System Model Development and Summary Report

Charles Town Utility Board

Dewberry Project Number: 50107004

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SYSTEM MODEL DEVELOPMENT AND SUMMARY REPORT

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SECTION 1 – EXECUTIVE SUMMARY

1.1 INTRODUCTION

The City of Charles Town, West Virginia, has been seeing a steady increase in residential and commercial customers since the early 2000s. Charles Town Utility Board (CTUB) currently serves about 6,400 customers in the area; roughly 90% of these customers are residential and 10% are commercial (based on the number of customers), with Hollywood Casino at Charles Town Races and Jefferson Medical Center as their two largest customers. When Dewberry met with CTUB, they stated that their water model had not been updated since 2015. To address the future demand increase and the outdated water model concerns, CTUB entered into an Agreement with Dewberry Engineers Inc. (Dewberry) in November 2018 to update the existing water model by incorporating all infrastructure installed since 2015, implementing operational changes in light of the recently constructed water treatment plant, analyzing the existing system for hydraulic limitations (bottle-necks), and identifying conceptual improvements needed to meet current demand projections, including fire flow allowances. The updated model will further be used as a long-term planning tool for evaluating the impacts of proposed development on the distribution system.

This report includes a description and graphics of the water model (before and after the updates and calibration), an inventory of major water distribution system components (tanks, pumps, valves, etc.), current and recommended operating philosophy, water model calibration information, water model results and figures, and recommendations to improve the water distribution and fire flow suppression systems.

1.2 SCOPE OF WORK

The Scope of Work agreed upon between CTUB and Dewberry includes the following key elements, which have each been addressed in this report:

- Obtain CTUB customer usage records (from January, 2018) and geocode demands for all customers to use in the WaterCAD model for base demands.
- Add Dewberry / USGS 2016 LIDAR topographic information to all elements in the model and generated 5-foot contours from this data.

- Perform a quality control review of assets shown on Record Drawings versus those in the model and resolve observed discrepancies after consulting with CTUB. Add pipes and junctions as necessary based on the findings.
- Clarify existing control rules within the model for valves, pumps, tank levels, etc. as necessary based on SCADA data and set limits.
- Clarify necessary information with CTUB to more accurately model the connection between the different pressure zones.
- Assign each junction to the appropriate pressure zone for better calibration of the model and results in the fire flow analysis.
- Update pump curves with multiple points for the pump curves and the efficiency curves.
- Data Gathering and Field Reconnaissance.
- Complete hydrant testing at 11 sites for calibration of the model and added these locations and the appropriate information in the model.
- Update the pipe material in the model using information from record drawings and consulting with CTUB.
- Calibrate the model under static and 168-hour extended period simulation (EPS).
- Run a fire flow analysis to identify junctions that are not compliant with state and local regulations for fire flow.
- Identification of Hydraulic Limitations (Bottle-Necks) and Near-term Improvements.
- Consideration of Other Related Improvements for the Overall Distribution System.

The updates and evaluations to the water distribution and fire flow systems for CTUB are provided in Section 2 of this report. The recommended improvements to the CTUB system are presented in Section 3 of this report.

SECTION 2 – WATER MODEL DEVELOPMENT CRITERIA

2.1 WATER MODEL OVERVIEWS

CTUB had previously developed a hydraulic model in WaterCAD. The last update to the model was done in May 2015 (by others); the purpose of this update was to model Jefferson Avenue, located in the Main System pressure zone, in order to show the existing fire flows and pressure of the existing lines. Since then there have been several capital improvements made in all three (3) pressure zones that were not reflected in the 2015 model. Ultimately, Dewberry made improvements to both the GIS and WaterCAD model, adding all the improvements made by CTUB since 2015, including updates to the controls in the model in order to evaluate the system more accurately. The model data was verified using the existing as-builts provided by CTUB. Once the model was up-to-date was underway, hydrant flow testing was completed throughout the service system to record system pressures and flows so the model could be calibrated for greater precision and accuracy. **Figure 2-1** show a flow schematic of the existing tanks and pumps in the Model with key information regarding these major assets. **Figure 2-2** show a WaterCAD nodal diagram of the main infrastructure elements of the three pressure zones for the existing CTUB Model.

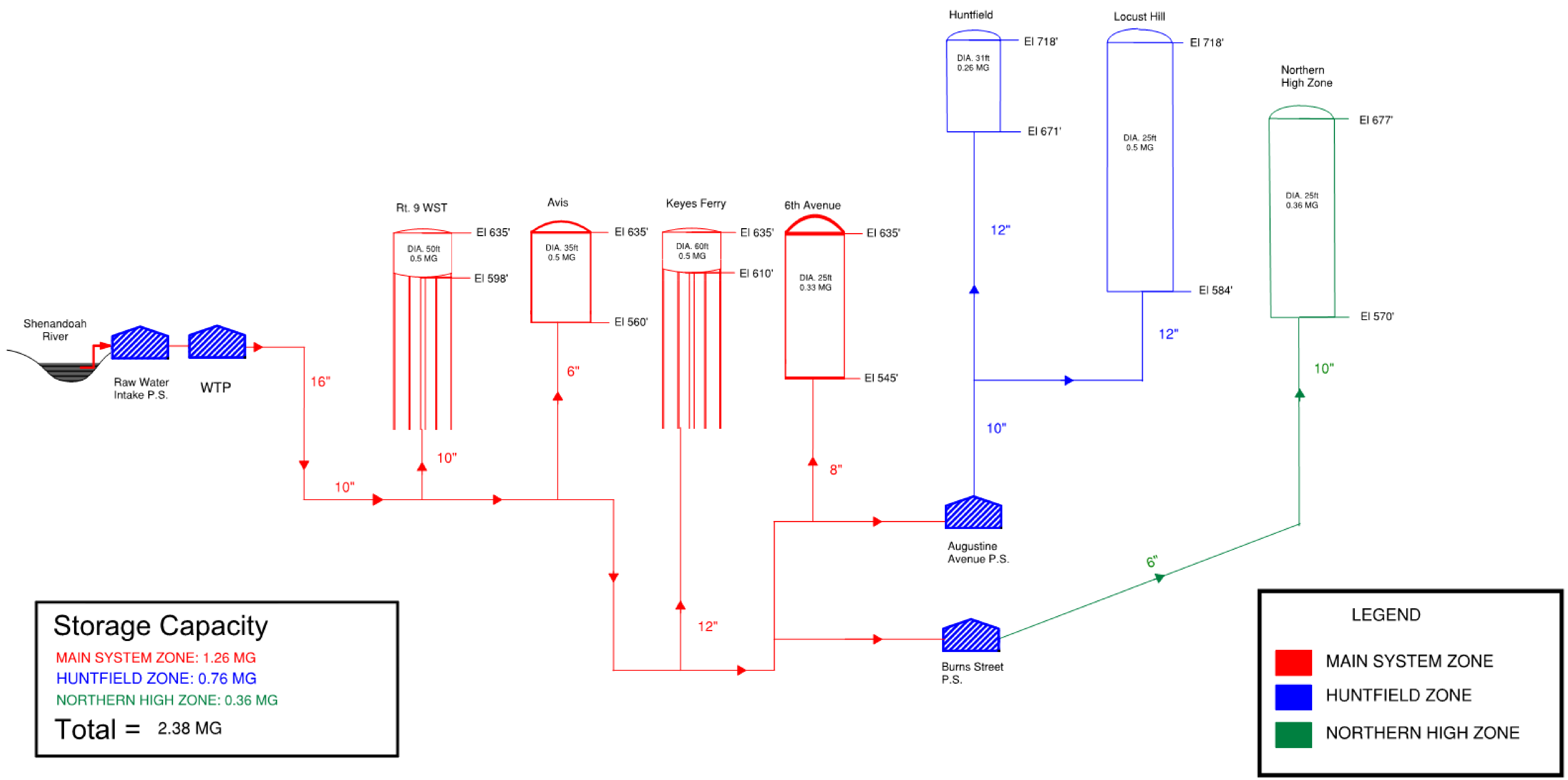

Figure 2-1: CTUB Flow Schematic Diagram

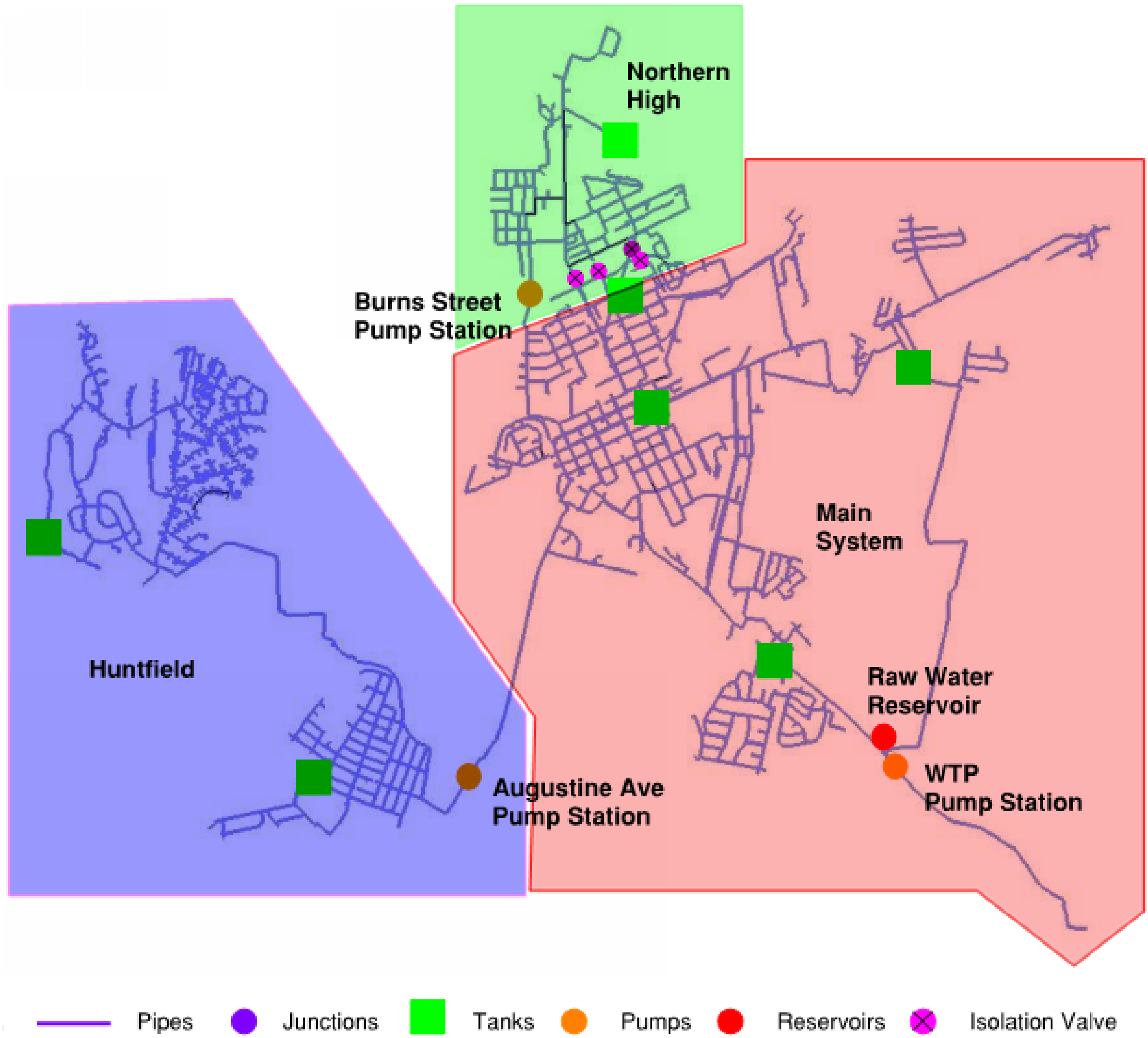

Figure 2-2: CTUB Model Nodal Diagram

2.2 HYDRAULIC MODEL DEVELOPMENT

The preliminary model that was provided to Dewberry contained the location of major assets (pumps, tanks, valves and pipelines), but it did not have the existing controls for valves, pumps, tank levels, etc. currently governing the operation of CTUB's water distribution system. The system was initially modeled to analyze only the area around Jefferson Avenue. This section of the report further discusses the changes that Dewberry made to the water distribution model in order to accurately represent CTUB's existing system.

2.2.1 Geocoding of Demands for WaterCAD

Geocoding the demands was necessary to apply the estimated demands to the appropriate nodes in the model in WaterCAD. CTUB provided Dewberry the account number and demand for each meter, as well as the street address associated with each account. The geocoding effort created a GIS layer that assigned a specific spatial location (latitudes and longitudes) to each meter data point. An example of the resultant geocoded information from GIS is provided as **Figure 2-3**. The geocoded demands are the pink circles, and the selected geocoded demand and its associated information is highlighted in blue.

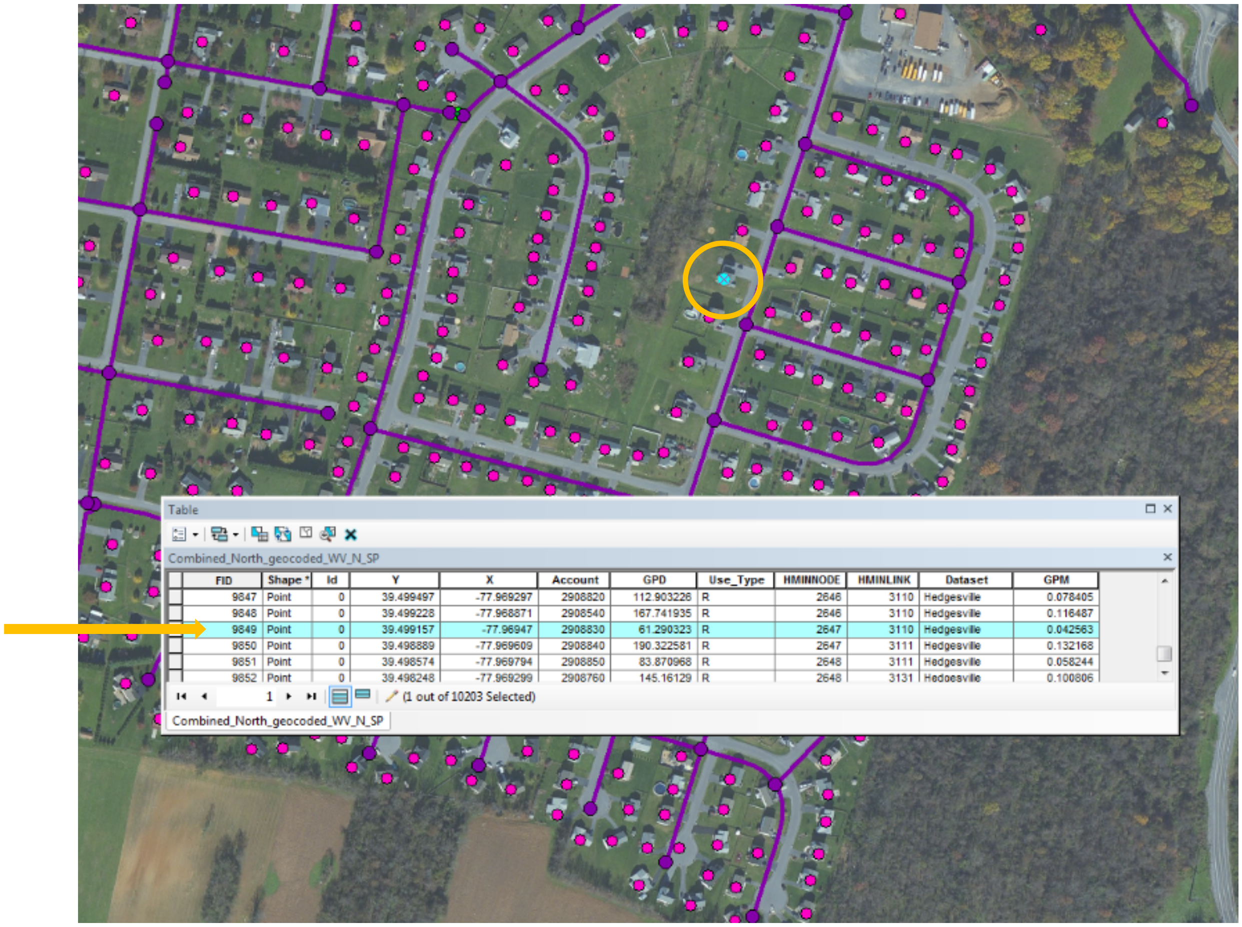

Figure 2-3: Example Geocoded Demand Mapping for the model

Once these demands were loaded into WaterCAD, Dewberry performed a quality check to verify that the large demands to the system (demands larger than 1.0 gpm) were assigned to the correct junction nodes in the model. When a comparison of the allocated demands with the GIS imagery revealed that not all of these large demands were assigned to the correct node, Dewberry clarified these discrepancies with CTUB. Dewberry also edited the piping and junctions in the WaterCAD model to reflect these changes for a better model of the existing system.

2.2.2 Diurnal Patterns by Demand Type

Table 2-1 shows the diurnal demand patterns that were used for each day during the seven (7) day extended period simulation (EPS) run and calibration based on *AWWA's M32 Computer Modeling of Water Distribution System, Fourth Edition* (Figure 6-1). These factors are further categorized by the geocoded demand type (residential, commercial, or industrial):

Table 2-1: Diurnal Patterns by Demand Type

RESIDENTIAL		COMMERCIAL		INDUSTRIAL	
Time from Start (hours)	Multiplier	Time from Start (hours)	Multiplier	Time from Start (hours)	Multiplier
1	0.6	1	0.16	1	0
2	0.2	2	0.16	2	0
3	0.175	3	0.16	3	0
4	0.2	4	0.16	4	0
5	0.2	5	0.16	5	0
6	0.4	6	0.16	6	0
7	1.0	7	0.16	7	0
8	1.15	8	0.16	8	2.0
9	1.6	9	0.16	9	2.0
10	1.8	10	1.8	10	2.0
11	1.65	11	1.8	11	2.0
12	1.65	12	1.8	12	2.0
13	1.55	13	1.8	13	2.0
14	1.4	14	1.8	14	2.0
15	1.4	15	1.8	15	2.0
16	1.45	16	1.8	16	2.0
17	1.6	17	1.8	17	2.0
18	1.5	18	1.9	18	2.0
19	1.2	19	1.9	19	2.0
20	1.1	20	1.9	20	0
21	0.6	21	1.9	21	0
22	0.5	22	0.16	22	0
23	0.5	23	0.16	23	0
24	0.6	24	0.16	24	0

Residential, Commercial, and Industrial patterns were all modeled as stepwise patterns. These diurnal patterns (listed for 24 hours) were repeated over the course of the 168-hour simulation.

2.2.3 LIDAR Topography

Dewberry updated the topographic information of all modeled assets in the model to utilize 2016 Dewberry / USGS LIDAR data, which is the latest and most accurate County-wide data available. As part of this effort, Dewberry also generated 5-foot contours from the LIDAR data for use in the model. As a result, the estimated accuracy of the elevation data in the Model is approximately ± 2.5 feet.

2.2.4 Pressure Zone

After calibrating the model, reviewing the existing information, and examining the valve control settings, Dewberry created boundaries for each pressure zone in the model, namely the Main System Pressure Zone, Northern High Pressure Zone, and Huntfield Pressure Zone. A map of the pressure zones for the entire system can be seen below in **Figure 2-4**, including the hydrant naming convention that was created by Dewberry to differentiate the hydrants for different pressure zones**.** **Figure 2-5** shows the location of the four (4) isolation valves that separate the Northern High Zone from the Main System Zone. With these boundaries created in the model, Dewberry was then able to calibrate the model.

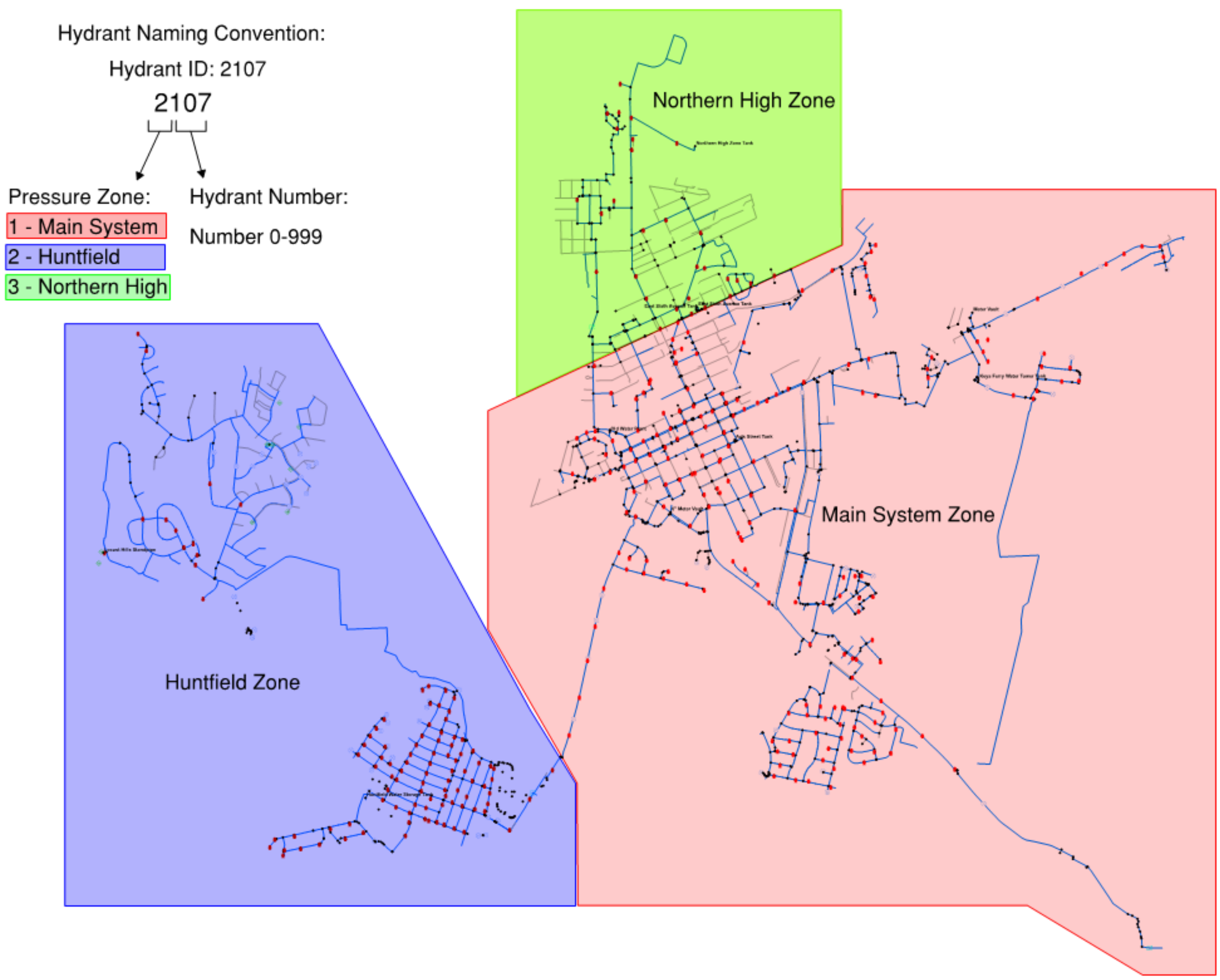

Figure 2-4: Charles Town Pressure Zone Boundaries and Hydrant Naming Convention

Figure 2-5: Isolation Valves Location

2.2.5 Quality Control Reviews

Dewberry compared pipe sizes/locations, junction elevations, tank locations/levels, valve locations, pump locations/pump curve information, and hydrant locations in the WaterCAD model versus those appearing in GIS, Record Drawings, or other supplemental information provided by CTUB. Observed discrepancies were corrected and updated in the model in consultation with CTUB. Valve controls and pump settings were also adjusted based upon updated information provided by CTUB.

Pump stations control setpoints were pulled from the SCADA system at the Water Treatment Plant and compared to historical tank level data to ensure accuracy. **Figure 2-6** shows an example of this comparison with a graph of model vs. SCADA of the Northern High tank level before the quality control review. After reviewing the data, setpoints were adjusted to match historical data. **Figure 2-7** shows the graph after the operational setting and control adjustments, a much better correlation.

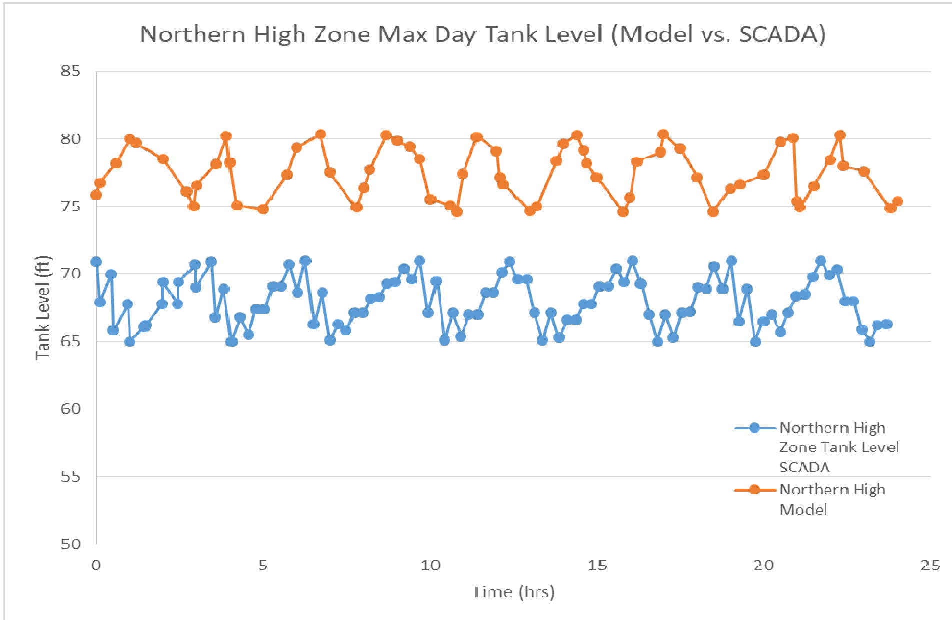

Figure 2-6: Northern High Zone Tank Level Output Before Updates (Model vs. SCADA)

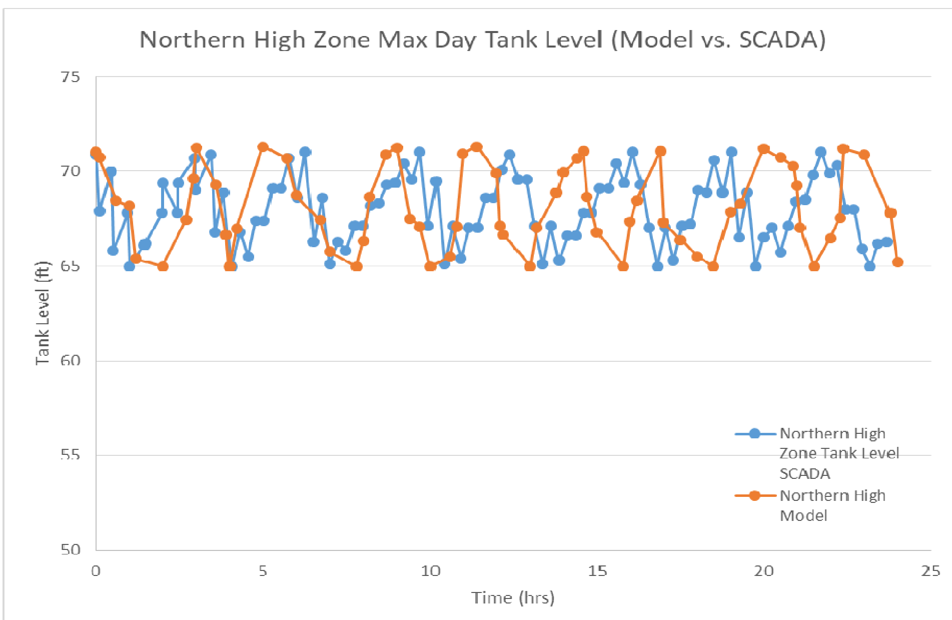

Figure 2-7: Northern High Zone Tank Level Output After Updates (Model vs. SCADA)

Table 2-2 provides a summary of setpoints, historical data and model controls.

Table 2-2: Summary of Setpoints and Model Controls

Pump Station	Tank	Pump On (Setpoint)	Pump Off (Setpoint)	Pump On (SCADA)	Pump Off (SCADA)	Pump On (Updated Model)	Pump Off (Updated Model)
WTP	Route 9	-	-	27’	40’	27’	37’
Augustine Avenue PS	Huntfield	36’	42’	36’	42’	36’	42’
Burns Street PS	Northern High	65’	71’	65’	71’	65’	71’

For purposes of this analysis, model controls were set to operate the WTP pump station based on level in the Route 9 Elevated Storage Tank. Record drawings indicate the overflow level of the Route 9 tank was established at approximately 37 feet; however, historical SCADA data recording tank level indicated that the Route 9 tank typically operates between 27 and 40 feet. The model controls were adjusted to turn off the pumps once the tank reaches 37 feet. Both the Huntfield and Northern High Zone tanks appeared to operate within the specified ranges.

2.2.6 Hydrant Testing

Dewberry personnel developed a hydrant testing protocol and worked in collaboration with CTUB to conduct hydrant testing at 13 locations (2 hydrants for each test, one flow hydrant and one pressure residual hydrant, while the pump stations were turned off during the test) throughout Charles Town water system, shown in **Figure 2-8** below. The nodal network (pipes and junctions) are shown in purple, and each individual hydrant is represented as a yellow circle.

Figure 2-8: Hydrant Test Locations

The resulting data was utilized in the WaterCAD model to help calibrate the model. However, due to specious data at hydrant locations #4 and #8, only 11 hydrant data points were used to calibrate the model. A copy of the hydrant testing protocol and data collected is provided in **Appendix A: Hydrant Test Protocol and Data.**

In order to accurately model a water system, Dewberry had to first calibrate the model. Upon completion of the quality control reviews and creating boundaries for the pressure zones, the model was calibrated using the "Darwin Calibrator" tool in WaterCAD under static simulation conditions.

Calibration required hydrant data from the hydrant tests, tank and pump SCADA data, and assumptions for friction losses in the pipelines in the model. For the friction losses in pipes, the Hazen-Williams "C" coefficients (friction losses in pipes) were assigned based on pipe material. The Hazen-Williams "C" coefficients that were assumed for the various pipe materials in the model are shown in **Table 2-3**.

Table 2-3: Hazen-Williams "C" Coefficients

Pipe Material	Minimum C-Value	Maximum C-Value
Asbestos Cement	80	150
CMP	60	100
Copper	130	150
Cast Iron	75	90
DIP	125	140
Galvanized Pipe	120	150
PVC	130	150

Darwin Calibrator automatically calibrates the model through the use of efficient genetic algorithms. This allows for multiple calibration candidates to be presented so the best possible solution to a given system can be found. The optimized calibrated solutions were exported into a new scenario and used in the existing water system model.

Using this calibrated model, Dewberry identified nodes in the area that did not meet state and local pressure requirements.

SECTION 3 - EXISTING SYSTEM ANALYSIS

Municipalities operating utility systems are governed by Title 64 Series 77 of the West Virginia Bureau of Public Health (WVBPH) Public Water System Design Standards (hereafter BPH Regulations). Portions of the regulations are quoted in the paragraphs below and serve as the basis of evaluation.

According to the BPH Regulations, pressures in these pipelines (and all such pipelines in the distribution system) need to be maintained at 30 psi minimum under static conditions and 20 psi under all dynamic flow conditions (including fire flow). An excerpt from the regulations appears below:

9.4.a. Pressures. -- The maximum variation between high and low levels in standpipes or elevated storage structures providing pressure to a distribution system shall not exceed thirty (30) feet (thirteen (13) pounds per square inch). The minimum pressure in the distribution system shall be thirty (30) pounds per square inch under static conditions and twenty (20) pounds per square inch under all flow conditions. The normal working pressures of the distribution mains shall be designed based upon the pipe manufacturer's recommendations and the applicable AWWA standards for the type of pipe. Pressure regulating/pressure reducing valves shall be used to protect the distribution mains from excessive pressures. When static pressures in the distribution mains exceed one hundred thirty five (135) pounds per square inch, the utility shall have the option of installing pressure reducing valves on service lines or requiring (or recommending) the customer install and maintain a pressure reducing valve on the customer's service line.

In practice, a pressure range of between 40 and 100 psig is typically preferred. The existing system was analyzed using the calibrated model and to ensure compliance with the following conditions:

- Greater than 20 psi minimum pressure under maximum day demands coupled with fire-flow conditions
- Greater than 30 psi minimum pressure under normal operating conditions with maximum day demands
- Less than 135 psi maximum pressure under normal operating conditions with average day demands

3.1 FIRE FLOW ANALYSIS

Dewberry developed the fire flow analysis to determine the system's response to a fire flow event at 500 gpm. **Table 3-1** shows the Fire Flow constraints used to analyze the system.

Table 3-1: Fire Flow Constraints

Fire Flow (Goal)	500 gpm
Fire Flow (Upper Limit)	1,000 gpm
Apply Fire Flows By	Adding to Baseline Demand
Pressure (Residual Lower Limit)	20 psi
Pressure (Zone Lower Limit)	20 psi

Initial tank levels were set at the corresponding pump on level to conservatively analyze system pressure. Based on the fire flow analysis report generated in WaterCAD, Dewberry determined which nodes are not compliant with state and local regulations for required fire flows and residual pressures during maximum day demands. **Figure 3-1** shows a map of which node failed to meet the desired fire flow of 500 gpm, and **Figure 3-2** shows a map of available fire flow.

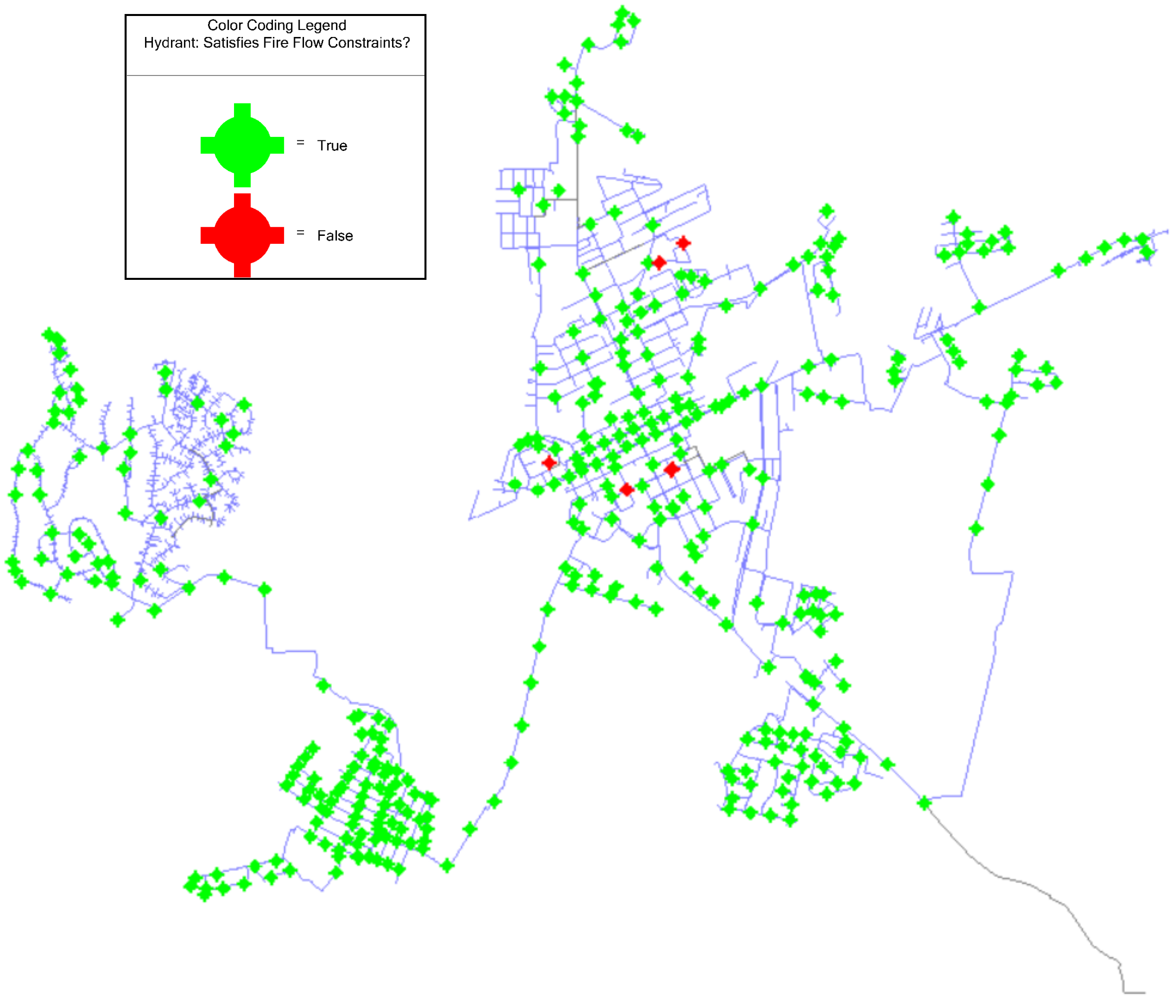

Figure 3-1: Fire Flow Pass/Fail Results

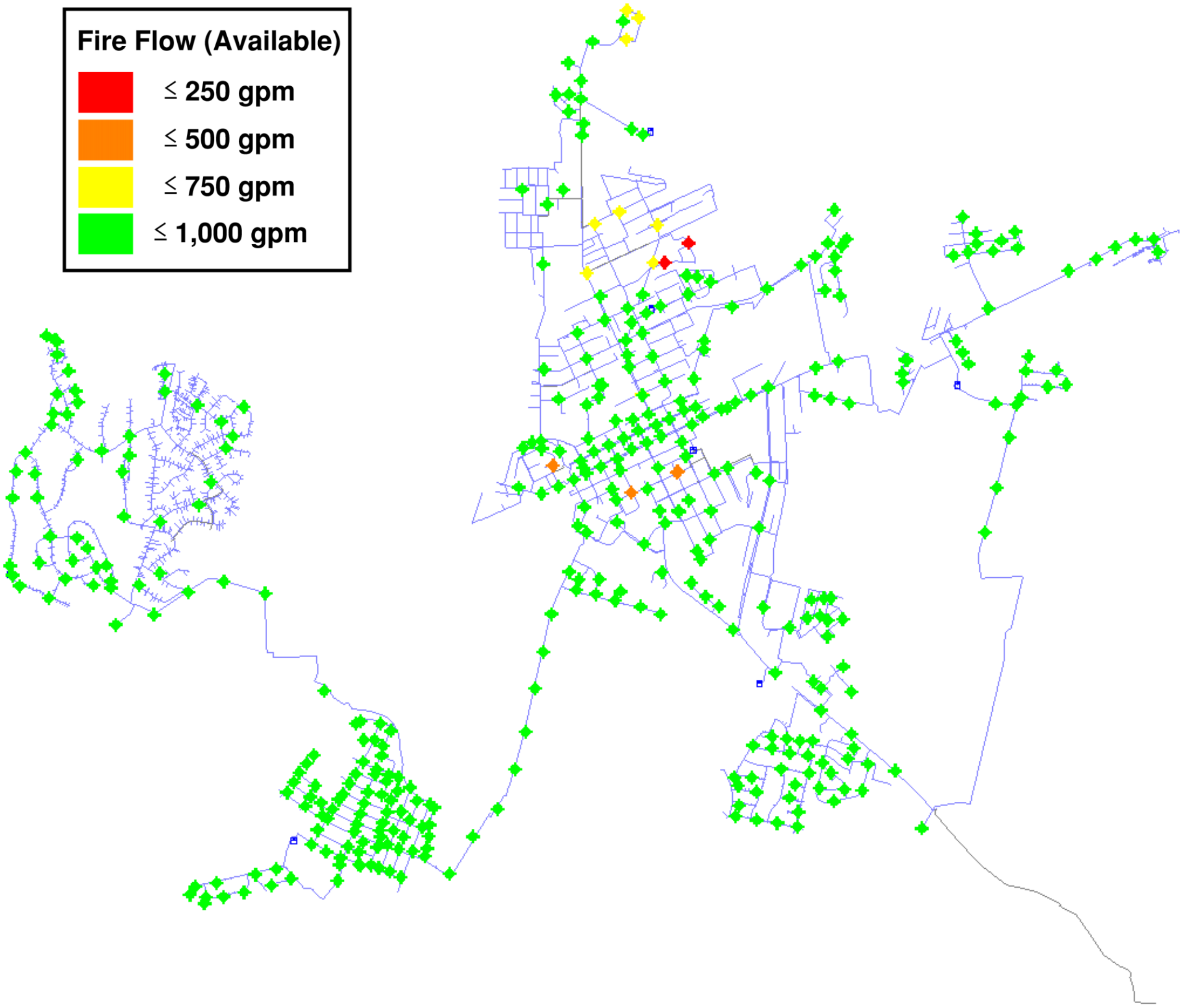

Figure 3-2: Fire Flow Analysis Results

3.1.1 Pressure Requirement Compliance

Once the Fire Flow Analysis was completed, Dewberry identified nodes that do not meet state and local pressure requirements. **Figure 3-3** shows a color-coded junction map based on minimum pressure under peak hour flow conditions.

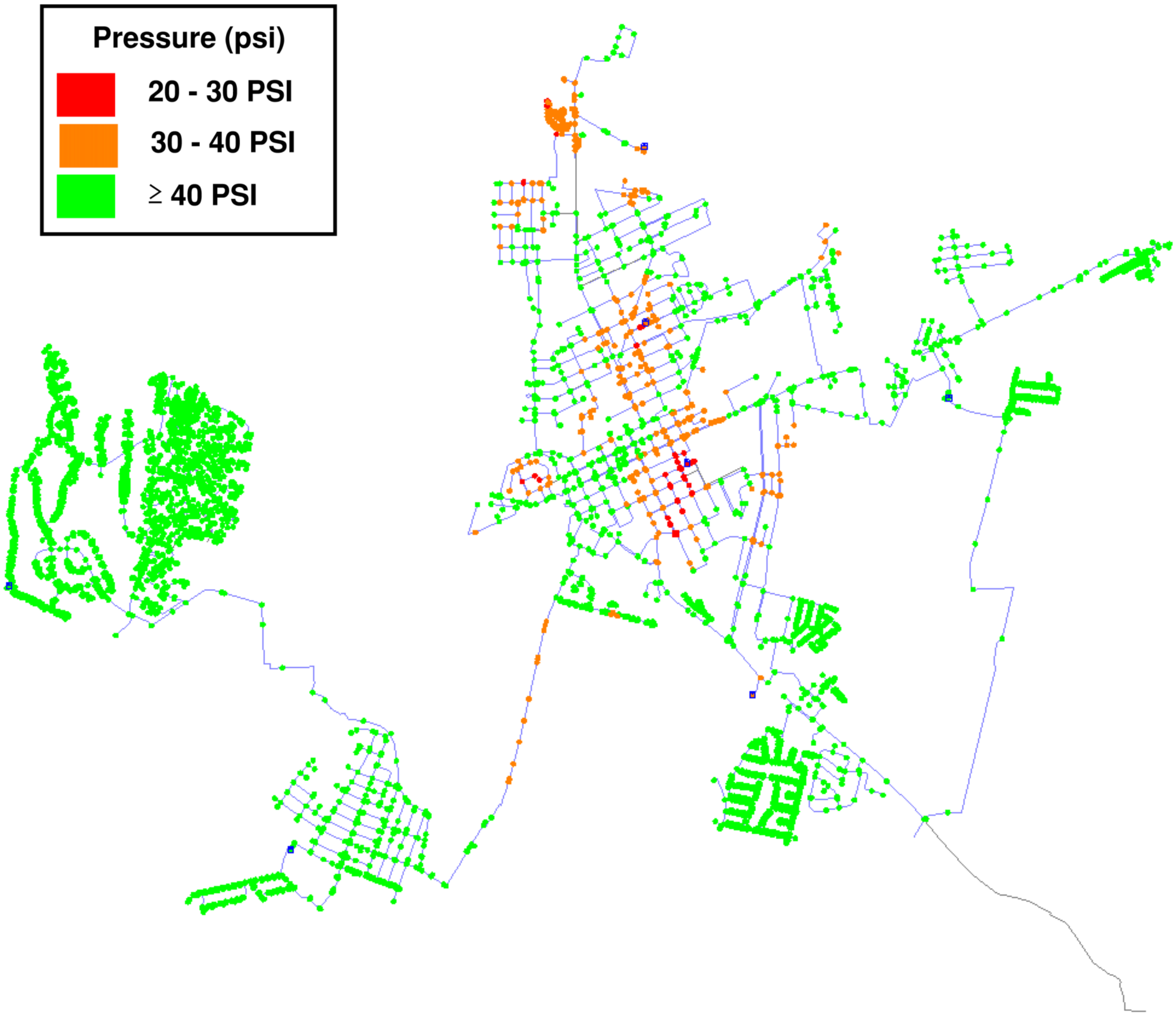

Figure 3-3: Minimum Pressures at Peak Flow

Three main areas of low pressure were identified by this analysis – Northern High Zone, 6th St Tank , and near the Avis Storage Tank. A more detailed look at these specific the low pressure areas are shown in **Figures 3-4 through 3-6**.

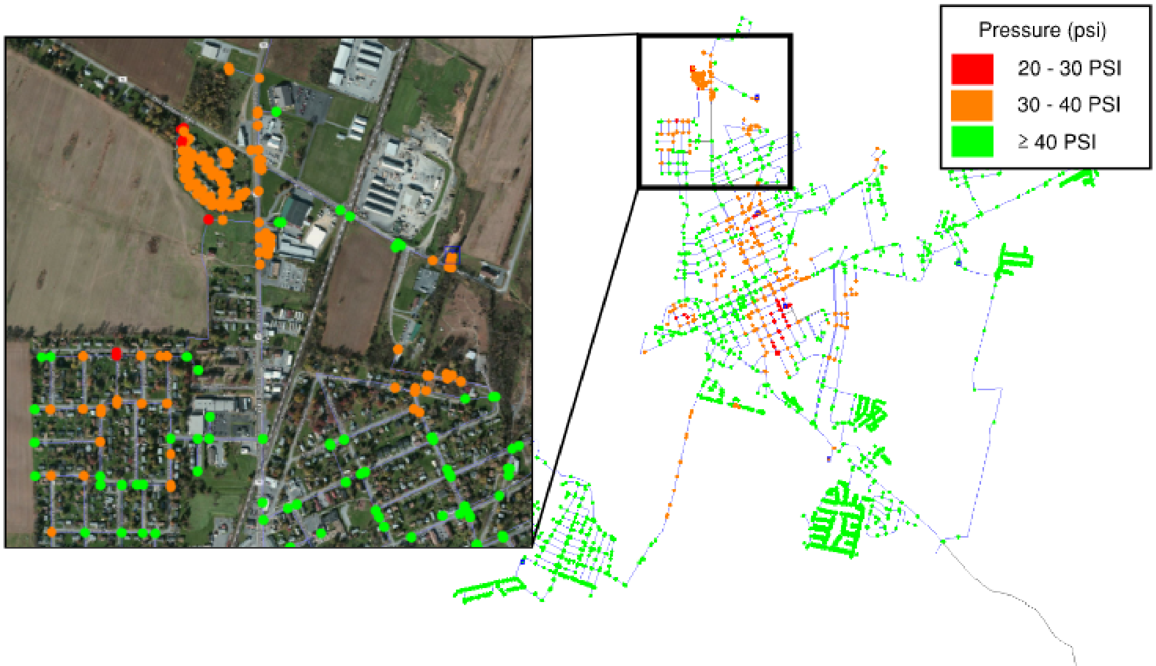

Figure 3-4: Low Pressure Area – Northern High Zone

Figure 3-5: Low Pressure Area – 6th St Ave Tank Area

Figure 3-6: Low Pressure Area - Avis St Tank Area

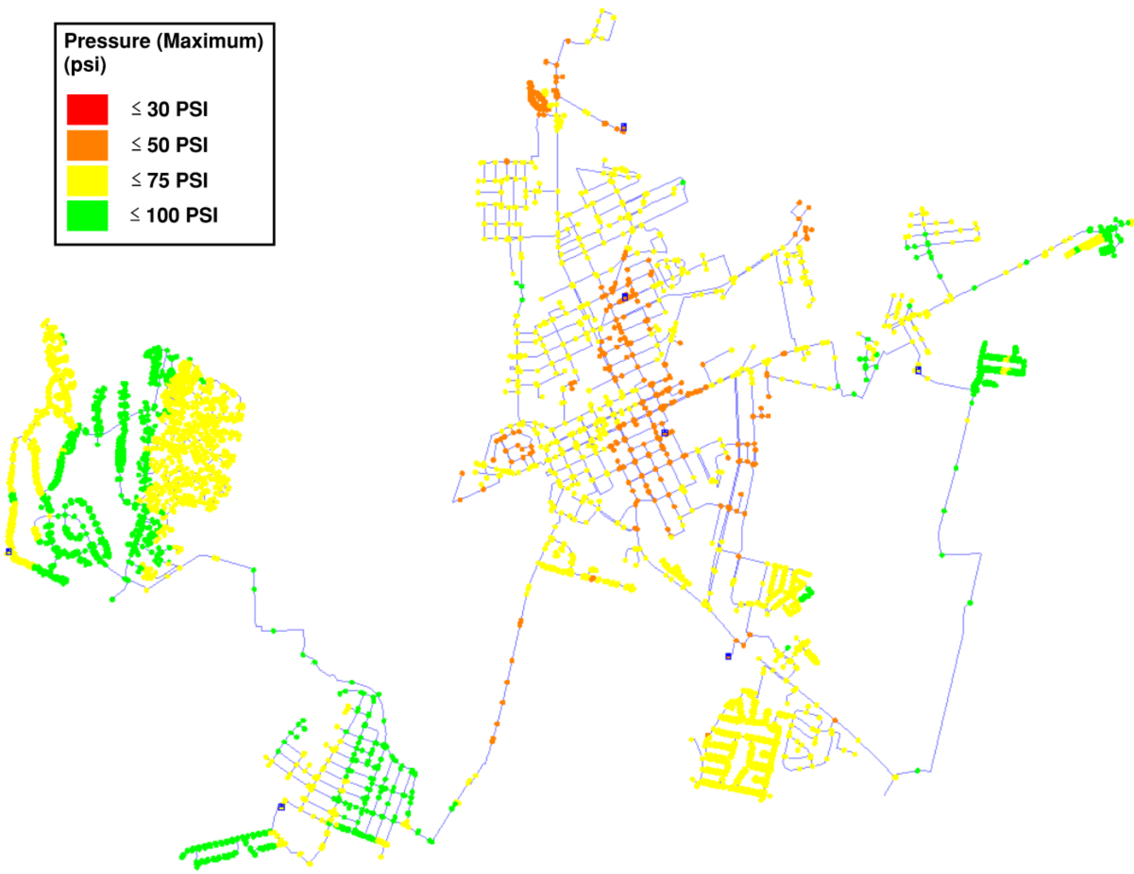

Figure 3-7: Maximum Pressure

Dewberry also analyzed the system to identify potential areas where high pressure may be a concern. To accomplish this, Dewberry utilized the extended period simulation based on average day demands to determine what normal operating maximum pressures could be expected. **Figure 3-7** provides a nodal diagram depicting the results of this analysis, which shows that no portion of the system experiences pressures greater than 100 psi.

3.1.2 Existing System Headloss

In order to better understand the existing infrastructure to evaluate it for potential improvements, an analysis of the highest headloss per thousand feet of pipe was calculated for each pipe segment in the model. The results from each hour of Day 2 in the EPS simulation (hours 25-48) were found for each pipe segment, and an average of these results were used to evaluate the "Top 100" pipe segments with the highest pressure loss gradient in the system. Results from Day 2 were used to let the water model adjust to the initial settings and stabilize until we observed a similar operational pattern day to day. The resulting figure of the top 100 segments are shown as thick red segments in **Figure 3-8** below.

Dewberry recommends that over the long-term, CTUB reviews all pipelines with headloss exceeding 5.0 feet per thousand feet (0.005 ft/ft) as it implements its capital improvements program. CTUB may consider either upgrading the identified pipelines, adding parallel lines, creating loops in the system, adding pressure reducing valves, adding additional storage, and/or adding booster pump station(s) to reduce headloss to below 5.0 feet per thousand feet.

The pipeline upgrades that Dewberry deemed necessary to improve the water distribution and fire flow availability are described subsequently in **Section 4 – System Improvement Recommendations**.

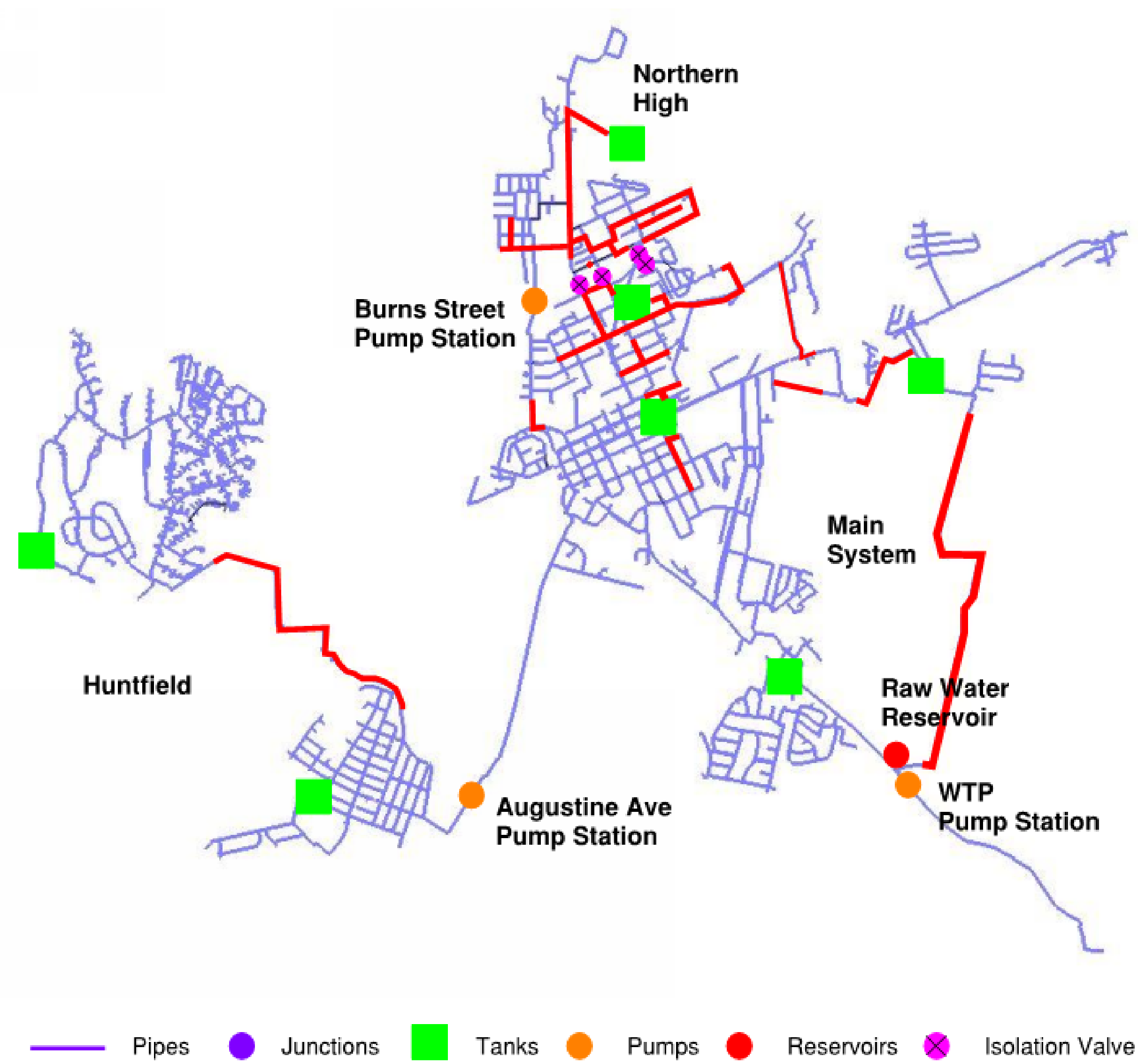

Figure 3-8: Top 100 Segments with Highest Headloss ft/ 1000 ft in Existing System

SECTION 4 – SYSTEM IMPROVEMENT RECOMMENDATIONS

Based on the fire flow analysis discussed above, the following water distribution system improvements were identified as necessary in order to achieve a minimum flow of 500 gpm at 20 psi minimum pressure.

Figure 4-1: Northern High Zone Waterline Improvements

Project 1 – Northern High Zone North Transmission Waterline Improvements: Parallel the existing 6-inch asbestos cement waterline which serves as the main transmission conduit for the Northern High Pressure Zone to eliminate this bottle-neck. The project will include approximately 2,700 LF of 10-inch PVC waterline as shown above.

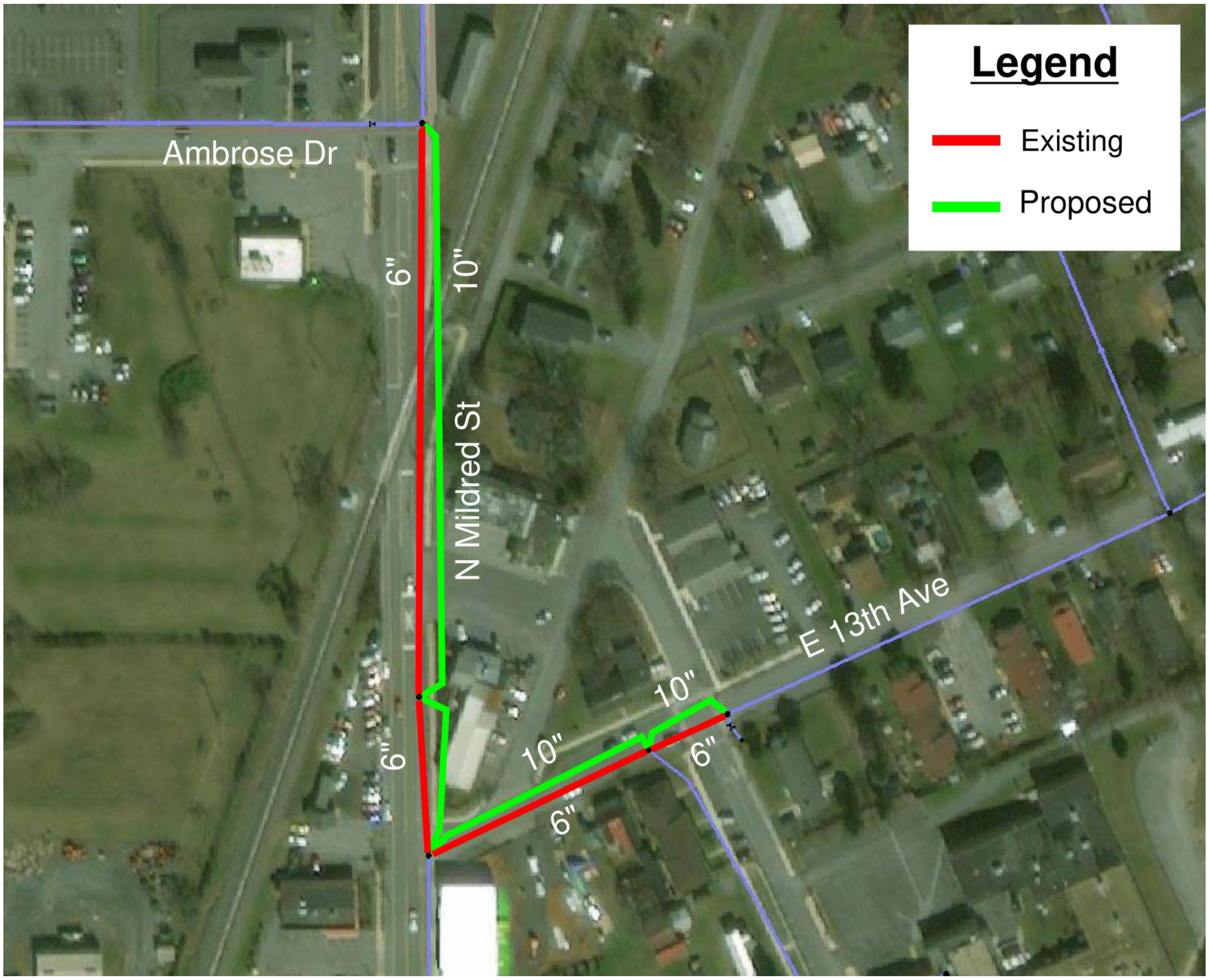

Figure 4-2: Northern High Zone Waterline Improvements

Project 2 – Northern High Zone South Transmission Waterline Improvements: Parallel the existing 6-inch asbestos cement waterline which serves as the main transmission conduit for the Northern High Pressure Zone to eliminate this bottle-neck. The project will include approximately 1,100 LF of 10-inch PVC waterline as shown above.

Figure 4-3: East 10th Avenue Waterline Improvements

Project 3 – East 10th Avenue Waterline Improvements: Install approximately 1,800 LF of 6-inch PVC waterline along East 10th Avenue from North Mildred Steert to North Fairfax Boulevard and install an interconnection between the existing 6-inch waterlines at the intersection of East 10th Street and North Fairfax Boulevard.

Figure 4-4: West Liberty Street Improvements

Project 4 – West Liberty Street Improvements: Install approximately 400 LF of 6-inch PVC waterline along West Liberty Street from North Water Street to Higgs Boulevard to provide adequate looping.

Figure 4-5: South Mildred Street Waterline Improvements

Project 5 – South Mildred Street Waterline Improvements: Install an interconnection between the existing 8-inch and 4-inch waterlines at the intersection of East Academy Street and South Mildred Street to improve looping.

Figure 4-6: West Academy Street Waterline Improvements

Project 6 – West Academy Street Waterline Improvements: Install an interconnection between the existing 8-inch waterlines at the intersection of West Academy Street and South Charles Street to improve looping.

CONCLUSION

Dewberry has developed a more accurate and updated model through the following methods:

- Use of LIDAR data for more accurate elevations
- Geocoding of demands to more accurately reflect actual conditions
- Addition of new construction projects
- Addition of controls to simulate actual operating procedures
- Updated diurnal patterns for extended period simulation (EPS)
- Calibration via hydrant testing and SCADA data

As was illustrated via **Figure 2-7**, the updated model now correlates with actual operating SCADA data and will serve as a useful tool for analyzing proposed development and new potential capital projects to support expected growth and development.

Based on the results from the calibrated model, several system improvements were identified and recommended in **Section 3** in order to improve fire flow capacity within the system.

ITEMS FOR FURTHER STUDY

The model update presented herein was limited to the scope of services presented in Section 1, Paragraph 1.2. For example, this report does not specifically address capital improvements needed to support future growth and development. CTUB would benefit from the following items for further study:

- Use the model to analyze storage requirements versus BPH regulations and determine water-age to examine potential areas which may be more at risk for THM and HAA5 formation.[1]

- Consider more detailed reviews of the Main Pressure Zone where pressures are generally much lower than other areas of the system to determine potential capital improvements to improve system pressure. Such reviews may include consideration of taller tanks, booster pumping stations, flow control valves, looping, parallel mains and other means to improve system pressures for area customers.

- Consider a systematic plan to upgrade segments with high pressure loss gradients as initially identified in Figure 3-6.

- Use the model to support a more rigorous water system master planning effort to identify short-term and long-term capital projects to address future growth and development.

These items will leverage the updated model to better address future growth and development.

1 The Stage 2 Disinfection Byproducts Rule promulgated by EPA governs Trihalomethanes (THM) and Haloaccetic acids (HAA5) in public water systems.

APPENDIX A

Hydrant Test Protocol and Test Data

Hydrant Flow Testing Work Plan

Project Name:		Page:	1
Client/Owner:		Date:	
Contact/Title:			
Dewberry Job#:			

1. Hydrant flow testing will be conducted to provide data for developing and calibrating the computerized hydraulic model. Coordination will be done with the District in regards to when these tests can be performed so that proper notification can be given advising customers of possible temporary discoloration of water. The location and number of the hydrant flow test to be performed will be provided.

2. At the time the tests are performed, the following information will need to be obtained as appropriate:

   - The pump stations, treatment plants or water supplies that were operational.

   - The number of pumps and their horsepower within the pump stations or treatment plants that were operating.

   - The water level elevations within each storage tank.

3. A minimum of two hydrants will be used to conduct the flow testing, one designated as the test hydrant to observe static and residual pressures and one designated as the flow hydrant to discharge water. Each hydrant used in the test will be manned. The selection of the flow hydrant will be made to minimize damage to private property, preferably near a catch basin or drainage swale, and to avoid discharging water onto streets.

4. Hydrants will be opened and closed slowly to avoid generating pressure surges within the system. The flow hydrant will be fully opened and allowed to discharge until the pitot gauge has stabilized so that an accurate reading can be recorded (typically about 10 seconds).

5. The data to be collected during each test will be as noted on the attached **Hydrant Flow Test Report.** Static pressure readings will be taken on both the test (pressure) hydrant and flow hydrant to correct for differences in elevation. Tests will be completed using the 2-1/2” outlets on the hydrants.

6. The discharge from the <u>flow hydrant</u> will be calculated based on the following formula:

$$Q_f = 29.83 \text{ x } c \text{ x } d^2 \text{ x } p^{0.5}$$

Where Q_f = gallons per minute
d = diameter of nozzle in inches (2-1/2")
p = pitot gauge in psi (measured at flow hydrant with pitot gauge instrument)
c = coefficient of discharge (0.85)

7. To determine the available flow at a residual pressure of 20 psi from the test results, the following formula will be used:

$$Q_{20} = Q_F \text{ x } (H_s - 20)^{0.54} / (H_s - H_r)^{0.54}$$

Where H_s = static pressure reading at the test hydrant
H_r – residual pressure reading from the test hydrant

Charles Town Hydrant Test Locations

Fire Hydrant Test Location	Flow Hydrant		Residual Hydrant	
	Address	ID	Address	ID
1	185 Stephanie Way, Charles Town, WV 25414	1165	19 Stephanie Way, Charles Town, WV 25414	1064
2	1000 Co Rte 340/4, Charles Town, WV 25414 Next to Windmill Crossing Sign	1059	912 Somerset Blvd, Charles Town, WV 25414	1061
3	15527 Charles Town Rd, Charles Town, WV 25414 Charles Town Potable Treatment Plant	1005	15376 Charles Town Rd. Charles Town, WV 25414	1011
4	565 Barksdale Dr, Charles Town, WV 25414	1173	242 Okanagan Dr., Charles Town, WV 25414	1174
5	839 M.L.K. Jr. Blvd., Charles Town, WV 25414	1121	718 W Washington St., Charles Town, WV 25414	1120
6	NW Corner of Finish Line Ave / Flowing Springs Rd Charles Town, WV 25414	1086	580 5th Ave, Ranson, WV, 25438	1161
7	207 N Fairfax Blvd, Ranson, WV 25438	1082	108 E 5th Ave, Ranson, WV 25438	1139
8	1453 N Mildred St., Ranson, WV 25438	3001	1208 N Mildred St., Ranson, WV 25438 SW Corner of 16th St / N Mildred St	3003
9	178 Robelei Dr., Ranson, WV 25438	3007	74 Robelei Dr., Ranson, WV 25438	3006
13	492 Oakmont Dr., Charles Town, WV 25414	2032	406 Oakmont Dr., Charles Town, WV 25414	2035
14	49 Patrick Henry Way, Charles Town, WV 25414	N/A	7 Captain Chews Trce, Charles Town, WV 25414	N/A
15	312 Baltusrol Dr., Charles Town, WV 25414	2033	Tuscawilla Dr / Packett Dr Charles Town, WV 25414	2034
16	452 Spyglass Hill Dr., Charles Town, WV 25414	2001	353 Spyglass Hill Dr., Charles Town, WV 25414	2004

Fire Hydrant Test

Location # 1

Date: 4-2-19
Time: 1:52 p.m
Weather: cloudy
Temp.: 46°F
Tester Name(s): Chris Hutzler

Legend: Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:
Hydrant ID: 2105
2 105
2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	34.5	1:54 p.m
Avis	1	63.4	1:54 p.m
Keyes Ferry	1	15.1	1:54 p.m
6th Ave.	1	77.6	1:54 p.m
Huntfield	2	41.1	1:54 p.m
Locust Hill	2	130.2	1:54 p.m
Northern High Zone	3	67.1	1:54 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 50 psi
Flow: 1190 gpm

Residual Hydrant ID:
Static Pressure: 70 psi
Residual Pressure: 64 psi

Notes: Flow acrossed from 185 Stephanie WAY
Due to orginal Hyd. connection stuck.

Form revised on March 26th, 2019

Fire Hydrant Test

Location # 2

Date: 4-4-19
Time: 12:55 p.m.
Weather: Partly cloudy
Temp.: 62°F
Tester Name(s): Larry Stewart

Legend: Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:
Hydrant ID: 2105
2 105
2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	33.0	12:55 pm
Avis	1	62.2	12:55 pm
Keyes Ferry	1	14.3	12:55 p.m
6th Ave.	1	76.7	12:55 p.m
Huntfield	2	41.4	12:55 p.m
Locust Hill	2	130.1	12:55 p.m
Northern High Zone	3	66.4	12:55 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): $2\frac{1}{2}$"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 50 psi
Flow: 1190 gpm

Residual Hydrant ID:
Static Pressure: 68 psi
Residual Pressure: 61 psi

Notes:

Fire Hydrant Test

Location # 3

Date: 4-2-19
Time: 1:27 p.m
Weather: cloudy
Temp.: 46°F
Tester Name(s): Chris Hutzler

Legend:	
Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:	
Hydrant ID:	2105
2	105

2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	34.3	1:28 p.m
Avis	1	63.1	1:28 p.m
Keyes Ferry	1	15.2	1:28 p.m
6th Ave.	1	77.4	1:28 p.m
Huntfield	2	40.7	1:28 p.m
Locust Hill	2	129.7	1:28 p.m
Northern High Zone	3	69.4	1:28 p.m

Flow Hydrant ID:
Hydrant Manufacturer: Kennedy
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 32 psi
Flow: 980 gpm

Residual Hydrant ID:
Static Pressure: 50 psi
Residual Pressure: 46 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location #4

Date: 4-4-19
Time: 1:30 p.m
Weather: Partly Cloudy
Temp.: 63°F
Tester Name(s): Larry Steward

Legend:		Hydrant Naming Convention:	
Pressure Zone	ID	Hydrant ID:	2105
Main	1	2	105
Huntfield	2	2 is the pressure zone ID and 105 is the hydrant number.	
Northern High	3		

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	33.0	1:35 p.m
Avis	1	62.8	1:35 p.m
Keyes Ferry	1	14.3	1:35 p.m
6th Ave.	1	77.2	1:35 pm
Huntfield	2	39.6	1:35 pm
Locust Hill	2	130.3	1:35 pm
Northern High Zone	3	64.4	1:35 pm

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 860 psi
Flow: 28 gpm

Residual Hydrant ID:
Static Pressure: 48 psi
Residual Pressure: 40 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location #5

Date: 4-4-19
Time: 1:55 pm
Weather: Partly Cloudy
Temp.: 63°F
Tester Name(s): Larry Stewart

Legend:	
Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:	
Hydrant ID:	2105
2	105

2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off.	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.6	2:05 p.m
Avis	1	62.9	2:05 pm
Keyes Ferry	1	14.3	2:05 pm
6th Ave.	1	77.3	2:05 pm
Huntfield	2	38.9	2:05 pm
Locust Hill	2	130.2	2:05 p.m
Northern High Zone	3	63.8	2:05 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 22 psi
Flow: 800 gpm

Residual Hydrant ID:
Static Pressure: 44 psi
Residual Pressure: 32 psi

Notes:

Fire Hydrant Test

Location #6

Date: 4-16-19
Time: 1:30p.m
Weather: Sunny
Temp.: 61°F
Tester Name(s): Larry Stewart

Legend:		Hydrant Naming Convention:	
Pressure Zone	ID	Hydrant ID:	2105
Main	1	2	105
Huntfield	2	2 is the pressure zone ID and	
Northern High	3	105 is the hydrant number.	

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	33.2	1:30p.m
Avis	1	62.3	1:30p.m
Keyes Ferry	1	14.3	1:30p.m
6th Ave.	1	76.7	1:30p.m
Huntfield	2	39.0	1:30p.m
Locust Hill	2	129.9	1:30p.m
Northern High Zone	3	66.5	1:30p.m

Flow Hydrant ID: #6
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 37 psi
Flow: 1030 gpm

Residual Hydrant ID: #6
Static Pressure: 50 psi
Residual Pressure: 42 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location #7

Date: 4-16-19
Time: 1:50 p.m
Weather: Sunny
Temp.: 61°F
Tester Name(s): Larry Stewart

Legend:	
Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:	
Hydrant ID:	2105
2	105

2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.8	1:55 p.m
Avis	1	62.5	1:55 p.m
Keyes Ferry	1	14.1	1:55 p.m
6th Ave.	1	77.6	1:55 p.m
Huntfield	2	38.2	1:55 p.m
Locust Hill	2	129.6	1:55 p.m
Northern High Zone	3	65.9	1:55 p.m

Flow Hydrant ID: #7
Hydrant **Manufacturer**: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: [redacted] 25 psi
Flow: [redacted] 840 gpm

Residual Hydrant ID: #7
Static Pressure: 46 psi
Residual Pressure: 38 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location # 8

Date: 4-16-19
Time:
Weather: Sunny
Temp.: 61°F
Tester Name(s): Larry Stewart

Legend:	
Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:	
Hydrant ID:	2105
2	105

2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.6	2:15 p.m
Avis	1	62.5	2:15 p.m
Keyes Ferry	1	14.1	2:15 p.m
6th Ave.	1	76.9	2:15 p.m
Huntfield	2	37.6	2:15 p.m
Locust Hill	2	129.1	2:15 p.m
Northern High Zone	3	65.2	2:15 p.m

Flow Hydrant ID: # 8
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded   Square

Pitot Pressure: 18 psi
Flow: 750 gpm

Residual Hydrant ID: # 8
Static Pressure: 50 psi
Residual Pressure: 44 psi

Notes:

Fire Hydrant Test

Location #9

Date: 4-18-19
Time: 12:51 p.m
Weather: Sunny
Temp.: 68°F
Tester Name(s): Larry Stewart

Legend:		Hydrant Naming Convention:	
Pressure Zone	ID	Hydrant ID:	2105
Main	1	2	105
Huntfield	2	2 is the pressure zone ID and	
Northern High	3	105 is the hydrant number.	

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.7	1:00 p.m
Avis	1	62.3	1:00 p.m
Keyes Ferry	1	13.8	1:00 p.m
6th Ave.	1	76.7	1:00 p.m
Huntfield	2	37.6	1:00 p.m
Locust Hill	2	128.1	1:00 p.m
Northern High Zone	3	64.5	1:00 p.m

Flow Hydrant ID: #9
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 15 psi
Flow: 650 gpm

Residual Hydrant ID: #9
Static Pressure: 32 psi
Residual Pressure: 22 psi

Notes:

Fire Hydrant Test

Location # 13

Date: 4-9-19
Time: 1:40 p.m
Weather: Sunny
Temp.: 75°F
Tester Name(s): Larry Stewart

Legend:		Hydrant Naming Convention:	
Pressure Zone	ID	Hydrant ID:	2105
Main	1	2	105
Huntfield	2	2 is the pressure zone ID and	
Northern High	3	105 is the hydrant number.	

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.8	1:45 p.m
Avis	1	62.7	1:45 p.m
Keyes Ferry	1	13.9	1:45 p.m
6th Ave.	1	77.0	1:45 p.m
Huntfield	2	36.9	1:45 p.m
Locust Hill	2	128.8	1:45 p.m
Northern High Zone	3	66.4	1:45 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 47 psi
Flow: 1160 gpm

Residual Hydrant ID:
Static Pressure: 74 psi
Residual Pressure: 64 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location # 14

Date: 4-2-14
Time: 2:24 p.m
Weather: Cloudy
Temp.: 46°F
Tester Name(s): Chris Hutzler

Legend: Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:
Hydrant ID: 2105
2 105
2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	33.4	2:23 p.m
Avis	1	63.6	2:23 p.m
Keyes Ferry	1	15.0	2:23 p.m
6th Ave.	1	77.9	2:23 p.m
Huntfield	2	40.3	2:23 pm
Locust Hill	2	130.3	2:23 p.m
Northern High Zone	3	65.0	2:23 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½"
Coefficient (Circle one): Rounded Square

Pitot Pressure: 45 psi
Flow: 1130 gpm

Residual Hydrant ID:
Static Pressure: 68 psi
Residual Pressure: 62 psi

Notes:

Fire Hydrant Test

Location #15

Date: 4-9-19
Time: 2:05 p.m
Weather: Sunny
Temp.: 75°
Tester Name(s): Larry Stewart

Legend:		Hydrant Naming Convention:	
Pressure Zone	ID	Hydrant ID:	2105
Main	1	2	105
Huntfield	2	2 is the pressure zone ID and	
Northern High	3	105 is the hydrant number.	

Pumps:			
Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks: Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.5	2:15p.m
Avis	1	63.1	2:15p.m
Keyes Ferry	1	13.8	2:15p.m
6th Ave.	1	77.5	2:15p.m
Huntfield	2	36.1	2:15p.m
Locust Hill	2	128.1	2:15p.m
Northern High Zone	3	64.3	2:15p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½
Coefficient (Circle one): Rounded Square

Pitot Pressure: 35 psi
Flow: 1000 gpm

Residual Hydrant ID:
Static Pressure: 62 psi
Residual Pressure: 46 psi

Notes:

Form revised on March 26th, 2019

Fire Hydrant Test

Location # 16

Date: 4-9-19
Time: 2:35 p.m
Weather: Sunny
Temp.: 75°F
Tester Name(s): Larry Stewart

Legend:	
Pressure Zone	ID
Main	1
Huntfield	2
Northern High	3

Hydrant Naming Convention:	
Hydrant ID:	2105
2	105

2 is the pressure zone ID and 105 is the hydrant number.

Pumps:

Location:	Pressure Zone ID:	On/Off	Flow (gpm)
WTP	1	off	
Huntfield	2	off	
Northern High	3	off	

Tanks:

Tank Name:	Press. Zone ID:	Tank Level (ft):	Time Stamp:
Rt. 9 WST	1	32.2	2:35 p.m
Avis	1	62.8	2:35 p.m
Keyes Ferry	1	14.0	2:35 p.m
6th Ave.	1	77.3	2:35 p.m
Huntfield	2	36.0	2:35 p.m
Locust Hill	2	127.7	2:35 p.m
Northern High Zone	3	63.7	2:35 p.m

Flow Hydrant ID:
Hydrant Manufacturer: American Darling
Nozzle Diameter (in): 2½
Coefficient (Circle one): Rounded Square

Pitot Pressure: 25 psi
Flow: 840 gpm

Residual Hydrant ID:
Static Pressure: 64 psi
Residual Pressure: 58 psi

Notes: