CITY OF ST. LOUIS

Project Planning Document

Drinking Water State Revolving Fund Fiscal Year 2024

DRAFT May 2023

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Abbreviations

AMP	Asset Management Plan
CIP	Capital Improvements Plan
City	City of St. Louis
DDT	Dichlorodiphenyltrichloroethane
DIP	Ductile Iron Pipe
DWSRF	Drinking Water State Revolving Fund
EGLE	Michigan Department of Environment, Great Lakes, and Energy
GAWA	Gratiot Area Water Authority
GPCL	Galvanized Previously Connected to Lead
GPM	Gallons per Minute
LSLR	Lead Service Line Replacements
MAHI	Median Annual Household Income
MDNR	Michigan Department of Natural Resources
MG	Million Gallons
MGD	Million Gallons per Day
MNFI	Michigan Natural Features Inventory
NAAQS	National Ambient Air Quality Standards
NREPA	Natural Resources and Environmental Protection Act (Act 451 of 1994)
O&M	Operation and Maintenance
PDSMI	Preliminary Distribution System Material Inventory
PSI	Pounds per Square Inch
U.S.	United States
USFWS	United States Fish and Wildlife Service
WRS	Water Reliability Study
WTP	Water Treatment Plant

I. INTRODUCTION

The City of St. Louis is submitting this Project Planning document to apply for a Drinking Water State Revolving Fund (DWSRF) low interest loan to address needed improvement to its water system. The proposed improvements include water main replacements, the insertion of valves into both existing water main and replaced water main, and the purchase of a valve turning machine.

The Project Planning document has been developed using the Michigan Department of Environment, Great Lakes, and Energy (EGLE), DWSRF Project Planning Guidance Document released in January 2023.

An Intent to Apply form was submitted to EGLE on October 27, 2022. The Intent to Apply form included a description of the proposed projects and preliminary costs. On November 30, 2022, a multi-jurisdictional webinar was held by EGLE while virtual office hours were held on December 13, 2022, and December 15, 2022, to ask questions about this project and to seek clarification regarding the required level of detail for this Project Planning document submission.

II. BACKGROUND

Study and Service Areas

The City of St. Louis is a 3.53 square mile community in north-central Gratiot County. St. Louis is surrounded by Bethany Township and Pine River Township. The City borders the City of Alma along US-127. The principal corridor through St. Louis is M-46 which passes through the center of the City.

Alma and St. Louis make up the Gratiot Area Water Authority (GAWA). A Water Reliability Study was completed in 2018, which can be found in Appendix A. The WRS includes information for the entire GAWA water system throughout Alma and St. Louis. The St. Louis water distribution network, which extends to sections of Bethany Township and Pine River Township, ties into Alma's water distribution system, as they are both a part of GAWA. The Authority's Water Treatment Plant provides water to St. Louis. The study area for this Project Planning document is limited to the St. Louis water system. Figure 1 presents a map of the existing water system in St. Louis.

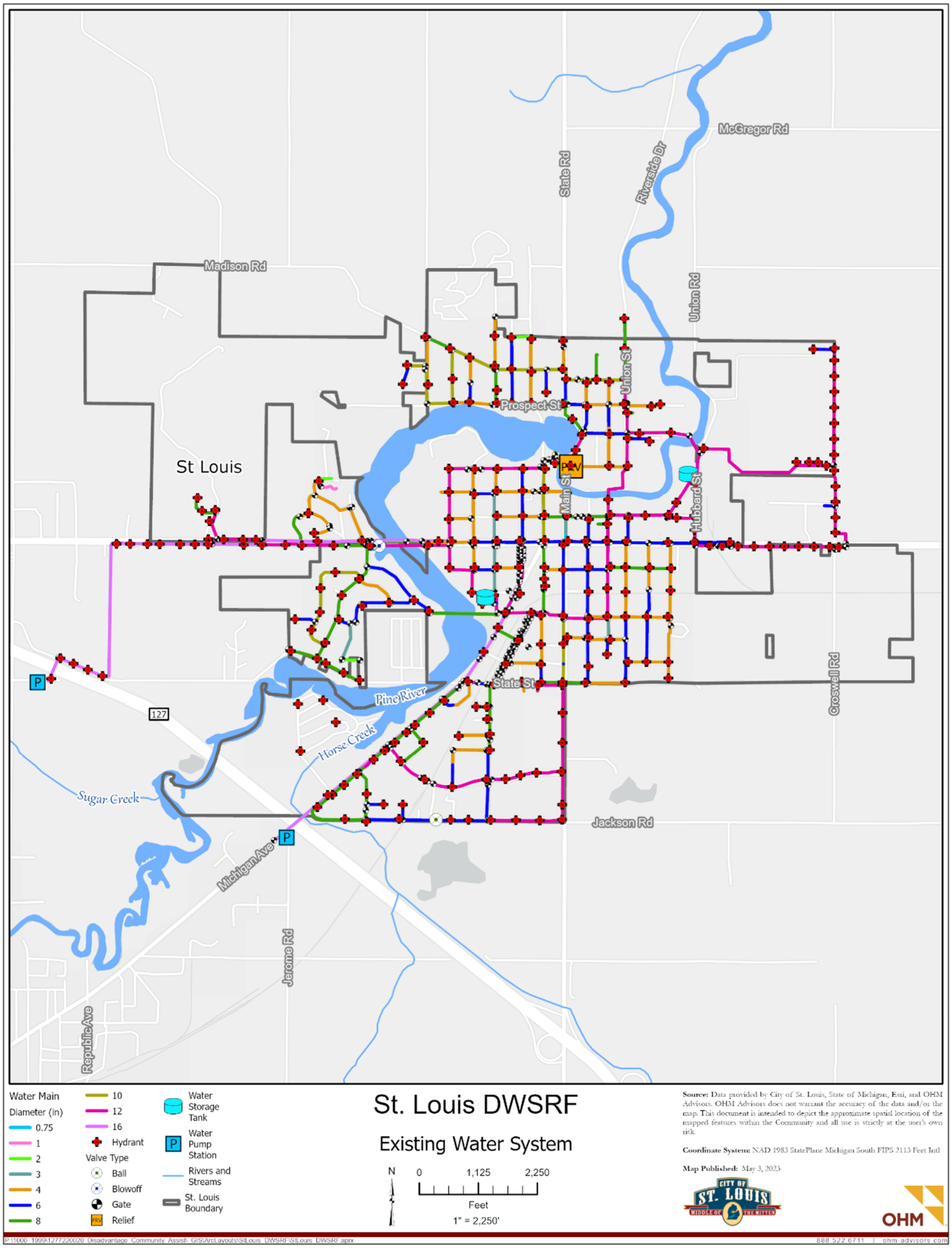

Figure 1: Existing Water System

Populations

The City of St Louis's population was 7,010 in April 2020. Gratiot County's population is projected to decrease by approximately 0.37% per year according to Michigan Labor Market Information. Applying a similar decrease for St. Louis, the population is projected to be about 6,439 in 2043. St. Louis does not have significant seasonal variation in population. The population data for the City is displayed in Table 1 below.

Table 1: Population Data

Demographic Data	2020 Census	Projected Gratiot County Change per Year	Extrapolated 2043 Projections
Total Population	7,010	-0.37%	6,439

Source: www.census.gov and www.milmi.org, accessed on 04/23/2023.

The system in St. Louis is a regional system as the service area includes sections of Bethany Township and Pine River Township. Using the Overburdened and Significantly Overburdened Calculation Worksheet, it was determined that the blended Median Annual Household Income (MAHI) for the system in St. Louis is $44,947, while the taxable value per capita is $11,630. Thus, the City meets the criteria for designation as a Significantly Overburdened Community. The application for overburdened status was completed on 2/8/2023 and can be found in Appendix B.

EGLE defines a "significantly overburdened community" as a municipality in which the following conditions are met:

A. Users within the area served by a proposed drinking water project, sewage treatment works project, or stormwater treatment project are directly assessed for the costs of construction.

B. The municipality demonstrates at least one of the following:
   (i) The median annual household income of the area served by a proposed project is less than 125% of the federal poverty guidelines for a family of four in the 48 contiguous United States. In determining the median annual household income of the area served by the proposed sewage treatment works project or stormwater treatment project under this sub-paragraph, the municipality shall utilize the most recently published statistics from the United States Census Bureau, updated to reflect current dollars, for the community that most closely approximates the area being served by the project. As used in this sub-paragraph, "federal poverty guidelines" means the poverty guidelines published annually in the Federal Register by the United States Department of Health and Human Services under its authority to revise the poverty line under 42 U.S.C. 9902. **For FY24, the 125% level would be an annual household income of less than $37,500.**
   (ii) The taxable value per capita of the area served by a project falls into the communities representing the lowest 10% of Michigan's population within that category. **For FY24, that value is less than $15,170 per capita.**

Existing Environment Evaluation

A. Cultural and Historic Resources

The City of St. Louis contains the St. Louis Downtown Historic District, which includes buildings constructed as early as the 1870s. The locations of the historic landmarks in St. Louis are shown in Figure 2.

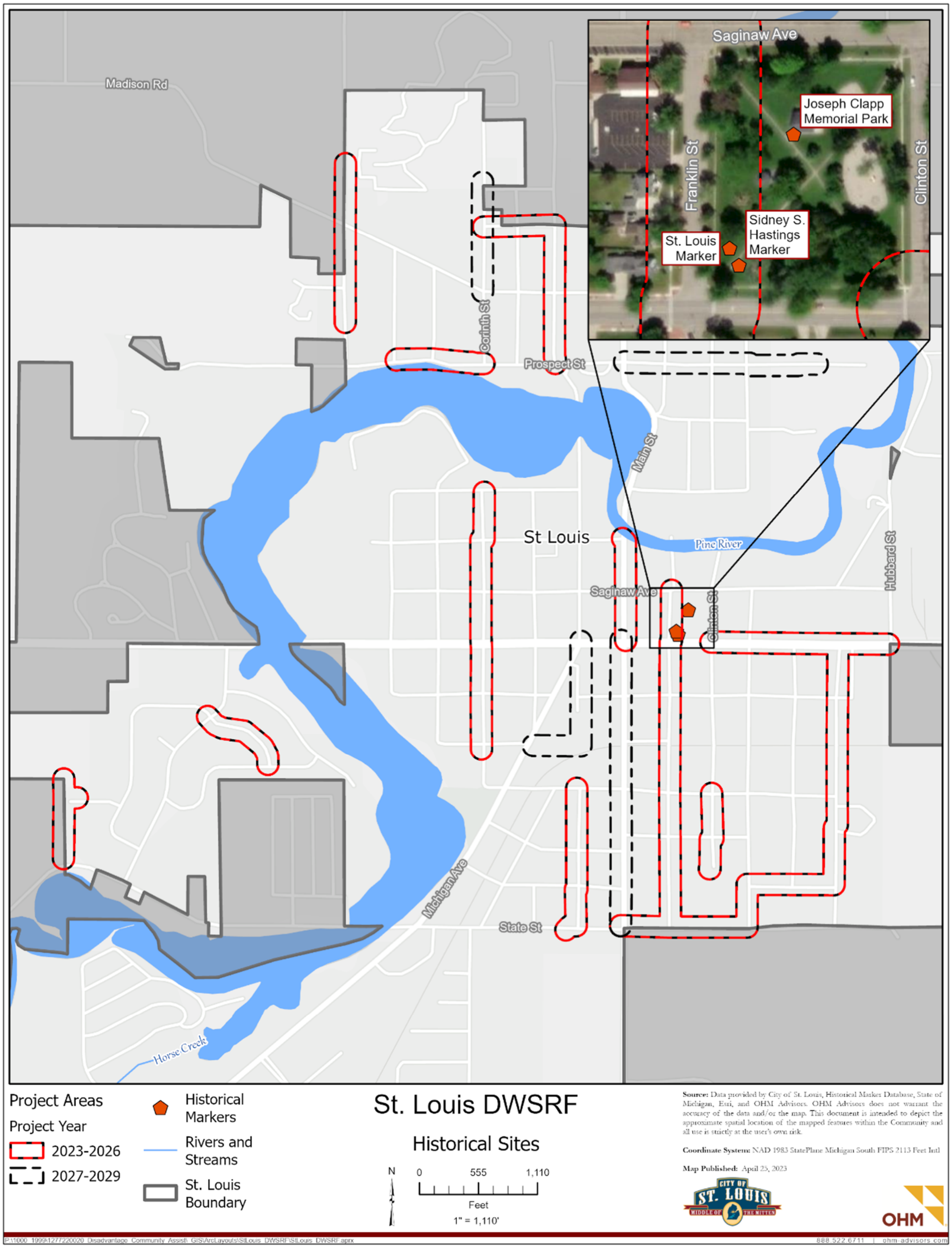

Figure 2: Historical Sites in St. Louis

B. Air Quality

According to the 2021 Michigan Air Quality Report, the area is in compliance with National Ambient Air Quality Standards (NAAQS) for carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

C. Wetlands

Wetlands exist in portions of the City of St. Louis, as shown in Figure 3. The wetlands are primarily found on the outskirts of St Louis, with a few wetlands located along the Pine River. The State of Michigan regulates wetlands under Part 303 of the Natural Resources and Environmental Protection Act (Act 451 of 1994 or NREPA).

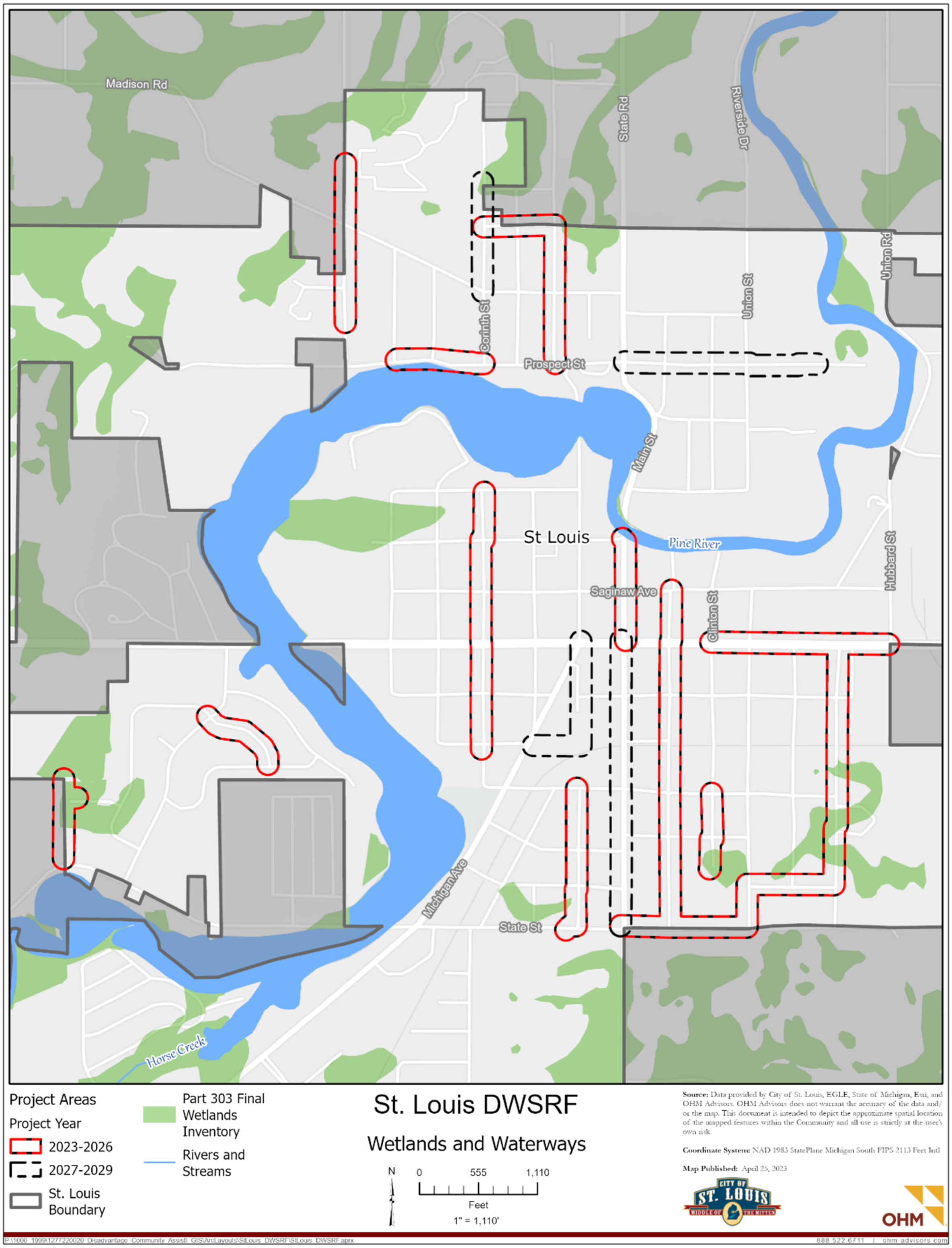

Figure 3: Wetlands and Waterways in St. Louis

D. Great Lakes Shorelands, Coastal Zones, and Coastal Management Areas

There are no coastal zones within the study area.

E. Floodplains

There are several areas designated as within the 100-year floodplain along the Pine River. A map of the 100-year floodplain in St. Louis can be found in Figure 4.

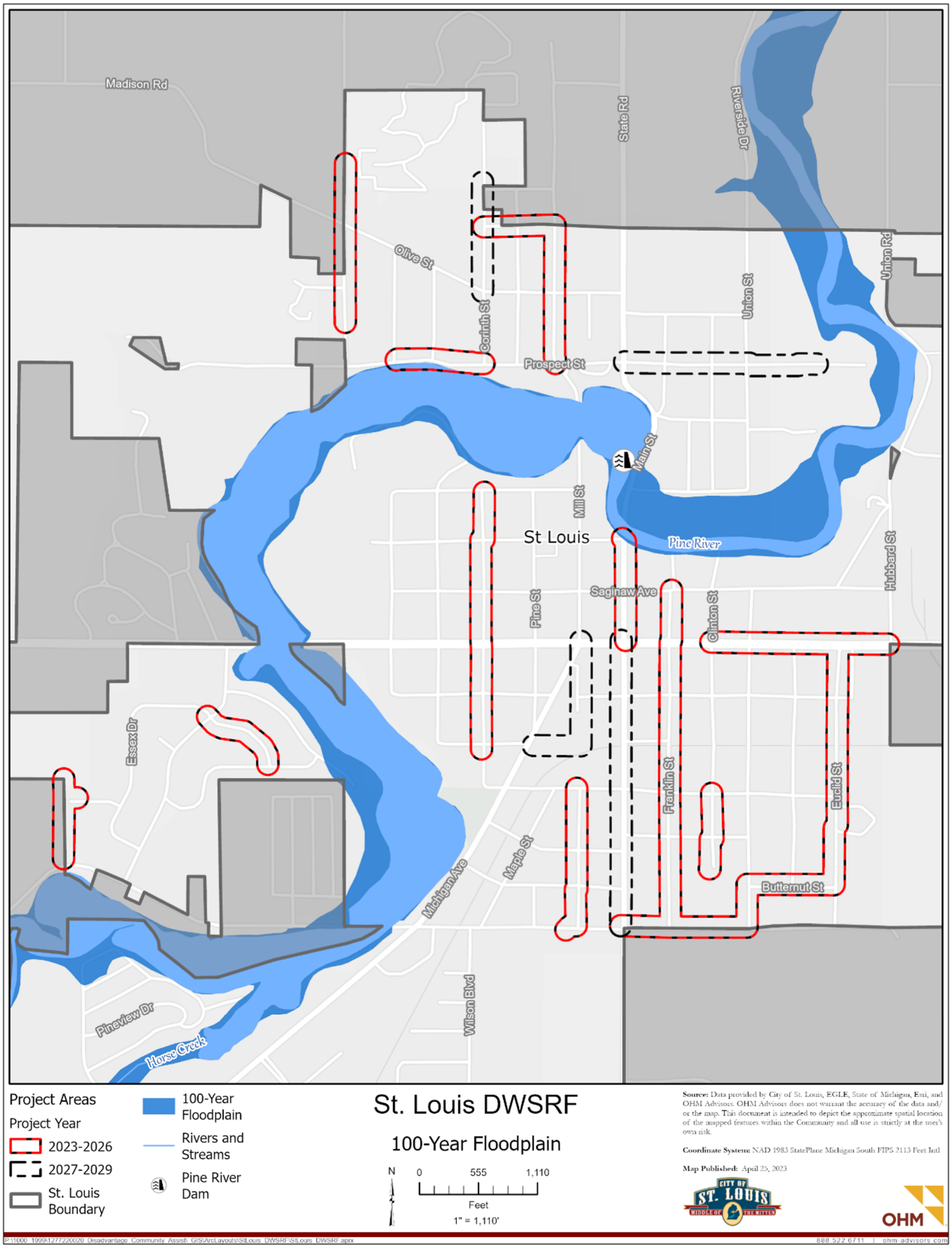

Figure 4: 100-Year Floodplain in St. Louis

F. Natural or Wild and Scenic Rivers

There are no Natural Rivers designated by the Michigan Department of Natural Resources (MDNR) or Wild and Scenic Rivers as designated by the National Wild and Scenic Rivers System in the City of St. Louis.

G. Major Surface Waters

The Pine River is located within the study area and is a part of the Upper Pine River Watershed. The Pine River Watershed eventually flows into Lake Huron. On the Pine River in St. Louis, there is a dam near the W.T. Morris Memorial Park between North Mill Street and North Main Street. The Pine River contains dichlorodiphenyltrichloroethane (DDT) contamination, which is also present at the former Michigan Chemical and Velsicol Chemical plant site. Clean up activities have included the removal and disposal of contaminated sediment and the operation of an in-place thermal treatment system. The levels of DDT in the fish from the river have reduced significantly, but an advisory remains in place. There are no other major surface waters present in the project area.

H. Topography

The terrain in St. Louis does not vary substantially. The only significant slopes within the study area are along the banks of the Pine River. The area is predominantly a plain, with several small hills throughout the City. Figure 5 presents a topographic map of the study area.

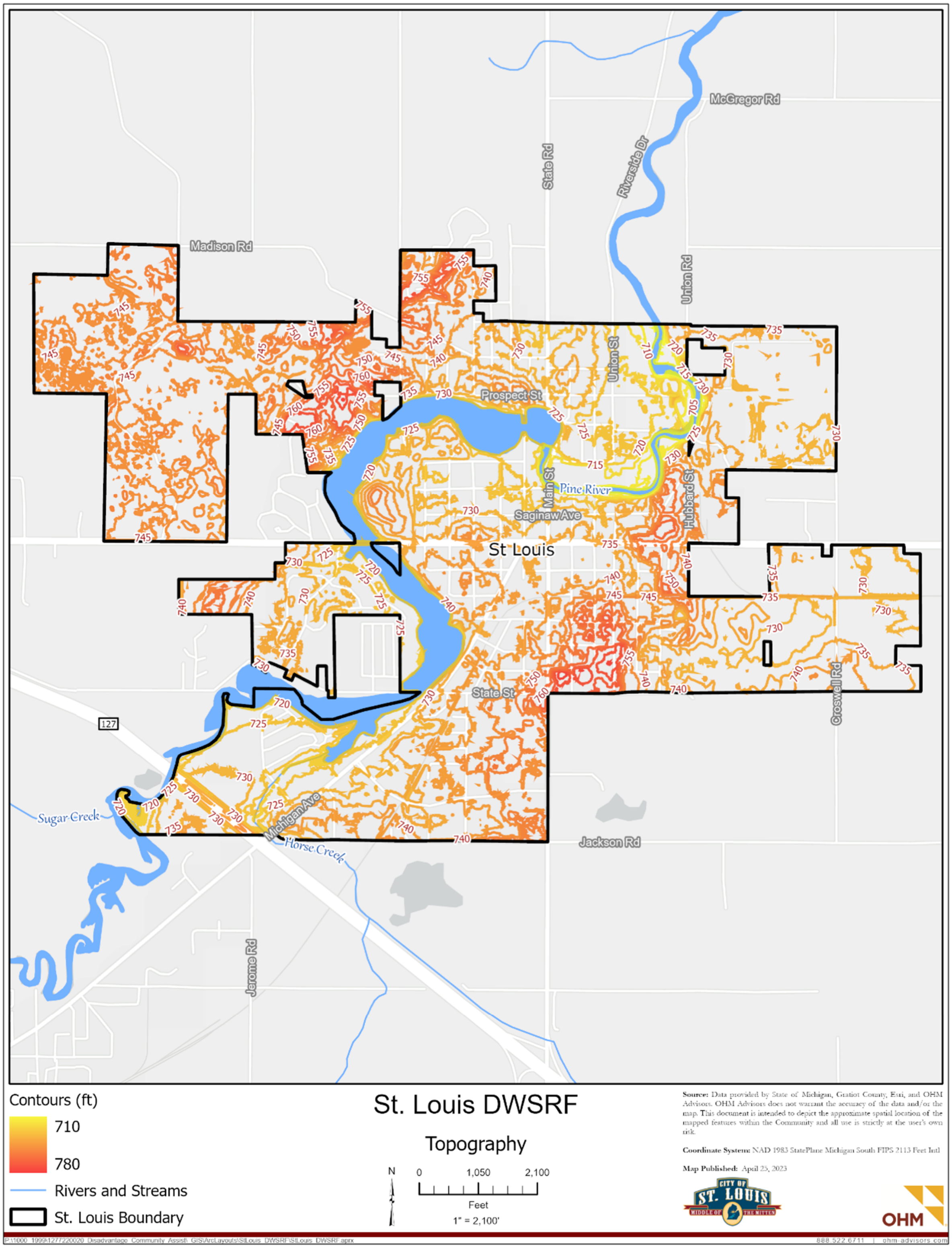

Figure 5: Topography in St. Louis

I. Geology

The bedrock geology of St. Louis includes Red Beds and Saginaw Formation. The quaternary geology is comprised of lacustrine clay and silt and end moraines of medium-textured fill.

J. Soil Types

A summary of the types of soils found in the City of St. Louis are presented in Figure 6, which are mostly moderately to poorly draining soils. The soils in St. Louis include loam, loamy sand, muck, peat, marl, pits, quarries, mines, sand, and sandy loam.

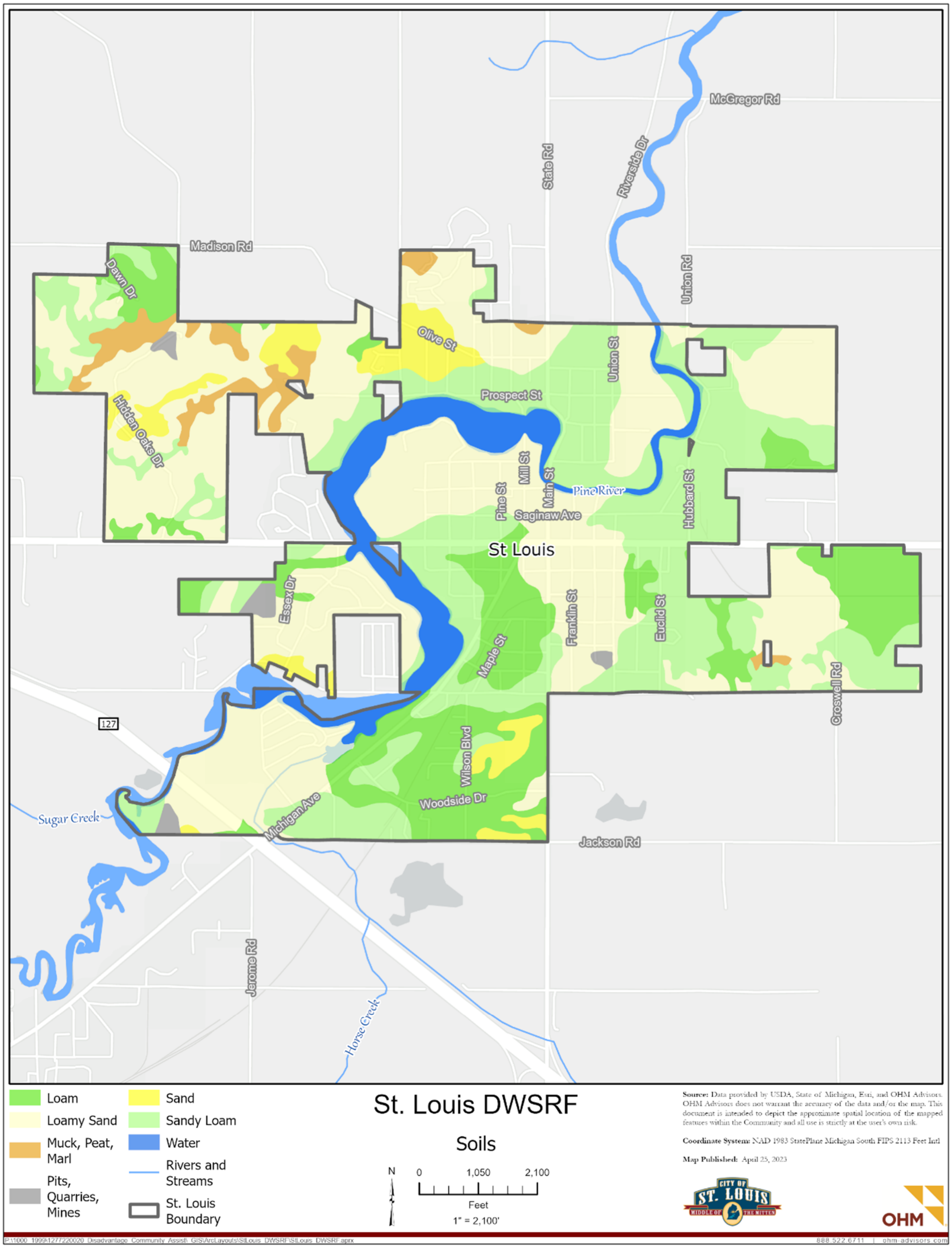

Figure 6: Soils in St. Louis

K. Agricultural Resources

In Gratiot County, about 80% of land is dedicated to farms, producing corn, wheat, sugar beets, beans, and livestock. There is no agricultural land found in the City of St. Louis and the service area does not extend into agriculturally zoned land in Bethany or Pine River Townships.

L. Fauna and Flora

Five State threatened, endangered, or species of special concern have been documented within 1.5 miles of the project area based on the Threatened and Endangered Species list generated by the Michigan Natural Feature Inventory (MNFI) Web Database. These species include the Black redhorse in 1995, Mudpuppy in 1995, Broad-leaved puccoon in 1893, and Ram's head lady's-slipper in 1895, which are all classified as state species of special concern. Sweet coneflower was observed in 1894 and is presumed to be extirpated. If observed, it would be considered State Threatened. The last observations of all five of these species are considered historical, and the species are not anticipated to be present. The United States Fish and Wildlife Service (USFWS) noted that there were six threatened and endangered species that may be present within 1.5 miles of the project area. The full MNFI and USFWS reviews can be found in Appendix C.

Existing System

The City of St. Louis switched from providing water to its residents from municipal wells to treated water provided by the Gratiot Area Water Authority (GAWA) in 2015. GAWA provides both St. Louis and the City of Alma with treated water from its water treatment plant, which is located in Alma. The distribution systems for each City are owned and operated separately. The shared assets of GAWA include the water plant, Michigan and Cheesman booster pump stations, wells, and river intake. Figure 1 displays the existing water system in the City of St. Louis.

A. Condition of Source Facilities

The City of St. Louis purchases water from GAWA. GAWA draws water from six groundwater wells and an intake on the Pine River for treatment. The water is treated and softened before pumping into the water distribution system. Both cities have Wellhead Protection Plans that protect GAWA's well fields from contamination. According to the 2021 Water Quality Report for St. Louis, there are not any substantial sources of contamination to these well fields. The Pine River has a high susceptibility of contamination but will only be used as a source in case of an emergency. The City previously operated several municipal wells that were decommissioned in 2015 when St. Louis connected to GAWA's system. These wells were abandoned and plugged in 2023.

B. Water Treatment

St. Louis receives treated water from the GAWA Water Treatment Plant, as mentioned. This plant is located in the City of Alma.

C. Storage Tanks and Pump Station Facilities

There are two elevated water storage tanks in St. Louis. The Crawford Street tank has a capacity of 500,000 gallons and was built in 1963. This tank was upgraded and painted in 2018. The Giddings Street tank has a capacity of 200,000 gallons and was built in 2016. According to the GAWA Water System Reliability Study (2018) in Appendix A, both tanks are in good condition but would benefit from routine inspection and maintenance. These tanks allow the City's system to maintain a pressure between 55-65 psi and provide the City with fire and emergency flows.

GAWA owns both the Cheesman and Michigan booster pump stations, which were constructed to provide flow to St. Louis. The Cheesman Booster Pump Station has a firm capacity of 2.45 million gallons per day (MGD) while the Michigan Booster Pump Station has a firm capacity of 3.0 MGD. GAWA also owns two water reservoirs that each have a volume of 1.0 million gallons (MG) with 0.9 MG of usable storage. The locations of the two pump stations and water storage tanks can be viewed in Figure 1.

There are no concerns about adequate storage capacity in St. Louis currently.

D. Service Lines

The City of St. Louis has a total of 1,412 service lines according to the Preliminary Distribution System Material Inventory (PDSMI) from December 2020. Of these 1,412 service lines, 409 are not lead or galvanized previously connected to lead (GPCL). There are 403 service lines that are made of unknown material. There are 562 service lines that are made of unknown material that is likely not lead. However, 38 service lines are known to be galvanized previously connected to lead material. The City has been replacing their galvanized service leads as a part of major projects since 2019 and plans to continue to make these replacements until all the galvanized service leads have been removed.

E. Condition of Distribution System

The City of St. Louis's water system consists of approximately 33 miles of water main. The following tables describe the water main in St. Louis by length and percentage of total pipe length. Table 2 describes the water main installation year. Table 3 describes the size of the water main and Table 4 describes the water main materials found in St. Louis. According to the City of St. Louis Water Asset Management Program (2017) in Appendix D, the City's water system has 634 valves and 245 hydrants. The sizes and types of valves and hydrants have not yet been documented. However, the City has identified a number of valves that are nonfunctioning and need to be updated.

Table 2: St. Louis Water Main Installation Year

Approximate Installation Year	Length (ft)	Percent of Pipe by Length
Unknown	3,632	2.1%
1900-1920	0	0%
1921-1940	42,691	25.1%
1941-1960	3,166	1.9%
1961-1980	59,322	34.8%
1981-2000	30,478	17.9%
2001-Current	30,932	18.2%
Total	170,221	100.0%

Table 3: St. Louis Water Main Pipe Diameter

Diameter (in)	Length (ft)	Percent of Pipe by Length
4	39,330	23.1%
6	40,182	23.6%
8	8,937	5.2%
10	25,649	15.1%
12	37,962	22.3%
16	18,160	10.7%
Total	170,221	100.0%

Table 4: St. Louis Water Main Pipe Material

Pipe Materials	Pipe Length (ft)	Percent of Pipe by Length
Unknown	18,181	10.7%
Asbestos Cement	25,281	14.9%
Cast Iron	87,677	51.5%
Copper	163	0.1%
Ductile Iron	20,688	12.2%
Galvanized Iron	407	0.2%
Polyvinyl Chloride	16,151	9.4%
Steel	1,673	0.1%
Total	170,221	100.0%

F. Residuals Handling

Residuals handling occurs at the GAWA Water Treatment Plant in the City of Alma, which is not included in the scope of improvements for this Project Planning document.

G. Water Meters

St. Louis had 1,418 service connections in 2018 according to the GAWA Water System Reliability Study (2018) in Appendix A. Table 5 lists the service connections in St. Louis by meter size.

Table 5: St. Louis Service Connection Meter Sizes

Meter Size (in)	Service Connections
5/8	1,278
3/4	58
1	38
1 1/2	9
2	25
3	2
4	2
6	4
8	2
Total	1,418

H. Operation and Maintenance

The City of St. Louis performs regular sampling to fulfill EGLE requirements, cross-connection inspections, and hydrant flushing. When breaks and water pressure and quality concerns arise, the City responds to resolve them. St. Louis does not have extensive records of the operation and maintenance history for its water system and intends to develop a more formal operation and maintenance program in the future. The City has been working to develop a regular flushing program and valve turning program but has faced challenges due to limited staffing.

I. Design Capacity of Waterworks System

According to the GAWA Water System Reliability Study (2018) in Appendix A, GAWA's well system and river pumping station have a total capacity of approximately 10,675 gallons per minute (GPM) (15.37 MGD). The 2037 projections include the use of 26.4% of the capacity of the system. As a result, planning for an upgraded capacity is not necessary.

J. Climate Resiliency

The GAWA Water Treatment Plant contains a standby power system that would allow the plant to continue to treat and pump water in the event of an emergency. The two storage tanks in St. Louis have a combined capacity of approximately 700,000 gallons which would also allow for treated water to be distributed in an emergency.

Both storage tanks in St. Louis are near the 100-year floodplain surrounding the Pine River. This could impact the function of the system in the event of flooding. However, the City has not experienced any flooding problems surrounding their storage tanks.

Because the existing and proposed water mains are buried and pressurized, there is no more susceptibility to flooding due to climate changes. The primary objectives of these projects are to improve the condition of the water system and comply with Act 399 requirements.

Need for the Project

The City of St. Louis needs water main replacements due to aging pipes. Over 25% of water main throughout St. Louis was installed between 1921 and 1940. Additionally, over 23% of water main in St. Louis is only 4-inches in diameter. The City has experienced water main breaks throughout its distribution network in the past. The City does not maintain detailed records of these breaks but hopes to develop an improved record keeping system for future water main breaks. This project will make progress towards upgrading the aging and undersized mains in St. Louis. Water main replacements will provide increased efficiency and capacity as well as increased reliability with the looping of dead ends.

In some areas, there are nonfunctioning or insufficient valves to meet standards. These valves will be upgraded as a part of the proposed work. The City also needs a valve turning machine to assist with system maintenance. A valve turning machine is designed to open, close or exercise valves safely and with less manual labor. As mentioned, the City has limited staff members and this machine would help maximize the efforts from staff and perform maintenance on the City's system.

Projected Future Needs

The population of St. Louis is expected to decrease slightly over the next 20 years. Approximately 35% of water main was installed between 1961 and 1980. According to the St. Louis Water Asset Management Program (2017) in Appendix D, 37.6% was expected to reach the end of its useful life in the next 20 years. According to St. Louis's Capital Improvements Plan (CIP) from 2017, the City plans to upgrade many sections of its water main through 2037. The full list of planned projects can be found in Appendix D.

III. NEW WATER SUPPLY WELL PROCEDURES

St. Louis is not proposing the construction of a new supply well within this project. This section is not applicable.

IV. ANALYSIS OF ALTERNATIVES

No Action

If water main is not replaced, it will continue to age further beyond its useful life and result in water main breaks and unreliable service. This will increase O&M costs for repairing breaks that will become more frequent over time. Water main breaks also leave the system vulnerable to loss of pressure and possible contamination, forcing users to be put on a boil water notice.

There are no alternatives to lead service line replacements. Per the 2018 State of Michigan Lead and Copper Rule, water supplies are required to replace all lead service lines by January 1, 2041, including portions on both public and private property. Removing only part of the lead service line is prohibited unless emergency repairs are necessary. Galvanized service lines that are or were attached to a lead service line must also be replaced. A water supply can use a different replacement schedule based on the water supply's asset management plan (AMP) if they receive permission from EGLE. To comply with the requirements of this rule, St. Louis must replace its lead service lines.

Optimum Performance of Existing System

Optimizing performance of the existing facilities will not protect St. Louis's system from water main breaks, nonfunctioning valves, and lead services.

Regionalization

St. Louis is already part of the regional system GAWA. There are no other authorities nearby and adding nearby communities into GAWA would not protect St Louis's systems against water main breaks and lead service replacement requirements.

Principal Alternative

Water Main Replacements

This Project Planning document includes water main replacement projects identified by the City. Looping of several dead ends throughout the system are included in these projects. The project areas are shown in Figure 7 and are described as follows.

Project 1. (2023 -2026 water main replacements). Replace 21,500 linear feet of existing 2-inch, 3-inch,4-inch, 6-inch, and 8-inch diameter water main on various areas within the City with 8-inch and 12-inch ductile iron pipe. An additional 1,400 linear feet of 8-inch water main will be newly constructed. Table 6 summarizes the existing and replacement diameter and length.

Table 6: Existing and Proposed Diameters and Lengths for Project 1 Pipe

Diameter	Existing Length (ft)	Alt 1. Project 1 Length (ft)
2	700	-
3	3,750	-
4	11,250	-
6	5,800	-
8	-	14,800
12	-	6,700
New (8)	-	1,400
Total	21,500	22,900

1. Alternative 1: Replacement of 21,500 linear feet of existing 2-inch, 3-inch, 4-inch, 6-inch, and 8-inch diameter pipe with 14,800 linear feet of 8-inch pipe and 6,700 linear feet of 12-inch pipe using open cut installation. An additional 1,400 linear feet of 8-inch water main will be constructed using directional drilling installation.

2. Alternative 2: Replacement of 21,500 linear feet of existing 2-inch, 3-inch,4-inch, 6-inch, and 8-inch diameter pipe with 14,800 linear feet of 8-inch diameter ductile iron pipe and 6,700 linear feet of 12-inch diameter ductile iron pipe using directional drilling installation. An additional 1,400 linear feet of new 8-inch water main will be constructed using directional drilling installation.

This project includes a valve replacement program, which requires the replacement of 10 valves per year for both alternatives. Valves will be replaced to remove nonfunctioning valves and improve the operation of the system. The addition of a valve turning machine for St Louis's use is also included in this project.

Project 2 (2026-2029 water main replacements). Replace 7,400 linear feet of existing 4-inch, 6-inch, and 8-inch diameter water main on various areas within the City with 8-inch ductile iron pipe, which is the current minimum recommended water main size.

1. Alternative 1: Replacement of 7,400 linear ft of existing 4-inch, 6-inch, and 8-inch diameter pipe with 7,400 linear feet of 8-inch diameter ductile iron pipe using open cut installation. An additional 500 linear feet of new 8-inch diameter ductile iron pipe will be constructed using directional drilling installation.
2. Alternative 2: Replacement of 7,400 linear ft of existing 4-inch, 6-inch, and 8-inch diameter pipe with 7,400 linear feet of 8-inch diameter ductile iron pipe using directional drilling installation. An additional 500 linear feet of new 8-inch water main will be constructed using directional drilling installation.

Table 7: Existing and Proposed Diameters and Lengths for Project 2

Diameter	Existing Length (ft)	Alt 1. Project 2 Length (ft)
4	3,172	-
6	1,879	-
8	2,349	7,400
New (8)	-	500
Total	**7,400**	**7,900**

This project also includes a valve replacement program for both alternatives. Valves will be replaced at a rate of 10 valves per year until all the valves in the system have been replaced to eliminate the nonfunctioning valves in St. Louis.

Lead Service Line Replacements

Project 3 (2023-2026 lead service line replacements). As reported in the PDSMI, the City has 38 service lines that are galvanized previously connected to lead. Of these lines, 26 have been replaced, leaving only 12 lines for remaining replacements. There are no alternatives to Lead Service Line Replacements (LSLR). Per the 2018 State of Michigan Lead and Copper Rule, water suppliers are required to replace all lead service lines by January 1, 2041, including portions on both public and private property. Removing only part of the lead service line is prohibited unless emergency repairs are necessary. Galvanized service lines that are, or were attached to a lead service line, must also be replaced. A water supply can use a different replacement schedule based on the water supply's asset management plan if they receive permission from EGLE. To comply with the requirements of this rule, the City must replace its remaining galvanized service lines. The replacement of these lines will be Project 3, which will occur during the Project 1 phase (2023-2026).

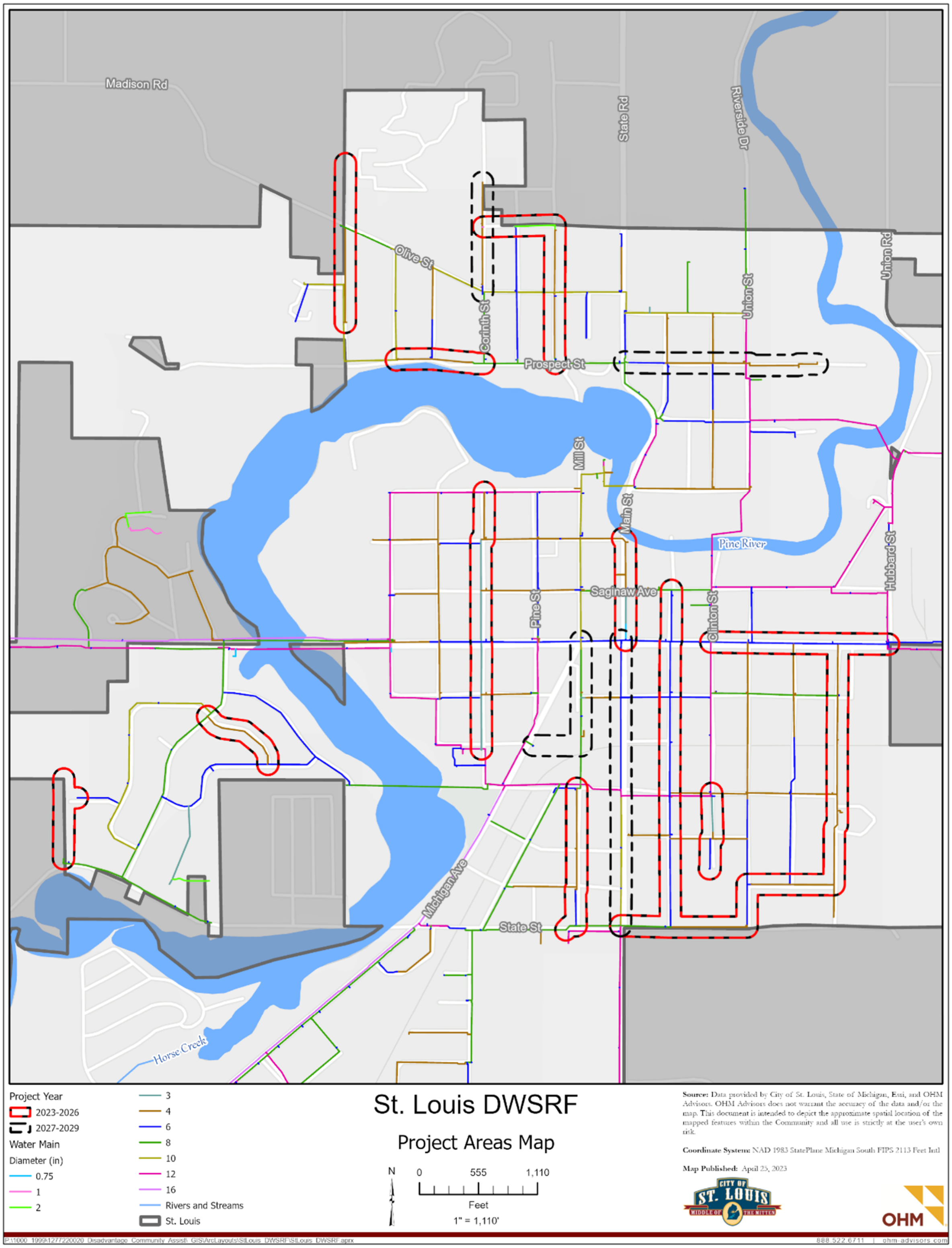

Figure 7: Proposed Water Main Replacements in St. Louis

Monetary Evaluation

Water Main Replacements

The opinions of probable costs were prepared for Project 1 and Project 2. The water main replacement installation methods varied between open cut and directional drill.

These cost opinions were organized by years of construction and are provided in Appendix E of this report. A summary of the present worth for the alternatives for the two water main projects are presented in Table 8. Operation and maintenance costs would be similar for the alternatives and were therefore omitted from the evaluation. A discount rate of two percent was used for the 20-year project life.

Table 8: Project 1 and 2 Alternatives Present Worth Comparison

Category	Alternative 1: Open Cut	Alternative 2: Direction Drill
Project 1		
Capital Cost	$23,650,000	$23,960,000
Salvage Value	$3,640,000	$3,640,000
Present Worth of Salvage Value	$2,450,000	$2,450,000
Total Present Worth	$21,200,000	$21,510,000
Project 2		
Capital Cost	$13,340,000	$13,590,000
Salvage Value	$2,400,000	$2,400,000
Present Worth of Salvage Value	$1,615,000	$1,615,000
Total Present Worth	$11,725,000	$11,975,000

Lead Service Line Replacements

Assuming that each service line is of consistent length (40 linear feet) and is replaced with 1-inch copper pipe with a stop box, the estimated cost per line is $8,000 plus a 15% engineering fee. Therefore, the capital cost for 12 service lines is $120,000. A summary of the present worth for the service line replacement of the 12 known galvanized lines, Project 3, is presented in Table 9.

Table 9: Service Line Replacement Present Worth

Category	Replacement of 12 known Galvanized Lines
Capital Cost	$120,000
Salvage Value	$60,000
Present Worth of Salvage Value	$40,378
Total Present Worth	$79,622

Environmental Evaluation

The proposed projects will address the necessary improvements and repair to the drinking water distribution system which are urgently needed to maintain compliance with state and federal requirements, improve the function and reliability of the system, and to protect public health. Temporary and/or moderate impact to the environment and to the public is expected during construction. The proposed construction will be performed in compliance with permit requirements.

Project 1 and 2 both include locations where existing wetlands are present. The wetlands in the vicinity of the project areas are shown in Figure 8. The directional drilling method would have a lower impact on wetlands compared to open cut. Both alternatives include the use of directional drilling in all areas where wetlands are present, which would minimize potential impacts.

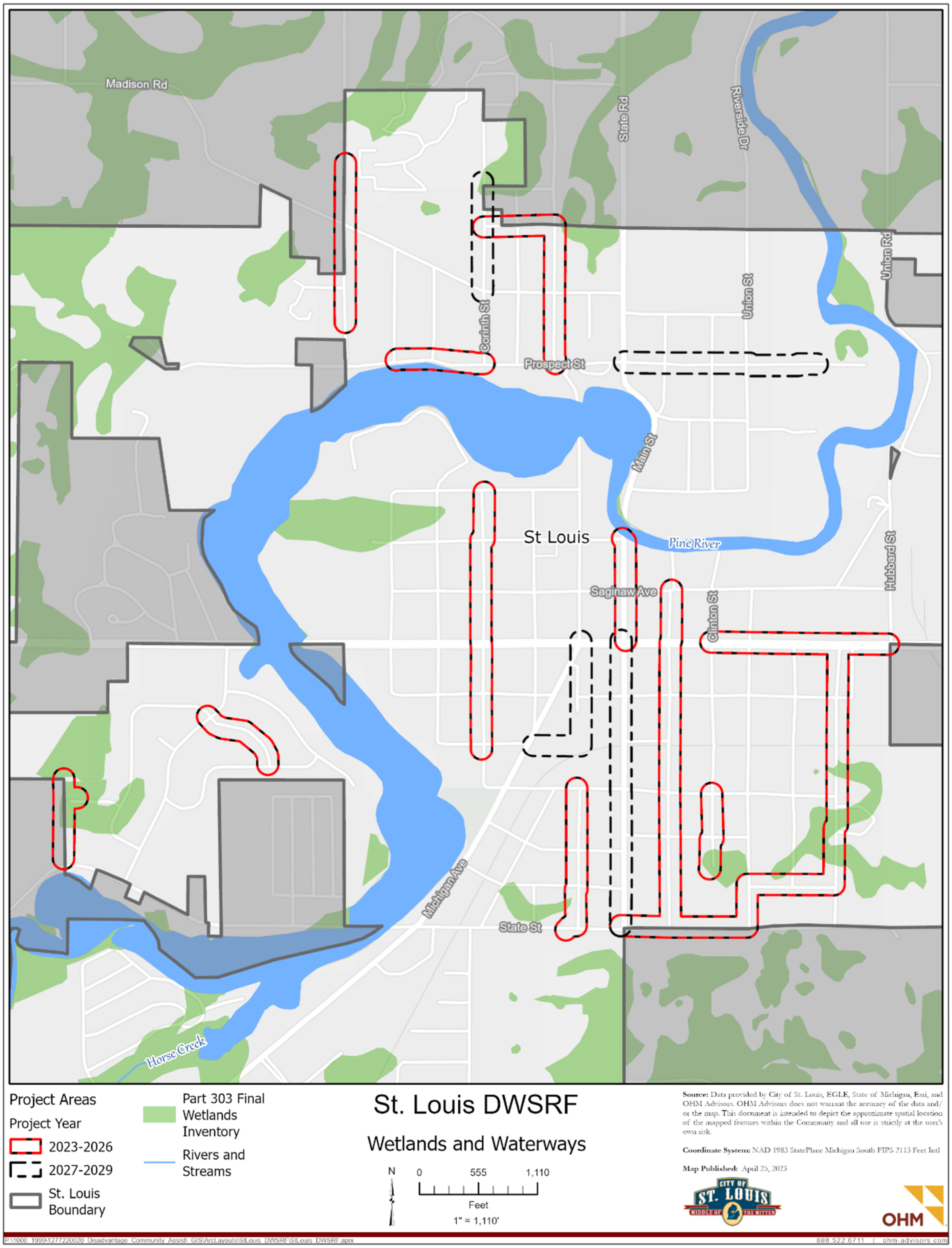

Figure 8: Project Area Wetlands and Waterways in St. Louis

The project area for Project 1 includes locations that are within the 100-year floodplain surrounding the Pine River. The specific locations of concern include the proposed construction on Prospect Street and Main Street. Several other areas include work in close proximity to the floodplain. The project area for Project 2 does not include any work within the floodplain. The 100-year floodplain can be observed in relation to the planned projects in Figure 9. Open cut would temporarily disturb the floodplain but could be restored after work is completed. However, directional drilling would minimize the disturbance in this area. Depending on when construction is completed, dewatering may be needed for open cut installation, but would not be needed for directional drilling.

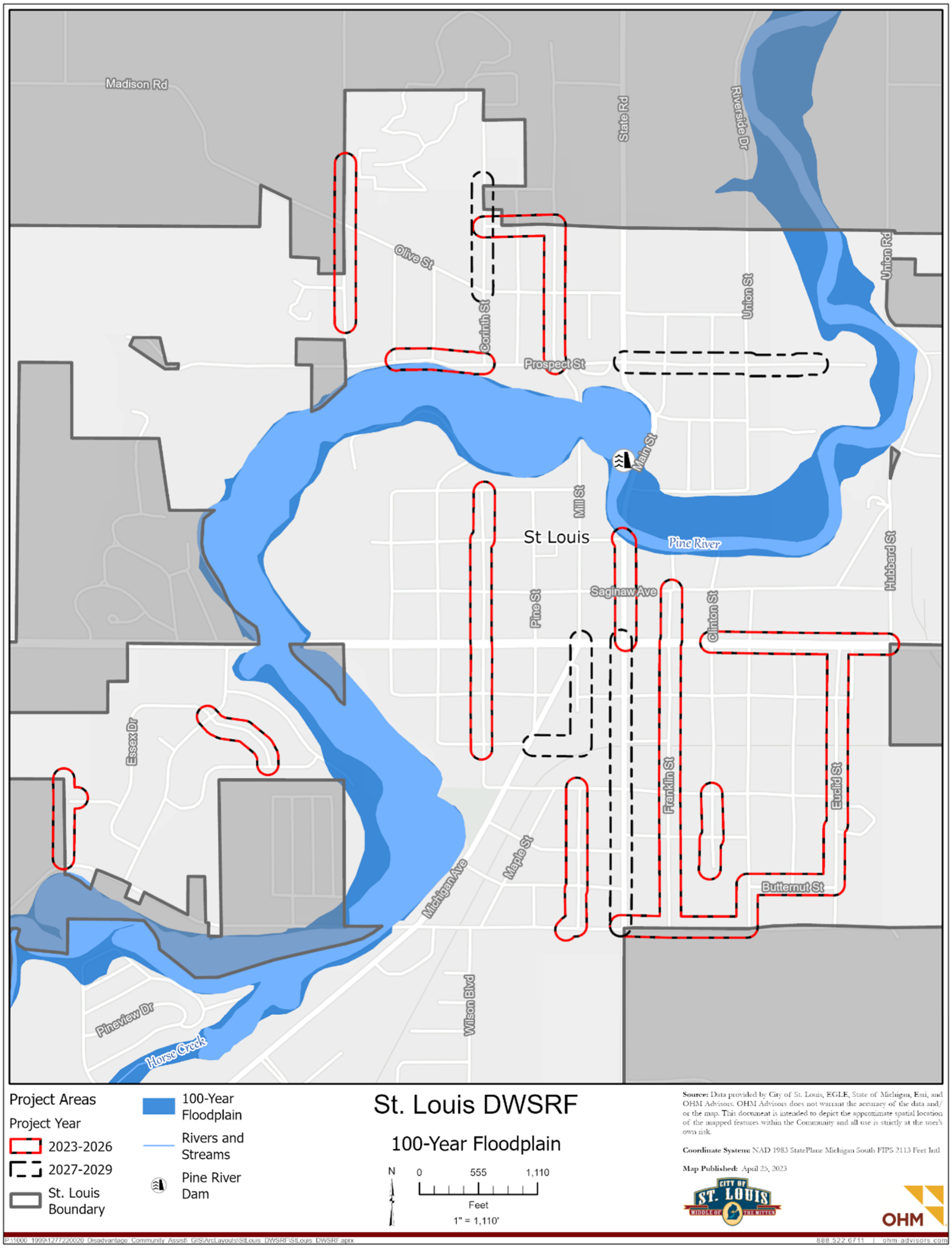

Figure 9: Project Area 100-Year Floodplain in St. Louis

Project 1 includes work in the vicinity of the historical sites in St. Louis. Construction will occur along Franklin Street, where two historic markers are located. A third historic marker is located nearby on the same block. The historical sites in the vicinity of the project area are shown in Figure 10. The construction will occur in the right-of-way and is not anticipated to negatively impact the historical properties. Directional drilling would minimize the disturbance in this area.

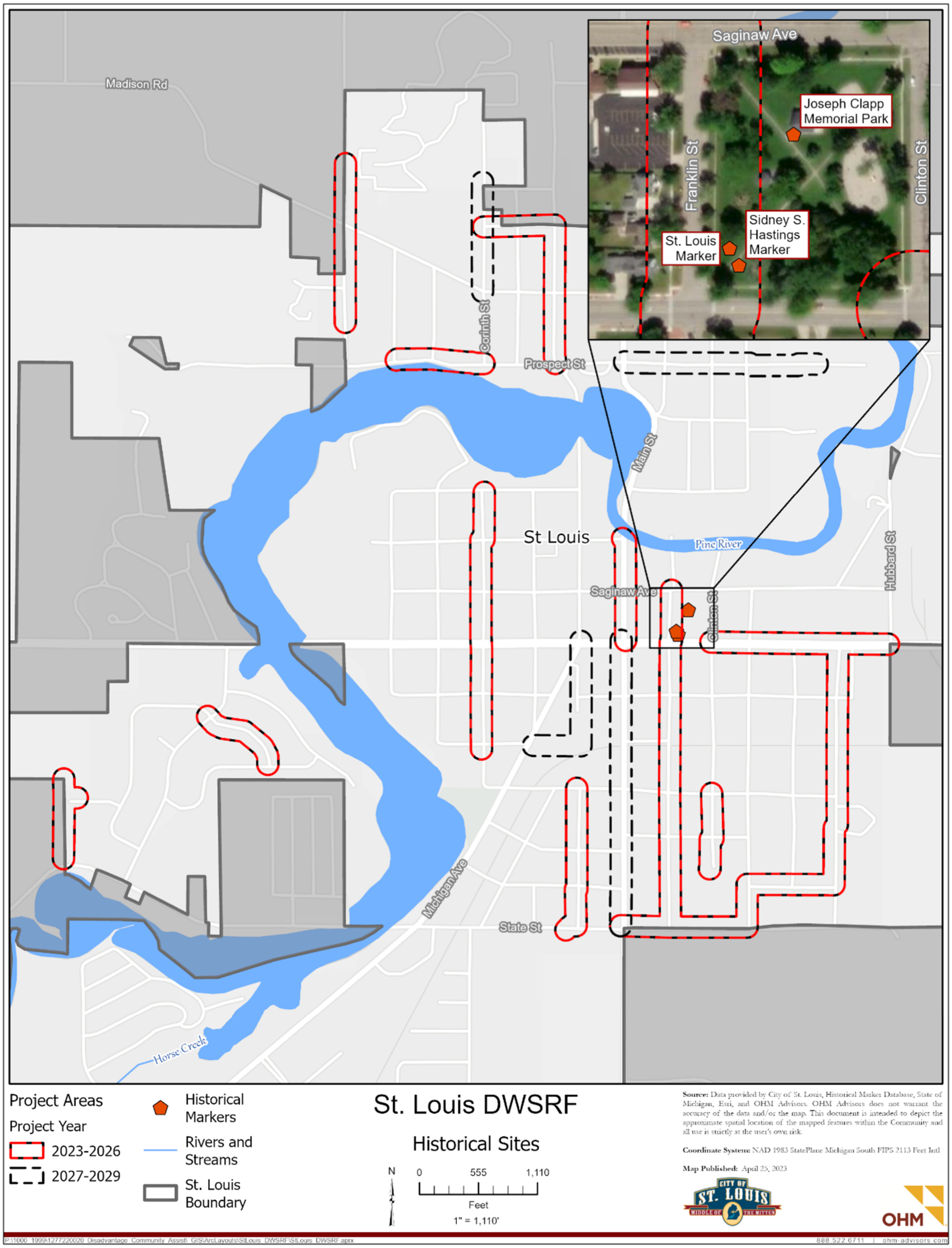

Figure 10: Project Area Historical Sites in St. Louis

As mentioned previously, five rare, endangered, and threatened species may be present in the project areas. The MNFI database identifies the type of habitat that is needed to support individual endangered, threatened, or species of special concern. If the needed habitat is no longer present in the area due to changes and development in the area, the observation is considered historical, and the individual species is not anticipated to be present. Table 10 summarizes the species and possible impacts based on a desktop review of the existing projects areas. The full MNFI and USFWS reviews can be found in Appendix C.

Table 10: MNFI Rare Species Review Summary

Species	Potential Impact
Mudpuppy	Historical; Needed habitat not present. No effect
Black redhorse	Historical; Needed habitat not present. No effect
Broad-leaved puccoon	Historical; Needed habitat not present. No effect
Ram's head lady's-slipper	Historical; Needed habitat not present. No effect
Sweet coneflower	Historical; Needed habitat not present. No effect

The USFWS identified six additional species that may be present in the project areas, as summarized in Table 11.

Table 11: USFWI Rare Species Review Summary

Species	Potential Impact
Eastern Massasauga	May affect, Not Likely to Adversely Affect (NLAA)
Eastern Prairie Fringed Orchid	No effect
Indiana Bat	May affect, Not Likely to Adversely Affect (NLAA)
Monarch Butterfly	No effect
Northern Long-eared Bat	May affect, Not Likely to Adversely Affect (NLAA)
Tricolored Bat	No effect

Most of the work is proposed at the same sites where existing facilities are located and in areas already developed. There is minimal habitat present for the listed species and none or low project impact is expected. Open cut would have more ground disturbance compared to directional drilling.

Presence of Contamination

According to EGLE's Inventory of Facilities accessible through the Remediation Information Data Exchange, there are 21 Part 201 and Part 213 sites within the City of St. Louis. Fourteen of the sites are Part 201 Environmental Contamination sites and eight are Part 213 sites, which are leaking underground storage tanks. A summary of the addresses is provided in Table 12. The locations are shown in Figure 11.

Table 12: Part 201 and Part 213 Sites Located in St. Louis

	Facility Name	Address	Part 201 or Part 213
1	106 N. Main St. & 101 E. Washington	106 N. Main St. & 101 E. Washington	201
2	101 Woodside Drive	101 Woodside Drive	201
3	1512 Virginia Street & Jackson Road Parcel	1512 Virginia Street & Jackson Road Parcel	201
4	219 South Mill Street	219 South Mill Street	201
5	220 South Main Street	220 South Main Street	201
6	220 West Washington Avenue	22 West Washington Avenue	201
7	400 Woodside Drive	400 Woodside Drive	201
8	North Street & North Mill Street - North	Northwest Corner of North Street & North Mill Street	201
9	City of St. Louis, Electric Dept	412 North Mill Street	201
10	Velsicol Chemical Corp	500 Bankston Street	201
11	VN & J SALES	702 W. Jackson Rd	201
12	Velsicol Burn Pit	1270 W Monroe Road	201
13	320 North Mill, St. Louis	300 North Mill Street	201
14	City Of St Louis	118 W Washington St	213
15	Transport Investment Corp	1000 Michigan Ave	213
16	St Louis Citgo LLC	705 E Washington St	213
17	Pine River Auto	101 E Washington St	213
18	7-eleven Store #73	102 W Washington St	213
19	Blodgett Oil Co #42	102 E Washington St	213
20	Cecil Gunderman	102 Michigan Ave	213
21	Mutual Savings	135 W Washington St	213

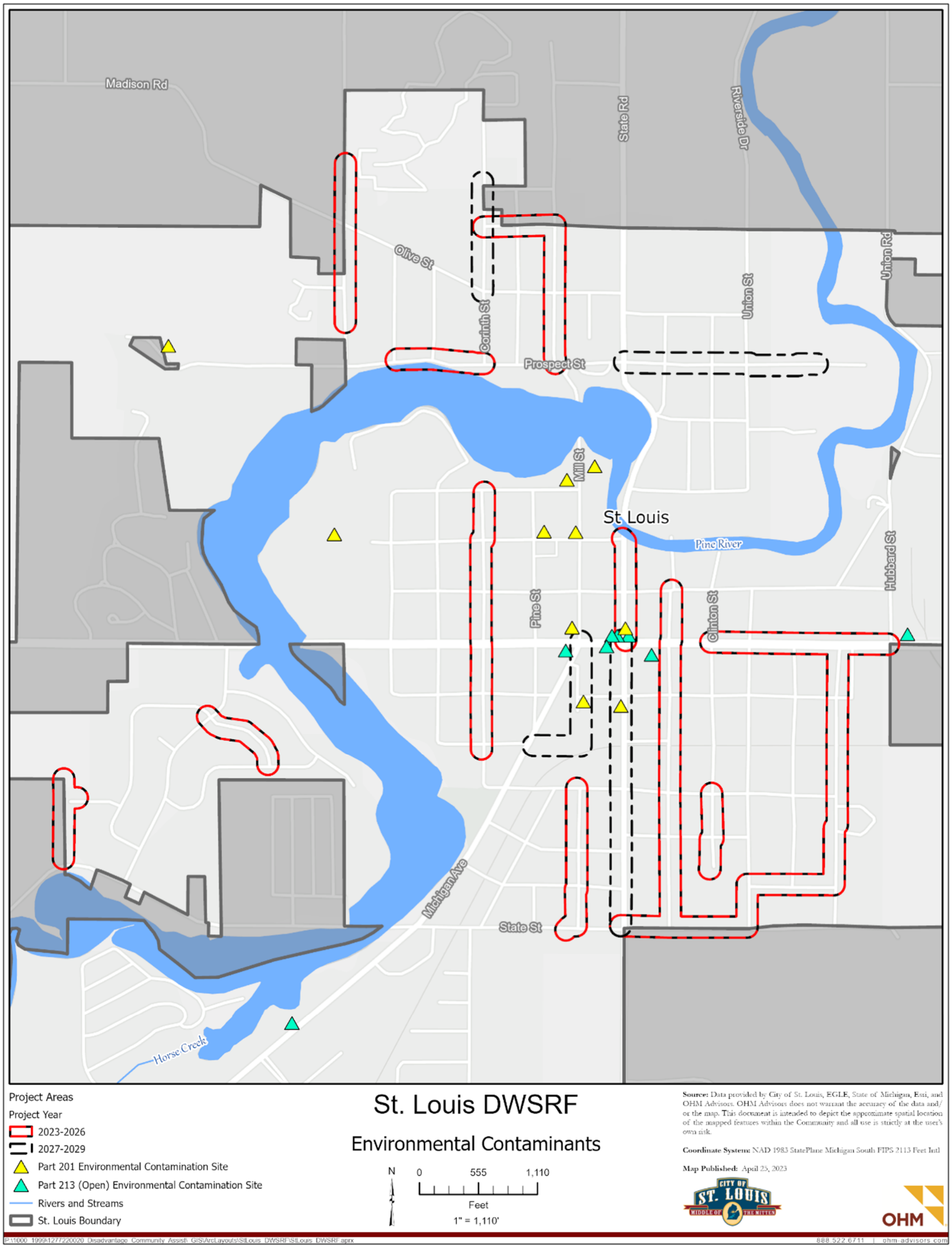

Figure 11: Environmental Contaminants in St. Louis

Project 1 includes an area along Main Street, where a Part 201 location is present. This Part 201 site is located at 106 N. Main Street & 101 E. Washington Street. This specific project area also includes two Part 213 sites, 101 E Washington Street and 102 W Washington Street. There are several other Part 201 and Part 213 sites located in close proximity to the proposed construction included in Project 1.

The project area for Project 2 includes two areas, along Mill Street and Main Street, where Part 201 sites are located. These sites include 220 S. Main Street and 219 S. Mill Street. This specific project area also includes the same Part 213 sites as mentioned for Project 1. There are several other Part 201 and Part 213 sites located nearby.

Both alternatives include the use of directional drilling in all construction areas where contaminated sites are present. Open cut installation would require that potentially contaminated soils be disturbed. In addition, dewatering may be required to install the water main, which would need to be tested prior to identifying a disposal method. Directional drilling would have a lower impact on the contaminated soils. Dewatering requirements are less likely to be needed during directional drilling.

Technical Considerations

Water Main Replacement

Replacing water mains that have passed or are reaching the end of their useful life will increase reliability of service to residents and customers and decrease the likelihood of water main breaks. Applicable EGLE procedures, Ten States Standards, and local ordinances shall be strictly adhered to during design and construction.

Lead Service Line Replacement

Replacing galvanized service lines previously connected to lead are critical to public health and must be completed to comply with the 2018 State of Michigan Lead and Copper Rule.

New/Increased Water Withdrawals

This section does not apply to this project, as little growth is anticipated within the City.

V. SELECTED ALTERNATIVE

Water Main Replacements

The selected alternatives are the completion of Project 1 and Project 2 using open cut installation as the main installation method and directional drilling in areas where wetland or contaminated sites are present.

The selected alternative also includes the valve replacement program in both Project 1 and Project 2. Valves will be replaced at a rate of 10 valves per year until all the valves in St. Louis have been upgraded. The acquisition of a valve turning machine for this City's use is included in the selected alternative as well.

Lead Service Line Replacements

Per the 2018 State of Michigan Lead and Copper Rule, the City must replace its galvanized service lines. This is the only cause of action, and therefore is the selected alternative.

Design Parameters

The water mains to be replaced are shown in Figure 7. The selected material for water main replacement is ductile iron. The water main replacement projects also include replacement of connected hydrants (a minimum of 1 hydrant every 500 linear feet) and the replacement of valves at a minimum of every 800 linear feet.

The following types of problems will be addressed by these projects:

- Water mains with a history of breakage will be replaced.
- Undersized water mains will be right sized to properly serve the community.

The 12 remaining galvanized service lines that are or were attached to a lead service line must also be replaced to comply with the 2018 State of Michigan Lead and Copper Rule. The selected material for service line replacement is 1 inch copper with a 1-inch stop box.

Applicable EGLE procedures, Ten States Standards, as well as local ordinances, shall be strictly adhered to during design and construction.

Useful Life

The weighted useful life for the selected projects was calculated as 43 years. The useful life for each asset included in the cost opinions were determined based on the values provided in the DWSRF Project Planning Document Preparation Guidance and Professional Engineer's opinion. Table 13 includes the useful life that was assumed for each asset included in the cost opinions and the present worth analysis.

Table 13: Useful Life of Assets

Asset	Useful Life (yrs)
Water Main	50
Fire Hydrant	30
Gate Valve and Well	30
Valve Replacement Program	30
Lead Service Line Replacement	50

Water and Energy Efficiency

Energy is needed to convey, treat, store, and distribute safe drinking water to the customers. Aging distribution systems are prone to breakage, allow extracted and treated drinking water to escape the distribution system thereby decreasing its energy efficiency. By replacing and maintaining aging water mains, the likelihood of main breaks is decreased, thus saving energy and water, and increasing the efficiency of the system.

Schedule for Design and Construction

The City of St. Louis is requesting consideration for fourth quarter funding under EGLE's DWSRF program. The proposed design and construction schedule is summarized in Table 14.

Table 14: Design and Construction Schedule

Task	Submittal Date
Draft Design Documents Submittal to EGLE	February 16, 2024
Environmental Assessments Published No Later Than	April 24, 2024
Part I and Part II Application	May 15, 2024
Final Documents Submittal to EGLE	May 17, 2024
Finding of No Significant Impacts Clearance; Plans & Specs Approved	May 24, 2024
Bid Ad Published No Later Than	May 24, 2024
Part III of Application; Bid Data Submittal (With Tentative Contract Award)	July 8, 2024
EGLE Order of Approval Issued	August 7, 2024
Borrower's Pre-Closing with the MFA	August 21, 2024
MFA Closing	August 28, 2024
Notice to Proceed Issued	October 27, 2024
Construction Completed for Project 1 (2023-2026)	December 31, 2026
Construction Completed for Project 2 (2026-2029)	December 31, 2029

Cost Summary

A summary of the cost by project area is presented in Table 15.

Table 15: Summary of Costs by Project Area

Category	Cost
Project 1 Cost	$23,650,000
Project 2 Cost	$13,340,000
Subtotal Water Mains	$36,990,000
Lead Service Line Replacement Cost	$120,000
Total Project Cost	**$37,110,000**

User costs have been evaluated and an analysis is provided in Table 16. The annual debt retirement was calculated assuming a 20-year loan at a 2.75% interest rate. Loan repayment will be through an adjustment to current user rates.

Table 16: User Cost Analysis

Project Area Name	Initial Capital Investment	Annual Debt Retirement (2.75%, 20-years)	Annual Cost per Household*	Monthly Cost per Household *
Project 1 Cost	$23,650,000	$1,553,000	$547.21	$45.60
Project 2 Cost	$13,340,000	$876,000	$308.66	$25.72
Lead Service Line Replacement Cost	$120,000	$8,000	$2.82	$0.23
Overall Cost	$37,110,000	$2,437,000	$859	$72

*Average household size of 2.47 in the City of St. Louis Area per 2020 Census.

Implementability

The selected alternative will be implemented by the City. All work is under the jurisdiction of the City and requires no inter-municipal agreements. The City of St. Louis has the legal, institutional, technical, financial, and managerial capacity to implement the projects. All work will be performed in road rights-of-way, with the exception of the GPCL replacements, which will extend onto private property from the stop box to the water meter.

VI. ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS

Adoption of this alternative would improve the reliability of the distribution system by replacing aging water mains. The alternative presented is not expected to result in major environmental impacts. Table 17 below depicts the environmental impact from each alternative.

Table 17: Environmental Impact

Category	Environmental Impact					
	Air	Wetland	Floodplain	Water/Land Resources	Historical /Tribal Resources	Endangered Flora and Fauna
Proposed Improvements	Low/ Standard Construction	Moderate/ Construction in Wetland	Moderate/ Construction in Floodplain	Low/ Standard Construction	Low/ Standard Construction	Low/ Standard Construction

Direct Impacts

Construction Impacts

1. Water Main Replacements: The water main replacement will be open cut installation with directional drilling in areas where wetlands exist and in the vicinity of contamination sites. Open cut installation requires more earth work in comparison to other construction methods. The construction impacts will be short-term impacts that will be mitigated through adequate restoration of the local roadway and City owned properties. Coordination with Gratiot County and EGLE will be required to obtain necessary permits. There are wetlands in St. Louis and a permit from the Michigan Department of Environment, Great Lakes, and Energy (EGLE) may be necessary. Work included in Project 1, specifically along Prospect Street and Main Street, will be in the 100-year floodplain and a permit will be required. During design, the necessary permits will be identified and obtained. Note that some water main replacements will be located near historical markers in the City of St. Louis. As work will be performed in the right-of-way, no negative impact to the historical properties is anticipated. Upon receipt of funding, further investigation will be needed, and a State Historic Preservation Office Part 101 application will be completed, if necessary. Normal construction activities have the potential to produce noise and dust. Work hours and construction noise will be required to meet local Ordinance requirements. All work will be required to comply with the State's Soil Erosion and Sedimentation Control requirements.
2. Service Line Replacements: Service lines will replace existing service lines. Impacts to the environment will be low, and standard construction practices and proper mitigation of impact will be observed and included in construction contracts. Construction work for this alternative could result in dust, noise, and possible traffic disruption at the service location. Short term service disruptions may also occur as service is switched to the new service line, but they will be properly planned and coordinated with customers to minimize public impact.

Operational Impacts

1. Water Main Replacements: The replacement of water main will have some impact on traffic in the vicinity of where the construction is occurring. It will be necessary to coordinate with the City's road maintenance to ensure the City's traffic control standards are met. The project

may require lane closures along most adjacent segments of road. The construction area impacts several signalized intersections, as well as many unsignalized intersections, and driveways. There are several businesses within the project areas for both Project 1 and Project 2. St. Louis High School could be affected by the construction along Franklin Street that is included in Project 1. The St. Louis Fire Department and the Wastewater Treatment Plant are located within the project area for Project 2. Coordination with the Fire Department, Wastewater Treatment Plant, St. Louis High School, as well as the affected businesses will be necessary. Staging coordination will be required to maintain existing assets in operation until new assets can be brought into service.

2. Service Line Replacements: The replacement of service lines will have some impact on traffic in the vicinity of where the construction is occurring. The project may require lane closures along most adjacent segments of road. The existing service line will continue to be in service while the new service line is constructed. However, short term service disruption may occur when service is switch to the new service line.

Social Impacts

Impacts on materials, land, and energy will be minimized by selection of qualified contractors. Once the projects located in the roadway are completed, the pavement that was disturbed will be restored.

Indirect Impacts

There are no anticipated impacts to the rate, density, or type of development due to this project. There is not projected to be any growth in the area over the next 20 years. There are no expected changes in land use. There are no expected changes in air quality due to primary or secondary development. Impacts related to air quality are limited to direct impacts due to traffic and construction equipment.

There are no anticipated changes to the natural setting or ecosystem. The MNFI and USFWS reviews indicated that special concern, threatened, and endangered species are not likely to be impacted by the proposed projects. Tree clearing will be avoided to the extent possible. If tree clearing is necessary, it will occur between October 1st and May 31st to minimize effects to sensitive species.

Impacts on cultural, human, social, and economic sources are expected to be minimal, and occur during the construction phase as a result of the traffic routing around the construction area. These impacts are expected to be short-term.

There is no anticipated resource consumption over the useful life of the water main and it is not expected to generate wastes. Aesthetic impacts are anticipated to be short-term and occur during the construction phase. Following construction, project areas will be restored to their previous conditions.

Cumulative Impacts

No cumulative impacts, for example population growth, are anticipated as a result of the improvement projects. Replacing aging and undersized water mains will improve the reliability of the system. GPCL will serve to protect public health.

VII. MITIGATION

Short-Term Impacts

Typical construction mitigation is expected for the selected alternatives. Traffic control may be required during the construction of the water mains. Access to some roads may be temporarily restricted to provide a safe working environment. Soil erosion and sedimentation control measures will be required during the water main replacements to ensure nearby sanitary mains are not impacted by the construction process. Vegetation disrupted by the construction process and areas within the 100-year floodplain will be rehabilitated to their original condition. Service will be maintained for residents during construction, with short-term disruptions expected during the connection of the new water main to the existing system. Mitigation of potential impacts will be properly performed to protect the environment and the public and will be in accordance with permit requirements. When the limits of ground-disturbing activities are further refined during the design phases for the various projects, additional review will be made to determine if the habitat for any sensitive species will be impacted.

An evaluation for the need to perform site visits to survey for wetlands will be performed during design. An evaluation of contamination sites and necessary mitigation will also be evaluated during design. Specifics on the exact pollutants are not always available; however, precautionary measures will be taken at each location to ensure that construction of the new water main does not further spread the contamination or result in contaminant exposure to residents or workers. Water mains in the presence of contaminants will be installed via directional drilling with ductile iron pipe. This method of installation and material will eliminate exposure to potential contaminants as well as reduce the risk of pipe failure due to a reaction with the pipe material. Specialized gaskets designed to withstand ground water contamination at water main joints will be proposed in these areas to help prevent contaminants from entering the system.

Construction activities start as early as 2024 for areas included in Project 1. Project 1 will be completed prior to the end of 2026. All construction activities are anticipated to conclude in 2029.

Long-Term Impacts

No long-term impacts are anticipated as part of the water main project. Projects are located in the same areas where existing water mains are located. Sensitive species are not anticipated to be impacted.

Limited tree clearing may be required. Trees to be removed would be identified during the design phase. If trees need to be removed, protective measures will be taken to ensure that threatened and endangered species are not impacted.

The proposed project is intended to improve the reliability of the existing system by replacing aging water mains with new water mains.

Indirect Impacts

The project is not intended to induce growth within the project area.

VIII. PUBLIC PARTICIPATION

Public Meeting

A public meeting was held on May 16, 2023, and the proposed projects were reviewed.

Public Meeting Advertisement

The public meeting notice was published on May 5, 2023. The public meeting notice was placed on the City's website along with a copy of the Draft Project Planning document for public review. A copy of the advertisement for the public meeting can be found in Appendix F.

Public Meeting Summary

The public meeting presentation, sign-in sheet, and a summary of the public meeting documents can be found in Appendix F.

Adoption of the Project Planning Document

The City Council adopted a resolution following the public meeting on May 16, 2023. A signed copy of the resolution is included in Appendix G, along with the DWSRF Submittal Form.

APPENDIX A

Gratiot Area Water Authority Water System Reliability Study (2018)

Gratiot Area Water Authority
Water System Reliability Study

Prepared For:
Gratiot Area Water Authority
Alma, Michigan

November 27, 2018
Project No. 160148

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List of Abbreviations/Acronyms

ADD	average day demand
Authority	Gratiot Area Water Authority
CIP	Capital Improvements Plan
EMCOG	East Michigan Council of Governments
ft	feet/foot
FTCH	Fishbeck, Thompson, Carr & Huber, Inc.
GIS	Geographic Information System
gpm	gallons per minute
HDPE	High-density polyethylene
in	inch/inches
ISO	Insurance Services Office
MDD	maximum day demand
MDEQ	Michigan Department of Environmental Quality
MG	million gallons
mgd	million gallons per day
MOR	Monthly Operating Report
PKHR	peak hour demand
psi	pounds per square inch
PVC	polyvinyl chloride
REU	Residential Equivalent Units
SCADA	Supervisory control and data acquisition
State	State of Michigan
Township	Arcada Township
WTP	Gratiot Area Water Treatment Plant

1.0 Executive Summary

The Gratiot Area Water Authority (Authority) owns the Gratiot Area Water Treatment Plant (WTP) (formerly known as the Alma Water Treatment Plant) and other shared water system assets that serve customers in the City of Alma and the City of Saint Louis. The WTP draws water from a series of groundwater supply wells and from an intake in the Pine River. The water is then treated and delivered to the customers of the Authority. The Authority contracts with the City of Alma for operation of the WTP. The distribution systems for each City are separately owned and operated by each respective City, while the water plant, Michigan and Cheesman booster stations, wells, and river intake are shared assets of the Authority. The Michigan Department of Environmental Quality (MDEQ) requires that each public water supply complete a Reliability Study and update their General Plan every five years. This report was completed as part of a water system Reliability Study and General Plan to fulfill the requirements for each City and for the Authority.

Each City's water system was analyzed using a variety of metrics as recommended by the MDEQ. These metrics give a general picture of the condition of the two systems. An overall assessment of the two systems was made using a calibrated hydraulic model, with respect to available pressure and fire flow.

The historical water demands of the system were analyzed for each City and were found to trend upwards from 2007 to 2016. Linear regression was used to find the slope of that upward trend and said slope was then used to project future demands. Table 1 contains the projected 5-year and 20-year water demands for each City.

Table 1 – Water Demand Projection Summary

Year	Average Day Demands (mgd)	Maximum Day Demands (mgd)	Peak Hour Demands (mgd)
City of Alma			
2017	1.11	1.66	2.49
2022	1.11	1.66	2.49
2037	1.11	1.66	2.49
City of Saint Louis			
2017	0.90	1.21	1.82
2022	0.91	1.22	1.83
2037	0.94	1.26	1.89
Combined Authority			
2017	2.01	2.87	4.31
2022	2.02	2.88	4.32
2037	2.04	2.92	4.37

The percentage of unaccounted water, or unbilled water, in the system was also evaluated for each city. An average unaccounted water percentage of 23.10% was calculated for Alma; however, with the addition of a new flow meter at the WTP, it was found that the water produced at the WTP was being overestimated in previous years. This caused the unaccounted water percentage to also be overestimated. The unaccounted water in Alma should be recalculated during the next Reliability Study to get a true measure of their unaccounted water percentage. The City of Saint Louis averaged an unaccounted water percentage of 12.27% from 2008 to 2016. A value of 10% unaccounted water is a typical goal for municipal water systems. Recommendations to decrease unaccounted water include replacement of aged pipe, meter replacement for customer services (especially the largest users), and regular calibration of key meters at the WTP and other distribution facilities.

The ability to provide adequate pressures and fire flows was evaluated for each system, using the Ten States Standards and fire flow recommendations from the Insurance Services Office (ISO) as benchmarks. The pressures were evaluated throughout the two systems for a worst-case scenario for the systems, a 2037 peak hour demand condition. Pressures throughout the two systems remained above 35 pounds per square inch (psi), the minimum pressure recommended by the Ten States Standards. The available fire flow was evaluated for a 2037 maximum day demand. A target available fire flow of 1,500 gallons per minute (gpm) was chosen using the ISO guidelines and input from each City. Areas that did not meet this available fire flow target were typically near older and smaller mains in the system, and dead-end mains.

The water storage available to the two systems was also examined. The volume of usable storage for each City appears to be adequate to meet equalization, emergency, and fire flow storage needs.

The water production capacity of the water supply and WTP facilities was also evaluated. The MDEQ generally requires communities begin planning for an expansion of their capacity when their maximum day demands exceed 80% of the firm capacity, which is the capacity with the largest process unit out of service. The projected maximum day demands for the Authority are well below 80% of the firm capacity of the water supply and treatment systems based on historical demand trends.

There has been consideration given, in the past, to eliminating the River Pumping Station and Pine River intake from the water supply system. This, in combination with the decreased well capacity from the existing wells that occurs with more wells in service, may limit total water supply capacity to the extent that additional wells will be needed to meet projected demands.

A Capital Improvements Plan (CIP) was created for 5-year and 20-year water distribution system improvements and water distribution facilities for each City; a separate 5-year and 20-year plan for the Authority was created for recommended improvements to the water plant and other shared assets. The estimated costs are preliminary in nature, and any project should include an updated budgetary estimate for its total projected cost.

2.0 Introduction

The Authority owns and operates a municipal water system which supplies water to the Cities of Alma and Saint Louis. Prior to 2012, the cities of Alma and Saint Louis each owned and operated independent water systems. The Alma water system was rated for 4.0 mgd and included Wells 1, 7, and 8 and a river intake, a lime softening plant, and an elevated water storage tank. The Saint Louis system was a groundwater supply system with 3.56 mgd total rated capacity, and an elevated water storage tank. A plume of contaminated groundwater was discovered to have impacted two of the Saint Louis wells, resulting in the need for an alternate water supply. An agreement was reached between the cities that Saint Louis would replace their water supply wells near the Alma water plant and Alma would supply Saint Louis with softened water from their system, allowing Saint Louis to abandon their existing well system. This was the basis on which the Authority was formed in 2012.

A series of improvements projects, known collectively as the Saint Louis Water Supply Replacement, were conducted by the City of Saint Louis to facilitate the combining of the systems. The projects included expansion of the existing Alma WTP from 4 to 6 mgd, construction of the Michigan and Cheesman Booster Pump Stations, construction of Well 9 and the Well 9 raw water transmission main, redundant finished water transmission mains connecting the cities' distribution systems, and the Giddings elevated water storage tank in Saint Louis. Water service to Saint Louis began on October 22, 2015. Construction of Wells 10 and 11 and their associated raw water transmission main was completed after the systems were connected, and further work to expand the groundwater supply is pending.

The shared assets owned by the Authority include the new groundwater supply wells, the existing Alma wells, a river intake and pump station, the WTP, the raw water transmission mains, and the booster pump stations. Each City continues to own and maintain their individual distribution systems, including the finished water transmission mains within their respective municipal jurisdictions.

In 2017, the Authority retained Fishbeck, Thompson, Carr & Huber, Inc. (FTCH) to complete a Reliability Study and General Plan for the combined water system and each respective City distribution system. As part of the study, FTCH updated the existing WaterGEMs hydraulic model of the combined system and conducted hydrant flow testing and calibration. The Reliability Study and General Plan are required to comply with the Part 12 and Part 16 rules of the State of Michigan (State) Safe Drinking Water Act, P.A. 399. A Reliability Study is required every five years, focusing primarily on evaluation of firm capacity of the water system to meet present and projected future water demands. An update to the General Plan is also required every five years, focusing primarily on the hydraulic performance of the distribution system and the development of 5-year and 20-year capital improvements plans. This report is intended to meet the State requirements for a Reliability Study and General Plan for both City systems and the shared Authority assets.

3.0 Water Distribution System

The Authority holds joint ownership of the water supply and treatment facilities, booster pumping stations, and raw water transmission systems, while each city retains sole ownership of their individual distribution systems, including elevated storage.

Two 16-in transmission mains and two booster stations, one on each transmission main, were constructed to provide flow to Saint Louis as part of the Saint Louis Water Supply Replacement projects. The Cheesman Booster Pump Station was constructed on the northern transmission main, with a firm capacity of 2.45 mgd. The Michigan Booster Pump Station was constructed on the southern transmission main, with a firm capacity of 3.0 mgd. Both booster stations were outfitted with calcium hypochlorite tablet feeders for as-needed supplemental disinfection.

The Giddings Elevated Water Storage Tank was constructed in the Saint Louis system in 2016. This tank, combined with the existing Crawford Elevated Water Storage Tank, provides system pressure and fire and emergency flows, similar to the performance provided by the distributed wells in the original Saint Louis water system.

The Saint Louis water system runs at a lower hydraulic grade line than the Alma water system. During typical operation, water is periodically transferred from Alma to Saint Louis through one of the booster stations to fill the Saint Louis elevated tanks. The booster stations can operate by gravity flow under average day operating conditions using a flow control valve to the fill the Saint Louis tanks.

There are significant sections of the distribution system in both cities that have undersized or older mains in need of replacement. The cities have been proactive in replacing these older mains and will continue a program of replacement into the future. Each of the cities is currently developing a Water Asset Management Program, which will aid in ensuring funds are available for the continued replacement of water main.

3.1 Alma Service Connections and Residential Equivalent Units

The current number of service connections in the Alma system by meter size are shown in Table 2.

Table 2 – Alma Service Connections by Meter Size

Meter Size (in)	Service Connections
5/8	2,665
3/4	54
1	194
1 1/2	-
2	79
3	8
4	12
6	1
8	-
Total	3,013

The current number of service connections in the Alma system by customer type are indicated in Table 3.

Table 3 – Alma Service Connections by Customer Type

Customer Type	Number of Meters
Corporate	236
Churches	-
Governmental	-
Industrial	25
Schools	109
Residential	2,629
Other	14
Total	3,013

Table 4 indicates the Residential Equivalent Units (REU) total for the Alma system. Each REU represents the water use for a single-family dwelling. For other types of customers, the REUs are estimated based on that customer's water use in comparison to a single-family unit.

Table 4 – Alma REUs

Meter Size (in)	Number of Meters	REU Meter Equivalent	REUs per Meter Size
5/8	2,665	1.0	2,665
3/4	54	1.1	59
1	194	1.4	272
1 1/2	-	1.8	0
2	79	2.9	229
3	8	11.0	88
4	12	14.0	168
6	1	21.0	21
8	-	29.0	0
Total REUs			3,503

3.2 Saint Louis Service Connections and Residential Equivalent Units

The current number of service connections in the Saint Louis system by meter size are indicated in Table 5.

Table 5 – Saint Louis Service Connections by Meter Size

Meter Size (in)	Service Connections
5/8	1,278
3/4	58
1	38
1 1/2	9
2	25
3	2
4	2
6	4
8	2
Total	1,418

The current number of service connections in the Saint Louis system by customer type are indicated in Table 6.

Table 6 – Saint Louis Service Connections by Customer Type

Customer Type	Number of Meters
Corporate	115
Churches	14
Governmental	32
Industrial	14
Schools	11
Residential	1,232
Total	1,418

Table 7 indicates the REU total for the Saint Louis system. Each REU represents the water use for a single-family dwelling. For other types of customers, the REUs are estimated based on that customer's water use in comparison to a single-family unit.

Table 7 – Saint Louis REUs

Meter Size	Number of Meters	REU Meter Equivalent	REUs per Meter Size
5/8"	1,278	1.0	1,278
3/4"	58	1.1	64
1"	38	1.4	53
1 1/2"	9	1.8	16
2"	25	2.9	73
3"	2	11.0	22
4"	2	14.0	28
6"	4	21.0	84
8"	2	29.0	58
		Total REUs	1,676

3.3 Alma Water Main

The water distribution system General Plan Map for both cities is illustrated on Figure 2 (page 18). Based on modeling data, there are more than 97 miles of water main in the Authority water distribution system with Alma having nearly 65 miles of water main.

The approximate year of installation for mains throughout the Alma System are listed by their corresponding length in Table 8. These years of installation were estimated from the City's Geographic Information System (GIS) database.

Table 8 – Alma Main Lengths by Installation Year

Approximate Year of Installation	Pipe Length (ft)	Percent of Pipe by Length
Unknown	20,774	6.1%
1900 – 1920	122,792	35.8%
1921 – 1940	10,827	3.2%
1941 – 1960	38,052	11.1%
1961 – 1980	52,483	15.3%
1981 – 2000	21,111	6.2%
2001 – Current	76,558	22.3%
Total	342,597	100.0%

The water mains in the Alma distribution system evaluated in this report range from 4 to 16 in. The lengths of water main are listed by size in Table 9.

Table 9 – Alma Main Lengths by Pipe Size

Diameter (in)	Pipe Length (ft)	Percent of Pipe by Length
4	46,174	13.5%
6	110,073	32.1%
8	47,035	13.7%
10	10,847	3.2%
12	100,956	29.5%
16	27,508	8.0%
Total	342,597	100.0%

The Alma water main lengths are indicated by pipe material in Table 10. The material proportions shown in Table 10 are based off those found in the GIS database. The pipe materials recorded in the hydraulic model inventory do not reflect the actual materials of the mains as indicated in Table 10. While the inventory noted in the model could be updated in the future, it does not have any impact on the hydraulic modeling results; the modeling is based on the Hazen Williams C-factor, which is estimated for each pipe based on flow tests and model calibration.

Table 10 – Alma Main Lengths by Pipe Material

Pipe Material	Pipe Length (ft)	Percent of Pipe by Length
Unknown	4,225	1.3%
Cast Iron	219,824	64.2%
Ductile Iron	112,448	32.8%
HDPE	770	0.2%
Asbestos Cement	5,329	1.6%
Total	342,597	100.0%

An inventory of all the Alma water main in the hydraulic model is included in Appendix 1.

3.4 Alma Water Storage

The Alma system has a single steel elevated storage tank:

- 500,000 Gallon
- Jerome Road
- Elevated
- Steel Spheroid
- Built 1964

The tank is in good physical condition. The tank was inspected internally and externally in 2013. In 2016, the interior of the tank was recoated. The cathodic protection was removed from the tank for painting and will be reinstalled in 2021. Routine maintenance of the interior and exterior paint systems, cathodic protection, and telemetry systems on the tank is recommended for system reliability. Continued routine paint inspections are recommended at the frequency prescribed by a paint inspection agency.

3.5 Saint Louis Water Main

The water distribution system General Plan Map for both cities is illustrated on Figure 2 (page 18). Based on modeling data, there are more than 97 miles of water main in the Authority water distribution system with Saint Louis having more than 32 miles of water main.

The approximate year of installation for mains throughout the Saint Louis System are listed by their corresponding length in Table 11.

Table 11 – Saint Louis Main Lengths by Installation Year

Approximate Year of Installation	Pipe Length (ft)	Percent of Pipe by Length
Unknown	3,632	2.1%
1900 – 1920	0	0%
1921 – 1940	42,691	25.1%
1941 – 1960	3,166	1.9%
1961 – 1980	59,322	34.8%
1981 – 2000	30,478	17.9%
2001 – Current	30,932	18.2%
Total	170,221	100.0%

The water mains in the Saint Louis distribution system evaluated in this report range from 4 to 16 in. The lengths of water main are listed by diameter in Table 12.

Table 12 – Saint Louis Main Lengths by Pipe Diameter

Diameter (in)	Pipe Length (ft)	Percent of Pipe by Length
4	39,330	23.1%
6	40,182	23.6%
8	8,937	5.2%
10	25,649	15.1%
12	37,962	22.3%
16	18,160	10.7%
Total	170,221	100.0%

The water mains in the Saint Louis system are constructed of seven different materials: Asbestos Cement, Cast Iron, Copper, Ductile Iron, Galvanized Iron, polyvinyl chloride (PVC), and Steel. The lengths of mains are presented by material in Table 13.

Table 13 – Saint Louis Main Lengths by Pipe Material

Pipe Material	Pipe Length (ft)	Percent of Pipe by Length
Unknown	18,181	10.7%
Asbestos Cement	25,281	14.9%
Cast Iron	87,677	51.5%
Copper	163	0.1%
Ductile Iron	20,688	12.2%
Galvanized Iron	407	0.2%
PVC	16,151	9.4%
Steel	1,673	0.1%
Total	170,221	100.0%

An inventory of all the Saint Louis water main in the hydraulic model is included in Appendix 1.

3.6 Saint Louis Water Storage

The Saint Louis system has two steel elevated storage tanks:

Crawford Street	Giddings Street	
500,000 Gallon	200,000 Gallon	
Elevated	Elevated Steel Spheroid	Steel Spheroid
Built 1963	Built 2016	

Both tanks are in good physical condition. The Crawford Street Tank was repainted, a cathodic protection system was added, and miscellaneous maintenance was performed on the tank in the spring of 2017. Routine maintenance of the interior and exterior paint systems, cathodic protection, and telemetry systems on the tanks is recommended for system reliability. Continued routine paint inspections are recommended at the frequency prescribed by a paint inspection agency.

3.7 Shared Assets – Water Main

The water distribution system General Plan Map for both cities is illustrated on Figure 2. The raw water transmission mains are considered shared assets for the two cities and are under the purview of the Authority. Table 14 below indicates the size and lengths of the transmission mains based on the facility they start from.

Table 14 – Shared Assets for Raw Water Transmission Main

Facility Name	Pipe Diameter (in)	Pipe Length (ft)
River Pumping Station	16/10	550/365
Well 1	6/10	40/375
Well 2A	12	2,815
Well 7	8	2,710
Well 8	12	3,700
Well 9	12	2,470
Wells 10 and 11	16	15,700
Combined Well Line in front of plant	16	330
	Total	29,055

3.8 Shared Assets – Water Storage

There are two ground storage tanks at the WTP that are shared assets of the Authority system:

At WTP	At WTP
1,000,000-gallon	1,000,000-gallon
Ground	Ground
Steel	Prestressed Concrete
Built 1964	Built 2015

Both tanks are in good physical condition. Routine maintenance of the interior and exterior paint systems, cathodic protection on the steel tank, and telemetry systems on both tanks is recommended for system reliability. Continued routine paint inspections are recommended at the frequency prescribed by a paint inspection agency.

3.9 Shared Assets Booster Stations

There are two booster stations that can supply water from the Alma distribution system to the Saint Louis distribution system. The booster stations were constructed as part of the Saint Louis Water Supply Project in 2015. Information on the booster station capacities are included in Table 15 below:

Table 15 – Booster Station Capacities

Pump Number	Pump Capacity (gpm)	Pump Capacity (mgd)
Cheesman Booster Station		
Cheesman Pump 1	1,700	2.45
Cheesman Pump 2	1,700	2.45
Total Capacity	3,400	4.90
Firm Capacity	1,700	2.45
Michigan Booster Station		
Michigan Pump 1	2,100	3.02
Michigan Pump 2	2,100	3.02
Total Capacity	4,200	6.05
Firm Capacity	2,100	3.02

4.0 Historical Water Use

Both Alma and Saint Louis record their respective billing data, while system demands are recorded using the Authority Supervisory control and data acquisition (SCADA) system; this data was used as a basis for analysis for each City's water demands and billing in this report, as well as the analysis for the Authority demands.

4.1 Alma Water Demands

The average daily water volume pumped to the system is referred to as the average day demand (ADD); in this report, the ADD was assessed annually. The maximum water pumped in a single day, for a given year, is referred to as the maximum day demand (MDD). The ratio of the MDD to the ADD is referred to as the peaking factor. The ADD and MDD for the Alma system were determined using data provided by the City of Alma and data from the Authority SCADA system. It should be noted the data for the years 2015 and 2016 were not used in this analysis. The data for the year 2015 was skewed because in October of that year Alma began supplying Saint Louis, creating an abnormally high ADD and MDD, which was not representative of Alma's true water demands. The amount of water going from Alma to Saint Louis was not recorded during 2015. The data for the year 2016 is much lower than the previous years' data, due to a change in the calculation of finished water pumpage. Before 2016, finished water pumpage was estimated by calculating average flow rates through the filters and multiplying this by how long the filters ran. With the upgrades to the WTP, the finished water can be metered directly, revealing that the previous estimations were high. However, for the purposes of future demand projections, the 2016 data was not used as it worked from a different baseline than the rest of the data. The ADD, MDD, and Peaking Factors for the years 2006 to 2016 are presented in Table 16. The averages, maximums, minimums and standard deviations for the ADD, MDD, and Peaking Factor were all calculated for the years 2006 to 2014.

Table 16 – Alma Historical Water Demands

Year	ADD (mgd)	MDD (mgd)	Peaking Factor (MDD:ADD)
2006	1.03	1.47	1.43
2007	1.06	1.63	1.54
2008	1.05	1.58	1.52
2009	1.02	1.45	1.42
2010	0.97	1.58	1.63
2011	0.96	1.45	1.52
2012	0.98	1.56	1.59
2013	1.01	1.53	1.52
2014	1.09	1.47	1.35
2015*	1.11	1.99	1.80
2016*	0.87	1.35	1.55
Total Average	1.02	1.52	1.50
Total Maximum	1.09	1.63	1.63
Total Minimum	0.96	1.45	1.35
Standard Deviation	0.04	0.07	0.09
Average + 1 StDev	1.06	1.59	1.59
Average + 2 StDev	1.11	1.66	1.68

*Data in these years was not used in the calculation of the statistical values in this table or demand projections later in this report.

4.2 Saint Louis Water Demands

The ADD and MDD for the system were determined using data provided by the City of Saint Louis for 2006 to 2015 and from the Authority for data after October 22, 2015. It should be noted the data for the years 2012 and 2015 were not used in this analysis. In 2012, a leak in the northern river crossing went undiscovered for months resulting in higher than normal water demands. The data for the year 2015 was skewed because in October of that year Alma began supplying Saint Louis, creating an abnormally low ADD for Saint Louis, which was not representative of Saint Louis's true water demands. The amount of water going from Alma to Saint Louis was not recorded during 2015. The ADD, MDD, and Peaking Factors for the years 2006 to 2016 are presented in Table 17. The averages, maximums, minimums and standard deviations for the ADD, MDD, and Peaking Factor were all calculated for the years 2006 to 2011, 2013 to 2014, and 2016.

Table 17 – Saint Louis Historical Water Demands

Year	ADD (mgd)	MDD (mgd)	Peaking Factor (MDD:ADD)
2006	0.83	1.32	1.59
2007	0.85	1.15	1.35
2008	0.86	1.17	1.36
2009	0.85	1.11	1.31
2010	0.84	1.15	1.37
2011	0.87	1.19	1.36
2012*	0.97	1.68	1.73
2013	0.89	1.07	1.20
2014	0.88	1.10	1.25
2015*	0.69	1.32	1.92
2016	0.82	1.06	1.29
Total Average	0.86	1.15	1.34
Total Maximum	0.89	1.32	1.59
Total Minimum	0.82	1.06	1.20
Standard Deviation	0.02	0.08	0.11
Average + 1 StDev	0.88	1.23	1.45
Average + 2 StDev	0.90	1.30	1.56

*Data in these years was not used in the calculation of the statistical values in this table or demand projections later in this report.

4.3 Authority Water Demands

The values for ADD, MDD, and Peaking Factors for the Authority were found by combining the individual values calculated for each City from the years 2006 to 2016. The Authority demand values are presented in Table 18. The statistical values that were calculated for the individual cities water demands were not calculated for the Authority because the demands values for the Authority were not used to project future demands.

Table 18 – Authority Historical Water Demands

Year	ADD (mgd)	MDD (mgd)	Peaking Factor (MDD:ADD)
2006	1.86	2.79	1.50
2007	1.91	2.78	1.46
2008	1.91	2.75	1.45
2009	1.87	2.56	1.37
2010	1.81	2.73	1.51
2011	1.83	2.64	1.44
2012	1.94	3.24	1.66
2013	1.90	2.60	1.37
2014	1.97	2.57	1.30
2015	1.79	3.31	1.85
2016	1.69	2.41	1.42

4.4 Alma Unaccounted Water

Water distribution systems typically "lose" water due to unmetered usage, leaks, meter errors, firefighting, illegal water use, or other reasons. This lost water is referred to as unaccounted water. One metric that can help to indicate the health of a water system is the percentage of water supplied to the system that ends up unaccounted. An unaccounted water percentage of 10% or below is considered typical.

Historical pumpage and billing data were examined to estimate the percentage of water lost or otherwise unaccounted.

The billing data was provided by the City of Alma for the period of 2007 to 2016. Before 2016, the water produced was calculated by taking the average flow through the filters and multiplying by the time the filters were run. In 2016, new finished water flow meters were installed at the WTP, allowing a more accurate calculation of the water produced.

Table 19 compares the water produced and the water billed and provides the amount of water that was unaccounted by year. Water produced was reported by the City of Alma on Monthly Operating Reports (MORs). The billing totals were calculated using the billing data provided by the City of Alma.

Table 19 – Alma Unaccounted Water

Year	Water Billed (MG)	Water Produced (MG)	Unaccounted Water (MG)	Unaccounted Water Percentage (%)
2007	290.50	360.81	70.31	19.49%
2008	285.73	382.07	96.34	25.22%
2009	266.53	377.67	111.14	29.43%
2010	278.83	357.34	78.51	21.97%
2011	291.28	349.49	58.21	16.66%
2012	279.82	366.26	86.43	23.60%
2013	277.81	364.27	86.46	23.73%
2014	270.26	394.29	124.03	31.46%
2015	260.09	386.49	126.40	32.70%
2016*	296.02	317.55	21.53	6.78%

*The calculation for Water Produced was changed in 2016 due to new flow meters at WTP.

In general, municipal water systems strive to reduce unaccounted water to less than 10% of total water use. The 2016 data is assumed to be the most accurate calculation of unaccounted water percentage due to the addition of the finished water flow meters at the WTP; the unaccounted water percentage of 6.78% calculated in 2016 shows that Alma is keeping unaccounted water at a minimum.

It should be noted that in 2015 the City of Alma began supplying water to Saint Louis, skewing the unaccounted water numbers higher for Alma. The water produced value for 2015 includes water that was provided to the City of Saint Louis but is not included in the water billed for the City of Alma; all the water pumped to Saint Louis would be calculated as unaccounted water. The water provided to Saint Louis from Alma during 2015 was not recorded.

4.5 Saint Louis Unaccounted Water

Historical pumpage and billing data were examined to estimate the percentage of water lost or otherwise unaccounted.

The billing data was provided by the City of Saint Louis for the period of 2008 to 2016. Before 2016, the systems were separate. The water produced from 2008 to 2015 is calculated from water provided by the Saint Louis well system. The water produced for 2016 is calculated from Authority SCADA data.

Table 20 compares the water pumped and the water billed and provides an estimation of water that was unaccounted by year.

Table 20 – Saint Louis System Unaccounted Water

Year	Water Billed (MG)	Water Produced (MG)	Unaccounted Water (MG)	Unaccounted Water Percentage (%)
2008	245.42	305.16	59.75	19.58%
2009	259.36	309.55	50.19	16.21%
2010	279.92	306.72	26.80	8.74%
2011	286.00	319.33	33.33	10.44%
2012	302.20	353.59	51.40	14.54%
2013	288.78	325.30	36.52	11.23%
2014	279.83	321.99	42.16	13.09%
2015	267.36	250.86	-16.50	-6.58%
2016*	229.98	299.30	69.32	23.16%

*The calculation for Water Produced was changed in 2016 due to water being provided from Alma and not Saint Louis's well system.

It should be noted that in 2015 the City of Alma began supplying water to Saint Louis, skewing the unaccounted water numbers lower for Saint Louis. The water produced value for 2015 does not include water that was provided to the City of Saint Louis from Alma; this water was still billed to Saint Louis’s customers resulting in an abnormally low unaccounted water value. The water provided to Saint Louis from Alma during 2015 was not recorded. The data for 2016 indicates considerable unaccounted water. Some of this could be attributed to water loss during construction of the South Transmission Main during which many main breaks occurred. Further analysis of unaccounted water, as more data becomes available, is recommended.

4.6 Top Water Users

The Authority provided records of the top ten water users for each City. The top ten users for each City were entered into the hydraulic model at their geographic locations to more accurately reflect the water demands of the system. The top users and their associated demands are shown in Table 21.

Table 21 – Top Water Users

Rank	Customer Name	Average Daily Usage (gal/day)	Average Daily Usage *(gpm)*
Alma			
1	Mid-Michigan Medical Center	39,452	27.40
2	Michigan Paving & Materials Co.	20,225	14.04
3	Scotsdale Estates	17,488	12.14
4	Alma Products	16,762	11.64
5	IAC	13,384	9.29
6	Masonic Pathway	13,176	9.15
7	JMC Communities	9,934	6.90
8	Robert Knight	9,573	6.65
9	Meijer	8,795	6.11
10	Alma Public Schools	8,000	5.56
Saint Louis			
1	Pine River Correctional Facility	154,607	107.37
2	Mid MI Correctional Facility	146,517	101.75
3	Plasti-Paint Inc.	14,195	9.86
4	Schnepp Nursing Home	10,982	7.63
5	Evergreen Village MHC, LLC	9,915	6.89
6	Carrie Knause School	5,870	4.08
7	Michigan Chloride Sales LLC	5,771	4.01
8	Pine River Health Care LLC	5,753	4.00
9	Saint Louis Housing	5,195	3.61
10	Alpha Custom Extrusions Inc.	3,639	2.53

5.0 Water Demand Projections

5.1 Population Projections

Population changes for both Alma and Saint Louis were examined as part of the future water demands projections. Demographic projections made by the East Michigan Council of Governments (EMCOG) in their *2013 Comprehensive Economic Development Strategy Area for Gratiot County, MI* report were used to calculate population projections for each community.

Alma's water system serves not only the City of Alma but also a small portion of the Pine River Township. The population served in the Arcada Township (Township) is not included in these population projections because only a small portion of the Township is served by the system and population growth in the Township is unlikely to have a significant effect on Alma water system.

Saint Louis's water system serves not only the City of Saint Louis but also a small portion of both Pine River and Bethany Townships. The populations served in the Townships are not included in these population projections because only small portions of each Township are served by the system and population growth in the Townships is unlikely to have a significant effect on Saint Louis water system.

The population projections for each community, and for the Authority as a whole, from the EMCOG report, are indicated in Table 22. It should be noted again that the small portions of both Pine River and Bethany Townships served by the Authority are not included in these population projections.

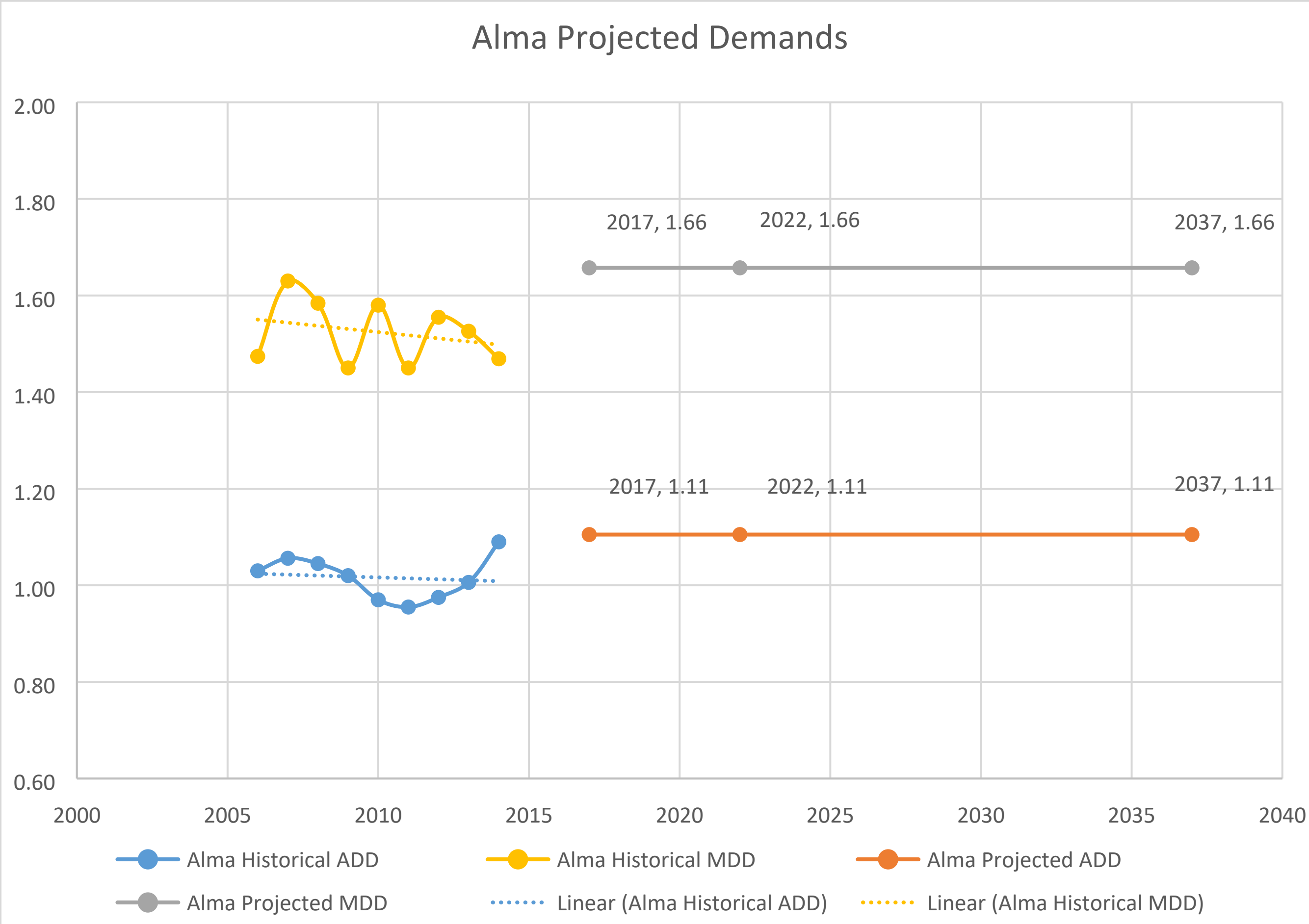
Table 22 – Population Projections 2010-2040 from EMCOG report

Basis and Year	Alma Population	Saint Louis Population	Total Authority Population
Census 2010	9,383	7,482	16,865
MDOT 2020	9,644	7,499	17,143
MDOT 2040	9,739	7,201	16,940

5.2 Alma Water Demand Projections

Both the ADD and MDD of Alma water system showed a trend of decreasing slightly over the years 2006 to 2014; the data for 2015 and 2016 was not used in demand projections as discussed in Section 4.1. For future projections, a conservative method of assuming no-growth was used to project future demand values for the ADD. The starting point for ADD was adjusted upward (increased y axis intercept) so that the starting point was equal to the average of the data plus two standard deviations. Statistically, this value is at the upper end of a range (with the lower end being the average minus two standard deviations) that should include 95% of the observed future values. The projected MDD values were found by multiplying the projected ADD values by the average peaking factor. The current and projected demands for the system using this method are illustrated in Figure 1.

Figure 1 – Projected Average and Maximum Day Demands for Alma



5.3 Alma Peak Hour Demand Projections

A critical flow value for water system modeling is the peak hour demand. This is the highest rate of flow expected over a one-hour period, and often corresponds to the point when the system is stressed to its greatest extent. Peak hour demand projections were estimated by multiplying the maximum day demand projections by a peak hour factor of 1.5. This factor was developed based on historical data and checked by comparing calculated peak hour factors to typical values from engineering literature. No diurnal data for Alma was available so this assumed factor for peak hour was used. The resulting peak hour demand projections along with the ADD and MDD demand projections are represented in Table 23.

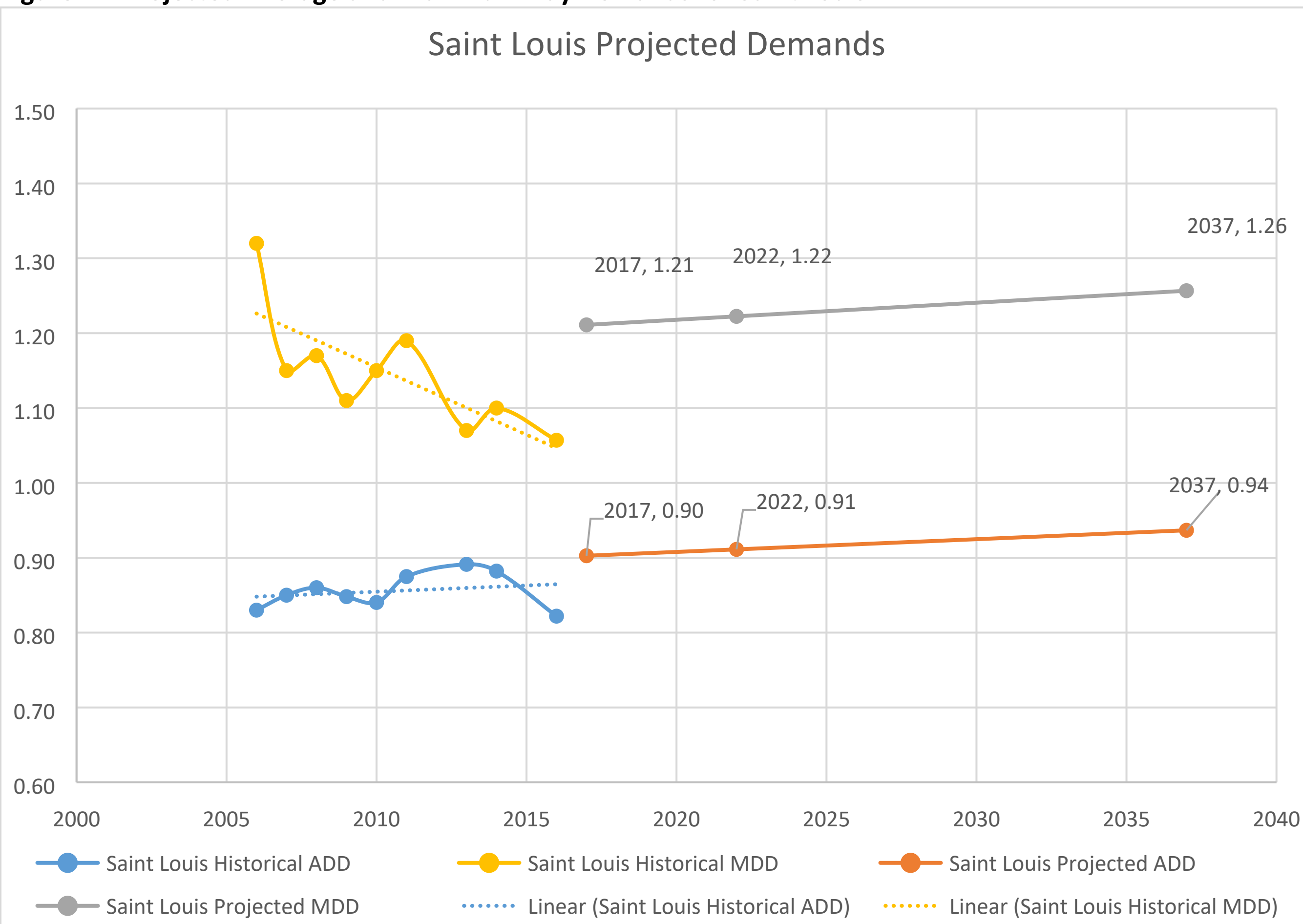
Table 23 – Alma Demand Projections

Year	Average Day Demands (mgd)	Maximum Day Demands (mgd)	Peak Hour Demands (mgd)
2017	1.11	1.66	2.49
2022	1.11	1.66	2.49
2037	1.11	1.66	2.49

5.4 Saint Louis Water Demand Projections

The Saint Louis water system ADD has indicated a slightly increasing trend and the MDD has shown a slightly decreasing trend over the time period of 2006 through 2016. It should be noted the data from 2012 and 2015 was not included for the reasons discussed in Section 4.2. A linear trendline was fit to the ADD data and the slope was applied to project future demand values for the ADD. The starting point for ADD was adjusted upward (increased y axis intercept) so the starting point was equal to the average of the data plus two standard deviations. Statistically, this value is at the upper end of a range (with the lower end being the average minus two standard deviations) that should include 95% of the observed future values. The projected MDD values were found by multiplying the projected ADD values by the average peaking factor. The current and projected demands for the system using these methods are illustrated in Figure 2.

Figure 2 – Projected Average and Maximum Day Demands for Saint Louis



5.5 Saint Louis Peak Hour Demand Projections

A critical flow value, as it relates to water system modeling, is the peak hour demand. This is the highest rate of flow expected over a one-hour period, and often corresponds to the point when the system is stressed to its greatest extent. Peak hour demand projections were estimated by multiplying the maximum day demand projections by a peak hour factor of 1.5. This factor was developed based on historical data and checked by comparing calculated peak hour factors to typical values from engineering literature. No diurnal data for Saint Louis was available so this assumed factor for peak hour was used. The resulting peak hour demand projections along with the ADD and MDD demand projections are represented in Table 24.

Table 24 – Saint Louis Demand Projections

Year	Average Day Demands (mgd)	Maximum Day Demands (mgd)	Peak Hour Demands (mgd)
2017	0.90	1.21	1.96
2022	0.91	1.22	1.96
2037	0.94	1.26	1.96

5.6 Authority Demand Projections

The demand projections for the entire system are a combination of the demand projections for both cities. The demand projections for the Authority system are shown in Table 25.

Table 25 – Authority Demand Projections

Year	Average Day Demands (mgd)	Maximum Day Demands (mgd)	Peak Hour Demands (mgd)
2017	2.01	2.87	4.31
2022	2.02	2.88	4.32
2037	2.04	2.92	4.37

6.0 Water Supply Evaluation

The evaluation of supply capacity requires consideration of water sources, storage, treatment, pumping, and distribution. System storage, pumping capacity, and the condition of the water treatment and source facilities are considered in detail in this section, while distribution is considered in detail in Section 7.0.

6.1 Water Source Facilities

6.1.1 Groundwater Supply Wells

The well system in and just southeast of Alma is considered a shared asset for the two cities. The wells original to the Alma system are Wells 1, 7, and 8. In addition to these wells, Wells 9, 10 and 11 have been constructed. The permitted well capacities as well as the observed well capacities are indicated in Table 26.

Table 26 – Groundwater Supply Wells Capacity

Facility	Permitted Pump Capacity (gpm)
Well 1	700
Well 7	900[1,2]
Well 8	900[1,2]
Well 9	625
Well 10	625
Well 11	625
Total Capacity	4,375
Firm Capacity	3,475

[1] – Permitted Pump Capacities from 2017 MDEQ Survey

[2] – Observed Pump Capacities, Well 7 - 486 gpm, Well 8 - 625 gpm

6.1.2 River Pumping Station

The River Pumping Station is considered a shared asset for the two cities. The capacity of the River Pumping Station is indicated in Table 27.

Table 27 – River Pumping Station Capacity

Pump Number	Pump Capacity (gpm)	Pump Capacity (mgd)
River Pump 1	2,100	3.02
River Pump 2	2,100	3.02
River Pump 3	2,100	3.02
Total Capacity	6,300	9.07
Firm Capacity	4,200	6.05

The total permitted capacity of the Authority's well system and river pumping station is 10,675 gpm (15.37 mgd); the firm capacity, with the largest unit out of service, is 7,675 gpm (11.05 mgd). The projected 2037 ADD and MDD for the Authority are 2.04 mgd and 2.92 mgd, respectively. The projected 2037 MDD is 26.4% of the firm capacity of the wells and River Pumping Station together. The (MDEQ recommends that if the MDD of the system is more than 80% of the firm capacity of the system, the system should begin planning for a capacity upgrade. Since this is not the case for the Authority, it is not required to begin planning for an upgrade in capacity.

However, the Authority would like to take the River Pumping Station out of service in the future, moving to a supply based on groundwater alone. Currently, the firm capacity of the well system alone is 3,475 gpm (5.00 mgd); however, this capacity is estimated to be further reduced to a value of 2,541 (3.66 mgd) due to increased drawdown from the new wells. The projected 2037 MDD is 80% of the firm capacity of the well system with the projected reductions in capacity. According to MDEQ guidelines, the Authority should plan to add more capacity to their well system.

6.2 Storage Assessment

Storage capacity for each City was evaluated to determine if adequate storage was provided. Two different storage calculation methods were used in accordance with two differing methods of storage analysis.

The first calculation used was as follows:

(Equalization Storage) + (Higher of Fire Storage or Emergency Storage) = Required Storage

The second calculation used was as follows:

(Fire Storage) + (Emergency Storage) = Required Storage

For equalization storage, which is intended to provide operational flexibility to meet varying demands, a value of 25% of the MDD is generally accepted. The maximum fire flow requirement for a major industrial user in the system is 3,500 gpm for 3 hours. Emergency storage, which considers major power outages, main breaks, or similar, considers the need for ADD storage for an extended duration. A 24-hour emergency was considered in this evaluation.

6.2.1 Alma Storage Assessment

The projected 2037 ADD for Alma is approximately 1.11 mgd, and the projected 2037 MDD for Alma is 1.66 mgd. Therefore, for equalization storage, 25% of 1.66 mgd equals 0.42 MG. For fire flow, 3500 gpm for 3 hours equals 0.63 MG. For emergency storage, a 24-hour emergency with ADD equals 1.11 MG. Since the emergency storage requirement exceeds the fire storage requirement, the emergency storage requirement was used in the first calculation:

0.42 MG + 1.11 MG = 1.53 MG of storage required

For the second calculation:

0.63 MG + 1.11 MG = 1.74 MG of storage required

The system has one elevated storage tank and two finished water storage tanks at the WTP. The elevated storage tank has a volume of 0.5 MG. The two finished water reservoirs at the WTP have a volume of 1.0 MG with 0.9 MG of usable storage each; this totals 2.3 MG of existing usable storage, which is greater than either calculated volume of storage required for Alma. From this evaluation, it appears the Alma has adequate storage capacity for equalization, emergencies, and fire flow well into the future.

6.2.2 Saint Louis Storage Assessment

The projected 2037 ADD for Saint Louis is approximately 0.94 mgd, and the projected 2037 MDD for Saint Louis is 1.26 mgd. Therefore, for equalization storage, 25% of 1.26 mgd equals 0.32 MG. For fire flow, 3500 gpm for 3 hours equals 0.63 MG. For emergency storage, a 24-hour emergency with ADD equals 0.94 MG. Since the emergency storage requirement exceeds the fire storage requirement, the emergency storage requirement was used in the first calculation:

0.32 MG + 0.94 MG = 1.26 MG of storage required

For the second calculation:

0.63 MG + 0.94 MG = 1.57 MG of storage required

The system has two elevated storage tanks. One elevated storage tank has a volume of 0.5 MG and the other has a volume of 0.2 MG. The two finished water reservoirs at the WTP have a volume of 1.0 MG with 0.9 MG of usable storage each; this totals to 2.5 MG of usable storage, which is greater than either calculated volume of storage required for Saint Louis. From this evaluation, it appears the Saint Louis has adequate storage capacity for equalization, emergencies, and fire flow well into the future.

6.3 Treatment Plant Capacity

Water is supplied to the cities from the Authority WTP which treats water pumped from either the Pine River or a network of groundwater supply wells near Alma and pumps it into the Alma distribution system pipe network. The WTP was upgraded as part of the Saint Louis Water Supply Replacement project. This included the addition of a new filter and clear well, rehabilitation of the existing filters, capability to isolate the existing clear wells, replacement of several older pumps, chemical feed system upgrades, a new backwash tank, a new finished water storage tank with baffling to improve chlorine contact time, and miscellaneous structural, mechanical, and HVAC improvements. These improvements also increased the capacity of the WTP from 4.0 mgd to 6.0 mgd.

The WTP is permitted to treat groundwater and surface water. Surface water is fed to the WTP from the River Pump Station located adjacent to the Pine River a few blocks from the WTP. The river intake feeds a wet well in the River Pump Station where three pumps are available to deliver water to the WTP. Wells No. 1, 7, 8, 9, 10 and 11 provide the groundwater supply. Additional groundwater capacity is still being added as part of the overall Saint Louis Water Supply Replacement project; refer to Section 6.4 for discussion of the installation of additional production wells.

The WTP uses upflow, solids contact clarifiers for lime-soda ash softening in a split treatment configuration. Coagulation is augmented with ferric chloride in both stages of pretreatment with provisions to add polymer if needed. The settled water from pretreatment is filtered through three relatively large media filters before storage and distribution. The filters utilize sand and anthracite media. Sulfuric acid is used occasionally, as needed, for pH control, but is being used sparingly as river water is relied upon less as a raw water source. Sodium Hypochlorite is used to disinfect the water. The WTP also has capability for powdered activated carbon feed for taste and odor control on an as-needed basis. Treated water is stored onsite in two – 1 MG ground storage tanks for continuous delivery to customers. The WTP site includes a backwash receiving tank, pump building, and a standby power generator building.

Table 28 – High Service Pump Station Capacity

Pump Number	Pump Capacity (gpm)	Pump Capacity (mgd)
HSP 1	2,100	3.0
HSP 2	2,100	3.0
HSP 3	2,100	3.0
Total Capacity	6,300	9.0
Firm Capacity	4,200	6.0

The plant has a generator which can provide backup power, allowing the plant to produce 6.0 mgd. Ten States Standards recommends that the plant have the ability to meet ADD on backup power. The plant can provide 6.0 mgd using backup power which is greater than the projected 2037 ADD for the system, 2.04 mgd.

The MDEQ generally requires that communities begin planning for an expansion of their capacity when their maximum day demands exceed 80% of the firm capacity, the capacity of the plant with the largest process unit out of service. The projected maximum day demands for the Authority are well below 80% of the firm capacity of the WTP.

6.4 Additional Groundwater Supply

The intention of the Saint Louis Water Supply Replacement project was to install new wells in the Alma area with a firm capacity of 2.70 mgd to replace the original Saint Louis groundwater supply system. So far, three new wells (9, 10, and 11) have been installed, each with a permitted capacity of 625 gpm, a combined total of 2.70 mgd. This does not yet meet the criteria of 2.70 mgd firm capacity that was originally planned as part of the project. The construction of a minimum of one more well (Well 12) is needed to replace Saint Louis's original well capacity and to meet the firm capacity target criteria.

Additional well capacity may be needed to offset the drawdown effect of the operation of the new wells on the existing wells (1, 7, and 8). In addition, significantly increased well production in the Alma area could affect the residential wells in the area. Therefore, additional well(s) have been recommended to spread out the withdrawal of groundwater and protect the sustainability of the aquifer. For additional information on this subject refer to the 2017 technical report, "Groundwater Supply Evaluation" by FTCH. In this report, the following recommendations are made:

- An aquifer performance test utilizing the supply wells pumping at the combined maximum permitted capacity should be completed.
- An additional supply well or wells, as needed, should be located at a greater distance from the existing wells.
- Funds should be set aside for the rectification of residential wells if they become impacted by future operation of the Authority wells.
- The Authority should continue to routinely monitor water level data from existing observation wells in the area to track the aquifer performance and recharge characteristics.

6.5 Water Shortage Response

The facilities have adequate resources and the ability to respond to emergency scenarios, such as power outages, water main breaks, water plant contamination/failure, storage contamination/failure, inorganic/organic contamination, bacteriological contamination, and water system depressurization.

In the event of an emergency, the standby power system at the treatment plant will allow the plant to treat and pump 3.0 mgd to the system. Water can also be provided on a temporary basis from the elevated storage in the system, which has a total capacity of 1.2 MG, with 0.5 MG in the Alma system and 0.7 MG in the Saint Louis system. The elevated tanks can supply water for approximately 14 hours, based on average day demand conditions and typical tank operating levels. Wells 8, 9, 10 & 11 have provisions to pump directly to the distribution system with chlorine added at the well houses. Arsenic concentrations at these wells should be monitored to ensure compliance with the arsenic standard to determine which wells can be suitably pumped direct to the system.

If the 16-in raw water line entering the plant were to fail, raw water from the wells could be pumped directly to the backwash tank at the plant; the backwash recycle pumps could then pump this water to the head of the plant, bypassing the failed line. However, water could only be supplied at a rate of 450 gpm using this bypass method. Plant personnel would provide first response to repair the inlet water main break and are authorized to bring in outside resources if necessary. Parallel water transmission lines and booster stations provide a reliable means to supply the Saint Louis water distribution system. Water main breaks on water distribution networks are handled by Alma or Saint Louis personnel.

Routine testing and monitoring of the water plant operation and distribution system will identify any trends of declining water quality. First response will be to identify the source of the problem and correct it.

If a water system depressurization scenario were to occur, both Alma and Saint Louis staff would issue boil water notices until the situation was resolved.

The two water storage tanks at the Water Plant, the elevated tank on Jerome Road in Alma, and the two elevated tanks in Saint Louis can provide emergency storage. Any of the tanks can be removed from service without limiting water supply to the system’s customers.

Any extended reduction in water plant or distribution capacity would be addressed by City of Alma and City of Saint Louis emergency response notifications and procedures.

Saint Louis will maintain three offline wells as an emergency backup supply until the Authority’s well system upgrades are completed with the addition of at least one additional well. These wells could be used to supply the Saint Louis system, in an emergency situation, as long as they are maintained in an operable condition. When enough wells have been drilled in Alma to replace the existing Saint Louis wells, the 3 wells will be abandoned.

7.0 Water Distribution System Evaluation

A pipe network analysis of the water distribution system was completed to evaluate the existing system, identify any deficiencies in the current system, and plan for future growth. Modeling scenarios were developed to reflect the current and projected system demands.

7.1 Basis for Model

The hydraulic model is based on maps from each City, hydrant flow testing, and staff input from each City.

7.2 Hydrant Flow Testing

A hydrant flow test analysis was completed on the model to identify locations where the system could be significantly stressed. In choosing the hydrant flow test locations, the age, diameter, location, and material of the pipes in the system were considered. In total, sixteen flow tests were completed with five hydrants used in each test. For each test, one hydrant was flowed, while residual pressures were observed at the hydrants not flowing. A list of the hydrant flow test locations is included in Appendix 2.

7.3 Model Calibration Adjustments

System operational data was recorded during the flow tests, including tank levels and pumps running. This data was used to adjust settings for pumps and tanks in the hydraulic model during calibration. The Hazen-Williams pipe friction C-factors were then adjusted over several iterations, so the hydraulic model output reflected field data. After calibration, the model was able to predict static and residual pressures within 3 psi for all the flow tests. The model calibration data is included in Appendix 3.

A Hazen Williams C-factor gives an indication of the condition of the pipe interior. As a reference, a C-factor of 130 is typically used for newly installed ductile iron pipe. A higher C-factor indicates a good condition of the pipe. A C-factor of 50 or below typically indicates a pipe with a deteriorating interior. The Hazen-Williams C-factors, by water main lengths, used in the calibrated model of Alma are listed in Table 29, while the same is listed for Saint Louis in Table 30.

Table 29 – Alma Main Lengths by C-Factor

C-Factor	Pipe Length (ft)	Percent of Pipe by Length
<= 40	30,895	9.02%
41-60	64,741	18.89%
61-80	109,216	31.87%
81-100	86,388	25.21%
101-120	51,456	15.02%
> 120	0	0.00%

Table 30 – Saint Louis Main Lengths by C-Factor

C-Factor	Pipe Length (ft)	Percent of Pipe by Length
<= 40	0	0.00%
41-60	42,062	24.71%
61-80	35,823	21.04%
81-100	34,488	20.26%
101-120	35,904	21.09%
> 120	21,945	12.89%

The aging parts of the distribution system are in need of replacement. Specific improvements are discussed in Section 8.0 of this report. Additionally, both cities should replace old or small diameter mains during any adjacent road or utility work.

7.4 Model Runs with 2017 Peak Hour Demands

The updated model was run at a 2017 peak hour demand condition to evaluate the current performance of the distribution system in a worst-case scenario. The peak hour demands for the large water users in the system were entered at their respective locations; the rest of the demand for the Authority was distributed evenly across the distribution system. The results of the 2017 peak hour demand scenario are presented in Figure 3 in the form of pressure contours. It should be noted that the contours are drawn based on pressures at the junctions and other locations in the system, while within the limits of the contour, may not correspond to the pressure shown; the contours are meant to be used for visualization alone.

The system pressures for Alma ranged from approximately 41.7 to 69.0 psi during the 2017 peak hour demand scenario, with a mean pressure of 60.2 psi.

The system pressures for Saint Louis ranged from approximately 45.3 to 70.7 psi during the 2017 peak hour demand scenario, with a mean pressure of 59.3 psi.

7.5 Model Runs with 2037 Peak Hour Demands

The updated model was run at a 2037 peak hour demand condition to evaluate the future performance of the distribution system. The results of the 2037 peak hour demand scenario are presented in Figure 4 in the form of pressure contours.

The system pressures for Alma ranged from approximately 41.6 to 68.9 psi during the 2037 peak hour demand scenario, with a mean pressure of 60.2 psi.

The system pressures for Saint Louis ranged from approximately 44.9 to 70.3 psi during the 2037 peak hour demand scenario, with a mean pressure of 58.9 psi.

7.6 Model Runs with 2017 Maximum Day Demands for Fire Flow

The available fire flow analysis calculates the flow rate that can be withdrawn from the system at a given node in the model while maintaining a pressure of 20 psi at all other nodes in the model. This analysis was completed for each node in the system at a 2017 maximum day demand condition. It should be noted the model interpolates fire flow values across the system, including the areas between the distribution mains. As such, the model will generate contour lines that extend over areas not served by the water system. Therefore, careful examination of the contour maps is necessary to identify areas with actual deficiencies. The results for the fire flow analysis are presented in Figure 5 in the form of available fire flow contours.

One important clarification to note is that the reported fire flows represent the flow available in the pipe at the location indicated. Quite often this flow can be higher than what a single hydrant could deliver, and multiple hydrants in the vicinity would be needed to get the reported flow rates out of the pipe. Depending on the hydrant and nozzle, maximum flows per hydrant may be in the range of 1,000 to 2,000 gpm. Fire hose or fire truck capacity also impose similar limits on the maximum flow each hydrant can withdraw from the system. It should also be noted that the available fire flows were modeled with a high service pump on at the plant; without this pump on, the available fire flow would be significantly less. It is recommended that Authority staff responding to a fire inform the plant of the emergency, so plant staff can act accordingly.

A minimum fire flow goal of 1,500 gpm was established for use in the study based on ISO recommendations for a residential area, both cities' staff input, and the current capabilities of the system. Industrial and commercial areas will require more fire flow using the same considerations. Areas with available fire flows less than 1,500 gpm were considered deficient for the purposes of this study.

There are several areas in both City systems with available fire flows below 1,500 gpm. Aging 4- and 6-in pipe, particularly when not interconnected with larger, adequately-sized pipe, was often a source of the deficient fire flows. There are several locations in both City systems where the small pipes are located at dead ends. These areas should be reviewed to ensure that adequate hydrant coverage is available. The Ten States' Standards sets the minimum diameter pipe that a fire hydrant can be connected to at 6 in. There are locations where hydrants have been installed on 4-in and smaller pipe, so the hydrants should be relocated to larger pipes or the pipes should be replaced. In the case of some dead ends, a hydrant installed on a smaller pipe may be left in place for flushing purposes, but the customers served at the dead end should have adequate fire flow coverage off the adjacent mains.

Model runs of 2037 maximum day demand conditions produced similar results to the above with a slight decrease in available fire flow numbers as demands increased. Figure 6 indicates the results for the fire flow analysis given 2037 maximum day demand conditions in the form of available fire flow contours.

7.7 Existing System Pressure Deficiencies

All areas of the distribution system have pressures above the minimum 35 psi during 2037 peak hour demand conditions.

7.8 Existing System Fire Flow Deficiencies

There are several areas in the City with available fire flows below the 1,500 gpm target. Specific improvements are included in Section 8.0 to address fire flow concerns.

8.0 Recommended Improvements

Recommended improvements to the distribution systems for each City and improvements to water system facilities are presented in this section. Where applicable, construction cost estimates are provided. Distribution system improvements are depicted on Figures 8 and 9.

8.1 5-Year Water Distribution System Improvements

The following are recommended improvements to water mains in the distribution system for each City with corresponding construction cost estimates to be done within the next 5 years. The difference in unit costs depends on the size of the main being installed and what kind of restoration must to be done after main installation. The location of each improvement is illustrated on Figures 8 and 9 and listed in Tables 31 and 32, along with the estimated costs of each improvement.

Table 31 – Alma 5-Year Distribution System Improvements Estimated Costs

Project No.	Project Description/Location	Replacement Main Diameter (in)	Main Length (ft)	Main Unit Cost ($/ft)	Water Main Cost
1	Replace 4-in mains along Center Street from Lincoln Avenue to Park Avenue	16	400	$315	$126,000
2	Replace 4-in mains along Pleasant Avenue from Rosedale Street to Eastward Street	8	800	$249	$199,000
3	Replace 6-in main along Hannah Avenue from Michigan Avenue to Ferris Avenue	8	900	$249	$224,000
4	Replace 4-in main along Lincoln Avenue from Marshall Street to Elizabeth Avenue	12	600	$281	$169,000
5	Replace 4-in mains along Francisco Avenue	8	500	$249	$125,000
6	Replace 4-in mains along Hayes Avenue from Marquette Avenue to Michigan Avenue	8	1,200	$249	$299,000
7	Replace 6-in mains along Iowa Street from Charles Street to Falkirk Avenue	8	1,800	$249	$448,000
8	Replace main along Chatterton from Pine Avenue to Carnahan Avenue	8	400	$249	$100,000
9	Replace mains along Pine Avenue from Washington Street to Panther Parkway	12	2,700	$281	$759,000
Cost of 5-Year Distribution System Improvements					$2,449,000

NOTE: Water main unit costs include water main and replacement of surface over the pipe only.

Table 32 – Saint Louis 5-Year Distribution System Improvements Estimated Costs

Project No.	Project Description/Location	Replacement Main Diameter (in)	Main Length (ft)	Main Unit Cost ($/ft)	Water Main Cost
1	Connect existing Westgate Manor Nursing Home owned 6-in main to 8-in main on Chatham Road	8	60	$249	$15,000
2	Replace mains along York Street from Surrey to Devon Street	8	1,800	$249	$448,000
3	Replace mains along Washington Avenue from Clinton Street to Hubbard Street	8	1,500	$249	$374,000
4	Replace 4-in mains along Saginaw Street	8	1,500	$249	$374,000
5	Replace mains along West Washington Avenue from the new 16-in transmission main to Clinton Street	12	2,400	$296	$710,000
6	Replace mains along Mill Street from Washington Street to North Street	12	1,500	$296	$444,000
7	Replace mains along Mill street from Washington Street to Hazel Street	8	1,400	$249	$349,000
8	Replace 4-in mains along Michigan Avenue and traveling up Pine Street to Washington Avenue	12	1,500	$281	$422,000
9	Replace mains in Orchard Hills	8	3,700	$264	$977,000
Cost of 5-Year Distribution System Improvements					$4,113,000

NOTE: Water main unit costs include water main and replacement of surface over the pipe only.

8.2 5-Year Water Facilities Improvements

The following are recommended improvements to water system facilities in each City and for the Authority as a whole to be done in the next 5 years. The improvements, their estimated cost, and project year are shown in Tables 33, 34 and 35.

Table 33 – Alma 5-Year Water System Facilities Improvement Estimated Costs

Project No.	Project Title	Fiscal Year	Project Cost	Short Description
1	On-going Meter Replacement Program	2018-2023	$120,000	Upgrade and replace water meters that slow over time.
2	Alma Water Tower Exterior Painting	2021	$475,000	Sandblast and paint elevated tank
3	Alma Water Tower Cathodic Protection	2021	$25,000	Install Cathodic Protection inside elevated tank
Cost of 5-Year Water System Facilities Improvements			$620,000	

Table 34 – Saint Louis 5-Year Water System Facilities Improvement Estimated Costs

Project No.	Project Title	Fiscal Year	Project Cost	Short Description
1	Municipal Services Complex – Develop City Engineering Standards	2019-2020	$10,000	Creating a set of development and construction standards to keep everyone on a "level playing field"
2	Garage – Painting	2019	$8,000	Repaint the Garage
3	Fire Hydrant Repainting Program	2020	$8,300	Still have one half of the fire hydrants to finish repainting.
4	Municipal Services Complex – Security Fencing	2020	$70,000	Install cameras and a perimeter fence with powered entrance gate around Water Department, DPW facilities and WWTP
Cost of 5-Year Water System Facilities Improvements			$96,300	

Table 35 – Authority 5-Year Water System Improvements Estimated Costs

Project No.	Project Title	Fiscal Year	Project Cost	Short Description
1	Inspect Groundwater Production Well No. 8	2019	$21,000	Pull and inspect well pump
2	Wellhouse No. 1 Building Repairs	2019	$16,500	Repair brick work to maintain weather tight conditions
3	Soda Ash Feeder	2020	$50,000	Replace Soda Ash Feeder
4	Replace all windows at the WTP	2020	$20,000	Replacement of the older single pane windows with double pane windows
5	Brick Planters	2020	$15,000	Rebuild/Replace brick plants in front of plant
6	Construct Well No. 12	2020	$750,000	Install new well and construct wellhouse
7	Re-Paint Clarifier Mechanisms	2021	$190,000	Repaint interior of clarifiers in the plant
8	Warm Air Incubator	2021	$7,000	Replace lab warm air incubator
9	SCADA Computer Replacements	2021-2023	$40,000	Replace SCADA computers and servers in the plant
10	Lime Slaker Replacements	2022-2023	$160,000	Replace Lime Slakers
11	Water Well VFD Replacements	2022-2023	$20,000	Replace Well VFDs
12	Clarifier Nos. 1 & 2 Roof Replacements	2023	$400,000	Replace roofing for clarifiers 1 & 2
13	Repair cracking in masonry in existing filter room	2023	$50,000	Investigate and repair cracking in masonry
Cost of 5-Year Water System Facilities Improvements			$1,739,500	

8.3 20-Year Water Distribution System Improvements

The following are recommended improvements to water mains in the distribution system for each City with corresponding construction cost estimates to be done within the next 6 to 20 years. The difference in unit costs depends on the size of the main being installed and what kind of restoration must be done after main installation. The location of each improvement is illustrated on Figures 8 and 9 and listed in Tables 36 and Table 37, along with the estimated costs of each improvement.

Table 36 – Alma 20-Year Distribution System Improvements Estimated Costs

Project No.	Project Description/Location	Replacement Main Diameter (in)	Main Length (ft)	Main Unit Cost ($/ft)	Water Main Cost
10	Replace mains along Harvard Avenue from Superior Street to Vasser Street	8	1,000	$249	$249,000
11	Replace 4-in mains along Richmond Street from Pine Avenue to Euclid Avenue	8	1,300	$249	$324,000
12	Replace mains along Rockingham Avenue from Ely Street to Hubbell Street	8	3,700	$249	$921,000
13	Replace mains along Moyer Avenue from Hillsdale Street to Hubbell Street	8	560	$249	$139,000
14	Replace mains along Hawthorne Street from State Avenue to Grafton Avenue	8	1,600	$249	$398,000
15	Replace mains along Elizabeth Street from Grafton Avenue to Court Avenue and south down Court Avenue, then east on Slater Street	8	2,400	$249	$598,000
16	Replace 4-inch main along Grover Avenue from Superior Street to Eastward Street, and dead end on Sunset Street	8	1,100	$249	$274,000
17	Replace mains along Pleasant Avenue from Eastward to Superior Street	8	800	$249	$199,000
18	Replace 4-inch main along Liberty Street from Pine Avenue to Euclid Avenue	8	1,300	$249	$324,000
19	Replace mains along River Street from Chatterton to Downie and over to Pine Avenue	8	3,200	$249	$797,000
20	Replace 4-inch main along Eastward Street from Grover Avenue to Republic Avenue	8	1,300	$249	$324,000
21	Replace mains along Hickory Street from Republic Avenue to Massachusetts Boulevard	8	1,300	$249	$324,000
22	Replace mains along Pennsylvania Avenue from Hickory Street to Michigan Avenue	8	1,000	$249	$249,000
23	Replace mains along Maryland and California	8	900	$249	$224,000
24	Replace mains along Massachusetts Boulevard	8	1,300	$249	$324,000
25	Replace mains along Carolina Street and Kensington Avenue	8	1,200	$249	$299,000
				Cost of 20-Year Distribution System Improvements	$5,967,000

Table 37 – Saint Louis 20-Year Distribution System Improvements Estimated Costs

Project No.	Project Description/Location	Replacement Main Diameter (in)	Main Length (ft)	Water Main Cost	Total Estimated Cost
10	New water main from the corner of Prospect and Hebron Street down to the end of Orchard Court	8	3,500	$205	$718,000
11	Replace mains along Devon Street	8	2,600	$249	$647,000
12	Replace mains along Franklin Street from Saginaw Street to State Street	8	3,300	$249	$822,000
13	Replace mains along Prospect from Seaman to dead end to east	8	1,500	$249	$374,000
14	Replace main along Locust Street from Maple Street to Mill Street	8	700	$249	$174,000
15	Replace mains along Main Street from Washington to the bridge	8	1,400	$264	$370,000
16	Replace 4-inch mains along Euclid Street	8	2,900	$249	$722,000
17	Install main along Walnut from Main Street to East Street and down East Street to Butternut	8	2,400	$249	$598,000
18	Replace 4-inch mains along Hazel Street	8	1,600	$249	$398,000
19	Replace mains along Corinth Street from Olive Street to dead end to the north	8	1,000	$249	$249,000
20	Replace mains along Prospect from Corinth to Teaman Street	8	900	$264	$238,000
21	Replace mains along Berea, west along Tamarack to Eden Street	8	1,700	$264	$449,000
22	Replace mains along Bankson from Tyrell to North Street	8	2,000	$249	$498,000
23	Replace mains along Prospect from Hebron to Teaman, north up Teaman to Olive	12	1,600	$281	$450,000
24	Replace mains along Olive Street from Corinth to Main	12	1,400	$281	$393,000
25	Replace mains along I & K from Main to Union	12	1,200	$281	$337,000
26	Replace 4-inch mains along Lincoln Street	8	1,100	$249	$274,000
27	Replace mains along Center Street from Watson to Main	8	2,200	$249	$548,000
28	Replace mains along Graham Street from Wilson to Woodside	8	1,400	$264	$370,000
29	Replace mains along Pine Street from Washington to North Street	8	1,600	$249	$398,000
30	Replace main along Butternut from East to Euclid Street	8	1,500	$249	$374,000
31	Replace mains along Mill Street from Hazel to State Street	8	1,300	$264	$343,000
32	Replace mains along Delaware Street from Crawford to North Street	8	2,500	$249	$623,000

Table 37 – Saint Louis 20-Year Distribution System Improvements Estimated Costs

Project No.	Project Description/Location	Replacement Main Diameter (in)	Main Length (ft)	Water Main Cost	Total Estimated Cost
33	Replace mains along East Street from Washington to State	8	2,800	$249	$697,000
34	Replace mains along Sharon Street from Olive to Prospect Street	8	1,100	$249	$274,000
35	Replace mains along Maple Street from Hazel to State Street	8	1,600	$249	$398,000
36	Replace mains along Surrey from Devon to dead end	8	1,700	$249	$423,000
37	Replace mains along Essex Street from Devon to York Street	8	900	$249	$224,000
				Cost of 20-Year Distribution System Improvements	$12,383,000

NOTE: Water main unit costs include water main and replacement of surface over the pipe only. This list is only preliminary and will be adjusted to align with the Saint Louis Street Reconstruction Program.

8.4 20-Year Water Facilities Improvements

The City of Alma is projecting that all tank maintenance will conducted in the 5-year planning period will last through the 20-year planning period. This assumption should be reviewed during the preparation of the next Reliability Study.

The following are recommended improvements to water system facilities in Saint Louis and for the Authority as a whole to be done in the next 20 years. The improvements, their estimated cost, and project year are shown in Tables 38 and 39.

Table 38 – Saint Louis 20-Year Water System Facilities Improvement Estimated Costs

Project No.	Project Title	Fiscal Year	Project Cost	Short Description
5	New Municipal Services Complex	2028	$7,000,000	N/A
		Cost of 20-Year Water System Facilities Improvements	$7,000,000	

Table 39 – Authority 20-Year Water System Improvements Estimated Costs

Project No.	Project Title	Fiscal Year	Project Cost	Short Description
14	Replace roof over Filter Nos. 1 and 2 and south end of pump room	2025	$28,000	Demolish the old roof and install a new built-up roof with gravel
15	Rebuild Well Pump No. 7	2026	$35,000	Rebuild Well Pump No. 7
16	Replace material in masonry joints	2026	$45,000	Block masonry infill between the concrete building tanks and frame have the existing masonry joint raked and tuck pointed
17	Rebuild Well Pump No. 1	2027	$30,000	Rebuild Well Pump No. 1
18	Paint exterior of chemical storage on third floor of the WTP	2027	$22,000	Paint exterior metal panels at Chemical Storage located on the third floor of the WTP
19	Cut in masonry control joints at the ends of lintels	2028	$7,000	Cut in Masonry Control Joints at the ends of lintels on the building.
20	Rebuild Raw Water Pumps No. 2 and 3	2029	$30,000	Rebuild Raw Water Pumps No. 2 and 3
21	Replace hydronic unit heaters	2030	$60,000	Replace the older hydronic unit heaters with new units
22	Replace Primary Clarifier Mechanism	2031	$600,000	This includes demolition of existing unit, new carbon steel clarifier installed, plus field painting
23	Replace Final Clarifier Mechanism	2032	$600,000	This includes demolition of existing unit, new carbon steel clarifier installed, plus field painting
24	Replace sludge recirculation pumps (2)	2034	$20,000	Replace sludge recirculation pumps with new units.
Cost of 20-Year Water System Facilities Improvements			$1,477,000	

8.5 Summary of Cost Estimation

All municipalities face the concerns of the increasing costs to repair and replace aging infrastructure, before major problems arise including: water distribution mains, sanitary sewer mains and wastewater treatment plants, storm sewers and streets. City staff and elected officials must prioritize projects for multiple asset management plans with consideration of available funds. State unfunded mandates must also be addressed.

The planning, engineering, and construction required to implement the recommended improvements could take from several months to many years. It is therefore recommended the cities begin planning and budgeting efforts as soon as practical, in conjunction with the asset management plan development.

Estimates of cost for distribution system improvements represent total project costs, including engineering and contingencies, for replacement of the water main and restoration of the driving surface directly above the main. Costs for replacement of adjacent utilities and road reconstruction are not included in the unit costs. Improvements should be coordinated with other utility and road replacement projects wherever feasible to maximize the benefit for the investment. City budgetary constraints will dictate the actual priorities and timing of construction for projects.

The construction cost estimates presented in this report reflect November 2018 costs. These opinions of cost were prepared to determine approximate project costs. There are a number of factors that could cause the actual project costs to deviate from these estimates. These include the competitive bidding climate at the time the construction bids are received, inflation, and additions to or changes in the scope of the project that may occur during the design process. The cities should update estimated costs prior to proceeding with any future work, and make necessary adjustments to determine the bidding climate in the year the work is proposed to be completed.

Figures

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 3 DATE: 10/22/2017 TIME: 10:52:39 AM USER: NTG

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Gratiot Area Water Authority

Gratiot County, Michigan

GAWA Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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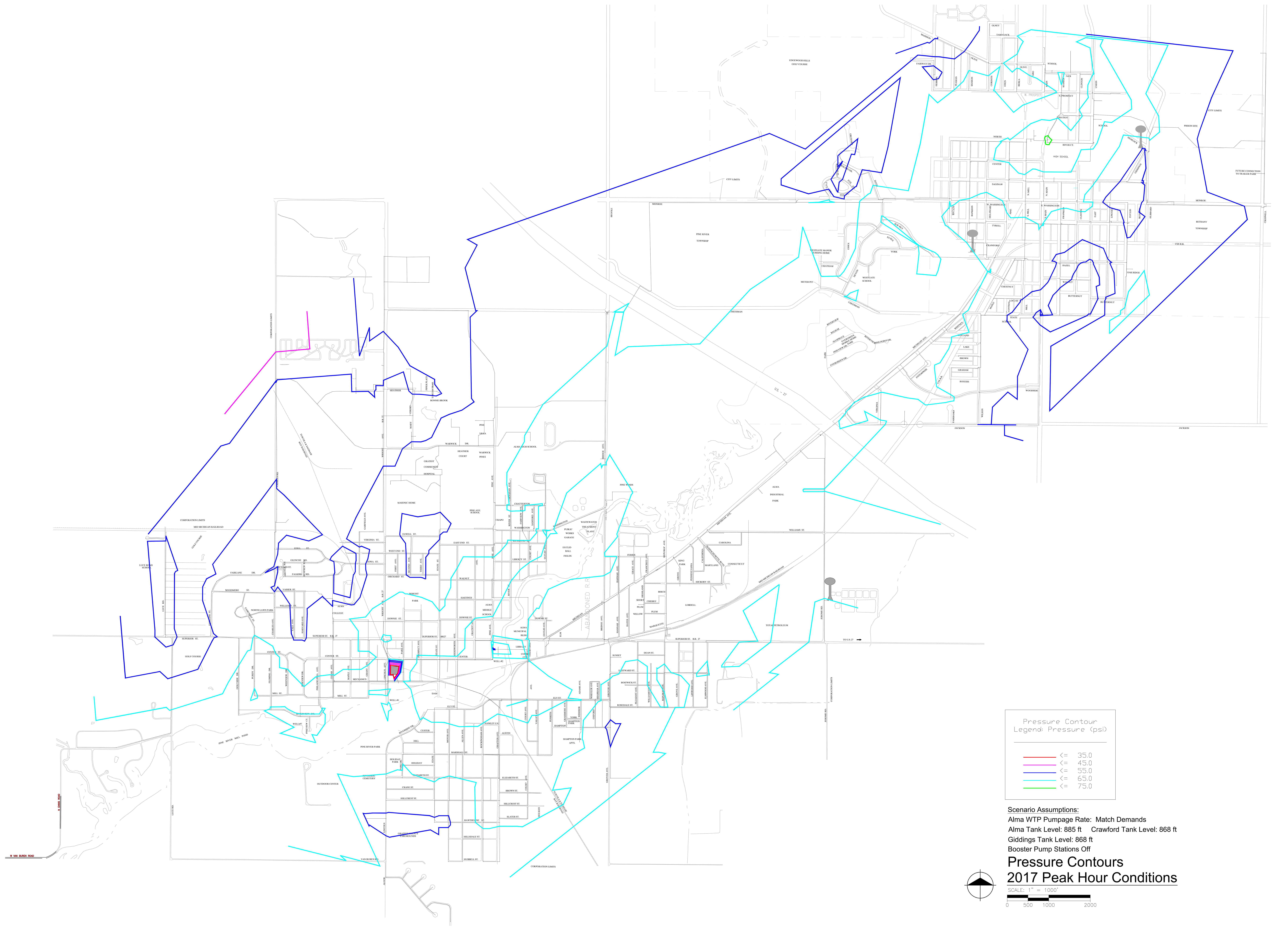
PROJECT NO.
G160148

SHEET NO.
3



Pressure Contour Legend: Pressure (psi)

red	<= 35.0
purple	<= 45.0
blue	<= 55.0
cyan	<= 65.0
green	<= 75.0

Scenario Assumptions:
Alma WTP Pumpage Rate: Match Demands
Alma Tank Level: 885 ft Crawford Tank Level: 868 ft
Giddings Tank Level: 868 ft
Booster Pump Stations Off

Pressure Contours
2017 Peak Hour Conditions

SCALE: 1" = 1000'
0 500 1000 2000

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Gratiot Area Water Authority

Gratiot County, Michigan

GAWA Reliability Study

Drawn By CGM
Designer CGM
Reviewer JW
Manager JW

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PROJECT NO.
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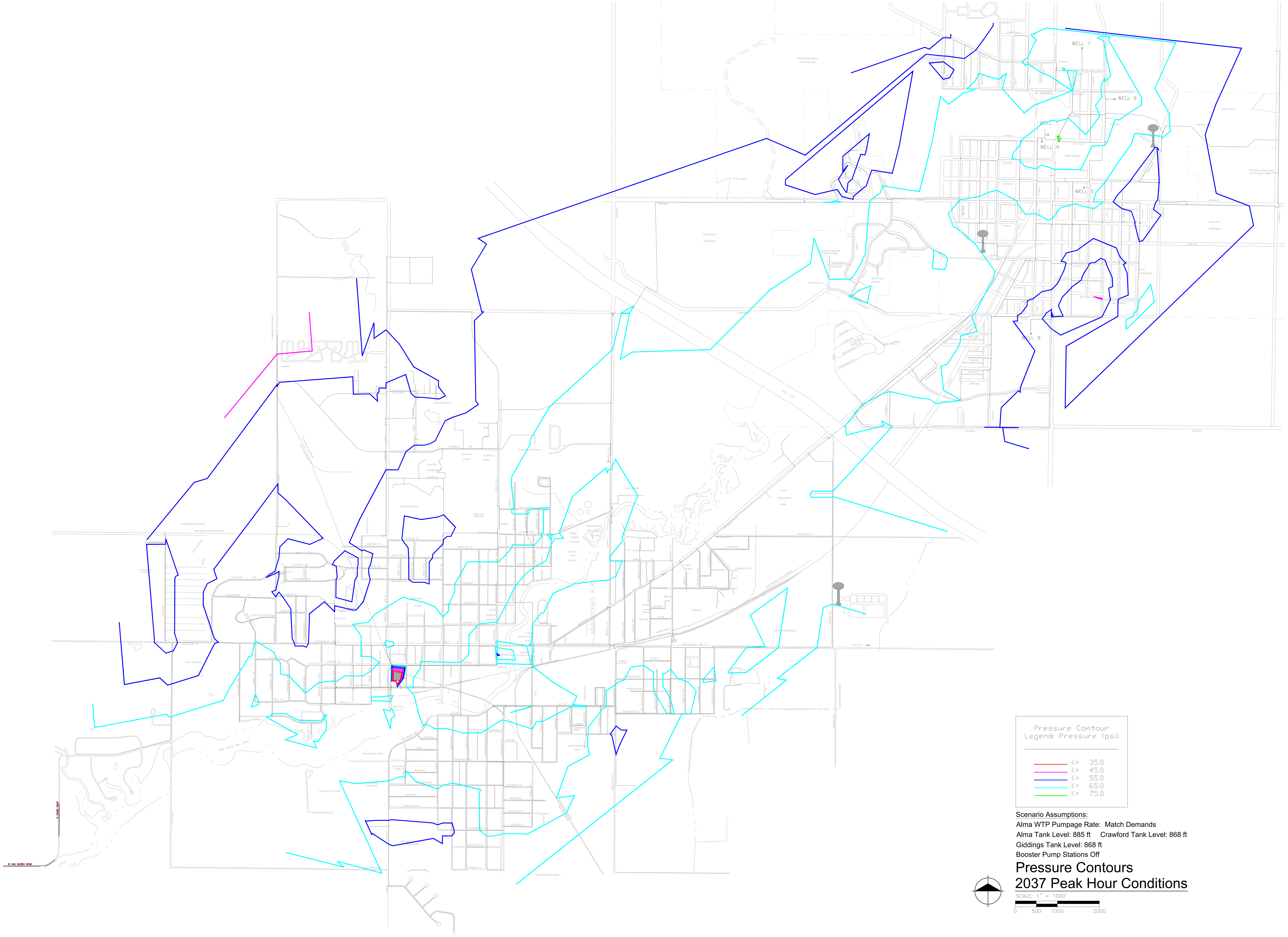
4

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 4 DATE: 11/8/2017 TIME: 4:34:40 PM USER: NTG

Gratiot Area Water Authority

Gratiot County, Michigan

GAWA Reliability Study



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Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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PROJECT NO.
G160148

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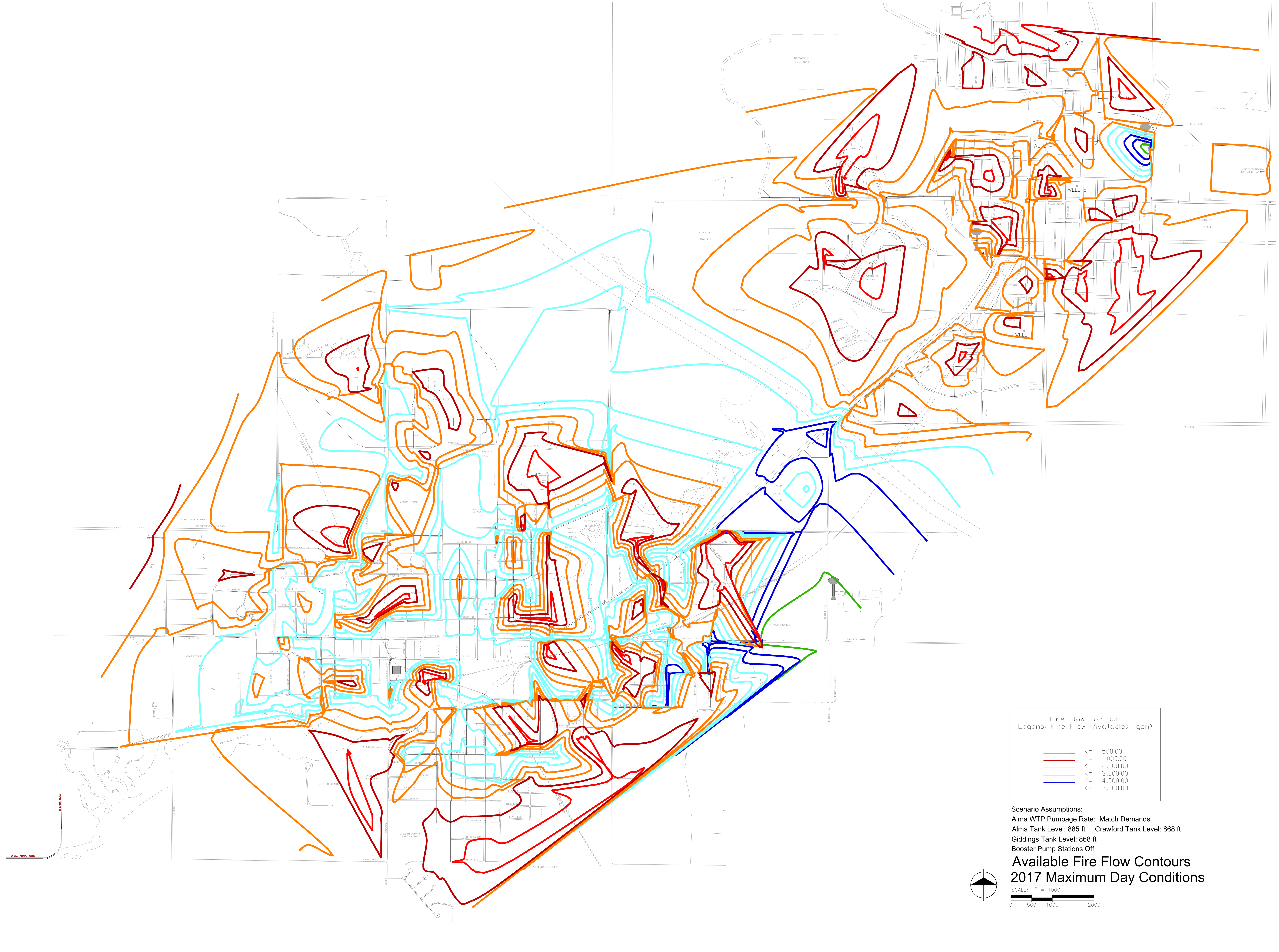
5

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 5 DATE: 11/8/2017 TIME: 4:35:12 PM USER: NTG



Fire Flow Contour
Legend: Fire Flow (Available) (gpm)

<= 500.00
<= 1,000.00
<= 2,000.00
<= 3,000.00
<= 4,000.00
<= 5,000.00

Scenario Assumptions:
Alma WTP Pumpage Rate: Match Demands
Alma Tank Level: 885 ft Crawford Tank Level: 868 ft
Giddings Tank Level: 868 ft
Booster Pump Stations Off

Available Fire Flow Contours
2017 Maximum Day Conditions

SCALE: 1" = 1000'
0 500 1000 2000

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Gratiot Area Water Authority
Gratiot County, Michigan
GAWA Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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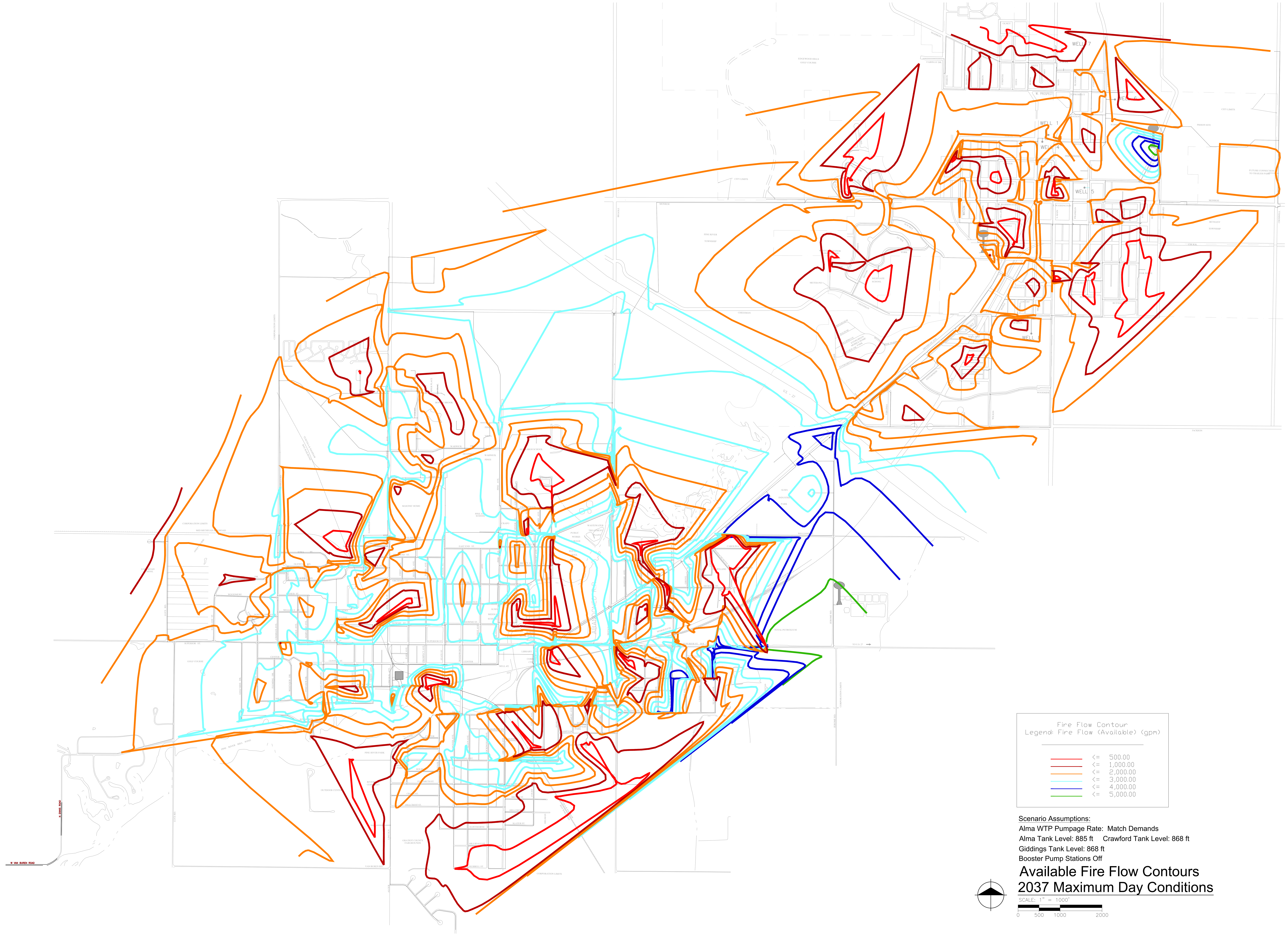
PROJECT NO.
G160148

SHEET NO.
6



Fire Flow Contour
Legend: Fire Flow (Available) (gpm)

- <= 500.00
- <= 1,000.00
- <= 2,000.00
- <= 3,000.00
- <= 4,000.00
- <= 5,000.00

Scenario Assumptions:
Alma WTP Pumpage Rate: Match Demands
Alma Tank Level: 885 ft Crawford Tank Level: 868 ft
Giddings Tank Level: 868 ft
Booster Pump Stations Off

Available Fire Flow Contours
2037 Maximum Day Conditions

SCALE: 1" = 1000'
0 500 1000 2000

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Gratiot Area Water Authority
Gratiot County, Michigan
GAWA Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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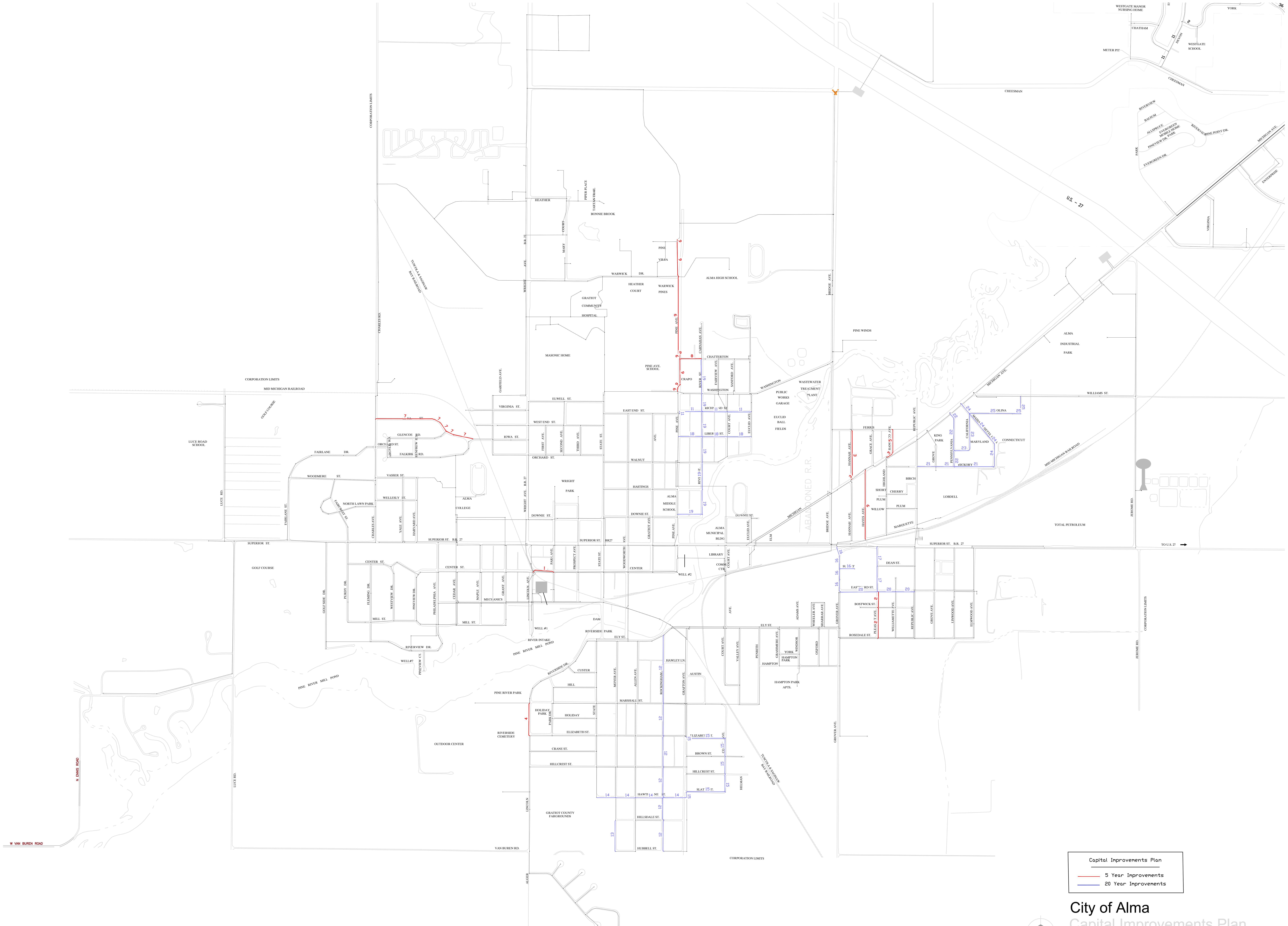
PROJECT NO.
G160148

SHEET NO.
7

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 7 DATE: 11/8/2017 TIME: 4:37:29 PM USER: NTG



Capital Improvements Plan

5 Year Improvements

20 Year Improvements

City of Alma

Capital Improvements Plan

NO SCALE

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Gratiot Area Water Authority

Gratiot County, Michigan

GAWA Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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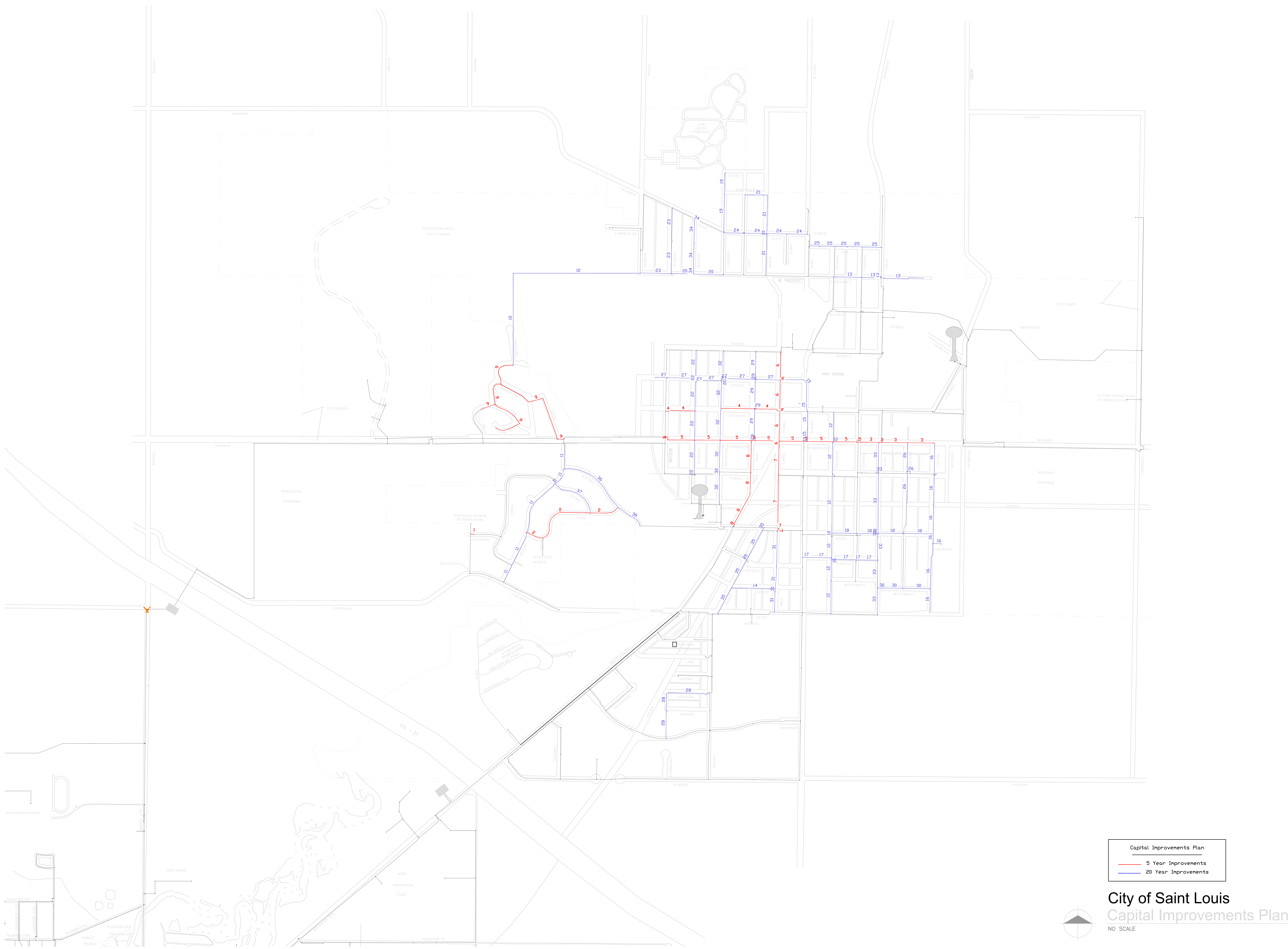
G160148

SHEET NO.
8

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 8 DATE: 10/30/2018 TIME: 12:34:36 PM USER: CGM



City of Saint Louis

Capital Improvements Plan

NO SCALE

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Gratiot Area Water Authority

Gratiot County, Michigan

Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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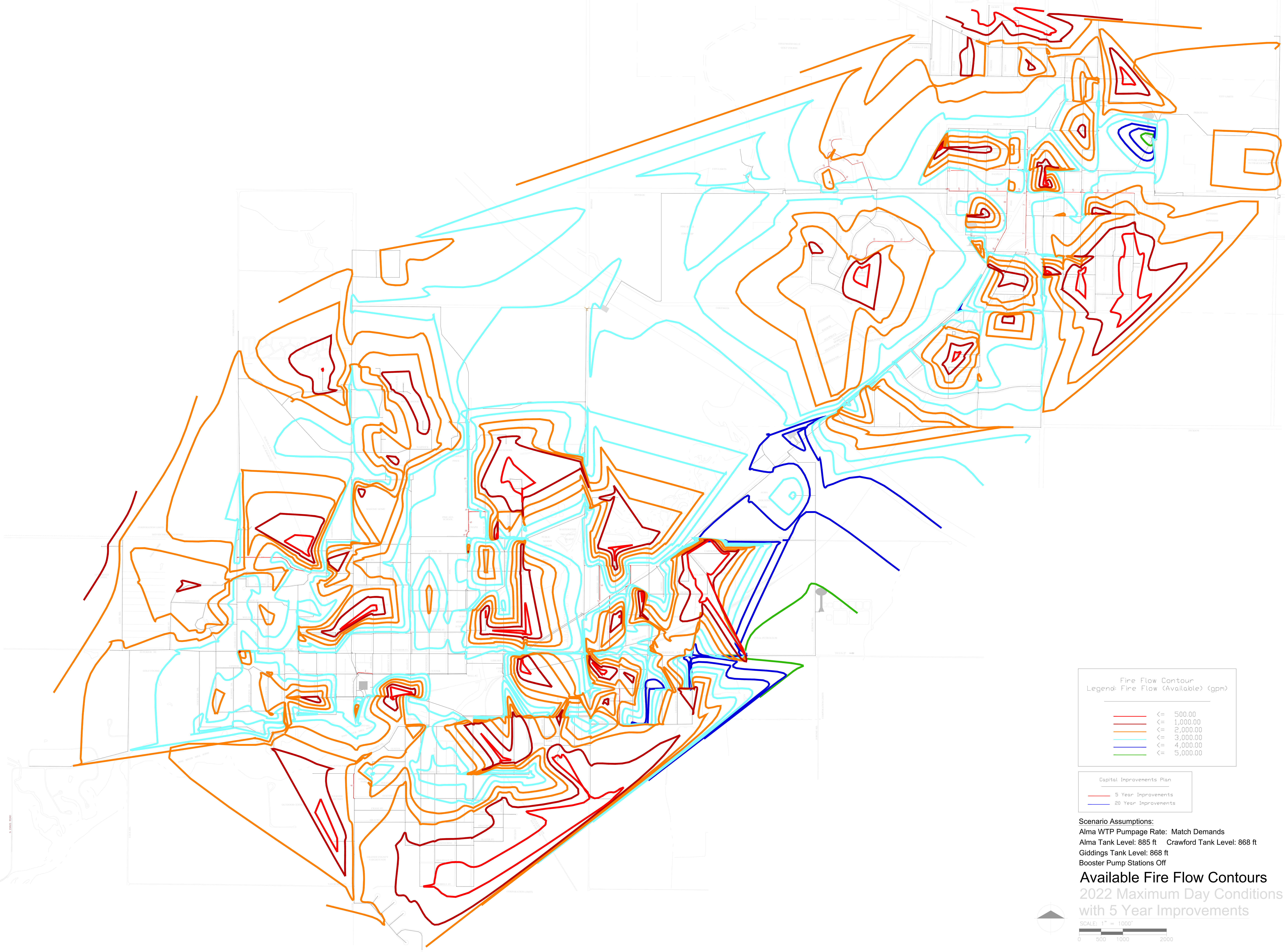
9

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 9 DATE: 10/30/2018 TIME: 12:36:08 PM USER: CGM



Scenario Assumptions:
Alma WTP Pumpage Rate: Match Demands
Alma Tank Level: 885 ft Crawford Tank Level: 868 ft
Giddings Tank Level: 868 ft
Booster Pump Stations Off

Available Fire Flow Contours

2022 Maximum Day Conditions with 5 Year Improvements

SCALE: 1" = 1000'
0 500 1000 2000

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Gratiot Area Water Authority

Gratiot County, Michigan

Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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10

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 10 DATE: 10/30/2018 TIME: 12:42:10 PM USER: CGM

Scenario Assumptions:
Alma WTP Pumpage Rate: Match Demands
Alma Tank Level: 885 ft   Crawford Tank Level: 868 ft
Giddings Tank Level: 868 ft
Booster Pump Stations Off

Available Fire Flow Contours

2037 Maximum Day Conditions
with 20 Year Improvements

SCALE: 1" = 1000'
0 500 1000 2000

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Gratiot Area Water Authority

Gratiot County, Michigan

Reliability Study

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

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PROJECT NO.
G160148

SHEET NO.
11

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 11 DATE: 10/30/2018 TIME: 12:43:16 PM USER: CGM

Appendix 1

Authority Water Main Inventory

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
3760	P-SL-PI-327	16	14.36	Ductile Iron	120	2012	Interconnect
3765	P-SL-PI-329	16	8.5	Ductile Iron	120	2012	Interconnect
3766	P-SL-PI-330	16	10.19	Ductile Iron	120	2012	Interconnect
3767	P-SL-PI-331	16	7.93	Ductile Iron	120	2012	Interconnect
3768	P-SL-PI-332	16	9.13	Ductile Iron	120	2012	Interconnect
3965	P-SL-PI-435	16	21.8	Ductile Iron	120	2012	Interconnect
3970	P-SL-PI-439	16	13.7	Ductile Iron	120	2012	Interconnect
3971	P-SL-PI-440	16	13.29	Ductile Iron	120	2012	Interconnect
3973	P-SL-PI-441	16	13.11	Ductile Iron	120	2012	Interconnect
3974	P-SL-PI-442	16	13.39	Ductile Iron	120	2012	Interconnect

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone

Alma Water Main Inventory

831	P-A-X-38	4	43.42	Ductile Iron	50	1900	Alma
832	P-A-X-40	4	420.71	Ductile Iron	50	1900	Alma
836	P-A-X-45	4	420.71	Ductile Iron	50	1900	Alma
837	P-A-X-49	4	400.71	Ductile Iron	50	1900	Alma
838	P-A-X-50	4	431.15	Ductile Iron	50	1900	Alma
839	P-A-X-51	4	431.15	Ductile Iron	50	1900	Alma
840	P-A-X-52	4	420.25	Ductile Iron	50	1900	Alma
841	P-A-X-53	4	447.33	Ductile Iron	50	1900	Alma
848	P-A-X-63	4	474.17	Ductile Iron	50	1900	Alma
861	P-A-X-86	4	439.49	Ductile Iron	70	1900	Alma
867	P-A-X-94	4	438.55	Ductile Iron	70	1900	Alma
875	P-A-X-118	4	491.19	Ductile Iron	70	1900	Alma
877	P-A-X-121	4	491.2	Ductile Iron	70	1900	Alma
879	P-A-X-125	4	434.53	Ductile Iron	70	1900	Alma
881	P-A-X-128	4	472.51	Ductile Iron	70	1900	Alma
894	P-A-X-168	4	432.11	Ductile Iron	70	0	Alma
901	P-A-X-181	4	305.83	Ductile Iron	70	1900	Alma
902	P-A-X-182	4	459.75	Ductile Iron	70	1900	Alma
903	P-A-X-183	4	536.17	Ductile Iron	70	0	Alma
904	P-A-X-185	4	50.56	Ductile Iron	70	0	Alma
905	P-A-X-186	4	432.11	Ductile Iron	50	1906	Alma
907	P-A-X-192	4	419.23	Ductile Iron	70	0	Alma
908	P-A-X-193	4	330.43	Ductile Iron	70	1900	Alma
909	P-A-X-194	4	366.18	Ductile Iron	70	0	Alma
910	P-A-X-197	4	536.17	Ductile Iron	70	2001	Alma
911	P-A-X-198	4	330.43	Ductile Iron	50	1906	Alma
914	P-A-X-207	4	835.89	Ductile Iron	70	1900	Alma
916	P-A-X-210	4	485.43	Ductile Iron	70	1900	Alma
920	P-A-X-217	4	45.52	Ductile Iron	70	1954	Alma
923	P-A-X-220	4	23.71	Ductile Iron	70	1954	Alma
928	P-A-X-226	4	457.12	Ductile Iron	70	2003	Alma
929	P-A-X-227	4	568.05	Ductile Iron	70	1900	Alma
973	P-A-X-294	4	600.99	Ductile Iron	50	0	Alma
985	P-A-X-313	4	18.8	Ductile Iron	40	1900	Alma
986	P-A-X-314	4	52.24	Ductile Iron	50	1900	Alma
987	P-A-X-315	4	27.34	Ductile Iron	50	1900	Alma
988	P-A-X-324	4	403.28	Ductile Iron	50	1906	Alma
989	P-A-X-325	4	15.95	Ductile Iron	70	0	Alma
1013	P-A-X-360	4	366.18	Ductile Iron	70	2001	Alma
1025	P-A-X-373	4	524.24	Ductile Iron	70	2001	Alma
1026	P-A-X-374	4	51.73	Ductile Iron	70	1900	Alma
1027	P-A-X-375	4	433.7	Ductile Iron	70	1900	Alma
1109	P-A-X-492	4	105.69	Ductile Iron	70	0	Alma
1120	P-A-X-510	4	18.36	Ductile Iron	50	0	Alma
1122	P-A-X-512	4	408.01	Ductile Iron	50	0	Alma
1133	P-A-X-535	4	413.18	Ductile Iron	70	1900	Alma
1134	P-A-X-536	4	26.48	Ductile Iron	70	1900	Alma
1135	P-A-X-537	4	101.56	Ductile Iron	70	1900	Alma
1144	P-A-X-567	4	76.59	Ductile Iron	70	1900	Alma
1145	P-A-X-568	4	113.11	Ductile Iron	50	1900	Alma
1146	P-A-X-569	4	179.98	Ductile Iron	50	1900	Alma
1157	P-A-X-588	4	990.67	Ductile Iron	50	1920	Alma
1158	P-A-X-589	4	254.48	Ductile Iron	50	1920	Alma
1159	P-A-X-590	4	228.83	Ductile Iron	50	1920	Alma
1160	P-A-X-592	4	990.67	Ductile Iron	50	1920	Alma
1161	P-A-X-593	4	332.36	Ductile Iron	50	1900	Alma
1172	P-A-X-612	4	451.03	Ductile Iron	50	1948	Alma
1175	P-A-X-615	4	1,191.57	Ductile Iron	70	2004	Alma
1188	P-A-X-640	4	172.14	Ductile Iron	70	0	Alma
1191	P-A-X-645	4	188.21	Ductile Iron	70	0	Alma
1192	P-A-X-646	4	1,081.72	Ductile Iron	70	1900	Alma
1194	P-A-X-649	4	566.49	Ductile Iron	30	1900	Alma
1216	P-A-X-678	4	359.12	Ductile Iron	70	1900	Alma
1240	P-A-X-709	4	528.24	Ductile Iron	30	1900	Alma
1243	P-A-X-712	4	528.24	Ductile Iron	30	2004	Alma
1244	P-A-X-713	4	397.26	Ductile Iron	30	2004	Alma
1246	P-A-X-715	4	397.26	Ductile Iron	30	1900	Alma
1250	P-A-X-721	4	545.55	Ductile Iron	30	1950	Alma
1256	P-A-X-729	4	674.68	Ductile Iron	30	2002	Alma
1271	P-A-X-745	4	470.69	Ductile Iron	70	1900	Alma
1273	P-A-X-747	4	572.59	Ductile Iron	40	0	Alma
1276	P-A-X-750	4	247.8	Ductile Iron	50	0	Alma
1279	P-A-X-758	4	1,206.92	Ductile Iron	50	1906	Alma
1288	P-A-X-787	4	133.5	Ductile Iron	50	1900	Alma
1290	P-A-X-790	4	388.49	Ductile Iron	50	2000	Alma
1315	P-A-X-855	4	150.8	Ductile Iron	40	1920	Alma
1316	P-A-X-857	4	657.51	Ductile Iron	50	1920	Alma
1339	P-A-X-906	4	314.8	Ductile Iron	50	1920	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1343	P-A-X-913	4	282.02	Ductile Iron	50	1937	Alma
1344	P-A-X-914	4	540.8	Ductile Iron	50	1937	Alma
1352	P-A-X-926	4	439.49	Ductile Iron	50	1920	Alma
1353	P-A-X-927	4	339.64	Ductile Iron	50	1920	Alma
1368	P-A-X-942	4	247.09	Ductile Iron	50	1920	Alma
1369	P-A-X-944	4	256.78	Ductile Iron	50	1962	Alma
1371	P-A-X-946	4	1,038.07	Ductile Iron	50	2011	Alma
1374	P-A-X-949	4	428.48	Ductile Iron	30	1953	Alma
1392	P-A-X-989	4	468.79	Ductile Iron	50	1906	Alma
1400	P-A-X-1000	4	295.98	Ductile Iron	70	1920	Alma
1401	P-A-X-1001	4	436.04	Ductile Iron	70	1954	Alma
1405	P-A-X-1005	4	750.8	Ductile Iron	20	1928	Alma
1415	P-A-X-943A	4	183.95	Ductile Iron	50	1920	Alma
1416	P-A-X-943B	4	204.72	Ductile Iron	50	1920	Alma
1471	P-A-X-1080	4	356.51	Ductile Iron	35	1900	Alma
1475	P-A-X-1085	4	114.28	Ductile Iron	50	1900	Alma
1483	P-A-X-1106	4	434.74	Ductile Iron	70	0	Alma
1484	P-A-X-1107	4	235.13	Ductile Iron	20	1900	Alma
1492	P-A-X-1125	4	509.25	Ductile Iron	20	1900	Alma
1504	P-A-X-1136	4	47.96	Ductile Iron	70	0	Alma
1526	P-A-X-1145	4	632.26	Ductile Iron	20	1946	Alma
1539	P-A-X-1160	4	37.24	Ductile Iron	70	0	Alma
1540	P-A-X-1161	4	498.93	Ductile Iron	70	0	Alma
1546	P-A-X-1164	4	332.90	Ductile Iron	50	1920	Alma
1553	P-A-X-1174	4	329.05	Ductile Iron	50	1900	Alma
1554	P-A-X-1175	4	380.41	Ductile Iron	50	1900	Alma
1558	P-A-X-1179	4	666.6	Ductile Iron	50	1900	Alma
1559	P-A-X-1180	4	369.23	Ductile Iron	50	1900	Alma
1571	P-A-X-1194	4	361.67	Ductile Iron	70	0	Alma
1572	P-A-X-1195	4	36.54	Ductile Iron	70	0	Alma
1579	P-A-X-1202	4	304.08	Ductile Iron	50	1900	Alma
1595	P-A-X-1218	4	153.79	Ductile Iron	50	1900	Alma
1596	P-A-X-1219	4	144.91	Ductile Iron	50	1900	Alma
1598	P-A-X-1221	4	366.81	Ductile Iron	50	0	Alma
3520	P-SL-PI-153	4	417.71	Ductile Iron	120	2012	Alma
3562	P-SL-PI-183	4	613.54	Ductile Iron	120	2012	Alma
3576	P-SL-PI-193	4	572.23	Ductile Iron	120	2012	Alma
3682	P-SL-PI-282	4	307.62	Ductile Iron	120	2012	Alma
4137	P-SL-PI-485	4	722.09	Ductile Iron	40	1900	Alma
4180	P-SL-PI-507	4	393.96	Ductile Iron	70	1900	Alma
4181	P-SL-PI-508	4	190.91	Ductile Iron	70	1900	Alma
1351	P-A-X-925	4.3	756.02	Ductile Iron	50	1946	Alma
833	P-A-X-41	6	445.83	Ductile Iron	60	1900	Alma
844	P-A-X-56	6	437.14	Ductile Iron	60	1900	Alma
850	P-A-X-69	6	423.55	Ductile Iron	75	1900	Alma
851	P-A-X-71	6	846.15	Ductile Iron	120	2005	Alma
852	P-A-X-73	6	466.93	Ductile Iron	120	2005	Alma
853	P-A-X-74	6	486.99	Ductile Iron	120	2005	Alma
860	P-A-X-84	6	430.53	Ductile Iron	75	1900	Alma
863	P-A-X-88	6	427.59	Ductile Iron	75	1900	Alma
865	P-A-X-92	6	43.97	Ductile Iron	75	1900	Alma
866	P-A-X-93	6	439.49	Ductile Iron	75	1900	Alma
874	P-A-X-110	6	420.3	Ductile Iron	75	1900	Alma
880	P-A-X-127	6	466.56	Ductile Iron	75	1900	Alma
886	P-A-X-136	6	472.52	Ductile Iron	75	0	Alma
888	P-A-X-159	6	306.62	Ductile Iron	75	2006	Alma
890	P-A-X-162	6	75.91	Ductile Iron	75	1900	Alma
900	P-A-X-180	6	472.51	Ductile Iron	75	2009	Alma
912	P-A-X-202	6	365.2	Ductile Iron	75	1900	Alma
913	P-A-X-204	6	472.51	Ductile Iron	75	1906	Alma
915	P-A-X-208	6	15.06	Ductile Iron	75	0	Alma
933	P-A-X-233	6	1,123.22	Ductile Iron	60	1900	Alma
937	P-A-X-241	6	304.04	Ductile Iron	60	1992	Alma
938	P-A-X-242	6	515.71	Ductile Iron	60	1998	Alma
940	P-A-X-246	6	309.41	Ductile Iron	60	1992	Alma
941	P-A-X-247	6	515.71	Ductile Iron	60	1998	Alma
944	P-A-X-250	6	403.34	Ductile Iron	60	1992	Alma
945	P-A-X-251	6	295.1	Ductile Iron	60	1992	Alma
946	P-A-X-252	6	515.71	Ductile Iron	60	1900	Alma
947	P-A-X-253	6	265.18	Ductile Iron	60	1900	Alma
948	P-A-X-255	6	619.35	Ductile Iron	60	1900	Alma
950	P-A-X-258	6	542.98	Ductile Iron	60	0	Alma
952	P-A-X-261	6	279.54	Ductile Iron	60	1979	Alma
953	P-A-X-262	6	251.96	Ductile Iron	60	1900	Alma
954	P-A-X-263	6	263.74	Ductile Iron	60	1900	Alma
955	P-A-X-264	6	263.74	Ductile Iron	60	1900	Alma
969	P-A-X-289	6	617.77	Ductile Iron	60	1900	Alma
975	P-A-X-299	6	280.28	Ductile Iron	55	1900	Alma
976	P-A-X-301	6	553.24	Ductile Iron	60	1900	Alma
977	P-A-X-302	6	13.67	Ductile Iron	60	1900	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
978	P-A-X-305	6	59.76	Ductile Iron	60	1900	Alma
984	P-A-X-312	6	249.51	Ductile Iron	55	1900	Alma
990	P-A-X-326	6	432.99	Ductile Iron	75	1900	Alma
991	P-A-X-327	6	402.9	Ductile Iron	75	1900	Alma
992	P-A-X-328	6	472.51	Ductile Iron	75	1900	Alma
993	P-A-X-329	6	311.51	Ductile Iron	60	1900	Alma
994	P-A-X-331	6	755.82	Ductile Iron	60	1960	Alma
995	P-A-X-333	6	90.12	Ductile Iron	60	1963	Alma
996	P-A-X-334	6	662.13	Ductile Iron	60	1966	Alma
999	P-A-X-338	6	50.56	Ductile Iron	60	1900	Alma
1000	P-A-X-339	6	59.39	Ductile Iron	70	1900	Alma
1002	P-A-X-341	6	392.61	Ductile Iron	70	1900	Alma
1012	P-A-X-357	6	146.63	Ductile Iron	75	1962	Alma
1014	P-A-X-361	6	192.06	Ductile Iron	75	1962	Alma
1015	P-A-X-362	6	163.97	Ductile Iron	75	1962	Alma
1020	P-A-X-368	6	277.45	Ductile Iron	60	1963	Alma
1022	P-A-X-370	6	211.07	Ductile Iron	75	1962	Alma
1023	P-A-X-371	6	242.73	Ductile Iron	75	1962	Alma
1024	P-A-X-372	6	345.87	Ductile Iron	75	1963	Alma
1028	P-A-X-377	6	376.06	Ductile Iron	75	1900	Alma
1029	P-A-X-382	6	237.58	Ductile Iron	75	1900	Alma
1030	P-A-X-383	6	477.74	Ductile Iron	75	1985	Alma
1031	P-A-X-388	6	392.19	Ductile Iron	75	1900	Alma
1032	P-A-X-389	6	477.74	Ductile Iron	75	1985	Alma
1033	P-A-X-391	6	392.19	Ductile Iron	75	1959	Alma
1034	P-A-X-392	6	237.58	Ductile Iron	75	1900	Alma
1035	P-A-X-393	6	208.86	Ductile Iron	75	1900	Alma
1036	P-A-X-394	6	13	Ductile Iron	75	1948	Alma
1037	P-A-X-395	6	719.03	Ductile Iron	75	1948	Alma
1038	P-A-X-396	6	41.13	Ductile Iron	75	1900	Alma
1039	P-A-X-398	6	1,085.35	Ductile Iron	60	1962	Alma
1042	P-A-X-404	6	239.1	Ductile Iron	60	1962	Alma
1043	P-A-X-406	6	314.1	Ductile Iron	60	1962	Alma
1044	P-A-X-407	6	271.21	Ductile Iron	60	1962	Alma
1045	P-A-X-408	6	800.96	Ductile Iron	60	1974	Alma
1046	P-A-X-409	6	708.97	Ductile Iron	60	1974	Alma
1047	P-A-X-410	6	331.15	Ductile Iron	60	1975	Alma
1048	P-A-X-411	6	132.79	Ductile Iron	60	1975	Alma
1049	P-A-X-412	6	121.18	Ductile Iron	60	1975	Alma
1050	P-A-X-413	6	85.48	Ductile Iron	60	1975	Alma
1051	P-A-X-414	6	100.70	Ductile Iron	60	1975	Alma
1052	P-A-X-415	6	192.45	Ductile Iron	60	1975	Alma
1053	P-A-X-416	6	297.30	Ductile Iron	60	1975	Alma
1056	P-A-X-419	6	349.65	Ductile Iron	60	1975	Alma
1060	P-A-X-425	6	309.01	Ductile Iron	60	1975	Alma
1064	P-A-X-429	6	1,010.94	Ductile Iron	75	1949	Alma
1065	P-A-X-430	6	127.49	Ductile Iron	75	1949	Alma
1066	P-A-X-431	6	184.94	Ductile Iron	75	1949	Alma
1067	P-A-X-432	6	146.96	Ductile Iron	75	1949	Alma
1068	P-A-X-433	6	343.99	Ductile Iron	60	1949	Alma
1070	P-A-X-435	6	152.63	Ductile Iron	75	1900	Alma
1071	P-A-X-436	6	823.53	Ductile Iron	75	1900	Alma
1072	P-A-X-437	6	112.06	Ductile Iron	75	1900	Alma
1073	P-A-X-438	6	123.17	Ductile Iron	75	1900	Alma
1086	P-A-X-453	6	307.51	Ductile Iron	75	1999	Alma
1087	P-A-X-456	6	151.59	Ductile Iron	60	1900	Alma
1094	P-A-X-472	6	272.33	Ductile Iron	75	1900	Alma
1099	P-A-X-479	6	135.5	Ductile Iron	75	0	Alma
1100	P-A-X-480	6	423.03	Ductile Iron	75	0	Alma
1101	P-A-X-481	6	267.29	Ductile Iron	75	0	Alma
1102	P-A-X-482	6	217.71	Ductile Iron	75	0	Alma
1106	P-A-X-487	6	542.04	Ductile Iron	60	1979	Alma
1112	P-A-X-495	6	164.11	Ductile Iron	75	0	Alma
1113	P-A-X-496	6	199.33	Ductile Iron	75	0	Alma
1114	P-A-X-497	6	582.46	Ductile Iron	75	0	Alma
1116	P-A-X-505	6	835.37	Ductile Iron	60	1937	Alma
1117	P-A-X-506	6	441.42	Ductile Iron	60	1900	Alma
1119	P-A-X-509	6	602.68	Ductile Iron	60	1977	Alma
1131	P-A-X-532	6	1,619.29	Ductile Iron	60	1900	Alma
1132	P-A-X-533	6	101.97	Ductile Iron	75	1900	Alma
1152	P-A-X-579	6	422.51	Ductile Iron	60	1900	Alma
1153	P-A-X-580	6	225.42	Ductile Iron	60	1900	Alma
1154	P-A-X-583	6	422.51	Ductile Iron	60	1900	Alma
1155	P-A-X-585	6	174.05	Ductile Iron	75	2002	Alma
1156	P-A-X-586	6	25.65	Ductile Iron	60	0	Alma
1169	P-A-X-607	6	344.06	Ductile Iron	70	1974	Alma
1170	P-A-X-608	6	348.13	Ductile Iron	70	1974	Alma
1171	P-A-X-611	6	205.45	Ductile Iron	70	1974	Alma
1173	P-A-X-613	6	205.45	Ductile Iron	70	1974	Alma
1174	P-A-X-614	6	344.06	Ductile Iron	50	1900	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1176	P-A-X-618	6	267.92	Ductile Iron	75	1963	Alma
1182	P-A-X-631	6	236.35	Ductile Iron	75	2002	Alma
1189	P-A-X-641	6	244.3	Ductile Iron	75	2002	Alma
1190	P-A-X-642	6	1,081.72	Ductile Iron	75	1900	Alma
1193	P-A-X-647	6	566.49	Ductile Iron	40	1900	Alma
1195	P-A-X-654	6	566.49	Ductile Iron	40	1900	Alma
1200	P-A-X-659	6	566.49	Ductile Iron	40	1900	Alma
1201	P-A-X-660	6	183.67	Ductile Iron	40	1900	Alma
1202	P-A-X-662	6	542.28	Ductile Iron	40	1900	Alma
1203	P-A-X-664	6	318.2	Ductile Iron	40	1900	Alma
1204	P-A-X-665	6	542.28	Ductile Iron	40	1900	Alma
1205	P-A-X-666	6	398.22	Ductile Iron	40	1900	Alma
1206	P-A-X-667	6	495.73	Ductile Iron	40	1900	Alma
1207	P-A-X-668	6	542.28	Ductile Iron	40	1900	Alma
1208	P-A-X-669	6	403.11	Ductile Iron	75	1993	Alma
1209	P-A-X-671	6	424.53	Ductile Iron	75	1993	Alma
1210	P-A-X-672	6	191.15	Ductile Iron	75	1993	Alma
1211	P-A-X-673	6	181.63	Ductile Iron	75	1993	Alma
1214	P-A-X-676	6	547.33	Ductile Iron	75	1900	Alma
1215	P-A-X-677	6	162.06	Ductile Iron	75	1993	Alma
1217	P-A-X-679	6	38.05	Ductile Iron	75	0	Alma
1218	P-A-X-680	6	547.78	Ductile Iron	75	1920	Alma
1219	P-A-X-681	6	384.78	Ductile Iron	75	1961	Alma
1220	P-A-X-682	6	159.11	Ductile Iron	75	1993	Alma
1221	P-A-X-683	6	119	Ductile Iron	75	1993	Alma
1222	P-A-X-684	6	144.63	Ductile Iron	75	1961	Alma
1224	P-A-X-687	6	276.64	Ductile Iron	75	1900	Alma
1225	P-A-X-688	6	257.3	Ductile Iron	75	1900	Alma
1226	P-A-X-689	6	276.64	Ductile Iron	75	1900	Alma
1227	P-A-X-690	6	749.2	Ductile Iron	75	1976	Alma
1231	P-A-X-696	6	303.09	Ductile Iron	40	1900	Alma
1232	P-A-X-697	6	263.41	Ductile Iron	40	1900	Alma
1233	P-A-X-698	6	263.41	Ductile Iron	35	1900	Alma
1234	P-A-X-699	6	303.09	Ductile Iron	35	1900	Alma
1235	P-A-X-700	6	773.63	Ductile Iron	35	1900	Alma
1237	P-A-X-705	6	528.24	Ductile Iron	40	1900	Alma
1238	P-A-X-706	6	25.86	Ductile Iron	40	1900	Alma
1239	P-A-X-708	6	344.06	Ductile Iron	40	1900	Alma
1241	P-A-X-710	6	398.22	Ductile Iron	40	1900	Alma
1242	P-A-X-711	6	495.73	Ductile Iron	40	1900	Alma
1245	P-A-X-714	6	495.73	Ductile Iron	40	1900	Alma
1247	P-A-X-717	6	344.06	Ductile Iron	40	1980	Alma
1248	P-A-X-718	6	545.95	Ductile Iron	40	1980	Alma
1249	P-A-X-720	6	398.22	Ductile Iron	40	1951	Alma
1251	P-A-X-723	6	322.42	Ductile Iron	40	1900	Alma
1252	P-A-X-724	6	36.19	Ductile Iron	40	1900	Alma
1253	P-A-X-725	6	322.42	Ductile Iron	40	1900	Alma
1254	P-A-X-726	6	674.68	Ductile Iron	40	1900	Alma
1255	P-A-X-728	6	91.94	Ductile Iron	40	1951	Alma
1257	P-A-X-730	6	315.29	Ductile Iron	40	1980	Alma
1258	P-A-X-731	6	121.02	Ductile Iron	40	1900	Alma
1259	P-A-X-732	6	315.29	Ductile Iron	40	1951	Alma
1260	P-A-X-733	6	674.68	Ductile Iron	40	1980	Alma
1261	P-A-X-735	6	333.26	Ductile Iron	40	1900	Alma
1262	P-A-X-736	6	528.24	Ductile Iron	40	1900	Alma
1263	P-A-X-737	6	333.26	Ductile Iron	60	1980	Alma
1265	P-A-X-739	6	269.51	Ductile Iron	35	0	Alma
1266	P-A-X-740	6	272.77	Ductile Iron	40	1976	Alma
1267	P-A-X-741	6	1,162.48	Ductile Iron	35	1974	Alma
1268	P-A-X-742	6	1,162.48	Ductile Iron	40	1980	Alma
1272	P-A-X-746	6	79.13	Ductile Iron	75	1993	Alma
1274	P-A-X-748	6	952.17	Ductile Iron	75	1900	Alma
1283	P-A-X-778	6	89.08	Ductile Iron	75	1900	Alma
1285	P-A-X-781	6	509.85	Ductile Iron	50	1900	Alma
1286	P-A-X-784	6	355.07	Ductile Iron	60	1900	Alma
1293	P-A-X-797	6	414.28	Ductile Iron	20	1900	Alma
1294	P-A-X-802	6	686.38	Ductile Iron	20	1900	Alma
1295	P-A-X-810	6	294.91	Ductile Iron	40	1900	Alma
1296	P-A-X-811	6	559.4	Ductile Iron	40	1900	Alma
1297	P-A-X-812	6	260.03	Ductile Iron	40	1900	Alma
1300	P-A-X-823	6	306.34	Ductile Iron	20	1928	Alma
1313	P-A-X-853	6	45.57	Ductile Iron	60	1920	Alma
1326	P-A-X-875	6	116.77	Ductile Iron	60	1900	Alma
1327	P-A-X-877	6	477.58	Ductile Iron	60	1971	Alma
1328	P-A-X-878	6	22.7	Ductile Iron	60	0	Alma
1329	P-A-X-880	6	21.33	Ductile Iron	60	1900	Alma
1334	P-A-X-897	6	30.24	Ductile Iron	60	1928	Alma
1335	P-A-X-898	6	1,241.93	Ductile Iron	60	1928	Alma
1336	P-A-X-899	6	822.81	Ductile Iron	60	1925	Alma
1337	P-A-X-903	6	647.71	Ductile Iron	60	1948	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1338	P-A-X-904	6	657.51	Ductile Iron	60	1948	Alma
1341	P-A-X-911	6	282.02	Ductile Iron	60	1955	Alma
1342	P-A-X-912	6	521.79	Ductile Iron	60	1955	Alma
1345	P-A-X-915	6	314.8	Ductile Iron	60	1986	Alma
1346	P-A-X-916	6	300.33	Ductile Iron	60	1986	Alma
1347	P-A-X-920	6	342.14	Ductile Iron	60	1920	Alma
1348	P-A-X-921	6	51.82	Ductile Iron	60	1920	Alma
1349	P-A-X-922	6	565.15	Ductile Iron	60	1961	Alma
1350	P-A-X-924	6	310.16	Ductile Iron	60	1928	Alma
1356	P-A-X-930	6	647.71	Ductile Iron	60	1979	Alma
1357	P-A-X-931	6	230.38	Ductile Iron	60	1955	Alma
1358	P-A-X-932	6	476.69	Ductile Iron	50	1920	Alma
1359	P-A-X-933	6	1,223.46	Ductile Iron	70	1971	Alma
1360	P-A-X-934	6	361.33	Ductile Iron	90	1974	Alma
1361	P-A-X-935	6	327.11	Ductile Iron	60	1900	Alma
1362	P-A-X-936	6	321.59	Ductile Iron	75	1900	Alma
1370	P-A-X-945	6	52.37	Ductile Iron	60	0	Alma
1372	P-A-X-947	6	398.34	Ductile Iron	40	1900	Alma
1373	P-A-X-948	6	544.86	Ductile Iron	40	1966	Alma
1375	P-A-X-950	6	246.2	Ductile Iron	40	0	Alma
1378	P-A-X-953	6	308.86	Ductile Iron	75	1900	Alma
1379	P-A-X-955	6	189.31	Ductile Iron	75	1900	Alma
1380	P-A-X-954	6	620.33	Ductile Iron	60	0	Alma
1397	P-A-X-997	6	122.94	Ductile Iron	75	0	Alma
1399	P-A-X-999	6	416.28	Ductile Iron	75	1985	Alma
1406	P-A-X-1006	6	147.99	Ductile Iron	20	1928	Alma
1421	P-A-X-1022	6	489.18	Ductile Iron	75	1997	Alma
1429	P-A-X-1031	6	464.45	Ductile Iron	75	0	Alma
1430	P-A-X-1032	6	547.94	Ductile Iron	75	0	Alma
1431	P-A-X-1033	6	139.74	Ductile Iron	75	0	Alma
1432	P-A-X-1034	6	333.96	Ductile Iron	75	0	Alma
1434	P-A-X-1037	6	137.77	Ductile Iron	75	0	Alma
1437	P-A-X-1040	6	546.48	Ductile Iron	75	0	Alma
1438	P-A-X-1041	6	397.48	Ductile Iron	75	0	Alma
1439	P-A-X-1042	6	377.71	Ductile Iron	75	0	Alma
1440	P-A-X-1043	6	302.22	Ductile Iron	75	0	Alma
1441	P-A-X-1045	6	372.51	Ductile Iron	75	1900	Alma
1442	P-A-X-1046	6	250.77	Ductile Iron	75	1900	Alma
1443	P-A-X-1047	6	152.22	Ductile Iron	75	1900	Alma
1446	P-A-X-1050	6	305.75	Ductile Iron	75	1900	Alma
1447	P-A-X-1051	6	40.97	Ductile Iron	75	1900	Alma
1453	P-A-X-1059	6	38.06	Ductile Iron	75	1900	Alma
1454	P-A-X-1060	6	203.6	Ductile Iron	75	1900	Alma
1455	P-A-X-1061	6	281.91	Ductile Iron	75	1900	Alma
1456	P-A-X-1062	6	88.1	Ductile Iron	75	1900	Alma
1457	P-A-X-1063	6	90.68	Ductile Iron	75	1900	Alma
1458	P-A-X-1064	6	184.84	Ductile Iron	75	1900	Alma
1459	P-A-X-1065	6	184.86	Ductile Iron	75	1900	Alma
1467	P-A-X-1074	6	1,267.32	Ductile Iron	75	0	Alma
1476	P-A-X-1088	6	341.46	Ductile Iron	120	1991	Alma
1477	P-A-X-1089	6	244.82	Ductile Iron	120	1991	Alma
1478	P-A-X-1090	6	346.29	Ductile Iron	60	1928	Alma
1479	P-A-X-1091	6	339.41	Ductile Iron	60	1928	Alma
1487	P-A-X-1110	6	122.59	Ductile Iron	40	1900	Alma
1491	P-A-X-1124	6	157.47	Ductile Iron	10	1900	Alma
1495	P-A-X-1128	6	22.2	Ductile Iron	50	0	Alma
1501	P-A-X-1134	6	20.86	Ductile Iron	60	1900	Alma
1505	P-A-X-471A	6	681.7	Ductile Iron	70	1900	Alma
1506	P-A-X-471B	6	397.47	Ductile Iron	75	1900	Alma
1509	P-A-X-719B	6	393.86	Ductile Iron	40	1951	Alma
1510	P-A-X-719A	6	548.94	Ductile Iron	40	1951	Alma
1515	P-A-X-405B	6	213.78	Ductile Iron	60	1962	Alma
1516	P-A-X-405A	6	555.77	Ductile Iron	60	1962	Alma
1517	P-A-X-919A	6	98.98	Ductile Iron	60	1979	Alma
1518	P-A-X-919B	6	715.82	Ductile Iron	120	1979	Alma
1519	P-A-X-403B	6	41.18	Ductile Iron	75	1962	Alma
1520	P-A-X-403A	6	112.21	Ductile Iron	60	1962	Alma
1523	P-A-X-316A	6	488.29	Ductile Iron	60	1900	Alma
1528	P-A-X-1141	6	320.76	Ductile Iron	75	1900	Alma
1529	P-A-X-1142	6	10.06	Ductile Iron	75	1900	Alma
1532	P-A-X-1149	6	34.38	Ductile Iron	100	0	Alma
1549	P-A-X-1170	6	18.48	Ductile Iron	55	0	Alma
1550	P-A-X-1171	6	161.3	Ductile Iron	50	1920	Alma
1551	P-A-X-1172	6	642.1	Ductile Iron	70	1975	Alma
1552	P-A-X-1173	6	38.34	Ductile Iron	60	1900	Alma
1555	P-A-X-1176	6	33.46	Ductile Iron	60	1900	Alma
1556	P-A-X-1177	6	43.61	Ductile Iron	50	1900	Alma
1557	P-A-X-1178	6	431.38	Ductile Iron	70	1974	Alma
1560	P-A-X-1181	6	44.82	Ductile Iron	50	1900	Alma
1561	P-A-X-1182	6	26.8	Ductile Iron	60	0	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1563	P-A-X-1186	6	23.98	Ductile Iron	60	1900	Alma
1564	P-A-X-1187	6	608.47	Ductile Iron	60	1963	Alma
1565	P-A-X-1188	6	31.26	Ductile Iron	75	0	Alma
1568	P-A-X-1191	6	80.41	Ductile Iron	100	0	Alma
1573	P-A-X-1196	6	30.59	Ductile Iron	100	0	Alma
1578	P-A-X-1201	6	840.69	Ductile Iron	60	1940	Alma
1580	P-A-X-1203	6	315.27	Ductile Iron	60	1900	Alma
1587	P-A-X-1210	6	383.08	Ductile Iron	100	2009	Alma
1592	P-A-X-1215	6	500	Ductile Iron	75	1900	Alma
1593	P-A-X-1216	6	453.86	Ductile Iron	75	1900	Alma
1594	P-A-X-1217	6	850	Ductile Iron	100	1900	Alma
1597	P-A-X-1220	6	284.72	Ductile Iron	40	1900	Alma
1602	P-A-X-317	6	473.08	Ductile Iron	60	1900	Alma
1603	P-A-X-318	6	465.41	Ductile Iron	60	1900	Alma
1671	P-A-CI-20	6	707.75	Ductile Iron	100	2007	Alma
1674	P-A-X-29	6	38.78	Ductile Iron	80	1900	Alma
1683	P-A-X-42	6	624.49	Ductile Iron	60	1991	Alma
1684	P-A-X-46	6	687.41	Ductile Iron	60	0	Alma
1685	P-A-X-47	6	416.91	Ductile Iron	60	1998	Alma
2986	P-A-CI-13	6	304.69	Ductile Iron	120	2008	Alma
3537	P-SL-PI-167	6	346.87	Ductile Iron	120	2012	Alma
3538	P-SL-PI-168	6	338.87	Ductile Iron	120	2012	Alma
3539	P-SL-PI-169	6	28.98	Ductile Iron	60	0	Alma
3578	P-SL-PI-195	6	41.5	Ductile Iron	60	0	Alma
3584	P-SL-PI-200	6	602.71	Ductile Iron	60	1900	Alma
3708	P-SL-PI-297	6	6.29	Ductile Iron	120	2012	Alma
3910	P-SL-PI-396	6	13.39	Ductile Iron	75	0	Alma
4017	P-SL-PI-461	6	218.21	Ductile Iron	60	1940	Alma
4018	P-SL-PI-462	6	516.02	Ductile Iron	60	1940	Alma
830	P-A-X-33	8	185.8	Ductile Iron	70	1900	Alma
834	P-A-X-43	8	341.61	Ductile Iron	80	2011	Alma
835	P-A-X-44	8	445.83	Ductile Iron	80	2011	Alma
842	P-A-X-54	8	399.21	Ductile Iron	70	1900	Alma
843	P-A-X-55	8	271.79	Ductile Iron	70	1900	Alma
849	P-A-X-66	8	423.55	Ductile Iron	110	1999	Alma
854	P-A-X-75	8	430.53	Ductile Iron	110	1999	Alma
855	P-A-X-76	8	465.42	Ductile Iron	80	1999	Alma
856	P-A-X-77	8	854.08	Ductile Iron	100	1998	Alma
857	P-A-X-79	8	842.44	Ductile Iron	70	1900	Alma
858	P-A-X-80	8	854.08	Ductile Iron	110	1997	Alma
859	P-A-X-82	8	474.17	Ductile Iron	70	1900	Alma
862	P-A-X-87	8	483.46	Ductile Iron	70	1900	Alma
864	P-A-X-89	8	427.59	Ductile Iron	110	1997	Alma
869	P-A-X-103	8	467.1	Ductile Iron	80	1998	Alma
873	P-A-X-109	8	24.86	Ductile Iron	70	1900	Alma
883	P-A-X-133	8	472.52	Ductile Iron	70	1900	Alma
891	P-A-X-163	8	393.24	Ductile Iron	70	1900	Alma
892	P-A-X-166	8	26.73	Ductile Iron	70	0	Alma
893	P-A-X-167	8	282.92	Ductile Iron	70	1920	Alma
896	P-A-X-171	8	472.51	Ductile Iron	70	1900	Alma
897	P-A-X-177	8	446.86	Ductile Iron	70	1900	Alma
906	P-A-X-188	8	509.44	Ductile Iron	110	1995	Alma
925	P-A-X-223	8	404.86	Ductile Iron	70	1900	Alma
936	P-A-X-239	8	304.04	Ductile Iron	80	1998	Alma
939	P-A-X-244	8	309.41	Ductile Iron	80	1998	Alma
942	P-A-X-248	8	403.34	Ductile Iron	80	1998	Alma
943	P-A-X-249	8	295.1	Ductile Iron	80	1998	Alma
957	P-A-X-269	8	331.52	Ductile Iron	70	1900	Alma
958	P-A-X-270	8	35.72	Ductile Iron	70	1900	Alma
966	P-A-X-285	8	51.29	Ductile Iron	70	1900	Alma
967	P-A-X-286	8	79.17	Ductile Iron	70	1900	Alma
968	P-A-X-287	8	449.08	Ductile Iron	70	1900	Alma
970	P-A-X-290	8	371.08	Ductile Iron	70	1900	Alma
971	P-A-X-291	8	68.13	Ductile Iron	70	0	Alma
997	P-A-X-336	8	137.79	Ductile Iron	70	1900	Alma
998	P-A-X-337	8	134.3	Ductile Iron	70	1900	Alma
1001	P-A-X-340	8	431.29	Ductile Iron	70	1900	Alma
1003	P-A-X-343	8	129.61	Ductile Iron	70	1900	Alma
1004	P-A-X-344	8	400.88	Ductile Iron	70	1900	Alma
1005	P-A-X-345	8	400.12	Ductile Iron	70	1900	Alma
1006	P-A-X-346	8	218.81	Ductile Iron	70	1900	Alma
1007	P-A-X-348	8	100.03	Ductile Iron	70	1900	Alma
1008	P-A-X-349	8	337.96	Ductile Iron	70	1900	Alma
1058	P-A-X-423	8	378.25	Ductile Iron	70	1900	Alma
1059	P-A-X-424	8	265.22	Ductile Iron	80	1975	Alma
1091	P-A-X-465	8	70.22	Ductile Iron	70	1900	Alma
1092	P-A-X-466	8	27.8	Ductile Iron	70	1900	Alma
1095	P-A-X-473	8	1,364.01	Ductile Iron	70	1900	Alma
1096	P-A-X-474	8	611.14	Ductile Iron	70	1900	Alma
1098	P-A-X-478	8	233.61	Ductile Iron	70	0	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1183	P-A-X-635	8	581.61	Ductile Iron	70	1900	Alma
1186	P-A-X-638	8	47.32	Ductile Iron	70	0	Alma
1198	P-A-X-657	8	318.2	Ductile Iron	70	1948	Alma
1199	P-A-X-658	8	495.73	Ductile Iron	70	1948	Alma
1212	P-A-X-674	8	532.6	Ductile Iron	70	1900	Alma
1213	P-A-X-675	8	38.05	Ductile Iron	70	0	Alma
1228	P-A-X-692	8	359.12	Ductile Iron	70	1948	Alma
1229	P-A-X-693	8	773.63	Ductile Iron	70	1948	Alma
1236	P-A-X-702	8	388.85	Ductile Iron	70	1948	Alma
1282	P-A-X-777	8	341.1	Ductile Iron	70	1900	Alma
1284	P-A-X-780	8	279.53	Ductile Iron	70	1925	Alma
1287	P-A-X-786	8	30.59	Ductile Iron	70	0	Alma
1289	P-A-X-788	8	479.77	Ductile Iron	70	1900	Alma
1291	P-A-X-794	8	482.74	Ductile Iron	70	1925	Alma
1292	P-A-X-795	8	723.77	Ductile Iron	70	1925	Alma
1304	P-A-X-834	8	496.9	Ductile Iron	110	1975	Alma
1311	P-A-X-846	8	55.76	Ductile Iron	70	1925	Alma
1322	P-A-X-870	8	185.17	Ductile Iron	70	1925	Alma
1323	P-A-X-872	8	113.84	Ductile Iron	70	1900	Alma
1324	P-A-X-873	8	23.89	Ductile Iron	70	1925	Alma
1325	P-A-X-874	8	119.15	Ductile Iron	70	1925	Alma
1330	P-A-X-888	8	21.83	Ductile Iron	70	1925	Alma
1333	P-A-X-894	8	23.75	Ductile Iron	70	1925	Alma
1354	P-A-X-928	8	316.53	Ductile Iron	70	1925	Alma
1355	P-A-X-929	8	417.65	Ductile Iron	70	1925	Alma
1385	P-A-X-965	8	387.9	Ductile Iron	70	1900	Alma
1390	P-A-X-984	8	50.18	Ductile Iron	70	1900	Alma
1391	P-A-X-985	8	396.27	Ductile Iron	70	1900	Alma
1393	P-A-X-992	8	23.33	Ductile Iron	70	1900	Alma
1396	P-A-X-996	8	1,730.23	Ductile Iron	110	1977	Alma
1404	P-A-X-1004	8	76.76	Ductile Iron	70	1900	Alma
1423	P-A-X-1025	8	352.56	Ductile Iron	70	1900	Alma
1424	P-A-X-1026	8	300.09	Ductile Iron	70	1900	Alma
1425	P-A-X-1027	8	867.28	Ductile Iron	110	1996	Alma
1426	P-A-X-1028	8	104.06	Ductile Iron	70	1920	Alma
1444	P-A-X-1048	8	220.94	Ductile Iron	70	1900	Alma
1445	P-A-X-1049	8	215.49	Ductile Iron	70	1900	Alma
1465	P-A-X-1072	8	352.93	Ductile Iron	70	1900	Alma
1466	P-A-X-1073	8	445.24	Ductile Iron	70	1900	Alma
1489	P-A-X-1112	8	118.77	Ductile Iron	70	1900	Alma
1490	P-A-X-1113	8	53.55	Ductile Iron	60	2000	Alma
1493	P-A-X-849A	8	218.61	Ductile Iron	70	1900	Alma
1494	P-A-X-849B	8	461.03	Ductile Iron	70	1900	Alma
1498	P-A-X-1131	8	17.78	Ductile Iron	70	0	Alma
1511	P-A-X-342B	8	398.73	Ductile Iron	70	1900	Alma
1512	P-A-X-342A	8	423.93	Ductile Iron	70	1900	Alma
1513	P-A-X-347B	8	504.34	Ductile Iron	70	1900	Alma
1514	P-A-X-347A	8	509.67	Ductile Iron	70	1900	Alma
1524	P-A-X-298B	8	55.9	Ductile Iron	75	1997	Alma
1525	P-A-X-298A	8	545.08	Ductile Iron	75	1997	Alma
1527	P-A-X-1140	8	33.84	Ductile Iron	70	1900	Alma
1534	P-A-X-1155	8	153.54	Ductile Iron	70	0	Alma
1535	P-A-X-1156	8	324.53	Ductile Iron	70	1900	Alma
1574	P-A-X-1197	8	363.3	Ductile Iron	70	1948	Alma
1575	P-A-X-1198	8	34.92	Ductile Iron	70	1948	Alma
1588	P-A-X-1211	8	300.1	Ductile Iron	80	1996	Alma
1589	P-A-X-1212	8	99.3	Ductile Iron	80	1996	Alma
1590	P-A-X-1213	8	99.21	Ductile Iron	80	1996	Alma
1591	P-A-X-1214	8	614.92	Ductile Iron	70	1900	Alma
1600	P-A-X-1224	8	506.08	Ductile Iron	70	1900	Alma
1609	P-A-X-1259	8	281.14	Ductile Iron	120	2006	Alma
1610	P-A-X-1260	8	428.68	Ductile Iron	120	2006	Alma
1611	P-A-X-1261	8	427.86	Ductile Iron	120	2006	Alma
1612	P-A-X-1262	8	249.26	Ductile Iron	80	2006	Alma
1667	P-A-CI-16	8	1,714.75	Ductile Iron	105	2007	Alma
1676	P-A-X-31	8	30.21	Ductile Iron	70	1900	Alma
1677	P-A-X-32	8	417.19	Ductile Iron	70	1900	Alma
1678	P-A-X-34	8	413.37	Ductile Iron	70	1900	Alma
1679	P-A-X-35	8	34.03	Ductile Iron	70	1900	Alma
1680	P-A-X-36	8	33.25	Ductile Iron	70	1900	Alma
1692	P-A-X-68	8	27.06	Ductile Iron	70	0	Alma
2989	P-A-CI-14	8	466.57	Ductile Iron	120	2007	Alma
2998	P-A-CI-18	8	1,016.54	Ductile Iron	80	2007	Alma
3544	P-SL-PI-172	8	546.75	Ductile Iron	100	2012	Alma
3546	P-SL-PI-173	8	548.07	Ductile Iron	100	2012	Alma
3548	P-SL-PI-174	8	619.58	Ductile Iron	100	2012	Alma
3550	P-SL-PI-175	8	528.01	Ductile Iron	100	2012	Alma
3554	P-SL-PI-178	8	556.66	Ductile Iron	100	2012	Alma
3557	P-SL-PI-179	8	608.08	Ductile Iron	100	2012	Alma
3588	P-SL-PI-203	8	298.37	Ductile Iron	80	2011	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
3870	P-SL-PI-366	8	210.88	Ductile Iron	70	1900	Alma
3902	P-SL-PI-390	8	35.53	Ductile Iron	120	2007	Alma
3912	P-SL-PI-398	8	26.82	Ductile Iron	80	2007	Alma
3917	P-SL-PI-401	8	16	Ductile Iron	120	2007	Alma
3923	P-SL-PI-405	8	152.79	Ductile Iron	110	1975	Alma
876	P-A-X-119	10	430.53	Ductile Iron	80	0	Alma
887	P-A-X-158	10	14.03	Ductile Iron	80	1900	Alma
924	P-A-X-222	10	16.2	Ductile Iron	80	1900	Alma
1079	P-A-X-445	10	13.64	Ductile Iron	80	0	Alma
1085	P-A-X-452	10	27.23	Ductile Iron	80	1999	Alma
1136	P-A-X-548	10	709.72	Ductile Iron	80	1900	Alma
1137	P-A-X-551	10	1,407.43	Ductile Iron	80	1900	Alma
1138	P-A-X-554	10	345.34	Ductile Iron	80	1900	Alma
1140	P-A-X-560	10	35.77	Ductile Iron	80	1900	Alma
1141	P-A-X-561	10	41.45	Ductile Iron	80	1900	Alma
1142	P-A-X-565	10	138.35	Ductile Iron	80	1900	Alma
1143	P-A-X-566	10	26.07	Ductile Iron	80	1900	Alma
1149	P-A-X-573	10	122.47	Ductile Iron	80	1900	Alma
1150	P-A-X-574	10	24.52	Ductile Iron	80	1900	Alma
1312	P-A-X-848	10	495.92	Ductile Iron	70	1965	Alma
1314	P-A-X-854	10	24.9	Ductile Iron	80	0	Alma
1317	P-A-X-859	10	647.71	Ductile Iron	80	1925	Alma
1318	P-A-X-860	10	706.38	Ductile Iron	40	1920	Alma
1319	P-A-X-867	10	67.58	Ductile Iron	80	1900	Alma
1320	P-A-X-868	10	153.04	Ductile Iron	80	1900	Alma
1321	P-A-X-869	10	61.33	Ductile Iron	80	1900	Alma
1376	P-A-X-951	10	50.93	Ductile Iron	80	0	Alma
1377	P-A-X-952	10	376.66	Ductile Iron	80	1900	Alma
1402	P-A-X-1002	10	1,481.76	Ductile Iron	80	1900	Alma
1403	P-A-X-1003	10	44.59	Ductile Iron	80	1900	Alma
1468	P-A-X-1075	10	1,314.41	Ductile Iron	80	1900	Alma
1496	P-A-X-847A	10	272.45	Ductile Iron	60	1965	Alma
1497	P-A-X-847B	10	374.14	Ductile Iron	60	1965	Alma
1503	P-A-X-844	10	80.93	Ductile Iron	80	1965	Alma
1533	P-A-X-1150	10	319.73	Ductile Iron	80	1965	Alma
1538	P-A-X-1159	10	19.45	Ductile Iron	80	0	Alma
1541	P-A-X-1162	10	46.55	Ductile Iron	80	0	Alma
1582	P-A-X-1205	10	26.71	Ductile Iron	80	0	Alma
1583	P-A-X-1206	10	396.84	Ductile Iron	80	0	Alma
3884	P-SL-PI-377	10	189.17	Ductile Iron	80	2014	Alma
3899	P-SL-PI-387	10	19.49	Ductile Iron	80	0	Alma
3900	P-SL-PI-388	10	323.93	Ductile Iron	60	1965	Alma
845	P-A-X-58	12	24.64	Ductile Iron	90	1900	Alma
846	P-A-X-61	12	483.46	Ductile Iron	100	2006	Alma
847	P-A-X-62	12	474.17	Ductile Iron	100	2006	Alma
868	P-A-X-101	12	840.62	Ductile Iron	90	1954	Alma
870	P-A-X-104	12	31.34	Ductile Iron	100	1954	Alma
871	P-A-X-105	12	440.73	Ductile Iron	90	1954	Alma
872	P-A-X-108	12	31.38	Ductile Iron	90	1954	Alma
889	P-A-X-160	12	1,314.77	Ductile Iron	90	1900	Alma
917	P-A-X-212	12	22.83	Ductile Iron	100	1954	Alma
918	P-A-X-214	12	31.62	Ductile Iron	100	1954	Alma
919	P-A-X-216	12	1,221.52	Ductile Iron	100	1954	Alma
921	P-A-X-218	12	82	Ductile Iron	100	1954	Alma
922	P-A-X-219	12	312.18	Ductile Iron	100	1954	Alma
926	P-A-X-224	12	48.95	Ductile Iron	90	1954	Alma
927	P-A-X-225	12	48.05	Ductile Iron	100	1954	Alma
930	P-A-X-228	12	121.9	Ductile Iron	100	2006	Alma
931	P-A-X-231	12	37.66	Ductile Iron	100	0	Alma
932	P-A-X-232	12	411.82	Ductile Iron	90	1954	Alma
934	P-A-X-234	12	515.71	Ductile Iron	100	2006	Alma
935	P-A-X-235	12	204.84	Ductile Iron	100	2006	Alma
949	P-A-X-257	12	571.61	Ductile Iron	90	1954	Alma
951	P-A-X-260	12	522.5	Ductile Iron	90	1954	Alma
956	P-A-X-267	12	1,275.02	Ductile Iron	80	1954	Alma
961	P-A-X-279	12	106.68	Ductile Iron	100	1900	Alma
963	P-A-X-282	12	1,319.37	Ductile Iron	80	1977	Alma
964	P-A-X-283	12	104.59	Ductile Iron	90	0	Alma
974	P-A-X-297	12	134.19	Ductile Iron	70	1900	Alma
982	P-A-X-309	12	309.69	Ductile Iron	100	1900	Alma
1009	P-A-X-350	12	308.88	Ductile Iron	90	1900	Alma
1010	P-A-X-351	12	257.81	Ductile Iron	90	1900	Alma
1011	P-A-X-352	12	135.75	Ductile Iron	90	1900	Alma
1016	P-A-X-363	12	31.79	Ductile Iron	90	0	Alma
1017	P-A-X-364	12	14.32	Ductile Iron	100	1962	Alma
1018	P-A-X-365	12	261.14	Ductile Iron	90	0	Alma
1019	P-A-X-366	12	439.22	Ductile Iron	90	1954	Alma
1021	P-A-X-369	12	201.29	Ductile Iron	90	1948	Alma
1040	P-A-X-399	12	49.02	Ductile Iron	100	0	Alma
1041	P-A-X-402	12	535.37	Ductile Iron	100	1962	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1054	P-A-X-417	12	111.2	Ductile Iron	100	1985	Alma
1055	P-A-X-418	12	620.82	Ductile Iron	100	1985	Alma
1057	P-A-X-421	12	479.65	Ductile Iron	100	1985	Alma
1062	P-A-X-427	12	1,636.05	Ductile Iron	100	1962	Alma
1063	P-A-X-428	12	482.95	Ductile Iron	90	1900	Alma
1069	P-A-X-434	12	209.19	Ductile Iron	100	1962	Alma
1074	P-A-X-439	12	179.67	Ductile Iron	100	1962	Alma
1075	P-A-X-440	12	920.53	Ductile Iron	100	1962	Alma
1076	P-A-X-442	12	134.35	Ductile Iron	100	1954	Alma
1077	P-A-X-443	12	120.66	Ductile Iron	100	1954	Alma
1078	P-A-X-444	12	87.91	Ductile Iron	100	1954	Alma
1080	P-A-X-446	12	238.85	Ductile Iron	100	1954	Alma
1081	P-A-X-447	12	346.29	Ductile Iron	100	1954	Alma
1082	P-A-X-448	12	400.97	Ductile Iron	90	1900	Alma
1083	P-A-X-449	12	37.8	Ductile Iron	90	1900	Alma
1084	P-A-X-450	12	225.11	Ductile Iron	90	1999	Alma
1088	P-A-X-457	12	211.92	Ductile Iron	100	2006	Alma
1089	P-A-X-458	12	112.32	Ductile Iron	90	2006	Alma
1090	P-A-X-462	12	1,365.74	Ductile Iron	75	1954	Alma
1093	P-A-X-469	12	633.14	Ductile Iron	75	1900	Alma
1097	P-A-X-477	12	457.66	Ductile Iron	70	1900	Alma
1125	P-A-X-517	12	325.28	Ductile Iron	80	1900	Alma
1147	P-A-X-570	12	518.49	Ductile Iron	100	1954	Alma
1148	P-A-X-572	12	987.08	Ductile Iron	90	1900	Alma
1162	P-A-X-594	12	341	Ductile Iron	100	1900	Alma
1163	P-A-X-595	12	594.35	Ductile Iron	90	1954	Alma
1164	P-A-X-597	12	1,347.00	Ductile Iron	60	1900	Alma
1165	P-A-X-598	12	350.77	Ductile Iron	90	1954	Alma
1166	P-A-X-599	12	559.06	Ductile Iron	90	1954	Alma
1167	P-A-X-602	12	133.13	Ductile Iron	90	1954	Alma
1168	P-A-X-603	12	92.29	Ductile Iron	100	1954	Alma
1181	P-A-X-628	12	297.05	Ductile Iron	100	1964	Alma
1280	P-A-X-766	12	121.06	Ductile Iron	80	1954	Alma
1281	P-A-X-767	12	52.97	Ductile Iron	80	1954	Alma
1298	P-A-X-816	12	82.5	Ductile Iron	50	1900	Alma
1299	P-A-X-822	12	773.03	Ductile Iron	50	1963	Alma
1301	P-A-X-832	12	398.75	Ductile Iron	100	1975	Alma
1302	P-A-X-831	12	1,022.48	Ductile Iron	100	1975	Alma
1303	P-A-X-833	12	757.02	Ductile Iron	100	1975	Alma
1306	P-A-X-837	12	377.48	Ductile Iron	100	1990	Alma
1307	P-A-X-838	12	135.69	Ductile Iron	100	1990	Alma
1308	P-A-X-839	12	147.45	Ductile Iron	100	1990	Alma
1309	P-A-X-840	12	233.49	Ductile Iron	100	1990	Alma
1310	P-A-X-841	12	331.39	Ductile Iron	100	1990	Alma
1331	P-A-X-889	12	15.71	Ductile Iron	100	1954	Alma
1332	P-A-X-891	12	733.66	Ductile Iron	100	1954	Alma
1340	P-A-X-909	12	317.19	Ductile Iron	100	1954	Alma
1363	P-A-X-937	12	60.91	Ductile Iron	100	1900	Alma
1364	P-A-X-938	12	393.68	Ductile Iron	100	1900	Alma
1367	P-A-X-941	12	292.88	Ductile Iron	90	1900	Alma
1381	P-A-X-958	12	596.37	Ductile Iron	100	1900	Alma
1382	P-A-X-959	12	184.74	Ductile Iron	70	1920	Alma
1383	P-A-X-960	12	247.7	Ductile Iron	90	1954	Alma
1386	P-A-X-966	12	24.81	Ductile Iron	100	1900	Alma
1387	P-A-X-967	12	151.11	Ductile Iron	100	1900	Alma
1394	P-A-X-993	12	380.16	Ductile Iron	100	1962	Alma
1395	P-A-X-994	12	676.12	Ductile Iron	100	1962	Alma
1398	P-A-X-998	12	780.28	Ductile Iron	100	1977	Alma
1407	P-A-X-1007	12	638.83	Ductile Iron	90	1954	Alma
1408	P-A-X-1010	12	1,642.71	Ductile Iron	100	1963	Alma
1409	P-A-X-1012	12	1,000.00	Ductile Iron	100	1963	Alma
1410	P-A-X-1013	12	100	Ductile Iron	100	1963	Alma
1414	P-A-X-821A	12	1,009.52	Ductile Iron	100	1963	Alma
1418	P-A-X-829A	12	33.36	Ductile Iron	100	1975	Alma
1419	P-A-X-829B	12	224.35	Ductile Iron	100	1975	Alma
1420	P-A-X-1021	12	754.62	Ductile Iron	100	1962	Alma
1422	P-A-X-1023	12	138.73	Ductile Iron	100	1997	Alma
1427	P-A-X-1029	12	390.84	Ductile Iron	90	1954	Alma
1428	P-A-X-1030	12	268.72	Ductile Iron	90	1954	Alma
1433	P-A-X-1036	12	423.76	Ductile Iron	90	1954	Alma
1435	P-A-X-1038	12	590.81	Ductile Iron	90	1954	Alma
1436	P-A-X-1039	12	353.22	Ductile Iron	90	0	Alma
1448	P-A-X-1052	12	294.54	Ductile Iron	90	1900	Alma
1449	P-A-X-1053	12	789.81	Ductile Iron	75	1966	Alma
1450	P-A-X-1055	12	646.05	Ductile Iron	90	1966	Alma
1451	P-A-X-1056	12	67.54	Ductile Iron	90	1900	Alma
1452	P-A-X-1058	12	601.31	Ductile Iron	90	1900	Alma
1460	P-A-X-1066	12	531.19	Ductile Iron	100	1900	Alma
1461	P-A-X-1067	12	269.16	Ductile Iron	100	1962	Alma
1462	P-A-X-1068	12	134.28	Ductile Iron	100	1954	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
1463	P-A-X-1070	12	160.48	Ductile Iron	100	2001	Alma
1464	P-A-X-1071	12	564.01	Ductile Iron	100	1954	Alma
1480	P-A-X-1092	12	338.81	Ductile Iron	100	1954	Alma
1481	P-A-X-1093	12	686.02	Ductile Iron	100	1954	Alma
1499	P-A-X-519B	12	867.71	Ductile Iron	80	1954	Alma
1500	P-A-X-519A	12	36.99	Ductile Iron	90	1954	Alma
1502	P-A-X-1135	12	280.42	Ductile Iron	100	1962	Alma
1507	P-A-X-1024A	12	326.11	Ductile Iron	90	1999	Alma
1508	P-A-X-1024B	12	1,429.38	Ductile Iron	90	1999	Alma
1521	P-A-X-400B	12	72.17	Ductile Iron	100	1974	Alma
1522	P-A-X-400A	12	270.99	Ductile Iron	100	1974	Alma
1530	P-A-X-1144	12	1,074.56	Ductile Iron	100	0	Alma
1531	P-A-X-1148	12	315.79	Ductile Iron	100	1954	Alma
1542	P-A-X-1163	12	16.91	Ductile Iron	100	0	Alma
1543	P-A-X-1165	12	378.84	Ductile Iron	90	1954	Alma
1544	P-A-X-1166	12	20.84	Ductile Iron	100	0	Alma
1545	P-A-X-1167	12	349.19	Ductile Iron	90	1954	Alma
1547	P-A-X-1168	12	21.53	Ductile Iron	90	0	Alma
1548	P-A-X-1169	12	972.13	Ductile Iron	70	1954	Alma
1569	P-A-X-1192	12	1,154.29	Ductile Iron	100	1964	Alma
1570	P-A-X-1193	12	565.8	Ductile Iron	100	1964	Alma
1576	P-A-X-1199	12	28.28	Ductile Iron	100	1900	Alma
1577	P-A-X-1200	12	825.64	Ductile Iron	100	1954	Alma
1584	P-A-X-1207	12	493.27	Ductile Iron	100	1954	Alma
1585	P-A-X-1208	12	360.67	Ductile Iron	90	1954	Alma
1586	P-A-X-1209	12	444.3	Ductile Iron	90	1954	Alma
1604	P-A-X-1254	12	404.67	Ductile Iron	120	2006	Alma
1605	P-A-X-1255	12	295.56	Ductile Iron	120	2006	Alma
1606	P-A-X-1256	12	328.07	Ductile Iron	120	2006	Alma
1607	P-A-X-1257	12	273.07	Ductile Iron	120	2006	Alma
1608	P-A-X-1258	12	984.98	Ductile Iron	120	2006	Alma
1614	P-A-X-1264	12	272.77	Ductile Iron	120	2005	Alma
1615	P-A-X-1265	12	434.07	Ductile Iron	120	2005	Alma
1616	P-A-X-1266	12	306.4	Ductile Iron	120	2005	Alma
1622	P-A-X-1276	12	726.88	Ductile Iron	120	2006	Alma
1623	P-A-X-1277	12	386.15	Ductile Iron	120	2005	Alma
1666	P-A-X-19	12	592.58	Ductile Iron	70	1976	Alma
1668	P-A-X-23	12	64.28	Ductile Iron	90	2006	Alma
1669	P-A-X-24	12	49.96	Ductile Iron	70	1900	Alma
1670	P-A-X-25	12	106.81	Ductile Iron	70	1900	Alma
1693	P-A-X-70	12	96.65	Ductile Iron	120	1900	Alma
1694	P-A-X-72	12	366.39	Ductile Iron	120	1900	Alma
1695	P-A-X-78	12	57.37	Ductile Iron	120	0	Alma
1704	P-A-X-115	12	1,591.86	Ductile Iron	100	1964	Alma
1705	P-A-X-116	12	1,229.91	Ductile Iron	100	1954	Alma
2795	P-A-CI-1	12	2,691.56	Ductile Iron	100	2007	Alma
2798	P-A-CI-2	12	2,536.86	Ductile Iron	100	2007	Alma
2799	P-A-CI-3	12	1,707.36	Ductile Iron	100	2007	Alma
2800	P-A-CI-4	12	1,091.10	Ductile Iron	100	2007	Alma
2804	P-A-CI-6	12	98.35	Ductile Iron	120	2007	Alma
2806	P-A-CI-8	12	178.38	Ductile Iron	120	2007	Alma
2810	P-A-CI-10	12	1,349.71	Ductile Iron	100	2010	Alma
2812	P-A-CI-12	12	2,025.49	Ductile Iron	100	2010	Alma
2819	P-A-PI-5	12	122.94	Ductile Iron	120	2015	Alma
2822	P-A-PI-6	12	309.36	Ductile Iron	120	2015	Alma
2823	P-A-PI-7	12	289.09	Ductile Iron	120	2015	Alma
2824	P-A-PI-8	12	341.32	Ductile Iron	120	2015	Alma
2827	P-A-PI-9	12	379.70	Ductile Iron	120	2015	Alma
2828	P-A-PI-10	12	453.58	Ductile Iron	120	2015	Alma
2829	P-A-PI-11	12	42.15	Ductile Iron	120	2015	Alma
2830	P-A-PI-12	12	318.2	Ductile Iron	120	2015	Alma
2831	P-A-PI-13	12	359.12	Ductile Iron	120	2015	Alma
2832	P-A-PI-14	12	749.20	Ductile Iron	120	2015	Alma
2833	P-A-PI-15	12	24.43	Ductile Iron	120	2015	Alma
2861	P-TM-PI1-IC1	12	12.25	Ductile Iron	120	2012	Alma
2863	P-TM-PI1-IC3	12	13.44	Ductile Iron	110	2012	Alma
2864	P-TM-PI1-IC4	12	10.65	Ductile Iron	120	2012	Alma
2865	P-TM-PI1-IC5	12	14.04	Ductile Iron	120	2012	Alma
2890	P-TM-PI5-IC1	12	13.84	Ductile Iron	120	2012	Alma
2894	P-A-X-1263	12	269.51	Ductile Iron	120	2006	Alma
2992	P-A-CI-15	12	1,242.98	Ductile Iron	100	2007	Alma
2993	P-A-CI-5	12	2,043.17	Ductile Iron	100	2007	Alma
3006	P-TM-PI1-IC8	12	10.14	Ductile Iron	120	2012	Alma
3517	P-SL-PI-150	12	715.03	Ductile Iron	80	0	Alma
3518	P-SL-PI-151	12	438.56	Ductile Iron	80	0	Alma
3552	P-SL-PI-176	12	671.17	Ductile Iron	100	2010	Alma
3553	P-SL-PI-177	12	611	Ductile Iron	100	2010	Alma
3558	P-SL-PI-180	12	30.21	Ductile Iron	100	1900	Alma
3582	P-SL-PI-198	12	279.45	Ductile Iron	100	2012	Alma
3586	P-SL-PI-201	12	161.79	Ductile Iron	100	2012	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
3587	P-SL-PI-202	12	104.82	Ductile Iron	100	2012	Alma
3597	P-SL-PI-211	12	271.4	Ductile Iron	100	1954	Alma
3598	P-SL-PI-212	12	181.98	Ductile Iron	100	1954	Alma
3683	P-SL-PI-283	12	326.59	Ductile Iron	100	2012	Alma
3881	P-SL-PI-375	12	2,159.49	Ductile Iron	90	1900	Alma
3883	P-SL-PI-376	12	37.9	Ductile Iron	120	2014	Alma
3896	P-SL-PI-385	12	890.39	Ductile Iron	90	1954	Alma
3901	P-SL-PI-389	12	11.5	Ductile Iron	120	2014	Alma
3903	P-SL-PI-391	12	28.84	Ductile Iron	120	2014	Alma
3960	P-SL-PI-432	12	6.3	Ductile Iron	120	2012	Alma
3976	P-SL-PI-443	12	925.63	Ductile Iron	100	1962	Alma
3977	P-SL-PI-444	12	165.61	Ductile Iron	100	1962	Alma
3979	P-SL-PI-445	12	2,308.61	Ductile Iron	120	2016	Alma
3981	P-SL-PI-446	12	1,357.83	Ductile Iron	120	2016	Alma
3983	P-SL-PI-447	12	933.67	Ductile Iron	120	2016	Alma
4014	P-SL-PI-459	12	624.96	Ductile Iron	100	1963	Alma
4015	P-SL-PI-460	12	365.04	Ductile Iron	100	1963	Alma
829	P-A-X-21	16	422.42	Ductile Iron	100	1900	Alma
1178	P-A-X-621	16	583.49	Ductile Iron	100	1900	Alma
1179	P-A-X-622	16	209.56	Ductile Iron	100	1900	Alma
1180	P-A-X-627	16	52.64	Ductile Iron	100	1963	Alma
1184	P-A-X-636	16	410.01	Ductile Iron	100	1900	Alma
1185	P-A-X-637	16	25.75	Ductile Iron	100	0	Alma
1384	P-A-X-963	16	1,078.91	Ductile Iron	100	1900	Alma
1388	P-A-X-973	16	152.36	Ductile Iron	100	1900	Alma
1389	P-A-X-974	16	312.83	Ductile Iron	100	1900	Alma
1536	P-A-X-1157	16	130.23	Ductile Iron	100	1900	Alma
1537	P-A-X-1158	16	362.88	Ductile Iron	100	1900	Alma
1562	P-A-X-1184	16	27.93	Ductile Iron	100	0	Alma
1566	P-A-X-1189	16	589.39	Ductile Iron	100	1963	Alma
1567	P-A-X-1190	16	297.36	Ductile Iron	100	1963	Alma
1599	P-A-X-1223	16	120.74	Ductile Iron	100	1900	Alma
1601	P-A-X-1225	16	176.12	Ductile Iron	100	1900	Alma
1648	P-A-X-1312	16	32.31	Ductile Iron	120	2002	Alma
1651	P-A-X-3	16	588.38	Ductile Iron	120	1900	Alma
2852	P-TM-PI1-2	16	890.33	Ductile Iron	120	2012	Alma
2853	P-TM-PI1-3	16	1,105.14	Ductile Iron	110	2012	Alma
2854	P-TM-PI1-4	16	1,186.57	Ductile Iron	110	2012	Alma
2868	P-A-PI2-1	16	96.65	Ductile Iron	120	2012	Alma
2887	P-TM-PI5-2	16	2,137.56	Ductile Iron	120	2012	Alma
3569	P-SL-PI-188	16	336.95	Ductile Iron	120	2012	Alma
3577	P-SL-PI-194	16	41.5	Ductile Iron	120	2012	Alma
3590	P-SL-PI-205	16	362.42	Ductile Iron	120	2012	Alma
3591	P-SL-PI-206	16	424.89	Ductile Iron	120	2012	Alma
3592	P-SL-PI-207	16	450.45	Ductile Iron	120	2012	Alma
3593	P-SL-PI-208	16	428.82	Ductile Iron	120	2012	Alma
3594	P-SL-PI-209	16	435.01	Ductile Iron	120	2012	Alma
3595	P-SL-PI-210	16	433.2	Ductile Iron	120	2012	Alma
3621	P-SL-PI-229	16	315.99	Ductile Iron	120	2012	Alma
3622	P-SL-PI-230	16	645.4	Ductile Iron	120	2012	Alma
3623	P-SL-PI-231	16	254.58	Ductile Iron	120	2012	Alma
3624	P-SL-PI-232	16	540.44	Ductile Iron	120	2012	Alma
3625	P-SL-PI-233	16	269.74	Ductile Iron	120	2012	Alma
3626	P-SL-PI-234	16	322.11	Ductile Iron	120	2012	Alma
3628	P-SL-PI-236	16	460.47	Ductile Iron	120	2012	Alma
3685	P-SL-PI-284	16	263.11	Ductile Iron	120	2012	Alma
3687	P-SL-PI-285	16	804.86	Ductile Iron	120	2012	Alma
3688	P-SL-PI-286	16	225.63	Ductile Iron	120	2012	Alma
3692	P-SL-PI-288	16	27.9	Ductile Iron	120	2012	Alma
3695	P-SL-PI-290	16	29.17	Ductile Iron	120	2012	Alma
3730	P-SL-PI-310	16	22.4	Ductile Iron	120	2012	Alma
3757	P-SL-PI-325	16	610.59	Ductile Iron	120	2012	Alma
3872	P-SL-PI-368	16	51.84	Ductile Iron	120	2014	Alma
3874	P-SL-PI-369	16	299.34	Ductile Iron	120	2014	Alma
3891	P-SL-PI-381	16	91.09	Ductile Iron	120	2012	Alma
3892	P-SL-PI-382	16	1,994.45	Ductile Iron	120	2012	Alma
3897	P-SL-PI-386	16	15.06	Ductile Iron	120	2014	Alma
3906	P-SL-PI-393	16	119.27	Ductile Iron	120	2014	Alma
3908	P-SL-PI-394	16	178.83	Ductile Iron	120	2012	Alma
3909	P-SL-PI-395	16	994.41	Ductile Iron	120	2012	Alma
3911	P-SL-PI-397	16	283.1	Ductile Iron	120	2014	Alma
3916	P-SL-PI-400	16	327.6	Ductile Iron	120	2014	Alma
3918	P-SL-PI-402	16	157.85	Ductile Iron	120	2014	Alma
3920	P-SL-PI-403	16	1,587.81	Ductile Iron	120	2012	Alma
3921	P-SL-PI-404	16	947.17	Ductile Iron	120	2012	Alma
3958	P-SL-PI-430	16	424.46	Ductile Iron	120	2012	Alma
3959	P-SL-PI-431	16	970.98	Ductile Iron	120	2012	Alma
3966	P-SL-PI-436	16	369.51	Ductile Iron	120	2012	Alma

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
Saint Louis Water Main Inventory							
2294	P-SL-X-112	1	162.84	Copper	135	1932	St_Louis
2595	P-SL-X-424	2.1	406.78	Galvanized iron	112.2	1962	St_Louis
2216	P-SL-X-33	3	269.91	Cast iron	50	1932	St_Louis
2293	P-SL-X-111	3	293.57	Cast iron	50	1932	St_Louis
2305	P-SL-X-123	3	508.8	Cast iron	50	1932	St_Louis
2318	P-SL-X-136	3	11.27	Cast iron	70	1963	St_Louis
2319	P-SL-X-137	3	437.33	Cast iron	50	1932	St_Louis
2320	P-SL-X-138	3	26.37	Cast iron	50	1932	St_Louis
2433	P-SL-X-255	3	34.69	Cast iron	50	1932	St_Louis
2434	P-SL-X-256	3	499.16	Cast iron	50	1932	St_Louis
2539	P-SL-X-362	3	350.12	Cast iron	50	1932	St_Louis
2204	P-SL-X-21	4	44.46	Cast iron	50	1932	St_Louis
2215	P-SL-X-32	4	800.49	Asbestos Cement	50	1932	St_Louis
2232	P-SL-X-49	4	1,456.15	Asbestos Cement	50	1932	St_Louis
2233	P-SL-X-50	4	484.74	Asbestos Cement	50	1932	St_Louis
2234	P-SL-X-51	4	431.04	Asbestos Cement	50	1932	St_Louis
2235	P-SL-X-52	4	895.85	Asbestos Cement	50	1932	St_Louis
2236	P-SL-X-53	4	227.59	Asbestos Cement	50	1932	St_Louis
2246	P-SL-X-64	4	443.22	Cast iron	80	1962	St_Louis
2292	P-SL-X-110	4	95.07	Cast iron	80	1963	St_Louis
2300	P-SL-X-118	4	353.69	Cast iron	50	1932	St_Louis
2303	P-SL-X-121	4	66.83	Cast iron	80	1962	St_Louis
2304	P-SL-X-122	4	553.6	Cast iron	50	1932	St_Louis
2306	P-SL-X-124	4	465.03	Cast iron	50	1932	St_Louis
2307	P-SL-X-125	4	429.07	Cast iron	80	1963	St_Louis
2311	P-SL-X-129	4	193.45	Cast iron	50	1932	St_Louis
2312	P-SL-X-130	4	53.13	Cast iron	50	1932	St_Louis
2313	P-SL-X-131	4	456.57	Cast iron	50	1932	St_Louis
2314	P-SL-X-132	4	54.93	Cast iron	50	1932	St_Louis
2315	P-SL-X-133	4	465.98	Cast iron	50	1932	St_Louis
2316	P-SL-X-134	4	44.31	Cast iron	50	1932	St_Louis
2321	P-SL-X-139	4	29.56	Cast iron	50	1932	St_Louis
2322	P-SL-X-140	4	524.68	Cast iron	50	1932	St_Louis
2323	P-SL-X-141	4	43.85	Cast iron	50	1932	St_Louis
2325	P-SL-X-143	4	394.05	Cast iron	50	1932	St_Louis
2328	P-SL-X-146	4	757.71	Cast iron	50	1932	St_Louis
2329	P-SL-X-147	4	138.7	Cast iron	50	1932	St_Louis
2332	P-SL-X-150	4	420.24	Cast iron	50	1932	St_Louis
2333	P-SL-X-151	4	749.43	Cast iron	50	1932	St_Louis
2347	P-SL-X-165	4	436.54	Cast iron	50	1932	St_Louis
2349	P-SL-X-167	4	448.53	Cast iron	50	1932	St_Louis
2352	P-SL-X-170	4	53.4	Cast iron	50	1932	St_Louis
2355	P-SL-X-173	4	42.59	Cast iron	50	1932	St_Louis
2356	P-SL-X-174	4	671.1	Cast iron	70	1950	St_Louis
2365	P-SL-X-183	4	699.54	Asbestos Cement	50	1932	St_Louis
2366	P-SL-X-184	4	33.52	Cast iron	50	1932	St_Louis
2367	P-SL-X-185	4	300.85	Cast iron	50	1932	St_Louis
2368	P-SL-X-186	4	3.91	Cast iron	50	1932	St_Louis
2371	P-SL-X-189	4	435.41	Cast iron	50	1932	St_Louis
2378	P-SL-X-196	4	481.05	Asbestos Cement	80	1963	St_Louis
2379	P-SL-X-197	4	43.3	Asbestos Cement	80	1963	St_Louis
2380	P-SL-X-198	4	362.37	Asbestos Cement	80	1963	St_Louis
2386	P-SL-X-204	4	926.8	Asbestos Cement	80	1963	St_Louis
2388	P-SL-X-207	4	34.56	Cast iron	50	1932	St_Louis
2391	P-SL-X-211	4	377.74	Asbestos Cement	50	1932	St_Louis
2400	P-SL-X-222	4	18.66	Cast iron	50	1932	St_Louis
2401	P-SL-X-223	4	648.44	Cast iron	50	1932	St_Louis
2413	P-SL-X-235	4	482.42	Cast iron	50	1932	St_Louis
2416	P-SL-X-238	4	482.42	Asbestos Cement	50	1932	St_Louis
2420	P-SL-X-242	4	330.93	Asbestos Cement	50	1932	St_Louis
2422	P-SL-X-244	4	591.06	Cast iron	50	1932	St_Louis
2424	P-SL-X-246	4	598.08	Cast iron	50	1932	St_Louis
2425	P-SL-X-247	4	339.05	Cast iron	50	1932	St_Louis
2430	P-SL-X-252	4	26.77	Cast iron	50	1932	St_Louis
2431	P-SL-X-253	4	530.94	Cast iron	50	1932	St_Louis
2435	P-SL-X-257	4	498.01	Cast iron	50	1932	St_Louis
2436	P-SL-X-258	4	502.22	Cast iron	50	1932	St_Louis
2439	P-SL-X-261	4	374.85	Asbestos Cement	50	1932	St_Louis
2454	P-SL-X-276	4	51.64	Cast iron	70	1977	St_Louis
2455	P-SL-X-277	4	470.46	Cast iron	70	1977	St_Louis
2457	P-SL-X-279	4	79.49	Cast iron	80	1963	St_Louis
2458	P-SL-X-280	4	457.33	Cast iron	50	1932	St_Louis
2462	P-SL-X-284	4	13.5	Cast iron	80	1963	St_Louis
2463	P-SL-X-285	4	504.54	Cast iron	50	1932	St_Louis
2464	P-SL-X-286	4	463.44	Cast iron	50	1932	St_Louis
2465	P-SL-X-287	4	475.61	Asbestos Cement	50	1932	St_Louis
2466	P-SL-X-288	4	499.69	Asbestos Cement	50	1932	St_Louis
2468	P-SL-X-290	4	474.81	Asbestos Cement	50	1932	St_Louis

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
2470	P-SL-X-292	4	392.82	Asbestos Cement	50	1932	St_Louis
2471	P-SL-X-293	4	974.09	Cast iron	50	1932	St_Louis
2472	P-SL-X-294	4	10.28	Cast iron	50	1932	St_Louis
2473	P-SL-X-295	4	44.91	Cast iron	50	1932	St_Louis
2474	P-SL-X-296	4	330.82	Cast iron	50	1932	St_Louis
2477	P-SL-X-299	4	401.84	Cast iron	50	1932	St_Louis
2490	P-SL-X-313	4	435.61	Cast iron	50	1932	St_Louis
2491	P-SL-X-314	4	452.87	Cast iron	50	1932	St_Louis
2505	P-SL-X-328	4	691.74	Cast iron	70	1950	St_Louis
2512	P-SL-X-335	4	129.65	Cast iron	80	1963	St_Louis
2514	P-SL-X-337	4	571.87	Cast iron	80	1963	St_Louis
2515	P-SL-X-338	4	355.3	Cast iron	80	1963	St_Louis
2516	P-SL-X-339	4	46.03	Cast iron	80	1963	St_Louis
2526	P-SL-X-349	4	389.75	Cast iron	50	1932	St_Louis
2528	P-SL-X-351	4	383.36	Cast iron	50	1932	St_Louis
2531	P-SL-X-354	4	739.34	Asbestos Cement	80	1963	St_Louis
2536	P-SL-X-359	4	338.74	Cast iron	50	1932	St_Louis
2537	P-SL-X-360	4	12.69	Cast iron	50	1932	St_Louis
2538	P-SL-X-361	4	71.02	Cast iron	50	1932	St_Louis
2540	P-SL-X-363	4	26.48	Cast iron	80	1973	St_Louis
2542	P-SL-X-365	4	333.56	Asbestos Cement	80	1963	St_Louis
2544	P-SL-X-367	4	435.52	Asbestos Cement	80	1963	St_Louis
2545	P-SL-X-368	4	369.67	Asbestos Cement	50	1932	St_Louis
2546	P-SL-X-369	4	727.44	Asbestos Cement	50	1932	St_Louis
2547	P-SL-X-370	4	144.57	Cast iron	50	1932	St_Louis
2548	P-SL-X-371	4	155.58	Asbestos Cement	50	1932	St_Louis
2567	P-SL-X-390	4	291.04	Asbestos Cement	80	1963	St_Louis
2568	P-SL-X-391	4	672.9	Asbestos Cement	80	1963	St_Louis
2573	P-SL-X-396	4	573.04	Asbestos Cement	80	1963	St_Louis
2621	P-SL-PI-13	4	487.76	Ductile Iron	110	2009	St_Louis
2330	P-SL-X-148	4.2	112.07	Ductile Iron	120	1995	St_Louis
2421	P-SL-X-243	5.8	55.23	PVC	148.5	1997	St_Louis
2191	P-SL-X-7	6	362.98	Cast iron	85	1963	St_Louis
2201	P-SL-X-18	6	686.42	Asbestos Cement	85	1963	St_Louis
2205	P-SL-X-22	6	26.08	Cast iron	50	1932	St_Louis
2208	P-SL-X-25	6	456.28	Cast iron	70	1977	St_Louis
2209	P-SL-X-26	6	480.54	Cast iron	50	1932	St_Louis
2210	P-SL-X-27	6	998.18	Cast iron	50	1932	St_Louis
2211	P-SL-X-28	6	1,130.68	Asbestos Cement	50	1932	St_Louis
2217	P-SL-X-34	6	291.21	Asbestos Cement	50	1932	St_Louis
2224	P-SL-X-41	6	787.85	Cast iron	50	1932	St_Louis
2231	P-SL-X-48	6	108.96	Cast iron	50	1932	St_Louis
2248	P-SL-X-66	6	503.3	Cast iron	85	1962	St_Louis
2250	P-SL-X-68	6	386.63	Cast iron	85	1962	St_Louis
2251	P-SL-X-69	6	388.97	Cast iron	85	1962	St_Louis
2252	P-SL-X-70	6	46.62	Cast iron	85	1962	St_Louis
2253	P-SL-X-71	6	420.02	Cast iron	85	1962	St_Louis
2254	P-SL-X-72	6	8.92	Cast iron	85	1962	St_Louis
2255	P-SL-X-73	6	367.25	Cast iron	85	1962	St_Louis
2256	P-SL-X-74	6	68.57	Cast iron	70	1974	St_Louis
2257	P-SL-X-75	6	283.25	Cast iron	70	1974	St_Louis
2258	P-SL-X-76	6	43.83	Cast iron	70	1974	St_Louis
2259	P-SL-X-77	6	407.92	Cast iron	70	1974	St_Louis
2260	P-SL-X-78	6	432.44	Cast iron	70	1974	St_Louis
2263	P-SL-X-81	6	63	Cast iron	70	1974	St_Louis
2264	P-SL-X-82	6	722.09	Cast iron	70	1974	St_Louis
2270	P-SL-X-86	6	227.03	Cast iron	80	1998	St_Louis
2282	P-SL-X-100	6	512.41	Cast iron	70	1977	St_Louis
2287	P-SL-X-105	6	57.36	Cast iron	70	1961	St_Louis
2289	P-SL-X-107	6	476.08	Cast iron	85	1963	St_Louis
2295	P-SL-X-113	6	20	Cast iron	50	1932	St_Louis
2299	P-SL-X-117	6	42.4	Cast iron	50	1932	St_Louis
2301	P-SL-X-119	6	34.77	Cast iron	50	1932	St_Louis
2302	P-SL-X-120	6	475.68	Cast iron	85	1962	St_Louis
2308	P-SL-X-126	6	48.87	Cast iron	85	1963	St_Louis
2317	P-SL-X-135	6	377.48	Cast iron	85	1963	St_Louis
2324	P-SL-X-142	6	484.47	Cast iron	85	1962	St_Louis
2344	P-SL-X-162	6	405.3	Cast iron	85	1962	St_Louis
2353	P-SL-X-171	6	669.51	Cast iron	50	1932	St_Louis
2354	P-SL-X-172	6	502.9	Cast iron	70	1961	St_Louis
2357	P-SL-X-175	6	315.28	Cast iron	70	1961	St_Louis
2359	P-SL-X-177	6	184.66	Cast iron	85	1962	St_Louis
2369	P-SL-X-187	6	404.57	Cast iron	70	1950	St_Louis
2370	P-SL-X-188	6	134.09	Cast iron	70	1950	St_Louis
2373	P-SL-X-191	6	510.44	Cast iron	50	1932	St_Louis
2392	P-SL-X-212	6	445.43	Cast iron	85	1963	St_Louis
2395	P-SL-X-217	6	679.23	Cast iron	50	1932	St_Louis
2397	P-SL-X-219	6	32.45	Cast iron	85	1962	St_Louis
2398	P-SL-X-220	6	672.52	Cast iron	85	1962	St_Louis
2403	P-SL-X-225	6	457.05	Cast iron	70	1977	St_Louis

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
2405	P-SL-X-227	6	46.13	Cast iron	50	1932	St_Louis
2408	P-SL-X-230	6	96.77	Asbestos Cement	50	1932	St_Louis
2409	P-SL-X-231	6	459.86	Asbestos Cement	50	1932	St_Louis
2411	P-SL-X-233	6	45.66	Cast iron	85	1962	St_Louis
2423	P-SL-X-245	6	603.84	Cast iron	85	1962	St_Louis
2428	P-SL-X-250	6	50.73	Cast iron	85	1963	St_Louis
2429	P-SL-X-251	6	24.2	Cast iron	85	1963	St_Louis
2432	P-SL-X-254	6	395.31	Cast iron	85	1963	St_Louis
2440	P-SL-X-262	6	7.27	Cast iron	85	1963	St_Louis
2441	P-SL-X-263	6	31.81	Cast iron	85	1963	St_Louis
2442	P-SL-X-264	6	586	Cast iron	85	1963	St_Louis
2443	P-SL-X-265	6	501.96	Cast iron	85	1963	St_Louis
2444	P-SL-X-266	6	55.04	Cast iron	50	1932	St_Louis
2445	P-SL-X-267	6	519.5	Cast iron	50	1932	St_Louis
2446	P-SL-X-268	6	366.91	Cast iron	85	1963	St_Louis
2460	P-SL-X-282	6	27	Cast iron	85	1963	St_Louis
2461	P-SL-X-283	6	22.7	Cast iron	85	1963	St_Louis
2467	P-SL-X-289	6	474.94	Cast iron	85	1963	St_Louis
2469	P-SL-X-291	6	40.93	Cast iron	85	1963	St_Louis
2475	P-SL-X-297	6	58.22	Cast iron	85	1962	St_Louis
2479	P-SL-X-301	6	931.11	Cast iron	50	1932	St_Louis
2480	P-SL-X-302	6	51.36	Cast iron	50	1932	St_Louis
2481	P-SL-X-303	6	46.41	Cast iron	85	1962	St_Louis
2484	P-SL-X-306	6	840.47	Cast iron	85	1963	St_Louis
2489	P-SL-X-311	6	13.65	Cast iron	85	1963	St_Louis
2494	P-SL-X-317	6	184.58	Asbestos Cement	50	1932	St_Louis
2499	P-SL-X-322	6	227.31	Cast iron	85	1963	St_Louis
2500	P-SL-X-323	6	527.86	Cast iron	85	1963	St_Louis
2501	P-SL-X-324	6	50	Cast iron	85	1963	St_Louis
2502	P-SL-X-325	6	15.8	Cast iron	85	1963	St_Louis
2503	P-SL-X-326	6	32.00	Cast iron	85	1963	St_Louis
2504	P-SL-X-327	6	496.73	Cast iron	85	1963	St_Louis
2506	P-SL-X-329	6	468.2	Cast iron	85	1963	St_Louis
2511	P-SL-X-334	6	98.4	Cast iron	85	1963	St_Louis
2517	P-SL-X-340	6	325.66	Asbestos Cement	85	1963	St_Louis
2525	P-SL-X-348	6	346.29	Cast iron	50	1932	St_Louis
2527	P-SL-X-350	6	23.49	Cast iron	50	1932	St_Louis
2529	P-SL-X-352	6	333.71	Cast iron	50	1932	St_Louis
2530	P-SL-X-353	6	528.48	Cast iron	50	1932	St_Louis
2532	P-SL-X-355	6	421.59	Cast iron	85	1962	St_Louis
2533	P-SL-X-356	6	62.95	Cast iron	85	1962	St_Louis
2534	P-SL-X-357	6	440.65	Cast iron	85	1962	St_Louis
2535	P-SL-X-358	6	376.26	Cast iron	85	1962	St_Louis
2541	P-SL-X-364	6	309.09	Cast iron	70	1973	St_Louis
2543	P-SL-X-366	6	898.64	Cast iron	85	1963	St_Louis
2554	P-SL-X-377	6	30.12	Asbestos Cement	120	1990	St_Louis
2557	P-SL-X-380	6	767.7	Asbestos Cement	85	1963	St_Louis
2558	P-SL-X-381	6	681.43	Asbestos Cement	85	1963	St_Louis
2560	P-SL-X-383	6	464.55	Asbestos Cement	85	1963	St_Louis
2566	P-SL-X-389	6	430.53	Asbestos Cement	85	1963	St_Louis
2569	P-SL-X-392	6	326.37	Asbestos Cement	85	1963	St_Louis
2570	P-SL-X-393	6	289.39	Asbestos Cement	85	1963	St_Louis
2575	P-SL-X-398	6	141.67	Cast iron	50	1932	St_Louis
2691	P-SL-PI-83	6	404.06	Ductile Iron	120	2009	St_Louis
2714	P-SL-PI-106	6	408.09	Ductile Iron	120	2009	St_Louis
2716	P-SL-PI-108	6	54.51	Ductile Iron	120	2009	St_Louis
3740	P-SL-PI-318	6	636.56	Ductile Iron	115	2012	St_Louis
3924	P-SL-PI-406	6	92.05	Ductile Iron	80	0	St_Louis
3937	P-SL-PI-415	6	849.57	Ductile Iron	80	0	St_Louis
3941	P-SL-PI-418	6	767.95	Ductile Iron	80	0	St_Louis
3945	P-SL-PI-421	6	533.3	Ductile Iron	80	0	St_Louis
3948	P-SL-PI-423	6	110.98	Ductile Iron	80	0	St_Louis
3949	P-SL-PI-424	6	868.49	Ductile Iron	80	0	St_Louis
3950	P-SL-PI-425	6	354.61	Ductile Iron	80	0	St_Louis
3956	P-SL-PI-429	6	329.42	Ductile Iron	85	1963	St_Louis
4431	P-SL-PI-751	6	325.7	Ductile Iron	130	2017	St_Louis
4432	P-SL-PI-752	6	364.47	Ductile Iron	130	2017	St_Louis
4433	P-SL-PI-753	6	675.72	Ductile Iron	130	2017	St_Louis
2562	P-SL-X-385	6.3	323.46	Cast iron	140	1963	St_Louis
2226	P-SL-X-43	7.3	755.26	PVC	145	2004	St_Louis
2237	P-SL-X-54	7.6	631.72	PVC	135	1996	St_Louis
2238	P-SL-X-56	7.6	430.41	PVC	135	1996	St_Louis
2288	P-SL-X-106	7.6	395.66	PVC	135	1995	St_Louis
2290	P-SL-X-108	7.6	179.25	PVC	135	1995	St_Louis
2291	P-SL-X-109	7.6	246.71	PVC	135	1995	St_Louis
2296	P-SL-X-114	7.6	432.33	PVC	135	1995	St_Louis
2343	P-SL-X-161	7.6	12	PVC	135	1996	St_Louis
2346	P-SL-X-164	7.6	12	PVC	135	1996	St_Louis
2571	P-SL-X-394	7.6	22.75	PVC	150	2004	St_Louis
2572	P-SL-X-395	7.6	300.97	PVC	150	2004	St_Louis

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
2574	P-SL-X-397	7.6	333.3	PVC	150	2004	St_Louis
2608	P-SL-X-438	7.6	54.97	PVC	150	0	St_Louis
2222	P-SL-X-39	8	303.82	Asbestos Cement	60	1932	St_Louis
2223	P-SL-X-40	8	549.19	Asbestos Cement	60	1932	St_Louis
2225	P-SL-X-42	8	247.24	Asbestos Cement	60	1932	St_Louis
2239	P-SL-X-57	8	856.82	Asbestos Cement	110	1967	St_Louis
2419	P-SL-X-241	8	826.73	Asbestos Cement	100	1965	St_Louis
2509	P-SL-X-332	8	514.59	Asbestos Cement	115	1963	St_Louis
2510	P-SL-X-333	8	21.35	Asbestos Cement	115	1963	St_Louis
2513	P-SL-X-336	8	372.86	Asbestos Cement	115	1963	St_Louis
2518	P-SL-X-341	8	442.72	Asbestos Cement	115	1963	St_Louis
2524	P-SL-X-347	8	464.08	Asbestos Cement	125	1963	St_Louis
3929	P-SL-PI-409	8	156.2	Ductile Iron	110	2011	St_Louis
3955	P-SL-PI-428	8	50.85	Ductile Iron	120	2012	St_Louis
2193	P-SL-X-10	8.1	561.99	Cast iron	80	1963	St_Louis
2207	P-SL-X-24	8.1	1,385.55	Cast iron	95	1977	St_Louis
2212	P-SL-X-29	8.1	240.76	Cast iron	60	1932	St_Louis
2213	P-SL-X-30	8.1	38.77	Cast iron	60	1932	St_Louis
2214	P-SL-X-31	8.1	940.16	Cast iron	60	1932	St_Louis
2218	P-SL-X-35	8.1	568.00	Cast iron	60	1932	St_Louis
2227	P-SL-X-44	8.1	415.31	Cast iron	60	1932	St_Louis
2228	P-SL-X-45	8.1	11.1	Cast iron	80	1962	St_Louis
2229	P-SL-X-46	8.1	62.09	Cast iron	80	1962	St_Louis
2230	P-SL-X-47	8.1	1,594.34	Steel	100	1962	St_Louis
2438	P-SL-X-260	8.1	459.67	Cast iron	80	1963	St_Louis
2449	P-SL-X-271	8.1	64.81	Cast iron	90	1963	St_Louis
2453	P-SL-X-275	8.1	232.36	Cast iron	90	1963	St_Louis
2456	P-SL-X-278	8.1	534.89	Cast iron	90	1963	St_Louis
2459	P-SL-X-281	8.1	399.26	Cast iron	90	1963	St_Louis
2486	P-SL-X-308	8.1	849.88	Cast iron	80	1963	St_Louis
2487	P-SL-X-309	8.1	38.66	Cast iron	80	1963	St_Louis
2488	P-SL-X-310	8.1	45.46	Cast iron	80	1963	St_Louis
2604	P-SL-X-420	8.1	136.25	Cast iron	70	1932	St_Louis
3849	P-SL-PI-349	8.1	6.9	Cast Iron	80	1962	St_Louis
3858	P-SL-PI-356	8.1	78.31	Steel	100	1962	St_Louis
3944	P-SL-PI-420	8.1	319.71	Cast iron	80	1963	St_Louis
2187	P-SL-X-3	8.6	420.01	Ductile Iron	110	2002	St_Louis
2219	P-SL-X-36	8.6	625.39	Ductile Iron	120	1998	St_Louis
2220	P-SL-X-37	8.6	430.98	Ductile Iron	120	1998	St_Louis
2221	P-SL-X-38	8.6	1,736.56	Ductile Iron	120	1998	St_Louis
2576	P-SL-X-399	8.6	253.51	Ductile Iron	110	2004	St_Louis
2577	P-SL-X-400	8.6	284.02	Ductile Iron	110	2004	St_Louis
2578	P-SL-X-401	8.6	411.76	Ductile Iron	110	2004	St_Louis
2619	P-SL-PI-11	8.6	18.78	Ductile Iron	120	2009	St_Louis
2641	P-SL-PI-33	8.6	12.83	Ductile Iron	120	2009	St_Louis
2692	P-SL-PI-84	8.6	8.03	Ductile Iron	120	2009	St_Louis
2694	P-SL-PI-86	8.6	3.91	Ductile Iron	120	2009	St_Louis
3831	P-SL-PI-338	8.6	145.27	Ductile Iron	110	2012	St_Louis
3936	P-SL-PI-414	8.6	96.74	Ductile Iron	110	2002	St_Louis
2186	P-SL-X-2	8.6	396.21	Ductile Iron	110	2002	St_Louis
2297	P-SL-X-115	10	478.9	Cast iron	80	1963	St_Louis
2298	P-SL-X-116	10	7.47	Cast iron	80	1963	St_Louis
2326	P-SL-X-144	10	487.31	Cast iron	80	1963	St_Louis
2327	P-SL-X-145	10	7.61	Cast iron	80	1963	St_Louis
2334	P-SL-X-152	10	42.82	Cast iron	115	1987	St_Louis
2335	P-SL-X-153	10	30.14	Cast iron	126.5	1987	St_Louis
2336	P-SL-X-154	10	362.76	Cast iron	115	1987	St_Louis
2338	P-SL-X-156	10	70.88	Cast iron	70	1932	St_Louis
2339	P-SL-X-157	10	184.22	Cast iron	70	1932	St_Louis
2340	P-SL-X-158	10	16.32	Cast iron	120	1996	St_Louis
2341	P-SL-X-159	10	440.91	Cast iron	80	1963	St_Louis
2381	P-SL-X-199	10	498.23	Cast iron	93.5	1963	St_Louis
2382	P-SL-X-200	10	368.66	Cast iron	130	1989	St_Louis
2383	P-SL-X-201	10	346.55	Cast iron	130	1989	St_Louis
2384	P-SL-X-202	10	450.04	Cast iron	130	1989	St_Louis
2385	P-SL-X-203	10	55.04	Cast iron	130	1989	St_Louis
2387	P-SL-X-205	10	509.22	Ductile Iron	130	2007	St_Louis
2389	P-SL-X-208	10	380.06	Cast iron	93.5	1962	St_Louis
2390	P-SL-X-210	10	524.94	Cast iron	93.5	1963	St_Louis
2393	P-SL-X-213	10	516.64	Cast iron	93.5	1962	St_Louis
2396	P-SL-X-218	10	315.76	Cast iron	93.5	1962	St_Louis
2399	P-SL-X-221	10	372.67	Cast iron	93.5	1962	St_Louis
2402	P-SL-X-224	10	317.55	Cast iron	93.5	1962	St_Louis
2404	P-SL-X-226	10	329.9	Cast iron	93.5	1962	St_Louis
2406	P-SL-X-228	10	226.85	Cast iron	130	1997	St_Louis
2407	P-SL-X-229	10	27.59	Cast iron	130	1997	St_Louis
2410	P-SL-X-232	10	160.66	Cast iron	93.5	1962	St_Louis
2412	P-SL-X-234	10	239.81	Cast iron	93.5	1962	St_Louis
2414	P-SL-X-236	10	198.47	Cast iron	93.5	1962	St_Louis
2415	P-SL-X-237	10	237.1	Cast iron	93.5	1962	St_Louis

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
2417	P-SL-X-239	10	311.18	Cast iron	93.5	1962	St_Louis
2437	P-SL-X-259	10	79.72	Cast iron	80	1963	St_Louis
2521	P-SL-X-344	10	351.87	Cast iron	80	1963	St_Louis
2522	P-SL-X-345	10	372.48	Cast iron	80	1963	St_Louis
2556	P-SL-X-379	10	731.24	Cast iron	70	1990	St_Louis
2592	P-SL-X-209	10	524.94	Cast iron	93.5	1963	St_Louis
2665	P-SL-PI-57	10	151.33	Cast iron	80	1963	St_Louis
2666	P-SL-PI-58	10	370.55	Cast iron	80	1963	St_Louis
2710	P-SL-PI-102	10	722.71	Ductile Iron	120	2009	St_Louis
2593	P-SL-X-422	10.7	197.85	PVC	150	2004	St_Louis
2594	P-SL-X-423	10.7	370.81	PVC	150	2008	St_Louis
2599	P-SL-X-429	10.7	795.98	PVC	150	2004	St_Louis
2600	P-SL-X-430	10.7	793.36	PVC	150	2004	St_Louis
2266	P-SL-X-84	11.4	2,227.46	PVC	135	1998	St_Louis
2267	P-SL-X-85	11.4	895.35	PVC	135	1998	St_Louis
2268	P-SL-X-87	11.4	781.84	PVC	135	1998	St_Louis
2269	P-SL-X-88	11.4	2,247.73	PVC	135	1998	St_Louis
2276	P-SL-X-94	11.4	35.23	PVC	135	1998	St_Louis
2277	P-SL-X-95	11.4	502.54	PVC	135	1998	St_Louis
2278	P-SL-X-96	11.4	57.24	PVC	135	1998	St_Louis
2280	P-SL-X-98	11.4	409.02	PVC	135	1998	St_Louis
2281	P-SL-X-99	11.4	796.36	PVC	135	1998	St_Louis
2283	P-SL-X-101	11.4	373.62	PVC	135	1998	St_Louis
2342	P-SL-X-160	11.4	390.32	PVC	135	1996	St_Louis
2345	P-SL-X-163	11.4	510.24	PVC	135	1996	St_Louis
2348	P-SL-X-166	11.4	430.61	PVC	135	1996	St_Louis
2350	P-SL-X-168	11.4	472.97	PVC	135	1996	St_Louis
2206	P-SL-X-23	12	139.35	Cast iron	75	1950	St_Louis
2243	P-SL-X-61	12	76.89	Cast iron	80	1962	St_Louis
2265	P-SL-X-83	12	767.34	Ductile Iron	120	1998	St_Louis
2271	P-SL-X-89	12	2,353.65	Ductile Iron	120	1998	St_Louis
2272	P-SL-X-90	12	790.45	Cast iron	115	1989	St_Louis
2273	P-SL-X-91	12	419.78	Cast iron	115	1989	St_Louis
2284	P-SL-X-102	12	37.53	Cast iron	90	1962	St_Louis
2285	P-SL-X-103	12	140.93	Cast iron	90	1961	St_Louis
2286	P-SL-X-104	12	300.41	Cast iron	90	1961	St_Louis
2310	P-SL-X-128	12	569.66	Cast iron	80	1962	St_Louis
2331	P-SL-X-149	12	1,241.96	Cast iron	90	1962	St_Louis
2337	P-SL-X-155	12	74.28	Cast iron	70	1932	St_Louis
2351	P-SL-X-169	12	411.8	Cast iron	80	1962	St_Louis
2358	P-SL-X-176	12	78.71	Cast iron	93.5	1962	St_Louis
2360	P-SL-X-178	12	558.39	Cast iron	93.5	1962	St_Louis
2361	P-SL-X-179	12	35.5	Cast iron	93.5	1963	St_Louis
2363	P-SL-X-181	12	338.57	Cast iron	93.5	1963	St_Louis
2364	P-SL-X-182	12	236.52	Cast iron	93.5	1963	St_Louis
2418	P-SL-X-240	12	457.08	Cast iron	93.5	1963	St_Louis
2426	P-SL-X-248	12	496.35	Cast iron	80	1962	St_Louis
2427	P-SL-X-249	12	439.3	Cast iron	80	1962	St_Louis
2447	P-SL-X-269	12	64.98	Cast iron	90	1962	St_Louis
2448	P-SL-X-270	12	518.7	Cast iron	90	1962	St_Louis
2476	P-SL-X-298	12	930.91	Cast iron	90	1962	St_Louis
2478	P-SL-X-300	12	409.45	Cast iron	90	1962	St_Louis
2482	P-SL-X-304	12	450.23	Cast iron	90	1962	St_Louis
2483	P-SL-X-305	12	59.01	Cast iron	80	1963	St_Louis
2485	P-SL-X-307	12	374.54	Cast iron	75	1950	St_Louis
2492	P-SL-X-315	12	121.49	Cast iron	80	1962	St_Louis
2493	P-SL-X-316	12	306.79	Cast iron	80	1962	St_Louis
2496	P-SL-X-319	12	253.27	Cast iron	80	1962	St_Louis
2497	P-SL-X-320	12	215.5	Cast iron	80	1962	St_Louis
2498	P-SL-X-321	12	456.85	Cast iron	80	1962	St_Louis
2523	P-SL-X-346	12	39.99	Cast iron	80	1963	St_Louis
2549	P-SL-X-372	12	842.73	Cast iron	70	1990	St_Louis
2550	P-SL-X-373	12	842.81	Cast iron	70	1990	St_Louis
2551	P-SL-X-374	12	941.02	Cast iron	70	1990	St_Louis
2552	P-SL-X-375	12	766.35	Cast iron	70	1990	St_Louis
2553	P-SL-X-376	12	683.2	Cast iron	70	1990	St_Louis
2561	P-SL-X-384	12	578.51	Ductile Iron	130	2015	St_Louis
2563	P-SL-X-386	12	720.32	Cast iron	70	1990	St_Louis
2564	P-SL-X-387	12	595.95	Cast iron	70	1990	St_Louis
2565	P-SL-X-388	12	501.62	Cast iron	70	1990	St_Louis
2579	P-SL-X-402	12	182.95	Cast iron	80	1962	St_Louis
2606	P-SL-X-436	12	250.81	Cast iron	75	1950	St_Louis
2607	P-SL-X-437	12	500.13	Cast iron	75	1950	St_Louis
3290	P-SL-PI-122	12	17.48	Ductile Iron	120	2012	St_Louis
3291	P-SL-PI-123	12	51.54	Ductile Iron	120	2012	St_Louis
3717	P-SL-PI-301	12	726.95	Ductile Iron	120	2012	St_Louis
3832	P-SL-PI-339	12	147.7	Ductile Iron	120	2012	St_Louis
3833	P-SL-PI-340	12	419.99	Ductile Iron	120	2012	St_Louis
3836	P-SL-PI-342	12	101.85	Ductile Iron	120	2015	St_Louis
3838	P-SL-PI-344	12	862.05	Ductile Iron	120	2015	St_Louis

FID	Pipe Id No.	Pipe Diameter	Pipe Length	Pipe Material	C-Factor	Installation Year	Zone
3855	P-SL-PI-353	12	9.11	Cast iron	80	1962	St_Louis
3856	P-SL-PI-354	12	408.86	Cast iron	80	1962	St_Louis
3857	P-SL-PI-355	12	38.33	Ductile Iron	120	2012	St_Louis
3927	P-SL-PI-408	12	884.6	Ductile Iron	130	2015	St_Louis
3940	P-SL-PI-417	12	330.07	Cast iron	70	1990	St_Louis
3987	P-SL-PI-448	12	7.04	Ductile Iron	120	2015	St_Louis
3990	P-SL-PI-450	12	6.53	Ductile Iron	120	2015	St_Louis
3991	P-SL-PI-451	12	88.28	Ductile Iron	120	2015	St_Louis
2362	P-SL-X-180	12.6	1,576.68	Ductile Iron	110	1989	St_Louis
3530	P-SL-PI-160	16	2.3	Ductile Iron	120	2012	St_Louis
3638	P-SL-PI-243	16	343.31	Ductile Iron	120	2012	St_Louis
3639	P-SL-PI-244	16	647.02	Ductile Iron	120	2012	St_Louis
3640	P-SL-PI-245	16	797.68	Ductile Iron	120	2012	St_Louis
3641	P-SL-PI-246	16	539.29	Ductile Iron	120	2012	St_Louis
3642	P-SL-PI-247	16	897.47	Ductile Iron	120	2012	St_Louis
3643	P-SL-PI-248	16	497.3	Ductile Iron	120	2012	St_Louis
3668	P-SL-PI-270	16	16.66	Ductile Iron	120	2012	St_Louis
3727	P-SL-PI-308	16	3,521.69	Ductile Iron	120	2012	St_Louis
3761	P-SL-PI-328	16	838.61	Ductile Iron	120	2012	St_Louis
3848	P-SL-PI-348	16	2,124.22	Ductile Iron	120	2012	St_Louis
3952	P-SL-PI-426	16	368.12	Ductile Iron	120	2012	St_Louis
3953	P-SL-PI-427	16	1,232.61	Ductile Iron	120	2012	St_Louis
4122	P-SL-PI-479	16	896.44	Ductile Iron	120	2012	St_Louis
4123	P-SL-PI-480	16	684.71	Ductile Iron	120	2012	St_Louis
4127	P-SL-PI-482	16	743.15	Ductile Iron	120	2012	St_Louis
4129	P-SL-PI-483	16	2,124.59	Ductile Iron	120	2012	St_Louis
4130	P-SL-PI-484	16	308.76	Ductile Iron	120	2012	St_Louis

Appendix 2

fTC&H

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

Gratiot Area Water Authority

Gratiot County, Michigan

GAWA Reliability Study

Drawn By CGM
Designer CGM
Reviewer JW
Manager JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G160148

SHEET NO.
XX

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: FIGURE 3 DATE: 11/26/2018 TIME: 5:07:19 PM USER: CGM

Gratiot Area Water Authority - Reliability Study
Hydrant Flow Testing for WaterCAD Model Calibration
May 2nd, 2017 City of Alma

We would like to perform flow tests at the following locations:

A. Flow Location (A-5): Intersection of Woodmere Street & Fairlane Street
Pressure Location A-1: Intersection of Purdy Drive & Superior Street
Pressure Location A-2: West of Intersection of Falkirk Road & Renfrew Road
Pressure Location A-3: West of Intersection of Woodmere Street & Faircrest Street
Pressure Location A-4: Northeast of Intersection of Woodmere Street & Fairlane Drive

B. Flow Location (B-5): Middle of Purdy Drive
Pressure Location B-1: Intersection of Purdy Drive & Superior Street
Pressure Location B-2: East of Intersection of Center Street & Fleming Drive
Pressure Location B-3: Intersection of Philadelphia Avenue & Mill Street
Pressure Location B-4: Intersection of Fleming Drive & Mill Street

C. Flow Location (C-4): Intersection of Moyer Avenue & Hawthorne Street
Flow Location (C-5): Intersection of State Street & Hawthorne Street
Pressure Location C-1: Intersection of Hawley Lane & Grafton Avenue
Pressure Location C-2: Intersection of Elizabeth Street & Rockingham Avenue
Pressure Location C-3: Intersection of Elizabeth Street & State Street

D. Flow Location (D-5): Intersection of Elmwood Avenue & Rosedale Street
Pressure Location D-1: West of Intersection of Bridge Avenue & Superior Street
Pressure Location D-2: Intersection of Ely Street & Wheeler Avenue
Pressure Location D-3: West of Intersection of Rosedale Street & Republic Avenue
Pressure Location D-4: Intersection of Eastward Street & Elmwood Avenue

E. Flow Location (E-5): Intersection of Hampton Street & Grassmere Avenue
Pressure Location E-1: Intersection of Rosedale Street & Grover Avenue
Pressure Location E-2: Intersection of Windsor Street & Hampton Street
Pressure Location E-3: Intersection of Court Avenue & Ely Street
Pressure Location E-4: Intersection of Grassmere Avenue & York Street

F. Flow Location (F-5): Intersection of Elwell Street & Second Avenue
Pressure Location F-1: Intersection of Downie Street & Prospect Avenue
Pressure Location F-2: Intersection of State Street and Hastings Street
Pressure Location F-3: On State Street between West End Street & Orchard Street
Pressure Location F-4: Intersection of West End Street & Third Avenue

G. Flow Location (G-5): Intersection of Chatterton Street & Fairview Avenue
Pressure Location G-1: On State Street between West End Street & Orchard Street
Pressure Location G-2: Intersection of Bridge Avenue & Ferris Street
Pressure Location G-3: Intersection of Washington Street & Euclid Avenue
Pressure Location G-4: Intersection of Sanford Avenue & Chatterton Street

H. Flow Location (H-5): On Alger Road just north of Walmart
Pressure Location H-1: Intersection of Warwick Drive & Elks Drive
Pressure Location H-2: 2nd Hydrant east of the Intersection of Alger Road & Cheesman Road
Pressure Location H-3: South of the Intersection of Heather Lane & Alger Road
Pressure Location H-4: On Alger Road just south of Walmart

I. Flow Location (I-5): Intersection of Marquette Boulevard & Republic Avenue
Pressure Location I-1: West of Intersection of Bridge Avenue & Superior Street
Pressure Location I-2: Southwest of Intersection of Michigan Street & Grace Avenue
Pressure Location I-3: Intersection of Plum Street & Highland Avenue
Pressure Location I-4: Intersection of Marquette Boulevard and Highland Avenue

Gratiot Area Water Authority - Reliability Study
Hydrant Flow Testing for WaterCAD Model Calibration
May 2nd, 2017 City of Saint Louis

We would like to perform flow tests at the following locations:

J. Flow Location (J-5): End of Fairway Drive
Pressure Location J-1: Intersection of Main Street & I and K Street
Pressure Location J-2: Intersection of Eden Street and Olive Street
Pressure Location J-3: Intersection of Sharon Street & Olive Street
Pressure Location J-4: Intersection of Hebron Street & Prospect Avenue

K. Flow Location (K-5): On Cheesman Road South of Westgate School
Pressure Location K-1: End of Surrey Road
Pressure Location K-2: South of Intersection of Devon Drive & Monroe Road
Pressure Location K-3: Northeast of Intersection of Devon Drive & Essex Drive
Pressure Location K-4: Intersection of Hebron Street & Prospect Avenue

L. Flow Location (L-4): Intersection of Saginaw Street & Pine Street
Flow Location (L-5): Intersection of Saginaw Street & Delaware Street
Pressure Location L-1: West of Intersection of Watson Street & Washington Avenue
Pressure Location L-2: Intersection of Hazel Street & Mill Street
Pressure Location L-3: Intersection of Saginaw Street & Mill Street

M. Flow Location (M-4): Intersection of Butternut Street & East Street
Flow Location (M-5): Intersection of Butternut Street & Lincoln Street
Pressure Location M-1: Intersection of Hazel Street & Franklin Street
Pressure Location M-2: Intersection of State Street & Franklin Street
Pressure Location M-3: Intersection of Hazel Street & Lincoln Street

N. Flow Location (N-5): Intersection of Jackson Street & Main Street
Pressure Location N-1: Intersection of Michigan Avenue & State Street
Pressure Location N-2: Intersection of State Street & Main Street
Pressure Location N-3: Intersection of Wilson Street & Jackson Street
Pressure Location N-4: North of Intersection of Jackson Street & Main Street

O. Flow Location (O-5): North of Intersection of I and K Street & Union Road
Pressure Location O-1: East of Intersection of Saginaw Street & East Street
Pressure Location O-2: East of Intersection of Gratiot Street & Union Street
Pressure Location O-3: Intersection of Prospect Street & Union Street
Pressure Location O-4: Intersection of I and K Street & Union Street

P. Flow Location (P-4): Intersection of Euclid Street & Washington Street
Flow Location (P-5): Intersection of Euclid Street & Tyrell Street
Pressure Location P-1: Intersection of Hazel Street & Franklin Street
Pressure Location P-2: East of Intersection of Saginaw Street & East Street
Pressure Location P-3: Intersection of Lincoln Street & Tyrell Street

Appendix 3

GAWA Reliability Study
Calibration Spreadsheet
Project No. G160148

Measurements based on May 2017 Flow Tests

Model Node ID	Field Observed Static Hyd Pressure (psi)	Static Time of day	Adjust for Gauge Discrepancies	**Adjusted Field Observed Static Hyd Pressure (psi)**	Trial 1 Model Static Pressure (PSI)	Static Pressure difference (PSI)	Field Observed Hyd Flow (gpm)	**calc'd Flow 0.9 COEFF**	Residual Time of day	**USE HYD READING FOR X-5 Field Observed Residual Hyd Pressure (psi)**	**pressure for data logger**	**Adjusted Observed Residual Hyd Pressure (psi)**	Trial 4 Model Static Pressure (PSI)	Trial 4 Static Pressure difference (PSI)	Trial 4 Model Residual Pressure (PSI)	Trial 4 Residual Pressure difference (PSI)
A-1	60.50		0.0	60.5	61.6	-1.1				**58.0**		58.0	61.0	-0.5	59.1	-1.1
A-2	53.50		0.0	53.5	53.0	0.5				**50.0**		50.0	53.4	0.1	51.7	-1.7
A-3	59.50		0.0	59.5	60.0	-0.5				**54.0**		54.0	60.0	-0.5	55.8	-1.8
A-4	56.00		0.0	56.0	57.2	-1.2				**48.5**		48.5	57.2	-1.2	48.6	-0.1
A-5	56.00	12:00:00 AM	0.0	56.0	57.2	-1.2	730.7	**657.6**	12:00:00 AM	**37.5**		37.5	57.2	-1.2	37.7	-0.2
B-1	60.50		0.0	60.5	64.5	-4.0				**56.5**		56.5	61.2	-0.7	59.1	-2.6
B-2	62.00		0.0	62.0	64.6	-2.6				**57.0**		57.0	61.9	0.1	59.1	-2.1
B-3	65.00		0.0	65.0	66.8	-1.8				**60.5**		60.5	64.2	0.8	62.3	-1.8
B-4	66.00		0.0	66.0	66.8	-0.8				**59.0**		59.0	64.1	1.9	60.4	-1.4
B-5	63.00	9:37:00 AM	0.0	63.0	64.6	-1.6	826.7	**744.0**	9:39:00 AM	**48.0**		48.0	61.9	1.1	45.8	2.2
C-1	68.00		0.0	68.0	67.4	0.6				**63.0**		63.0	67.3	0.7	63.8	-0.8
C-2	68.00		0.0	68.0	63.8	4.2				**60.0**		60.0	66.5	1.5	61.9	-1.9
C-3	64.00		0.0	64.0	61.6	2.4				**52.0**		52.0	64.3	-0.3	55.3	-3.3
C-4	61.00		0.0	61.0	57.3	3.7				**45.5**		45.5	60.0	1.0	45.2	0.3
C-5	60.50	9:59:00 AM	0.0	60.5	57.3	3.2	710.9	**639.8**	10:02:00 AM	**35.5**		35.5	60.0	0.5	34.8	0.7
D-1	72.00		0.0	72.0	67.3	4.7				**65.5**		65.5	72.1	-0.1	69.2	-3.7
D-2	66.00		0.0	66.0	67.4	-1.4				**63.5**		63.5	66.5	-0.5	63.1	0.4
D-3	64.00		0.0	64.0	64.7	-0.7				**60.0**		60.0	65.1	-1.1	59.0	1.0
D-4	64.50		0.0	64.5	64.4	0.1				**59.5**		59.5	64.2	0.3	60.8	-1.3
D-5	64.00	10:38:00 AM	0.0	64.0	64.6	-0.6	813.7	**732.3**	10:40:00 AM	**46.5**		46.5	64.7	-0.7	46.3	0.2
E-1	63.00		0.0	63.0	62.4	0.6				**49.0**		49.0	60.4	2.6	51.2	-2.2
E-2	65.00		0.0	65.0	64.8	0.2				**42.0**		42.0	64.9	0.1	44.7	-2.7
E-3	71.00		0.0	71.0	73.8	-2.8				**67.5**		67.5	69.9	1.1	66.9	0.6
E-4	65.00		0.0	65.0	67.0	-2.0				**48.0**		48.0	65.6	-0.6	46.0	2.0
E-5	68.00	10:20:00 AM	0.0	68.0	67.0	1.0	675.0	**607.5**	10:21:00 AM	**32.0**		32.0	67.0	1.0	31.5	0.5
F-1	62.50		0.0	62.5	62.3	0.2				**57.5**		57.5	62.2	0.3	59.7	-2.2
F-2	59.00		0.0	59.0	59.2	-0.2				**54.0**		54.0	59.2	-0.2	56.6	-2.6
F-3	56.00		0.0	56.0	58.0	-2.0				**51.0**		51.0	57.0	-1.0	54.4	-3.4
F-4	55.00		0.0	55.0	54.9	0.1				**50.0**		50.0	54.9	0.1	51.8	-1.8
F-5	53.00	11:16:00 AM	0.0	53.0	57.1	-4.1	659.0	**593.1**	11:20:00 AM	**30.5**		30.5	54.6	-1.6	31.6	-1.1
G-1	56.00		0.0	56.0	57.0	-1.0				**54.0**		54.0	56.5	-0.5	55.4	-1.4
G-2	67.00		0.0	67.0	65.2	1.8				**63.0**		63.0	67.4	-0.4	66.3	-3.3
G-3	63.00		0.0	63.0	65.2	-2.2				**60.0**		60.0	63.9	-0.9	63.9	-3.9
G-4	60.00		0.0	60.0	58.7	1.3				**58.0**		58.0	60.9	-0.9	59.2	-1.2
G-5	59.00	11:36:00 AM	0.0	59.0	60.9	-1.9	347.9	**313.1**	11:40:00 AM	**8.5**		8.5	60.0	-1.0	8.7	-0.2
H-1	53.00		0.0	53.0	56.5	-3.5				**49.0**		49.0	52.7	0.3	50.7	-1.7
H-2	50.00		0.0	50.0	52.0	-2.0				**44.0**		44.0	50.5	-0.5	46.8	-2.8
H-3	48.00		0.0	48.0	49.8	-1.8				**42.0**		42.0	47.6	0.4	44.6	-2.6
H-4	50.50		0.0	50.5	52.4	-1.9				**44.0**		44.0	50.5	0.0	46.1	-2.1
H-5	52.00	8:40:00 AM	0.0	52.0	53.4	-1.4	773.3	**734.6**	8:50:00 AM	**42.0**		42.0	52.3	-0.3	42.8	-0.8

GAWA Reliability Study
Calibration Spreadsheet
Project No. G160148

Measurements based on May 2017 Flow Tests

Model Node ID	Field Observed Static Hyd Pressure (psi)	Static Time of day	Adjust for Gauge Discrepancies	**Adjusted Field Observed Static Hyd Pressure (psi)**	Trial 1 Model Static Pressure (PSI)	Static Pressure difference (PSI)	Field Observed Hyd Flow (gpm)	**calc'd Flow 0.9 COEFF**
I-1	66.00		0.0	66.0	64.3	1.7		
I-2	65.00		0.0	65.0	64.3	0.7		
I-3	62.00		0.0	62.0	64.3	-2.3		
I-4	61.00		0.0	61.0	62.1	-1.1		
I-5	61.00	10:54:00 AM	0.0	61.0	62.1	-1.1	800.4	**720.4**
J-1	60.50		0.0	60.5	61.0	-0.5		
J-2	59.00		0.0	59.0	58.7	0.3		
J-3	55.00		0.0	55.0	55.2	-0.2		
J-4	50.50		0.0	50.5	54.7	-4.2		
J-5	52.00	8:57:00 AM	0.0	52.0	55.3	-3.3	745.2	**670.6**
K-1	64.00		0.0	64.0	64.0	0.0		
K-2	64.00		0.0	64.0	63.0	1.0		
K-3	59.50		0.0	59.5	58.0	1.5		
K-4	58.00		0.0	58.0	57.4	0.6		
K-5	59.50	2:08:00 PM	0.0	59.5	61.0	-1.5	620.0	**558.0**
L-1	63.00		0.0	63.0	63.0	0.0		
L-2	59.50		0.0	59.5	57.5	2.0		
L-3	64.50		0.0	64.5	64.2	0.3		
L-4	61.00		0.0	61.0	63.3	-2.3		
L-5	60.50	10:35:00 AM	0.0	60.5	62.5	-2.0	206.7	**186.0**
M-1	50.50		0.0	50.5	52.4	-1.9		
M-2	43.50		0.0	43.5	44.4	-0.9		
M-3	52.00		0.0	52.0	52.7	-0.7		
M-4	43.00		0.0	43.0	43.7	-0.7	506.2	**455.6**
M-5	54.50	12:40:00 PM	0.0	54.5	54.1	0.4	438.4	**394.6**
N-1	58.00		0.0	58.0	59.3	-1.3		
N-2	56.00		0.0	56.0	46.8	9.2		
N-3	56.00		0.0	56.0	55.4	0.6		
N-4	53.00		0.0	53.0	52.2	0.8		
N-5	52.00	1:15:00 PM	0.0	52.0	52.2	-0.2	773.3	**696.0**
O-1	58.00		0.0	58.0	59.5	-1.5		
O-2	63.00		0.0	63.0	64.8	-1.8		
O-3	63.50		0.0	63.5	65.2	-1.7		
O-4	64.00		0.0	64.0	65.1	-1.1		
O-5	63.50	9:52:00 AM	0.0	63.5	64.7	-1.2	843.7	**759.3**
P-1	50.50		0.0	50.5	52.8	-2.3		
P-2	58.00		0.0	58.0	58.5	-0.5		
P-3	57.50		0.0	57.5	58.6	-1.1		
P-4	50.00		0.0	50.0	52.1	-2.1		
P-5	51.00	11:23:00 AM	0.0	51.0	52.2	-1.2	725.8	**653.2**

Model Node ID	Residual Time of day	**USE HYD READING FOR X-5 Field Observed Residual Hyd Pressure (psi)**	**pressure for data logger**	**Adjusted Observed Residual Hyd Pressure (psi)**	Trial 4 Model Static Pressure (PSI)	Trial 4 Static Pressure difference (PSI)	Trial 4 Model Residual Pressure (PSI)	Trial 4 Residual Pressure difference (PSI)
I-1		**60.5**		60.5	66.4	-0.4	63.3	-2.8
I-2		**60.0**		60.0	64.3	0.7	61.1	-1.1
I-3		**56.0**		56.0	62.4	-0.4	58.0	-2.0
I-4		**54.0**		54.0	62.1	-1.1	56.4	-2.4
I-5	10:56:00 AM	**45.0**		45.0	62.1	-1.1	45.7	-0.7
J-1		**58.0**		58.0	61.0	-0.5	58.2	-0.2
J-2		**54.5**		54.5	58.7	0.3	54.0	0.5
J-3		**50.0**		50.0	55.2	-0.2	49.0	1.0
J-4		**44.0**		44.0	52.2	-1.7	42.8	1.2
J-5	9:08:00 AM	**39.0**		39.0	52.1	-0.1	38.2	0.8
K-1		**61.5**		61.5	64.1	-0.1	63.2	-1.7
K-2		**62.0**		62.0	63.2	0.8	59.9	2.1
K-3		**39.0**		39.0	59.0	0.5	41.5	-2.5
K-4		**32.5**		32.5	57.4	0.6	33.7	-1.2
K-5	2:11:00 PM	**27.0**		27.0	61.0	-1.5	29.8	-2.8
L-1		**58.5**		58.5	63.2	-0.2	60.4	-1.9
L-2		**56.5**		56.5	58.4	1.1	58.0	-1.5
L-3		**62.5**		62.5	64.3	0.2	63.5	-1.0
L-4		**58.5**		58.5	62.0	-1.0	60.5	-2.0
L-5	10:37:00 AM	**3.0**		3.0	62.1	-1.6	3.6	-0.6
M-1		**42.0**		42.0	51.9	-1.4	43.1	-1.1
M-2		**43.0**		43.0	44.4	-0.9	43.1	-0.1
M-3		**23.5**		23.5	52.7	-0.7	26.1	-2.6
M-4	12:42:00 PM	**18.0**		18.0	43.7	-0.7	15.0	3.0
M-5	12:42:00 PM	**13.5**		13.5	54.1	0.4	12.6	0.9
N-1		**57.0**		57.0	57.7	0.3	57.4	-0.4
N-2		**53.0**		53.0	54.4	1.6	52.5	0.5
N-3		**51.0**		51.0	55.5	0.5	51.6	-0.6
N-4		**48.0**		48.0	52.2	0.8	48.5	-0.5
N-5	1:21:00 PM	**42.0**		42.0	52.2	-0.2	44.0	-2.0
O-1		**57.0**		57.0	58.0	0.0	57.0	0.0
O-2		**62.0**		62.0	63.0	0.0	62.0	0.0
O-3		**62.0**		62.0	65.1	-1.6	64.0	-2.0
O-4		**63.0**		63.0	65.1	-1.1	62.2	0.8
O-5	9:54:00 AM	**50.0**		50.0	64.7	-1.2	50.8	-0.8
P-1		**49.5**		49.5	52.3	-1.8	51.9	-2.4
P-2		**56.0**		56.0	58.0	0.0	58.0	-2.0
P-3		**55.5**		55.5	58.6	-1.1	55.3	0.2
P-4		**48.0**		48.0	50.4	-0.4	48.8	-0.8
P-5	11:24:00 AM	**37.0**		37.0	52.1	-1.1	34.0	3.0

APPENDIX B

Overburdened Calculation Worksheet

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

OVERBURDENED AND SIGNIFICANTLY OVERBURDENED COMMUNITY STATUS DETERMINATION WORKSHEET

The following data is required from each State Revolving Fund (SRF) applicant requesting a determination for overburdened and significantly overburdened community status.

The most recent census and tax data are available in a searchable table on EGLE's State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development webpage along with an excel worksheet to help determine blended Median Annual Household Income (MAHI) and blended taxable value per capita for regional systems. The MAHI and taxable value per capita table will be used to make all FY24 determinations. Applicants are encouraged to visit this page prior to completing this form to see if they qualify based on MAHI (blended MAHI if applicable) or taxable value per capita (blended taxable value per capita if applicable) alone. If so, they only need to fill out lines 1 and 2 of this form, electronically sign it on page 2, and submit.

Alternately, **if the applicant's MAHI or blended MAHI is above the state average - $63,498 for FY24 – they cannot be determined as being overburdened or significantly overburdened for FY24 funding and should not complete or turn in this form**.

For applicants whose MAHI or blended MAHI is below $63,498 but do not automatically qualify based on MAHI or taxable value per capita alone, please complete the entire form and return to:

Mark Conradi
conradim@michigan.gov

Name of Applicant

City of St. Louis

Please check the box indicating which funding source this determination is for:

DWSRF ☑

CWSRF ☐

1. Is this a regional system? A regional system refers to any system that serves more than one municipality (cities, townships, and/or villages)

Yes ☑
No ☐

If yes, refer to the instructions at the end of this form to complete calculations for a blended MAHI and blended taxable value per capita. Additionally, page 3 of this form will also need to be completed.

2. Median Annual Household Income from table on the overburdened webpage (blended if applicable)

$44,947

3. Taxable Value Per Capita from table on the overburdened webpage (blended if applicable)

$11,630

4. Total amount of anticipated debt for the proposed project (amount of loan requested for FY24 loan)

5. Annual payments on the existing debt for the system

6. Total operation, maintenance, and replacement expenses (OM&R) for the system on an annual basis

7. Number of residential equivalent users (REUs) in the system

***I (** Keith W. Risdon, PE, Public Services Director **) hereby certify that the information in this form is complete, true, and correct to the best of my knowledge.**

Keith W. Risdon, PE Digitally signed by Keith W. Risdon, PE Date: 2023.02.08 17:11:05 -05'00' 02/08/2023

Signature Date

For determinations made using anticipated debt, a final determination will be made based upon the awarded loan amount and not the anticipated amount provided on this form.

Regional System Breakdown (If applicable)

Name of municipality	Percentage of flow
City of St. Louis	94.29%
Bethany Township	1.25%
Pine River Township	4.46%

If more spaces are needed, please include them in the email along with this submission. Percentages of flow must add up to 100%.

OVERBURDENED AND SIGNIFICANTLY OVERBURDENED COMMUNITY STATUS INSTRUCTIONS AND GUIDANCE

The following instructions provide guidance to fill out the overburdened and significantly overburdened determination community status worksheet. Systems across the state use many types of methods for billing and some include items that others do not. The purpose of the determination is to put all systems on a level playing field by breaking down system debt, expenses, and number of customers in the same manner. The instructions address each question in the order they are presented on the worksheet.

1. **Regional systems (if applicable) – Blended MAHI and taxable value per capita calculations**

   The definition of overburdened and significantly overburdened communities first requires "(a) Users within the area served by a proposed drinking water project, sewage treatment works project, or stormwater treatment project are directly assessed for the costs of construction." That means that the calculations need to be based on who is paying for the proposed SRF loan.

   For systems that serve more than one municipal entity a blended MAHI and taxable value per capita calculation must be completed. Page 3 of the worksheet includes spaces for a system to list all the municipalities (cities, townships, and/or villages) and the percentage of flow they provide to the system. The flow percentages should be based on the most recent data available.

   The reason flow is used is because most systems add debt costs to customers' bills and those are determined by flow. In rare cases there might be municipal agreements that vary slightly from this method and those will require the applicant to contact EGLE and provide the data separate from this worksheet. EGLE will take each municipality's MAHI and taxable value per capita and multiply it by the percentage of flow and then add them all together to come up with the blended number to be used in the determination (e.g., (municipality A MAHI * flow) + (municipality B MAHI * flow) + (municipality C MAHI * flow = Blended MAHI for the system)). The same formula will be repeated swapping out taxable value per capita for MAHI to determine a blended taxable value per capita.

   The most recent census and tax data are available in a searchable table on EGLE's State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development webpage. This table will be used to make all FY24 determinations. Use the excel FY24 Overburdened Calculation Template also located on the State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development webpage. Tab 1 titled, "Blended MAHI and TVPC calcs" will allow the applicant to input the names of the municipalities, their percentage of flow, the MAHI for each found in the table listed above, and the taxable value per capita for each in the table listed above, to calculate a blended MAHI and blended taxable value per capita of the regional system. **If the blended MAHI is above $63,498 the project cannot qualify for overburdened or significantly overburdened status and the rest of the form should not be filled out or turned in.**

2. **Median Annual Household Income**

   Use the "Fiscal Year 2024 Overburdened Median Annual Household Income (MAHI) and Taxable Values List for SRF Projects; the State of Michigan MAHI is $63,498 for FY24 Projects" searchable table located on the State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development webpage. Search for the system's MAHI and enter it. **If the**

MAHI is above $63,498 the project cannot qualify for overburdened or significantly overburdened status and the rest of the form should not be filled out or turned in.

For regional systems that serve more than on municipality (cities, townships, and/or villages), refer to the instructions for regional systems in step 1 if you have not already completed calculating a blended MAHI for the system. Once the blended MAHI is determined, enter it on line 2 of the worksheet.

3. **Taxable Value Per Capita**

   This data is found in the same location as the MAHI data and was likely already entered by the applicant while completing line 2. If not, repeat the directions for step 2 and enter the taxable value per capita from the table.

   For regional systems that serve more than on municipality (cities, townships, and/or villages), refer to the instructions for regional systems in step 1 if you have not already completed calculating a blended taxable value per capita for the system. Once the blended taxable value per capita is determined, enter it on line 3 of the worksheet.

4. **Total amount of anticipated debt for the proposed project**

   Fill in the total amount of the proposed loan for the project requesting State Revolving Loan financing in FY24.

   EGLE will amortize this amount to determine a yearly cost to the applicant. The excel FY24 Overburdened Calculation Template, also located on the [State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development] webpage, has this calculation built in so the applicant only needs to enter full FY24 the loan amount when completing that as well.

   Note that this loan amount is an estimate and often changes after project plans are submitted and bids come in. EGLE will run this determination again prior to finalizing the Project Priority List (PPL). Changes in the loan amount can sometimes change an applicant's status from overburdened to not or vice versa if the initial calculation is close to the 1% MAHI threshold.

   Thus, if a system is determined to be overburdened or not based on annual user costs being greater than 1% of system's MAHI vs being determined overburdened by MAHI or state taxable value per capita alone, a loan amount will be provided to the applicant that provides the cutoff loan value to either gain or lose overburdened status.

5. **Annual Payments on the existing debt of the system**

   Fill in the yearly total of any current debt payments for the system. If coming in for a CWSRF project only include debt payments for the wastewater system and if coming in for a DWSRF project only include debt payments for the drinking water system.

   In a regional system the additional debt payments of connected systems may be added if the connected systems are included in the blended MAHI and taxable value per capita calculations and there is no double-counting. For example, if a regional treatment system is coming in for the loan, a connected collection system could add any additional annual debt costs that the collection system passes onto its customers after paying all debt and expenses to the regional treatment system. This is to account for the fact that the MAHI and state taxable values are being blended so the annual debt payments of the regional system can be blended as well to determine the average user cost of the regional system.

6. **Total operation, maintenance, and replacement (OM&R) expenses for the system on an annual basis**

   As with the annul debt payments, the amount listed here should include only wastewater OM&R for CWSRF loans and only drinking water OM&R for DWSRF loans. If the accounting is combined split the costs as accurately as possible.

   The OM&R costs should reflect all annual expenses for the system that are recovered annually through rates. This means that if a community makes an annual contribution of $50,000 a year to a capital improvement fund, they could add that number to the yearly OM&R costs. If they have accumulated $250,000 in that account and plan on using all in the calendar year they are applying for the loan, they cannot claim that amount as it is not a yearly expense; only the $50,000 is. This is also true for depreciation expenses with no cash value or yearly contribution. They cannot be included.

   In a regional system the additional OM&R expenses of connected systems may be added if the connected systems are included in the blended MAHI and taxable value per capita calculations, there is no double-counting, and the expenses follow the same OM&R rules listed above. For example, if a regional treatment system is coming in for the loan, a connected collection system could add any additional annual OM&R costs that the collection system passes onto its customers after paying all debt and expenses to the regional treatment system. This is to account for the fact that the MAHI and state taxable values are being blended so the annual OM&R expenses of the regional system can be blended as well to determine the average user cost of the regional system.

7. **Number of residential equivalent users (REUs) in the system**

   REUs refer to number of standard household hookups in a system. In a bedroom community, with little to no commercial or industrial customers, this number clear. However, most systems have a combination of customer types. The purpose of this form is to determine the average bill for a typical residential customer to determine if it is high enough to pose a burden on the ratepayer.

   There are two standard ways of determining REUs: meter size and average flow.

   - Meter size

     This is the preferred method as it eliminates most variables that using flow may have. To determine the number of REUs in a system take all the systems' meters and convert them down to 5/8ths-inch or ¾-inch (whichever is the system's standard residential size). Use the capacity of the pipe to convert down (e.g., a 2-inch meter would be equivalent to about 8, 5/8ths-inch meters, a 4-inch meter would be equivalent to about 25, 5/8ths-inch meters, etc.). The resulting number of equivalent 5/8ths-inch or ¾-inch meters would be the number of REUs in the system.

- Average flow

  The average flow method requires the system to determine the average yearly flow for a typical residential household (i.e., a 5/8ths-inch or ¾-inch connection). The system takes the most recent yearly flow data of the entire system and divides by the average household usage number to come up with the number of REUs.

EGLE will look at the numbers provided and may have questions based on the population size vs number of REUs. EGLE will reach out and ask to see the calculations in some instances. Applicants are encouraged to include an excel sheet with these calculations along with the submittal of this form to reduce any back-and-forth communications.

Signature

A typed name and accompanying electronic signature are required for the form to be accepted. If this section is left blank the form will be returned to the sender and not reviewed until it has been signed and sent back.

Final Determination

If the system's MAHI or blended MAHI (if applicable) is over the state average - $63,498 for FY24 – it cannot be determined as being overburdened or significantly overburdened for FY24 funding.

EGLE will take the information provided on this form and enter it into the FY24 Overburdened Calculation Template spreadsheet to calculate the average yearly cost per REU. If a community or system is not determined to be overburdened or significantly overburdened based on MAHI or taxable value per capita alone, this calculation will determine if the costs are greater than 1% of the system's MAHI.

The FY24 Overburdened Calculation Template spreadsheet with the calculations and final determination will be sent to the applicant after the review has been completed by EGLE. A blank version is available on the State Revolving Fund – Overburdened Community Definition and Scoring Criteria Development webpage. Ideally the applicant has already completed the calculations using the instructions above prior to submitting. If the applicant completes the worksheet and determines they do not qualify for overburdened status it is requested that they do not submit the completed worksheet unless they have questions. The applicant's preliminary findings using the FY24 Overburdened Calculation Template are not official until they have been reviewed by EGLE as discrepancies and/or questions about some of the numbers may arise. However, EGLE is providing the template to allow applicants to have a good idea of how the determination will result prior to hearing back officially from EGLE.

Please contact Mark Conradi (conradim@michigan.gov) with any questions on the completion of the form.

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

EGLE does not discriminate on the basis of race, sex, religion, age, national origin, color, marital status, disability, political beliefs, height, weight, genetic information, or sexual orientation in the administration of any of its programs or activities, and prohibits intimidation and retaliation, as required by applicable laws and regulations. Questions or concerns should be directed to the Nondiscrimination Compliance Coordinator at EGLE-NondiscriminationCC@Michigan.gov or 517-249-0906.

This form and its contents are subject to the Freedom of Information Act and may be released to the public.

APPENDIX C

MNFI and USFWS Database Review

OHM
Advancing Communities®

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis Butternut St Watermain Replacement (Euclid St – East St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis S. Franklin St. Watermain Replacement (M-46 – E. State St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis M-46 Watermain Replacement (Clinton St – Hubbard St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

No Records Found

Query Results Generated on Apr 07, 2023

Database Updated on Mar 20, 2023

New Search Refine Search Previous 25 Records Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis S. Clinton St. Watermain Replacement (Hazel St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

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T 734.522.6711
F 734.522.6427
OHM-Advisors.com

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

OHM
Advancing Communities®

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis East St Watermain Replacement (Butternut St – State St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis E. State St. Watermain Replacement (Butternut St – State St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis S. Main St. Watermain Replacement (M-46 – State St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

OHM Advisors®
34000 PLYMOUTH ROAD
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MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – City of St. Louis Euclid Watermain Replacement (M-46 – Butternut St), Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project location was checked against known localities for rare species, and **0** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The work for this project involves the replacement of existing watermain within the ROW in a previously developed area.

OHM Advisors has made the determination that no additional effort is required related to potential field surveys for listed species. In the event known threatened and endangered species are observed during project activities, observations will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 30 and Gratiot County

Query Results Generated on Apr 07, 2023

No Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

No records were found in the database matching your criteria

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – N. Franklin Watermain Replacement (M-46 – Saginaw), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **2** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Black redhorse (Moxostoma duquesnei) and Mudpuppy (Necturus maculosus). Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **2** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Black redhorse (Moxostoma duquesnei) State Species of Special Concern. MNFI describes the habitat for this species swift flowing areas in medium- to large-sized rivers with clear water and sand, gravel, and rock substrates. Black redhorse is less tolerant of turbid water, low gradient rivers, and siltation than golden redhorse. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Black redhorse is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 19 and Gratiot County

Query Results Generated on Apr 07, 2023

Displaying Record 1 to 2 of 2 Records Found

Database Updated on Mar 20, 2023

New Search Refine Search ◀ Previous 25 Records Next 25 Records ▶

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Black redhorse	Moxostoma duquesnei	SC		1921-11-03			Pine River, below St Louis	University of Michigan Museum of Zoology. 1921. Museum specimen #85885..	12N	02W	7, 18, 19	Gratiot
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	02W	19	Gratiot

New Search Refine Search ◀ Previous 25 Records Next 25 Records ▶

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – E. Prospect Watermain Replacement (N. Main – WWTP), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **2** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Black redhorse (Moxostoma duquesnei) and Mudpuppy (Necturus maculosus). Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **2** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Black redhorse (Moxostoma duquesnei) State Species of Special Concern. MNFI describes the habitat for this species swift flowing areas in medium- to large-sized rivers with clear water and sand, gravel, and rock substrates. Black redhorse is less tolerant of turbid water, low gradient rivers, and siltation than golden redhorse. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Black redhorse is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 02W, Section 19 and Gratiot County

Query Results Generated on Apr 07, 2023

Displaying Record 1 to 2 of 2 Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Black redhorse	Moxostoma duquesnei	SC		1921-11-03			Pine River, below St Louis	University of Michigan Museum of Zoology. 1921. Museum specimen #85885..	12N	02W	7, 18, 19	Gratiot
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	02W	19	Gratiot

New Search | Refine Search | Previous 25 Records | Next 25 Records

OHM
Advancing Communities®

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – Delaware Watermain Replacement (M-46 – Crawford), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **1** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Mudpuppy (Necturus maculosus) Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **1** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

Web Database Search

Search Results for Town 12N, Range 03W, Section 25 and Gratiot County
Query Results Generated on Apr 07, 2023

Displaying Record 1 to 1 of 1 Records Found
Database Updated on Mar 20, 2023

New Search | Refine Search | ◀ Previous 25 Records | Next 25 Records ▶

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	03W	24, 25	Gratiot

New Search | Refine Search | ◀ Previous 25 Records | Next 25 Records ▶

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – Essex Drive Watermain Replacement (Devon – York), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **1** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Mudpuppy (Necturus maculosus) Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **1** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 03W, Section 25 and Gratiot County

Query Results Generated on Apr 07, 2023

Displaying Record 1 to 1 of 1 Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	03W	24, 25	Gratiot

New Search | Refine Search | Previous 25 Records | Next 25 Records

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – S. Mill St. Watermain Replacement (M-46 – Railroad), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **1** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Mudpuppy (Necturus maculosus) Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **1** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – S. Mill St. Watermain Replacement (Hazel – W. State), St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and **1** State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Mudpuppy (Necturus maculosus) Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing ROW in a previously developed area.

For the **1** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Mudpuppy (Necturus maculosus) State Species of Special Concern. MNFI describes the habitat for this species permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. No in water work or work occurring below the ordinary high water mark will occur during this project. The last observation of this species within 1.5 miles of the project area occurred in 1995 and is considered historical. OHM has determined no effect to this species. In the event Mudpuppy is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

MNFI Home Contact Us Plant List Animal List Abstracts Help

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

Web Database Search

Search Results for Town 12N, Range 03W, Section 25 and Gratiot County **Query Results Generated on Apr 07, 2023**

Displaying Record 1 to 1 of 1 Records Found **Database Updated on Mar 20, 2023**

New Search | Refine Search | ◀ Previous 25 Records | Next 25 Records ▶

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	03W	24, 25	Gratiot

New Search | Refine Search | ◀ Previous 25 Records | Next 25 Records ▶

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 03W, Section 25 and Gratiot County

Query Results Generated on Apr 07, 2023

Displaying Record 1 to 1 of 1 Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Mudpuppy	Necturus maculosus	SC		1995-05-15	Animal		St. Louis Pine River	MI Herp Atlas 2022. Excel spreadsheet containing MI Herp Atlas data and file geodatabase.	12N	03W	24, 25	Gratiot

New Search | Refine Search | Previous 25 Records | Next 25 Records

April 7th, 2023

Michigan Natural Features Inventory (MNFI) Web Database Review – Jerome ROW Watermain Replacement, St. Louis, Gratiot County, MI

OHM has reviewed the Threatened and Endangered Species list generated by the MNFI Web Database, conducted on April 7th, 2023. During this Review, the project locations were checked against known localities for rare species, and 3 State threatened, endangered, or species of special concern have been documented within the 1.5 mile project area buffer and it is possible that without proper management negative impacts may occur. The species listed include the following: Broad-leaved puccoon (Lithospermum latifolium), Ram's head lady's-slipper (Cypripedium arietinum) and Sweet coneflower (Rudbeckia subtomentosa. Additionally, ESA Section 7 species were generated via the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website. Determinations for Federally listed species will be made utilizing the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) website.

The proposed project will include the installation of watermain involving opencut within the existing roadway in a previously developed area.

For the **3** State listed species in the document provided OHM Advisors has made preliminary determinations related to potential field surveys for listed species. In response to the Rare Species Review provided by MNFI OHM Advisors has prepared the following strategy and documentation to ensure this project does not result in take of species listed in the review.

Broad-leaved puccoon (Lithospermum latifolium) State Species of Special Concern. MNFI describes the habitat for this species as river banks, and in rich woods and edges associated with floodplains. A desktop review of the surrounding landcover has determined that no suitable habitat is located within the project area. The last observation of this species within 1.5 miles of the project area occurred in 1893 and is considered historical. OHM has determined no effect to this species. In the event Broad-leaved puccoon is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

Ram's head lady's-slipper (Cypripedium arietinum) State Species of Special Concern. MNFI describes the habitat for this species as cedar-fir-spruce beach ridges and in forests along the Great Lakes shoreline in northern Michigan. Also occurs in upland jack, red, and white pine forests, in conifer-dominated swamps, and at the margins of bedrock glades. A desktop review of the surrounding landcover has determined that no suitable habitat is located within the project area. The last observation of this species within 1.5 miles of the project area occurred in 1895 and is considered historical. OHM has determined no effect to this species. In the event Ram's head lady's-slipper is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

Sweet coneflower (Rudbeckia subtomentosa) believed extirpated State Threatened if observaed. MNFI describes the habitat for this species as edges of moist open woods and thickets adjacent to prairies. A desktop review of the surrounding landcover has determined that no suitable habitat is located within the project area. The last observation of this species within 1.5 miles of the project area occurred in 1894 and is considered historical. OHM has determined no effect to this species. In the event Sweet coneflower is observed during project activities said observation will be reported to local county MDNR office within 24 hours.

If additional information is needed, please contact me via email at wade.rose@ohm-advisors.com.

Sincerely,

Wade Rose, OHM Advisors Ecologist

Michigan Natural Features Inventory

Web Database Search

MICHIGAN STATE UNIVERSITY EXTENSION

Search Results for Town 12N, Range 03W, Section 26 and Gratiot County

Query Results Generated on Apr 07, 2023

Displaying Record 1 to 3 of 3 Records Found

Database Updated on Mar 20, 2023

New Search | Refine Search | Previous 25 Records | Next 25 Records

Abstract	Common Name	Scientific Name	State Status	Federal Status	Last Observed Date	Element Category	Mapping Precision	Site of Observation	Best Documentation of EO	Town	Range	Section	County
	Broad-leaved puccoon	Lithospermum latifolium	SC		1893-06-20	Plant	G	ALMA		12N	03W	26, 27, 28, 33, 34, 35	Gratiot
	Ram's head lady's-slipper	Cypripedium arietinum	SC		1895-05-22	Plant	G	ALMA		12N	03W	26, 27, 28, 33, 34, 35	Gratiot
	Sweet coneflower	Rudbeckia subtomentosa	X		1894-08-28	Plant		ALMA	Davis, Charles A. 1894-08-28. US	12N	03W	26, 27, 28, 29, 31, 32, 33, 34, 35, 36	Gratiot

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APPENDIX D

City of St. Louis Water Asset Management Program (2017)

City of St. Louis
Water Asset Management Program
WSSN 6320

Project No. 171394
December 28, 2017




Fishbeck, Thompson, Carr & Huber, Inc.
engineers | scientists | architects | constructors

City of Saint Louis
Water Asset Management Program
WSSN 6320

Prepared For:
City of Saint Louis
Saint Louis, Michigan

December 28, 2017
Project No. G171394

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List of Abbreviations/Acronyms

AMP	Asset Management Plan
AWWA	American Waterworks Association
BRE	Business Risk Exposure
CIP	Capital Improvements Plan
COF	Consequence of Failure
FTCH	Fishbeck, Thompson, Carr & Huber, Inc.
GIS	Geographic Information System
HDPE	High-Density Polyethylene
HVAC	Heating, Ventilating, Air and Cooling
LOS	Level of Service
MDEQ	Michigan Department of Environmental Quality
MG	Million Gallons
MGD	Million Gallons per Day
POF	Probability of Failure
PRV	Pressure Reducing Values
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
REU	Residential Equivalent Unit

1.0 Executive Summary

The Cities of Alma and St. Louis form the Gratiot Area Water Authority (GAWA). The City of Saint Louis (City) water system receives water from GAWA. The water received from GAWA is distributed to approximately 7,060 people in the City. The City water system is comprised of both water storage and distribution infrastructure. The City's water system assets are managed by the Water Department, which is part of the Public Works Unit. The Water Department and system administrators work collaboratively to develop, implement and maintain an asset management program that strives to maintain an established level of service to its customers. The City's mission is to provide safe, reliable, and affordable water service to their customers, as detailed in the City's level of service goals.

This report summarizes the comprehensive Water Asset Management Program (AMP) the City has in place to meet the Michigan Department of Environmental Quality (MDEQ) asset management and capital improvements plan requirements for community water supplies as defined in the Michigan Drinking Water Act, Part 399, R 325.10102. The framework of the City's AMP is comprised of five core components: asset inventory, criticality analysis, level of service (LOS), capital improvements plan (CIP), and revenue structure.

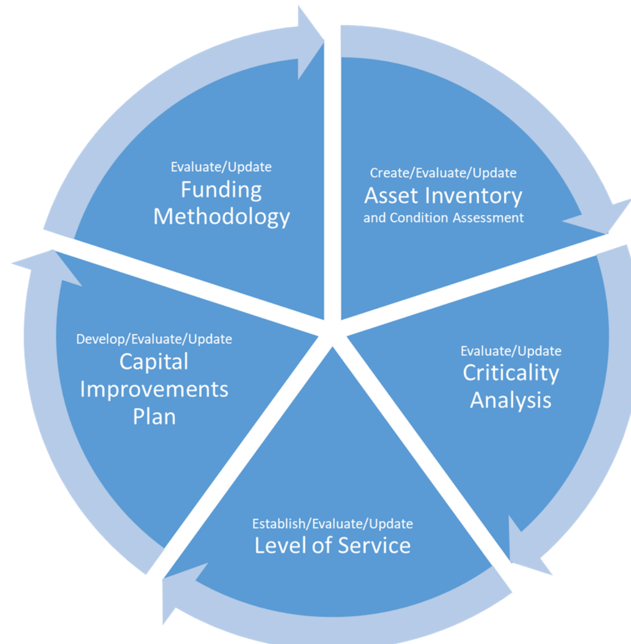
The City maintains an existing inventory of horizontal assets in a hydraulic model database while a separate inventory of vertical assets in an Excel database was developed as part of the AMP. The inventories include information on all water system assets, including description, location, age, condition, expected remaining life and replacement cost. Asset condition assessments were completed using existing information maintained in the databases and observations of vertical assets based on site visits completed by FTCH. The inventory data was evaluated to determine which assets are most critical through calculation of the probability of failure (POF), consequence of failure (COF) and Business Risk Exposure (BRE). The asset inventory and criticality components are critical steps in identifying deficiencies within the water system's infrastructure to help recognize where replacement and rehabilitation projects are needed.

Using the principles of asset criticality analysis, and various efforts such as water system studies and master plans, project needs are regularly reviewed and updated based on identified water system needs . Projects are ranked based on several evaluation criteria and weighting factors for entry into the City's water system CIP. Some of these factors include safety, regulatory compliance, coordination with other projects, operations and maintenance costs, asset reliability and consequences of asset failure and level of service. An annual CIP is prepared and submitted to the City Council for their approval.

The level of service criteria for the City water system is one of the core AMP components. This report includes the City's established LOS, consolidating key performance targets that the water system strives to provide. Consideration is given to the selected LOS when the City makes decisions on projects, performance targets and water rates to customers.

The City's funding structure and rate methodology is described in the report, City of Saint Louis, MI, Water Asset Management Plan Financial Analysis, December 2017 by Municipal Analytics, LLC; a summary of this report is included in Appendix 3. A full version of this report will be sent at a later time.

2.0 Introduction



This report was completed as part of an overall AMP that was developed for the City. In 2017, the City retained Fishbeck, Thompson, Carr & Huber, Inc. (FTCH) to complete an AMP for the City's water system in response to the MDEQ requirement that systems supplying water to over 1,000 people must implement a water AMP by January 1, 2018.

An AMP is a program that identifies the desired level of service at the lowest life cycle cost for rehabilitating, repairing, or replacing the assets associated with the waterworks system. It's an important tool for maintaining a water system's current and future effectiveness. As part of an AMP, water system administrators inventory and plan replacement of water system assets so they can continue to provide safe water reliably to their customers. The AMP also helps set water rates to ensure that funding is available to replace water system assets as they reach the end of their useful life. In short, an AMP allows a water system to provide cost-effective service to their water system customers, now and into the future.

There are five core components to an AMP:

1. Asset Inventory.
2. Criticality Analysis.
3. Level of Service (LOS).
4. Capital Improvement Planning.
5. Funding Structure and Rate Methodology.

The asset inventory is a detailed list of all water system assets, including asset description, location, age, condition, estimated remaining life and replacement cost. The results of condition assessments are updated in the asset inventory as they are conducted. Further description of the City's asset inventories and how they are managed is included in Section 4.0.

The criticality analysis involves ranking the water system assets that are most critical to the system and consists of two parts: the probability of failure (POF) and the consequence of failure (COF). Generally, a numerical value is assigned to each of these two parts, and the two numerical values are multiplied together, with the resulting number representing the overall "criticality", or Business Risk Exposure (BRE), of the asset. The POF score is based on several parameters, but the condition of the asset, as assessed during the Asset Inventory component, is the most important; assets that are in poor condition are generally assigned a higher POF. The COF relates to the impact the failure of a given asset would have on other equipment or processes, public health, the environment, property damage and lost revenue. A higher score is given to assets whose failure would have a greater impact. How the City assigns criticality and uses this information to identify projects is described in Section 5.0.

Level of service (LOS) defines the standards by which the City will judge the water system performance over the long term and sets operational standards that the water system is attempting to achieve on its customer's behalf. LOS is established by defining concrete, achievable and trackable goals to be used as a tool to help guide customer expectations about cost of service as well as water system operational and management strategies. The establishment of the City's LOS and how it fits in the City's AMP is described in Section 6.0.

A Capital Improvements Plan (CIP) identifies water system replacement and rehabilitation needs for 5-year and 20-year planning periods. CIP projects are identified for replacement, rehabilitation or improvement using the results of the asset inventory, condition assessment and criticality analysis. The CIP is then subject to a formal approval process by the water system's leadership. It is understood that the expected costs and timelines for individual projects may fluctuate based on changing needs in the water system. Further detail on the City's CIP is discussed in Section 7.0.

The rate funding structure and funding methodology portion of the AMP is intended to demonstrate how the City will position itself financially to implement the CIP. The rate methodology is how the City ensures rates and charges are adequate to provide sufficient revenue to fund operation, maintenance, capital improvement projects, debt costs and other financial policies. The rate structure and funding methodology is described in the Municipal Analytics report.

An AMP report is not a static document intended to plan for all the water system's current and future needs. It is intended to be a "working document" requiring periodic updates and adjustments to maintain a good plan for keeping the City's water system safe, operating well, and cost effective for its customers.

3.0 Water System Overview

The City of Saint Louis (City) has a contract with GAWA to receive softened groundwater. Prior to 2012, the cities of Alma and Saint Louis each owned and operated independent water systems. The Saint Louis system was a groundwater supply system with 3.56 mgd total rated capacity, and an elevated water storage tank. A plume of contaminated groundwater was discovered to have impacted two of the Saint Louis wells, resulting in the need for an alternate water supply. An agreement was reached between the cities that Saint Louis would replace their water supply wells near the Alma water plant and Alma would supply Saint Louis with softened water from their system, allowing Saint Louis to abandon their existing well system. This was the basis on which the Gratiot Area Water Authority (GAWA) was formed in 2012.

The City water system contains about 32.2 miles of water main. The water main size ranges from 2-inch to 16-inch. Cast iron is the most common water main material present in the system; the next most common is ductile iron. The system also includes smaller areas of asbestos cement and plastic piping. The City has room for improving existing water main throughout the system with roughly 65% of the system installed before 1980.

The City currently has an average daily water demand of 0.90 million gallons per day (MGD) with an estimated future demand of 0.94 MGD by 2037. Most of the recent growth in the City's water demands has been due to the addition of the correctional facilities to the northeast of the system. Since merging with Alma and forming the GAWA, the City's only responsibilities in the water system are the water mains and two elevated storage tanks. The City has a 0.50 million gallon (MG) elevated storage tank at West Crawford Street and a 0.20 MG elevated storage tank at Giddings Street.

This AMP is intended to cover the assets for the City of Saint Louis assets alone, and not the assets owned by GAWA.

4.0 Asset Inventory

An inventory of the assets within the City's water system was completed. This section includes a summary of the processes used to develop the inventory of assets for the City's water system. Generally, all assets with a value of $5,000 or more were included in the analysis, along with certain lower cost assets considered vital to the system.

Assets are grouped into two types: horizontal and vertical. Horizontal and vertical assets are managed by the Water Department and include assets such as water mains, valves, and hydrants used to distribute water to the system's customers and water storage facilities.

4.1 Horizontal Assets

The City maintains an inventory of water mains in a hydraulic model database of the water system. The City also has a General Plan map with an inventory of valves and hydrants in the system.

4.1.1 Water Mains

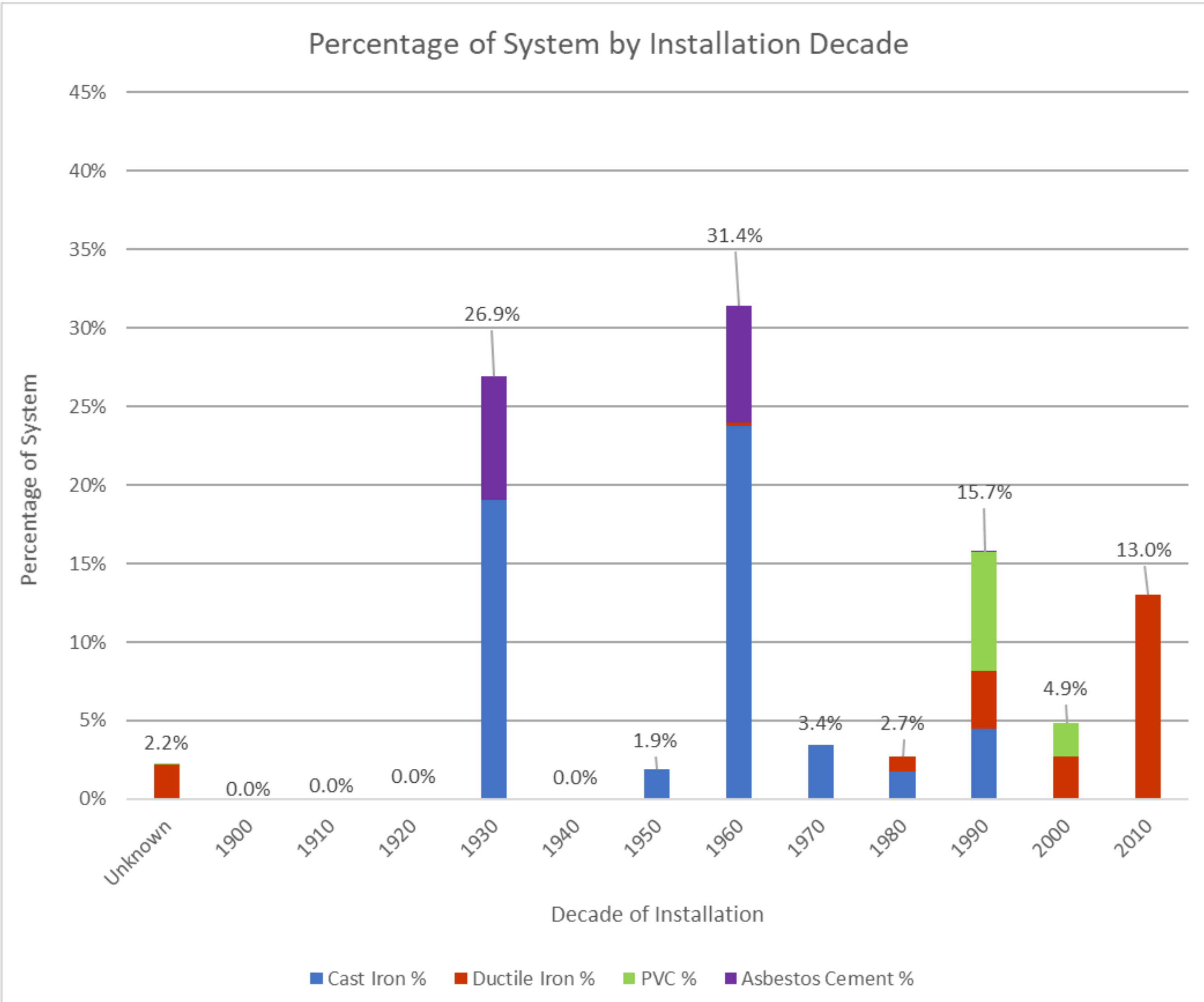
The City's water system contains more than 32 miles of water main. An inventory of the water mains is maintained in a hydraulic model database.

The following parameters are recorded in the GIS database:

- Identification Number
- Diameter
- Hazen Williams C-factor
- Length
- Installation Year
- Material

As part of the AMP, the condition of the water mains was assessed. While the condition could not be visually observed, the water main age in conjunction with the material and C-factor were considered to be good indicators of the condition of the mains.

The graph below presents a breakdown of the percentage of water mains in the system by the decade in which the mains were installed. It also includes information on the proportion of water mains installed by material.



The graph shows that cast iron is the most common material in the system. The majority of the cast iron was installed before the 1970s. Ductile iron is the second most common pipe material with the majority of installations occurring post-1980. These is also a significant amount of PVC and Asbestos Cement installed in the system.

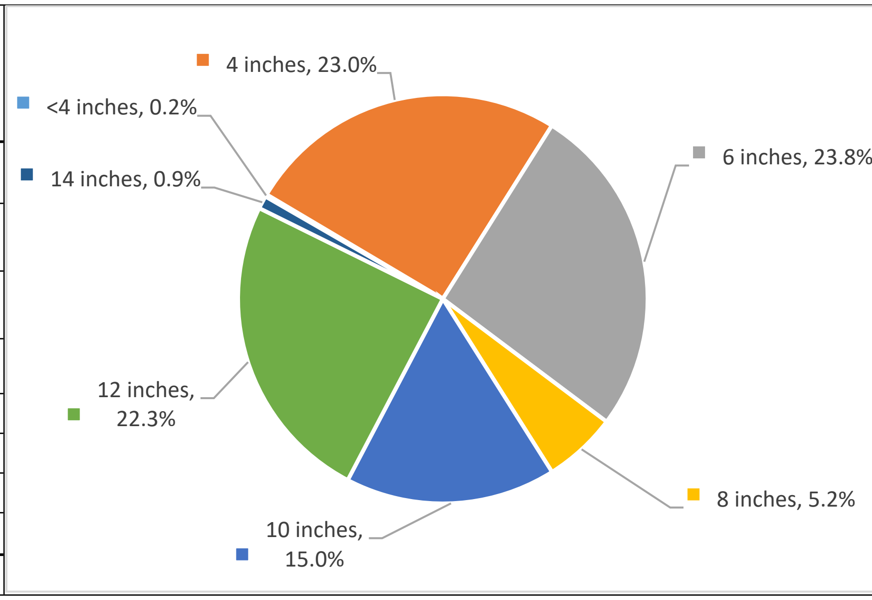
To determine the expected useful life for each type of water main, the AWWA report “Buried No Longer” was used. In the report, the typical estimated service life of water main was investigated using utilities’ experiences, extensive research, and professionals’ experiences. A Long Service Life (LSL) and a Short Service Life (SSL) were estimated for different regions around the United States and for different sizes of systems. For the purposes of this report, the estimated service lives for the Midwestern region with a medium to small size system were used. The average of the LSL and the SSL was used as the expected useful life. The expected service life of a cast iron main was estimated at 100 years, the expected service life of a ductile iron main was estimated at 80 years, the expected service life of an Asbestos Cement water main was estimated at 70 years, and the expected service life of a PVC water main was estimated at 55 years.

Based on the data from the model database, about 11.9% of the water mains in the system are currently beyond their useful life and 37.6% will reach the end of their useful life within the next 20 years. It should be noted that any main with an unknown installation year was assumed to be at the end of its useful life. It should also be noted that some pipe can remain in service beyond these theoretical expected service lives. Regardless, this criterion can be used as a good guide for the overall condition of pipe in the system, and for budgeting for future replacement.

The diameters of the water mains in the system range from 2-inches up to 16-inches. Table 4.1 shows the length and percentage of the system of water main by diameter.

Table 4.1 – Length of Main based on Diameter

Diameter	Length of Main (ft)	Percentage of Total
<4 inches	294	0.2%
4 inches	39,167	23.0%
6 inches	40,572	23.8%
8 inches	8,937	5.2%
10 inches	25,649	15.0%
12 inches	37,961	22.3%
14 inches	1,577	0.9%
16 inches	16,584	9.7%
Total	**170,448**	



Roughly 52% of the system is made up of 8-inch or smaller diameter mains. This is typical of similarly sized systems, where mains 12 inches and larger are used as transmission mains; smaller mains branch off the transmission mains to provide water to adjacent customer communities. The MDEQ recommends that the smallest main in a water system be 6 inches; the City needs to improve in this respect with more than 23% of the existing system made up of mains with a diameter of less than 6 inches.

4.1.2 Hydrants

The City's water system has 245 hydrants. An inventory of the hydrants in the system is maintained in the City's General Plan map. However, only the location of each hydrant is currently recorded. The hydrant number, size, and type will be determined by the City and inventoried in the future.

4.1.3 Valves

The City's water system has 634 valves. An inventory of the valves in the system is maintained in the City's General Plan map. However, only the location of each valve is currently recorded. The valve number, size, and type will be determined by the City and inventoried in the future.

4.1.4 Future Updates to Horizontal Asset Inventory

The City has created and maintains an inventory of horizontal assets including water mains in a hydraulic model database and an inventory of hydrants and valves in a General Plan map. The City will continue to maintain the existing inventories annually and record information for the hydrants and valves. It is recommended that the City develop a GIS database of their water system assets in the future.

4.2 Vertical Assets

Vertical assets within the City's water system include two water storage facilities. A tabulation and condition assessment of the City's vertical assets was completed as part of this report. As a rule of thumb, any asset worth more than $5,000 was assessed. Where applicable, some assets were assessed as one cohesive group.

For all vertical assets evaluated, the following parameters were recorded at a minimum:

- Asset Type
- Asset ID
- Asset Location
- Physical Condition
- Capacity/Size
- Cost
- Year Installed
- Expected Useful Life

4.2.1 Water Storage

The City owns two water storage tanks. These include two elevated storage tanks. The tank location, type, material, year of installation, and volume are listed in Table 4.2.

Table 4.2 – Water Storage Facilities

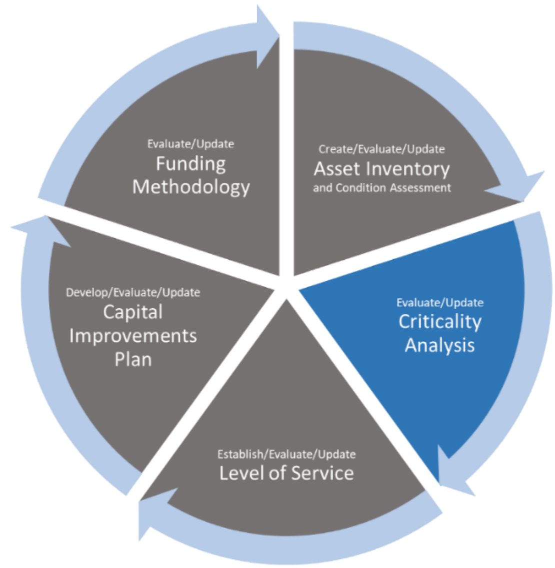
Tank Location	Tank Type	Tank Material	Year of Installation	Volume (MG)
West Crawford Street	Elevated	Steel	1963	0.5
Giddings Street	Elevated	Steel	2016	0.2

FTCH conducted a site visit to each water storage facility to conduct a visual assessment of current conditions. Tank inspection reports were also used for each tank to assess the condition of the tanks where they were available.

4.2.2 Future Updates to Vertical Asset Inventory

An inventory of the current vertical assets of the City water system was created as part of this report. The City will continue to update the inventory of vertical assets annually and record additional parameters for these assets where applicable. The City will continue to maintain and update their vertical asset inventory, using the inventory as a tool for water system planning.

5.0 Criticality Analysis



The criticality analysis component of the AMP utilizes information contained within the asset inventories to prioritize the replacement of assets based on a calculated criticality score. The criticality analysis provides the City with a tool to plan asset replacement/rehabilitation projects well into the future and set adequate funding structure and water rates to cover the corresponding investment. The purpose of this section is to summarize the methods used to determine the criticality of the City's water system assets.

5.1 Horizontal Assets

A criticality assessment of water mains throughout the water system was completed using information from the City's hydraulic model database. The criticality of hydrants and valves were assumed to be equal to their corresponding water mains.

5.1.1 Probability of Failure Metrics/Methods

The metrics used to determine the POF for individual water mains are listed below. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest POF. The rubric used in determining the score for each metric used is shown in Table 5.1, while a description of each metric and the reasoning for using said metric is listed below.

1.) Remaining Useful Life

Water mains have different expected useful lives depending on their material. The Buried No Longer report completed by the American Water Works Association (AWWA) determined typical useful lives for water mains in the Midwest region. The age of each water main was subtracted from its expected useful life to determine the water main's remaining useful life. The score was then determined based on the remaining useful life ranges in Table 5.1.

2.) Hazen Williams C-factor

The hydraulic model of the City water system is calibrated every 5 years during the development of the City water system Reliability Study issued in 2017. The Hazen Williams C-factors are adjusted until pressures in the hydraulic model match pressure data obtained during hydrant flow tests. The C-factors correspond to the pipe's roughness, which often has a strong correlation with its condition. The score for C-factor is based on the calculated C-factor in the hydraulic model for the water main.

Table 5.1 – Horizontal Assets, Probability of Failure

Evaluation Metric	5	4	3	2	1
	Very High	High	Moderate	Low	Very Low
Remaining Useful Life (in Years)	<20	21-30	31-40	41-50	>51
C-factor	<59	60 - 69	70 - 89	90 - 109	>110

5.1.2 Consequence of failure Metrics/Methods

The metrics used to determine the COF for individual water mains are listed below. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest COF. The rubric used in determining the score for each metric used is shown in Table 5.2, while a description of each metric and the reasoning for using said metric is listed below.

1.) Length

The longer the length of water main in need of replacement, the more difficult it will be to replace. The length score was based on the length of water main to be replaced.

2.) Water Service Disruption

Some water mains are more critical to servicing customers of the system. While losing a single water main will typically leave some customers without water, the loss of another more strategically important main can result in hundreds or thousands of customers being without water. The Water Service Disruption COF metric measures the number of customers affected by the loss of a single water main.

3.) Accessibility

Some water mains can be difficult to reach if they were to fail. The harder it is or costlier it is to reach a water main to replace or repair it, the higher the Accessibility COF metric will be.

4.) Critical Customer Impact

The failure of a water main and subsequent loss of service to surrounding customers can have a much greater consequence depending on the user. Critical users in a system are typically hospitals, industry, businesses, schools, and other users who have a population that would be greatly affected by a loss of water. The score for mains near to critical users is determined by the type of user.

5.) Diameter

In general, the larger the diameter of the water main, the more important it is to the water system and subsequently its customers. Also, the damages caused by a significant main break on a larger pipe have more potential to cause damage compared to a smaller pipe. The diameter score was based on the diameter in inches for each water main.

Table 5.2 – Distribution Assets, Consequence of Failure

Evaluation Metric	5	4	3	2	1
	Very High	High	Moderate	Low	Very Low
Length (feet)	Over 2000	1001-2000	501-1000	51-500	1-50
Water Service Disruption	Water source; no redundancy	Facility (station, tank) or Connection to >30% of system; no redundancy or 5 with redundancy	Connection to 15-30% of system; no redundancy or 4 with redundancy	Connection to <15% of system; no redundancy or 3 with redundancy	Anything else
Accessibility	Directional Drilled	Under a major road	Under a minor road	In the right of way	Uncongested Area
Critical Customer Impact	Medical Facilities or major industries	Major Living Areas (prison, retirement home, etc.)	School, church, Sizable Business or Government Office	Residential	No Customer
Diameter	≥ 24-inch main	20 to 16-inch main	14 to 12-inch main	10 to 8-inch main	≤ 6-inch main

5.2 Vertical Assets

A criticality assessment of vertical assets in the water system was completed using information gleaned from site visits to water system facilities by FTCH, in conjunction with information provided by the City.

5.2.1 Probability of Failure Metrics/Methods

The metrics used to determine the POF for vertical assets are described below. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest POF. The rubric used in determining the score for each metric used is shown in Table 5.3, while a description of each metric and the reasoning for using said metric is listed below.

1.) Physical Condition

The worse the physical condition of a vertical asset the more likely it is to fail. The physical condition score was determined from the condition of the asset observed during the site visits and City staff input.

2.) Remaining Useful Life

The age of a vertical asset in relation to the typical useful life of that type of asset is important to the POF of the asset. The remaining useful life score was determined using the difference of the age of the asset and its typical useful life.

3.) Operational Complexity

The more complex the operation of a vertical asset is, the more likely one of its components is to fail. The operational complexity score was determined based on the complexity of operating a vertical asset.

4.) Operational Frequency

If a vertical asset is constantly utilized, it is more likely to fail due to the stress of constant operation. The operational frequency score was determined based on the frequency with which an asset is in operation during normal water system operation.

Table 5.3 – Vertical Assets, Probability of Failure

Evaluation Metric	5	4	3	2	1
	Very High	High	Moderate	Low	Very Low
Physical Condition	Very Poor	Poor	Fair	Good	Very Good
Remaining Useful Life	< 20% of useful life remaining	Age between 20% and 40% of useful life remaining	Age between 40% and 60% of useful life remaining	Age between 60% and 80% of useful life remaining	> 80% of useful life remaining
Operational Complexity	Very Complex	Complex	Moderate	Simple	Very Simple
Operational Frequency	Very Frequent	Frequent	Moderate	Irregular	Very Irregular

5.2.2 Consequence of Failure Metrics/Methods

The metrics used to determine the COF for vertical assets are described below. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest COF. The rubric used in determining the score for each metric used is shown in Table 5.4, while a description of each metric and the reasoning for using said metric is listed below.

1.) Water Supply

The importance of a vertical asset to maintaining a supply of water to the system is an important aspect of the COF of that asset. The water supply score is determined based on the effect the loss of a vertical asset would have on the ability of the water system to continue to supply water to its customers.

2.) Water Quality

The importance of a vertical asset to maintaining the quality of water in the system is an important aspect of the COF of that asset. The water quality score is determined based on the effect the loss of a vertical asset would have on the quality of the water in the system.

3.) Financial Impact

If a vertical asset fails, it must be replaced. Depending on the cost of replacing that asset, it can be paid for from the City's budget or force the City to take out a loan. The financial impact score is determined based on the impact of the cost of replacing a vertical asset.

4.) Safety

To maintain a water system, City staff must perform periodic maintenance on and work around vertical assets. The safety of these workers and the general public is important. The failure of certain vertical assets can result in a workplace hazard for City staff or even be a public safety hazard. The safety score is determined based on the threat to City staff and the general public's health due to the failure of a vertical asset. The higher the calculated BRE, the more critical the asset.

Table 5.4 – Vertical Assets, Consequence of Failure

Evaluation Metric	5	4	3	2	1
	Very High	High	Moderate	Low	Very Low
Water Supply	Violation of Regulatory Standard	Process shut-down	Potential process upset	Loss of redundancy	No impact
Water Quality	Violation of Regulatory Standard	Process shut-down	Potential Process Upset	Loss of redundancy	No impact
Financial Impact	Major Cost (> $100,000)	Significant Cost ($50,001-$100,000)	Moderate Cost ($10,001-$50,000)	Minor Cost ($5,001-$10,000)	Insignificant ($1-$5,000)
Safety	Loss of Life	Severe Injury to employees or public	Minor injury requiring treatment off-site or lost time	Minor injury requiring no treatment with no lost time	No injury

5.3 Business Risk Exposure

The assets that have the greatest POF and the greatest COF will be the assets that are most critical to the system. The Business Risk Exposure (BRE) is the overall score that takes into account the POF and COF ratings and quantifies the criticality.

BRE = POF x COF

Since the POF and COF each have a score of 1 through 5, the BRE score is 1 through 25. Refer to Table 5.5 for the BRE Matrix.

Table 5.5 – Business Risk Exposure Matrix

25	20	15	10	5	**5**	Consequence of Failure
20	16	12	8	4	**4**	
15	12	9	6	3	**3**	
10	8	6	4	2	**2**	
5	4	3	2	1	**1**	
5	**4**	**3**	**2**	**1**		
Probability of Failure						

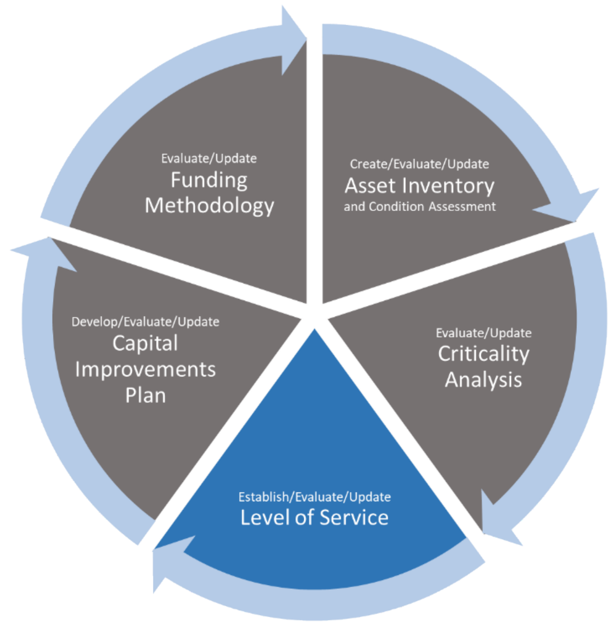
High	High Priority (15 - 25)
Medium	Medium Priority (5 - 14)
Low	Low Priority (1 - 4)

Assets with the highest BRE scores are those that should be rehabilitated or replaced first. Assets with the lowest scores are those that do not currently require any rehabilitation or replacement, but should be monitored at regular intervals to verify the scores do not change. Assets in the middle should be evaluated on a case-by-case basis to determine their priority. The MDEQ guidelines for determining criticality state a BRE score above 15 is deemed high.

As part of the AMP criticality analysis, a BRE value was calculated for every asset in the water system. A map showing the BRE calculated for all the water mains in the system is included in Figure 1. A portion of the BRE calculations for the vertical assets in the system is included in Appendix 1.

6.0 Level of Service Goals

The City's LOS is used to set the fundamental framework for how the water system is operated and to help guide the City with its capital planning. This section describes the LOS the City intends to provide its customers, as well as, the process used to establish the LOS and how it affects the AMP process.



6.1 LOS Philosophy

The City's LOS plays an important role in capital improvements planning. LOS goals are used to prioritize capital investment and guide decision-making. LOS incorporates public health goals and community values, and balances these expectations with available staff, funding and other high priority water system needs. The LOS sets reasonable standards to maintain a balance between customer expectations, their tolerance for service interruptions and their willingness to pay for corresponding capital investment. The LOS also provides the City with a way to document the expectations of their customers, quantify performance targets and track progress.

6.2 LOS Selection

The City's selected LOS were determined based on several goals including delivery of a reliable supply of safe drinking water to its customers, maintaining compliance with local, state and federal regulations, and several technical, managerial and financial goals. Establishing the overall water system LOS for inclusion in the AMP was an iterative process with initial LOS developed by the consulting engineer and modified based on City comment until a consensus set of LOS goals was reached.

6.3 LOS Parameters

The LOS for the City is defined using the following parameters: service categories, LOS goals, metrics to measure progress in achieving goals, and specific targets for those metrics. The LOS table is organized by categories of service. These categories cover the following three service attributes that are important in meeting customer expectations:

- Reliable and Responsive Water Service
- Adequate Capacity
- Recovery of Full Cost of Service

Within each service category are LOS goals that identify how the City strives to meet the service goal. For each goal, there is a Performance Indicator defining how the service is experienced, or received, and a Performance Measure defining the criteria by which each goal/indicator can be measured. The Specific Performance Target is a detailed metric the City targets for each performance indicator. The established LOS for the City water system along with their corresponding indicators, measures and targets are shown in Table 6.1. The City will use the performance targets to determine whether they are meeting the corresponding LOS into the future. The continued monitoring of these performance targets will ensure the City is fulfilling the LOS established for the system. The LOS should continue to be updated in response to changing water system needs and customer expectations.

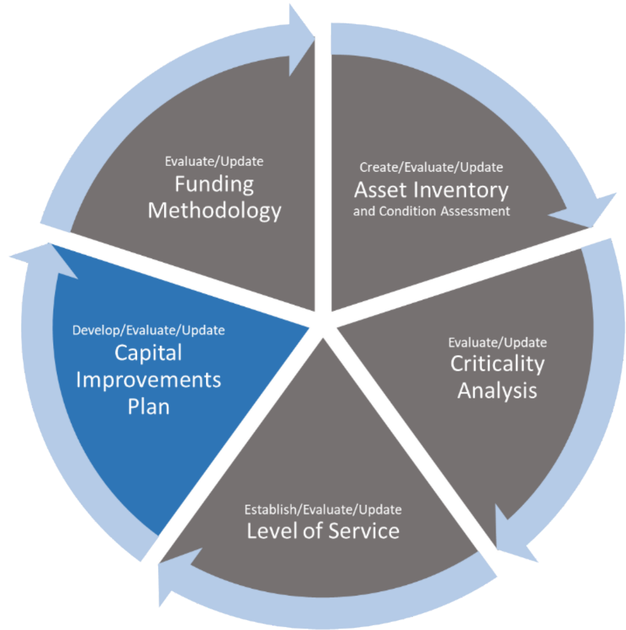
Table 6.1 – Level of Service Table

LEVEL OF SERVICE	PERFORMANCE INDICATOR	PERFORMANCE MEASURE	SPECIFIC PERFORMANCE TARGET
What is the category of Service?	In what ways is the Service experienced or received?	How can the indicator be measured?	What is the target for the measure of each performance indicator?
Reliable and Responsive Water Service	Minimize Service Interruptions/ Disruptions	Number of Service Interruptions/Disruptions per Year.	2 Disruptions of <4 hours 1 Disruptions of 4-12 hours 1 Disruptions of >12 hours per 1,000 customers, per year
	Maintain Regulatory Compliance	Number of Regulatory Violations	Maintain 100% Compliance with drinking water regulations
	Maintain Water Quality throughout the System	Number of Violations of Maximum Contaminant Levels.	No violations
		Number of customer complaints about water quality	Less than 5 customer reports on water quality issues per quarter.
	Minimize Water Main Breaks	Number of water main breaks per year per mile of water main.	1.5 water main breaks per 10 miles of pipe annually.
	Maintain Pressures within Regulatory Standards	Pressures will be maintained between 35 and 100 psi.	Pressure is maintained within these standards 99% of the time.
Adequate Capacity	Provide Emergency and Fire Flow to Customers	% of customers within hydrant coverage	99% hydrant coverage for all customers in the system.
		Meet ISO Standards for available fire flow.	1,500 gpm for 1 hour Residential 2,000 gpm for 2 hours Commercial 3,500 gpm for 3 hours Industrial
	Maintain Adequate Capacity for the System	% of maximum day demands met by Pump Capacity	100% or greater of maximum day demands met by pump capacity
		% of 24-hour average day demand volume met by Storage Capacity	100% or greater of 24-hour average day demand volume met by Storage Capacity
		% of 24-hour average day demands that can be met with standby power	100% or greater of 24-hour average day demands met with standby power
Recover Full Cost of Service	Charge Appropriate Water Rates to Customers	Maintain a Capital Improvements Plan for the Water System	Update Capital Improvements Plan every 3 years
		Maintain Customer Meter Condition and Accuracy	Evaluate condition and accuracy of 5% of meters in system annually
	Minimize Non-Revenue Water	Minimize Unmetered Water Loss	Maintain non-revenue water loss to < 10%
		Calibration of Source Facility and Distribution Facility Meters	Calibrate key meters at facilities and large users regularly

7.0 Capital Improvement Plan

This section summarizes the current CIP for the City and the methods by which the CIP was developed.

7.1 Development of CIP Projects



Proposed capital projects are identified in a number of different ways including review of the criticality analyses from Section 5.0., determination of system needs by staff and system administrators, results of recent planning studies, and coordination with need-based projects for other system utilities (roads, sewer, or storm). The proposed capital projects are then prioritized for completion using the same factors that helped to identify the projects and cost estimates are developed in present day costs.

To keep a water system in good condition, it must be renewed by replacing water mains on a regular basis. The goal is to replace water mains before they can reach the end of their expected useful life. To assess the condition of the City's water system, the expected and remaining useful life of each water main was calculated based on recommendations established in the AWWA report, "Buried No Longer." The useful life calculations are described in more detail in Section 4.1.1.

The CIP was developed based on replacing any water main that had reached the end of its useful life within twenty years. It is estimated that 37.6% of the system will reach the end of its useful life within the next 20 years. The City could replace 1.88% of the system per year for the next 20 years to ensure no water mains in the system reached their useful life in the planning period. The recommended 5-Year CIP replaces 1.78% of the system per year, while the recommended 20-Year CIP replaces 1.77% of the system per year.

The 5-and 20-Year CIP for horizontal assets in the system were developed and prioritized using the factors described above. Estimated costs for the projects were estimated using unit costs from similar constructed water main projects in the region. Costs include excavation, installation of the new main, and restoration above the water main installation site; they do not include road replacement. The costs also include factors for contingency and engineering. The project descriptions, estimated year of completion, water main diameters, water main lengths, water main unit costs, water main total costs, and BRE scores are shown in Appendix 2. A map of the location of each of these projects is shown in Figure 2.

The horizontal asset projects were selected based on a variety of factors. The criticality analysis for each water main was one of the main determinants qualifying a water main for replacement. Other factors for water main replacement included coordination with projects intended for other system utilities, frequency of main breaks and repairs needed for water mains, and hydraulic performance improvement targets identified as part of the City's Reliability Study. Where possible, the horizontal asset projects were prioritized by the BRE score received as part of the criticality analysis.

The 5-and 20-Year CIP for vertical assets in the system were developed and prioritized using the factors described above. Costs for the projects were estimated using a combination of equipment quotes, costs from similar projects, and City input. Contingency and engineering are not included in the projects that involve a simple replacement or rehabilitation of equipment in kind that could be procured directly by the City. However, contingency and engineering is included for all construction projects. The project descriptions, estimated year of completion, total estimated costs and BRE scores are shown in Appendix 2.

The CIPs presented do not include any provisions for lead service line replacement. It is anticipated that legislation will be issued in the coming year which could greatly increase water system liability for costs for service line replacement. It is recommended that the CIPs be revised as necessary when details on future legislation regarding removal of lead services become known.

7.2 5-Year CIP Projects

The 5-Year CIP includes 7 horizontal asset projects which will require $4,139,000 of funding.

The 5-Year CIP includes 5 vertical asset projects which will require $454,600 of funding. The projects were prioritized using the factors described in Section 7.1. Most of the projects involve basic maintenance, including painting hydrants, tanks, and water department facilities. Installing perimeter fencing and cameras around several water department facilities will increase security and longevity of these properties for the City. Creating a set of construction standards for the City will help guide all future engineering projects to be more consistent.

It is understood that the expected costs and timelines for individual projects may fluctuate based on changing needs in the water system.

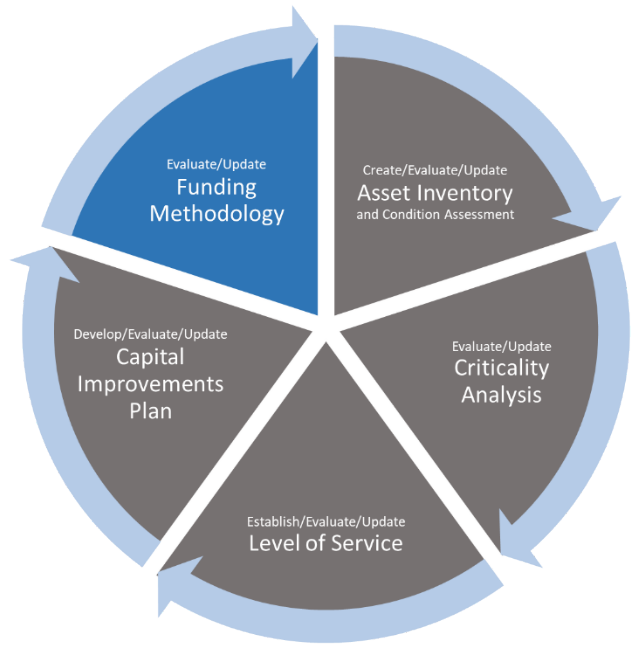
7.3 20-Year CIP Projects

The 20-Year CIP describes projects that would be done 6 to 20 years into the future. The 20-Year CIP includes 24 horizontal asset projects which will require $11,550,000 of funding

The 20-Year CIP includes 1 vertical asset project which will require $7,000,000 of funding. The only capital project included in the 20-Year CIP is the construction of the new municipal services complex. The existing facilities for the Water and Electric departments are outdated. Combining the Electric and Water Departments into a shared building will provide the City with improved facilities for these two departments.

It is understood that the expected costs and timelines for individual projects may fluctuate based on changing needs in the water system.

8.0 Funding Structure and Rate Methodology

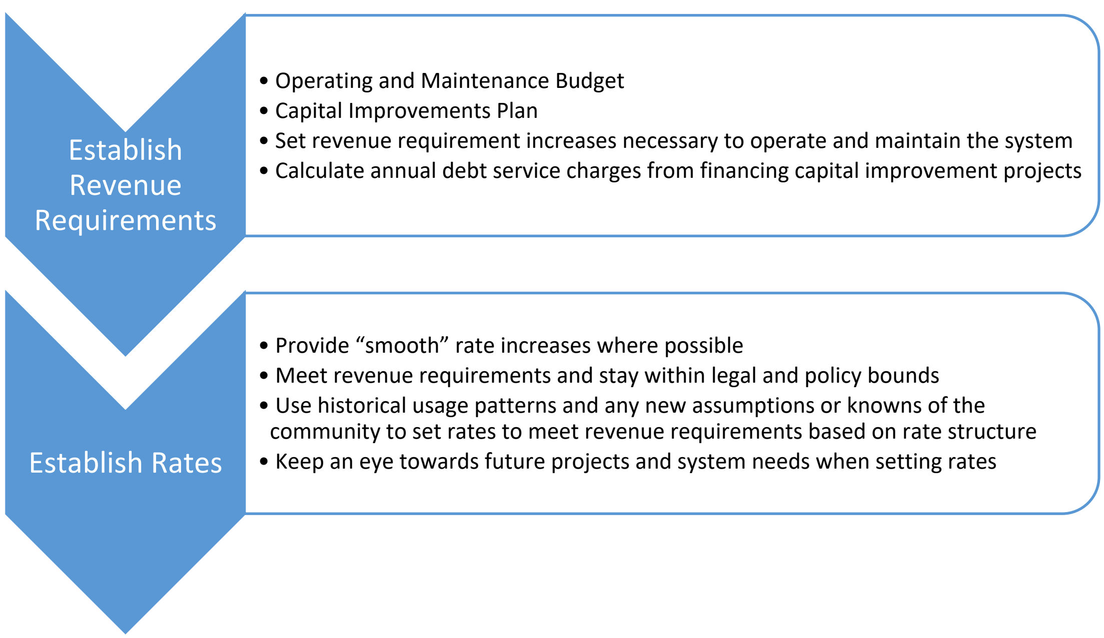


The funding structure and rate methodology section of the AMP is intended to ensure that the water system will have funding for future capital improvements projects necessary to maintain the established LOS.

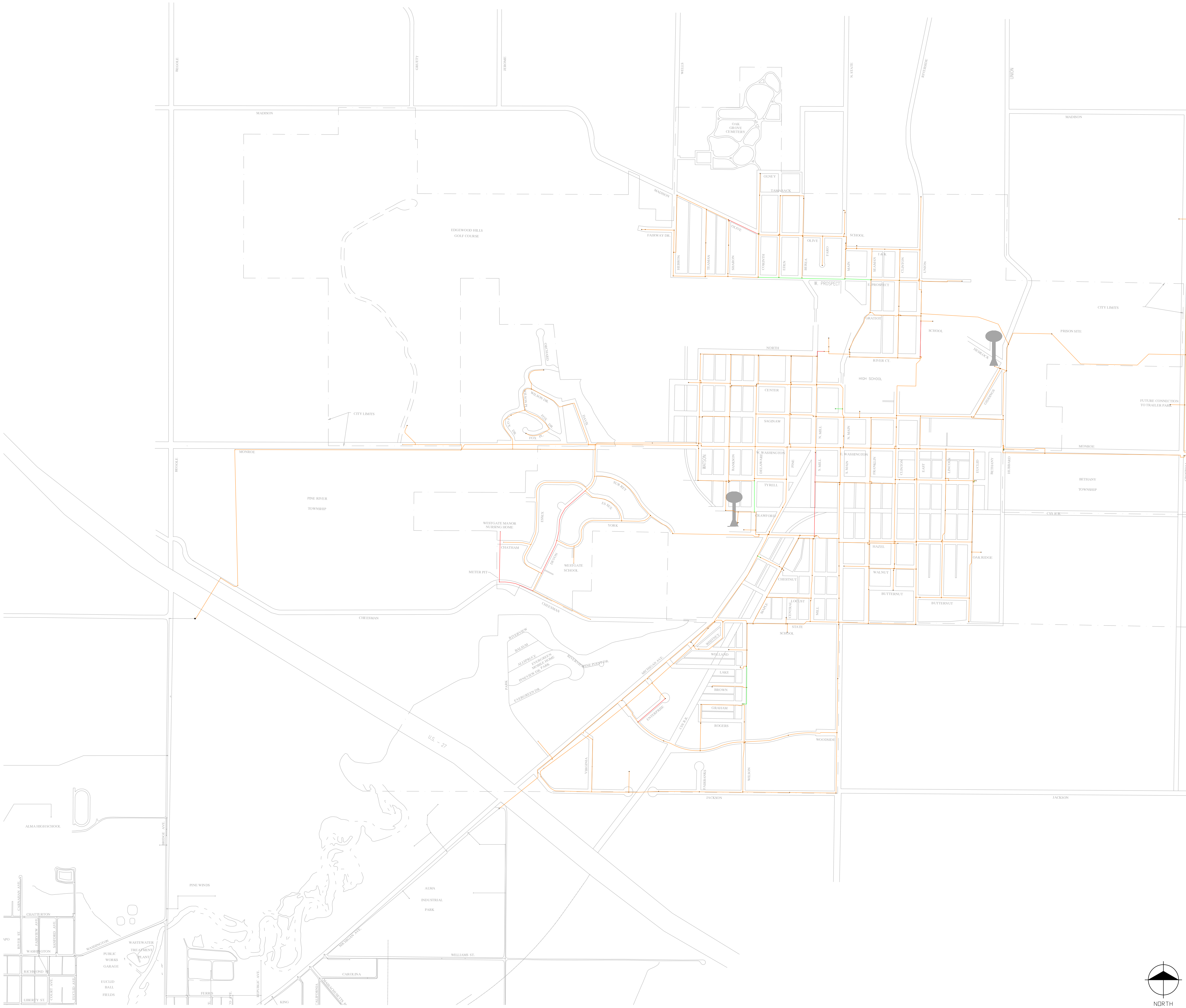
The City has two separate types of monthly water utility rate charges for its customers. The first water utility rate is a commodity charge, which is billed on a per 1,000-gallon basis for usage. This charge is based on funding the cost of operating and maintaining the water system and capital improvements projects. The City bills a fixed "ready-to-serve" charge based on meter size that is intended to fund debt service for the system.

Adjustments to the water rates are calculated by City staff, and at times a third party consultant. The recommended rate adjustments are then submitted to the City Council for approval. In the past, this was done on an "as-needed" basis. Going forward, the City will adjust rates annually. The rate adjustments will be based on a 10-year utility rate model, which considers operation and maintenance costs and planned capital improvements projects. The utility rate model includes rate smoothing, to minimize rate variability from year to year.

The funding structure and rate methodology is further described in the report, City of Saint Louis, MI, Water Asset Management Plan Financial Analysis, December 2017 by Municipal Analytics, LLC. Reference this report for detailed financial information related to funding water system improvements. The financial projections include bond issues in fiscal years 2019 and 2025 to fund project needs not covered by water system revenues.



Figures



Business Risk Exposure (1-25)

<= 4.0
<= 14.9
<= 25.0

NORTH

City of Saint Louis
Business Risk Exposure

NO SCALE

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

City of Saint Louis
Saint Louis, Michigan

Water Asset Management Program

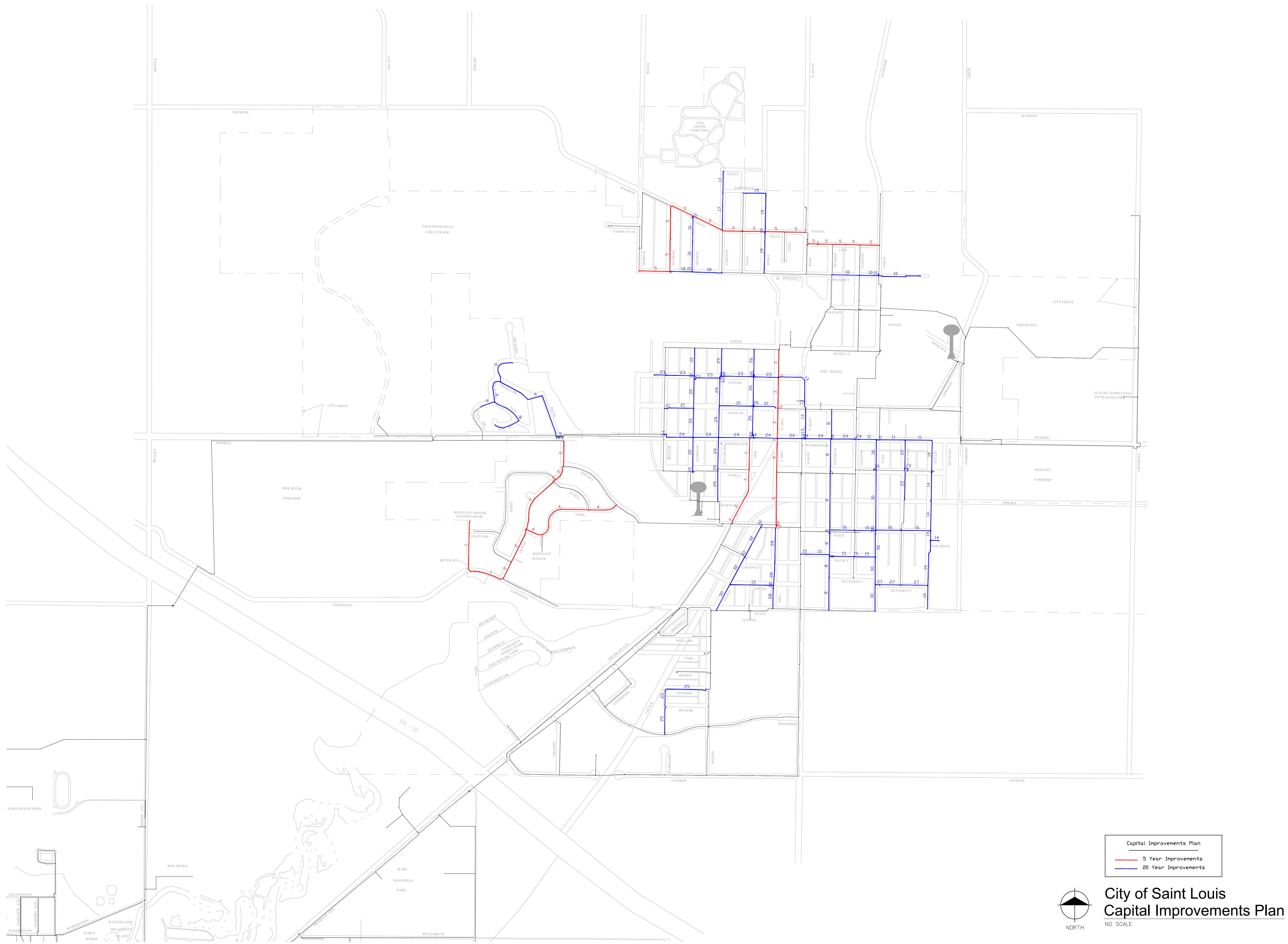
Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G171394

SHEET NO.
1

PLOT INFO: Z:\2016\160148\CAD\PNA\GAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: AMP F1 DATE: 12/21/2017 TIME: 9:48:43 AM USER: NTG



City of Saint Louis
Capital Improvements Plan
NO SCALE

City of Saint Louis
Saint Louis, Michigan

Water Asset Management Program

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

Drawn By	CGM
Designer	CGM
Reviewer	JW
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G171394

SHEET NO.
2

PLOT INFO: Z:\2016\160148\CAD\PNAGAWA RELIABILITY STUDY 04_13_2016.DWG LAYOUT: AMP F2 DATE: 12/21/2017 TIME: 9:52:52 AM USER: NTG

Appendix 1

Facilities Data

Asset Type	Asset ID	Asset Location	Capacity	Cost	Year Installed	Physical Conditon	Equipment Age (Years)	Equipment Standard Life	Remaining Life yrs	Remaining Life %	Operational Complexity	Operational Frequency
Steel Single Pedestal Elevated Ta	Crawford Elevated Tank	Crawford Tank	500,000 gal	$2,000,000	1963	Fair	55	100	45	45.44	Simple	Frequent
Control Panel	0	Crawford Tank	0	$15,000	1990	Good	28	25	0	0.00	Complex	Irregular
Main Breaker Load Center	0	Crawford Tank	0	$1,500	1990	Good	28	25	0	0.00	Simple	Irregular
Steel Single Pedestal Elevated Ta	Giddings Street Elevated Tank	Giddings Street	200,000 gal	$1,500,000	2016	Very Good	2	100	98	98.48	Simple	Frequent
Control Panel	0	Giddings Street	0	$15,000	2016	Very Good	2	25	23	93.93	Complex	Irregular
Main Breaker Load Center	0	Giddings Street	0	$1,500	2016	Very Good	2	25	23	93.94	Simple	Irregular

Probability of Failure

Physical Condition Score 1-5	Age Factor Score 1-5	Operations Complexity Score 1-5	Operational Frequency Score 1-5	**Probability of Failure 1-5**
3	1	3	5	**3.0**
3	5	5	3	**4.0**
3	5	3	3	**3.5**
1	1	3	5	**2.5**
1	1	5	3	**2.5**
1	1	3	3	**2.0**

Consequence of Failure

Water Supply Score 1-5	Water Quality Score 1-5	Financial Impact Score 1-5	Safety Score 1-5	**Consequence of Failure 1-5**	**Business Risk Exposure (1-25)**
5	3	5	5	**4.5**	**13.5**
3	3	3	3	**3.0**	**12**
3	3	1	3	**2.5**	**8.75**
5	3	5	3	**4.0**	**10**
3	3	3	3	**3.0**	**7.5**
3	3	1	3	**2.5**	**5**

Appendix 2

Saint Louis Capital Improvements Plan
Saint Louis Water Asset Management Plan

Percentage Replaced per Year
1.78%

5-Year Horizontal Asset Improvement Estimated Costs

Project No.	Project Description/Location	Estimated Year of Completion	Replacement Main Diameter (inches)	Main Length (feet)	Main Unit Cost ($/foot)	Water Main Cost	BRE Score (1-25)
1	Replace mains west of Cheesman and Devon intersection along Cheesman, then up to meet Pine River Health Care.	2018	8	1,400	$249	$349,000	16.00
2	Replace mains along Devon Street	2019	8	2,600	$249	$647,000	13.00
3	Replace mains along Mill Street from Washington to North Street	2019	12	1,500	$296	$444,000	12.47
4	Replace mains along York Street from Surrey to Devon Street	2020	8	1,800	$249	$448,000	12.00
5	Replace mains along Olive Street from Union Street, down Teaman and west along Prospect	2021	12	5,000	$296	$1,480,000	12.72
6	Replace mains along Mill street from Washington to Hazel	2022	8	1,400	$249	$349,000	11.00
7	Replace 4-inch mains along Michigan and traveling up Pine Street to Washington Avenue	2022	12	1,500	$281	$422,000	11.00
					Cost of 5-Year Horizontal Asset Improvements	$4,139,000	

Saint Louis Capital Improvements Plan
Saint Louis Water Asset Management Plan

5-Year Vertical Asset Improvement Estimated Costs

Project No.	Project Title	Project Year	Project Cost	Short Description	BRE Score (1-25)
1	Fire Hydrant Re-Painting Program	FY 16/17 - 17/18	$16,600	Priming and painting all the fire hydrants.	N/A
2	Municipal Services Complex - Develop City Engineering Standards	FY 17/18	$10,000	Creating a set of development and construction standards to keep everyone on a	N/A
3	Crawford Water Tower Painting and Upgrades	FY 17/18	$350,000	Repaint the tank and some additional upgrades to increase lifespan of tower.	13.50
4	Water Department Garage - Painting	FY 18/19	$8,000	Repaint the Garage.	N/A
5	Municipal Services Complex - Security Fencing	FY 19/20	$70,000	Install cameras and a perimeter fence with powered entrance gate around Water Department, DPW facilities and WWTP.	N/A
Cost of 5-Year Vertical Asset Improvements			$454,600		

Saint Louis Capital Improvements Plan
Saint Louis Water Asset Management Plan

Percentage Replaced per Year
1.77%

20-Year Horizontal Asset Improvement Estimated Costs

Project No.	Project Description/Location	Estimated Year of Completion	Replacement Main Diameter (inches)	Main Length (feet)	Water Main Cost	Total Estimated Cost	BRE Score (1-25)
8	Replace mains along Franklin Street from Saginaw to State Street	2022	8	3,300	$249	$821,000	11.17
9	Replace mains in Orchard Hills	2023	8	3,700	$264	$976,000	10.83
10	Replace mains along Prospect from Seaman to dead end to east	2024	8	1,500	$249	$374,000	10.60
11	Replace mains along Washington from Clinton to Hubbard Street	2024	8	1,500	$249	$374,000	10.56
12	Replace main along Locust Street from Maple Street to Mill Street	2025	8	700	$249	$175,000	10.56
13	Replace mains along Main Street from Washington to the bridge	2025	8	1,400	$264	$370,000	10.28
14	Replace 4-inch mains along Euclid Street	2026	8	2,900	$249	$722,000	10.13
15	Install main along Walnut from Main Street to East Street and down East Street to Butternut	2027	8	2,400	$249	$597,000	10.00
16	Replace 4-inch mains along Hazel Street	2027	8	1,600	$249	$398,000	10.00
17	Replace mains alnog Corinth Street from Olive Street to dead end to the north	2028	8	950	$249	$237,000	10.00
18	Replace mains along Prospect from Corinth to Teaman Street	2028	8	855	$264	$226,000	9.92
19	Replace mains along Berea, west along Tamarack to Eden Street	2028	8	1,700	$264	$449,000	9.85
20	Replace mains along Bankson from Tyrell to North Street	2029	8	2,000	$249	$498,000	9.83
21	Replace 4-inch mains along Saginaw Street	2030	8	1,500	$249	$374,000	9.71
22	Replace 4-inch mains along Lincoln Street	2030	8	1,100	$249	$274,000	9.60
23	Replace mains along Center Street from Watson to Main	2031	8	2,200	$249	$548,000	9.48
24	Replace mains along West Washington Avenue from the new 16-inch transmission main to Clinton Street	2032	12	2,400	$296	$711,000	9.48
25	Replace mains along Graham Street from Wilson to Woodside	2033	8	1,400	$264	$370,000	9.39
26	Replace mains along Pine Street from Washington to North Street	2033	8	1,600	$249	$398,000	9.16
27	Replace main along Butternut from East to Euclid Street	2034	8	1,500	$249	$374,000	8.80
28	Replace mains along Mill Street from Hazel to State Street	2034	8	1,300	$264	$343,000	8.80
29	Replace mains along Delaware Street from Crawford to North Street	2035	8	2,500	$249	$622,000	8.68
30	Replace mains along East Street from Washington to State	2036	8	2,800	$249	$697,000	8.65
31	Replace mains along Sharon Street from Olive to Prospect Street	2037	8	900	$249	$224,000	8.46
32	Replace mains along Maple Street from Hazel to State Street	2037	8	1,600	$249	$398,000	8.24
					Cost of 20-Year Horizontal Asset Improvements	$11,550,000	

Saint Louis Capital Improvements Plan
Saint Louis Water Asset Management Plan

20-Year Vertical Asset Improvement Estimated Costs

Project No.	Project Title	Project Year	Project Cost	Short Description	BRE Score (1-25)
6	Municipal Services Complex - New Municipal Services Complex	FY 27/28	$7,000,000	Combining Electric and Water Department into a common facility.	N/A
	Cost of 20-Year Vertical Asset Improvements		$7,000,000		

Appendix 3

SUMMARY OF FINANCIAL ANALYSIS AND RATE IMPACTS:

Prior to completing the following summary report of findings, Municipal Analytics reviewed the financial analysis and rate model with the St. Louis City Manager, Finance Director and Director of Public Services. They are in agreement with the overall funding strategy for capital improvements, and the resulting rates required to fund operations, maintenance, replacement, capital and debt. Included below are some snapshots from the rate model, related to water capital, debt, cash and rates. The large changes in monthly RTS are due to a change in rate structure, which brings the City's meter ratios in line with standard AWWA meter ratios.

In the rate model, a portion of fixed O&M costs have been allocated to the commodity charge, to reduce the impact on smaller customers.

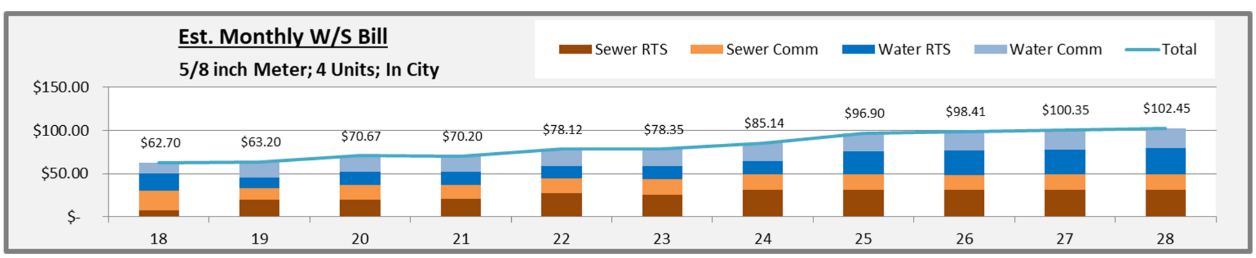
Anticipated 10-year rate structure (will be reviewed and revised annually, to conform to current financial needs and customer base):

	Current	Recommended	Estimated	Estimated	Estimated	Estimated
	2018	**2019**	**2020**	**2021**	**2022**	**2023**
Monthly WATER RTS						
5/8 inch	$ 19.84	$ 13.06	$ 15.91	$ 14.33	$ 14.49	$ 15.17
3/4 inch	$ 20.36	$ 13.06	$ 15.91	$ 14.33	$ 14.49	$ 15.17
1 inch	$ 20.96	$ 32.66	$ 39.79	$ 35.82	$ 36.23	$ 37.92
1.25 inch	$ 21.32	$ 52.25	$ 63.66	$ 57.30	$ 57.96	$ 60.68
1.5 inch	$ 21.79	$ 65.31	$ 79.57	$ 71.63	$ 72.45	$ 75.84
2 inch	$ 25.28	$ 104.50	$ 127.31	$ 114.61	$ 115.92	$ 121.35
3 inch	$ 28.40	$ 195.94	$ 238.71	$ 214.89	$ 217.35	$ 227.53
4 inch	$ 37.39	$ 326.56	$ 397.86	$ 358.15	$ 362.25	$ 379.22
6 inch	$ 49.10	$ 653.12	$ 795.72	$ 716.30	$ 724.51	$ 758.44
8 inch	$ 62.10	$ 1,045.00	$ 1,273.14	$ 1,146.09	$ 1,159.21	$ 1,213.51
Commodity Charge: WATER	$ 3.24	$ 4.39	$ 4.59	$ 4.68	$ 4.87	$ 4.99

The impact of water rates on a typical residential customer can be seen here:

			18	19	20	21	22	23	24	25	26	27	28
Customer Impact Estimator-WATER			**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
			Current Rates										
Units (1000 gal)	4	Comm	$ 12.96	$ 17.56	$ 18.37	$ 18.72	$ 19.49	$ 19.95	$ 20.54	$ 21.14	$ 21.83	$ 22.46	$ 23.15
Meter Size	5/8 inch	RTS	$ 19.84	$ 13.06	$ 15.91	$ 14.33	$ 14.49	$ 15.17	$ 15.95	$ 27.16	$ 28.06	$ 28.94	$ 29.87
	In City	**Total/Mo**	**$ 32.80**	**$ 30.62**	**$ 34.28**	**$ 33.05**	**$ 33.98**	**$ 35.12**	**$ 36.49**	**$ 48.30**	**$ 49.89**	**$ 51.40**	**$ 53.02**
		% change		-6.6%	12.0%	-3.6%	2.8%	3.3%	3.9%	32.4%	3.3%	3.0%	3.1%

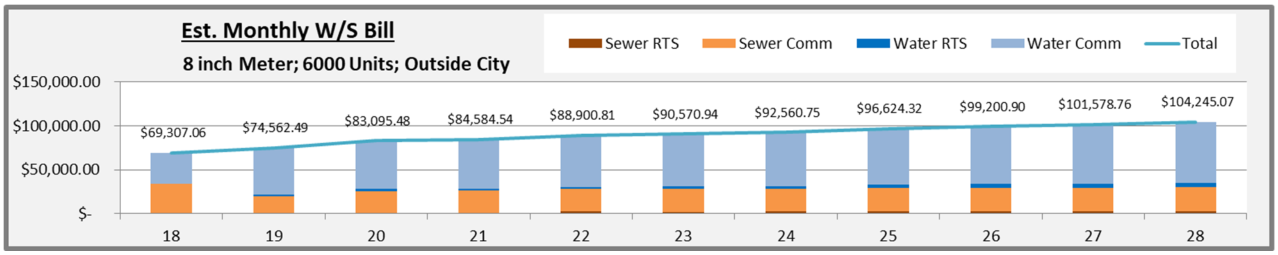
The impact of combined monthly water and sewer bills for a residential customer is summarized in the following 10-year rate forecast:



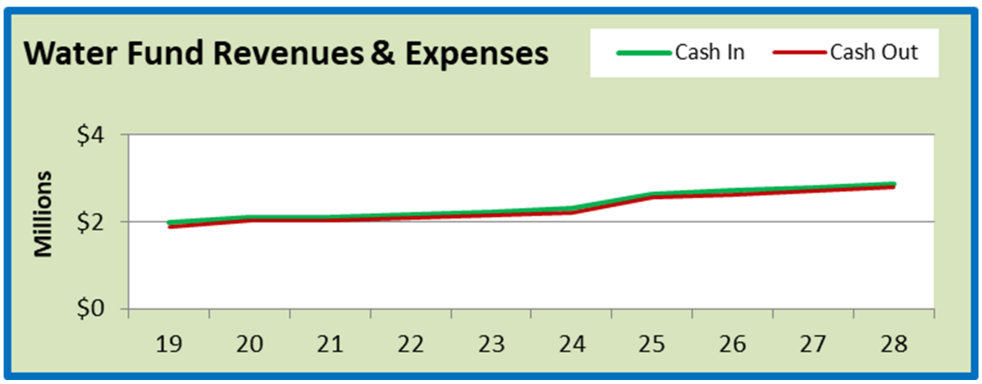
The City's largest customer is expected to pay substantially more for water under the new rate structure:

			18	19	20	21	22	23	24	25	26	27	28
Customer Impact Estimator-WATER			**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
			Current Rates										
Units (1000 gal)	6000	Comm	$ 35,215.60	$ 52,674.33	$55,098.31	$56,169.62	$58,477.95	$59,846.49	$61,622.06	$63,431.67	$65,482.63	$67,394.58	$69,444.48
Meter Size	8 inch	RTS	$ 124.20	$ 2,089.99	$ 2,546.29	$ 2,292.17	$ 2,318.42	$ 2,427.01	$ 2,551.72	$ 4,345.17	$ 4,490.04	$ 4,629.85	$ 4,778.86
	Outside City	**Total/Mo**	**$ 35,339.80**	**$ 54,764.33**	**$57,644.60**	**$58,461.80**	**$60,796.37**	**$62,273.50**	**$64,173.78**	**$67,776.84**	**$69,972.67**	**$72,024.43**	**$74,223.33**
		% change		55.0%	5.3%	1.4%	4.0%	2.4%	3.1%	5.6%	3.2%	2.9%	3.1%

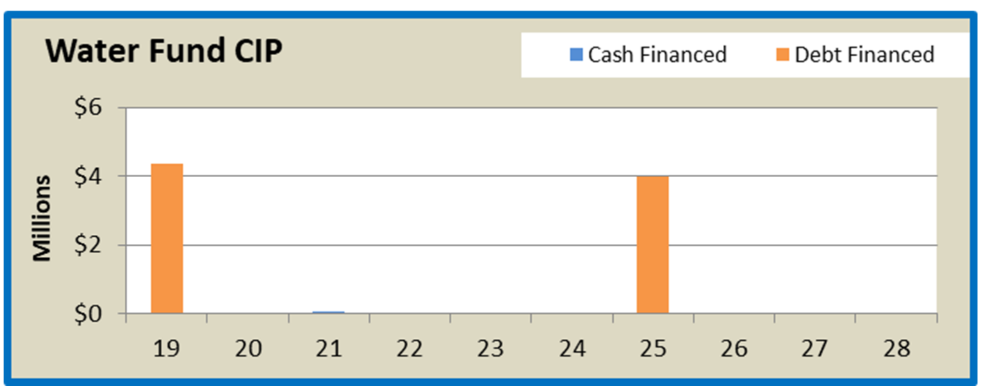
However, due to proposed changes to the City's sewer rate structure, the overall impact on the largest customer is expected to be much less severe:



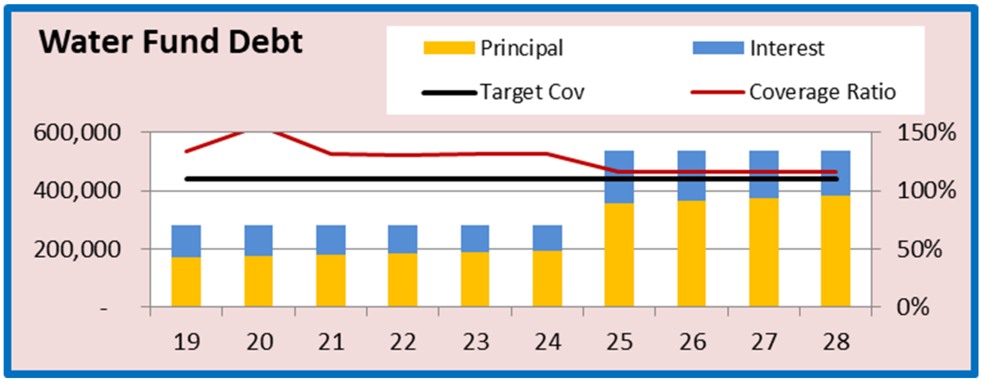
The rates above are expected to be sufficient to meet the revenue needs of the Water Fund and avoid any gap in funding, as illustrated in revenue and expense comparison chart below:



Based on the capital projects identified in the City's Water AMP, the City anticipates two bond issues over the next ten years, along with a minimal amount of capital funding from cash:



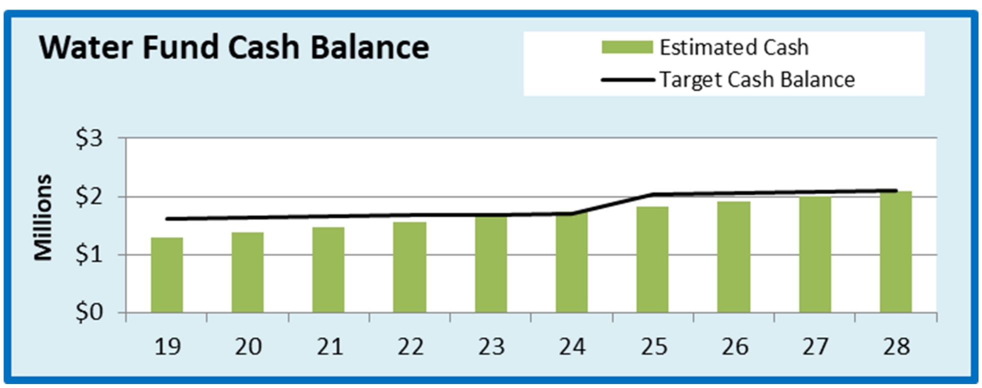
The debt service associated with the above bond issues, as well as the estimated bond coverage ratios, are illustrated here:



The forecasted cash balance in the Water Fund is summarized in the following chart. The difference between estimated cash balances and target cash balances is not significant. As part of our rate analysis, we are recommending the City consider 4 separate cash reserves:

- 90 days O&M expenses
- 125% of annual debt service requirements
- 10% of replacement value of water assets
- Customer deposits

The difference between estimated and target cash is well within the O&M reserve amount, which simply means the City should be able to meet it obligated reserves, but may fall a little short in the O&M reserve. Raising rates to cover this gap is warranted at this time.



APPENDIX E

Opinion of Probable Costs

Project Summary
Engineer's Opinion of Probable Project Cost

OHM Advancing Communities℠ Engineering Advisors

Owner:	**City of St. Louis**	**Date:**	**4/11/2023**
Project:	**DWSRF Project Planning Document FY2024**	**Project No.**	**1277220020**
Work:	**Open Cut Water Main Installation**	**Prepared By:**	**CD**
	Project 1 2023-2026 Water Main Replacement	**Reviewer:**	
	[X] Conceptual [ ] Preliminary [ ] Final	**Current ENR:**	**13745**

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization, Max 5%	1	LSUM	$617,000	$617,000
2	Audio Video Route Survey	1	LSUM	$10,000	$10,000
3	Traffic Maintenance and Control, Max 5%	1	LSUM	$362,000	$362,000
4	Soil Erosion and Sedimentation Control	1	LSUM	$215,000	$215,000
5	Water Main, CL-54, DI, 8 inch, Pavement	14,800	Ft	$210	$3,108,000
6	Water Main, CL-54, DI, 8 inch, Directionall Drill	1,400	Ft	$315	$441,000
7	Water Main, CL-54, DI, 12 inch, Pavement	6,700	Ft	$260	$1,742,000
8	Fire Hydrant	46	Ea	$10,000	$460,000
9	Gate Valve and Well (8-inch)	34	Ea	$7,000	$238,000
10	Gate Valve and Well (12-inch)	13	Ea	$8,000	$104,000
11	Valve Replacement Program (8-inch)	40	Ea	$7,000	$280,000
12	Connection to Existing Water Main	144	Ea	$4,500	$648,000
13	Valve Turning Machine	1	Ea	$151,138	$151,138
14	Wetland Restoration	5	acre	$130,000	$682,500
15	Restoration	65%		$7,021,000	$4,563,650
				SUBTOTAL:	**$13,622,000**
	CONTRACTUAL REQUIREMENTS				
	General Conditions	8%			$1,090,000
	General Requirements	4%			$545,000
	Contingencies	20%			$2,725,000
		TOTAL CONSTRUCTION COST:			$17,982,000
	PROJECT COSTS				
	Design and Construction Engineering	25%			$4,496,000
	Finance and Legal	5%			$900,000
	Geotechnical Services	1.5%			$270,000
			TOTAL PROJECT COSTS:		$5,666,000
	ENGINEER'S OPINION OF PROJECT COST				**$23,650,000**

Project Summary
Engineer's Opinion of Probable Project Cost

OHM Advancing Communities
Engineering Advisors

Owner:	**City of St. Louis**	**Date:**	**4/11/2023**
Project:	**DWSRF Project Planning Document FY2024**	**Project No.**	**1277220020**
Work:	**Directional Drill Water Main Installation**	**Prepared By:**	**CD**
	Project 1 2023-2026 Water Main Replacement	**Reviewer:**	
	[X] Conceptual [ ] Preliminary [ ] Final	**Current ENR:**	**13745**

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization, Max 5%	1	LSUM	$651,000	$651,000
2	Audio Video Route Survey	1	LSUM	$10,000	$10,000
3	Traffic Maintenance and Control, Max 5%	1	LSUM	$479,000	$479,000
4	Soil Erosion and Sedimentation Control	1	LSUM	$229,000	$229,000
5	Water Main, CL-54, DI, 8 inch, Directionall Drill	16,200	Ft	$315	$5,103,000
6	Water Main, CL-54, DI, 12 inch, Directionall Drill	6,700	Ft	$375	$2,512,500
7	Fire Hydrant	46	Ea	$10,000	$458,000
8	Gate Valve and Well (8-inch)	34	Ea	$7,000	$238,000
9	Gate Valve and Well (12-inch)	13	Ea	$8,000	$104,000
10	Valve Replacement Program (8-inch)	40	Ea	$7,000	$280,000
11	Connection to Existing Water Main	144	Ea	$4,500	$648,000
12	Valve Turning Machine	1	Ea	$151,138	$151,138
13	Wetland Restoration	1	acre	$130,000	$130,000
14	Restoration	30%		$9,343,500	$2,803,050
				SUBTOTAL:	**$13,797,000**
	CONTRACTUAL REQUIREMENTS				
	General Conditions	8%			$1,104,000
	General Requirements	4%			$552,000
	Contingencies	20%			$2,760,000
				TOTAL CONSTRUCTION COST:	$18,213,000
	PROJECT COSTS				
	Design and Construction Engineering	25%			$4,554,000
	Finance and Legal	5%			$911,000
	Geotechnical Services	1.5%			$274,000
				TOTAL PROJECT COSTS:	$5,739,000
	ENGINEER'S OPINION OF PROJECT COST				**$23,960,000**

Project Summary
Engineer's Opinion of Probable Project Cost

OHM Advancing Communities
Engineering Advisors

Owner:	**City of St. Louis**	**Date:**	**4/11/2023**
Project:	**DWSRF Project Planning Document FY2024**	**Project No.**	**1277220020**
Work:	**Open Cut Water Main Installation**	**Prepared By:**	**CD**
	Project 2 2027-2029 Water Main Replacement	**Reviewer:**	
	[X] Conceptual [ ] Preliminary [ ] Final	**Current ENR:**	**13745**

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization, Max 5%	1	LSUM	$363,000	$363,000
2	Audio Video Route Survey	1	LSUM	$7,000	$7,000
3	Traffic Maintenance and Control, Max 5%	1	LSUM	$266,000	$266,000
4	Soil Erosion and Sedimentation Control	1	LSUM	$74,000	$74,000
5	Water Main, CL-54, DI, 8 inch, Pavement	7,400	Ft	$210	$1,554,000
6	Water Main, CL-54, DI, 8 inch, Directionall Drill	500	Ft	$315	$157,500
7	Fire Hydrant	16	Ea	$10,000	$160,000
8	Gate Valve and Well (8-inch)	13	Ea	$7,000	$91,000
9	Valve Replacement Program (Gate Valve and Well 8-inch)	50	Ea	$7,000	$350,000
10	Valve Replacement Program (Gate Valve and Well 10-inch)	20	Ea	$7,500	$150,000
11	Valve Replacement Program (Gate Valve and Well 12-inch)	110	Ea	$8,000	$880,000
12	Valve Replacement Program (Gate Valve and Well 16-inch)	20	Ea	$20,000	$400,000
13	Valve Replacement Program (Gate Valve and Box 4-inch)	110	Ea	$1,500	$165,000
14	Valve Replacement Program (Gate Valve and Box 5-inch)	1	Ea	$1,700	$1,700
15	Valve Replacement Program (Gate Valve and Box 6-inch)	260	Ea	$2,000	$520,000
16	Connection to Existing Water Main	53	Ea	$4,500	$238,500
17	Water Service (3/4-inch)	1	LSUM	$12,000	$12,000
18	Water Service (1-inch)	2	LSUM	$154,000	$308,000
19	Water Service (1.5-inch)	3	LSUM	$1,300	$3,900
20	Water Service (2-inch)	4	LSUM	$65,080	$260,320
21	Water Service (3-inch)	5	LSUM	$10,640	$53,200
22	Wetland Restoration	1	Acre	$130,000	$75,400
23	Restoration	30%		$5,305,120	$1,591,536
				SUBTOTAL:	**$7,682,000**
	CONTRACTUAL REQUIREMENTS				
	General Conditions	8%			$615,000
	General Requirements	4%			$308,000
	Contingencies	20%			$1,537,000
				TOTAL CONSTRUCTION COST:	$10,142,000
	PROJECT COSTS				
	Design and Construction Engineering	25%			$2,536,000
	Finance and Legal	5%			$508,000
	Geotechnical Services	1.5%			$153,000
				TOTAL PROJECT COSTS:	$3,197,000
	ENGINEER'S OPINION OF PROJECT COST				**$13,340,000**

Project Summary
Engineer's Opinion of Probable Project Cost

OHM Advancing Communities
Engineering Advisors

Owner:	**City of St. Louis**	**Date:**	**4/11/2023**
Project:	**DWSRF Project Planning Document FY2024**	**Project No.**	**1277220020**
Work:	**Directional Drill Water Main Installation**	**Prepared By:**	**CD**
	Project 2 2027-2029 Water Main Replacement	**Reviewer:**	
	[X] Conceptual [ ] Preliminary [ ] Final	**Current ENR:**	**13745**

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization, Max 5%	1	LSUM	$370,000	$370,000
2	Audio Video Route Survey	1	LSUM	$7,000	$7,000
3	Traffic Maintenance and Control, Max 5%	1	LSUM	$304,000	$304,000
4	Soil Erosion and Sedimentation Control	1	LSUM	$79,000	$79,000
5	Water Main, CL-54, DI, 8 inch, Directionall Drill	7,900	Ft	$315	$2,488,500
6	Fire Hydrant	16	Ea	$10,000	$158,000
7	Gate Valve and Well (8-inch)	13	Ea	$7,000	$91,000
8	Valve Replacement Program (Gate Valve and Well 8-inch)	50	Ea	$7,000	$350,000
9	Valve Replacement Program (Gate Valve and Well 10-inch)	20	Ea	$7,500	$150,000
10	Valve Replacement Program (Gate Valve and Well 12-inch)	110	Ea	$8,000	$880,000
11	Valve Replacement Program (Gate Valve and Well 16-inch)	20	Ea	$20,000	$400,000
12	Valve Replacement Program (Gate Valve and Box 4-inch)	110	Ea	$1,500	$165,000
13	Valve Replacement Program (Gate Valve and Box 5-inch)	1	Ea	$1,700	$1,700
14	Valve Replacement Program (Gate Valve and Box 6-inch)	260	Ea	$2,000	$520,000
15	Connection to Existing Water Main	53	Ea	$4,500	$238,500
16	Water Service (3/4-inch)	1	LSUM	$11,270	$11,270
17	Water Service (1-inch)	2	LSUM	$153,640	$307,280
18	Water Service (1.5-inch)	3	LSUM	$1,300	$3,900
19	Water Service (2-inch)	4	LSUM	$65,080	$260,320
20	Water Service (3-inch)	5	LSUM	$10,640	$53,200
21	Wetland Restoration	1	Acre	$130,000	$75,400
22	Restoration	15%		$6,078,670	$911,801
				SUBTOTAL:	**$7,826,000**
	CONTRACTUAL REQUIREMENTS				
	General Conditions	8%			$627,000
	General Requirements	4%			$314,000
	Contingencies	20%			$1,566,000
				TOTAL CONSTRUCTION COST:	$10,333,000
	PROJECT COSTS				
	Design and Construction Engineerinç	25%			$2,584,000
	Finance and Legal	5%			$517,000
	Geotechnical Services	1.5%			$155,000
				TOTAL PROJECT COSTS:	$3,256,000
	ENGINEER'S OPINION OF PROJECT COST				**$13,590,000**

Project Summary
Engineer's Opinion of Probable Project Cost

OHM Advancing Communities
Engineering Advisors

Owner: City of St Louis
Project: DWSRF Project Planning Document FY2024
Work: Open Cut Water Main Installation
Lead Service Lines
[X] Conceptual [ ] Preliminary [ ] Final

Date: 4/11/2023
Project No. 1277220020
Prepared By: CD
Reviewer:
Current ENR: 13745

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Lead Service Line Replacement	12	LSUM	$8,000	$96,000
				SUBTOTAL:	**$96,000**
		TOTAL CONSTRUCTION COST:			$96,000
	PROJECT COSTS				
	Design and Construction Engineering	15%			$15,000
		TOTAL PROJECT COSTS:			$15,000
ENGINEER'S OPINION OF PROJECT COST					**$120,000**

APPENDIX F

Public Meeting Documents

APPENDIX 3: NOTICE OF PROJECT PLANNING PUBLIC MEETING

(To be used as Template)

The________________(Name of Applicant)______________will hold a public meeting on the proposed ______(description)________ project for the purpose of receiving comments from interested persons.

The meeting will be held at ______ p.m. on _____(Date)______at _________(Location)_________.

The purpose of the proposed project is ____

____

____

Project construction will involve ____

____

____

Impacts of the proposed project include ____

____

____

The estimated cost to users for the proposed project will be _________________________________

____

Copies of the plan detailing the proposed project are available for inspection at the following location(s): ____

____

Written comments received before the meeting record is closed on _______(Date and Time)_____ will receive responses in the final project planning document. Written comments should be sent to: ____

APPENDIX G

Submittal Form and Resolution for DWSRF Project Plan

APPENDIX 4: SAMPLE RESOLUTION

A RESOLUTION ADOPTING A FINAL PROJECT PLANNING DOCUMENT

FOR WATER SYSTEM IMPROVEMENTS

AND DESIGNATING AN AUTHORIZED PROJECT REPRESENTATIVE

WHEREAS, the ____________(legal name of applicant)_________ recognizes the need to make improvements to its existing water treatment and distribution system; and

WHEREAS, the ____________(legal name of applicant)_________ authorized ______(name of consulting engineering firm)____ to prepare a Project Planning Document, which recommends the construction of ____

____

WHEREAS, said Project Planning Document was presented at a Public Hearing held on ______(Date and Time)_____ and all public comments have been considered and addressed;

NOW THEREFORE BE IT RESOLVED, that the __________(legal name of applicant)_________ formally adopts said Project Planning Document and agrees to implement the selected alternative ______________________(Selected Alternative Description)__________________________

BE IT FURTHER RESOLVED, that the _____(title of the designee's position)___, a position currently held by ______(name of the designee)____, is designated as the authorized representative for all activities associated with the project referenced above, including the submittal of said Project Planning Document as the first step in applying to the State of Michigan for a Drinking Water State Revolving Fund Loan to assist in the implementation of the selected alternative.

Yeas (names of Members voting Yes):

Nays (names of Members voting No):

I certify that the above Resolution was adopted by ____(the applicant's governing body)_________ on ____(date of adoption)___.

BY: ______________________________ ______________________________

Name (please print or type) Title

______________________________ ______________________________

Signature Date