

CITY OF EUREKA, MISSOURI
WATER DISTRIBUTION SYSTEM EVALUATION

December 28, 2018

PREPARED FOR:



CITY OF EUREKA
EUREKA, MISSOURI

PREPARED BY:

Bartlett & West

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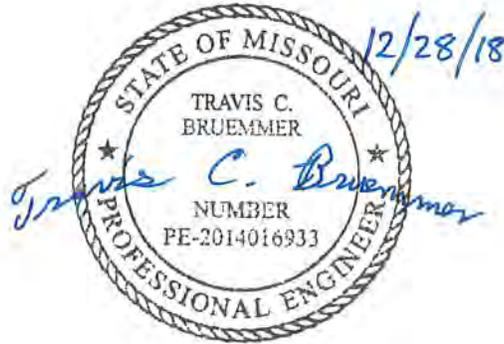
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Project Number 19500.004

December 28, 2018

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Water Distribution System Evaluation

City of Eureka, Missouri

Date: December 28, 2018
To: City of Eureka, Missouri
From: Bartlett & West, Inc.
Re: Water Distribution System Evaluation

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**Water Distribution System Evaluation
City of Eureka, Missouri**

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Water Distribution System Evaluation

City of Eureka, Missouri

Section 1. EXECUTIVE SUMMARY

The City of Eureka contracted with Bartlett & West for a water distribution system analysis. A system upgrade is in need and the City has been presented with several options to solve the current issues their water supply is having. They have been approached in relation to joining the Jefferson County Public Sewer District, who is proposing construction of a new water treatment plant that would serve various entities in the surrounding area, and by Missouri American Water Company who would buy their system and supply the City with water from an outside source or could provide bulk supply. The City of Eureka's water system is currently comprised of several service/pressure zones and are served by multiple wells located within the system. The system also includes several ground storage tanks for water storage.

To determine if the City's system would distribute successfully if an outside water source was introduced, the following data was provided by the City. Flow data from wells and water treatment plants, booster stations, pumping rate information, pump curves, dimensions, elevations, maps showing pipelines of current system and pressures were all supplied to compose a hydraulic model. Once the provided data was inputted into the hydraulic model, scenarios could be performed to see how the water flowed throughout the system and what factors would change pressures and flow.

Upon completion of the hydraulic model, it was determined that all the piping is connected, and the storage tanks have about the same overflow elevation; so theoretically, one outside water source could supply to all users. Section 5 explores what upgrades would be necessary to make the system work given the options presented to the City.

Water Distribution System Evaluation

City of Eureka, Missouri

Section 2. INTRODUCTION

The City of Eureka's water system is at a state where additional treatment is of interest for their well water. They have been presented with the options of upgrading the current system or allowing an outside source to provide water to the over 10,000 residents in Eureka. Existing system facilities are discussed in Section 3, a hydraulic model representing the distribution system and demand is shown in Section 4 and the Recommended Improvements are explained in Section 5.

2.1. Recommended Improvements

Scenario 1: Installing a trunk line coming in from the East side of the City and running along the Interstate to accommodate a supply from Missouri American.

Scenario 2: Installing a trunk line coming in from the South and running it along Highway 109 to accommodate a supply from Jefferson County Public Sewer District.

Scenario 3: Updating water treatment system for each well and keeping current distribution system and looking at two alternatives.

- Shutting Well 6 off and filling Legends tank with the rest of the system.
- Maximizing Well 9's water in distribution system.

Section 3. EXISTING WATER DISTRICT FACILITIES

The City of Eureka’s water system involves six (6) wells, seven (7) tanks, eight (8) booster stations and 3,600 connections to service the 10,000 residents. Appendix A shows a map of existing facilities and the zones are represented in a map in Appendix B.

This water system is monitored and controlled through a SCADA system. It tracks pressures, tank levels, pumps, fluoride levels, chlorine residuals, hardness levels, softening cycles and discharge. Pressure zones are maintained and adjusted as needed by opening and closing valves, along with starting and stopping well operation.

3.1. Supply Facilities

Currently six (6) wells feed into the distribution system to supply water to residents. These 6 wells are deep wells ranging from 500 feet deep to 1,235 feet deep. Each well has its own pump that is used to fill storage tanks or distribute directly into the system. Chlorine contact times take place in the pipe or in the tank before reaching users. Table 3-1 shows additional details on each well.

**Water Distribution System Evaluation
City of Eureka, Missouri**

Table 3-1. Well Details

MoDNR Well ID	Eureka Well ID	Location	Depth (ft)	Ground Elevation (MSL)	Current Pumping Rate (gpm)	2017 Average Monthly Flow (gpm)	2017 Max Monthly Flow (gpm)	2017 Total Flow (gpm)
Well No. 5	Well No. 1 (Howerton)	533 Howerton Ln.	500	507	830	11,949,421	23,249,000	144,220,000
Well No. 6	Well No. 5 (Drewel)	Drewel Park	645	449	860	12,282,737	22,842,000	142,623,000
Well No. 7	Well No. 6 (Legends)	503 Vista Hills Ct.	1,235	605	460	11,013,684	15,880,000	133,591,000
Well No. 8	Well No. 8 (Viola)	687 Viola Ln.	865	600	680	9,361,947	12,601,000	109,953,000
Well No. 9	Well No. 9 (Arbors)	739 Brewster Rd.	635	664	800	1,117,882	3,170,000	10,244,000
Well No. 10	Well No. 10 (Ashton)	1414 West Main St.	695	490	480	6,748,526	13,312,000	80,072,000

3.2. Storage Facilities

Water is stored in seven (7) tanks scattered throughout the City. Six (6) hold 500,000 gallons and one (1) holds 250,000 gallons. Legends, the large Viola and Arbors tanks are located next to their corresponding well. Forby, Niehoff, Brock and small Viola tanks fill up from the Howerton, Drewel and Ashton Wells (Wells No. 1, 5 and 10). Water is pumped out of them with the booster station to the system. Chlorine contact time for water treatment is achieved in the Legends tank, large Viola tank and Arbors tank. All the tanks have approximately the same overflow elevation. Table 3-2 shows additional details on each tank.

**Water Distribution System Evaluation
City of Eureka, Missouri**

Table 3-2. Tank Details

Tank Name	Location	Dimensions		Gross Volume (gal)	Approximate Ground Elevation	Approximate Overflow Elevation
		Height (ft)	Diameter (ft)			
Arbors	739 Brewster Rd.	20	69	500,000	629	649
Forby Road	360 Forby Rd.	40	46	500,000	605	645
Legends	503 Vista Hills Ct.	40	47	500,000	608	648
Niehoff/Augustine	765 Niehoff Dr.	60	37	500,000	591	651
Brock/Palisades	109 Brock Rd.	40	46	500,000	606	646
Small Viola	687 Viola Ln.	32	33	250,000	615	647
Large Viola	687 Viola Ln.	32	52	500,000	615	647

3.3. Distribution Facilities

The water is distributed through the system by gravity or booster stations that pressurize the waterlines. There are eight (8) booster stations located around the City. The booster systems are generally composed of an emergency high flow pump, at least one volume pump and a jockey pump for low flows. Most of the volume pumps run automatically and are dependent on pressure settings. Wells 1, 5, and 10 supply the main zone of the system and operate together to fill the Brock Tank, Niehoff Tank, Forby Tank and the small Viola Tank. Well 6 feeds directly into the Legends Tank, Well 8 feeds directly into the large Viola Tank and Well 9 feeds directly into the Arbors Tank. Water from these tanks is pumped to the distribution zone via adjacent booster stations. In addition, the large Viola Tank can fill the small Viola Tank. The wells are all connected to the SCADA system for operational control. Wells and pump stations throughout the system can be turned on and off as needed to adjust to system demands and help maintain required pressures and tank levels. A map showing the approximate system pressures of the distribution system can be found in Appendix C. Table 3-3 shows additional details of the system’s booster stations.

Water Distribution System Evaluation
City of Eureka, Missouri

Table 3-3. Booster Station Details

Existing Facilities- Booster Station Pumps

Name	Location	Typical Source	No. of Volume Pumps	Design Flow and Head	Type of Pump	No. of Jockey Pumps	Suction (psi)	Discharge (psi)	Average Month (gallons)	Average Day (gallons)	Peak Month (gallons)	Peak Day (gallons)
Arbors	739 Brewster Rd.	Well 9	4	490 gpm 266 ft	Variable speed		5	95	1,240,429	3,398	3,115,000	103,833
Forby	360 Forby Rd.	Wells 1, 5 & 10	2	80 gpm 155 ft	Variable speed		20	61	1,352,789	3,706	1,891,000	63,033
Legends	503 Vista Hills Ct.	Well 6	2	1,000 gpm 280 ft	Variable speed	1	12	112	-	-	-	-
Niehoff/Augustine	765 Niehoff Dr.	Wells 1, 5 & 10	3		Variable speed		20	60	918,579	2,517	1,495,000	49,833
Palisades/Brock	109 Brock Rd.	Wells 1, 5 & 11	2	75 gpm 263.7 ft	Variable speed	1	20	108	-	-	-	-
Large Viola	687 Viola Ln.	Well 8	2	600 gpm 158 ft	Variable speed		12	62	-	-	-	-
Small Viola	687 Viola Ln.	Wells 1, 5 & 10	2		Variable speed		10	110	2,339,000	6,408	6,108,000	203,600
Emerald View	4589 Emerald View Ct.		2	96.4 gpm 144 ft	Variable speed		45	108	670,200	1,836	670,200	22,340

**Water Distribution System Evaluation
City of Eureka, Missouri**

Section 4. MODEL DEMAND

A skeleton model was created of the City’s water distribution system in the WaterGEMS hydraulic modeling software by Bentley Systems to analyze pressure zones and varying scenarios. Data provided by the City was used to draw the water system. Tank dimensions, pump curves and elevations were required to help analyze the system and properly run the model. The maps provided in this report are images from the water model. No large users were involved in the average customer demand analysis, only the 10,000 residents.

To ensure the system could handle water demand for most scenarios, average day, peak day and peak demand over a 24-hour time period were determined and simulated in the water model. Table 4-1 presents a summary of 2017 and 2018 (through October) of the City’s average day and peak day water use.

Table 4-1. Water Production Summary

City of Eureka, MO
2017 & 2018 System Water Production
Summary

2017	
Yearly Total (gpd)	619,337,838
Average (gpd)	1,696,816
Peak Day (gpd)	3,549,000
Peak Date	July 13, 2017
Peak Day Over 24 hrs (gpm)	2,465
Peak to Avg. Day Ratio	2.09

2018*	
Yearly Total (gpd)	552,307,000
Average (gpd)	1,816,799
Peak Day (gpd)	3,680,000
Peak Date	July 26, 2018
Peak Day Over 24 hrs (gpm)	2,556
Peak to Avg. Day Ratio	2.03
*Jan.-Oct. Data Only	

Water Distribution System Evaluation City of Eureka, Missouri

Table 4-2 shows total gallons produced for each month during the year 2017. A daily average was estimated by taking the year's total divided by 365 (days) and divided again to find average gallons per minute. These values were then divided by the number of nodes in the water model to simulate demand throughout the system.

Table 4-2. Average Water Demand Per Node Analysis

City of Eureka Average Water Demand Analysis	
Month	Water Produced (Gallons)
January 2017	40,076,000
February 2017	34,512,000
March 2017	36,983,000
April 2017	37,984,000
May 2017	49,576,000
June 2017	69,018,000
July 2017	86,534,000
August 2017	74,206,000
September 2017	65,359,000
October 2017	52,890,000
November 2017	36,025,000
December 2017	36,175,000
Total	619,338,000
Number of Water District System Nodes	520
Average Daily Water Produced (GPD)	1,696,816
Average Water Produced (GPM)	1,178.3
Single Average Water Demand Per Node (GPD)	3,263
Model Input - Single Average Water Demand Per Node (GPM)	2.266

Water Distribution System Evaluation City of Eureka, Missouri

Table 4-3 summarizes the factors for each demand scenario used in the water model. The peak month factor was calculated by dividing peak month well production by average month well production, and the peak day factor was determined by multiplying the peak month factor by 1.25; a common factor. Then, the peak hour factor was determined by further multiplying the peak day factor by 1.5, a common diurnal pattern factor. These factors allowed us to see how the model functions on an average demand day compared to a peak demand day, and what changes may be needed to accommodate demand.

Table 4-3. Hydraulic Model Node Summary

City of Eureka		
Demand Scenario	Factor	Demand Per Node (GPM)
Average	1.00	2.266
Peak Month	1.68	3.807
Peak Day	2.10	4.759
Peak Hour	3.15	7.138

Section 5. RECOMMENDED IMPROVEMENTS

5.1. Recommended Improvements Descriptions

This analysis assumes that all tanks, wells, pumps and pipes present are in good working condition. Any addition of pipe is for the purpose of achieving desired pressure values as needed if an outside water source were to be introduced. For Scenarios 1 and 2, an extended period simulation was conducted. To mimic extreme conditions, the peak value of the peak month was used and multiplied by 1.25.

5.1.1. Scenario 1

An outside source coming in from the East provided by Missouri American to connect to a new trunk line that runs along I-44. In addition, constructing a new 12" line bored under I-44. The distribution system is all connected, some valves would have to be opened and some valves would have to be closed to help maintain the required pressures for the varying zones. A map of the proposed scenario is in Appendix D.

5.1.2. Scenario 2

An outside source coming in from the South provided by Jefferson County Public Sewer District to connect to a new trunk line that runs along Highway 109. In addition, constructing a new 12" line bored under I-44. The distribution system is all connected, some valves would have to be opened and some valves would have to be closed to help maintain the required pressures for the varying zones. A map of the proposed scenario is in Appendix E.

5.1.3. Scenario 3

This scenario includes upgrading treatment methods at existing wells along with additional improvements instead of bringing water in from an outside source. One option evaluated would be taking Well 6 off-line and use the other 5 wells to fill the Legends tank. Well 9 currently has the best finished water quality and lowest current usage. The existing system is adequate to supply demand, however, to maximize utilization of Well 9 into the system a check valve or other yard piping modifications may need to be installed at the Arbors plant site. For the short term, the existing crossing is adequate to supply demand. A map of the proposed scenario is in Appendix F.

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5.2. Estimated Cost for Recommended Improvements

Opinions of estimated project cost have been developed for each scenario 1, scenario 2 and scenario 3. These opinions are based on the following:

- Approximation of pipe needed to be upgraded or newly installed determined by water modeling software to achieve desirable results.
- Average price per quantity of the varying sizes of pipe to be upgraded or installed.

Each scenario is summarized in Table 5-1 and details are included in Appendix G.

Total project costs and construction costs provided herein are made on the basis of Engineer’s experience and qualifications and represent the engineer’s best judgment. The Engineer cannot and does not guarantee that bids or actual total project or construction costs will not vary from the estimate of the preliminary cost opinion. This estimate is intended to assist in budgetary assessment and does not guarantee that actual project costs will not exceed or be lower than the amounts stated in this opinion.

Table 5-1. Overall Distribution Project Cost Summary

Scenario	Overall Distribution Project Estimate
1	\$3,000,000
2	\$1,670,000
3	\$210,000

APPENDIX A

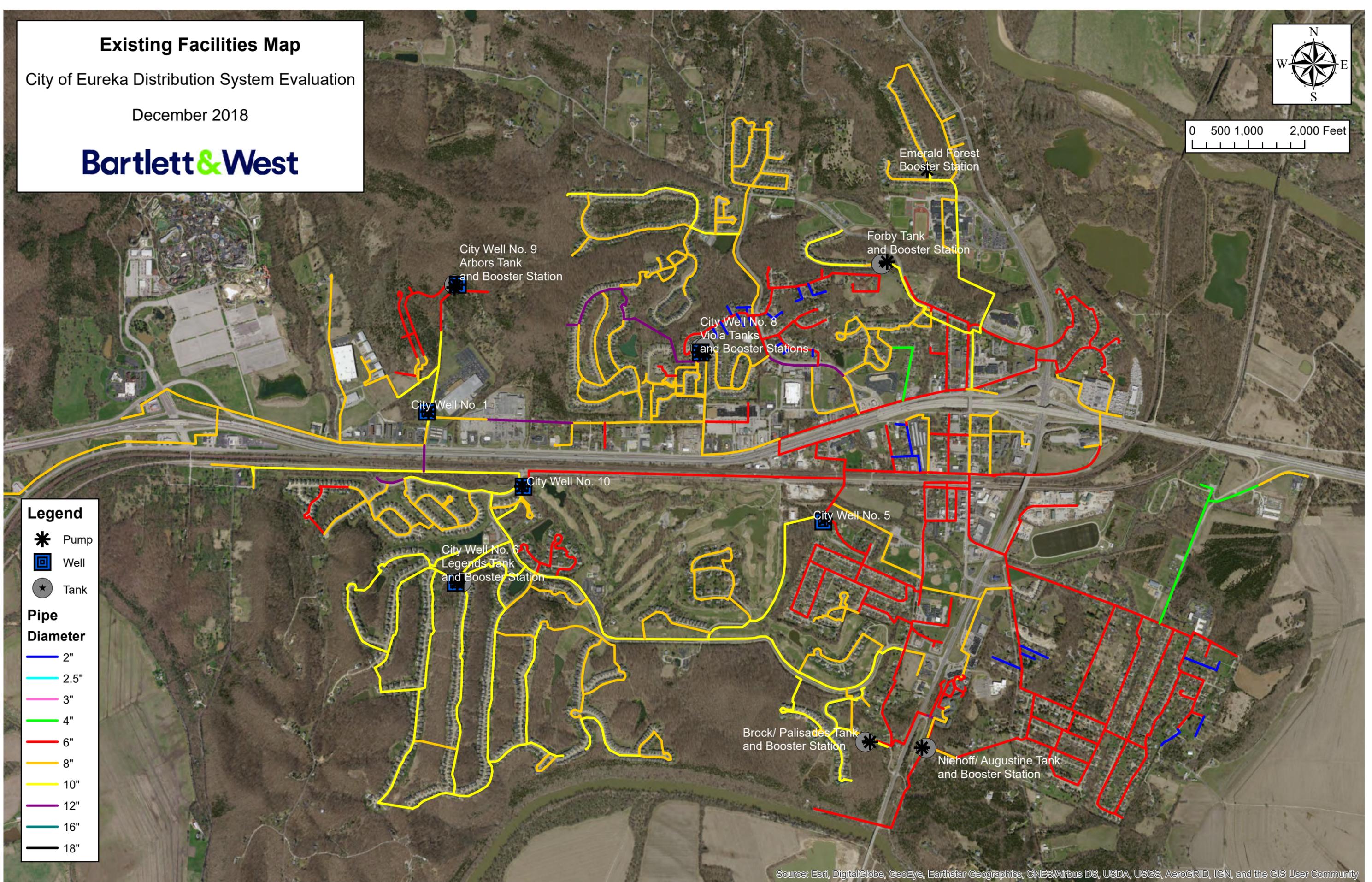
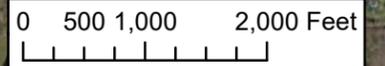
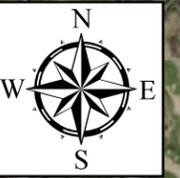
EXISTING DISTRICT FACILITIES MAP

Existing Facilities Map

City of Eureka Distribution System Evaluation

December 2018

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Legend

- Pump
- Well
- Tank

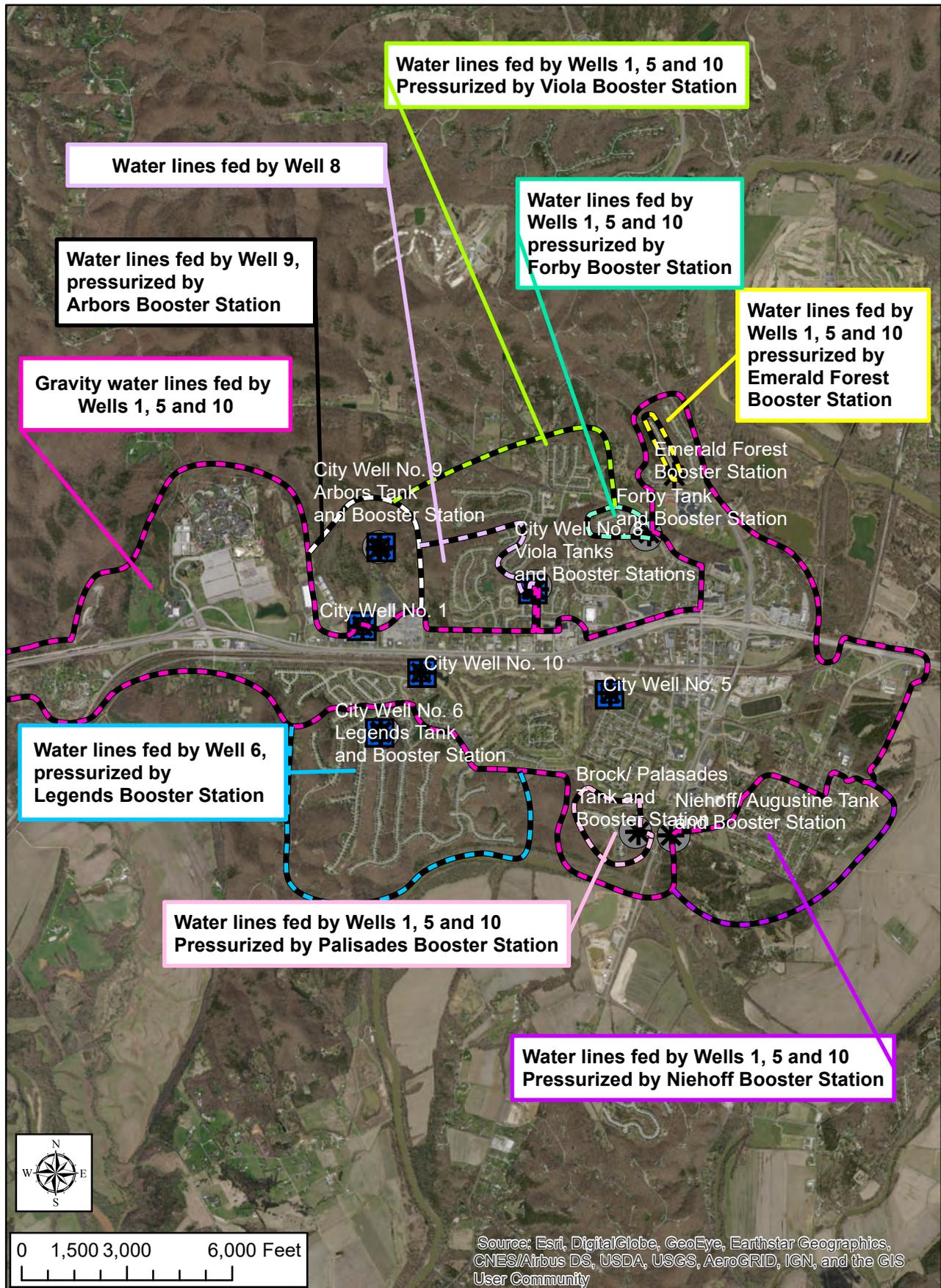
Pipe Diameter

- 2"
- 2.5"
- 3"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

APPENDIX B

EXISTING WATER DISTRIBUTION ZONES MAP

Distribution Zones City of Eureka, Missouri



APPENDIX C

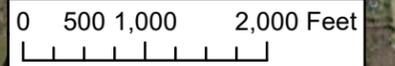
EXISTING SYSTEM PRESSURES MAP

Existing Facilities Map

City of Eureka Distribution System Evaluation

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Legend

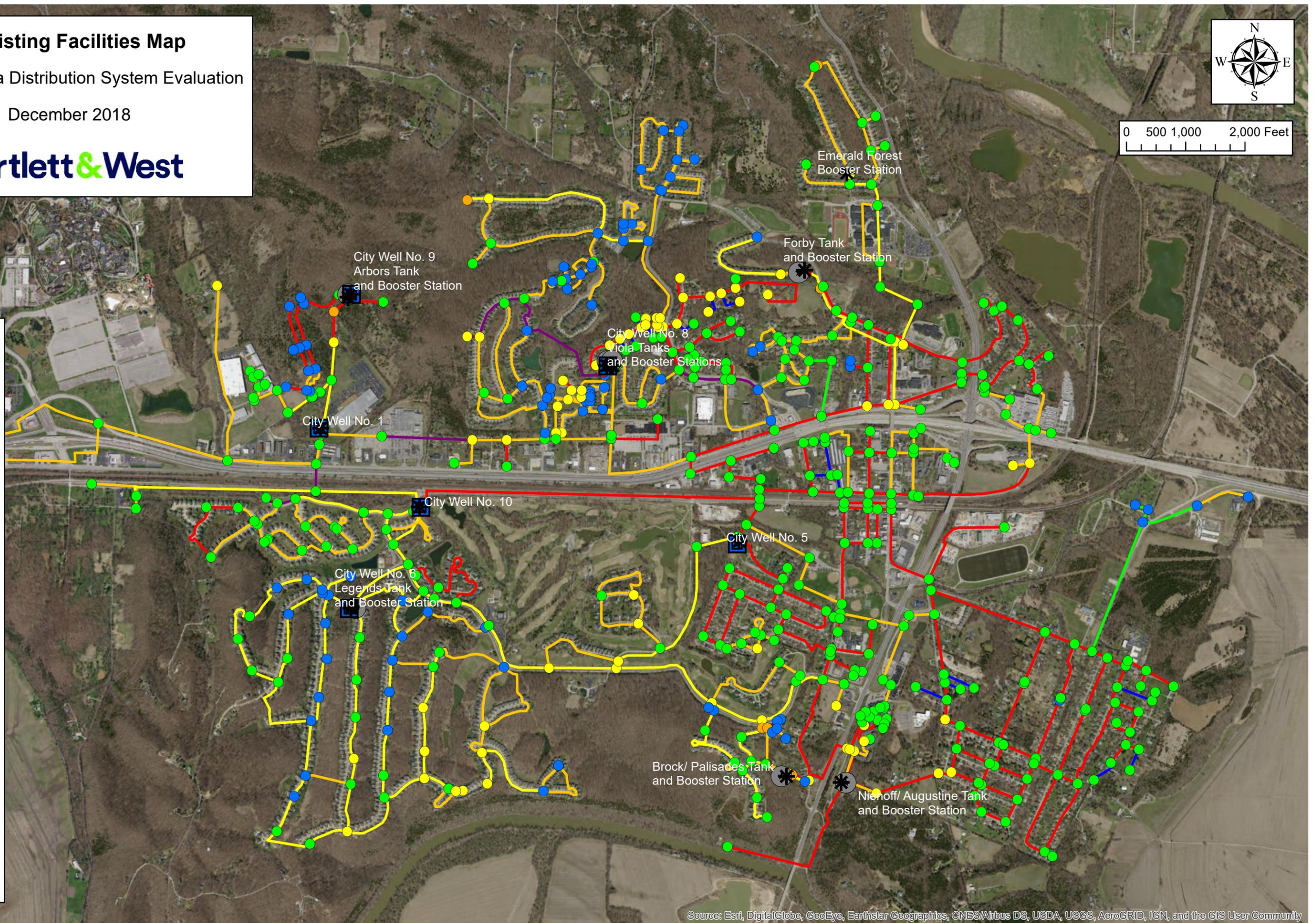
- Pump
- Well
- Tank

Pipe Diameter

- 2"
- 2.5"
- 3"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

Junction Pressure

- <20 psi
- 20-35 psi
- 35-60 psi
- 60-100 psi
- 100-150 psi
- 150-200 psi
- >200 psi



APPENDIX D

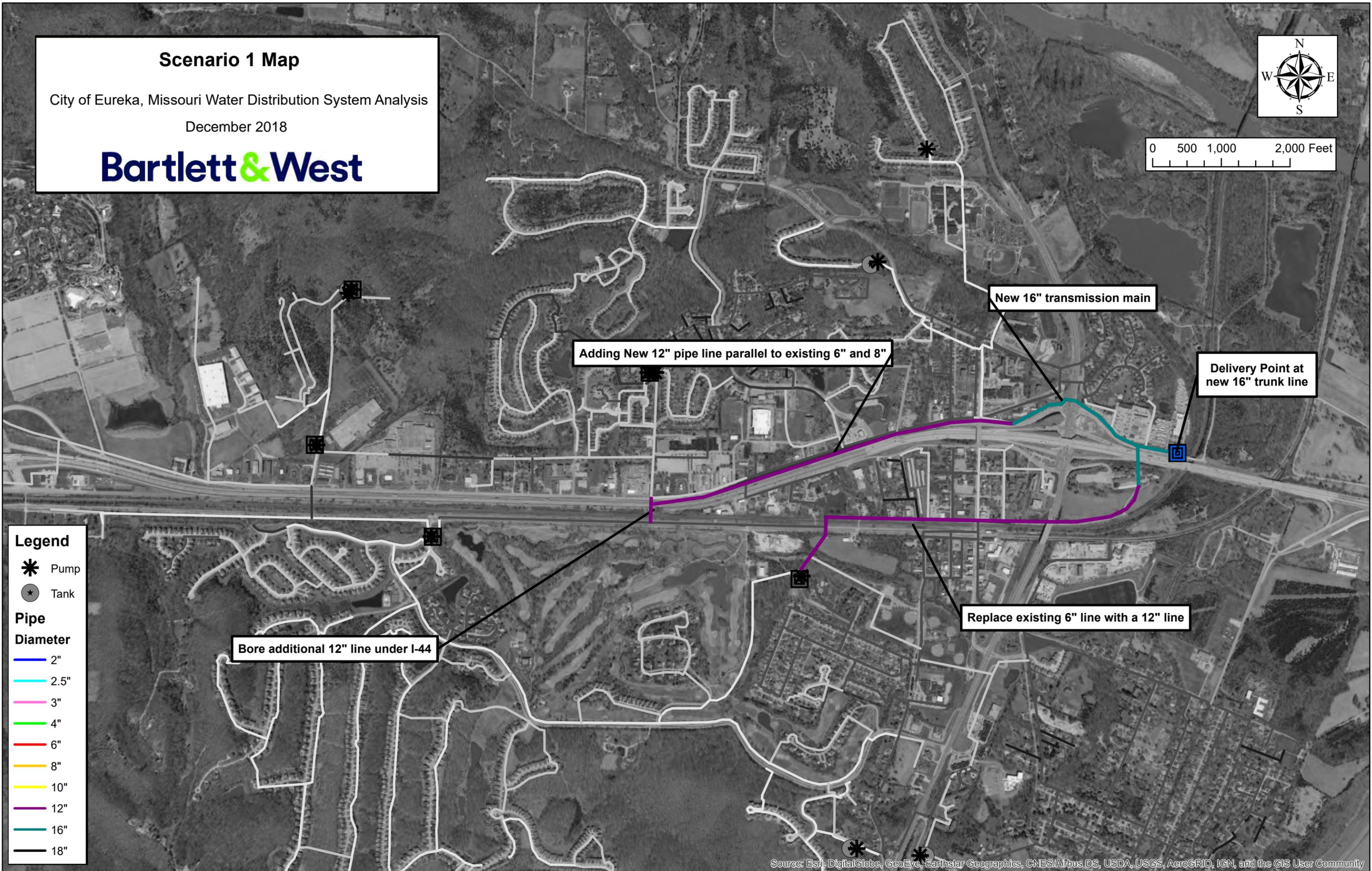
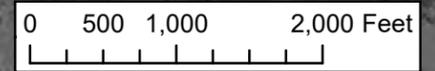
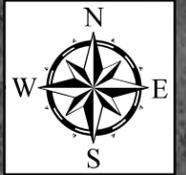
SCENARIO 1 MAP

Scenario 1 Map

City of Eureka, Missouri Water Distribution System Analysis

December 2018

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Legend

- Pump
- Tank

Pipe Diameter

- 2"
- 2.5"
- 3"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

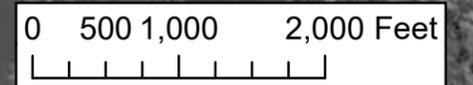
APPENDIX E

SCENARIO 2 MAP

Scenario 2 Map

City of Eureka, Missouri Water Distribution Analysis

December 2018



Bore under I-44 with new 12" line

Replace existing 6" line with 12"

Replace existing 8" line with 12"

New 12" line tied into 16" trunk line and existing lines

Delivery Point at new 16" trunk line

Legend

- * Pump
- Tank

Pipe Diameter

- 2"
- 2.5"
- 3"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

APPENDIX F

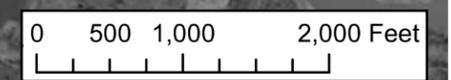
SCENARIO 3 MAP

Scenario 3 Map

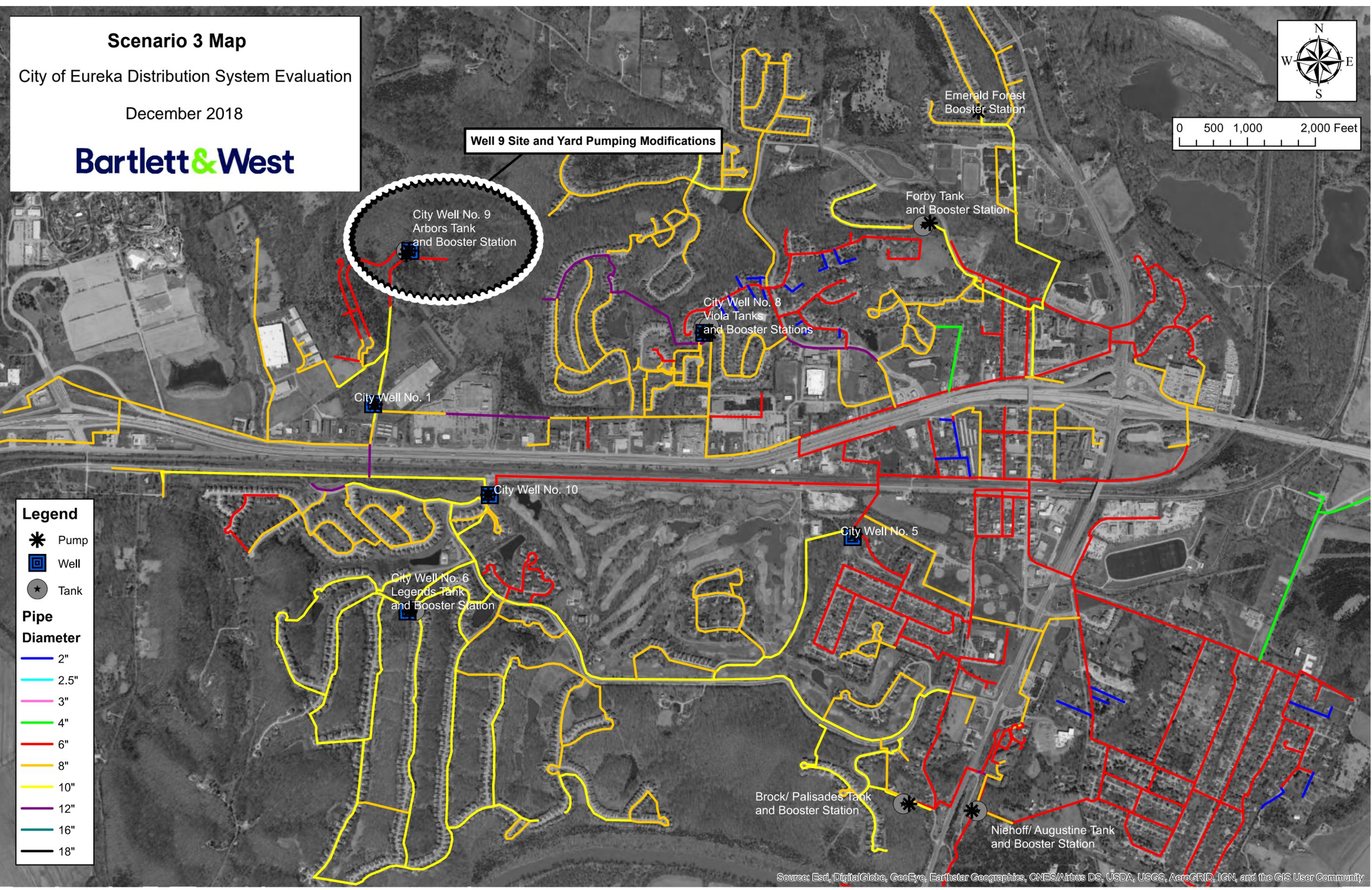
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Well 9 Site and Yard Pumping Modifications



- Legend**
- * Pump
 - Well
 - ⊙ Tank
- Pipe Diameter**
- 2"
 - 2.5"
 - 3"
 - 4"
 - 6"
 - 8"
 - 10"
 - 12"
 - 16"
 - 18"

APPENDIX G

RECOMMENDED IMPROVEMENTS COST OPINIONS

City of Eureka, Missouri
Recommended Improvements Cost Opinions - December 2018

Project No. 19500.004

PROJECT/DESCRIPTION	UNIT	QUANTITY	UNIT COST	EXTENSION
Scenario #1 - Missouri American Source Water feeding in from the East				
16" C900 PVC Water Line	LF	2,400	\$110.00	\$264,000.00
12" PR200 PVC Water Line	LF	10,700	\$80.00	\$856,000.00
16" Highway Crossings (Bore)	LF	750	\$525.00	\$393,750.00
12" Highway Crossings (Bore)	LF	300	\$375.00	\$112,500.00
12" Railroad Crossings (Bore)	LF	300	\$395.00	\$118,500.00
Valves, Appurtenances and Misc.	LS	1	\$560,000.00	\$560,000.00
Total Estimated Construction Cost:				\$2,304,750.00
Construction Contingency:				\$230,500.00
Non-Construction Contingency:				\$464,750.00
TOTAL ESTIMATED COST OF RECOMMENDED IMPROVEMENTS (Scenario #1):				\$3,000,000.00
Scenario #2 - Jefferson County Source Water feeding in from the South				
16" C900 PVC Water Line	LF	2,000	\$110.00	\$220,000.00
12" PR200 PVC Water Line	LF	5,450	\$80.00	\$436,000.00
12" Highway Crossings (Bore)	LF	325	\$375.00	\$121,875.00
12" Railroad Crossings (Bore)	LF	325	\$395.00	\$128,375.00
Valves, Appurtenances and Misc.	LS	1	\$328,000.00	\$328,000.00
Total Estimated Construction Cost:				\$1,234,250.00
Construction Contingency:				\$123,400.00
Non-Construction Contingency:				\$312,350.00
TOTAL ESTIMATED COST OF RECOMMENDED IMPROVEMENTS (Scenario #2):				\$1,670,000.00
Scenario #3 - Upgrading Existing System*				
Well 9 Site Modifications	LS	1	\$100,000.00	\$100,000.00
Valves, Appurtenances and Misc.	LS	1	\$50,000.00	\$50,000.00
Total Estimated Construction Cost:				\$150,000.00
Construction Contingency:				\$15,000.00
Non-Construction Contingency:				\$45,000.00
TOTAL ESTIMATED COST OF RECOMMENDED IMPROVEMENTS (Scenario #3):*				\$210,000.00

*This represents only the upgrades to the existing distribution system, and the estimated cost does not include supply or treatment improvements recommended in other sections of the report.