EUFAULA OKLAHOMA 1872

CITY-WIDE WATER ANALYSIS REPORT

FOR THE CITY OF EUFAULA/EUFAULA PUBLIC WORKS AUTHORITY

CG COWAN GROUP™ ENGINEERING

November 2018

CITY OF EUFAULA, OKLAHOMA

CITY-WIDE WATER ANALYSIS REPORT

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____________________________, 2018.

_______________________________	_______________________________
City Clerk	Mayor

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1. EXECUTIVE SUMMARY

Worldwide, a dependable supply of water is necessary for the social, economic and environmental well-being for every city and municipality. As the county seat of McIntosh County, Oklahoma, the City of Eufaula (City) is located approximately 30 miles north of McAlester and 32 miles south of Muskogee. The name "Eufaula" comes from the Eufaula Tribe, part of the Muscogee Creek Confederacy. The City and county are within the jurisdiction of the federally recognized Muscogee Creek nation. The population was 2,813 at the time of the 2010 census and is projected to be over 4,300 by the year 2050.

In August 2018, the City and Eufaula Public Works Authority (EPWA) retained Cowan Group Engineering (CGE) to perform a city-wide water system analysis. This assessment included the development of a comprehensive water model of the distribution system and culminated with the creation of a Capital Improvements Plan (CIP), which contains prioritized recommendations for water system improvements through 2050.

Through this city-wide water system analysis and hydraulic water model development, the City has committed to gaining a better understanding of the mechanics and condition of the existing water system. The overall goals of an effective hydraulic model are to provide an evaluation of the existing water system with respect to distribution system pressures and available fire flows. Existing flow and pressure data were used to calibrate the model and ensure it was an accurate representation of the water system. Once calibrated, the model was used to evaluate five scenarios, including evaluation of the existing system conditions as well as proposed future improvements related to pressure, flow, and storage.

Today, the City's water distribution system includes over 125,000 linear feet (24 miles) of water lines, one ground storage tank, one elevated storage tank, three booster pumping stations, and 1,800 water meters to serve its residential and commercial customers.

The overall distribution system for the City of Eufaula is in fair to poor condition. The main issues impacting the performance of the existing system include:

- Numerous line breaks that result in significant water loss and system down time, during which many customers are without service.
- Water loss is a critical issue due to the cost of treatment and lack of revenue generation from the water that is lost during a line break. From 2015 to 2017, the City experienced 37% - 53% unaccounted water production.
- Lack of isolation valves to shut off sections or areas of the system to repair waterlines or perform routine maintenance.

- Areas within the system are not capable of providing adequate fire flow due to existing small diameter lines.

After CGE completed its investigation of the City's water system and hydraulic model, a recommended Capital Improvement Plan (CIP) was developed. Each water system project on the CIP is ranked from critical to long term and will provide the City with numerous benefits in the areas of operations and maintenance, planning, development, asset management, and infrastructure improvement. The critical-ranked improvements will immediately address the main issues identified above, and greatly enhance the day-to-day performance of the City's water system. The CIP is provided in Table 1 below.

Table 1
City of Eufaula
Capital Improvement Plan

Year	Item #	Category	Project	Conceptual Cost[1]
2019 - 2020	A.1	Critical	12" Waterline Replacement	$ 134,000
	A.2	Critical	10" Waterline Replacement	$ 196,000
	A.3	Critical	8" Waterline Replacement	$ 1,349,000
	A.4	Critical	6" Waterline Replacement	$ 2,739,000
	A.5	Critical	10" Gate Valve Installation	$ 24,500
	A.6	Critical	8" Gate Valve Installation	$ 22,000
	A.7	Critical	6" Gate Valve Installation	$ 28,800
	A.8	Critical	4" Gate Valve Installation	$ 28,800
	A.9	Critical	2" Gate Valve Installation	$ 2,400
	A.10	Critical	FH Assembly Replacement	$ 350,000
	A.11	Critical	Inline PRVs Installation	$ 210,000
	A.12	Critical	Install Automatic Flushing Valves	$ 68,000
	A.13	Critical	Spheroidal Elevated Storage Tank Valve Vault Replacement	$ 50,000
	A.14	Critical	WTP Back-up Generator Installation	$ 125,000
			Subtotal	$ 5,327,500
			Contingency (20%)	$ 1,065,500
			Total for Critical Improvements	**$ 6,393,000**

Table 1 (continued) City of Eufaula Capital Improvement Plan				
Year	Item #	Category	Project	Conceptual Cost[1]
2021 - 2023	B.1	Short	6" Waterline Replacement	$ 1,065,500
	B.2	Short	Install Passive Mixing System at Spheroidal Tower	$ 75,000
	B.3	Short	New Ground Storage Tank at Swadley Drive	$ 1,250,000
	B.4	Short	Ground Storage Tank Valve Vault Replacement	$ 100,000
	B.5	Short	Booster Pump Station Replacement	$ 250,000
	B.6	Short	Pressure Plane Valving	$ -
	B.7	Short	Develop and Implement Asset Management Plan	$ -
	B.8	Short	Encourage Water Conservation and Rationing	$ 20,000
			Subtotal	$ 2,760,500
			Contingency (20%)	$ 552,100
			Total for Short Term Improvements	**$ 3,312,600**

Table 1 (continued) City of Eufaula Capital Improvement Plan				
Year	Item #	Category	Project	Conceptual Cost[1]
2025 - 2050	C.1	Long	Waterline Upsizing	$ 1,067,500
	C.2	Long	Construct Elevated Storage Tank at River Oaks Booster	$ 800,000
			Subtotal	$ 1,867,500
			Contingency (20%)	$ 373,500
			Total for Long Term Improvements	**$ 2,241,000**

Total CIP Conceptual Cost[1]	**$ 11,946,600**

[1]Conceptual Costs include construction costs only. Cost do not include engineering studies, design, right-of-way, survey, land acquisition, legal and financial advisor fees. All costs are based upon 2015 construction costs.

The recommended Critical, Short Term, and Long Term Improvements will provide the City with numerous benefits, from enhanced operations and maintenance to future planning and economic development. The Critical category improvements will immediately improve the day-to-day performance and reliability of the water distribution system due to the scheduled replacement and upsizing of aging, fragile cast iron water lines and installation of system isolation valves. Upsizing waterlines scheduled for replacement will also increase system capacity with respect to fire flow. Short Term and Long Term Improvements recommend replacing other aging system components as necessary, or the addition of new system components driven by growth and development of the City.

2. INTRODUCTION

A. Overview

The City of Eufaula (City) has identified a need to revise and update maps and develop a hydraulic model of the drinking water system they currently own and operate. The purpose of this project is to comprehensively analyze the drinking water system as well as develop a calibrated dynamic hydraulic model of the water distribution system that can be utilized as a decision tool for long term planning, budgeting and improvements to the water system. Three categories of improvements and needs will be suggested consisting of critical, short term, and long term.

Figure 1: City of Eufaula City Hall.

Cowan Group Engineering (CGE) was selected by the City to develop and maintain a comprehensive water model for the above mentioned reasons. CGE has coordinated with City staff to develop the model and report, and the assistance was fundamental to building a comprehensive water analysis of the system. CGE would like to thank those who participated in providing valuable information during the data gathering and validation phase of this project.

B. Project Objective

The results of the updated city-wide water system assessment and hydraulic model will provide numerous benefits to the City including:

- Increase efficiency for the operation and maintenance of the water distribution system
- Improve response time to problems and emergencies
- Provide relevant information to be used for economic development and planning
- Accurate evaluation of new developments with regard to water service
- Comprehensive assessment of fire flow capacity throughout the City
- Capability of expanding the model to evaluate water quality issues such as water age and disinfectant residuals

- Define problem areas in the distribution system and prioritize projects for the Capital Improvements Plan

All of these benefits will allow the City to become more proactive in the areas of planning, development, infrastructure improvements, operation and maintenance while decreasing costs through efficient utilization and effective scheduling of capital improvement projects.

C. Project Requirements

Task One – Planning and Data Gathering

Task One includes the review of existing Geographic Information System (GIS) waterline data from the City and verifying primary water system infrastructure, including water storage tanks/towers, booster pump stations, waterline sizes, connections, and locations within the city.

CGE has developed an accurate and complete water distribution map utilizing GIS technology, information provided on maps from previous contracts, and interviews with key staff. After producing these distribution maps, CGE validated point locations and elevations through LIDAR aerial mapping and on-site survey at key locations.

Task Two – Distribution System and Water Loss Audit

Task Two involves map development of existing water infrastructure including the items listed in Task One above, as well as information related to repairs of existing waterlines, areas of repeated waterline breaks, inoperable isolation valves, and failed or inoperable fire hydrants. This task will also provide recommendations for the installation of valves on critical water lines and at strategic locations for system isolation during maintenance activities, repair of waterline breaks, and construction activities.

The water loss audit includes the review of water produced and water sold for the 2017 calendar year. This information will be used in conjunction with American Water Works Association (AWWA) software to analyze the system and determine water loss and water loss trends, and to provide recommendations to reduce water loss in both the short and long term.

Task Three – Water Model

The first tier of the model involves an evaluation of the primary infrastructure including water sources, storage tanks and towers, booster pump stations and waterlines that are 2-inches and greater.

The second tier of the model focuses on the evaluation of the secondary infrastructure, including smaller line sizes, and proposed areas of development. This portion of the model is important in the planning of future developments and determining the improvements which can net the greatest gains in pressure and flow.

The third and final tier is the maintenance component of the model where additions, deletions and modifications to the water system are modeled to assist with planning and development. The third tier also involves future maintenance of the model, as well as continued coordination with City staff.

The model was used to analyze the water distribution system under a variety of demand and flow conditions to identify any system deficiencies and to recommend water distribution system improvements that address water pressure, fire protection, line replacement, system redundancy and long term water planning.

Task Four – Final Report

The final report will provide the results in written format and include numerous maps and tables from the evaluation of the existing water distribution system and the proposed scenarios. This report will be a decision-making tool and guide for the City as it will include a Capital Improvement Plan (CIP) for the water system. The plan will include recommended improvements prioritized into three categories: Critical, Short Term, and Long Term improvements. Each line item in the CIP will contain a description of the recommended improvement as well as probable estimated construction costs.

D. Project Goals

The CGE team is very familiar with goal setting, in fact, it is a basis for our company and this very important water model. The project goals are key targets for the water model report and recommendations, including:

1. Understand the quantity of water production capable
   To quantify the amount of water the City of Eufaula can produce from their water source, as well as the quality of water.

2. Improvements within the system
   To isolate problem areas in the current system and identify reasonable solutions. These solutions should identify the most immediate needs within the system. This goal will be accomplished through analyzing many scenarios within the model.

3. Improve planning
   To provide the best water model service maintenance to assist with future planning and development for the City. This goal will be accomplished through constant coordination and participation with the water operations, planning, and fire department staff.

4. Provide accurate information
   To provide proper supply and fire flow information in order to help the City obtain the best possible ISO ratings and have a full grasp of how the water distribution system is operating. This goal will be achieved through constant coordination and participation with the water operations, planning, and fire department staff.

5. Become a useful and versatile tool
   CGE also intends for this water model and report to provide the tools to help build the City of Eufaula to be:

   a. The best and most reliable water supplier they can be by supplying consistently safe and cost-effective water service
   b. Ready for growth with a clear vision of the future
   c. Aware of its infrastructure age, abilities, strengths, weaknesses, and needs
   d. Able to take ownership, as they have shown a willingness do so by commissioning such an extensive study

3. EXISTING WATER FACILITIES

A. General Service Area

The City of Eufaula's corporate boundaries currently encompass a land area of 6.59 square miles and a water area of 3.02 square miles. The City is located in McIntosh county at the junction of US 69 and State Highway 9. The corporate boundaries currently service water customers ranging from residential to light commercial and industrial. See existing water distribution map in APPENDIX B.1.

In order to create an estimate of future flows within the water distribution system, the population growth of an area must first be understood. Some of the factors which control population growth are: zoning, land density, historical land use, and employment opportunities. To quantify growth based on these factors would require a master plan for development. Typically, in the absence of such information, census data is used to make a representative projection. The City's current and projected population can be seen in Table 2.

Table 2 City of Eufaula Historical and Projected Population		
YEAR	**SOURCE**	**POPULATION**
1980	Actual	3,159
1990	Actual	2,652
2000	Actual	2,639
2010	Actual	2,813
2011	Actual	2,832
2012	Actual	2,830
2013	Actual	2,848
2014	Actual	2,862
2015	Actual	2,876
2016	Actual	2,902
2017	Actual	2,888
2020	Projected	3,300
2025	Projected	3,470
2030	Projected	3,660
2035	Projected	3,870
2040	Projected	4,100
2050	Projected	4,350

The actual and projected values were obtained from the United States Census Bureau. From the data, CGE evaluated the growth trends that display a gradual increase for the next thirty years. These growth values are based on the area still available for development within the corporate limits of the City. The City experienced a slight population decline in the 1990s but since has gradually increased yearly. The population is anticipated to slightly increase in the next thirty years due to the remaining available land development area.

B. Water Supply/Source

The City owns and operates approximately 5,250 linear feet of 10-inch raw water line originating at Eufaula Lake and terminating at the water treatment plant. The City's water treatment plant is located within the corporate limits of the City of Eufaula and contains a 0.5 million-gallon clearwell. The City distributes treated water to its citizens and customers through over 125,000 linear feet of water distribution lines ranging from 1 to 10-inch in diameter. The City also

Figure 2: Lake Eufaula.

supplies an emergency water connection to the McIntosh County Rural Water District No. 6, which is located to the west of the City.

The City retains 1,683 acre-feet/year in water rights granted to them by the Oklahoma Water Resources Board (OWRB). This equates to an available annual flow of 548 million gallons per year available for the City to supply to its customers, or approximately 1.5 million gallons per day (MGD). The OWRB water rights permit can be found in APPENDIX A.1.

The water distribution system currently conveys anywhere from 445,000 to 557,000 gallons per day (gpd), or roughly 300-400 gallons per minute (gpm). Complete utilization of surface water rights is imperative if the City is to continue utilizing its ability to produce its own water. At an average flow rate of 350 gpm, less than 40 percent of the water rights are currently being utilized.

An evaluation of the water treatment plant was not included in the scope of this project, but City staff has identified the need to install back-up power at the facility. Therefore, a backup generator has been included in the CIP. CGE will continue to keep in contact with the City for any unforeseen future water treatment plant improvements.

A study conducted by The Oklahoma Rural Water Association identified and recommended the need to increase the water and sewer rates set forth in the Fee Schedule implemented in March of 2016, for both the minimum monthly charges and the per thousand gallons rates charged for water (Residential, Commercial, Outside City Limits), and Sewer (Residential, Commercial, Outside City Limits). The City and Eufaula Public Works Authority (EPWA) adopted a resolution amending the fee schedule for water and sewer, which was approved and signed on September 10, 2018. The new rates are shown in Table 3.

Table 3
City of Eufaula
Minimum Rate for Water Per Month Increasing Each Year ($)

	Current	2018	2019	2020	2021	2022	2023	2024
Residential	12.50	20.00	27.50	35.00	42.50	50.00	57.50	62.50
Commercial	14.50	22.00	29.50	37.00	44.50	52.00	59.50	64.50
Outside City Limits	22.50	30.00	37.50	45.00	52.50	60.00	67.50	72.50

The rate per thousand gallons charged for amounts used over the minimum charged 2,000 gallons, will increase by $1.00 for water, and $0.50 for sewer, respectively. The said increases began with the October 2018 billing cycle, and are to be reflected in the Fee Schedule, with the listed increase for future years becoming effective on the October billing cycle of the referenced year.

C. Water Quality

The City's system is currently out of compliance with the Stage 1 Disinfectants and Disinfection Byproduct Rule (DBPR), which requires that total trihalomethanes (TTHMs) and five species of haloacetic acids (HAA5) not exceed 80 µg/L and 60 µg/L respectively, and that the total organic carbon (TOC) removal performance ratio be at least equal to 1.00. The City is under consent order with ODEQ for a violation of minimum TOC percent removal ratios and is borderline compliant with HAA5 concentrations in the system.

Figure 3: City of Eufaula Water Treatment Plant.

The purpose of the Stage 1 DBPR is to improve public health protection by reducing exposure to disinfection byproducts (DBPs). Some DBPs have been shown to cause cancer in lab animals and suggest bladder cancer, liver or kidney problems, and central nervous disorders in humans. Although TOC has no direct health effects, it is a precursor to the formation of DBPs. Most drinking water sources contain a variety of organic matter, some of which comes from natural sources. DBP precursors react with disinfectants to produce DBPs, including TTHMs and HAA5s.

The Stage 1 DBPR was promulgated on December 16, 1998 and became effective for systems serving populations less than 10,000 on January 1, 2004. The Stage 1 DBPR applies to all sizes of community water systems and non-transient-non-community water systems that add a disinfectant to the drinking water during any part of the treatment process and transient non-community water systems that use chlorine dioxide.

D. Storage Facilities

The City utilizes two (2) different water storage facilities to supply general demand to the system, as well as fire flow and pressure. The total capacity of these two storage facilities is 930,000 gallons. Each storage facility is described as follows:

<u>**Spheroidal Elevated Tower**</u>

The Spheroidal Elevated tower is located on the North side of Woodland Avenue at its intersection with Eufaula High School. It is a composite tower which has a base and a steel tank with a diameter of 36.67 feet and a height of 177 feet. It has the capacity to store 181,500 gallons of water and is monitored by a pressure gauge. The elevated tower was not inspected as a part of this project.

Figure 4: Elevated Spheroidal Tower at Eufaula High School Facilities.

<u>**Ground Storage Tank**</u>

Figure 5: Ground Storage Tank on Swadley Drive.

The Ground Storage tank is located on the North side of the intersection of Swadley Drive and Lackey Drive. It is a 62.5-foot diameter concrete tank with a height of 32 feet. It has the capacity to store 748,000 gallons of water and is monitored by SCADA. This tank was not inspected as a part of this project.

E. Pumping Facilities

Currently, the City is served by three (3) independent booster pump stations located within the distribution system, and below is a brief description:

Cox's Chicken Booster

The Cox's Chicken Booster Station is located at the intersection of Lakeland Drive and Anderson Bell Street, and it is equipped with two pumps capable of producing 238 GPM each. The booster station is supplied water from the elevated spheroidal water tank, and its pumped water is dedicated to the southwest portion of the distribution system. The booster station is equipped with standby power in case of emergency.

Figure 6: Cox's Chicken Booster Station.

River Oaks Booster

Figure 7: River Oaks Booster Station.

The River Oaks Booster Station is located at the intersection of East 120 Road and Shawnee Street and is equipped with two pumps capable of producing 35 gpm each. The booster station is supplied water from the distribution system. Its pumped water is dedicated to the Southeastern portion of the distribution system. The booster station does have standby power in case of emergency.

Eagle Bluff Pressure Tank

The Eagle Bluff Pressure Tank is located off Wildcat Lane to the north of Mongoose Lane and is equipped with a pressure tank capable of sustaining acceptable pressure when the distribution system is not able to provide them due to demand. The pressure tank is supplied water from the distribution system and the Cox's Chicken Booster Station. Its pumped water is dedicated for distribution to the Eagle Bluff area residents. The booster station does not have standby power in case of emergency.

Figure 8: Eagle Bluff Pressure Tank.

The booster pump station facilities referenced above were not inspected as a part of this project.

F. Distribution System

Currently, the City of Eufaula owns a total of 1,807 water meters which are read with the use of a drive-by Automatic Meter Reading (AMR) system that was installed approximately 2 years ago. The categorized use of these meters was provided by the City billing department and can be seen in Table 4. The meter sizes were provided by the City billing department and can be seen in Table 5.

Table 4
City of Eufaula
Meter Classification

Type	Number
Residential	1,335
Commercial	232
Outside City Limits	240
Total	1,807

Table 5
City of Eufaula
Meters by Size

Size	Number
5/8" - 3/4"	1,767
1"	2
2"	36
4"	2
Total	1,807

The distribution system throughout the City is comprised of waterlines ranging from 1 inch to 10 inches in diameter, some of which are 50 or more years old. An approximate breakdown of the total lengths for each size can be seen in Table 6.

Table 6
City of Eufaula
Line Size and Length

Size in Inches	Length in Feet	Length in Miles
1	4,000	0.76
2	36,000	6.82
3	11,000	2.08
4	135,000	25.57
6	76,000	14.40
8	43,000	8.14
10	16,000	3.03
Total	321,000	60.80

G. Communications

The supervisory control and data acquisition (SCADA) system controls communications within a water distribution system and is integral to proper operations. The SCADA system could be considered the brain of a water supply and distribution system. It is run by a computer program which communicates with the components of the system, usually through telephone lines. It can order the high service pumps to turn on because a tower/tank water level is low, and when the pumps turn on to fill the tower/tank, the water treatment plant will start to operate to supply water and pressure to the pumps, and so on and so forth. The Eufaula SCADA system is currently operated and monitored daily by the Eufaula Public Works Authority through a computer system located at the Eufaula water treatment plant.

H. Operations

The Eufaula Public Works Authority (EPWA) oversees and carries out operations of the drinking water supply, storage, production facilities, and distribution system. Daily duties and maintenance routines involve a strict surveillance of the SCADA system.

4. HYDRAULIC MODEL (HM) INTRODUCTION

A hydraulic/water distribution model is a hydraulic analysis that is simulating the dynamics of an existing or proposed water system. CGE utilizes the software Innovzye Infowater MSX, a fully GIS-integrated water distribution modeling and management software application. A water distribution system is a network of all water sources, waterlines, pumps, valves, storage tanks, fire hydrants, and service connections. All of these rely on the pressure created by either the height of the water in feet or the head of a pump created by force. These heights and forces of water are usually measured in pounds per square inch (psi). While the mechanics of this may sound simple, modeling of a distribution system is a very labor intensive and complex simulation process.

The subject model will include the mapping and hydraulic analysis of the City of Eufaula water distribution system for its existing, proposed, and future conditions. These conditions will be analyzed by simulating the dynamics of the system under steady-state and extended period simulations. These simulation methods are described in detail below:

<u>Steady-State Simulation</u>

A steady-state simulation computes the state of the system assuming that the hydraulic demands and boundary conditions do not change with respect to time. This simulation can be used for many different conditions such as average day demand, maximum day demand, peak hour demand with storage tank levels at full or minimum levels, and during fire protection usage. It is used to determine the very basic distribution system issues with respect to pressure and/or flow. A steady-state simulation is used to calibrate and validate the model using actual pressures collected within the distribution system.

<u>Extended Period Simulation</u>

The extended period simulation determines the dynamic behavior of the system over a period of time, computing the system as a series of steady-state simulations with hydraulic demands and boundary conditions changing with respect to time. This simulation is used once the steady-state performance calibration is completed. The extended period simulation analyzes the effects of changing water demands over time, fill and drain cycles of storage tanks, and response of pumps and valves to system changes.

The extended period simulation is typically run at multiples of 24-hour time simulations. The changing water demands are modeled using a Demand Pattern. Demand patterns are created by means of multipliers representing changing water usage throughout the day. The City of Eufaula diurnal demand curve was developed by the American Water Works Association (AWWA) based on average day flows (AWWA Manual M32, 2012).

The City of Eufaula could not provide adequate hourly flow data in order to develop a diurnal curve for residential and commercial usage, so the respective diurnal curves were developed for Average Day Demand based on an industry standard AWWA curve:

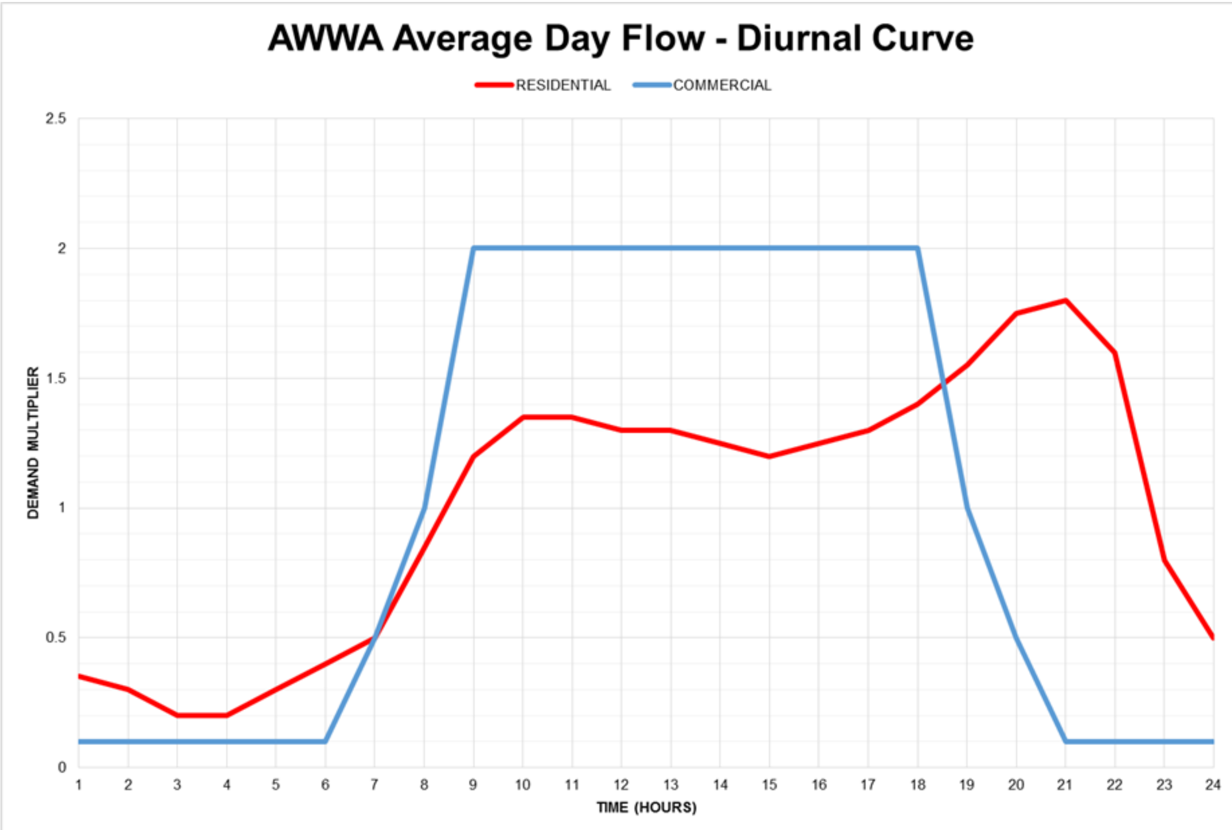

Figure 9: City of Eufaula Average Day Demand.

5. HYDRAULIC MODEL (HM) DEVELOPMENT

A. Overview

The water model was developed by inputting system elements into the Infowater software including water sources, pipes, junctions, tanks, reservoirs, pumps, and valves. The data needed to input each element of the water model required thorough investigation of the existing distribution system. The CGE team utilized the following information provided by City employees and CGE's professional land surveyor:

- Topographic survey

- Record drawings/plans
- Pump curves
- Historical flow data
- Booster station operations

The data obtained will be discussed in further detail in the sections below for the process of developing the City of Eufaula's water distribution model.

B. Survey & Mapping

The City of Eufaula identified the need to improve the overall mapping of their existing water distribution system. The City has an existing GIS database that was created by the Oklahoma Water Resources Board and consists of water maps and waterline location and sizing. The objective of updating and correcting the overall water distribution system mapping will improve the accuracy of the hydraulic water model and provide the City with a resource for the overall maintenance and operation of their water system.

CGE downloaded the existing GIS shape files as a resource to begin verifying the location and sizes of the existing water infrastructure. The process of verifying the mapping of the existing water system included obtaining as-built drawings from the City. Fire hydrant locations and other pertinent data was obtained from the City.

CGE developed an overall base map in ArcGIS software from this information to begin field verification by topographic survey and conversations with City staff. The topographic survey included setting up boundary control within the City and survey points at each water tower and booster pump for horizontal and vertical data. CGE staff spent time field verifying the locations of strategic water line connections and corroborating areas with differing data. CGE met with City staff to review the water line map and go over each area to identify needed corrections of water line locations, sizes, and connections. The overall base map was updated from these review meetings and was used as a basis for the hydraulic water model. The subject overall base map will need to be updated and continually verified to keep this map current and a valuable resource for the City.

C. Distribution System Data

A water model is developed by inputting system data into the following elements:

- Pipes
- Junctions
- Tanks
- Reservoirs

- Pumps
- Valves

System data includes information which defines the physical properties of each element. These water model elements and physical properties are discussed in further detail below:

Pipes
A pipe is a link that conveys water from one junction to another within the network. The mapping of the overall water distribution system provided pipe locations, pipe diameter, and pipe lengths for the water model. The water model also requires a roughness coefficient for pipe friction. A pipe roughness coefficient of 120 was used for the subject model. The minor-losses caused by pipe fittings have been ignored because they do not contribute substantially to the overall head loss through the system. A check valve can be inputted on the pipe settings to control the direction of flow.

Junctions
A junction is a node placed at the intersection of two or more pipes and/or specific locations to represent the high/low areas of the system, fire hydrants, and water demand locations. Junctions can represent points of consumption and are locations for analysis of pressure and demands. All junction nodes require the input of a ground elevation and the option for inputting multiple demand categories and patterns. CGE secured the most current (2010) 2-foot contours and imagery from the United States Geological Survey in order to extract elevation data for the model. The water demand calculations and allocation of the demands to the nodes are discussed in further detail in the Water Demand section.

Tanks
A tank is a storage node having a finite volume flow with a varying water surface elevation with time due to distribution system demands. The tank node requires the input of an elevation of the bottom of the tank, lowest allowable water level, highest allowable water level, initial water level when the simulation begins, and the diameter of the tank. CGE surveyed the base, tank top, and tank top cap for each of the two (2) City of Eufaula's towers/tanks. The tank levels inputted for the water model were based upon the operation levels city staff has programmed within the SCADA system. The operation of these tanks is discussed in further detail in the Distribution System Operations section.

Reservoir
A reservoir is a storage node having infinite volume of flow with a constant water level (or head) within the network. This constant water level is provided in the model to represent the actual pressure of that point in the distribution system.

Pumps

A pump is an element or node that adds energy to the system in the form of an increase in the hydraulic grade. The type of pump curves used on the subject model were Exponential 3-Point Curves in which the elevation of the pump, diameter of the pump, shutoff head, design head, design flow, high head, and the high flow are inputted into the model. CGE was provided the pump curves for the two (2) City of Eufaula Booster stations and one (1) pressure tank. The pumps within the Eufaula distribution system are operated on variable frequency drives (VFDs), so multiple pump curves were required to be developed to simulate the current operation of the system. A VFD controls the amount of electricity that is applied to the motor which allows it to run slower than its design, and this allows the pump to provide only the amount of water that is needed at that time and conserve energy.

Valves

A valve used in a water model is a control valve that regulates either the flow or pressure within the system. Valves were used in the subject model to regulate the flow and pressure at the booster stations and the tanks/towers.

Control Data

The model has a control data module that alters the status of pipes, valves, and pumps based upon input system criteria. This function controls when pipes or pumps open or close and when pumps turn on or off depending on a setting of a system element. These controls simulate the operation of the distribution system.

A summary of the system elements is provided in Table 7:

Table 7: Water Model Elements

Pipes	1,022
Junction	861
Tanks	2
Reservoir	1
Pumps	6
Valves	1

The overall development of the water distribution model will be defined by the data inputted into these system elements. All of these elements are tied together to create the distribution system and each is affected by the other elements.

D. Distribution System Operations

One of the key objectives when developing the water model is to be able to run scenarios based upon how the existing water distribution system is currently being operated in real-time. CGE met with City staff on numerous occasions to discuss the details of operation, flow, booster stations, and storage tank facilities.

The system receives raw water from Eufaula Lake through a 10-Inch raw water transmission line located to the west of Eufaula within city limits and is pumped to the Water Treatment Plant. The treatment plant pumps water into the distribution system from the clear well by utilizing three high-service pumps. The high service pump station is equipped with two 75 HP pumps each capable of providing 700 GPM and one 125 HP pump capable of 1400 GPM.

The ground storage tank level is controlled by the high service pumps. When the tank reaches its lower levels, it triggers the high service pump station to turn on to meet demands. The spheroidal water tank is controlled by the ground storage tank levels.

The City also has the booster station at River Oaks that pumps to residents both outside and inside city limits. The water model was set up based upon these parameters and controls to simulate the current operation of the system.

E. Water Demands

The consumption or use of water, also known as water demand, is the driving force behind the hydraulic dynamics occurring in the water distribution system. CGE secured flow data from the City for the model to simulate the production during average day demand, peak day demand, and peak hour demand. The City provided CGE with Monthly Operation Reports (MORs) from 2015 through 2018. An MOR is a log sheet completed daily by collecting the water flow data from the treatment plant and sample sites as required by ODEQ. The data from those MORs can be seen in APPENDIX A.3.

CGE used the flow data from the City's production record logs, MORs and Utility Billing to set up a mass balance to review the inflow and outflow of water through the distribution system. Table 8 shows a comparison of the flows and high volume of unaccounted production water:

Table 8
City of Eufaula
Water Flow Balance

	Total Water Inflow/Outflow (Gallons)		
	2015	2016	2017
Total Production (Inflow)	220,668,000	162,447,000	203,315,000
Eufaula Utility Billing (Consumption)	103,452,016	102,410,054	122,367,274
Unaccounted Water Production	117,215,984	60,036,946	80,947,726

The Unaccounted Water Production ranges from 37% to 53% in the analyzed calendar years above. As displayed in Table 8, the City billing shows that billed water is lower than the amount of produced water by the water treatment plant. Possible explanations for the apparent water loss are due to water lost during water line breaks, water used to fight fires, other system leakage, errors in measurement, and unmetered water distribution throughout the City.

Currently, the water plant flow data provided is based off a water meter which is read visually once daily at the plant by City staff. The City's billing information for consumption information is deemed to be accurate, as the water meters are relatively new.

The City currently has a total of 1,807 active meters within their system, of which 1,335 meters are residential usage. CGE quantified every residential house (service connection) as an accurate method of distributing each demand. These demands were allocated to the nearest model node within the categories displayed above. This established the baseline for the Average Day Demand for the steady-state simulation. The baseline water demand was checked during the model calibration process to verify the operation of the system as identified in Table 9.

Table 9
Baseline Water Demand

InfoWater Demand	Classification	Average Demand (GPM)
Demand 1	Residential	0.12
Demand 3	Commercial	0.50

The baseline water demand during a steady-state simulation does not change over time, but in reality, the water demand varies continuously. The extended period simulation utilizes diurnal curves to define the water demand pattern through a 24-hour average day simulation. There are also additional demand events within a water distribution system that must be considered when modeling:

Average Day Demand

The average rate of demand for an average day (past, present, or future). This is based on the average base flow for the year and represents what is expected for a normal day of operation for the system. Using utility meter readings and assuming an inaccuracy of 5 percent due to age the CGE team estimates a daily average flow of 550,000 gallons per day.

Maximum Day Demand

The average rate of use on the maximum usage day (past, present, or future). This is based on the highest day's flow for a year and represents a day, for example, in mid-summer when all consumers are watering their yard and filling swimming pools. The maximum day in most instances is experienced in either July or August. During the system evaluation the CGE team could not find record of an actual recording of max day. Therefore, it was estimated by using a common peaking factor of 1.8 which yielded a max day of approximately 990,000 gallons per day.

Peak Hour Demand

The average rate of usage during the maximum hour of usage, typically is the peak of the maximum day demand (past, present, or future).

The average day demand, as earlier specified, for the City of Eufaula is 550,000 gallons per day, and the largest daily usage given from the peaking factor is 990,000 gallons per day. The peaking factor was then distributed through the average day diurnal curve previously discussed in order to develop the maximum day demand pattern. The maximum day demand diurnal curve is detailed below:

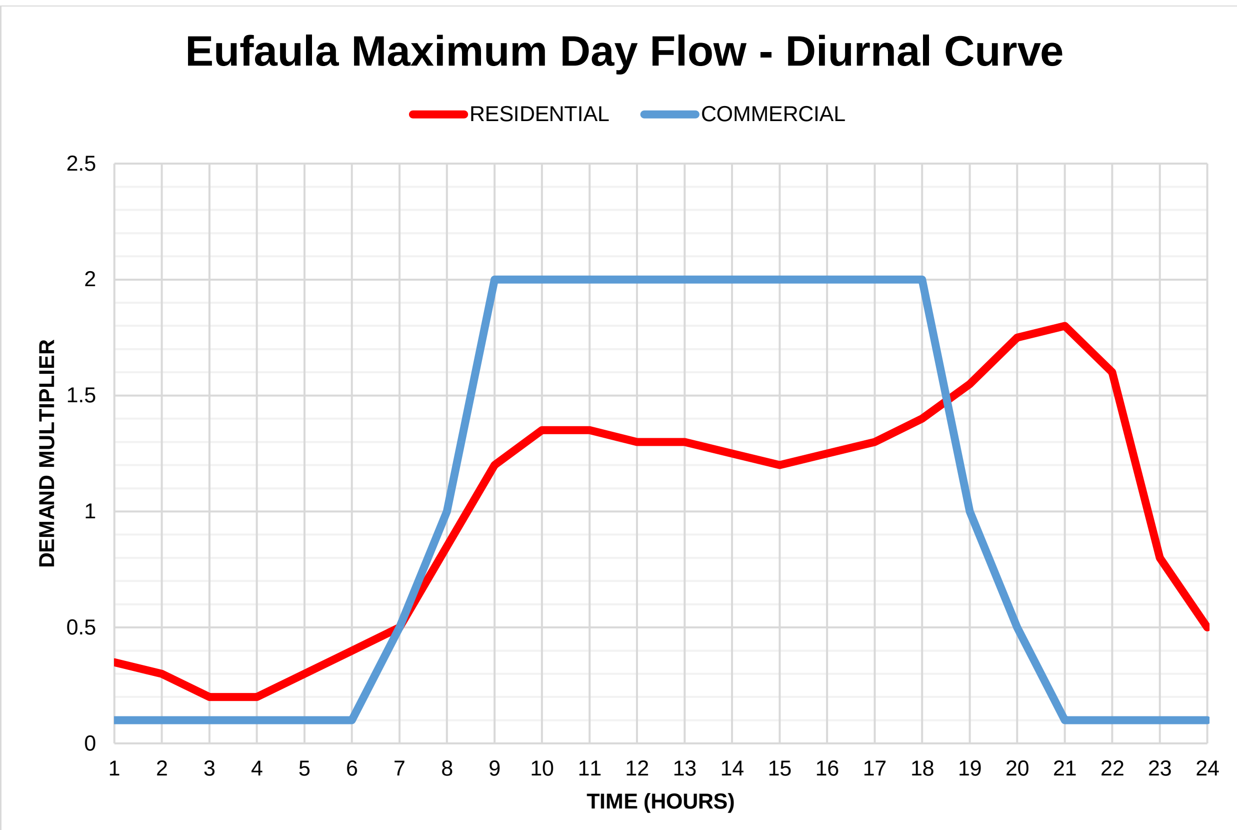

Figure 10: City of Eufaula Maximum Day Flow.

The peak hour developed from distributing the peaking factor through the demand multipliers gave a peak hour of 1.8 peaking factor for commercial and 2.05 peaking factor for residential. The three demand scenarios (average day demand, maximum day demand, and peak hour demand) were used for each simulation of the system for existing, proposed, and future conditions.

Future Demands

Future demands were considered within this model for long-range planning and further development for the City of Eufaula. All future demands were considered residential in order to present a more conservative representation. Residential flows usually present a larger demand on the system, as previously shown in the population projections. The estimated 2050 growth is a population of approximately 4,350 people. The estimated increase in population would correlate to an increase of about 1,000 water meters.

Fire Protection Demands

Fire protection demands represent a large percentage of the total demand for the system. One of the primary benefits of providing water for fire protection is a reduction in insurance rates for residents and businesses within the community. In Eufaula and around the United States, fire protection infrastructure is audited and rated by the Insurance Service Office (ISO) using the Fire Protecting Rating System.

Figure 11: City of Eufaula Fire Hydrant.

Fire codes require these fire flow demands be met for a minimum time requirement in the system. In developing the model, CGE set the fire flow demand at 1500 gpm at each fire hydrant and evaluated the available fire flow at 25 psi.

F. Model Calibration

Data collection is the first step in the model calibration process to verify that the water distribution model replicates existing field conditions. Spot checks of system pressure with city staff were used for verification of model performance compared to actual system function.

The pump data that was utilized at each booster station was verified with the pump curves based upon checking the head and flow for variable speeds during the simulation. The pumps and tanks were checked with each other to ensure that when tank levels were decreasing to a control level the pumps would turn on, and when they increased to the control level the pumps would turn off.

6. HYDRAULIC MODEL (HM) ANALYSIS

A. Overview

The development and calibration of the existing water model provides a foundation to proceed with analyzing the existing water system for any deficiencies or problems and to evaluate new scenarios to provide solutions and develop recommended improvement projects for the future.

During the model calibration, a steady-state simulation was analyzed to validate the base model and to determine basic distribution system issues with pressure and/or flow. The following scenarios were simulated using the extended period simulation for 48 hours to determine the hydraulic behavior of the system over time. Each scenario performs a simulation for Average Day Demand and Maximum Day Demand based upon the demand patterns referenced in earlier sections of this report. The peak hour determined by the diurnal curves was 5:00 PM, which represents the peak hour flow during the 24-hour period. The fire flow simulation is also analyzed at the peak hour for the Average Day Demand and Maximum Day Demand conditions.

The following scenarios do not encompass every possible simulation for the existing distribution system or proposed improvements but do provide an analysis to better understand the existing water system and a plan of action to improve the system going forward.

B. Scenario 1: Existing Water Distribution System

Scenario 1 – Existing Water Distribution System is a simulation, as best represented, of the existing water distribution system as it currently functions and operates in 2018. Scenario 1 was run using the extended period simulation for Average Day Demand, Maximum Day Demand, and Fire Flow Demand at peak hour (5:00 PM). Refer to APPENDIX B – Scenario 1, Sections B.2 – B.5 for the output results from each simulation including Junction Map, Pipe Map, Average Day Demand at Peak Hour and Maximum Day Demand at Peak Hour, respectively.

<u>Overview</u>

During this scenario simulation run, pressure throughout the system works off of the head created by the ground storage tank and the spheroidal tower. Pressure in the outlying areas southeast and southwest of town are sustained by the existing pump stations. Overall the system has generally acceptable pressures during average day flows. Areas to the north of the plant and directly east of the City witness higher pressures, some in the 130-psi range. These are a little excessive and are created by the high service pumps but are required to fill the storage tanks. Some of the higher elevation areas in the system could witness pressures as low as 25 psi. Flow through the system is capable of supplying all customers with water even under max day conditions. In its current state, many of the distribution lines require constant maintenance and pressure throughout the system is not adequate, with some areas experiencing extremely high pressures and other areas with extremely low pressures.

<u>Fire Flow Demand</u>

Evaluation of the system, and review of the model results, shows that the existing water distribution network does not have adequate supply in its system to provide the required fire flow demand and maintain 25 psi in a large majority of the system. There is also not enough supply for fire flow during an average day or maximum day simulation in certain areas of the distribution system.

C. Scenario 2: Waterline Improvements

Scenario 2 – Waterline Improvements is a simulation to improve the function of the water distribution system by replacing high priority lines. Refer to APPENDIX C – Scenario 2, Sections C.1 – C.5 for the output results from each simulation including Water Distribution Map, Junction Map, Pipe Map, Average Day Demand at Peak Hour, and Maximum Day Demand at Peak Hour, respectively.

The existing lines in the City are undersized and nearing the end of their useful life. The City is often fixing leaks on many of the same lines as they break. Some of the breaks are most likely caused by higher pressures in the system and brittleness due to age. CGE proposes the construction or replacement of many of the high priority lines outlined in this scenario. City Staff helped identify many of the pipe upgrades and the model was reviewed to identify areas where water was bottlenecked due to undersized lines. Upsizing lines will help to alleviate these bottlenecks and allow a more even flow of water throughout the City. Replacing aging infrastructure will greatly reduce the number of line breaks as well as the number of leaks in the system.

After evaluating the proposed system improvements and reviewing the model output results, the need for these improvements is validated. Refer to the Recommendations section of this report for probable construction cost estimates for proposed Scenario 2 improvements.

D. Scenario 3: Pressure Control Valves and System Isolation Valves

Scenario 3 – Pressure control valves and system isolation valves is a simulation to provide new pressure control valves in the system to bring high pressure zones down to an acceptable range and create more even pressure zones throughout the City. The addition of pressure control valves will alleviate the high-pressure zones thus decreasing the likelihood of leaks caused by the stress of high system pressures on the waterlines.

In addition to pressure control valves, the distribution system needs a multitude of isolation valves installed throughout the network. These valves will allow the system to be sectioned off for maintenance, repairs, and during construction activities. The existing system has very few valves, which causes large portions of the city to be out of service when emergency repairs are needed or routine maintenance is performed.

Refer to APPENDIX D – Scenario 3, Sections D.1 – D.5 for the output results from each simulation including Water Distribution Map, Junction Map, Pipe Map, Average Day Demand at Peak Hour and Maximum Day Demand at Peak Hour, respectively.

After evaluating the proposed system improvements and reviewing the model output results, the need for the proposed pressure control valves and system isolation valves is validated. The creation of pressure zones during the extended period simulation of the Maximum Day Demand still allows the system to still provide all of the necessary flows and pressures to meet the peak demand. Refer to the Recommendations section of this report for probable construction cost estimates for proposed Scenario 3 improvements.

E. Scenario 4: New Water Tower at River Oaks

Scenario 4 – New Water Tower at River Oaks is a simulation to provide a new storage tank to be supplied water by the River Oaks Booster Station for supply of water pressure to the areas in the southeast portion of the distribution system. The proposed water storage will allow the system pressure to be provided by elevated water rather than continuous pump pressure. Based on the results of the model, a 100,000-gallon elevated storage tank at 160 feet of height is proposed, which will provide storage for one day's projected usage at max demand.

Refer to APPENDIX E – Scenario 4, Section E.1 – E.5 for the output results from each simulation including Water Distribution Map, Junction Map, Pipe Map, Average Day Demand at Peak Hour and Maximum Day Demand at Peak Hour, respectively.

After evaluating the proposed system improvements and reviewing the model output results, the need for the proposed storage tank at the River Oaks Booster Station is validated. The additional storage during the extended period simulation of the Maximum Day Demand allows the system to pull water from the storage tank and for the pumps to only run for filling of the tank at approximately 8 hours a day to meet the peak demand. The existing system during the Scenario 1 simulation required the pumps to run continuously to keep pace with the peak demand through the 48-hour scenario run. This pump run condition was validated with City Staff. Refer to the Recommendations section of this report for probable construction cost estimates for proposed Scenario 4 improvements.

F. Scenario 5: 2050 Water Distribution System

Scenario 5 – 2050 Water Distribution System is a simulation of the City of Eufaula's water system with the City fully developed. The year 2050 is a fair planning projection for the City of Eufaula improvements and has an estimated population of 4,350 people. The projected average day water demand in 2050 is 820,000 gallons per day. The simulation includes all of the needed water infrastructure improvements to provide a quality water distribution system. The improvements include upsizing existing waterlines as discussed in previous scenarios.

Given the estimated future demand, the pumps in both the Cox's Chicken and River Oaks Booster stations would need to be replaced in order to handle maximum day demands. These modifications to the booster stations could be done a number of ways including adding more pumps or simply increasing the size and operation of those in place.

Additionally, the model indicated that the behavior of the water distribution system with respect to the fill/drain cycles of the existing spheroidal elevated storage tank could be improved with the actuation (closing) of some of the proposed system isolation valves identified in Scenario 3. CGE will work with City staff and discuss system isolation strategies improve the overall water quality in the distribution system, as well as efficient cycling of the water storage facilities.

Refer to APPENDIX F – Scenario 5, Sections F.1 – F.5 for the output results from each simulation including Water Distribution Map, Junction Map, Pipe Map, Average Day Demand at Peak Hour and Maximum Day Demand at Peak Hour, respectively.

After evaluating the proposed system improvements and reviewing the model output results, the need for these improvements is validated. Refer to the Recommendations section of this report for probable construction cost estimates for proposed Scenario 5 improvements.

7. CONCLUSIONS

After extensive research and process analysis the CGE team is very comfortable with the model as presented in this report. Although it was developed based primarily on consumption data it is a very useful tool which properly shows how the system is currently operating. With that said, and after development, the most important part of a water model is maintenance. A water model is a constantly evolving and dynamic tool for any City. It requires continued maintenance and updating in order to remain relevant and develop with the City. Coordination and involvement with the water operations staff, City, Fire Marshall, and planning personnel is recommended in order for the model to be utilized and maximized for both short and long term planning.

As previously mentioned, the model was based primarily on flow data provided from the consumption side of the system. Therefore, it is nearly impossible to properly quantify the amount of water lost in the system specifically due to unmetered losses. All of the recommendations provided in the next section will allow CGE to improve the model while ultimately improving the City's water infrastructure and operations.

It is notable that the City of Eufaula does generally have a good distribution system in place. Although it may be oversized in certain areas such as pumping, this means it is capable of handling growth. The condition of the waterlines is deteriorating quickly due to age and past repairs, but proposed critical and short term improvements will greatly enhance the performance and reliability of the water distribution system and significantly decrease water loss and the frequency of emergency repairs.

8. RECOMMENDATIONS

After careful consideration and evaluation, the CGE team recommends the City consider three categories of improvements/needs consisting of Critical, Short Term, and Long Term. Each category contains a written recommendation and concludes with the proposed Capital Improvements Plan describing physical improvements by category, year of improvement and an estimated construction cost. Below are parameters for each category, including non-physical recommendations to improve the City of Eufaula's water system.

- ✓ **Critical** – Recommended water system improvements that must be addressed immediately because they are imperative to current operations of the distribution system. (2019 - 2020)

- ✓ **Short Term** – Recommended water system improvements that need to be addressed as soon as possible, but are not imperative to the immediate daily operations of the system and will take some planning before implementation, or the improvements are reliant on the completion of a critical category item. (2021 – 2023)

- ✓ **Long Term** – Recommended water system improvements which will take extensive planning and are for the betterment of the system overall. (2025 to future)

CGE recognizes that some of the items listed below as critical or short term are currently being pursued by the City of Eufaula but did find it important to state them in order to assist with the prioritization of the entire recommendations list.

A. Critical

1. <u>Waterline Replacements</u>
   Table 11 in this report identifies numerous waterlines that need to be replaced primarily due to the amount of breaks these lines have experienced in the past. Waterlines slated for replacement range in size from 4 inches to 10 inches, and recommended replacement

sizes for these lines range from 6 inches to 10 inches. The referenced waterlines recommended for replacement total approximately 35,000 linear feet.

2. Isolation Valves
   Isolation valves are recommended to be installed is various locations throughout the water distribution system. The existing system has very few valves, which causes large portions of the city to be out of service when emergency repairs are needed, or routine maintenance is performed. Approximately seven 10-inch valves, eleven 8-inch valves, sixteen 6" valves, eighteen 4-inch valves, and four 2-inch valves have been budgeted for installation. See Table 10 items A.6 – A.9.

3. Fire Hydrant Assembly Replacement
   Replacement of nonfunctioning or aged fire hydrant assemblies is recommended to maintain and improve the firefighting capabilities of the community. Approximately 70 fire hydrant assemblies have been budgeted for replacement.

4. Inline Pressure Control Valves
   Replacement of existing pressure control valves and the addition of valves in new locations are recommended to reduce operating pressures in certain parts of the distribution system that are currently experiencing excessive pressures. High pressures put unnecessary strain on distribution piping, valves, and fittings, and can cause line breaks in aged piping systems, creating operations and maintenance issues and impacting the overall performance of the system. A total of 6 pressure control valves for replacement and new installation is recommended.

5. Automatic Flushing Valves
   Automatic flushing valves are recommended to be installed at locations designated by city staff. The city practices routine system flushing to maintain water quality throughout the system, especially on dead end waterlines and on lines with relatively low demand. It is recommended that 17 valves be installed throughout the city.

6. Spheroidal Elevated Storage Tank Valve Vault Replacement
   The valve vault adjacent to the existing elevated storage tank located on the north side of Woodland Avenue and Eufaula High School is in poor condition and in need of replacement. This line item includes replacement of the vault structure and all required valves and equipment.

7. Backup Generator at the Water Treatment Plant
   The water treatment plant is not currently equipped with backup power and cannot produce water during a power outage. A backup generator is recommended to be

installed at the water treatment plant to allow water treatment plant operations to continue in the event of a power outage.

B. Short Term

1. Waterline Replacements and Looping
   Table 12 in this report identifies numerous waterlines that require replacement or upsizing to enhance the performance of the distribution system, including increased flow, reduced water age, and better pressure. Waterlines selected for replacement range in size from 2 inches to 4 inches, and recommended replacement sizes for these lines are 6 inches. The referenced waterlines recommended for replacement total approximately 22,000 linear feet.

2. Passive Mixing System at Existing Spheroidal Tower
   The existing spheroidal tower needs a passive mixing system installed. A passive mixing system is a device that allows water to enter the tower at a higher elevation than it exits through the same pipe. This is accomplished with check valves that control the flow of water through the single entrance/exit waterline. This would ensure proper mixing of the water and the constant use of the tank's height to provide proper pressure to the system. Proper mixing in tanks also helps decrease the chance of water aging in the tank before being released to distribution.

3. Replace Existing Ground Storage Tank at Swadley and Lackey Drives
   Replace the existing ground storage tank with a new 750,000-gallon tank at the same location. The existing tank is nearing the end of its useful life and needs to be replaced. The hydraulic model indicated that the size of the existing tank is able to meet system demands and functions properly.

4. Ground Storage Tank Valve Vault Replacement
   The valve vault adjacent to the existing ground storage tank located on the North side of the intersection of Swadley Drive and Lackey Drive is in poor condition and in need of replacement. This line item includes replacement of the vault structure and all required valves and equipment, and should be replaced in conjunction with the construction of the new proposed ground storage tank.

5. Booster Pump Station Replacement
   Replace the existing booster stations with new stations at the same locations. The existing booster stations will need to be replaced during the planning period either due to age or increased demand due to growth and should be appropriately budgeted for.

6. Pressure Plane Valving
   Utilize previously installed system isolation valves to modify the operation of the distribution system. The model indicated that closing some proposed isolation valves will improve the fill/drain cycles of the existing spheroidal elevated storage tank, which decrease water age and reduce the formation of disinfection byproducts in the tower.

7. Asset Management Plan
   An asset management plan must be put in place for the City's water infrastructure. This report is a great start because it includes pictures and the condition of all of the current assets within the water system. The asset management plan would be utilized to identify the value and existing service life of all system assets.

   Understanding and prioritizing the assets in a system is paramount to any operations program whether it be drinking water, wastewater, or a fire department. This can be done with the simplest of spreadsheets and needs to be updated yearly at a minimum. As the asset management plan is further developed it can assist in development of the capital improvements plan and yearly maintenance scheduling.

8. Encourage Water Conservation and Rationing
   Education regarding the importance of water conservation has become critical for cities all over the United States. Most people do not think about where water comes from or how it gets to the faucet. When you inform them about the importance of conserving water and how it is a limited resource, people can implement conservation strategies. This fairly inexpensive tool can help reduce overall demand, and significantly decrease water demand spikes caused by excessive irrigation.

C. Long Term

1. Line Upsizing
   As part of Scenario 5: 2050 Water Distribution System, lines were upsized lines in the water model to provide long term benefits to the functionality of the distribution system but are not necessary to complete in the short term. Upsizing lines increases flow capacity, firefighting capabilities, and increases pressure by decreasing the head loss in the system. Waterlines selected for replacement range in size from 4 inches to 8 inches, and recommended replacement sizes for these lines are 6 inches to 12 inches. The referenced waterlines recommended for replacement total approximately 3,600 linear feet.

2. Construct Elevated Storage Tank at River Oaks
   The proposed storage tank will allow the system pressure to be provided by elevated water rather than continuous pump pressure. Based on the results of the model, a 100,000-

gallon elevated storage tank at 160 feet of height is proposed, which will provide storage for one day's projected usage at the max day demand.

D. Capital Improvements Plan

The Capital Improvement Plan includes recommendations outlined for each category. It is recommended that the CGE team be a part of the plan's implementation in order to ensure that all options are pursued in the proper order, to maximize the benefit of the improvements to the city.

Table 10 prioritizes the Capital Improvements recommended by the CGE team. The cost associated with each item includes construction costs only. The table is color coordinated to clarify improvements for Critical, Short Term and Long Term improvements.

Table 10
City of Eufaula
Capital Improvement Plan

Year	Item #	Category	Project	Conceptual Cost[1]	
2019 - 2020	A.1	Critical	12" Waterline Replacement	$	134,000
	A.2	Critical	10" Waterline Replacement	$	196,000
	A.3	Critical	8" Waterline Replacement	$	1,349,000
	A.4	Critical	6" Waterline Replacement	$	2,739,000
	A.5	Critical	10" Gate Valve Installation	$	24,500
	A.6	Critical	8" Gate Valve Installation	$	22,000
	A.7	Critical	6" Gate Valve Installation	$	28,800
	A.8	Critical	4" Gate Valve Installation	$	28,800
	A.9	Critical	2" Gate Valve Installation	$	2,400
	A.10	Critical	FH Assembly Replacement	$	350,000
	A.11	Critical	Inline PRVs Installation	$	210,000
	A.12	Critical	Install Automatic Flushing Valves	$	68,000
	A.13	Critical	Spheroidal Elevated Storage Tank Valve Vault Replacement	$	50,000
	A.14	Critical	WTP Back-up Generator Installation	$	125,000
			Subtotal	$	5,327,500
			Contingency (20%)	$	1,065,500
			Total for Critical Improvements	**$**	**6,393,000**

Table 10 (continued)
City of Eufaula
Capital Improvement Plan

Year	Item #	Category	Project	Conceptual Cost[1]	
2021 - 2023	B.1	Short	6" Waterline Replacement	$	1,065,500
	B.2	Short	Install Passive Mixing System at Spheroidal Tower	$	75,000
	B.3	Short	New Ground Storage Tank at Swadley Drive	$	1,250,000
	B.4	Short	Ground Storage Tank Valve Vault Replacement	$	100,000
	B.5	Short	Booster Pump Station Replacement	$	250,000
	B.6	Short	Pressure Plane Valving	$	-
	B.7	Short	Develop and Implement Asset Management Plan	$	-
	B.8	Short	Encourage Water Conservation and Rationing	$	20,000
			Subtotal	$	2,760,500
			Contingency (20%)	$	552,100
			Total for Short Term Improvements	**$**	**3,312,600**

Table 10 (continued)
City of Eufaula
Capital Improvement Plan

Year	Item #	Category	Project	Conceptual Cost[1]	
2025 - 2050	C.1	Long	Waterline Upsizing	$	1,067,500
	C.2	Long	Construct Elevated Storage Tank at River Oaks Booster	$	800,000
			Subtotal	$	1,867,500
			Contingency (20%)	$	373,500
			Total for Long Term Improvements	**$**	**2,241,000**

Total CIP Conceptual Cost[1]	**$**	**11,946,600**

[1]Conceptual Costs include construction costs only. Cost do not include engineering studies, design, right-of-way, survey, land acquisition, legal and financial advisor fees. All costs are based upon 2015 construction costs.

Tables 11, 12, and 13 consist of details on Critical, Short term, and Long term line improvements. The tables include the extents of the improvements as well as the total length to be replaced. The cost associated with each item includes construction costs only.

Table 11
City of Eufaula
Critical Line Improvements Summary

Priority	Street	Extents	Exist. (In.)	Prop. (In.)	Length (LF)	Unit Cost	Cost
West Side of Rail Road							
1	US 69 Crossing	Bunny Creek Rd to Birkes Rd.	10	12	300	$ 134,000	$ 134,000
2	Foley Street	7th Street to Front Street	8	8	3,900	$ 60.00	$ 234,000
3	2nd Street	Selmon Road to Spheroidal Elevated Tower	10	10	2,800	$ 70.00	$ 196,000
6	Grand Avenue	7th Street to 2nd Street	6	6	2,550	$ 50.00	$ 127,500
7	Locust Avenue	Hwy 69 to 4th Street	4	6	1,500	$ 50.00	$ 75,000
10	High Street	6th Street to Main Street	6	6	2,500	$ 50.00	$ 125,000
11	Rock Avenue	6th Street to 3rd Street	4	6	1,300	$ 50.00	$ 65,000
14	Forrest Avenue	Indian Health Center to Main Street	6	6	3,200	$ 50.00	$ 160,000
15	Front Street	Forrest Ave. to Elm Avenue	4	6	1,400	$ 50.00	$ 70,000
18	Main Street	Forrest Ave. to Memorial Dr.	6	6	2,900	$ 50.00	$ 145,000
19	1st Street	High St. to Selmon Rd.	2	6	1,200	$ 50.00	$ 60,000
22	1st Street	Memorial Dr. to Border St.	2	6	300	$ 50.00	$ 15,000
23	1st/Anderson Bell	Bill McCarty St. to High St.	6	6	1,800	$ 50.00	$ 90,000
26	2nd Street	Oak St. to Forrest Ave.	4	6	400	$ 50.00	$ 20,000
27	3rd Street	Greenwood Cemetary to Foley Street	4	6	2,900	$ 50.00	$ 145,000
20	4th Street	Border Street to Woodland Ave.	4	6	3,000	$ 50.00	$ 150,000
21	5th Street	Foley St. to High St.	4	6	1,400	$ 50.00	$ 70,000
22	6th Street	Rock Ave. to Woodland Ave.	4	6	2,800	$ 50.00	$ 140,000
23	7th Street	Grand Ave. to Oak Ave.	4	6	800	$ 50.00	$ 40,000
30	Memorial Dr.	2nd St. to Main St.	4	6	1,000	$ 50.00	$ 50,000
31	Border St.	4th St. to 5th St. to Foley St.	8	8	1,800	$ 60.00	$ 108,000
33	Rock Ave.	3rd St. to 6th St.	4	6	800	$ 50.00	$ 40,000
34	Sunset Strip	3rd St. to 6th St.	4	6	800	$ 50.00	$ 40,000
35	Forrest Ave.	Main Street to B St.	8	8	850	$ 60.00	$ 51,000
36	Oak Ave.	Main St. to 2nd St.	4	6	850	$ 50.00	$ 42,500
East Side of Rail Road							
4	E Street	Broadway Avenue to Clifford Seals Street	8	8	2,200	$ 60.00	$ 132,000
5	B Street	Indian Avenue to Lincoln Avenue	4	6	3,250	$ 50.00	$ 162,500
8	Belt Avenue	B Street to L Street	6	6	2,900	$ 50.00	$ 145,000
9	McKinley Avenue	Front Street to E Street	8	8	1,300	$ 60.00	$ 78,000
12	JC Watts Jr Ave.	B Street to H Street	4	6	1,350	$ 50.00	$ 67,500
13	Harrison Avenue	E Street to Lakeshore Drive	4	6	1,200	$ 50.00	$ 60,000
16	Clifford Seals St.	B Street to Lakeshore Drive	4	6	1,680	$ 50.00	$ 84,000
17	Lincoln Avenue	Front Street to G Street	4	6	1,700	$ 50.00	$ 85,000
20	Broadway Ave.	Main Street to L Street	4	6	4,100	$ 50.00	$ 205,000
21	L St.	Elm Ave. to McKinley Ave.	4	6	1,400	$ 50.00	$ 70,000
24	K St.	Broadway Avenue to Belt Ave.	2	6	800	$ 50.00	$ 40,000
25	J St.	Broadway Avenue to Belt Ave.	4	6	800	$ 50.00	$ 40,000
28	F St.	Lincoln St. to Clifford Seals St.	6	6	300	$ 50.00	$ 15,000
29	H St.	McKinley Ave. to Clifford Seals St.	6	6	1,100	$ 50.00	$ 55,000
32	G St.	JC Watts Jr Ave. to Clifford Seals St.	6	6	800	$ 50.00	$ 40,000
						Subtotal	$ 3,672,000
						Contingency (20%)	$ 734,400
						Total for Critical Improvements	$ 4,406,400

Table 12
City of Eufaula
Short Term Line Improvements Summary

Priority	Street	Extents	Exist. (In.)	Prop. (In.)	Length (LF)	Unit Cost	Cost
1	Jones Road	Main Street to E 1210 Rd.	2	6	5,450	$ 50.00	$ 272,500
2	N 4180 Road	E 1210 Road to End of Line	2	6	2,860	$ 50.00	$ 143,000
3	N S 418	Dabbs Road to End of Line	2	6	1,200	$ 50.00	$ 60,000
4	E 1210 Road	Jones Road to Dabbs Road	3	6	2,350	$ 50.00	$ 117,500
5	Dabbs Road	E 1210 Road to N S 418 Road	3	6	1,340	$ 50.00	$ 67,000
6	E W 1207 Road	Dabbs Road to Dogwood Drive	4	6	1,460	$ 50.00	$ 73,000
7	Dogwood Drive	EW 1207 Road to E 120 Road	4	6	6,650	$ 50.00	$ 332,500
						Subtotal	$ 1,065,500
						Contingency (20%)	$ 213,100
						Total for Short Term Improvements	**$ 1,278,600**

Table 13
City of Eufaula
Long Term Line Improvements Summary

Priority	Street	Extents	Exist. (In.)	Prop. (In.)	Length (LF)	Unit Cost	Cost
1	Lake Crossing	Lakeshore Drive to Sequoyah Drive	8	12	1,800	$ 500.00	$ 900,000
2	Swadley Dr.	Palmer Ln. to Hill Dale Dr.	4	6	1,800	$ 50.00	$ 90,000
3	Shawnee Dr.	Mohawk Dr. to E. 120 Rd.	4	6	850	$ 50.00	$ 42,500
4	Hwy 69/Hwy 9 Cros	Near Harley Jones Rd. and Dollar General	4	6	700	$ 50.00	$ 35,000
						Subtotal	$ 1,067,500
						Contingency (20%)	$ 213,500
						Total for Long Term Improvements	**$ 1,281,000**

The recommended Critical, Short Term, and Long Term Improvements will provide the City with numerous benefits, from enhanced operations and maintenance to future planning and economic development. The Critical category improvements will immediately improve the day-to-day performance and reliability of the water distribution system due to the scheduled replacement and upsizing of aging, fragile cast iron water lines and installation of system isolation valves. Upsizing waterlines scheduled for replacement will also increase system capacity with respect to fire flow. Short Term and Long Term Improvements recommend replacing other aging system components as necessary, or the addition of new system components driven by growth and development of the City.