vol	30.06590 ft^3		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	0 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 10:52:03 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

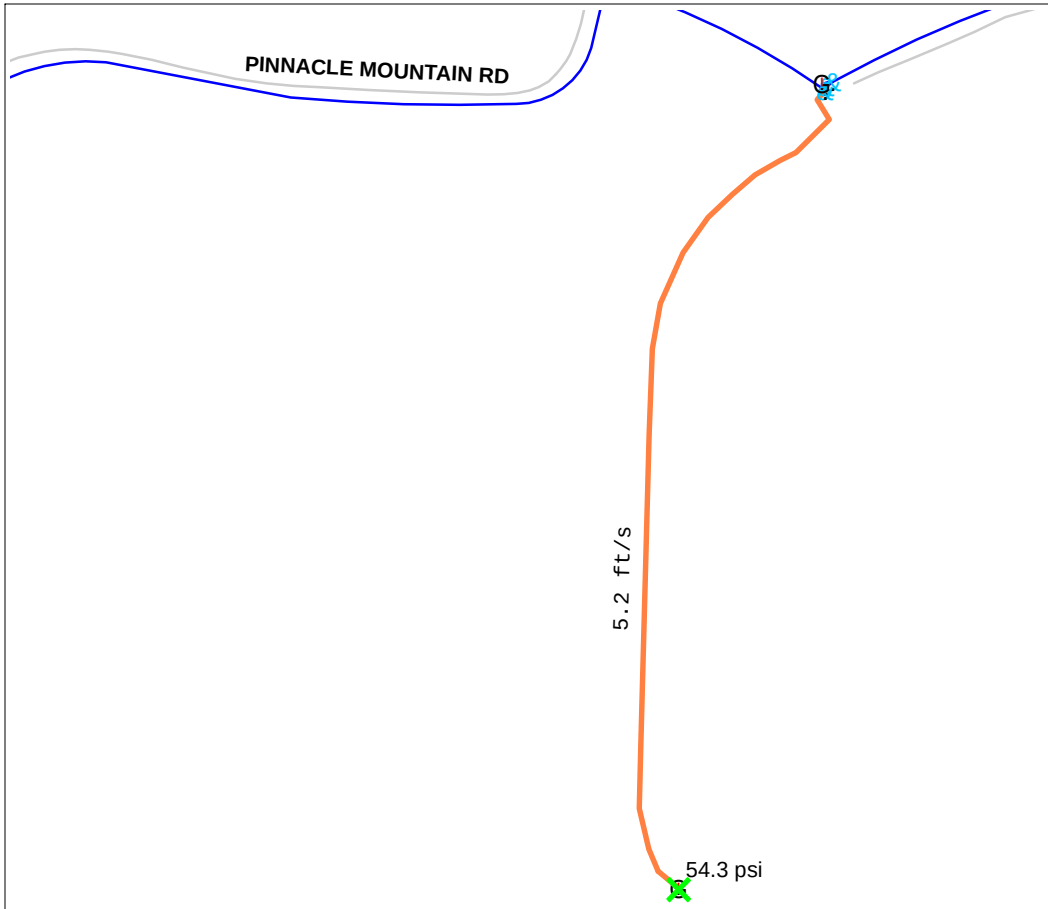
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE6	Sequence	29	Static Pressure	104.48300				
Date of Flush		Start Time		Res. Pressure	101.35990		Turbidity		
Duration	0 min.	Open Hydrant	07-3164	Discharge Flow	699.12192		Disinf. Res.		
Valves to Open				Available Flow	3,742.95488		pH		
Valves to Close				Total Pipe Len.	34.9 ft		Iron		
				Min Flushing Vol	6.84650 ft^3		Odor		
Pipes to Flush	PI-921,PLATFH-07-3164			Desired Flushing Vol	20.53950 ft^3		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	0 min.		Other		

Prepared By: Hazen and Sawyer

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

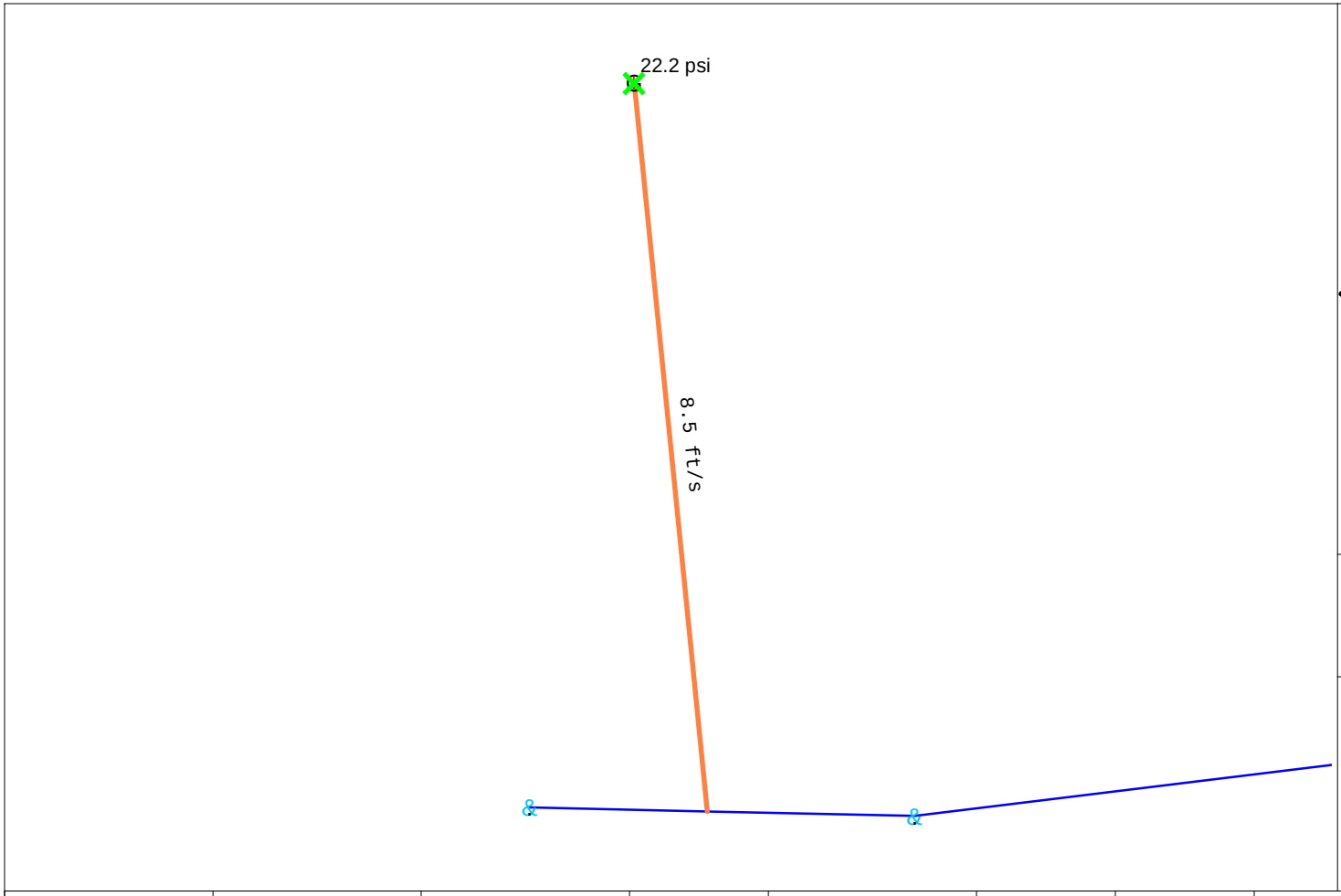
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Kenmure-Greenleaf Dr. pumps on

Zone	ZONE6	Sequence	30	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	62.81510 psi				
Duration	9 min.	Open Hydrant	07-3363	Res. Pressure	54.33350 psi		Turbidity		
Valves to Open				Discharge Flow	819.11424		Disinf. Res.		
				Available Flow	1,900.15616		pH		
Valves to Close				Total Pipe Len.	944.2 ft		Iron		
				Min Flushing Vol	325.36280		Odor		
Pipes to Flush	P-14557,PLATFH-07-3363			Desired Flushing Vol	976.08850		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	9 min.		Other		

Prepared By: Hazen and Sawyer

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

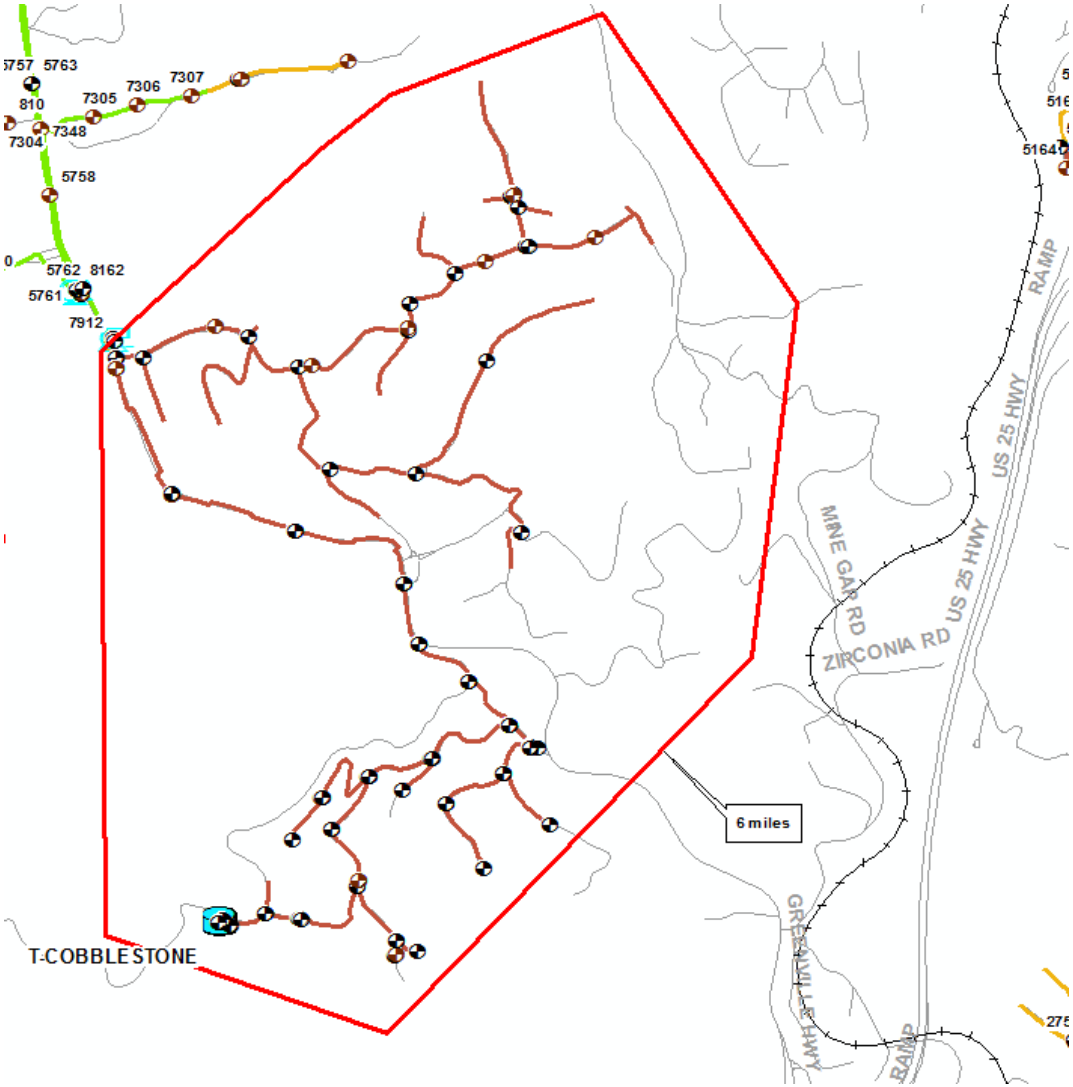
Note: Both Kenmure-Greenleaf Dr. pumps on

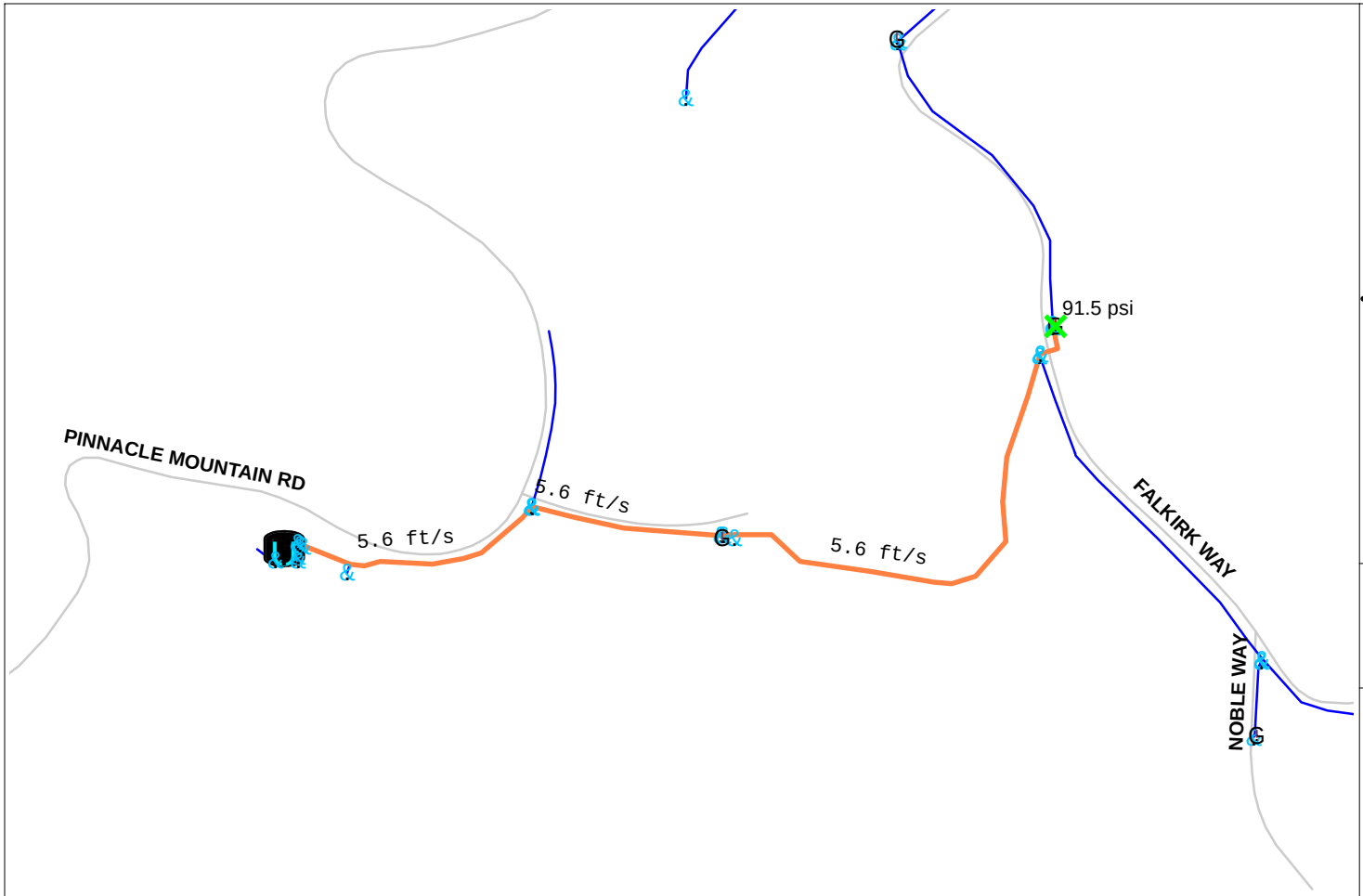
Zone	ZONE6	Sequence	31	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	22.79950 psi				
Duration	0 min.	Open Hydrant	07-1184	Res. Pressure	22.16170 psi		Turbidity		
Valves to Open				Discharge Flow	752.59072		Disinf. Res.		
				Available Flow	1,623.99328		pH		
Valves to Close				Total Pipe Len.	7.6 ft		Iron		
				Min Flushing Vol	1.50000 ft^3		Odor		
Pipes to Flush	PLATFH-07-1184			Desired Flushing Vol	4.50000 ft^3		HPC		
				Min Flushing Time	0 min.		Color		
				Desired Flushing	0 min.		Other		

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Zone 7


5757
5763
810
7305
7306
7307
7304
7348
5758
5762
8162
5761
7912
T-COBBLESTONE
6 miles
MINE GAP RD
ZIRCONIA RD
US 25 HWY
US 25 HWY
RAMP
RAMP
5164



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

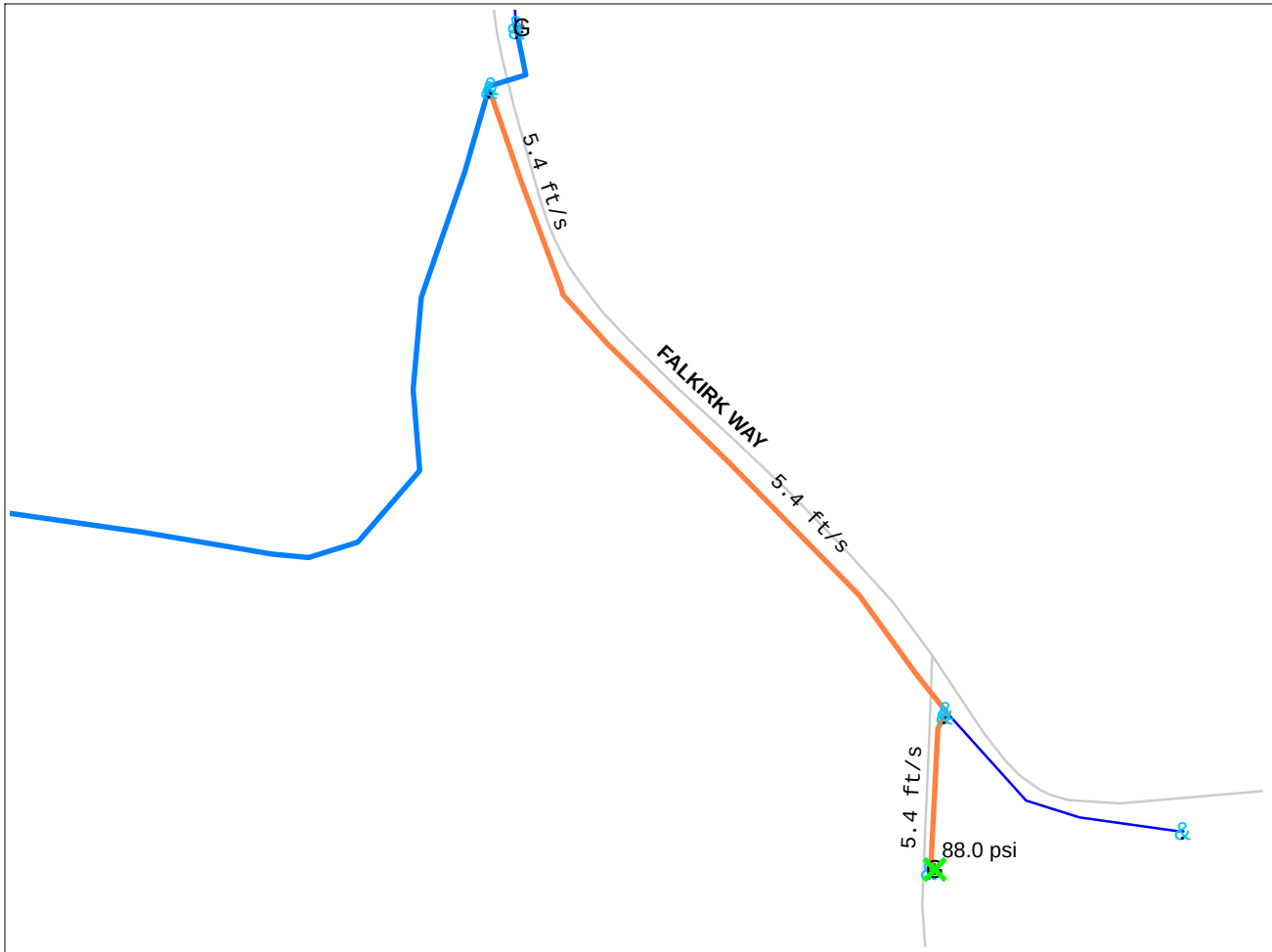
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

				Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Zone	ZONE7	Sequence	1	Static Pressure	101.27740				
Date of Flush		Start Time		Res. Pressure	91.45510 psi		Turbidity		
Duration	14 min.	Open Hydrant	07-3168	Discharge Flow	863.90304		Disinf. Res.		
Valves to Open				Available Flow	2,737.25536		pH		
Valves to Close				Total Pipe Len.	1,555.4 ft		Iron		
				Min Flushing Vol	531.69580		Odor		
Pipes to Flush	P-10869,P-9861,P-9863,PI-10637,PI-10639,P-9867,P-9869,PI-10643,PI-10645,PLATFH-07-3168			Desired Flushing Vol	1,595.08740		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	14 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

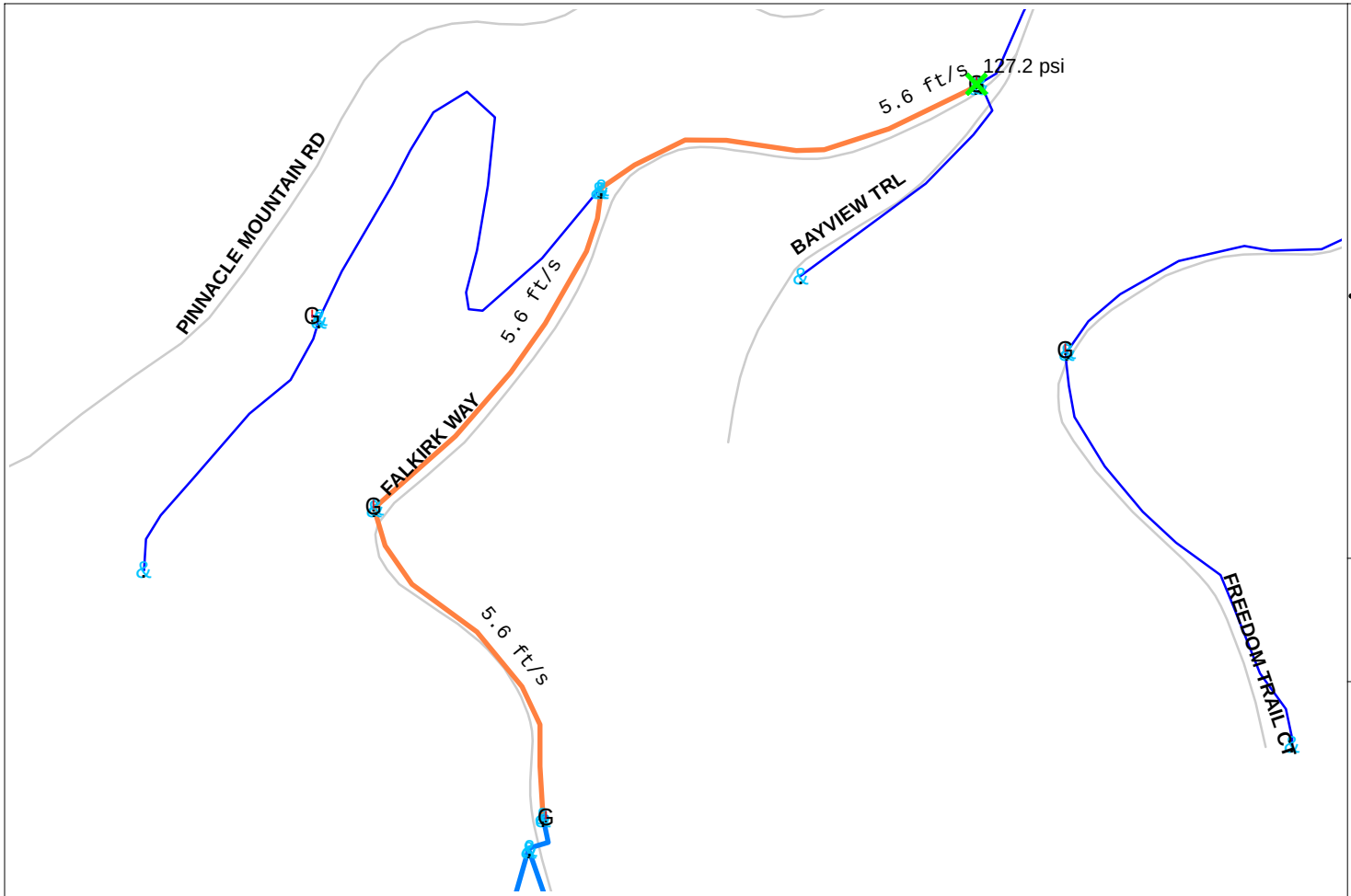
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	2	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	108.64370				
Duration	7 min.	Open Hydrant	07-3170	Res. Pressure	87.98300 psi		Turbidity		
Valves to Open				Discharge Flow	848.20960		Disinf. Res.		
				Available Flow	1,867.86656		pH		
Valves to Close				Total Pipe Len.	725.0 ft		Iron		
				Min Flushing Vol	251.93700		Odor		
Pipes to Flush	P-10871,PI-10641,PI-10653,PI-10655,PLATFH-07-3170			Desired Flushing Vol	755.81110		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	7 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	3	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	146.76700				
Duration	15 min.	Open Hydrant	07-3174	Res. Pressure	127.18150		Turbidity		
Valves to Open				Discharge Flow	862.30592		Disinf. Res.		
				Available Flow	2,390.61088		pH		
Valves to Close				Total Pipe Len.	1,696.4 ft		Iron		
				Min Flushing Vol	580.22660		Odor		
Pipes to Flush	P-9871,P-9873,P-9881,PI-10647,PLATFH-07-3174			Desired Flushing Vol	1,740.67970		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	15 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

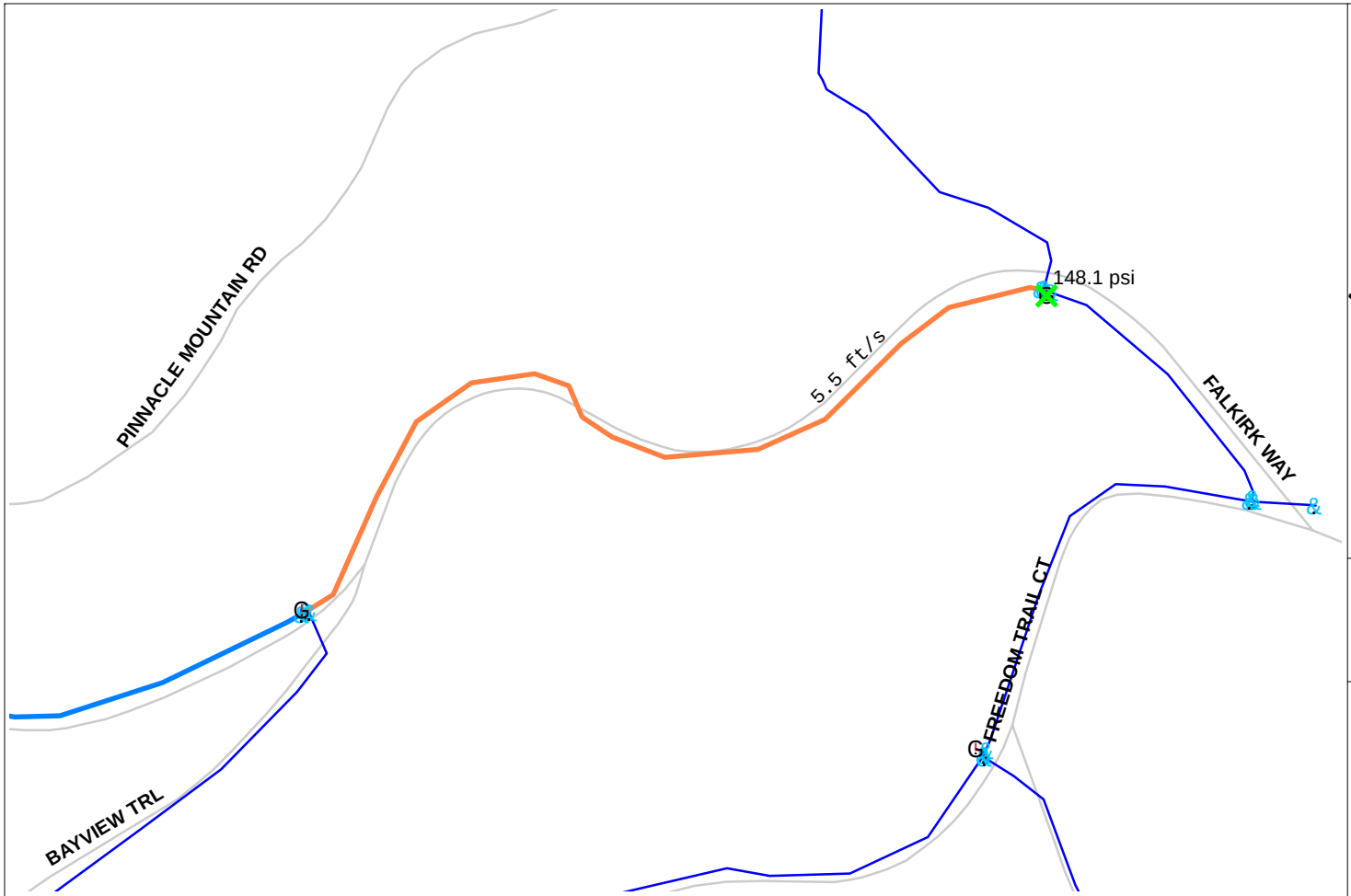
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	4	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	70.07570 psi				
Duration	10 min.	Open Hydrant	07-3357	Res. Pressure	51.11680 psi		Turbidity		
Valves to Open				Discharge Flow	796.33792		Disinf. Res.		
				Available Flow	1,350.88576		pH		
Valves to Close				Total Pipe Len.	1,005.4 ft		Iron		
				Min Flushing Vol	349.44370		Odor		
Pipes to Flush	PI-10649,PI-10657,PLATFH-07-3357			Desired Flushing Vol	1,048.33120		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

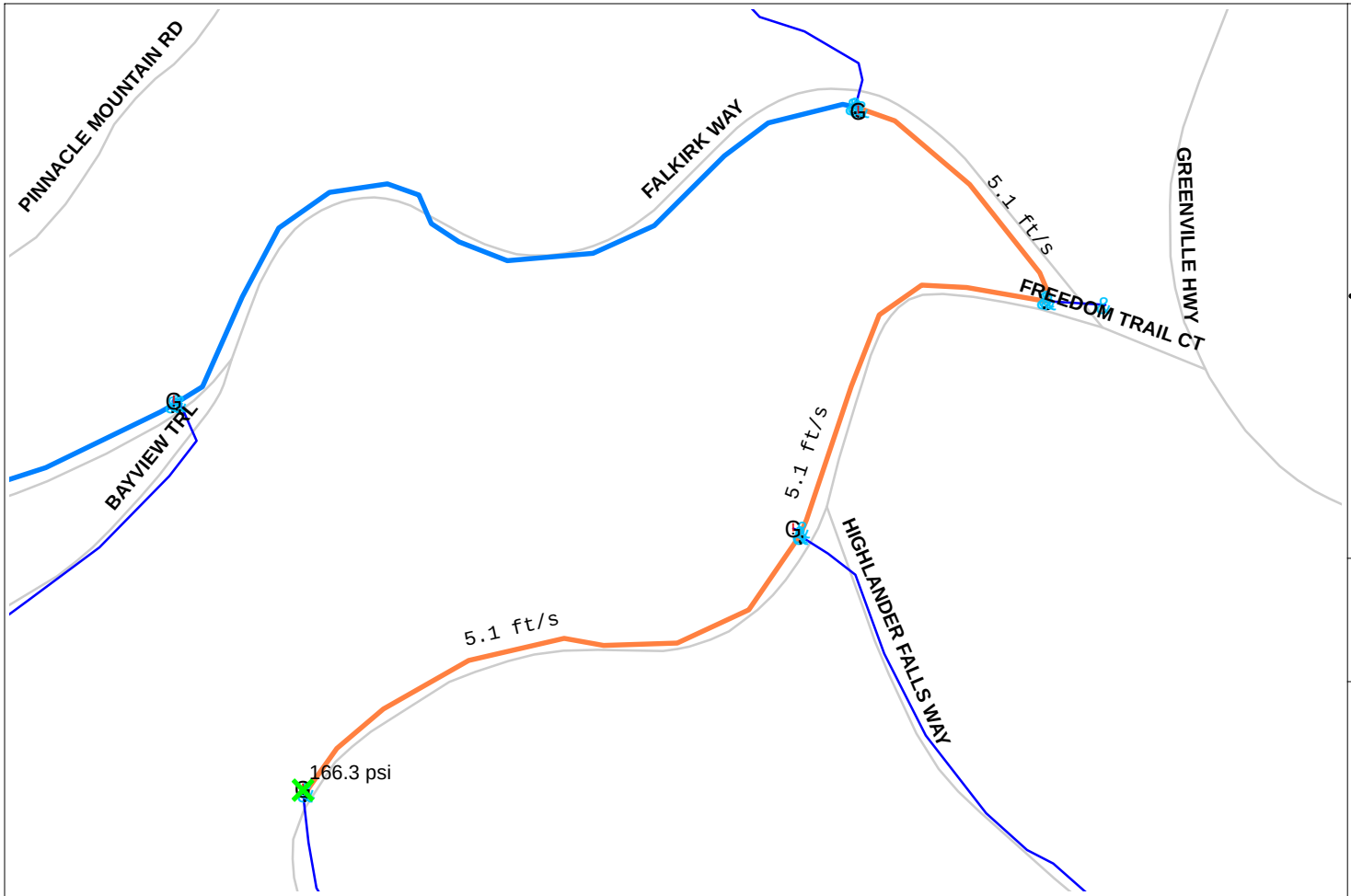
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	5	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	171.89490				
Duration	8 min.	Open Hydrant	07-3176	Res. Pressure	148.10530		Turbidity		
Valves to Open				Discharge Flow	845.84864		Disinf. Res.		
				Available Flow	2,328.53152		pH		
Valves to Close				Total Pipe Len.	870.2 ft		Iron		
				Min Flushing Vol	297.37020		Odor		
Pipes to Flush	P-9883,P-9885,P-9887,PI-10659,PI-10663,PLATFH-07-3176			Desired Flushing Vol	892.11060		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	8 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

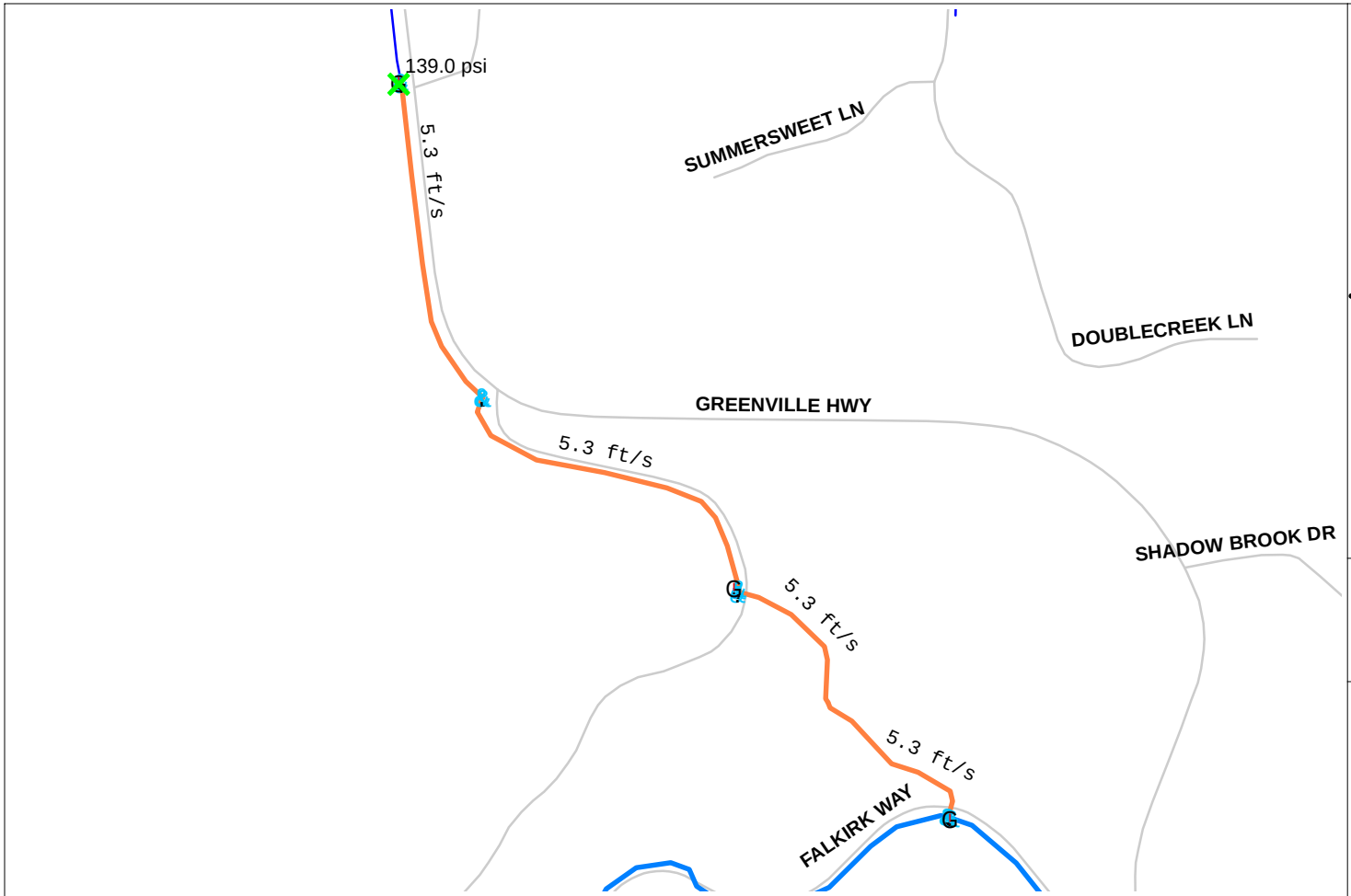
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	6	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	194.42660				
Duration	12 min.	Open Hydrant	07-1192	Res. Pressure	166.30950		Turbidity		
Valves to Open				Discharge Flow	806.47616		Disinf. Res.		
				Available Flow	2,180.97152		pH		
Valves to Close				Total Pipe Len.	1,269.5 ft		Iron		
				Min Flushing Vol	442.58530		Odor		
Pipes to Flush	P-9889,P-9891,P-9893,P-9895,PI-10671,PLATFH-07-1192			Desired Flushing Vol	1,327.75590		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

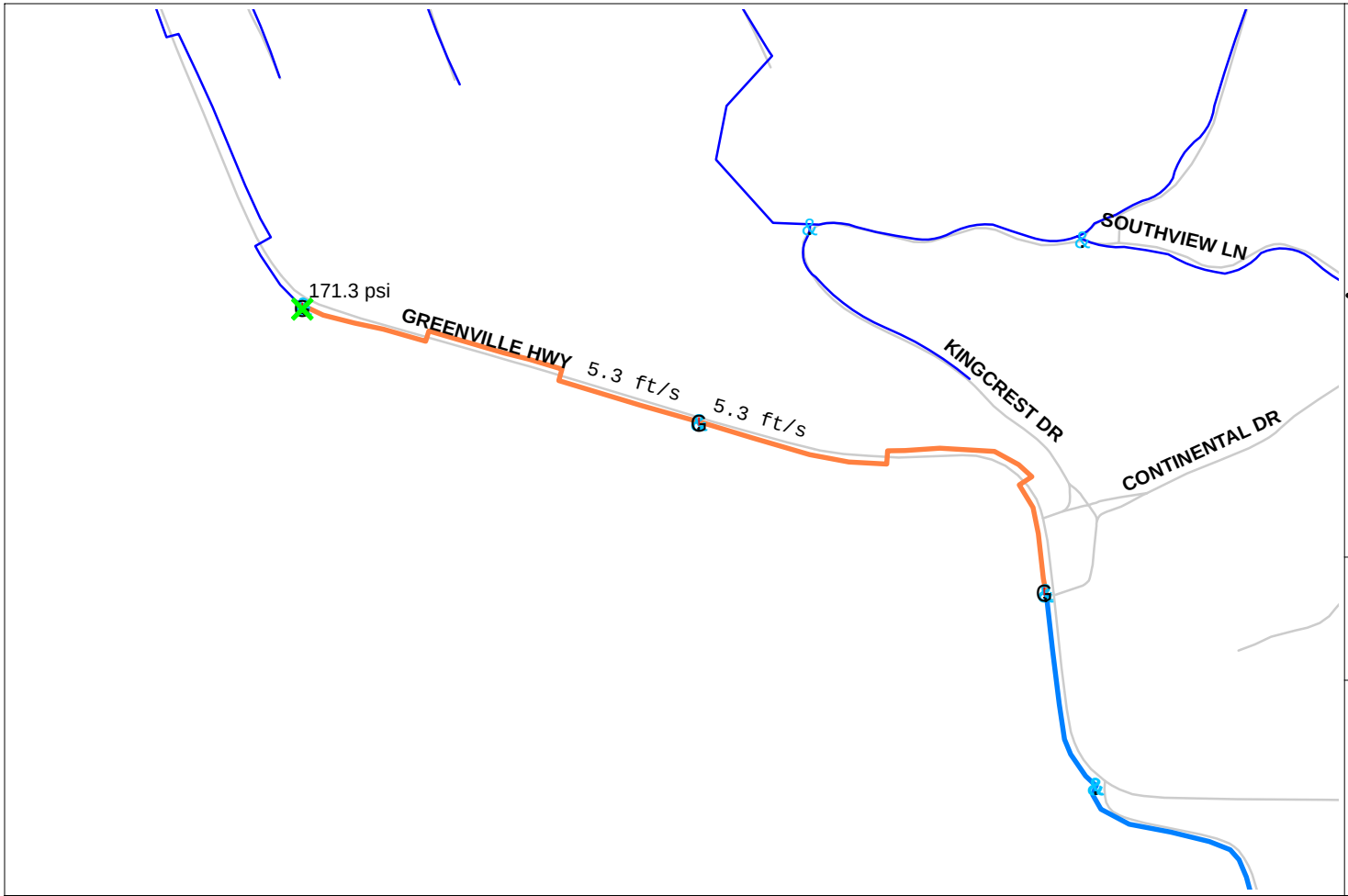
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	7	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	170.58850				
Duration	16 min.	Open Hydrant	07-1178	Res. Pressure	138.99400		Turbidity		
Valves to Open				Discharge Flow	819.66976		Disinf. Res.		
				Available Flow	1,924.59904		pH		
Valves to Close				Total Pipe Len.	1,731.3 ft		Iron		
				Min Flushing Vol	591.81620		Odor		
Pipes to Flush	P-10875,PI-10665,PI-10679,P-9899,PI-10681,PI-10683,PLATFH-07-1178			Desired Flushing Vol	1,775.44850		HPC		
				Min Flushing Time	5 min.		Color		
				Desired Flushing	16 min.		Other		

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Legend

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- Closed Valve
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- Flushing Pipe

Hendersonville Water Sewer

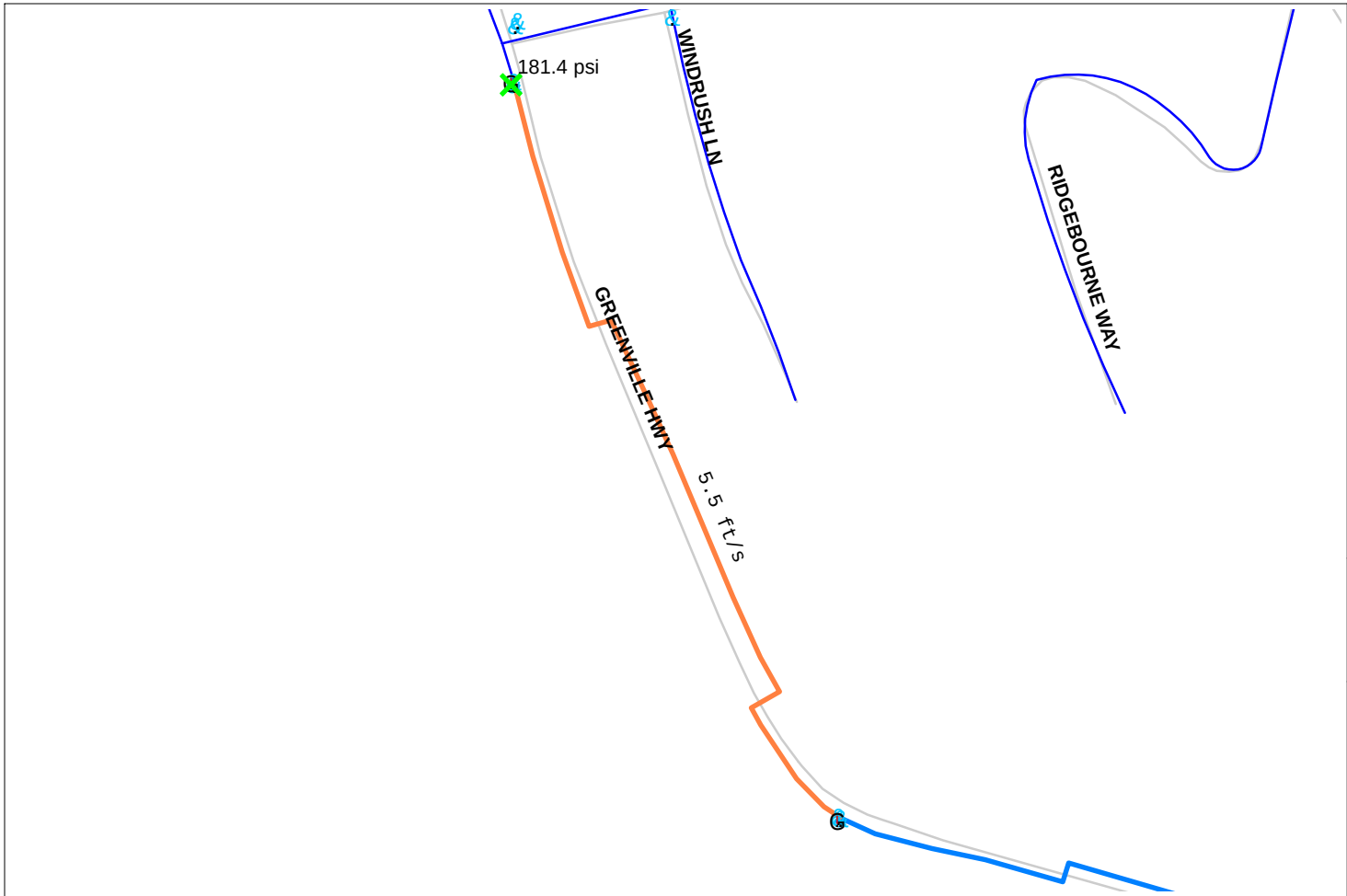
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	8	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	216.07590				
Duration	23 min.	Open Hydrant	07-1174	Res. Pressure	171.33170		Turbidity		
Valves to Open				Discharge Flow	818.00320		Disinf. Res.		
				Available Flow	1,836.47968		pH		
Valves to Close				Total Pipe Len.	2,497.9 ft		Iron		
				Min Flushing Vol	853.96710		Odor		
Pipes to Flush	P-9901,P-9905,PI-10685,PI-10687,PLATFH-07-1174,PLATFH-07-3354			Desired Flushing Vol	2,561.90130		HPC		
				Min Flushing Time	8 min.		Color		
				Desired Flushing	23 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
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Hendersonville Water Sewer

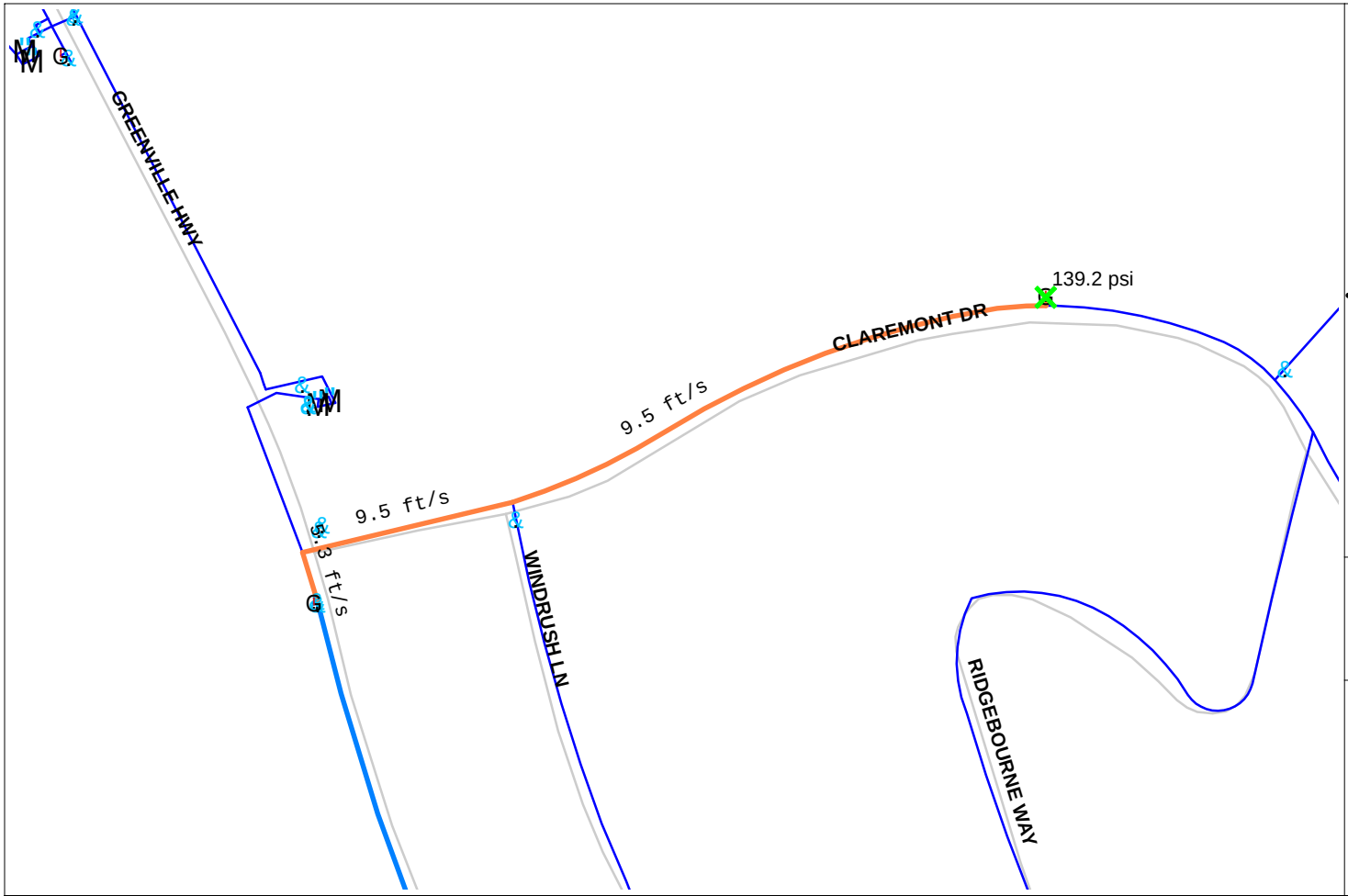
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	9	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	235.56990				
Duration	12 min.	Open Hydrant	07-3354	Res. Pressure	181.41690		Turbidity		
Valves to Open				Discharge Flow	841.75168		Disinf. Res.		
				Available Flow	1,792.80192		pH		
Valves to Close				Total Pipe Len.	1,277.6 ft		Iron		
				Min Flushing Vol	437.08490		Odor		
Pipes to Flush	P-9907,PI-10689,PLATFH-07-3354			Desired Flushing Vol	1,311.25480		HPC		
				Min Flushing Time	4 min.		Color		
				Desired Flushing	12 min.		Other		

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Legend

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- Closed Valve
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Hendersonville Water Sewer

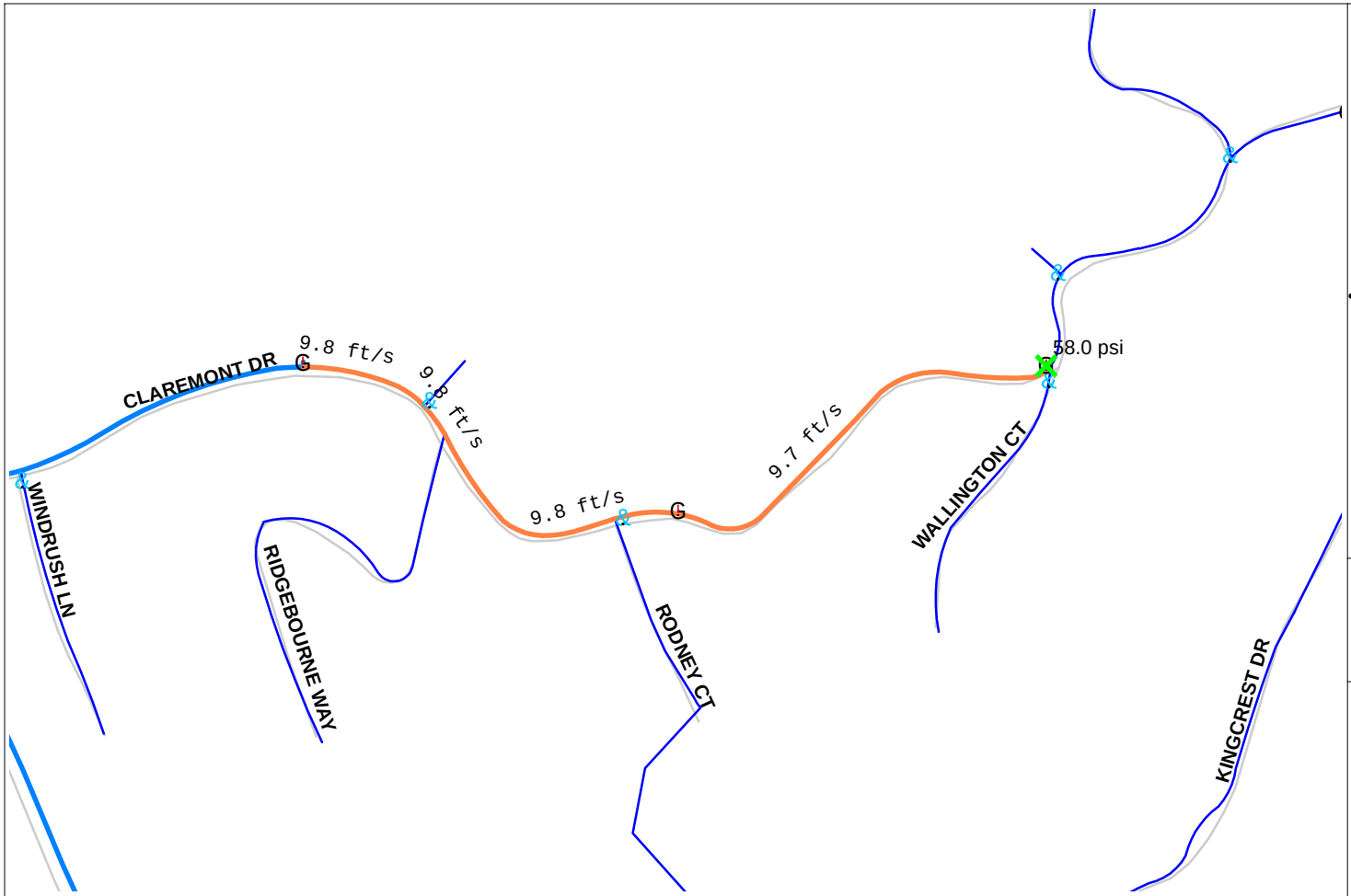
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	10	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	212.15870				
Duration	6 min.	Open Hydrant	07-3335	Res. Pressure	139.23460		Turbidity		
Valves to Open				Discharge Flow	819.39200		Disinf. Res.		
				Available Flow	1,393.45248		pH		
Valves to Close				Total Pipe Len.	1,006.4 ft		Iron		
				Min Flushing Vol	203.28400		Odor		
Pipes to Flush	P-15341,P-2107,PLATFH-07-3335,P-2085,P-9909			Desired Flushing Vol	609.85190		HPC		
				Min Flushing Time	2 min.		Color		
				Desired Flushing	6 min.		Other		

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Date: 7/27/2016 11:14:35 AM



Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

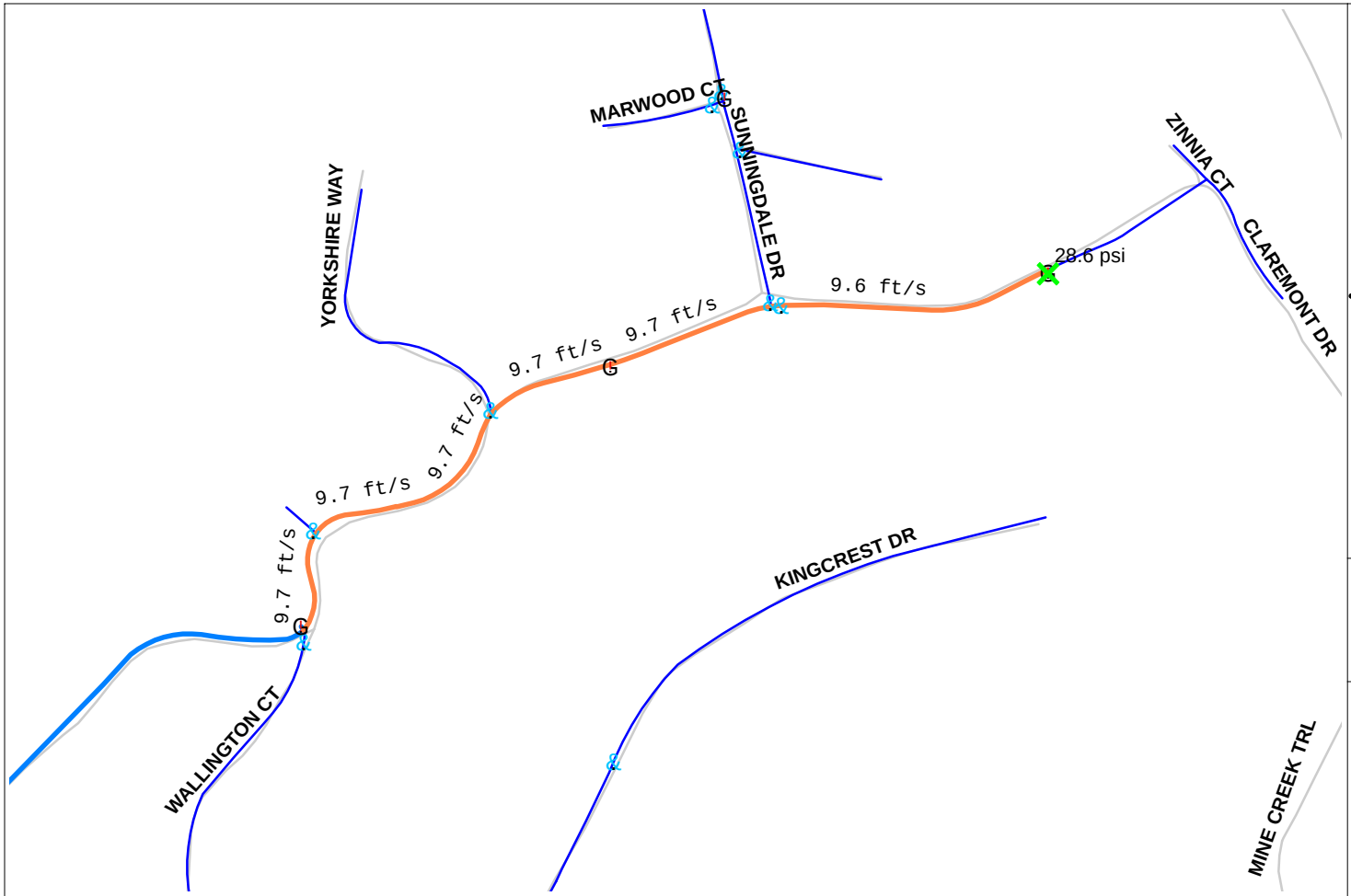
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	11	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	181.81550				
Duration	10 min.	Open Hydrant	07-3337	Res. Pressure	58.04040 psi		Turbidity		
Valves to Open				Discharge Flow	846.47360		Disinf. Res.		
				Available Flow	980.70112		pH		
Valves to Close				Total Pipe Len.	1,992.6 ft		Iron		
				Min Flushing Vol	386.97480		Odor		
Pipes to Flush	P-12897,P-2101,P-2103,P-2105,P-9437,PI-10073,PLATFH-07-3337			Desired Flushing Vol	1,160.92450		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

Prepared By: Hazen and Sawyer

Date: 7/27/2016 11:14:35 AM



Legend

- Flushing Hydrant
- Closed Valve
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Hendersonville Water Sewer

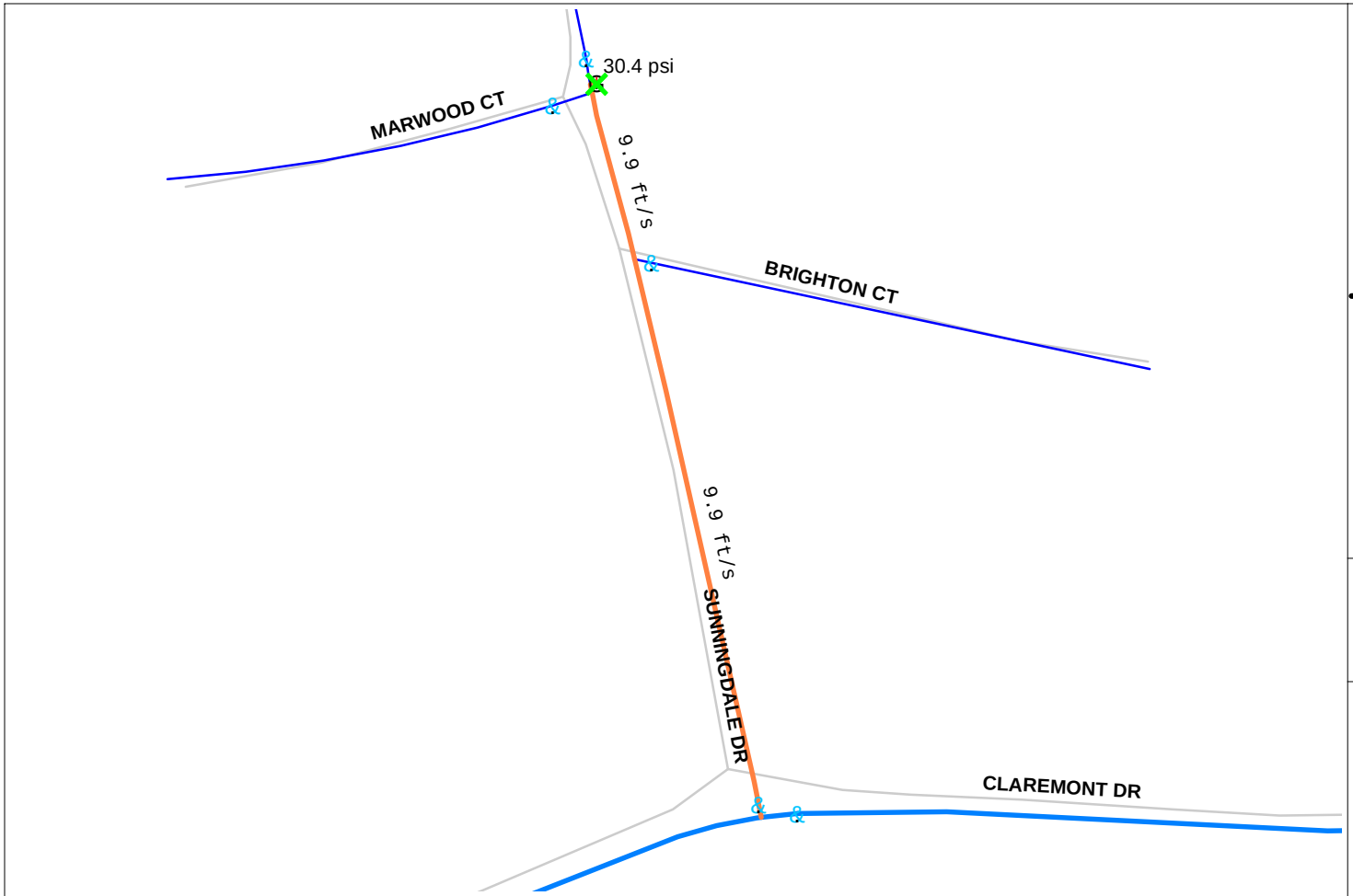
UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	12	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	196.11210				
Duration	10 min.	Open Hydrant	07-3339	Res. Pressure	28.63640 psi		Turbidity		
Valves to Open				Discharge Flow	848.00128		Disinf. Res.		
				Available Flow	871.61088		pH		
Valves to Close				Total Pipe Len.	1,998.9 ft		Iron		
				Min Flushing Vol	390.77260		Odor		
Pipes to Flush	P-10879,P-14013,P-14015,P-9439,P-9441,P-9443,PI-10075,PI-2427,PLATFH-07-3339			Desired Flushing Vol	1,172.31790		HPC		
				Min Flushing Time	3 min.		Color		
				Desired Flushing	10 min.		Other		

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Legend

- Flushing Hydrant
- Closed Valve
- Open Valve
- Flushed Pipe
- Flushing Pipe

Hendersonville Water Sewer

UNIDIRECTIONAL FLUSHING PROGRAM

Note: Both Claremont (main) pumps off

Zone	ZONE7	Sequence	13	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	206.51120				
Duration	2 min.	Open Hydrant	07-3340	Res. Pressure	30.39660 psi		Turbidity		
Valves to Open				Discharge Flow	873.62464		Disinf. Res.		
				Available Flow	901.47008		pH		
Valves to Close				Total Pipe Len.	465.6 ft		Iron		
				Min Flushing Vol	91.14540 ft^3		Odor		
Pipes to Flush	P-2095,P-2099,PI-2451,PLATFH-07-3340			Desired Flushing Vol	273.43630		HPC		
				Min Flushing Time	1 min.		Color		
				Desired Flushing	2 min.		Other		

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