City of St. Charles

2024 Water Utility Master Plan

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EXECUTIVE SUMMARY

GENERAL BACKGROUND

The City of St. Charles was incorporated in 1874 and is located in Kane County, Illinois. St. Charles straddles the Fox River between South Elgin and Geneva. The City developed its first potable water supply in 1907. Since then, the City has been dedicated to providing a continuous supply of safe, reliable, and economical potable water to its more than 19,000 accounts. The users who receive water from the City of St. Charles constitute residential, commercial, industrial, and institutional users. In total, these clients utilize approximately 3.56 million gallons of water per day. The existing water facilities maintained by the City include seven wells, four treatment facilities, three elevated towers, several ground storage reservoirs, and approximately 250 miles of water main.

The City of St. Charles has an estimated population of 33,781 based on the 2020 Census and interpolated growth projections. The City has seen significant growth and redevelopment over the past five years, and based on recently approved developments this growth is expected to continue into the near future. As a result, the City has been actively pursuing a strategic plan to address water quality and quantity through a 20-year planning horizon. In order to better sequence and develop capital projects, it is in the City's best interest to maintain an updated Water System Master Plan. The plan was developed as a collaborative effort with input from Public Works, Engineering, Finance, and Community Development Departments. The Water System Master Plan provides a roadmap for the water distribution system, supply, treatment, and storage improvements required to meet the City's short and long-term goals.

MASTER PLANNING

A Water Master Plan Facility Plan is a management and planning document used to identify, evaluate, and plan required water distribution and other infrastructure improvements. It provides an assessment of the distribution, storage, and supply abilities to meet both current and future regulatory requirements and provides critical information for improvements to correct current or projected deficiencies.

Master plans are typically updated every five years, or when significant changes in growth or regulatory requirements have occurred or are expected. The City of St. Charles most recent Water Master Plan was prepared in 2018 and has reached the five-year mark. Since the 20018 update, the City has implemented a number of the recommendations including interconnect of Well #7 & 13 and expansion of the Oak Street Treatment Facility. However, in an effort to remain proactive the City is seeking to update the Master Plan to develop a single document which includes a Capital Improvements Plan to assist in budgeting for necessary improvements and to provide a guide for future improvements.

The ultimate goal of this plan is to establish the community's current and future water production and infrastructure needs and develop an implementation plan to meet those needs. This plan will provide the blueprint for future improvements, expansion phasing, and capital improvement projects.

COMMUNITY NEEDS

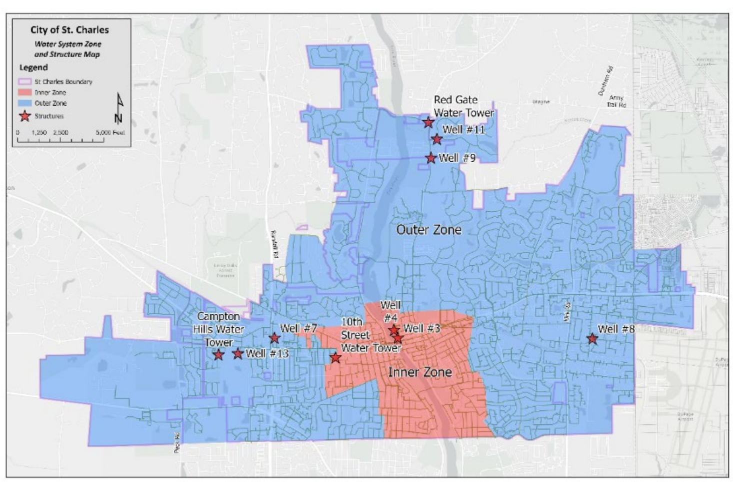
The City of St. Charles has grown from a community of 17,492 in 1980 to 27,910 people in 2000 to an estimated 33,781 people at the end of 2023, as determined with an annual growth projection of 1.1%. Historically, the City has had adequate capacity to serve its planning area under all circumstances. During extremely high water usage periods, the City may draw down reservoirs to meet peak demand hours, however at no point was the system in jeopardy of not meeting demands.

Section 2 of this Plan identifies population growth projections for five-, 10-, 15-, 20-year and 'buildout' planning horizons. In order to estimate the future water demand that the City must be able to provide, these growth timelines were developed and analyzed, summarized in the table below.

	Current	1-5 Year 2028	5-10 Year 2033	10-15 Year 2038	15-20 Year 2043	20+ Year Buildout
Current PE	56,425	56,425	56,425	56,425	56,425	56,425
Cumulative Growth PE	-	13,708	16,876	18,606	19,102	23,854
Total P.E.	56,425	70,133	73,301	75,031	75,527	80,279
ADD (MGD)	4.21	5.23	5.47	5.60	5.64	5.99
MDD (MGD)	8.96	11.14	11.64	11.91	11.99	12.75
Firm Capacity Req'd	9.00	11.25	11.75	12.00	12.00	12.75

As will be discussed in Section 2, the City has capacity to provide the average daily demand throughout the planning horizon. However, the maximum day demand exceeds what is currently available. Analysis of alternatives for additional water supply is reviewed in Section 5 and Section 6 of this report.

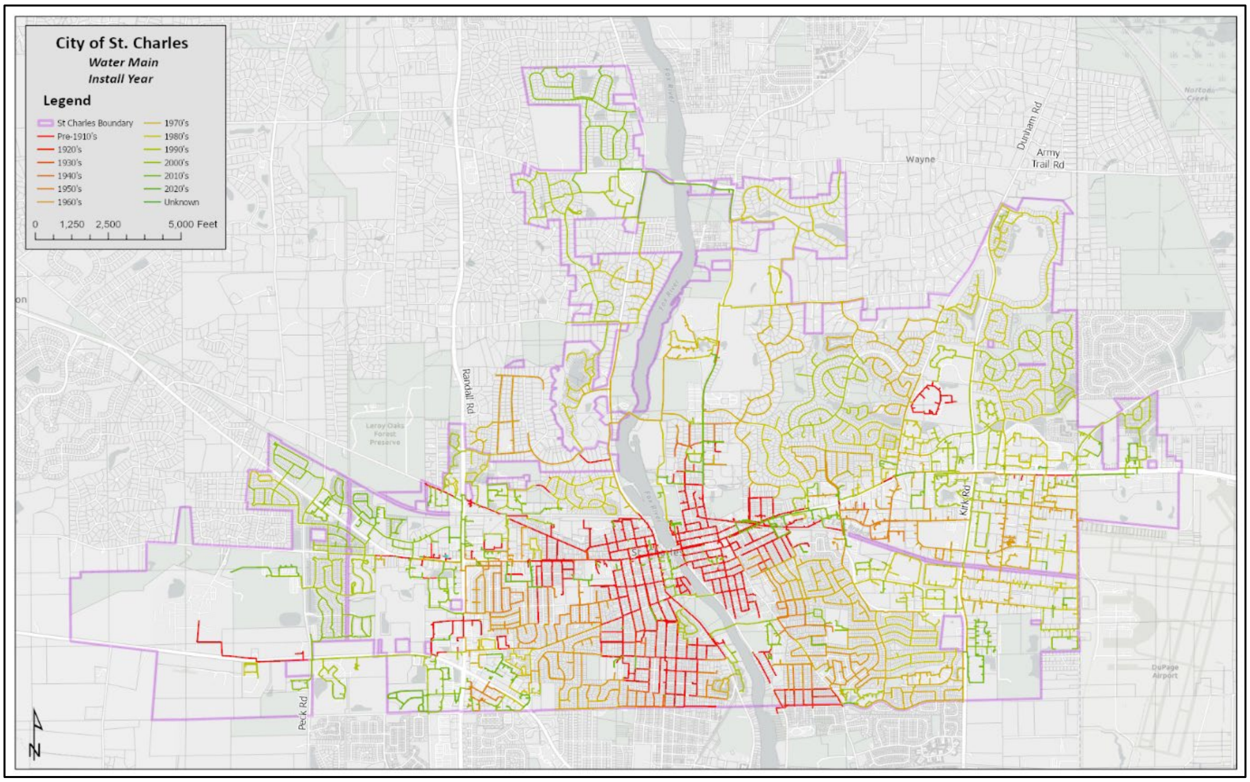
WATER DISTRIBUTION SYSTEM EVALUATION



The City's Water Department has adopted a proactive water main maintenance, flushing, and rehabilitation programs to sustain the level of service provided to the community. The water main rehabilitation program is often coordinated with the City's Capital Improvement's Program for street rehabilitation and reconstruction to minimize costs. The City's water system has a large service area that is divided into two zones to maintain adequate water pressures across varying topographic regions, the Inner Service Area (shown in red) and Outer Service Area (shown in blue).

The City's water distribution system includes roughly 250 miles of water main, 2,987 fire hydrants, and 4,035 system valves. As calculated in Section 3, the existing City of St. Charles water distribution system value is estimated at approximately $428 million including system valves and hydrants, prior to depreciation. The total replacement cost for the water system, estimated at approximately $642 million, was calculated by adding 50% the unit asset value to account for surface restoration, contingencies, project management, design and administration. Based on a seventy-five-year service life for this buried infrastructure, an average of **$8.56** Million would need to be budgeted annually in order to replace distribution system on an on-going 75-year basis. This budgetary amount would also need to be increased by the Construction Cost Index (CCI) each year.

This annual reinvestment should be prioritized based on a number of criteria including main diameter, age, break frequency, soil conditions, and the presence of lead services, among others. These criteria are discussed in Section 3 of this report, with recommended alternatives for rehabilitation of the distribution system identified in Section 4.



In conjunction with planned water main replacement, the City has developed and is implementing a comprehensive plan to replace all the lead services lines in the City of St. Charles to comply with Illinois Statute 415 ILC 5/17.12. The distribution system has approximately 2,350 known lead service line connections. In 2022, the City started replacing lead service lines. The current Lead Service Line Replacement Plan targets an annual investment of approximately $8.42M to replace these lead services over a 10-year period.

WATER SUPPLY, TREATMENT & STORAGE EVALUATION

The City of St. Charles water supply and storage system consists of seven wells, three water treatment facilities, three elevated water towers, and several ground storage reservoirs with booster stations. As with most municipal water supplies, this existing infrastructure has been constructed over decades and the components within the system vary in age. The City of St. Charles follows a rigorous maintenance program for the wells, towers and distribution system to ensure reliability of the infrastructure.

The City's groundwater wells are drilled into one of two distinct aquifers; Well #7, 9, 11 and 13 are supplied by a shallow sand and gravel aquifer commonly known as the St. Charles Aquifer, and Wells #3, 4, and 8 are supplied by a deep aquifer known as the Galesville Aquifer. Shallow wells typically contain iron and manganese and are treated through a filtration process, whereas the deep wells contain radium which requires ion-exchange or HMO filtration to treat to regulatory levels. The City recently completed the Well #7 & 13 interconnect project which expanded the filtration capacity at the Well #13 site, allowing Well #7 to be brought back into service and treated at this regional facility located on Oak Street.

Presently, the City's wells operate at roughly 75% of the capacity that they were designed to produce. These reduced capacities are a function of aquifer limitations, chlorination capacities, elevated iron levels, pump curve limitations, and physical age of the well pumps themselves. Daily production rates are selected to *produce the highest quality of water possible* by maximizing the use of wells that produce the highest quality water.

		Original Design Capacities		Current Capacities	
Well	**System Served**	**Design Capacity (GPM)**	**Design Capacity (MGD)**	**Current Capacity (GPM)**	**Current Capacity (MGD)**
3	Inner	1,000	1.44	850	1.22
4	Inner	1,000	1.44	750	1.08
Total	**Inner**	**2,000**	**2.88**	**1,600**	**2.30**
7	Outer	1,750	2.52	1,750	2.52
8	Outer	1,200	1.73	950	1.37
9	Outer	2,150	3.10	1,500	2.16
11	Outer	1,900	2.74	650	0.94
13	Outer	1,500	2.16	1,500	2.16
Total	**Outer**	**8,500**	**12.25**	**6,100**	**9.15**

As detailed in Section 2 – Community Needs, the City anticipates significant growth over the next five to 10 years. For planning purposes, this growth is anticipated to result in increased maximum day water usage on a linear basis. As a result, the current maximum day demand of 8.96 MGD may increase to more than 11 MGD over the next five years, and 12 MGD over 20 years. Therefore, the City should continue reviewing alternatives for additional water supply and treatment, and must maintain all current facilities. The table on the following page illustrates the current production capacities, and projected supply deficiencies over the planning horizon.

	Future Demands and Supply Capacities				
Year	Max Demand (MGD)	Supply (MGD)	Deficiency (MGD)	Firm Supply (MGD)	Firm Deficiency (MGD)
2023	9.00	11.45	-	8.93	0.07
2028	11.25	11.45	-	8.93	2.32
2033	11.75	11.45	0.30	8.93	2.82
2038	12.00	11.45	0.55	8.93	3.07
2043	12.00	11.45	0.55	8.93	3.07
Buildout	12.75	11.45	1.30	8.93	3.82

The City is currently in design of the Well #8 Expansion & Rehabilitation project, expected to bid in early 2025. This project includes drilling a new deep well on the far east end of the community, and conveying water to the existing Well #8 treatment facility on Ohio Avenue for radium removal. This is anticipated to provide an additional 1.44 MGD of production capacity when it comes online in 2026. While this would satisfy the demand in 2026, growth is anticipated to again outpace production capacity in 2027 and forward. Therefore, the City will need to continue the process of identifying the next water source(s) and the respective treatment needs for these new sources. Section 6 of this report identifies and evaluates alternatives for meeting the current and future water supply needs. Options reviewed include converting to sourcing water from the Fox River or Lake Michigan, as well as shallow or deep groundwater wells.

In addition to water supply needs, changes in State and federal regulations will likely require additional treatment within the planning horizon. Notably, this may include treatment for per- and polyfluoroalkyl substances, or PFAS. PFAS are a contaminant of developing concern within the water and public health sectors. In April 2024 the USEPA implemented final National Drinking Water Standards for six PFAS compounds, with compliance required to be achieved by April 2029. The City has been completing PFAS compound testing on the groundwater wells since 2020 as required by the EPA. The three deep wells (Well #3, 4 & 8) have never had a detected level of any of the regulated PFAS compounds, however three shallow wells (Well #9, 11 & 13) each returned results over the detection threshold for PFAS compounds, but below the recently issued USEPA limits. Based on the detection levels at the shallow wells it is recommended that the City evaluate alternatives for treatment, if and when required.

The City continues to identify city-wide water softening as a long-term goal to improve water quality. This Master Plan evaluates the two viable options for softening: ion-exchange and membrane separation (reverse osmosis). Each process has advantages and disadvantages that the City will need to consider.

Within Section 6 of this study, two approaches were analyzed to meet these future supply and treatment needs. The first alternative included independent treatment and upgrade of each individual facility (radium removal for a new deep well, ammonia removal at Well #11, PFAS treatment at Well #9, softening at Well #9/11). The second alternative developed was a regional treatment facility at Well #9/11 with a new deep well onsite, which would mitigate each of these issues jointly.

Recommendations and Summary

The City is responsible for providing safe and reliable water service for its residential and non-residential customers. This Master Plan describes the future capacity needs, the existing supply, storage, treatment, and distribution system infrastructure, and recommended improvements to maintain the current level of service. Recent regulatory changes, aging infrastructure, and continued growth of the community will require significant investment by the City to ensure the continued supply of safe and reliable water service. Section 4 and 6 of this report provide recommendations for distribution upgrades and supply/treatment upgrades, respectively. These recommendations were incorporated into the implementation plan below to be used for planning purposes.

City of St. Charles
10-Year Capital Improvements Plan
($ in Millions, 2024 Dollars)

Water Supply, Treatment & Storage Upgrades											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**Project Total**
Water Well Test Drilling	0.32	0.32									***0.64***
Well #8 Expansion & Rehabilitation	0.75	8.75	8.75								***18.25***
Well #11 Booster Station Electrical Upgrades	0.02	0.15									***0.17***
Well #9 & 11 Treatment Plant and New Deep Well		0.15	3.50	25.40	25.40						***54.45***
Reservoir #3/4 Repair & Coating		0.75									***0.75***
Red Gate Tower Repair & Coating					0.85						***0.85***
Campton Hills Tower Repair & Coating							0.85				***0.85***
10th Street Tower Repair & Coating									0.63		***0.63***
Fiscal Year Total:	**1.09**	**10.12**	**12.25**	**25.40**	**26.25**	**0.00**	**0.85**	**0.00**	**0.63**	**0.00**	***76.59***

Distribution System Upgrades											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**Project Total**
Annual Lead Line Replacement	0.17	0.38	8.42	8.42	8.42	8.42	8.42	8.42	8.42	8.42	***67.91***
S. 7th Ave WM (Main to Division)	0.03										***0.03***
Prairie Street WM (13th to Randall)	1.59										***1.59***
4th, 6th & 7th WM Phase II	1.82										***1.82***
Swenson FDR (Kirk to Kautz)	0.45										***0.45***
Division Street WM (IL 25 to Kirk)	0.06	0.02	1.89								***1.97***
Beatrice WM (S. 7th to W. Dead-End)	0.05	1.00									***1.05***
N. 12th Street WM (W. Main to Dead-End)	0.04	1.53									***1.57***
N. 6th Street WM (State St. Creek to State)	0.05	0.71									***0.76***
Stem & Stenson FDR (Kirk to Kautz)		0.58									***0.58***
S. 4th Place WM (Beatrice to Moore)		0.06	0.80								***0.86***
Rt. 64 WM (S. 19th Street to S. 17th Street)		0.04	0.46								***0.50***
Cutler St. WM (S. 8th-S. 7th & Mosedale to Horne)		0.06	0.77								***0.83***
Southgate Course and 2 Courts		0.14	2.80								***2.94***
Horne WM (S. 8th-S. 7th & Horne to Fellows)			0.07	0.96							***1.03***
Wing Lane WM (N. Tyler to Allen)			0.06	0.83							***0.89***
WM Replacement at Eastern Trunk P#3			0.12	1.81	2.17						***4.10***
S. 14th Street WM & S. 16th Street (14th to Prairie)				0.10	1.27						***1.37***
Annual Water Main Replacement not ID in CIP						8.56	8.56	8.56	8.56	8.56	***42.80***
Fiscal Year Total:	**4.26**	**4.52**	**15.39**	**12.12**	**11.86**	**16.98**	**16.98**	**16.98**	**16.98**	**16.98**	***133.05***

SECTION 1

INTRODUCTION AND BACKGROUND

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1. Introduction and Background

1.1. General Background

The City of St. Charles was incorporated in 1874 and is located in Kane County, Illinois, along the Fox River between Geneva and South Elgin. The City developed its first potable water supply in 1907 and provides a continuous supply of safe, reliable and economical potable water to all of its residents and businesses. The service area also includes several unincorporated areas, as well as Kane County and State of Illinois owned parcels. The City actively manages a strategic plan to address water quality and quantity issues through annual inspection, replacement, and expansion programs.

The City of St. Charles has grown from a community of 17,492 residents in 1980 to 27,910 in 2001 and 33,781 people at the end of 2023. Residential water usage for the community in 2022 was 2,098,351 gallons per day, while the non-residential (commercial, industrial, and municipal) usage was 1,406,564 gallons per day. This equates to an average daily usage of approximately 3.44 MGD.

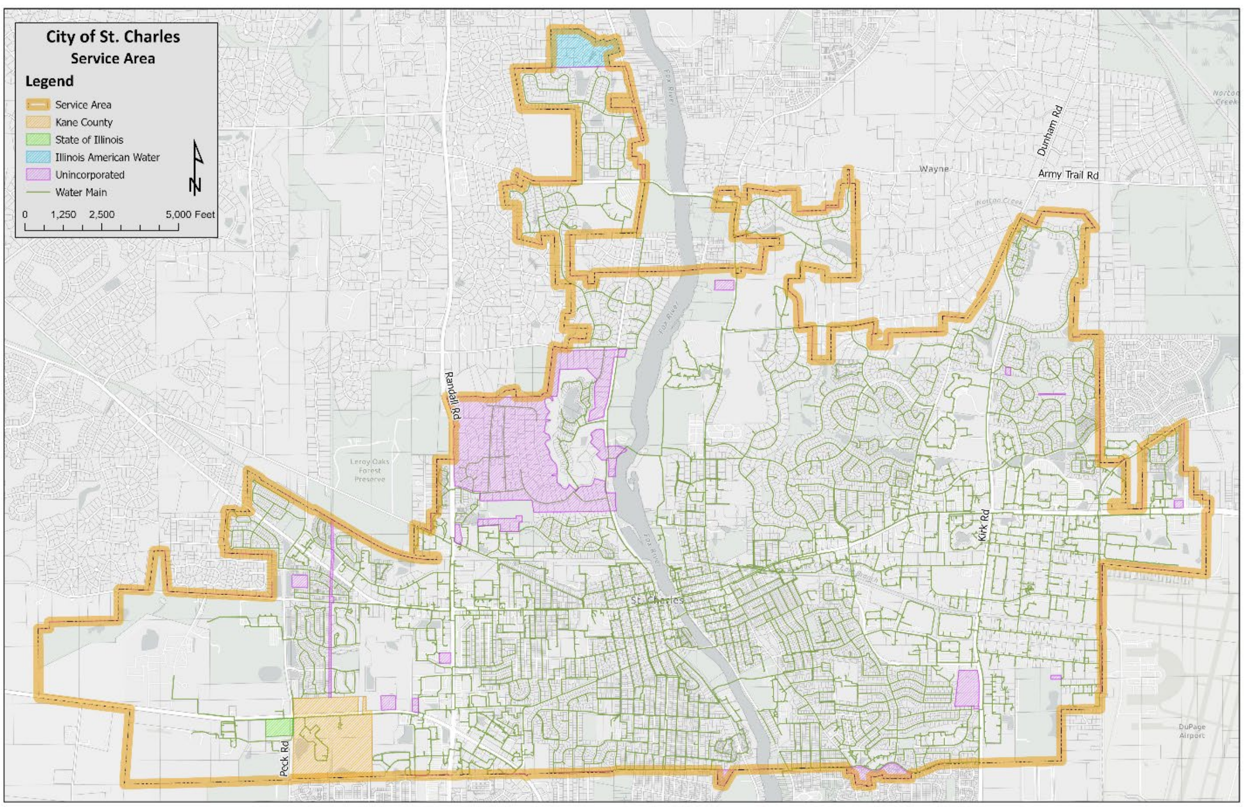

Figure 1-1: City of St. Charles Service Area

The City's water system is divided into two zones to maintain adequate water pressures across varying topography. The Inner Service Area (shown in red in Figure 1-2) generally serves the valley along the Fox River. The Outer Service Area (shown in blue in Figure 1-2) supplies water to the remainder of the City and is generally at a higher elevation. Figure 1-2 provides a basic overview of the two service areas. The two service areas are connected via pressure sustaining valves which regulate the water pressure in the two zones. However, the two zones operate independently and the PRV's are not frequently utilized.

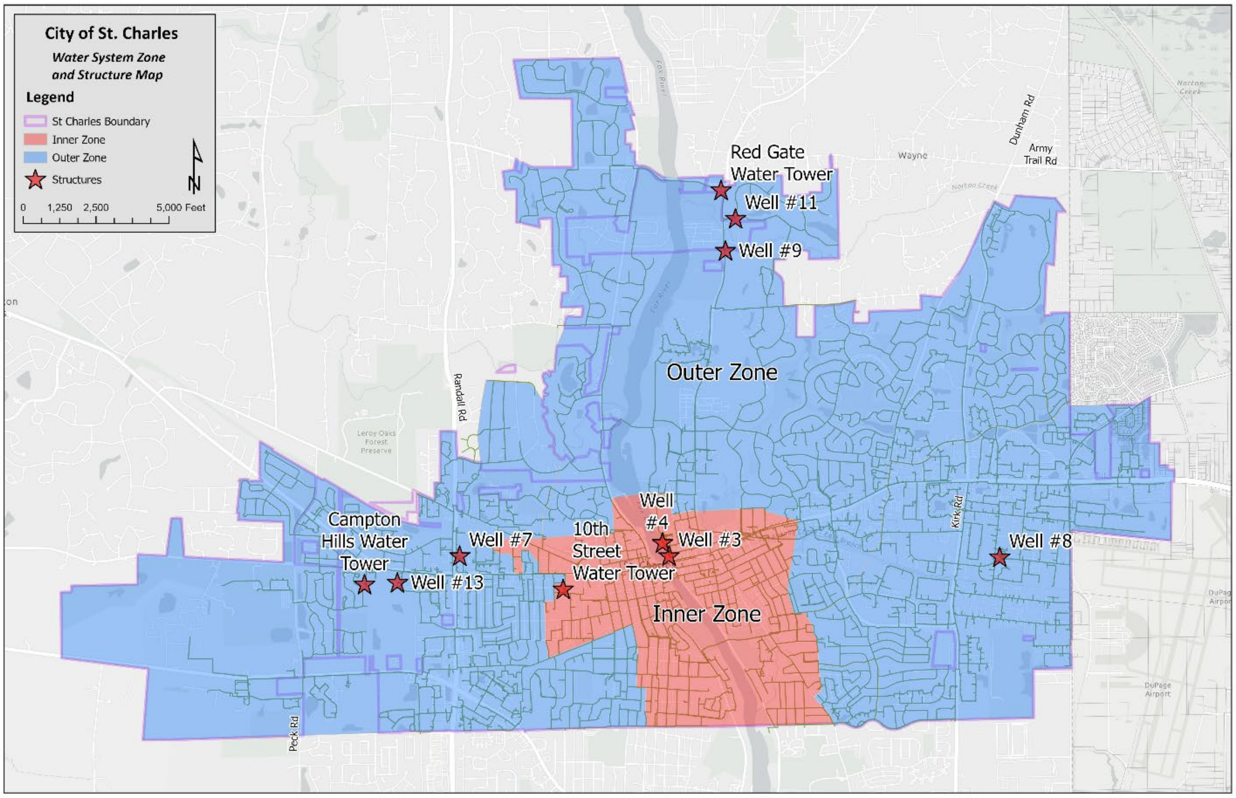

Figure 1-2: City of St. Charles Pressure Zones

1.2. Existing Distribution System

The City of St. Charles maintains roughly 250 miles of water main and approximately 3,000 fire hydrants. As stated previously, the distribution system is divided into inner and outer zones. The City is able to transfer water between zones through the use of the pressure sustaining valves. These valves can be manually operated to provide water to the inner system from the outer system and are rarely opened. The City Water Department has adopted proactive water main maintenance, flushing, and rehabilitation programs to sustain the level of service provided to the community. The water main rehabilitation program is often coordinated with the City's Capital Improvement's Program for street rehabilitation and reconstruction to minimize costs.

1.3. Existing Supply, Treatment and Storage Infrastructure

The City of St. Charles water supply and storage consists of seven wells, three water treatment facilities, a 300,000-gallon spheroid water tower, a 1,500,000-gallon spheroid water tower, a 1,000,000-gallon Hydropillar® water tower, and several ground storage reservoirs with booster stations. As with most municipal water supplies, the existing infrastructure has been constructed over several decades and the components within the system vary in age. The City of St. Charles follows a rigorous maintenance program for the wells, towers and distribution system to ensure reliability of the infrastructure.

The City of St. Charles' source water is supplied by two distinct aquifers: a shallow sand and gravel aquifer and a deep sandstone aquifer. Well #7, 9, 11 and 13 are supplied by a shallow sand and gravel aquifer commonly known as the St. Charles Aquifer. This shallow formation provides water with high concentrations of iron in some locations (west of the Fox River). At Well #7 and 13, water is currently filtered to remove iron. Well #3, 4, and 8 are supplied by a deep sandstone aquifer known as the Ironton-Galesville Aquifer. Water from this aquifer has concentrations above the USEPA Maximum Contaminant Level for radium and is treated to meet this regulation using a combination of Hydrous Manganese Oxide (HMO) filtration and Ion Exchange. The City currently has active booster station and ground storage reservoir capacity of 2.90 million gallons. These ground storage reservoirs are used in conjunction with the existing elevated water towers to meet the Peak Hourly and Fire Flow Demands placed on the system.

1.4. Water System Operation

The City's robust SCADA system works in conjunction with experienced operational staff to handle non-routine events as well as perform continual modifications to optimize water quality. In general, the water system operates based on the elevated storage tank levels. The levels of these three tanks dictates which wells/booster pumps run, and at what speeds. All three elevated storage tanks are strategically located throughout the system to maintain consistent pressure in each of the two service zones. The hydraulic grade line (HGL) represents total pressure supplied relative to sea level.

The City maintains an HGL of approximately 910 feet in the outer service area. Therefore, if the elevation in the system is 780 feet above sea level, the water pressure at this location would equate to 56 psi (910 ft HGL – 780 ft Elevation = 130 ft ÷ 2.31 ft/psi). Similarly, the City maintains an HGL of approximately 855 feet in the inner service area. This portion of the community is much lower in elevation near the river, dropping to as low as 690 feet, which would equate to 72 psi. An elevation profile of Route 64 across the

City is shown below that depicts the significant topographical variation throughout the community that necessitates the two separate pressure zones.

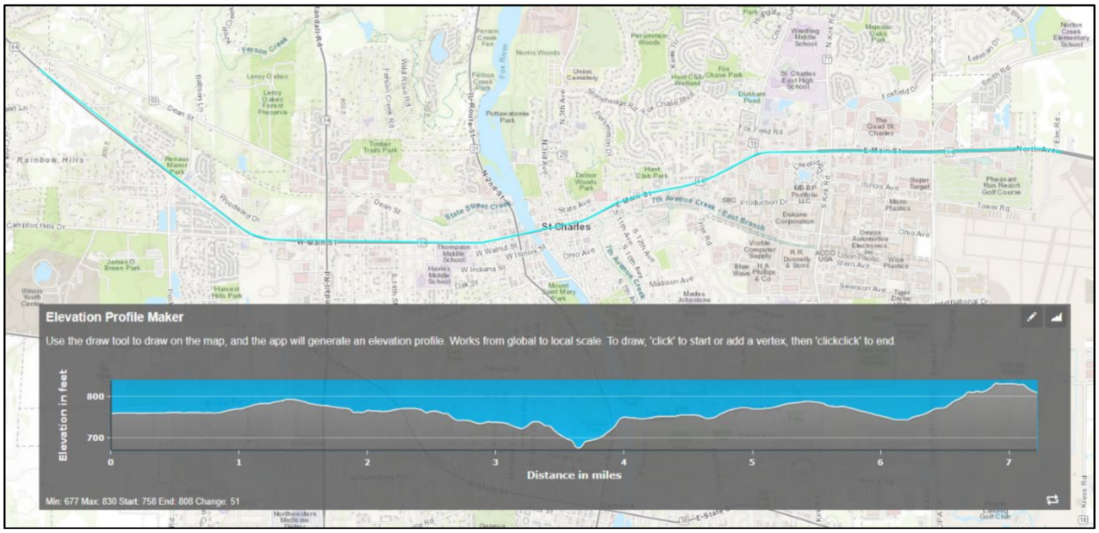

Figure 1-3: Route 64 Elevation Profile

1.5. Purpose and Scope

A Water Master Plan Facility Plan is a management and planning document used to identify, evaluate, and plan required water distribution and facility improvements. It provides an assessment of the distribution, storage, and supply abilities to meet both current and future loads, flows and regulatory requirements and provides critical information for improvements to correct current or projected deficiencies.

Master plans are typically updated every five years, or when significant changes in growth or regulatory requirements have occurred or are expected. The City's most recent Water Master Plan was prepared in 2018 and is now five years old. Since the 2018 Plan, the City of St Charles has implemented a number of the recommendations including the installation of new and replaced water main, construction of the Well #7 & 13 Interconnect, and begun design of the Well #8 Expansion & Rehabilitation. However, in an effort to be proactive, the City is seeking to update the Water Master Plan to develop a Capital Improvements Plan to assist in budgeting for necessary improvements and to provide a guide for future improvements.

The ultimate goal of this plan is to establish the community's current and future water production and infrastructure needs and develop an implementation plan to meet those needs. This plan will provide the blueprint for future improvements, expansion phasing, and capital improvement projects. The following sections will provide a detailed analysis of the City of St. Charles' long-term needs and a selection of alternatives, cost estimates and schedule for implementation of the recommended improvements to the distribution system and water supply, storage, and treatment infrastructure.

- Section 2 – Community Needs
- Section 3 – Existing Distribution System Evaluation
- Section 4 – Analysis for Distribution System Alternatives
- Section 5 – Evaluation of Existing Water Supply, Treatment & Storage Facilities
- Section 6 – Analysis of Water Supply, Treatment, and Storage Alternatives
- Section 7 – Recommendations and Summary

SECTION 2

COMMUNITY NEEDS

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2. Community Needs

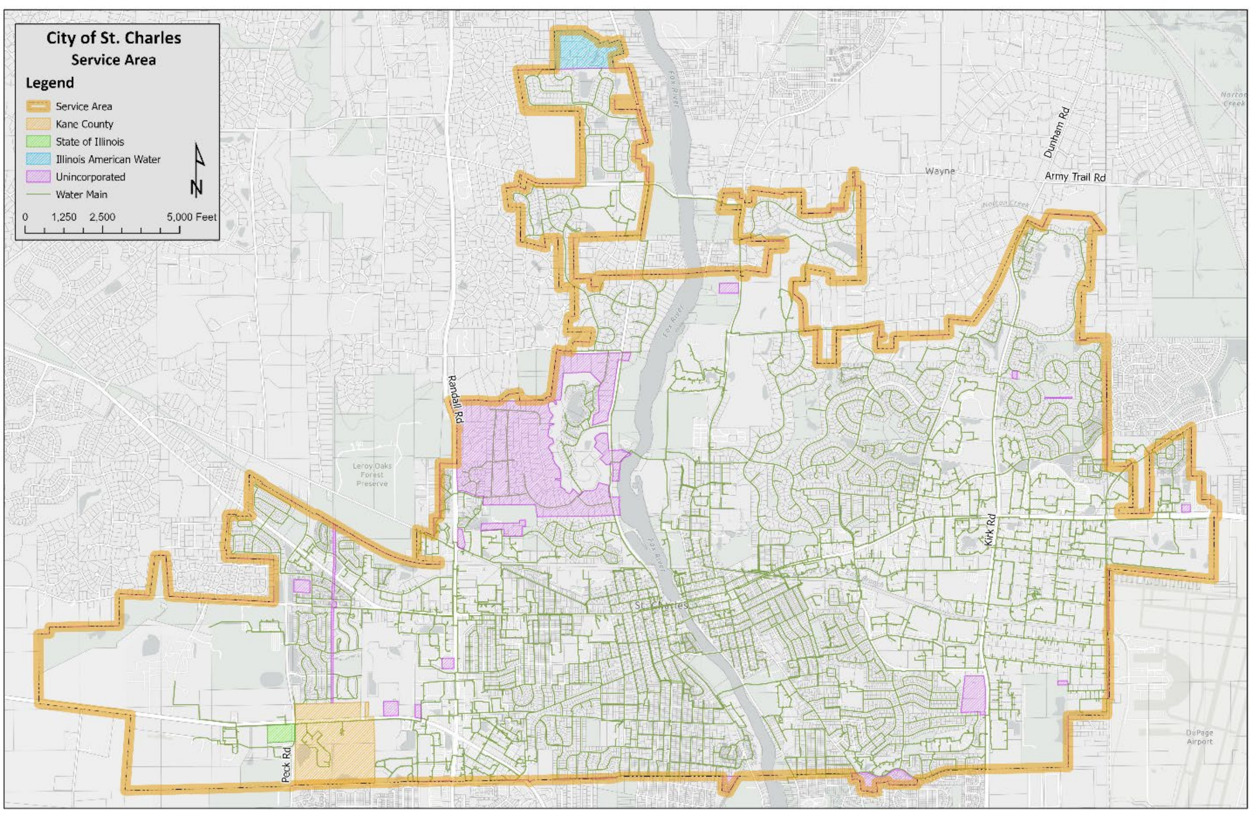
2.1 Introduction

This section includes a discussion of City's water service planning area, current and future population equivalents, water usage, and regulatory considerations in order to provide a complete evaluation of the City's drinking water needs. The City has experienced significant growth since completion of the 2018 Water Master Plan, and as such projecting for future water demands will be critical to the City's long-term planning.

2.2 General Background

The City of St. Charles is located in Kane County, 40 miles west of Chicago and is approximately 9,500 acres in size. The City of St. Charles is situated along the Fox River and its location has made it attractive to residential, industrial and commercial development. The City of St. Charles Service Area is bounded on the south by Geneva, on the north by South Elgin, and West Chicago to the east. The City's service area boundary is shown below in orange, with the purple line representing the City's corporate boundary. The service area extends beyond the corporate boundary in some locations, serving unincorporated portions of Kane County as well as County-owned and State of Illinois-owned properties.

Figure 2-1: City of St. Charles Service Area



The City of St. Charles has grown from a community of 17,492 in 1980 to 27,910 people in 2000 to an estimated 33,781 people at the end of 2023, as determined with an annual growth projection of 0.7% from the 2020 American Community Survey population estimate of 33,081. The City Council has recently approved several new developments throughout the City limits that have increased the overall demand on the system. The remaining undeveloped properties within the St. Charles service area have been assigned a land use and density.

2.3 Existing Conditions

Most communities contain both residential and non-residential land uses. Analysis of current and future water usage is often done on the basis of "population equivalents", or P.E., which provide a common basis for residential and non-residential demands to be analyzed. One P.E. is equivalent to the water consumed by one resident, as determined by historic data. This can then be applied to non-residential water usage to obtain a total equivalent population for the City's service area.

2.3.1 Residential Population

The historical growth of the residential population within the service area has varied over the past 25 years. In 2023, the City had a total customer base (including residential and non-residential) of 13,642 accounts. However, this cannot necessarily be correlated with the total population served.

In order to determine the total PE within the Service Area, the residential population is established as the first step. The City's population from the 2020 census can be found in Table 2-1. The table identifies the existing population within the City as well as the anticipated 2023 and 2043 population based on the Chicago Metropolitan Agency for Planning (CMAP) population projection of 0.70% growth per year.

This growth projection equates to a 2023 estimate of 33,781 and a 2043 estimate of 38,838 residents. However, this CMAP data has proven to overestimate growth for many area communities and as such the City's own development tables were utilized to estimate future residential and non-residential population.

Table 2-1: CMAP Population Projections to 2043 (2020 Census Basis)

Municipality	2020 Census Population	CMAP Projection	2023 Population Forecast	2043 Population Forecast
City of St. Charles	33,081	0.70%	33,781	38,838

2.3.2 Total Population Equivalents

The table below illustrates the breakdown between residential and non-residential water billing throughout the City over the past five full fiscal years. The non-residential water billing includes commercial, industrial, non-profit, and any billed-municipal water usage.

Table 2-3: Total Water Metered (2018 – CY 2022)

Calendar Year	Total (GPD)	Residential (GPD)	Non-Residential (GPD)
2018	3,645,066	2,261,989	1,383,077
2019	3,563,989	2,170,792	1,393,197
2020	3,560,556	2,324,567	1,235,989
2021	3,602,798	2,258,740	1,344,058
2022	3,504,915	2,098,351	1,406,564
Five Year Average:	**3,575,465**	**2,222,888**	**1,352,577**

The residential and non-residential water usage remained relatively consistent between FY2018-2022 with year-over variations of no more than 4%. As shown in the table, the residential water usage in the City accounts for nearly 62% of billings, though it represents more than 90% of total accounts. This annual water billed does not represent the total water metered, however, which is discussed on the following page as unaccounted-for water and non-revenue water.

The residential population equivalents were calculated by dividing the residential water sold by the total number of residents within the Service Area. The year-end 2023 population estimate of 33,781 based on the 2020 Census and CMAP growth projection was utilized as it represents the best available information. This per capita water metered equates to 62.1 gpd/capita, which was then used to determine the equivalent population of the non-residential water usage. This resulted in an additional 22,644 PE to be served by the City's water distribution system for a total of 56,425 PE.

Table 2-2: Current Total Population Equivalent

Description	Total
FY2022 Residential Water Metered (GPD)	2,098,351
Residential PE	33,781
Residential Per Capita Water Metered (GPD)	62.1
FY2022 Non-Residential Water Metered (GPD)	1,406,564
Non-Residential PE (at 60.2 GPD/PE)	22,644
Total Current PE	**56,425**

2.3.3 Water Loss

While the City must meet the system water demand on a daily basis, not all of this water can be metered or billed. This difference in net production and authorized consumption is commonly referred to as water loss. This water loss consists of both real losses (main breaks, twice-yearly flushing, and leakage) and apparent losses (metering inaccuracies and unauthorized consumption). The table below shows the number of water main breaks over the last five years that account for a portion of these real losses.

	5-Year Main Break Frequency by Size								
Fiscal Year	Pipe Diameter							Service / Valve	Total
	4"	6"	8"	10"	12"	16"	Unlisted		
2018/19	3	15	1	0	4	0	44	25	92
2019/20	0	22	6	2	1	0	7	15	53
2020/21	4	28	12	0	1	0	30	24	99
2021/22	5	39	11	3	2	0	0	45	105
2022/23	3	54	23	5	11	1	0	17	114
Totals:	15	158	53	10	19	1	81	126	463
Average Breaks/Leaks per Year:									**93**

As tracked by the City, this would be referred to as Unaccounted-For Water (UFW). Additionally, a portion of the metered water usage is not billed. This may be due to the water being used by municipal accounts which will not be billed, or other known agreements which are in place. The difference between the net water produced and the total billed (and collected) is referred to as Non-Revenue Water, which includes water loss or UFW. The table below shows the approximate unaccounted-for water and non-revenue water over the past five calendar years.

Table 2-3: Water Loss Evaluation

Calendar Year	Pumped (MGD)	Metered (MGD)	Billed (MGD)	Unaccounted-For Water (%)	Non-Revenue Water (%)
2018	4.14	3.65	3.35	11.88%	18.97%
2019	4.10	3.56	3.25	13.15%	20.80%
2020	4.17	3.56	3.28	14.66%	21.46%
2021	4.45	3.60	3.35	19.06%	24.83%
2022	4.19	3.50	3.25	16.34%	22.38%
Average:	**4.21**	**3.56**	**3.30**	**15.02%**	**21.69%**

The average unaccounted-for water/water loss of systems in the United States is approximately 16%, according to the US EPA. The City of St. Charles is currently just over 15%, indicating a well-maintained system. The City’s non-revenue water exceeds 21%, however, indicating possible metering issues or a large quantity of municipal or unbilled usage.

Additionally, while the gallons metered per capita was found to be 62.1 gpd/PE, the actual per-PE water usage is higher due to this non-revenue water. The average water pumped of 4.19 MGD divided among the 56,425 PE equates to 74.3 gpd/PE pumped.

2.4 Future Population Projections

The current usage is discussed previously in this section, with a five-year average daily demand of 4.21 MGD. The projected population equivalents were established by reviewing the City's Community Development records, wastewater treatment plant records, approved development plans, and the City's Comprehensive Land Use Plan. Analysis of the projected land use was the basis for developing future population projections.

2.4.1 Future Development Tables

The table below lists all ongoing and potential development projects in the City of St. Charles, the type of project, the PE factor associated with this category, and the total additional estimated PE. These projects include those currently in construction, planning, programming, or identified for future development. As shown, more than 13,000 additional PE of planned population is anticipated in the five-year horizon.

ID	Name	Type	PE	Water Demand (GPD)	Development Status (Years)					
					Constructed	1 to 5	5 to 10	10 to 15	15 to 20	Buildout (20+)
1	Brooke Toria Subdivision	Residential	56	4,161	X					
2	Charlestown Mall Redevelopment	Commercial	241	17,869		X				
		Residential	1,060	78,721		X				
		Commercial	241	17,869			X			
		Residential	1,060	78,721			X			
3	Charlestown Lakes	Residential	585	43,466	X					
4	Petkus Property Springs at STC	Residential	771	57,285	X					
5	Pheasant Run Lot #1-McGrath Honda Phase 1	Commercial	240	17,832	X					
6	Pheasant Run Lot #1-McGrath KIA Phase 2	Commercial	160	11,888	X					
7	Pheasant Run Lot #1-McGrath Phase 3	Commercial	250	18,575		X				
8	Pheasant Run Lot #2 - Center & Complex	Commercial	825	61,298		X				
9	Pheasant Run Lot #3-Smaller single story rooms	Commercial	240	17,832		X				
10	Pheasant Run Industrial Building Lot A	Commercial	232	17,267		X				
11	Pheasant Run Indistrial Building Lot B	Commercial	154	11,442	X					
12	Pheasant Run Industrial Building Lot C	Commercial	108.2	8,039	X					
13	Pheasant Run Industrial Building Lot D	Commercial	87.4	6,494	X					
14	Pheasant Run Industrial Planned Offsite McGrath	Commercial	172.6	12,824			X			
15	Pheasant Run Industrial Parcels #2 & #3	Commercial	223.9	16,637			X			
16	Silverado Memory Care	Residential	145	10,774	X					
17	Pheasant Trails Development	Commercial	60	4,458		X				
18	Jet Brite Carwash	Commercial	0	0		X				

ID	Name	Type	PE	Water Demand (GPD)	Development Status (Years)					
					Constructed	1 to 5	5 to 10	10 to 15	15 to 20	Buildout (20+)
19	Pride of Kane	Commercial	50	3,715	X					
20	Smithfield Foods	Commercial	2	149		X				
21	Smithfield Addition	Commercial	80	5,944	X					
22	Smithfield Addition Phase #2	Commercial	80	5,944		X				
23	Tiger Drylac	Commercial	205	15,232	X					
24	Inter Plastics	Commercial	151	11,219	X					
25	Perfect Plastics Addition	Commercial	239	17,758	X					
26	425 38th Ave Building Addition	Commercial	114	8,470	X					
27	AJR Filtration Expansion	Industrial	103	7,653			X			
28	Royal Fox Country Club Building	Commercial	25	1,858		X				
29	McKnight Dentistry	Commercial	50.4	3,745	X					
30	Thorntons	Commercial	0	0	X					
31	Franky's	Commercial	0	0		X				
32	Well Now	Commercial	15	1,115		X				
33	Andy's Custard	Commercial	15	1,115	X					
34	East Side Park Natatorium	Government	73	5,424			X			
35	Munhall Glen	Residential	175	13,003	X					
36	Indiana Place Aka Old Crystal Lofts	Residential	60	4,458		X				
37	Moonlight Theater	Commercial	14	1,040	X					
38	River East Lofts	Residential	146	10,848			X			
39	First Street Project Phase 3	Retail/Office	106.6	7,920	X					
		Residential	44.9	3,336	X					
40	First Street Project Phase 3	Retail/Office	91.5	6,798	X					
		Residential	80.5	5,981	X					
41	First Street Project Phase 3	Retail/Office	97.5	7,244	X					
		Residential	73.5	5,461	X					
42	First Street 6	Commercial	217.0	16,123		X				
43	First Street 7B	Residential	40.5	3,009	X					
44	First Street 8	Public	66.0	4,904		X				
45	10s 1st Plaza	Residential	0.0	0	X					
46	River 504 Milestone Row 2	Commercial	107.5	7,987		X				
		Residential	185.5	13,783		X				

ID	Name	Type	PE	Water Demand (GPD)	Development Status (Years)					
					Constructed	1 to 5	5 to 10	10 to 15	15 to 20	Buildout (20+)
47	Baker Field Subdivision	Residential	7	520		X				
		Residential	3.5	260	X					
48	Old Police Station Project-Redevlopment of old police station	Commercial	301	22,364			X			
		Residential	301	22,364			X			
49	City View Subdivision	Residential	14.0	1,040		X				
50	Lexington Club	Residential	440	32,692				X		
51	Extreme Clean Express Carwash	Commercial	43	3,195	X					
52	1023 W Main Gas Station	Commercial	5.0	372	X					
53	Parkside Reserves	Residential	10.5	780		X				
54	Prairie Centre Club House	Residential	97.0	7,207	X					
55	Prairie Centre-D1 Residential	Residential	91.5	6,798	X					
56	Prairie Centre-D2 Residential	Residential	112.5	8,359	X					
57	Prairie Centre Unit MU-D1	Commercial	83.2	6,182	X					
		Residential	111.8	8,307	X					
58	Prairie Centre Unit MU-D2	Commercial	83.2	6,182		X				
		Residential	111.8	8,307		X				
59	Prairie Centre Unit MU-D3	Commercial	83.2	6,182		X				
		Residential	111.8	8,307		X				
60	Prairie Centre -C1 Residential	Residential	112.5	8,359	X					
61	Prairie Centre C2 Residential	Residential	94.5	7,021	X					
62	Prairie Centre F1 Residential	Residential	112.0	8,322	X					
63	Prairie Centre F2 Residential	Residential	115.5	8,582	X					
64	Prairie Centre E Residential	Residential	135.0	10,031	X					
65	Prairie Centre B1 Residential	Residential	151.5	11,256		X				
67	Prairie Centre B2 Mixed Use	Commercial	60.8	4,517		X				
		Residential	108.2	8,039		X				
68	Prairie Centre B3 Mixed Use	Commercial	60.8	4,517		X				
		Residential	108.2	8,039		X				
69	Prairie Centre-Anthony Place	Residential	139.0	10,328	X					
70	Prairie Centre Retail/Rest A	Commercial	45.0	3,344		X				
71	Prairie Centre Retail/Rest B1	Commercial	25.0	1,858		X				

ID	Name	Type	PE	Water Demand (GPD)	Development Status (Years)					
					Constructed	1 to 5	5 to 10	10 to 15	15 to 20	Buildout (20+)
72	Prairie Centre Retail/Rest B2	Commercial	25.0	1,858			X			
73	Prairie Centre Retail/Rest C1	Commercial	18.0	1,337			X			
74	Prairie Centre Retail/Rest C2	Commercial	18.0	1,337			X			
75	Prairie Centre Retail/Rest D	Commercial	36.0	2,675			X			
76	Anthony Place Ph2	Residential	225.0	16,718			X			
77	Police Facility	Government	25	1,858	X					
78	Beef Shack	Commercial	0	0	X					
79	Meijer Store Outlets	Commercial	32	2,378	X					
80	Anthem Heights	Residential	273	20,284	X					
81	Tractor Supply	Commercial	8	594	X					
82	Kiddie Academy	Commercial	50	3,715	X					
83	Pet Suites	Commercial	54	4,012	X					
84	Advanced Care	Commercial	18	1,337	X					
85	Prairie Winds- Phase 1	Residential	675	50,153	X					
86	Prairie Winds-Phase 2	Residential	1,351	100,379		X				
87	Animal Hospital	Commercial	30	2,229	X					
88	Belle Tire	Commercial	50	3,715	X					
89	Learning Exp	Commercial	28.8	2,140	X					
90	Kane County Multi-use Building	Government	1,100	81,730				X		
			15	1,115	X					
91	Tri-Com	Government	15	1,115	X					
92	Gun Range	Residential	10	743	X					
93	IYC Annexation	Government	1,026	76,232		X				
94	Legacy Business Park	Commercial	120	8,916			X			
95	Legacy Business Park	Commercial	30	2,229			X			
96	CMD - Swenson Ave	Commercial	10	743					X	
97	CMD	Commercial	10	743					X	
98	CMD	Commercial	10	743					X	
99	CMD	Commercial	10	743					X	
100	CMD	Commercial	10	743					X	

ID	Name	Type	PE	Water Demand (GPD)	Development Status (Years)					
					Constructed	1 to 5	5 to 10	10 to 15	15 to 20	Buildout (20+)
101	Petkus Property Unincorp.	Residential	440	32,692						X
102	Oak Rd and Elm Rd	Commercial	170	12,631					X	
103	Pheasant Run Trails	Commercial	60	4,458					X	
104	St Charles Heights	Residential	17.5	1,300		X				
105	Cumberland Pkwy	Residential	28	2,080		X				
106	Regole Farm	Residential	245	18,204						X
107	CMD West	Commercial	70	5,201					X	
108	CMD West #2	Commercial	60	4,458					X	
108	CMD West #2	Commercial	60	4,458					X	
109	Stuarts Crossing	Commercial	0	0		X				
110	Baker Lot	Commercial	10	743		X				
111	St. Charles Commercial Center Unit 14 Lot 1	Commercial	10.0	743				X		
112	Walnut and S. 19th	Residential	30	2,229			X			
113	30 N 14th St	Residential	28	2,080		X				
115	Foundry Industrial Subdivision	Commercial	30	2,229					X	
116	Corporate Reserve Business Park	Commercial	30	2,229			X			
117	Rt. 64 Development LLC	Commercial	15	1,115			X			
118	Everbrook Academy	Commercial	50	3,715	X					
119	Pine Ridge Business Park	Commercial	150	11,145				X		
120	St. Charles Park District	Government		0				X		
121	Kane County Fair Grounds	Commercial	2,147	159,522						X
122	Zylstra Business Park	Commercial	30	2,229				X		
123	Well #7 & 13 WTP	Municipal	67	4,978		X				
124	Main Street LLC	Commercial	10	743		X				
125	Rainbow Hills Subdivision	Residential	200	14,860						X
126	Lake Charlotte Subdivision	Residential	483	35,887						X
127	Bonnie Drive Subdivision	Residential	109	8,099						X
128	Dean Street Four (4) Lots	Residential	14	1,040						X
129	Natural Garden Nursery	Residential	230	17,089						X
130	Oakwood Drive Four (4) Lots	Residential	32	2,378						X
131	Dean Street Undeveloped Farmland	Residential	80	5,944						X
132	Undeveloped Farmland (NE Corner of Rt. 38/Peck)	Residential	243	18,055						X
133	Undeveloped Farmland (Far West Route 38)	Residential	525	39,008						X
		Totals:	23,854	1,772,369	6,525	7,184	3,168	1,730	500	4,748

2.4.2 Future Population Projection Summary

The approved/permitted, and potential population equivalents were established by reviewing the City's detailed water and sewer billing records, wastewater treatment plant flow monitoring records, approved development plans, and the City's Comprehensive Land Use Plan. Analysis of the projected land use was the basis for developing future population projections. These growth estimates are summarized in the table below.

Table 2-4: Future Population Projections Summary

	Current 2023	1-5 Year 2028	5-10 Year 2033	10-15 Year 2038	15-20 Year 2043	20+ Year Buildout
Current PE	56,425	56,425	56,425	56,425	56,425	56,425
Cumulative Growth PE	-	13,708	16,876	18,606	19,102	23,854
Total P.E.	**56,425**	**70,133**	**73,301**	**75,031**	**75,527**	**80,279**

2.5 Capacity Requirements

As discussed in Section 1, the average daily demand and maximum day demand are defined using historic information based on the City's billing and pumpage data throughout each year. The average daily usage and maximum day usage are the criteria used by the Illinois EPA to evaluate the water systems production needs. In accordance with Title 35, Subtitle F, Part 654.202, the Illinois EPA requires the public water supply to have sufficient capacity to meet the average daily usage with the largest producing well out service and meet the maximum day usage with all of the wells in production. These criteria are the minimum requirements.

Systems with multiple wells are typically designed to meet the maximum daily demand with the largest well out of production. This design allows the municipality to meet the needs of the residents and businesses while performing routine maintenance on the supply wells. Without this redundancy, the work must be performed in off-peak periods, which restricts and increases the cost of the maintenance activities.

2.5.1 Historic Water System Demands

In order to determine the adequacy of the existing supply and distribution system, historical peak day and month consumption data was reviewed. The table on the following page illustrates the peak day demand of each month over the past 10 years. The numbers reflect the total amount of water supplied by the City, not the water billed to customers. The variation between water supplied and water sold is attributed to the various forms of water loss. The 10-year average maximum day was calculated to be 7.35 MGD.

While five-year and 10-year historical demands are typically utilized for planning purposes, the City experienced significant demands in 2012 and 2022. Therefore, these years will also be used as they are indicative of actual water consumption during periods of low precipitation and high population growth.

Table 2-5: Historic Water System Demands

	Inner Zone Max Consumption		Outer Zone Max Consumption		System Max Consumption
Year	1st Largest	2nd Largest	1st Largest	2nd Largest	
2012	1.66 MG	1.65 MG	7.48 MG	6.80 MG	8.96 MG
2013	1.42 MG	1.30 MG	5.36 MG	5.04 MG	6.78 MG
2014	1.32 MG	1.26 MG	4.89 MG	4.79 MG	5.85 MG
2015	1.37 MG	1.30 MG	4.83 MG	4.63 MG	5.84 MG
2016	1.63 MG	1.44 MG	5.07 MG	4.65 MG	6.51 MG
2017	1.40 MG	1.37 MG	6.53 MG	4.89 MG	7.94 MG
2018	1.91 MG	1.78 MG	5.50 MG	5.26 MG	7.41 MG
2019	1.61 MG	1.60 MG	6.13 MG	5.17 MG	7.74 MG
2020	2.04 MG	1.94 MG	5.89 MG	5.81 MG	7.94 MG
2021	1.51 MG	1.42 MG	5.77 MG	5.51 MG	7.29 MG
2022	1.68 MG	1.34 MG	6.86 MG	5.87 MG	8.55 MG

The maximum day demand over the previous 10-year period was 8.96 MGD in July of 2012. To further analyze the historical water usage, maximum day peaking factors were calculated. These factors are the ratio of the maximum day each year, to the average daily usage of that same year.

Average	Factor
1-Year	2.04
5-Year	2.03
10-Year	2.20

The ultimate peaking factor is calculated as the ratio of the maximum day to either the 5-year or 10-year daily average usage. This provides a more conservative approach to planning and is used in hydraulic modeling. The 5-year average daily usage was 4.21 MGD, and the 10-year average daily usage 4.07 MGD. These corresponded to peaking factors of 2.03 and 2.20, respectively. A peaking factor of 2.0 or under is considered typical, and as such the peaks observed by the City appear high but within reason. Therefore the 2.20 peaking factor will be utilized for planning and hydraulic modeling.

2.5.2 Overall System Capacity

Historically, the City has had adequate capacity to serve its planning area under all circumstances. During extremely high water usage periods, the City may draw down reservoirs to meet peak demand hours, however at no point was the system in jeopardy of not meeting demands.

Future Water Demands

Water usage has generally decreased over the past decade as a result of higher efficiency water fixtures, watering restrictions, and a public effort to reduce unnecessary water consumption. While the City should not depend on a decrease in demand, this trend is seen in most communities and represents a national shift rather than a local anomaly. It is unlikely that demand will return to levels seen in the early 2000's unless significant droughts are experienced.

Section 2.4 of this Plan identified population growth projections for five-year, 2030, and 2040 planning horizons. Associated increases in water demand for each of these phases was developed by extrapolating current water usage per PE. For example, at the calculated 75 gallons per PE/day of water pumped, the 2023 population estimate of 66,329 equates to a total average daily demand of approximately 5.0 MGD. The table below includes the extrapolated demands based on population projects.

Table 2-6: Future Water Demands

	Current	1-5 Year 2028	5-10 Year 2033	10-15 Year 2038	15-20 Year 2043	20+ Year Buildout
Current PE	56,425	56,425	56,425	56,425	56,425	56,425
Cumulative Growth PE	-	13,708	16,876	18,606	19,102	23,854
Total P.E.	56,425	70,133	73,301	75,031	75,527	80,279
ADD (MGD)	4.21	5.23	5.47	5.60	5.64	5.99
MDD (MGD)	8.96	11.14	11.64	11.91	11.99	12.75
Firm Capacity Req'd	9.00	11.25	11.75	12.00	12.00	12.75

The firm capacity that is recommended is the minimum amount of well production available with the largest well out of service. With a current maximum day demand of 8.96 MGD the recommended firm capacity is 9.0 MGD. The tables above illustrate the maximum day demand increasing proportionally to the average demand based on population growth. While the maximum day demand may not follow a linear relationship, this provides a conservative estimate for water supply planning.

The City has a total well design capacity of 15.12 MGD and a firm capacity of 12.02 MGD. However, due to the age and condition of the wells, the production capacity is currently limited to approximately 11.45 MGD with a firm capacity of 8.93 MGD. As shown in the table, the City has capacity to provide the average daily demand throughout the four planning horizons. However, the maximum day demand exceeds what is currently available due to the lowered production capacity of wells at all phases. Analysis of the existing wells and alternatives for additional supply sources are reviewed in Section 5 and Section 6 of this report.

SECTION 3

EXISTING DISTRIBUTION SYSTEM EVALUATION

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3. EXISTING DISTRIBUTION SYSTEM EVALUATION

This section describes the current conditions, deficiencies, and maintenance issues related to the City's water distribution system. A hydraulic analysis of the City's distribution system was performed in order to identify restrictions within the existing distribution system and develop recommendations for future improvement projects. Current water supply, storage, and treatment will be reviewed in Section 5.

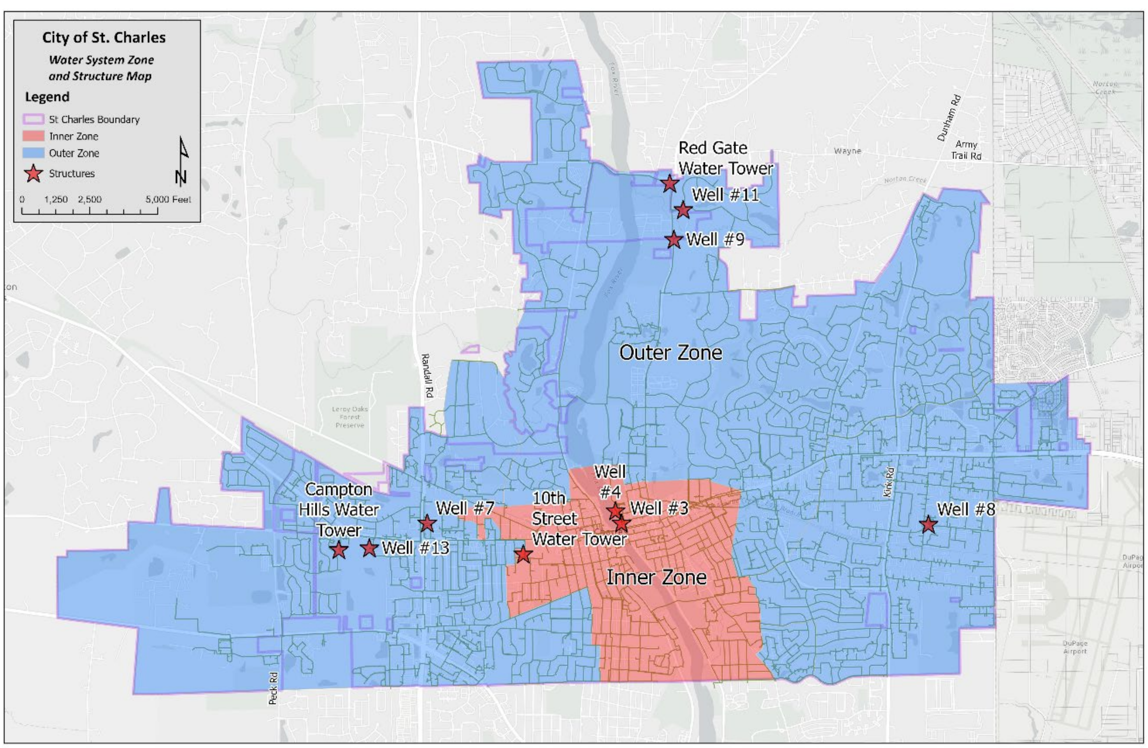
3.1 GENERAL BACKGROUND

The City of St. Charles has grown from a community of 17,492 residents in 1980 to 27,910 in 2001 and 33,781 in 2023. The residential water billed for the community in Calendar Year 2022 was 2,098,351 gallons per day, while the non-residential (commercial, industrial, and municipal) usage was approximately 1,406,564 gallons per day. The average total pumpage was approximately 4.21 MGD, which includes unbilled and unmetered water pumpage.

The City of St. Charles maintains roughly 250 miles of water main, 2,987 fire hydrants, 4,035 system valves, and two distinct pressure zones within the distribution system. The City has the ability to transfer water from the outer service area to the inner through the use of pressure sustaining valves. However, under typical operation these valves remain closed. Additionally, a booster pump at the Well #3/4 WTP can convey water from the inner zone to the outer.

The City Water Department has adopted proactive water main maintenance, flushing, and rehabilitation programs to sustain the level of service provided to the community. The water main rehabilitation program is often coordinated with the City's Capital Improvement's Program for street rehabilitation and reconstruction to minimize costs.

Figure 3-1: Water System Zone and Structure Map



3.1.1 Inner Service Area

The Inner Service Area generally serves the residents and businesses within the valley along the Fox River, and for the most part, the downtown area. In general, this is the older portion of town, and has approximately 46 miles of water main, 400 valves, and 500 hydrants. In 2022 this zone had an approximate residential demand of 500,000 gpd and commercial demand of 310,000 gpd. The Inner Service Area is supplied by two wells, Wells #3 and 4, which are located in the heart of downtown on Riverside Avenue. In addition, this service zone also has an elevated storage tank located on 10th street, and ground storage at the Riverside Radium Removal Facility (Well #3/4 WTP).

The majority of water main, especially in the downtown area, is smaller than eight-inches in diameter, with an appreciable amount of 4-inch main. Smaller main sizes were a common practice when these mains were installed, but current design standards dictate that new water mains should be no smaller than eight inches. These design standards were implemented to address the long-term efficiency loss due to corrosion and present-day fire flow demands.

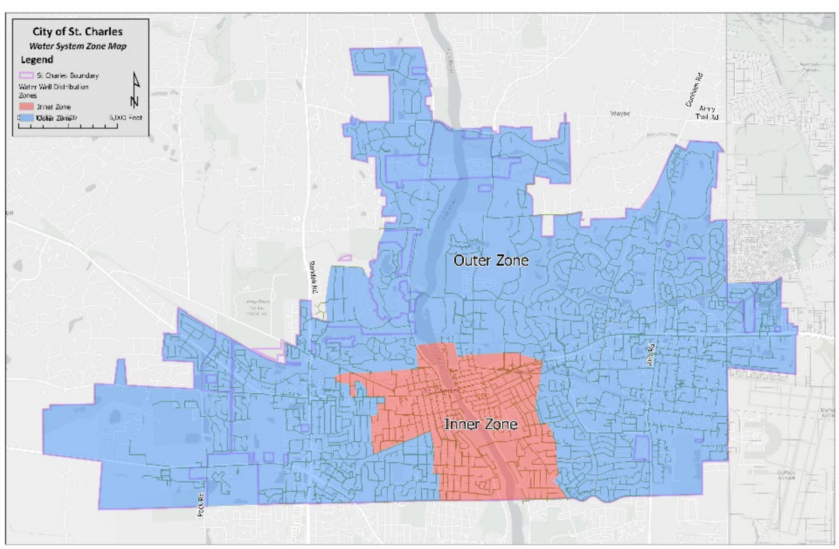
3.1.2 Outer Service Area

The Outer Service Area supplies water to the remainder of the City and is generally at a higher elevation, with the largest demands. The Outer Service Area has approximately 194 Miles of water main, 2,300 valves, and 2,400 hydrants. In 2022 this zone had an approximate residential demand of 1.60 MGD and commercial demand of 1.10 MGD.

The Outer Service Area is supplied by multiple wells, including Wells #7, 8, 9, 11, and 13. However, the operation of each of these wells is dependent on system conditions, and if other system components are down for maintenance. Two elevated storage tanks are located within the outer service area, one tower is located on the western side of town (Campton Hills Tower) and the other one the northeastern side of town (Red Gate Tower). Additionally, there are two 1.0 MG ground storage reservoirs at the Well #8 WTP. The two service areas are connected via pressure reducing valves which are capable of supplying water to the Inner Service Area from the Outer Service Area if Wells 3 and 4 are out of service.

The Outer Service Area in general consists of newer water main that is eight-inch in diameter or larger. This is a result of new construction following the new design standards that were implemented, which typically allows for greater capacity, and minimal efficiency loss.

Figure 3-2: Water System Zone Map



3.2 WATER QUALITY

The City of St. Charles is committed to supplying a safe, reliable and economical potable water supply to all residents and businesses within the City's service area. The City operates three water treatment facilities and provides chlorination and fluoridation to ensure that they are providing a safe water supply. As a result, the City meets all IEPA and USEPA requirements for primary and secondary water quality standards.

While the existing water supply is safe, it also contains high levels of the minerals calcium and magnesium, commonly referred to as hardness. Hard water is common in water systems that use groundwater as their source. As groundwater travels through the aquifer it dissolves minerals such as calcium and magnesium. The City of St. Charles has a water hardness range of 19 – 32 grains per gallon, which is generally defined as very hard, as seen in the following AWWA Hardness Classification Scale table. As a result, many of St. Charles' customers treat their water with privately owned water softeners.

Table 3-1: AWWA Hardness Classification Scale

Hardness Classification	Grains per Gallon (gpg)	Parts per Million or mg/l
Soft	0 to 4.3	0 to 75
Moderately Hard	4.3 to 8.8	75 to 150
Hard	8.8 to 17.1	150 to 300
Very Hard	17.1 and above	300 and above

The Environmental Protection Agency does not have a Primary or Secondary drinking water standard regarding water hardness as it does not present any health concerns. The concerns associated with hardness levels are related to aesthetics, such as mineral deposits, soap consumption and service life of appliances.

The City completed the Ohio Avenue Water Treatment Facility in 2006. This facility uses a combined Hydrous Manganese Oxide (HMO) and Ion Exchange filtration process to achieve the primary objective of radium removal. As a byproduct of the use of these technologies, the Ohio Avenue Facility also achieves significant removal of carbonate hardness associated with calcium and magnesium ion concentrations. The City completed the Riverside Radium Removal Facility in 2012 for Wells 3 and 4 which uses the same treatment processes to remove radium from deep well sources.

Recently, there has been increased interest within the City to investigate softened water throughout the community. As a result, alternatives for expansion of water softening for the City will be further investigated in Section 6.

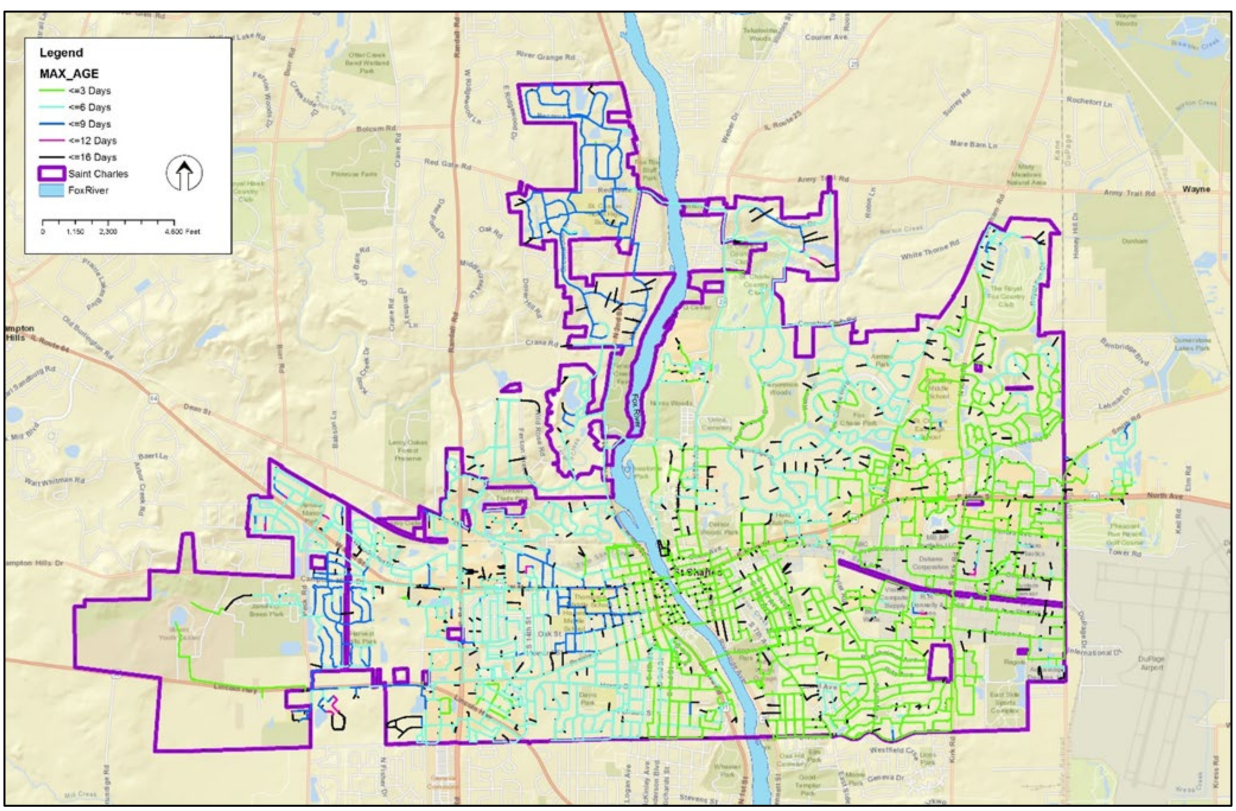
3.2.1 Water Age

Over the last few years, water age has become more of a concern, and many are working on ways to minimize the water age throughout the water distribution system. Water age can be affected by several different factors, which include water system demands, well run time, reservoir capacity, elevated storage capacity, water main layout, water main size, etc.

Typically, water age is defined at the amount of time (days) of which water resides in the system prior to entering the customer's home. The longer it takes for water to leave the water treatment plant and enter a home for consumption can result in loss of chlorine residual, odors, and potentially color changes. In general, anything less than three days age is considered 'very good'.

The City's water system was modeled to identify the water age throughout the system based on usage. The figure below shows the water age within each pipe on average. Light Green identifies areas of water age of less than three days, light blue represents areas with less than six days, dark blue represents less than nine days. On average the City's system has a water age of three to six days. The area of longer-duration ages is typically found in the northwest portion of the system and is likely related to lower water demands in these primarily residential areas, couple with the presence of the 1.5MG Red Gate Tower. This tower is needed as it provides storage and fire flow capacities in the area, primarily to St. Charles North High School. The City does not experience issues with a loss of chlorine residual, odors, or color change associated with water age.

Figure 3-3: System Wide Water Age



3.3 DISTRIBUTION SYSTEM EVALUATION

The City's water distribution system includes roughly 250 miles of water main, 2,987 fire hydrants, and 3,882 system valves. For planning purposes the value of water main and other system components can be estimated to project a total system asset value. As shown in the table below, the existing City of St. Charles water distribution system value is estimated at approximately $620 million including system valves and hydrants, which accounts for surface restoration, contingencies, project management, design and administration.

Table 3-2: Distribution System Replacement Cost

System Asset	Quantity	Unit Cost	Total Replacement Cost ($ Million)
≤4-Inch Main	41,765	$500	$22.89
6-Inch Main	275,851	$525	$144.83
8-Inch Main	435,624	$540	$235.24
10-Inch Main	123,062	$560	$68.92
12-Inch Main	225,124	$575	$129.45
14-Inch Main	4,238	$600	$2.55
16-Inch Main	62,660	$625	$39.17
18-Inch Main	1,541	$640	$0.99
Total:	-	-	**$642.04**
Annual Replacement Funding Level (75-Year):			**$8.56M**

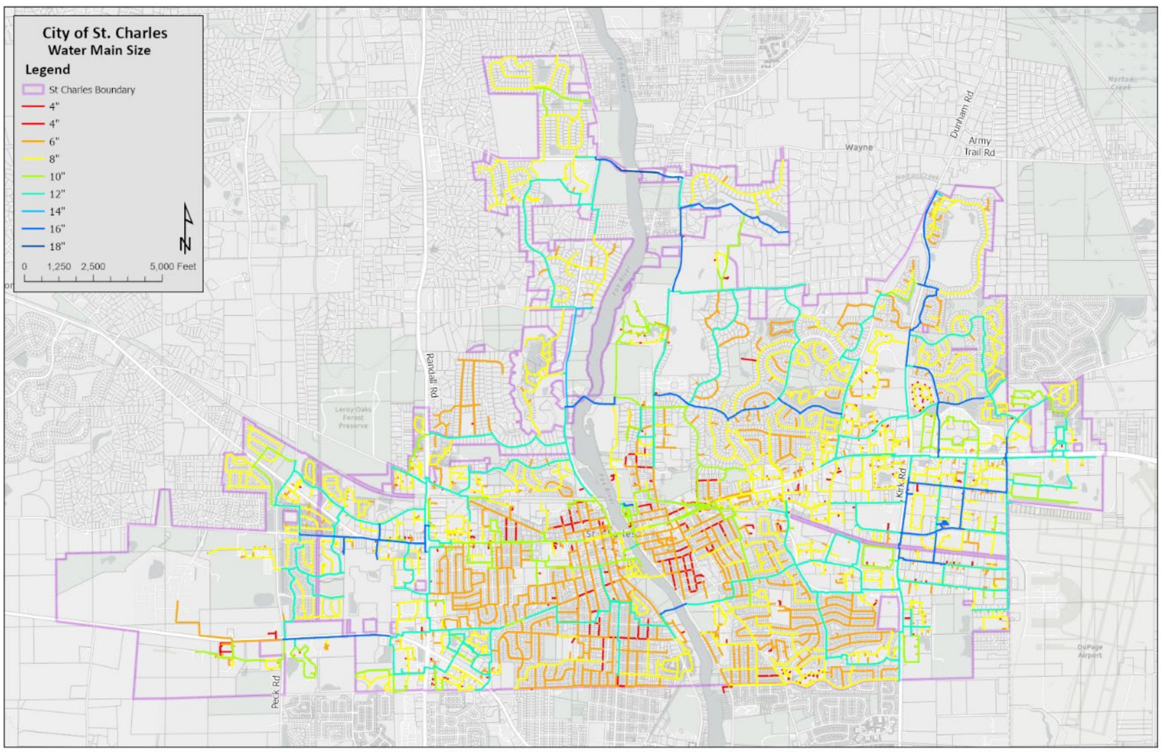
Based on straight-line depreciation and a seventy-five-year service life for this infrastructure, **an average of $8.56 Million would need to be reinvested annually into the distribution system**. It is highly recommended that the City move towards fully funding this distribution system replacement program. Alternatives for distribution projects are identified in Section 4 of this report and may include replacement of deteriorated main prone to breaks, upsizing of main to improve available fire flows, transmission main upgrades to improve conveyance throughout the system, or a combination of these.

This budgetary amount would need to be increased by the Construction Cost Index (CCI) each year, which has averaged 5% over the past decade. This annual reinvestment should be prioritized based on a number of criteria including main diameter, age, break frequency, soil conditions, and the presence of lead services, among others. These criteria will be discussed within this section, with recommended alternatives for rehabilitation and upgrade of the distribution system in Section 4.

3.3.1 Water Main Size

Shown below is the water main layout for the City of St. Charles. Water main in red represents 4-inch, orange 6-inch, yellow 8-inch, green 10-inch, teal 12-inch, light blue 14-inch, blue 16-inch and dark blue 18-inch. The table below identifies the breakdown of the water main sizing within the City. As shown in the table, the majority of the water main in the community is six and eight inch, with downtown areas generally smaller diameter.

Figure 3-4: Water Main Size



Current accepted practice is installation only of 8-inch and larger diameter water main. This includes residential as well as commercial applications. Historically, water main as small as 4-inch was installed for residential areas. As fire flow requirements and water quality concerns have grown, the need for larger main has as well. The City of St. Charles has minimal 4-inch diameter main, comprising less than 5% of the total system and isolated primarily to the inner service area. Industry standard for many years was to utilize 6-inch for residential areas, and as such makes up more than 20% of the City's system. While this provides adequate fire protection in some areas, it may be insufficient in neighborhoods with large homes requiring commercial-grade fire protection.

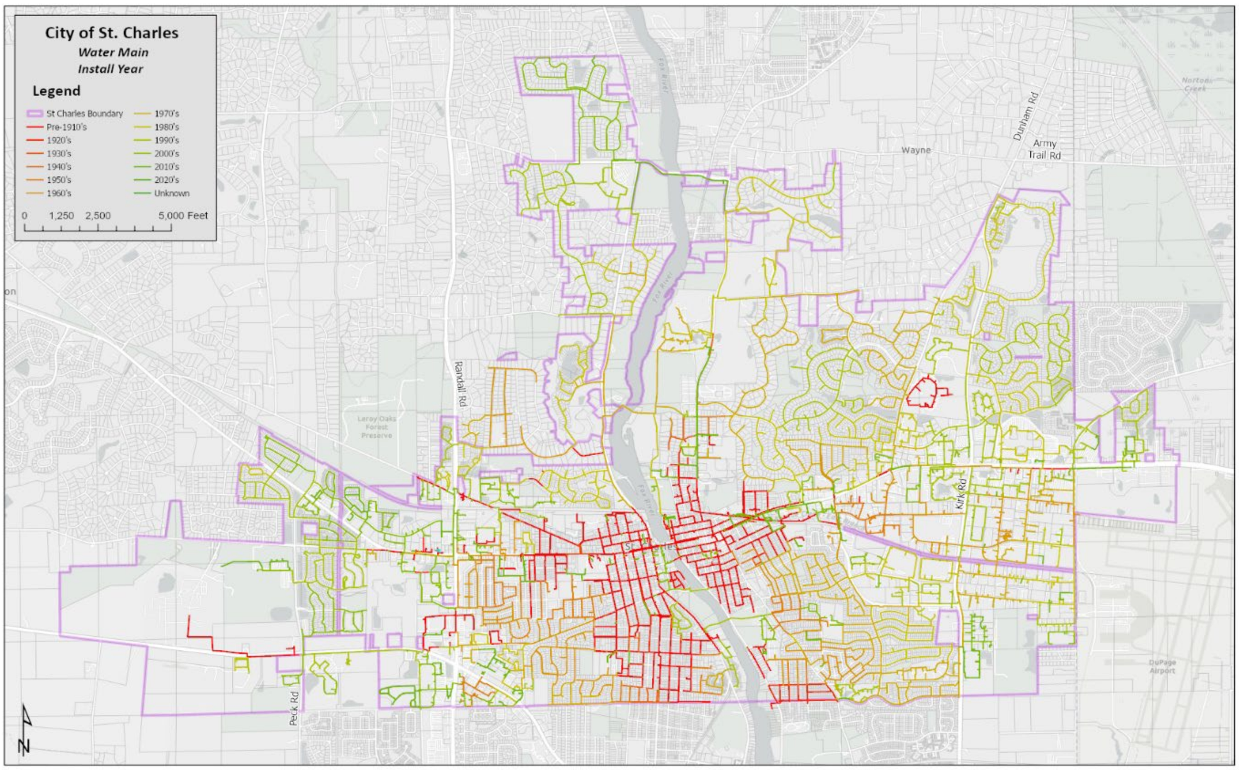
Table 3-3: Water Main Size Composition

Diameter	Feet	Miles	%
≤4-Inch	41,765	7.9	3.57%
6-Inch	275,851	52.2	23.58%
8-Inch	435,624	82.5	37.24%
10-Inch	123,062	23.3	10.52%
12-Inch	225,124	42.6	19.24%
14-Inch	4,238	0.8	0.36%
16-Inch	62,660	11.9	5.36%
18-Inch	1,541	0.3	0.13%
Total	1,169,865	222	100%

3.3.2 Water Main Age

Shown above is the water main installation date for the City of St. Charles. Pipe installation date for each pipe is characterized by the decade where the oldest pipes are depicted in red and gradually transitions to green for the latest pipes installed. The table above identifies the breakdown of the water main installation dates within the City. As shown in the table, the majority of the water main (67%) was installed in the between 1960 and 2020 with a median installation year in the early 1980's.

Figure 3-5: Water Main Age



According to the AWWA's "Buried No Longer" study performed in 2012, the lifespan of water main depends primarily on material and installation region. For the Midwest region, PVC water main can be expected to last approximately 55 years, ductile iron between 50-100 years, and cast iron 85-120 years (in the absence of pressure and other operational issues). From a capital replacement standpoint, water main is anticipated to last up to 75 years if properly installed. Roughly 50% of the City's distribution system is 50 years or older, and 30% of the system (all main pre-1950's) exceeds the typical 75-year service life. These are shown in red in the chart to the right.

Table 3-4: Water Main Age Composition

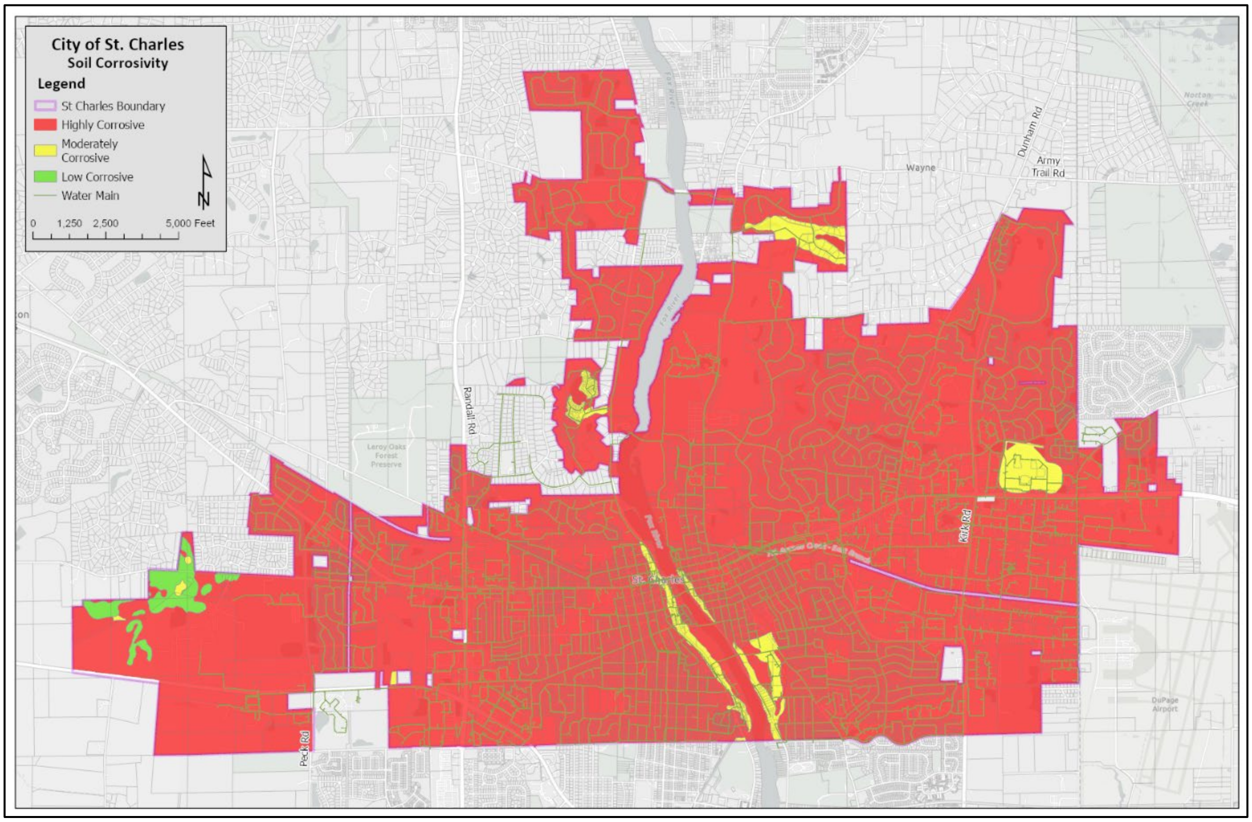
Decade	Feet	Miles	%
<1930	225,514	42.71	14.76%
1940	217,035	41.11	14.21%
1950	60,120	11.39	3.94%
1960	115,776	21.93	7.58%
1970	189,244	35.84	12.39%
1980	222,133	42.07	14.54%
1990	229,971	43.56	15.05%
2000	141,911	26.88	9.29%
2010	78,546	14.88	5.14%
2020	47,297	8.96	3.10%
Unknown	18	0.00	0.00%
Total	1,527,565	289.31	100.00%

3.3.3 Corrosive Soils

The City of St. Charles has experienced a significant number of water main breaks throughout the distribution system. One of the affecting factors of water main breaks has been identified and attributed to corrosive soils. Over time, as water main is exposed to corrosive soils, the pipe and fittings begin to deteriorate both internally and externally. As a result of this decay the service life of the water main is significantly reduced, much of this is due to the reduced wall thickness of the water main itself.

The graphic below illustrates the various corrosivity levels of soils within the City, as mapped by the US Department of Agriculture (USDA). Green represents low soil corrosivity, yellow moderate, and red high. Unfortunately, approximately 97% of the City of St. Charles' service area falls within the 'high' corrosivity soil areas.

Figure 3-6: Corrosive Soil Locations



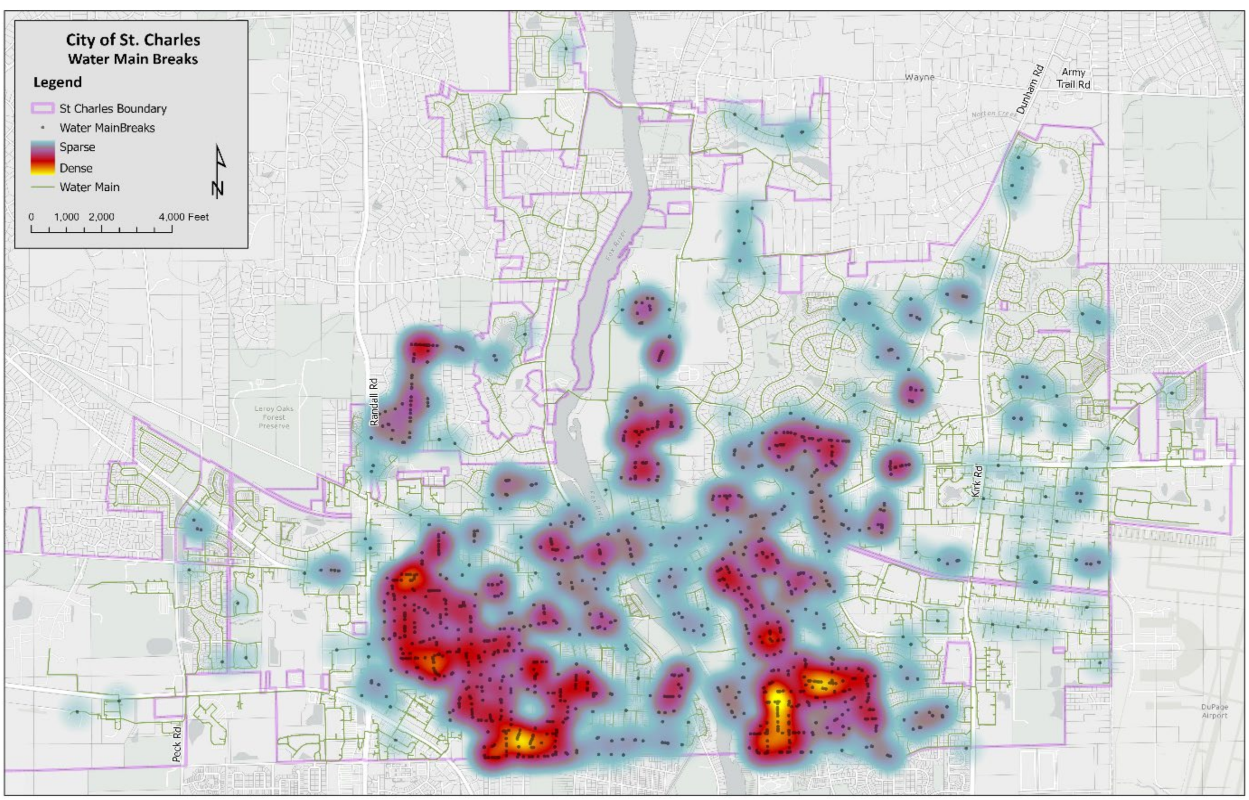
3.3.4 Water Main Breaks

The City of St. Charles water distribution system has been in operation since the early 1900's, and the rate of deterioration of water mains exceeds the rate of replacement. The majority of rehabilitation work performed within the system has been a direct result of leakage or water main breaks.

The system has been identified as relatively fragile because of the age of the water main piping and the materials that much of it was constructed using (e.g. cast-iron). The City should work to replace the older and deteriorated sections of water main pipe with piping manufactured of non-corrosive materials such as PVC, HDPE, or wrapped ductile iron as the majority of the City contains corrosive soils.

The following map identifies the City's water distribution system, with a heat map overlay identifying potential problem areas within the City limits. Areas in blue have very few water main breaks, yellow and red have progressively more main breaks, and shades of yellow depict areas with the highest concentrations of main breaks. These failures could be a result of a combination of several factors including insufficient construction materials or techniques, "hot" soils which can be the cause of increased pipe deteriorating, etc. These specific locations should be kept in mind when water main is being repaired and replaced. Further investigations may be needed to identify if different construction techniques or materials are warranted.

Figure 3-7: Water Main Break History through 2024



3.3.5 Lead Service Survey

Lead and Copper Rule Background

In response to the 1986 amendment to the Safe Drinking Water Act, the Environmental Protection Agency (EPA) adopted the Lead and Copper Rule (LCR) in 1991, which was later revised as the Lead and Copper Rule Revisions (LCRR) in 2021. The LCR requires water suppliers to deliver water that is minimally corrosive, thereby reducing the likelihood that lead and copper will be introduced into the drinking water from the corrosion of customer lead and copper plumbing materials. Prior to the LCR inception, the previous standard was to measure lead at the entry point to the distribution system and report issue when levels exceeded 50 parts per billions (ppb). While the old system was easier to test and enforce, most of the lead and copper reaching the taps of customers was (and still is) already within the system in the form of lead solder and the lining of old piping. In accordance to the LCR, testing must be done at the tap of customers on a six (6) month, year, or triennial schedule (smaller districts with a history of low results may only need to test every 9 years).

Over the years, the LCR has seen a few adaptations. Namely, in January of 2000, municipalities were required to install the "best available corrosion control mechanisms" and to continue to observe water levels even after the implementation of corrosion control. In 2004 and 2006, revisions and minor additions to the rule were implemented, in 2007 the EPA enhanced implementation in the areas of monitoring, treatment, customer awareness, and service line replacement. And in 2016 the EPA published additional options that may further revise the rule in the future.

In its current state, the LCR still requires testing at the customer's tap. If 10% of the tested taps exceed a concentration of 15 ppb for lead, or copper concentrations exceed 1300 ppb further action is required to minimize corrosion. Please note, municipalities are only in violation if they report concentrations greater than those noted and do nothing to fix the issue within a predetermined period of time. These fixes may include replacement of piping, fixtures and fittings within the system, or it may be more cost effective to change the corrosivity of the water within the system to prevent pickup of the unwanted chemicals.

Since 2021, the LCRR now requires testing in schools and childcare facilities, locations of lead service lines to be made public, establishing a trigger level for earlier mitigation in more communities, in addition to using science-based testing protocols to find more sources of lead in drinking water to drive more and complete lead service line replacements. This rule required identification of at-risk communities and ensure systems are in place to establish a rapid response by taking actions to reduce elevated levels of lead in drinking water.

Subsequently, in October 2024 the US EPA passed the Lead and Copper Rule Improvements. While there are a number of revisions to monitoring and testing, likely the most impactful from a long-term planning standpoint is the modification of the timeline for full lead service line replacement to within 10 years, beginning in 2027. This will expedite the City's previous 22-year plan and require an increase in annual funding level from $3,500,000 to an estimated $8,416,000.

Lead Service Line Replacement Comprehensive Plan

The City has developed and is implementing a comprehensive plan to replace all the lead services lines in the City of St. Charles to comply with Statute 415 ILC 5/17.12. This requires the owners and operators of a community water supply to develop, implement and maintain a comprehensive water service line material inventory as well as a comprehensive lead service line replacement plan. The Statute's purpose is to reduce the exposure of lead in the drinking water supply to all members of the community.

The total number of water service lines connected to the distribution system of the community water supply is approximately 12,998 water customers. The City's distribution system has approximately 2,350 known lead service line connections. To replace these lead service lines, the City initially plans to work on replacing emergency leaks or damaging water services, infrastructure replacement projects, and follow along with the IEPA's Priority Replacement Program to replace lead services at a rate of 3% per year starting with high-risk facilities and followed by the census metric tracts.

Highlighted in Figure 3-8, high-risk facilities include preschools, parks, playgrounds, hospitals, clinics, and licensed daycares. The census metric tracts include the median house income, children under age 6, poverty rate, unemployment rate, social security rate, minority and limited English-speaking household, supplemental security income, and houses built pre-1990.

Figure 3-8: Lead Service Line Replacement Plan – High-Risk Facilities Map

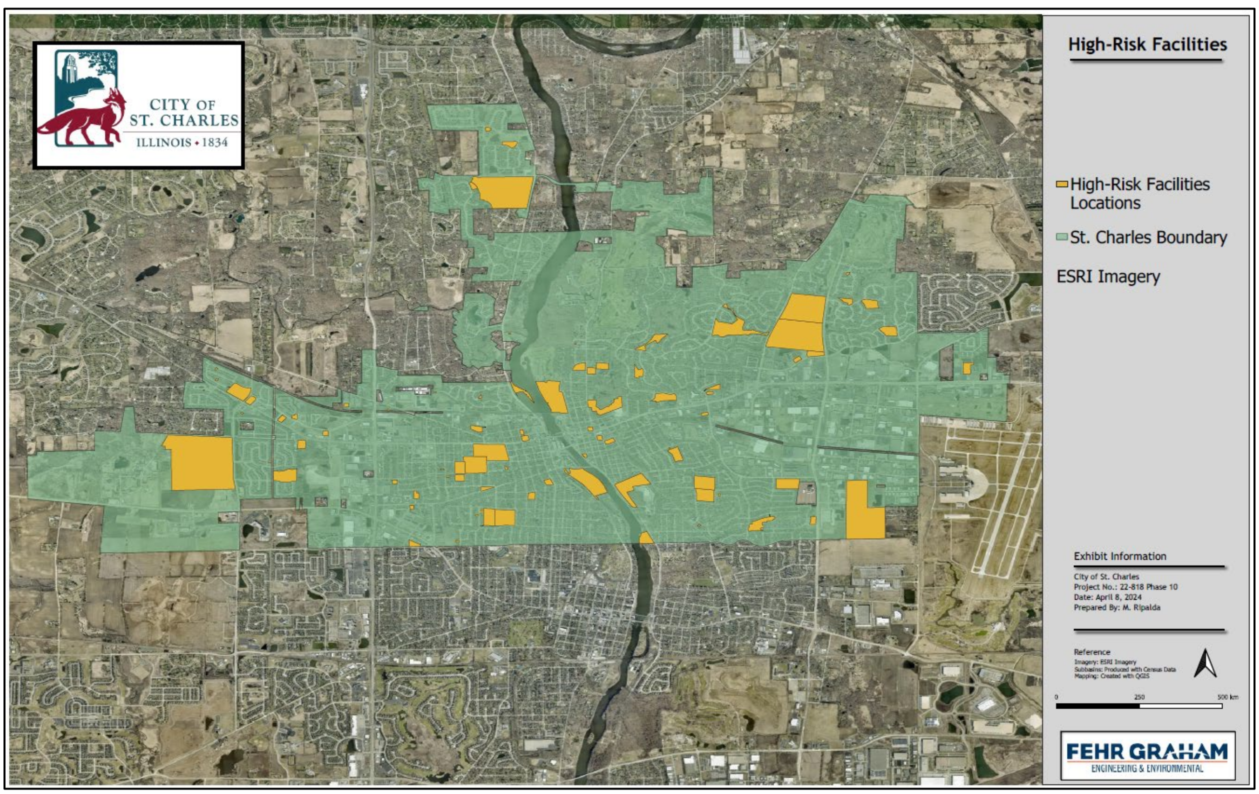
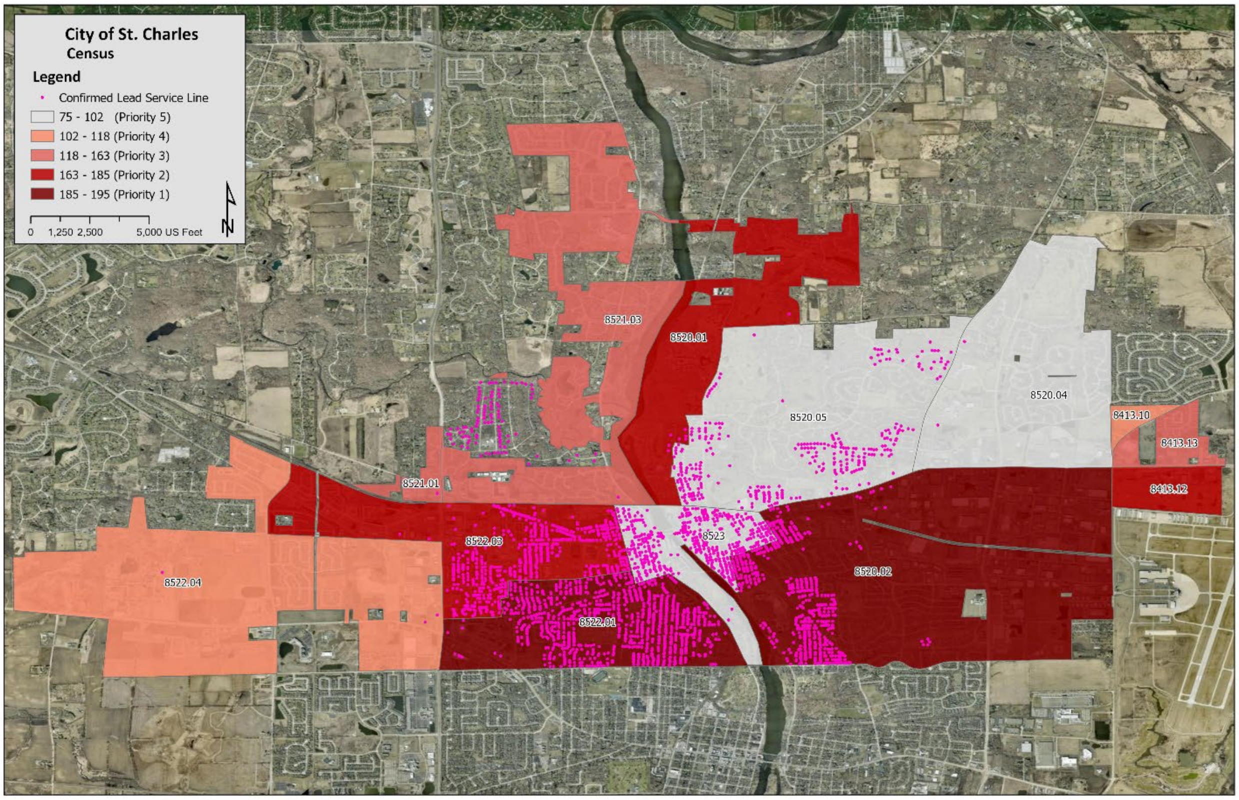


Figure 3-9: Lead Service Census Tract Heat Map



As seen from Figure 3-9, the City plans to target sector 8520.02 first because it is most represented in the target census metric tracts. This sector contains about 1,317 lead service lines and will take approximately 5 years to complete. After, the City will move to sector 8522.01 since it falls within the second most of the target metrics. This sector contains 1,142 lead services and will take approximately four years to complete. The City will then continue to target the next areas with properties in the greatest need of lead service replacement until all target areas are free of lead service lines.

In 2022, the City started replacing lead service lines. The City completed phases 1 and 2, totaling a completion of seven properties by 2023.

Lead Service Summary

The City of St. Charles is committed to replacing all lead service line in compliance with IEPA's updated lead regulations. The City will initially focus on lead water main leaks and water main replacement work, then the City will follow a proposed lead service line replacement plan by targeting high risk facilities followed by census tract metrics to prioritize replacement work in areas with the highest disadvantaged needs. The City will continue to apply for more state funding options and monitor proposed laws and policies to better identify future requirements to lead regulations.

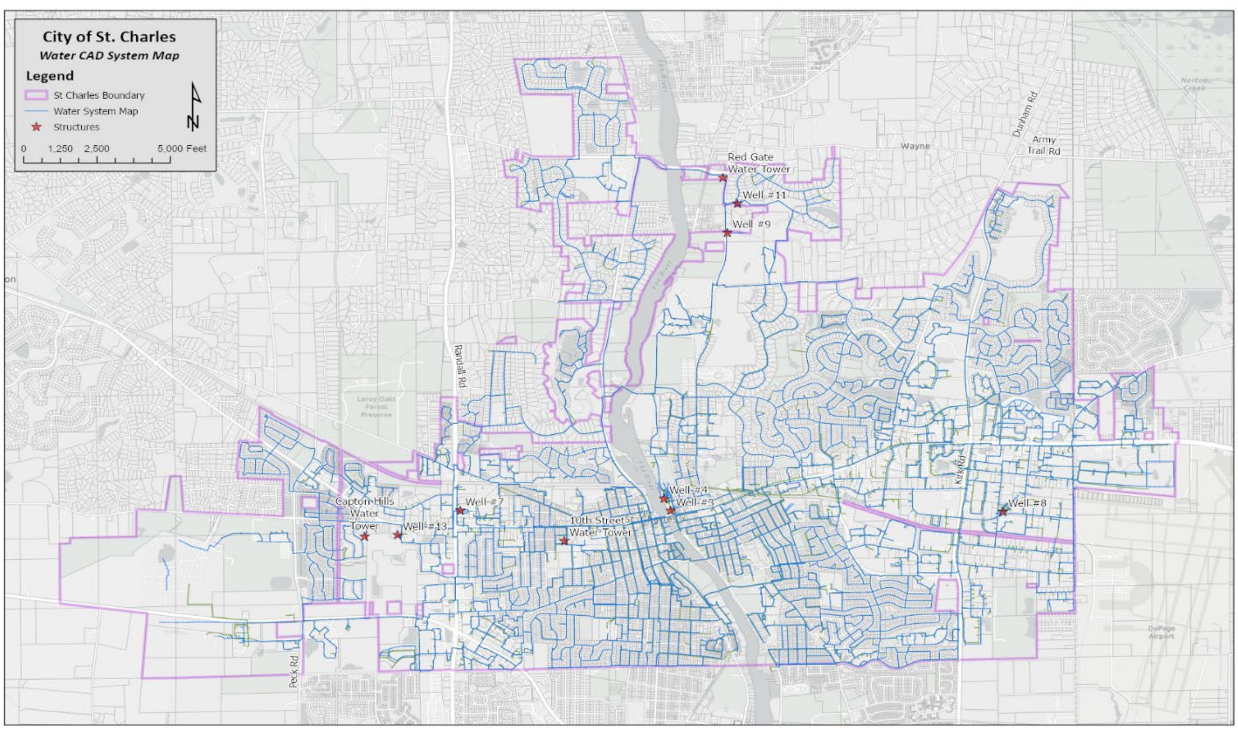
3.4 WATER DISTRIBUTION SYSTEM MODELING

The City maintains a Bentley WaterCAD® V8i distribution system model, hosted by Trotter and Associates, Inc. The model is a valuable tool for evaluating the impact of potential development, as well as to measure the benefits received from capital improvement and rehabilitation projects.

In 2023 the City elected to update the model from the existing GIS data which incorporate all of the improvements that occurred since 2018. Since 2018, multiple water main improvement projects have occurred, as well as the development of new properties. The 2023 model was updated based on new GIS data to reflect those changes. Upon incorporation of the new updates, and minor calibration of the hydraulic model, multiple scenarios and analysis were performed on the existing system. The results of this analysis are as follows.

The features in the model include wells, storage facilities, and distribution system. Each feature's characteristics are simulated within the model, including pipe sizes and lengths, storage reservoir characteristics, pump performance curves and ground elevations. The purpose of the model was to analyze the existing distribution system, to identify capacity issues and to evaluate the impacts of proposed improvements. The accuracy of the current model is sufficient to evaluate existing conditions and to make future recommendations for upgrade of the City's distribution system based on future projected demands. The figure below shows the existing system as modeled in WaterCAD V8i. However, as the City performs improvements, it is recommended that the water model be updated regularly.

Figure 3-10: WaterCAD Water System Map



3.4.1 Water Modeling Assumptions and Limitations

The following assumptions were utilized to most accurately analyze the water system for the Master Plan. The available fire flows and pressures reported represent instantaneously available capacities at the water main and fire hydrants listed throughout. Assumptions were made in regard to future water usage/daily demands for the City, as necessary. Per the Joint Committee on Administrative Rules – Tile 35, Appendix B: Commonly Used Quantities of sewage flows from Miscellaneous Type Facilities was also used when existing data was not available.

3.4.2 Water Model Update

The City IS Department provided an updated geodatabase through the end of calendar year 2023 for use in updating the WaterCAD/GEMS model. The GIS information was utilized to determine all water system features, including water main, valves, and hydrants, which were created or modified since the 2021 update. All modifications following the 2021 update were then incorporated into the water model to accurately reflect the current water system.

3.4.3 Fire Flow Requirements

Per the adopted 2015 International Fire Code, the fire-flow duration for commercial properties is two hours for Needed Fire Flows (NFFi) up to 3,000 gpm and three hours for needed Fire Flows up to 4,000 gpm. Properties requiring greater than 4,000 gpm fire flows require a flow duration of four hours.

The needed fire-flow duration for 1-and 2-family dwellings with an effective area of 3,600 square feet or less is one hour, and dwellings larger than 3,600 square feet is two hours. Buildings other than one and two-family dwellings require fire flows per table B105.1 (minimum required fire-flow and flow durations for buildings) within Appendix B of the International Fire Code. These requirements are also reviewed on a case-by-case basis by the City Fire Department during development review.

Figure 3-11: 2015 IFC Fire Flow Requirements – Appendix B

TABLE B105.1(2)
REFERENCE TABLE FOR TABLES B105.1(1) AND B105.2

FIRE-FLOW CALCULATION AREA (square feet)					FIRE-FLOW (gallons per minute)[b]	FLOW DURATION (hours)
Type IA and IB[a]	Type IIA and IIIA[a]	Type IV and V-A[a]	Type IIB and IIIB[a]	Type V-B[a]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
—	—	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
—	—	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
—	—	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
—	—	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
—	—	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
—	—	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
—	—	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
—	—	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.
a. Types of construction are based on the *International Building Code*.
b. Measured at 20 psi residual pressure.

3.4.4 WaterCAD Model Hydraulic Analysis & Results

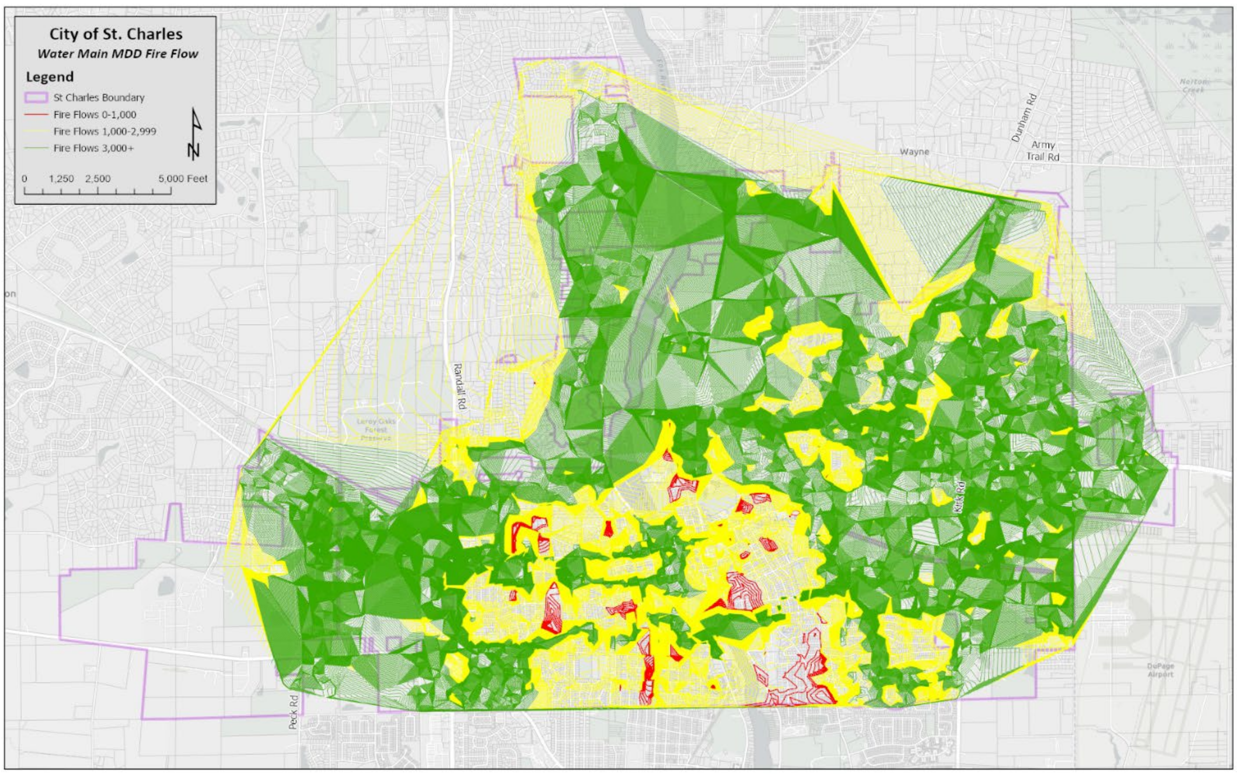
The City's distribution system was analyzed to see the flows available through the service areas for both the Inner and Outer Service Areas Systems. During this analysis, the model was run under maximum daily demand (MDD) conditions to provide a conservative analysis of the system. A peaking factor of 2.20 was used to establish the demand for the maximum day conditions, which was substantiated by historical flow data provided by the City.

The following sections provide an analysis of the water distribution system based on both available fire flows and pressure. Specific areas for improvements are identified in Section 4 with conceptual project routing and cost estimates provided.

Present Day Available Fire Flows

The WaterCAD computer modelling software was used to identify the available fire flow capacity throughout the City of St. Charles water distribution system, defined as the maximum deliverable flow from a single hydrant, while maintaining residual pressures no less than 20 psi. An extended period analysis provided a comprehensive overview of the system's status over a 24-hour period including peak demand conditions. The scenario was run under 'maximum day demand' conditions, which utilizes the 10-year peaking factor described in Section 2 of this report.

Figure 3-12: City of St. Charles - Available Fire Flows



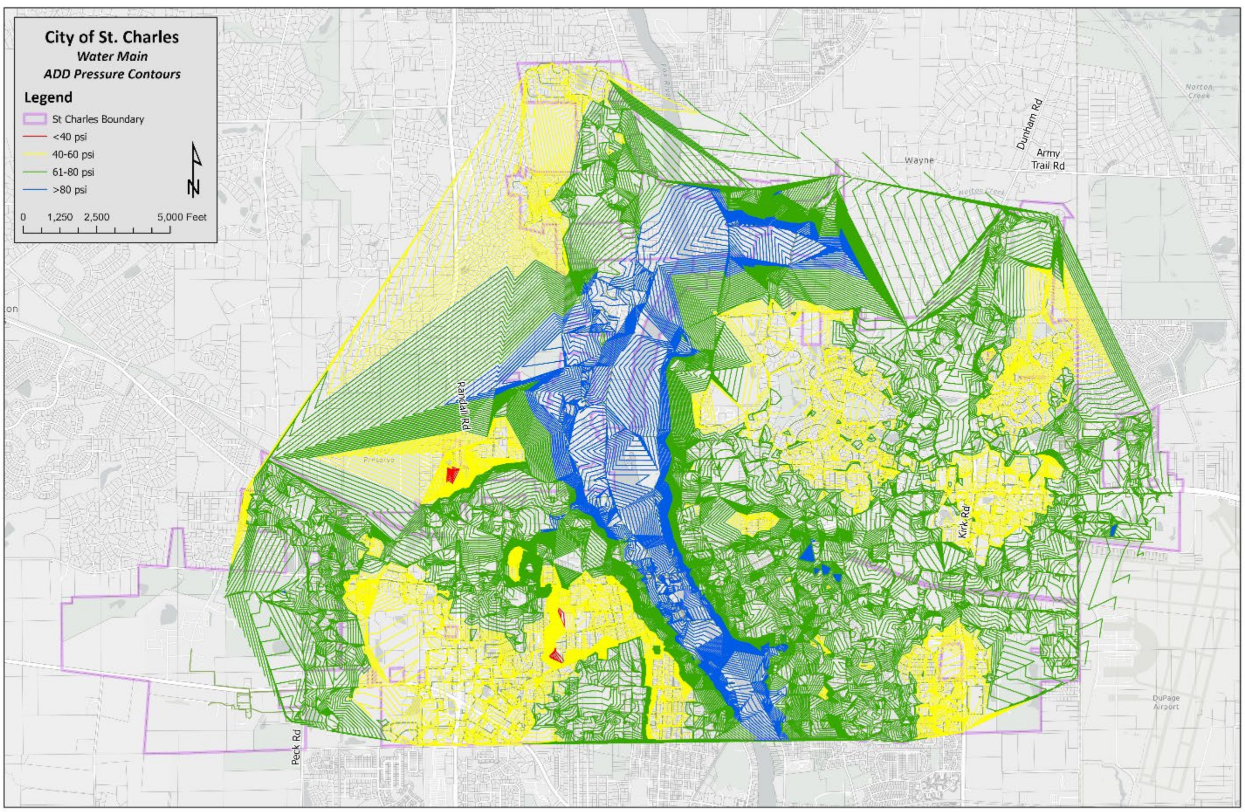
The results from the simulation were then used to generate an available fire flow contour map. The fire flow contour map below has identified the available fire flows throughout the City, and each contour is defined as less than or equal to the value presented. The fire flow contour map below identifies areas of insufficient fire flow, flow less than 1,000 gpm, in red, potentially insufficient areas of fire flow between 1,000 and 3,000 gpm in yellow and areas of sufficient fire flow greater than 3,000 gpm in green. Each of the areas of concern was analyzed, the cause determined, and recommended improvements developed to alleviate the situation.

Present Day Pressure Contour Map

In addition to fire flow, the WaterCAD computer modelling software was used to identify the available pressures throughout the City of St. Charles water distribution system. An extended period analysis provided a comprehensive overview of the system's status over a 24-hour period in an average daily demand condition.

The pressure contour map below has identified areas of low pressure, defined as less than or equal to 40 psi, in red and areas 40-60 psi are in yellow, 60-80 psi are in green, and greater than 80 psi are in dark blue. The areas of low pressure identified during the analysis were due to high ground elevation in comparison with the hydraulic grade-line of the distribution system.

Figure 3-13: City of St. Charles Pressure Contour Map



3.5 Distribution System Summary

The City of St. Charles water distribution system is over 250 miles of water main piping, valves, fire hydrants, and service connections. The total asset value of the distribution system is approximately $642M as identified in the table below. Based on a 75-year service life for the buried water infrastructure, the **City would need to be investing approximately $8.56 Million annually** into replacement of the system.

System Asset	Quantity	Unit Cost	Total Replacement Cost ($ Million)
≤4-Inch Main	41,765	$500	$22.89
6-Inch Main	275,851	$525	$144.83
8-Inch Main	435,624	$540	$235.24
10-Inch Main	123,062	$560	$68.92
12-Inch Main	225,124	$575	$129.45
14-Inch Main	4,238	$600	$2.55
16-Inch Main	62,660	$625	$39.17
18-Inch Main	1,541	$640	$0.99
Total:	-	-	**$642.04**
Annual Replacement Funding Level (75-Year):			**$8.56M**

It is recommended that the City not only budget for the annual replacement program, but also prioritize specific projects through the service area. Section 4 outlines specific projects that address available fire flows throughout the City and consist of both rehabilitation and upgrade of the distribution system as well. The prioritization of these projects will be discussed in Section 4. Each project is rated based on criteria such as main diameter, age, available fire flows, break frequency, lead services, water quality, and several others. This prioritization was utilized for the development of the Capital Improvements Program and Implementation Schedule.

Lead Service Summary

The City of St. Charles is committed to replacing all lead service line in compliance with IEPA's updated lead regulations. The City will initially focus on lead water main leaks and water main replacement work, then the City will follow a proposed lead service line replacement plan by targeting high risk facilities followed by census tract metrics to prioritize replacement work in areas with the highest disadvantaged needs. The City will continue to apply for more state funding options and monitor proposed laws and policies to better identify future requirements to lead regulations. The City has identified a **required funding level of approximately $3.5M annually** to comply with lead service line replacement regulations between 2026-2045 as identified in Table 3-8.

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SECTION 4

ANALYSIS FOR DISTRIBUTION SYSTEM ALTERNATIVES

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4. ANALYSIS FOR DISTRIBUTION SYSTEM ALTERNATIVES

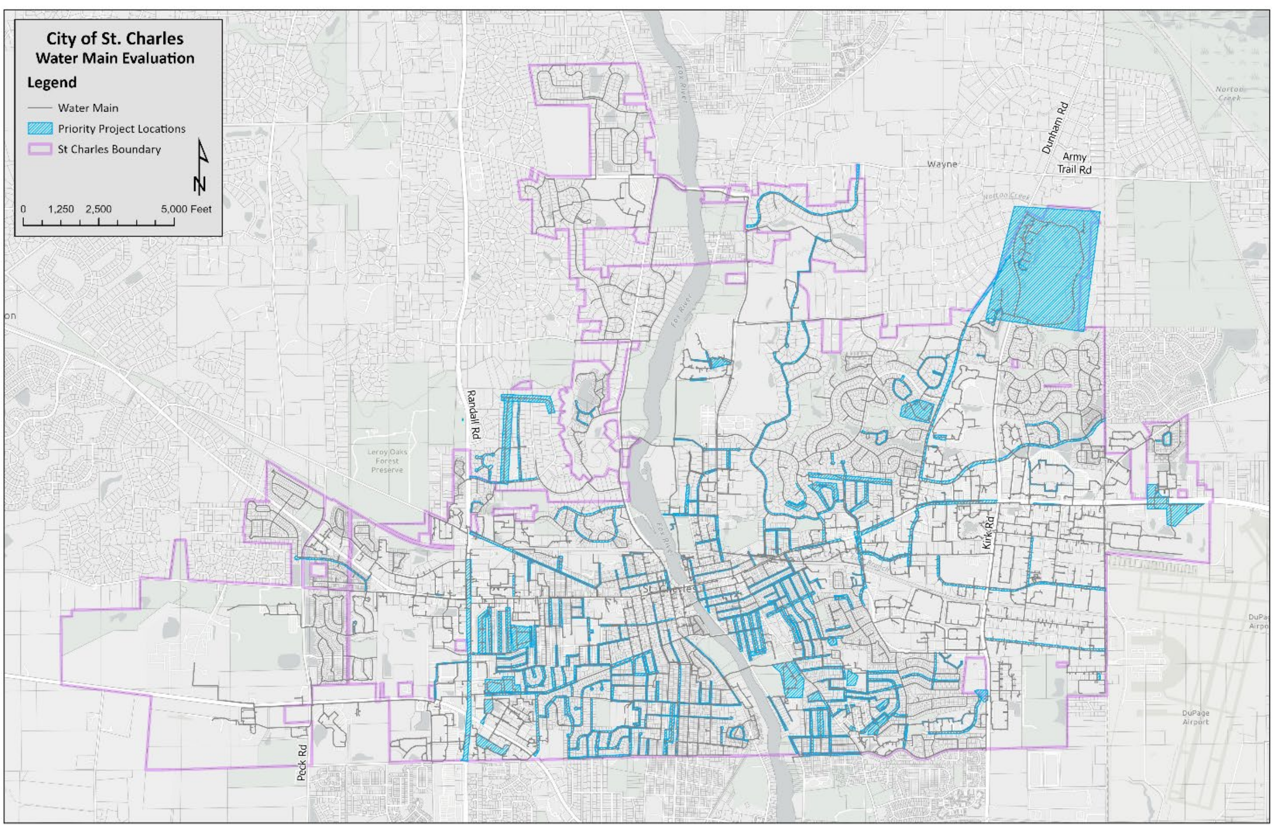
As discussed in Section 3, it is recommended that the City fully fund the distribution system replacement program over a 75-year period. This will avoid escalating main breaks and continue to improve water quality. The required funding level to accomplish this is estimated at $8.56M annually. This would be in addition to the roughly $3.5M annually dedicated to the federally required lead service line replacement. This Section 4 identifies projects to prioritize in the use of the annual replacement program.

4.1. RECOMMENDED DISTRIBUTION SYSTEM CAPITAL IMPROVEMENT PROJECTS

Through work sessions with City staff, a number of capital improvement projects were identified to rehabilitate and upgrade the distribution system. As discussed in Section 3, the water system has been constructed throughout the last century. As a result of the age of the system, many of the components are at or beyond their anticipated service life and will require rehabilitation or replacement.

Through review of water main age, size, material, break history, and available fire flows detailed in Section 3, priority rehabilitation areas within the distribution system were identified. These areas may exhibit low available fire flow (AFF), a high frequency of main breaks, or a combination of issues. The City has identified more than 250 individual projects and ranked each as described on the following page. The exhibit below shows the priority project locations.

Figure 4-1: Priority Distribution Project Locations



4.1.1. Prioritization of Distribution System Improvement Projects

In order to objectively rank the identified distribution system capital improvement projects, the below prioritization matrix was created. Through work sessions with City staff, the following six criteria were identified as most important when selecting a project:

1. Lead Service – The relative amount of lead services removed as part of the project.
2. Water Quality/Customer Service – Replacement of main associated with water quality complaints.
3. Coordination Value – Large Improvements throughout the project area for the associated costs, including coordination with sewer, storm, and roadway capital improvement projects.
4. Water Main Age – With main installed in the 1960's approaching the end of its service life.
5. Main Break Frequency – Replacement of main breaking often reduces staff labor and expense.
6. Public Safety/Available Fire Flow – High density locations near Public Facilities such as Schools, or Municipal Buildings.

Each of these criteria were then weighted with a 1-6 factor (as indicated in the list above), with the higher number indicating the greater weight. The projects were then given a score from 1-7 for each of the criteria, which were multiplied by the weight factor and added to arrive at a total "Criticality Index." The table below is a sample section of the table showing the current 30 highest ranked projects utilizing this matrix. The City utilizes these tables and prioritization method to select projects for each year's water main improvements program. These projects may change in priority depending on external factors such as roadway programs, recent main breaks, etc.

				Project Prioritization						
Rank #	Water Main Location	Length (ft.)	Project Cost (inc. Eng. & Legal)	Public Safety /Fire Flow (6)	Main Break Frequency (5)	Water Main Age (4)	Coordination Value (3)	Water Quality (2)	Lead Service (1)	Total Score
1	Wing Ave from N 11th Ave to N 13th Ave	814	895,800.00	5	5	4	5	2	4	94
2	N 3rd Ave from North Ave to Delnor Avenue	1,399	1,590,100.00	5	5	4	5	1	5	93
2	S 5th St from W Main St through Baker Field Park to S 7th St	4,549	5,219,400.00	5	5	3	6	2	4	93
4	N 6th St from Mark St to State St	735	877,100.00	5	5	3	6	1	5	92
5	Cutler St from S 8th St to S 7th St	733	924,600.00	3	5	5	6	2	4	89
5	Division St from S 2nd Place to Eastside Dr	1,914	2,012,100.00	3	5	5	6	2	4	89
7	Cedar Ave from Riverside Ave to N 7th Ave	1,506	1,583,800.00	5	3	3	6	4	5	88
8	N 12th St from Dean St and to W Main St	1,521	1,608,800.00	5	5	2	6	1	4	87
8	State St from N 6th St to N 4th St	637	667,700.00	3	5	3	6	5	4	87
8	S 16th St and S14th St from and to Howard St and Prarie St	1,945	2,213,300.00	3	5	4	6	3	4	87
8	Walnut St from S 11th St to S 10th St	376	465,800.00	3	5	5	6	1	4	87
12	S 12th St from Fellows St to Gray St	1,068	1,216,100.00	5	3	3	6	4	3	86
13	S 14th St around Howard St	1,576	1,867,600.00	3	5	4	6	2	4	85
14	N 12th Ave from Wing Ave to E Main St	802	922,800.00	5	5	4	2	1	5	84
14	S 10th St from Gray St to Horne St	1,954	2,233,700.00	3	5	4	6	2	3	84
14	S 4th St off of Gray St	496	694,100.00	5	4	2	6	2	4	84
17	S 10th Ave from Adams Ave to Madison Ave	957	1,007,300.00	3	5	3	7	1	5	83
17	N 7th St off of State St	325	371,900.00	3	5	4	6	1	4	83
19	N 6th Ave from Marion Ave to Allen Lane	609	668,500.00	3	5	4	5	2	4	82
19	S 5th Pl from Moore Ave to Eastside Dr	815	1,020,900.00	3	5	3	6	2	5	82
19	N Riverside Ave off of E Main St	1,017	997,300.00	3	5	2	6	5	3	82
22	S 6th St from Prarie St to Fellows St	2,427	2,594,000.00	3	5	3	6	2	4	81
22	S 13th St from Howard St to Prairie St	753	880,400.00	3	5	3	6	2	4	81
22	S 11th Ave From Madison Ave to Fern Ave	539	669,500.00	3	5	3	6	2	4	81
25	Howard St from Evergreen St to S 14th St (a little past)	2,015	2,038,400.00	3	5	3	6	2	3	80
25	S 8th St from Horne St to Mosedale St	599	659,500.00	3	5	3	6	1	5	80
25	S 7th St from Fellows St to Horne St, with backyard line	2,290	2,201,900.00	3	5	2	5	5	4	80
25	S 8th St from Westfield Dr to Fellows St	542	622,800.00	3	5	3	6	2	3	80
25	Jackson Ave from South Ave to Spring Ave	1,318	1,495,300.00	5	2	4	6	1	4	80
25	Moore Ave from Riverside Ave (25) to S 7th Ave	1,928	1,999,400.00	3	4	4	6	2	4	80

4.2. TRANSMISSION MAIN UPGRADES

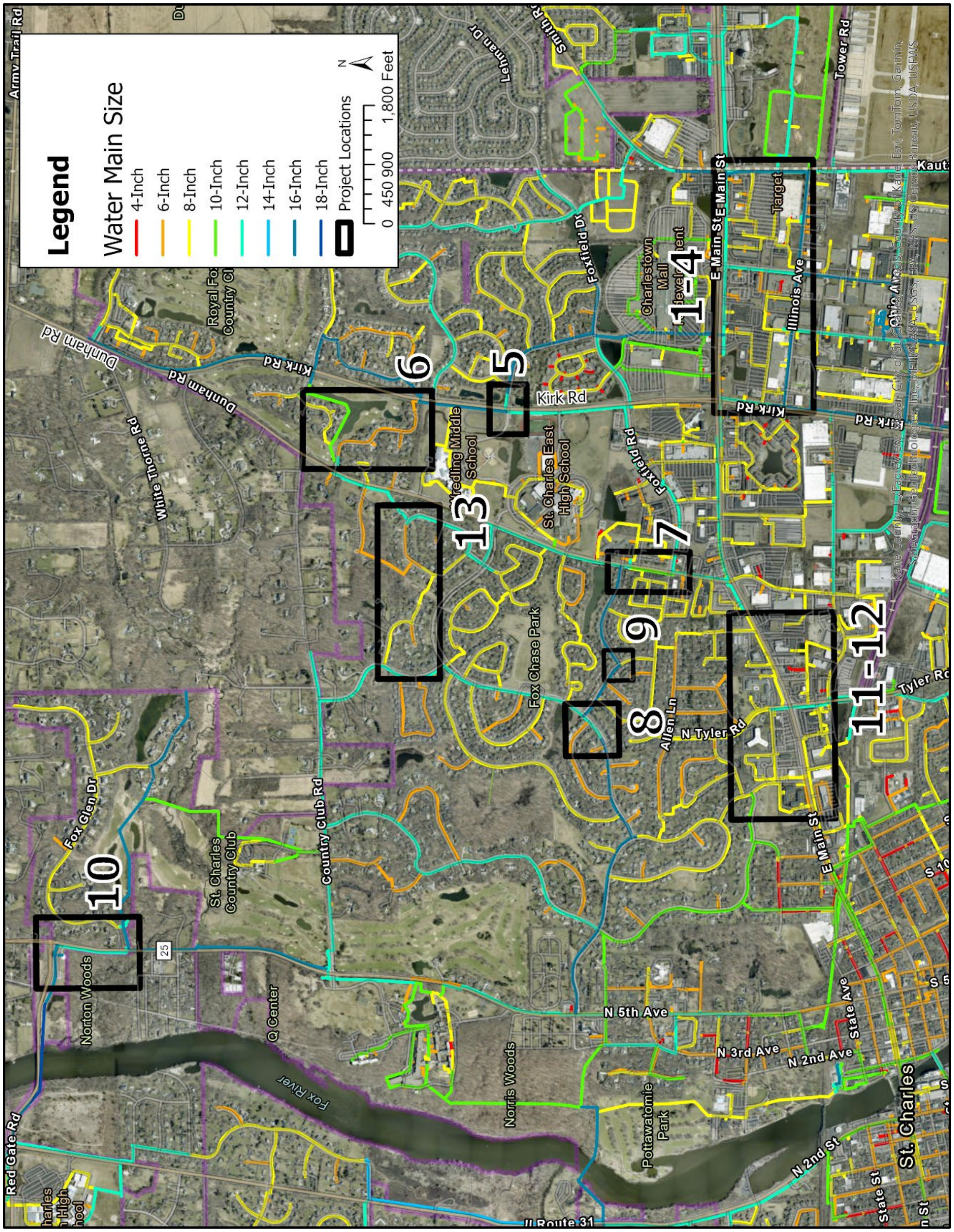
4.2.1. Long-Term Transmission Main Upgrades

TAI also evaluated areas within the distribution system where larger diameter transmission main could be improved. The City's system has a significant amount of large diameter mains, but some are separated by segments of smaller diameter mains that increases the amount of head loss as water travels through the system, also known as bottlenecks. TAI evaluated 13 areas in the system where this occurs, as well as other regions where potential transmission main connections can improve the available fire flows and conveyance throughout the system.

The map on the following page outlines the 13 areas that were investigated. Below is a description of each area and the upgrades that were considered:

1. Route 64 & Charlestowne Region – 12-inch main upsize to 16-inch from Kautz Road to Kirk Road
2. Kautz Road & Route 64 – 12-inch main upsize to 16-inch from Illinois Ave to Route 64
3. 38th Avenue & Illinois Avenue – 12-inch main upsized to 16-inch from Illinois Avenue south to existing 16-inch along 38th Avenue
4. Kirk Road & Route 64 – 12-inch main upsize to 16-inch from Illinois Avenue to Route 64
5. Fox Chase Drive & Kirk Road – 12-inch main upsize to 16-inch from Kirk Road east to existing 16-inch along Fox Chase Drive
6. Royal St. Georges Court – 6-inch main upsize to 12-inch main along Royal St. Georges Court to existing 16-inch along Kirk Road
7. Dunham Road & Fox Chase Boulevard – 10-inch main upsize to 12-inch main from Fox Chase Boulevard to Foxfield Drive
8. Fox Chase Boulevard & Huntington Road – 12-inch upsize to 16-inch from Huntington Road to existing 16-inch along Fox Chase Boulevard
9. Huntington Road & Fairfax Road – 8-inch upsize to 16-inch from Fairfax Road east to existing 16-inch along Huntington Road
10. IL-25 and Red Gate Road – 12-inch upsize to 16-inch from Red Gate Road to Fox Glen Drive
11. Hunt Club Drive & Persimmon Drive – 8-inch upsize to 12-inch from Persimmon Drive to Route 64
12. Route 64 & Persimmon Drive – 8-inch upsize to 12-inch main along Route 64 from 2020 E Main Street Hunt Club Drive
13. Stirrup Cup Court & Highgate Courts – 6-inch and 8-inch upsize to 12-inch from Aintree Road to Highgate Court

Figure 4-3: Transmission Main Upgrades - Projects



The table below outlines the estimated probable project cost of each 13 identified transmission main upgrades. Projects range from $65,625 to $2.1 million, and the total cost for all the projects to be completed is roughly $11.2 million.

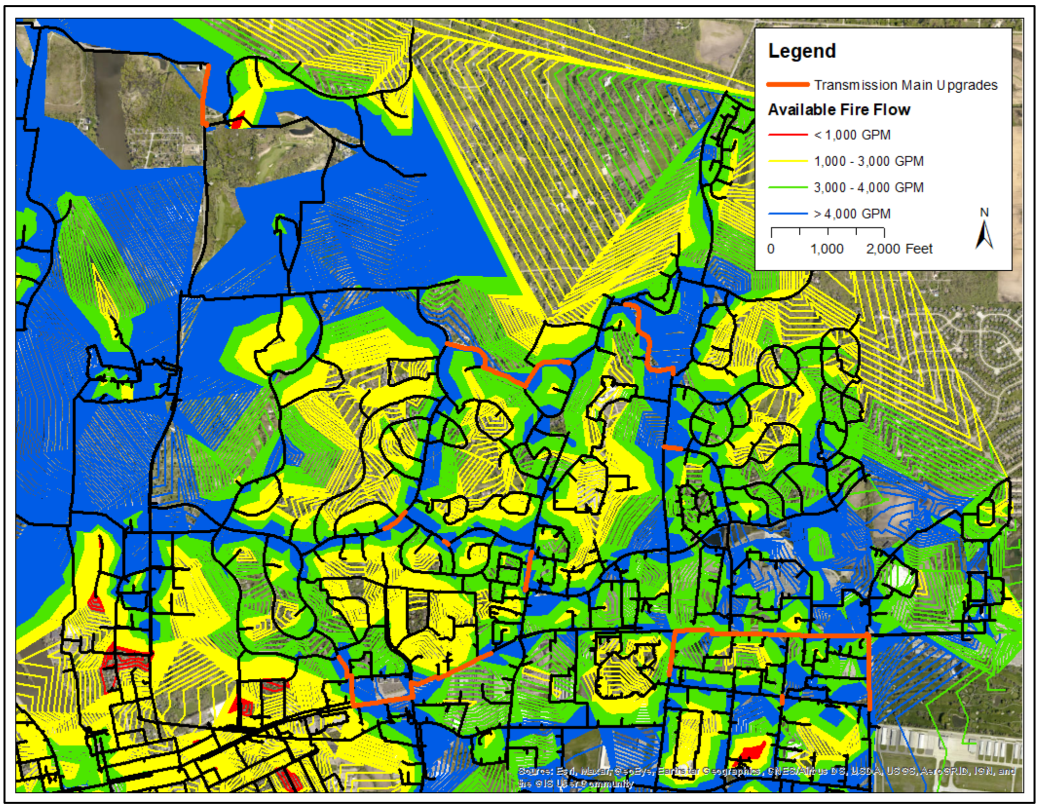
Transmission Main Improvements						
Description		Diameter (in)		Linear Feet	Cost per LF	Cost
		Abandoned Main	New Main			
1	Route 64 & Charlestowne Region	12	16	3,420	$ 625.00	$ 2,137,500.00
2	Kautz Road & Route 64	12	16	1,365	$ 625.00	$ 853,125.00
3	38th Avenue & Illinois Avenue	12	16	105	$ 625.00	$ 65,625.00
4	Kirk Road & Route 64	12	16	900	$ 625.00	$ 562,500.00
5	Fox Chase Drive & Kirk Road	12	16	1,190	$ 625.00	$ 743,750.00
6	Royal St. Georges Court	6	12	1,955	$ 575.00	$ 1,124,125.00
7	Dunham Road & Fox Chase Blvd	10	12	670	$ 575.00	$ 385,250.00
8	Fox Chase Blvd & Huntington Road	12	16	1,110	$ 625.00	$ 693,750.00
9	Huntington Road & Fairfax Road	8	16	90	$ 625.00	$ 56,250.00
10	IL-25 & Red Gate Road	12	16	1,170	$ 625.00	$ 731,250.00
11	Hunt Club Drive & Persimmon Drive	8	12	1,010	$ 575.00	$ 580,750.00
12	Route 64 & Hunt Club Drive	8	12	2,990	$ 575.00	$ 1,719,250.00
13	Stirrup Cup Court & Highgate Court	6	12	800	$ 575.00	$ 460,000.00
		8	12	1,955	$ 575.00	$ 1,124,125.00
			Total LF:	**2,755**	**Total Cost:**	**$ 1,584,125.00**
			Total LF:	**18,730**	**Total Cost:**	**$ 11,237,250.00**

Evaluation of Available Fire Flow – Long-term Transmission Main

The exhibits on the following page represent the available fire flows of the City's system with the recommended transmission main upgrades. Contours in red represent insufficient available fire flow (less than 1,000 gpm), contours in yellow represent flows between 1,000 and 3,000 gpm, contours in green represent flows between 3,000 and 4,000 gpm, and contours in blue represent available fire flows greater than 4,000 gpm.

As shown, the available fire flows significantly increase along the identified project routes and creates a continuous flow path throughout this region of the system.

Figure 4-4: Available Fire Flow – Transmission Main Upgrades



Transmission Main Upgrades Prioritization

The improvements were analyzed on a cost-per-gpm of increased available fire flow to aide the City in prioritizing projects within the CIP. The below table includes the 13 projects identified, the total project cost, increase in AFF, and the subsequent cost-per-gpm of increase.

While a useful tool to evaluate projects in a subjective manner, this method of prioritizing is limited as it does not take into account regional improvements created by some of the projects. For example, the Route 64/Kautz/Kirk Projects #1-4 only show an average increase along the replaced main of approximately 350 gpm. However, these projects significantly increase the flows available to be conveyed into the Charlestowne Mall/Springs at St. Charles/Charlestowne Lakes development areas. Therefore, while the below can be used in prioritizing, the City should review the regional improvements associated with each project as well to assist in developing the CIP.

Transmission Main Improvements				
Description		Total Project Cost	Increase in Average AFF (GPM)	Cost per GPM Increase
1	Route 64 & Charlestowne Region	$ 2,137,500.00	370	$ 5,777.03
2	Kautz Road & Route 64	$ 853,125.00	364	$ 2,343.75
3	38th Avenue & Illinois Avenue	$ 65,625.00	299	$ 219.48
4	Kirk Road & Route 64	$ 562,500.00	361	$ 1,558.17
	Projects 1 through 4	**$ 3,618,750.00**	**387**	**$ 9,350.78**
5	Fox Chase Drive & Kirk Road	$ 743,750.00	299	$ 2,487.46
6	Royal St. Georges Court	$ 1,124,125.00	1,909	$ 588.86
7	Dunham Road & Fox Chase Blvd	$ 385,250.00	425	$ 906.47
8	Fox Chase Blvd & Huntington Road	$ 693,750.00	425	$ 1,632.35
9	Huntington Road & Fairfax Road	$ 56,250.00	463	$ 121.49
10	IL-25 & Red Gate Road	$ 731,250.00	5,915	$ 123.63
11	Hunt Club Drive & Persimmon Drive	$ 580,750.00	737	$ 787.99
12	Route 64 & Hunt Club Drive	$ 1,719,250.00	1,439	$ 1,194.75
	Projects 11 and 12	**$ 2,300,000.00**	**1,388**	**$ 1,657.06**
13	Stirrup Cup Court & Highgate Court	$ 1,584,125.00	1,519	$ 1,042.87
Total Cost:		**$ 11,237,250.00**	**Average $/GPM:**	**$ 1,986.14**

4.3. Impacts of Upsizing Water Mains Throughout the System

The City has adopted minimum fire flow requirements of 1,000 gpm in residential neighborhoods and 3,000 gpm in commercial/industrial/institutional areas. Figure 4-1 indicates that the existing distribution system lacks capacity to deliver the minimum fire flow (3,000 gpm) throughout a portion of the downtown area, where a large portion of commercial/industrial/and institutional areas reside. The majority of the residential areas in the heart of the downtown area have sufficient fire flow protection in excess of 1,500 gpm.

The water mains in these older residential areas were constructed with 4-inch and 6-inch diameter pipes. The distribution system includes roughly 12 miles of 4-inch diameter and 70 miles of 6-inch diameter water main. Not only are these mains of inadequate size, but for the most part also have reached the end of their useful service life; their replacement should be planned.

Figure 4-8 illustrates the impact on fire flows throughout the City's water distribution system of replacing all 4-inch and 6-inch water mains with larger 8-inch piping. Upon completion, the water system would have capacity to provide all residential areas with fire flows in excess of 1,500 gpm, and most all commercial locations with over 3,000 gpm.

Prioritization of the capital improvements projects should be based upon the City's knowledge and understanding of the age and condition of the undersized pipe segments. The WaterCAD model indicates that within areas of undersized water main, available flows are restively uniform but deficient to convey necessary fire flows. Not one particular area seems to contain a particularly restrictive hydraulic condition. For this reason, additional criterion such as corrosive soils, high-capacity users, and potential need for emergency services should be used to prioritize projects.

There exists approximately 428,000 lineal feet of 4-inch and 6-inch water main in the system. A long-term 25-year plan to replace these pipes would include the replacement of 15,200 l.f. of pipe per year.

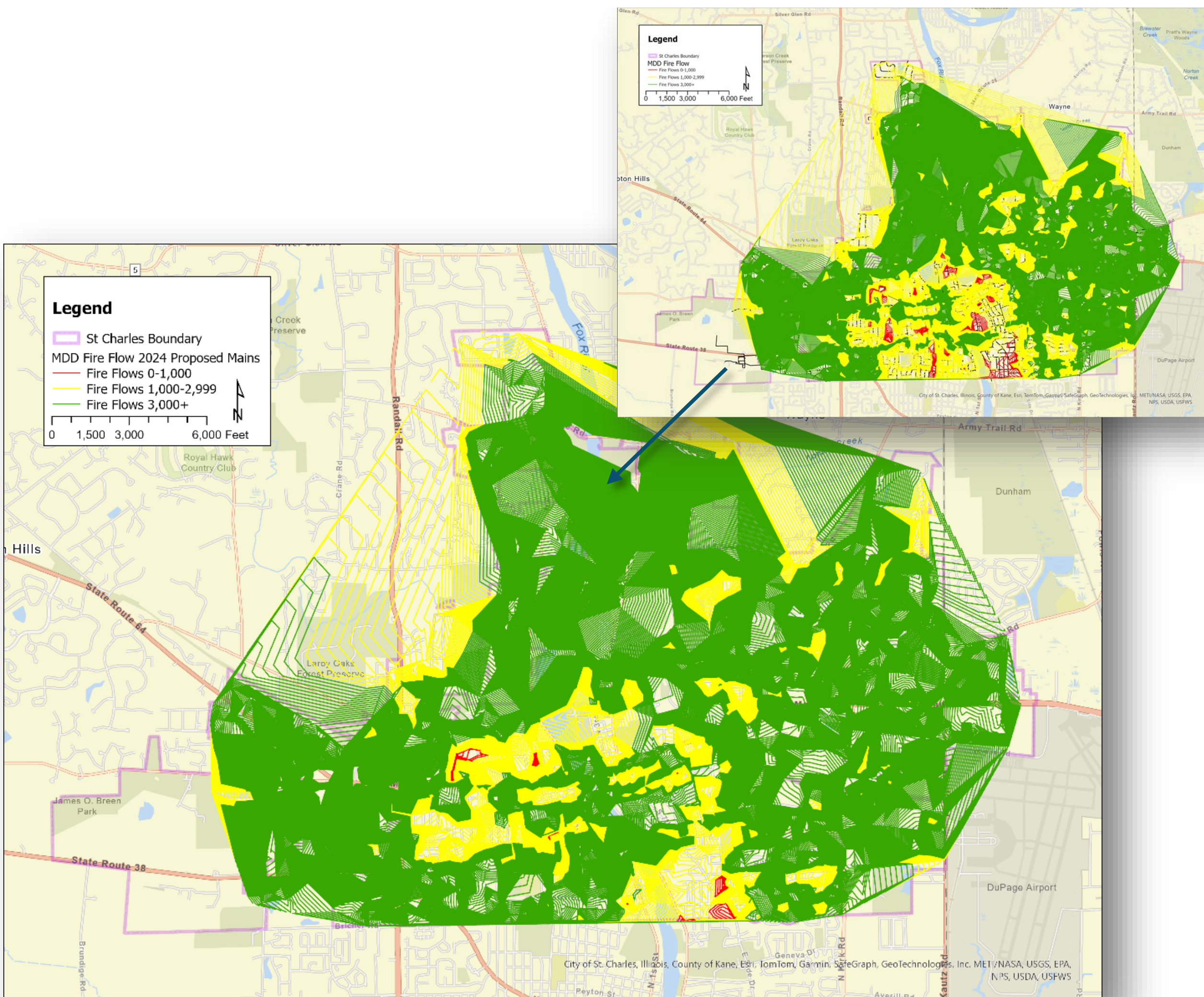
The replacement cost for the 4-inch and 6-inch water main is listed in total to be $90 million. The replacement cost for fire hydrants and water valves in these areas is estimated at $17 million for a total program cost of $107 million. The replacement cost for the 4-inch and 6-inch water main, in addition for the fire hydrants and water valves in these areas is estimated to be a total of $231 million.

Straight-line spending and ignoring inflation require an annual capital expenditure of approximately $4.62 million in order to have completed the replacement of all 4-inch and 6-inch water main over the next 50 years.

Table 4-3: City Wide 4 & 6-Inch Water Main Replacement

Upsize 4 & 6-inch Water Main Replacement					
Description	Diameter (in)		Linear Feet	Cost per LF	Cost
	Abandoned Main	New Main			
Upsize 4-Inch Main	4	8	61839	$ 540.00	$ 33,393,060.00
Upsize 6-Inch Main	6	8	366110	$ 540.00	$ 197,699,400.00
		Total LF:	427,949	Total Cost:	$ 231,092,460.00

Figure 4-5: Upsizing Water Main (Before/After)



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SECTION 5

EVALUATION OF EXISTING WATER SUPPLY, TREATMENT & STORAGE FACILITIES

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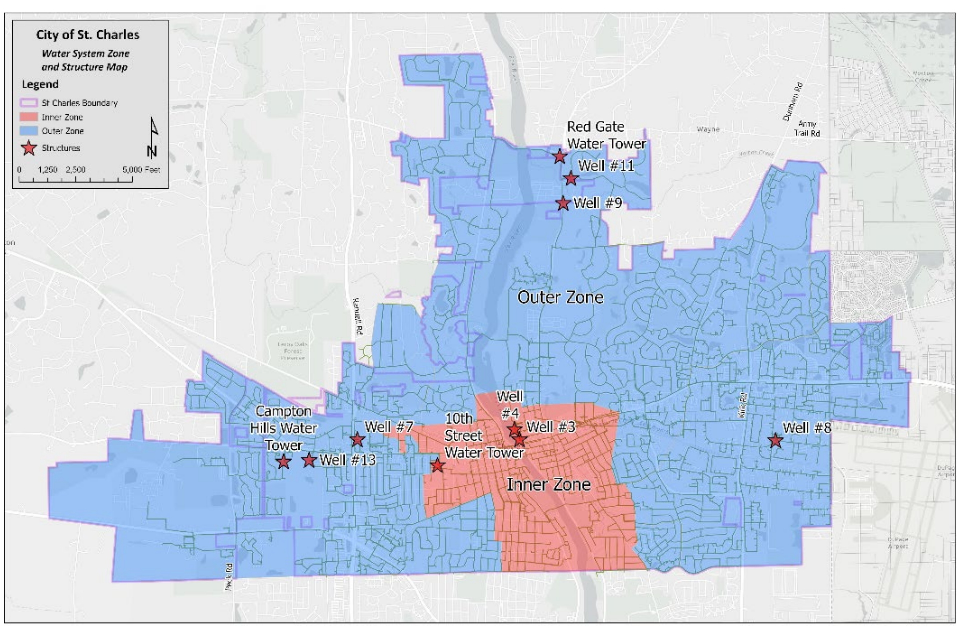
5. EVALUATION OF EXISTING WATER SUPPLY, TREATMENT & STORAGE FACILITIES

5.1. GENERAL WATER SYSTEM INFORMATION

The City of St. Charles water supply and storage system consists of seven wells, three water treatment facilities, a 300,000-gallon spheroid water tower, a 1,500,000-gallon spheroid water tower, a 1,000,000-gallon Hydropillar® water tower, and several ground storage reservoirs with booster stations. As with most municipal water supplies, the existing infrastructure has been constructed over several decades and the components within the system vary in age. The City of St. Charles follows a rigorous maintenance program for the wells, towers and distribution system to ensure reliability of the infrastructure.

The City currently has an active booster station and ground storage reservoir capacity of 2.9 million gallons. This includes approximately 500,000 gallons in ground storage at Well #3/4, two 1.0 MG ground storage reservoirs at the Well #8 WTP, and 236,000 gallons at Well #11.

The City's Wells and Water Towers have been strategically placed throughout the City's service area, and source water is supplied by two distinct aquifers. Well #7, 9, 11 and 13 are supplied by a shallow sand and gravel aquifer commonly known as the St. Charles Aquifer. Wells #3, 4, and 8 are supplied by a deep aquifer known as the Galesville Aquifer. The exhibit below shows the different sites of both the wells and elevated storage.



5.2. Water System Capacities

5.2.1. Current Well Capacities

Each of the wells in the City of St. Charles is operated at a lower production rate than originally designed, for a variety of reasons. As such, the actual capacity of City's water distribution network is lower than the original design. The current well capacities in Table 5-1 below indicate the actual operating production rates under existing conditions.

Presently, the City's wells operate at 74.7% of the capacity that they were designed to produce. Production is set at current levels at each well for a specific reason – chlorination capacities, elevated iron levels, and pump curve limitations. It should be noted that these "current" rates are designed to *produce the highest quality of water possible* by maximizing use of wells that produce the highest quality water.

With the replacement of the Well #7 pump and the Well 7 and 13 interconnect project, Well #7 will be utilized to produce approximately 1,750 GPM of high quality water. These current rates and required future capacities are discussed in further detail in Section 6.

Table 5-1: Current Well Capacities

		Original Design Capacities		Current Capacities (2023)	
Well	**System Served**	**Design Capacity (GPM)**	**Design Capacity (MGD)**	**Current Capacity (GPM)**	**Current Capacity (MGD)**
3	Inner	1,000	1.44	850	1.22
4	Inner	1,000	1.44	750	1.08
Total	**Inner**	**2,000**	**2.88**	**1,600**	**2.30**
7	Outer	1,750	2.52	1,750	2.52
8	Outer	1,200	1.73	950	1.37
9	Outer	2,150	3.10	1,500	2.16
11	Outer	1,900	2.74	650	0.94
13	Outer	1,500	2.16	1,500	2.16
Total	**Outer**	**8,500**	**12.25**	**6,100**	**9.15**
	Total System Capacity:		15.13	-	11.45

The Illinois EPA requires that a community be capable of supplying enough water to meet the maximum day demand with the largest well out of service, referred to as *firm capacity* (Adm. 604.230). The following table provides an overview of the supply wells at design and firm capacities, as well as reservoir capacities.

Table 5-1: Well and Reservoir Capacities

	System Served	Current Capacity (GPM)	Current Capacity (MGD)	Firm Capacity (GPM)	Firm Capacity (MGD)	Reservoir Capacity (gallons)
3	Inner	850	1.22	-	-	250,000
4	Inner	750	1.08	750	1.08	250,000
Total	**Inner**	**1,600**	**2.30**	**750**	**1.08**	**500,000**
7	Outer	1,750	2.52	-	-	0
8	Outer	950	1.37	950	1.37	2,000,000
9	Outer	1,500	2.16	1,500	2.16	0
11	Outer	650	0.94	650	0.94	236,500
13	Outer	1,500	2.16	1,500	2.16	0
Total	**Outer**	**6,350**	**9.16**	**4,600**	**6.63**	**2,411,500**

The City's system firm capacity is 1.08 MGD for the inner, and 6.63 MGD for the outer service area (with the largest wells out of service in each zone). Through the use of PRV's and a booster pump the City can transfer between zones if necessary. Therefore, the combined firm capacity of the system is 8.93 MGD.

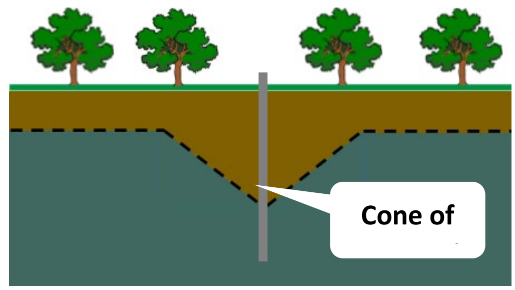
The City of St. Charles has identified that the highest consumption rate over the past three years was 8.55 MGD in July 2022. However, looking further into historical pumping records shows a maximum of 8.96 MGD in 2012, which should be considered during long-term planning.

Table 5-2: City of St. Charles Historical Water Consumption

	Inner Zone Max Consumption		Outer Zone Max Consumption		System Max Consumption
Year	1st Largest	2nd Largest	1st Largest	2nd Largest	
2012	1.66 MG	1.65 MG	7.48 MG	6.80 MG	8.96 MG
2013	1.42 MG	1.30 MG	5.36 MG	5.04 MG	6.78 MG
2014	1.32 MG	1.26 MG	4.89 MG	4.79 MG	5.85 MG
2015	1.37 MG	1.30 MG	4.83 MG	4.63 MG	5.84 MG
2016	1.63 MG	1.44 MG	5.07 MG	4.65 MG	6.51 MG
2017	1.40 MG	1.37 MG	6.53 MG	4.89 MG	7.94 MG
2018	1.91 MG	1.78 MG	5.50 MG	5.26 MG	7.41 MG
2019	1.61 MG	1.60 MG	6.13 MG	5.17 MG	7.74 MG
2020	2.04 MG	1.94 MG	5.89 MG	5.81 MG	7.94 MG
2021	1.51 MG	1.42 MG	5.77 MG	5.51 MG	7.29 MG
2022	1.68 MG	1.34 MG	6.86 MG	5.87 MG	8.55 MG

5.2.2. 18-Hour Run Time Capacity

Figure 5-1: Cone of Depression



Traditionally, a community's firm system capacity is a function of the capacity remaining with the largest well out of service and is based on a 24-hour run time for each well. During this period the community must be capable of meeting the maximum day demand. Peak hour demands are met by drawing from elevated storage or booster pumping water from ground level storage.

When running a well for a long duration (days), the aquifer can be stressed and start to create a cone of depression (see figure to the right). A cone of depression occurs when the aquifer water surface elevation begins to drop near the well due to the inability to recharge adequately. When a system experiences a depressed aquifer, it can result in lower pumping capacities. Therefore, this evaluation will also consider well capacity on an 18-hour run time basis in addition to the traditional 24-hour cycle. While the City of St. Charles has not experienced significant capacity reductions during periods of extended pumping, it should still be taken into account.

The table below illustrates the well capacities updated to reflect a maximum 18-hour run time. Additionally, the far-right column lists the inner and outer pressure zone production capacities with the largest well out of service (firm capacity).

Table 5-3: Well and Reservoir 18-Hour Run Time Capacity

Well and Reservoir Capacity - Modified Run Time					
Well	System Served	Current Capacity (GPM)	Current Capacity (MGD)	18 Hour Run Capacity	18 Hour Run Firm Capacity
3	Inner	850	1.22	0.91	0.91
4	Inner	750	1.08	0.81	-
Total	**Inner**	**1,600**	**2.30**	**1.72**	**0.91**
7	Outer	1,750	2.52	1.89	-
8	Outer	950	1.37	1.03	1.03
9	Outer	1,500	2.16	1.62	1.62
11	Outer	650	0.94	0.71	0.71
13	Outer	1,500	2.16	1.62	1.62
Total	**Outer**	**6,350**	**9.16**	**6.87**	**4.98**

With the City's well pump time reduced to 18-hours per day, the firm capacity is reduced to 0.91 MGD for the inner system, and 4.98 MGD for the outer. These numbers can be used for evaluating the system's ability to meet average day demands, however they are not intended to be used for maximum demand scenarios when wells will be pumping as much as necessary to meet demand. The combined firm 18-hour capacity is roughly 6.7 MGD, which is sufficient throughout the planning period for average day demands.

5.3. Water Supply and Treatment Evaluation

5.3.1. Well #3 & 4

Wells #3 and #4 are located within the municipal complex along First Avenue. Well #3 is located in the courtyard north of City Hall at 2 E. Main Street. The well was originally drilled into the Mt. Simon Aquifer in 1919. The well construction included a casing down to bedrock but was left open to multiple aquifers including the dolomite, St. Peter, Galesville and Mt. Simon. During the 1970's it was found that the Mt. Simon formation contained high chloride concentrations. To mitigate the problem, the City of St. Charles sealed the well to formations up to the Galesville Aquifer, which is still used today. The existing well is 1,192 feet deep with a pump setting of 804 feet below grade. The static water level in the well is 416 feet below grade or 388 feet above the pump.

Well #4 is located adjacent to the City of St. Charles Police Department. Similar to Well #3, the well was originally open to several aquifers, including the Mt. Simon and Galesville Aquifers. Around 1970, the City modified the well by sealing the lower portion, the Mt. Simon Aquifer, to eliminate contamination by chlorides. Well #4 is 1,645 feet deep with a pump setting of 821 feet below grade. The static water level in the well is 370 feet below grade or 451 feet above the pump.

Although Wells #3 and #4 are only approximately 540 feet from each other, the City charts approximately a 45-foot difference in static water elevation between the two wells. This difference could be attributed to several causes. One explanation may be sealed off in Well #3 and not in Well #4 contributing to Well #4's higher water level. A third explanation is that Well #4 is still seeing some static pressure from the Mt. Simon aquifer.

In 2012, the City constructed a new water treatment plant at Well #3 & 4, to treat the raw influent for Radium, as well as to soften water to the Inner Service Area.

Finished water from Wells 3 and 4 is a composite of water that has taken three paths through the filtration plant. The flows in the table at right describe how water is divided when each of the wells is in operation and when both wells are being run simultaneously. Dividing the flow and blending with raw water allows the City to efficiently treat water while still achieving the necessary contaminant removal levels.

(GPM)	Well 3	Well 4	Well 3/4
HMO Filtration	385	381	783
Ion Exchange	500	504	987
Bypass Flow	115	115	230
Total Flow	1000	1000	2000

An ion exchange system was installed at the water treatment plant and functions in the same way as many household water softening systems. Raw water is fed into the ion exchange unit where it comes in contact with a cation charged resin bed. The resin exchanges positively charged ions such as magnesium and calcium, the primary contributors to water hardness, for innocuous sodium ions. Over time, even with repeated backwashing, the capacity of the resin to replenish its concentration of sodium ions will be reduced. It is suggested that the City test a core sample of the ion exchange resin at Well 3/4, as the relatively recent construction of this facility will provide a strong baseline reading.

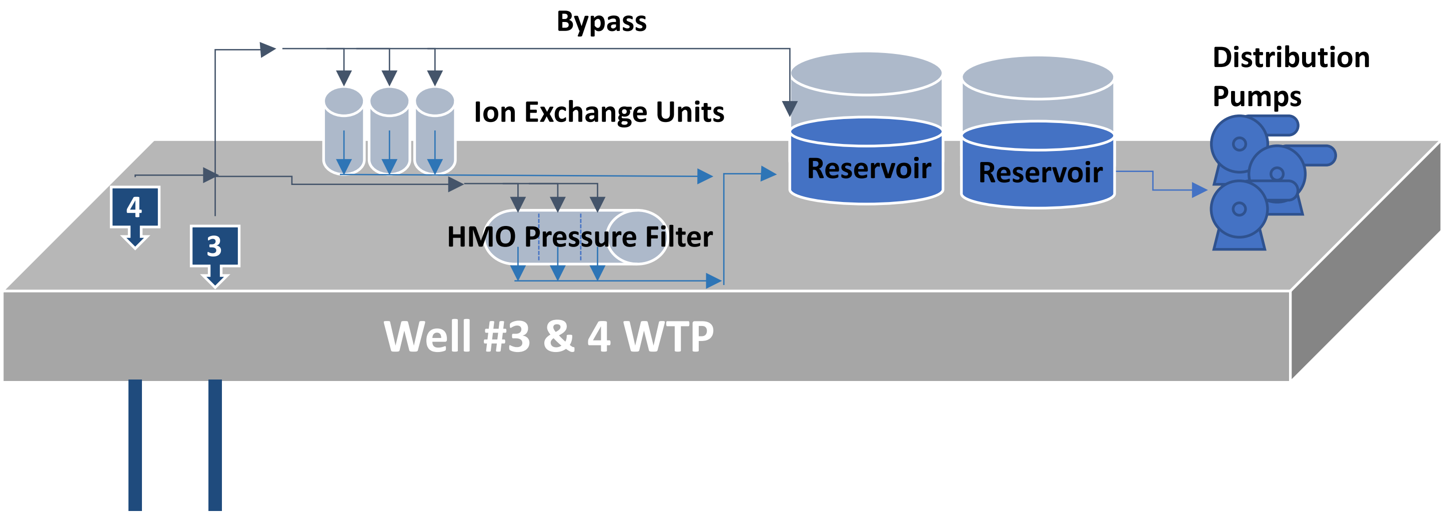
Well 3 Radium (pCi/L)	10.92
Well 4 Radium (pCi/L)	10.44
Softener Radium (pCi/L)	2.03
HMO Radium (pCi/L)	2.01

The ion exchange process has a very high removal rate for not only calcium and magnesium ions, but also Radium 226 and 228. Since the implementation of this technology, the City has seen radium removal rates in excess of 80%. Removal is likely higher but finished radium levels fall below concentrations that can be accurately measured. The MCL for combined radium 226 and 228 is 5 pCi/L. Presently, radium removal through ion exchange and HMO filtration achieves finished radium concentrations of 2.03 and 2.01 pCi/L, respectively, allowing for blending to occur with raw water and remain below the regulated concentration.

The Ion Exchange system was combined with a HMO (Hydrous Manganese Oxide) filtration system. The treatment process includes the creation of a HMO slurry, which is a mixture of manganese sulfate, potassium permanganate, and water. This HMO slurry is injected into the raw water prior to filtration. The HMO particles absorb radium from the raw water and are filtered out in the anthracite filter media. Routine backwash cycles clear HMO particles from the filter media. Backwash flow is diverted to the City's sanitary sewers. By combining the HMO process with ion exchange the City is able to meet both the radium removal requirement and the hardness removal goal for the inner system. Shown at right is the blending rate through the two treatment processes and bypass when each well is online as well as when both wells are simultaneously in operation.

GPM	Well 3	Well 4	Well3/4
HMO Filtration	385	381	783
Ion Exchange	500	504	987
Bypass Flow	115	115	230
Total Flow	1000	1000	2000

Treated water mixed with bypass water is pumped to two, 250,000-gallon reservoirs. Water is pumped from storage to meet demand through three booster pumps housed within the treatment plant. These pumps are capable of pushing water to the outer zone during times of high demand.



A raw water panel analysis was completed for Well #3 and #4 in July of 2023 by Water Systems Engineering, inc. Relevant raw water testing results are outlined in the table below.

Parameters	Well 3	Well 4	Units
PH Value	7.64	7.66	NA
Total Alkalinity	280	276	mg/l
Total Dissolved Solids	398	396	mg/l
Conductivity (µm)	553	550	NA
Total Hardness	248	252	mg/l
Carbonate Hardness	248	252	mg/l
Non-Carbonate Hardness	ND	ND	mg/l
Chlorides (as Cl)	8	14.1	mg/l
Nitrate (Nitrogen)	0.6	ND	mg/l
Iron Total (as Fe)	0.03	0.04	mg/l
Manganese (as Mn)	ND	ND	mg/l
Sulfate (as SO_4)	2	3	mg/l
Silica (as SiO_2)	7.9	8	mg/l
Total Organic Carbon ©	1.0	0.6	mg/l
Nitrate-N	0.6	ND	mg/l
Ammonia-N	NA	NA	mg/l

The total dissolved solids are at the upper limit to be considered normal and is not a cause for concern. Water Systems Engineering noted that elevated resuspended iron levels is an indication of iron accumulation that could create an environment for iron related fouling.

The condition assessment table on the following page includes all of the major equipment at the Well #3 and Well #4 site. As part the conditions assessment it was determined that several pieces of equipment are beyond their useful life and are in need of replacement. Some of these items include chemical pumps, HMO equipment, VFD's and the Well #4 pump and motor. Based on this assessment there are several pieces of equipment that will be at the end of their useful life by 2029 with some items extending through 2049.

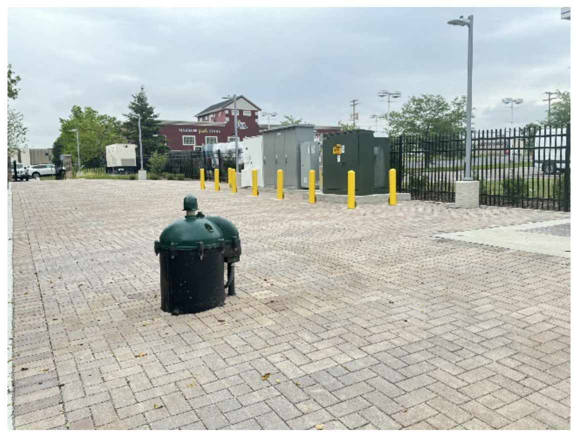
<u>It is important to note that these tables represent the typical capital replacement timeline for equipment of this nature. There are often intermediate rehabilitations necessary during these service lives, such as pump rebuilds, motor replacement, etc., which will still need to be scheduled to prolong the service life to the intervals indicated. For example, a well pump may have a 40 year service life indicated prior to full replacement being necessary, but this is predicated on the City performing routine maintenance including pulling pump and replacing necessary components.</u>

Equipment	Manufacturer	Condition	Installation or Rebuild Year	Service Life	Replacement Year
Well 3/4					
Actuators - Old	Rotork	Good Condition	2009	20	2029
125 HP Motor 1	Baldor	Good Condition	2009	25	2034
75 HP Motor 2	Baldor	Good Condition	2009	25	2034
75 HP Motor 3	Baldor	Good Condition	2009	25	2034
Airwash Blower	Kaeser	Fair Condition	2010	25	2035
Air Relief Valve for Finished Water	Valmatic	Good Condition	2009	15	2024
Air relief valve on softener - (3)	Valmatic	Good Condition	2009	15	2024
Air Relief Valves (on top of filter) - (4)	Valmatic	Good Condition	2023	15	2038
Auto Valves - (9)	Quarter Master	Good Condition	2009	20	2029
Bleach Tanks - 50 Gallon tanks	CHEM-Tainer	Fair Condition	2009	20	2029
Centrifugal Pump 1	Patterson	Good Condition	2009	25	2034
Centrifugal Pump 2	Patterson	Good Condition	2009	25	2034
Centrifugal Pump 3	Patterson	Good Condition	2009	25	2034
Chemical Feed Transfer Pump (2)	March	Fair Condition	2009	10	2019
Depth Sensors for Sodium and Manganese - (2)	Vega	Good Condition	2020	15	2035
Fluoride Scales (unused) - (2)	Force Flow	Good Condition	2009	10	2019
Fluoride Tanks (unused) - (2)	CHEM-Tainer	Good Condition	2009	10	2019
Chemical Tank Scales - (2)	Force Flow	Good Condition	2009	10	2019
Guardian Eyewashes - (2)	Guardian	Good Condition	2009		-
HACH Meter (2)	HACH	Good Condition	2009	20	2029
HMO Chemical Mixer (2)	Lightnin	Fair Condition	2009	10	2019
HMO Feed Pump	Bredel 15	Good Condition	2016	8	2024
HMO Pressure Filter Internal Components	Tonka	Good Condition	2022	20	2042
HMO Pressure Filter Media	Tonka	Good Condition	2022	10	2032
HMO Pressure Filter Vessel	Tonka	Good Condition	2009	40	2049
HMO Scales - (2)	Force Flow	Good Condition	2009	10	2019
HMO Solution Storage Tank (2)	Poly Pro	Fair Condition	2009	20	2029
HMO Supply - BBU	Watts	Fair Condition	2009	10	2019
Hypo Bulk Tank Depth Sensors - (2)	Vega	Good Condition		15	-
Hypo Quills - (3)	SAF-T-FLO	Good Condition			-
Hypo Transfer Pump	WEG	Fair Condition			-
Ion Exchange Unit (3) Internal Components	Tonka	Good Condition	2022	20	2042
Ion Exchange Unit (3) Resin Media	Tonka	Good Condition	2022	10	2032
Ion Exchange Vessel (3)	Tonka	Good Condition	2009	25	2034
Magnetic Flow Meter - 2"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 2"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 4"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 4"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 10"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 10"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 10"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 10"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 12"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 6"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 6"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 6"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 6"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 8"	Endress & Hauser	Good Condition	2009	20	2029
Magnetic Flow Meter - 8"	Endress & Hauser	Good Condition	2009	20	2029
Manganese Sulfate Storage Tank	Poly Pro	Good Condition	2009	20	2029
Motor Control Center VFD	Eaton	Good Condition	2009	30	2039
New Brine Pump	Abaque	Good Condition	2023	15	2038
New Brine Pump	Abaque	Good Condition	2023	15	2038
Prominent Chemical Pump - (5)	Prominent	Good Condition	2009	10	2019
SCADA PLC	Allen-Bradley	Good Condition	2020	15	2035
Sodium Hypochlorite Tank	Poly pro	Fair Condition	2009	20	2029
Sodium Permanganate Storage Tank	Poly Pro	Good Condition	2009	20	2029
VFD Booster Pump 1	Eaton	Good Condition	2009	10	2019
VFD Booster Pump 2	Eaton	Good Condition	2009	10	2019
VFD Booster Pump 3	Eaton	Good Condition	2009	10	2019
Well 3 Pump & Motor	Byron Jackson	Fair Condition	1984	40	2024
Well 4 Pump & Motor	Byron Jackson	Poor Condition	1970	40	2010

5.3.2. Well #7

Located on Randall Road just north of the intersection with Illinois Route 64, Well #7 provides water to the outer service area with a capacity of 2.52 MGD. Constructed in 1965, Well #7 is supplied by a shallow sand and gravel aquifer commonly known as the St. Charles Aquifer. The well depth is 175 feet with a pump setting at 110 feet below grade.

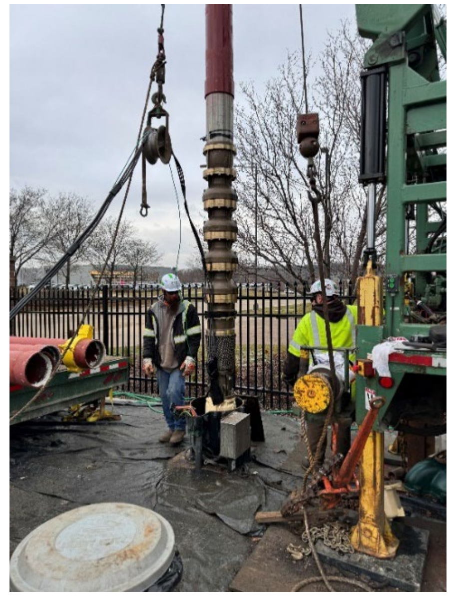
Well #7 historically has concentrations of metals such as iron and manganese at or above the Minimum Concentration Level set by the US EPA. This facility was originally designed to reduce these concentrations below the MCL through aeration and filtration. The well also displays very high hardness levels in its influent water of around 530 mg/L as calcium carbonate.



Over the last 60 years a variety of technologies have been implemented for hardness, iron and manganese removal. This included media gravel gravity filtration with aeration and backwash capabilities. The media and process implemented proved to not be as effective as originally designed, which resulted in the deterioration of the filter aeration system.

In 2001 Well #7 only produced 2.16 MGD and was indicating iron removal efficiency problems and shortened filter run times. In 2002 improvements were completed consisting of new piping, installation of a potassium permanganate chemical feed system to chemically oxidize the iron in the raw water and replacement of filter media with manganese greensand. The runtime between filter backwashes and finished water quality dramatically improved following these improvements. Resulting in the Well operating at capacity at 1900 GPM as it was designed to.

Following the 2002 improvements, the City commissioned Hungerford & Terry, Inc. to perform an evaluation of the manganese greensand media to identify the remaining service life and determine whether a media replacement was necessary. Four cores were sent to a testing facility and analyzed, and included the North Tank East and West Cells, as well as the South Tank East and West Cells. Hungerford & Terry concluded that the media was still in good condition but in regard to manganese removal, the media was no longer effective.



In the 15 years since the previous rehabilitation, Well #7 again experienced a decline in finished water quality. Due to the deteriorating condition of the filter equipment and media, Well #7 saw significantly increased iron levels in the finished water. For this reason, this well was utilized as little as possible and only put into service during periods of high demand.

In 2022-2023, the existing Well 7 treatment facility was decommissioned and demolished with the exception of the Well #7 pump. The Well pump was removed and replaced and placed on a variable frequency drive. The site was completely restored with a new fence and permeable paver lot. Back-up power and control was achieved with the installation of a diesel generator, transformer, CT cabinet, ATS, and switchgear. As part of the improvements, the existing water main was disconnected from distribution and re-connected to an existing raw water main to supply raw water from the Well #7 site to the Oak St. Facility for treatment. The new Well #7 pump is designed for a maximum flow rate of 1,750 GPM at 330 ft of total dynamic head. However, better water quality is observed (lower turbidity and TSS) if the well is run at 1,500 gpm, which is the current operating flow rate. At the Oak St. Facility the water is being treated via two horizontal Greensand Plus pressure filters with anthracite beds. The filters are designed for iron and manganese removal. At this site, there are a total of four filters, that are sized to treat all of the raw water from Well #7 and Well #13.

A full panel Raw Water analysis was completed onsite in February of 2024 by Water Systems Engineering, inc. The raw water testing results are outlined in the table below.

Parameters	Well 7	Units
PH Value	7.47	NA
Total Alkalinity	336	mg/l
Total Dissolved Solids	900	mg/l
Conductivity (µm)	1,250	NA
Total Hardness	552	mg/l
Carbonate Hardness	336	mg/l
Non-Carbonate Hardness	216	mg/l
Chlorides (as Cl)	154.0	mg/l
Nitrate (Nitrogen)	ND	mg/l
Iron Total (as Fe)	1.85	mg/l
Manganese (as Mn)	0.18	mg/l
Sulfate (as SO4)	76	mg/l
Silica (as SiO2)	29.4	mg/l
Total Organic Carbon ©	ND	mg/l
Nitrate-N	<0.03	mg/l
Ammonia-N	0.4	mg/l

From the two samples acquired and tested by Water Systems Engineering, Inc, a few parameters were noted that differed from the historical Well #7 Raw Water Characteristics. Total dissolved solids were elevated at 900 mg/l and it was noted that typically a TDS above 400 mg/l indicates an ionically congested environment. Total iron concentrations were elevated in the aquifer sample ranging from 3.11mg/l - 3.5 mg/l as compared to 2.7 mg/l historically. These elevated levels or iron can result in an environment prone to iron related fouling. The total manganese tested in the water ranged from 0.05 to 0.18 mg/l as compared to 0.05 mg/l historically. Typically, manganese levels in excess of 0.1 mg/l can also be an indication of iron related fouling.

The conditions assessment table shown below includes all of the major equipment at the Well #7 site. This equipment was replaced and installed as part of the Well 7 and 13 Interconnect project in 2023-2024. As part of these improvements and the service life ranging from 15 to 40 years it is anticipated that equipment will not require replacement until 2038 with some equipment remaining in operation through 2063.

Equipment	Manufacturer	Condition	Installation or Rebuild Year	Service Life	Replacement Year
		Well 7			
300 kW Generator	Caterpillar	New	2023	30	2053
Automatic Transfer Switch	ASCO	New	2023	30	2053
Power Distribution Center	Siemens	New	2024	30	2054
SCADA PLC	Allen-Bradley	New	2023	15	2038
Variable Frequency Drive	ABB	New	2023	15	2038
Well Pump & Motor	Byron Jackson	New	2023	40	2063

5.3.3. Well #8 – Ohio Avenue Water Treatment Facility

Well #8 is located at the intersection of Ohio Avenue and 37th Avenue. Well #8 and a booster station were constructed in the 1960's to serve the expanding eastern industrial park and surrounding business district in the Outer Service Area. The original facilities included a 1,200 GPM well, two 1,000,000-gallon steel ground storage reservoirs, and a booster station. Well #8 was originally installed to a depth of 1,368 feet with a pump setting of 811 feet below grade.

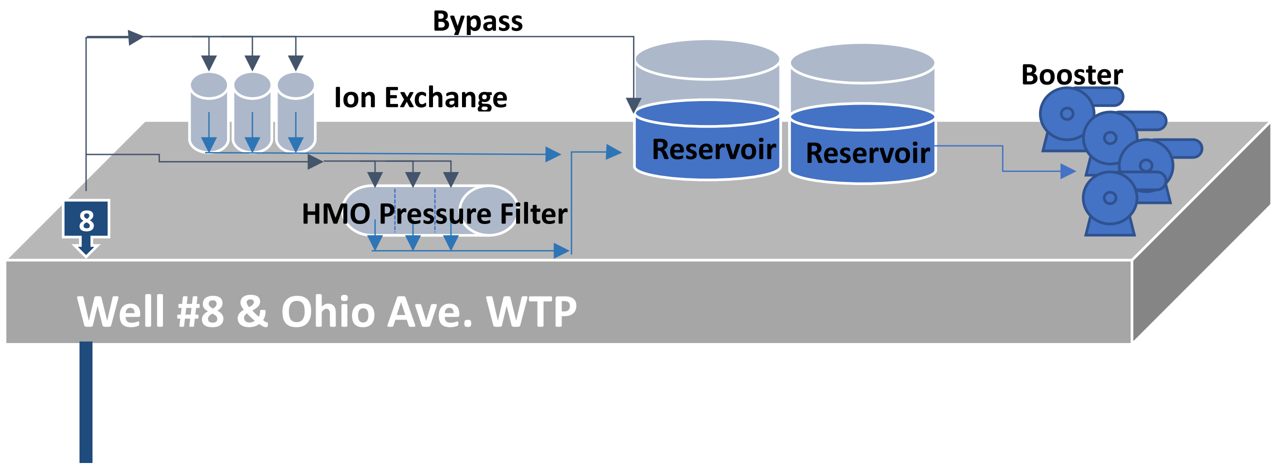
Similar to Wells #3 and 4, Well #8 draws from the Galesville Aquifer and therefore the raw water contains naturally occurring Radium. The combined radium 226 and 228 level in the raw water is 11.99 pCi/L, well above the MCL of 5 pCi/L. As a result, in order to maintain compliance with Radium standards, raw water from Well #8 was blended with water from the distribution system in the ground storage reservoirs. Due to blending requirements, Well #8 was limited in production to approximately 10% of its 1.73 MGD capacity. The 2001 Water Supply Report recommended a radium removal facility be constructed on the Well #8 site. The construction of this facility has allowed for production from Well 8 to reach 1.38 MGD. A secondary benefit of the radium removal technology utilized at the Ohio Avenue treatment facility is softened water. Raw water from Well #8 contains a hardness level of 298 mg/L, but treatment through HMO filtration and ion exchange achieves a finished hardness concentration of between 140 mg/L and 180 mg/L.

The Ohio Avenue Water Treatment Facility is located adjacent to the existing booster station. At the treatment facility, raw water is split between three Ion Exchange Units and one, four-cell HMO Horizontal Pressure Filter which together can produce up to 2,000 gpm of finished water. These processes are used in parallel to remove radium and decrease water hardness. This facility is the first to ever employ this blending strategy, and as such has received recognition for its groundbreaking design and efficiency from the American Water Works Association (AWWA). The Ohio Avenue Water Treatment Facility has been used as a template for the Well 3/4 facility as well as other treatment plants around the nation.

During development of the filtration facility, it was calculated the City would need to treat 66-80% of water in order to meet the combined radium MCL. Treatment of 66-80% of water would result in water hardness lower than the targeted 140 mg/L. Therefore, the ion exchange process was combined with HMO Filtration to maintain ideal water conditions.

By combining the HMO Process with Ion Exchange, the City is now able to meet both the radium removal requirement and the hardness removal goal. As a result, the productivity of Well #8 has increased from 0.173 MGD to 1.3 MGD since the construction of the filtration facility.

Several upgrades to this facility have been identified to further improve its production of high quality water. The well head was converted to a pitless adaptor, improving ease of maintenance and reducing the risk of freezing. Variable Frequency Drives were also installed at this facility to reduce wear on motors.



Well #8 is the only facility in the City to operate on 2400V electricity. This is a result of the size of the well pump, and the depth of the pumping level. A traditional 460V motor would require a significantly larger cable to carry the requisite current, and the largest Byron-Jackson motor available for this voltage is 300 HP. The previous well pump motor was 400 HP, and the existing is currently 350 HP which resulted in a slight decrease in capacity. The current well pump in service is designed for 1200 gpm at 760 ft TDH, which does not exceed 300 HP on its curve. Therefore, conversion to 480V may be possible, but due to the age of the pump it would be recommended that the City replace the pump and motor in combination. The cost of this conversion and replacement is estimated at $1,250,000 for the new pump and motor including pulling and setting. An additional $250,000 is estimated for an appropriately sized drive with sine wave filter, breaker, metering switchboard, utility transformer and replaced service secondaries including installation. It is recommended that the City budget $1.5M for this conversion. The City is currently in the design phase of the “Wel #8 Expansion & Rehabilitation” project, discussed further in Section 6, which includes the conversion of this well pump and associated electrical components to 460V.

The ion exchange units and HMO pressure filters at Ohio Avenue are capable of treating more water than Well #8 is capable of producing. This additional treatment capacity could be used to treat the production capacity of another well. In the future, another Galesville aquifer well could be drilled and treated at the Ohio Avenue Facility. An additional well would increase the region that receives water from Ohio Avenue, as the water currently only meets the demands of the industrial park that it is located within. Increasing the area served by the Ohio Avenue Facility would increase residential access to softened water and could decrease water quality complaints in the surrounding neighborhoods. The additional well would not be able to be drilled at the existing Ohio Avenue location, as this close proximity to Well #8 would decrease the static water elevation below acceptable levels. Standard practice typically dictates wells in the same aquifer be located at least 1,500 ft away from each other.

Water produced at the Ohio Avenue facility has historically been distributed based upon local pressure. A transducer onsite detects when the region around the Ohio Avenue WTP demands additional water and pushes water through the booster pump. This operation is unique to the rest of the City, where water production is dictated by water tower levels.

A full panel Raw Water analysis was completed onsite in July of 2023 by Water Systems Engineering, inc. The raw water testing results are outlined in the table below.

Parameters	Well 8	Units
PH Value	7.53	NA
Total Alkalinity	288	mg/l
Total Dissolved Solids	421	mg/l
Conductivity (µm)	585	NA
Total Hardness	268	mg/l
Carbonate Hardness	268	mg/l
Non-Carbonate Hardness	ND	mg/l
Chlorides (as Cl)	23.5	mg/l
Nitrate (Nitrogen)	0.4	mg/l
Iron Total (as Fe)	0.05	mg/l
Manganese (as Mn)	ND	mg/l
Sulfate (as SO4)	41	mg/l
Silica (as SiO2)	8.6	mg/l
Total Organic Carbon ©	0.4	mg/l
Nitrate-N	0.4	mg/l
Ammonia-N	NA	mg/l

From the two samples acquired and tested by Water Systems Engineering, Inc, a few parameters were noted that should be mentioned. Resuspended iron tested at 4.3 mg/l in the casing which is elevated and is a sign of iron fouling. As part of this biological testing and ATP testing resulted in 45,000 cpm in the run sample which is well below the threshold of concern for biofouling.

The conditions assessment table shown on the following page includes all of the major equipment at the Well #8 site. According to this condition's assessment approximately 71% of the equipment is either beyond its useful life or will reach its useful like in the next 4 years. 29% of the equipment has a service life that will not require replacement until the year 2025 to 2046. Based on this assessment, it has been determined that a majority of the equipment will require replacement or has already surpassed its useful life and is in need of replacement currently.

Based on the need for an additional water supply, availability of excess water treatment capacity, and needed rehabilitation of the Well #8 facilities, the City has elected to proceed with the Well #8 Expansion & Rehabilitation project. Design of this project began in 2024 and will include the drilling of a new deep well at the corner of Ohio Avenue and Kautz Road with raw main back to the Well #8 site. Flow from both the new deep well and Well #8 will be treated through the HMO and Ion-Exchange processes at the Well #8 site. The project will also include the rehabilitation of the Well #8 booster station, including architectural and electrical rehabilitation. The Well #8 pump will be replaced with a 480v pump and motor, and new breaker, switchboard, and utility transformer. The project is expected to be awarded for construction in 2025 and completed in 2026. This project is estimated to provide an additional 1,000 gpm or 1.44 MGD of production capacity in the outer pressure zone.

Equipment	Manufacturer	Model	Condition	Installation or Rebuild Year	Service Life	Replacement Year
			Well 8			
100 HP Motor A	Toshiba Int'1	B1004VLF3USH	Good Condition	1985	25	2010
100 HP Motor B	Toshiba Int'1	B1004VLF3USH	Good Condition	1985	25	2010
150 HP Motor C	Toshiba Int'1	B1504VLF4USH	Good Condition	1985	25	2010
150 HP Motor D	Toshiba Int'1	B1504VLF4USH	Good Condition	1985	25	2010
Actuator Old - (32)	Limitorque	I722444	Good Condition	2006	20	2026
SCBA Air Tank Gauge/Regulator	AIR Systems	RG-5000-2Y Regulator	Good Condition	2019	15	2034
SCBA Air Hose	AIR Systems	3MM 1/4 "	Good Condition	2019	15	2034
Air Relief Valve on Softener - (3)			Needs replacement - End of Service Life	2006	15	2021
Air Relief Valves on Filter - (4)		20365210K	Good Condition	2023	15	2038
Air Tanks - (3) SCBA		DOT - 3AA2400A	Good Condition	2019		-
Airwash Blower	Kaeser	BB 88 C	Good Condition	2006	20	2026
Automatic Transfer Switch	ASCO	7000 Series	Good Condition	2006	20	2026
Automatic Valves - (7)	Watts		Good Condition	2006	20	2026
Batch/Chemical Measuring Tanks - (2)	Assmann	250 Gallons	Good Condition			-
Booster PLC SCADA	Allen-Bradley	Panel View Plus	Good Condition	2020	15	2035
Centrifugal Booster Pump A	Aurora	411N LFC 5x6x17	Good Condition	1985	25	2010
Centrifugal Booster Pump B	Aurora	411N LFC 5x6x17	Good Condition	1985	25	2010
Centrifugal Booster Pump C	Aurora	411N LFC 5x6x17	Good Condition	1985	25	2010
Centrifugal Booster Pump D	Aurora	411N LFC 5x6x17	Good Condition	1985	25	2010
Chlorine Heads - (4)	Superior		Good Condition	2015	15	2030
Chlorine Flow Controllers - (2)	Chemical Injection Tech	Chlorine Room	Good Condition	2015	15	2030
Chlorine Injectors - (2) (Pre and Post)			Good Condition	2015	15	2030
Cylinder Scales - (4)	Force Flow / Wizard		Fair Condition	2006	10	2016
Distribution Pump Valves - (25)			Good Condition	1985	30	2015
Eye wash station - (3)	1 Bradley and 2 Guardian		Good Condition			-
Franklin Electric Pump	Franklin	4103012415	Poor Condition			-
Gas Chlorinator - (2) (pre and post)	Superior	AutoValve	Good Condition	2015	15	2030
Gas Chlorinator - (2) Heads	Superior	AutoValve	Good Condition	2015	15	2030
Gas Detector	ATI		Good Condition	2006	10	2016
Generator - 900 kW	Kohler	900REOZDB	Good Condition	2006	30	2036
Hach Meter	HACH	21272003301	Good Condition	2006	20	2026
HMO auto valves - (5)	Quarter Master		Good Condition	2006	20	2026
HMO Day Tank	Chem-Tainer	600 Gallons	Good Condition	2006	20	2026
HMO Day Tank Mixer	Lightnin EV	EV5P33	Fair Condition	2006	12	2018
HMO Feed Pump - (2)	Watson Marlow	Peristaltic 6201OU	Good Condition	2020	15	2035
HMO Filter Flow Meter	Endress & Hauser	Promag 50W 1"	Good Condition	2006	20	2026
HMO Mixing Tank	Chem-Tainer	600 Gallons	Good Condition	2006	20	2026
HMO Mixing Tank Mixer	Lightnin EV	EV5P33	Fair Condition	2006	12	2018
HMO Pressure Filter Internal Components	USFilter		Good Condition	2006	20	2026
HMO Pressure Filter Media	USFilter		Good Condition	2006	10	2016
HMO Pressure Filter Vessel	USFilter	MF-21.00	Good Condition	2006	40	2046
HMO Transfer Pump	Fybroc	Series 1530	Fair Condition	2006	10	2016
HMO Depth Sensor - (2)	Vega	PULS 21	Good Condition			-
IEX Brine Pumps - (2)	March Pump	TE 7.5 KMO ZHP	1 Good Condition 1 Fair Condition	2018	10	2028
Ion Exchange Flow Meter - (4)	Endress & Hauser		Good Condition	2006	20	2026
Ion Exchange Unit (3) Resin Media	USFilter		Good Condition	2018	10	2028
Ion Exchange Unit (3) Internal Components	USFilter		Good Condition	2006	20	2026
Ion Exchange Unit (3) Vessel	USFilter	161913	Good Condition	2006	25	2031
Magnetic Flow Meter - 1"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 1"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 10" Well 8 Raw	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 16"	Unknown (In Electric Vault)		Good Condition	2006	20	2026
Magnetic Flow Meter - 2"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 2"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 2"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 2"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 3" Brine	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 4"	Foxboro	1/A Series	Good Condition	2006	20	2026
Magnetic Flow Meter - 6"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 6"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 6"	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 8" HMO	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026
Magnetic Flow Meter - 8" IEX	Endress & Hauser	Promag 50W	Good Condition	2006	20	2026

Equipment	Manufacturer	Model	Condition	Installation or Rebuild Year	Service Life	Replacement Year
Well 8 (Cont.)						
Manganese Sulfate Tank	Assmann		Good Condition	2015	20	2035
Manganese Sulfate Transfer Pump	March Pump	TE-5C-MD-TE	Good Condition	2015	10	2025
Manganese Depth Sensor	Vega	PULS 21	Good Condition	2015	15	2030
PLC SCADA - (2)			Good Condition	2006	20	2026
Pressure Sensor (by centrifugal pumps) - (4)			Good Condition	2006	15	2021
SKA Pak Plus - (2) Kits	Rev K Scott Safety	SAR222010211011	Good Condition			-
Sodium Depth Sensor	Vega	PULS 21	Good Condition	2015	15	2030
Sodium Permanganate Tank	Assmann		Good Condition	2015	20	2035
Sodium Permanganate Transfer Pump	March Pump	TE-5C-MD-TE	Good Condition	2015	10	2025
Transducer for Brine Level - (2)			Good Condition	2015	15	2030
VFD 1	Eaton	PowerXL Enclosed PG1 Drive	Good Condition	2016	15	2031
VFD 2	Eaton	PowerXL Enclosed PG1 Drive	Good Condition	2016	15	2031
VFD 3	Eaton	PowerXL SVX9000	Good Condition	2016	15	2031
VFD 4	Eaton	Power XL SVX9000	Good Condition	2016	15	2031
Water Reservoir Transducer - (2)			Good Condition	2023	15	2038
Well #8 2400V MB & Starter Panel	Ideal Electric		Poor Condition	1979	30	2009
Well 8 Pump & Motor	Byron Jackson		Fair Condition	1979	40	2019

5.3.4. Well #9

Well #9 is located on north Illinois Route 25, near the intersection with Sunset Drive. This well draws from the shallow sand and gravel St. Charles Aquifer. Well #9 was originally constructed with capacity to deliver in excess of 1,900 GPM or 2.74 MGD. Current output from the well is set to 1,500 GPM in order to balance water production throughout the City's distribution system.

Well #9 is the City's most economical water source, because it pumps directly from the aquifer to the distribution system without reservoirs, booster stations, or treatment. The only requirements for water quality adjustment include fluoridation and chlorination prior to entering the distribution system, although Well #9 has very high hardness of 464 mg/L. As a result, the City's water system relies heavily on Well #9 as its primary source for meeting the community's demands. The performance of this well has been optimized through the implementation of a VFD, which has improved pump startup and overall efficiency greatly.

In 2018, an inspection of the Well's electrical service and grounding revealed many inadequacies that were recommended to be addressed. Notably, the system disconnect from the grid was located at the MCC inside of the building. A generator installed outside of the building was connected to the ATS, which switched power from the transformer and the generator to the structure. In order to meet NEC regulations, the transformer was recommended to be replaced with a current transformer/main that could operate as the first point of disconnect for the system. This new CT/main also must be grounded to meet regulations. The existing 277/480 three-phase service is not grounded at the service first point of disconnect, due to the installation of the ATS. The generator was also in need of replacement. It was recommended that the generator be grounded independently of the CT, with its own ground triad and neutral bonded to ground. Improper or insufficient grounding can lead to stray and circulating currents that can damage equipment and cause electrolysis within the structure. The recommended improvements were completed in 2020 as part of the Well #9 Electrical Upgrades Project.

Well #9 has undergone several improvements since its initial construction. This has included an upgrade of the original 150 horsepower pump motor to a 200-horsepower motor, as well as the installation of a reduced voltage starter, both in 2002. More recently, in 2007, the pump depth was increased 10 feet in response to decreased static water elevations. A full panel Raw Water analysis was completed onsite in July of 2023 by Water Systems Engineering, inc. The raw water testing results are outlined in the table on the following page.

Parameters	Well 9	Units
PH Value	7.40	NA
Total Alkalinity	348	mg/l
Total Dissolved Solids	865	mg/l
Conductivity (µm)	1,201	NA
Total Hardness	464	mg/l
Carbonate Hardness	348	mg/l
Non-Carbonate Hardness	116	mg/l
Chlorides (as Cl)	152	mg/l
Nitrate (Nitrogen)	0.50	mg/l
Iron Total (as Fe)	0.04	mg/l
Manganese (as Mn)	ND	mg/l
Sulfate (as SO4)	54	mg/l
Silica (as SiO2)	15.5	mg/l
Total Organic Carbon ©	1.6	mg/l
Ammonia-N	NA	mg/l

From the two samples acquired and tested by Water Systems Engineering, Inc, a few parameters were noted that should be mentioned. Total Hardness at 464mg/l was elevated along with the total dissolved solids at 865 mg/l. As part of this biological testing, ATP testing resulted in 97,000 cpm in the run sample which is near the threshold of concern for biofouling but does not exceed that point and therefore it is unlikely this has negatively impacted the well.

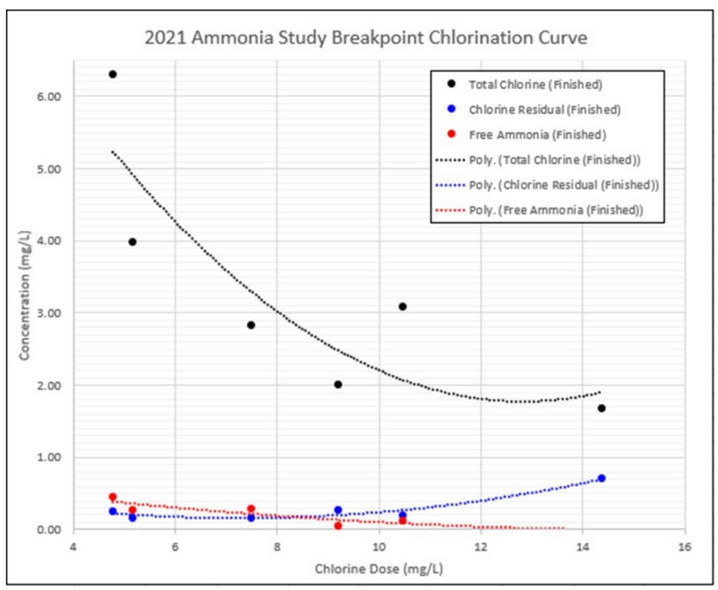
Equipment	Manufacturer	Condition	Installation or Rebuild Year	Service Life	Replacement Year
		Well 9			
300 kW Generator	Caterpillar	Good Condition	2021	30	2051
Air Tank Gauge/regulator	AIR Systems	Good Condition			-
Air Hose	AIR Systems	Good Condition			-
Air Tanks - (2)	AIR Systems	Good Condition			-
Air Relief Valve	Valmatic	Good Condition			-
Chlorine Heads - (2)	Superior	Good Condition			-
Automatic Transfer Switch	ASCO	Good Condition	2021	30	2051
Carrier Water/booster pump	Gould's	Good Condition			-
Cylinder Scales - (2)	Force Flow / Wizard	Good Condition	2015	10	2025
Distribution Valves - (3)	American	Good Condition			-
Fluoride Base Plate	Force Flow / Wizard	Good Condition			-
Fluoride Bulk Tank	Assmann	Good Condition	2015	20	2035
Fluoride Day Tank	CHEM-Tainer	Good Condition	2015	20	2035
Fluoride Feed Pump	LMI	Fair Condition	2009	10	2019
Fluoride Transfer Pump	March Pump	Good Condition	2015	10	2025
Gas Chlorinator	Superior	Good Condition	2015	15	2030
Gas Detector	ATI	Good Condition	2015	10	2025
Hach Meter	HACH			20	-
Magnetic Flow Meter - 10" Well 9 Raw	Badger	Fair Condition	2009	20	2029
Motor Control Center	Square D/Eaton	Needs Replacement - End of Service Life	1981	30	2011
SKA PAK Plus Kits - (3)	Scotts	Good Condition			-
Tank Depth Sensor	Vega	Good Condition		15	-
Well 9 Pump & Motor	US Electric	Fair Condition	1981	40	2021

5.3.5. Well #11

Well #11 is located on north Route 25 near the intersection with Fox Glen Drive. The infrastructure at this site includes a shallow well, 236,500-gallon reservoir, three booster pumps, chlorination, and fluoridation systems within a 2,500 square foot facility. This well was originally designed for a production capacity of 1,900 GPM, or 2.74 MGD.

Since its original construction, Well #11 has not had any major improvements. A future concern that should be addressed is the status of the booster pumps at Well #11. Although the facility houses three boosters, only one booster pump (Booster A) is currently operational. This is because the boosters are capable of outrunning the well, which would lead to the reservoir being drained. Increasing the current production capacity of the well, or installing variable frequency drives, would address this concern and allow the City to use the facility more efficiently.

The well is presently operated at 500-1,000 GPM, as this is the maximum amount that can be effectively chlorinated. Water from the well appears to be unable to maintain a residual, likely due to ammonia converting chlorine ions to chloramines, creating a large chlorine demand. In order to quantify the presence of ammonia in the raw water, the City performed interval sampling to establish a baseline raw ammonia concentration.



Studies were performed in 2021 and 2022 to investigate the ammonia levels and their impact on the chlorine residual. During those studies, 100 samples of raw and finished water were taken over 11 days. In 2021, six days of sampling were completed between July 21, 2021, and August 4, 2021. The chlorine dosage to the raw water was increased each of the six days and the Residual (Free) Chlorine, Finished Water Total Ammonia, Total Chlorine and Monochloramine concentrations were monitored. This data showed that with the well flow rate reduced to 500 gpm (26% capacity) and a very high chlorine dosage of 14.4 mg/L, the residual (free) chlorine reached a level of 0.71 mg/L, with a total chlorine level of 1.68 mg/L and ammonia at 0.07 mg/L. This study suggested that the breakpoint chlorine level is at a dosage level of approximately 12-14 mg/L.

Five additional days of sampling were completed between June 23, 2022, and July 21, 2022. This data showed that with the well flow rate reduced to 790 gpm (41% capacity) residual free chlorine reached 1.02 mg/L, with a total chlorine level of 1.38 mg/L and ammonia at 0.10 mg/L. Section 6 further discusses the results of this breakpoint testing and alternatives to recapture the Well #11 full capacity.

The ammonia present in Well #11 raw water averaged 0.70 mg/L, which is the highest of any of the production wells. Iron and manganese, other potential consumers of free chlorine, were also present in concentrations exceeding the SWDA SMCLs. Samples of the raw and finished water indicated that the change in iron and manganese concentrations before and after chlorine disinfection was minimal. However, nearly all free ammonia was consumed through disinfection, confirming ammonia as the primary component limiting the chlorine residual. In 2022, TAI began investigating alternative treatment solutions to regain the maximum capacity of this well. These improvements are further discussed in Section 6 treatment alternatives.

Water quality analysis commissioned by the City of St. Charles was executed in 2018 by PDC Laboratories. This study found that the concentration of manganese in water from Well #11 exceeded the MCL set by the US EPA in its Secondary Drinking Water Standards. As such, further testing should be executed at this facility to determine the extent of this problem and if treatment is required. Further testing is encouraged as the water from Well #9, which is located under a half mile away and draws from the same aquifer, provides water with a manganese concentration of 0.016 mg/L, far below the MCL. Other than this concern, raw water from Well #11 does not exceed any MCLs for primary or secondary standards. As such, no additional treatment beyond chlorination and fluoridation is required. A full panel Raw Water analysis was completed onsite in June of 2023 by Water Systems Engineering, inc. The raw water testing results are outlined in the table below.

Parameters	Well 11	Units
PH Value	7.42	NA
Total Alkalinity	380	mg/l
Total Dissolved Solids	780	mg/l
Conductivity (µm)	1,083	NA
Total Hardness	504	mg/l
Carbonate Hardness	380	mg/l
Non-Carbonate Hardness	124	mg/l
Chlorides (as Cl)	104	mg/l
Nitrate (Nitrogen)	0.8	mg/l
Iron Total (as Fe)	0.02	mg/l
Manganese (as Mn)	ND	mg/l
Sulfate (as SO4)	36	mg/l
Silica (as SiO2)	18.6	mg/l
Total Organic Carbon ©	1.5	mg/l
Ammonia-N	NA	mg/l

From the two samples acquired and tested by Water Systems Engineering, Inc, a few parameters were noted that should be mentioned. Total Hardness at 504mg/l was elevated along with the total dissolved solids at 780 mg/l. As part of this biological testing, ATP testing resulted in 97,000 cpm in the run sample which is near the threshold of concern for biofouling but does not exceed that point and therefore it is unlikely this has negatively impacted the well.

The conditions assessment table shown below includes all of the major equipment at the Well #11 site.

Equipment	Manufacturer	Condition	Installation or Rebuild Year	Service Life	Replacement Year
Well 11					
50 HP Motor 1		Not in use	1990	25	2015
50 HP Motor 1		Not in use	1990	25	2015
75 HP Motor 1	GE Motor	Good Condition	1990	25	2015
Air relief valve	Valmatic	Good Condition		15	-
Air Tank Gauge/Regulator	AIR Systems	Good Condition			-
Air Tanks - (3)		Good Condition			-
Automatic Transfer Switch	ASCO	Fair Condition	1990	30	2020
Centrifugal Pump 1	Aurora	Fair Condition	1990	25	2015
Centrifugal Pump 2	Aurora	Not in use	1990	25	2015
Centrifugal Pump 3	Aurora	Not in use	1990	25	2015
Chlorine Alarm Systems - (2)	ATI	Good Condition		15	-
Chlorine Heads - (2)	Superior	Good Condition		15	-
Chlorine Injection Point	Superior	Good Condition		15	-
Chlorine Legs (2)	Superior			15	-
Cylinder Scales - (4)	Force Flow / Wizard	Good Condition	2015	10	2025
Depth Sensor	Vega	Good Condition		15	-
Distribution Pump Valve - (9)	American	Good Condition	1990	20	2010
Eyewash Station	Guardian	Good Condition			-
Fluoride Bulk Tank	Assmann	Good Condition	2015	20	2035
Fluoride Day Tank	CHEM-Tainer	Good Condition	2015	20	2035
Fluoride Feed Pump	LMI	Fair/Poor Condition	2009	10	2019
Fluoride Transfer Pump	March Pump	Good Condition	2015	10	2025
Gas Chlorinator	Superior	Good Condition	2015	15	2030
Generator	Caterpillar	Fair Condition	1990	30	2020
Hach Meter	HACH	Good Condition		20	-
Magnetic Flow Meter - 10" Finished	Badger	Fair Condition	2009	20	2029
Magnetic Flow Meter - 10" Raw	Badger	Fair Condition	2009	20	2029
Motor Control Center	Square D	Needs Replacement - End of Service Life	1990	30	2020
Chlorine Pig Tails - (4)		Good Condition		15	-
Pressure Sensor - (3)		Good Condition		15	-
Reservoir Sensors - (2)		Good Condition		15	-
Scale for Fluoride bulk tank	Force Flow / Wizard	Good Condition		10	-
SKA Pack Plus - (3)	Scotts	Good Condition			-
Well 11 Pump & Motor	US Motors Byron Jackson	Fair Condition	1990	40	2030

Based on the conditions assessment for the Well #11 site approximately 80% of the equipment will have reached the end of its useful life by the near 2029 with most equipment reaching that point by the year 2025. Some pieces of equipment to note that have reached the end of their useful life are the generator, fluoride feed pump, motor control center, automatic transfer switch, centrifugal pumps and motors. In the next 5 to 10 years the Well #11 pump and motor along with the fluoride bulk tank, day tank and gas chlorinator will require replacement. Based on this assessment, it has been determined that a majority of the equipment will require replacement or has already surpassed its useful life and is in need of replacement currently.

5.3.6. Well #13

Well #13 is located on the west side of the community on Oak Street just south of Illinois Route 64. The well site was identified in the 1980's as a potential water supply site for the City and was annexed in the early 1990's as part of the West Gateway annexation. Based on test drilling and analysis performed on the well site, it was anticipated that the water quality at Well #13 would be very similar to the water quality at Well #7 and would therefore require iron removal. The City elected to construct a new well and iron removal facility on the site to provide additional capacity to the Outer Zone.

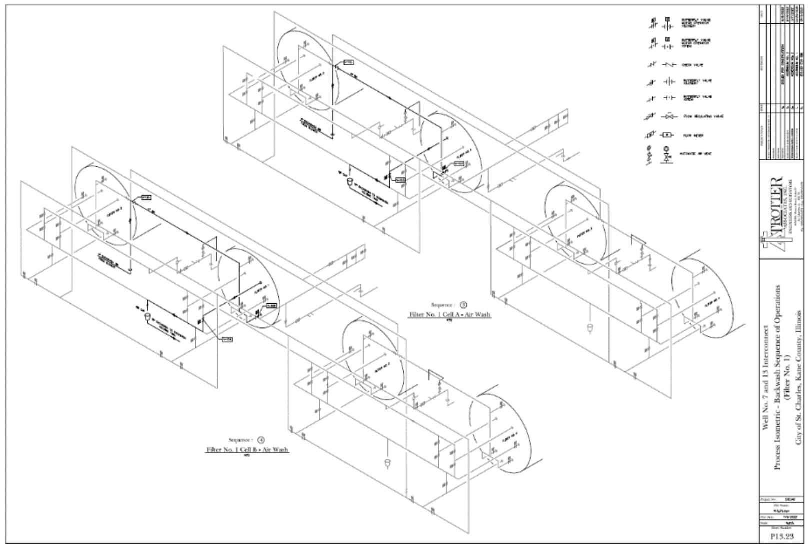
In 2003 the Oak Street Water Filtration Facility was completed providing the City the ability to produce 2.16 MGD of treated water for domestic, commercial and fire suppression use. Well #13 draws water from the St. Charles Aquifer with a well depth of 156 feet and a pump setting at 120 feet below grade. The well pumps raw water to the filtration facility where it is combined with chlorine and potassium permanganate solutions to oxidize the iron in the raw water. Flow is then split between two, two-cell horizontal pressurize filters, which completes the removal of iron by filtering out the oxidized iron through greensand filter media. Once the water has been filtered, fluoride and chlorine are injected.

As shown in the water quality table on the following page, water drawn from Well 13 has high concentrations of hardness and metals such as iron and manganese. The Oak Street Filtration Facility is designed to reduce these concentrations below the Maximum Concentration Levels set by the EPA. Treatment at the Oak Street Facility begins with the addition of chlorine and sodium permanganate to the raw water to oxidize iron and manganese ions. Flow is then split between two, two-celled horizontal pressure filters. These filters remove oxidized metals through filtration using greensand, a manganese oxide media. The Oak Street Facility is capable in removing in excess of 90% of Well 13's raw water iron concentration.

Since the construction of the Oak Street Water Filtration Facility, Trotter and Associates has coordinated with the City of St. Charles to update the facility with the installation of a Variable Frequency Drive and a conversion of the disinfection process from gaseous chlorine to sodium hypochlorite at Well 13.

In 2022-2023 as part of the Well 7 and 13 Interconnect project, an additional pair of Hungerford and Terry pressure filters were installed and commissioned in order to treat the raw water supplied by Well #7. The addition of two new pressure filters at this facility also included the interconnecting of the process piping within the Oak St. Facility to allow for any of the four filters to be paired with either Well #7, Well #13, or both wells. With this new addition, the existing chemical pumps were replaced with Prominent solenoid diaphragm pumps and additional pumps were added to accommodate the two additional pressure filters.

The Oak Street facility has the increased capability to dose sodium permanganate, fluoride, and sodium hypochlorite. There is a dedicated pump for each well raw water line for pre-chlorination and sodium permanganate, with common post-chlorination and fluoride injection into the finished water header. As part of this project, color monitoring was implemented to monitor the color of the finished water out of the building to further assist with the quality of the water being produced. A chlorine analyzer was also installed which analyzes the finished water to determine the amount of additional chlorine necessary to meet EPA requirements.



Along with the installation of the two pressure filters to accommodate and treat the raw water flow from Well #7, the existing two pressure filters dedicated to Well #13 were rehabilitated. As part of this rehabilitation, the existing media was removed, the existing concrete fillet within the tank was partially removed in order to replace the air wash manifold. After the installation of the new air wash manifold was completed, the new concrete was placed along with all internal piping, gravel and media. All of the existing Rotork electrically operated valves were replaced on these filters with new valves as they were at the end of their service life. The backwash supply piping was reconfigured utilizing three modulating Rotork Valves to utilize flow from distribution during the backwash sequencing. The backwash valves operate based on a target opening position before the PID loop begins to maintain a target flow rate.

Another addition to the Well 7 and 13 interconnect project is the construction and installation of a dual pump backwash forcemain lift station. Two additional pumps located inside of the backwash holding tank at the Oak St. Facility is designed to pump 200 GPM at 60 ft TDH (each). These Xylem pumps are controlled via an ultrasonic level sensor that monitors the level in the holding tank and activating one or both pumps depending on level. A backup float system was implemented and set at the high water level to issue an alarm if the level achieves the high level set point. This forcemain replaces the existing gravity sewer to the City's Zylstra lift station with a 6" forcemain to the Harvest Hills sanitary distribution system.

A full panel Raw Water analysis was completed onsite in June of 2023 by Water Systems Engineering, inc. The raw water testing results are outlined in the table below.

Parameters	Well 13	Units
PH Value	7.48	NA
Total Alkalinity	292	mg/l
Total Dissolved Solids	791	mg/l
Conductivity (µm)	1,098	NA
Total Hardness	384	mg/l
Carbonate Hardness	292	mg/l
Non-Carbonate Hardness	92	mg/l
Chlorides (as Cl)	150	mg/l
Nitrate (Nitrogen)	ND	mg/l
Iron Total (as Fe)	1.26	mg/l
Manganese (as Mn)	ND	mg/l
Sulfate (as SO_4)	49	mg/l
Silica (as SiO_2)	13.9	mg/l
Total Organic Carbon ©	1.5	mg/l
Nitrate-N	NA	mg/l
Ammonia-N	NA	mg/l

From the samples acquired and tested by Water Systems Engineering, Inc, all of the parameters closely resembled the historical Well #13 Raw Water Characteristics. Total dissolved solids were elevated at 791 mg/l and it was noted that typically a TDS above 400 mg/l indicates an ionically congested environment. Total iron concentrations at around 1.3-1.4 mg/l closely match what has been tested historically at 1.4 mg/l. The total Manganese tested in the water was below the detectable limit of 0.1mg/l but has historically been 0.05-0.08 mg/l. Water Systems Engineering noted that the higher-than-expected levels of resuspended iron can typically correlate to the presence of iron reducing bacteria.

The conditions assessment table shown on the following page includes all of the major equipment at the Well #13 site. Based on this assessment, approximately 83% of the major equipment has been replaced in last few years and will not require rehabilitation or replacement until 2032 through 2063. The sodium hypochlorite, fluoride and sodium permanganate transfer pumps are in need of replacement as they have reached the end of their service life as of 2013. The fluoride bulk and day tanks along with the sodium permanganate bulk tank have reached the end of their useful life and it is recommended that these pieces of equipment also be replaced.

Equipment	Manufacturer	Condition	Installation or Rebuild Year	Service Life	Replacement Year
Well 13					
Airwash Blower	Roots	New	2023	20	2043
Automatic Transfer Switch	ASCO	Good Condition	2021	30	2051
Blower VFD	ABB	New	2023	30	2053
Fluoride Bulk Tank	Assmann	Good Condition	2003	20	2023
Fluoride Day Tank	Assmann	Good Condition	2003	20	2023
Fluoride Feed Pump	ProMinent	New	2023	10	2033
Fluoride Transfer Pump	March Pump	Good Condition	2003	10	2013
Generator	Generac	Good Condition	2002	30	2032
Hypochlorite Bulk Tank #1	Assmann	Good Condition	2016	20	2036
Hypochlorite Bulk Tank #2	Assmann	Good Condition	2016	20	2036
Hypochlorite Bulk Tank #3	Assmann	New	2023	20	2043
Hypochlorite Transfer Pump	March Pump	Good Condition	2016	10	2026
Magnetic Flow Meter - 10" Backwash Supply	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 10" Filter 1-4 Raw Split	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 10" Filter 2 Raw	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 10" Filter 4 Raw	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 10" Well 13 Raw	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 10" Well 7 Raw	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 16" Finished	McCrometer	New	2023	20	2043
Magnetic Flow Meter - 6" Backwash Waste	Krohne	New	2023	20	2043
Motor Control Center	Allen-Bradley	Good Condition	2002	30	2032
Sodium Permanganate Bulk Tank	Assmann	Good Condition	2003	20	2023
Sodium Permanganate Day Tank	Assmann	Good Condition	2003	20	2023
Sodium Permanganate Transfer Pump	March Pump	Good Condition	2003	10	2013
Pressure Filters 1/2 Internal Components	Hungerford & Terry	New	2023	20	2043
Pressure Filters 1/2 Media	Hungerford & Terry	New	2023	10	2033
Pressure Filters 1/2 Vessels	Hungerford & Terry	Good Condition	2006	40	2046
Pressure Filters 3/4 Internal Components	Hungerford & Terry	New	2023	20	2043
Pressure Filters 3/4 Media	Hungerford & Terry	New	2023	10	2033
Pressure Filters 3/4 Vessels	Hungerford & Terry	New	2023	40	2063
Waste Backwash Pumps - (2)	Xylem/Flygt	New	2023	15	2038
Well 13 Permanganate Day Tank	Assmann	New	2003	20	2023
Well 13 Permanganate Feed Pump	ProMinent	New	2023	10	2033
Well 13 Pre-Chlorination Hypo Day Tank	Assmann	New	2003	20	2023
Well 13 Pre-Chlorination Hypo Feed Pump	ProMinent	New	2023	10	2033
Well 13 Pump & Motor	Byron Jackson	Good Condition	2002	40	2042
Well 13 VFD	ABB	Good Condition	2002	30	2032
Well 7 Permanganate Day Tank	Assmann	Good Condition	2023	20	2043
Well 7 Permanganate Feed Pump	ProMinent	New	2023	10	2033
Well 7 Pre-Chlorination Hypo Day Tank	Assmann	New	2023	20	2043
Well 7 Pre-Chlorination Hypo Feed Pump	ProMinent	New	2023	10	2033
Well 7/13 Post-Chlorination Hypo Day Tank	Assmann	Good Condition	2016	20	2036
Well 7/13 Post-Chlorination Hypo Feed Pump	ProMinent	New	2023	10	2033

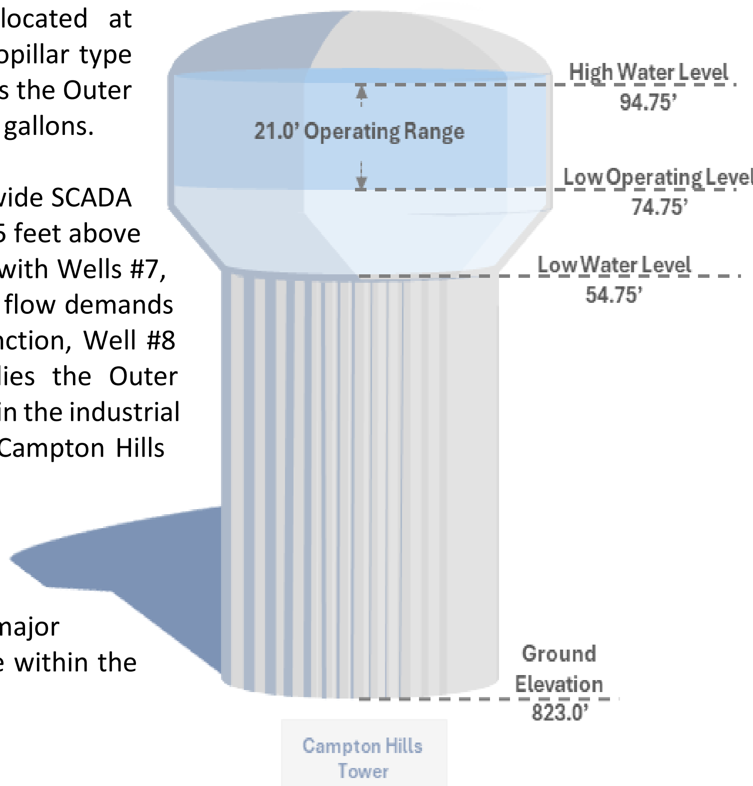
5.4. ELEVATED STORAGE

The City owns and maintains three elevated storage tanks (water towers) and a number of ground storage reservoirs throughout the service area. Through analysis of the City's existing water storage and expected growth, Trotter and Associates (TAI) does not recommend constructing any additional water storage during the 10-year planning horizon of the 2023 Water Master Plan.

TAI estimates that the City will have an average daily water demand of 5.64 million gallons and a maximum daily water demand of 12.0 million gallons in 2043. This maximum daily demand is used to calculate the recommended water storage, which was determined to be approximately 5.25 million gallons (MG). The City currently has an elevated and ground storage capacity of 5.70 MG. Therefore, the current storage capacity is likely adequate through the planning horizon of this Study.

5.4.1. Campton Hills Tower

The Campton Hills Water Tower is located at 36W565 Campton Hills Road. This hydropillar type tower was constructed in 1986 and serves the Outer Service Area with a capacity of 1,000,000 gallons.



The hydropillar is monitored via the citywide SCADA system and has an overflow level of 94.75 feet above grade. The Tower is used in conjunction with Wells #7, 9, 11, and 13 to meet the usage and fire flow demands within the Outer Service Area. In conjunction, Well #8 and its associated infrastructure supplies the Outer Service Area based on local pressure within the industrial park instead of water elevations in the Campton Hills Tower.

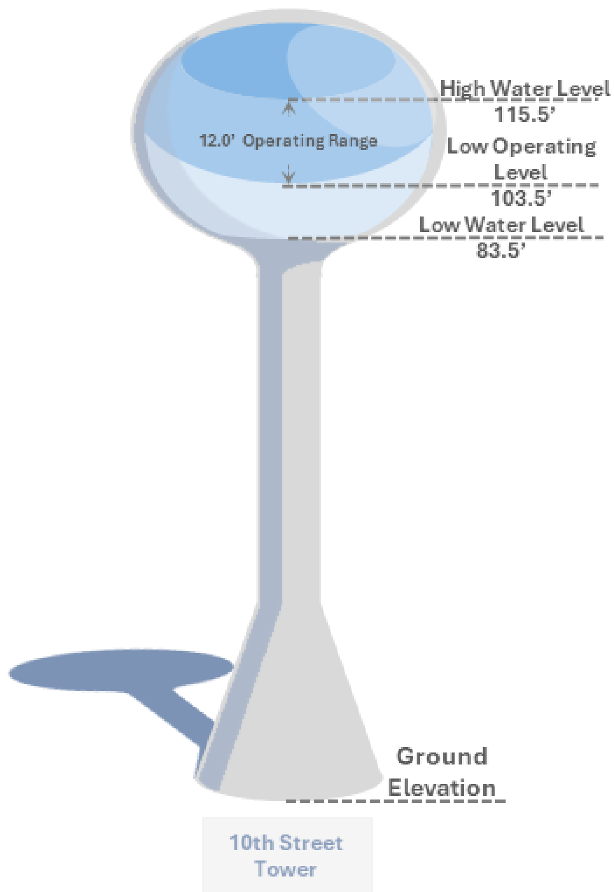
The Campton Hills Water Tower was recoated in the fall of 2018, and It is not anticipated that any further major rehabilitation will be required at this site within the planning horizon of this report.

5.4.2. 10th Street Tower

The 10th Street Water Tower was constructed in 1956, is located at 103 South 10th Street just North of Haines Middle School. This water spheroid tower has a capacity of 300,000 gallons, and serves the Inner Service Area.

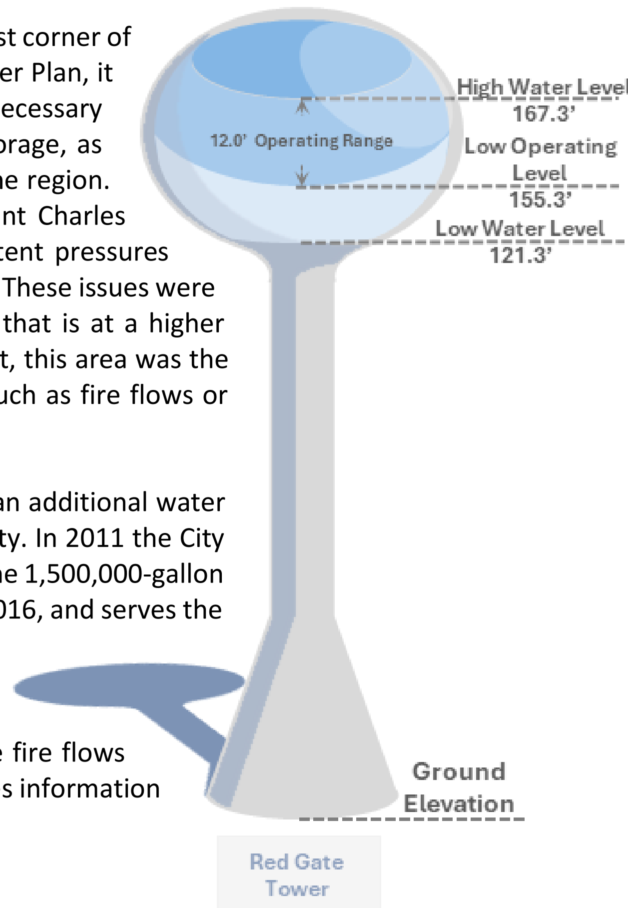
Working in conjunction with the booster station 3/4, the 10th Street Water Tower helps provide consistent pressures and provide adequate fire flows for the inner system. The Tower is monitored via the citywide SCADA system and has an overflow level of 115.5 feet above grade. The City of St. Charles has elected to use the top twelve feet of this tower for bounce prior to calling for water from booster station 3/4.

The 10th Street tower was re-coated and structurally repaired in the fall of 2020, and as such is not anticipated to require significant rehabilitation work during the planning horizon of this report.



5.4.3. Red Gate Tower

The Red Gate Water tower is located on the southwest corner of Red Gate Road, and Route 25. During the 2007 Master Plan, it was identified that an additional water tower was necessary to address the need for addition elevated water storage, as well as to provide increased fire flow capacities to the region. The Reserves of Saint Charles, located north of Saint Charles North High School, exhibited lower and less consistent pressures and fire flows than areas further south in the system. These issues were attributed to the fact that The Reserves is an area that is at a higher elevation than the majority of the system. As a result, this area was the first to be affected during any abnormal situation such as fire flows or supply infrastructure being removed for servicing.



The 2007 report recommended the construction of an additional water tower and outlined potential sites throughout the City. In 2011 the City selected the Red Gate Road and Route 25 location. The 1,500,000-gallon spheroid was constructed and placed online in late 2016, and serves the northern portion of the system. As part of the project, a new 16-inch water main installed, crossing the Fox River and made direct improvements to The Reserves in terms of available fire flows and pressures. The spheroid tower relays and receives information through the citywide SCADA system.

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SECTION 6

ANALYSIS OF WATER SUPPLY, TREATMENT, AND STORAGE ALTERNATIVES

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6. Analysis of Water Storage, Supply and Treatment Alternatives

Section 5 of this study reviewed the current condition and capacity of the City's water supply sources, treatment facilities, and storage infrastructure. Alternatives for additional water supply and associated treatment to meet future capacity needs will be reviewed in this section, and a proposed implementation plan for any recommended improvements in Section 7.

6.1. Water Supply Analysis

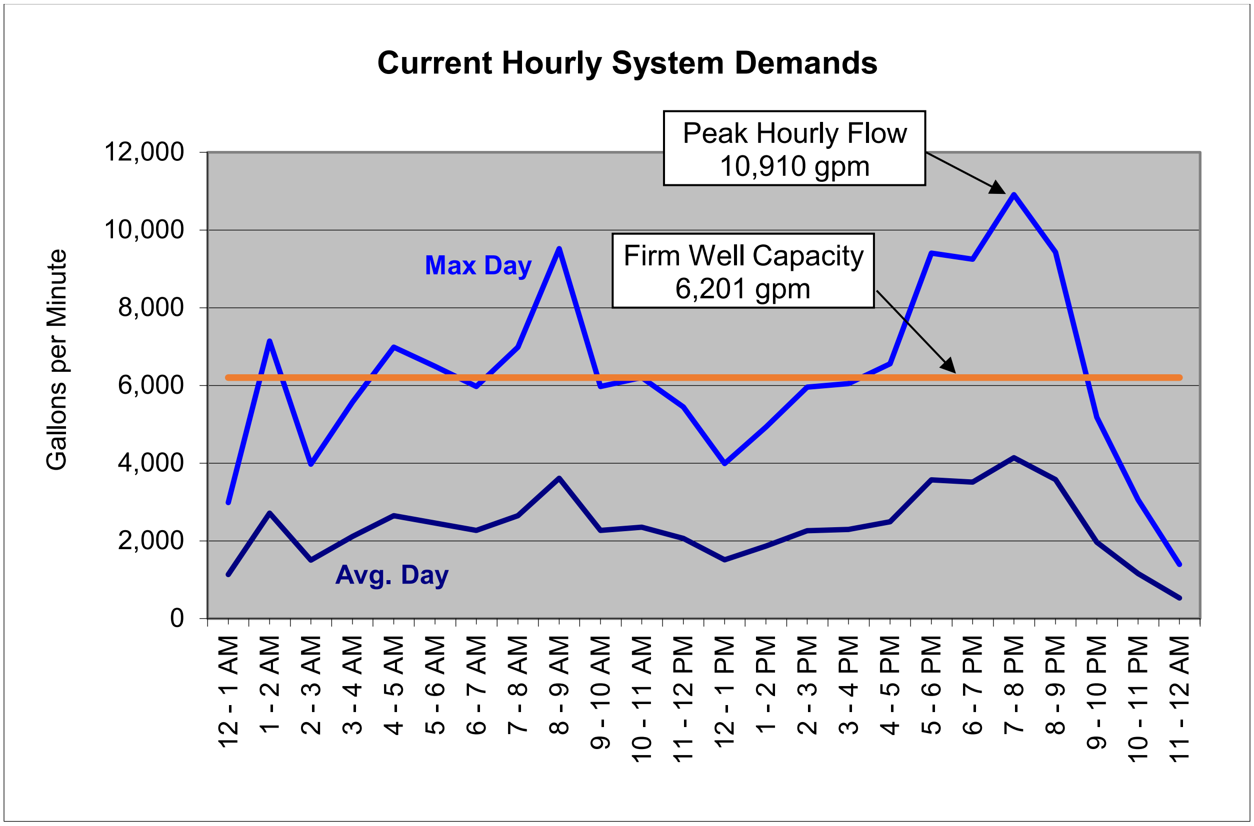
As detailed in Section 2 "Community Needs", the City is experiencing significant current, planned, and programmed growth. This growth has exceeded the Chicago Metropolitan Agency for Planning's (CMAP) projections, and will require optimizing the existing production wells, and planning for additional sources as well. The table below, previously discussed in Section 5, illustrates the current capacity of the wells. This Plan evaluated the existing water supply source's ability to meet both the current peak hourly demands, as well as the long-term maximum day demands.

		Original Design Capacities		Current Capacities (2023)	
Well	**System Served**	**Design Capacity (GPM)**	**Design Capacity (MGD)**	**Current Capacity (GPM)**	**Current Capacity (MGD)**
3	Inner	1,000	1.44	850	1.22
4	Inner	1,000	1.44	750	1.08
Total	**Inner**	**2,000**	**2.88**	**1,600**	**2.30**
7	Outer	1,750	2.52	1,750	2.52
8	Outer	1,200	1.73	950	1.37
9	Outer	2,150	3.10	1,500	2.16
11	Outer	1,900	2.74	650	0.94
13	Outer	1,500	2.16	1,500	2.16
Total	**Outer**	**8,500**	**12.25**	**6,100**	**9.15**
	Total System Capacity:		15.13	-	11.45
	Total Firm Capacity:		12.03	-	8.93

Ability to Meet Current Demands

The maximum day usage was identified as 8.96 MGD in 2012. The current firm well capacity is 8.93 MGD, meaning that even with the City's largest well out of service the system is able to supply adequate water to meet the current maximum day demand. To determine the system's ability to meet the current *peak hourly* demand, the diurnal peak of that maximum day was reviewed. The diurnal curve represents the water usage across a typical 24-hour day. For example, water usage at 2:00 am is minimal, and is represented with a 0.5 multiplier of the day's total usage. Similarly, a community such as St. Charles with a significant commercial base may see a maximum hour usage at 9:00 am when both residential and commercial operations are using water, and a multiplier of 1.5 – 2.0 may be observed.

The Peak Hourly Flow is defined as the maximum hourly flow, often occurring on the maximum day. To evaluate the system's ability to meet this flow, trending of the actual diurnal flows seen by the City was performed. These diurnal factors were then applied to the average daily demand and maximum day demand to create the chart below. The peak hourly flow would be anticipated to occur at 7:00 PM on the maximum day with an hourly flow rate of just under 11,000 gpm.



The 'current well capacity' line in the graph above represents the 8.93 MGD (6,201 gpm) well production firm capacity and all well outputs maximized to practical levels. The hourly flow exceeds this production capacity several times throughout the day, which would require boosting flow into the system from ground storage. The total supplemental volume required on this maximum day is approximately 875,000 gallons. While the City has this storage capacity available, the system would be required to refill the reservoirs during off-peak hours in the event of multiple consecutive high-demand days.

Because the current firm well capacity is nearly identical to the maximum day demand, there would be very little net loss of water volume across the full 24-hour period. Therefore, multiple days of current maximum day demand could be sustained through a drawdown of storage during peak usage during the day and refilling during the low usage overnight.

Ability to Meet Future Demands

While the City's well sources have a total design capacity of 15.13 MGD and a firm design capacity of 11.45 MGD, this has been reduced due to the age of the wells and treatment facilities. Section 2 identified the required water production capacities at each step in the community's future development. Over the 5-, 10-, and 20-year period the projected maximum day demand is anticipated to exceed the current firm supply capacity.

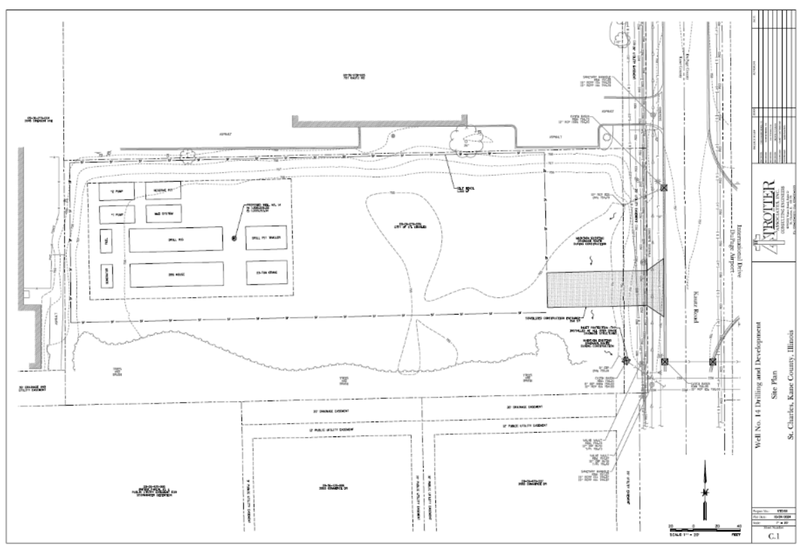
If additional sources are not identified and installed, the City may be required to curtail development or institute more stringent water use restrictions. In order to maintain adequate capacity, several alternatives for additional water supply are reviewed in the following sections. This additional demand and supply deficiency is outlined in the table below over the planning horizon. As shown, over the next 10 years there is a 2.82 MGD, or roughly 2,000 gpm, supply capacity deficit anticipated.

	Future Demands and Supply Capacities				
Year	Max Demand (MGD)	Total Supply (MGD)	Total Deficiency (MGD)	Firm Supply (MGD)	Firm Deficiency (MGD)
2023	9.00	11.45	-	8.93	0.07
2024	9.45	11.45	-	8.93	0.52
2025	9.90	11.45	-	8.93	0.97
2026	10.35	11.45	-	8.93	1.42
2027	10.80	11.45	-	8.93	1.87
2028	11.25	11.45	-	8.93	2.32
2029	11.35	11.45	-	8.93	2.42
2030	11.45	11.45	-	8.93	2.52
2031	11.55	11.45	0.10	8.93	2.62
2032	11.65	11.45	0.20	8.93	2.72
2033	11.75	11.45	0.30	8.93	2.82
2034	11.80	11.45	0.35	8.93	2.87
2035	11.85	11.45	0.40	8.93	2.92
2036	11.90	11.45	0.45	8.93	2.97
2037	11.95	11.45	0.50	8.93	3.02
2038	12.00	11.45	0.55	8.93	3.07
2043	12.00	11.45	0.55	8.93	3.07
Buildout	12.75	11.45	1.30	8.93	3.82

Current Water Supply Improvements

The City's 2018 Water Utility Master Plan had previously identified a supply deficit over the subsequent 10-year period as well. In response, the City completed the Well #7 & 13 Interconnect project, which restored the capacity of existing Well #7 through additional parallel treatment at the Oak Street WTP which treats Well #13 water. This additional 1,750 gpm capacity is reflected in the tables above as currently available supply capacity. The 2018 Plan further recommended an additional deep groundwater well on the City's far east side with treatment at the existing Ohio Avenue WTP, which currently provides treatment for Well #8.

The ion exchange units and HMO pressure filters at Ohio Ave WTP/Well #8 are capable of treating more water than Well #8 itself is capable of producing. This additional treatment capacity was identified as being able to treat the production capacity of an additional well in the area. Another Galesville aquifer well could be drilled and treated at the Ohio Avenue Facility. An additional well would increase the region that receives water from Ohio Avenue, as the water currently only meets the demands of the industrial park that it is located within. Increasing the area served by the Well #8 Facility would increase residential access to softened water and could decrease water quality complaints in the surrounding neighborhoods. The additional well would not be able to be drilled at the existing Ohio Avenue location, as this close proximity to Well #8 would decrease the static water elevation below acceptable levels. Standard practice typically dictates wells in the same aquifer be located at least 1,500 ft away from each other.



The City entered into design of the proposed new Deep Well as part of the "Well #8 Expansion & Rehabilitation" project in early 2024. The City is currently reviewing options for location of the new deep well, with a detention basins located on Kautz Road across from International Boulevard identified as the preferred site. The project generally includes drilling of a new deep well, conveyance of the raw water from the new well to the Ohio Ave WTP site, piping modifications with the treatment facility to accept the additional raw water supply, and rehabilitation of the treatment facility as well as the adjacent booster station.

The project is anticipated to advertise for bid in late 2024/early 2025, commence construction in summer of 2025, with construction completion in winter of 2026. The project will be funded through the Illinois EPA SRF low-interest loan program, and is currently on the State's FY2025 Intended Funding List with funds reserved for this timeline.

The additional deep well on the City's east side is targeting a design capacity of 1,000 gpm. The existing Ohio Avenue facility is capable of treating this supply, and the onsite existing booster station has the capacity to convey the treated water into the distribution system from the existing ground storage reservoirs. The table below reflects this additional 1,000 gpm of available water supply beginning in 2026.

	Future Demands and Supply Capacities (with Well #8 Expansion Completed in 2026)				
Year	Max Demand (MGD)	Total Supply (MGD)	Total Deficiency (MGD)	Firm Supply (MGD)	Firm Deficiency (MGD)
2023	9.00	11.45	-	8.93	0.07
2024	9.45	11.45	-	8.93	0.52
2025	9.90	11.45	-	8.93	0.97
2026	10.35	12.89	-	10.37	-
2027	10.80	12.89	-	10.37	0.43
2028	11.25	12.89	-	10.37	0.88
2029	11.35	12.89	-	10.37	0.98
2030	11.45	12.89	-	10.37	1.08
2031	11.55	12.89	-	10.37	1.18
2032	11.65	12.89	-	10.37	1.28
2033	11.75	12.89	-	10.37	1.38
2034	11.80	12.89	-	10.37	1.43
2035	11.85	12.89	-	10.37	1.48
2036	11.90	12.89	-	10.37	1.53
2037	11.95	12.89	-	10.37	1.58
2038	12.00	12.89	-	10.37	1.63
2043	12.00	12.89	-	10.37	1.63
Buildout	12.75	12.89	-	10.37	2.38

The construction of the new deep well and treatment of the Ohio Avenue WTP restores firm capacity to meet anticipated maximum day demand in 2026. However, due to the continued growth projected within the City, the firm supply deficit will continue through the planning period. The anticipated firm supply deficit at the end of the 10-year horizon is 1.38 MGD, or roughly 1,000 gpm. Therefore, following the completion of the Well #8 Expansion & Rehabilitation project, additional water supply source(s) will still be required.

Additional Water Supply Alternatives

In 2007 the Kane County Water Resources Division conducted a workshop on the implementation of sustainable water supplies in Kane County. This workshop identified four potential water sources for the developing communities of Kane County to meet future water demands: Lake Michigan, the Fox River, Shallow Aquifers and Deep Aquifers. These remain the four most cost-effective and reliable methods of water production.

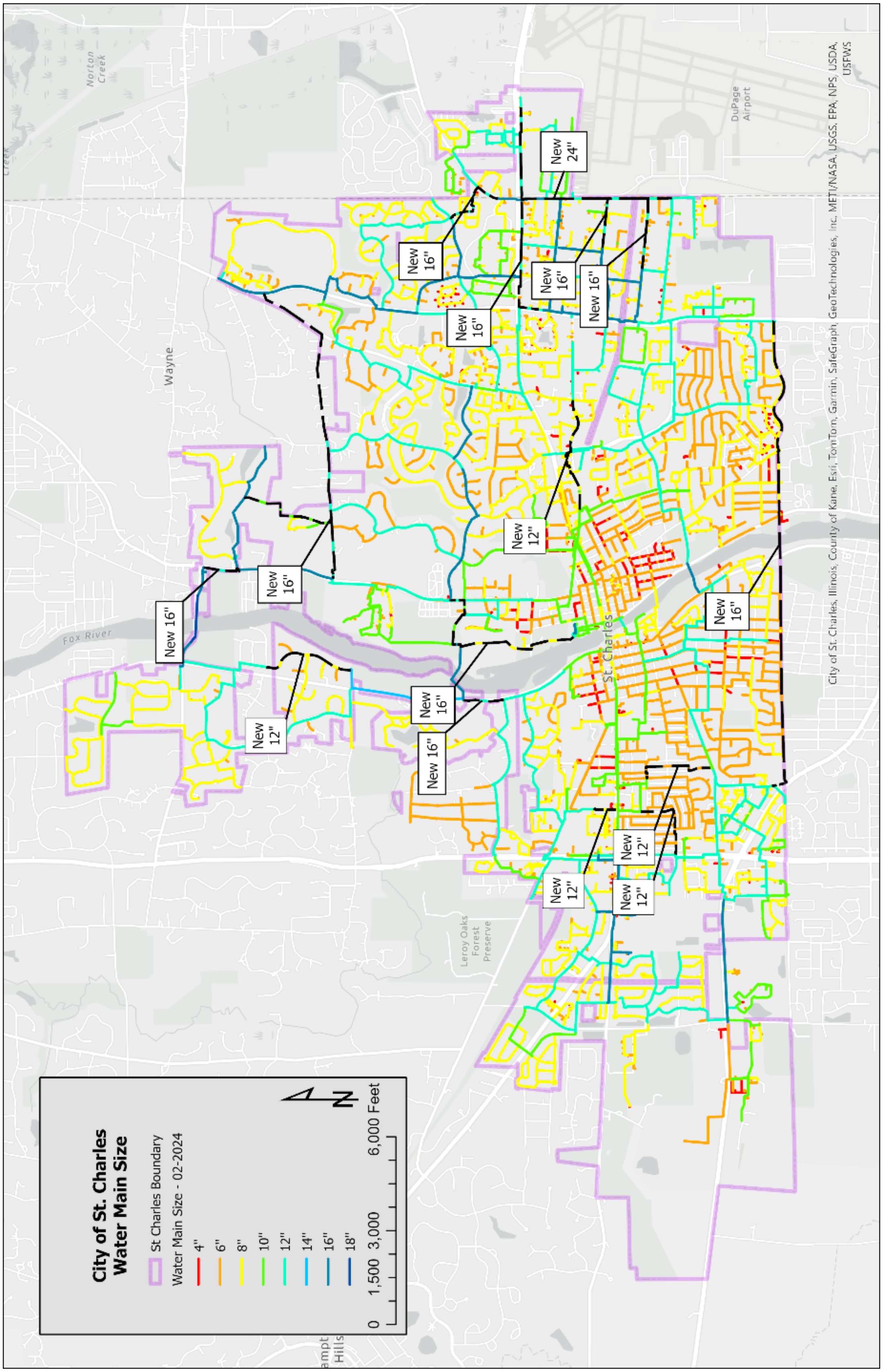
6.1.1. Water Supply Alternative #1 - Lake Michigan

The City of St. Charles was contacted by the DuPage Water Commission (DWC) in September 2017 regarding the extension of service of treated Lake Michigan Water to serve the City. The DuPage Water Commission is a separate government entity formed under the State of Illinois Water Act of 1985. The DuPage Water Commission is managed by a 13-member board, six board members are from member communities, six members are from DuPage County, and the Chair is appointed by the County Board Chair. The DuPage Water Commission currently serves 26 communities in addition to portion of unincorporated DuPage County and Illinois American Water. The Water Commission's 48-inch transmission main is located near the intersection of Route 64 and Prince Crossing Road in unincorporated West Chicago.

The transmission main would likely have to be extended to a common facility near the intersection of Route 64 and Smith Road. The distance from the existing transmission main at Prince Crossing to Smith Road is approximately four miles. Based on rough hydraulics and a maximum day demand of 13.6 MGD, a 36-inch water transmission main would be required with a velocity of 3 ft/s. It is assumed that the transmission main could be constructed within the right-of-way of Route 64. Along the route, the transmission main would need to cross Illinois Route 59, as well as the Powis Road railroad crossing. The estimated cost of extending a 36-inch transmission main this length is approximately $17.2M.

Water from DWC would be stored in a reservoir and the water would need to be boosted to match the City's hydraulic grade line. The Commission typically requires communities to maintain the equivalent of two days' allotment in storage, which would equate to 10 million gallons. The City's current storage equates to roughly 5.7 million gallons; therefore, the City would likely need to construct additional storage. The cost of the booster station and reservoir is estimated to be approximately $16.4M.

Many communities served by the DWC are supplied water through multiple connections. Due to the distance from the nearest Commission supply point, the City of St. Charles would have only one transmission main. The City's distribution system has not been constructed to convey flow from a single point on the east side of the system across the entire service area. In order to accommodate a single source of supply, major distribution system improvements would be required. In order to determine the necessary transmission and distribution main upgrades necessary to convey flow throughout the system, a potential single point feed on the far east side was hydraulically modeled. The exhibit on the following page illustrates the additional water main necessary to support this distribution. This includes approximately 12,300 LF of 12-inch main, 47,100 LF of 16-inch main, and 8,000 LF of 24-inch main. The estimated cost of this addition transmission main is approximately $42.0M, with a segment estimate provided following the exhibit.


City of St. Charles
Water Main Size
St Charles Boundary
Water Main Size - 02-2024
4"
6"
8"
10"
12"
14"
16"
18"
0 1,500 3,000 6,000 Feet
N
New 24"
New 16"
New 16"
New 16"
New 16"
New 12"
New 16"
New 16"
New 16"
New 12"
New 16"
New 16"
New 12"
New 12"
New 12"
Wayne
Norton Creek
Fox River
St. Charles
DuPage Airport
Leroy Oaks Forest Preserve
City of St. Charles, Illinois, County of Kane, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Lake Michigan Water Supply - Necessary Transmission Main Upgrades					
Segment Description	Diameter (in)		Linear Feet	Cost per LF	Total Capital Cost (Inc. GC's, Cont. & Eng)
	Existing Main	New Main			
New 12-Inch Main S 17th St	-	12	1,022	$ 575	$ 587,650
Upsize 6-Inch Main Oak St	6	12	1,465	$ 575	$ 842,375
Upsize 6-Inch Main S 13th St	6	12	2,086	$ 575	$ 1,199,450
Upsize 8-Inch Main Indiana St	6	12	186	$ 575	$ 106,950
Upsize 8-Inch Main N 17th St	8	12	750	$ 575	$ 431,250
Upsize 8-Inch Main Meadow Rd	8	12	3,112	$ 575	$ 1,789,400
Upsize 8-Inch Main Production Dr	8	12	3,658	$ 575	$ 2,103,350
New 16-Inch Main Gray St and Division St	-	16	15,328	$ 625	$ 9,580,000
New 16-Inch Main Country Club Rd and Dunham	-	16	5,461	$ 625	$ 3,413,125
Upsize 8-Inch Main Pottawatomie Park	8	16	3,680	$ 625	$ 2,300,000
Upsize 10-Inch Main Marion Ave	10	16	1,560	$ 625	$ 975,000
Upsize 10-Inch Main St Charles Country Club	10	16	2,785	$ 625	$ 1,740,625
Upsize 12-Inch Main Country Club Dr	12	16	4,641	$ 625	$ 2,900,625
Upsize 12-Inch Main Illinois Rote 25	12	16	942	$ 625	$ 588,750
Upsize 12-Inch Main Illinois Route 31	12	16	1,851	$ 625	$ 1,156,875
Upsize 12-Inch Main Stern Ave	12	16	2,296	$ 625	$ 1,435,000
Upsize 12-Inch Main Ohio Ave	12	16	2,173	$ 625	$ 1,358,125
Upsize 12-Inch Main Route 65 and South Kirk Rd	12	16	4,279	$ 625	$ 2,674,375
Upsize 12-Inch Main Smith Rd and Charter 1 Ave	12	16	2115	$ 625	$ 1,321,875
Upsize 24-Inch Main Route 64 and Kautz Rd	12	24	8010	$ 690	$ 5,526,900
		Total LF:	67,400	Total Cost:	$ 42,040,000

The DuPage Water Commission would also likely require that the City purchase their water allocation, or connection fee. That connection fee has not been estimated as part of this study, however if the City elects to further pursue this alternative it is recommended that the City meet with the Commission to discuss this point specifically.

The City of St. Charles current base water rate is $5.71 per thousand gallons, which covers the cost of production, treatment, distribution, operations, and debt service. The Commission's current rate for bulk water supply is $5.58 per thousand gallons. The City's current water loss equates to approximately 22%. Therefore, the City should estimate the cost of water supply to be $5.58 times 1.22 or $6.81 per thousand gallons sold, plus the cost for distribution, operations, and debt service. The City's rate would need to increase to cover the cost of purchased water and also include any capital improvements required to implement the connection. A conceptual cost estimate for the capital improvements required for this alternative is included on the following page. This estimate does not include the connection fee purchase of the allocation.

Conversion to Lake Michigan Supply Engineer's Opinion of Probable Cost	
Description	Total Probable Cost
SUMMARY	
CONNECTION FEE	(Not Included)
LAND ACQUISITION	$500,000
GENERAL CONDITIONS	$3,654,813
SUPPLY MAIN EXTENSION	$17,200,000
TRANSMISSION / DISTRIBUTION MAINS	$42,040,000
SITEWORK	$2,611,440
METERING STRUCTURE	$701,540
CLEAR WELL	$2,683,200
BOOSTER STATION	$3,469,900
RESERVOIRS	$10,296,000
Construction Sub-Total:	**$83,157,000**
Contingency @ 20%:	$16,632,000
Engineering & Administration @ 15%:	$14,969,000
PROBABLE PROJECT COST:	**$114,758,000**

6.1.2. Water Supply Alternative #2 - Fox River

The Fox River is an available source for drinking water and is currently used by the City of Aurora and the City of Elgin. Withdrawal from the Fox River is limited during low flow periods and regulated by the Illinois Department of Natural Resources. The limiting factor is the seven-day low flow in a ten-year period, commonly referred to as the 7Q10. The 7Q10 for the Fox River in St. Charles is 148 cfs. While the Fox River may be a viable alternative, one of the sources for the river is the shallow aquifer currently used by the City. The static and pumping water levels for Well 7, 9, 11 and 13 are all above the NWL of the Fox River. It is widely recognized that these shallow aquifers contribute to the flow of the River and are essentially a source for the river. Under these circumstances, it is much more economical for the community to draw its water directly from the aquifers rather than downstream (i.e. the river). Furthermore, treatment of shallow well water is much more economical than treatment of surface water. Surface water contains significantly greater contaminants such as silt, nutrients, fecal and others, generally requiring a higher treatment level. Therefore, it is not recommended that the City pursue Fox River water.

Groundwater Well Sources

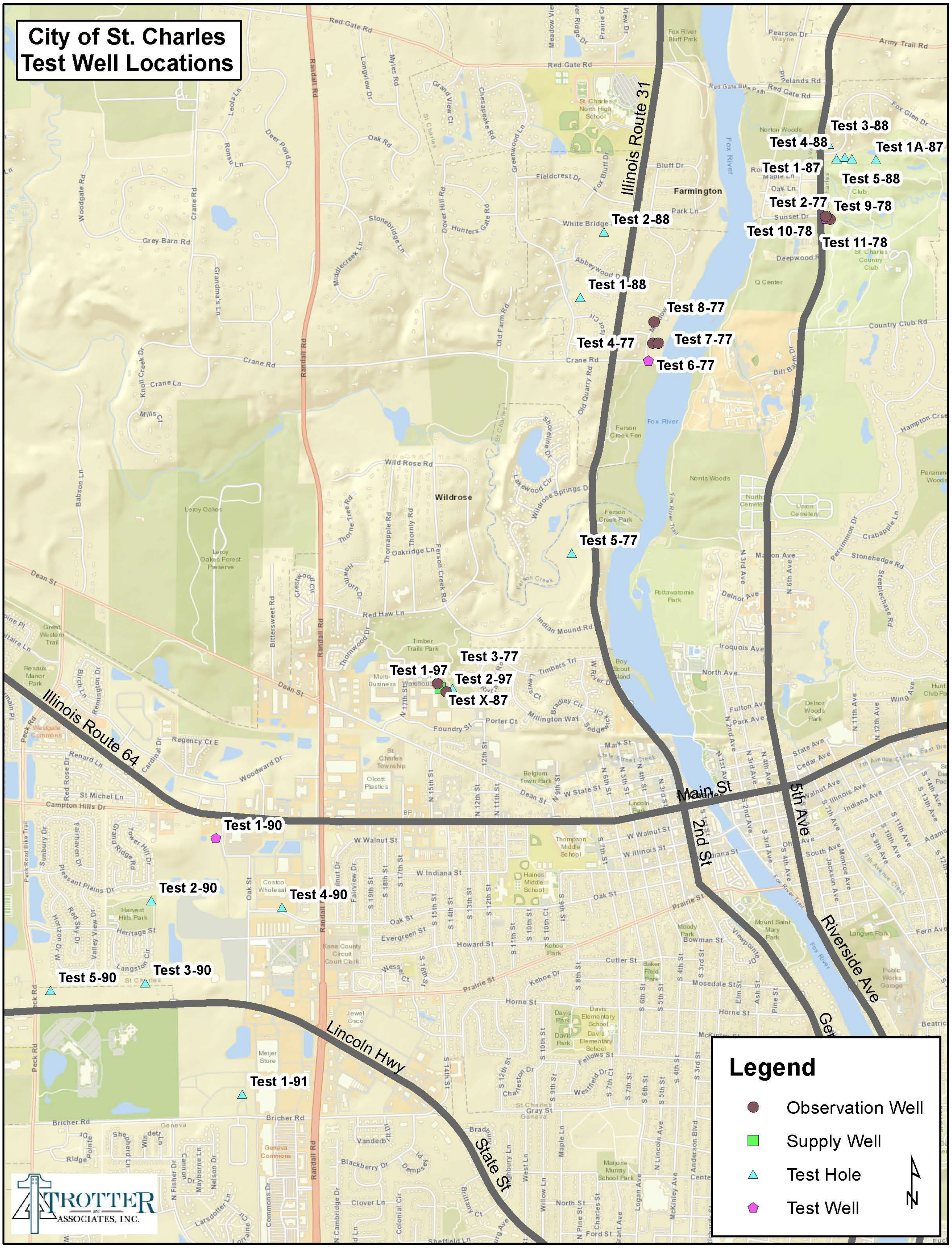
The shallow sand and gravel aquifer is a significant natural resource for the community. The limits of the aquifer have been established and recharge is provided through local precipitation. Static levels within the aquifer vary seasonally as well as from year to year. Since the source water is local precipitation, the water level is affected by drought conditions. The Illinois State Water Survey has begun to develop a model in conjunction with Kane County. While previous models have been prepared for this aquifer, the ISWS model should provide a more accurate estimation of this aquifer's sustainability. Based on current field observations for static water levels, it is unlikely that this aquifer is being overused under current conditions. Shallow wells in the region are typically capable of producing 750 – 1,500 gpm, with the City's four shallow aquifer wells capable of producing at the high end of this range.

Three deep aquifers are available; St. Peters Sandstone, Ironton Galesville, and the Mt. Simon Aquifer. The St. Peter Sandstone Aquifer, sometimes referred to as the Ancell Unit, is currently not used by the City of St. Charles because of its limited production capacity. Local wells in this formation produce 200 to 400 gpm. The water within the St. Peters Sandstone commonly requires treatment for radium reduction.

The City has three active production wells within the Ironton Galesville Aquifer. Wells #3, 4 and 8 produce between 750 and 950 gpm each. The raw water from the wells contains radium and requires treatment to meet Drinking Water Standards. This aquifer is utilized by many of the communities throughout the Fox Valley Area. At one time, most of the communities in the Chicago Metropolitan Area were drawing water from this aquifer. In the early to mid-1990's, many communities east of the Fox Valley switched to Lake Michigan Water. Since that time the aquifer's static level has begun to recover. However, as the far west suburbs continue to develop, more water is being drawn from this source. The Illinois State Water Survey (ISWS) has developed an extensive model of this aquifer as well as documented its decline, recovery and sustainable capacity.

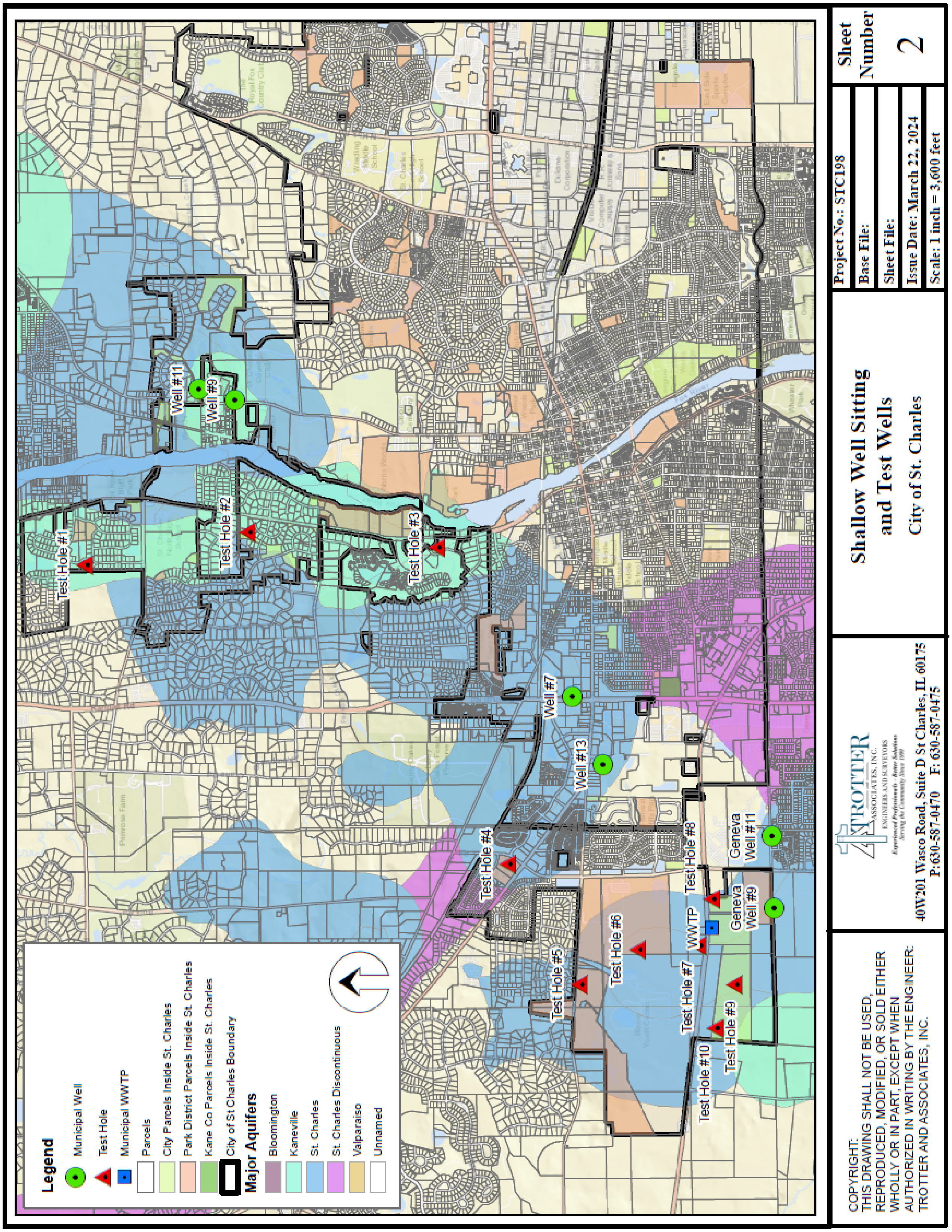
The Mt. Simon Aquifer is much deeper source. Wells #3 and 4 were at one time open to both the Galesville and Mt. Simon Aquifers. While the Mt. Simon is a significant source, the City sealed the wells from the lower formation in the 1970's. This was done to mitigate concerns regarding high chloride concentrations. At the 2007 Kane County Sustainable Water Supply Workshop, representatives of the ISWS provided an overview of the challenges in managing withdrawal from the available sources. The area-wide analysis demonstrates that while adequate water is available, conservation of these resources is prudent to protect the long-term viability of water supply systems. The Illinois State Water Survey encouraged use of surface and shallow aquifer water for base demands and relying on the deep aquifers during drought and peak demand periods.

A number of test holes, test wells, and observation wells were contracted by the City between 1977 and 2022 to locate suitable high-capacity production wells. A table listing each of these testing locations is included below, and a map depicting each is shown on the following page.


City of St. Charles
Test Well Locations
Test 3-88
Test 4-88
Test 1A-87
Test 1-87
Test 5-88
Test 2-77
Test 9-78
Test 2-88
Test 10-78
Test 11-78
Test 1-88
Test 8-77
Test 4-77
Test 7-77
Test 6-77
Test 5-77
Test 3-77
Test 1-97
Test 2-97
Test X-87
Test 1-90
Test 2-90
Test 4-90
Test 5-90
Test 3-90
Test 1-91
Illinois Route 31
Illinois Route 64
Lincoln Hwy
State St
Main St
2nd St
5th Ave
Riverside Ave
Randall Rd
Legend
Observation Well
Supply Well
Test Hole
Test Well
N
TROTTER and ASSOCIATES, INC.

Name	Function	Driller's Log	Notes
1-77	Test Hole	X	For Well 8/1-77
2-77	Test Hole	X	Becomes Well 9
3-77	Test Hole	X	Moline
4-77	Observation Well	X	For Well 10/6-77
5-77	Test Hole	X	Indian Mound/Ferson Creek
6-77	Test Well		Potential Well 10
7-77	Observation Well		For Well 10/6-77
8-77	Observation Well		For Well 10/6-77
9-78	Test Well		
10-78	Observation Well		For Well 9/9-78
11-78	Observation Well		For Well 9/9-78
1-80	Test Hole		Closest to Well 11 Location
1-87	Test Hole		Becomes Well 11
1-87A	Test Hole		
X-87	Supply Well		Foundry Supply, Used as Test Well in '97 by City
1-88	Test Hole	X	Well 12 Candidate
2-88	Test Hole	X	Well 12 Candidate
3-88	Test Hole	X	For Well 11
4-88	Test Hole	X	For Well 11
5-88	Test Hole	X	For Well 11
1-90	Test Well	X	Becomes Well 13
2-90	Test Hole	X	
3-90	Test Hole	X	
4-90	Test Hole	X	
5-90	Test Hole	X	
1-91	Test Hole	X	Bricher Road
1-97	Observation Well		For Foundry/X-87
2-97	Observation Well		For Foundry/X-87
1-22	Test Hole	X	Test Hole #8 from 2021 Well Siting Study
2-22	Test Hole	X	Test Hole #9 from 2021 Well Siting Study
3-22	Test Hole	X	Test Hole #10 from 2021 Well Siting Study

As part of the 2021 Shallow Well Siting Study, the City identified 10 additional potential well sites. The exhibit on the following page shows the existing wells in the area, as well as the additional test holes. In 2022 the City commissioned the drilling of Test Holes #8, 9 and 10 as the preferrable sites to begin exploration. However, bedrock was encountered shallower than anticipated at these locations (73 ft – 123 ft). Additionally, Test Hole #8 found no confining clay layer, and Test Hole #10 was found to have a very think sand/gravel seam. The City has elected to continue test drilling for potential shallow wells, with additional drilling anticipated in 2024/2025.


Legend
Municipal Well
Test Hole
Municipal WWTP
Parcels
City Parcels Inside St. Charles
Park District Parcels Inside St. Charles
Kane Co Parcels Inside St. Charles
City of St Charles Boundary
Major Aquifers
Bloomington
Kaneville
St. Charles
St. Charles Discontinuous
Valparaiso
Unnamed
Well #11
Well #9
Test Hole #1
Test Hole #2
Test Hole #3
Test Hole #4
Test Hole #5
Test Hole #6
Test Hole #7
Test Hole #8
Test Hole #9
Test Hole #10
Well #7
Well #13
Geneva Well #11
Geneva Well #9
WWTP
Sheet Number
2
Project No.: STC198
Base File:
Sheet File:
Issue Date: March 22, 2024
Scale: 1 inch = 3,600 feet
Shallow Well Sitting and Test Wells
City of St. Charles
TROTTER ASSOCIATES, INC.
ENGINEERS AND SURVEYORS
40W201 Wasco Road, Suite D St Charles, IL 60175
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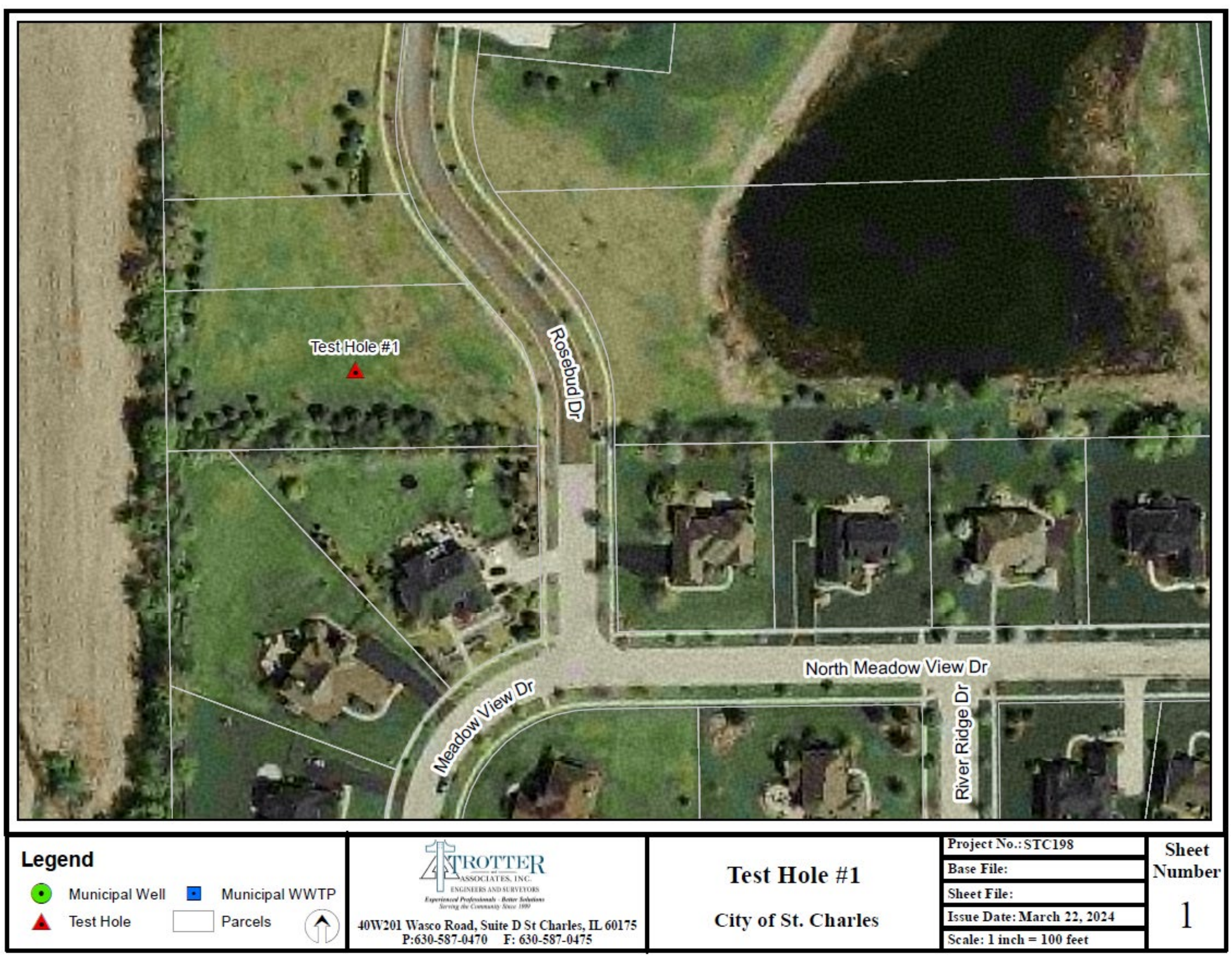
6.1.3. Water Supply Alternative #3 – Shallow Groundwater Well

While there are a number of sites identified for a potential shallow groundwater well, the cost for each location would be relatively similar for the wells themselves. Differences in capital cost would likely be associated with the treatment facility location, raw main routing to the treatment facility, and finished water routing a transmission main of size to receive the supply flow.

For the purposes of this study, the Test Well #1 location on Rosebud Drive at the City's far north side is considered as a representative shallow well site. This site would likely be suitable for a treatment facility on site, however finished water transmission main would likely need to extend roughly 3,800 linear feet to meet the 16-inch river crossing main near Red Gate Road and Route 31. Cost associated with the treatment of each supply alternative are discussed in Section 6.3 – Water Treatment Analysis.

Concerns associated with shallow groundwater wells are typically associated with the potential for contamination if there is not a well-defined confining layer, or if the aquifer in the area is influenced by surface water runoff. These concerns have been heighted in recent years with the development of PFAS testing and regulations which may indicate the presence of these regulated compounds in extremely low concentrations (parts per trillion). Therefore, if a shallow groundwater well is selected, treatment for potential PFAS mitigation should be considered. PFAS implications are further discussed in Section 6.3.



A shallow groundwater well would be expected to produce 1,000 – 1,500 gpm in this area, which would meet the City's needs in the 10-year planning horizon when coupled with the Well #8 Expansion project.

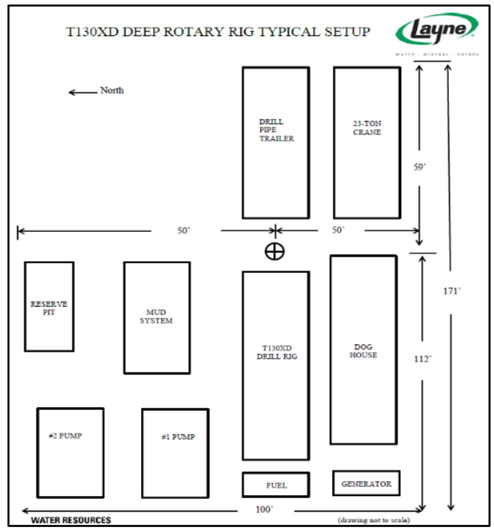
The total estimated capital cost for the drilling of the well, well pump, transmission main, and other utilizes is estimated to be approximately $6.2M. The specific location of Test Hole #1 at Rosebud Drive would not require property acquisition while other potential sites may. However, of the current test holes identified, this location represents a conservative location from a capital cost perspective. At a minimum it would be expected that a shallow well would require iron and/or manganese removal to meet water quality standards, in addition to typical disinfection and fluoridation.

Alternative #3 - Shallow Groundwater Well				
Description				Total Probable Cost
SUMMARY				
GENERAL CONDITIONS	1	Lump Sum	$870,000	$870,000
SITE WORK	1	Lump Sum	$150,000	$150,000
12" TRANSMISSION MAIN	3800	Lin. Ft	$450	$1,710,000
DRILLING SHALLOW WELL	1	Lump Sum	$750,000	$750,000
SHALLOW WELL PUMP	1	Each	$500,000	$500,000
PITLESS ADAPTER, PIPING, VAULT	1	Lump Sum	$150,000	$150,000
SITE ELECTRICAL / CONTROLS	1	Lump Sum	$350,000	$350,000
LAND ACQUISITION	0	Acre	$100,000	$0
			SUBTOTAL CONSTRUCTION:	**$4,480,000**
			CONTINGENCY @ 20%:	$896,000
			ENGINEERING & ADMIN @ 15%:	$806,400
			PROJECT TOTAL:	**$6,182,400**

6.1.4. Water Supply Alternative #4 – Deep Groundwater Well

The deep Galesville Aquifer is much more prevalent throughout the region than the shallow sand and gravel aquifer. As a result, siting a deep well is less problematic so long as proper separation between deep wells is maintained. The capital costs associated with deep wells are typically higher due to the physical drilling depth, well pump depth and size, and supporting electrical components.

Deep wells also require a larger site footprint due to the size of the drilling rig and supporting components necessary. While shallow wells can be located on relatively small sites, like the City's Well #7, deep wells require a larger footprint for the initial construction as well as subsequent maintenance equipment.



A deep groundwater well would be expected to produce approximately 1,000 gpm in this area without interference from other deep wells. This would meet the City's anticipated supply need in the 10-year planning horizon when coupled with the Well #8 Expansion project. However, as the demand increases between the 10- and 20-year horizons additional capacity may be required.

At a minimum it would be expected that a deep well would require radium removal to meet water quality standards, in addition to typical disinfection. Treatment cost estimates can be found in Section 6.3. Below is a conceptual opinion of probable construction cost assuming the same Test Hole #1 location.

Alternative #4 - Deep Groundwater Well				
Description				Total Probable Cost
SUMMARY				
GENERAL CONDITIONS	1	Lump Sum	$1,220,000	$1,220,000
SITE WORK	1	Lump Sum	$250,000	$250,000
12" TRANSMISSION MAIN	3800	Lin. Ft	$450	$1,710,000
DRILLING DEEP WELL	1	Lump Sum	$1,500,000	$1,500,000
DEEP WELL PUMP	1	Each	$1,000,000	$1,000,000
PITLESS ADAPTER, PIPING, VAULT	1	Lump Sum	$150,000	$150,000
SITE ELECTRICAL / CONTROLS	1	Lump Sum	$500,000	$500,000
LAND ACQUISITION	0	Acre	$100,000	$0
			SUBTOTAL CONSTRUCTION:	**$6,330,000**
			CONTINGENCY @ 20%:	$1,266,000
			ENGINEERING & ADMIN @ 15%:	$1,139,400
			PROJECT TOTAL:	**$8,735,400**

6.2. Water Treatment Analysis

The City provides a continuous supply of safe and reliable drinking water to its residential and non-residential customers. Providing a safe supply of drinking water requires that all state and federal regulations pertaining to contaminants are met at all times. Treatment required for water supplies depends on the source of the water – whether groundwater or surface water – as well as the raw water quality. In St. Charles this means that the shallow groundwater wells and deep groundwater wells require different treatment processes. On the shallow wells, filtration is typically required for iron and manganese removal. On the deep wells radium removal is required. As discussed in Section 5, the City's existing groundwater well supplies may require additional treatment, including:

- Well #9 – PFOS/PFBS Removal
- Well #11 – Ammonia Removal
- Well #7/9/11/13 – Hardness Removal

Additionally, any new water supply sources will require treatment facilities to be constructed in order to meet US EPA National Primary Drinking Water Standards, including:

- Future Shallow Well – Iron/Manganese Removal
- Future Deep Well – Radium Removal

Section 6.2 of this report will discuss alternatives for meeting existing water treatment needs, as well as future water supply treatment requirements. These treatment needs may be managed through independent treatment upgrades, or common facilities which provide treatment for one or more well supplies and multiple contaminants simultaneously.

6.2.1. Perfluoroalkyl / Polyfluoroalkyl (PFAS) Removal

Per- and polyfluoroalkyl substances (PFAS) are a contaminant of developing concern within the water and public health sectors. These chemicals are man-made substances that are extremely persistent in both the environment and within the human body; once PFAS is present in an aquifer or body of water in significant concentrations, removal can be extremely challenging. The EPA currently states that there is evidence that exposure to elevated PFAS concentrations can result in adverse human health effects. Elevated PFAS concentrations have been linked to conditions such as low infant birth weights, immune system suppression, cancer (for PFOA), and thyroid hormone disruption (for PFOS).

PFAS substances have been utilized in a variety of applications since their introduction in the 1940's. They can have been incorporated in applications such as food packaging, heat- and stick-resistant cooking surfaces, clothing, furniture, and adhesives. In the past, fire suppression foams used to combat gasoline or oil fire have contained high concentrations of PFAS, and these foams have contributed significantly to PFAS discharge to natural waterways. Most PFAS chemicals are no longer manufactured in the United States, though the bond within these chemicals is significantly strong that they do not naturally degrade easily. Since the EPA has begun monitoring PFAS, related substances have been detected in rivers, lakes, and subterranean aquifers.

PFAS have been nicknamed “forever chemicals” due to the difficulty of removal from contaminated bodies of water and soils. However, several technologies have been identified for their capability to isolate the substances: Granular Activated Carbon (GAC), Ion Exchange (IEX), and Reverse Osmosis (RO).

In April 2024 the US EPA implemented final National Drinking Water Standards for six PFAS compounds; PFOS, PFOA, PFNA, PFBS, PFHxS, and GenX. Compliance is required to be achieved for each of the six compounds by April 2029, with an intermediate monitoring deadline of April 2027. The final rule requires quarterly monitoring, with the results calculated on a running annual average (RAA) basis. Of the six regulated contaminants, PFOA and PFOS have an MCL of 4.0 ng/L (ppt), while PFNA, PFHxS, and GenX have an MCL of 10 ng/L. Additionally, a hazard index calculation is applied when a mixture of any two of the six regulated compounds are found to be present together in quantities exceeding the practical quantitation level (PQL). The sixth PFAS compound, PFBS, which is one of the most prevalent and does not have an independent MCL is included in this hazard calculation. A calculated hazard index exceeding 1.0 would result in a violation.

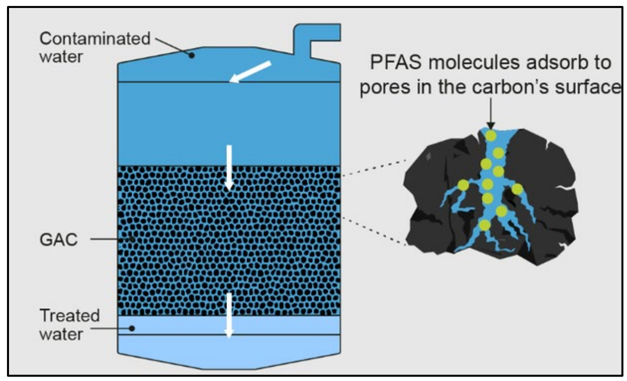
Chemical	Maximum Contaminant Level Goal (MCLG)	Maximum Contaminant Level (MCL)
PFOA	0	4.0 ppt
PFOS	0	4.0 ppt
PFNA	10 ppt	10 ppt
PFHxS	10 ppt	10 ppt
HFPO-DA (GenX chemicals)	10 ppt	10 ppt
Mixture of two or more: PFNA, PFHxS, HFPO-DA, and PFBS	Hazard Index of 1	Hazard Index of 1
Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.		

The City has been completing PFAS compound testing on the groundwater wells since 2020 as required by the EPA. The three deep wells (Well #3, 4 & 8) have never had a detected level of any of the regulated PFAS compounds since testing began in 2020. The three operational shallow wells (Well #9, 11 & 13) each returned results over the detection threshold for PFAS compounds. Specifically, Well #9 has returned PFBS results from 2.2 – 3.2 ng/L and one PFOS result of 2.3 ng/L; Well #11 returned one PFBS result of 2.7 ng/L, and Well #13 returned PFBS results from 2.9 – 3.6 ng/L and PFHxS results of 2.3 ng/L. All of these results were under the (then future) US EPA MCL for each compound, and the hazard index would have been triggered. PFBS was the most commonly occurring compound in the shallow wells, which is regulated through the hazard index only. No mixtures of other PFAS compounds were found over their respective PQL’s in addition to the PFBS, and as such the hazard index would not apply.

The Well #9 PFOS result of 2.3 ng/L represents the closest detected level to the US EPA MCL of 4.0 ng/L. When discussing concentrations of regulated compounds in parts per trillion, a result 1.7 ng/L below the MCL threshold merits consideration. Further, while the Illinois EPA has not set state-specific PFAS regulations yet, the State reserves the right to set limits below the US EPA standards. If the Well #13 PFHxS levels were found to approach the 10 ng/L threshold additional treatment at that location may be required. Therefore, alternatives for PFAS removal are reviewed for planning purposes.

Treatment Option #1: Granulated Activate Carbon (GAC)

Granular activated carbon (GAC) technology is a partially renewable source that uses an adsorption process to treat a wide variety of contaminants in water. These contaminants are generally taste and odor compounds, natural organic matter, VOCs, SOCs, and disinfection byproduct precursors. According to the USEPA, results for this technique is up to greater than 99% removal of PFBS. As implied by its namesake, this treatment process uses an active carbon media as a filter with the most common media derived from coal or coconut. The process uses the carbon media in a filter vessel or column through the use of gravity or pressure. As water passes through the GAC, contaminants adsorb to the granules via Van Der Waals forces. Treated Water is then collected at the underdrain where it is redirected for further treatment. As water passes through the GAC's void spaces, also known as pores, the granules may displace, leading to a homogenization of apparent density. This reduces the system's efficiency, requiring backwashing for restratification to restore graded density.



Once the GAC reaches breakthrough, meaning the activated carbon becomes saturated with contaminants, the spent carbon can either be disposed of or restored to regain its adsorptive capacity. It should be noted that in April 2024 the US EPA designated PFOA and PFOS as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) substances. This hazardous designation means additional regulations are placed on the transportation, storage, and ownership of spent PFAS adsorption media. Therefore, the City would need to work under the assumption that any future PFAS treatment that involves storage of spent treatment media will remain under City liability in perpetuity.

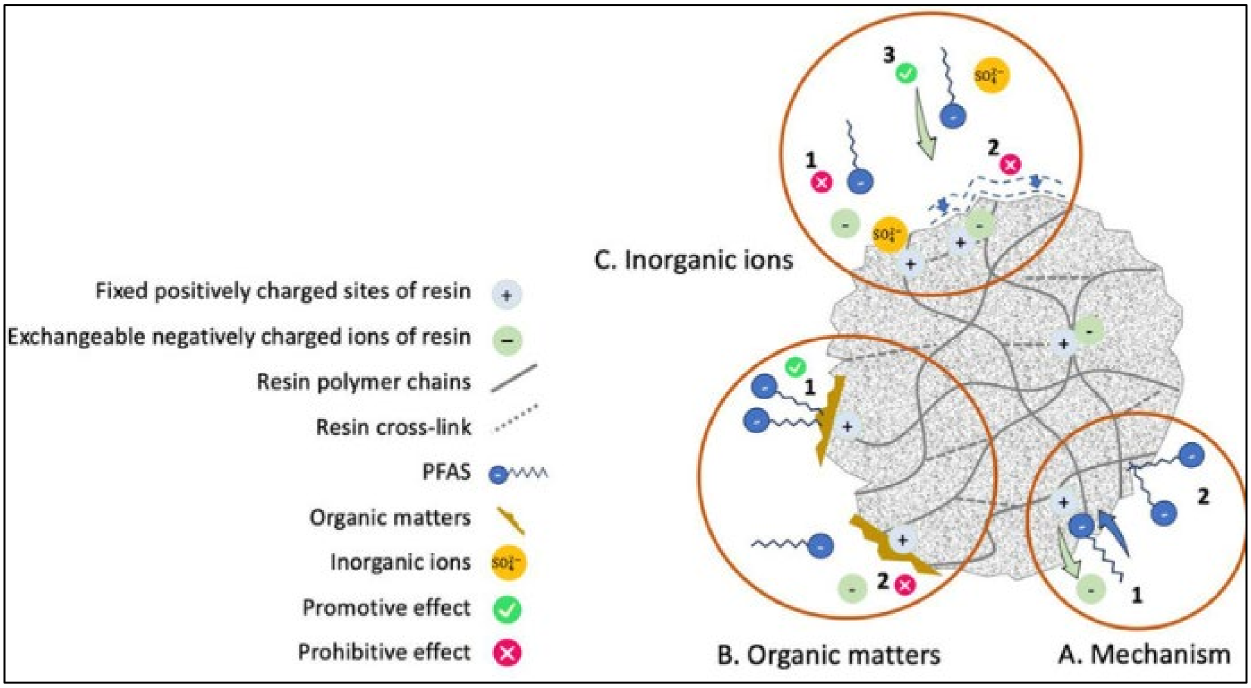
Regarding restoration of the spent carbon, there are two options: regeneration and reactivation. Regeneration extends the useful life of GAC by removing the contaminants without destroying it. This is done through exposing GAC to steam or hot gas. This process tends to have a higher media loss due to its inability to fully remove the contaminant from the regenerative process. On the other hand, reactivation refers to the process of removing and destroying contaminants through incineration. Unlike regeneration, this process returns the media to its initial activated state.

However, the incineration process involved in GAC reactivation tends to have a higher carbon footprint. Additionally, air emissions from the reactivation process pose a disadvantage due to the potential for future regulatory requirements limiting emissions. In terms of the filtering process, GAC's ability to adsorb PFAS may be hindered due to competition for other contaminants, so it is imperative that pilot testing is done, for at least a year, in order to determine what type of GAC treatment should be used.

Yet, it is worth mentioning that GAC is widely studied for PFAS treatment more so in comparison to other treatments with high removal rate of long-chain PFAS and moderate removal of short-chain compounds. And while reactivation for the media is high, vessels/filter systems do not require a large footprint. Additionally, GAC has a lower capital cost compared to other treatment options.

Treatment Option #2: Anion Exchange (AIX)

Ion-exchange (IEX) resin technology is often used for water softening and the USEPA recognizes this technique as one of the best practices for PFAS removal. The process has the capability of up to greater than 99 percent removal of PFOS and PFBS. Influent water is passed through a vessel that holds a resin bed comprised of small beads that contain negatively charged ions bound to positive anion groups. The negatively charged PFOS/PFBS atoms that are present in the water "exchange" places with the readily available negative ion groups since they posses a higher affinity to the positive anions. This removes the contaminants from the source water resulting in an innocuous effluent solution.



Asadi, Fatemeh & Banayan Esfahani, Ehsan & Mohseni, Madjid. (2023). Effects of Water Matrix on Per- and Poly-fluoroalkyl Substances (PFAS) Treatment: Physical-separation and Degradation Processes – A review. Journal of Hazardous Materials Advances.

Similar to the City's ion-exchange process for radium removal, continuous cycle through the resin degrades the concentration of available ions for exchange which requires the resin to go through regeneration or be disposed of. Because of the concentrated nature of the waste stream during a regeneration, disposal and exchange of the resin once fully loaded is recommended. Similar to spent GAC media, the PFAS-laden resin may be subject to CERCLA standards depending on the PFAS compounds.

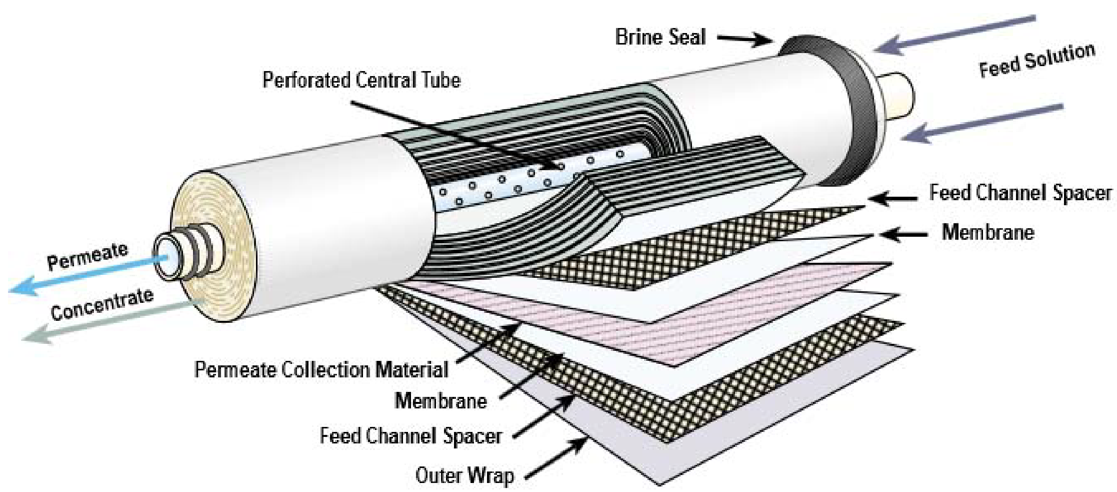
If the resin is not replaced at the proper time, an effect called chromatographic peaking can occur. This happens when water passes through the highly concentrated resin, PFBS ions can leak into effluent, and the water leaving the system can become more concentrated. Even so, there are many reasons why the EPA approves this technology as one of the most beneficial PFOS/PFBS removal techniques. In addition to the effectiveness of the removal, the system has minimal chemical additives and requires only moderate operation. It is also one of the most common technologies used and can be generally inexpensive to implement.

Treatment Option #3: Membrane Separation/Reverse Osmosis (RO)

Reverse Osmosis (RO) systems are commonly used to desalinate ocean or brackish water and is another EPA recognized BAT that can remove PFBS. Opposed to the chemical processes that are used for ion-exchange and granulated activated carbon, reverse osmosis works using physical mechanisms where the influent water is forced through a semipermeable membrane at very high pressures. Water that passes through membrane is called permeate and it is free of the targeted contaminants. Concentrate is the remaining water that exits the system with the unwanted solutes. There are a variety of reverse osmosis membranes that are engineered for certain permeation capabilities and reject characteristics for specific contaminant removal. The effectiveness of these membranes led the EPA to identify them as BAT for many inorganic compounds.

RO is a continuous process that does not require backwashing, but the technology does require pretreatment and post-treatment, and periodic descaling depending on raw water quality. Fouling and scaling can occur when organic or inorganic particles and substances attach to the membrane. The deposits can block the membrane pores and decrease the efficiency of the process as well as increase the pressure drop which will degrade the membrane and increase energy costs. This can be prevented by using a more porous cartridge filter to pretreat the influent water and remove large particles. Post-treatment will also be necessary to adjust alkalinity and pH and remove dissolved gases in order to decrease corrosivity of the effluent water.

Membranes are commonly wound in a spiral around a central tube, as shown in the figure above. Water is then fed laterally through a spiral, and pressure will force the water through the membrane where it will enter the collection tube through an inner channel space. As the influent runs parallel to the membrane surface, water will carry away PFOS/PFBS ion and other unwanted solutes from the membrane surface, preventing fouling. The contaminants will exit as a concentrated solution to be collected for wastewater treatment.



RO technologies can be advantageous due to their smaller footprints and high removal efficiencies. The process also requires much fewer chemical inputs than the other proposed techniques. In addition, the modular nature of membrane technologies means that it is easy to add capacity to these systems.

Well #9 PFAS Treatment Summary

While all three technologies reviewed for PFOS/PFBS removal have been proven effective in full-scale applications, if treatment for PFOS/PFBS alone is pursued then consideration should be given to Granular Activated Carbon (GAC) treatment. A GAC system would represent the simplest, and likely most cost-effective solution for PFOS/PFBS removal. Anion exchange processes typically require upstream filtration, which is not present at Well #9, to avoid organic fouling and other negatively charged ions in the raw water may out-compete the PFAS due to the extremely low concentration of PFAS in the raw water. Reverse osmosis, while effective, requires significantly more ancillary treatment processes than GAC. This would include upstream pressure and cartridge filtration, water storage, boosting, and potentially decarbonation. The waste stream from reverse osmosis is also a liquid, which may be harder to capture and treat if future regulations require PFAS treatment of waste streams.

Due to the proximity of Well #9 and 11, it is recommended that if the City elected to pursue PFAS treatment that capacity in a facility be provided for both wells. It is likely that if PFAS compounds were consistently detected in Well #9, then in time they would also be detected at Well #11. A common treatment facility for both wells would have an appreciably lower capital cost than separate facilities, but would require a raw main extension from one well site to the other. Below is a conceptual opinion of probable construction cost for a common PFAS treatment facility utilizing a GAC process.

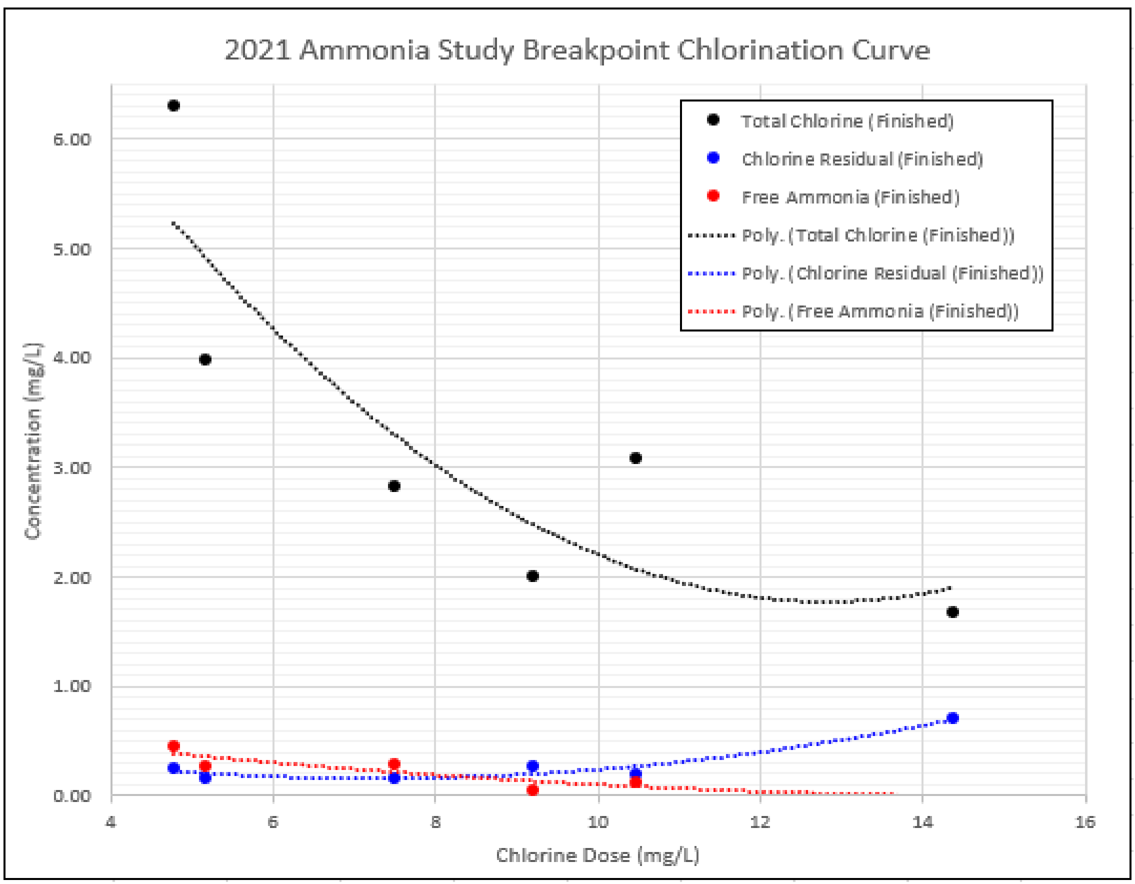
It is recommended that the City pursue pilot testing of the three available technologies for removal of PFAS compounds, and more specifically the PFBS, PFOS, and PFHxS detected in the shallow groundwater wells.

Well #9/11 PFAS Treatment GAC Facility	
Description	**Probable Cost**
SUMMARY	
GENERAL CONDITIONS	$2,395,300
SITEWORK	$459,800
TREATMENT PLANT FACILITY	$9,315,980
BACKWASH TANK	$919,920
LAND ACQUISITION	$200,000
Construction Sub-Total:	**$13,291,000**
Contingency @ 20%:	$2,658,200
Engineering & Administration @ 15%:	$2,392,400
PROBABLE PROJECT COST:	**$18,342,000**

6.2.2. Ammonia Removal

The City of St. Charles' Well #11 has been operating at reduced capacity due to the inability to produce the desired chlorine residual in the finished water at higher flow rates. The City requested that an investigation of the chlorine residual at Well #11 be performed and recommendations provided to increase the capacity of this well back to the production capacity of the well and well pump itself. In order to do this, the system needs to maintain a chlorine residual of at least 2.0 mg/L into the distribution system.

The well is presently operated at 500-1,000 GPM, as this is the maximum amount that can be effectively chlorinated. Water from the well appears to be unable to maintain a residual, likely due to ammonia converting chlorine ions to chloramines, creating a large chlorine demand. In order to quantify the presence of ammonia in the raw water, the City performed interval sampling to establish a baseline raw ammonia concentration. Six days of sampling were completed between July 21, 2021, and August 4, 2021. The chlorine dosage to the raw water was increased each of the six days and the Residual (Free) Chlorine, Finished Water Total Ammonia, Total Chlorine and Monochloramine concentrations were monitored. This data showed that with the well flow rate reduced to 500 gpm (26% capacity) and a very high chlorine dosage of 14.4 mg/L, the residual (free) chlorine reached a level of 0.71 mg/L, with a total chlorine level of 1.68 mg/L and ammonia at 0.07 mg/L. This study suggested that the breakpoint chlorine level is at a dosage level of approximately 12-14 mg/L.



Five additional days of sampling were completed between June 23, 2022, and July 21, 2022. This data showed that with the well flow rate reduced to 790 gpm (41% capacity) residual free chlorine reached 1.02 mg/L, with a total chlorine level of 1.38 mg/L and ammonia at 0.10 mg/L.

The 2021 study concluded that the breakpoint chlorine level is at a dosage of approximately 12-14 mg/l. The 2022 study concluded that breakpoint chlorination was reached, however the chlorine dosing peaked at 14 mg/L. From the data, and chlorine dosing rate calculations, it is estimated that a chlorine dose of 16 mg/L may achieve the target residual of 2.0 mg/L.

A number of alternatives to return Well #11 to its well capacity were reviewed. While some of the options are viable, treatment of ammonia is a notoriously difficult process without a clearly preferred treatment alternative. The table below summarizes the seven treatment options reviewed and their relative advantages and disadvantages.

Process	Advantages	Disadvantages	Viable
Breakpoint Chlorination	• 99%+ NH3 removal possible • Effective & economical for low concentrations of ammonia	• High feed rates & operational cost • Risk of producing disinfectant byproducts (DBPs), including chloramines, which can cause health, odor, and taste issues	✓
Nitrification (Biological)	• Minimal to no chemical additives for biology to function • Low maintenance • Lower chlorine feed & cost	• Sensitive to water chemistry, temperature, and ambient conditions • Less adaptable to intermittent flows • Long time to grow biology before full treatment capacity is realized	✓
Ion Exchange	• 95%+ NH3 removal possible • IX media can be selective to ammonia over hardness ions • Less additional mechanical equipment to maintain than other options such as aeration	• Ammonia ions can be displaced into the finished water by hardness ions as the IX media becomes saturated • IX media requires backwash which will contain chlorides which the WWTP does not have the capacity to accept due to WWTP effluent limits	No
Reverse Osmosis	• Small footprint • High removal efficiency • Expensive	• Requires backwash, which significantly increases wasted water • Increased potential for fouling	✓
Aeration / Air Stripping	• 90-95% NH3 removal possible • Raising pH also precipitates hardness-causing ions • No backwash or regeneration	• High pH (>11) required to strip NH_3 • Precipitation of byproducts (e.g. Fe/Mn) • Freezing & scaling of equipment • Efficiency drops with air/water temp	No
Granular Activated Carbon	• Low operating cost • Low maintenance • No additional chemicals	• Ammonia is inorganic and not preferentially absorbed by carbon • Ammonia absorption is highly dependent on acidity of the carbon	No
Ozone	• Ozone reactions are fast in direct contact with ammonia • Ozone reduces ammonia to nitrates (similar to biological nitrification)	• Bromate (BrO3−) is a regulated by-product of ozone disinfection • Oxidation reactions with ozone are much slower and less effective in indirect contact with ammonia	No

Well #11 Ammonia Treatment Summary

Breakpoint chlorination, biological filtration/nitrification, and reverse osmosis were all found to be viable alternatives for ammonia removal at Well #11. However, breakpoint chlorination is not recommended as the required chlorine dosage poses a significant risk for the formation of disinfection byproducts in the distribution system. While reverse osmosis is effective in ammonia removal, the capital cost associated with a reverse osmosis treatment facility solely for ammonia removal at Well #11 would not be practical. Therefore, consideration should be given to ammonia nitrification through biological filtration if the City wishes to recapture the production capacity of Well #11.

A conceptual level opinion of probable cost for a biological filtration facility is included below for planning purposes. This estimate assumes that land adjacent to the existing Well #11 facility could be purchased and utilized for a new treatment structure.

Well #11 Ammonia Treatment Facility				
Description				Total Probable Cost
SUMMARY				
GENERAL CONDITIONS	1	Lump Sum	$1,700,000	$1,700,000
SITE WORK	1	Lump Sum	$250,000	$250,000
12" TRANSMISSION MAIN	250	Lin. Ft	$450	$112,500
BIOLOGICAL FILTRATION FACILITY	1	Lump Sum	$6,100,000	$6,100,000
SITE ELECTRICAL / CONTROLS	1	Lump Sum	$100,000	$100,000
LAND ACQUISITION	2	Acre	$100,000	$200,000
			SUBTOTAL CONSTRUCTION:	**$8,462,500**
			CONTINGENCY @ 20%:	$1,692,500
			ENGINEERING & ADMIN @ 15%:	$1,523,250
			PROJECT TOTAL:	**$11,679,000**

6.2.3. Hardness Removal

In addition to maintaining excellent water quality, the City has identified implementing city-wide (utility-scale) water softening as a concept to be evaluated. The water softening level being evaluated consists of a finished water hardness of approximately 150 mg/L hardness, this is similar to water quality provided from Lake Michigan.

Hardness in water is the presence of dissolved magnesium and calcium ions. These ions combine most commonly with carbonate ions in water to create mineral deposits. Although water hardness is not regulated by the EPA in its Primary Drinking Water Regulations, it is a Secondary Drinking Water Standard under Total Dissolved Solids with Secondary MCL of 500 mg/L. Hardness presents aesthetic concerns to consumers such as mineral deposits in piping, diminished soap effectiveness, and decreased lifespans of appliances.

Calcium and magnesium ions enter drinking water primarily through the dissolution of minerals in subterranean aquifers. As the City of St. Charles sources all of its drinking water from shallow and deep wells, high concentrations of hardness are to be expected. Tests have displayed that each of the wells used by the city provide water that is classified as either "Hard" or "Very Hard". Even Lake Michigan water which is commonly referred to as "soft" is actually categorized as "Moderately Hard" at 130 mg/L.

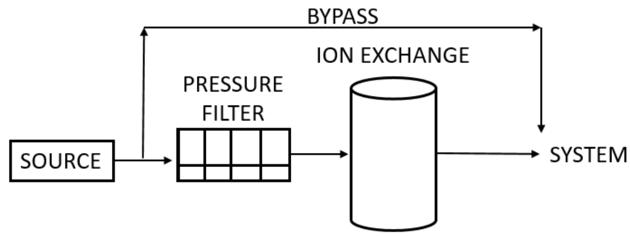
Water softening in St. Charles is currently achieved primarily through household water softening systems. These systems are paid for and operated by residents and require regular replacement of a softener salt media. Implementation of city-wide softening would reduce reliance on these devices and could potentially reduce the use of household softening. At present, the high hardness entering homes can scale pipes before reaching household softeners or the softeners may not be maintained well enough to work efficiently. As such, the City receives complaints from consumers regarding the hardness of their water.

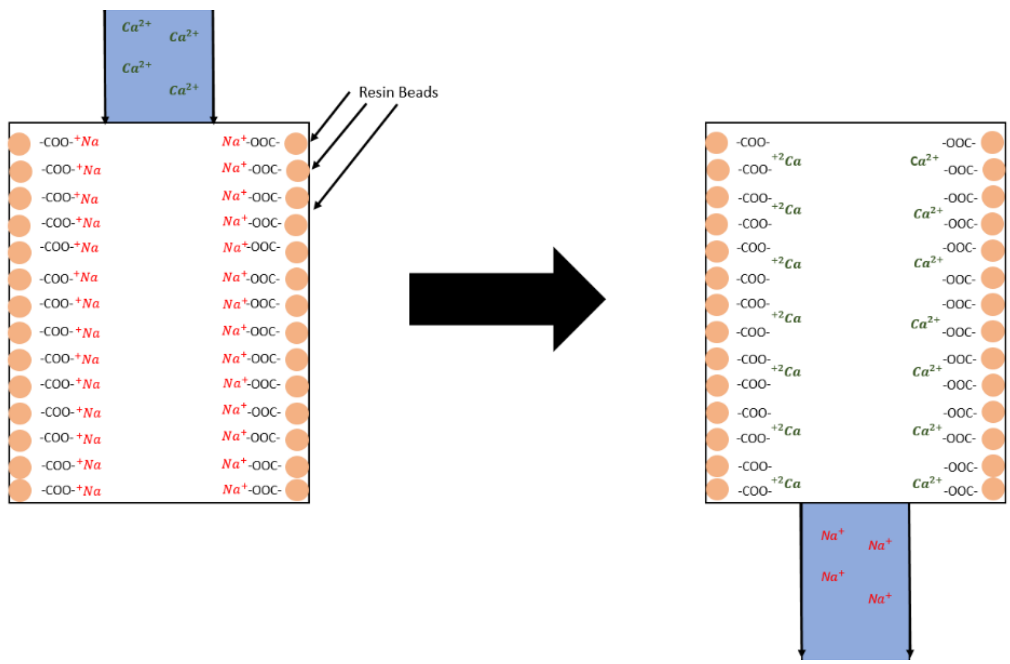
The City currently operates ion-exchange processes at the combined Well #3/4 facility, as well as the Ohio Avenue/Well #8 facility. This process is utilized to remove radium present in the deep well water, but as a byproduct also removes hardness. As a result, water quality varies across the distribution system with some residents receiving harder water than others. However, the level of hardness is still within the "Hard" to "Very Hard" range.

Viable alternatives for municipal water softening have developed rapidly over recent years, resulting in several potential technologies with different removal efficiencies and characteristics. The 2018 Water Utility Master Plan evaluated four potential alternatives that could be employed by the City of St. Charles including ion-exchange, lime softening, membrane separation (RO), and pelletizing. Each of these technologies provide distinct benefits and draw backs. Through the 2018 Plan and subsequent evaluations lime softening and pelletizing were removed from consideration. Lime softening was eliminated due to the capital cost, footprint necessary for the various processes, and inability to deal with intermittent or highly variable flows. Pelletizing was found to be ineffective due to the high proportion of magnesium-based carbonate hardness, which pelletizing is not efficient in removal. Therefore the two remaining alternatives to achieve softening would be ion-exchange and membrane separation, or reverse osmosis.

Ion-Exchange Softening

Municipal ion-exchange technology uses similar mechanisms to the household water softeners that are currently employed by many residents of St. Charles. An ion-exchange resin featuring positively charged sodium ions bound to negative anion groups is used to attract positively charged calcium and magnesium ions in the influent water. This resin consists of plastic beads with a diameter of around 0.6 mm, with each bead bonded to a mobile sodium ion. Calcium and magnesium ions, possess a greater affinity for the resin than sodium ions, so the resin will "exchange" the sodium cation for the calcium or magnesium cation, removing it from the source water. Sodium ions will not contribute to pipe scaling or mineral formation as they are significantly more soluble than calcium or magnesium. Shown at right is the system diagram. The system diagram displays that this alternative requires fewer additional pre- and post-treatment processes when compared to other alternatives discussed in this report.





Continuous cycles through the resin will degrade the concentration of available sodium ions for ion-exchange. In order to replenish or recharge the resin, a brine solution is used to backwash the media. Water with a high concentration of sodium chloride is used for backwashing, though this water has the capacity to raise chloride concentrations in effluent water. As backwashing is completed, the wastewater will have very high concentrations of calcium and magnesium ions that it has removed from the ion-exchange media as well as chlorides, and will need to be treated. In the City of St. Charles, this wastewater from backwashing presents the most significant challenge associated with the implementation of city-wide ion exchange.

Chlorides leaving the ion exchange unit must be monitored, as the wastewater facilities of the City of St. Charles already have high chloride concentrations in their influent waters. The Main Wastewater Treatment Facility has an average effluent chloride concentration of approximately 1,053 mg/L and the West Side Treatment Plant has a concentration of 1,361 mg/L. Wastewater treatment facilities have minimal removal efficiency for chlorides as they are not design for this purpose. As such, additional influent chlorides from ion exchange processes would not be removed in effluent wastewater.

These high concentrations of chlorides raise concern regarding the concentrations of chlorides that would be added by future implementation of ion exchange systems. Each combined treatment facility for Wells 7/13 and Wells 9/11 would be designed to treat a maximum flow of 3,000 GPM. The influent water has a total hardness of approximately 500 mg/L. Treatment would target a finished hardness of 130 mg/L. Flow would be divided through eight treatment vessels, each with a diameter of 10 feet. During average daily operation, the two systems would treat a total of 2,157,840 gallons, as 26% of flow would bypass the softeners. The eight treatment vessels would use a total of 18,864 pounds of salt each day. Therefore, the systems require 9,616 lbs of salt to treat 1,000,000 gallons of water. Sodium chloride is 61% chloride by weight, and using the current daily influent flow of 5 MGD to the Main Treatment Plant and 0.5 MGD to the West Side Treatment Plant, it was found that ion exchange at Wells 9/11 and 7/13 would lead to influent chloride concentrations of 1,153 mg/L at the Main WWTP and 3,478 mg/L at the West WWTP.

Over the last 10 years, chlorides have become a regulatory discussion, with wastewater facilities tributary to impaired waterways receiving NPDES permit limits for chlorides. Future regulations regarding chlorides are likely to set a Maximum Contamination Level of 500 mg/L in wastewater effluent. Furthermore, wastewater from the City of St. Charles discharges directly into the Fox River which was until recently listed by the Illinois EPA in its 303 (d) list of impaired waterways, with a "medium" priority level for chloride pollution. In the latest iteration of the 303 (d) list the Fox River chloride impairment was removed.

In order to examine the plausibility of softening using ion exchange, calculations were completed to determine the necessary reduction in residential softening to meet a potential future 500 mg/L water quality standard. The tables on the following page represent two scenarios; current average daily water production of 4.2 MGD and the future 6.0 MGD daily water production. For each scenario two options are considered – discharging a Well #7/13 IEX regeneration waste to the Main WWTP or discharging this waste to the West Side WRF. In both scenarios the Well #9/11 IEX regeneration is tributary to the Main WWTP.

As these tables show, implementation of ion-exchange softening without a corresponding drastic reduction in residential water softening would lead to WWTP effluent chloride concentrations further exceeding a potential future water quality standard. In the future daily average flow scenario, in order to achieve the 500 mg/L target all regeneration waste from a Well #7/13 facility would need to be conveyed to the Main WWTP. Even then, a reduction of nearly 80% of residential softening would need to occur after the implantation of city-scale softening to achieve the target.

For comparison purposes, conceptual site layouts for the two treatment facilities, as well as opinions of probable cost were developed. These can be found on the following pages.

Current Average Daily Flow (4.2 MGD)			
Regen Discharge Split Between Main WWTP & West WRF			
Main WWTP		West Side WRF	
43,910	lb influent total existing	5,675	lb influent total existing
1,569	lb cl influent 3/4/8 IEX	-	lb cl influent 3/4/8 IEX
1,532	lb cl influent 3/4/8/9/11 Raw	1,532	lb cl influent 7/13 Raw
40,809	lb cl influent res. Softeners	4,143	lb cl influent res. Softeners
3,912	lb cl influent for 9/11 IEX	-	lb cl influent for 9/11 IEX
-	lb cl influent for 7/13 IEX	3,912	lb cl influent for 7/13 IEX
47,822	lb influent total future	9,588	lb influent total future
1,147	mg/L cl future	2,299	mg/L cl future
66%	**Req'd res. softener reduction**	**181%**	**Req'd res. softener reduction**
Regen Discharge All to Main WWTP			
Main WWTP			
43,910	lb influent total existing		
1,569	lb cl influent 3/4/8 IEX		
1,532	lb cl influent 3/4/8/9/11 Raw		
40,809	lb cl influent res. Softeners		
3,912	lb cl influent for 9/11 IEX		
3,912	lb cl influent for 7/13 IEX		
51,735	lb influent total future		
1,241	mg/L cl future		
76%	**Req'd res. softener reduction**		

Future Average Daily Flow (6.0 MGD)			
Regen Discharge Split Between Main WWTP & West WRF			
Main WWTP		West Side WRF	
62,791	lb influent total existing	8,513	lb influent total existing
2,017	lb cl influent 3/4/8 IEX	-	lb cl influent 3/4/8 IEX
2,346	lb cl influent 3/4/8/9/11 Raw	2,346	lb cl influent 7/13 Raw
58,429	lb cl influent res. Softeners	6,167	lb cl influent res. Softeners
5,988	lb cl influent for 9/11 IEX	-	lb cl influent for 9/11 IEX
-	lb cl influent for 7/13 IEX	5,988	lb cl influent for 7/13 IEX
68,780	lb influent total future	14,501	lb influent total future
1,153	mg/L cl future	3,478	mg/L cl future
67%	**Req'd res. softener reduction**	**184%**	**Req'd res. softener reduction**
Regen Discharge All to Main WWTP			
Main WWTP			
62,791	lb influent total existing		
2,017	lb cl influent 3/4/8 IEX		
2,346	lb cl influent 3/4/8/9/11 Raw		
58,429	lb cl influent res. Softeners		
5,988	lb cl influent for 9/11 IEX		
5,988	lb cl influent for 7/13 IEX		
74,768	lb influent total future		
1,793	mg/L cl future		
77%	**Req'd res. softener reduction**		

Figure 6-1: Well #7/13 Ion-Exchange Treatment Facility

Figure 6-2: Well #9/11 Ion-Exchange Treatment Facility

Well #7/13 Ion Exchange Softening at Common Plant	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$1,724,174
SITEWORK	$1,540,466
ION EXCHANGE FACILITY	$7,120,593
EFFLUENT LIFT STATION	$917,300
Construction Sub-Total	**$11,310,000**
Contingency @ 20%	$2,262,000
Engineering & Administration @ 15%	$2,035,800
PROBABLE PROJECT COST:	**$15,610,000**

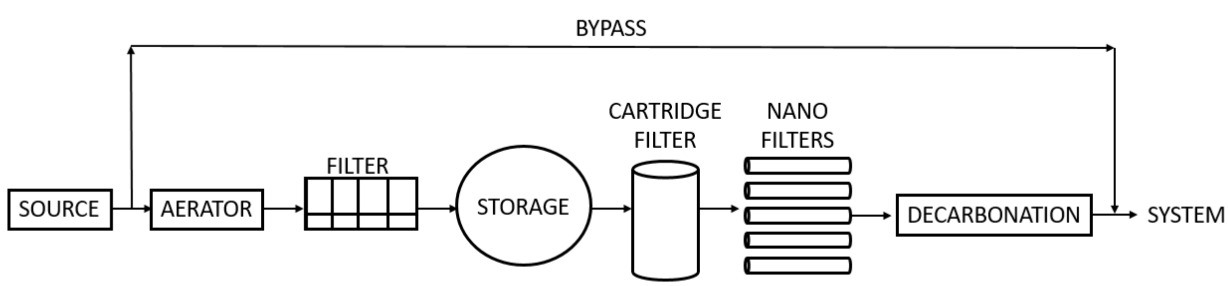
Well #9/11 Ion Exchange Softening at Common Plant	
Description	Total Probable Cost
SUMMARY	
LAND ACQUISITION	$100,000
GENERAL CONDITIONS	$2,098,492
SITE WORK	$1,595,096
WELL #9 & 11 TO WATER PLANT	$1,428,400
ION EXCHANGE PLANT	$8,017,206
Construction Sub-Total	**$13,240,000**
Contingency @ 20%	$2,648,000
Engineering & Administration @ 15%	$2,383,200
PROBABLE PROJECT COST:	**$18,280,000**

Membrane Separation (Reverse Osmosis)

Membrane softening works using physical mechanisms, whereas technologies such as ion-exchange or lime softening use chemical processes. This process is the same as was discussed in the section regarding PFAS removal. In membrane softening, influent water is forced through a semi-permeable membrane at very high pressures. For reverse osmosis, a pore size of 0.001 nanometers is used. Reverse osmosis uses smaller pores, with a size of 0.0001 – 0.001 nm. In order to prevent fouling or blocking of these pores, water treated using membrane softening should first pass through a more porous cartridge filter to reduce the concentration of larger particles.

Reverse osmosis uses very high pressure to reverse the natural process of balancing concentrations known as osmosis. Water would tend to flow across a semi-permeable membrane from a region with more dissolved solids to a region with fewer dissolved solids in order to balance the concentrations of contaminants between the two regions. In reverse osmosis, a pump is used to force water through a membrane from the more contaminated raw region to the pure effluent region. In natural osmosis, a molecular gradient is the impetus for movement of water whereas reverse osmosis uses an induced pressure gradient to encourage water movement.

Membrane softening technologies can be advantageous due to their small footprints and high removal efficiencies. Desired effluent hardness levels can be easily maintained by updating the blending ratio of untreated water, as treated water from reverse osmosis has lower quality variability than in the case of other technology alternatives. Another advantage of membrane filtration is that it requires fewer chemical inputs than other softening processes. Lastly, the modular nature of membrane technologies mean that it is easy to add capacity to these systems. If the population of the community expands beyond current projections, the City would be able to add additional racks of membrane spirals as opposed to constructing larger facilities as would be necessitated by other alternatives. The process diagram below shows the technologies used in membrane filtration softening.



A significant challenge associated with membrane softening is the high level of reject water produced. Contemporary reverse osmosis systems reject approximately 20% of water that enters the system. This is a challenge particularly for the Wells #7 and 13 for the City of St. Charles, where the reject water would typically be tributary to the West Side Wastewater Treatment Plant, which currently lacks the capacity to handle the reject water that would be produced by reverse osmosis at these wells. Therefore, reject from a Well #7/13 reverse osmosis facility may need to be pumped to one of the Main WWTP tributary basins.

Recently the City has discussed potentially expanding the existing West Side Wastewater Treatment Plant. If an expansion project is on the horizon for the West Side Facility, the City could increase the proposed capacity to include the reject water from the membrane softening process. Conversely, membrane filtration is an attractive alternative for the City of St. Charles as the process removes chlorides from influent water. Chloride waste from softening is one of the primary concerns for the City, so an alternative utilizing membrane softening could effectively address this concern.

If the City were to implement city-scale water softening, the most economical means would be through regional treatment facilities for the shallow wells; Well #7/13 WTP and Well #9/11 WTP. Conceptual opinions of probable cost, and layouts were developed for each of these alternatives.

The capital cost of a common Well #9/11 reverse osmosis facility is approximately 18% higher than a common Well #7/13 facility would be, because the first stage of pressure filtration already exists for Well #7/13 at the Oak Street WTP. Additionally, it is anticipated that a common Well #9/11 facility site along Route 25 would require additional raw water transmission main from each well to the treatment plant. The conceptual site for the Well #9/11 facility is on the west side of Route 25, north of the Q Center.

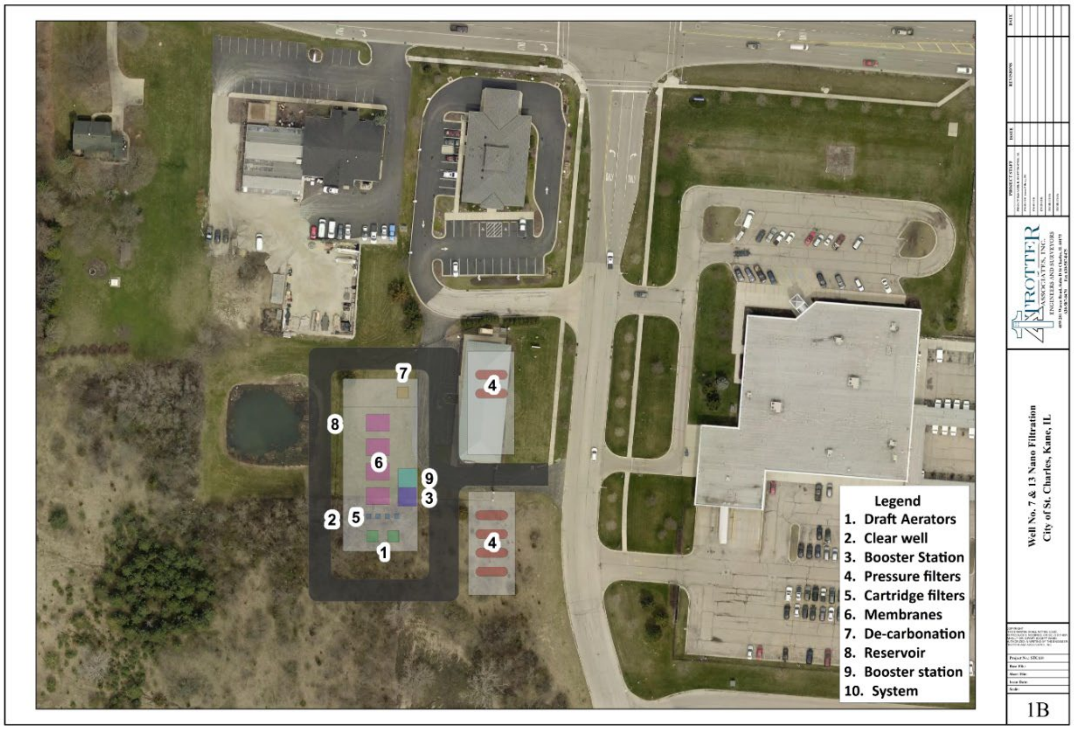


Figure 6-3: Well #7/13 Reverse Osmosis Treatment Facility

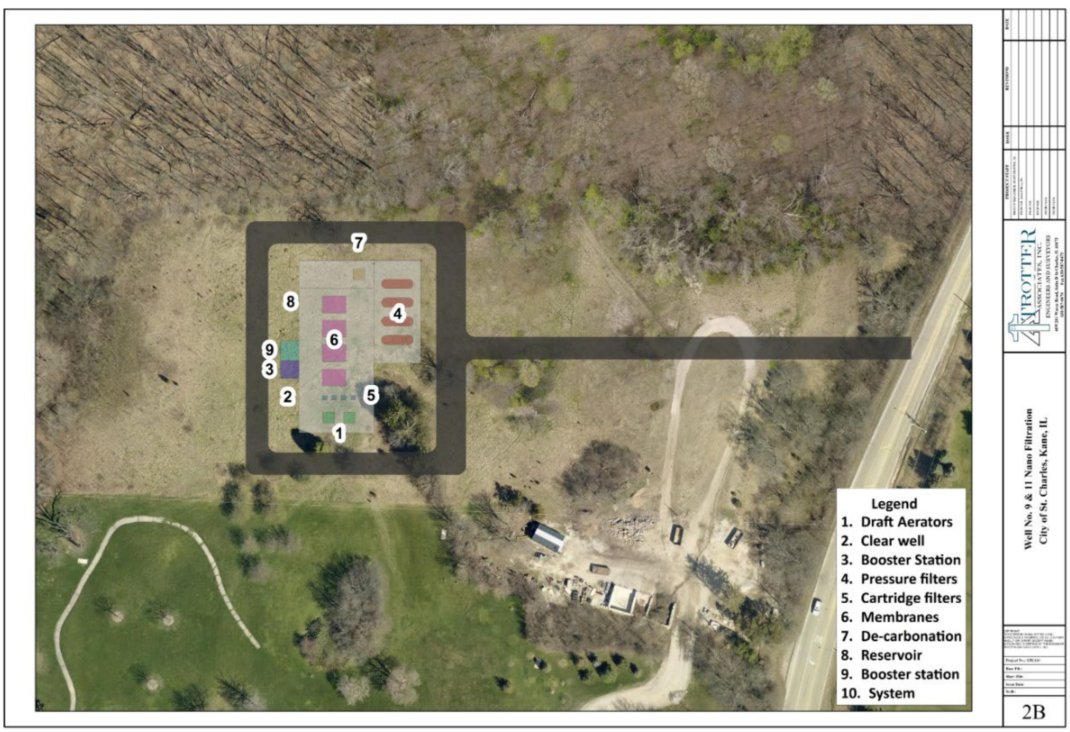


Figure 6-4: Well #9/11 Reverse Osmosis Treatment Facility

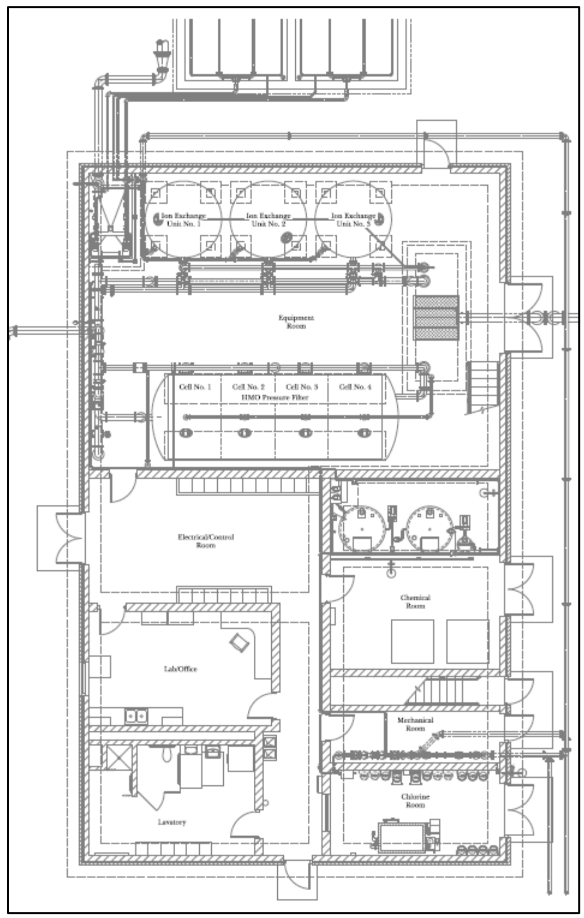
Well #7/13 Reverse Osmosis Softening at Common Plant	
Description	Total Probable Cost
SUMMARY	
LAND ACQUISITION	$400,000
GENERAL CONDITIONS	$4,460,505
SITEWORK	$3,038,020
INDUCED DRAFT AERATOR	$300,300
RAW WATER RESERVOIR	$2,687,100
PRESSURE FILTRATION FOR WELL #7	$7,935,981
MEMBRANE SYSTEM	$10,171,813
FINISHED WATER RESERVOIR	$2,687,100
SUBTOTAL CONSTRUCTION	**$31,690,000**
CONTINGENCY @ 20%	$6,338,000
ENGINEERING & ADMINISTRATION @ 15%	$5,704,200
PROBABLE PROJECT COST:	**$43,740,000**

Well #9/11 Reverse Osmosis Softening at Common Plant	
Description	Total Probable Cost
SUMMARY	
LAND ACQUISITION	$400,000
GENERAL CONDITIONS	$5,271,233
SITEWORK	$4,463,921
WELL #9 & 11 TO WATER PLANT	$3,682,476
INDUCED DRAFT AERATOR	$300,300
RAW WATER RESERVOIR	$2,688,400
PRESSURE FILTRATION	$7,923,337
MEMBRANE SYSTEM	$10,227,501
FINISHED WATER RESERVOIR	$2,688,400
SUBTOTAL CONSTRUCTION	**$37,650,000**
CONTINGENCY @ 20%	**$7,530,000**
ENGINEERING & ADMINISTRATION @ 15%	**$6,777,000**
PROBABLE PROJECT COST:	**$51,960,000**

Hardness Treatment Summary

The City has evaluated community-scale water softening a number of times over the past 20 years. Due to footprint, capital cost, or regulatory concerns, the viable alternatives have been reduced to ion-exchange or membrane separation (RO) softening. While ion-exchange has a significantly lower capital cost, it runs the risk of exceeding future chlorides water quality standards if less than 80% of residential softening is eliminated. This high level of residential reduction in use may provide to be very difficult to achieve as some residents may elect to further soften water below the municipal target of 150 mg/L. Reverse osmosis, on the other hand, has a higher capital cost but will remove hardness and other contaminants very effectively.

6.2.4. Radium Removal



The City currently operates radium removal facilities at Well #8/Ohio Ave WTP, and Well #3/4 WTP. Both of these facilities utilize parallel ion-exchange and HMO filtration for radium removal. The ion-exchange portion of the process also provides hardness removal, allowing the City to produce softer water while complying with radium requirements. Similar to ion-exchange for softening, the cationic resins within the vessels exchange positively charged sodium ions bound to the resin for the positively charged radium ions. The resin is regenerated by brining and backwashing, resulting in a waste rate of 3- 4% of forward flow. The hardness and radium are discharged to the sanitary sewer system. The HMO process is a adsorption and filtration technology. HMO (hydrous manganese oxide) is injected as slurry into the raw water; radium adheres to the HMO particles, which are then removed through filtration.

If the City elects to drill a new deep well, it is anticipated that a treatment facility with parallel IEX/HMO processes, similar to Wells #3/4/8, would be implemented. A conceptual opinion of probable cost for this supply treatment is included below. This estimate does not include the drilling of the well, pump, associated utilities, and site work, which can be found in Section 6.1. The following sub-sections 6.2.6 and 6.2.7 provide alternatives for wholistic supply and treatment which include both the supply costs from Section 6.1 and these treatment costs within Section 6.2.

Radium Removal for New Deep Well Supply				
Description				Total Probable Cost
SUMMARY				
GENERAL CONDITIONS	1	Lump Sum	$1,810,000	$1,810,000
12" TRANSMISSION MAIN	150	Lin. Ft	$450	$67,500
SITE WORK	1	Lump Sum	$350,000	$350,000
RADIUM REMOVAL FACILITY	1	Lump Sum	$6,800,000	$6,800,000
			SUBTOTAL CONSTRUCTION:	**$9,027,500**
			CONTINGENCY @ 20%:	$1,805,500
			ENGINEERING & ADMIN @ 15%:	$1,624,950
			PROJECT TOTAL:	**$12,458,000**

6.2.5. Iron / Manganese Removal

The City currently operates a common iron and manganese removal facility for shallow Well #7 & 13 at the Oak Street WTP. The treatment process includes horizontal pressure filters comprised of anthracite and Greensand Plus media. Chemical pre-treatment of the raw water includes chlorination with sodium hypochlorite, as well as sodium permanganate. These chemicals assist in the oxidation process of iron and manganese. These metals oxidize upstream and within the filter, with the Greensand media acting as a catalyst to expedite the oxidation reaction. Oxidized iron and manganese is precipitated and removed across the media, allowing the filtered effluent to travel through the filters and out.

If the City elects to drill a new shallow well for additional water supply, it is anticipated that the treatment process and structure would be modeled off the Well #7/13 Oak Street WTP to maintain consistency in technologies and operations. A conceptual opinion of probable construction cost for the treatment facility is included below. Similar to the radium removal treatment, this does not include the drilling of the well, pump, or associated utilities which can be found in Section 6.1.

Iron/Manganese Removal for New Shallow Well Supply				
Description				Total Probable Cost
SUMMARY				
GENERAL CONDITIONS	1	Lump Sum	$1,560,000	$1,560,000
12" TRANSMISSION MAIN	150	Lin. Ft	$450	$67,500
SITE WORK	1	Lump Sum	$350,000	$350,000
PRESSURE FILTRATION FACILITY	1	Lump Sum	$5,800,000	$5,800,000
			SUBTOTAL CONSTRUCTION:	**$7,777,500**
			CONTINGENCY @ 20%:	$1,555,500
			ENGINEERING & ADMIN @ 15%:	$1,399,950
			PROJECT TOTAL:	**$10,733,000**

6.2.6. Water Treatment Alternative #1 – Independent Treatment

The City will be required to complete treatment upgrades in order to recapture well capacity, comply with future regulatory requirements, provide improved water quality, and expand water production capacity to meet community growth. These needs vary in urgency and priority, however all will likely be required to be completed within the 20-year planning period.

The first alternative for long-term water treatment considers each of the improvements separately; PFAS removal at Well #9/11, ammonia removal at Well #11, softening at Well #9/11, and radium removal at a new deep well. For this alternatives, the following treatment processes were selected:

- Well #9/11 PFAS Removal – Granular activated carbon (GAC) was selected as the preferred solution for this alternative as it is a proven technology with solid waste stream and lower capital cost compared to ion-exchange or reverse osmosis.
- Well #11 Ammonia Removal – Biofiltration was selected for this alternative as it does not risk disinfection byproducts as breakpoint chlorination would, and has a significantly smaller footprint and lower capital cost than reverse osmosis.
- Well #9/11 Hardness Removal – Ion-exchange treatment was selected for this alternative to provide softening at a common facility. It is recommended that the City consider construction of a single softening facility at a common Well #9/11 site. A common facility at Well #9/13 with capacity of 3,000 gpm would be able to provide approximately 4.3 MGD of softened water. Coupled with the existing capacity of Well #3/4/8 which are already softened, the City's total softened water capacity would be roughly 5,500 gpm or 7.9 MGD. This would be further expanded with the completion of the Well #8 Expansion & Rehabilitation project. Therefore, the City may be able to provide the average daily demand as primarily softened water with the construction of only one softening facility. In order to convey this flow from a common Well #9/11 facility, transmission main upgrades discussed in Section 4 would likely need to be completed as well.
- New Deep Well Radium Removal – Parallel ion-exchange and HMO filtration were selected as the preferred radium removal technologies for this alternative, matching existing City facilities.

The table below reflects the total conceptual opinion of probable cost for the completing the treatment upgrades identified above as independent processes.

Water Treatment Alternative #1 - Independent Treatment	
Description	Total Probable Cost
SUMMARY	
WELL #9 PFAS REMOVAL - GRANULAR ACTIVATED CARBON WTP	$18,342,000
WELL #11 AMMONIA REMOVAL - BIOFILTRATION WTP	$11,679,000
WELL #9/11 HARDNESS REMOVAL - ION EXCHANGE WTP	$18,280,000
NEW DEEP WELL RADIUM REMOVAL - ION EXCHANGE / HMO WTP	$12,458,000
ALTERNATIVE #1 TOTAL:	**$60,759,000**

6.2.7. Water Treatment Alternative #2 – Regional Treatment

Due to the complexity of operating separate treatment facilities and processes to accomplish all of the City's water treatment goals, the feasibility of a single common facility was reviewed. Each of the technologies reviewed are capable of removing multiple contaminants in varying efficiencies. To determine whether a common process could provide treatment for several contaminants simultaneously, the detected contaminant levels across all wells were reviewed against their respective water quality goals, summarized in the tables below.

Detected Contaminant Levels	Well No.	Well No. 3	Well No. 4	Well No. 8	Well No. 7	Well No. 9	Well No. 11	Well No. 13
Contaminants (units in mg/L unless noted otherwise below)								
Hardness (Ca2+, Mg2+)		250	240	260	530	450	530	430
Iron -Fe2+ (soluble)		0.19	0.17	0.028	2.7	0.01	0.32	1.4
Manganese Mn2+ (soluble) (µm/L)		5.2	4.7	3.4	50	16	130	50
Iron Oxides - FeO, Fe(OH)3 (Insoluble, Fully Oxidized)							0.17	
Radium (Combined Ra226/Ra228)(piC/L)		10.92	10.44	11.99				
Ammonia / Ammonium (NH3, NH4$^+$)(as N)		0.43	0.45	0.52	0.22	0.075	0.62	0.12
Nitrate(NO3$^-$)(as N)							0.3	
Shorter-chain PFAS Compounds (PFBA, PFHxA, PFBS, PFHxS, etc.)								
Perfluorohexanesulfonic acid (PFHxS) (ppt)								2.3
Perfluorobutanesulfonic acid (PFBS) and its related compound potassium-PFBS (ppt)						3.2	2.7	3.6
Hexafluoropropylene dimer acid (HFPO-DA) and its ammonium salt (ppt)								
Longer-chain PFAS Compounds (PFOS, PFOA, PFNA, etc.)								
Perfluorooctanoic acid (PFOA) (ppt)								
Perfluorooctanesulfonic acid (PFOS) (ppt)						2.3		
Perfluorononanoic acid (PFNA) (ppt)								

Water Quality Goals, MCLs, & SMCLs	Well No.	Well No. 3	Well No. 4	Well No. 8	Well No. 7	Well No. 9	Well No. 11	Well No. 13
Contaminants (units in mg/L unless noted otherwise below)								
Hardness (Ca2+, Mg2+)		140	140	140	140	140	140	140
Iron -Fe2+ (soluble)		0.3	0.3	0.3	0.3	0.3	0.3	0.3
Manganese Mn2+ (soluble) (µm/L)		50	50	50	50	50	50	50
Iron Oxides - FeO, Fe(OH)3 (Insoluble, Fully Oxidized)		ND	ND	ND	ND	ND	ND	ND
Manganese Oxides- MnO, Mn(OH)2) (Insoluble, Fully Oxidized) (µm/L)		ND	ND	ND	ND	ND	ND	ND
Radium (Combined Ra226/Ra228)(piC/L)		5	5	5	5	5	5	5
Ammonia / Ammonium (NH3, NH4$^+$)(as N)		0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nitrate(NO3$^-$)(as N)		10	10	10	10	10	10	10
Shorter-chain PFAS Compounds (PFBA, PFHxA, PFBS, PFHxS, etc.)								
Perfluorohexanesulfonic acid (PFHxS) (ppt)		ND	ND	ND	ND	ND	ND	ND
Perfluorobutanesulfonic acid (PFBS) and its related compound potassium-PFBS (ppt)		ND	ND	ND	ND	ND	ND	ND
Hexafluoropropylene dimer acid (HFPO-DA) and its ammonium salt (ppt)		ND	ND	ND	ND	ND	ND	ND
Longer-chain PFAS Compounds (PFOS, PFOA, PFNA, etc.)								
Perfluorooctanoic acid (PFOA) (ppt)		ND	ND	ND	ND	ND	ND	ND
Perfluorooctanesulfonic acid (PFOS) (ppt)		ND	ND	ND	ND	ND	ND	ND
Perfluorononanoic acid (PFNA) (ppt)		ND	ND	ND	ND	ND	ND	ND

LEGEND - Contaminants Levels
Detected
Not Detected/Below Level of Concern
No/Insufficient Sample Data

Each of the contaminants present were then listed in a matrix to visually represent the most effective treatment for multiple contaminants. 28 treatment processes and technologies were reviewed, which are shown in the tables below. Green boxes indicated effective treatment for a particular contaminant, orange indicated ineffective or not established as a full-scale technology for a given parameter.

Master Treatment Alternatives Matrix

Contaminants (units in mg/L unless noted otherwise below) / Treatments & Treatment Alternatives	Bypass/Blending	*Granular Activated Carbon Absorption (Non-regenerative)	**Powdered Activated Carbon (PAC) Absorption + Filtration or Clarification	Permanganate Absorption/Precipitation	Hydrous Manganese Oxide (HMO) Absorption/Precipitation	Ion Exchange - Regenerative Anion Resins	Ion Exchange - Non-Regenerative Anion Resins	Ion Exchange - Regenerative Cation Exchange Resin	Ion Exchange - Non-Regenerative Cation Resins	Ion Exchange - Non-regenerative Inorganic Zeolite Media	****Novel Ion Exchange / Absorptive Medias (Bench/Pilot Scale, NOT Commercial Scale)	Granular Media Pressure Filtration (Gravel, Sand, Anthracite)	Granular Media Pressure Filtration (Greensand MnO Media)
Hardness (Ca2+, Mg2+)													
Iron -Fe2+ (soluble)													
Manganese Mn2+ (soluble) (μm/L)													
Iron Oxides - FeO, Fe(OH)3 (Insoluble, Fully Oxidized)													
Manganese Oxides- MnO, Mn(OH)2) (Insoluble, Fully Oxidized) (μm/L)													
Radium (Combined Ra226/Ra228)(piC/L)								>99%	>99%	>99%			
Ammonia / Ammonium (NH3, NH_4^+)(as N)													
Alkalinity (Bicarbonate, carbonate, and hydroxide ions),Nitrate and various trace contaminants present in anionic form such as arsenic, selenium, chromium, perchlorate, and uranium													
Shorter-chain PFAS Compounds (PFBA, PFHxA, PFBS, PFHxS, etc.)													
Perfluorohexanesulfonic acid (PFHxS) (ppt)		>99%	<=99%				>99%				>99%		
Perfluorobutanesulfonic acid (PFBS) and its related compound potassium-PFBS (ppt)		>99%	<=90%				>99%				>99%		
Hexafluoropropylene dimer acid (HFPO-DA) and its ammonium salt (ppt)		>99%					>99%				>99%		
Longer-chain PFAS Compounds (PFOS, PFOA, PFNA, etc.)													
Perfluorooctanoic acid (PFOA) (ppt)		>99%	<=95%				>99%				>99%		
Perfluorooctanesulfonic acid (PFOS) (ppt)		>99%	<=99%	<53%			>99%				>99%		
Perfluorononanoic acid (PFNA) (ppt)		>99%	<=98%				>99%				>99%		

Master Treatment Alternatives Matrix

Contaminants (units in mg/L unless noted otherwise below) / Treatments & Treatment Alternatives	Membrane Filtration - Microfiltration	Membrane Filtration - Ultrafiltration	Membrane Separation - Nanofiltration	Membrane Separation - Reverse Osmosis	Aeration / Air Stripping	Biological Filtration (Trickling filter, etc.)	Biological Nitrification/Denitrification	Conventional Treatment (Coagulation, Flocculation, Clarification, Filtration)	UV Irradiation	Ozone	Breakpoint Chlorination	Chlorine Gas / Sodium Hypochlorite	Corrosion Sequestration (Poly/ortho phosphate)*****
Hardness (Ca2+, Mg2+)			>99%	>99%									
Iron -Fe2+ (soluble)			>99%	>99%									
Manganese Mn2+ (soluble) (μm/L)													
Iron Oxides - FeO, Fe(OH)3 (Insoluble, Fully Oxidized)			>99%	>99%									
Manganese Oxides- MnO, Mn(OH)2) (Insoluble, Fully Oxidized) (μm/L)			>99%	>99%									
Radium (Combined Ra226/Ra228)(piC/L)				>99%									
Ammonia / Ammonium (NH3, NH_4^+)(as N)			<66%	>99%									
Alkalinity (Bicarbonate, carbonate, and hydroxide ions),Nitrate and various trace contaminants present in anionic form such as arsenic, selenium, chromium, perchlorate, and uranium			***	***									
Shorter-chain PFAS Compounds (PFBA, PFHxA, PFBS, PFHxS, etc.)													
Perfluorohexanesulfonic acid (PFHxS) (ppt)			>99%	>99%									
Perfluorobutanesulfonic acid (PFBS) and its related compound potassium-PFBS (ppt)			>99%	>99%									
Hexafluoropropylene dimer acid (HFPO-DA) and its ammonium salt (ppt)			>99%	>99%									
Longer-chain PFAS Compounds (PFOS, PFOA, PFNA, etc.)													
Perfluorooctanoic acid (PFOA) (ppt)		<=56%	>99%	>99%									
Perfluorooctanesulfonic acid (PFOS) (ppt)		<=43%	>99%	>99%									
Perfluorononanoic acid (PFNA) (ppt)			>99%	>99%									

LEGEND - Treatment Alternatives
Effective Treatment
Ineffective Treatment

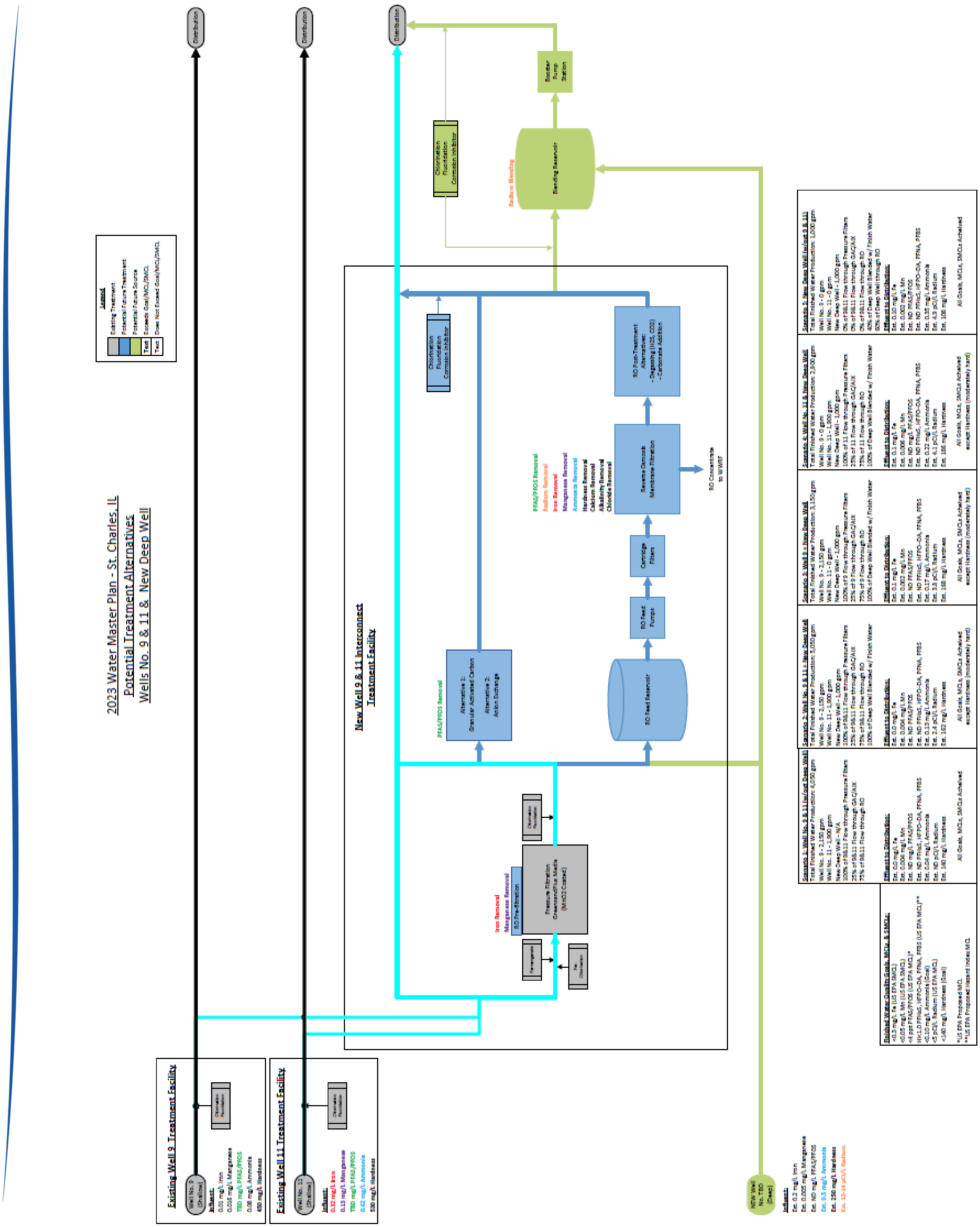
As shown in the preceding tables, several of the treatment processes remove more than one present contaminant. The most effective across all processes was membrane separation, reverse osmosis. Specifically, RO is proven very effective in removal of PFAS compounds, radium, iron/manganese, ammonia, hardness, and chlorides among others. As such, it would be a beneficial choice for a combined treatment facility to remove these contaminants.

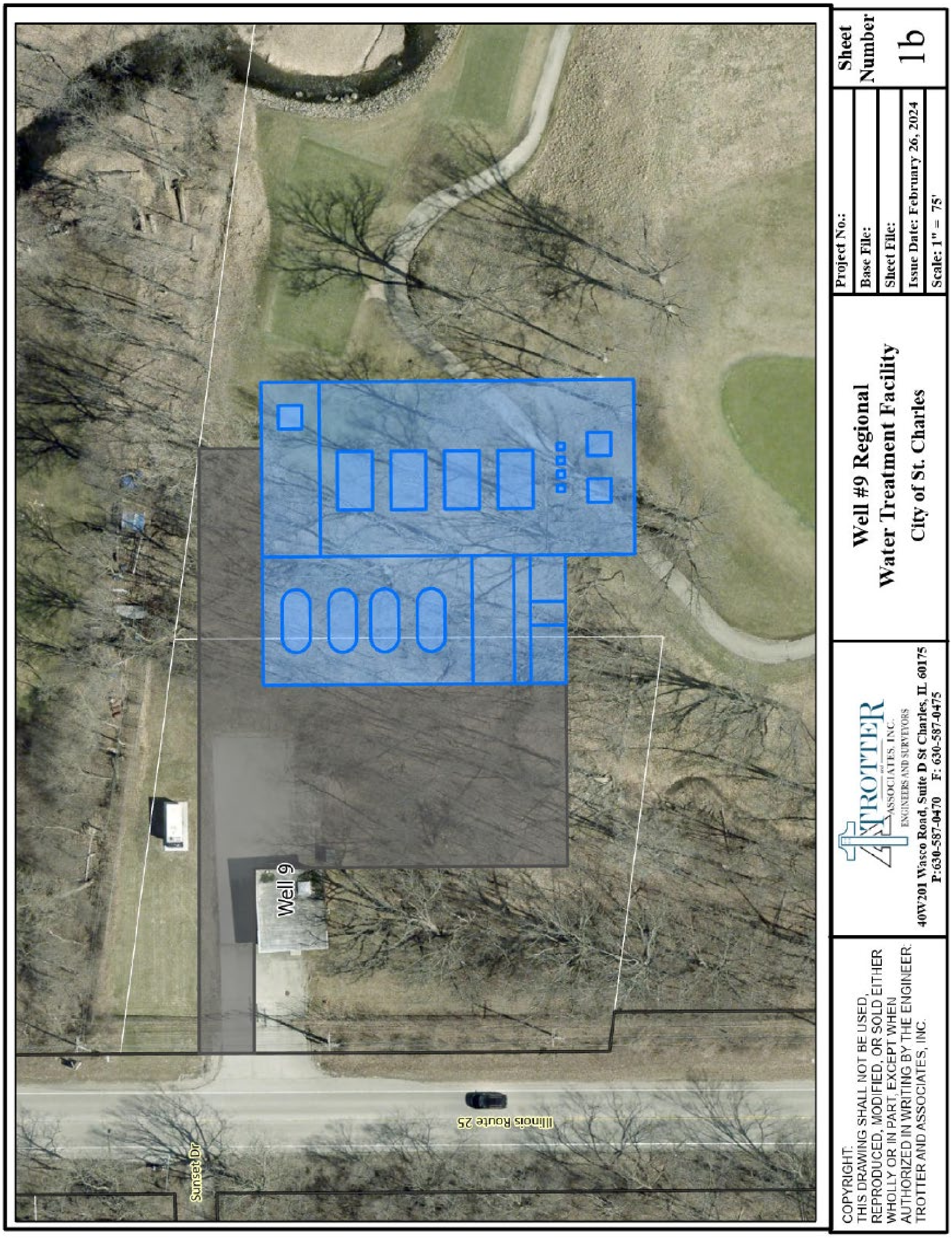
On the following page is a process flow diagram developed illustrating the components which would comprise this facility. It is very similar to a conventional reverse osmosis facility; however, it also incorporates the deep well supply conveyed to the proposed WTP. In this case the deep well could either be blended with the shallow wells in the reservoir to meet radium limits or could be directed to the RO membranes for radium removal if sufficient blending flow was not available at that time. This process flow diagram represents an RO facility treating water from Well #9 & 11, in addition to a new deep well.

One of the advantages to this alternative is that it would accomplish softening without contributing chlorides to the waste stream of the WWTP. Alternative #1 considered the use of the less expensive ion-exchange process which may present regulatory issues down the road with chlorides water quality standards. A drawback to this process flow is that it would generate a waste stream (RO reject) with elevated PFAS. However, if PFAS limitations were applied to wastewater/biosolids in the future, a GAC system could be installed on the RO reject stream for PFAS adsorption. This would also require a smaller GAC system than full process flow, since it's only treating the +/- 20% reject stream from the RO process.

A conceptual opinion of probable cost for this alternative is included below. The site for this proposed WTP could be east side of Rt. 25/north of Q Center previously discussed, or if land was available, it could be located at Well #9 or 11. Example layouts of each of these sites follows the process flow diagram.

Treatment Alternative #2 – Regional Treatment	
Description	Total Probable Cost
SUMMARY	
LAND ACQUISITION	$400,000
GENERAL CONDITIONS	$5,500,413
SITEWORK	$4,463,921
WELL #9 & 11 TO WATER PLANT	$3,682,476
INDUCED DRAFT AERATOR	$300,300
RAW WATER RESERVOIR	$2,688,400
PRESSURE/CARTRIDGE FILTRATION	$8,553,675
MEMBRANE SYSTEM	$11,054,122
FINISHED WATER RESERVOIR/BOOSTERS	$2,688,400
SUBTOTAL CONSTRUCTION:	**$39,340,000**
CONTINGENCY @ 20%:	**$7,868,000**
ENGINEERING & ADMINISTRATION @ 15%:	**$7,081,200**
PROBABLE PROJECT COST:	**$54,290,000**


2023 Water Master Plan - St. Charles, IL
Potential Treatment Alternatives
Wells No. 9 & 11 & New Deep Well
New Well 9 & 11 Interconnect Treatment Facility
Existing Well 9 Treatment Facility
Existing Well 11 Treatment Facility
Distribution
Distribution
Distribution
Blending Reservoir
RO Feed Reservoir
Reverse Osmosis Membrane Filtration


Well 9
Illinois Route 25
Sunset Dr
Sheet Number
1b
Project No.:
Base File:
Sheet File:
Issue Date: February 26, 2024
Scale: 1" = 75'
Well #9 Regional
Water Treatment Facility
City of St. Charles
TROTTER AND ASSOCIATES, INC.
ENGINEERS AND SURVEYORS
40W201 Wasco Road, Suite D St Charles, IL 60175
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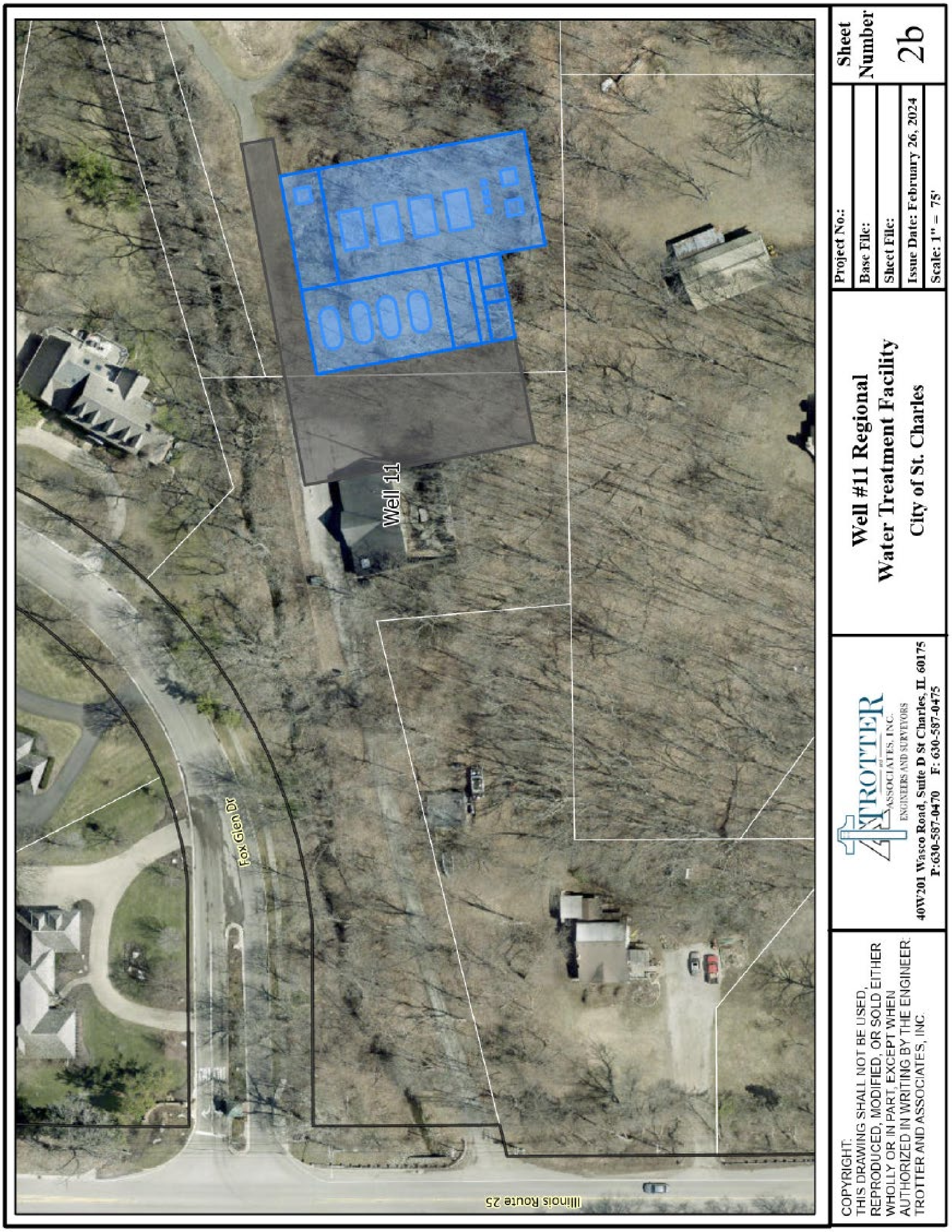
Well 11
Fox Glen Dr
Illinois Route 25
Sheet Number
2b
Project No.:
Base File:
Sheet File:
Issue Date: February 26, 2024
Scale: 1" = 75'
Well #11 Regional
Water Treatment Facility
City of St. Charles
TROTTER and ASSOCIATES, INC.
ENGINEERS AND SURVEYORS
40W201 Wasco Road, Suite D St Charles, IL 60175
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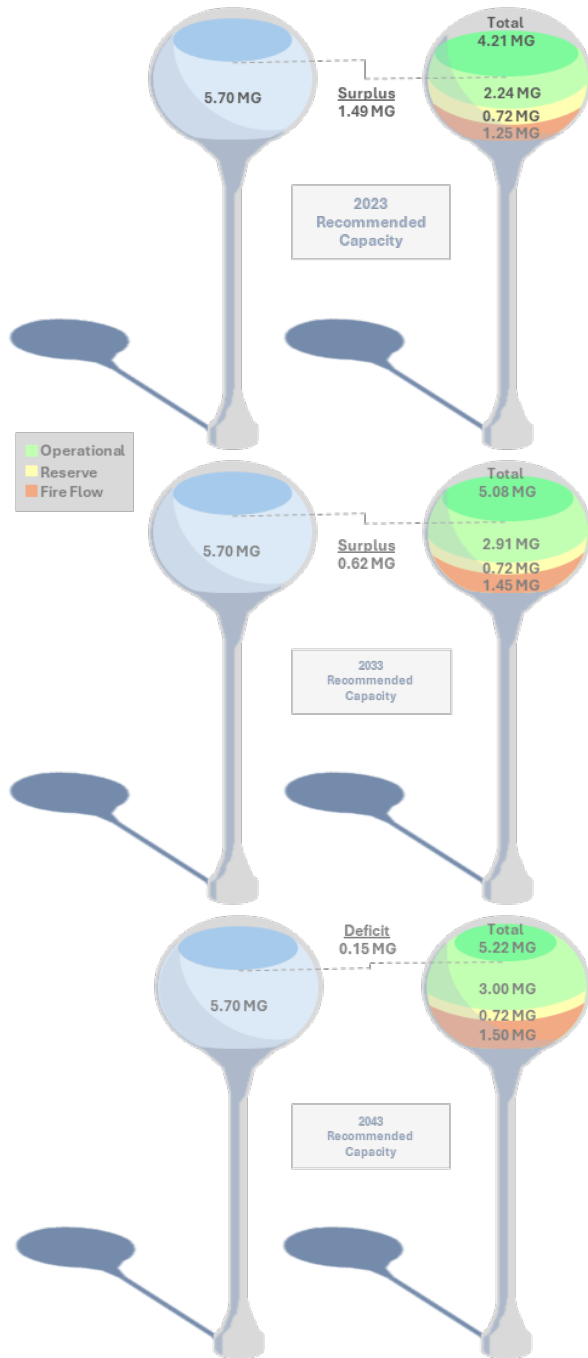
6.3. Water Storage Analysis



Recommended water storage volume consists of three components: fire flow, operational, and reserve storage. Fire flow requires 3,000 gallons per minute for four hours, or 720,000 gallons of storage. Operational storage is equivalent to 25% of the maximum day demand (8.96 million gallons), or 2.24 million gallons. Lastly, the City should maintain 12.5% of the maximum day demand, 1.25 million gallons in reserve storage. Combining these components gives a recommended 2023 Storage of approximately 4.2 MG, a 2033 storage capacity of 5.1 MG, and a 2043 storage capacity of 5.2 MG.

Under average day demand the City has the well production and treatment capacity to produce 3,000 gpm in surplus capacity. Some communities consider this excess capacity under average demand scenarios as the fire flow capacity and reduce the associated storage recommendation. While this may be the case under average demand scenarios, it does not account for a fire flow scenario during high demand periods. Therefore, it is recommended that the three above storage recommendations of fire flow, operational, and reserve be utilized for planning purposes.

The exhibits to the right display the current storage capacity for the City of St. Charles, as well as the 2023 and 2043 storage recommendations for the three components detailed above. As shown in the exhibit, the City currently has a storage surplus of 1.5 MG, as well as an estimated surplus of 500,000 gallons in 2043.

It should also be noted that while the City has a 'surplus' based on recommended standards, the storage serves a number of additional purposes such as reduction in water hammer and increased fire flows in areas of water towers.

While it is not recommended that the City construct additional water storage through the current planning horizon, the existing storage facilities will need to be maintained and rehabilitated. The City budgets for tank inspections annually on a rotating basis to cover all storage infrastructure. Most of the City's water storage infrastructure remains in very good condition, with both the Campton Hills and 10th Street towers recently rehabilitated. The two ground storage reservoirs at Ohio Avenue were also rehabilitated in 2020 and are not anticipated to require significant investment in the near-term.

6.4. SUMMARY

As detailed in Section 2 – Community Needs, the City of St. Charles anticipates significant growth over the next five years. For planning purposes, this growth is anticipated to result in increased maximum day water usage on a linear basis. As a result, the current maximum day demand of 8.96 MGD may increase to 11.64 MGD in 2033 by the end of the 10-year planning horizon. Therefore, the City should continue reviewing alternatives for additional water supply and treatment, and must maintain all current facilities.

Section 6.1 of this report reviewed four alternatives for additional water supplies, at least one of which will be needed within the five-year planning period. Of the four alternatives, sourcing Lake Michigan water via the DuPage Water Commission was found to have the highest capital cost by a significant margin, and would also require raising water rates to the current DWC rate plus operating expenses and debt service. The Fox River alternative was not recommended due to both the potential for contamination, and the capital cost associated with constructing regional surface water treatment facilities. The remaining two options, shallow or deep groundwater wells, are both viable and should continue to be pursued by the City. The cost of a shallow well was estimated at $6.2M without treatment, and a deep well at $8.7M. With the associated filtration or radium removal required, this translates to $16.9M for a shallow well with treatment, or $21.1M for a deep well with treatment. In order to determine a suitable site for a shallow well the City should continue its test hole drilling program. **It is recommended that the City continue to budget approximately $200,000 annually until a suitable well site is found.** This amount would cover test holes, and a test well if a promising location is identified.

The City will also be required to upgrade the existing treatment facilities in order to recapture well capacity at Well #11 due to elevated ammonia, mitigate potential PFAS compounds at Well #9 and/or #13, and move towards the goal of softened water. These treatment challenges can be dealt with individually, or through regional treatment facilities. Section 6.2 of this report developed Alternative #1 to include individual treatment processes for each of these treatment needs at a total estimated capital cost of $60.8M. Alternative #2 considers a regional treatment facility near Well #9 & 11 which would include installation of a reverse osmosis process to remove radium, PFAS, ammonia, chlorides, and provide softened water. The total estimated capital cost for this alternative was $54.3M. **Due to the lower capital cost, reduced built infrastructure to maintain, and improved water quality, Alternative #2 would be recommended.** Both of these alternatives include the cost for radium treatment of a new deep well, and as such the only additional cost would be the actual well drilling. Currently Well #9 & 11 comprise roughly 1.4 MGD of the City's daily water production, which at a 20% RO reject rate would mean approximately 280,000 GPD of additional loading to the Main WWTP. The 2023 Facility Plan identified a buildout flow to the plant of 6.09 MGD, compared to an 80% allowable loading of approximately 7.2 MGD. Therefore, the Main WWTP likely has this excess capacity.

Because PFAS and ammonia treatment efficiency are relatively site-specific, it is recommended that the City perform pilot testing of several technologies prior to selecting an alternative. The three primary PFAS removal processes of granular activated carbon, anion exchange, and reverse osmosis should be tested for removal of all PFAS compounds. **It is recommended that the City budget approximately $150,000 for six-month pilot testing and reporting.**

The table below shows the impact to City water supply with completion of the Well #8 Expansion in 2026, as well as the drilling of a new deep well in conjunction with Alternative #2 Water Treatment Facility in 2029. As shown, the completion of these project is anticipated to provide adequate supply and treatment capacity through City buildout.

	Future Demands and Supply Capacities (with Well #8 Expansion Completed in 2026 & Alternative #2 WTP Completed in 2029)				
Year	Max Demand (MGD)	Total Supply (MGD)	Total Deficiency (MGD)	Firm Supply (MGD)	Firm Deficiency (MGD)
2023	9.00	11.45	-	8.93	0.07
2024	9.45	11.45	-	8.93	0.52
2025	9.90	11.45	-	8.93	0.97
2026	10.35	12.89	-	10.37	-
2027	10.80	12.89	-	10.37	0.43
2028	11.25	12.89	-	10.37	0.88
2029	11.35	15.55	-	13.03	-
2030	11.45	15.55	-	13.03	-
2031	11.55	15.55	-	13.03	-
2032	11.65	15.55	-	13.03	-
2033	11.75	15.55	-	13.03	-
2034	11.80	15.55	-	13.03	-
2035	11.85	15.55	-	13.03	-
2036	11.90	15.55	-	13.03	-
2037	11.95	15.55	-	13.03	-
2038	12.00	15.55	-	13.03	-
2043	12.00	15.55	-	13.03	-
Buildout	12.75	15.55	-	13.03	-

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SECTION 7

SUMMARY & IMPLEMENTATION PLAN

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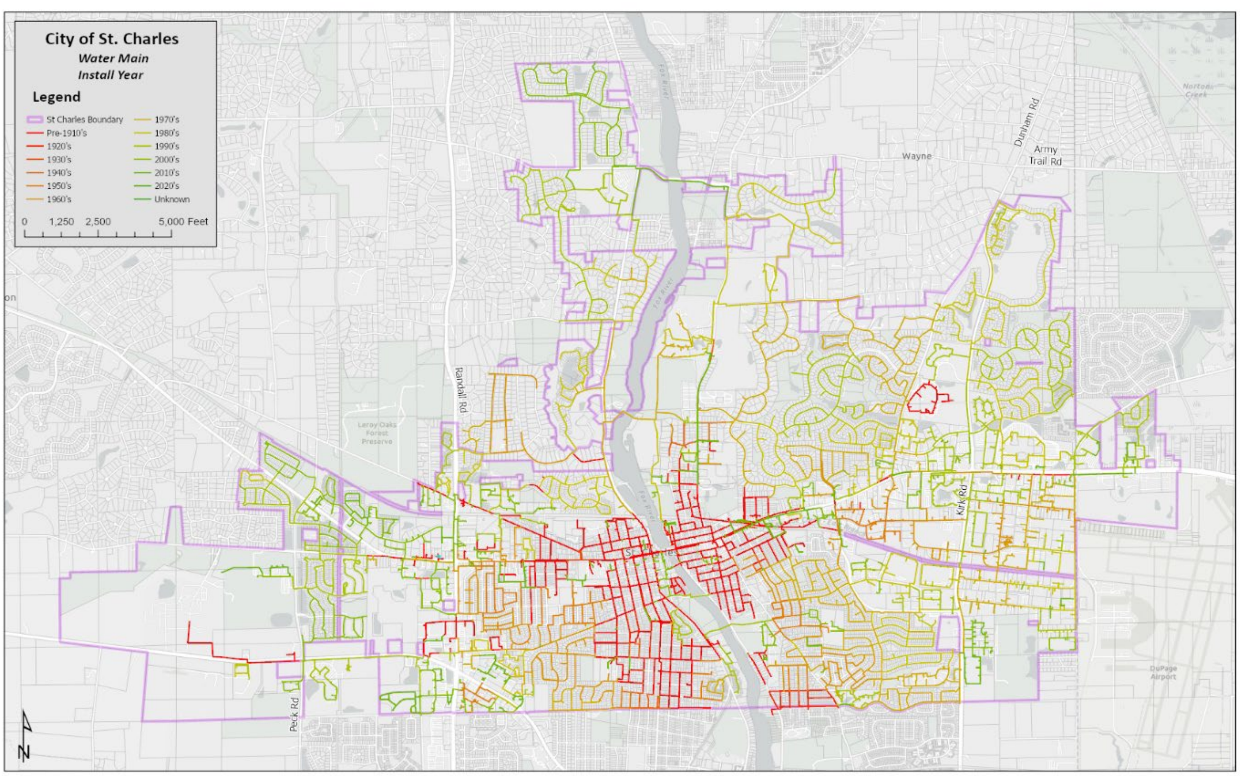
7. Summary & Implementation Plan

7.1. Implementation Plan

The City is responsible for providing safe and reliable water service for the communities both within the corporate boundary and in the neighboring areas. The preceding sections have described the Planning Area, the current and future capacity needs, the existing supply, storage, treatment, and distribution system infrastructure, and recommended improvements to maintain the level of service that the community's residents and businesses expect.

As discussed in Section 2, there is a significant amount of growth projected within the service area which requires an expansion of the existing water supply, and rehabilitation of existing treatment infrastructure to meet these development needs. Additionally, new regulatory requirements, specifically involving lead service lines and emerging contaminants such as PFAS will require a significant investment to maintain State and Federal Compliance.

Based on the distribution system analysis within Section 3, the City should target an annual replacement funding level of approximately $8.56M in water main replacement and upgrades. This is based on an average 75-year service life of the buried piping. Nearly 30% of the City's distribution system has met or exceeded this anticipated 75-year service life. As pipe ages beyond this service life, main breaks and deterioration may occur more rapidly and result in increased emergency repair costs. The distribution projects identified in the implementation plan build towards this $8.56M annual funding level. Priority should be given to projects replacing aged 4-inch main which is primarily located within the inner pressure zone, or downtown area. Additionally, the City has identified an annual Lead Service Line Replacement funding level of $8.42M top meet the revised LSRI regulations.



City of St. Charles
10-Year Capital Improvements Plan
($ in Millions, 2024 Dollars)

Water Supply, Treatment & Storage Upgrades											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**Project Total**
Water Well Test Drilling	0.32	0.32									***0.64***
Well #8 Expansion & Rehabilitation	0.75	8.75	8.75								***18.25***
Well #11 Booster Station Electrical Upgrades	0.02	0.15									***0.17***
Well #9 & 11 Treatment Plant and New Deep Well		0.15	3.50	25.40	25.40						***54.45***
Reservoir #3/4 Repair & Coating		0.75									***0.75***
Red Gate Tower Repair & Coating					0.85						***0.85***
Campton Hills Tower Repair & Coating							0.85				***0.85***
10th Street Tower Repair & Coating									0.63		***0.63***
Fiscal Year Total:	**1.09**	**10.12**	**12.25**	**25.40**	**26.25**	**0.00**	**0.85**	**0.00**	**0.63**	**0.00**	***76.59***

Distribution System Upgrades											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**Project Total**
Annual Lead Line Replacement	0.17	0.38	8.42	8.42	8.42	8.42	8.42	8.42	8.42	8.42	***67.91***
S. 7th Ave WM (Main to Division)	0.03										***0.03***
Prairie Street WM (13th to Randall)	1.59										***1.59***
4th, 6th & 7th WM Phase II	1.82										***1.82***
Swenson FDR (Kirk to Kautz)	0.45										***0.45***
Division Street WM (IL 25 to Kirk)	0.06	0.02	1.89								***1.97***
Beatrice WM (S. 7th to W. Dead-End)	0.05	1.00									***1.05***
N. 12th Street WM (W. Main to Dead-End)	0.04	1.53									***1.57***
N. 6th Street WM (State St. Creek to State)	0.05	0.71									***0.76***
Stem & Stenson FDR (Kirk to Kautz)		0.58									***0.58***
S. 4th Place WM (Beatrice to Moore)		0.06	0.80								***0.86***
Rt. 64 WM (S. 19th Street to S. 17th Street)		0.04	0.46								***0.50***
Cutler St. WM (S. 8th-S. 7th & Mosedale to Horne)		0.06	0.77								***0.83***
Southgate Course and 2 Courts		0.14	2.80								***2.94***
Horne WM (S. 8th-S. 7th & Horne to Fellows)			0.07	0.96							***1.03***
Wing Lane WM (N. Tyler to Allen)			0.06	0.83							***0.89***
WM Replacement at Eastern Trunk P#3			0.12	1.81	2.17						***4.10***
S. 14th Street WM & S. 16th Street (14th to Prairie)				0.10	1.27						***1.37***
Annual Water Main Replacement not ID in CIP						8.56	8.56	8.56	8.56	8.56	***42.80***
Fiscal Year Total:	**4.26**	**4.52**	**15.39**	**12.12**	**11.86**	**16.98**	**16.98**	**16.98**	**16.98**	**16.98**	***133.05***

Values in the table above are in million-dollar units, in 2024 dollars. Future budgeting should utilize a construction cost index (CCI) to project costs and funding needs. While the CCI has fluctuated significantly over the past several years, a value in the range of 4-5% annually is recommended.

7.2. Capital Funding and Alternative Funding Sources

The City has several different funding options available in order to successfully fund the outlined projects. Some of the different funding options include the Illinois EPA State Revolving Fund (SRF) Low-Interest Loan Program, Bonds, and Grants.

7.2.1. Illinois EPA Low-Interest Loan State Revolving Fund (SRF)

The IEPA State Revolving Fund is a program that has been developed as a part of the Illinois Clean Water Initiative (CWI). It is this initiative that maintains the Public Water Supply Loan Program (PWSLP) which funds water distribution, supply, and storage projects, and has been doing so since the late 1980's. Each year, this program receives Federal Capital Funding which is matched with State Funds, interest earning, repayment money, and the sale of bonds. It is these funding mechanisms that are utilized by the State to form a continuous source of financing for water infrastructure projects.

The Illinois EPA Low-Interest Loan program was developed to provide financial assistance to both the public and private applications for design and construction of projects that protect or improve the quality of Illinois' water resources. In the past several years, the State has funded around $300-400 Million dollars of clean water projects. For state fiscal year 2025, the base interest rate is 1.87% with an intended total funding amount of approximately $355M. Principal Forgiveness is available through the SRF program for qualifying projects, which currently include primarily lead service replacement projects and emerging contaminants (PFAS) related projects. As the City may elect to implement projects to mitigate potential PFAS concerns, this principal forgiveness should be identified and requested with any Project Plan.

A specific application process has been developed to obtain SRF funding, and requires a project nomination form, as well as planning approval of a project plan or facility plan for the community pursuing funding. Once a community has an approved proejct plan, additional documentation including a loan application will be completed with a financial checklist. At the point where the project has been bid, and is moved into construction, a final loan agreement will be executed.

Each year the loan rate is established on July 1st, and a typical loan is written around a 20-year term. However, the state has recently developed additional programs to provide reduced interest rates for "small communities", and "hardship rates". Reduction of rates can also come from specific design considerations that reduce impacts on the environment and reduce the overall energy footprint. This reduction can equate to a reduction of 0.2% off the base interest rate.

7.2.2. Grants

The City may be eligible to receive grant funding from several different sources, including the Department of Commerce and Economic Opportunity (DCEO), as well as the USEPA. Each program is appropriated funds from U.S. Congress in January, and funds begin to be administered by each state in early spring. Each state receives a different allocation of funds depending on several factors that evaluate the total need. Therefore, a state in greater need of funds will be appropriated a larger quantity of funding.

Each of the different grant funding sources have numerous grants available. Typically, in both cases the grants that are obtained are tied to economic need, as well as an attempt to bring jobs and/or resources to the community. A grant that is provided to a community is typically less than $500,000, and is also matched by the community. Therefore, for a project that receives a $200,000 grant, the City would fund $200,000 as well, equating to a total project cost of $400,000.

Due to the income of neighborhoods within the service area, it is unlikely that the City would qualify for the need-based grant programs. The most applicable grant for communities such as St. Charles are energy grants, currently administered by Commonwealth Edison. These grants primarily cover lighting, HVAC, and building envelope improvements, and likely wouldn't be applicable to large scale treatment projects.

Additionally, the government is currently implementing a federal infrastructure plan that allocates roughly $2 trillion to improve the nation's infrastructure. A portion of the funding will go directly to support drinking water, wastewater and stormwater systems. The City should keep track of this funding over the several years and apply for any eligible grants for the proposed projects.

American Rescue Plan Act of 2021

The American Rescue Plan Act of 2021 (ARPA) was established on March 11, 2021 to provide funding for investments in water, sewer, and broadband infrastructure. The ARPA provided $350 billion in additional funding for state and local governments. The state funding portion has allocated $195 billion where $25.5 billion was distributed among all 50 states and the District of Columbia and the remaining was distributed based on unemployment. The local funding portion is roughly $130 billion which was equally divided among cities and counties.

Funding was distributed to localities in two tranches in 2022 and 2023. This funding has largely been utilized by the entities that have received it, however some county and State programs continue to offer ARPA funds for specific purposes. The remaining funds will likely be fully utilized by the time the City implements any of the identified water system capital improvements.

7.2.3. Bonds

Bonds can be broken into several different categories including General Obligation Bonds, Revenue bonds, and Tax Increment Financing District Funding.

General Obligation Bonds (GO)

A general obligation bond (GO) is secured through taxable property within a community and is a municipal bond that is backed by the credit and taxing power of the issuing jurisdiction. A GO bond is not issued against the revenue from a project or development. Therefore, the value of the bond is held completely against the asset value and not the amount of the utility consumed. Typically, a general obligation bond has lower interest rates as there is less risk of default and are generally used to fund projects that will serve the community, such as roads, parks, equipment, and bridges.

Revenue Bonds

A revenue bond is supported and funded by the revenue of a specific project, and/or user charge revenues. Typically, holders of revenue bonds can only rely on the specific project's income, has higher risk and pays a higher interest rate. Revenue bonds are issued in blocks of time that typically fully mature within 20 to 30 years. One disadvantage of the revenue bond is that there is inherent concern that the bond ordinance requires the establishment of reserve funds to cover the risk of revenues falling short of the retirement requirement, and this burden falls onto the users of the utility or product being purchased.

Tax Increment Financing District Funding (TIF)

A TIF district is formed within a specific boundary within the facility planning area or municipal boundary within the community. This TIF district is used to create and dedicate a source of revenue that can be used to fund and retire debt within a specific area. Typically, this type of bonding is done within an area that doesn't have infrastructure or services.

A TIF district is created prior to the development of a property and the value of the bond is set prior to the start of work. However, there is the option to add additional projects to a TIF district if it is proven that the district can withstand the added debt, the required revenues to payback the deficit, as well as sufficient time to pay it back. The Tax Increment Allocation Redevelopment Act (TIF Act) in 1977, changed the TIF requirements and provided the ability of municipalities the power and authority to address the adverse conditions and conservation of areas within their planning areas. Municipalities are able to take redevelopment projects that were essential to the economic well-being of the community.

7.2.4. Capital Infrastructure Bills

In October of 2018, S.3021 "America's Water Infrastructure Act of 2018" was passed by Congress and signed into law. This Act combines the biennial Water Resources Development Act (WRDA) and the reauthorization of the Water Infrastructure Financing and Innovation Act (WIFIA). The law will double grants to states for the Drinking Water Revolving Loan Fund and reauthorizes the WIFIA program. WIFIA is primarily a large-scale program with a minimum project size of $20M for large communities (population over 25,000). If the City elected to move forward with the construction of a regional water treatment facility as identified in Section 6, WIFIA funding can be explored either as a primary funding source or in conjunction with another mechanism such as Illinois EPA SRF funding.

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