City of Sycamore

City of Sycamore

2024 Water Master Plan

TROTTER and ASSOCIATES, INC.
ENGINEERS AND SURVEYORS
St. Charles, IL • Fox Lake, IL • Lake Geneva, WI
630.587.0470 • www.trotter-inc.com

Table of Contents

Section **Page**

6. Analysis of Water Supply, Storage and Treatment Alternatives

7. Recommendations and Summary

This Page Intentionally Left Blank

LIST OF FIGURES

SECTION PAGE

This Page Intentionally Left Blank

List of Tables

SECTION PAGE

This Page Intentionally Left Blank

Glossary of Terms

Term	Definition
ACS	American Community Survey
ADD	Average Day Demand
AFF	Available Fire Flow
avg	Average
BAT	Best available technology
C	Celsius
cf	Cubic feet
CMAP	Chicago Metropolitan Agency for Planning
DAF	Daily Average Flow
Diurnal Pattern	Variation over the course of a day
DNR	Department of Natural Resources
EcoCAT	Ecological Compliance Assessment Tool
EPA	Environmental Protection Agency
F	Fahrenheit
Firm Capacity	Capacity with one pump out of service
FPA	Facility Planning Area
fps	Feet per second
ft	Feet
FY	Fiscal year
gal	Gallons
gcd	Gallons per capita per day
GIS	Geographical Information System
gpd	Gallons per day
gpm	Gallons per minute
HDPE	High density polyethylene
HGL	Hydraulic gradeline
HMO	Hydrous manganese oxide
HP	Horsepower
hr	Hour
HZ	Hertz
IDNR	Illinois Department of Natural Resources

IEPA	Illinois Environmental Protection Agency
IEX	Ion-exchange
IHPA	Illinois Historical Preservation Agency
in	Inch
ISO	International Organization for Standards
L	Liter
l.f.	Lineal feet
lbs	Pounds
max	Maximum
MCC	Motor control center
MCL	Maximum Contaminant Level
MDD	Maximum Daily Demand
MG	Million gallons
mg/L	Milligrams per liter
MGD	Million gallons per day
min	Minimum or minute
mL	Milliliter
NFF	Needed Fire Flows
NRW	Non-revenue water
NPDES	National Pollutant Discharge Elimination System
PE	Population Equivalent
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
pCi	Picocuries
RO	Reverse osmosis
SCADA	Supervisory Control and Data Acquisition
sf	Square Feet
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
WRT	Water Remediation Technologies, LLC.
WTP	Water Treatment Plant
yr	Year

SECTION 1

INTRODUCTION AND BACKGROUND

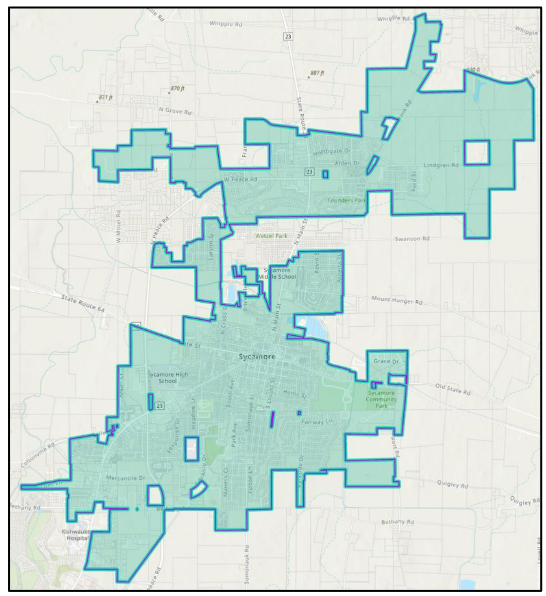
This Page Intentionally Left Blank

1. INTRODUCTION AND BACKGROUND

1.1. GENERAL BACKGROUND

The City of Sycamore was incorporated as a Village in 1858 and established as a City in 1869. Located in DeKalb County, Illinois, the City covers approximately 6,625 acres or 10.4 square miles of land surrounding the intersection of Route 64 and Route 23. Outlined in the exhibit below is the City's corporate boundary. In 1888, the City developed its first public water supply and to this day still owns and maintains a well-operated water system that spans throughout the City's boundary, serving the community's residents as well as commercial, industrial, and municipal users.

City of Sycamore – Corporate Boundary



The most recent study of the City's water distribution system was conducted in 2019, which was a complete Water System Master Plan. This 2024 Water Master Plan was finalized in July of 2025. It is entitled the 2024 Water Master Plan as it utilizes data from the 2024 calendar and budget year. At the time of the previous report, the residential population was estimated at 17,897. According to the American Community Service survey, the population grew with an annual growth rate of approximately 0.25% to 18,171 in 2022, and the estimated population for 2024 is 18,625. The residential water billing for the community in FY2023 was 1,063,933 gallons per day, while the non-residential (commercial, industrial, and municipal) usage was approximately 481,179 gallons per day. This equates to an average daily billing for the City of approximately 1.52 MGD across the entire service area, with an average pumpage throughout the City of 1.89 MGD. The difference between the two numbers, billing and water pumpage, is primarily due to the various forms of non-revenue water, discussed further in Section 2 of this report.

In 2021, the City's Comprehensive Plan was updated, including prospective future improvements and developments. The City plans to ultimately expand land use by approximately 12,000 acres, which includes additions of various residential and commercial areas, however majority remained identified for agricultural purposes.

Since the completion of the 2019 Water Master Plan, the City has completed a number of the recommended improvements throughout the distribution system, as well as at the treatment facilities. This has equated to an investment of more than $16.6M and replacement of more than 8,500 feet of water main. These improvements include significant water main improvements along DeKalb Avenue, Route 64, Sabin Street, Exchange Street, and North Cross Street as well as the 2025 improvements currently in design which include replacements along S. Main Street, E. Lincoln Street, Locust Street, and Park Avenue. Additionally, the Well #7 Radium Removal WTP will be completed in early 2025. As the City has completed many of the projects identified in the 2019 Water Master Plan, staff has requested an update to the Master Plan to continue identifying and prioritizing water system improvements.

1.2. EXISTING DISTRIBUTION SYSTEM

The City of Sycamore maintains roughly 121 miles of water main serving the community's 18,600 residents as well as commercial, industrial, and municipal users. The Sycamore Public Works Water Division has adopted a proactive water main maintenance and replacement, lead service replacement, flushing, and rehabilitation programs to sustain the level of service provided to the community. The goal for the City after completion of this report is to continue the water main rehabilitation program yearly with the City's future Capital Improvement's Program for street rehabilitation and reconstruction to minimize costs. The City has initiated two rounds of lead water service replacement programs and has only four known lead water services. These remaining four have opted out of the free replacement program.

The City commissioned a computerized water model to be developed in 2007 to evaluate a number of system scenarios. Since then, the model was updated in 2019 as part of the last Water Master Plan. As such, the City requested that Trotter and Associates update the existing hydraulic model utilizing Bentley WaterCAD® V8i based on the current GIS databases and projects, upgrades, and replacements over the last 5 years. 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. The WaterCAD® model is used to reflect the distribution system's capabilities under Maximum Day Demand (MDD), Fire Flow conditions, and has been developed to include data for all hydrants throughout the service area.

1.3. EXISTING TREATMENT AND STORAGE INFRASTRUCTURE

The City of Sycamore water supply and storage consists of five deep groundwater wells, five radium removal treatment facilities, a 750,000-gallon water tower, and a 1.5 MG water tower. Each of the City's wells draw water from deep sandstone aquifers and have a combined design pumping capacity of approximately 8.6 MGD. Water from these aquifers have been observed to have measureable concentrations of radium that may be above the USEPA Maximum Contaminant Level of 5 piC/L. In order to meet this standard, the City of Sycamore signed an agreement with Water Remediation Technology, LLC (WRT) in 2005 for the implementation of radium removal facilities at Well #6, 8, and 9 and again in 2012 for a facility at Well #10. The systems use an adsorptive media to remove radium from the source water. In addition to implementing the facilities, WRT is also responsible for maintaining them, providing the WRT media for each of the systems, and the removal and disposal of old or spent media to a licensed facility. The City renewed the contract for Well #6, 8, 9, and 10 in 2017 which ends in 2027.

In the 2019 Water Master Plan, the City of Sycamore identified the need of future rehabilitation of Well #7, which was taken offline in the summer of 2015 due to increasing concentrations of radium in the source water. One of the alternatives identified in the report was the implementation of utilizing Hydrous Manganese Oxide (HMO) absorption and pressure filtration technology at Well #7 in lieu of the other WRT systems in the City. In August 2022, the City received a reservation of Funds letter from the Illinois IEPA, indicating that the rehabilitation project was approved and selected on the State's FY2024 Intended Funding list. The City was also able to obtain $1.25M in Principal Forgiveness associated with the Well #7 project. The facility is set to be completed and put into service by early 2025.

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 Sycamore has made an effort to perform routine maintenance for the wells and treatment facilities to keep them in good operational order.

Two elevated storage towers provide the City with a combined 2.25 MG capacity of water for the system. The distribution system operates based on the two towers to provide consistent pressures and hydraulic grade line within the system. As tower levels fall, the SCADA system will start wells to recover, following a lead/lag cycle. Tower #1, located within the southern half of the system was recoated in 2022.

1.4. Water System Typical Operation

The City's 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 City's water system operates through alternating the wells in operation based on a set cycle. The City's existing SCADA system assigns a number to each well, which is typically 1-5. The well identified as #1 will be the first to kick on based on the tower setpoints. If the towers continue to drop, the well in positions #2, 3, 4, and 5 will kick on to supplement as required. As the towers recover, the wells kick off in the same fashion, however it is in reverse order with the lead pump turning off first. For example, the well in position #1 kicks off first, then 2, 3, 4, and ultimately 5. This lead/lag system can be altered by SCADA to rotate each well through each of the different positions so equal run times are obtained.

The levels of the two tanks dictates when wells run and is shown in the tables below. Each table identifies the hydraulic grade lines for when each additional well kicks on. Each of the elevated storage tanks are strategically located throughout the system to maintain as consistent a pressure throughout the water system as possible. The hydraulic grade line (HGL) represents total pressure supplied relative to sea level.

The City maintains an HGL of approximately 991 feet within service area. Therefore, if the ground elevation at a point in the system is 880 feet above sea level (near Tower #1), the water pressure at this location would equate to 48 psi (991 HGL – 880 ft Elevation = 111 ft ÷ 2.31 ft/psi). Typical pressure fluctuations throughout the day are limited to approximately 3-4 psi based on the tower operating levels shown in the table on the following page.

Tank 1 Settings		Tank 2 Settings	
Lead Start	Lead Stop	Lead Start	Lead Stop
989.93	994.93	986.31	995.31
Lag Start	Lag Stop	Lag Start	Lag Stop
988.93	995.43	985.31	997.81
3rd Start	3rd Stop	3rd Start	3rd Stop
987.93	993.93	984.31	990.31
4th Start	4th Stop	4th Start	4th Stop
985.93	992.93	981.81	987.81
5th Start	5th Stop	5th Start	5th Stop
983.93	988.93	972.81	978.81

1.5. Purpose and Scope

A Water Master 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 system's abilities to meet both current and future demands and regulatory requirements and provides critical information for improvements over the 20-year planning period.

Master Plans are typically updated every five to 10 years, or when significant changes in growth or regulatory requirements have occurred or are expected. An approved Master Plan is also needed to secure IEPA Funding. The City of Sycamore's most recent Water Master Plan was prepared in 2019. Since completion of that report, the City has implemented a number of the recommendations including the installation of new and replaced water main, replacement of lead services, and the implementation of the Well #7 HMO treatment facility. In an effort to continue their proactive approach to infrastructure maintenance and upgrade, the City is seeking to update the Master Plan and 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. In addition, the master plan can also be used to assist the City with the procurement of an IEPA low interest loan funding.

1.6. Summary

The following sections will provide a detailed analysis of the City of Sycamore 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

This Page Intentionally Left Blank

2. Community Needs

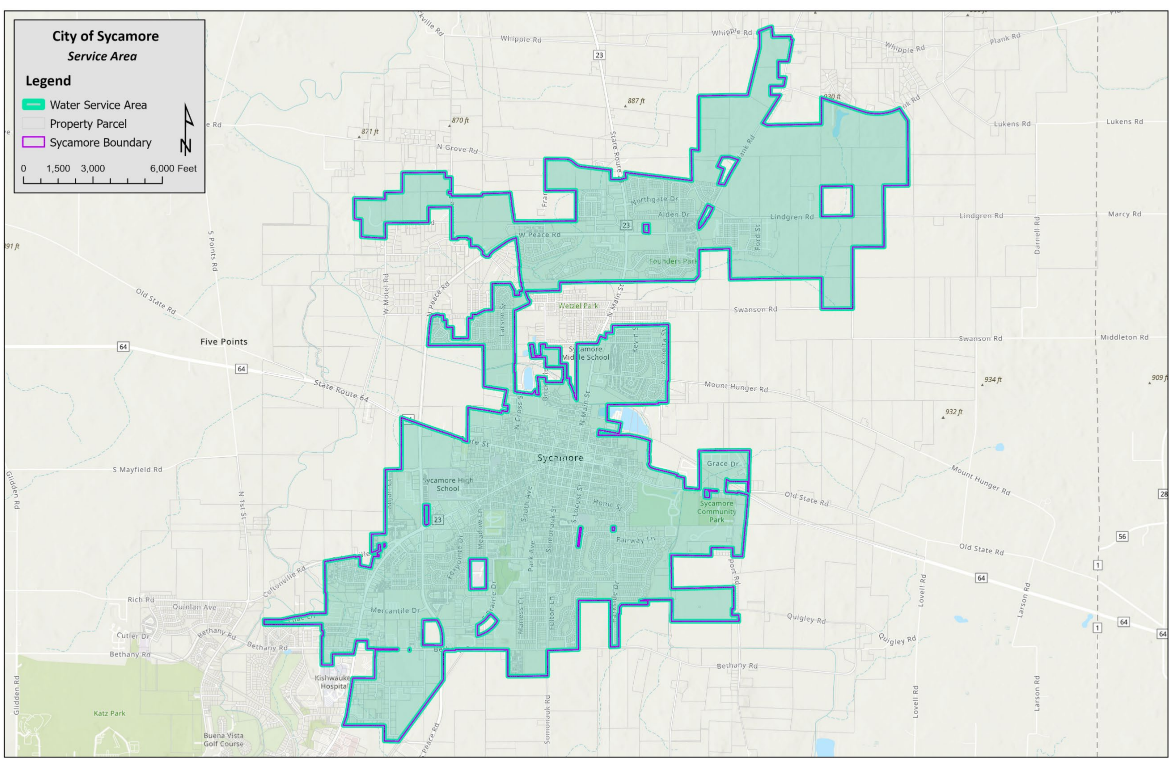
This section includes a discussion of the City's water service planning area, current and future population projections, water usage, and regulatory considerations in order to provide a complete evaluation of the City's drinking water needs. The 2019 Water Master Plan estimated a 2024 residential population of approximately 19,848 based on an annual growth rate of 1.64%. The actual 2024 residential population is currently estimated at 19,841, indicating a very accurate estimated growth rate over the past five years. Maintaining accurate growth rate projections will again be critical to the City's long-term planning.

2.1 General Background

The City of Sycamore is located in DeKalb County, 58 miles west of Chicago and roughly 29 miles southeast of Rockford. The City's planning area extends from the intersection of Route 64 and Route 23, covering about 6,625 acres or 10.3 square miles of land. The population has grown from a community of 10,058 in 1990, to 14,750 people in 2005, and 18,577 people in 2020 according to the American Community Survey.

In 2021, the City commissioned an update to the Comprehensive Plan that outlines the goals and objectives for the City's future improvements and developments throughout a specific geographic planning area. Historically, the City's planning area includes the entire Sycamore corporate limits as well as the land within a mile and a half radius of these limits. The Comprehensive Plan identifies an increase of land use by 5,672 acres, and although 50% of the proposed land use will be slated for agricultural purposes, the planned residential, commercial, and industrial developments are predicted to increase by approximately 40%, and thus, have a significant impact on the overall demand of the City's water system.

Figure 2-1: City of Sycamore – Water System Service Area



2.2 EXISTING CONDITIONS

Most communities contain both residential and non-residential land uses. Analysis of current and future water usage often utilizes "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.

2.2.1 Resident Population

In fiscal year 2019, the City had a total customer base (including residential and non-residential) of 6,918 service connections. However, this cannot necessarily be correlated with the total population served. In order to determine the total PE within the City's Service Area, the residential population is established as the first step. The City's population from the 2020 American Community Survey (ACS) can be found in Table 2-1. The ACS is a yearly survey executed by the U.S. Census Bureau which contacts over 3.5 million households. This data is used to provide updated community estimates in the 10 years between nationwide censuses. The table also identifies the anticipated 2045 population based on three different annual growth rates.

The Chicago Metropolitan Agency for Planning (CMAP) conducts a Socioeconomic Forecast study for the northeastern counties of Illinois for regional planning purposes. Although the City of Sycamore lies just outside the primary CMAP subregion, Dekalb County was still included in the forecast as part of the Illinois Outer Counties subregion. The total population including all counties in this subregion are projected to have an annual growth rate of 0.52% forecasted to 2050. The second projected growth rate was presented in the 2018 Dekalb County Comprehensive Economic Development Strategy. This document stated an expected growth total rate of 6.2% from 2016-2025, equating to a 0.69% growth per year.

These low growth rates were calculated for the County as a whole, and while the population growth for the entire county has decreased, the City of Sycamore has experienced otherwise. As part of the 2019 Water Master Plan, the City is estimated a steeper growth rate due to increasing upcoming residential developments with an estimated 75 single-family homes per year, equating to a 1.64% annual growth rate. By utilizing the 2020 American Community Survey (ACS) in conjunction with the City's specific historical growth, a more accurate representation of the 2024 population was achieved. This Master Plan will utilize the expected annual growth rate of 1.64% for a conservative approach on further calculations.

Table 2-1: Population Projections to 2045

	Projected Annual Growth Rate	2020 ACS Population	2024 Population Forecast	2045 Population Forecast
CMAP	0.52%	18,577	18,967	21,156
Dekalb County CEDS	0.69%	18,577	19,097	22,074
City of Sycamore	1.16%	18,577	19,459	24,827
	1.64%	**18,577**	**19,841**	**27,992**

2.2.2 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.

The residential and non-residential water usage results show increases and decreases between FY2019-2023. The largest residential variation occurred in FY2021 with an increase of 7.55% from the previous year most likely due to the Covid-19 pandemic. The largest non-residential variation occurred in FY2022 with an increase of 11.75% also most likely due to the return from the pandemic. As shown below, the residential water usage in the City accounts for over 69% of billings, though it represents more than 90% of total accounts. This annual water billed does not represent the total water metered (or pumped) for the City, which would help quantify the water loss and non-revenue water of the system. Water loss and non-revenue water is discussed further in the following section.

Table 2-2: Total Water Billed (FY2019-2023)

Fiscal Year	Total (GPD)	Residential (GPD)	Non-Residential (GPD)
FY2019	1,443,758	1,016,423	434,658
FY2020	1,481,708	1,014,767	466,941
FY2021	1,543,843	1,091,348	452,495
FY2022	1,601,367	1,095,699	505,668
FY2023*	1,518,112	1,036,933	481,179
5-Year Average:	**1,517,758**	**1,049,570**	**468,188**
	100%	**69.15%**	**30.85%**

**In 2023 the City moved from a May 1 – April 30 fiscal year to a January 1 – December 31 fiscal year.*

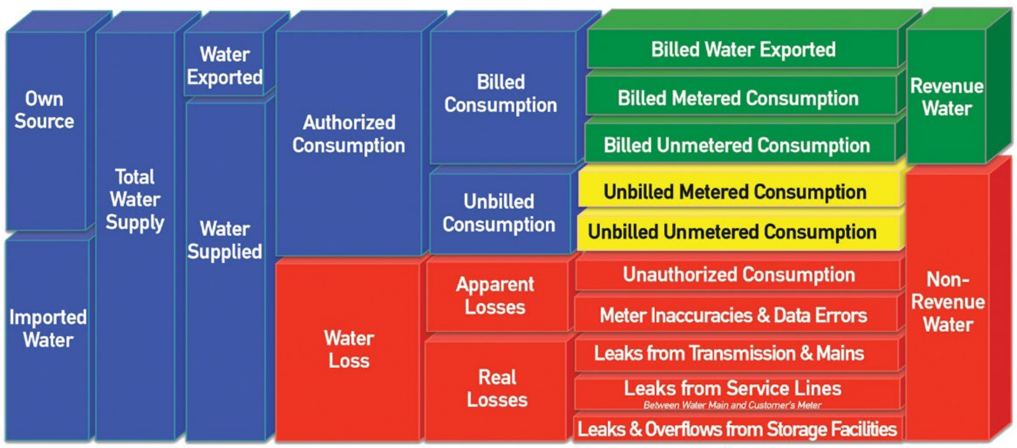
The residential population equivalents were calculated by dividing the residential water sold by the total number of residents within the Service Area. The 2020 population estimate of 18,577 based on the ACS projection was utilized for this estimate as it follows the approximations used by the City. In order to estimate the population in 2024, a projected compound annual growth rate of 1.64% was used. The per capita water billed equates to 52.9 gpd/capita, which was then used to determine the equivalent population of the non-residential water billing. This resulted in an estimated 8,850 PE of non-residential use to be served by the City's water distribution system, for a total of 28,691 PE.

Table 2-3: Current Total Population Equivalent

Description	Total
5-Year Average Residential Water Billed (GPD)	1,049,570
2024 Residential PE	19,841
Residential Per Capita Water Billed (GPD)	52.9
Non-Residential Water Billed (GPD)	468,188
Non-Residential PE (at 52.9 GPD/PE)	8,850
Total 2024 (Current) PE	**28,691**

2.2.3 Water Loss

While the City must meet the system water demand on a daily basis, not all of the supplied water can be metered or billed. Water supplied is the total amount of water that is pumped by the wells into the distribution system. The City does not import or export water, and as such all water provided by the wells is represented by the "Water Supplied" in the graphic below. From being pumped, water supplied can be broken down into two separate categories, authorized consumption and water loss. Authorized consumption describes all water that is approved by the water utility for use. This category consists of billed authorized consumption and unbilled authorized consumption. Billed consumption includes all the accounts of water within a customer billing system and is the source of revenue for the water utility. Unbilled consumption is water that is consumed but not charged to an account and can include water used for firefighting, flushing, street cleaning, and usage for the municipality itself. A simplified graphic of this concept is shown below.



Water loss can be broken into two categories: real losses and apparent losses. Real losses are the primary source of losses, consisting of leakage from distribution mains and service connections. This results in water systems requiring an increased volume of water to be extracted, larger infrastructure capacity than needed, and excessive energy usage to meet the demands of the community.

Table 2-4: Average Non-Revenue Water

Fiscal Year	Pumped (MGD)	Billed (MGD)	NRW (%)
FY2019	1.89	1.47	22.32%
FY2020	1.96	1.55	20.95%
FY2021	1.95	1.58	19.06%
FY2022	1.80	1.54	14.67%
FY2023	1.89	1.56	17.64%
Average:	**1.90**	**1.54**	**18.93%**

Apparent losses account for the nonphysical losses in a water system which occur from inefficiencies in measurement, recording, and archiving water volumes. The main sources of apparent loss is from meter inaccuracies, data handling errors, and unauthorized consumption. Unauthorized consumption water loss is due to water theft or meter tampering. Apparent losses impact water system management by skewing the quantification of water demand in a community and causing water utilities to suffer a loss of potential revenue. The sum of unbilled authorized consumption and water loss equates to Non-Revenue Water (NRW). Typically, the majority of NRW is due to inefficiencies to the water distribution system, water loss.

The average non-revenue water of systems in the United States is approximately 16%, according to the USEPA. The City of Sycamore's 5-year average non-revenue water equates to approximately 19%, an improvement from the 2019 Master Plan level of 23%. The improvement is likely related to the City's meter replacement, water main replacement program, and reduction in auto-flusher usage.

The City has also improved tracking of non-revenue water real losses over the past five years. This has included accounting for water usage through hydrant flushing, main breaks, filling/flushing associated with water main improvement projects, and quantifying auto-flusher usage. In 2023 this tracking identified approximately 10.3% of the total 17.6% non-revenue water.

Additionally, while the gallons billed per capita was found to be 52.9 gpd/PE, the water usage is higher due to this water loss. The average daily water pumped of 1.89 MGD divided among the 28,691 PE equates to 66.2 gpd/PE pumped. However, as the City replaces water main throughout the system the total non-revenue water should decrease over time with rehabilitation, and net revenues should increase.

2.3 Future Population Projections

In order to estimate the future water demand that the City must be able to provide, four growth categories were developed and analyzed. Future population equivalents were established by reviewing the City's expected residential lots, approved non-residential development plans, and the City's Future Land Use Plan. Ultimately four different population equivalents were developed; 2025 (current), 2030, 2035, and 2045. These effectively represent the current, five, 10, and 20-year estimates. They were determined as identified below, and are described in further detail on the following pages:

- ***2025** – This represents the existing population estimates as described in Section 2.2.2.*
- ***2030** – This includes all developments that are considered "Final Platted Lots" for single-, two- and multi-family homes, as well as 1/3 of identified future Non-Residential Development. In the previous report, it was assumed that roughly half of the planned "Final Platted Lots" were completed based on the City's current PE so the remaining "Final Platted Lots" were used.*
- ***2035** – This includes 33% of developments that are considered "Preliminary Platted Lots" for single-, two- and multi-family homes, as well as 33% of the remaining (2/3) identified Non-Residential Development.*
- ***2045** – This includes he remaining 67% of developments that are considered "Preliminary Platted Lots" for single-, two- and multi-family homes, as well as 67% of the remaining identified (2/3) Non-Residential Development.*

The City maintains a database that outlines the development of residential areas. While keeping track of lots already built-out, the City also designates platted and vacant lots to either single-family, two-family, or multi-family homes in existing and new neighborhood establishments. The City identifies these residential developments as either Final Platted Lots or Preliminary Platted Lots. Final Platted Lots are already annexed and are ready for construction. While the Preliminary Platted Lots are located, they are not as far into the development process, and would not be considered "shovel ready."

The City's future non-residential growth was evaluated from open space areas planned for commercial, industrial, and other business developments. Open space acreage was calculated from the Proposed Land Use Table and Future Land use Map within the Comprehensive Plan, shown in Figure 2-2, on page 2-7. This boundary includes both vacant residential lots as well as non-residential uses. Areas illustrated in striped orange and purple (future business and industrial areas) identify non-residential open spaces, and is approximately 312 acres in total size.

2.3.1 2030 Population Projection

The 2030 population projection utilized is the sum of all Final Platted Lots for single-, two- and multi-family homes described in the City's database. In the 2019 Water Master Plan, a total of 783 lots were identified as "Final Platted Lots" by the City, and it was expected that these will be developed within the next five years. Based on the current population equivalent of 28,691, it is assumed that only roughly 1,484 PE or 46% was built out in the past 5-years. This Plan's 5-year projection includes the remaining "Final Platted Lots" to be built out as described in the City's database, described in Table 2-5 below.

For calculation purposes, it is assumed there will be three houses/lots per acre, with 3.5 residents per home for single- and two-family and 2.5 residents per home for multi-family. The three residential categories were multiplied by open space density factors which takes into consideration land dedicated to roads, utilities and green space. The calculated PE values are represented in Table 2-5, and equate to a total of 1,168 PE of residential growth by 2030.

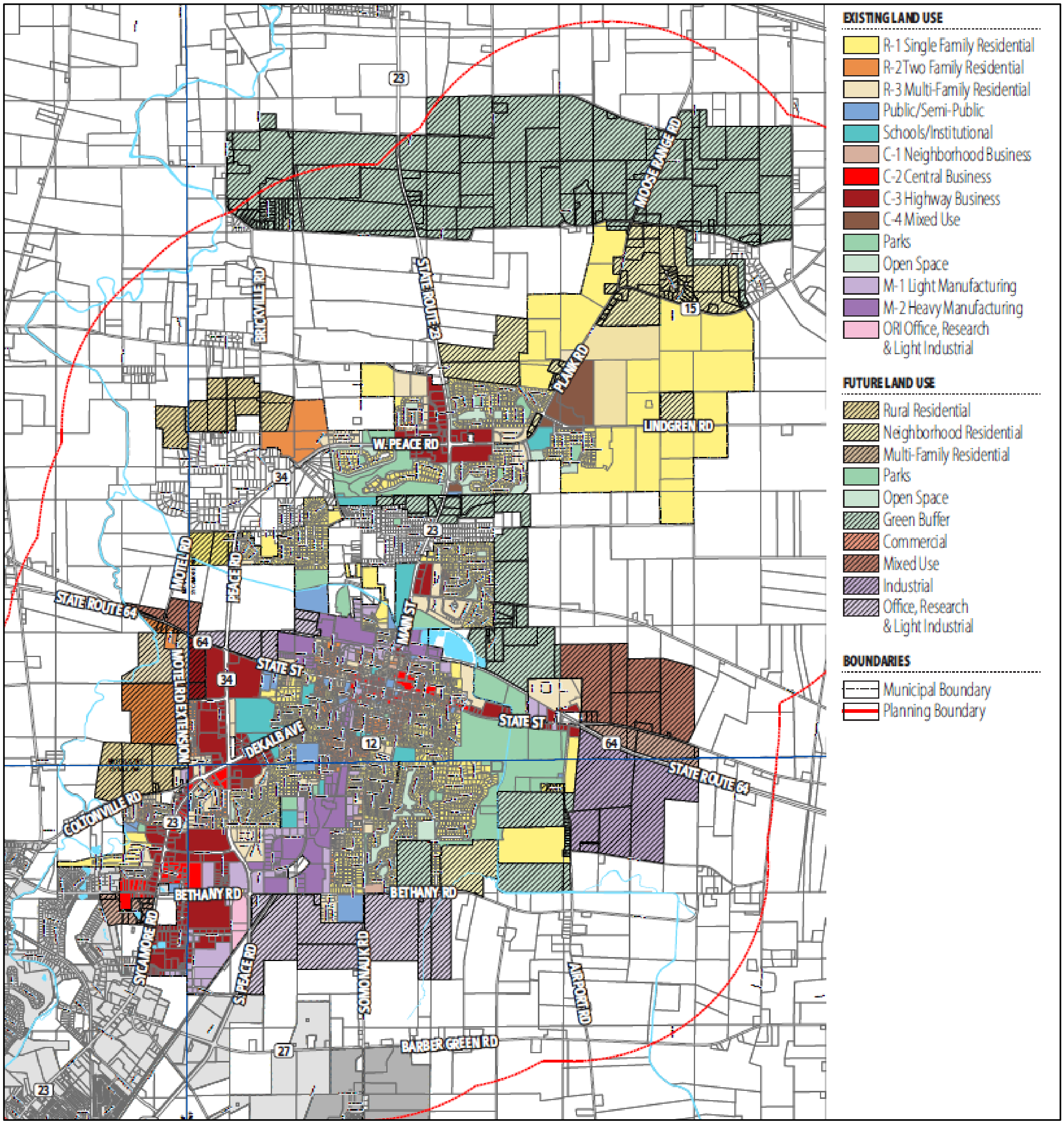
For the non-residential PE projection, about one-third (1/3) of the remaining 189 acres of available open space is expected to be constructed by 2030. The remaining 2/3 of the open space acreage is anticipated to develop between 2030-2045. This resulting 63 acres (189 ÷ 3) was then multiplied by 9.0 PE/acre for a total of 569 non-residential PE by 2030. The 9.0 PE/acre was calculated using a sample non-residential area of the City, correlated to the respective water usage within that area. This generally tracks with density usage of other communities and is further described in Section 2.3.3. Over the next five years, the City can expect total population equivalent growth of roughly 1,737 PE, which equates to an annual growth rate of 1.18%.

Table 2-5: 2030 Residential and Non-Residential PE Growth

Land Use	Lots	Area (Acres)	Percent	PE
Single-Family Residential (3 lots/acre, 3.5 PE/unit, 10% open space)	263	88	42.95%	828
Two-Family Residential (3 lots/acre, 3.5 PE/unit, 20% open space)	57	19	9.35%	160
Multi-Family Residential (3 lots/acre, 2.5 PE/unit, 30% open space)	103	34	16.75%	180
Non-Residential Open Area	-	63	30.95%	569
Total PE Growth:	**423**	**204**	**100%**	**1,737**

DSAFS

Figure 2-2: Current Land Use



** The area along Motel Road/Galloway Court above identified as Future Rural Residential has since been annexed to R-4 Existing Rural Residential.*

2035 Population Projections

The 2035 PE projections were calculated similarly to the 2030 projection. The City has identified several locations as “Preliminary Platted Lots” which are expected to develop in the 15 years following the 2030 benchmark (2030-2045). The City expects to build out a total of 2,165 lots for single-family residential homes, 288 two-family lots, and 152 multi-family lots. The same factors used previously were multiplied by the designated residential lots to obtain a total residential PE growth of 7,892 in the 2030-2045 period.

In addition to the “Preliminary Platted Lots”, the remaining 2/3 of non-residential open areas (as previously discussed) are predicted to build out consistently between 2030 and 2045, equating to an additional 2,100 PE. The total residential and non-residential growth rate from 2030 to 2045 was calculated as 2.0%, and results in a total PE growth of 9,992, and are illustrated in Table 2-6 below.

Table 2-6: Preliminary Platted PE Growth (2030-2045)

Land Use	Lots	Area (Acres)	Percent	PE
Single-Family Residential (3 lots/acre, 3.5 PE/unit, 10% open space)	2,165	722	65.51%	6,820
Two-Family Residential (3 lots/acre, 3.5 PE/unit, 20% open space)	288	96	8.71%	806
Multi-Family Residential (3 lots/acre, 2.5 PE/unit, 40% open space)	152	51	4.60%	266
Non-Residential Open Area	-	233	21.18%	2,100
Total	**2,605**	**1,218**	**100.00%**	**9,992**

In order to delineate a population projection for 2035, a linear interpolation was performed. Every five years, the City can expect to grow 33% of the total 9,992 PE, or about 3,331 PE. Therefore, by adding 33% of the estimate to the 2030 PE, the City obtains a 2030 population estimate, shown in the table below. The expected population equivalent in 2035 is 33,759 PE.

$$\frac{9{,}992\ PE}{15\ Years} = 666\frac{PE}{Year} \qquad 666\frac{PE}{Year} \times 5\ Years = 3{,}331\ PE$$

	2025 (Current)	2030 (5-Year)	2035 (10-Year)
Current P.E.	28,691	28,691	28,691
Growth P.E.	-	1,737	5,068
Total P.E.	**28,691**	**30,428**	**33,759**

2.3.2 2045 Population Projections

The 2040 population projections are a continuation of the 2035 calculation. As previously stated, the City has identified several locations throughout town as "Preliminary Platted Lots", as well as the remaining open areas that could be developed as non-residential.

The City expects to build out a total of 2,165 lots for residential homes, 288 two-family lots, and 152 multi-family lots by 2045 with a total residential PE growth of 7,892. In addition to the "Preliminary Platted Lots", the remaining 2/3 of non-residential open areas (as previously discussed) are predicted to be built out by 2045, equating to an additional 2,100 PE. This equates to an addition growth of 9,992 PE from 2030 to 2045. The table below identifies the population equivalent for 2040, estimated at 40,420 PE.

	2025 (Current)	2030 (5-Year)	2035 (10-Year)	2045 (20-Year)
Current P.E.	28,691	28,691	28,691	28,691
Growth P.E.	-	1,737	5,068	11,729
Total P.E.	**28,691**	**30,428**	**33,759**	**40,420**

2.3.3 Build-Out Population Projection

In addition to the 20-year planning PE, a Build-Out population projection was calculated based on the City's Future Land Use Plan. Build-Out population will occur when all available lots have been developed within their existing zoning designation.

Table 2-7 on the following page outlines the variety of proposed land uses that are outlined in the City's 2021 Comprehensive Plan. According to this Plan, the City's residential and non-residential land use will increase by approximately 53% and more than half of the new land will be devoted to parks, open space, and green buffers. These areas will not contribute a significant increase to the projected PE growth. However, the future population projection calculation is highly dependent on the new residential, commercial, and industrial areas.

About 27% of the proposed land will go to residential development according to the Plan. These areas were split into 5 categories: Single Family, Two Family, Multi-Family, neighborhood, and rural. The rural residential areas are anticipated to be exclusively on well/septic and will not require City water service. Like the previous calculations, neighborhood residential areas will have three lots per acre, 3.5 residents per home, and 20% of the area will be dedicated to open space. Multi-family residential areas were multiplied by 9.0 units per acre, 2.5 PE/unit, and 20% open space based on feedback from the City.

Table 2-7 on the following page represents these estimated values.

Commercial development makes up about 2% of the proposed land use. The PE growth from these areas were calculated from the current commercial land use and water billing data. The total commercial water billing was divided by the current total commercial acreage (described in the Comprehensive Plan). The current commercial areas are using approximately 440 GPD/acre. The water billed per PE for the City was estimated at 52.9 GPD/PE, and therefore the existing commercial PE per acre can be calculated to be 8.3 PE/Acre. It is anticipated that all future commercial developments will reflect the same water usage.

A similar process was utilized to evaluate Mixed Use, Industrial, and Office locations. The mixed-use PE contribution was calculated by using the City's current Land Use Map. A small area that contained a variety of businesses was calculated and divided by the water usage of those developments. This equated to about 483 GPD/acre and approximately 9.1 PE/acre. It is anticipated that all future commercial developments will reflect the same water usage. The sample that was used for the Mixed-Use analysis was representative of several other land use types, and therefore the same value was also used for office, research and light industrial land uses.

Based on this identified potential growth, the build-out population projection for the City of Sycamore is an additional 21,571 PE. Although this PE has been identified as potential, it is not anticipated that it will occur within the next 20 years, or within the planning period of this report. It is recommended that this additional PE be reviewed and reevaluated at the point that the comprehensive plan is updated, as well as when the Water Master Plan is updated. Therefore, future water demands should not be based on this conservative estimate.

Table 2-7: Ultimate Build-Out PE Growth (Beyond 2045)

Land Use	Area in Acres	Percent	PE
Single-Family Residential (3 lots/acre, 3.5 PE/unit, 10% open space)	159	2.70%	1,501
Two-Family Residential (3 lots/acre, 3.5 PE/unit, 20% open space)	248	4.22%	2,080
Multi-Family Residential (9 lots/acre, 2.5 PE/unit, 20% open space)	230	3.91%	4,133
Neighborhood Residential (3 units/acre, 3.5 PE/unit, 10% open space)	604	10.29%	5,709
Rural Residential	349	5.94%	0
Commercial	121	2.07%	1,007
Highway Business	153	2.60%	1,266
Mixed Use	386	6.57%	3,203
Industrial	39	0.66%	351
Office, Research, Light Industrial	582	9.91%	5,297
Park/Green Buffer/Undeveloped	3,003	51.14%	0
Total	**5,873**	**100.00%**	**24,548**

2.3.4 Future Population Projection Summary

The future population equivalents were established by reviewing the City's detailed water billing records, approved development plans, plat tracking spreadsheets, as well as the City's Comprehensive Plan and Future Land Use Plan. Analysis of the projected land use was the basis for developing future population projections. These growth estimates are summarized below in Table 2-10 below.

Table 2-8: Future Population Projection Summary

	2025 (Current)	2030 (5-Year)	2035 (10-Year)	2045 (20-Year)	Ultimate Build-Out
Current P.E.	28,691	28,691	28,691	28,691	28,691
Growth P.E.	-	1,737	5,068	11,729	36,277
Total P.E.	**28,691**	**30,428**	**33,759**	**40,420**	**64,968**

2.3 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 enough 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. From a practical standpoint, this 'well out of service' scenario would also be representative of a WRT media exchange at one of the treatment facilities. However, these standards are not typically overlapping – that is, the capacity is not based on the largest well out of service and another treatment facility out of service due to media exchange. These criteria are the minimum requirements, and communities often plan for more conservative circumstances.

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 wells. Without this redundancy, the work must be performed in off-peak periods, which restricts and increases the cost of the maintenance activities.

2.4.1 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 10-year average daily water usage was calculated to be 1.86 MGD. The variation between water supplied and water sold is attributed to the various forms of water loss. Table 2-9 illustrates the highest two days of pumpage for each of the past 10 years. The numbers shown reflect the maximum amount of water supplied by the City, not the water billed to customers.

Average	MGD
1-Year	1.88
5-Year	1.90
10-Year	1.86

Table 2-9: Historic Water System Maximum Day Demands

Year	1st Largest (MG)	2nd Largest (MG)
2012	3.14	3.06
2013	3.22	2.97
2014	2.78	2.47
2015	2.71	2.49
2016	3.09	2.95
2017	3.84	3.46
2018	2.95	2.94
2019	4.21	2.85
2020	3.93	3.26
2021	3.43	3.25
2022	3.18	2.74
2023	3.21	3.13

The maximum day demand (MDD) over the previous 10-year period was 4.21 MGD, which occurred on July 28th, 2019. The second highest recorded rate was 3.93 MGD and occurred on September 23rd, 2020. The third highest consumption occurred on September 16th, 2017, with a value of 3.84 MGD. After review, it was determined that the July 28th, 2019 day was not a function of high service area demand and likely represents an outlier. Therefore, the September 23rd, 2020 usage of 3.93 MGD will be utilized for maximum day demand calculations.

To further analyze the historical water usage, maximum day peaking factors (PF) were calculated. These factors are the ratio of the maximum day demand observed over a certain time span, compared to the average daily usage during the same time period.

Peaking Factor (Based on 4.21 MGD MDD)	
5-Year	2.07
10-Year	2.11

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. As seen in the table above, this corresponded to peaking factors of 2.07 and 2.11, respectively.

A peaking factor of 1.8-2.2 is considered typical and is highly dependent on the types of commercial and industrial users that a community has. The peaks observed by the City appear to be within reason, and therefore don’t create any uncertainty in the data. However, due to the close values of the 5 and 10-year peaking factors, the 2.11 peaking factor will be utilized for planning and hydraulic modeling.

2.4.2 Overall System Capacity

Historically, the City has had adequate supply to serve its planning area under all circumstances. During extremely high-water usages, the City has been required to put additional wells into service to cover the peak, however at no point was the system in jeopardy of not meeting demands from a supply standpoint. This means that the wells currently in operation are anticipated to have sufficient capacity to meet existing demands. The distribution system's capacity to convey the required flows is reviewed in Sections 3.

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. For the City of Sycamore, it is unlikely that the water demands will vary significantly unless a substantial drought is experienced in the area. The City has experienced relatively consistent demands, and there is no reason to expect that this would change.

Section 2.3 of this Plan identified population growth projections for 5-year, 10-year, and 20-year planning periods. Associated increases in water demand for each of these phases was developed by extrapolating current water usage per PE. For example, when extrapolated out using the growth percentage, the 2030 population estimate of 30,428 equates to a total average daily demand of approximately 2.01 MGD. The table below includes the extrapolated demands based on population projects.

Table 2-10: Future Water Demands

	2025 (Current)	2030 (5-Year)	2035 (10-Year)	2045 (20-Year)	Ultimate Build-Out
Current P.E.	28,691	28,691	28,691	28,691	28,691
Growth P.E.	-	1,737	5,068	11,729	36,277
Total P.E.	28,691	30,428	33,759	40,420	64,968
ADD (MGD)	1.90	2.01	2.31	2.98	4.64
MDD (MGD)	3.93	4.16	4.78	6.16	9.61
Firm Capacity Required	**4.00**	**4.20**	**4.80**	**6.20**	**9.70**

The firm capacity that is recommended is the minimum amount of well production available with the largest well out of service (Well #9). With a current maximum day demand of 3.93, based on historical data, the recommended current firm capacity is 4.0 MGD. The tables above illustrate the maximum day demand increasing proportionally 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 8.57 MGD and a firm capacity of 6.63 MGD. The City has capacity to provide the average daily demand throughout the 20-year planning period. Beyond the 20-year planning horizon the firm capacity may see a slight deficit relative to the max day demand, however this should be reviewed in future planning and does not require additional sources in the near-term.

This Page Intentionally Left Blank

SECTION 3

EXISTING DISTRIBUTION SYSTEM EVALUATION

This Page Intentionally Left Blank

3. EXISTING DISTRIBUTION SYSTEM EVALUATION

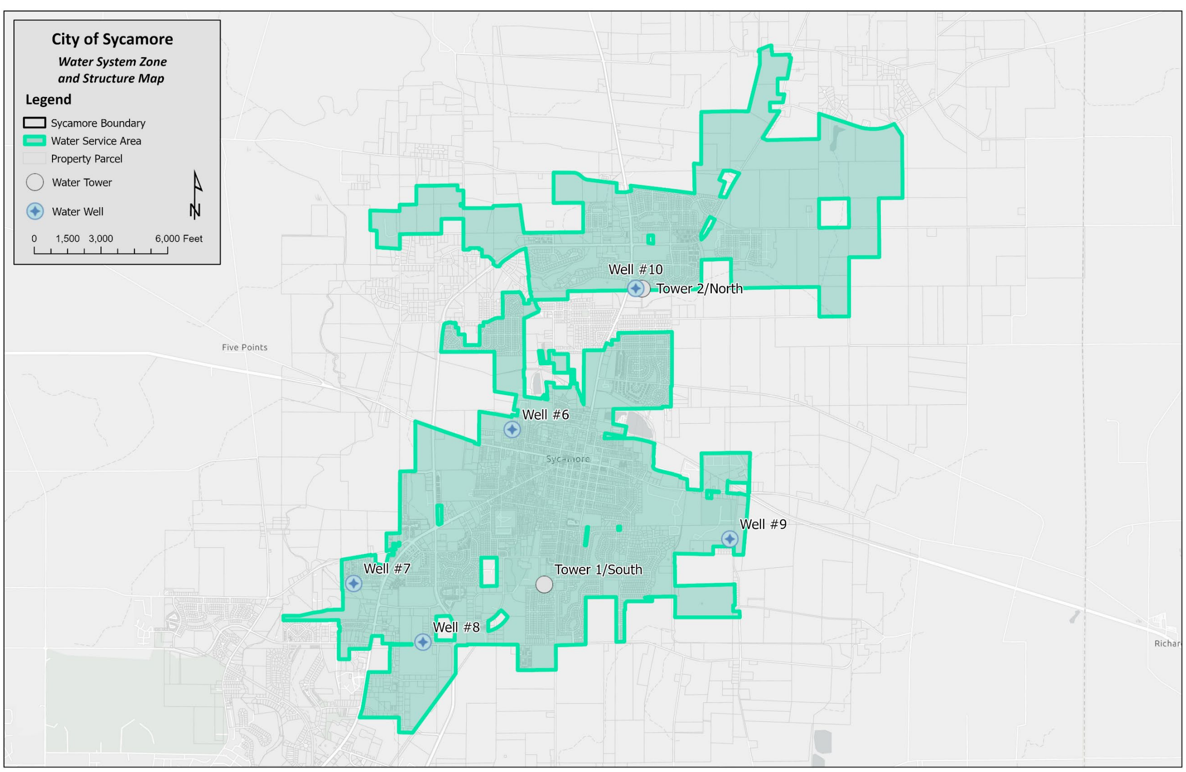
This section describes the current conditions, limitations, and maintenance issues related to the City's water distribution system. A hydraulic analysis of the City's distribution system was performed in order to identify restrictions within the existing distribution system and develop recommendations for future improvement projects. Alternatives for improvements will be reviewed in Section 4.

3.1 GENERAL BACKGROUND

The City provides an average of approximately 1.89 MGD to its residential, commercial, and industrial customers. The distribution system consists of a single pressure zone and experiences minimal elevation change throughout the system. Water is supplied to the City via five wells, Wells # 6, 7, 8, 9, and 10. Well #7 was previously limited in production rate due to radium levels, but is anticipated to be returned to full service in winter 2024 with the completion of a new water treatment facility at this location. The City of Sycamore owns and maintains roughly 121 miles of water main of varying sizes, ages, and conditions throughout the system and approximately 1,586 fire hydrants.

Figure 3-1 provides a basic layout of the City's service area, as well as identifies the locations of the City's two elevated storage towers, five active wells (#6, 7, 8 ,9, 10). The oldest parts of the distribution system are generally in the center of the City, near Well #6 and the downtown area. The northern and southern ends of town have been subject to recent development over the last two decades and are constructed of newer materials/larger main. The City of Sycamore's Water Division has adopted a water main maintenance and flushing programs to sustain the level of service provided to the community.

Figure 3-1: Water System Structure Map



3.2 DISTRIBUTION SYSTEM EVALUATION

As stated previously, the City's water distribution system includes roughly 121 miles of water main, and 1,586 fire hydrants. For planning purposes, the value of water main and other system components can be estimated to project a total distribution system asset value. As shown in the table below, the existing City of Sycamore water distribution system infrastructure replacement value is estimated at approximately $362 million including system valves and hydrants, prior to depreciation.

Table 3-1: Distribution System Asset Value & Replacement Cost

System Asset	Quantity (LF)	Unit Value	Total Replacement Value ($ Million)
≤4-Inch Main	45,703	$500	$22.85
6-Inch Main	163,948	$525	$86.07
8-Inch Main	151,369	$540	$81.74
10-Inch Main	275,541	$560	$154.30
12-Inch Main	1,257	$575	$0.72
14-Inch Main	279	$600	$0.17
16-Inch Main	97	$625	$0.06
Unknown	341	$561	$0.19
System Valves	1,617	$4,500	$7.28
Hydrants	1,586	$5,500	$8.72
Total:	641,738	-	**$362.11 Million**

The service life of distribution system components varies widely based on material, installation methods, operating pressures, and soil conditions, among other considerations. Based on surveys of communities across the country, the American Water Works Association compiled a research report in 2012 entitled "Buried No Longer" which includes estimates of water main service life by material. From these surveys an estimated 75-year average life can be used for planning and budgeting purposes. It should be noted that water main may well exceed this service life, and piping reaching 75 years alone would not merit recommendation for replacement. Actual replacement schedules should be dictated by frequency of main breaks, the need to increase capacity, improve water quality, or other criteria.

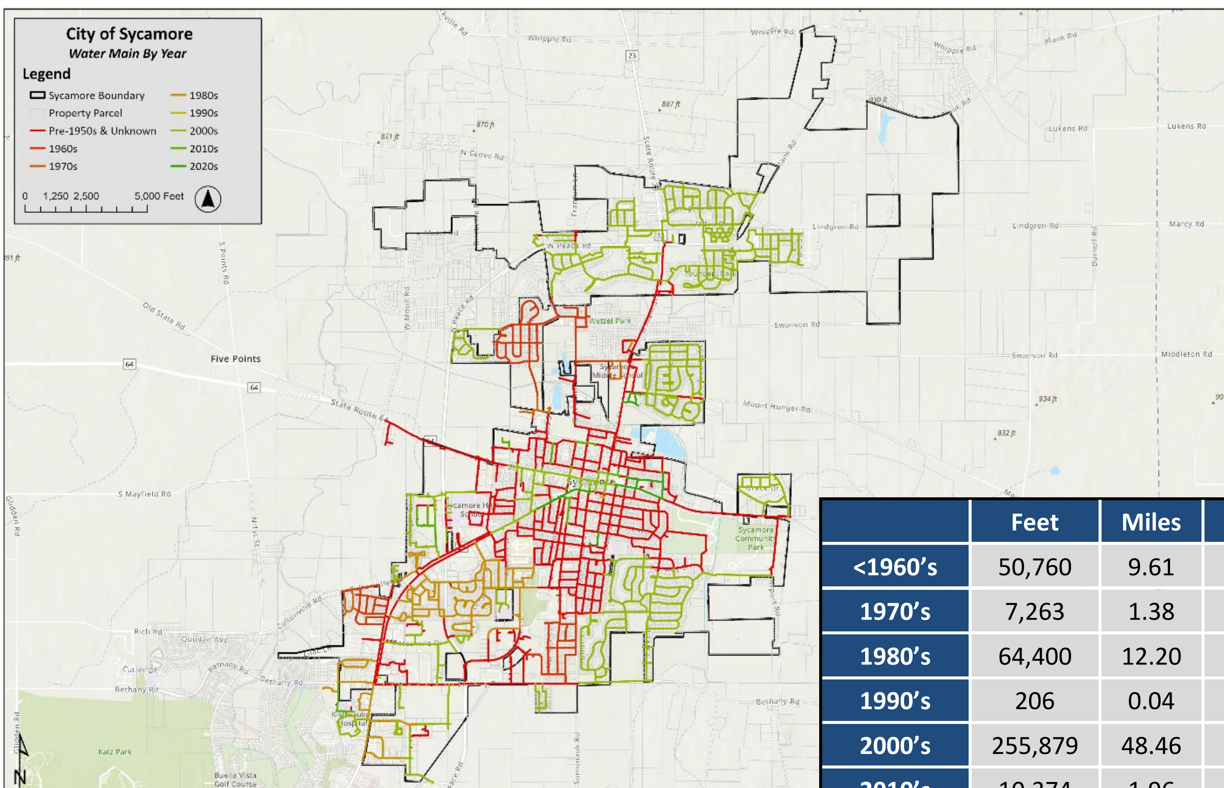
Using this estimated 75-year service life for the City's infrastructure, an average of $4.83 Million in 2025 dollars would need to be budgeted annually in order to replace all of the existing distribution system by the year 2100. This budgetary amount would need to be increased by the Construction Cost Index (CCI) each year. This annual reinvestment should be prioritized based on a number of criteria including available fire flow, main 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.

3.2.1 Water Main Age

Shown below is the water main installation date for the City of Sycamore. Water main in dark red represents pipe installed in the 1950's or earlier, red is 1960's, orange 1970's, light orange 1980's, yellow 1990's, light green 2000's, green 2010's, and dark green is 2020's. The table below identifies the breakdown of the water main age by decade within the City. As shown in the table, the largest percentages of the water main system were either installed during the 1980's (10%) or recently in the 2000's (40%).

As previously discussed, according to the AWWA's "Buried No Longer" study, the lifespan of water main depends primarily on material and installation region. For the Midwest region, PVC 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 operational issues). From a replacement standpoint, water main is anticipated to last up to 75 years if properly installed. About 9% of the City's distribution system is 50 years or older. Therefore, during capital planning, the City should include age as a metric for prioritization. As water main segments begin to exhibit breaks with increasing frequency or leaks are observed, this is a sign of piping approaching its useful service life and should be added to a capital improvements program.

Figure 3-2: Water Main Installation Year



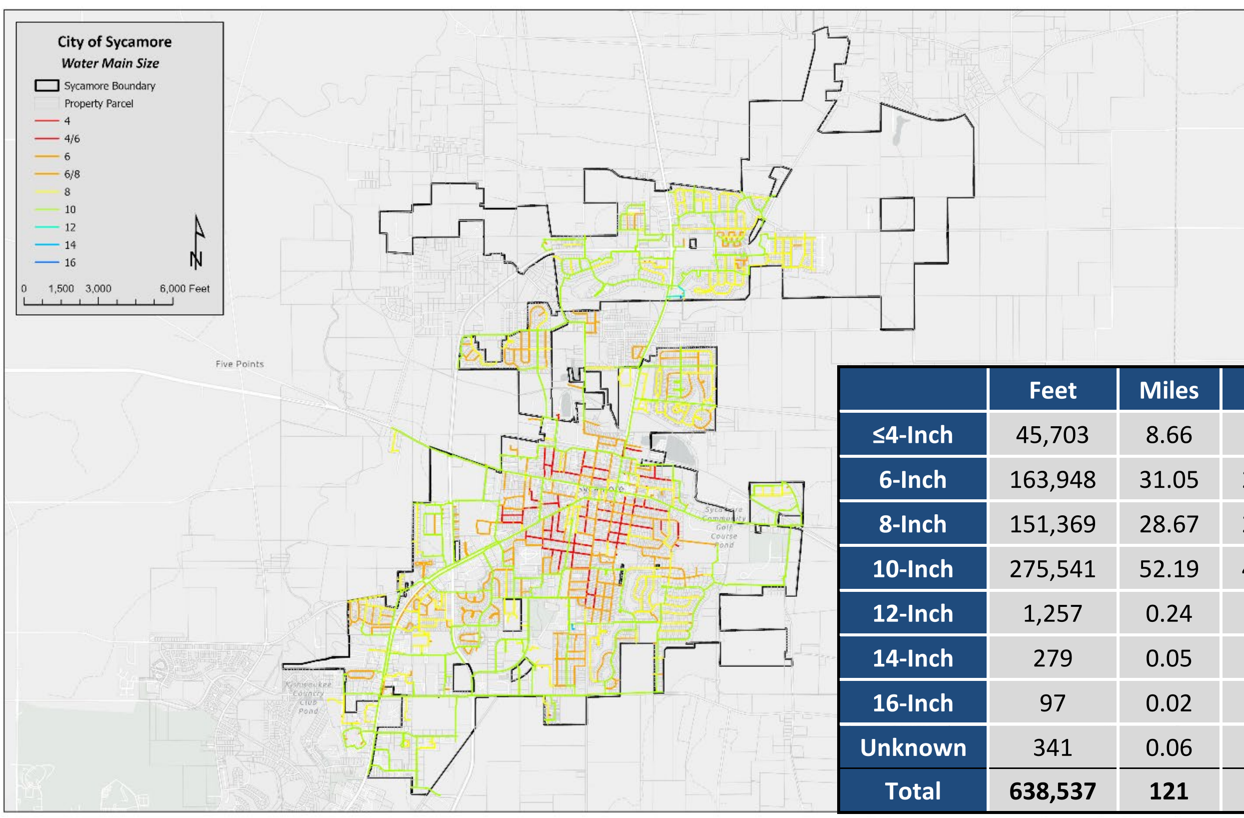
	Feet	Miles	%
<1960's	50,760	9.61	7.95%
1970's	7,263	1.38	1.14%
1980's	64,400	12.20	10.09%
1990's	206	0.04	0.03%
2000's	255,879	48.46	40.07%
2010's	10,374	1.96	1.62%
2020's	11,993	2.27	1.88%
Unknown	237,663	45.01	37.22%
Total	**638,537**	**121**	**100%**

3.2.2 Water Main Size

Shown below is the water main sizing within the City of Sycamore. Water main in red represents 4-inch, orange 6-inch, yellow 8-inch, green 10-inch, teal 12-inch, light blue 14-inch, and dark blue 16-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 6-inch to 10-inch, with downtown areas generally smaller diameter, the majority being 4-inch and 6-inch.

Current State regulations require that new water main be 6-inch and larger in diameter. This includes both residential and commercial applications. City standards require the installation of 8-inch or larger main. Historically, mains as small as 4-inch were installed in residential areas. Increasing fire flow requirements through the years have led to a need for larger main. About 7% of the City's system is comprised of 4-inch, isolated primarily in the downtown residential area. Industry standard for many years was to utilize 6-inch for residential areas, and as such makes up more than 26% 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 or older homes more susceptible to fire damage. It should be noted that increasing the size of water main will increase the amount of storage within these pipes, and will result in longer water ages through the system. Therefore, new water main must be a balance between sizing large enough to provide adequate capacity, without oversizing unnecessarily and creating water quality issues.

Figure 3-3: Water Main Size



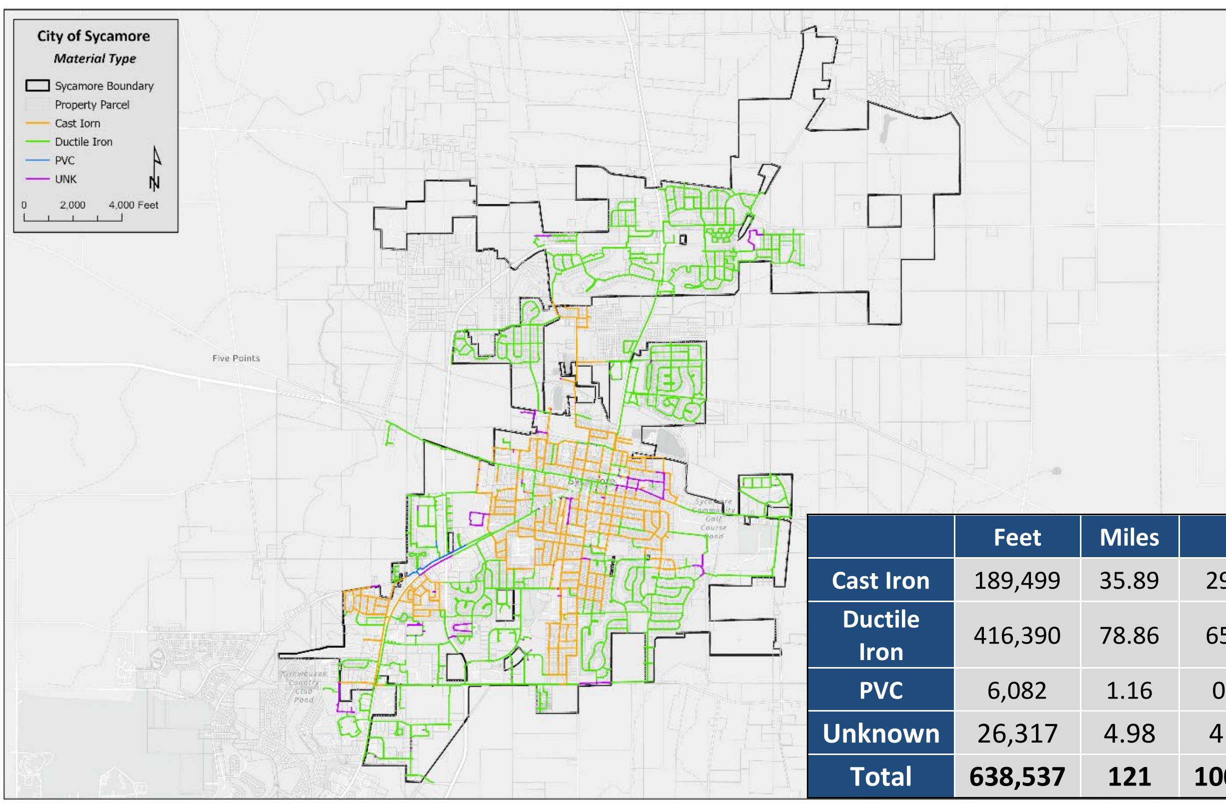
	Feet	Miles	%
≤4-Inch	45,703	8.66	7.16%
6-Inch	163,948	31.05	25.68%
8-Inch	151,369	28.67	23.71%
10-Inch	275,541	52.19	43.15%
12-Inch	1,257	0.24	0.20%
14-Inch	279	0.05	0.04%
16-Inch	97	0.02	0.02%
Unknown	341	0.06	0.05%
Total	**638,537**	**121**	**100%**

3.2.3 Water Main Material

Shown below is the water main construction material for the City of Sycamore's distribution system. Water main in blue represents PVC, green ductile iron, orange cast iron, and violet unknown material. The table below identifies the breakdown of the water main material. As shown in the table, the majority of the water main (95%) is either cast or ductile iron. The remaining 5% of the system is either PVC, plastic, lead, or unknown.

Corresponding to the era in which the City's distribution system was constructed, much of the pipe is either cast iron or ductile iron. According to the AWWA, cast iron was predominantly used from the early 1900s through the 1950s. In the 1960s ductile iron and pre-stressed concrete pipe became the most commonly used materials. Polyvinyl chloride was commercially available in the late 1940s but did not become widely used until the mid-1970s. The City's distribution system follows this historic trend, with the first installations in the service area in the early 1900s being cast iron, and the remaining consisting of ductile iron, with a recent transition to PVC. With the exception of portions of unincorporated areas, the City largely ceased installation of cast iron and has migrated to ductile iron and PVC. These materials are less brittle and are more widely accepted as an industry standard at present when compared to cast iron.

Figure 3-4: Water Main Material



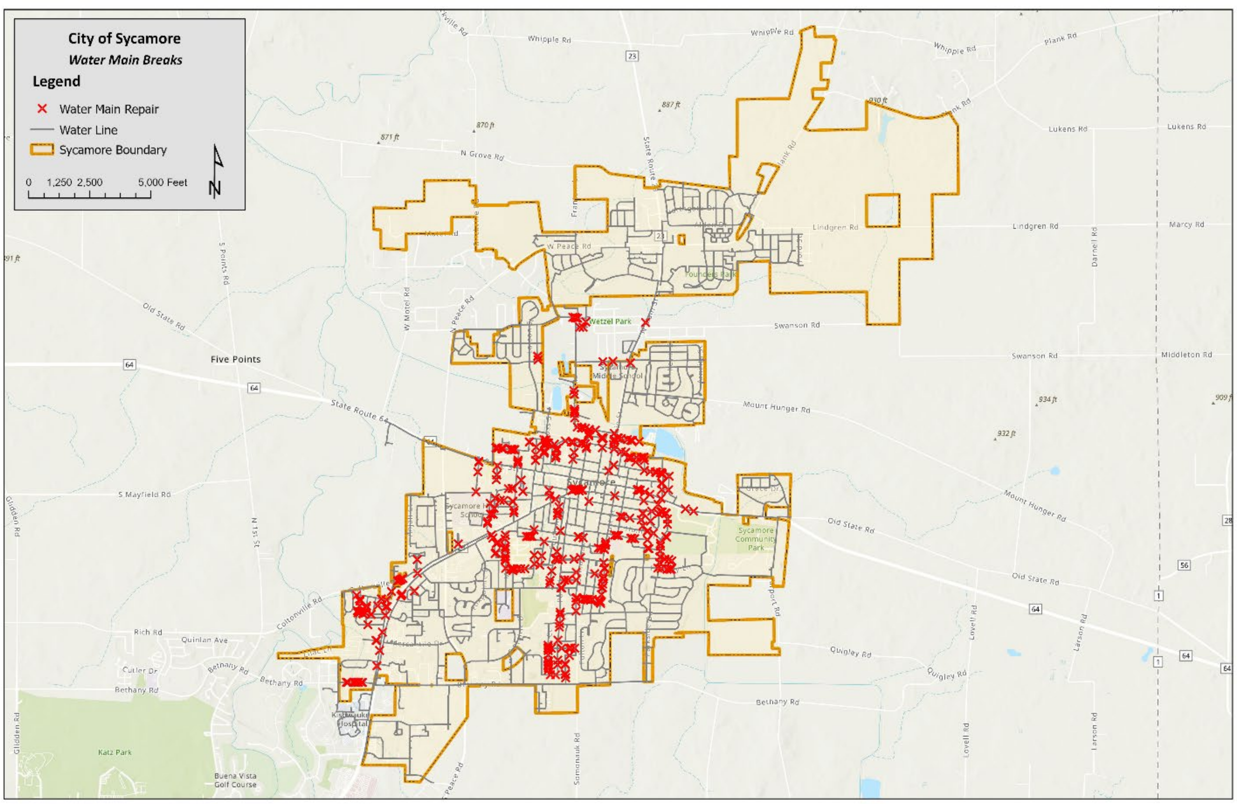
	Feet	Miles	%
Cast Iron	189,499	35.89	29.68%
Ductile Iron	416,390	78.86	65.21%
PVC	6,082	1.16	0.96%
Unknown	26,317	4.98	4.12%
Total	**638,537**	**121**	**100.00%**

3.2.4 Water Main Breaks

The City of Sycamore's water distribution system has been in operation since the early 1900's, and as such consists of water main of varying condition. Areas of the system may experience more frequent water main breaks due to 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 water main exhibiting more frequent main breaks 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 main break locations throughout the City limits. These failures could be a result of a combination of several factors including insufficient construction materials or techniques, or corrosive soils which can be the cause of increased pipe deterioration. Many of the breaks are localized within the older portions of the distribution system where the water main may be approaching its anticipated service life. Water main corrosion is typically a chemical process wherein the metal of the pipes (ductile iron or cast iron) reacts with water and oxygen, and the metal is dissolved resulting in corrosion pits. These pits weaken the pipe wall which may lead to leaking or breaks under pressure.

Figure 3-5: Water Main Breaks



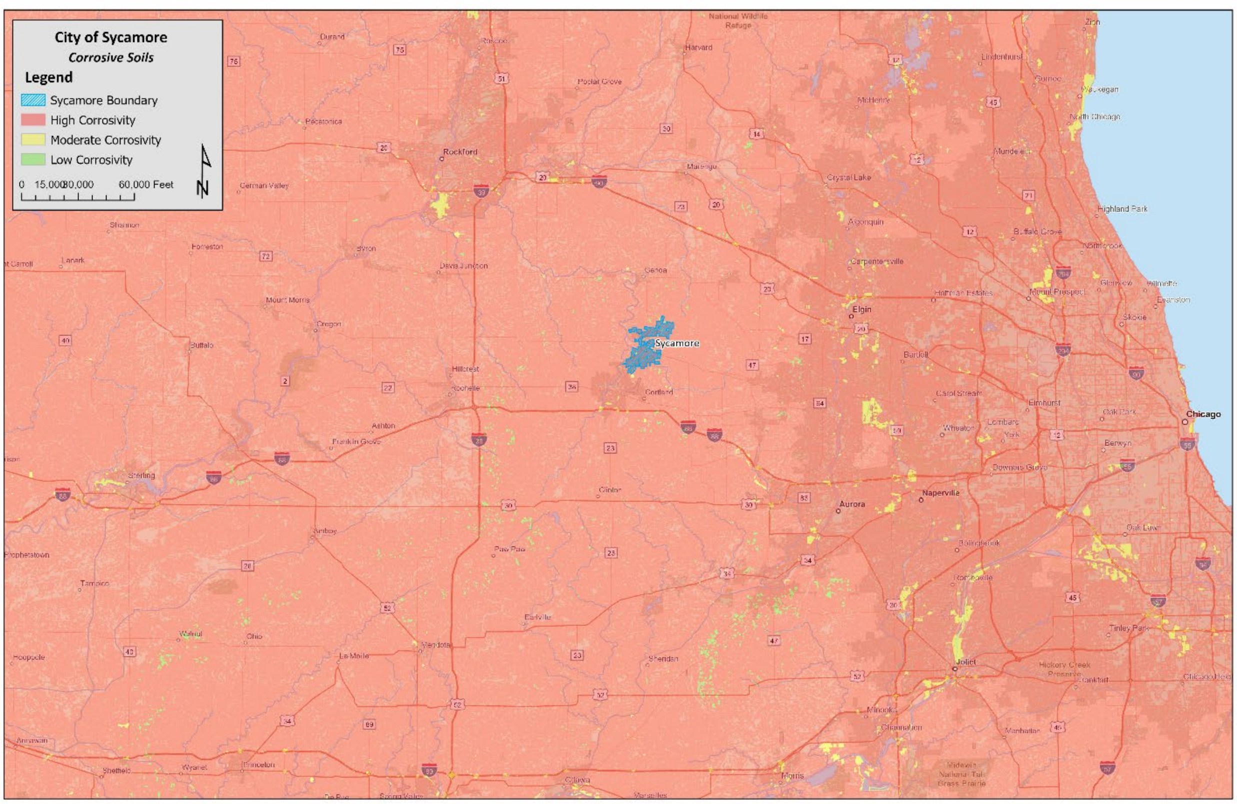
3.2.5 Corrosive Soils

The City of Sycamore has experienced water main breaks throughout the distribution system. One of the affecting factors of water main breaks could be 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. Historically, water main was direct buried and backfilled with soil. Modern installation techniques require the use of bedding and backfill with stone, which helps mitigate the effects of surrounding corrosive soils.

The graphic below illustrates the corrosivity levels of soils within northeastern Illinois, as mapped by the US Department of Agriculture (USDA). Green represents low soil corrosivity, yellow moderate, and red high. Similar to most communities within the region, approximately 98% of the City of Sycamore's service area falls within the 'high' corrosivity soil areas. This is entirely within the expected range for towns in northeastern Illinois, where corrosive soils are widespread.

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. If ductile-iron pipe is going to be utilized, it should be wrapped in polyethylene given the damage that the aggressive soils in the area have caused to the existing iron-based piping.

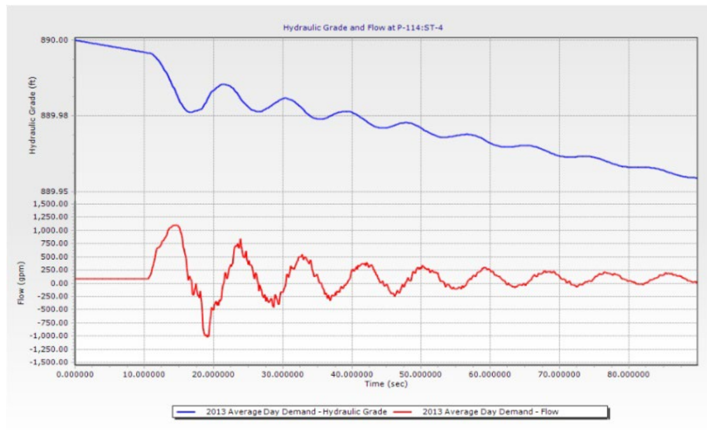
Figure 3-6: Corrosive Soils in Northeastern Illinois



3.2.6 Water Hammer

Water hammer can be a nuisance to customers, as well as cause serious damage to the water distribution system such as water main breaks or pump damage. Water hammer results during transient conditions in the piping system. The longitudinal transient wave that moves throughout the system causes pressures to oscillate repeatedly between alternating peaks and valleys while the transient conditions persists and then gradually subsides. The duration and magnitude of the transient condition are dependent on the dynamics, geometry, and operation of the system.

Severe transient conditions, such as those that can occur when a pump is shut down rapidly following a loss of power, can pull a vacuum during the drop-in pressure that occurs as the transient pressure wave moves away from the pump, only to be followed by a rapid climb to pressures far in excess of normal operating pressures. The arrival of the return longitudinal wave is marked by the water hammer sound as the wave rebounds and reverses.



In many communities, transients have caused unwanted discharge of RPZ backflow preventers, and there are few operational adjustments that can be made to control the water hammer that is experienced. The transients result from the configuration of the distribution system and usually a result of areas remote from the nearest open-air water surface (water tower). This is often the case with communities that have undersized or distant elevated storage tanks.

The City has previously only experienced water hammer in areas near well sites when these wells were suddenly shut off. Historically this was most prevalent in the Electric Park neighborhood outside of Well #7, however the rehabilitated well and treatment facility include a variable frequency drive that will dampen transients when the well shuts off. Small diameter water main and a lower elevation at the well may contribute to these conditions, resulting in multiple main breaks in the area. At other well sites, installation of Variable Frequency Drives (VFDs) has also mitigated the effect of water hammer.

3.2.7 Lead Service Replacement Plan

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. 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, 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 private-side household plumbing. In accordance to the LCR, testing was required to be done at the tap of customers on a six (6) month, year, or triennial schedule.

The LCRR 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. 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 service piping, fixtures and fittings.

Since 2021, the LCRR now requires testing in schools and childcare facilities, locations of lead service lines to be made public, and establishes a trigger level for earlier mitigation, 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 requires identification of at-risk communities and ensure systems are in place to establish a rapid response to reduce elevated levels of lead in drinking water.

Subsequently, in October 2024 the US EPA passed the Lead and Copper Rule Improvements (LCRI). 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. The LCRI also revised the exceedance level from 15 ppb to 10 ppb. These changes will significantly affect many communities within northern Illinois with a high prevalence of lead services.

Lead Piping & Fittings Legislative History	Allowable Lead (% of total material)
Pre-1986	No Regulation
1986 Safe Drinking Water Act Lead Ban	< 8.0%
2011 Reduction of Lead in Drinking Water Act	< 0.25%

The City has taken a proactive approach to lead service line replacement, well before regulations would require replacements. This approach allowed the City to secure more than $4.5M in loan funding with full principal forgiveness for lead service line replacement. Funding is currently very competitive, and many communities who have waited to begin service replacement will be required to expend local funding to meet the requirements.

As of April 2024, the City had 48 services requiring replacement, however after this season's service replacement program only five service replacements remain. Of these five, four property owners have refused participation in the program. While the City will be required to monitor and test for the presence of lead as part of the LRCI, the service replacement program is nearly complete.

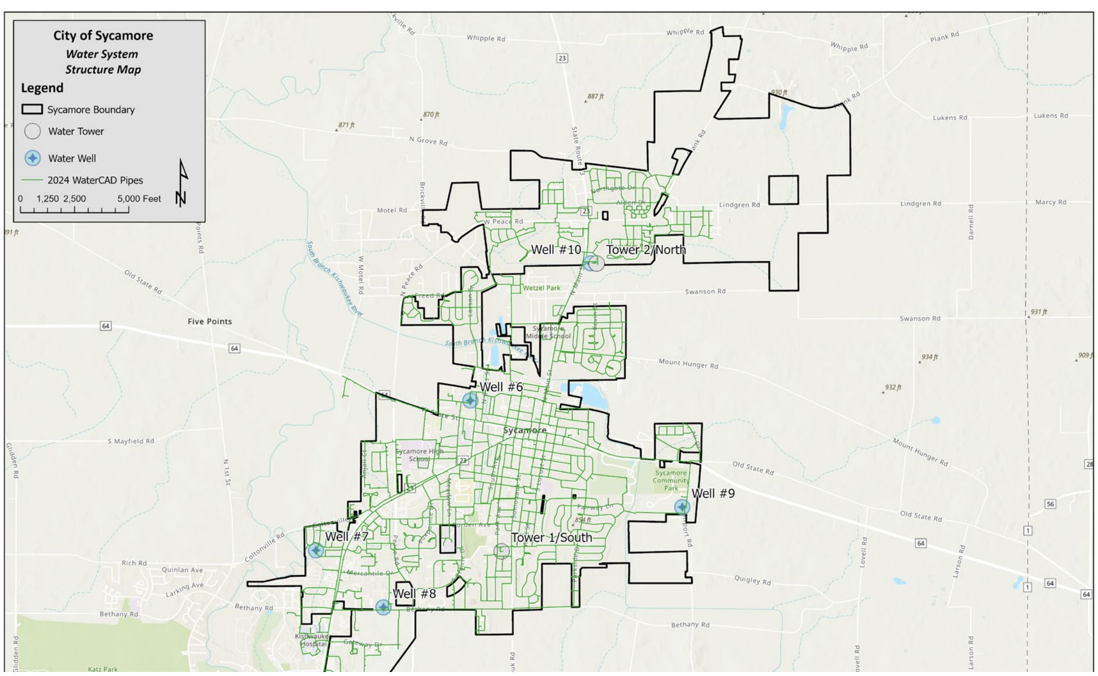
3.3 Water Distribution System Modeling

The City's WaterCAD hydraulic model was last updated to represent the distribution system in 2021. Trotter and Associates and the City have worked together to update the hydraulic model in the upgraded WaterCAD/GEMS software using information from the City's latest GIS database, which includes the distribution projects completed since the 2019 Water Master Plan. The model is a valuable tool for assessing potential capital improvement projects and system rehabilitation needs, while also evaluating the impact of potential new developments.

The hydraulic modeling software has the capability to evaluate multiple data points simultaneously and therefore reach a higher degree of calibration than previous versions. Field flow testing was completed at representative locaitons throughout the distribution system, and the model was then calibrated through fire flow testing.

The features in the model include wells, elevated storage/towers, hydrants, valves, and the 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. Figure 3-7 shows the existing system as modeled in WaterCAD/GEMS.

Figure 3-7: WaterCAD Water System Map



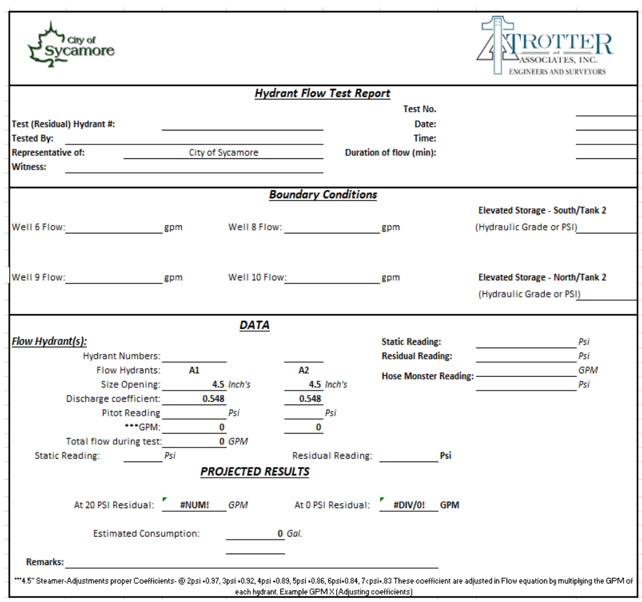
3.3.1 Water Model Assumptions and Limitations

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.

3.3.2 Water Model Calibration

Once the model was updated to include modifications since the 2021 update, it was necessary to verify that the conditions of the model accurately represent the actual operations of the distribution system. To do this, the City and third-party consultant performed multiple hydrant tests throughout the service area and the entire distribution system. Hydrant testing is critical for distribution modeling and requires a specific operating procedure. The City utilized a Hose Monster® unit during all testing. The Hose Monster allowed the City to obtain accurate and consistent results for all hydrant tests.

In addition to utilizing the Hose Monster, the City was provided a specific data sheet outlining all data to be collected during the hydrant tests. For example, the data sheet identified the test and flow hydrants, time of day, flow received, and both residual and static pressures. The City also provided information in regard to all boundary conditions during testing identifying the tower levels and Well pumps in operation/running.



City of Sycamore

TROTTER and ASSOCIATES, INC.
ENGINEERS AND SURVEYORS

Hydrant Flow Test Report

Test (Residual) Hydrant #: ______ Test No. ______
Tested By: ______ Date: ______
Representative of: City of Sycamore Time: ______
Witness: ______ Duration of flow (min): ______

Boundary Conditions

Well 6 Flow: ______ gpm Well 8 Flow: ______ gpm Elevated Storage - South/Tank 2 (Hydraulic Grade or PSI) ______

Well 9 Flow: ______ gpm Well 10 Flow: ______ gpm Elevated Storage - North/Tank 2 (Hydraulic Grade or PSI) ______

DATA

Flow Hydrant(s):

Hydrant Numbers:		
Flow Hydrants:	A1	A2
Size Opening:	4.5 Inch's	4.5 Inch's
Discharge coefficient:	0.548	0.548
Pitot Reading	Psi	Psi
***GPM:	0	0
Total flow during test:	0 GPM	

Static Reading: ______ Psi
Residual Reading: ______ Psi
Hose Monster Reading: ______ GPM
______ Psi

Static Reading: ______ Psi Residual Reading: ______ Psi

PROJECTED RESULTS

At 20 PSI Residual: #NUM! GPM At 0 PSI Residual: #DIV/0! GPM

Estimated Consumption: 0 Gal.

Remarks: ______

***4.5" Steamer-Adjustments proper Coefficients- @ 2psi +0.97, 3psi +0.92, 4psi +0.89, 5psi +0.86, 6psi+0.84, 7<psi+.83 These coefficient are adjusted in Flow equation by multiplying the GPM of each hydrant. Example GPM X (Adjusting coefficients)

In total, 23 fire flow tests were completed throughout the distribution system. Four of these tests were later identified as faulty due to incorrect recording and were performed again to ensure accurate data. Upon retesting these locations each test was brought into calibration. The results were used to calibrate the distribution model to reflect the field observations.

Calibration of the hydraulic model was performed in accordance with the recommendations of the American Water Works Association's "Computer Modeling of Water Distribution Systems" Manual (AWWA M-32). Each flow test was input individually by setting the time of day, supply pressure and flows, and water tower elevations. During the initial evaluation, the static pressures were verified, and minor adjustments made to obtain a minimal margin of error. The observed fire flow in the field was simulated in the model as a point demand, and the model was run to verify that the residual pressure recorded in the field closely match those projected by the model.

Calibration is an iterative task and requires that most of the points be revisited two to three times to ensure that the modifications that were made didn't affect other tests. Calibration began with hydrants near connection points to water supplies (wells), and moved outward, away from supply sources. For accurate results it was necessary to have the hydraulic model correctly depict pipe diameters, lengths, pumps, controls, etc., the model relies largely on the Hazen-Williams roughness coefficients or C-Factors.

The model relies largely on the Hazen-Williams roughness coefficients or C-Factors. C-Factors were adjusted from 130 (new, smooth pipe) to 70 (old, rough pipe). Newer areas of town were first set at the higher value and modifications occurred as needed to adjust the model to reflect the field conditions Table 3-3. below identify the starting values that were used for the water main to begin the calibration process. These values were then adjusted to calibrate the model to the results found within the field.

Table 3-2: C-Factor Starting Value

	1960	1970	1980	1990	2000	2010
UNK	100	100	100	100	100	100
PVC	125	125	130	130	135	135
HDP	125	125	130	130	130	130
DI	95	95	100	105	105	110
CI	95	95	100	100	100	100

With an average deviation of 1.90% (static) and 4.10% (residual) for the entire system, the WaterCAD/GEMS model is considered to be very accurate and capable of producing real-time fire flow and pressure data for evaluation and analysis purposes. The results of the fire flow testing and calibration can be found on the following page.

		Field			WaterCAD results					
		Flow	Static	Residual	Static			Residual		
Test No.	Location	GPM	psi	psi	psi	Difference psi	Difference %	psi	Difference psi	Difference %
1	Stonegate	1682	62	51	61	-1	-2%	50	-1	-2%
2	Alden	1639	59	53	58	-1	-2%	50	-3	-6%
3	Freed	1803	66	56	65	-1	-2%	53	-3	-5%
4	Maplewood	1723	64	57	63	-1	-2%	55	-2	-4%
6	Airport	1682-1723	65	54	63	-2	-3%	51	-3	-6%
7	64 (downtown)	1723	55	51	53	-2	-4%	49	-2	-4%
8	64 (west)	1504	67	44	69	2	3%	42	-2	-5%
9	South	1303	62	54	61	-1	-2%	57	3	6%
10	Borden	1550	50	46	49	-1	-2%	46	0	0%
11	Sandberg	1764	63	59	63	0	0%	56	-3	-5%
12	Bethany	1456	43	39	41	-2	-5%	36	-3	-8%
13	Oakland	1550+	49	40	49	0	0%	38	-2	-5%
14	Stonehenge	1356	64	54	63	-1	-2%	52	-2	-4%
15	Hathaway	1595+	46	41	46	0	0%	41	0	0%

3.3.3 Fire Flow Requirements

Per the 2012 International Fire Code, the fire-flow duration for commercial properties is two hours for Needed Fire Flows (NFF_i) 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 IFC.

In general, commercial, municipal, and industrial properties require a minimum of 3,500 gpm of available fire flow. Residential properties generally require a minimum of 1,500 gpm of fire flow capacity. Both of these guidelines vary by square footage, building density, construction materials, and other factors.

Figure 3-8: 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 WaterCAD Model Hydraulic Analysis & Results

The City's distribution system was analyzed to see the flows available through the service area, as well as the static and residual pressures. 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 2.26 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.

Available Fire Flow Mapping

The WaterCAD computer modeling software was used to identify the available fire flow capacity throughout the City's 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 results from the simulation were then used to generate an available fire flow contour map. The fire flow contour maps on the following page identify the available fire flows throughout the City, and each contour is defined as less than or equal to the value presented. The contour map identifies areas of flow less than 1,000 gpm, in red, areas of fire flow between 1,000 and 3,000 gpm in yellow and areas greater than 3,000 gpm in green.

In order to visualize the impact of the distribution system improvements completed since the 2019 Water Master Plan, the original fire flow contour map from that report is included on the following page for reference. As shown, fire flows in the areas surrounding the improvement projects are significantly increased. This is especially prevalent along DeKalb Avenue, the east end of Route 64, Sabin/Exchange Area, as well as the North Cross Street area. In addition to increased fire flow capacities, these areas may see improvements to water quality based on the increased conveyance regionally.

The 2025 Water Main Improvements project, currently in design, is expected to further improve fire flow capacities along the S. Main Street, Locust Street, Park Avenue, as well as several others in this area. As part of the design process for each water main improvement project the City has the improvement modeled in WaterCAD/GEMS to determine the impact of the upgrades, as well as to evaluate any alternative routes which may be more impactful from a capacity standpoint.

Figure 3-9: Available Fire Flows (2025)

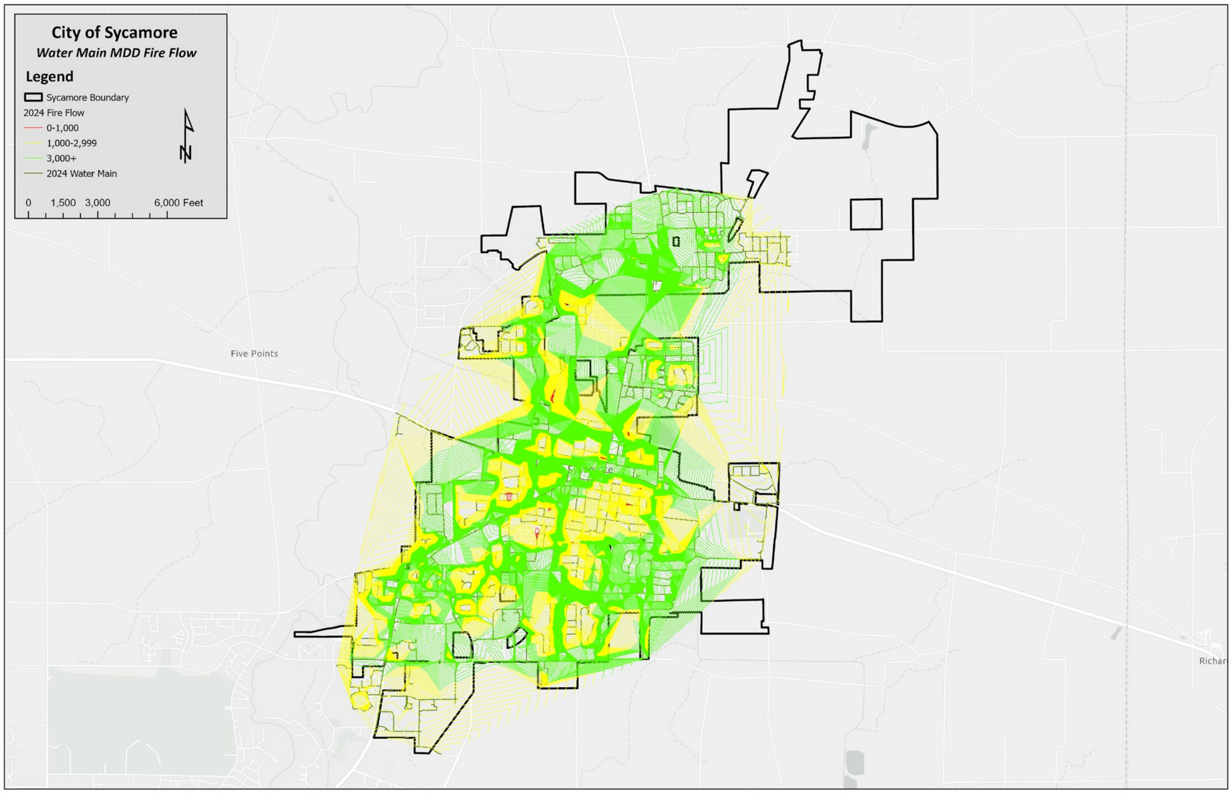
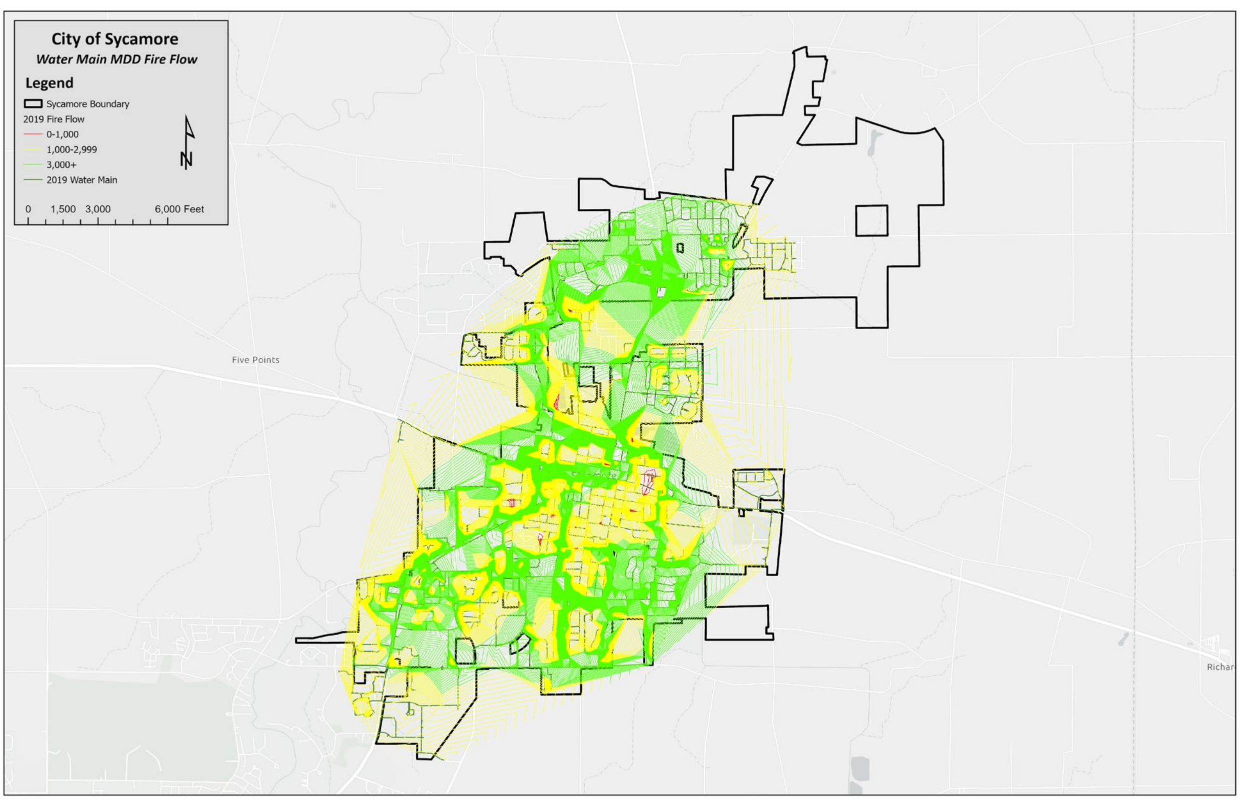


Figure 3-10: Available Fire Flows (2019)



Pressure Contour Mapping

In addition to fire flow, the WaterCAD/GEMS computer modelling software was used to identify the available pressures throughout the City of Sycamore's water distribution system. An extended period analysis provided a comprehensive overview over a 24-hour period including peak demand conditions.

The pressure contour map on the following page has identified areas of low pressure, defined as less than or equal to 40 psi, in red and areas less than 50 psi are in orange, less than 60 psi are in yellow, less than 70 psi are in green, less than 80 psi in light blue, 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. Overall, static pressures throughout the distribution system are generally between 60-80 psi.

Similar to the fire flow mapping, pressure contours in 2019 prior to the City's current distribution system improvement program were reviewed. As expected, the pressures across the system are largely unchanged since the 2019 report. This is because static pressures are a function of ground elevation, and primarily the operating level of the water towers. Replacement or upsizing of water main typically does not increase local static pressures, unless it mitigated a specific pressure issue in the system.

Figure 3-12: Pressure Contour Map (2025)

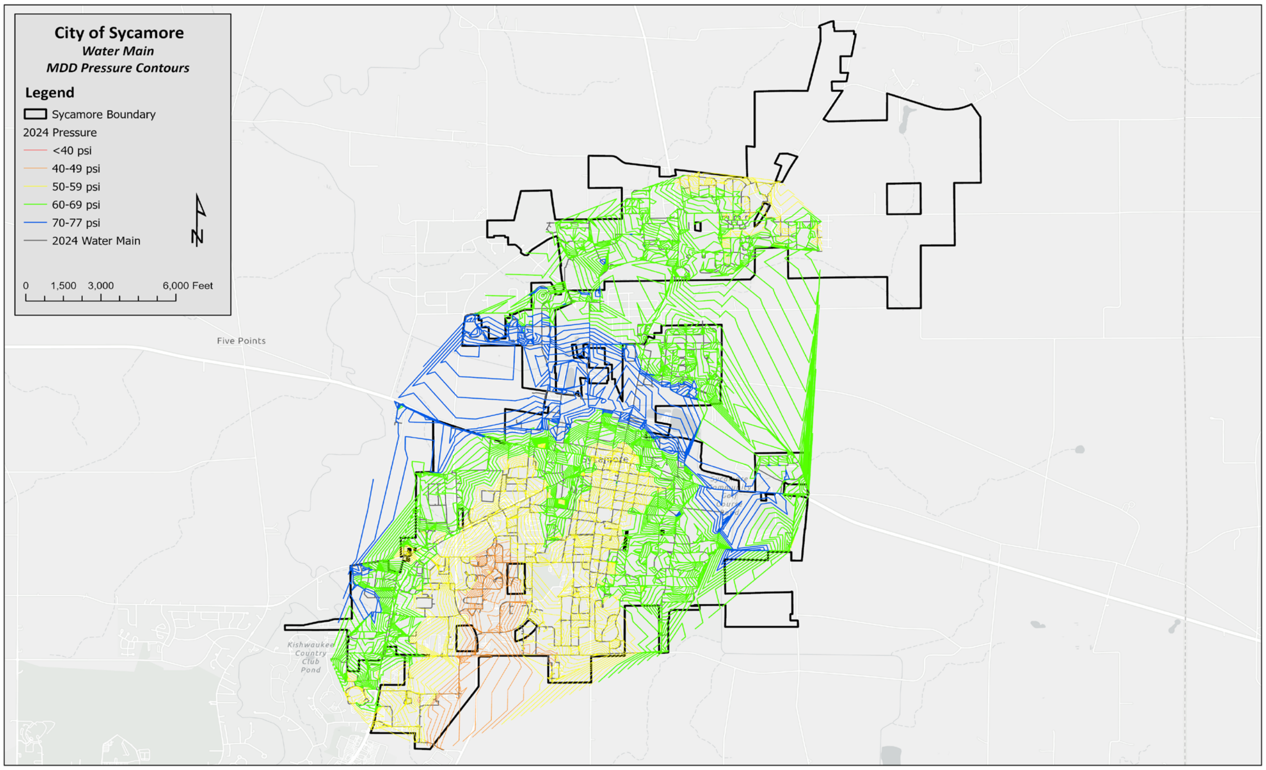
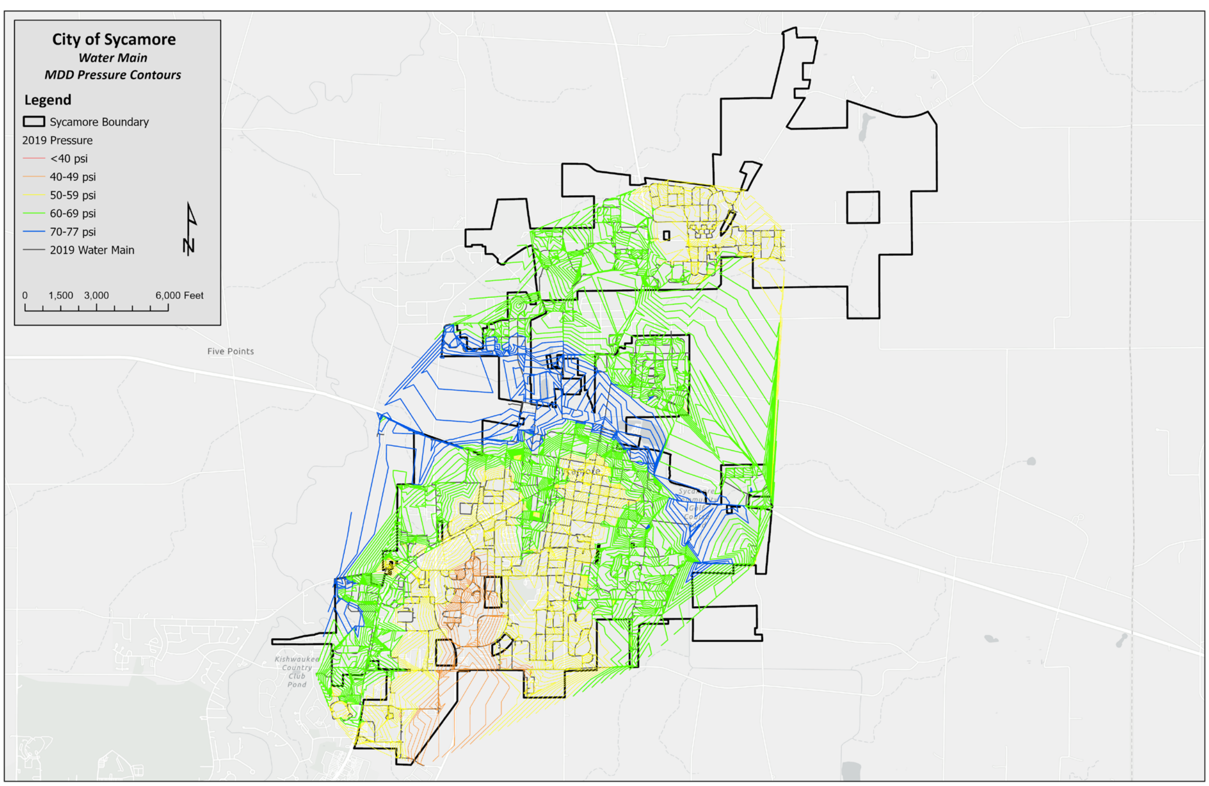


Figure 3-11: Pressure Contour Map (2019)

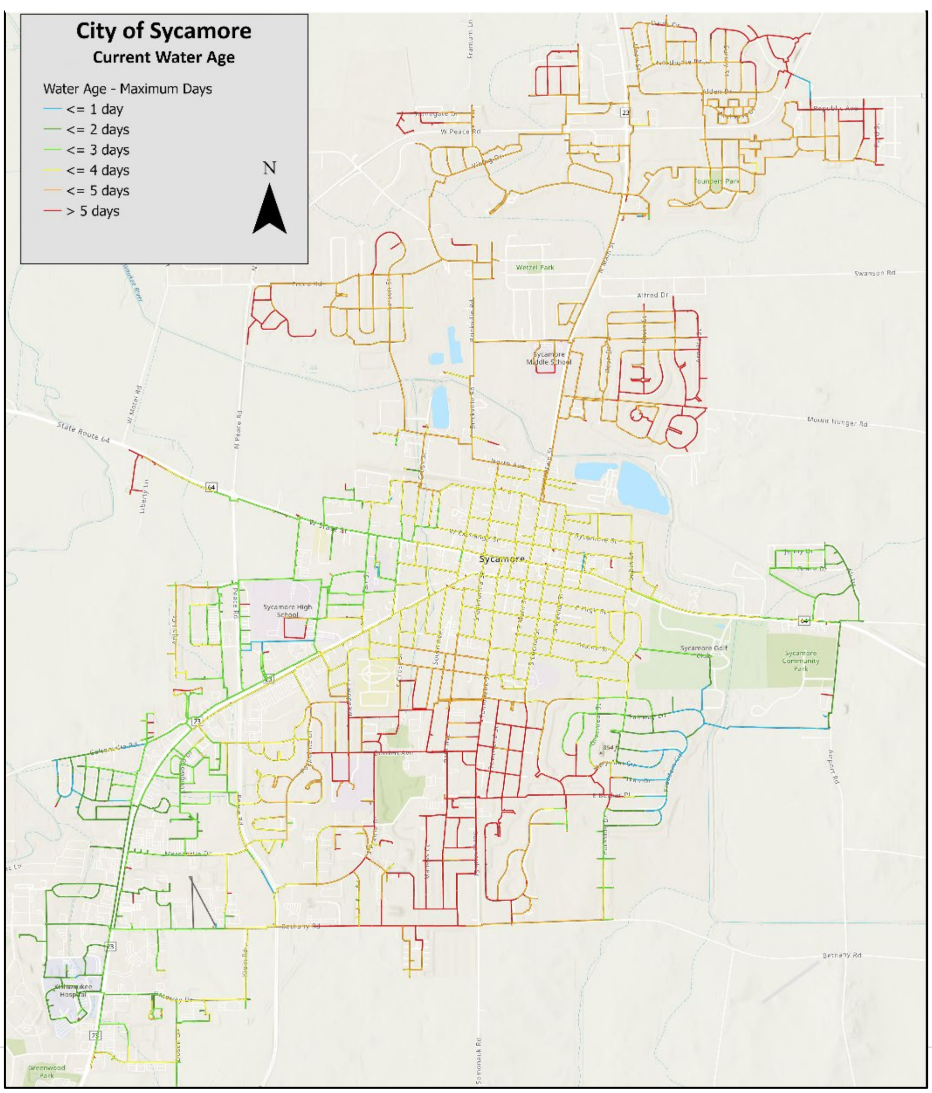


Water Age

Water age, the duration that water is in the distribution system before being delivered to the consumer, is a strong indicator of overall water quality. Water age can be affected by several different factors, which include water system demands, well run time, elevated storage capacity, water main layout, water main size, etc. Increased water age can result in loss of chlorine residual, odors, and potential color changes. In general, anything less than three days age is considered 'very good', while above five days is where residual degradation may begin to occur.

Figure 3-12 shows the maximum water age within each pipe segment. Teal identifies areas of water age of less than one day, dark green represents age up to two days, light green represents up to three days, yellow represents up to four days, orange represents up to five days, and red represents over five 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 northeast portion of the system and is likely related to the 1.5 MG elevated storage tank in this region. This tower is needed as it provides storage and improves water pressure consistency throughout the City, providing net benefits.

Figure 3-13: Distribution System -Maximum Water Age



3.5 Distribution System Summary

The City of Sycamore water distribution system is over 121 miles of water main piping, valves, fire hydrants, and service connections. Since the completion of the 2019 Water Master Plan, the City has completed a number of the recommended improvements throughout the distribution system, investing more than $10.7M and replacement of more than 8,500 feet of water main. These improvements include significant water main improvements along DeKalb Avenue, Route 64, Sabin Street, Exchange Street, and North Cross Street, as well as the 2025 improvements currently in design which include replacements along S. Main Street, E. Lincoln Street, Locust Street, and Park Avenue.

The total replacement value of the distribution system is estimated at approximately $362M, as identified in the table below. Based on an average 75-year service life for the buried water infrastructure, this would require an annual reinvestment of approximately $4.83M. Throughout northeastern Illinois, communities are experiencing rapidly increasing numbers of main breaks and degradation of installed mains. Similar to the City, many are budgeting to increase routine annual water main replacement. If the City did not continue its proactive water main replacement program, it may result in increasing main breaks and strain on City staff and budgets due to future emergency repairs.

System Asset	Quantity (LF)	Unit Value	Total Replacement Value ($ Million)
≤4-Inch Main	45,703	$500	$22.85
6-Inch Main	163,948	$525	$86.07
8-Inch Main	151,369	$540	$81.74
10-Inch Main	275,541	$560	$154.30
12-Inch Main	1,257	$575	$0.72
14-Inch Main	279	$600	$0.17
16-Inch Main	97	$625	$0.06
Unknown	341	$561	$0.19
System Valves	1,617	$4,500	$7.28
Hydrants	1,586	$5,500	$8.72
Total:	641,738	-	**$362.11 Million**

It is recommended that the City continue to work towards the annual funding level identified over the 20-year planning period. Section 4 outlines several 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 is discussed in Section 4. Each project is rated based on criteria such as main age, material, available fire flows, and break frequency, among others. This prioritization is utilized for the development of the Implementation Schedule within Section 7.

This Page Intentionally Left Blank

SECTION 4

ANALYSIS FOR DISTRIBUTION SYSTEM ALTERNATIVES

This Page Intentionally Left Blank

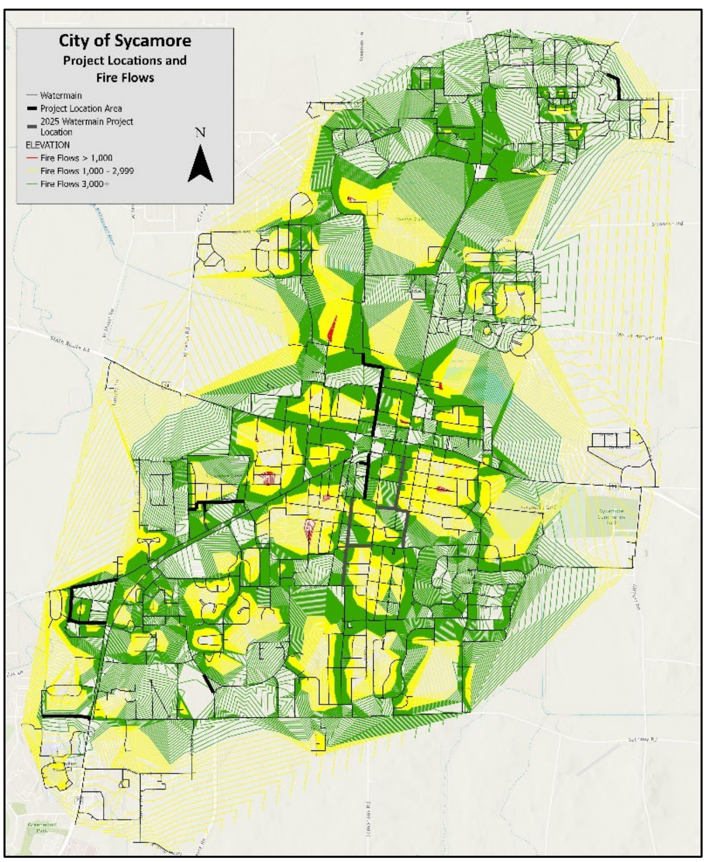
4. Analysis for Distribution System Alternatives

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 would be recommended to plan for rehabilitation or replacement.

Through review of water main age, size, material, break history, and available fire flows detailed in Section 3, eight priority rehabilitation areas within the distribution system were identified, two of which are slated to be completed in 2025. These areas may exhibit low available fire flow (AFF), a high frequency of main breaks, or a combination of issues. Each of these areas are discussed in further detail in the following pages, with prioritization of the improvements reviewed at the end of this section. The projects are numbered by orientation and do not represent prioritization. Full line-item cost estimates for each project can be found in Appendix A.

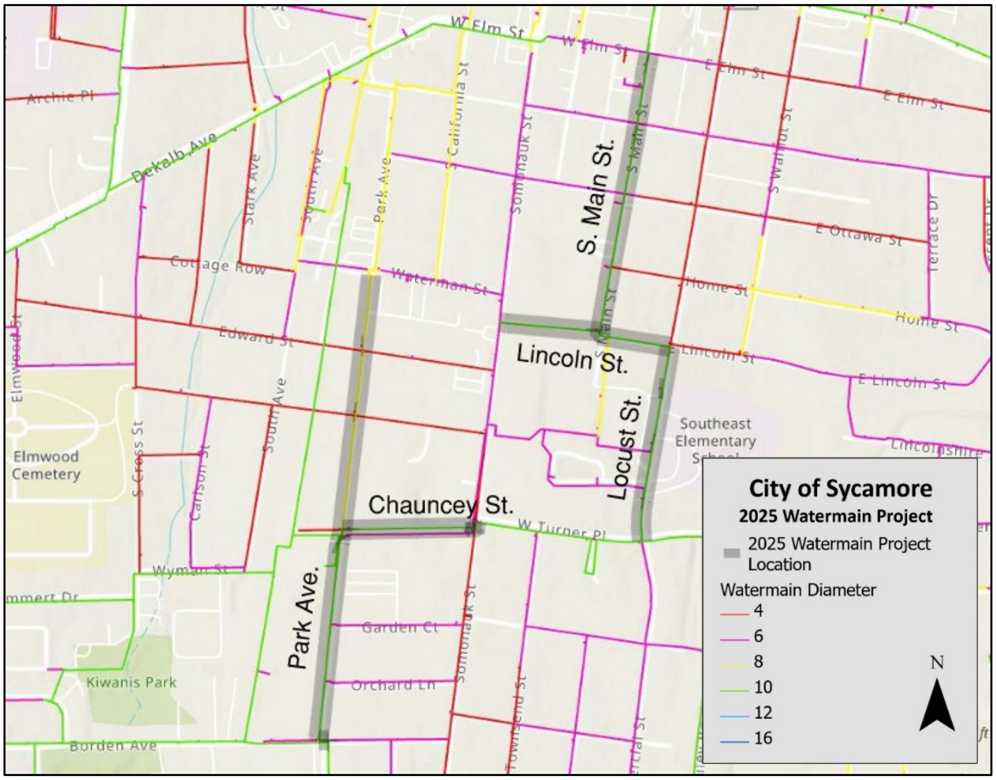
A. 2025 Watermain Project
B. North Grove School Connection
C. California, Blackhawk, & Blumen Gardens
D. California, Brickville, & North
E. Sycamore High School
F. Electric Park
G. Bethany Rd. (Rt. 23 to Health Club)
H. Peace Rd. Connection



Available Fire Flows – Project Locations (Completed)

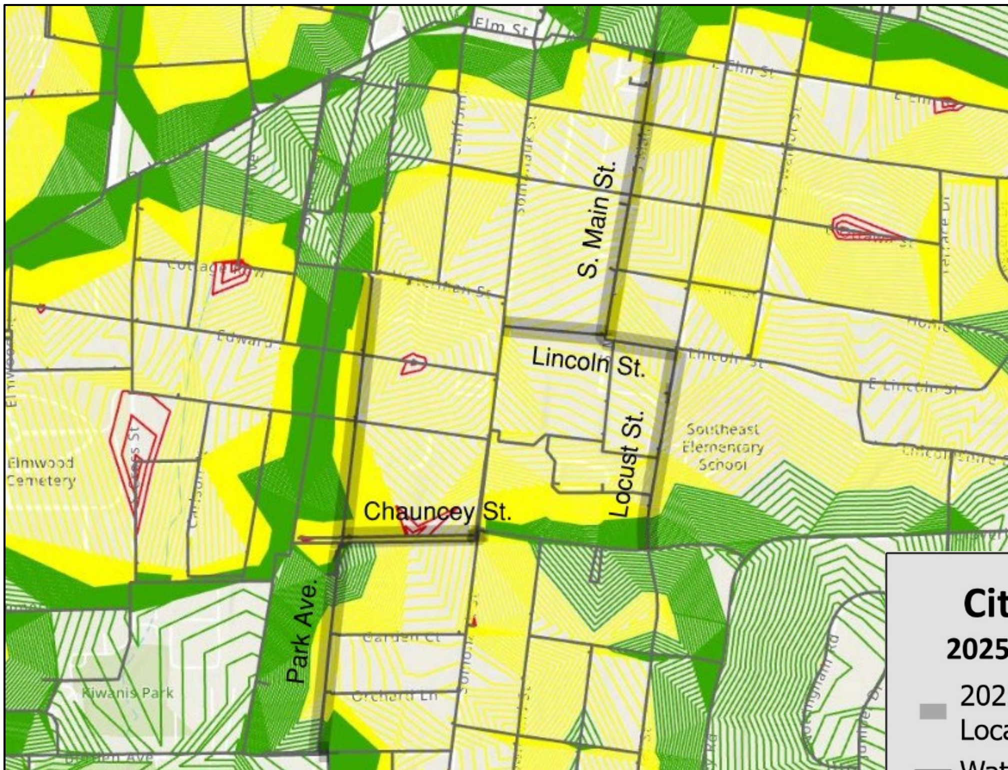
4.1.1 2025 Watermain Project

The 2025 Watermain Project includes upgrades and replacements of watermain as first identified in the 2019 Water Master Plan. The project includes sections of watermain along Park Avenue, Chauncey Street, Locust Street, Lincoln Street, and Main Street. The watermain infrastructure would be upsized from 4-, 6-, and 8-inch watermain to 8- and 10-inch watermain.

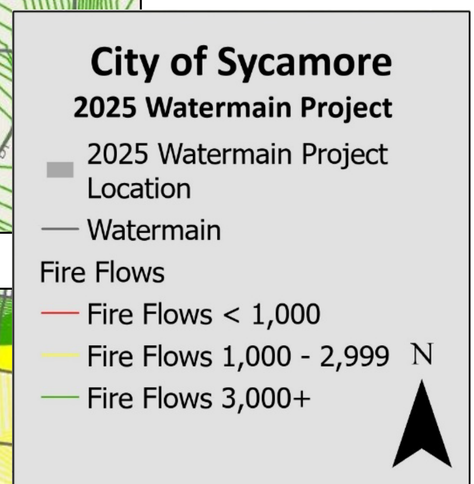


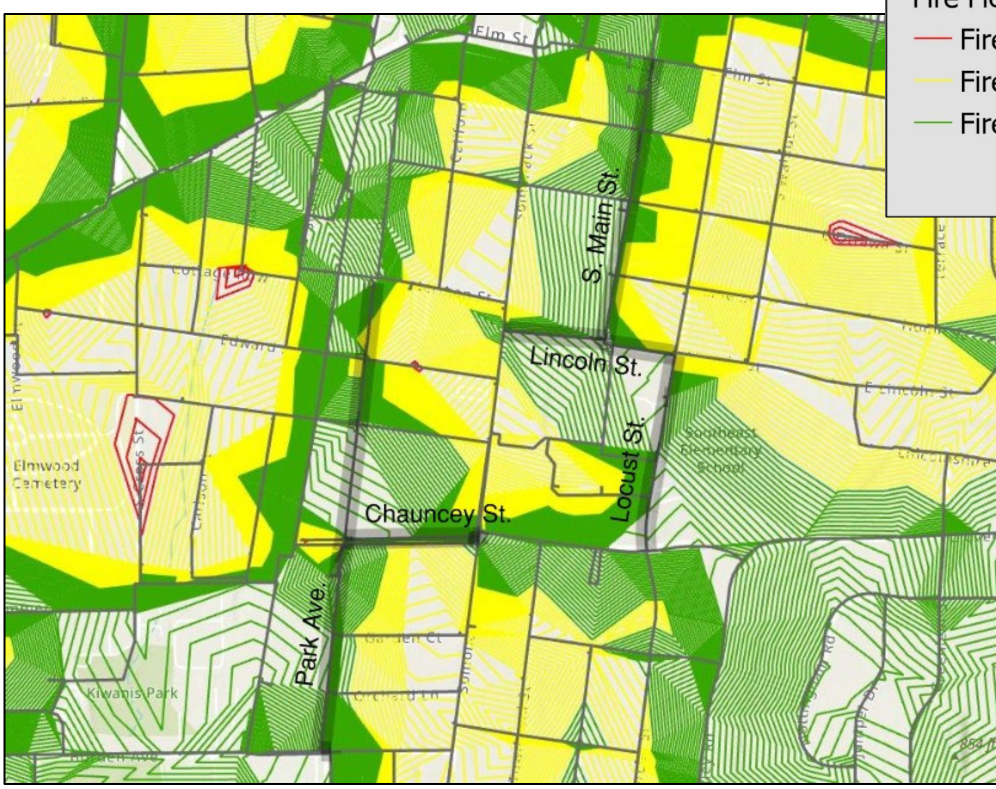
Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
South Main Street	4 & 6	10	1600
Lincoln Street	4	10	960
Locust Street	4 & 6	10	1080
Chauncey Street	4	10	760
Park Avenue	4 & 6	8 & 10	2650
Total	**-**		**7050**

The existing distribution layout provides approximately 1,500 to 2,750 gallons per minute of Available Fire Flow along Main Street, Lincoln Street, and Locust Street, and approximately 850 to 2,500 gallons per minute of Available Fire Flows along Park Avenue and Chauncey Street, just shy of the recommended 3,000 gallons per minute. Upsizing these mains to 10-inch and Park Avenue to 8-inch will increase Available Fire Flows to 3000+ gallons per minute. Additionally, this new upsized main would improve the movement of water throughout this area from Tower 1. The City is planning to complete this improvement project in 2025 pending IEPA Loan approval.



2025 Watermain Project – Current Available Fire Flows

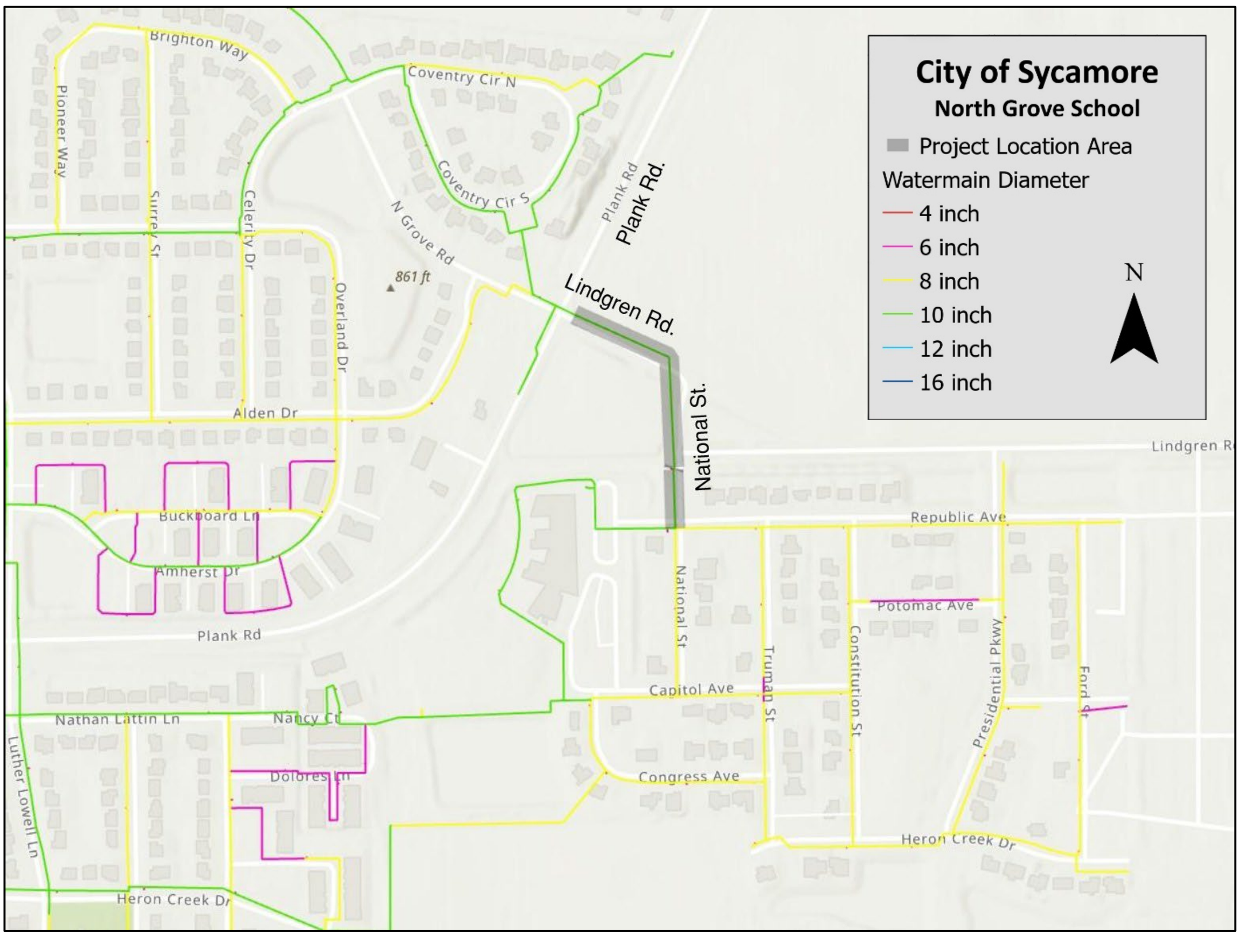




2025 Watermain Project – Proposed Available Fire Flows

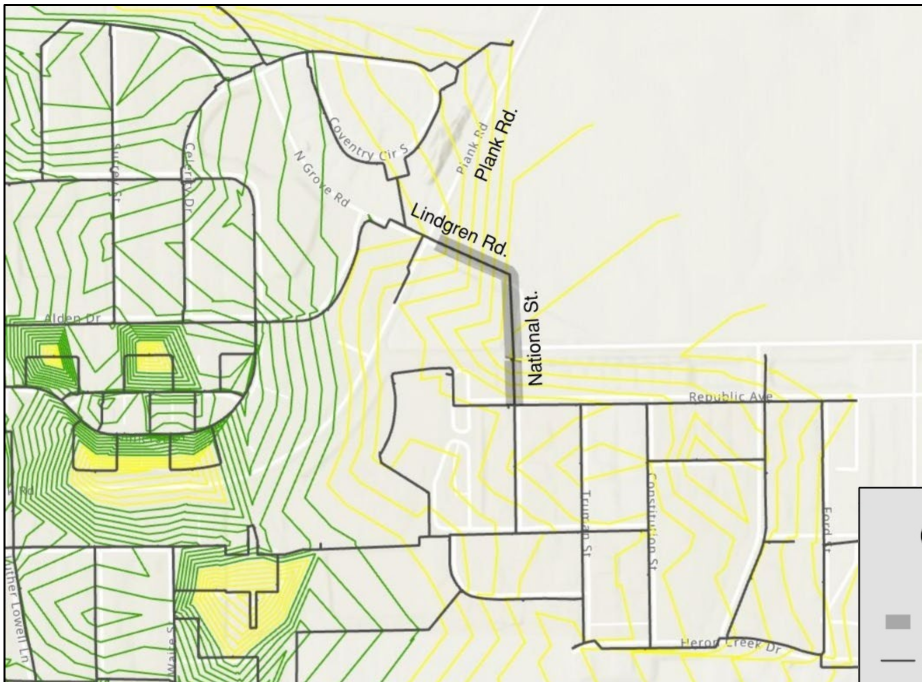
4.1.2 North Grove School Connection – 10-inch Main

Located in the northeast corner of the City, North Grove Elementary School opened in the late 2000s. The neighborhood around the Elementary School is still undergoing construction of new homes. There is 8-inch water main running throughout the neighborhood, as well as a 10-inch water main that circles around the west side of the school. Another 10-inch water main serves the adjacent neighborhood, across Plank Road. In order to maximize fire protection to the Elementary School, it is recommended to install a connecting 10-inch water main between the two neighborhoods that will cross Plank Road. This project is currently out for bid and anticipated for construction in the summer of 2025.

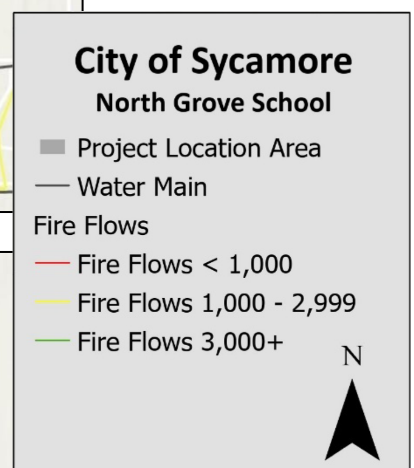


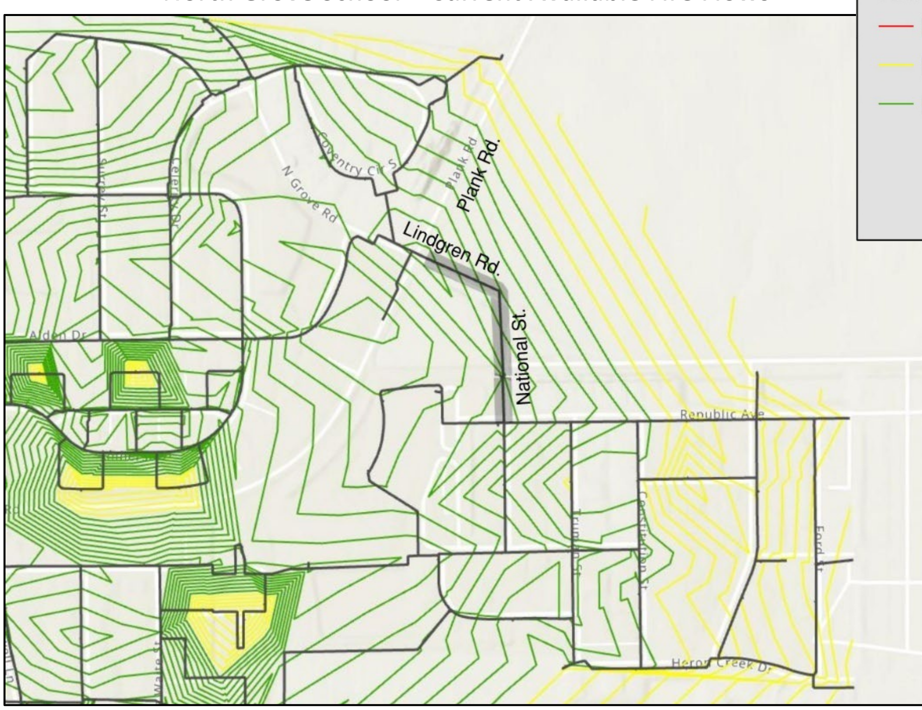
Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Lindgren Road	-	10	775
National Street	8	10	225
Total	**-**	**-**	**1000**

The existing distribution layout provides approximately 2,750 gallons per minute of Available Fire Flow to North Grove Elementary School, just under the recommended 3,000 gallons per minute. Upsizing a segment of 8-inch main along Lindgren Road and installing new 10-inch main to the intersection of Grove Road and Plank Road will allow the school to receive Available Fire Flows exceeding 3,400 gallons per minute.



North Grove School – Current Available Fire Flows





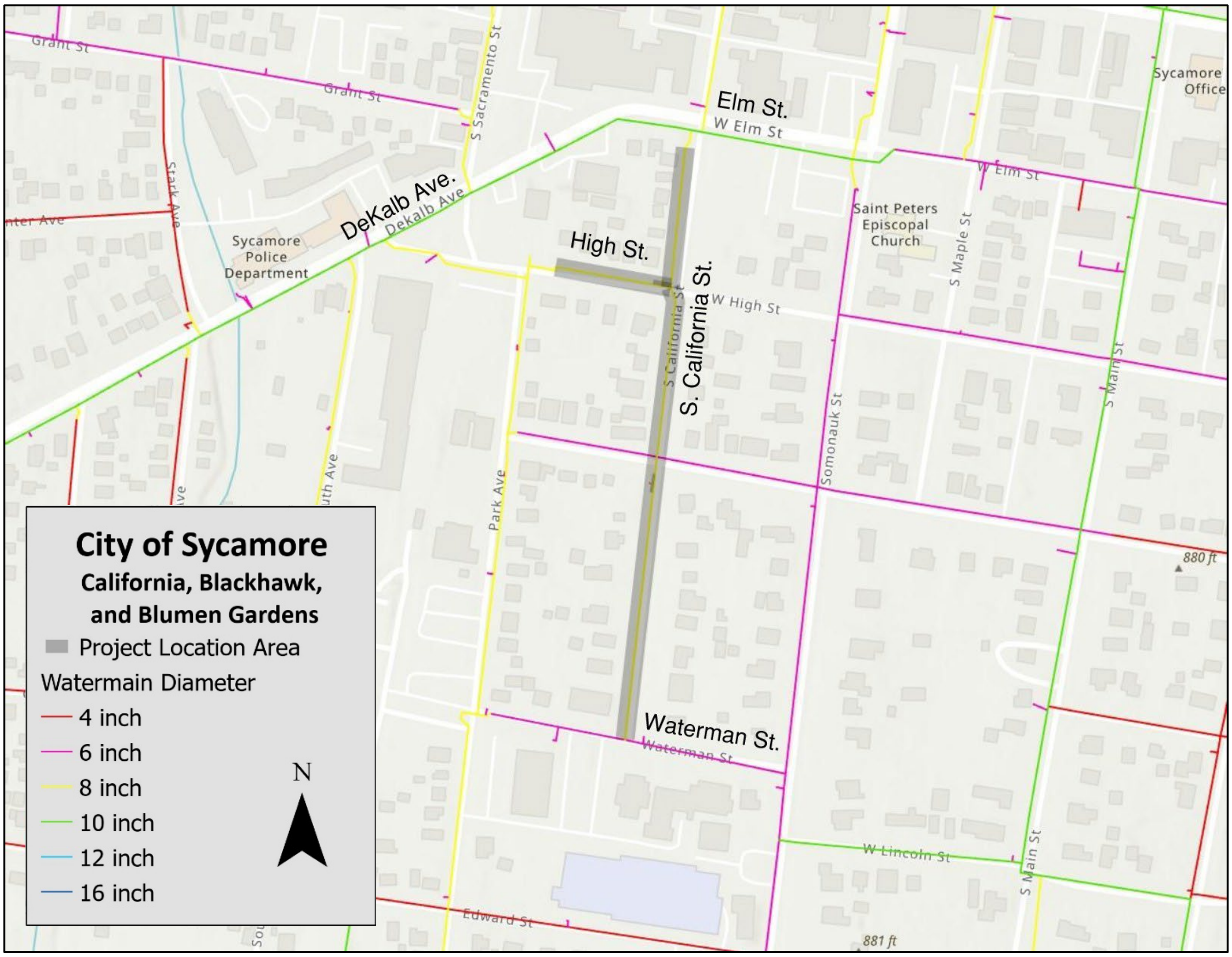
North Grove School – Proposed Available Fire Flows

Project #1 - North Grove School Connection	
Description	Total Probable Cost
SUMMARY	
SITEWORK	$226,674
Construction Sub-Total	$226,674
Contingency 20%	$45,335
PROBABLE CONSTRUCTION COST:	$272,009
ENGINEERING & ADMIN (15%)	$40,801
PROBABLE PROJECT COST:	**$312,810**

Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	32	SQ YD	$110	$3,520
Trench Backfill, Patch	39	CU YD	$40	$1,560
Trench Backfill, Bedding & Over Pipe	237	CU YD	$40	$9,480
Backfill	20	CU YD	$15	$300
Parkway Restoration	501	SQ YD	$20	$10,020
Ductile Iron Water Main, Class 52, 10" w/ Testing	700	FT	$250	$175,000
Connections to Existing System	2	EA	$8,000	$16,000
Traffic Control: 5% of Project Cost				$10,794
TOTAL WATER MAIN IMPROVEMENTS:				**$226,674**

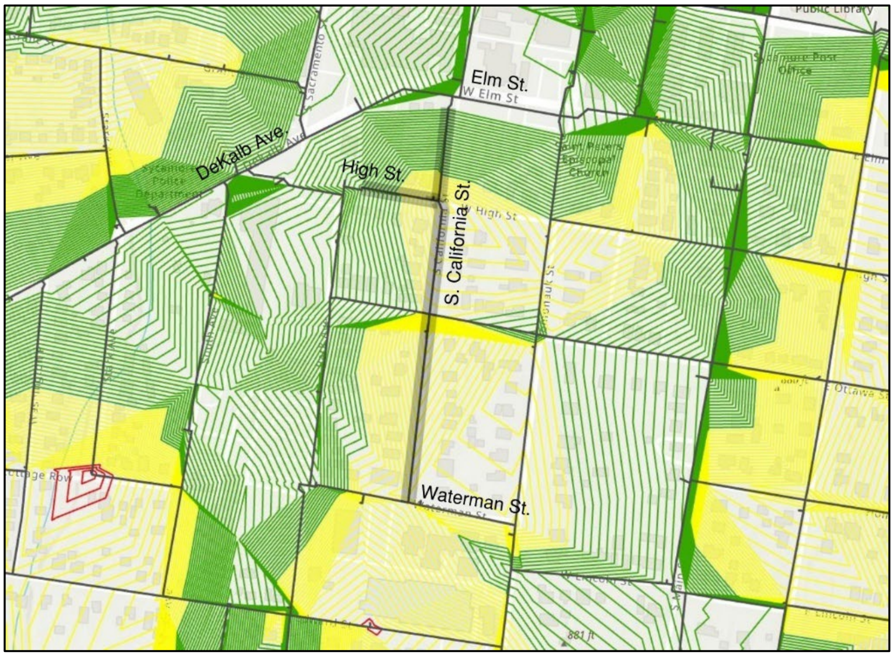
4.1.3 California, Blackhawk, & Blumen Gardens

The Blumen Gardens and Blackhawk Area are bordered by High Street to the north, Edward Street to the south, Park Avenue to the east, and South Avenue to the west. This industrial area is just south of Dekalb Avenue and contains 8- and 10-inch main that runs under buildings and residential backyards, proving difficult to maintain and operate. There are also limited valves along this line which cause larger shut down areas during main breaks.

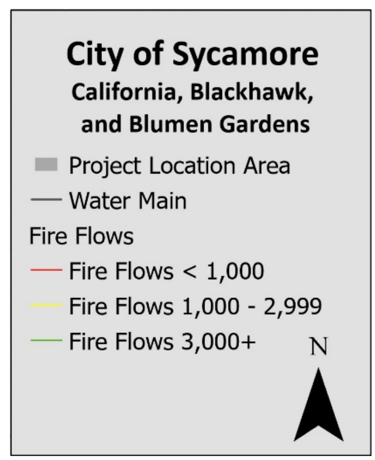


Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
California Street	4	8	1350
W High Street	6	8	275
Total	**-**	**-**	**1625**

The existing surrounding main consists of mainly 4- and 6-inch main until the 2025 Watermain Improvements Project is completed which would result in larger 8- and 10-inch main to the east of this proposed improvement. This improvement would include abandonment of the existing Blumen Gardens and Blackhawk main and upsizing the 4-inch main along California street down to Waterman Street to. The remaining 6-inch main along High Street would also be upsized to maintain water transfer and available fire flows. The analysis includes the proposed improvements after the 2025 Watermain Improvements project is completed.



California, Blackhawk, & Blumen Gardens – Current Available Fire Flows

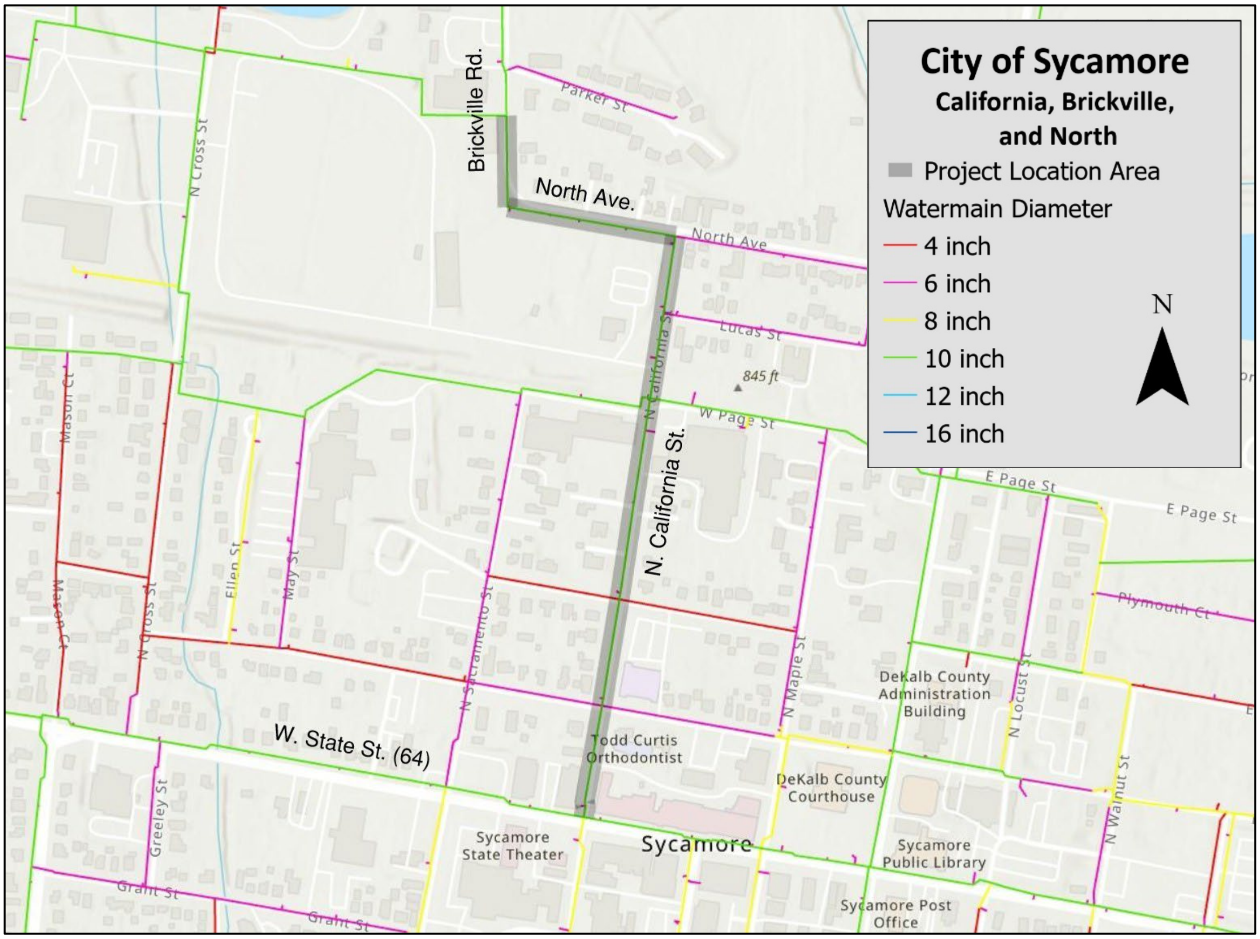


California, Blackhawk, & Blumen Gardens – Proposed Available Fire Flows

Project #2 - California, Blackhawk, & Blumen Gardens				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,065,597
Construction Sub-Total				$1,065,597
Contingency 20%				$213,119
PROBABLE CONSTRUCTION COST:				$1,278,716
ENGINEERING & ADMIN (15%)				$191,807
PROBABLE PROJECT COST:				**$1,470,524**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 10"	1050	FT	$9	$9,450
Abandonment of Existing Water Main - 8"	780	FT	$8	$6,240
Abandonment of Existing Water Main - 6"	1063	FT	$7	$7,441
Abandonment of Existing Water Main - 4"	1350	FT	$6	$8,100
Hot-Mix Asphalt Class D Patch	128	SQ YD	$110	$14,080
HMA Driveway Pavement, 2", Remove & Replace	224	SQ YD	$90	$20,160
PCC Curb & Gutter, Remove & Replace	325	FT	$60	$19,500
Trench Backfill, Patch	142	CU YD	$40	$5,689
Trench Backfill, Driveway	156	CU YD	$40	$6,222
Trench Backfill, Bedding & Over Pipe	481	CU YD	$40	$19,259
Backfill	951	CU YD	$15	$14,268
Parkway Restoration	815	SQ YD	$20	$16,307
Ductile Iron Water Main, Class 52, 8" w/ testing	1625	FT	$225	$365,625
Gate Valve in Vault, 8"	6	EA	$10,000	$60,000
Fire Hydrant, Complete	6	EA	$15,000	$90,000
Water Service Connection, Long	14	EA	$8,000	$112,000
Water Service Connection, Short	20	EA	$5,000	$100,000
Adjust Existing Sanitary Services	34	EA	$3,000	$102,000
Connections to Existing System	5	EA	$8,000	$40,000
Traffic Control: 5% of Project Cost				$49,256
TOTAL WATER MAIN IMPROVEMENTS:				**$1,065,597**

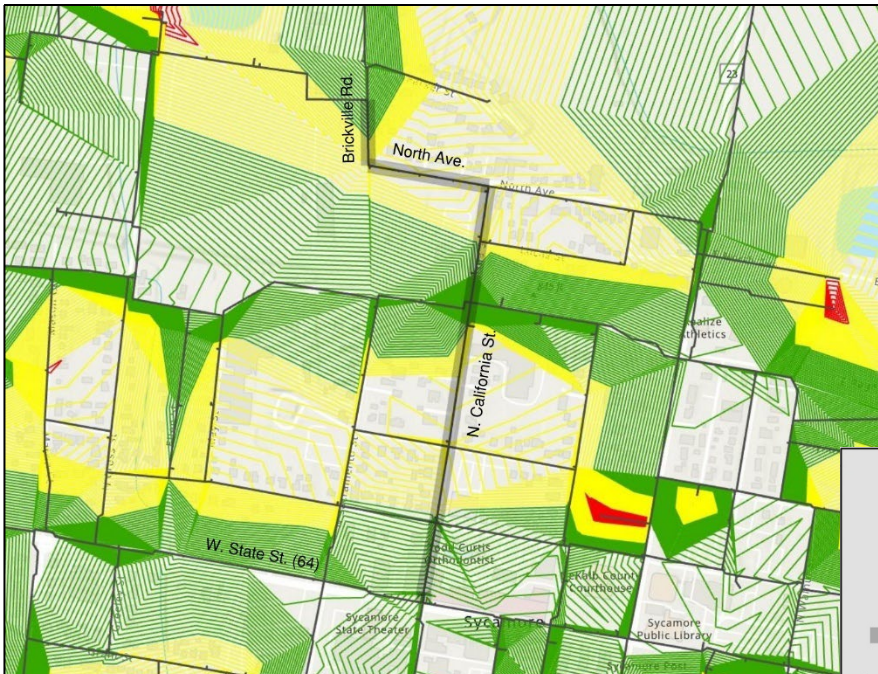
4.1.4 California/Brickville/North – 10-inch Main

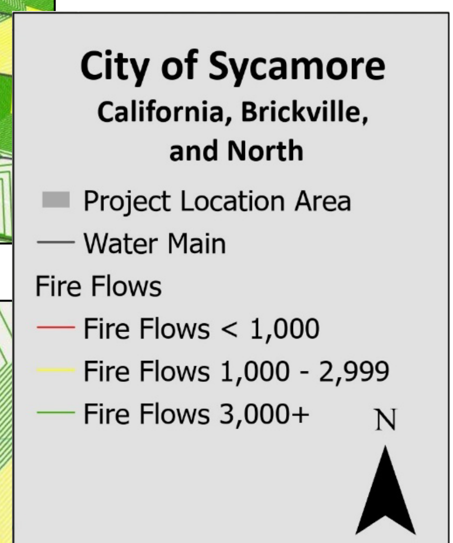
Tower 2 and Well 10, located adjacent to the DeKalb County History Museum in the north side of the City's distribution system, are capable of providing sufficient flow and pressure to meet all demand throughout this region. Tower 1 and Wells 6, 8, and 9 are likewise capable of meeting the maximum day demands of the southern portion of the City. In emergency scenarios, the City may rely on a handful of critical mains with 10-inch diameters to transfer large volumes of water between these areas.



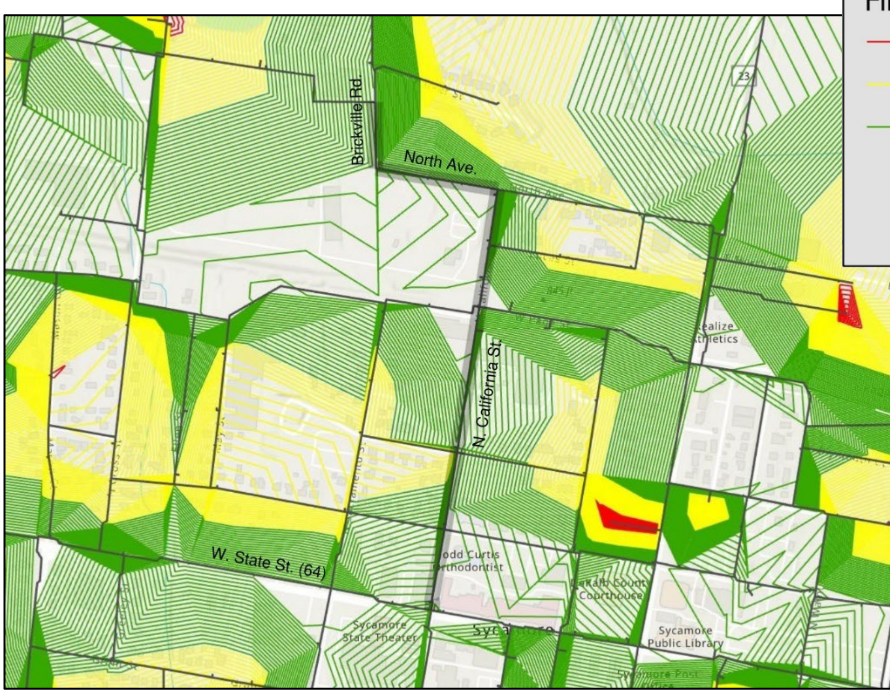
Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
California Street	6 & 8	10	2000
North Avenue	6	10	600
Brickville Road	6	10	475
Total	**-**	**-**	**3075**

Currently, two 10-inch water mains provide conveyance between the north and south sections of the City. These are located along Rt. 23 to the east and Cross Street to the west. There is also a 10-inch water main running along Brickville Road, though this main constricts to a 6-inch diameter around Parker Street. Increasing this main's diameter to 10-inches, along with segments of North Avenue and California Street, will allow for a third path for water to flow. The southern terminus of this installation is the 10-inch water main along State Street.

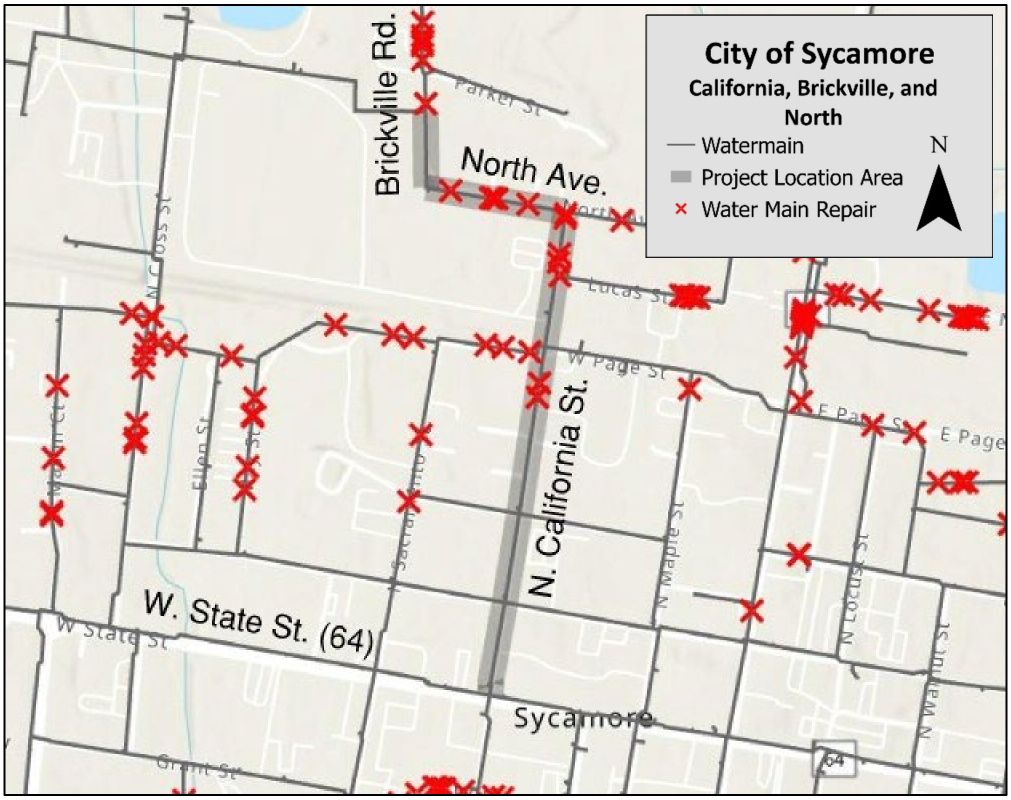




California/Brickville/Main – Current Available Fire Flows



California/Brickville/Main – Proposed Available Fire Flows



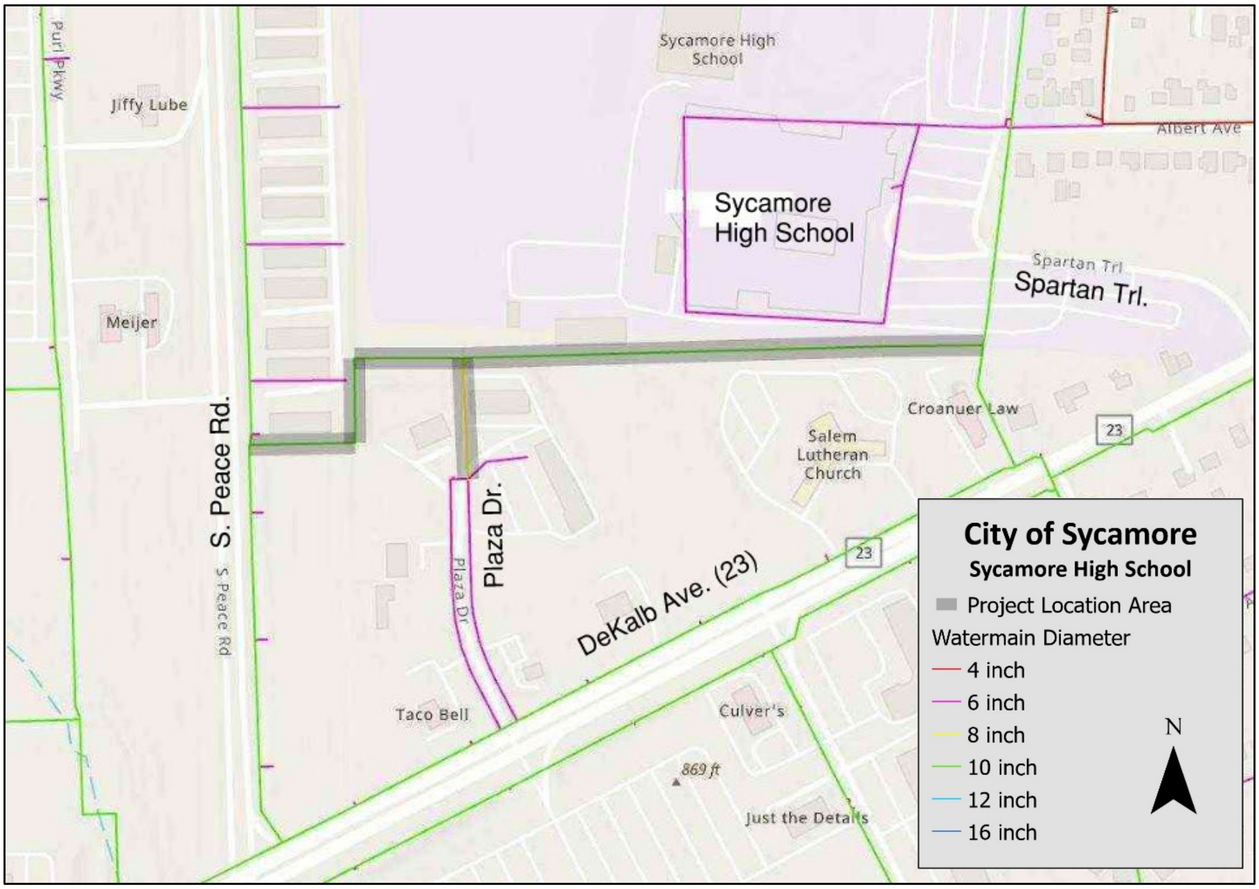
California/Brickville/Main – Watermain Break History

The primary benefit of this improvement project is allowing more water to flow south from Tower 2 in the event of an emergency, such as a fire or major main break. Current system operation may lead to Well 10 filling Tower 2 while these two structures fulfill the demands in the north side of town, rather than contributing to demands on the south side. Additionally, the stretch of North Avenue that would be replaced through this project has experienced a very high rate of main breaks over its service life. This project could be completed with the redevelopment of the adjacent Sycamore Industrial Park. The City has started the process to fund this project by submitting a Funding Nomination Form for $2.8 million to cover engineering and construction costs. The City is also anticipating utilizing acoustical analysis to investigate the condition of this main.

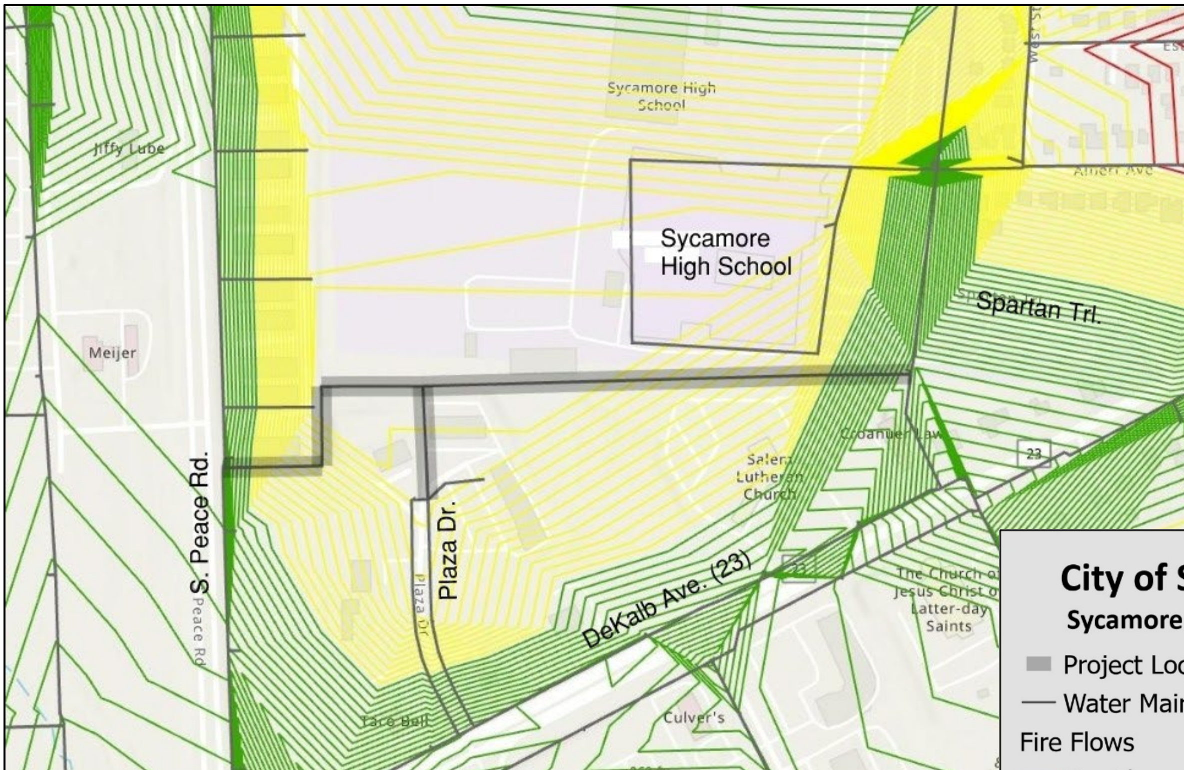
Project #3 - California, Brickville, and North				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,834,609
Construction Sub-Total				$1,834,609
Contingency @ 20%				$366,922
PROBABLE CONSTRUCTION COST:				$2,201,530
ENGINEERING & ADMIN (15%)				$330,230
PROBABLE PROJECT COST:				**$2,531,760**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 8"	54	FT	$8	$432
Abandonment of Existing Water Main - 6"	3,111	FT	$7	$21,777
Parking Lot Rehab	280	SQ YD	$58	$16,240
Hot-Mix Asphalt Class D Patch	80	SQ YD	$110	$8,800
HMA Driveway Pavement, 2", Remove & Replace	90	SQ YD	$90	$8,100
PCC Curb & Gutter, Remove & Replace	615	FT	$60	$36,900
Trench Backfill, Patch	354	CU YD	$40	$14,178
Trench Backfill, Driveway	100	CU YD	$40	$4,000
Trench Backfill, Bedding & Over Pipe	911	CU YD	$40	$36,444
Backfill	1,948	CU YD	$15	$29,225
Parkway Restoration	1,670	SQ YD	$20	$33,400
Ductile Iron Water Main, Class 52, 10" w/ testing	3,075	FT	$250	$768,750
Gate Valve in Vault, 10"	11	EA	$11,000	$121,000
Fire Hydrant, Complete	11	EA	$15,000	$165,000
Water Service Connection, Long	25	EA	$8,000	$200,000
Water Service Connection, Short	14	EA	$5,000	$70,000
Adjust Existing Sanitary Services	39	EA	$3,000	$117,000
Connections to Existing System	12	EA	$8,000	$96,000
Traffic Control: 5% of Project Cost				$87,362
TOTAL WATER MAIN IMPROVEMENTS:				**$1,834,609**

4.1.5 Sycamore High School – 10- and 8-inch Main

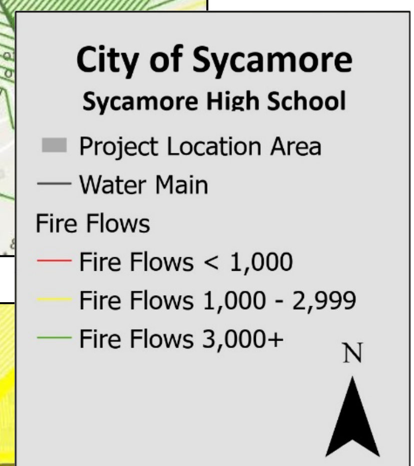
Sycamore High School is centrally located within the City's distribution system and serves approximately 1,400 staff and students. Currently, the high school is served by a 6-inch loop of water main that stems from West Street to the northeast. In order to improve both fire flow and service redundancy, it is recommended to increase the number of water lines that access the high school. The high school currently receives approximately 1,500 gallons per minute of Available Fire Flow. It is recommended that a 10-inch main along with new hyrdants be installed between West Street and Peace Road to allow more water transfer near the school.

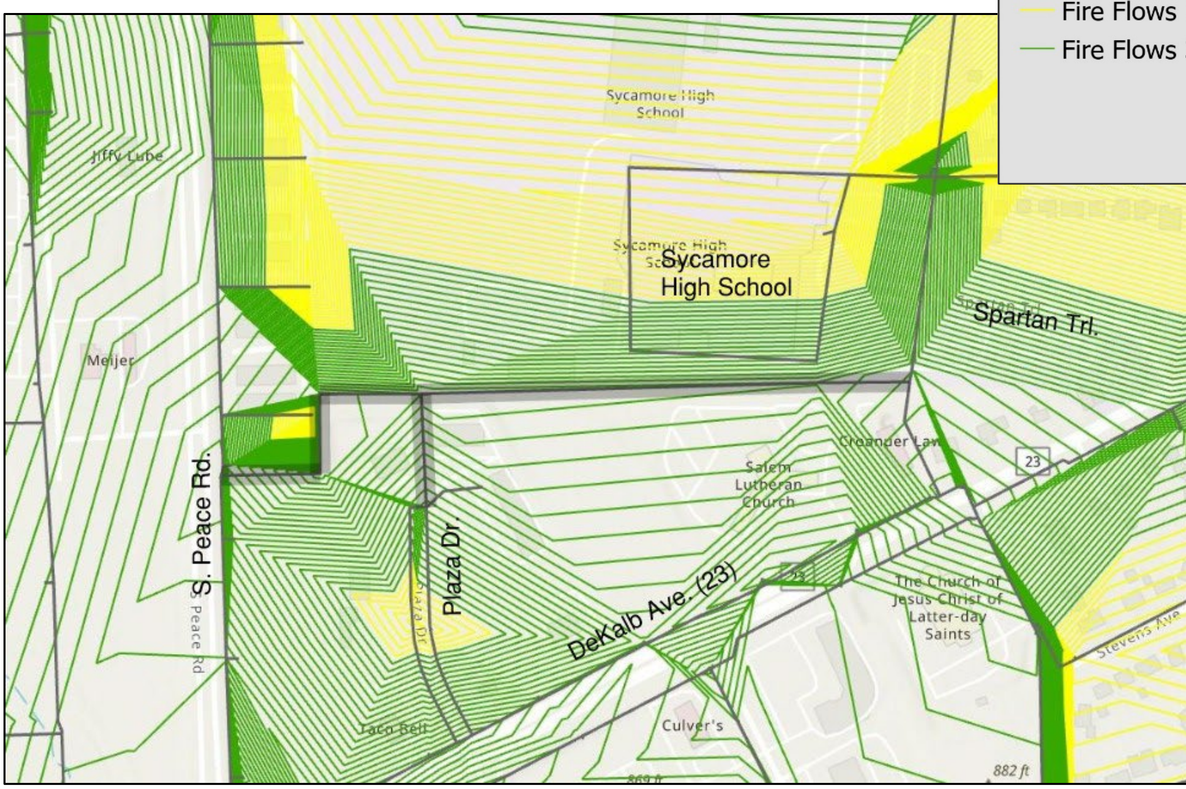


In addition, an 8-inch main should be installed on the new 10-inch main stemming south to connect to the existing 6-inch Plaza Drive loop just southwest of the school to improve water transfer in this area as well as provide a future connection location. These improvements will increase Available Fire Flow at the high school from the new hydrants to approximately 3,200 gallons per minute, above the recommended 3,000 gallons per minutes. These improvements are located in open space and are unlikely to disturb traffic or water supply during construction. This Improvement will be coordinated with future School District Improvements at the High School.



Sycamore High School – Current Available Fire Flows



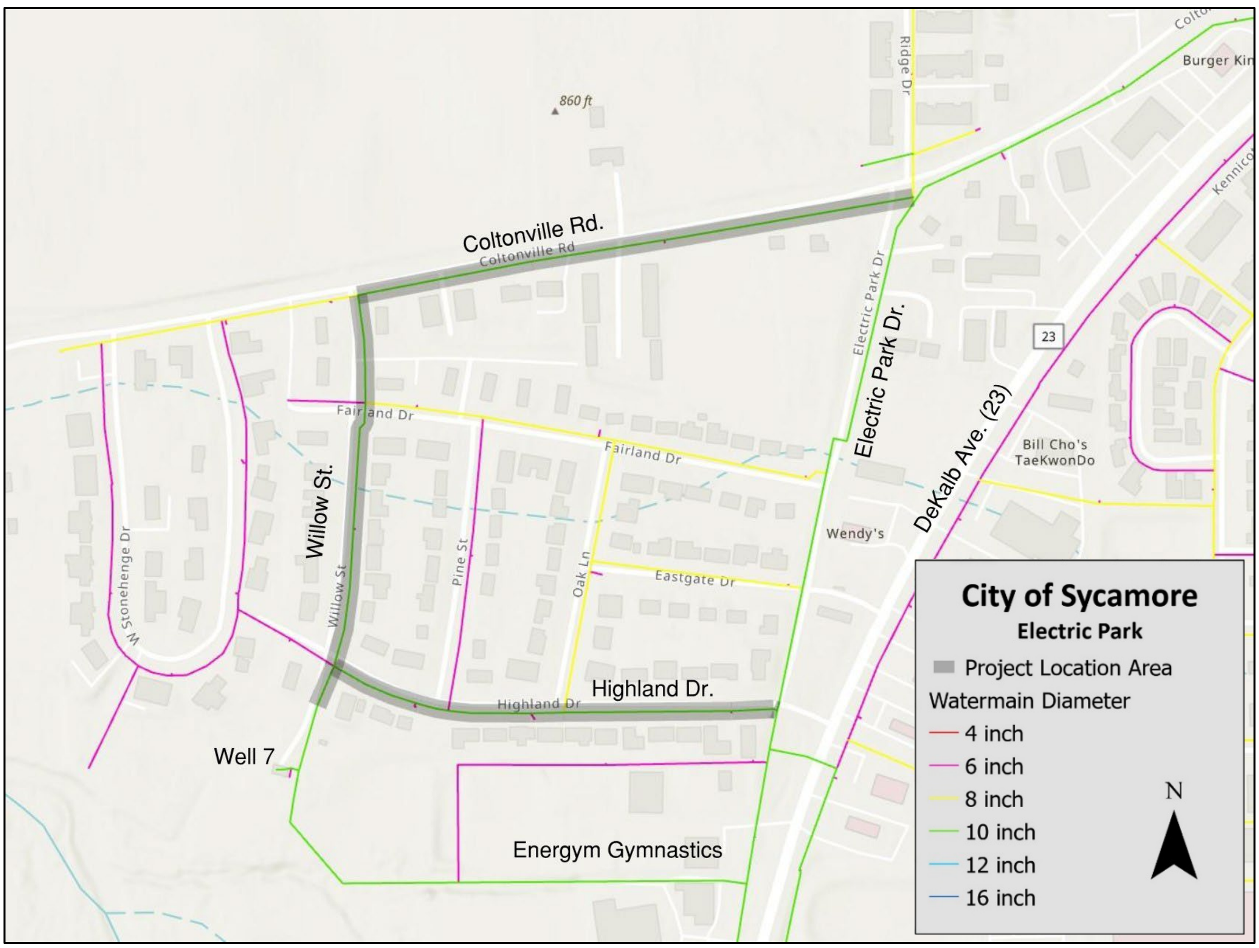


Sycamore High School – Proposed Available Fire Flows

Project #4 - Sycamore High School				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$923,932
Construction Sub-Total				$923,932
Contingency @ 20%				$184,786
PROBABLE CONSTRUCTION COST:				$1,108,719
ENGINEERING & ADMIN (15%)				$166,308
PROBABLE PROJECT COST:				**$1,275,027**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	64	SQ YD	$110	$7,040
PCC Curb & Gutter, Remove & Replace	24	FT	$60	$1,440
Trench Backfill, Patch	78	CU YD	$40	$3,129
Trench Backfill, Bedding & Over Pipe	651	CU YD	$40	$26,027
Backfill	1,633	CU YD	$15	$24,500
Parkway Restoration	1,400	SQ YD	$20	$28,000
Ductile Iron Water Main, Class 52, 10" w/ testing	1,868	FT	$250	$467,000
Ductile Iron Water Main, Class 52, 8" w/ testing	328	FT	$225	$73,800
Gate Valve in Vault, 10"	7	EA	$11,000	$77,000
Gate Valve in Vault, 8"	2	EA	$10,000	$20,000
Fire Hydrant, Complete	8	EA	$15,000	$120,000
Connections to Existing System	4	EA	$8,000	$32,000
Traffic Control: 5% of Project Cost				$43,997
TOTAL WATER MAIN IMPROVEMENTS:				**$923,932**

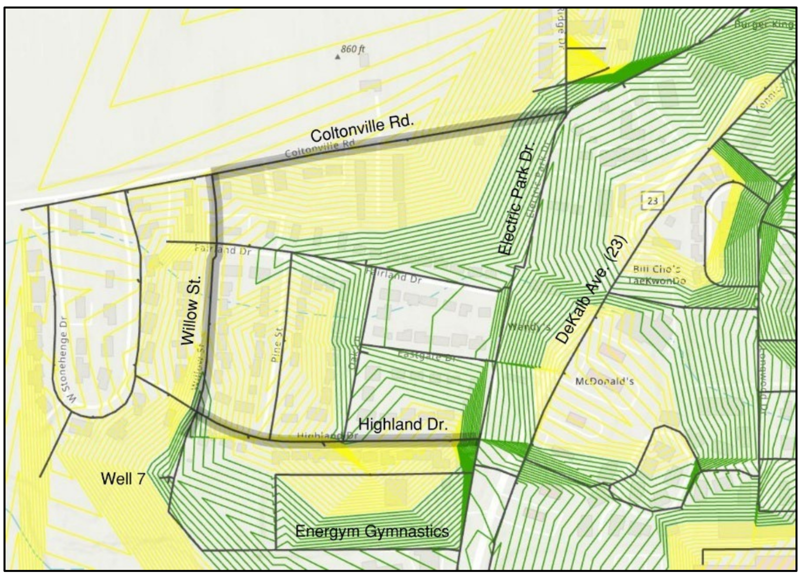
4.1.6 Electric Park – 8/10-inch Main

As will be discussed in Section 5 of this report, Well 7 is scheduled to be completed in early 2025 and would improve the City's resiliency and the overall ability of the distribution system to respond to adverse conditions. Through conversation with City staff, the startup of Well 7 in the past has led to main breaks throughout the Electric Park neighborhood due to transient pressure waves. Transient waves occur when there is a sudden change in the supply of water, creating a pocket of built up pressure that then propagates back toward the point that has changed the water supply. This creates a drastic swing on the pressure exerted on the water main. Water main in this area typically exceeds 50 years in age and has displayed an increasing frequency of breaks even without Well 7 in operation. Upsizing of water main and replacing old segments will reduce main breaks by subjecting older mains to less pressure variation.

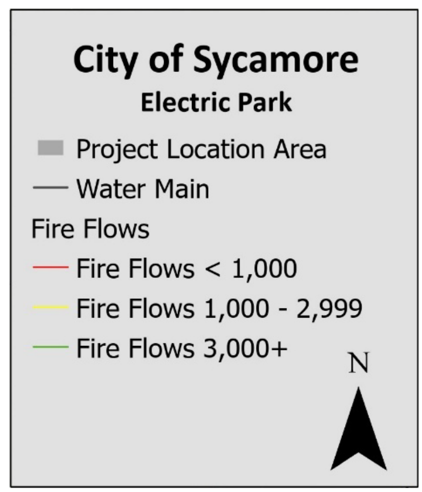


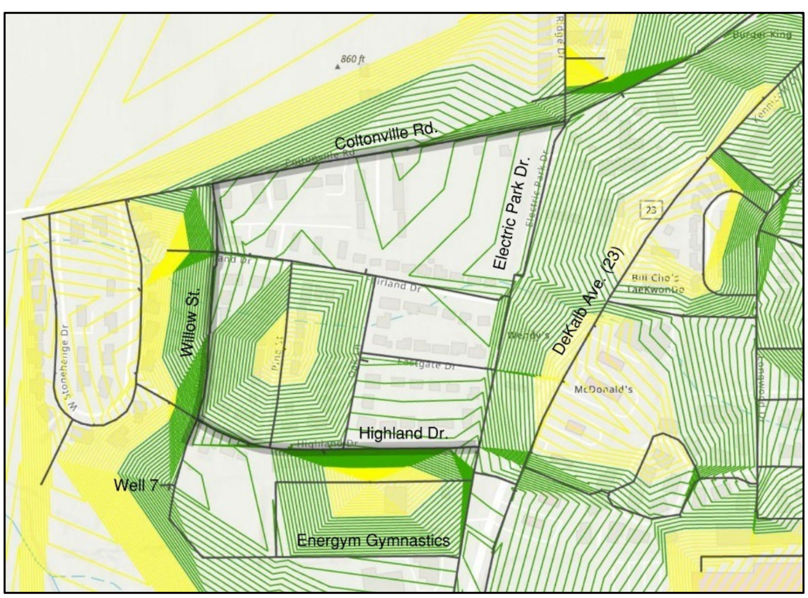
Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Highland Drive	6	10	1119
Willow Street	8	10	1041
Coltonville Road	8	10	1310
Total	**-**		**3470**

The proposed water main rehabilitation project that will maximize the benefit of bringing Well 7 online includes upsizing of water main along Willow Street up to Coltonville Road and east towards DeKalb Avenue. Currently, the east end of Coltonville road does not have watermain and leads to a dead end. The improvement project would add a connecting 10-inch main to DeKalb Avenue, roughly 625 LF. This section would most likely be completed by a developer if it would occur before the project. This also includes upsizing the main along Highland Drive from the well to the 10-inch water main along DeKalb Avenue. These two continuous stretches of 10-inch main would be the primary path of flow leaving the well. This would may also allow the City to abandon the 10-inch water main that currently runs south of the well in the future, along the back side of what is currently Energym Gymnastics. This should be revisited during a conceptual design phase. The City is also anticipating utilizing acoustical analysis to investigate the condition of this main.

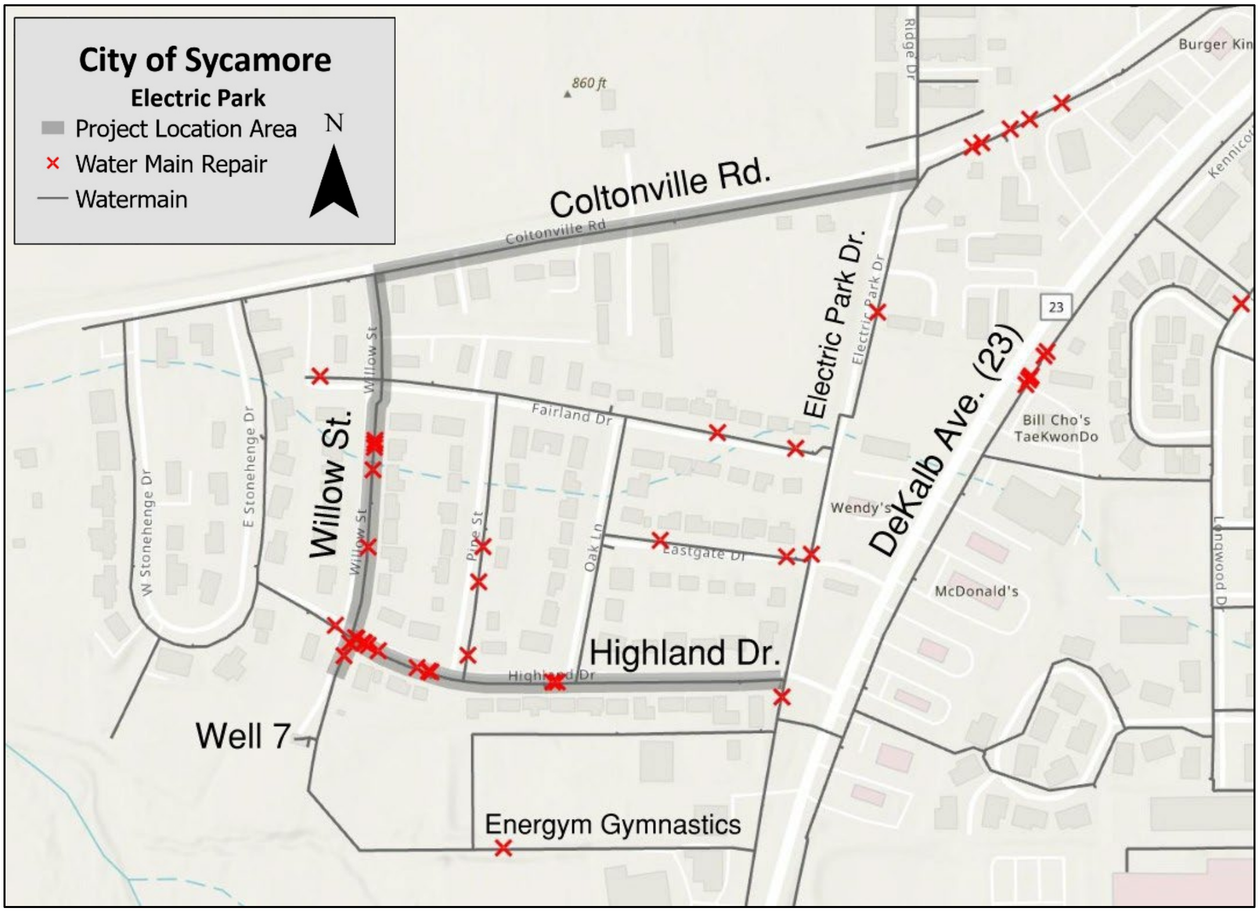


Electric Park – Current Available Fire Flows





Electric Park – Proposed Available Fire Flows

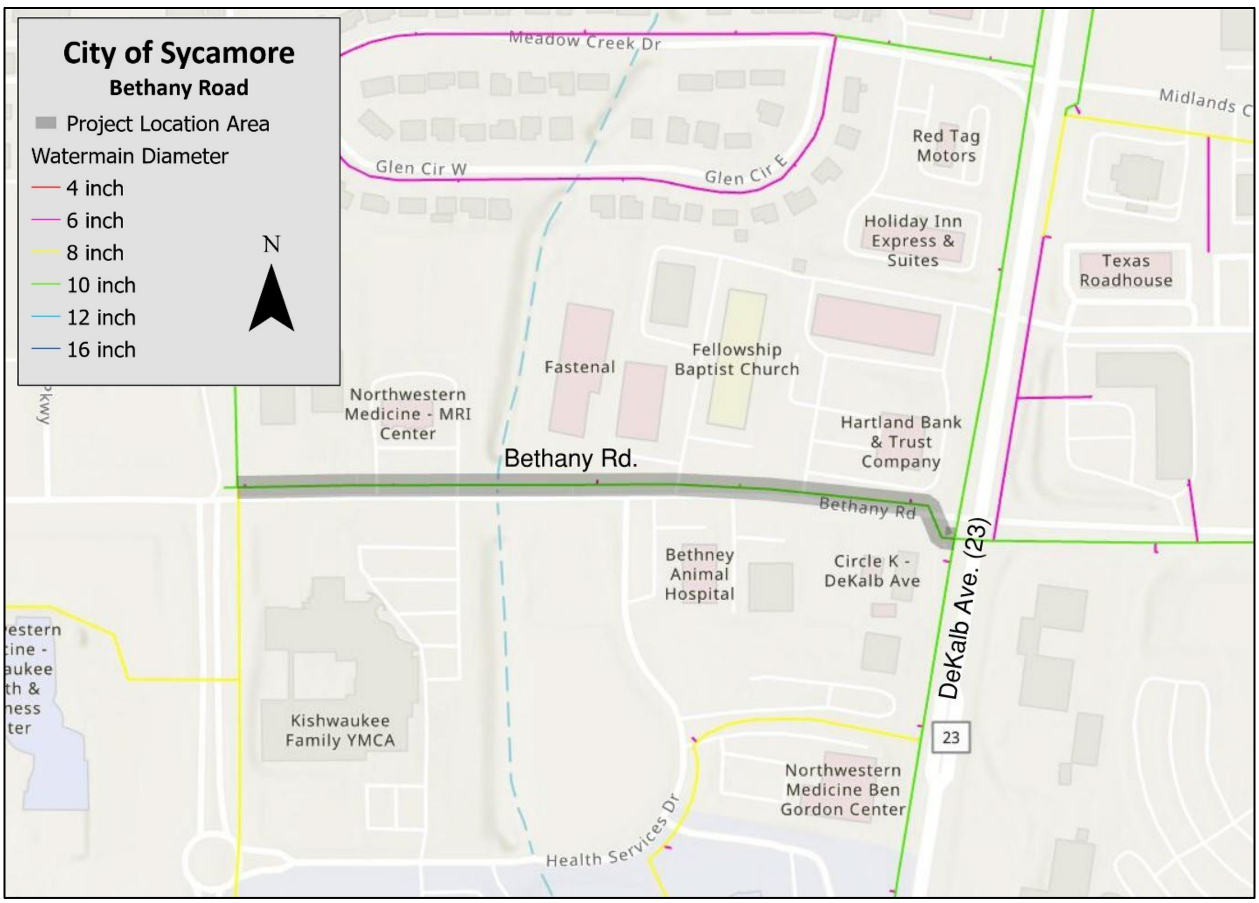


Electric Park – Watermain Break History

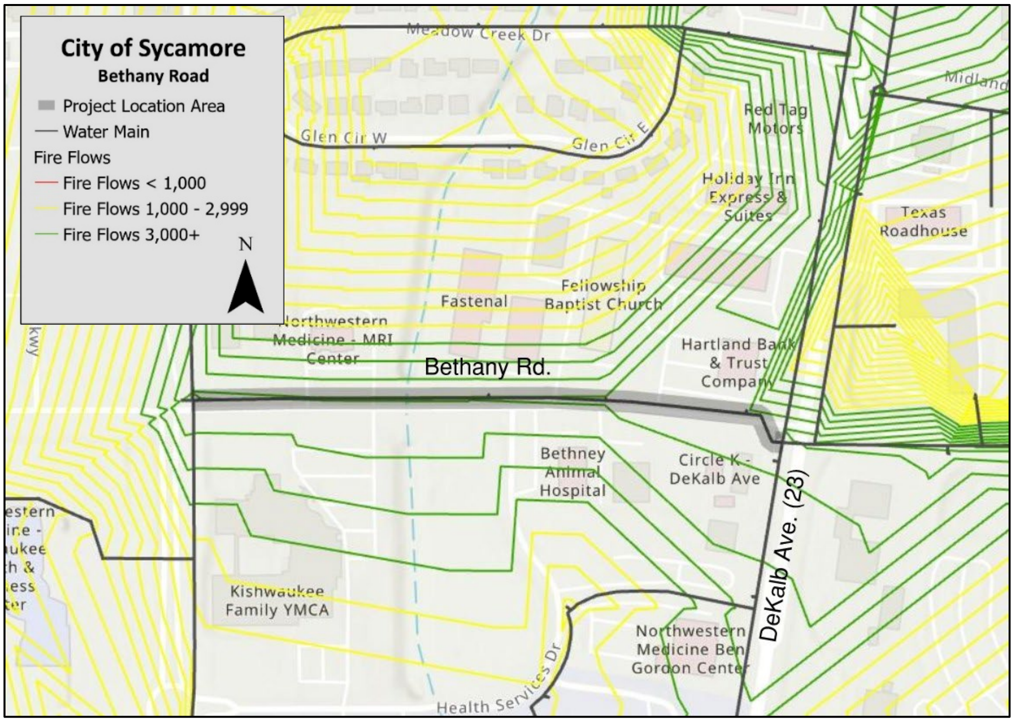
Project #5 - Electric Park				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,995,175
Construction Sub-Total				$1,995,175
Contingency @ 20%				$399,035
PROBABLE CONSTRUCTION COST:				$2,394,210
ENGINEERING & ADMIN (15%)				$359,132
PROBABLE PROJECT COST:				**$2,753,342**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 8"	1,821	FT	$8	$14,568
Abandonment of Existing Water Main - 6"	1,119	FT	$7	$7,833
Hot-Mix Asphalt Class D Patch	160	SQ YD	$110	$17,600
HMA Driveway Pavement, 2", Remove & Replace	220	SQ YD	$90	$19,800
PCC Curb & Gutter, Remove & Replace	694	FT	$60	$41,640
Trench Backfill, Patch	196	CU YD	$40	$7,822
Trench Backfill, Driveway	244	CU YD	$40	$9,778
Trench Backfill, Bedding & Over Pipe	1,028	CU YD	$40	$41,126
Backfill	2,256	CU YD	$15	$33,833
Parkway Restoration	1,933	SQ YD	$20	$38,667
Ductile Iron Water Main, Class 52, 10" w/ testing	3,470	FT	$250	$867,500
Gate Valve in Vault, 10"	12	EA	$11,000	$132,000
Fire Hydrant, Complete	12	EA	$15,000	$180,000
Water Service Connection, Long	16	EA	$8,000	$128,000
Water Service Connection, Short	28	EA	$5,000	$140,000
Adjust Existing Sanitary Services	44	EA	$3,000	$132,000
Connections to Existing System	11	EA	$8,000	$88,000
Traffic Control: 5% of Project Cost				$95,008
TOTAL WATER MAIN IMPROVEMENTS:				**$1,995,175**

4.1.7 Bethany Rd. (Rt. 23 to Health Club) – 10-inch Main

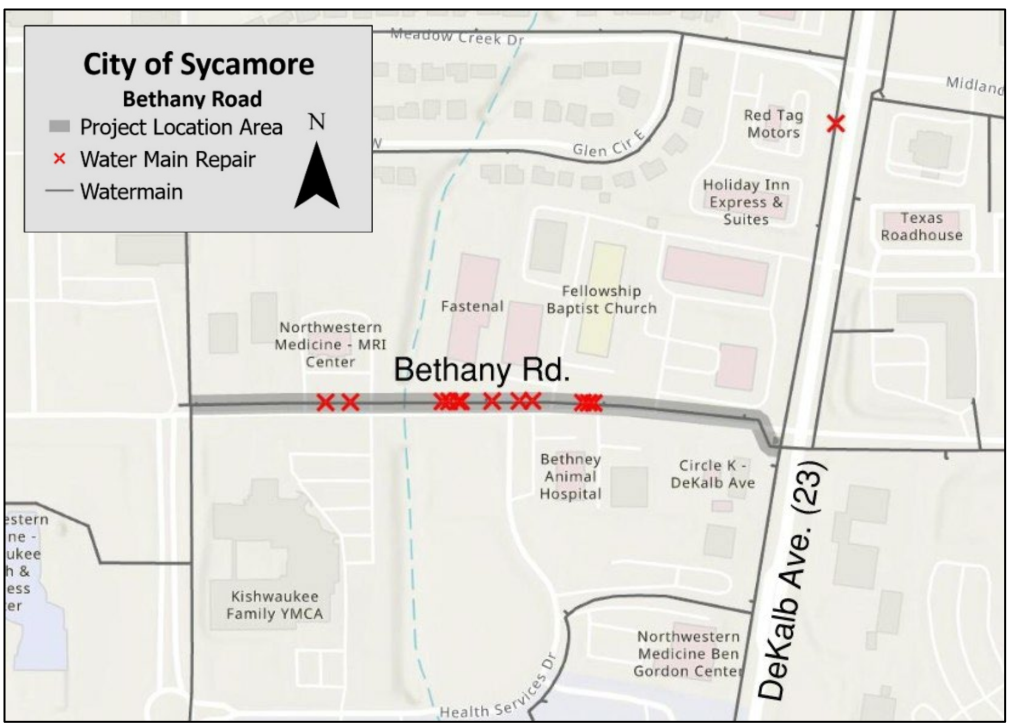
The 10-inch water main along Bethany Road, west of the intersection with Route 23, has displayed a high frequency of main breaks in recent years. This water main provides flow to the north end of the Northwestern Medicine Kishwaukee Hospital complex. Replacing this water main should reduce the frequency of water main breaks along this stretch. This will allow for consistent supply of the maximum level of fire protection to the fire from Well 8 and Tower 1 to the east. TAI recommends replacing the existing 10-inch main with the same diameter main. This will minimally affect fire flows through the region, as the older pipe is likely tuberculated and buildup may be contributing to head loss along the length of the pipe. However, these differences are not expected to be appreciable, and the water main in the area is capable of provided the recommended 3,000 gallons per minute of commercial Available Fire Flow. This project should be targeted for completion when the maintenance costs and service outages exceed the cost of the project. Alternatively, the City has explored the use of lining for rehabilitating the pipe. This cannot be completed due to the segments of main with 45-degree or greater bends. It is unclear how the main crosses under the creek.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Bethany Road	10	10	1450
Total	**-**	**-**	**1450**



Bethany Road – Existing and Proposed Available Fire Flows



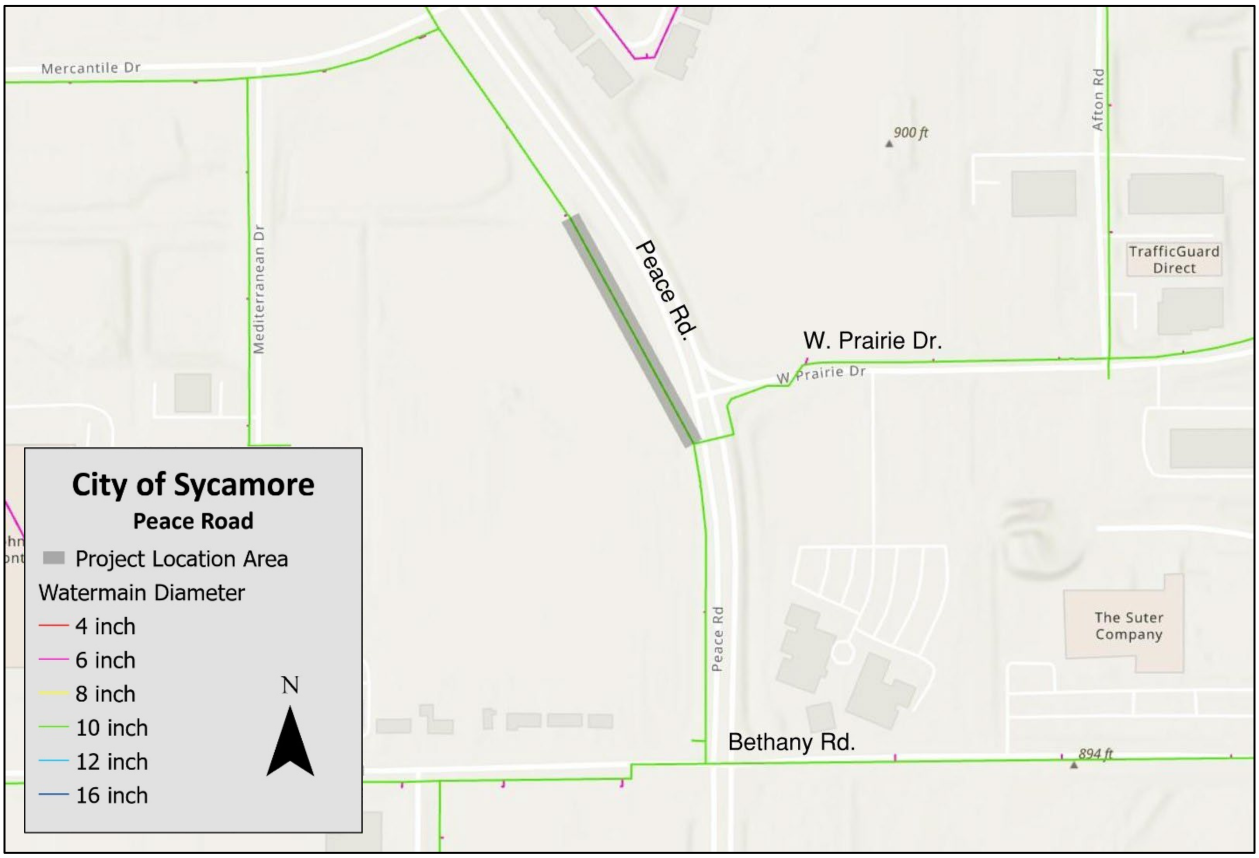
Bethany Road – Watermain Break History

Project #6 - Bethany Road	
Description	Total Probable Cost
SUMMARY	
SITEWORK	$750,776
Construction Sub-Total	$750,776
Contingency @ 20%	$150,155
PROBABLE CONSTRUCTION COST:	$900,932
ENGINEERING & ADMIN (15%)	$135,140
PROBABLE PROJECT COST:	**$1,036,071**

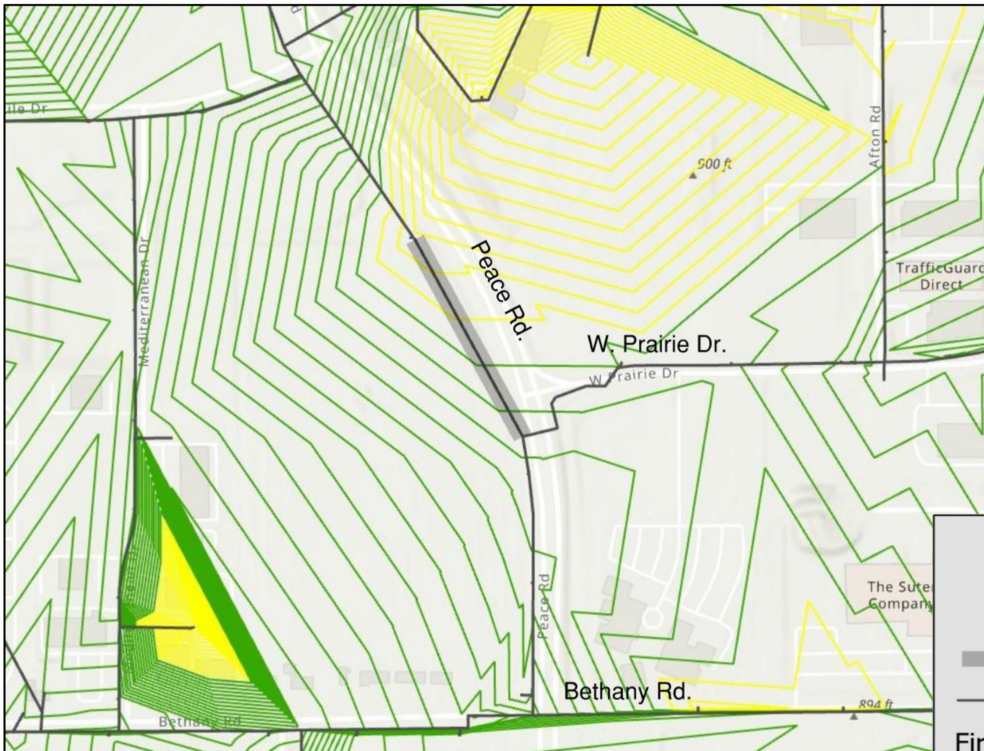
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 10"	1,450	FT	$9	$13,050
Hot-Mix Asphalt Class D Patch	32	SQ YD	$110	$3,520
HMA Driveway Pavement, 2", Remove & Replace	80	SQ YD	$90	$7,200
PCC Curb & Gutter, Remove & Replace	290	FT	$60	$17,400
Trench Backfill, Patch	39	CU YD	$40	$1,564
Trench Backfill, Driveway	89	CU YD	$40	$3,556
Trench Backfill, Bedding & Over Pipe	430	CU YD	$40	$17,185
Backfill	997	CU YD	$15	$14,957
Parkway Restoration	855	SQ YD	$20	$17,093
IL-62 Jack & Bore, 10"	1,450	FT	$250	$362,500
Gate Valve in Vault, 10"	5	EA	$11,000	$55,000
Fire Hydrant, Complete	5	EA	$15,000	$75,000
Water Service Connection, Long	5	EA	$8,000	$40,000
Water Service Connection, Short	7	EA	$5,000	$35,000
Adjust Existing Sanitary Services	12	EA	$3,000	$36,000
Connections to Existing System	2	EA	$8,000	$16,000
Traffic Control: 5% of Project Cost				$35,751
TOTAL WATER MAIN IMPROVEMENTS:				**$750,776**

4.1.8 Peace Road Connection – 10-inch Main

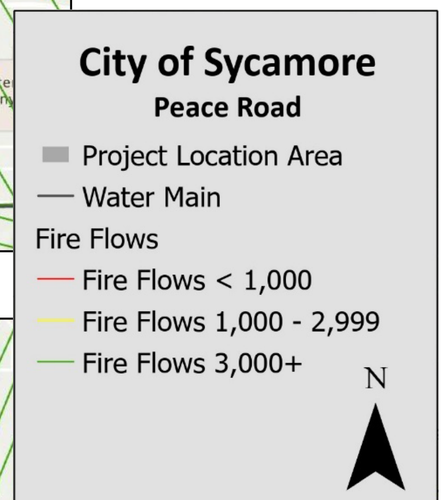
In the existing distribution system, there is a gap of approximately 700 feet between two 10-inch water main segments along Peace Road. The northern end appears to have been stubbed to allow for this connection in the past, south of the intersection of Mercantile Drive and Peace Road. To the south, the 10-inch main turns east at the intersection of Peace Road and Prairie Drive. Installing a continuous 10-inch water main through the area would allow for a second path for water to flow north directly from Well 8, which is located just west of the intersection of Bethany Road and Mediterranean Drive. A 10-inch main currently runs along Mediterranean Drive but connecting the water mains along Peace Road will allow for redundancy and better looping through the area. This parcel is located in unincorporated DeKalb County. Any annexation agreement would include a requirement to complete the watermain connection.

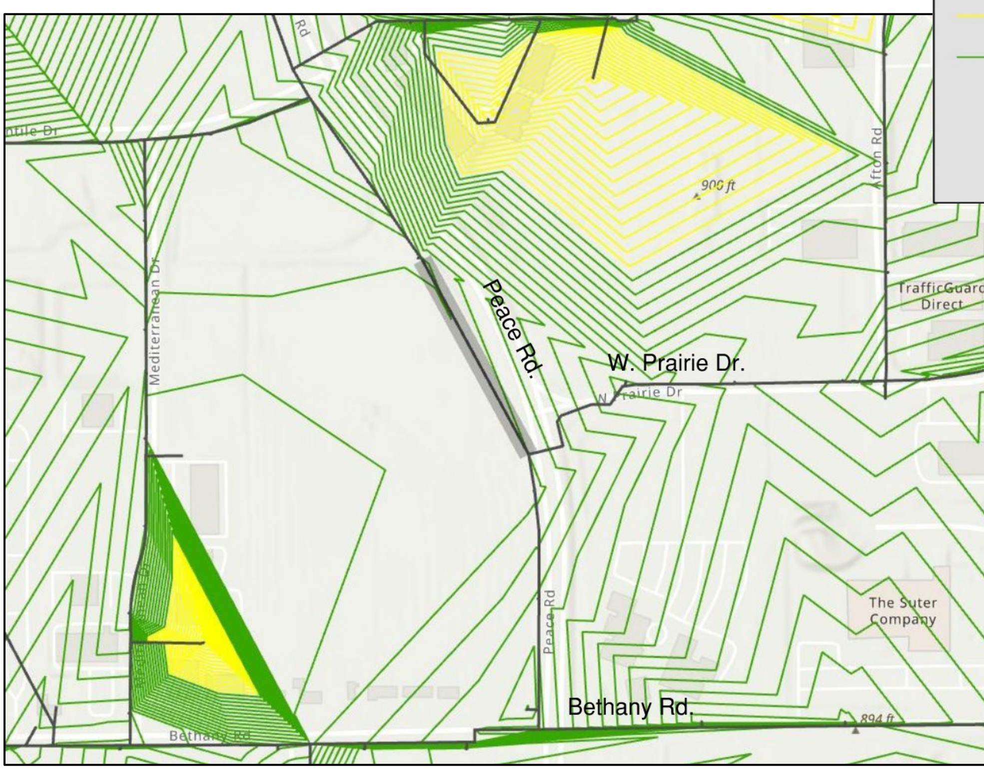


Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Peace Road	-	10	700
Total	**-**	**-**	**700**



Peace Road – Current Available Fire Flows





Peace Road – Proposed Available Fire Flows

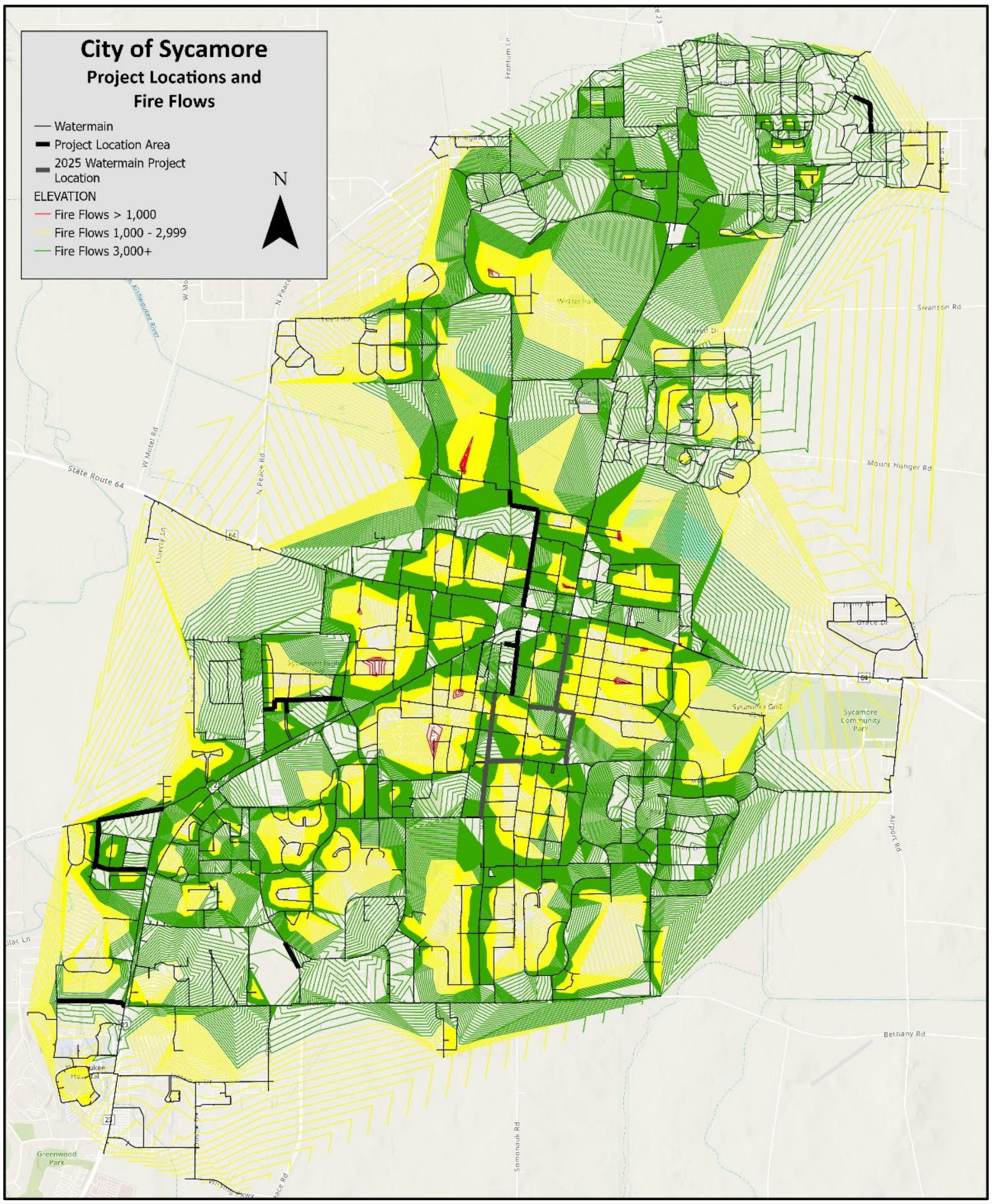
Project #7 - Peace Road Connection				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$320,395
Construction Sub-Total				$320,395
Contingency @ 20%				$64,079
PROBABLE CONSTRUCTION COST:				$384,475
ENGINEERING & ADMIN (15%)				$57,671
PROBABLE PROJECT COST:				**$442,146**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	16	SQ YD	$110	$1,760
PCC Curb & Gutter, Remove & Replace	140	FT	$60	$8,400
Trench Backfill, Patch	20	CU YD	$40	$782
Trench Backfill, Bedding & Over Pipe	207	CU YD	$40	$8,296
Backfill	526	CU YD	$15	$7,887
Parkway Restoration	451	SQ YD	$20	$9,013
Ductile Iron Water Main, Class 52, 10" w/ testing	700	FT	$250	$175,000
Gate Valve in Vault, 10"	3	EA	$11,000	$33,000
Fire Hydrant, Complete	3	EA	$15,000	$45,000
Connections to Existing System	2	EA	$8,000	$16,000
Traffic Control: 5% of Project Cost				$15,257
TOTAL WATER MAIN IMPROVEMENTS:				**$320,395**

Summary of Water Main Fire Flow Improvements

If the above identified improvements were completed, the resulting fire flow map would be as shown below. The outlined project locations are highlighted in blue. This map includes the completion of the 2025 Watermain Improvement Project which is set to begin in mid-2025.

As indicated, the majority of the areas with less than 1,000 gpm (red) of available fire flow have been eliminated with negligible areas remaining. Additionally, most of the downtown and outlying commercial areas have been increased to over 3,000 gpm of available fire flow.

Available Fire Flows - Projects Completed



Impacts of Upsizing Water Mains Throughout the System

The majority of residential areas in the heart of the downtown area have sufficient fire flow protection in excess of 1,200 gpm. The ISO provides this information through the Public Protection Classification (PPC) program. The PPC program provides classification for the overall water system ranging for 1-10. Class 1 generally represents excellent fire protection, and Class 10 indicates that the area's fire-suppression program doesn't meet ISO's minimum certification criteria. The City has participated in the ISO evaluation for several years. In an effort to continue the improvement of the overall water system the City is anticipating regularly updating the water distribution model.

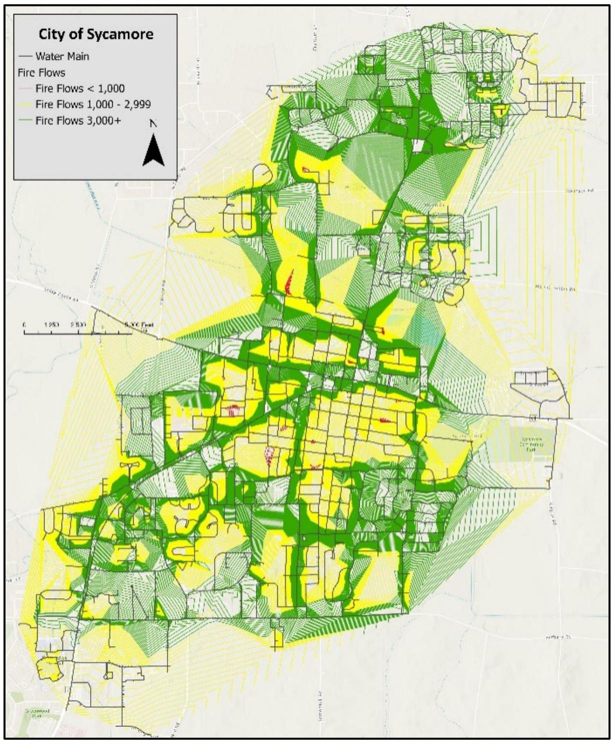
The water mains in these older residential areas were originally constructed with 4-inch and 6-inch diameter pipes. The distribution system includes roughly six miles of 4-inch diameter and 30 miles of 6-inch diameter water main. This small diameter main restricts the ability of the system to convey large volumes of water throughout these areas. Upsizing the 4- and 6-inch water main 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 any small diameter pipe segments. The WaterCAD model indicates that within areas of small diameter water main, available flows are primarily uniform but may be inadequate to convey large volumes of water. No one particular area seems to contain a particularly restrictive hydraulic condition. For this reason, additional criterion beyond diameter such as corrosive soils, high-capacity users, and potential need for emergency services should be used to prioritize projects.

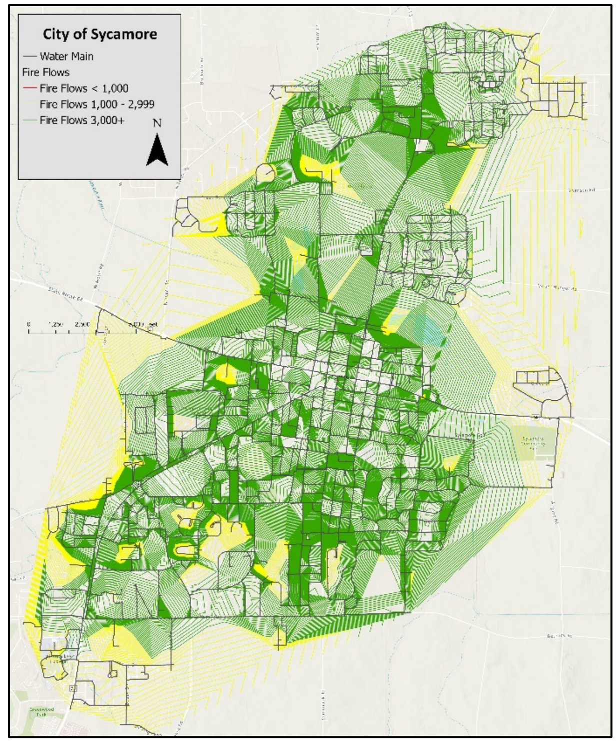
There exists approximately 210,000 lineal feet of 4-inch and 6-inch water main in the system. The replacement cost for the 4-inch and 6-inch water main is estimated at $85 million. The replacement cost for fire hydrants and water valves in these areas is estimated at $10 million for a total program cost of $95 million. The most cost-effective way to complete upsizing of small diameter main is to coordinate their replacement with other capital improvement projects such as roadway construction or development, reducing overall pavement restoration costs incurred by the City. Other cost saving options include in-house design/construction or coordination with proposed developments.

If the City were ultimately to replace all 4-inch and 6-inch main throughout the system with a minimum 8-inch diameter main, it would increase the volume of water stored in the system (within pipes) by approximately 350,000 gallons. This would represent an increase in water age of approximately 4-5 hours at current demand. Therefore, it is important that the City balance the need to increase fire flows, with the goal of improving water quality.

It the City were to achieve the $4.83M annual funding goal for water main replacements identified in Section 3, it would take approximately 20 years to complete the upsizing of all small diameter main if this was the sole focus of infrastructure replacement. From a practical standpoint, there will be competing priorities over replacing main solely based on size. If the City were to set a goal of replacing all small diameter main over 30 years this would require an annual investment of approximately $3.2M. It is recommended that the City utilize main size, and thus fire flow capacities, as one criteria for replacement prioritization.



Available Fire Flows – Current with 4" & 6" Main



Available Fire Flows – After 4" & 6" Main Replacement

4.2 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. System Benefit – The overall benefit that the project will have on, not just surrounding areas, but the system as a whole.
2. Water Quality – Replacement of main to improve water quality as well as main associated with water quality complaints.
3. Available Fire Flows – Projects focused on increasing the available fire flows in the area
4. Water Main Condition/Break Frequency – The replacement of water main that has experienced increased breaks and/or repairs over the years. Replacement of the main is intended to reduce service interruptions and City expenses such as staff time and contracted repair expenses.
5. Public Benefit (Value) – The impact of the proposed project compared to the overall cost of the implementation.
6. Construction Offsets – The ability to complete work with Public Works crews or to offset costs using redevelopment connection costs. This will reduce total cost but may require schedule adjustment.

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 7 proposed projects (excluding the 2025 Project) were then given a score from 1-5 for each of the criteria, which were then multiplied by the weight factor and added together to arrive at a total score or "Criticality Index."

As illustrated in the table on the following page, the projects ranged in criticality from 27 to 84, with the four highest projects being the California and Brickville, Electric Park, Sycamore High School, and Blumen Gardens. The estimated project costs for these three projects are $2.53 Million, $2.75 Million, $1.28 Million, and $1.47 Million, respectively.

The City should look to budget for each of the 7 projects to be implemented as part of a total capital improvement plan. The larger projects could be broken into multiple phases in order to make them financially manageable.

The prioritization table listed on the next page represents the 7 projects identified for implementation but can also be used as a guideline for identifying future projects. The listed criteria can be applied for other areas of concern in the future to assist with further project scheduling.

	Project Description	Capital Cost	Project Selection Criteria						Total Score	Ranking
			System Benefit	Water Quality	Available Fire Flows	Watermain Condition/Break Frequency	Public Benefit (Value)	Construction Offsets		
			6	5	4	3	2	1		
1	North Grove School Connection	$569,971	3	2	5	1	5	5	66	5
2	California, Blackhawk, and Blumen Gardens	$1,470,524	4	3	2	5	4	4	74	4
3	California, Brickville, and North	$2,531,760	5	3	3	5	5	2	84	1
4	Sycamore High School	$1,275,027	4	3	4	2	5	5	76	3
5	Electric Park	$2,753,342	4	5	2	4	4	1	78	2
6	Bethany Road	$1,036,071	1	1	1	5	1	1	33	6
7	Peace Road	$442,146	2	1	1	1	1	1	27	7
		$10,078,841								

This Page Intentionally Left Blank

SECTION 5

EVALUATION OF WATER SUPPLY, TREATMENT, AND STORAGE FACILITIES

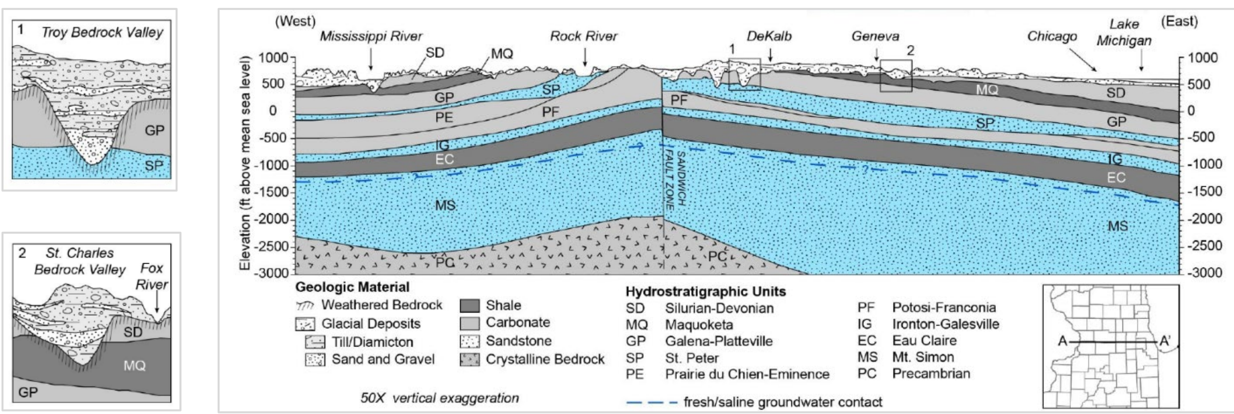
This Page Intentionally Left Blank

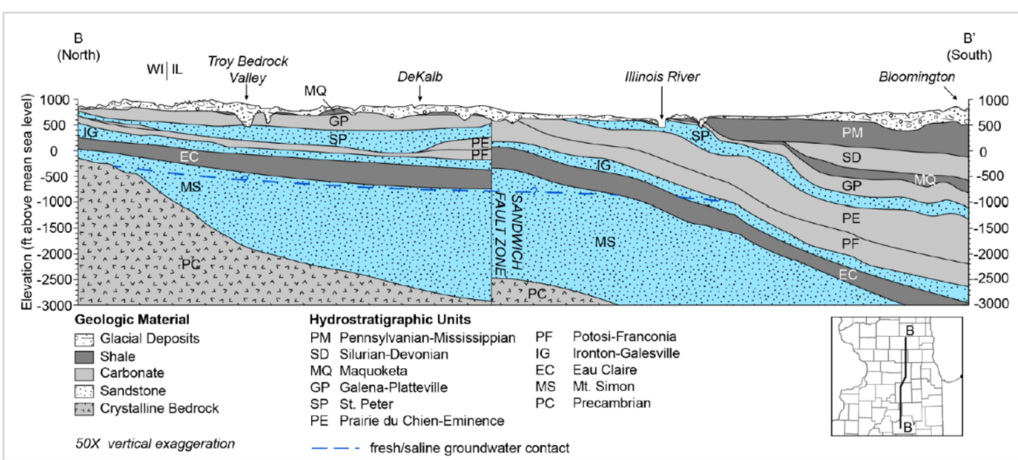
5. Evaluation of Existing Water Supply, Treatment & Storage Facilities

5.1 General Water System Information

The City of Sycamore's water supply, treatment and storage system consists of five groundwater wells ranging in depths from 1200 to 1300 feet, each with their own associated treatment facility, a 0.75 MG toro ellipse multi-column water tower, and a 1.5 MG spheroid water tower. Groundwater is accessed through wells that penetrate consolidated aquifers hundreds of feet below the surface. Surface water from watersheds recharges unconsolidated shallow aquifers through percolation or infiltration in granular sediments, whereas consolidated aquifers, like the City's, are recharged at the outcrop since they are enclosed by confining units such as shale.

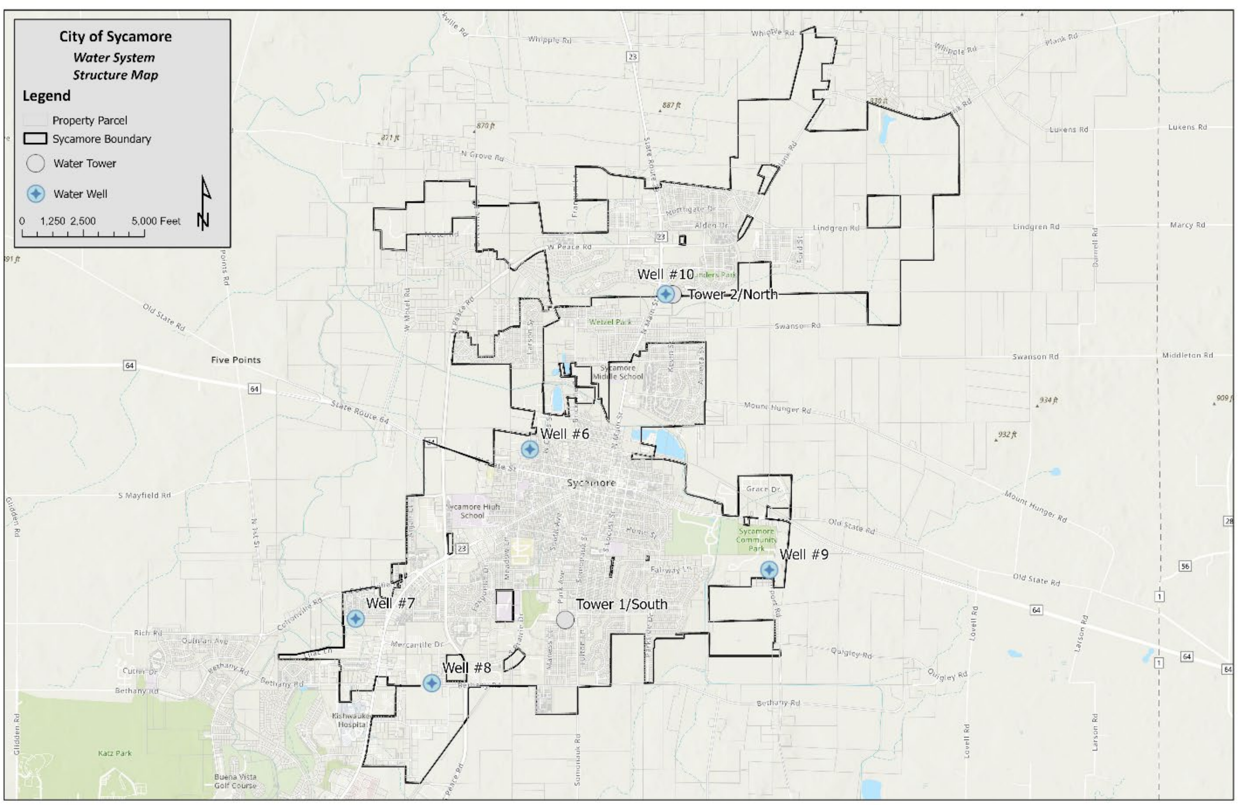
The City's water distribution system largely relies on deep bedrock aquifers at depths greater than 1000 ft, most of which are part of the Cambrian-Ordovician sandstone system. The diagrams below illustrate a cross section of the aquifers underlying DeKalb County and surrounding areas. These diagrams were sourced from a groundwater study conducted by the Illinois State Water Survey in 2015, focusing on Northern Illinois and Southern Wisconsin. As shown, wells in DeKalb County, including the City of Sycamore, have a higher chance of reaching the Mt. Simon Aquifer at depths of 1000 feet or more.





The raw source water from all of the City's wells meets all regulatory requirements set by the EPA for drinking water, with the exception of radium concentration. Radium is a naturally occurring element that is present in varying amounts in the rocks and soil within the earth's crust. This radium is most commonly present as Radium-226 and Radium-228. In the early 2000's the USEPA implemented a National Primary Drinking Water Standard for radium limits as a Maximum Contaminant Level (MCL) of 5 pCi/L. In order to comply with this regulation, the City implemented four radium removal treatment facilities, provided and maintained by Water Remediation Technology, LLC (WRT). After flowing through the WRT treatment units, the water from each well is also disinfected, dosed with fluoride, and phosphate before it is distributed. In 2024 the City constructed a new radium removal facility for Well #7 utilizing a hydrous manganese oxide (HMO) filtration process. This facility is expected to be online in spring 2025.

The exhibit below shows the current, active sites of each well and elevated storage towers. The City's five wells and two water towers have been strategically placed throughout the water system service area based on demand and anticipated development at the time of each well's drilling. The most recently constructed infrastructure, Well #10 and the associated on site treatment facility, as well as Tower #2 are located in the northeastern portion of the service area. The area further north and east of this site is within the City's corporate boundary but is primarily farmland at this time. This well, treatment facility, and tower were located to serve both the existing northern service area as well as additional development that may occur within this portion of the service area in the future.



5.2 Water System Capacities

5.2.1 Current Well Capacities

Each of the active wells in the City of Sycamore are currently being operated near or at the original design point. A treatment facility is currently being constructed at the Well #7 site, which will allow this supply to be returned to its original design capacity. The current active well capacities under existing conditions are indicated in Table 5-1 below.

The system's current design capacity equates to 8.57 MGD, while the system's firm capacity equates to 6.63 MGD with Well #9 offline. The firm capacity is the amount of well production available with the largest well out of service (Well #9). The Illinois EPA requires that communities be able to supply the maximum day demand with the largest production well out of service.

Section 2.3 of this report outlines the current average daily demand and maximum day demand for the City to be 1.90 MGD and 3.93 MGD, respectively. Even with Well #9 out of service, the City can provide adequate water supply to their consumers, easily satisfying the average daily demands. To determine if the system capacity is sufficient for maximum day demands, a diurnal peak curve is used, which is discussed later in this Section. Although the current system capacity is sufficient for the City's current customers, the City must also evaluate the capacity for increased demands in the future. This evaluation is included in Section 5.2.2.

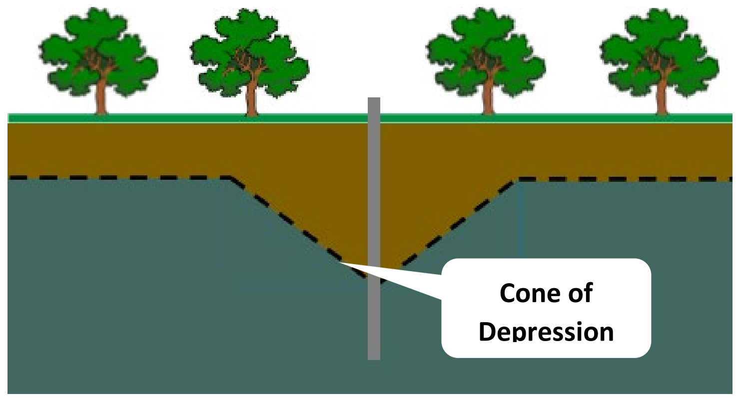
Table 5-1: Current Well Capacity

Well	Well Design Capacity (GPM)	Well Design Capacity (MGD)	WTP Design Capacity (GPM)	WTP Design Capacity (MGD)	System Firm Capacity (GPM)	System Firm Capacity (MGD)
6	1,000	1.44	1,000	1.44	1,000	1.44
7	1,200	1.73	1,500	2.16	1,200	1.73
8	1,200	1.73	1,350	1.94	1,200	1.73
9	1,350	1.94	1,300	1.87	*	*
10	1,200	1.73	1,300	1.87	1,200	1.73
Total	**5,950**	**8.57**	**6,450**	**9.28**	**4,600**	**6.63**

** Well #9 Removed from service to represent "firm capacity"*

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 typically met by drawing from elevated 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 Sycamore has not experienced significant capacity reductions during periods of extended pumping, it should still be recognized during planning efforts.

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

Table 5-2: 18-Hour Run Time Capacity

Well	Capacity (GPM)	Capacity (MGD)	18 Hour Run Capacity	Firm 18 Hour Run Capacity
6	1,000	1.44	1.08	1.08
7	1,200	1.73	1.30	1.30
8	1,200	1.73	1.30	1.30
9	1,350	1.87	1.40	-
10	1,200	1.73	1.30	1.30
Total	**4,750**	**6.77**	**6.38**	**4.98**

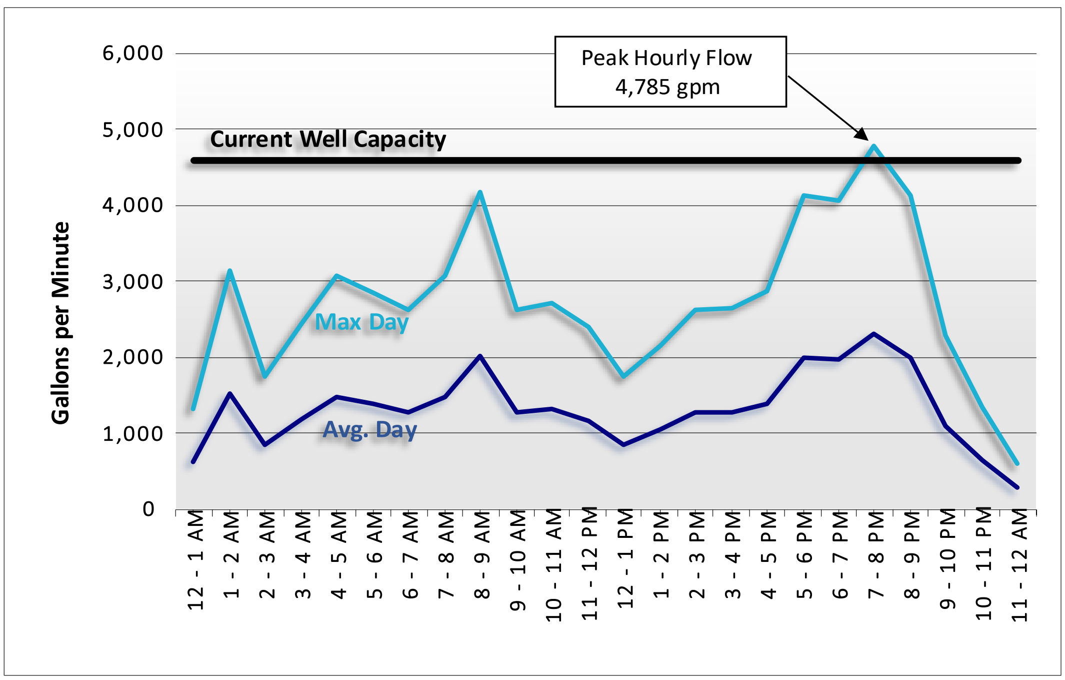
With the City's well pump time reduced to 18-hours per day, the firm capacity is reduced to 4.98 MGD for the entire system. These numbers can be used for evaluating the system's ability to meet average day demands, however they are not intended to be used for maximum demand scenarios when wells will be pumping as much as necessary to meet demand.

Ability to Meet Current Peak Hourly Demands

To determine the system's ability to meet the maximum day demand of 3.93 MGD, the diurnal peak of the maximum day is 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 Sycamore with a 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 4,785 gpm.

Figure 5-2: Current Peak Hourly System Demands



The Current Well Capacity line in the graph above represents the 6.63 MGD (4,600 gpm) well production firm capacity (with Well #9 out of service). The hourly flow exceeds this production capacity only once throughout the day, which would require flow into the system from the elevated storage tanks. The total supplemental volume required on this maximum day is only 11,100 gallons. However, the system may not be able to sufficiently meet peak demands in the future as demand increases with growth. Therefore, the future well capacity requirements are also reviewed.

5.2.2 Future Well Capacity Requirements

Section 2.3 of this Plan identified population growth projections for 5-year, 10-year, and 20-year planning periods. Associated increases in water demand for each of these horizons were developed by extrapolating current usage per PE, as identified in Section 2.3.4. For example, at the calculated 66.2 gallons per PE/day of water pumped, the 2030 population estimate of 30,428 equates to an average daily demand of approximately 2.01 MGD. Table 5-3: Future Water Demands below includes the extrapolated demands based on population projections. The table illustrates 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.

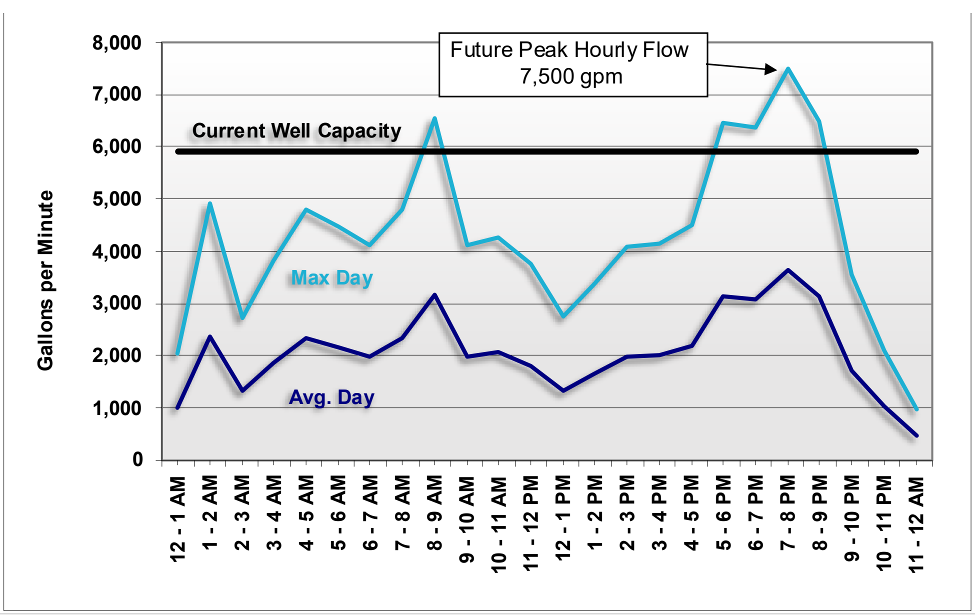
Table 5-3: Future Water Demands

	2025 (Current)	2030 (5-Year)	2035 (10-Year)	2045 (20-Year)	Ultimate Build-Out
Current P.E.	28,691	28,691	28,691	28,691	28,691
Growth P.E.	-	1,737	5,068	11,729	36,277
Total P.E.	28,691	30,428	33,759	40,420	64,968
ADD (MGD)	1.90	2.01	2.31	2.98	4.64
MDD (MGD)	3.93	4.16	4.78	6.16	9.61
Firm Capacity Required	**4.00**	**4.20**	**4.80**	**6.20**	**9.70**

Ability to Meet Future Peak Hourly Demands

Utilizing the 2045 Maximum Day Demand of 6.61 MGD, the ability of the system to meet the peak hourly demand through the planning horizon was evaluated. As shown in Figure 5-3 below, the peak hourly flow at this future maximum day condition is approximately 7,500 gpm. The total net volume required from storage would still be only approximately 190,000 gallons. This City has ample storage capacity available to supplement during this future peak hourly demand and refill in the off-peak hours.

Figure 5-3: Future Peak Hourly System Demands



5.3 Water Supply and Treatment Evaluation

As previously discussed, the City of Sycamore's water distribution system is supplied by five deep groundwater wells. Each of the wells have drilled depths that range from 1,200 feet to 1,300 and pump source water from the Mt. Simon sandstone aquifer. This raw water pumped from each of the wells have experienced the presence of radium and barium, leading to the City commissioning the construction of radium removal facilities at each operating well. The City works actively to ensure the residents of the service area are provided with ample and safe water. An evaluation of the system's supply and treatment processes is described in the following sections.

5.3.1 Water Quality

The City of Sycamore is committed to supplying a safe, reliable and economical potable water supply to all residents and businesses within the City's service area. Overall, the City of Sycamore's raw source water meets all Primary Drinking Water Standards (US EPA), with the exception of barium and radium. Other water quality characteristics are identified as taste, odor, color, hardness, etc. which represent non-regulatory Secondary Drinking Water Standards for aesthetics.

Hardness

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 Sycamore has a hardness range of 289-314 parts per million, which is defined as hard to very hard water, as seen in the following AWWA Hardness Classification Scale table.

Table 5-4: 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 EPA does not have a drinking water regulation for hardness as it does not present health concerns. The concerns associated with hardness levels are related to aesthetics, such as mineral deposits, soap consumption, and service life of appliances.

	Hardness (mg/L)
Well #6	289
Well #7	292
Well #8	267
Well #9	283
Well #10	314

Barium Concentration

Barium is a naturally occurring alkaline earth metal that is commonly found in the Midwest. It is present in brines/fluids associated with oil and gas development, landfill leachate, coal waste, and high-octane fuels. Barium is also used to make electrical components, dyes, fireworks, ceramics and glass, but dissolves into water resources through drilling waste discharges, copper smelting, and motor vehicle manufacturing.

	MCL Limit (ppb)	Raw Barium (ppb)
Well #6	2,000	1,200
Well #7		1,020
Well #8		2,900
Well #9		2,200
Well #10		2,100

Health effects of different barium compounds vary with how well the compound dissolves into water. Compounds with low solubility are typically not harmful but ingesting high levels of barium compounds that have high solubility in water can cause gastrointestinal issues, muscle weakness, high blood pressure, and problems with the nervous and circulatory systems.

These adverse health effects led the EPA to set the MCL for barium to 2.0 mg/L or 2000 ppb. The City of Sycamore does not have any issues with meeting this requirement, but it is noted that Well #8 and 9 raw water may exceed this level without the WRT treatment present.

Radium Concentration

Radium is a naturally occurring radioactive metal that exists in rocks, soil, and groundwater. In Northern Illinois, it is common for groundwater supplies to contain varying concentrations of radium. The radium is embedded in the bedrock that surrounds the aquifer, and thus can be transferred into the surrounding water. This can become an issue when the water is extracted by wells for drinking water. When water that contains high levels radium is consumed, it acts similarly to calcium and is adsorbed into bone tissues. These deposits can deteriorate the surrounding tissues and increase the risk of bone cancer.

	MCL Limit (pCi/L)	Raw Radium (pCi/L)
Well #6	5.0	5.2
Well #7		9.2
Well #8		12.9
Well #9		11.7
Well #10		4.6

Radium and other radioactive elements are measured in units called "curies" (Ci) which equates to one gram of radium. When evaluating levels in water, units of one trillion curies per liter of water or picocuries per liter (pCi/L) is used. Under the Safe Drinking Water Act, the U.S. Environmental Protection Agency (USEPA) set the Maximum Contaminant Level (MCL) for the combined radium isotopes Ra-226 and Ra-228 in drinking water to 5 pCi/L.

The City of Sycamore's wells draw source water that contains concentrations ranging from approximately 4-14 pCi/L. Some of these values are above the MCL, which prompted the City to evaluate and commission the construction of the WRT facilities in the 2000's.

WRT Radium Removal Treatment Facilities

In 2007, the City of Sycamore entered an agreement with Water Remediation Technology, LLC (WRT) for radium removal facilities at each of the operating wells, Well #6, 8, 9, and 10. The City made a capital outlay towards the installation of the systems, and pays a monthly fee for the rental of equipment and operation. The systems for Well #6, 8 and 9 were leased with a 10-year contract in 2007, while the Well #10 system was sold to the City in 2014. In 2017, the City elected to renew the contract for an additional 10-year term to 2027.

The City utilizes four WRT Radium Removal Systems with their Z-88® adsorptive media which attracts radium and removes it from the source water as it flows through. As a result, the system process does not produce wastewater and thus, does not affect the local wastewater treatment plant. The contracts with WRT include maintenance of each system as well as removal, replacement, and disposal of spent media as needed to a licensed nuclear waste facility.

Before the treatment systems were installed, the raw source water contained radium levels ranged from approximately 6-10 pCi/L and were above the USEPA MCL of 5 pCi/L. Within the agreement between WRT and the City, an Agreed Radium Concentration for each well is established. This value represents the maximum amount radium that should be present in the raw well water to be treated. If levels in the raw water exceed this concentration, WRT charges the City to compensate the excess treatment that is necessary to reduce the radium concentration to meet the MCL.

The combined radium 226/228 concentration range of the finished water is documented in the City's Annual Consumer Confidence Reports and the values over the past three years are represented in the table below. With these facilities, radium levels are reduced from the Agreed Radium Concentration range to a range that satisfies the USEPA standards for drinking water, ensuring safe, potable water distributed to all service consumers.

5.3.2 Well #6

Well #6 is the oldest operating Well in the system and is located on Maertz Drive, near the center of the City and just north of the intersection of Center Cross Street and State Street. Originally drilled in 1970, Well #6 had a depth of 1,214 feet into the Mt. Simon sandstone aquifer. However, in 1997 the well was plugged to a depth of 796 feet due to address the elevated barium levels. The well setting is approximately 495 feet and operates with a static level of 185 ft and a pumping level of about 272 ft, at a capacity of 900 gpm. Well #6 along with all the other well sites have installed backup diesel generators, which run weekly and sends out an alarm to notify the City when they are being used.

The WRT system at Well #6 was leased and installed in 2007. Well #6 pumps water to the system first through two WRT treatment vessels, one after the other, but also has a bypass that can allow flow directly into the distribution system if needed. In addition to WRT treatment, raw water from Well #6 is also treated with fluoride, phosphate, and chlorine. According to the WRT contract with the City, the Agreed Radium Concentration of the source water supplied by Well #6 is 6.7 pCi/L, and after treatment this concentration is reduced to or under the MCL. Of the contaminants that are monitored by the City as well as the EPA for drinking water regulations, the finished water from this well does not violate any water quality standards, shown in the table to the below.

The Well #6 pump was replaced in February 2020 and is very good condition. The raw well flow meter, chemical scales, and chlorination system was replaced in 2024 and as such no major rehabilitations are anticipated to be required at Well #6 in the near future.

Well #6	Raw	MCL
Radium (piC/L)	6.70	5.00
Barium (mg/L)	1.20	2.00
Hardness (mg/L)	289	N/A
Iron (mg/L)	0.17	0.30
Fluoride (mg/L)	0.47	2.00

Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Anticipated Service Life	Expiration of Anticipated Service Life
Well No. 6						
Well No. 6 Pump	Layne/Aurora	12RKBH 8 Stage	New Feb 2020	2020	50	2070
Well No. 6 Motor	U.S. Motor			2020	20	2040
Globe Style Silent Check Valve	Val-Matic		Good Condition	2007	20	2027
WRT Vessels	Silvan Industries	06-M-02	Good Condition	2007	20	2027
WRT Cartidge Filter	VAF/Evoqua	V-1000	Good Condition	2007	25	2032
WRT Bag Filter			Good Condition	2007	25	2032
Chlorinator			Fair Condition	2007	15	2022
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Fair Condition	2007	15	2022
Chemical Feed Scales	Force Flow		Fair Condition	2007	15	2022
Fluoride Feed Pump	Blue-White	ProSeries-M2	Good Condition	2021	15	2036
Phosphate Feed Pump	Blue-White	ProSeries-M2	Good Condition	2020	15	2035
Well No. 6 VFD	ABB	ACQ580-01-260A-4	NEW Nov. 2021	2021	15	2036
Well No. 6 MDP	Square D Company		Good Condition	2007	30	2037
Transfer Switch	Emerson	ASCO 7000 Series	Fair Condition	2007	30	2037
SCADA Control Panel	Metropolitan Industries	-		2007	15	2022
Generator	Caterpillar	(300 kW)	Good Condition	2007	30	2037

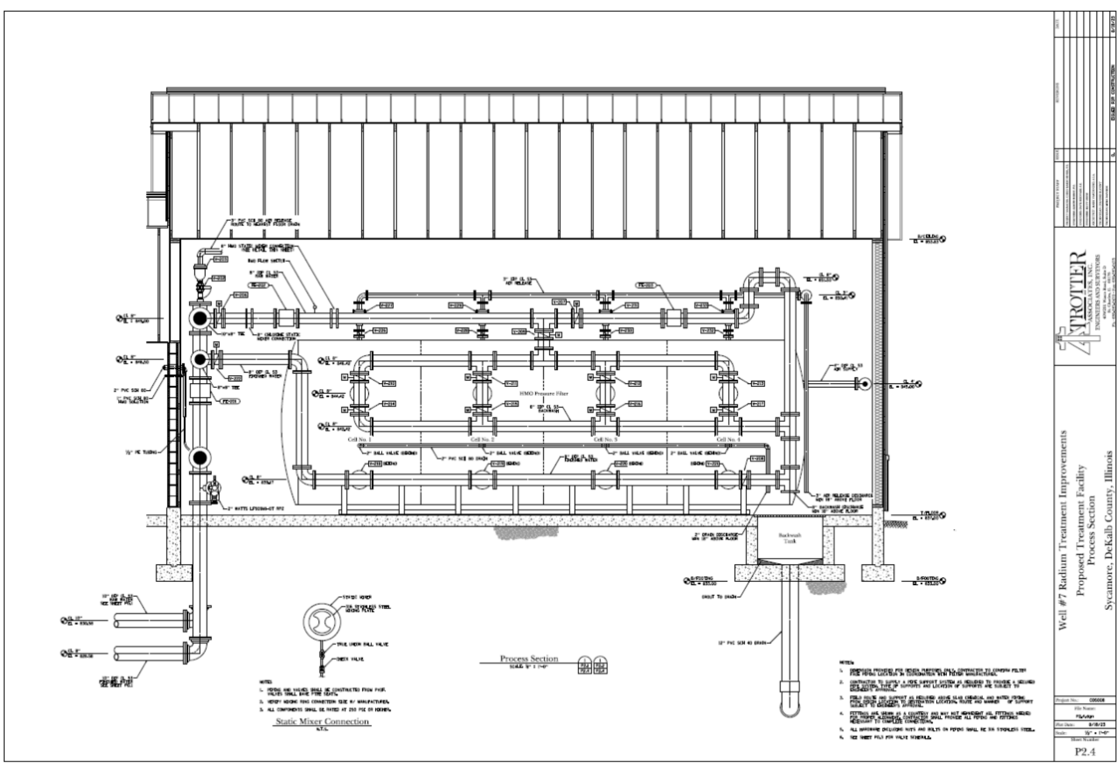
Well No. 6 Driller's Log	
Distance (ft)	**Description**
0 to 5	loam, silty clay, organic matter, non-calcareous, soil
5 to 45	till, loam, sand, pebbles, gravel
45 to 55	sand and gravel, unsorted, outwash/ice contact
55 to 60	sand, ground, course gravel, more sorted/above
60 to 65	till, silty clay loam, sand, gravel,
65 to 80	outwash same as 55-60' interval
80 to 90	till, loam, sandier than above, few organic material, non-calcareous
90 to 110	dolomite, limestone
110 to 165	limestone & shale
165 to 461	limestone
461 to 465	sandstone
465 to 485	limestone
485 to 495	sandy limestone
495 to 530	sandstone, streaks of dolomite
530 to 820	sandstone
820 to 875	sandy limestone
875 to 885	limestone w/ shale streaks
885 to 900	sandy limestone
900 to 910	dolomite
910 to 928	limestone
928 to 930	shale
930 to 935	sandy limestone with shale streaks
935 to 955	limestone
955 to 1020	sandy limestone
1020 to 1214	sandstone

5.3.3 Well #7

Well #7 is located on Willow Street, just east of Dekalb Avenue and south of Highland Drive. With a depth of 1,233 feet below the ground surface into the Mt. Simon aquifer. The well setting is approximately 370 feet and operates with a static level of 250 ft and a pumping level of about 275 ft, at a capacity of 1,200 gpm. The well was taken offline in the summer of 2015 due to increasing concentrations of radium in the source water. Although concentrations fluctuated at this well, levels started approaching the MCL in 2014 and into 2015. Instead of implementing another WRT treatment facility, the City reduced the pumping capacity of the well which produced lower raw radium concentrations below the MCL. In order to regain the capacity of the production well, the City elected to construct a radium removal facility.

In 2023 the City commissioned a study of radium removal alternatives including and additional WRT system, or a hydrous manganese oxide (HMO) pressure filtration option. The City proceeded with an HMO system design, which was bid in early 2023 and is anticipated to be completed in early 2025. While this project was identified on the City's capital program, it was expedited in order to receive $1.25M in principal forgiveness through the IEPA.

The new process includes one four-cell pressure filtration vessel that a portion of the raw Well #7 flow will be conveyed to. The HMO slurry will be injected upstream of the filter, which co-precipitates the radium ions and can be removed across the filter media. The pressure differential across the filter is monitored, and after it reaches a specified level the filter is backwashed utilizing raw water to dislodge and clean the media bed.



Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Anticipated Service Life	Expiration of Anticipated Service Life
Well No. 7						
Well No. 7 Pump	Johnston Pump Company		Good Condition	2024	50	2074
Well No. 7 Motor	U.S. Motor	(200 HP) RUS1 Frame: H445TPA	Good Condition	2024	20	2044
HMO Electric Valves	DeZurik/Rotork		New - Good Condition	2024	20	2044
HMO Day Tank	Chem-Tainer	600 Gallons	New - Good Condition	2024	20	2044
HMO Day Tank Mixer	Lightnin EV	EV5P33	New - Good Condition	2024	12	2036
HMO Feed Pump - (2)	Blue-White	MD3	New - Good Condition	2024	15	2039
HMO Filter Flow Meter	Krohne Flow Instruments	Optiflux 2000	New - Good Condition	2024	20	2044
HMO Mixing Tank	Chem-Tainer	600 Gallons	New - Good Condition	2024	20	2044
HMO Mixing Tank Mixer	Lightnin EV	EV5P33	New - Good Condition	2024	12	2036
HMO Filter Internal Comp.	WesTech		New - Good Condition	2024	20	2044
HMO Pressure Filter Media	WesTech		New - Good Condition	2024	10	2034
HMO Pressure Filter Vessel	WesTech	MF-21.00	New - Good Condition	2024	40	2064
HMO Transfer Pump		Series 1530	New - Good Condition	2024	10	2034
HMO Depth Sensor - (2)	Vega	PULS 21	New - Good Condition	2024	10	2034
Manganese Sulfate Tank	Assmann		New - Good Condition	2024	20	2044
Mang. Sulfate Transfer Pump	March Pump	TE-5C-MD-TE	New - Good Condition	2024	10	2034
Manganese Depth Sensor	Vega	PULS 21	New - Good Condition	2024	15	2039
Sodium Depth Sensor	Vega	PULS 21	New - Good Condition	2024	15	2039
Sodium Permanganate Tank	Assmann		New - Good Condition	2024	20	2044
Sodium Transfer Pump	March Pump	TE-5C-MD-TE	New - Good Condition	2024	10	2034
Chlorinator	Superior	Auto-Valve	New - Good Condition	2024	20	2044
Chlorine Booster Pump	Pentair/STA-RITE	HP20F3-02	New - Good Condition	2024	25	2049
Chemical Feed Scales	Force Flow		New - Good Condition	2024	20	2044
Fluoride Feed Pumps	Blue-White	MD3	New - Good Condition	2024	15	2039
Phosphate Feed Pump	Blue-White	MD3	New - Good Condition	2024	15	2039
Well No. 7 VFD	ABB	ACQ580-34-240A-4	New - Good Condition	2024	15	2039
Well No. 7 MCC	Rockwell Automation	Centerline 2100	New - Good Condition	2024	30	2054
Transfer Switch	ASCO	300 Series 600A	New - Good Condition	2024	30	2054
SCADA Control Panel	Metropolitan Industries	-	New - Good Condition	2024	15	2039
Generator	Kohler		Fair Condition		30	-

Well No. 7 Driller's Log	
Distance (ft)	**Description**
0 to 8	Fill
8 to 25	Clay
25 to 55	Clay and gravel
55 to 115	Sand and gravel
115 to 125	Shale
125 to 145	Broken limestone
145 to 155	Broken limestone and shale
345 to 500	Hard gray limestone
500 to 505	Hard sand and green shale
505 to 525	Hard sandstone with limestone and shale
525 to 560	Hard sandy limestone
560 to 575	Hard white sandstone
575 to 793	White soft sandstone
793 to 809	Firm pinkish sandstone
809 to 820	Reddish shale
820 to 880	Medium hard sandstone with limestone shales
880 to 942	Hard limestone
942 to 1060	Medium/hard limestone with shale shells
1060 to 1080	Hard white sandstone and limestone
1080 to 1116	White sandy limestone
1116 to 1123	Medium white sandstone
1123 to 1195	Soft white sandstone
1195 to 1205	Medium white sandstone

5.3.4 Well #8

In the southeast region of the City, Well #8 is located near the intersection of Bethany Road and Mediterranean Drive, just west of Peace Road. The well was drilled at a 1,274 foot depth in 1987. The well setting is approximately 530 feet and operates with a static level of 300 ft and a pumping level of about 475 ft, at a capacity of 1,060 gpm. The current pump was originally installed in 1987 and is a Johnston 12GMC model with a U.S. WP-1 250V motor.

The WRT system at this site is under the same contract as the one at Well #6. The WRT equipment was leased to the City and installed in 2007 with two treatment columns in series. Well #8 has an established Agreed Radium Concentration 9.2 pCi/L, the highest out of all the wells. However, with the existing radium removal facility, levels are able to meet the MCL standard of 5 pCi/L. In addition, all other monitored and regulated contaminants are below the maximum contaminant level.

Well #8	Influent	MCL
Radium (piC/L)	13.7	5.00
Barium (mg/L)	2.90	2.00
Hardness (mg/L)	267	N/A
Iron (mg/L)	0.12	1.00
Fluoride (mg/L)	0.65	2.00

The Well #8 pump and motor were rebuilt in 2023/2024 and are not anticipated to need rehabilitation or replacement in the near-term. The chlorination system is nearing the end of its useful service life and replacement should be programmed within the next several years. This would include the chlorinator and associated equipment; however the scales were replaced in 2024 and will not require replacement. While no specific issues have yet been noted, City should budget for replacement of the existing generator and ATS, which date to 1988.

Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Anticipated Service Life	Expiration of Anticipated Service Life
Well No. 8						
Well No. 8 Pump	Johnston Pump Company	12GMC 10 Stage	Good Condition	2023	50	2073
Well No. 8 Motor	U.S. Motor	(250 HP) WP-1 Frame: 445TPA	Good Condition	2023	20	2043
Globe Style Silent Check Valve	Val-Matic		Good Condition	2007	20	2027
WRT Vessels	Silvan Industries	08-M-01	Good Condition	2006	30	2036
WRT Cartidge Filter	VAF/Evoqua	V-1500	Fair Condition	2007	25	2032
WRT Bag Filter			Good Condition	2007	25	2032
Chlorinator				2007	15	2022
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Good Condition	2007	15	2022
Chemical Feed Scales	Force Flow		New in May 2024	2024	15	2039
Fluoride Feed Pump	Blue-White	ProSeries-M2		2021	15	2036
Phosphate Feed Pump	Blue-White	ProSeries-M2		2021	15	2036
Well No. 8 VFD	ABB		Good Condition	2007	15	2022
Well No. 8 MCC	Square D Company	Model 5	Fair Condition	1987	30	2017
Transfer Switch	ASCO		Fair Condition	1988	30	2018
SCADA Control Panel	Metropolitan Industries	-		2007	15	2022
Generator	Kohler Power Systems	Cummins Engine NTA855G3	Fair Condition	1988	30	2018

5.3.5 Well #9

Well #9 is located in the far eastern part of town, west of Airport Road, and just north of Hillside Road and adjacent to the Park District's Community Center. The well was drilled 1,285 feet into the Mt. Simon Aquifer in 2004. Having the largest capacity out of all the four wells, Well #9 setting is approximately 475 feet and operates with a static level of 265 ft and a pumping level of about 400 ft, at a capacity of 1,500 gpm.

The Agreed Radium Concentration of Well #9 is 6.4 pCi/L, the lowest out of the four wells. The WRT systems were installed under the same contract as Well #6 and 8 and also operates with two treatment columns. Alike the other systems, the finished water quality meets all standards for contaminants monitored by the City and the EPA, shown in the table below and to the left.

Well #9 is slated to be pulled and preventative maintenance performed in 2025. The well pump variable frequency drive was replaced in 2024. Similar to the other treatment facilities, the chemical feed systems have been replaced within the last five years, as well as the majority of the chlorination system, including the chlorinator and appurtenances. Following the pulling and maintenance of the well pump in 2025, the Well #9 and treatment facility will not require significant rehabilitation in the near-term.

Well #9	Influent	MCL
Radium (piC/L)	7.8	5.00
Barium (mg/L)	2.20	2.00
Hardness	283	N/A
Iron (mg/L)	0.22	1.00
Fluoride (mg/L)	0.64	2.00

Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Anticipated Service Life	Expiration of Anticipated Service Life
Well No. 9						
Well No. 9 Pump	Byron-Jackson	12EHM 10 Stage	Good Condition	2005	50	2055
Well No. 9 Motor	Byron-Jackson	(250 HP) BJ 480V 14" H	Good Condition	2005	20	2025
WRT Vessels	Silvan Industries	09-M-02	Good Condition	2006	30	2036
WRT Cartidge Filter	VAF/Evoqua	V-1500	Good Condition	2006	25	2031
WRT Bag Filter			Good Condition	2006	25	2031
Automatic Control Valve	OCV Fluid Solutions		Good Condition	2005	15	2020
Chlorinator	Superior	Auto-Valve	Good Condition	2021	15	2036
Chlorine Booster Pump	STA-RITE	Signature 2000	Good Condition	2005	15	2020
Chemical Feed Scales	Force Flow		Good Condition	2005	15	2020
Fluoride Feed Pump	Blue-White	ProSeries-M2	Good Condition	2020	15	2035
Phosphate Feed Pump	Blue-White	ProSeries-M2	Good Condition	2020	15	2035
Well No. 9 VFD	ABB		New June 2024	2024	15	2039
Well No. 9 MCC	Square D Company	Model 6	Good Condition	2005	30	2035
Transfer Switch	Emerson	ASCO Series 300	Good Condition	2005	30	2035
SCADA Control Panel	Metropolitan Industries	-	Fair Condition	2005	15	2020
Generator	Kohler Power Systems	(275 kW) 35DREDZV	Good Condition	2005	30	2035

Well No. 9 Driller's Log	
Distance (ft)	**Description**
0 to 5	Sandy clay
5 to 33	Clay
33 to 110	Very sandy clay
110 to 165	Sandy clay mixed with gravel embedded
165 to 180	White lime
180 to 250	Gray & white lime mixed
250 to 330	White lime
330 to 340	90% lime, 10% shale
340 to 390	White lime
390 to 410	White and gray lime
410 to 530	Lime
530 to 545	sandy limestone some shale w/ 100% sandstone-St. Peter
545 to 600	Very sandy lime
600 to 810	Sandstone
810 to 850	Sandstone & lime streaks
850 to 935	sandstone
935 to 1020	Sandy lime with streaks of shale
1020 to 1065	50% gray lime with 50% sand
1065 to 1230	Galesville sandstone
1230 to 1285	lime & shale

5.3.6 Well #10

Well #10 was constructed alongside Tower #2 in the northern region of the City just east of Main Street and south of Heron Creek Drive. The well is the most recently activated well, originally drilled in 2010. The well was drilled to a depth of 1,325-foot depth. The well pump setting is approximately 475 feet and operates with a static level of 204 ft and a pumping level of about 320 ft, at a capacity of 1,200 gpm.

Because the well was drilled after the original WRT contract was signed for Wells #6, 8, and 9, the WRT system Well #10 was originally under its own contract. The City was able to renew both contracts together in 2017 and the last media replacement was conducted in February 2020. As seen in the water quality table to the right, Well #10 has an Agreed Radium Concentration of 8.1 pCi/L, and all other contaminants meet the EPA MCL standards.

Well #10	Influent	MCL
Radium (piC/L)	4.6	5.00
Barium (mg/L)	1.30	2.00
Hardness (mg/L)	314	N/A
Iron (mg/L)	0.31	1.00
Fluoride (mg/L)	0.71	2.00

City staff has noted a consistent and problematic increase in differential pressure across the WRT system, however, which impacts the well pump capacity. This differential appears to be tied to the headloss induced by the Filtrek cartridge filter upstream of the WRT vessels. At a clean state with no pressure loss across the filter the well will produce roughly 950 gpm. However over the course of several weeks the headloss across the filter will increase to 10 psi or greater, which reduces the capacity to as low as 600 gpm. Staff has reported that WRT has reviewed this issue and indicated that the filter porosity is as large as possible, and that WRT believed the issue to be related to raw water quality. The media was scalped by WRT in 2024 and the pressure issues lessened. The media has also been sampled by WRT and may be replaced in 2025.

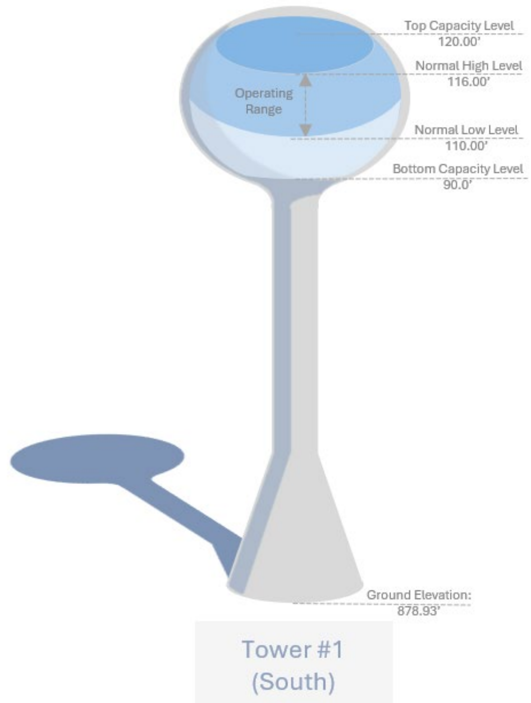
Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Anticipated Service Life	Expiration of Anticipated Service Life
Well No. 10						
Well No. 10 Pump	American Marsh	12HCRA 9 Stage	Good Condition	2014	50	2064
Well No. 10 Motor	U.S. Motor	(250 HP) DN14 Frame: H445TPA	Good Condition	2014	20	2034
Globe Style Silent Check Valve	Val-Matic		Good Condition	2014	20	2034
WRT Vessels	Universal Tank & Fabrication	S/N: 732401 & 732402	Good Condition	2014	30	2044
WRT Cartidge Filter	Fil-Trek Corporation		Good Condition	2014	25	2039
Automatic Control Valve	OCV Fluid Solutions		Good Condition	2014	15	2029
Magnetic Flow Meter	Krohne Flow Instruments		Good Condition	2014	15	2029
Chlorinator	Wallace & Tiernan	Model V10K	Good Condition	2014	20	2034
Chemical Scales	Force Flow	XT-200MA/XT-600MA/XT-150MA	Good Condition	2014	20	2034
Fluoride Feed Pump	Blue-White	ProSeries-M2	Good Condition	2014	15	2029
Phosphate Feed Pump	Blue-White	ProSeries-M2	Good Condition	2014	15	2029
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Good Condition	2014	25	2039
Well No. 10 VFD	ABB		Good Condition	2014	10	2024
Well No. 10 MCC	Square D Company		Good Condition	2014	30	2044
Transfer Switch	Emerson	ASCO 7000 Series	Good Condition	2014	30	2044
SCADA Control Panel	Metropolitan Industries	-	Good Condition	2014	20	2034
Generator	Kohler Power Systems		Good Condition	2014	30	2044

Well No. 10 Driller's Log	
Distance (ft)	**Description**
0 to 20	No record
20 to 90	drift
90 to 125	lime
125 to 140	lime/shale
140 to 170	lime/shale mix
170 to 175	shale
175 to 180	lime shale mix
180 to 455	lime
455 to 460	lime, shale mix
460 to 515	lime
515 to 520	shale
520 to 560	sandy shale lime
560 to 570	sandy lime cemented sandstone
570 to 790	sandstone shale mix
790 to 795	sandstone
795 to 825	sandstone shale mix
825 to 860	sandstone
860 to 865	cemented sandstone
865 to 875	sandy lime, cemented sandstone
875 to 880	red sandy lime
880 to 895	shale chint mix, sandy lime
895 to 900	shale lime sandy mix
900 to 905	shale mix cemented ss some lime
905 to 920	less shale sandy lime chint mix
920 to 925	chinty sandy lime
925 to 930	lime, shale, sandy lime, chint
930 to 935	sandy lime
935 to 945	lime, sandy lime, granite
945 to 955	sandy lime
955 to 1005	sandy lime shale mix
1005 to 1015	granity-type w/some shale mix
1015 to 1020	sand lime, lots of factors
1020 to 1025	tannish sands lime
1025 to 1035	sandy lime quartz mix factors
1035 to 1090	sand streaks, shale cemented streak
1090 to 1175	cemented sandstone, sand streaks shale
1175 to 1180	white sand-sticky shale bluish
1180 to 1185	brown lime hard
1185 to 1205	sticky shale little sand mix
1205 to 1215	sticky shale lime mix
1215 to 1225	sandy lime or cemented shale mix

5.4 Evaluation of Elevated Storage

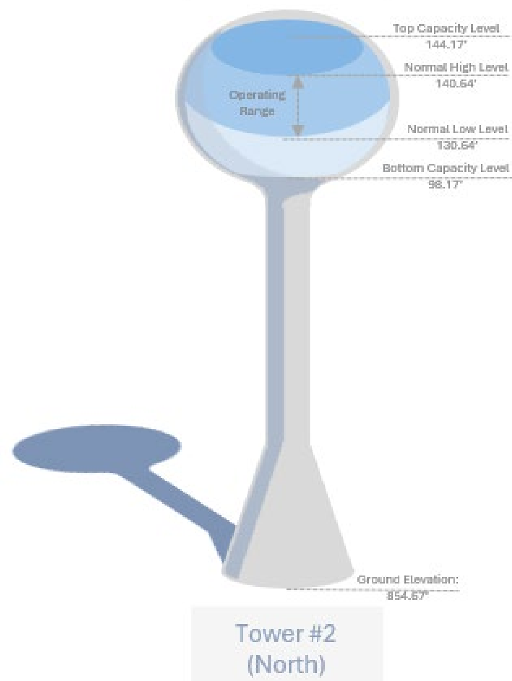
This section describes the current and future storage capacity requirements while Section 6 will describe alternatives to meet these requirements. The City owns and maintains two elevated storage tanks (water towers) with a combined storage of 2,250,000 gallons. This storage capacity contains reserved water that is crucial for fire flows and maximum day demands as well as operating the City's distribution system.

Both of the towers are strategically placed throughout the service area in order to maintain consistent water system pressures. The City's wells operate off of the elevated storage tower levels, pumping on and off as the hydraulic grade line of the towers change. The well supply functions with a lead/lag operation, meaning as the Tower levels drop to their low setpoints, the wells will kick on to supplement as required. Once the Tower reaches the high setpoints, the wells will turn off until drawn below a subsequent pump on level.



5.4.1 Tower #1 (South Tower)

Tower #1, or the South Tower, is located on the southwest corner of Park Avenue and Becker Place. This multi-column tower was the only existing storage tank when the City's 2007 Master Water Plan was developed and it is located at the same site as the deactivated Well #5. Constructed in 1962, the 9-column tower has a 750,000-gallon capacity with an elevation of 879 feet, height of 120 feet, and overlow elevation of 999 feet. The South Tower has an operating head range of 30 feet, as shown in the diagram to the right. The tower was repaired by JetCo in 2021, as well as repainted and a mixer installed in 2022.



5.4.2 Tower #2 (North Tower)

Tower #2, or the North Tower, was built in 2014 and was constructed at the same site as Well #10, near the intersection of Main Street and Heron Creek Drive. This 1,500,000-gallon spheroid tower has an elevation of 855 feet and height of 144 feet, equating to an overflow elevation of 999 feet. The North Tower has an operating head range of 46 feet, as shown in the diagram to the right. This tower remains in good condition and is not in immediate need of rehabilitation or recoating. Staff has not reported any issues related to stratification of water or loss of residual within this tower, even with the large storage capacity.

5.4.3 Water Storage Capacity Evaluation

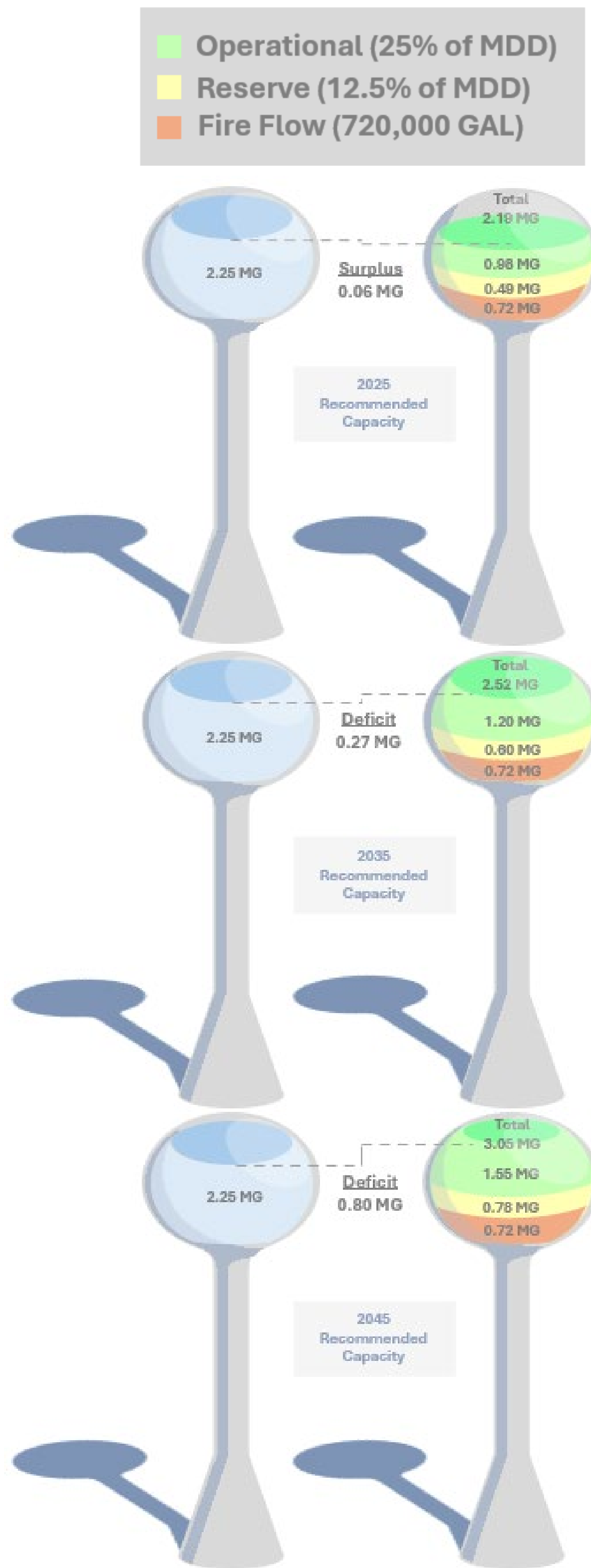
Recommended water storage volume consists of three components: fire flow, operational, and reserve storage. Fire flow requires 3,000 gallons per minute for four hours, or 720,000 gallons of storage. Operational storage is equivalent to 25% of the maximum day demand or MDD (3.93 million gallons), or 982,000 gallons. Lastly, the City should maintain 12.5% of the maximum day demand, 491,000 gallons in reserve storage. Combining these components gives a recommended 2025 Storage of approximately 2.19 MG, a 2035 storage capacity of 2.52 MG, and a 2045 storage capacity of 3.05 MG.

Under average day demand the City has the well production and treatment capacity to produce 3,300 gpm in surplus firm 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 Sycamore, as well as the 2035 and 2045 storage recommendations for the three components detailed above. As shown in the exhibit, the City currently meets the recommended storage, but would see a deficit over the 10-year and 20-year planning periods.

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.

Options for additional and/or relocated and expanded storage is explored further within Section 6 of this report. The City should seek to maintain adequate water storage while balancing any increase in water age resulting from a larger storage capacity and less daily 'bounce' within the tower.



This Page Intentionally Left Blank

Section 6

Analysis of Water Supply, Treatment, and Storage Alternatives

This Page Intentionally Left Blank

6. Analysis of Water Supply, Storage and Treatment Alternatives

Section 5 of this study reviewed the current condition and capacities of the City's water storage infrastructure, supply sources, and treatment facilities. This section will review alternatives, and any recommendations associated with the water supply, storage, and treatment facilities.

As discussed in Section 5, it is anticipated that the City will have adequate supply capacity throughout the 20-year planning period based on current growth projections. This is a result of the recent radium removal upgrades to Well #7 allowing this existing supply source to be maximized. Therefore no additional supply capacity is recommended at this time.

6.1 Water Storage Alternatives

The City currently has two existing water towers with a total of 2.25 million gallons of storage. However, at the rate that the City is growing, and based on the recommendation for water storage volumes, it is anticipated that by 2035 the City may have a slight deficit of approximately 270,000 gallons. By 2045 if population growth trends continue, the City may see a deficit of 800,000 gallons. Therefore, it is recommended that consideration be given to additional storage within the planning period.

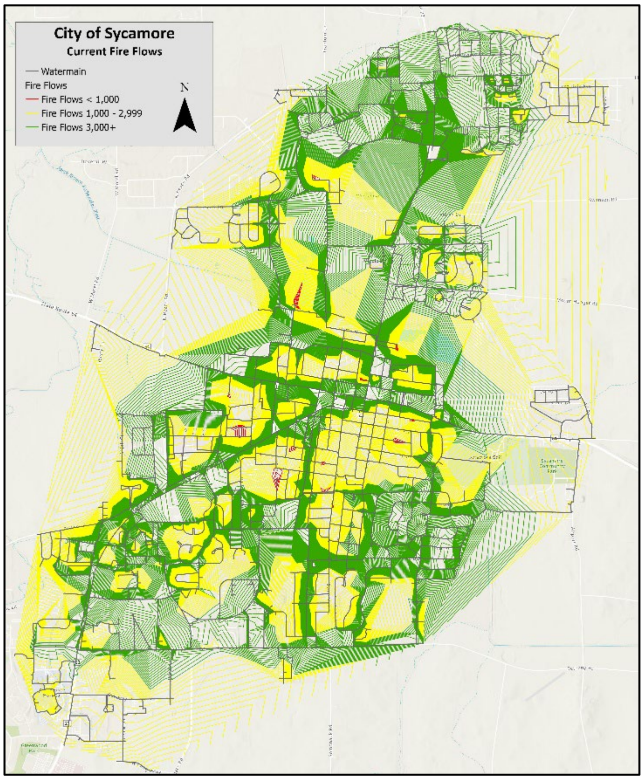
Tower #1 is 62 years old and was recently repaired and recoated. It is estimated that this tank has approximately 25 years of remaining service life with routine maintenance. Additional storage could be provided by an additional third tower of relatively minimal size (0.5 – 0.75 MG), or through replacement of Tower #1 with a larger tower depending on future demands. Tower #1 is located in a primarily residential area with a relatively small surrounding demand base. This results in less than optimal 'bounce' within the tower and longer water age. As an alternative to future replacement of Tower #1 at the existing site, a site near Well #8 was reviewed based on potential fire flows and water age impacts.

Alternate 1.0 Million Gallon Tower at Well #8

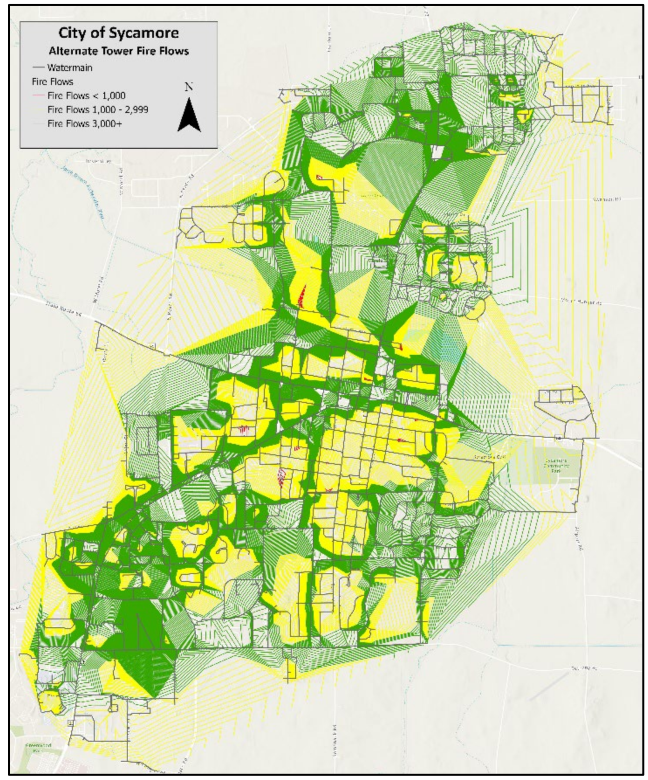
The existing site currently owned by the City that was reviewed was the Well #8 property. This site is relatively small, however, and there would likely not be enough open space to support an elevated tank. There are areas that are undeveloped near the existing facility and a new tower and/or well facility could be constructed through property purchase. This location is also located near more commercial/industrial users, increasing the demand base surrounding the tower and increasing the bounce this tower would see and potentially reducing water age throughout the residential areas surrounding the existing Tower #1.

Upon running the hydraulic model with the new 1.0 MG water tower at this location, it is clear that the alternate tower location provided greater fire flow capacities throughout the industrial and commercial areas on the southwest region of the City. In addition, construction of a tower near Well #8 would allow the City to remove Tower #1 from service to allow for maintenance or repair if the City elected to keep it in service. The estimated construction cost for the 1.0 MG tower is approximately $4.9M and the recommended project budget is $5.8, which includes land acquisition and engineering.

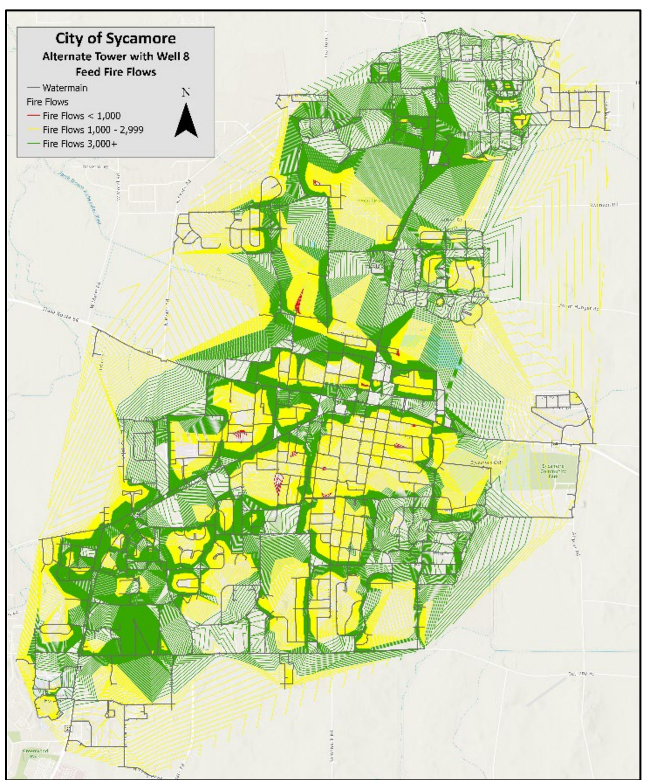
The exhibits on the following pages show the existing fire flows and water age with Tower #1 still in service, as well as the anticipated fire flows and water age with a new 1.0 MG tower in service and Tower #1 offline. In addition, they show the anticipated fire flows and water age with Well #8 feeding directly to the new 1.0 MG tower near the Well #8 site, as opposed to distribution. If a direct feed to the tower were implemented, it is recommended that a connection directly to the distribution system be maintained to provide maximum fire flow capacities during a emergency scenarios.



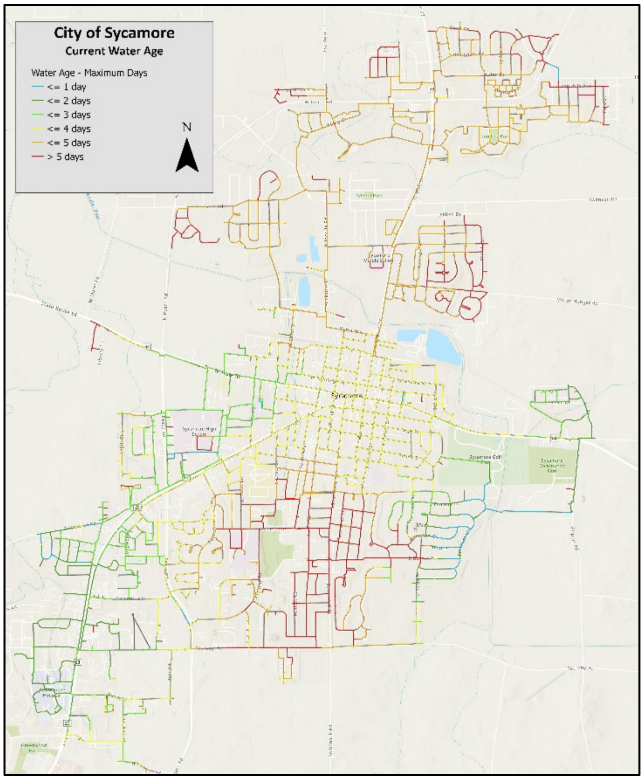
Current Fire Flows



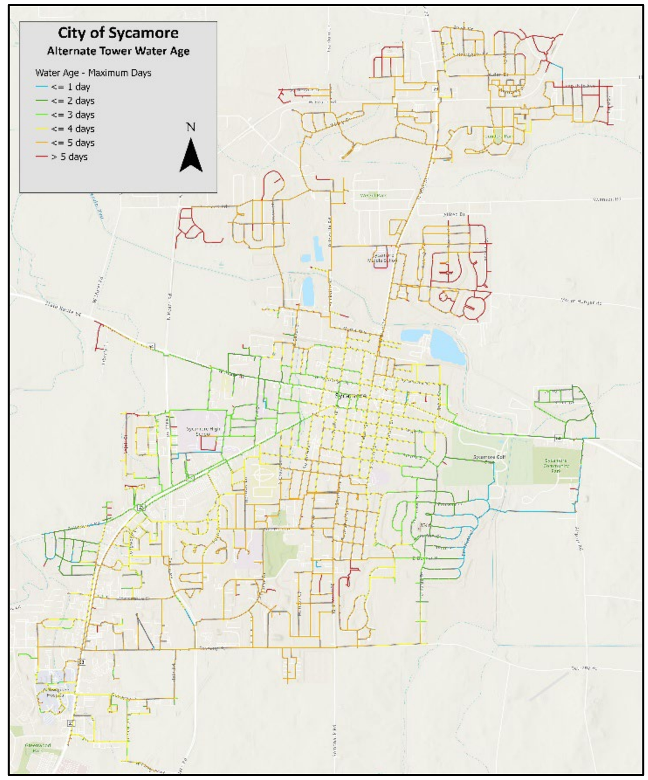
Alternate Tower Fire Flows



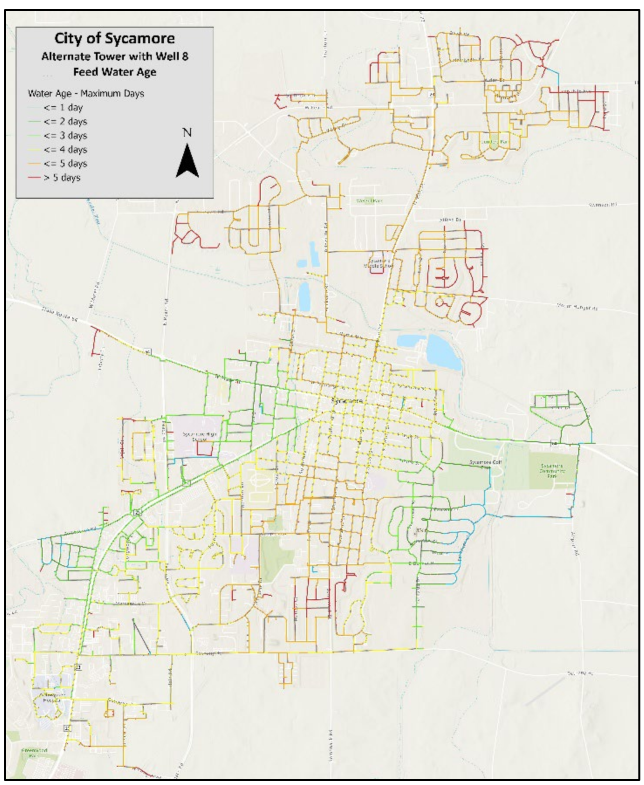
Alternate Tower with Well 8 Direct Feed Fire Flows



Current Water Age



Alternate Tower Water Age



Alternate Tower with Well 8 Feed Water Age

6.2 Water Treatment Alternatives

As identified in Section 5, the City of Sycamore utilizes deep groundwater wells for water supply, and has observed raw radium levels that exceed the 5 pCi/L MCL in their water supplies and as a result currently operates five radium removal treatment facilities. While additional supply sources are not recommended at this time, maintaining the existing radium removal facilities will be required throughout the planning period. Currently, the City operates two distinct radium removal processes as discussed in Section 5; WRT adsorption and HMO filtration.

6.2.1 Water Remediation Technology, LLC (WRT) Adsorption

The City of Sycamore currently operates four radium removal treatment facilities provided by Water Remediation Technology, LLC (WRT) at Wells #6, 8, 9 & 10 to meet the MCL standard for radium. The first two systems were installed in 2007 at Well's #6, and 8, followed by Well #9 in 2009. In 2014, the City constructed Well #10 and the associated WRT treatment facility, however the City purchased the treatment equipment outright, with WRT only providing maintenance and media exchanges.

The systems installed from WRT utilize adsorption technology to reduce the concentrations of radium in the City's current water supply. Adsorption is the process wherein molecules of one substance attach to the surface of another, in this case radium is chemically attracted to the surface of a proprietary adsorptive media, Z-88®, which is a zeolite-based treatment media. This method requires the influent water to pass through the media with a series of upflow (or downflow in the case of Well #10) treatment vessels utilizing the pressure produced from the well pump. The radium ions are absorbed into the material while the treated water flows out. The media is eventually loaded with the contaminant and are replaced and disposed of at a licensed facility. As a result, wastewater treatment facilities in the City are not affected by additional waste products.

The adsorption method is not classified as a best available technology (BAT) as determined and identified by the EPA. To be a BAT, the treatment technology must meet several criteria such as having demonstrated consistent removal of the target contaminant under field conditions. Some of those criteria include cost of achieving BAT effluent reductions; age of equipment and facilities involved; the processes employed by the industry and potential process changes; non-water quality environmental impacts, including energy requirements; as well as any other factors as EPA deems appropriate. A number of WRT systems have been permitted and constructed throughout the United States, and the technology has been proven to reduce radium content to the MCL standards. However, due to the relative recent introduction to the market the EPA has yet to identify it as a BAT.

This process does not require additional chemical usage or storage and therefore the system can operate unattended until replacement and disposal of exhausted media is needed, which is about every 1-2 years. In addition, media does not require backwashing, and the system generally has low energy requirements.

WRT Lease Contracts

Each of the WRT systems that are currently installed within the community are leased on an annual basis from WRT, with the exception of Well #10, as equipment was purchased outright.

As part of the leasing contract from WRT, they provide a relatively complete contaminant removal solution. WRT's services include both operation and maintenance of the vessels at each location. WRT is responsible for reviewing the installed process equipment (sampling/monitoring), as well as maintaining the radiation safety assurance program that provides all of the handling and transportation of radioactive treatment residuals. Each contract from WRT is set up in a cost per gallon treated basis, and typically is on a 5, 10, or 20-year cycle.

Beyond the sampling and monitoring, the lease from WRT also includes the disposal of material to licensed low-level radioactive waste facilities, installation of replacement media, provides a radioactive materials license for system operation and media handling for the term of the contract, as well as guaranteeing the City will meet the current MCL for radium within drinking water and process performance.

In 2007, the City of Sycamore entered into the original 10-year agreement with WRT during the initial installations at Well's #6, 8, and 9. During the initial 10-year lease period for the City of Sycamore, WRT was experiencing high operational costs for the installed vessels due to the frequent need for media replacements at each location. Near the end of the contract, water quality testing was performed at each location. The water quality testing indicated that in addition to the presence of radium, the City also had minor levels of barium within the source water. Due to the type of technology that WRT uses for radium removal, the vessels are also capable of treating the source water for barium. Since the raw water contained both contaminants, radium and barium, the vessels were treating both. This change in source water composition was causing the WRT media to reach the end of its service life more quickly and required replacement more frequently. This additional cost was absorbed by WRT, as it was not written into the original contract.

In 2017 the WRT contract for leasing the equipment to the City of Sycamore expired and was up for renewal. During the contract negotiations for the 2017-2027 contract, the overall cost for leasing the equipment increased significantly. Much of this was attributed to the presence of barium, and the additional costs for media replacement. Upon negotiations of new terms, the City entered into a new agreement with WRT, which expires in 2027.

As a result of the significant increase in annual costs during the 2017 contract negotiates, the City reviewed alternative technologies for radium removal. After reviewing ion-exchange softening, lime softening, HMO filtration, and pelletizing, the City elected to move forward with construction of an HMO facility at Well #7, anticipated to be brought online in early 2025.

6.2.2 Hydrous Manganese Oxide (HMO) Filtration

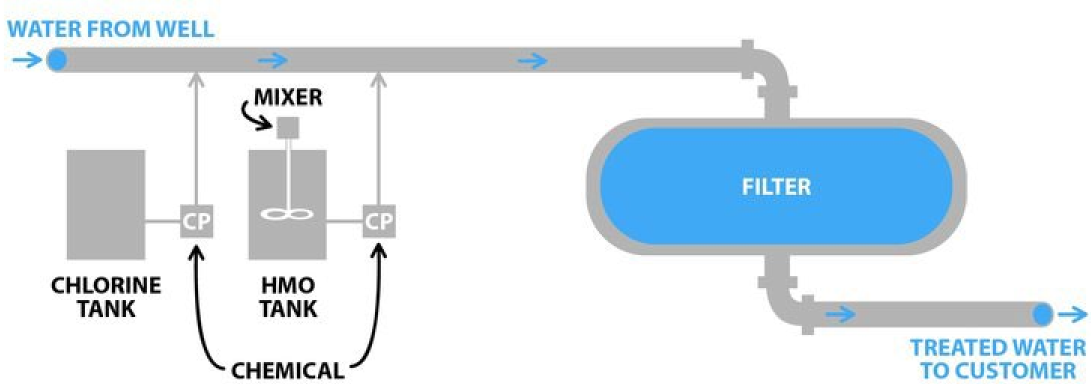
Manganese dioxide, often called Hydrous Manganese Oxide (HMO), is commonly used with conventional filtration to remove iron and manganese from water, but it has been proven under extensive research by the American Water Works Association (AWWA) to be an efficient method for radium removal as well. This process begins with a controlled dosage of HMO solution to the influent. The slurry can be purchased pre-formed or prepared at the treatment facility using a mixture of manganese sulfate, potassium permanganate, and water. The slurry will be added to the source water and due to its natural affinity, radium readily adsorbs onto the negatively charged surface of HMO molecules. Radium is then co-precipitated with HMO as a solid when the water passes through granular filtration.

The filtered water is then ready to be distributed while the contaminant is trapped in the filter media. Backwashing is required to clean the media of the accumulated contaminants. This will produce wastewater with high radium concentrations that must be treated at a wastewater treatment facility. In addition, the aged and ineffective media will eventually need replacement and appropriate disposal, typically every 10-12 years.

The effectiveness of HMO filtration depends on the quality of the raw water. High concentrations of iron can compete with radium ions and oxidization pretreatment with chlorine may be required. This process will also require intermediate operator skills as the HMO additions must be dosed cautiously. Excess HMO can clog the filter media while insufficient HMO will decrease removal efficiency. Although HMO filtration is not considered a BAT by the EPA, it still approves the technology for radium removal since it has shown to effectively reduce concentrations to meet the MCL standard. Utilizing HMO in addition to filtration can be up to 90% effective and is highly considered for facilities that already have a filtration system implemented where the HMO solution can easily be added to the process.

As part of the treatment process, approximately 4% of the forward flow is discharged as backwash. The backwash from the HMO process contains a small amount of the co-precipitated HMO slurry which contains the removed radionuclides. This will be treated by the WWTP and removed from the plant by the solids handling & dewatering process.

The HMO process is relatively simple, and only requires chemical addition and filtration. This process is also very similar to the technology implemented by WRT. The City is currently in the process of bringing the Well #7 WTP online, which utilizes an HMO filtration process.



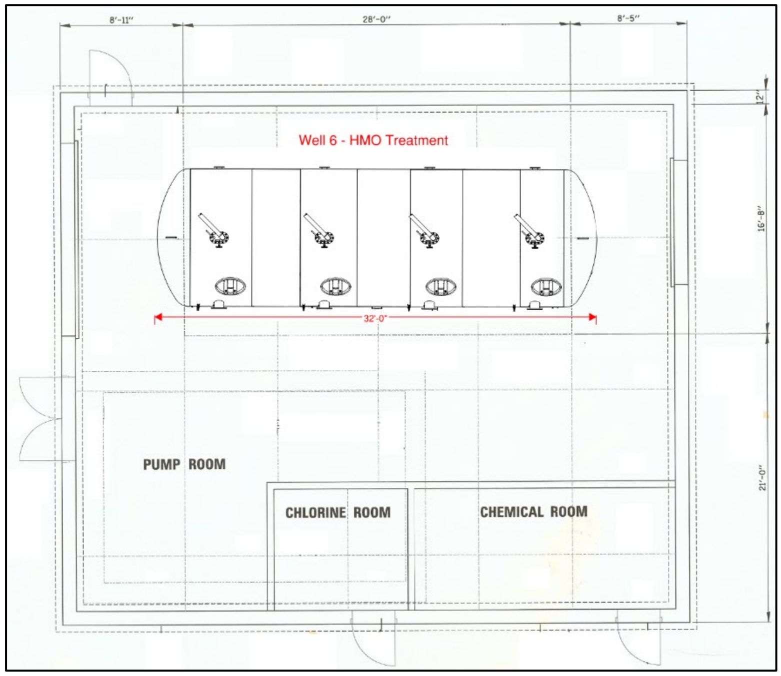
6.2.3 Radium Removal Alternatives – Existing Facilities

Due to the operational costs and the City's reliance on Water Remediation Technology for treatment, it was determined that each well should be reviewed for retrofitting/rehabilitation with a new radium removal technology. As identified in Section 6.2, although several options are available to the City, the recommended alternative radium removal technology was found to be Hydrous Manganese Oxide (HMO) Filtration. This is primarily due to the simplicity of the system, and the fact that the technology could be installed in the existing buildings for most of the well sites. As part of the analysis, each well was reviewed in terms of space available for the new technology within the existing structure, as well as the costs associated with the equipment in terms of the initial capital investment and the 20-year O&M costs.

The following analysis and estimates are built around each of the WRT systems being decommissioned at Well's #6, 8, 9, 10 and the construction of a new HMO treatment process at each location. Well #7 was not reviewed as the new Radium Removal Improvements Project will be online and operational. It is unlikely that new treatment processes could be installed within the existing buildings to replace the WRT systems by the current lease expiration in 2027, and as such the City may elect to negotiate either a short-term or long-term contract with WRT based on the anticipated 2027 lease terms.

The proposed systems have been preliminarily designed to meet the current IEPA regulations of maintaining a filter loading rate of 4 gpm/sf. However, as part of the treatment process, a cell within the proposed pressure vessel has the potential to go into backwash during regular operation. At that point, the effective surface area would be reduced, and the loading rate would increase. Therefore, it is recommended that the system be designed for 3.0 gpm/sf to account for the backwashing of the media and to maintain the 4gpm/sf loading rate during a backwash condition. This will ensure that the City is providing not only a high-quality product to its customers, but it will also ensure that each system is compliant with the outlined rules and regulations.

Well #6 - HMO Filtration



Well #6 is the oldest operating Well in the system and is located on Maertz Drive, near the center of the City, and was originally drilled in 1970. The existing well house has a large footprint, as well as large overhead doors and headroom for removal and replacement of equipment. Well #6 was evaluated for the installation of a new HMO filtration system that would be housed within the existing facility's structure.

The HMO system would consist of the addition of a single cylindrical horizontal pressure filter that is anticipated to be 12 ft in diameter and 32 ft long (shown on the right). The existing building has a 14-foot overhead door that would allow for the new filter to be brought in without significant modifications. In addition, the existing building is approximately 43 feet long, and therefore each side of the filter would have a minimum of 4 feet clear space around the entire system. This clear space would allow for influent and effluent piping to be installed, as well as space for typical operation and maintenance procedures.

Overall, the existing treatment facility structure is in good condition, and only requires minor modifications and alterations. In addition to the HMO filter, the project also includes chemical feed equipment for the HMO process, electrical upgrades, as well as additional SCADA and Controls.

The overall estimated construction cost is approximately $3.4M and the recommended project budget is $3.9M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility and the potential improvements are located below.

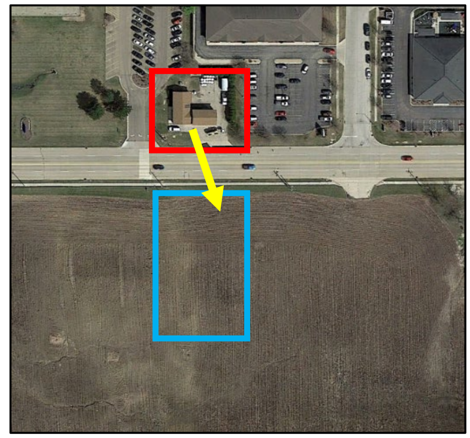
Well #6 Radium Removal - HMO	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$527,390
Site Work	$19,250
HMO Filter	$1,915,000
Electrical/SCADA/I&C	$369,000
Construction Sub-Total	**$2,830,640**
Contingency @ 20%	$566,128
Engineering & Administration @ 15%	$509,515
PROBABLE PROJECT COST:	**$3,906,283**

The operational costs of the HMO process are minimal, and only requires a small amount of chemical addition to the raw water. It is anticipated that the proposed facility would use approximately four gallons of a solution of manganese sulfate and sodium permanganate per day to create approximately 73 gallons of HMO slurry. There is also a minimal amount of additional power consumption for this equipment, which includes a blower for backwashing and the chemical feed pumps. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 8 hours per week.

The proposed HMO equipment also requires media exchanges throughout its service life, it is anticipated that this exchange would occur once every 10 years. It is anticipated that the cost per cubic yard for removal and replacement of the material is $200/cy, and the cost was spread out over 10-years. This results in annual O&M of approximately $41,000, or $0.07 per 1,000 gallons produced. This O&M cost excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

Well #6 HMO – Operation and Maintenance Costs				
Chemical	**Daily Usage**		**Cost/Unit**	**Annual Cost**
Manganese Sulfate (29.4% Solution)	0.98	gallons	$ 7.12	$ 2,552.20
Sodium Permanganate (20% Solution)	1.35	gallons	$ 22.70	$ 11,164.61
			Total Annual Chemical Cost:	$ 13,716.81
Power	**Daily Usage**		**Cost/Unit**	**Annual Cost**
Blowers	143	kW	$ 0.14	$ 7,316.21
Chem Feed Pump	1	kW	$ 0.14	$ 76.21
			Total Annual Power Cost:	$ 7,392.42
Labor	**Hours per Week**		**Cost/Hour**	**Annual Cost**
Operations	8	Hours	$ 40.00	$ 16,640.00
			Total Annual Labor Cost:	$ 16,640.00
Media Exchange	**Volume**		**Cost/Cy**	**Annual Cost**
HMO Media - 10-year Replacement	148	CY	$ 200.00	$ 2,960.00
			Total Media Waste Stream Cost:	$ 2,960.00
			Total Annual O&M Cost:	**$ 40,709.23**
			Cost per Thousand Gallons:	**$ 0.07**

Well #8 – HMO Filtration



In the southeast region of the City, Well #8 is located near the intersection of Bethany Road and Mediterranean Drive, just west of Peace Road. Within the existing site, there is a single building which incorporates the existing treatment facility, generator, as well as the Well, and chemical feed equipment. The existing facility is not sufficient in size for the addition of a new HMO pressure filter and therefore the building would need to be expanded. However, the existing site is likely too small (0.25 acres) and is bounded on all sides (shown in red).

In order to construct and install the improvements at Well #8, the City would need to purchase additional land and construct a new building and treatment facility at that location. As stated previously, the existing site is landlocked on all sides, however directly south of the existing facility, across Bethany Road is an open field that could be purchased (shown in blue). The additional land is 0.5 acres in size and could house the new treatment facility. Alternatively, the City could utilize this location or a similar location for both the treatment facility and the water tower as identified in Section 6.1.1.

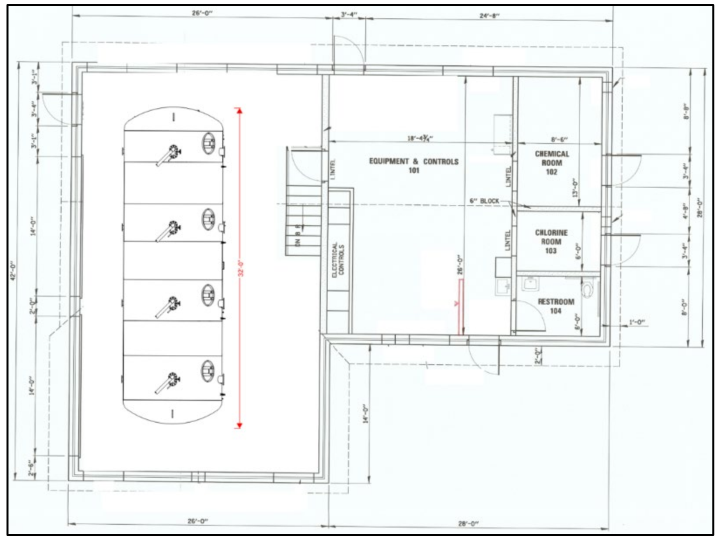
This project includes the purchase and development of the land directly to the south of the existing site with a new treatment building. The new building would be approximately 40 feet by 60 feet long and would house a new HMO Pressure Filter that is 12 feet in diameter, and 32 feet long. The existing building would be maintained and would house all electrical gear, and emergency power, as well as the existing well.

The overall estimated construction cost is approximately \$6.4M and the recommended project budget is \$7.4M, which includes engineering and contingencies. This results in an annual O&M cost of approximately \$44,000, or \$0.08 per 1,000 gallons produced. A conceptual cost estimate for construction of this facility is included below and O&M costs on the following page.

Well #8 Radium Removal - HMO	
Description	Total Probable Cost
SUMMARY	
General Conditions	$864,380
Site Work	$282,500
Well #8 Addition	$1,900,000
HMO Filter	$1,915,000
Electrical/SCADA/I&C	$414,000
Construction Sub-Total	**$5,375,880**
Contingency @ 20%	$1,075,176
Engineering & Administration @ 15%	$967,658
PROBABLE PROJECT COST:	**$7,418,714**

Well #8 HMO – Operation and Maintenance Costs						
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (29.4% Solution)	1.24	gallons	$	7.12	$	3,232.78
Sodium Permanganate (20% Solution)	1.71	gallons	$	22.70	$	14,141.84
			Total Annual Chemical Cost:		$	17,374.62
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.14	$	7,316.21
Chem Feed Pump	1	kW	$	0.14	$	76.21
			Total Annual Power Cost:		$	7,392.42
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	8	Hours	$	40.00	$	16,640.00
			Total Annual Labor Cost:		$	16,640.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	148	CY	$	200.00	$	2,960.00
			Total Media Waste Stream Cost:		$	2,960.00
			Total Annual O&M Cost:		**$**	**44,367.04**
			Cost per Thousand Gallons:		**$**	**0.08**

Well #9 – HMO Filtration



Well #9 is located in the far eastern part of town, west of Airport Road, and just north of Hillside Road, and has the largest capacity out of all the four wells. This facility was constructed in 2007, and is divided into two main areas, one with the WRT treatment equipment, and the other as a lab/electrical/control room. The existing well is located within the yard, on the north side of the facility.

The proposed improvements for Well #9 include converting the existing facility to the HMO process (shown on the right), which includes a vessel that is anticipated to be 12 feet in diameter and 32 feet in length. As part of the proposed project, the existing building would need to be modified to allow for the installation of the new equipment. A new 14-foot overhead door would need to be installed on the south side of the facility, within a small addition to allow access around the proposed equipment. This clear space would allow for influent and effluent piping to be installed, as well as space for typical operation and maintenance procedures.

Overall, the existing treatment facility structure is in good condition, and only requires minor modifications and alterations. In addition to the HMO filter, the project also includes chemical feed equipment for the HMO process, electrical upgrades, as well as additional SCADA and Controls.

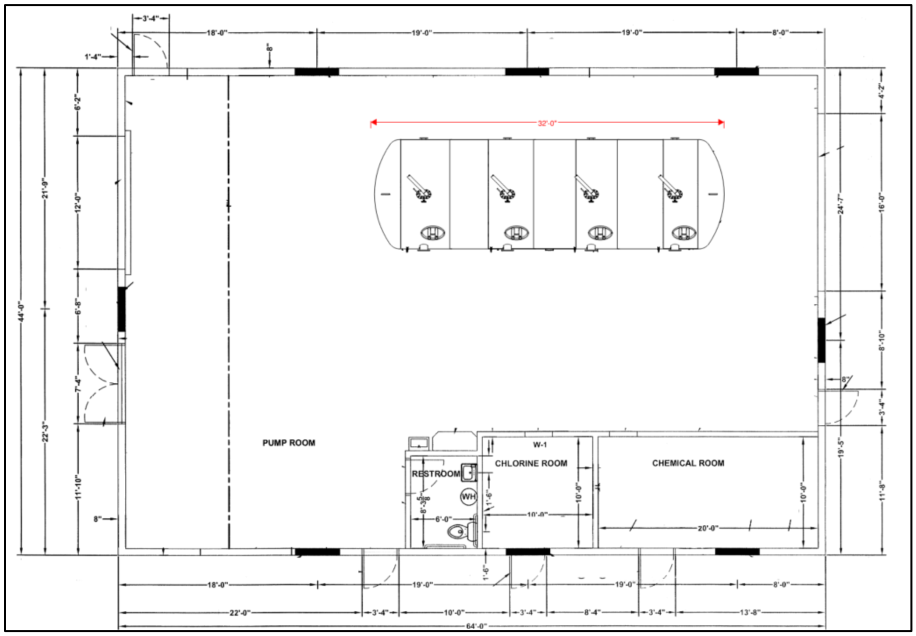
The estimated construction cost is $4.2M and the recommended project budget is $4.8M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility is included below and O&M costs on the following page.

Well #9 Radium Removal - HMO	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$661,580
Site Work	$80,000
Building Modifications	$382,500
HMO Filter	$1,915,000
Electrical/SCADA/I&C	$444,000
Construction Sub-Total	**$3,483,080**
Contingency @ 20%	$696,616
Engineering & Administration @ 15%	$626,954
PROBABLE PROJECT COST:	**$4,806,650**

Well #9 HMO – Operation and Maintenance Costs							
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (29.4% Solution)	1.09	gallons	$	7.12	$	2,835.77
Sodium Permanganate (20% Solution)	1.50	gallons	$	22.70	$	12,405.12
Total Annual Chemical Cost:					$	15,240.90
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.14	$	7,316.21
Chem Feed Pump	1	kW	$	0.14	$	76.21
Total Annual Power Cost:					$	7,392.42
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	8	Hours	$	40.00	$	16,640.00
Total Annual Labor Cost:					$	16,640.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	148	CY	$	200.00	$	2,960.00
Total Media Waste Stream Cost:					$	2,960.00
Total Annual O&M Cost:					**$**	**42,233.32**
Cost per Thousand Gallons:					**$**	**0.08**

Well #10 – HMO Filtration

Well #10 is the newest well and facility within the system and was constructed in 2014. The site includes a well, water treatment facility, as well as Tower #2. The existing facility is in very good condition and is roughly 64 feet by 44 feet. Due to the overall size, it is not anticipated that any modifications to the existing structure would be required to implement any future improvements or conversion to a new technology.



The proposed radium removal conversion consists of the installation on of a single HMO pressure filtration system. The vessel for Well #10 is estimated to be 12 feet in diameter and 32 feet in length (shown to the right) and should fit within the footprint of the existing WRT equipment.

Well #10 has an existing 16 ft x 16 ft overhead door that could be utilized for installing the equipment and minimizing the overall construction duration period. The existing piping could be modified to connect to the HMO equipment, and this Well could be quickly modified, and started up seamlessly. In addition to the equipment and piping costs, the project also includes minor modifications to the electrical and controls for integration of the new technology.

The estimated construction cost is $3.6M and the recommended project budget is $4.15M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility is included below and O&M costs on the following page.

Well #10 Radium Removal - HMO	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$610,370
Site Work	$26,750
HMO Filter	$1,915,000
Electrical/SCADA/I&C	$453,000
Construction Sub-Total	**$3,005,120**
Contingency @ 20%	$601,024
Engineering & Administration @ 15%	$540,922
PROBABLE PROJECT COST:	**$4,147,066**

Well #10 HMO – Operation and Maintenance Costs							
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (29.4% Solution)	1.09	gallons	$	7.12	$	2,835.77
Sodium Permanganate (20% Solution)	1.50	gallons	$	22.70	$	12,405.12
Total Annual Chemical Cost:					$	15,240.90
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.14	$	7,316.21
Chem Feed Pump	1	kW	$	0.14	$	76.21
Total Annual Power Cost:					$	7,392.42
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	8	Hours	$	40.00	$	16,640.00
Total Annual Labor Cost:					$	16,640.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	148	CY	$	200.00	$	2,960.00
Total Media Waste Stream Cost:					$	2,960.00
Total Annual O&M Cost:					**$**	**42,233.32**
Cost per Thousand Gallons:					**$**	**0.08**

6.2.4 Summary of Selected Alternatives

As identified, there are several different options for the City of Sycamore in terms of radium removal technologies that could be implemented at the existing water treatment facilities. Currently the City is utilizing an adsorption technology provided by WRT at Well's 6, 8, 9, and 10. The most appropriate alternative technology to WRT was identified as Hydrous Manganese Oxide (HMO) filtration which will be utilized at Well #7. Each of the City's existing wells were reviewed, and conceptual designs and costs were developed.

The table below provides a side by side comparison of the reviewed technologies for each facility, and their respective capital and O&M costs annually, as well as over a 20-year life. It should be noted that the capital costs developed for the WRT systems was developed by assuming that the City would be required to invest into the existing facilities again in 2027. Based on the previous contracts that were provided to the City, a capital investment in 2027 was determined through interpolation. It was assumed that in 2007 Well #6, #8, and #9 had a capital cost of approximately $750,000 each, or a total capital cost of $2.25M. This capital cost was calculated by converting the purchase price for Well #10 of $860,000 to 2007 dollars. In 2017 the City obtained an updated contract from WRT for outright purchasing of the equipment after 10 years of service. This purchase price in 2017 equated to $1.36M, and therefore the equipment was depreciated $0.90M over the 10 years from 2007. Assuming the same rate of depreciation for the next 10 years, the estimated capital cost for purchasing the equipment in 2027 would be around $450,000. However, this cost may vary if the depreciation is not linear as estimated, therefore the capital cost for 2027 could be range from approximately $450,000 to $900,000. A rehabilitation cost was also assumed for WRT if the existing systems were bought outright. Based on average lifespan, the WRT systems at Well 6, 8, and 9 would be recommended for rehabilitation by 2035 and Well 10 by 2040.

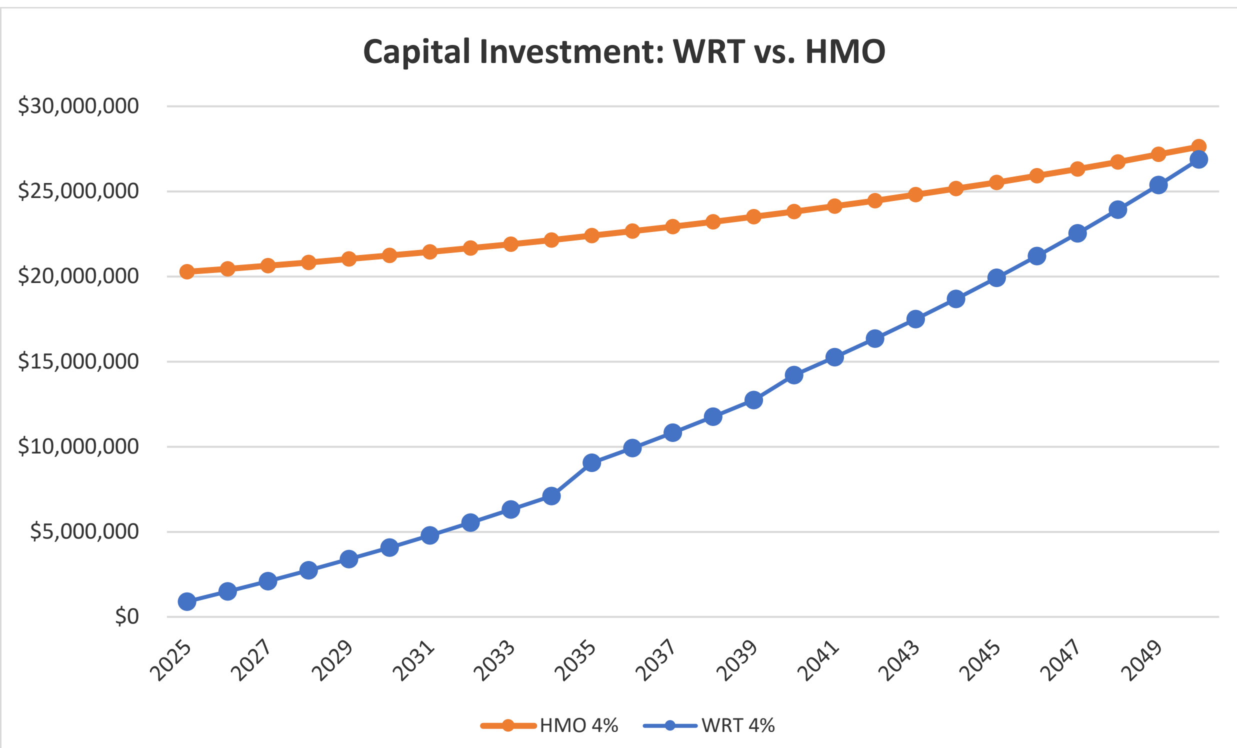
Each of the identified capital costs include the 20% conceptual contingency. Also, it should be noted that these estimated costs include engineering and legal/administrative, which is estimated at 15% of the construction total. The annual operating and maintenance costs for each facility are totalized over the 20 years cycle. The table allows for a direct comparison between the proposed conversion to HMO, as well as the maintaining the WRT systems, and the associated capital investment versus the 20-year O&M costs.

		Capital Cost	O&M Cost	20-Year O&M Costs	20-Year Present Value
Well #6	Alternative #1 - Convert to HMO	$3,906,283	$70,216	$1,404,326	$5,310,609
	Alternative #2 - Maintain WRT	$200,000	$482,497	$2,248,721	$2,818,782
Well #8	Alternative #1 - Convert to HMO	$7,418,714	$80,633	$1,612,666	$9,031,381
	Alternative #2 - Maintain WRT	$350,000	$186,264	$2,897,616	$3,617,677
Well #9	Alternative #1 - Convert to HMO	$4,806,650	$74,557	$1,491,134	$6,297,785
	Alternative #2 - Maintain WRT	$350,000	$173,561	$2,622,607	$3,342,668
Well #10	Alternative #1 - Convert to HMO	$4,147,066	$74,557	$1,491,134	$5,638,200
	Alternative #2 - Maintain WRT	$0	$162,042	$3,507,996	$3,958,232

In addition to comparing the two systems side by side from a capital investment and O&M standpoint, a breakeven analysis was also performed for the two selected alternatives. The breakeven analysis was used to identify the point in time (year) where the two systems would meet in the total overall investment required by the City. This review consisted of totaling both the initial capital costs for each system, as well as the annual operation and maintenance costs year over year.

When reviewing the O&M costs, it was assumed that each year the costs for both systems would increase at 4% annually to address inflation and operation costs (power, chemical, manpower, etc.). Initially maintaining the WRT system has a lower overall capital investment by the City ($0.90M). However, on average, the WRT system has a higher operation and maintenance cost associated with it and is shown by the slope in the blue line. In comparison to converting to HMO (identified in orange), the overall capital investment is much higher ($20.3M), and the overall O&M is lower on an annual average basis, a lower slope.

Therefore, by projecting the costs of the two systems out over several years, it can be anticipated that by 2050 the two systems would meet and "breakeven". Any subsequent years beyond that point, the conversion to HMO would be financially less expensive to own and operate as an alternative to maintaining the WRT systems at each facility. This equates to approximately a 30-year payback period for the City upon the initial investment.



6.3 Summary

Section 6 was broken down into three components: water storage, water supply, and water treatment alternatives. Following the recent completion of the Well #7 HMO WTP, the City is expected to have sufficient water capacity throughout the 20-year planning horizon, and as such additional water supply is not anticipated to be necessary. However, routine maintenance and replacement of components will still be necessary as identified within Section 5 and the Condition Assessment Tables.

The City may see a slight deficit in water storage capacity based on AWWA recommendations near the 10-year planning period. This could be mitigated through the installation of a new third tower while maintaining the existing Tower #1, or through the construction of a larger new tower on the south side of the service area and decommissioning of existing Tower #1. Because Tower #1 may approach its anticipated service life over the 20-year planning horizon of this study, it is anticipated that the long-term capital cost of constructing a new 1.0 MG tower and decommissioning Tower #1 would be less than construction of a new 500,000 gallon tower and replacement of Tower #1 several years later. It is recommended that the City begin reviewing alternative locations for a Tower #1 replacement, prioritizing areas near larger demands (commercial/industrial) and large diameter water main.

The existing water treatment facilities are generally in good condition with only minor rehabilitations expected over the next 5-10 years. However, the City's contract with WRT is expiring in 2027 and the City will need to make a decision with regard to the long-term water treatment path of the community. Conversion to HMO filtration at each of the facilities represents a significantly higher initial capital cost, but a lower operating and maintenance cost, and would retain control of operations within City staff. Therefore, the capital improvements plan in Section 7 outlines a potential timeline for conversion to HMO filtration for long-term water treatment.

Section 7

Recommendations and Summary

This Page Intentionally Left Blank

7. Recommendations and Summary

The City is responsible for providing a safe and reliable supply of water to more than 18,500 residents, as well as commercial, industrial, and municipal users. The preceding sections have described the planning area, the current and future capacity needs, the existing supply, storage, treatment, and distribution system infrastructure, and recommendations for improvements over the 20-year planning horizon.

As with most communities, Sycamore's water infrastructure has been constructed over decades, with existing equipment dating back to 1970 and water main constructed as far back as the 1920's. While the City has maintained the water system, capital investment will continue to be required to maintain this level of service. Additionally, capital projects focusing on regulatory compliance (radium removal), water quality (chlorine residual and age), and improved service (fire flows) were identified throughout Sections 3-6 of this report. These capital projects vary in scale and priority and must be scheduled carefully to meet the City's long-term water system goals.

The implementation plans on the following pages were developed in conjunction with City staff and aim to allocate capital projects according to the City's priorities and available funding. Discussion of available funding sources, including the State Revolving Fund (SRF) loan program are also included. While this report does not include a rate study, it is recommended that the City complete an analysis either internally or in conjunction with a third-party to determine the funding necessary to support the implementation plan. This rate study should focus on the existing base rate water charges and radium treatment fees, with a review of the meter maintenance fees. The City has several relatively unique rate structure features which should be considered when analyzing future revenue generation needs.

City staff and TAI identified several key projects that must be completed on schedule to maintain the overall integrity of the water system. These are included in the implementation plans on the following pages, and are listed chronologically below:

- 2025: Main Street, Lincoln, Locust, Chauncy & Park Water Main Replacement ($6.0M)
- 2025: North Grove School Water Main Connection ($570,000)
- 2026: California, Brickville & North Water Main Replacement ($2.53M)
- 2026: Begin Treatment System Evaluation & Design (WRT Contract Expires 2027)
- 2026 – 2030: Radium Removal Improvements – Maintain WRT ($0.9M) or HMO System ($20.3M)
- 2027: Electric Park Water Main Replacement ($2.75M)
- 2028: Sycamore High School Water Main Improvements ($1.27M)
- 2029: California, Blackhawk & Blumen Gardens Water Main Improvements ($1.47M)
- 2030: Bethany Road Water Main Replacement ($1.04M)
- 2031: Peace Road Water Main Improvements ($440,000)
- 2032 – 2045: Distribution System Projects (Goal of $4.83M Annually)
- 2035: Construct Tower #3 ($5.6M)

7.1 Implementation Plans

As identified in Section 6, the City will need to make a significant decision with regards to the future of radium removal within the water system. A number of alternative technologies for treatment were reviewed, and ultimately two main options identified. The City can either elect to maintain the WRT system and enter into a new agreement or construct HMO treatment facilities owned and operated by the City. The implementation plans below reflects the first alternative – maintaining the WRT systems. As discussed in Section 6, maintaining the WRT system will require a capital investment. The equipment will be 20 years in age at the next contract renewal (2027) and was estimated that the high end of the capital cost investment would be required for purchase of the existing equipment. For the four existing wells, this represents a total capital cost of approximately $0.9M.

Table 7-1: Alternative #1 Maintain WRT Treatment (Treatment & Storage Capital Plan)

	Fiscal Year Cash Flow ($ in Millions, 2025 Dollars)											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Project Total**
Well #6/8/9/10 - WRT Rehabilitation			0.90									***0.90***
Additional Elevated Tower (Tower #3)											5.60	***5.60***
Fiscal Year Total:	**0.00**	**0.00**	**0.90**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5.60**	***6.50***

Table 7-2: Alternative #1 Maintain WRT Treatment (Distribution Capital Plan)

	Fiscal Year Cash Flow ($ in Millions, 2025 Dollars)											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Project Total**
Main St, Lincoln, Locust & Park	6.00											***6.00***
North Grove School Connection*	0.57											***0.57***
California, Brickville & North	0.17	2.36										***2.53***
Electric Park		0.18	2.57									***2.75***
Sycamore High School*			0.09	1.18								***1.27***
California, Blackhawk & Blumen				0.10	1.37							***1.47***
Bethany Rd. (Rt. 23 to Health Club)					0.07	0.97						***1.04***
Peace Road						0.03	0.41					***0.44***
Annual Water Main Program								4.83	4.83	4.83	4.83	***19.32***
Fiscal Year Total:	**6.74**	**2.54**	**2.66**	**1.28**	**1.44**	**1.00**	**0.41**	**4.83**	**4.83**	**4.83**	**4.83**	**35.39**

* Reduced Cost Due to In-House Design and Construction

The second alternative available to the City for radium removal is conversion to hydrous manganese oxide (HMO) treatment. This would include replacement of the WRT equipment at Wells #6, 8, 9 & 10. It is anticipated that a new structure would need to be constructed at Well #8 to house the HMO equipment, and similarly an addition to the structure at Well #9. Since the City cannot have more than one treatment facility offline at a given time, conversion to HMO treatment would need to be phased. A service termination agreement would be negotiated with WRT, and the sites would be retrofitted one each year. This could be accomplished through individually bid contracts or a single larger contract spanning several years. While there would be economy of scale realized with a single contract, it may require more coordination between the City and selected Contractor.

Table 7-3: Alternative #2 Covert to HMO Treatment (Treatment & Storage Capital Plan)

		Fiscal Year Cash Flow ($ in Millions, 2025 Dollars)										
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Project Total**
Well #6 - HMO Conversion		0.25	3.65									***3.90***
Well #8 - HMO Conversion			0.50	6.90								***7.40***
Well #9 - HMO Conversion				0.30	4.50							***4.80***
Well #10 - HMO Conversion					0.26	3.90						***4.16***
New Elevated Tower (Tower #3)											5.60	***5.60***
Fiscal Year Total:	**0.00**	**0.25**	**4.15**	**7.20**	**4.76**	**3.90**	**0.00**	**0.00**	**0.00**	**0.00**	**5.60**	***25.86***

Table 7-4: Alternative #2 Convert to HMO Treatment (Distribution Capital Plan)

		Fiscal Year Cash Flow ($ in Millions, 2025 Dollars)										
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Project Total**
Main St, Lincoln, Locust & Park	6.00											***6.00***
North Grove School Connection*	0.57											***0.57***
California, Brickville & North	0.17	2.36										***2.53***
Electric Park		0.18	2.57									***2.75***
Sycamore High School*			0.09	1.18								***1.27***
California, Blackhawk & Blumen				0.10	1.37							***1.47***
Bethany Rd. (Rt. 23 to Health Club)					0.07	0.97						***1.04***
Peace Road						0.03	0.41					***0.44***
Annual Water Main Program								4.83	4.83	4.83	4.83	***19.32***
Fiscal Year Total:	**6.74**	**2.54**	**2.66**	**1.28**	**1.44**	**1.00**	**0.41**	**4.83**	**4.83**	**4.83**	**4.83**	**35.39**

* Reduced Cost Due to In-House Design and Construction

7.2 Capital Funding and Alternative Funding Sources

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

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.

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.

Existing SRF Debt Service & Retirement

The City has historically funded capital projects both locally, and through loan programs. Sycamore currently has three Illinois EPA SRF loans on the books in various amounts, with one additional expected to begin repayment this year for the Well #7 WTP. The City has annual debt repayments of $50,000 and $60,000 for improvements to Well #9 in 2005 via two separate loans, as well as $70,000 annual for a loan supporting the upfront cost of the WRT system installation in 2007 ($1.3M). Additionally, the Well #7 WTP loan repayments in the amount of approximately $230,000 annually will begin in 2025.

	Fiscal Year Debt Service ($ in Millions, 2025 Dollars)											
Project Description	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Project Total**
Well 9 - Part 1 (2003 IEPA Water)	0.05											***0.00***
Well 9 - Part 2 (2005 IEPA Water)	0.06	0.06	0.06									***0.12***
WRT System Installation (2006 IEPA Water)	0.07	0.07	0.07									***0.14***
Well #7 HMO WTP (2024 IEPA Water)	0.12	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	***2.30***
Fiscal Year Total:	**0.30**	**0.36**	**0.36**	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	***2.86***

Each of the original WRT loans have a 20-year life and are anticipated to be retired in 2025 and 2027. This retirement will result in the City being able to reallocate funds and revenues to future projects, and potentially future debt service if additional loans are procured.

Future Debt Service

If the City elected to fund the treatment rehabilitation through SRF loans, the annual debt repayments could be calculated as shown in the below two tables. Depending on the implementation of these projects the City could utilize one larger loan to fund multiple rehabilitations, or separate loans for each well facility. The table to the right illustrates the annual debt service associated with a loan for converting the remaining wells to HMO at a total amount of $20.3M. The corresponding annual debt repayment for this scenario is approximately $1.2M per year.

City of Sycamore - HMO Conversion
Debt Service Schedule

Loan Principal at 1st Payment:	**$20,300,000**
Interest Rate:	2.000%
Loan Term (years):	20
Annual Payment:	$1,241,481

Repayment Schedule:

Year	Beginning Principal Balance	Principal Payment	Interest Payment	Total Payment	Ending Principal Balance	Payment No.
2021	$20,300,000	$835,481	$406,000	$1,241,481	$19,464,519	1
2022	$19,464,519	$852,191	$389,290	$1,241,481	$18,612,328	2
2023	$18,612,328	$869,235	$372,247	$1,241,481	$17,743,093	3
2024	$17,743,093	$886,620	$354,862	$1,241,481	$16,856,473	4
2025	$16,856,473	$904,352	$337,129	$1,241,481	$15,952,121	5
2026	$15,952,121	$922,439	$319,042	$1,241,481	$15,029,682	6
2027	$15,029,682	$940,888	$300,594	$1,241,481	$14,088,795	7
2028	$14,088,795	$959,705	$281,776	$1,241,481	$13,129,089	8
2029	$13,129,089	$978,900	$262,582	$1,241,481	$12,150,190	9
2030	$12,150,190	$998,478	$243,004	$1,241,481	$11,151,712	10
2031	$11,151,712	$1,018,447	$223,034	$1,241,481	$10,133,265	11
2032	$10,133,265	$1,038,816	$202,665	$1,241,481	$9,094,449	12
2033	$9,094,449	$1,059,592	$181,889	$1,241,481	$8,034,856	13
2034	$8,034,856	$1,080,784	$160,697	$1,241,481	$6,954,072	14
2035	$6,954,072	$1,102,400	$139,081	$1,241,481	$5,851,672	15
2036	$5,851,672	$1,124,448	$117,033	$1,241,481	$4,727,224	16
2037	$4,727,224	$1,146,937	$94,544	$1,241,481	$3,580,287	17
2038	$3,580,287	$1,169,876	$71,606	$1,241,481	$2,410,412	18
2039	$2,410,412	$1,193,273	$48,208	$1,241,481	$1,217,139	19
2040	$1,217,139	$1,217,139	$24,343	$1,241,481	$0	20

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 any further. The most applicable grant for communities such as the City 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 rehabilitation 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.

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.

7.3 Recommended Funding for Capital Projects

A number of capital improvement projects have been identified as necessary for the continued operation and maintenance of the City's water system, which range significantly in scale. The City has historically funded smaller capital improvement projects locally utilizing available funding. Based on the evaluations in Sections 3 & 4, the City should be working towards an annual funding level goal of approximately $4.83M in annual distribution system replacement. If the City targeted a 100-year replacement period instead, it reduces the annual funding level to $3.62M, however this may exceed AWWA estimates for water main service life. Because this is an on-going program it is recommended that these projects be funded locally through water revenues.

In addition to the distribution system rehabilitation, several storage and treatment capital projects have been slated for implementation. These include the long-term construction of Tower #3 ($5.6M), as well as either rehabilitating the existing WRT systems ($0.9M) or conversion to City-wide HMO ($20.3M) at the remaining wells. It is recommended that the City consider funding these projects through the Illinois EPA's SRF low-interest loan program. The current interest rate is under 2.0%, lower than typical bonding interest rates. Additionally, the debt service for the SRF loans could be accommodated through user rate increases, rather than property tax increases often used for funding General Obligation Bonds.

As previously discussed, it is recommended that a rate study or analysis be performed to ensure that the City's future rate structures are adequate to support the community's long-term needs. Much of the capital requirements over the next 10 years depends on the whether the City elects to maintain the WRT radium removal processes or convert to facilities owned and operated by the City. To determine terms of a subsequent WRT contract, the City should begin discussions with WRT in the near future.

This Page Intentionally Left Blank

City of Sycamore

City of Sycamore

Experienced Professionals – Better Solutions

TROTTER and ASSOCIATES, INC.
ENGINEERS AND SURVEYORS

St. Charles, IL • Fox Lake, IL • Lake Geneva, WI
630.587.0470 • www.trotter-inc.com