Planning Report

Baxter Water System Planning and Hydraulic Model

Baxter, Minnesota

BAXTE 178474 | November 22, 2024

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SEH No. BAXTE 178474

November 22, 2024

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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Date: November 22, 2024 License No.: 46613

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Prepared for City of Baxter

1 Introduction

This report summarizes the recent work completed for the City of Baxter to update and utilize the City's water system hydraulic model. In addition, other water system planning elements were re-assessed to provide a foundation for making future water system planning decisions. The City of Baxter's hydraulic water distribution system model was last revised in 2009-2010. This comprehensive update involved collecting and integrating current data, adjusting the model to reflect the city's expanded water system, and verifying its accuracy through extensive field testing. The updated model now accurately represents the current conditions and performance of the water system, providing a reliable tool for future system planning and operational analysis.

Additionally, the updated model was used to evaluate the overall performance of the water system and to evaluate specific system changes that may be necessary such as at the intersection of TH 210 and TH 371 where a potential interchange may be built. The use of the model helps to ensure the system's readiness for accommodating current water customers and for future growth. In addition, water use projections were updated and overall water system vision mapping was developed to guide future water system planning decisions.

1.1 Scope

This report began with an analysis of community development and growth including population, and existing and future land uses in Section 2.1. Section 2.2 covers water consumption projections, which serve as the foundation for evaluating and identifying recommended improvements to the system. The assumptions and conclusions presented in Section 2.1 were used to develop projections of water requirements that are presented in Section 2.2. Section 3 discusses the update of the hydraulic water model and the predictions it demonstrates for 2045 and the ultimate system build-out. Section 4 covers the Highway 210 & 371 Interchange project, its effect on the water system, and recommended improvements to accommodate this infrastructure expansion. Section 5 summarizes the evaluation of the water system and the recommended system improvements. Below is a summary of the outlined scope items that this report intends to address.

1. **Water Model Update** – Calibrate water model and utilize the model to demonstrate present and future scenarios to assist City planning efforts.
2. **Water Demand Analysis and Projections** – Model water demand projections based on population projects and predicted future land use.
3. **Trunk Highway 210/371 Trunk Water Main Changes** – Utilize the model to recommend improvements to maintain desired system operations as major changes are expected at the intersection of trunk highways 210 and 371.

4. **Ultimate Water System Planning** – Provide system recommendations to enhance system performance and plan for adequate infrastructure growth to accommodate the projected growth.

Because needs change over time, municipal water system planning is a continuous process. Therefore, the longer-term projections and improvements discussed in this report should be reviewed, re-evaluated, and modified as necessary, to assure the adequacy of future planning efforts. Proper future planning will assure system expansion is coordinate and constructed in a most effective manner.

1.1.1 Background

The City of Baxter provides water to its customers via four (4) groundwater wells, located adjacent to the water treatment plant on Mapleton Road. The City of Baxter includes four (4) wells, three (3) elevated storage tanks, and one (1) water treatment plant with a clearwell. The City of Baxter maintains over 416 miles of transmission and distribution water mains including ductile iron pipe (DIP), polyvinyl chloride (PVC), and high-density polyethylene (HDPE) and sizes up to 24 inches in diameter. The system uses one pressure zone.

The City of Baxter is adjacent to Brainerd and in one of the few non-metro counties which is projected to have significant population increase and growth potential. Therefore, strategic planning is crucial to align the expansion of municipal water system facilities with both short-term and long-term community needs. To anticipate the rising population and water demand, the City of Baxter is updating their long-range planning documents for the water system. This report summarizes the findings of the water system hydraulic model update and therefore, the future system demands and infrastructure needs. The study's primary objectives were to update the hydraulic model and assess water needs and system expansion required to serve current and future City customers.

New population projections and anticipated land use maps have been developed. This study evaluates the current and future water needs of the City of Baxter system and recommends necessary improvements to maintain adequate water service. This report covers a planning period extending to 2045 and an ultimate system build-out. This report will guide the future expansion and redevelopment of the water system.

The table below provides a history of water system facility construction.

Table 1 – City of Baxter Water System Facility Construction Timeline

Year	Facility	Type	Status	Notes
2007	Well No. 1R	Supply	Active	700 gpm
2007	Well No. 2R	Supply	Active	700 gpm
2007	Well No. 3R	Supply	Active	700 gpm
2007	Well No. 4R	Supply	Active	700 gpm
1997	North Tower	Storage	Active	750,000 gallons
2012	East Tower	Storage	Active	1.250,000 gallons
1977	South Tower	Storage	Active	400,000 gallons
2007	Clearwell (WTP)	Storage	Active	300,000 gallons

Year	Facility	Type	Status	Notes
2007	Interconnect Building	Supply	Active/Inactive	Active during construction activities requiring WTP/wells be out of service
2007	Water Treatment Plant	Treatment	Active	-

Source: City of Baxter Records

1.2 Existing Water System

The City of Baxter water system's first well was constructed in 19XX. The original well and small water main system continued to grow and extend out as the community grew. The table above shows a history of the expansion and growth of the City of Baxter water system. The water system has grown to include four (4) water storage tanks, four (4) groundwater supply wells, an interconnect building, and a water treatment plant.

1.2.1 Supply

Table 2 lists the City of Baxter's groundwater supply wells. The City of Baxter receives water from wells located adjacent to the water treatment plant on Mapleton Road. Water is accessed from an unconfined sand and gravel aquifer.

The City of Baxter will be provided with a memorandum regarding well explorations that have occurred in 2024. This will provide information on the stratigraphy and existing water presence at various boring locations to assist planning for future well locations, some of which are currently in design.

Table 2 – Existing Well Facilities

MN Unique Well ID #	Facility	Year Installed	Capacity (gpm)	Operational Capacity* (gpm)	Well Depth (ft)	Status
752207	Well No. 1R	2007	700	700	140.0	Active
741694	Well No. 2R	2006	700	600	150.0	Active
733068	Well No. 3R	2006	700	500	145.0	Active
752208	Well No. 4R	2007	700	700	150.0	Active

Source: City of Baxter Records, SEH Recommendation

**Recommended operational capacity to maintain a drawdown around or less than 60 feet from ground surface elevation.*

1.2.1.1 Water Pumpage

Historical water pumping data for the City of Baxter's water supply wells is summarized in the table below.

Table 3 – Recent Historical Water Pumpage

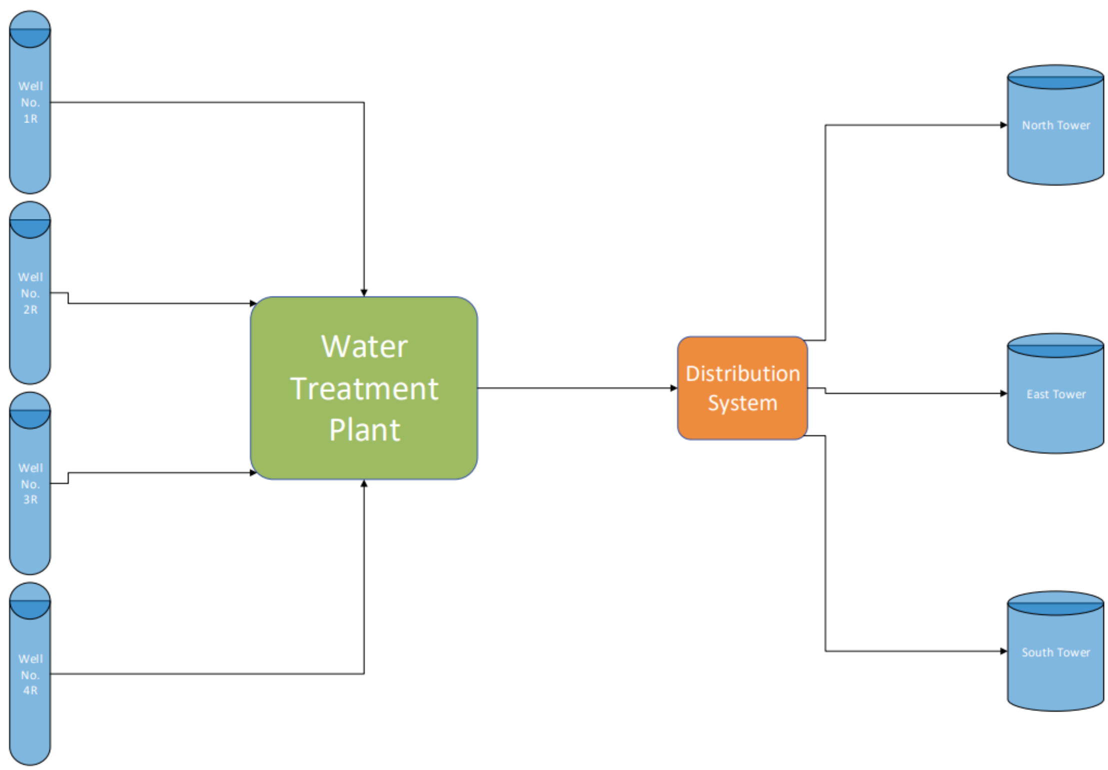
Well No.	2021*		2022		2023	
	Total	% of Total	Total	% of Total	Total	% of Total
1R	7,184,030	22.6%	50,189,915	17.5%	90,262,246	19.5%
2R	6,461,229	20.3%	58,838,965	20.5%	118,328,53	27.1%
3R	8,243,221	26.0%	118,543,09	41.3%	148,363,43	32.0%
4R	9,875,609	31.1%	59,431,750	20.7%	106,184,05	22.9%
Total	**31,764,089**		**287,003,723**		**463,138,274**	

Source: MPARS

**The WTP was under construction in 2021, and the City of Baxter bought water from the City of Brainerd for this duration.*

1.2.2 Treatment

The City of Baxter utilizes a gravity filtration plant that is supplied directly from the wells. The water is then pumped from the clearwell into the distribution system and water towers.



1.2.3 Storage

Water storage tanks play a significant role in the operation of the water system by sustaining pressure and supplying water when needed, particularly during high demand summary days.

Three elevated tanks and one ground level reservoir provide distribution storage for the City of Baxter water system. These facilities are noted in the table below.

Table 4 – Existing Water Storage Facilities

Structure Name	Type of Structure	Year Constructed	Primary Material	Storage Capacity (Gallons)
North Tower	Elevated	1997	Steel	750,000
East Tower	Elevated	2012	Steel	1,250,000
South Tower	Elevated	1977	Steel	400,000

Source: City of Baxter Records

The Clearwell at the water treatment plant is considered operational storage and is excluded from the total water storage facility capacity.

1.2.4 Distribution

The water distribution system provides a means of transporting and distributing water from the supply sources to customers and other points of usage. The distribution system must be capable of supplying adequate quantities of water at reasonable pressures throughout the service area under a range of operating conditions. Furthermore, the distribution system must be able to provide not only uniform distribution of water during normal and peak demand conditions but must also be capable of delivering adequate water supply for fire protection purposes.

The City of Baxter water system is comprised of approximately 416 miles of water main ranging in size up to 24 inches in diameter as illustrated in Appendix C. The current water main size inventory is summarized in the table below. Of the 416 miles of water main 61% is 12 inches in diameter or larger which represent transmission mains in the system. Transmission water mains work to deliver large flows across the water system from the supply source, out to and from water storage facilities. The presence of large water main, as exists in the City of Baxter water system, supports the ability of the water system to transmit large system flows.

Table 5 – Existing Water System Piping

Pipe Size (inches)	Percent of Total (%)	Length (feet)	Length (Miles)
4 or less	0.05%	1,020	0.2
6	4.1%	90,520	17.1
8	14.4%	315,956	59.8
10	19.6%	429,857	81.4
12	24.4%	536,117	101.5
14	20.4%	448,739	85.0
16	10.6%	232,221	44.0
18	5.7%	124,272	23.5
24	0.8%	17,675	3.3
Total	**100%**	**2,196,377**	**416.0**

Source: Water Model Export

2 Water Needs Analysis

2.1 Population and Community Growth

This section summarizes the planning assumptions made regarding future service area characteristics for the City of Baxter's water service. Below is a summary of the newest data which will be utilized for this report.

2.1.1 Population Forecast

There is generally a close relationship between a community's population and total water consumption volume. Future water sales can be expected to generally reflect future changes in service area population. Similarly, commercial, public, and industrial water consumption will also tend to vary proportionally with the growth of the community. For purposes of this analysis, it is important to understand historical population trends and develop realistic future projections.

The City's estimated population in 2023 was 9,092 according to the State of Minnesota Demographers. The table below summarizes historical population of the City as provided by the US Census bureau and the State Demographer.

Table 6 – Historical Population Data

Year	Population	Average Annual Growth Rate %
1950	310	3.1%
1960	450	2.5%
1970	600	5.0%
1980	1200	6.7%
1990	3619	3.6%
2000	5,698	2.5%
2010	7,610	1.2%
2020	8,640	0.5%
2023	9,092	1.7%

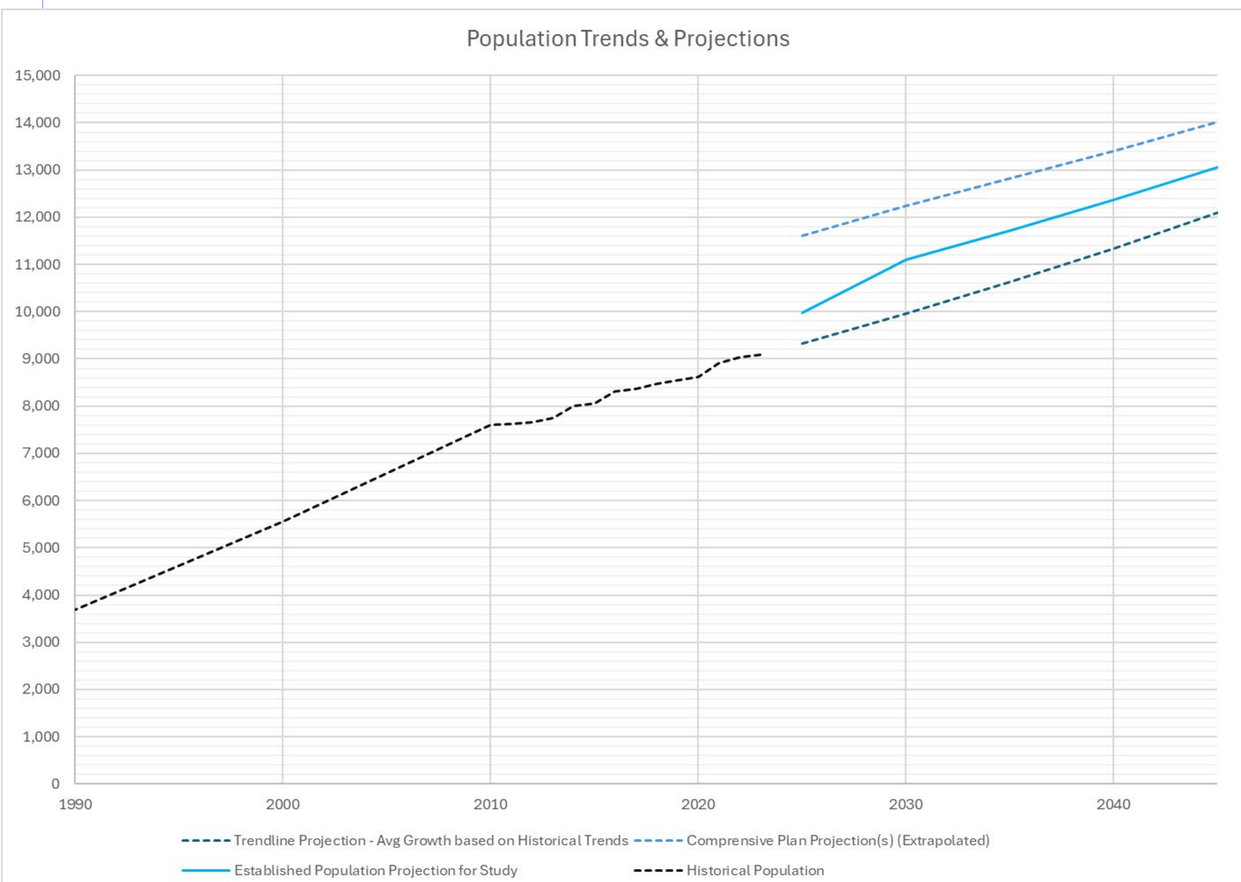
Source: Us Census & MN State Demographer

The City of Baxter has experienced significant population growth over the previous four decades and in recent years, continued growth has resulted in elevated water consumption. The table above summarizes past trends, and the table below represents estimated population projections for the City. Future population estimates are based on the historical growth rate (Average Projection) and the City's Comprehensive Plan through 2035 (Maximum Projection).

Table 7 – Projected Population Data

Year	Selected Population Projection	Annual Average Growth Rate
2025	9,969	2.0%
2030	11,105	1.1%
2035	11,721	1.1%
2040	12,373	1.1%
2045	13,063	1.1%

Source: City of Baxter Comprehensive Plan & Population Trend Data



Projections noted above indicates the City of Baxter's service area total population has the potential to increase to approximately 13,000 people by the year 2045. This estimate was developed by extrapolating the City's comprehensive plan population projection for 2035 and averaging the population estimate with recent growth trends.

This estimate includes areas of the City expected for expansion as cited in the comprehensive plan. For this report, in calculation per capita water use, it is estimated that approximately 8-10% of the existing population base is served by private wells. It is assumed that as the boundaries of the City grow and rural areas are annexed, a percentage of residents (4%) may remain on private wells throughout the planning period but many other existing well users in older neighborhoods will be added to the water system as sewer and water is extended into existing neighborhoods. As a result, the percentage of the population served by the water system is expected to increase

2.1.2 Land Use Considerations

For this study, existing City land use data and land use projections were reviewed. The Land use map included in Appendix B illustrates current land use and represents the nature and extent of existing development within the City, future growth, and land use. The City's existing land use is a diverse mix of historical development patterns flanked by commercial, industrial, and residential developments.

Analyzing Existing Water Use: The current land use, which reflects how the land is actually being used (not just how it is zoned), will help in understanding the existing water consumption patterns. For example, residential areas, commercial corridors, and industrial zones each have different water usage profiles.

Projecting Future Water Demand: By examining the development trends and potential changes in land use, such as the expansion of commercial areas along Highway 371 or the utilization of existing residential lots, future water demand can be projected. This includes considering how the community's vision for land use, as expressed through zoning and planning, will shape future development and water needs.

In summary, understanding both the current and planned land use will allow for an accurate analysis of existing water use and informed projections of future water demand based on anticipated land development.

2.1.3 Water Service Area

The extend of this report includes the existing water service area and potential annexation areas as defined in the land use planning map (See Appendix A). The water system will be discussed in more detail in Section 5. Most of the land within existing City limits is served by water main with the exception of a few undeveloped areas. The water system is first expected to grow in the existing high-density areas, with the potential for additional growth/annexation in the north.

2.2 Water Requirements

This section updates water use history with current information and provides new water use projections based on new population data.

2.2.1 Water Consumption History

An analysis was made of past water consumption characteristics by reviewing annual pumpage and water sales records. Average and maximum day water consumption for both summer and winter months was analyzed with the amount of water sold. Projections of future requirements are based on the results of this analysis, coupled with estimates of population and community growth. A summary of key historical water use parameters are included in Appendix A. Overall yearly water use is summarized in Table 8 below.

Table 8 – Historical Water Use Summary

Year	City Population	Average Day (AD) Water Pumped/Sup. (MGD)	Maximum Day (MD) Water Pumped/Sup. (MGD)	MD:AD Ratio	Estimated Average Summer Day Water Use (MGD)
2005	7,219	0.77	1.13	1.47	1.46
2006	7,594	1.08	0.98	0.90	2.06
2007	7,758	1.09	1.02	0.93	2.07
2008	7,827	1.05	1.05	1.00	2.00
2009	7,921	1.03	2.01	1.96	1.95
2010	7,610	0.93	1.47	1.58	1.77
2011	7,620	0.92	0.93	1.01	1.75
2012	7,661	0.94	1.00	1.06	1.79
2013	7,747	0.97	1.90	1.96	1.84
2014	8,002	0.94	1.90	2.03	1.78
2015	8,065	0.99	1.90	1.92	1.88
2016	8,318	1.05	1.91	1.82	1.99
2017	8,360	1.02	2.11	2.06	1.95
2018	8,478	1.05	2.64	2.52	1.99
2019	8,555	0.97	2.20	2.26	1.85
2020	8,612	0.97	2.06	2.13	1.84
2021	8,911	0.98	2.03	2.06	1.87
2022	9,030	1.00	1.99	1.98	1.91
2023	9,092	1.27	2.87	**2.26**	2.41
	Maximum	**1.27**	**2.87**	**2.52**	**2.41**

Source: City of Baxter Records

2.2.2 Water Consumption and Pumpage Projections

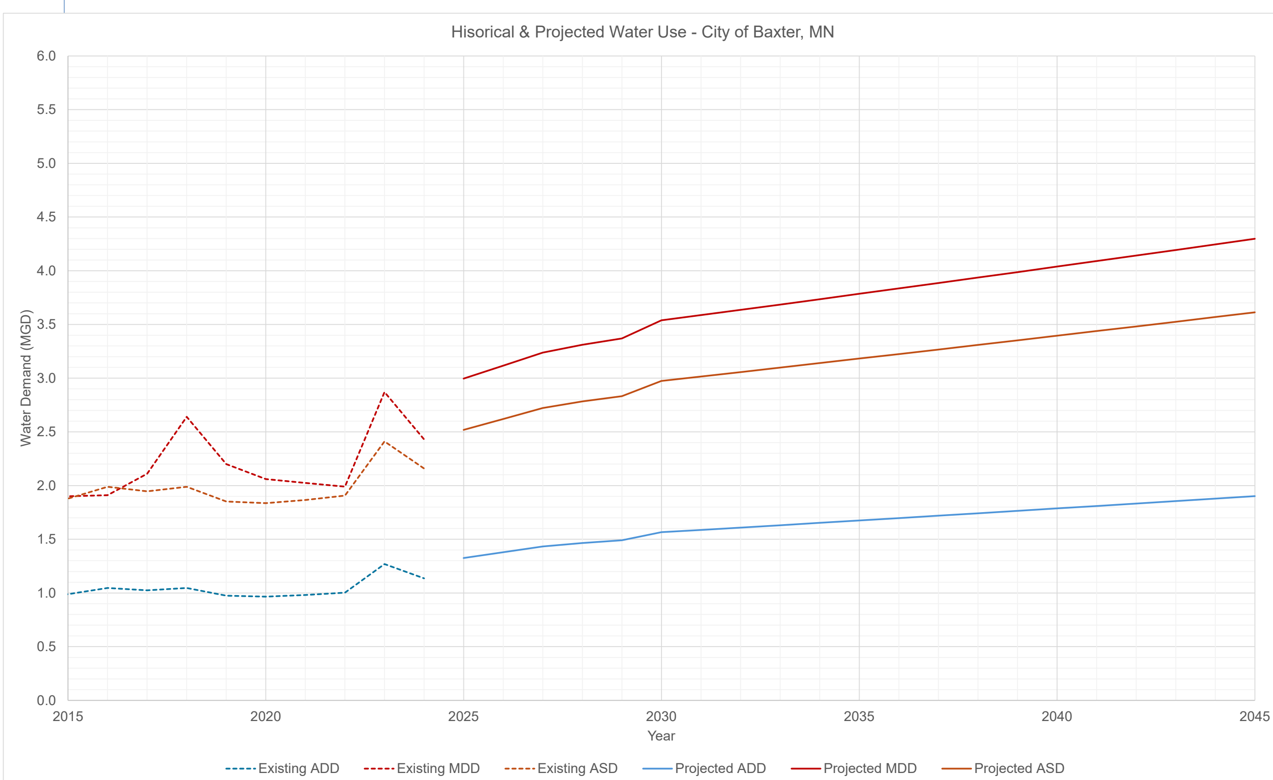
Population growth, development, customer water needs, conservation, and climate all affect future water needs. This section provides a projection of water needs to the year 2045 and ultimate system buildout based on these factors. Projections are based on anticipated population growth and conversation, as well as on buildout of all service areas, which represents ultimate water system demand potential. For purposes of this analysis, two different water use estimates will be developed. This first estimate will be a growth trend projection based on anticipated population growth with per capita water consumption averages applied to the growth projections. This estimate will help to establish water demand estimates on a yearly basis. The other projection method will be land use based and will help determine the ultimate water demand that could become a reality.

2.2.3 Projected Water Use by Population

The table below summarizes the population-based water needs projections for current water use. Various demand analysis in Appendix A analyzed historical water use according to population. Since overall water use can be greatly impacted by weather, special attention to recent dry/hot years were considered. 2023 was an especially dry year and also represents current water use trends. During 2023, average per capita water use was found to be 56.5 gallons per person per day and total water use across the system (including commercial and industrial use) was found to be 153.4 gallons per person per day. In addition, the recent ratio of maximum day to average day water use of 2.26 was used to establish projected Maximum day water use. These factors were then considered and applied to the population growth projections. It should be noted that with the assumptions shown in the table represent an estimate of water use potential, actual water use will be driven by numerous factors including weather and precipitation. By 2045 the City of Baxter could experience a maximum day demand of 4.3 MGD.

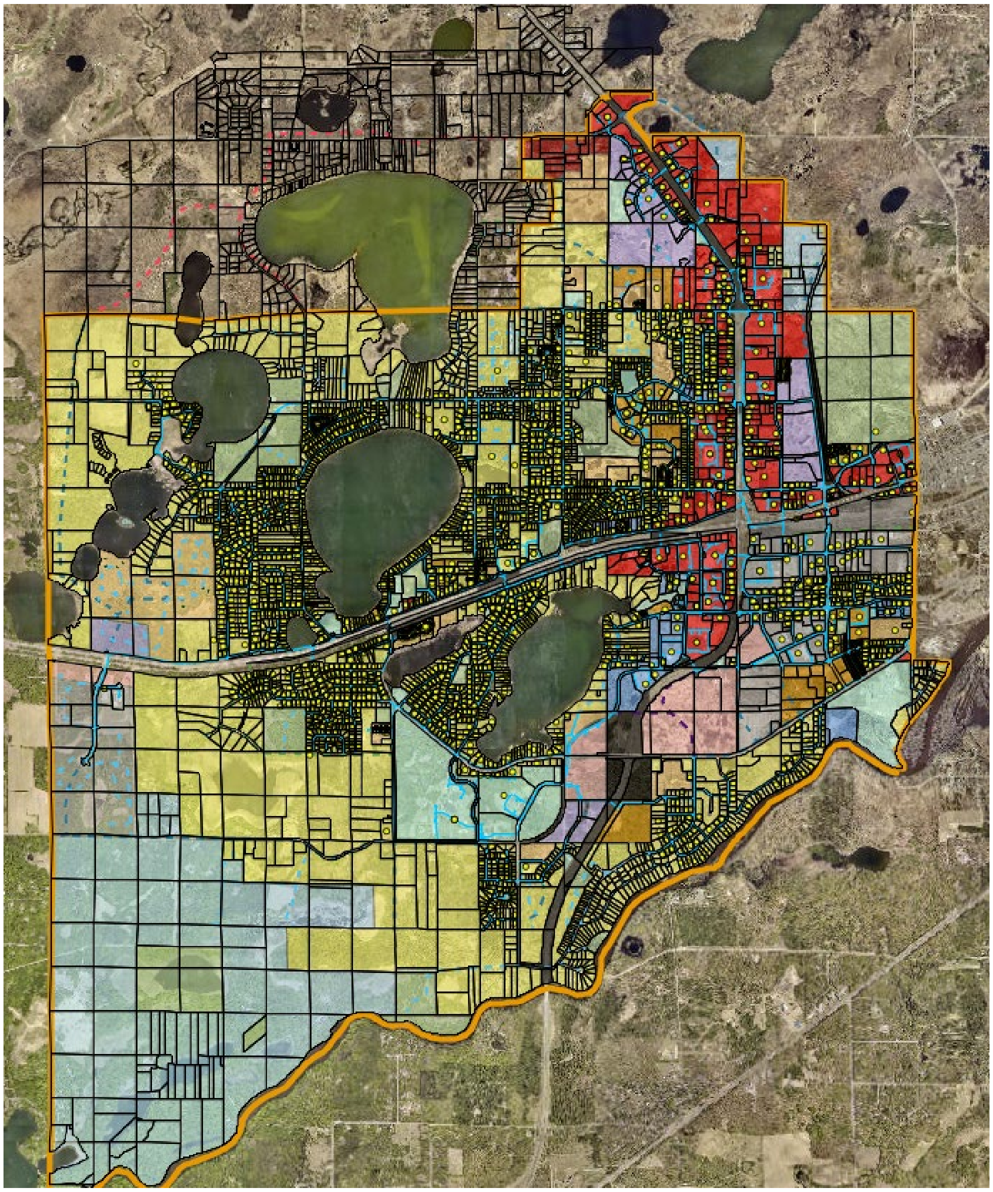
Table 9 – Projected Water Use – By Population

Year	Water Service Population	Projected Average Day (ADD) Demand (MGD)	Projected Average Summer Day Demand (ASD) (MGD)	Maximum Day Demand (MDD) Water Pumped (MGD)
2025	8,642	1.33	2.52	3.00
2035	10,920	1.67	3.18	3.79
2045	12,398	1.90	3.61	4.30



2.2.4 Projected Water Use by Land Use

It is beneficial to estimate future water system demands from various perspectives to capture a range of potential outcomes. Besides the population-based method discussed earlier, this plan also examines projected land uses, estimating water demands based on assumed unit demand per area for different land uses. Appendix A provides a detailed breakdown of the full buildout water needs estimated for the City. The image below documents a live planning map that was developed for this project. This data set incorporated existing City land use planning information for use in understanding current water use characteristics and potential water use.



Using GIS land use data, land areas were paired with historical water billing records. The effort established "real" water use estimates for each land use type. These demand per acre figures were then applied to a full build out scenario for the City. The result of this analysis are shown in Table 10 below.

Table 10 – Existing Water Use by Land Use Type

Land Use Type	Existing Acres	ADD/Acre (gpd/acre)	Total ADD (gpd)	ASD/ADD	ASD (gpd)
Business Gateway	2	680	1,561	2.73	4,261
Commercial	487	731	355,679	1.78	633,212
General Industrial	173	337	58,142	2.21	128,366
High Density Residential	112	1226	137,793	1.93	265,684
Medium Density Residential	86	580	49,905	1.94	96,779
Mixed Use	25	1284	32,390	1.98	64,287
Office Service	54	761	40,954	2.30	94,282
Parks	52	73	3,803	2.93	11,160
Public/Semi-Public/Institutional	204	100	20,401	2.72	55,439
Single Family Residential	1612	205	330,257	1.78	588,825
Total	**2,808**		**1,031,000**	**-**	**1,942,000**

With the unit demand per ace levels established, an additional effort to apply these unit demand loads to undeveloped acres was completed. results of the land use-based water demand projections are presented in Table 11 Below. The timing of this expected development will largely depend on market forces, so the yearly water use projections offer a reasonable estimate of demand during the planning period, while the land use projections help to understand the total ultimate water system needs, regardless of timing. It should be noted that this estimate includes areas that extend beyond current City limits so that an estimate of “ultimate” water use can be considered.

Table 11 – Project Water Use by Land Use Type – Growth Areas

Potential Future Water Use - Future Growth Areas								
Land Use Type	**Future Acres**	**Future Units**	**ADD/Acre (gpd/acre)**	**Total ADD (mgd)**	**ASD/ADD**	**ASD (gpd)**	**AWD/ADD**	**AWD (gpd)**
Business Gateway	274	5	836	148,850	2.75	409,000	0.13	20,000
Commercial	437	18	750	213,200	1.80	384,000	0.58	124,000
Commercial Industrial	46	126	1300	39,000	1.95	76,000	0.31	12,000
General Industrial	397	12	1000	258,050	2.20	568,000	0.31	80,000
Single Family Residential - TBD	2106	-	250	341,900	1.78	609,000	0.65	222,000
Single Family Residential - DEV	1090	415	170	120,250	2.00	241,000	0.65	78,000
High Density Residential	138	47	1300	116,350	1.95	227,000	0.52	61,000
Medium Density Residential	434	23	600	169,650	1.96	333,000	0.53	90,000
Mixed Use	257	95	1300	217,100	2.00	434,000	0.53	115,000
Office Service	93	29	800	48,750	2.30	112,000	0.30	15,000
Parks	754	43	75	37,050	3.00	111,000	0.20	7,000
Public/Semi-Public/Institutional	274	82	100	17,550	2.72	48,000	0.23	4,000
UUT - Residential - EC		230	170	-	1.78	-	0.65	-
UUT - Residential - FD	120	-	250	19,500	1.78	35,000	0.65	13,000
UUT - Commercial - Light Industrial	80	-	1000	52,000	1.21	63,000	0.31	16,000
			Total	**1,799,000**	**-**	**3,650,000**	**-**	**857,000**

Table 12 – Projected Full Development Ultimate Water Use

Total Ultimate Water Use Potential	Average Day (MGD)	Max Day (MGD)	Avg. Summer Day - ASD (MGD)	Avg. Winter Day - AWD (MGD)
	3.07	6.93	6.05	1.43

2.2.5 Potential Large Water Users

The current water usage projections are based on existing customer types. However, unique customers with significantly larger water needs could impact future projections. Although there are no immediate inquiries from such large users in Baxter, the potential exists. Examples of large-scale water users include "wet" industries and data centers, which often require much more water than typical commercial or industrial users. If a customer of this scale were to connect to the system, it would raise concerns about the water system's ability to provide reliable service to both the new user and neighboring customers. For planning purposes, accommodating such users was not included due to their unique nature. Should such a user consider locating in Baxter, a separate capacity review would be necessary to assess the impact on the entire water system, ensuring consistent water service.

2.2.6 Variations in Water Use

2.2.6.1 Seasonal Variations

Seasonal fluctuations in water usage are important factors in the design and sizing of water supply and storage facilities. The seasonal nature of water consumption in the City of Baxter can be demonstrated by an analysis of monthly pumpage variations. The City of Baxter's monthly pumpage variations in 2023 are presented in Figure X-X. In 2023, the maximum monthly pumpage occurred in July, while the minimum monthly pumpage occurred November through April.

2.3 Water Needs for Fire Protection

In addition to the water supply requirements for residential, public, commercial, and industrial consumption, water system planning for fire protection needs is an important consideration. In most instances, water main sizes are designed specifically to supply needed fire flow requirements.

Benefits of providing adequate fire protection for the City include the reduction of insurance rates for residential homes and commercial business in the community. In the United States, guidelines for determining fire flow requirements are developed based on recommendations offered by the Insurance Services Office (ISO), which is responsible for evaluating and classifying municipalities for fire insurance rating purposes.

When a community evaluation is conducted by ISO, the water system is evaluated for its capacity to provide needed fire flow at a specific location and will depend on land use characteristics and the types of properties to be protected. The ISO has developed a method for design and evaluation of a municipal system which will indicate the Needed Fire Flow (NFF). For residential buildings the NFF is determined by the distance between structures as shown below:

Distance between Structures (ft)	***Fire Flow*** *(gpm)*
More than 100	500
31-100	750
11-30	1,000
Less than 11	1,500

Fire protection needs vary with the physical characteristics of each building that is to be protected. For example, needed fire flows for a specific building can vary from 500 gpm to as high as 12,000 gpm, depending on habitual classifications, separation distances between buildings, height, materials of construction, size of the building, and the presence or absence of building sprinklers. Municipal fire insurance ratings are partially based on the Village's ability to provide needed fire flows up to 3,500 gpm. If a specific building has a needed fire flow greater than this amount, the community's fire insurance rating will only be based on the water system's ability to provide 3,500 gpm.

However, in high value districts containing commercial and industrial buildings, fire flow requirements of up to 3,500 gpm or more can be expected. These values can be reduced if existing buildings have sprinklers. Below is a formula that has been established for determining the NFF for commercial and industrial structures and is documented in the *Fire Protection Rating System* and AWWA M31:

NFF = 18 x F x $A^{0.5}$ [O x (X+P)]

Where: NFF = needed fire flow (gpm)

F = class of construction coefficient

A = effective area (ft²)

O = occupancy factor

X = exposure factor

P = communication factor

Based on current insurance classification guidelines, base fire flow requirements are not expected to change over the planning period. The base fire flow used in this study of 3,500 gpm for 3 hours is based on typical ISO recommendations.

Table 13 shows typical fire flow requirements for various land uses. These requirements were used as a basis for evaluating the Shakopee water system. The requirements shown in the table are only intended as a general guideline. The actual needed fire flow for a specific building can vary considerably, as discussed above.

Table 13 – Fire Flow Needs

Land Use	Approximate Needed Fire Protection (gpm)
Single & Two-Family	
Over 100 feet Building Separation	500
31 to 100 feet Building Separation	750
11 to 30 feet Building Separation	1,000
10 feet or Less Building Separation	1,500
Multiple Family Residential Complexes	2,000 to 3,000+
Average Density Commercial	1,500 to 2,500+
High Value Commercial	2,500 to 3,500+
Light Industrial	2,000 to 3,500
Heavy Industrial	2,500 to 3,500+
Other Commercial, Industrial & Public Buildings	Up to 12,000

3 Water Model Construction & Calibration

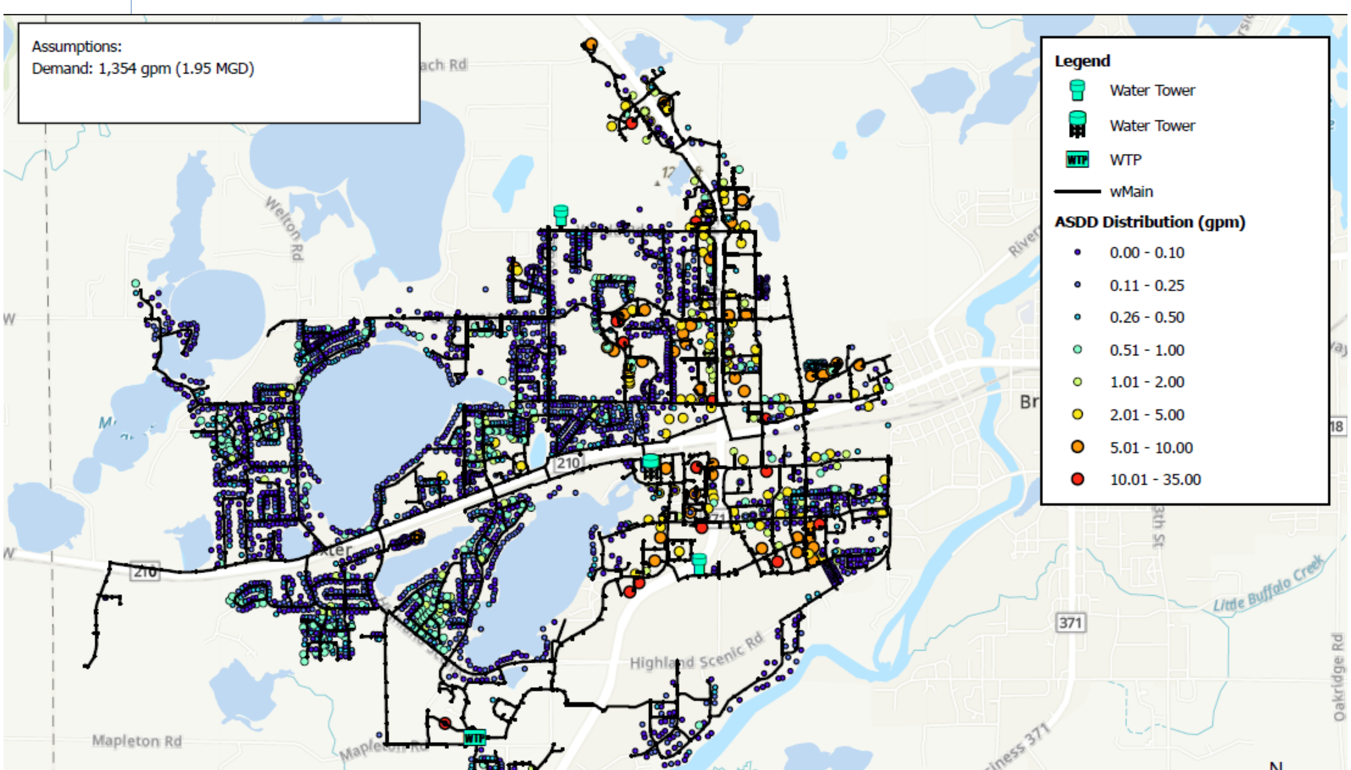
A water model is an effective tool for assessing the current state of water systems and simulating the impact of proposed enhancements. Although a previous model was developed by another consultant and last utilized as part of the water tower project, this project provides an opportunity to create an up-to-date, calibrated model which reflect current system conditions. The following is a summary of the techniques and methods employed to develop and calibrate the updated water model.

3.1 Model Construction

The model was developed using WaterCAD v8i software. The City provided the most current Geographic Information Systems (GIS) data, historical operator data and historical pumping data. With this information, SEH produced the most current version of the computer water model and water system schematic. All pipes in the GIS were included in the model, and ground elevations were gathered from existing Lidar topographic data. The model was also analyzed visually to verify locations of the existing distribution piping. Storage, pumping, and supply facilities were modeled based on available water system data. As the Baxter water system expands, additional piping and facilities can be added to the model and calibration can be done to include future infrastructure as it is constructed.

3.2 Demand Allocation

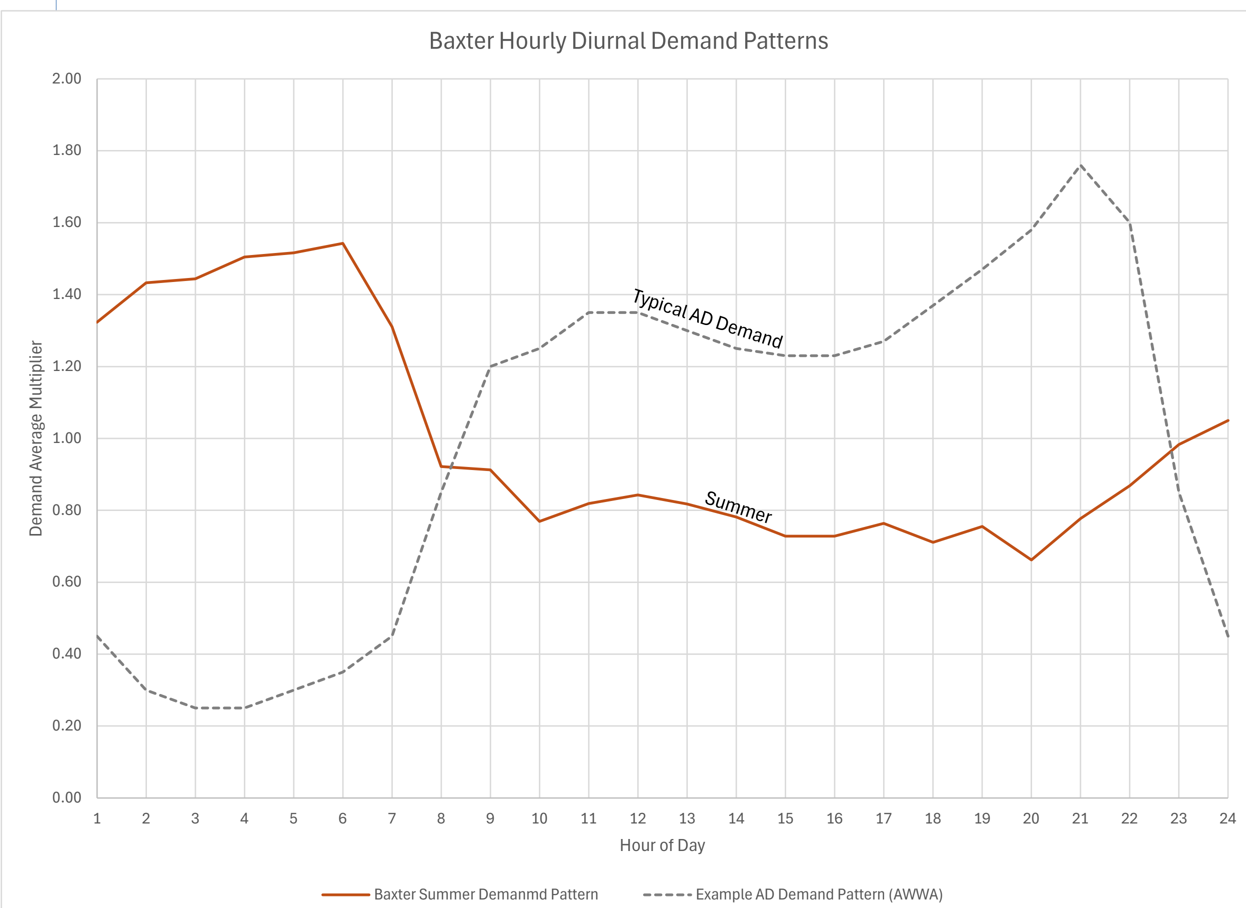
Customer water demands were represented in the model through the use of 2023 water billing data obtained from the City. This was an important step in creating the model to established proper assignment of current customer demands to the proper pipe junction nodes. Data from the billing software was received from the City was geo-located in GIS by customer meter address. The implementation of geo-located demand data allows for the model to be used in a way that more closely matches current system operations. A summary of the demand allocation exercise is included in the figure located in Appendix B. The except below shows the realized summer water use being more intense in commercial areas. A similar map showing Average Day wat4r use is also included in Appendix B.



3.2.1 Hourly Demand Variation (Diurnal Demand)

Variations in demand intensity can significantly impact system performance and are often modeled using a diurnal demand curve applied to the base demand. Diurnal demand curves illustrate the ratio of hourly water usage to daily usage on an hourly basis. This is incorporated into the model to more accurately reflect lower usage at night and higher usage during the day.

A custom diurnal demand curve for the Baxter water system was developed. Over several days, system supply pumping and storage facilities were monitored, and system pressures were tracked using pressure monitors (Telogs) installed on hydrants. Additionally, Baxter provided SCADA data for the same period, which included well flow rates, tank levels, interconnect flows, and other system data such as operating pressures. The diurnal curve below is representative of typical demand patterns experiences in the City of Baxter during the summer months. The result are indicative of irrigation demand occurring over night with the demand peaking between Midnight and 6 am. This is consistent with other communities, which often is a result of irrigation systems being limited to operate over night. The other flow curve shown on the chart is representative of what can typically be observed when irrigation demand is not present, with water use limited overnight and peaking in both the morning and evening. These demand patter considerations can be utilized within the hydraulic model to simulate hourly system operation and resulting performance.



3.3 Water Model Calibration

A well-calibrated water distribution model is essential for ensuring the model's reliability as a trusted tool for evaluating water systems. To achieve this, extensive field testing and calibration exercises were conducted. These efforts were crucial to ensure that the newly updated water model produces accurate and dependable results that closely mirror real-world conditions. The calibration process involved rigorous testing to fine-tune the model parameters, ensuring that the simulated data aligns with actual field measurements. This approach assures that the model can be confidently used for planning, analysis, and decision-making in water system management well calibrated water distribution model is paramount for the use of the model as a trusted water system evaluation tool.

3.3.1 Micro Calibration

The Baxter water system model was micro-calibrated using results from flow testing performed for this study in May of 2024. The summarized flow testing results are located in Appendix B. During the model calibration process, pumping rates, customer demands, and storage tank water levels were set to match the field conditions, and pipe roughness coefficients were adjusted until the calibrated system model adequately simulated field test data.

Precise duplication of the field test results at all locations during the calibration process is not realistic due to the many factors that influence the field test results. The goal of model calibration is to minimize the error between the field test data and the model simulations and create a "best fit" at all locations; therefore, some error between the field tests and model simulations is expected. However, limits to the amount of allowable error must also be made to ensure the calibrated model is a reasonably accurate representation of the actual water distribution system. The desired accuracy for the City's computer model is the greater of plus or minus 25 percent or 2 psi of the recorded pressure difference to a maximum of 5 psi, and plus or minus 10 percent of the recorded flow. For adequate model calibration, the desired accuracy must be met at a minimum percentage of the field test locations. The goal of this project is to have a minimum of 80 percent of the field test results within the desired calibration accuracy before the model is considered calibrated. Appendix B summarizes the accuracy of the model calibration. The model calibration results meet the calibration standards for static hydrants, with 14 out of 14 (100 percent) within the calibration criteria. The model calibration results are higher than calibration standards for residual hydrants, with 14 out of 14 (100 percent) residual hydrants within the calibration criteria.

3.3.2 Macro Calibration

Additionally, an extended period model simulation calibration or “macro–calibration” operation was conducted. Rather than simulating discrete points in time, the system was modeled with historical demands and operational information from data provided by Baxter. The model results were then compared with historical tank levels to confirm the accuracy of the model. Results of this calibration exercise are included in Appendix B.

Once the computer water model was constructed and calibrated, the model was used to calculate the normal working pressures (static pressures) and the available flow for fire protection (fire flow) in the water distribution system as well as numerous other modeling exercises described below.

3.4 Water Model Development Summary

In conclusion, the construction and calibration of the Baxter water model involved a comprehensive process, utilizing the latest software and data to ensure accuracy and reliability. This updated model not only reflects the current conditions of the water system but also provides a robust tool for future planning and management. By incorporating detailed demand data and conducting extensive calibration exercises, the model is well-equipped to support decision-making and enhance the overall efficiency and effectiveness of the Baxter water system. The successful development of this model marks a significant step forward in the city's efforts to maintain and improve its water infrastructure

4 Water System Evaluation

One of the goals of this report is to utilize the updated water model to provide for a comprehensive evaluation of the water system. The model plays in an important role in evaluating the performance of the water system in addition to other engineering tools which work hand in hand with the model. A general evaluation of the water system supply and storage systems was completed so that they could also be considered in various water model operational analysis. This section begins with an overall system review and evaluation which is further analyzed utilizing the up-to-date hydraulic model.

4.1 Water Supply Needs

Recently there has been much discussion regarding the need for additional water supply wells for the City of Baxer. Over the past few years, dry how weather has resulted in high water use days that have pushed existing supply wells to capacity. In addition, some of the wells are loosing capacity and require regular rehabilitation. As such, there are current planning efforts in place to develop additional water supply wells for the city. The demand projections developed earlier in this report provide for an estimate of future demands so that appropriately size facilities can be developed.

The reliable supply capacity of a water system is the total available delivery rate with the largest pumping unit(s) out of service. The reliable supply capacity is less than the total supply capacity because well and other supply pumps must be periodically taken out of service for maintenance. These water supply pumps can be off-line for periods of several days to several weeks. Because of this, system wide well supply requirements will assume that the Baxter water supply system should be capable of meeting maximum day demands with the largest well out of service.

The current reliable water supply capacity, utilizing the noted operational capacity of the wells is 1,800 gpm (2.6) MGD. The realized supply capacity of the supply wells varies with reduced water availability in the aquifer, so the “operational firm capacity” is what is considered for the supply needs evaluation.

Table 14 – Water Supply Needs

Pumping Capacity Analysis	Design Demand Period			
	2025	2035	2045	Ultimate
Maximum Day Demand (mgd)[1]	3.00	3.79	4.30	6.93
Average Day Demand (mgd)	1.33	1.67	1.90	3.07
Average Summer Day Demand (mgd)	2.52	3.18	3.61	6.05
Existing Operational Firm Supply Capacity (mgd)[2]	2.59	2.59	2.59	2.59
Firm Supply Mass Balance (mgd)[3]	**-0.41**	**-1.20**	**-1.71**	**-4.34**

1. Calculation assumes proposed MDD
2. Based on recommended firm well operational capacity
3. A positive value represents a surplus. A negative valve represents a deficiency.

The results indicated in the table above indicate immediate water supply needs. Currently the system is short 0.41 MGD or 285 gpm. The deficit in supply will continue to grow as demand increases into the future. This evaluation suggests that City will need 2-3 additional water supply wells over the next 20-year planning period in order to meet projected system demand. The quantity of wells required will be dependent on the realized system demand and producing capacity of the constructed wells. Current planning efforts are under way to develop additional water supply wells both near the existing water treatment plant as well as exploration for a more remote well field.

4.2 Reliable Pumping Capacity and Storage

Now that the reliable supply capacity for the whole system was established, the system can be further broken down to assess the ability of the system to deliver adequate water service to the customers.

4.3 Water Storage Needs

The purpose of a water distribution system is to deliver water in adequate quantity and at acceptable pressure from the source of supply to the customers. A water system should be capable of meeting all demands during the period of maximum use without reducing pressure below an acceptable limit. This can be achieved though the combination of supply and storage facilities working together to sustain system demands.

Elevated water storage tanks serve water systems in multiple ways. The primary purpose is to provide stored water to supply water to the system in the event of a supply shortage. Supply facilities (such as the wells and Water Treatment Plant High Service Pumps) work to fill the water storage tanks and pump directly to satisfy customer water demands. In the event of a well or supply facility failure due to power outage etc. the storage facility holds water in reserve to feed customers with water despite a loss of power.

Furthermore, system storage is used as a "cushion" to equalize fluctuations in customer demands, establish and maintain water system pressures, provide operational flexibility for water supply facilities, and improve water supply reliability. As customer demands exceed supply capacities during peak hour conditions, these excess demands must be met by depleting available storage. The amount of storage depleted is referred to as equalizing storage for peak hour requirements.

Of equal importance is a water storage tanks ability to support water flows for fire protection. A water storage facility does this in two different functions. First, the storage facility holds water in reserve to supply high levels of flows that exceed the capacity of the water supply wells. Additionally, the placement of a storage facility within the water system supports nearby pressure and flows increasing the available flows to the nearby distribution system.

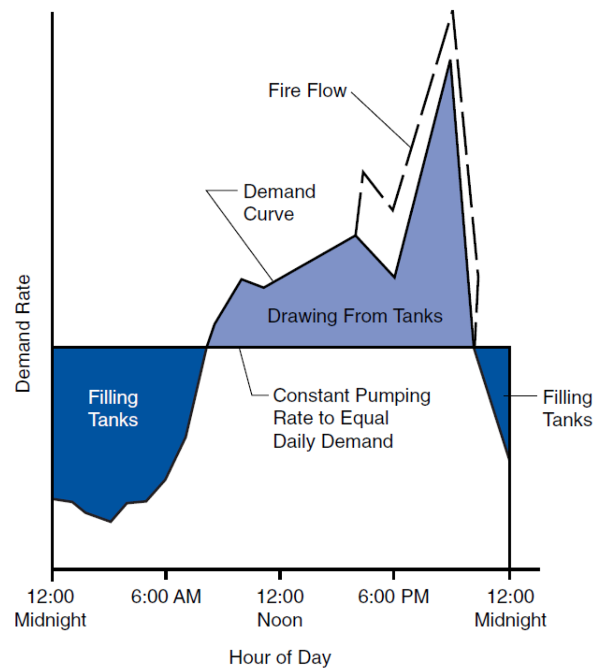
In Summary, the functions of water distribution storage include:

- Equalizing storage (sometimes termed operational storage).
- Fire storage.
- Emergency storage.

Each of these storage components are further defined below:

Equalizing Storage

Equalizing storage works to allow the supply & treatment pumping systems to be sized and operate to produce at the rate of average demand over the course of a day. For example, during peak hours of water use, when customers are using large amounts of water, system demand may exceed the production rate of the water supply/treatment. It is during this time when water storage facilities will drain to satisfy the increased system demand. This concept is further illustrated in the figure below.



Fire Storage

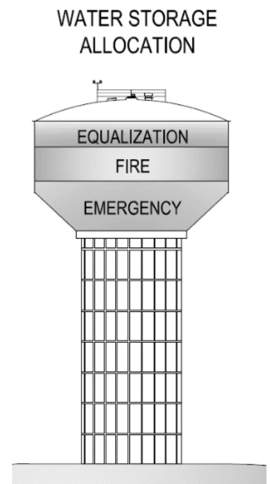
Fire storage includes water held in the tank in the case of an emergency. To assure a reliable supply for fire protection, this reserve storage should not be utilized to meet peak hour requirements and should be available when needed. Guidelines for determining fire flow requirements are developed based on recommendations offered by the Insurance Services Office (ISO), which is responsible for evaluating and classifying municipalities for fire insurance rating purposes. When a community evaluation is conducted by ISO, the water system is evaluated for its capacity to provide needed fire flow at a specific location and will depend on land use characteristics and the types of properties to be protected. Since this memo intends to size water storage for a part of the water system that is primarily residential in nature, a common high end goal for residential fire flow is to provide a flow rate of 1,500 gpm for 2 hours. This figure will be used as a basis for estimating the amount of water to be held in the proposed storage tank for fire protection.

Emergency Storage

Emergency storage is required to meet system water demands during an emergency event that limits or disrupts supply. Some examples of emergency events include water main breaks, equipment failure, and power failure or source contamination.

Water Storage Sizing Criteria

As new users are continually added to the Shakopee water system, water usage will continue to increase. As noted earlier, there is a strong relationship between water storage needs, system supply and system water demands. One of the important functions that an elevated water storage tank provides is delivery of water to feed system demands that exceed the supply capacity. This function helps to sustain consistent system pressures in the water system during periods of high demand. In a similar fashion, the tank will fill when supply flow rates exceed the demand rate during periods of low demands (in the middle of the night for example). For purposes of this analysis two separate sizing criteria were utilized in order to establish when the additional of additional storage to the South water system will be required.



The sizing criteria are as follows:

1. ***Requirement 1*** *- Average daily consumption should not exceed the available storage.* This sizing metric is commonly used by the Minnesota Department of Natural Resources (DNR) when determining if additional water storage is warranted.
2. ***Requirement 2*** *- Available storage should be large enough to provide equalization storage (15% of MD) plus (+) Fire storage (+) 1/2 Average Day Demand for reserve storage. (Fire storage based on largest land use fire flow requirement in the zone being analyzed)*

This sizing practice is a commonly used industry requirement for storage that also accounts for hourly system operation in order to satisfy peak water demands.

4.3.1 Water Supply and Storage Needs Analysis

To determine the water supply and storage needs of a community, average daily demands, peak demands, and emergency needs must be considered. In the sections below, calculations are used to determine future water supply and storage volume requirements for the SPUC water system. Water storage facilities should be capable of supplying the desired rate of fire flow for the required length of time during peak demands when the water system is already impacted by other uses and with the largest supply pump out of service.

The calculations below assume that maximum day demands are occurring on the system, storage volume is reduced by peak demands greater than firm supply pumping rate (i.e. equalization storage is expended). For purposes of this analysis, it is assumed that the “firm capacity” of the water supply wells and high service pumps (largest pump out of service) is capable of supplying maximum day demands.

Table 15 – Water Storage Needs Analysis

	Design Demand Period			
Pumping Capacity Analysis	**2025**	**2035**	**2045**	**Ultimate**
Maximum Day Demand (mgd)[1]	3.00	3.79	4.30	6.93
Average Day Demand (mgd)	1.33	1.67	1.90	3.07
Assumed Firm Supply Capacity (mgd)[2]	2.59	4.32	5.18	6.98
Firm Supply Mass Balance (mgd)[3]	**-0.41**	**0.53**	**0.88**	**0.05**
Recommended Storage Volume				
Maximum Day Equalization Volume (gallons)[4]	449,402	567,810	644,692	1,039,713
Reserve Storage (1/2 AD)	663,000	837,000	951,000	1,534,000
Fire Protection Volume (gallons)[5]	630,000	630,000	630,000	630,000
Requirement 1 Recommended Total Volume (gallons)	*1,325,669*	*1,674,956*	*1,901,747*	*3,067,000*
Requirement 2 Recommended Total Volume (gallons)	*1,742,402*	*2,034,810*	*2,225,692*	*3,203,713*
Existing Storage & Pumping Volume				
Surplus Firm Pump Volume (gallons)[7]	(50,000)	70,000	110,000	10,000
North Water Tower	750,000	750,000	750,000	750,000
South Water Tower	400,000	400,000	400,000	400,000
East Water Tower	1,250,000	1,250,000	1,250,000	1,250,000
Total Existing Volume Available (gallons)	*2,350,000*	*2,470,000*	*2,510,000*	*2,410,000*
Storage Requirement 1 Mass Balance (gallons)	**1,024,331**	**795,044**	**608,253**	**-657,000**
Storage Requirement 2 Mass Balance (gallons)	**607,598**	**435,190**	**284,308**	**-793,713**
Additional Storage Recommended	**-**	**-**	***R**	***700,000**

1. Calculation assumes single zone water system operation
2. Assumed Firm Supply = MDD
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate using the Baxter summer diurnal curve
5. Fire Protection storage was calculated based on one fire of 3,500 gpm for 3 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

*R. Added storage can occur sooner if capacity of South Tank Replaced

4.3.1.1 Water Storage Recommendations

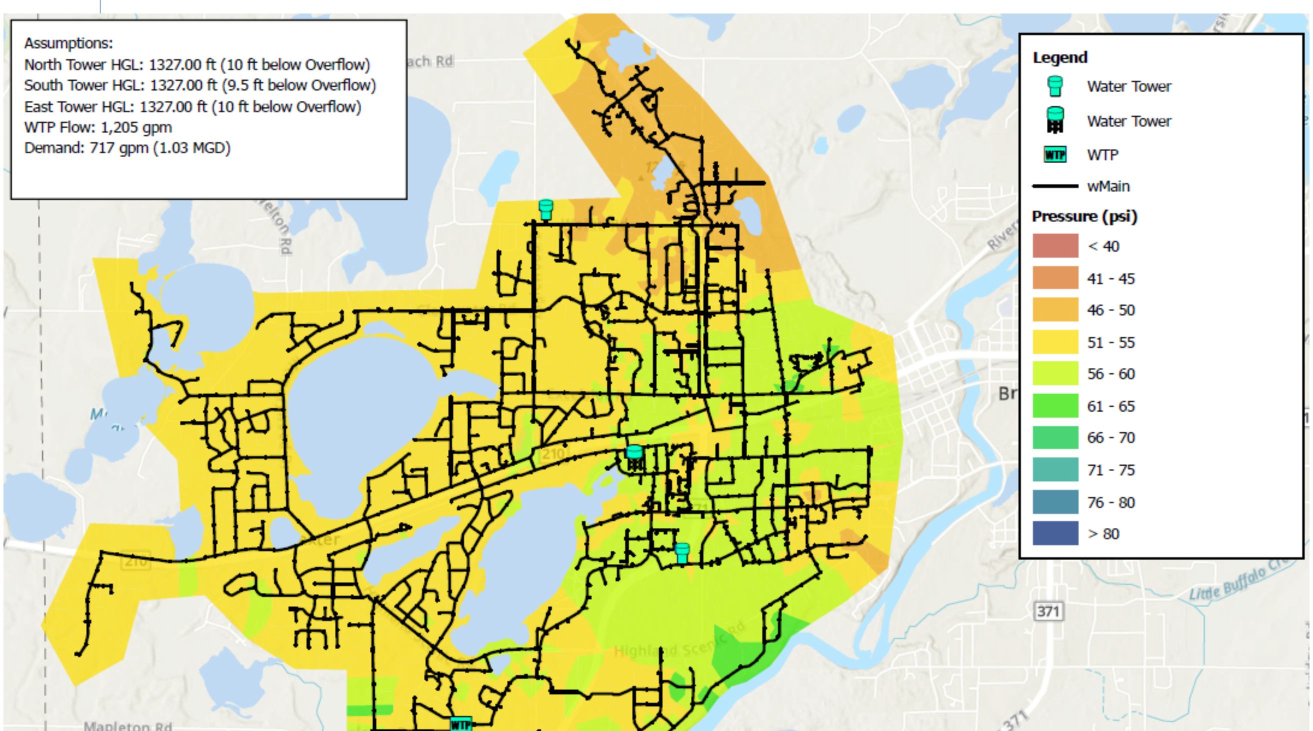
The evaluation summarized in the table above reveal that the city does not have an immanent need for additional storage, rather, the lack of supply is of most concern. Through the 20-year planning period (2045) the calculation above indicates adequate storage available, if additional reliable water supply wells are added to the system. This is also predicated on the assumption that the existing supply facilities (Water treatment plant and wells) have backup power available.

In addition, the necessity of additional storage can often come down to operational preferences. Current conditions with lack of supply will require system operations to rely on a higher percentage of water storage for operations. This can lead to the perception that there is a lack of water storage available to the water system.

Ultimately, the city may require at least one more elevated water storage tank to provide recommended water storage volume. If the existing South Water Tower (400,000 gallon) capacity were maintained, it would be recommended to construct an additional water tower with a nominal capacity of 750,000 gallons. Alternatively, the City could choose to minimize the number of water storage tanks that need to be maintained and construct a nominal 1,250,000 gallon tank and remove the South water tower from operation and demolish. If this approach were taken, the new facility could be constructed in the next 20-year planning period. This could be timed with the next major rehabilitation of the South tank. Rather than invest in the next major rehabilitation and paint job, the funds could be put toward the new water storage tank.

4.4 Water Distribution System - Water Model Hydraulic Analysis

The updated water model provides for an opportunity to simulate operations of the existing water system under various demand loading and operational assumptions. This provides for the ability to observe the holistic operation of the water system and identify deficiencies and areas that may require upgrades. Later in this report, a summary of specific project water main analysis was completed for the potential TH 210/371 interchange project. The effort summarized in this section is intended to evaluate complete system operations with respect to level of service provided to customers and performance efficiency of the whole water system. Important factors in proper distribution system performance include normal operating pressures, the available flow for fire protection and distribution pipe flow velocity. The following sections discuss how the system was analyzed using a computer water model.



4.4.1 Water System Pressures

A water distribution system is designed to provide pressures within a range of minimum and maximum allowable conditions. When system pressure is too low, customers may complain of inadequate water supply, customer meters may tend to record inaccurately, and fire protection will be limited. When system pressure is too high system operation and maintenance issues may occur and will tend to cause higher consumption rates by customers. High water system pressures can also increase the amount of water loss, as leakage rates will increase with increases in system pressure.

Water system pressure will vary around the service area based on land elevations, and to a lesser extent supply rates and customer demands. Areas higher in topographic elevation will tend to exhibit lower water system pressures. In general, as customer demands increase pressures will decrease, however, the effect of demands on overall system pressures is usually minor.

Ten States Standards for water system design suggest that a minimum pressure of 35 psi and a maximum pressure of 80 psi be provided at all locations in the service area under normal operating conditions. If service pressures exceed 80 psi at the water main in the street, plumbing code calls for PRV's (Pressure Reducing Valves) be installed at service lines. Furthermore, water systems are required to be operated so that under fire flow conditions, the residual pressure in the system will not fall below 20 psi at any location.

Generally speaking, pressures in the Baxter water system fall withing the desired bandwidth with the lowest pressure at 45 psi and maximum pressure at 72 psi. System pressures can vary slightly depending on pump operation, demand and level of water in the elevated storage tanks. In general, the Baxter water system can continue to operate as a single pressure zone and maintain desirable service pressures for the customers. **Figures documenting water system pressures for the Baxter water system are included in Appendix C**

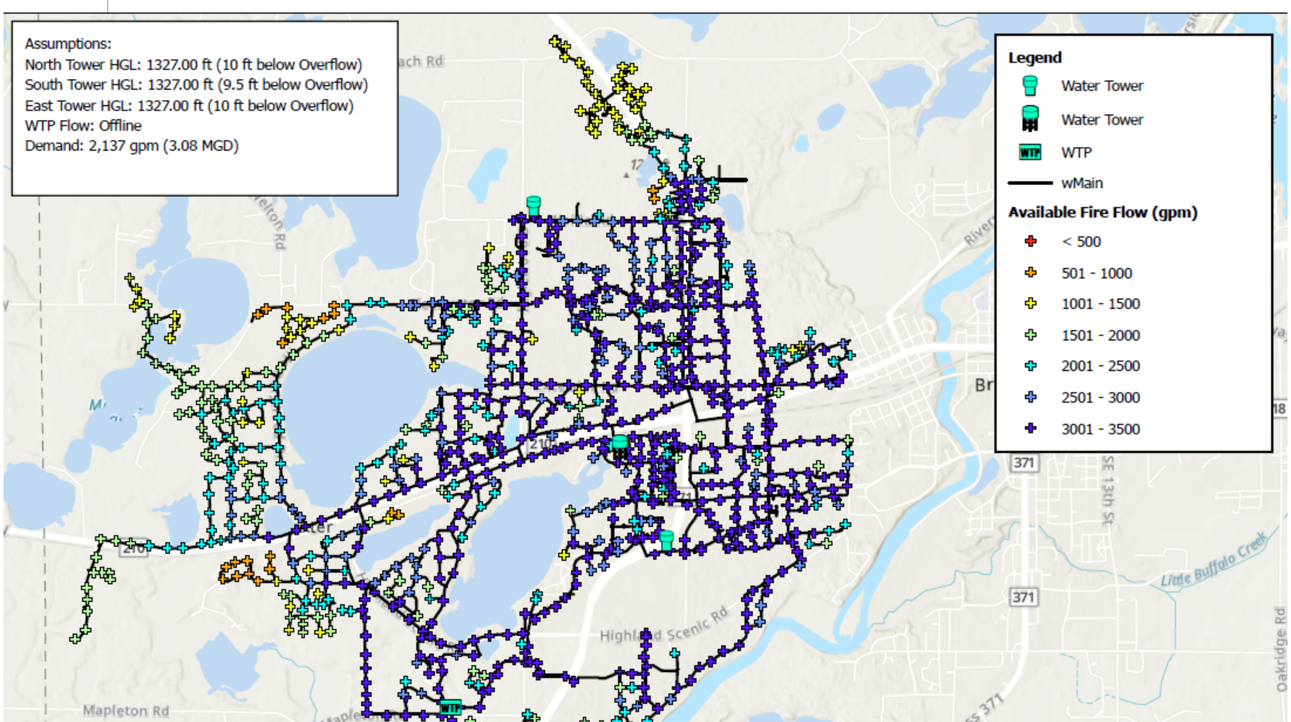
4.4.2 Pipe Carrying Capacities

The pipe network and physical condition of the pipes impact the flow carrying capacity of a water system. Flow carrying capacity refers to the ability of the pipe network to transfer water across the system without inducing high velocity and head loss. Pipes with high velocities and head losses often indicate water mains that are exceeding their flow capacity. Mathematically, head loss is a function of velocity, and high head losses often occur within water mains that exhibit high velocities (greater than 5 feet per second). However, older water mains may also exhibit high head losses as a result of loss in hydraulic capacity due to the deterioration of the interior of the pipe, even when velocities are within acceptable values.

Peak Hour Operation: Steady State Analysis: Initially the model water set up to operate and simulate the peak hour of operation in a given year. This “peak Hour” simulation represents a point in the water system when the highest amount of water would be flowing to meet customer demand as well as deliver water to and from the elevated storage tanks. A figure documenting the peak hour operation is included in Appendix C. This simulation did not reveal any pipes with velocities greater than the 5 fps threshold noted above which is a result of prudent trunk main planning and implementation.

4.4.3 Calculated Available Fire Flow

Water system planning for fire protection is an important consideration. In most instances, water main sizes are designed specifically to supply desired fire flows. Guidelines for determining fire flow requirements are provided by the Insurance Service Organization (ISO). ISO is responsible for evaluating and classifying municipalities for fire insurance rating purposes. Fire protection needs vary with the physical characteristics of each building to be protected (See section 2.3). For example, needed fire flows for a specific building can vary from 500 gpm to as high as 12,000 gpm, depending on habitual classifications, separation distances between buildings, height, materials of construction, size of the building, and the presence or absence of building sprinklers. Municipal fire insurance ratings are partially based on the City's ability to provide needed fire flows up to 3,500 gpm. If a specific building has a needed fire flow greater than this amount, the community's fire insurance rating will only be based on the water system's ability to provide 3,500 gpm. **Figures documenting calculated available fire flow across the water system are included in Appendix C.**



In general, the Baxter water system has a strong network of trunk water main and elevated water storge tanks, which contribute to high availability of fire flow. One exception to this is on the west boundary of the City, near Timberwood Drive. Though this area is served by a large trunk water main, this area is not looped and is far removed from a water tower. Though the available flow is over 1,000 gpm, it may not be sufficient for some types of building uses. Ideally, this area would be looped to provide redundant supply and to increase fire flow availability. In the short term it is recommended that this area be looped in the Trunk water main grid. Long term, when it is time to construct the next elevated water storage tank, this area may be a good candidate for location of the storage facility. Additional discussion related to fire flow is summarized in section 6 of this report.

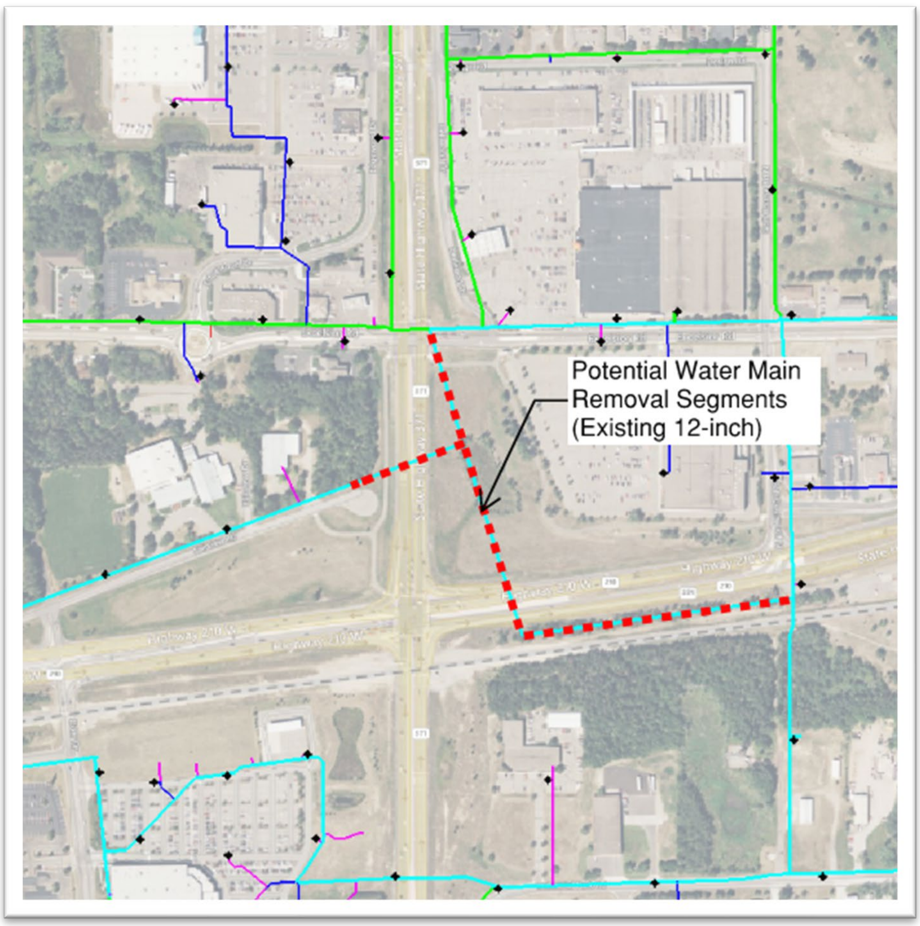
4.4.4 Existing System Water Model Analysis Summary

In conclusion, the updated hydraulic analysis of the Baxter water system demonstrates a robust and efficient network capable of meeting current demands and providing reliable service. The system maintains desirable pressure levels and exhibits strong fire flow availability, particularly due to its well-structured trunk water mains and elevated storage tanks.

However, to further enhance the system's reliability and performance, it is recommended to address the identified deficiency near Timberwood Drive by looping the trunk water main grid in the short term. Additionally, considering this area for the location of the next elevated water storage tank in the long term would significantly improve fire flow availability and overall system redundancy. These improvements will ensure the Baxter water system continues to operate effectively and meets the growing needs of the community. Additional specific improvements are examined further, later in this report.

5 Trunk Highway 210 & 371 Interchange Water Main Analysis

One of the initial goals for update of the water model was to use the model evaluate potential water system changes considering the anticipated Highway 210/371 interchange project. Currently, 12-inch water main crosses both TH 210 and TH 317 in the vicinity of this intersection.



If MNDOT moves forward with the eventual construction of an interchange, it is likely that this exiting water main will need to be either removed or moved to a new location as it will conflict with the new roadway construction.

5.1 Water Main Service Function

The primary purpose of this water main is use as transmission main moving water from the South to the North. The pipe segments in question do not have any fire hydrants or water services connected along the route. As such it was initially presumed that the removal of these segments may have a very limited impact on local service and the overall water system operation.

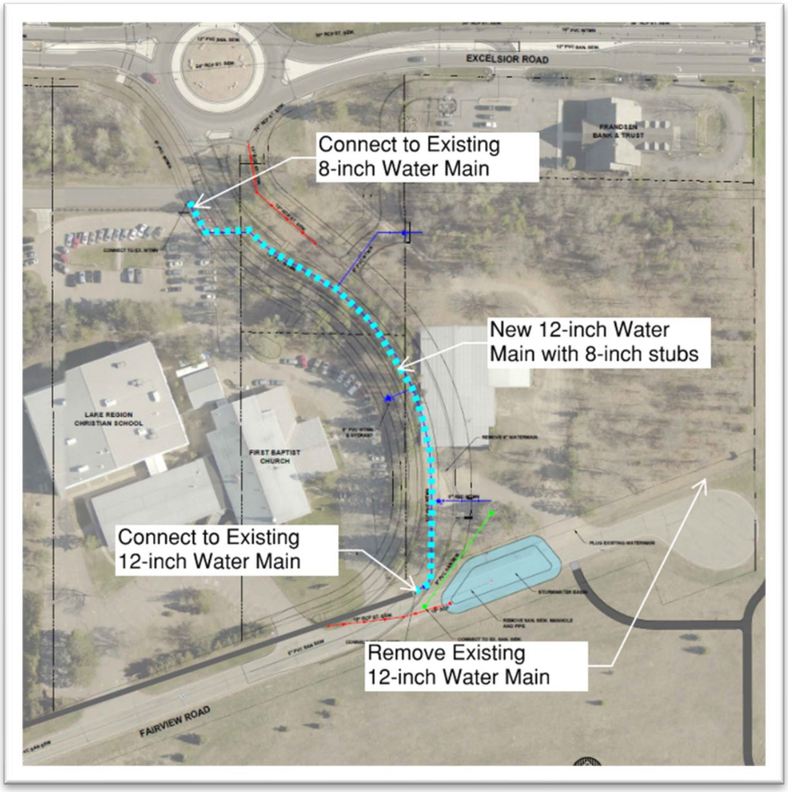
As such the water model was utilized to test this assumption and operated with various scenarios that both included the main and excluded the main which utilizing short term (2025) and long term (2045) water demand projections.

5.2 Water Model Hydraulic Analysis

The newly calibrated hydraulic water model was utilized to simulate the operation of the existing and proposed water main configurations. For comparison purposes, a proposed 8-inch water main was identified to be installed along the proposed looped alignment. This water main segment was simulated in the model to connect from the existing of the existing 12-inch along Fairview to the existing 8-inch stub from the Excelsior Roundabout. Use of a 12-inch main along this segment was also considered, but there was a limited realized benefit in upsizing the main. In addition, there is already an 8-inch stub at the roundabout which would be sufficient and now require excavation of the roadway in order to replace the stub.

First, the system was modeled with and simulated with the water main remaining in place, as is currently configured. These scenarios provide for a baseline understanding of the realized performance of the water main. With this established, the model was then set up with scenarios representing the removal of the water main.

Proposed water main re-routing: The removal of the water main as shown in the figure above would result in a dead end main along Fairview Road at the end of the cul-de-sac. As such, it is recommended that this main be connected and “looped to the existing 10-inch water main along Excelsior Road. Currently there are preliminary plans in place to connect Fairview Road to Excelsior at the roundabout, which would provide an opportunity to loop the water main along the proposed road alignment. A preliminary plan developed by Widseth was provided showing the proposed water main rerouting. This configuration was included in the proposed water system model and concurs with recommendations developed through this analysis.



5.3 Water Model Simulation Results

5.3.1 Existing Configuration Hydraulic Model Results

The existing water system configuration was simulated with near term (2025) and long term (2045) demand levels. The model was operated while using various simulation techniques including developing estimates for Available Fire Flow and Average Summer Day operations over an extended period. These simulations provide for an understanding of the amount of "load" that each of the subject pipes is responsible to convey under current conditions. This provides for a baseline to understand how various pipes currently provide service and so that it can be compared to the revised system with the subject pipe(s) removed

5.3.2 Proposed Configuration Hydraulic Model Results

The water system model was then operated under similar conditions with the subject water main removed and the proposed 8-inch looped water main installed. The model simulations for both near term and long-term conditions revealed more than sufficient carrying capacity and available fire flow for the proposed configuration. The suggested changes did not have any meaningful negative impact on pressure, flow or overall water system operation.

5.4 Recommendations

Based on the analysis above, it is recommended to reroute the existing water main to avoid conflicts with the new roadway construction. The proposed solution involves connecting and looping the water main along Fairview Road to the existing 10-inch main on Excelsior Road. This connection can be achieved using an 8-inch water main, which is deemed sufficient and avoids the need for extensive excavation. This approach ensures minimal impact on local water service and maintains a high level of service for the nearby water customers and supports the overall operation of the water system.

6 Ultimate Water System Planning Map

Through the years the City of Baxter has developed and maintained a long-range water system planning map. This guiding document provides a vision for future water system development and water main sizing. As part of this scope of work and analysis, this existing document was referenced for incorporation with the water system model. Within the model, future system scenarios were developed that incorporate potential growth areas and resulting system demand. This

6.1 Ultimate Water System Development & Analysis

For this effort, we first reviewed existing water system planning maps to understand the current layout and imported the pipe recommendations into the water model. Next, we incorporated anticipated demands on the piping grid by overlaying the existing map piping with demand projections based on anticipated land use, growth, development, and service expansion to unserved neighborhoods. This ensured the updated map aligned with the long-term vision for water distribution as it relates to land use and the comprehensive plan. We then confirmed the hydraulic model by analyzing the overall ultimate water system and updating piping to deliver the desired level of service.

Based on these modeling results, we confirmed and recommended appropriate pipe size updates, considering water demand, hydraulic capacity, and system efficiency. Additionally, we integrated pending recommendations by reviewing other proposed water system improvements, assessing their feasibility, and aligning them with overall system enhancement goals.

This effort has resulted in an updated GIS-based ultimate system map that identified key water main upgrades, expansion trunk main sizes, and locations for proposed supply and storage facilities as identified in the ongoing system analysis.

6.2 Recommended Improvements

With updated water use projections and new ultimate land use planning information, the recommended short term and long-term water system improvement recommendations have been summarized below.

The purpose of this section of the report is to review and recommend facility improvement priorities for the water system moving forward. With growth of the City, and therefore the water system expected during the next planning period, additional water system to facilities should be planned for so all customers receive exceptional water service. While it is impossible to know exactly how growth will occur in the area in terms of specific users and road alignment, general estimates in relation to future land use can be made and facilities planned for based on these assumptions.

The ultimate water system planning map, presented in Figure 6-1 represents a guiding document for the growth and expansion of the water supply, distribution, and storage systems. Expansion of the water system in a manner outlined in this document will help to assure that an exceptional and robust water system is provided to all customers in the future.

6.3 System Planning

Figure 6-1 illustrates the water system plan to meet current and projected water system needs through the Ultimate water system planning period. As mentioned previously, these improvements are intended to correct existing deficiencies as well as meet the needs for future growth and development. To demonstrate the effectiveness of the recommended improvements, Figures included in Appendix C illustrate the anticipated maximum day demand pressures and maximum day fire flows, respectively, with the recommended improvements while delivering ultimate water system demands.

The recommended improvement plan to serve the future service area has been developed as a tool to guide the City of Baxter in the siting and sizing of future system improvements. While the plan may represent the current planned expansion of the City of Baxter system future changes in land use, water demands, or customer characteristics could substantially alter the implementation of the plan. For this reason, it is recommended that the plan be periodically reviewed and updated using area planning information to reflect the most current projections of the City of Baxter service area growth and development.

The improvement plan serves as a guiding document that outlines current conditions and provides recommendations for future development. It is based on projected conditions fort he year 2045. As time moves forward, new information and events will influence the development of the City of Baxter service area. Therefore, the plan must be flexible and adaptable; it should be regularly reviewed and utilized but also adjusted to reflect changes and new insight. Updates should ideally occur every five to ten years.

6.4 Summary of Improvements

One of the main objectives of this report was to develop a long-range improvements plan for water system facilities. This report provides information on the anticipated cost and timing of future water supply, storage, and distribution improvements. This section summarizes the recommended water system improvements with prioritization for system improvements.

6.4.1 Supply

Based upon the current and projected water system needs, additionally wells will be required to provide reliable supply capacity for current and future water demands. Up to 3 new wells are identified as a need to support water system growth through the 2045 planning period.

6.4.2 Treatment

The existing water treatment plant has adequate capacity for current water system needs. However, within the 2045 planning period the water demands will require a treatment plant addition or expansion. The recommendation for additional treatment is an expansion of the existing treatment plant building to the north of the existing treatment location. This would include the addition of four new filter cells, designed to mirror the existing filtration arrangement.

6.4.3 Storage

The current water system is supported by adequate water storage volumes, however, as water system demand grows and summer demands continue to increase, additional storage will be necessary. A potential location for the nest tower could be on the west side of the system where there is currently a fire flow limitation. An option for this tank would be to build it with added capacity to replace the south tank and reduce ongoing operations and maintenance costs. If expansion were to take place beyond the current planning area, or if an unforeseen large water user were added to the system, additional storage may be required.

6.4.4 Distribution

Figure 6-1 presents an update to the Baxter Water System Master Plan map. The figure illustrates the recommended improvements to be the existing distribution system to serve the current and potentially expanded service area. The improvements have been recommended to strengthen the existing water distribution network, and support system expansion into potential future service areas. Existing trunk main looping is executed well in the system but should continue to be considered with new water main construction. The layout of trunk mains in this report would provide water supply and fire protection capabilities to existing and projected service areas. In addition, any recommended new water mains will continue water supply and storage facilities with points of use in the system.

Section 5 of this report was a standalone effort that was developed in anticipation of water main conflicts related to the construction of a roadway interchange. Specific future water mains of interest may be of interest as development pressures are realized.

6.4.4.1 Mapleton & Timberwood Trunk Water Main Looping

Currently, the trunk water main system has robust carrying capacity and future trunk main can be installed as development allows. However, there is a notable weakness related to fire flow on the west side of the City. If the City would like to attract additional users to this industrial area, a looped trunk water main is recommended to be installed along Mapleton road – providing a looped backbone on the south and west side of the water system. For long term planning, this key water main segment would be integral and needed if a future water tower were sited in this area. Looping the trunk water main in this area will increase fire flow availability to 3,500 gpm + with current flow available is in the 1,500 gpm range which may not be adequate for some potential water users, especial those with sizable fire protection needs.

6.4.5 Highway 371 North Looping

As development extends further north past pine beach road, the ability to maintain robust fire flow will be limited by the presence of dead-end water main. Looping of this main with a trunk water main connecting back near the North water tower will dramatically increase fire flow in the area in addition to providing added redundancy to the area.

6.4.6 General water main looping

Where possible, efforts should be made to loop dead end areas, especially those with low end fire flow as documented in the fire flow analysis mapping. Examples of these areas include:

Briarwood Drive and Brentwood Lane: These areas end in a dead end loop, connect these areas to another main may not be possible unless development brings additional watermain nearby from the South and west. Looping to the north would be difficult due to the presence of the railroad.

Cottage Grove Drive & Northwood Drive: Once the final segments of water main along **Clearwater Road** are installed, these areas will become looped in, resulting in a sizeable increase in fire flow.

Jasperwood Drive to Forestview Drive: The recent completion of the South Forestview project has resulted in an extension of water main to this neighborhood, though it is essentially on a looped dead end. A crossing of TH 371 was proactively installed as part of the project. The next step will be to continue the main along Jasperwood and loop the connection to Ironwood Drive and Marble Road

6.4.7 Future Water Main

The ultimate water system planning map provides for suggested water main sizing in areas that are yet to be developed. These sizing recommendations have been confirmed by the modeling efforts and provide a vision for the water system to work towards. May of the proposed trunk water mains follow assumed alignments that may change depending on developer plan. As such, the availability of the up-to-date water model will be a helpful tool to update the proposed system in figure water modeling simulations. As development plans become clearer, the updated water model can be consulted to verify pipe size needs according to proposed. The updated model is considered a dynamic planning tools that can continue to be updated and leveraged for years to come.

6.5 Future Water Model Use

Given the evolving nature of water system planning, it is important to recognize that planning dynamics can change over time. With the City now equipped with an updated water system model, this tool can be continuously utilized to address project needs as they arise. This model provides a robust collection of analysis tool to incorporate future demands and various development scenarios. It is recommended that this model continue to be updated maintained on a yearly basis to make sure the model represents current conditions. Furthermore, as projects arise, the model can be consulted to right size facilities and confirm design decisions.

6.5.1 Other Water Model Uses

The Insurance Services Office (ISO) conducts regular surveys to evaluate and rate the City's water infrastructure. With the recent calibration of the City's water system model, results can be made available to the ISO in lieu of traditional hydrant testing. This approach enhances efficiency and provides a more comprehensive understanding of the water system's performance under various conditions. By leveraging the calibrated model, the City can support the ISO with a more complete picture of the strength of the water system from a fire flow perspective, which is advantageous in achieving a positive rating.

6.6 Conclusion

The 2024 Water System Model update and Planning Report for the City of Baxter provides guiding map to ensure the City’s water system can effectively meet the demands of its growing population. This effort includes current water use projections that can guide future system planning. The plan identified the need for additional water supply, treatment, storage facilities, and improved distribution networks to accommodate both current and future growth scenarios, including potential annexations.

Most importantly, the City is now equipped with a current and up to date water system model that is a powerful tool for efficient and valuable water system planning decisions. Active planning, regular updates, and flexible implementation strategies are key components of this comprehensive approach, ensure the City of Baxter can sustainably manage its water resources for years to come.

dmk

Appendix A

Water Needs Planning

City of Baxter, Minnesota
Estimated Population Change since 2020

CALCULATION OF CITY ESTIMATE	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
New housing units (prev. year)	(2020 figures	15	14	72	218	0	0	0	0	0	0
+units moved in (prev. year)	are	0	0	0	0	0	0	0	0	0	0
- units moved out or demolished (prev. year)	U.S.	1	3	2	2	0	0	0	0	0	0
+ housing units annexed to the city (prev. year	Census	0	0	0	0	0	0	0	0	0	0
= net change in housing units (prev. year)	counts)	14	11	70	216	0	0	0	0	0	0
+ total housing units (beginning of prev. year)		3,675	3,689	3,700	3,770	3,986	3,986	3,986	3,986	3,986	3,986
= Total Housing Units (at end of prev. year)	**3,675**	**3,689**	**3,700**	**3,770**	**3,986**	**3,986**	**3,986**	**3,986**	**3,986**	**3,986**	**3,986**
x occupancy rate from 2000 Census	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%	94.1%
= Households (occupied housing units)	**3,458**	**3,471**	**3,482**	**3,548**	**3,751**	**3,751**	**3,751**	**3,751**	**3,751**	**3,751**	**3,751**
x number of persons per household**	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49	2.49
= Estimated Population #	**8,612**	**8,645**	**8,671**	**8,835**	**9,341**	**9,341**	**9,342**	**9,342**	**9,342**	**9,342**	**9,342**
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**

NOTES:

Includes single-family and multiple-family units.

***Based on persons per household illustrated in 2020 Census*

Jan 1st City Estimate

ESTIMATED TOTALS (2020-2030)

319 bldg permits for new housing units

0 units moved in

8 units moved out or demolished

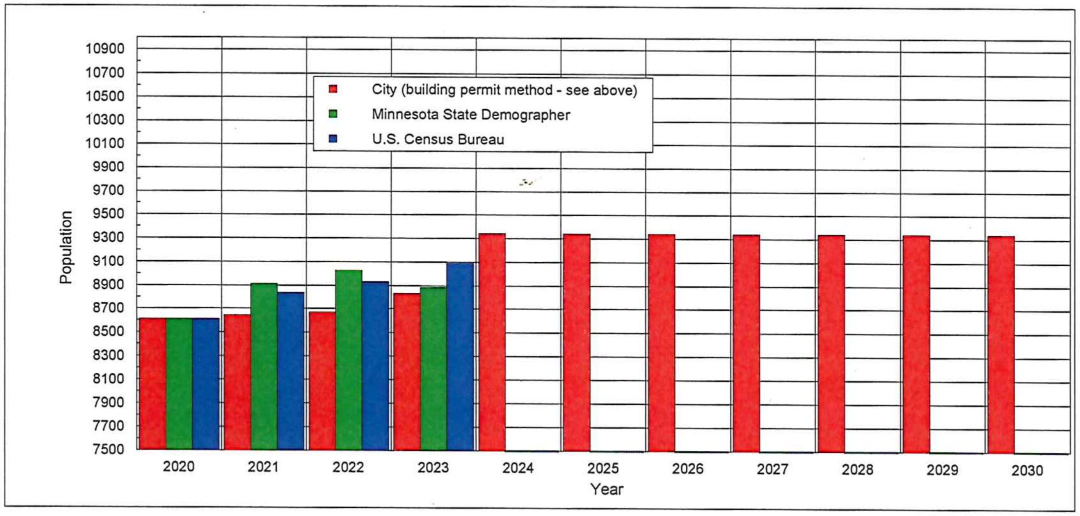
0 housing units annexed to the city

311 net change in total housing units

293 net change in occupied housing units (households)

730 net change in population

POPULATION ESTIMATES (2020 Census population shown for comparison)



	2020 CENSUS	2021 EST.	2022 EST.	2023 EST.	2024 EST.	2025 EST.	2026 EST.	2027 EST.	2028 EST.	2029 EST.	2030 EST.
City (building permit method - see above)	*8,612*	8,645	8,671	8,835	9,341	9,341	9,342	9,342	9,342	9,342	9,342
		-	-	-	-	-	-	-	-	-	
Minnesota State Demographer	*8,612*	8,911	9,030	8,885	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	
U.S. Census Bureau	*8,612*	8,837	8,931	9,092	-	-	-	-	-	-	-

sources: 2020 population, households, housing units and occupancy rate from 2020 Census
Annual Building Permit Data - City of Worthington Community Development Department
Annual State Demographer Estimates - April 1st
Annual U.S. Census Estimates - July 1st

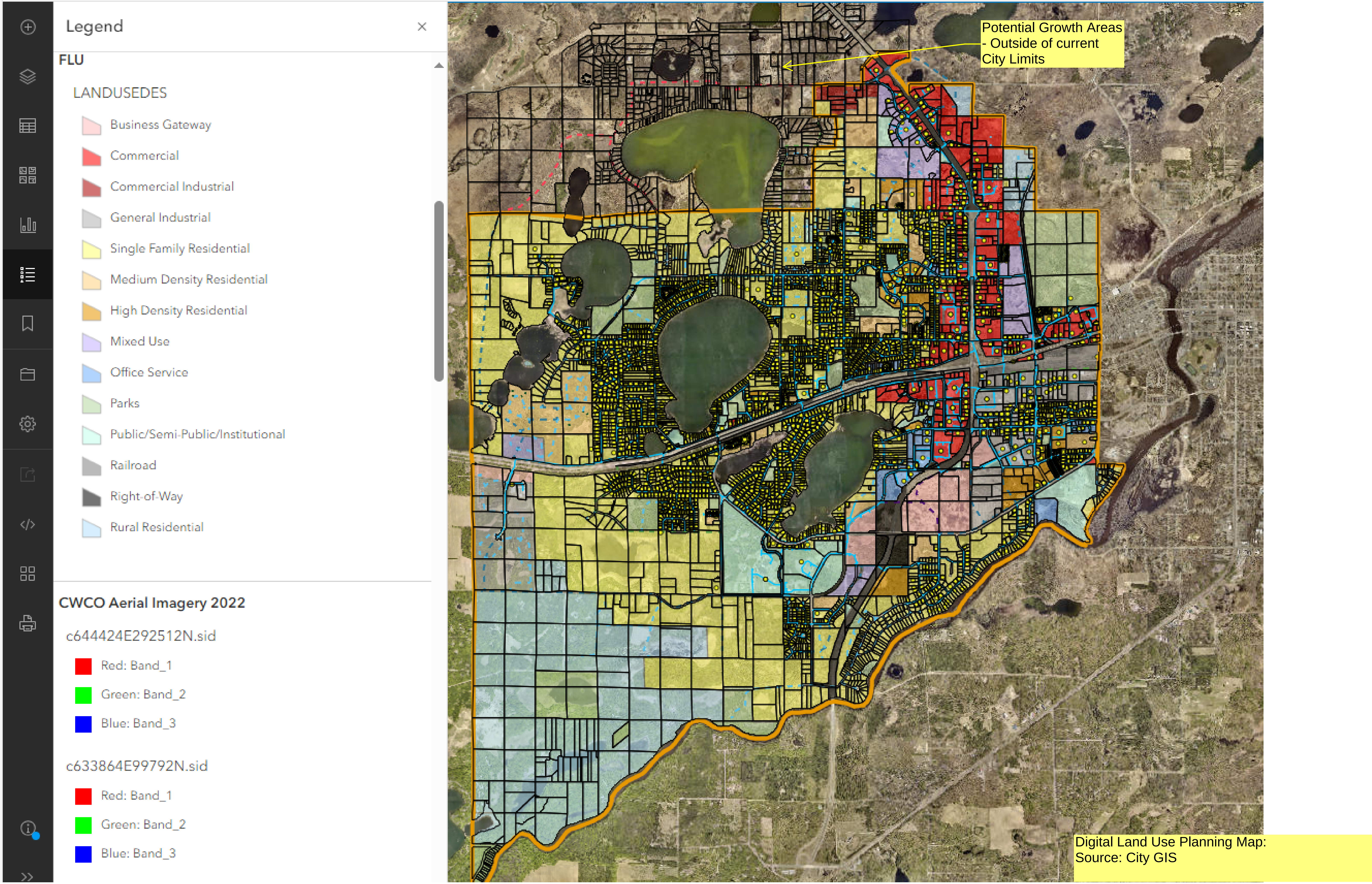

Legend
FLU
LANDUSEDES
Business Gateway
Commercial
Commercial Industrial
General Industrial
Single Family Residential
Medium Density Residential
High Density Residential
Mixed Use
Office Service
Parks
Public/Semi-Public/Institutional
Railroad
Right-of-Way
Rural Residential
CWCO Aerial Imagery 2022
c644424E292512N.sid
Red: Band_1
Green: Band_2
Blue: Band_3
c633864E99792N.sid
Red: Band_1
Green: Band_2
Blue: Band_3
Potential Growth Areas - Outside of current City Limits
Digital Land Use Planning Map:
Source: City GIS

Table A1
City of Baxter - Historical Water Use

Year	City Population	Estimated Population Served (Inc. Multi Fam)	% of Population Served	*Estimated Population Served from Res. Conn.	Total Connections	Residential Connections	Total Water Pumped or Transfered (MGY)	Residential Water Delivered (MGY)	Average Day (AD) Water Pumped/Sup. (MGD)	Maximum Day (MD) Water Pumped/Sup. (MGD)	MD:AD Ratio	Estimated Average Summer Day Water Use (MGD)	All Served Pop Residential Per Capita Water Use (gpd)	*Res.Service Per Capita Water Use (gpd)	Total Per Capita Water Use (All Water) (gpd)
2005	7,219	4,660	65%	4,115	2,255	1,646	279.9	132.0	0.77	1.13	1.47	1.46	77.6	87.9	165
2006	7,594	5,468	72%	4,556	2,531	1,822	395.6	129.0	1.08	0.98	0.90	2.06	64.6	77.6	198
2007	7,758	5,741	74%	4,842	2,690	1,937	398.5	130.0	1.09	1.02	0.93	2.07	62.0	73.6	190
2008	7,827	5,852	75%	5,218	2,899	2,087	384.4	157.5	1.05	1.05	1.00	2.00	73.7	82.7	180
2009	7,921	6,114	77%	4,732	2,629	1,893	374.2	150.6	1.03	2.01	1.96	1.95	67.5	87.2	168
2010	7,610	6,266	82%	4,781	2,656	1,912	339.3	149.0	0.93	1.47	1.58	1.77	65.1	85.4	148
2011	7,620	6,390	84%	4,820	2,678	1,928	335.5	138.5	0.92	0.93	1.01	1.75	59.4	78.7	144
2012	7,661	6,515	85%	4,957	2,754	1,983	344.4	158.6	0.94	1.00	1.06	1.79	66.7	87.7	145
2013	7,747	6,641	86%	4,911	2,767	1,965	353.3	144.5	0.97	1.90	1.96	1.84	59.6	80.6	146
2014	8,002	6,778	85%	4,800	2,743	1,920	342.2	131.5	0.94	1.90	2.03	1.78	53.2	75.1	138
2015	8,065	7,022	87%	5,970	3,373	2,388	360.8	144.3	0.99	1.90	1.92	1.88	56.3	66.2	141
2016	8,318	7,318	88%	5,975	3,450	2,390	382.1	147.0	1.05	1.91	1.82	1.99	55.0	67.4	143
2017	8,360	7,390	88%	6,035	3,495	2,414	373.8	105.7	1.02	2.11	2.06	1.95	39.2	48.0	139
2018	8,478	7,538	89%	6,015	3,485	2,406	381.9	108.9	1.05	2.64	2.52	1.99	39.6	49.6	139
2019	8,555	7,645	89%	6,000	3,498	2,400	355.8	104.7	0.97	2.20	2.26	1.85	37.5	47.8	127
2020	8,612	7,732	90%	6,065	3,538	2,426	352.6	120.5	0.97	2.06	2.13	1.84	42.7	54.4	125
2021	8,911	8,051	90%	6,025	3,523	2,410	358.3	132.7	0.98	2.03	2.06	1.87	45.2	60.3	122
2022	9,030	8,190	91%	6,053	3,533	2,421	366.3	116.2	1.00	1.99	1.98	1.91	38.9	52.6	123
2023	9,092	8,272	91%	5,985	3,513	2,394	463.1	132.1	1.27	2.87	**2.26**	2.41	43.8	60.5	153
2024	9,341	8,521	91%	6,040	3,513	2,416		124.2	1.1	2.4	2.1	2.16	41.3	56.5	138.0
										10-Year Avg	**2.1**		**45.1**	**58.2**	**135.0**
										10-Year Max	**2.5**		**56.3**	**75.1**	**153.4**
										Selected for Projections	**2.26**		**56.3**	**75.1**	**153.4**

*Estimated residential service population using 2.5 persons per household and count of residential connections.

Table A2
City of Baxter - Historical Population

Year	US Census + State Demographer Estimate
1960	**1037**
1970	**1556**
1980	**2625**
1990	**3695**
2000	**5555**
2010	**7610**
2011	7620
2012	7661
2013	7747
2014	8002
2015	8065
2016	8318
2017	8360
2018	8478
2019	8555
2020	**8612**
2021	8911
2022	9030
2023	9092

Table A3
City of Baxter - Average Growth Water Use Projections

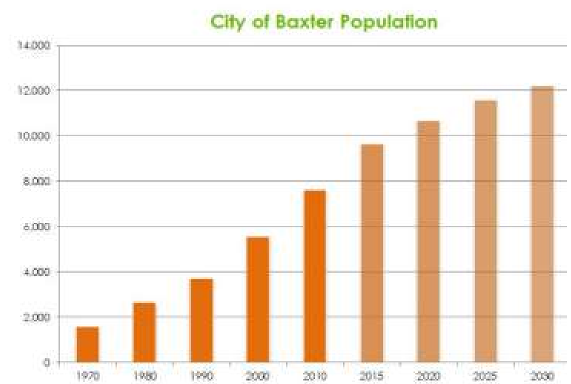
Year	City Population Projection - Avg Growth	City Population Projection - Comp Plan Projection(s)
2025	9,332	11,607
2026	9,454	11,727
2027	9,578	11,847
2028	9,703	11,967
2029	9,830	12,087
2030	9,959	12,207
2031	10,090	12,327
2032	10,222	12,447
2033	10,356	12,567
2034	10,491	12,687
2035	10,629	12,814
2036	10,768	12,934
2037	10,909	13,054
2038	11,052	13,174
2039	11,197	13,294
2040	11,344	13,414
2041	11,492	13,534
2042	11,643	13,654
2043	11,795	13,774
2044	11,950	13,894
2045	12,106	14,014

Demographic Trends

Baxter is expected to continue growing significantly for the next twenty-plus ye
The graph below shows Baxter's historic and projected population from 1970 t
2035, according to the Minnesota State Demographer. The graph and table o
next page illustrate historic and projected population in and around Baxter – C
Wing County, Brainerd, Crow Wing Township and the unorganized territory are

Crow Wing County is projected to increase by about 29% to over 80,000 by 2035 (more than the State of Minnesota's 20% increase in the same time period). Brainerd is due to increase less than 8% to about 14,613 population, whereas Baxter with all of its available land, is due to inherit much of Crow Wing County's increased population, growing by 68% to 12,814, approaching Brainerd's size. Brainerd is actually projected to de
slightly in population between 2030 and 2035, according to the State Demogr
If these trends continue, by the middle of the century Baxter would have a larg
population than Brainerd.

Baxter Population 1970 - 2035 (projecte



Historic and Projected Population 2010-2035 – Minnesota, Baxter & Vicinity

Geography	2010	2015	2020	2025	2030	
Minnesota	5,278,190	5,537,385	5,772,258	5,987,609	6,182,306	6,:
Crow Wing County	62,500	66,067	69,995	73,687	77,114	
City of Baxter	7,610	9,678	10,701	11,607	12,251	
City of Brainerd	13,590	14,406	14,578	14,689	14,661	
Crow Wing Township	1,966	2,051	2,245	2,416	2,536	
Unorganized Territory	5,424	6,321	6,720	7,064	7,285	

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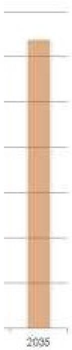

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apher.
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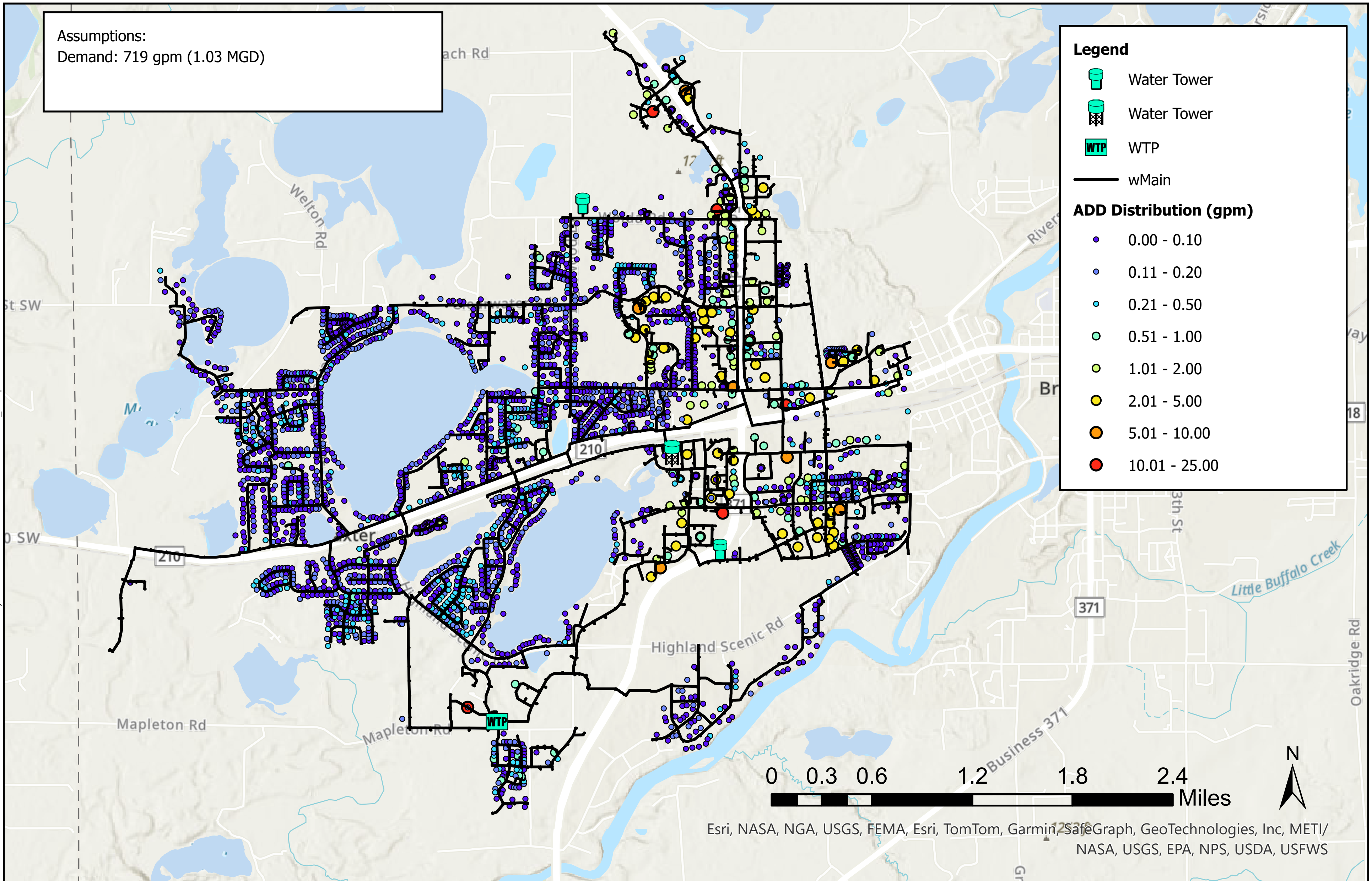
2035
363,010
80,350
12,814
14,613
2,640
7,473

Table A4
City of Baxter - Estimated Yearly Water Use Projections

Year	Selected Average Population Projection	City Population - Low	Estimated Population Served (Inc. Multi Fam)	% of Population Served	*Estimated Population Served from Res. Conn.	Total Connections	Residential Connections	Average Day (AD) Water Pumped/Sup. (MGD)	Average Summer Day (ASD) Water Pumped/Sup. (MGD)	Maximum Day (MD) Water Pumped/Sup. (MGD)
2024	**10,300**	9,211	8,300	90%	6,083	3,579	2,433	1.27	2.42	2.88
2025	9,559	9,332	8,642	90%	6,180	3,645	2,472	1.33	2.52	3.00
2026	9,910	9,454	8,990	91%	6,278	3,711	2,511	1.38	2.62	3.12
2027	10,264	9,578	9,341	91%	6,375	3,777	2,550	1.43	2.72	3.24
2028	10,459	9,703	9,550	91%	6,473	3,843	2,589	1.46	2.78	3.31
2029	10,610	9,830	9,719	92%	6,570	3,909	2,628	1.49	2.83	3.37
2030	11,105	9,959	10,207	92%	6,668	3,975	2,667	1.57	2.97	3.54
2031	11,227	10,090	10,346	92%	6,765	4,041	2,706	1.59	3.02	3.59
2032	11,349	10,222	10,487	92%	6,863	4,107	2,745	1.61	3.06	3.64
2033	11,472	10,356	10,630	93%	6,960	4,173	2,784	1.63	3.10	3.69
2034	11,596	10,491	10,774	93%	7,058	4,239	2,823	1.65	3.14	3.73
2035	11,721	10,629	10,920	93%	7,155	4,305	2,862	1.67	3.18	3.79
2036	11,850	10,768	11,063	93%	7,253	4,371	2,901	1.70	3.22	3.84
2037	11,979	10,909	11,208	94%	7,350	4,437	2,940	1.72	3.27	3.89
2038	12,110	11,052	11,354	94%	7,448	4,503	2,979	1.74	3.31	3.94
2039	12,241	11,197	11,502	94%	7,545	4,569	3,018	1.76	3.35	3.99
2040	12,373	11,344	11,651	94%	7,643	4,635	3,057	1.79	3.40	4.04
2041	12,509	11,492	11,797	94%	7,740	4,701	3,096	1.81	3.44	4.09
2042	12,646	11,643	11,946	94%	7,838	4,767	3,135	1.83	3.48	4.14
2043	12,784	11,795	12,095	95%	7,935	4,833	3,174	1.86	3.53	4.19
2044	12,923	11,950	12,246	95%	8,033	4,899	3,213	1.88	3.57	4.25
2045	13,063	12,106	12,398	95%	8,130	4,965	3,252	**1.90**	3.61	**4.30**

Appendix B

Water Model Update - Calibration



Path: C:\Users\hschumacher\OneDrive - Short Elliott Hendrickson Inc\Project Folders\WMs\Baxter\Baxter Water Model_DT.aprx

SEH

3535 VADNAIS CENTER DR.
ST. PAUL, MN 55110
PHONE: (651) 490-2000
FAX: (651) 490-2150
WATTS: 800-325-2055
www.sehinc.com

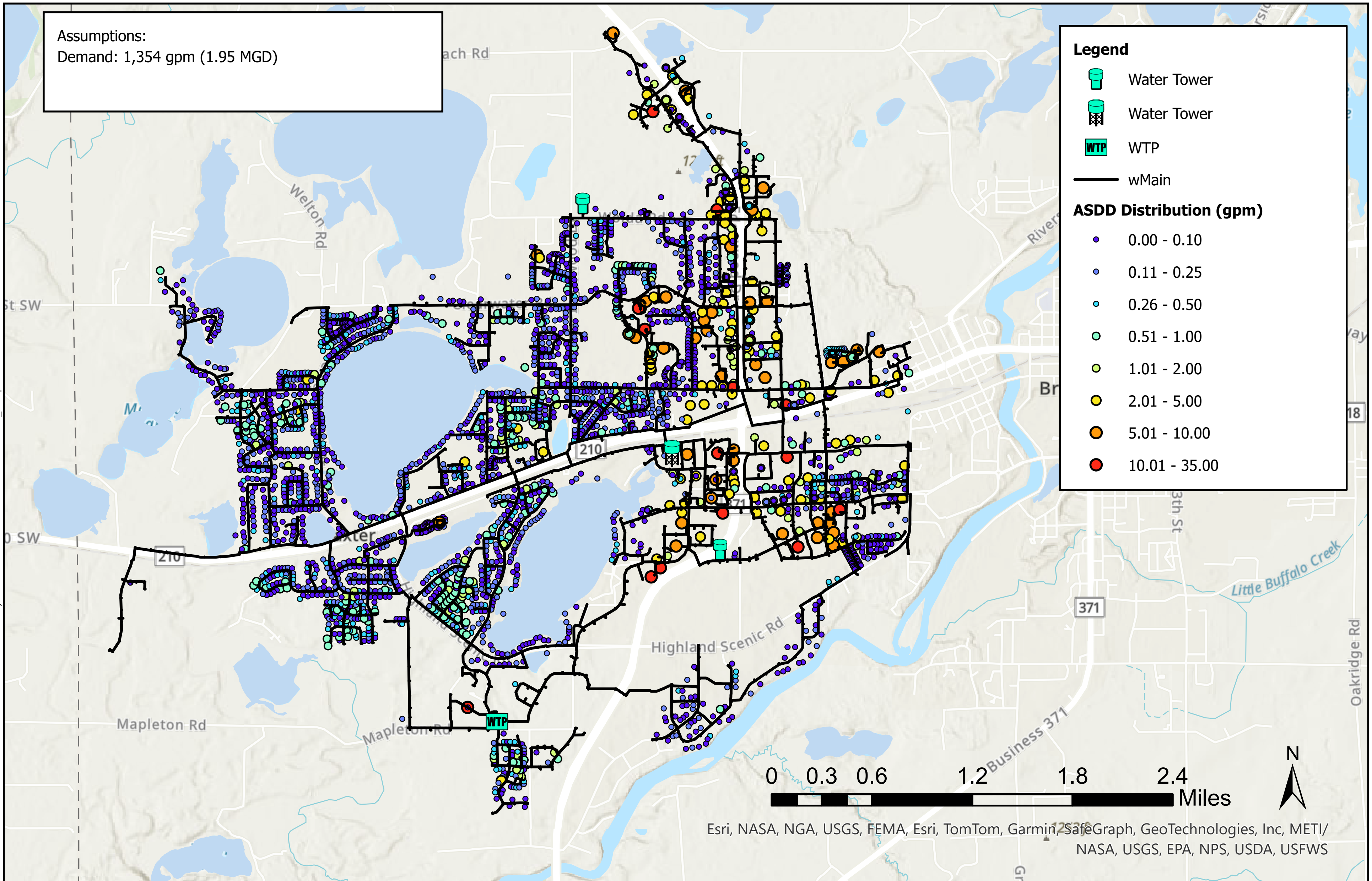
Project: BAXTE 178474
Print Date: 11/22/2024

Map by: hschumacher
Projection:
Source:

EXISTING SYSTEM DEMAND DISTRIBUTION AVERAGE DAY DEMAND

2024 Baxter Water Model
Baxter, Minnesota

Figure 10



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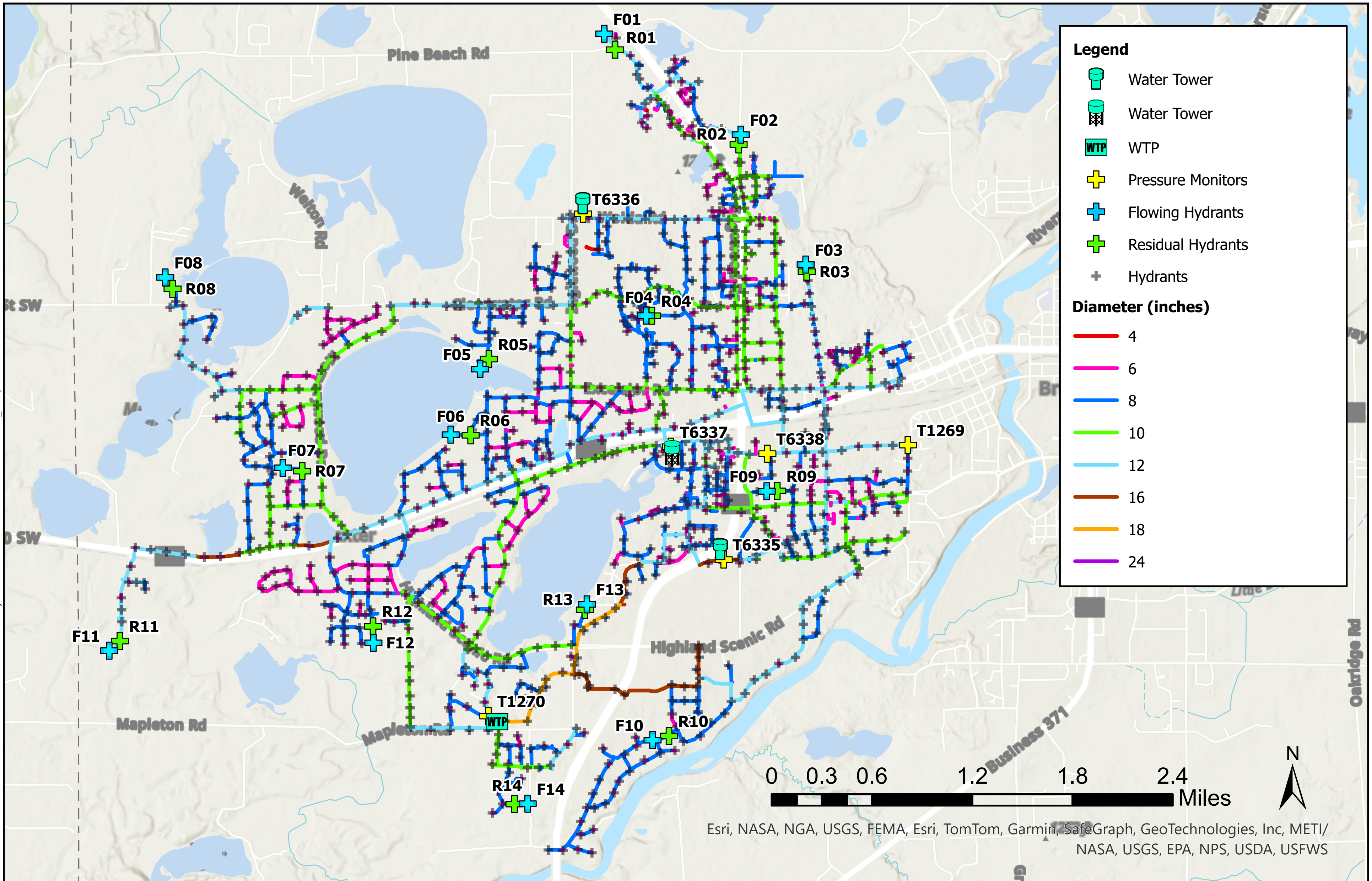
Project: BAXTE 178474
Print Date: 11/22/2024

Map by: hschumacher
Projection:
Source:

EXISTING SYSTEM DEMAND DISTRIBUTION AVERAGE SUMMER DAY DEMAND

2024 Baxter Water Model
Baxter, Minnesota

Figure 11



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Project: BAXTE 178474
Print Date: 11/22/2024

Map by: hschumacher
Projection:
Source:

FLOW TESTING MAP
JUNE 2024

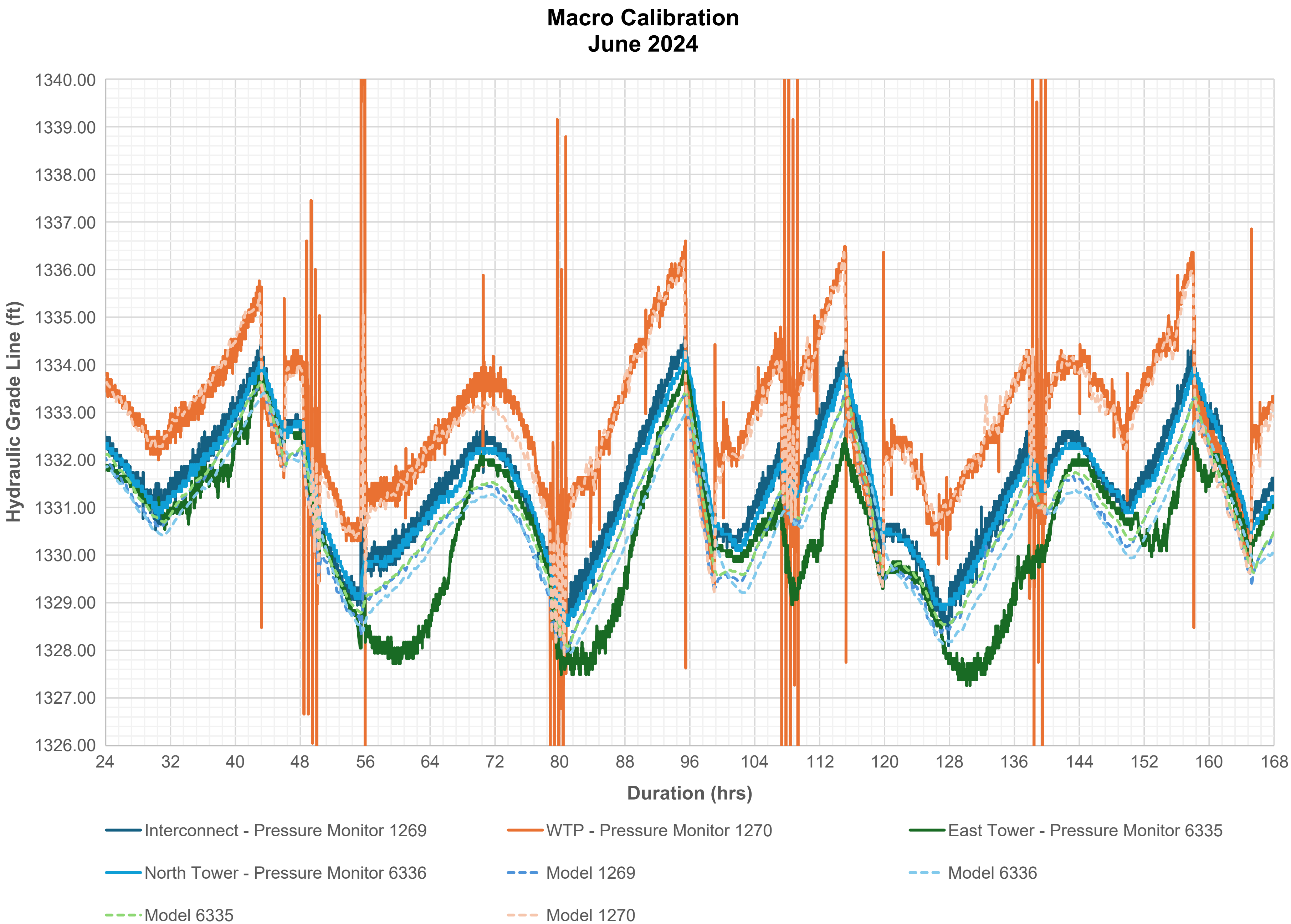
2024 Baxter Water Model
Baxter, Minnesota

Figure B.1

FIELD FLOW TESTING RESULTS

Flow Test Name	Date	Time	FLOWING DATA				RESIDUAL GUAGE RESULTS				MODEL RESULTS			CALIBRATION	
			Size	Pitot Pressure (psi)	Location	Flow (gpm)	Static (psi)	Residual (psi)	Location	Diff (psi)	Static (psi)	Residual (psi)	Diff (psi)	Diff Static (psi)	Diff Static (psi)
F01	5/27/2024	10:00 AM	2.5	35	Pine Beach Rd - Dondelinger Automotive	1078	52	38	Intersection of Pine Beach Rd and Edgewood Dr	14	53	39	14	-1	-1
F02	5/27/2024	10:15 AM	2.5	37	Intersection of Dellwood Dr and Novotny Rd N	1109	53	49	South of Intersection of Dellwood Dr and Novotny Rd N	4	53	48	5	0	1
F03	5/27/2024	10:26 AM	2.5	40	North End of Cypress Drive	1152	57	52	Second Hydrant from North End of Cypress Drive	5	55	51	4	2	1
F04	5/27/2024	10:41 AM	2.5	33	End Hydrant on Fox Rd	1047	58	51	Second Hydrant from End on Fox Rd	7	57	49	8	1	2
F05	5/27/2024	10:57 AM	2.5	30	End Hydrant on Kimberlee Ct	998	56	49	Second Hydrant from End on Kimberlee Ct	7	55	47	8	1	2
F06	5/27/2024	11:08 AM	N/A	N/A	End Hydrant on Sandstone Rd	900	56	51	Second Hydrant from End on Sandstone Rd	5	54	49	5	2	2
F07	5/27/2024	11:26 AM	N/A	N/A	End Hydrant on Honeysuckle Way	920	57	51	Second Hydrant from End on Honeysuckle Way	6	56	49	7	1	2
F08	5/27/2024	11:40 AM	N/A	N/A	End Hydrant on Red Sequoia Dr	860	56	47	Second Hydrant from End on Red Sequoia Dr	9	54	45	9	2	2
F09	5/27/2024	12:47 PM	N/A	N/A	Goedderz Rd - Viking Electric	1015	60	60	Goedderz Rd - Sound Communications	0	60	59	1	0	1
F10	5/27/2024	1:00 PM	N/A	N/A	Intersection of Forestview Dr and River Vista Dr	1045	58	52	Hydrant on Forestview Dr and west of Scenic River Dr	6	56	50	6	2	2
F11	5/27/2024	1:20 PM	N/A	N/A	End Hydrant on Logging Rd	955	56	49	Second Hydrant from End on Logging Rd	7	56	47	9	0	2
F12	5/27/2024	1:33 PM	N/A	N/A	Intersection of Joler Rd and 2nd St	920	56	53	Second Hydrant from End on 2nd St	3	56	51	5	0	2
F13	5/27/2024	1:45 PM	N/A	N/A	End Hydrant on Highland Scenic Ct	960	57	52	Second Hydrant from End on Highland Scenic Ct	5	56	52	4	1	0
F14	5/27/2024	1:55 PM	N/A	N/A	Intersection of Jasper Wood Dr and Oakldale Rd	860	59	48	Hydrant on Oakdale Rd and west of Jasper Wood Dr	11	58	48	10	1	0

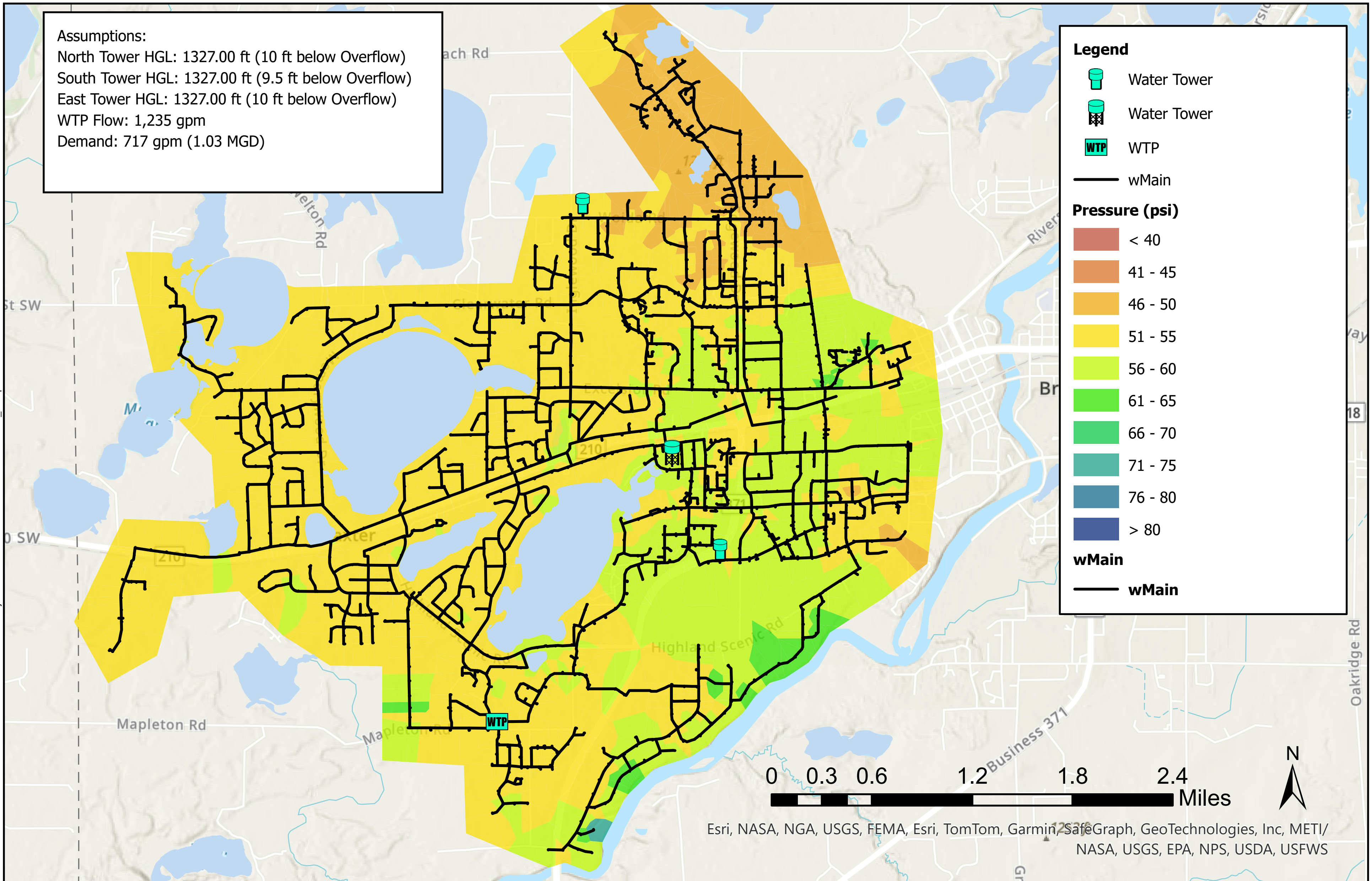
Criterial	Static Count	Residual Count
-2	0	0
-1	1	1
0	4	2
1	5	3
2	4	8
Sum	14	14
Total	14	14
Percentage	**100%**	**100%**



Macro Calibration
June 2024
Hydraulic Grade Line (ft)
1340.00
1339.00
1338.00
1337.00
1336.00
1335.00
1334.00
1333.00
1332.00
1331.00
1330.00
1329.00
1328.00
1327.00
1326.00
24
32
40
48
56
64
72
80
88
96
104
112
120
128
136
144
152
160
168
Duration (hrs)
Interconnect - Pressure Monitor 1269
WTP - Pressure Monitor 1270
East Tower - Pressure Monitor 6335
North Tower - Pressure Monitor 6336
Model 1269
Model 6336
Model 6335
Model 1270

Appendix C

Existing Water Model Results



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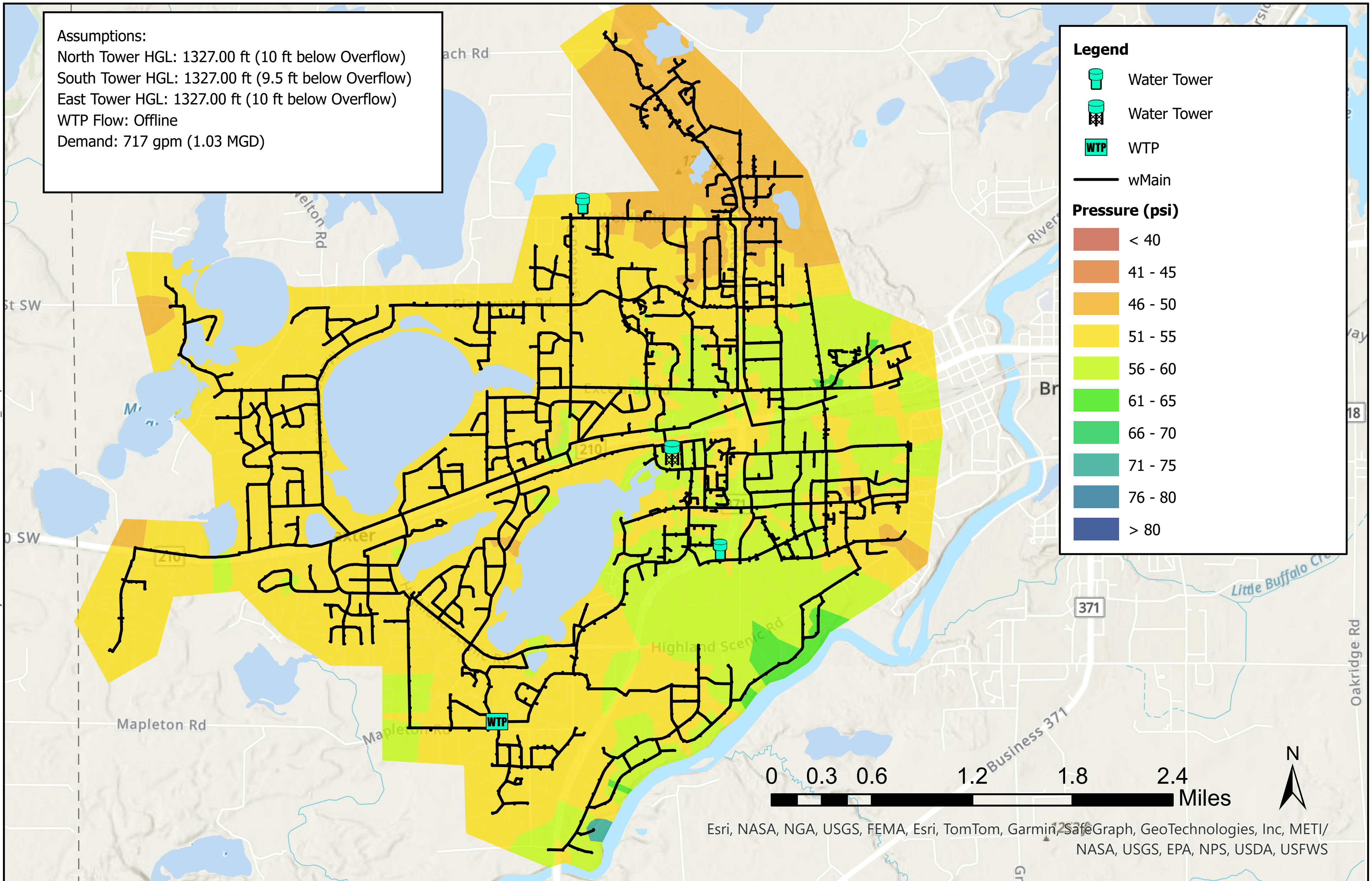
Projection:
Source:

EXISTING SYSTEM PRESSURE AVERAGE DAY DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.1



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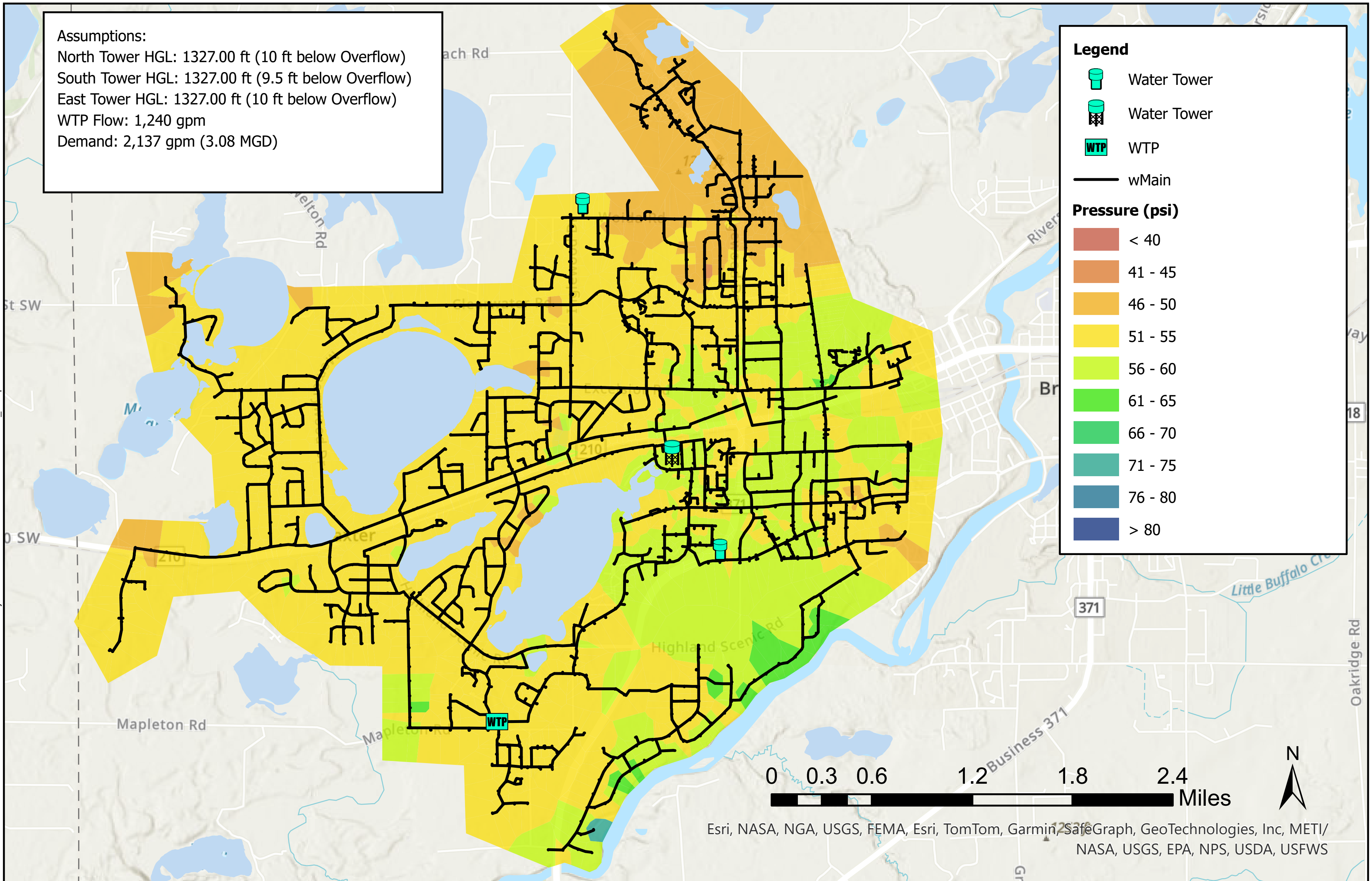
EXISTING SYSTEM PRESSURE
AVERAGE DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.2



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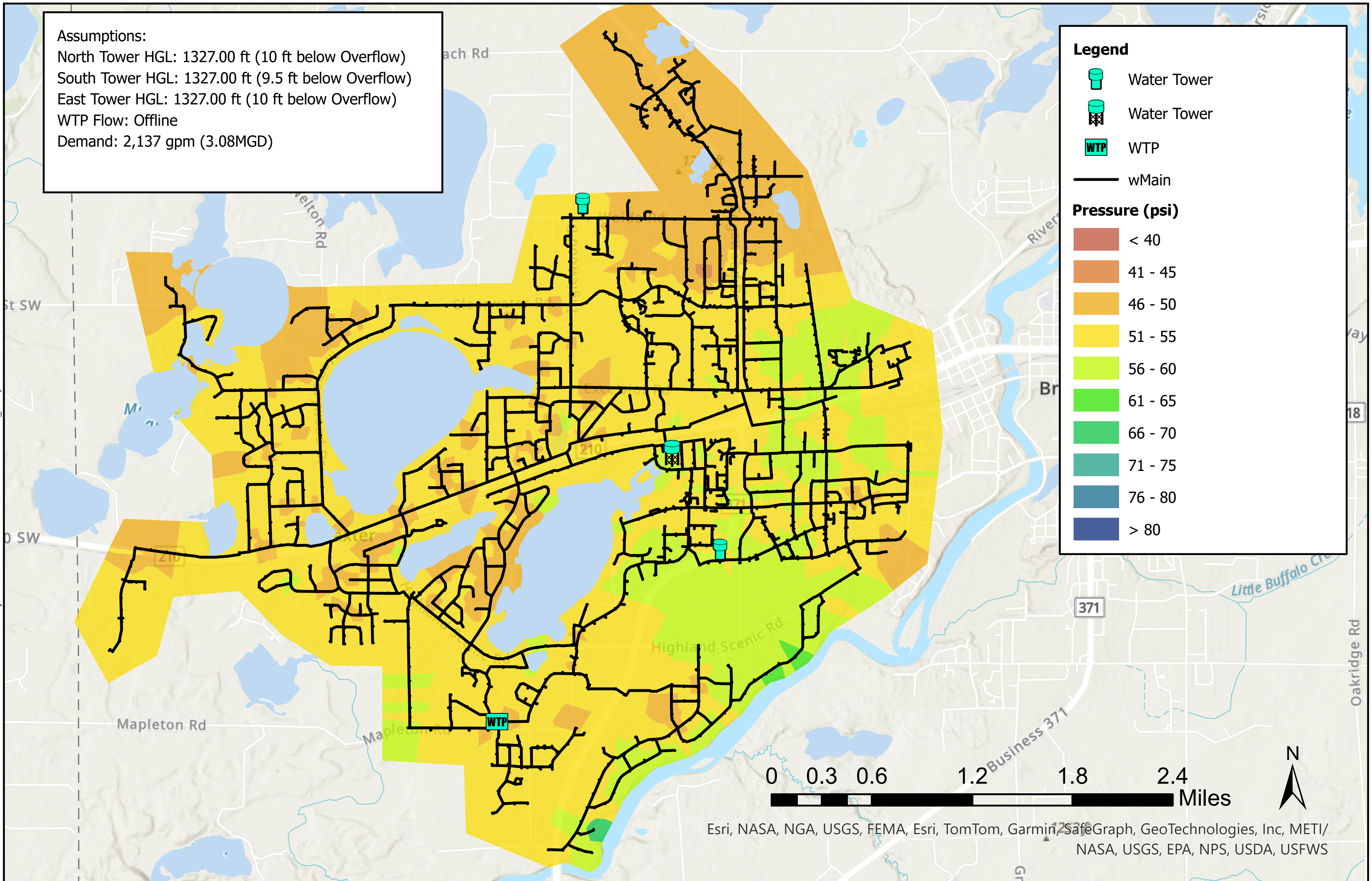
EXISTING SYSTEM PRESSURE
MAXIMUM DAY DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.3

Assumptions:
North Tower HGL: 1327.00 ft (10 ft below Overflow)
South Tower HGL: 1327.00 ft (9.5 ft below Overflow)
East Tower HGL: 1327.00 ft (10 ft below Overflow)
WTP Flow: Offline
Demand: 2,137 gpm (3.08MGD)



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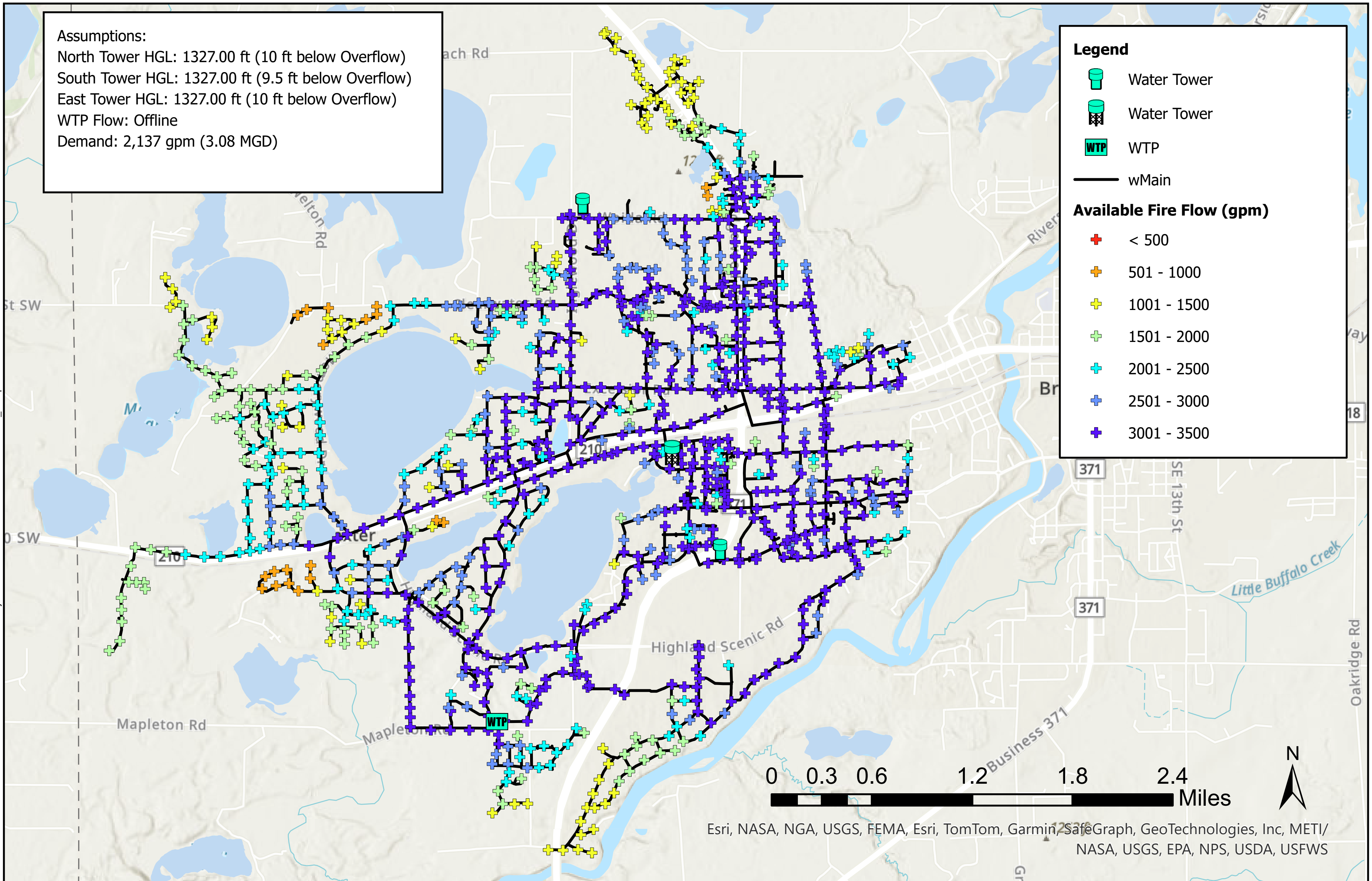
EXISTING SYSTEM PRESSURE
MAXIMUM DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.4



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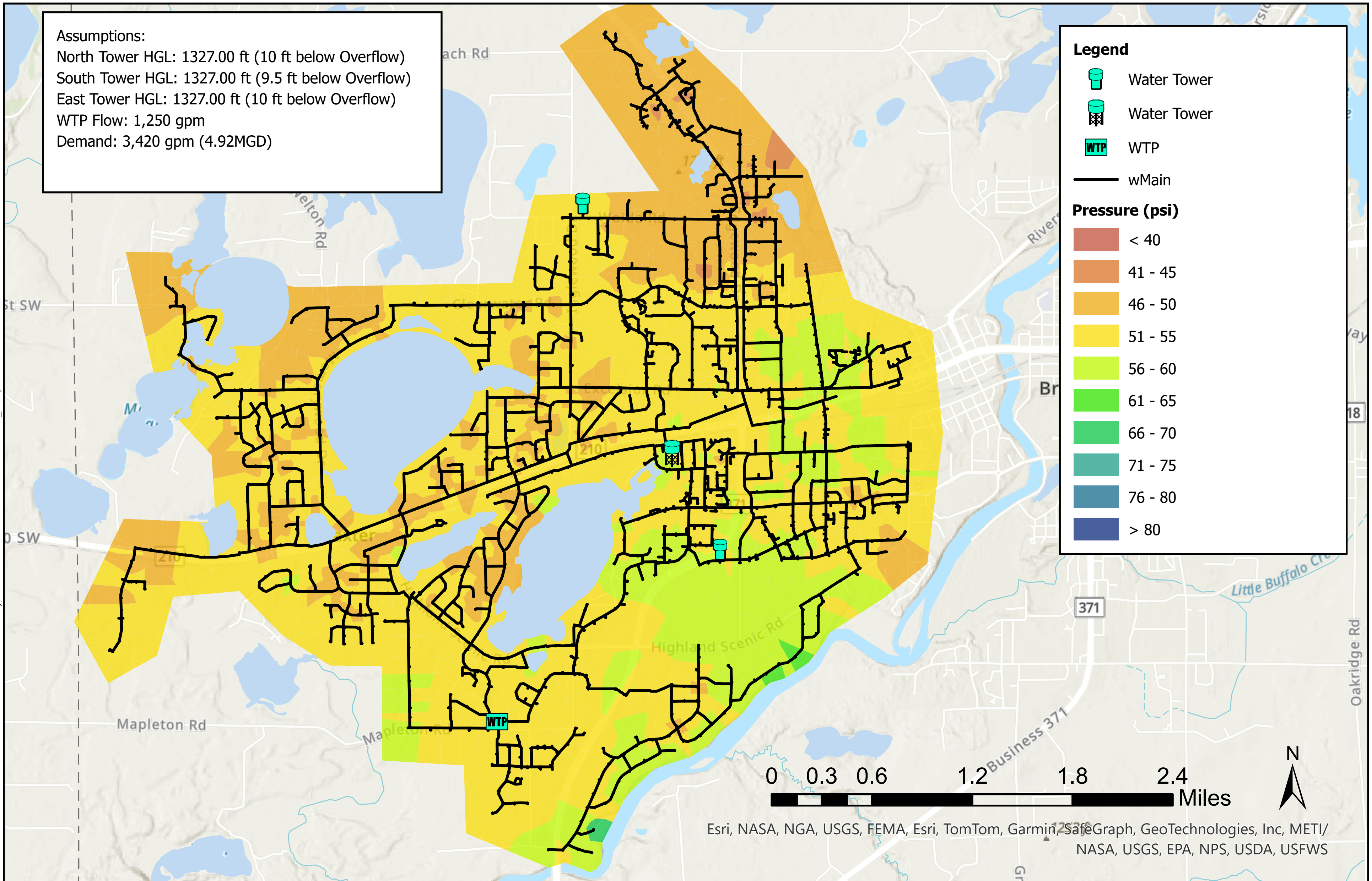
EXISTING SYSTEM FIRE FLOW
MAXIMUM DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.5



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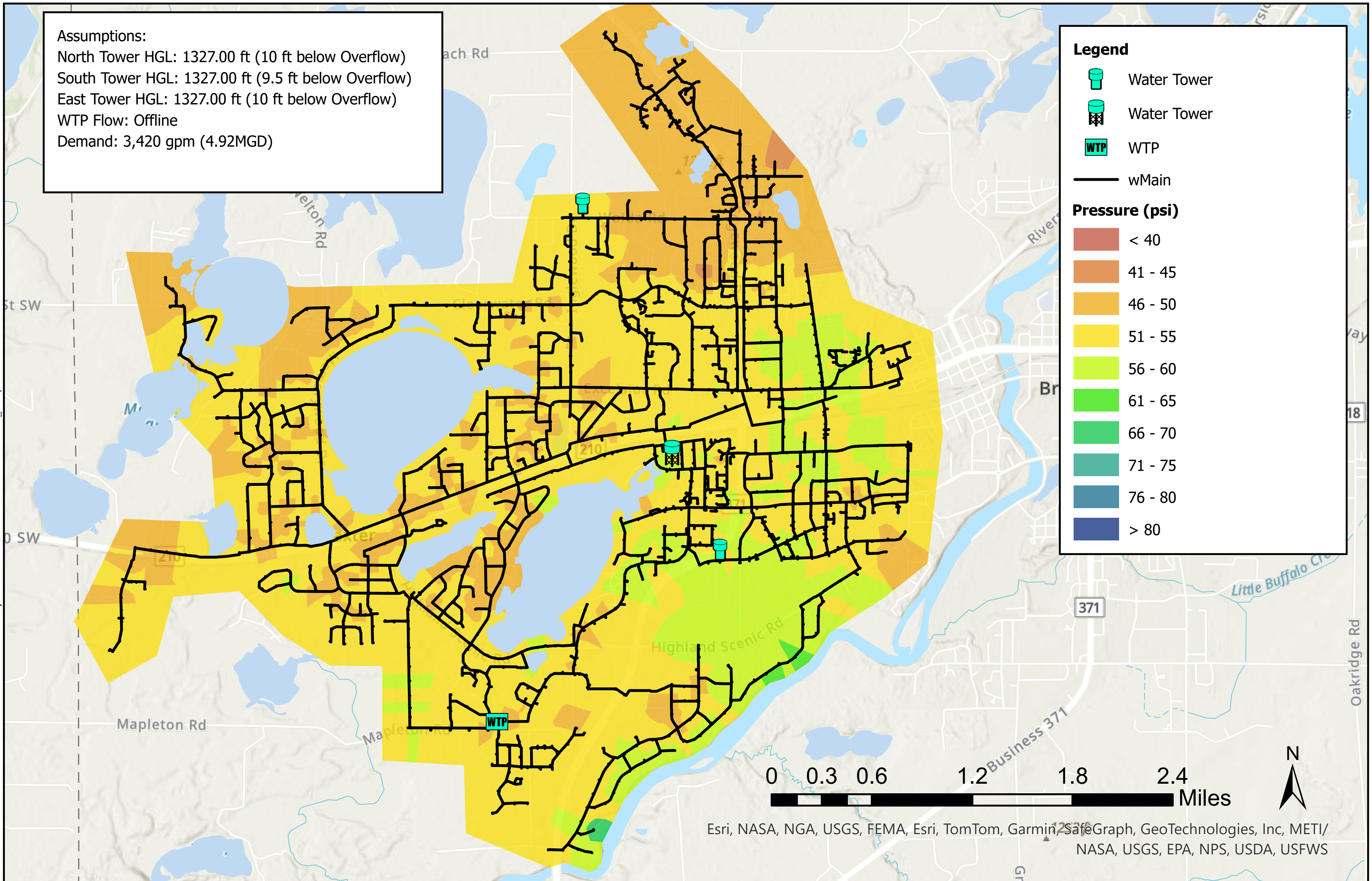
EXISTING SYSTEM PRESSURE
PEAK HOUR DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.6



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Projection:
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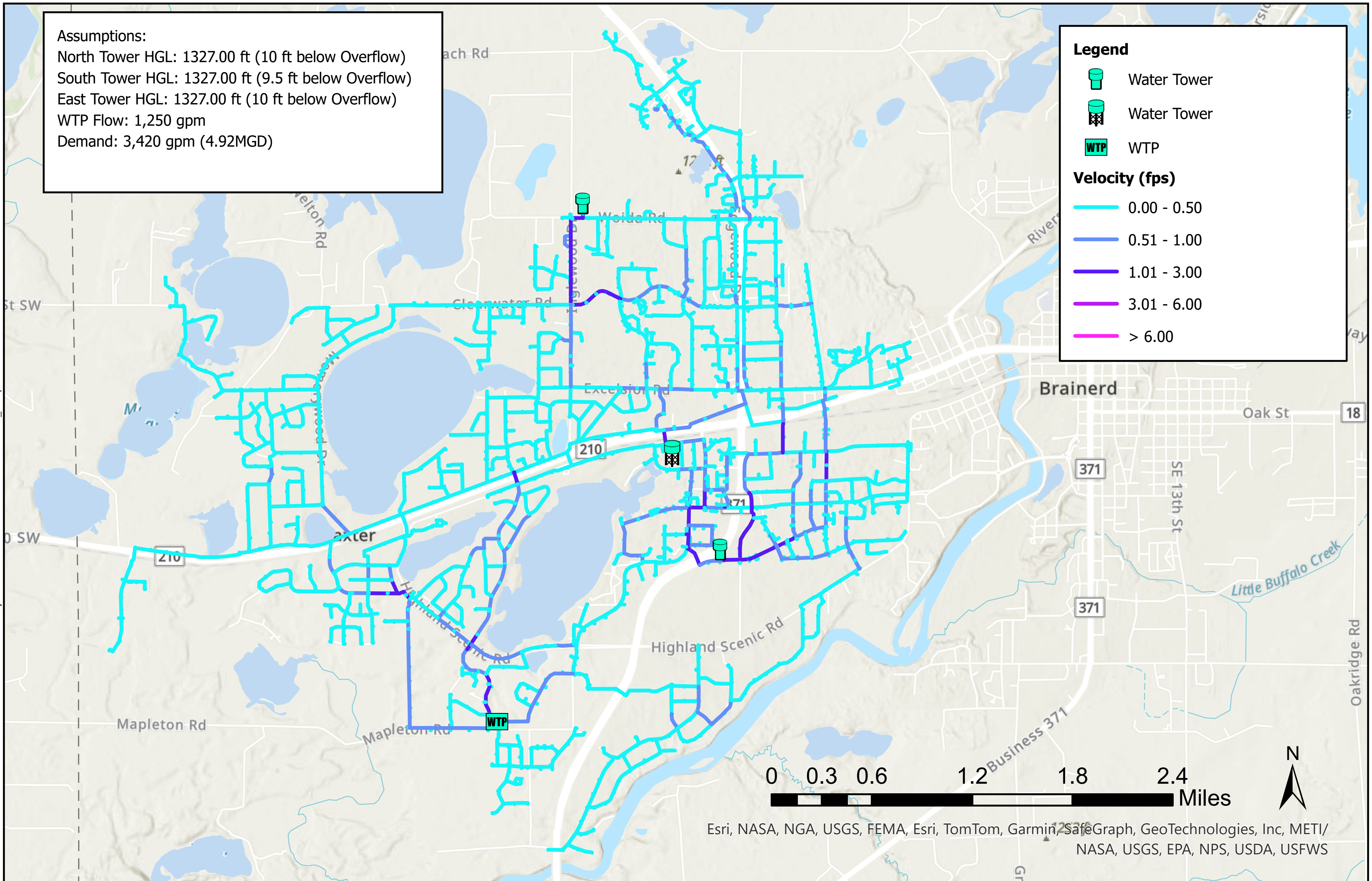
EXISTING SYSTEM PRESSURE PEAK HOUR DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.7



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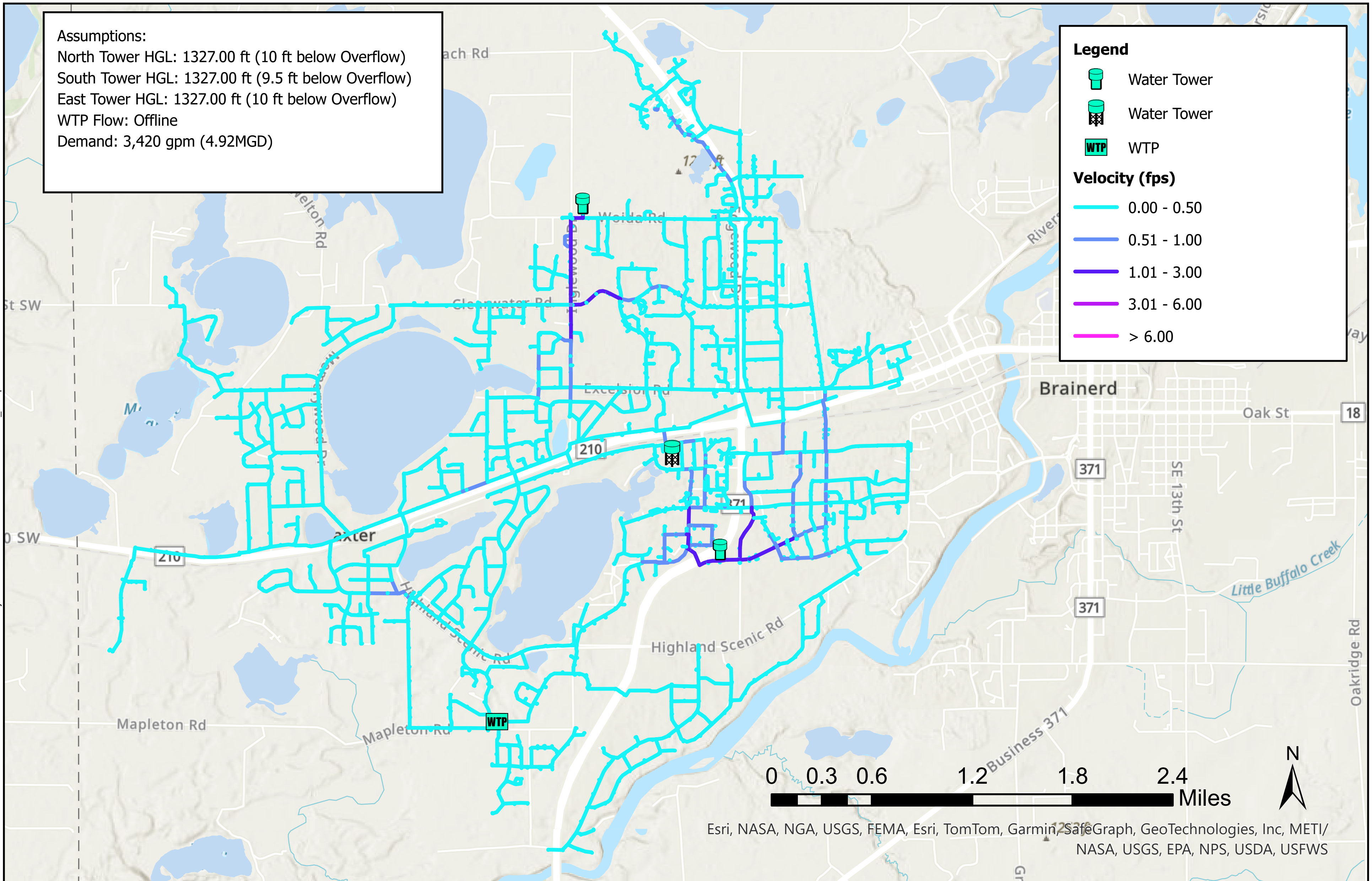
EXISTING SYSTEM VELOCITY
PEAK HOUR DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.8



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EXISTING SYSTEM VELOCITY PEAK HOUR DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure C.9

Appendix D

HWY 371-210 Interchange Anlaysis

Hwy 371 and Hwy 210
Baxter Intersection Improvement Project

Project update: Summer 2024

DEPARTMENT OF TRANSPORTATION

About the project

MnDOT, in partnership with the city of Baxter and Crow Wing County, plan to design and construct a new intersection at Hwy 371 and Hwy 210, which includes the BNSF railroad. This intersection is critical for both the local community and the greater region.

The project will identify, prioritize, and select a preliminary design through a comprehensive analysis of existing and future demographics, land use, development, transportation operations and safety data.

Planning and design is expected to continue through 2027, with construction anticipated to begin in 2028. When complete, the project will improve access, safety and traffic flow through the Brainerd Lakes area.

Project goals

- **Understand intersection issues and needs**
- **Identify future improvements that support access and traffic flow**
- **Develop a community supported preliminary design**
- **Improves motorist and pedestrian access and safety**

Project schedule

Phase 1

(Summer/fall 2024)

Introduce the project, collect further feedback on issues and needs and present and collect feedback on initial concepts

Phase 2

(Fall 2024 – Spring 2025)

Present and collect feedback on refined design concept

Phase 3

(Spring - fall 2025)

Present final design concept and preliminary layout

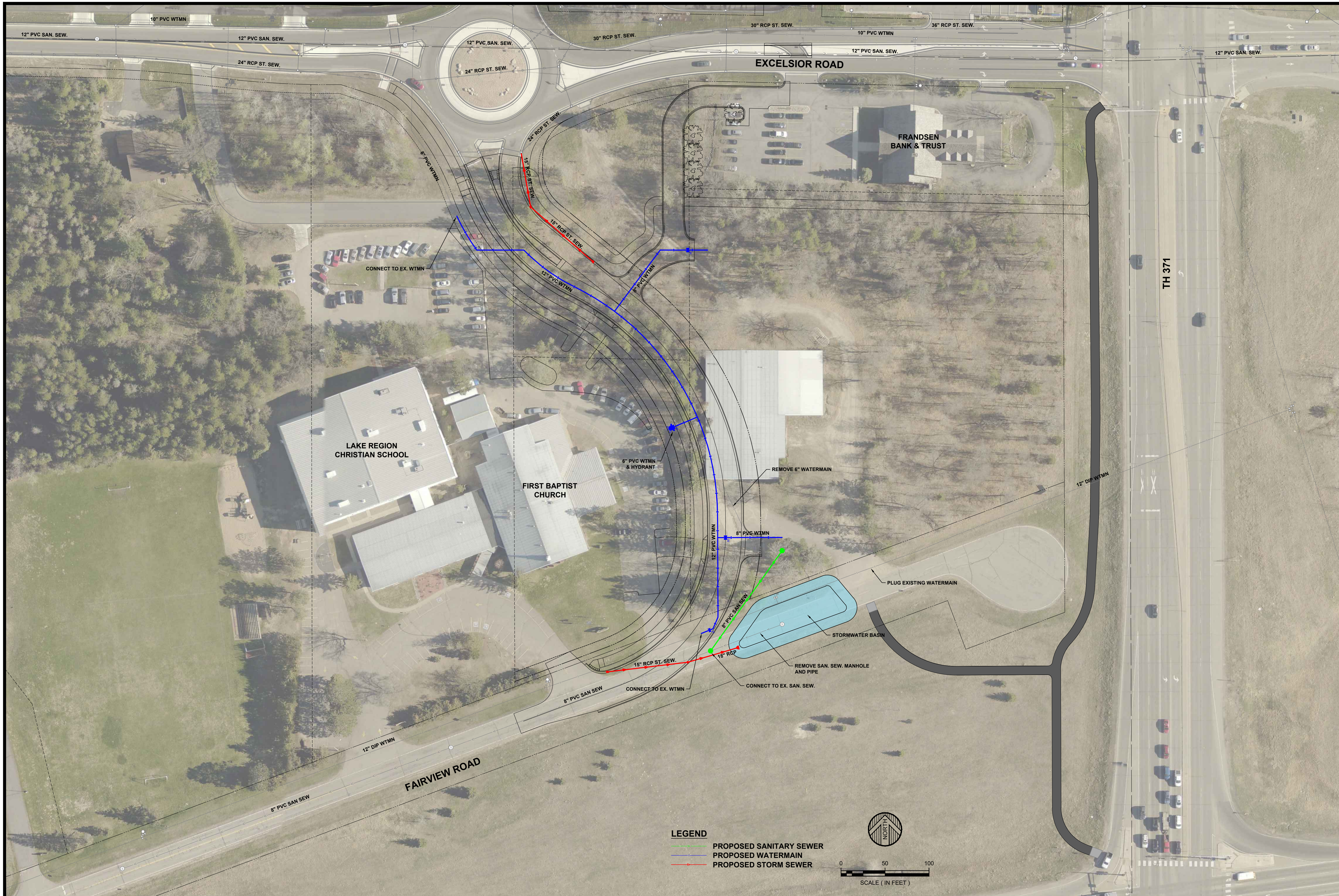
For more information

Eric Schiller
Project Manager
MnDOT
218-821-6552
eric.schiller@state.mn.us

Visit our project website to learn more!

Sign up for email updates on our website.

talk.dot.state.mn.us/hwy-371-and-hwy-210-baxter-intersection-improvement-project



WIDSETH SMITH NOLTING
Engineering | Architecture | Surveying | Environmental

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DATE	REV#	REVISIONS DESCRIPTION	BY

DATE: JUNE 2024
SCALE: AS SHOWN
DRAWN BY: A.L.W.
CHECKED BY: A.L.W.
JOB NUMBER: 2024-10124

FAIRVIEW ROAD EXTENSION TO EXCELSIOR ROAD
CITY OF BAXTER
BAXTER, MINNESOTA

FUGURE 1 - UTILITY IMPROVEMENTS

SHEET NO.
FIG 1

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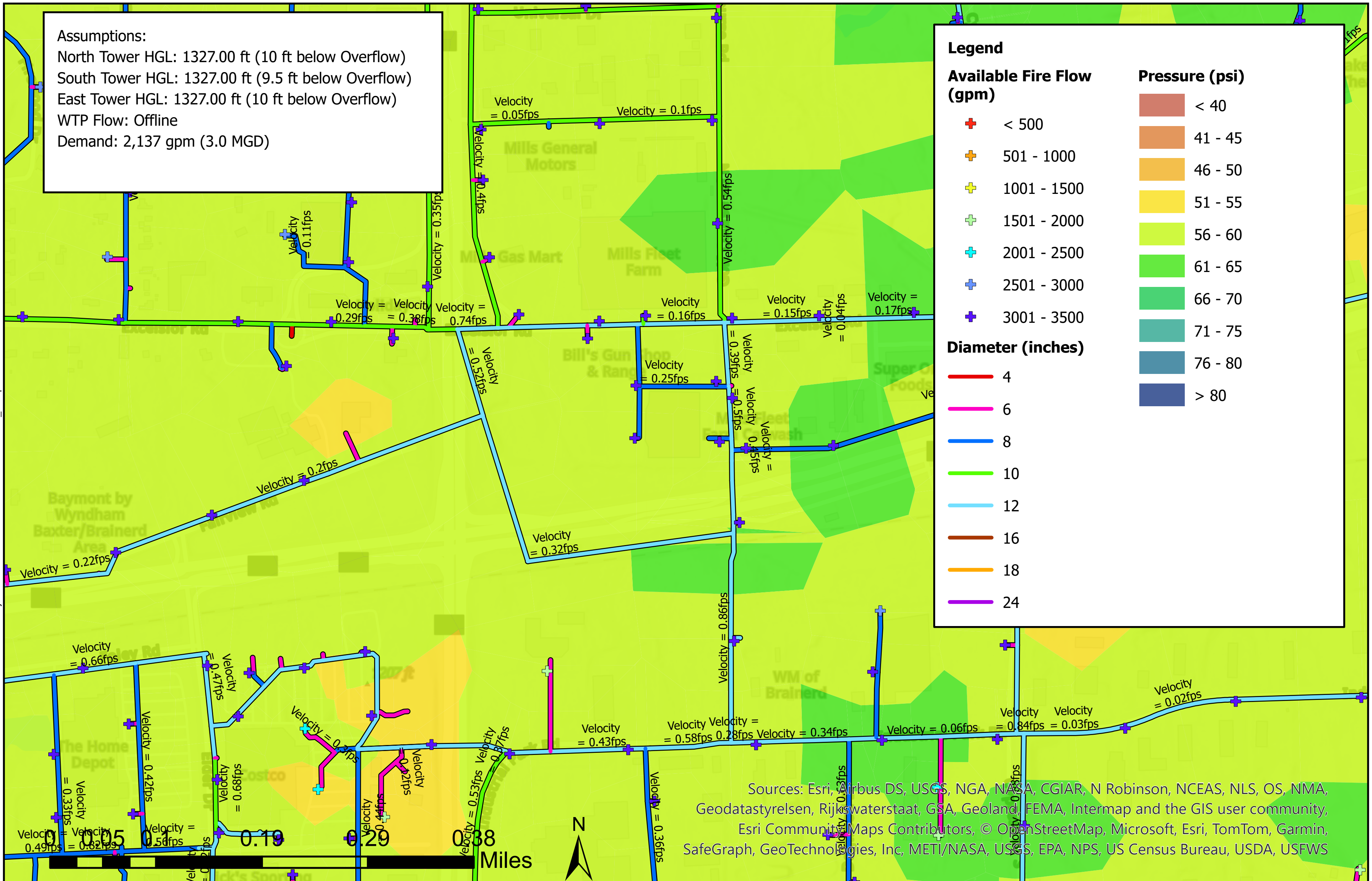

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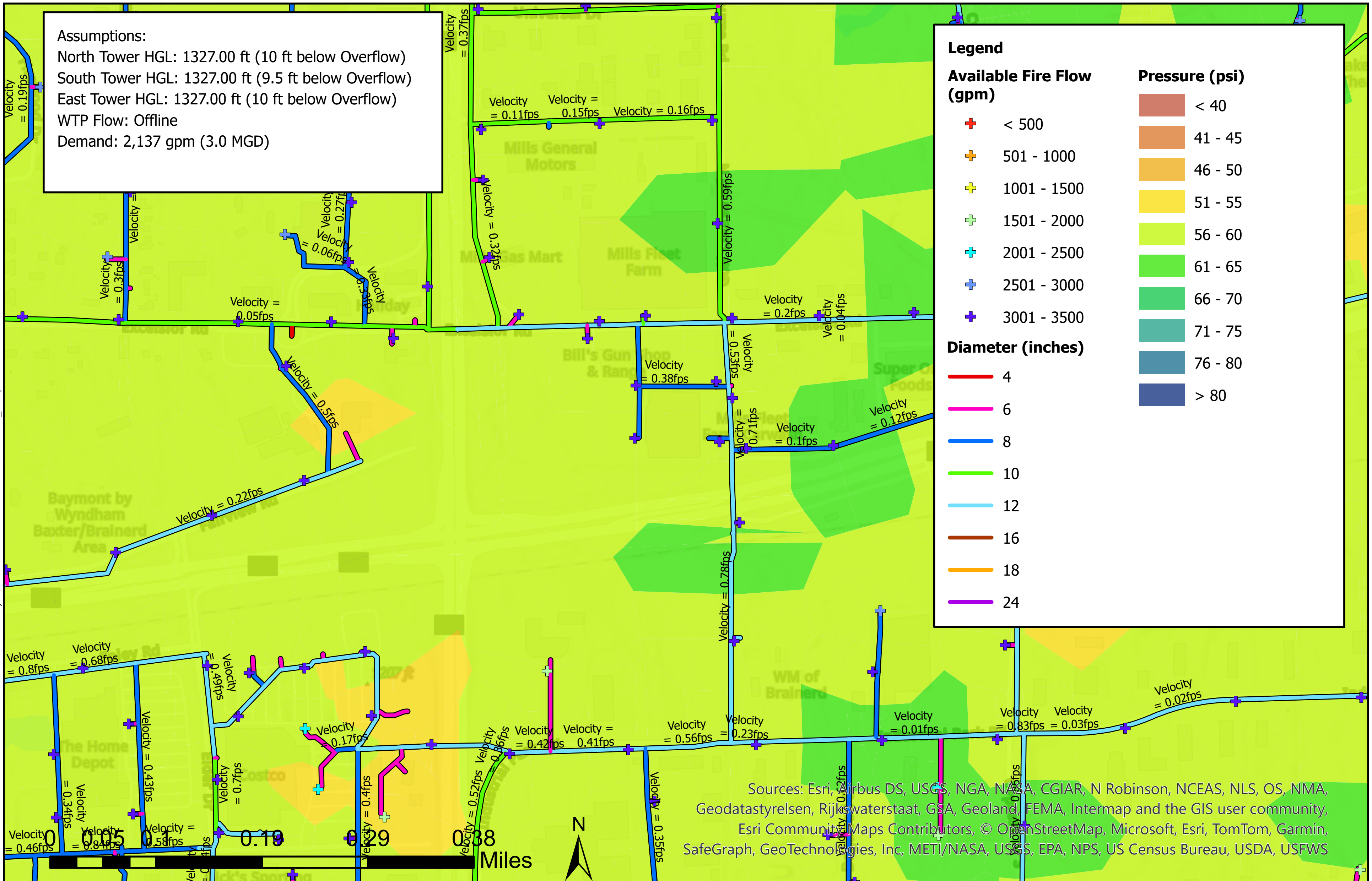
Source:

NEAR TERM PRESSURE & FIRE FLOW - EXISTING MAXIMUM DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure D.1



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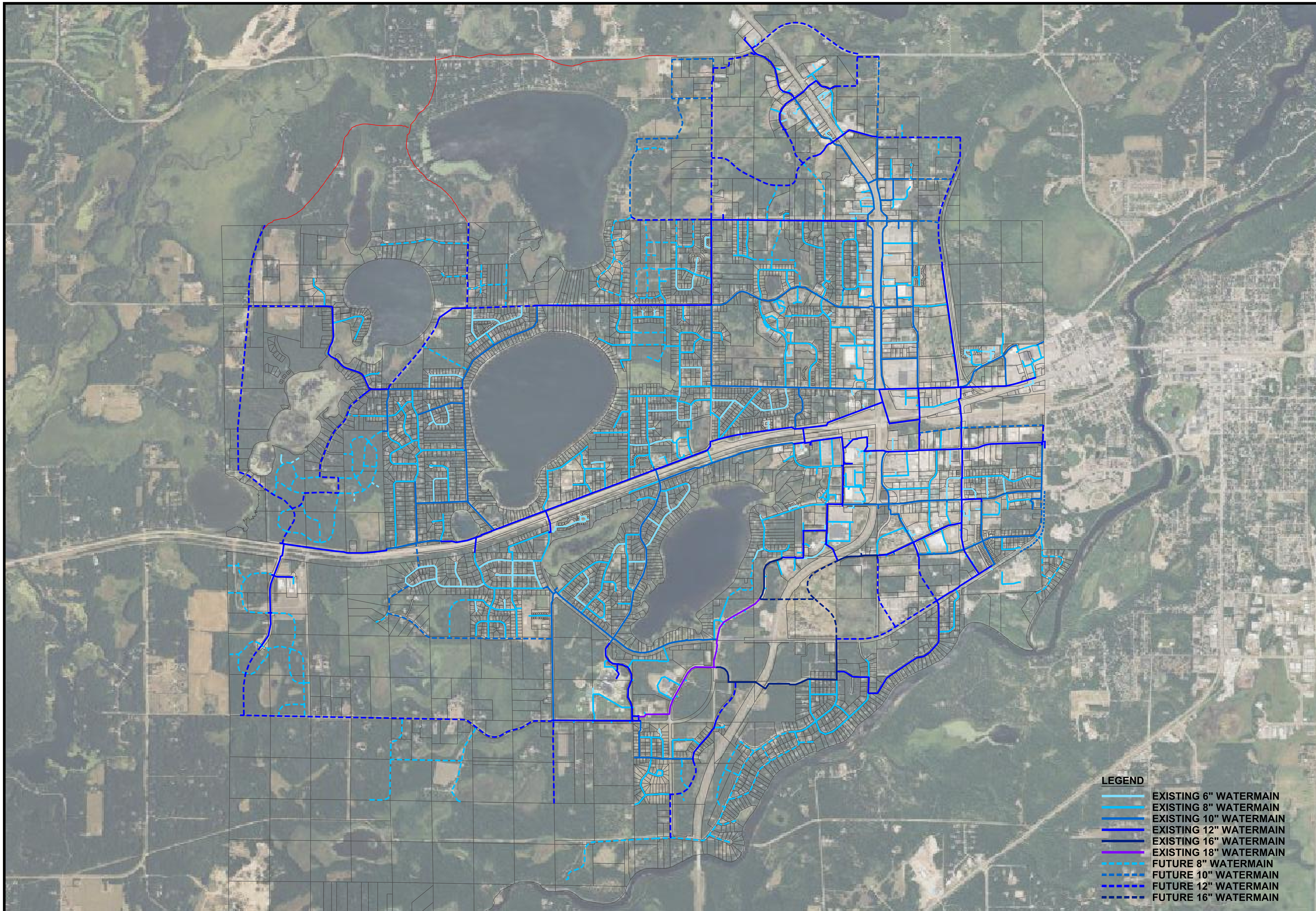
NEAR TERM PRESSURE & FIRE FLOW - IMPROVEMENT MAXIMUM DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure D.2

Appendix E

Future Water System Planning and Modeling



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ARIC WELCH DATE: #### LIC. NO. ####

DATE	REV#	REVISIONS DESCRIPTION	BY

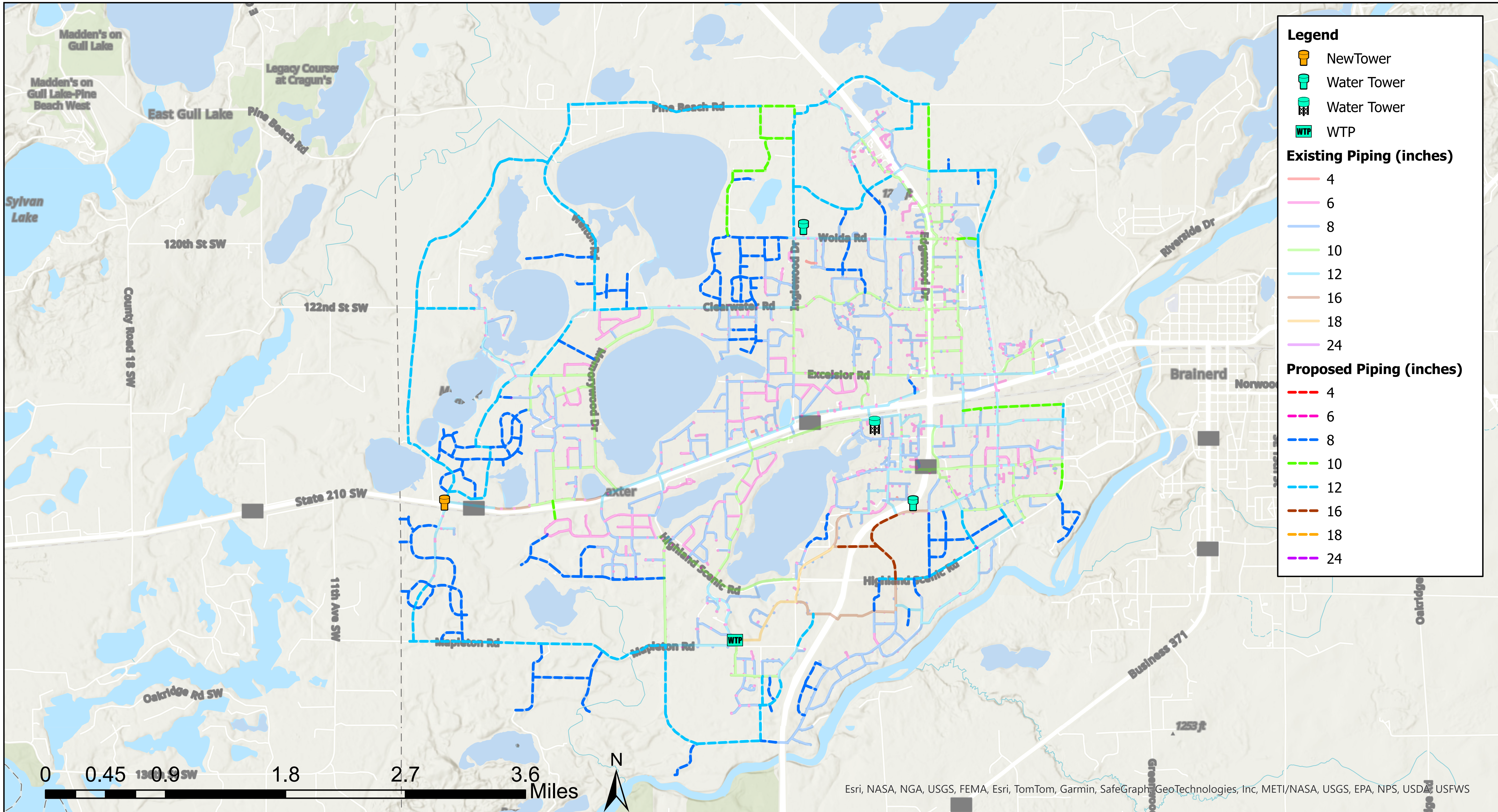
DATE: SEPT 2023
SCALE: NTS
DRAWN BY: A.L.W.
CHECKED BY: A.L.W.
JOB NUMBER: K:CITY OF BAXTER

LONG RANGE WATER MAP
CITY OF BAXTER
BAXTER, MINNESOTA

LONG RANGE WATER MAP

SHEET NO.
####

SHEET #### OF ####



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ULTIMATE SYSTEM PLANNING MAP

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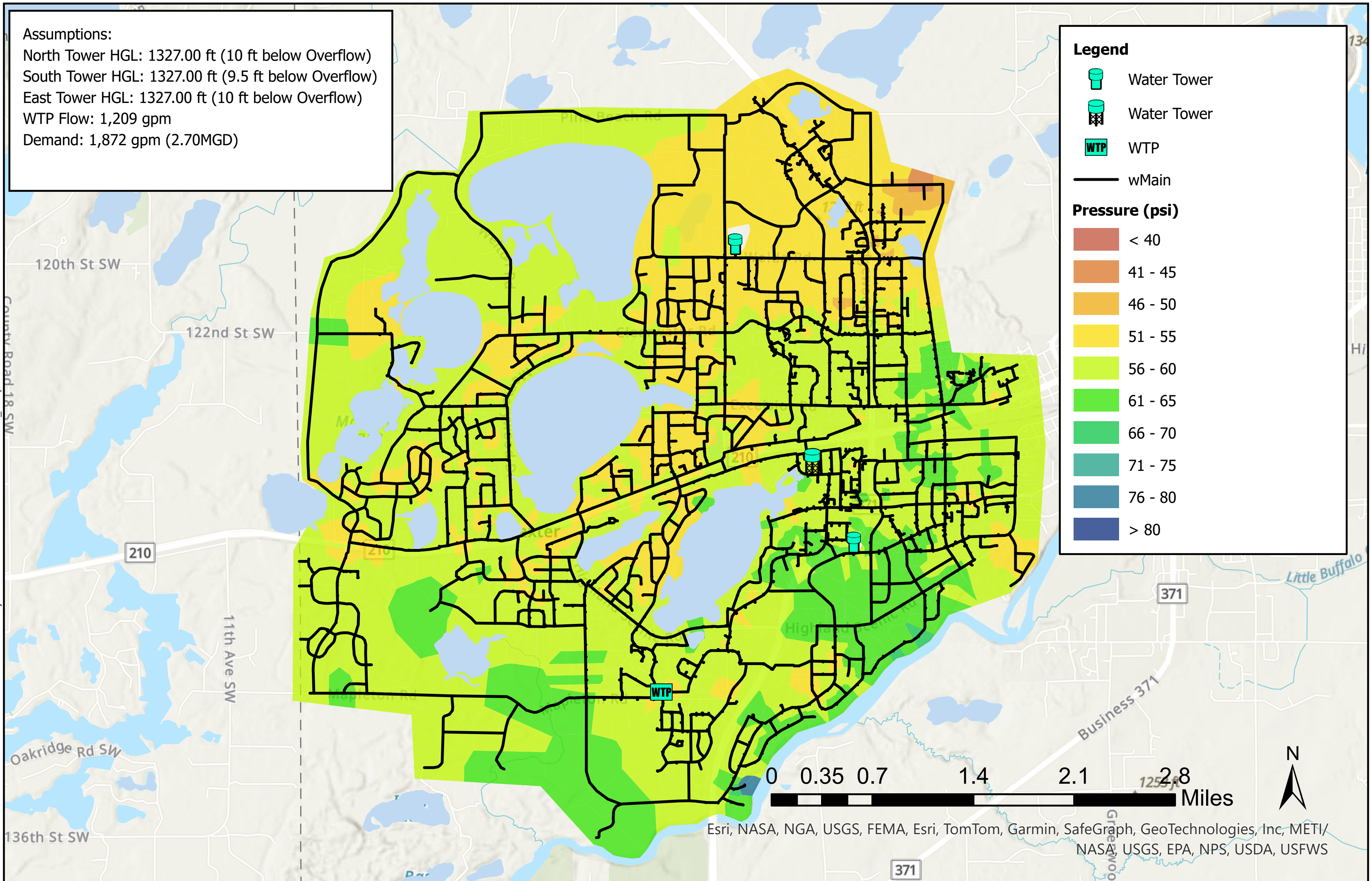
Baxter, Minnesota

Figure 6.1



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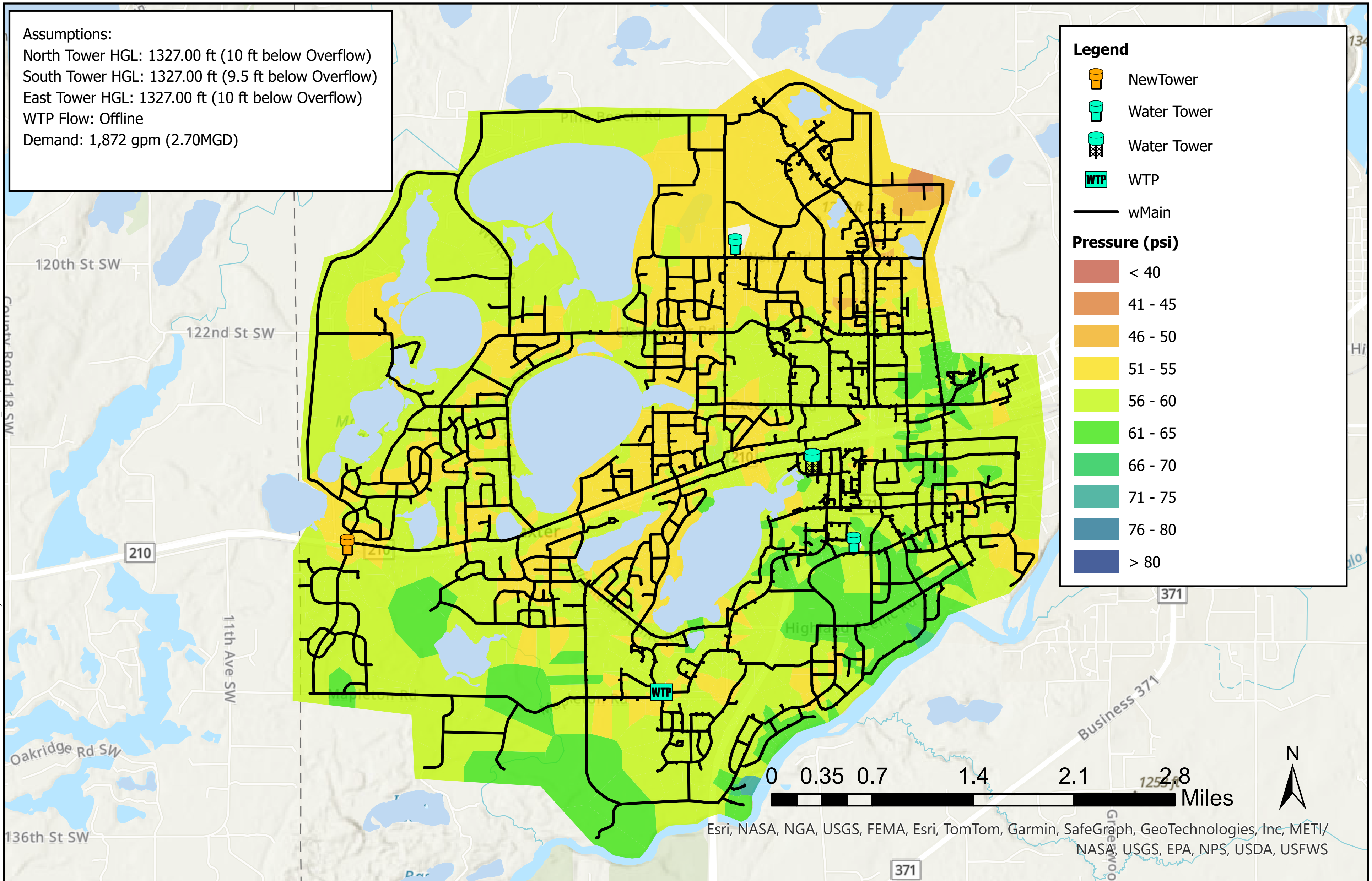
ULTIMATE SYSTEM PRESSURE
AVERAGE DAY DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure E.1



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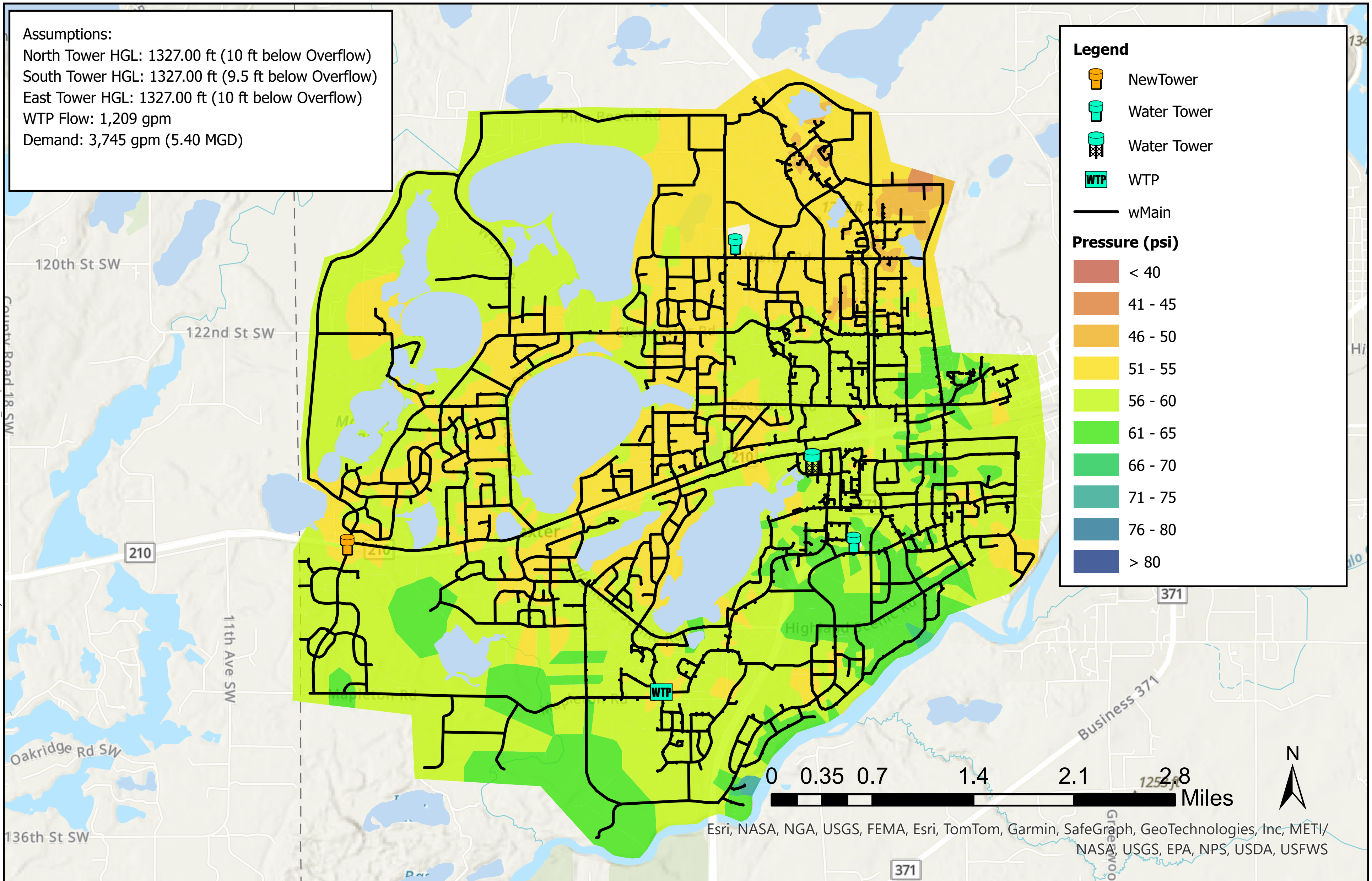
ULTIMATE SYSTEM PRESSURE AVERAGE DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure E.2



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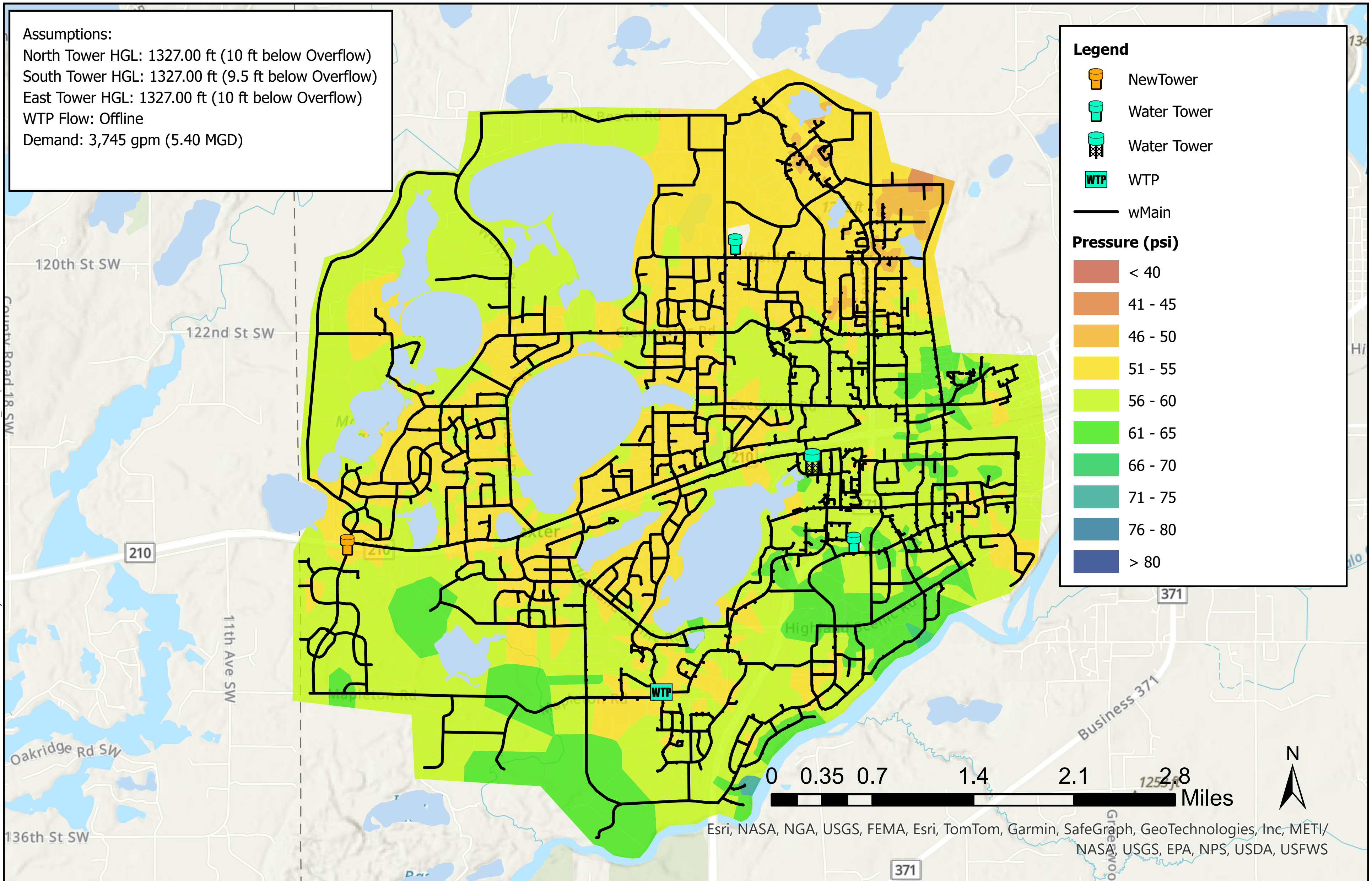
2024 Baxter Water Model
Baxter, Minnesota

Figure E.3



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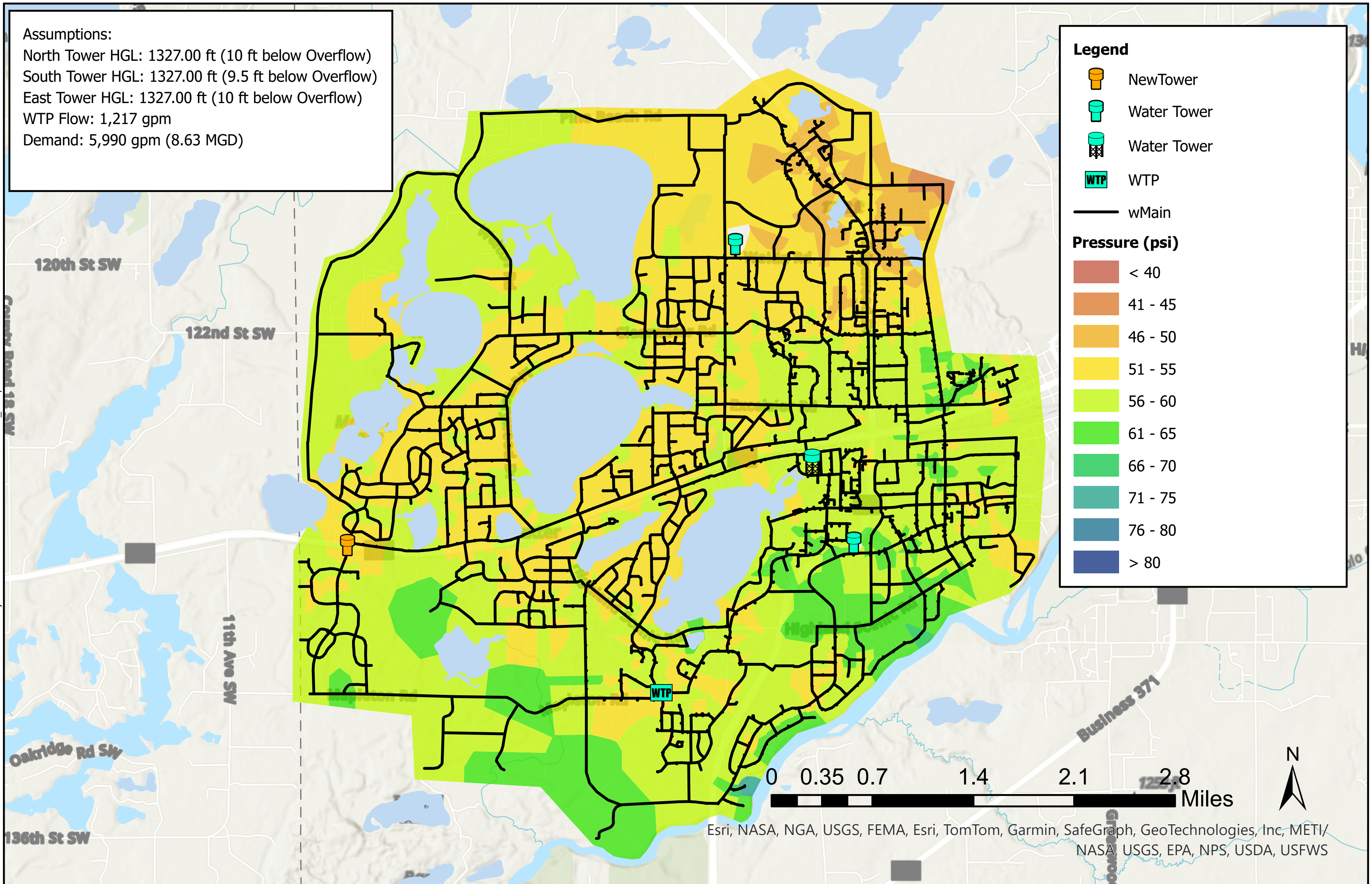
Projection:
Source:

ULTIMATE SYSTEM PRESSURE
MAXIMUM DAY DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure E.4



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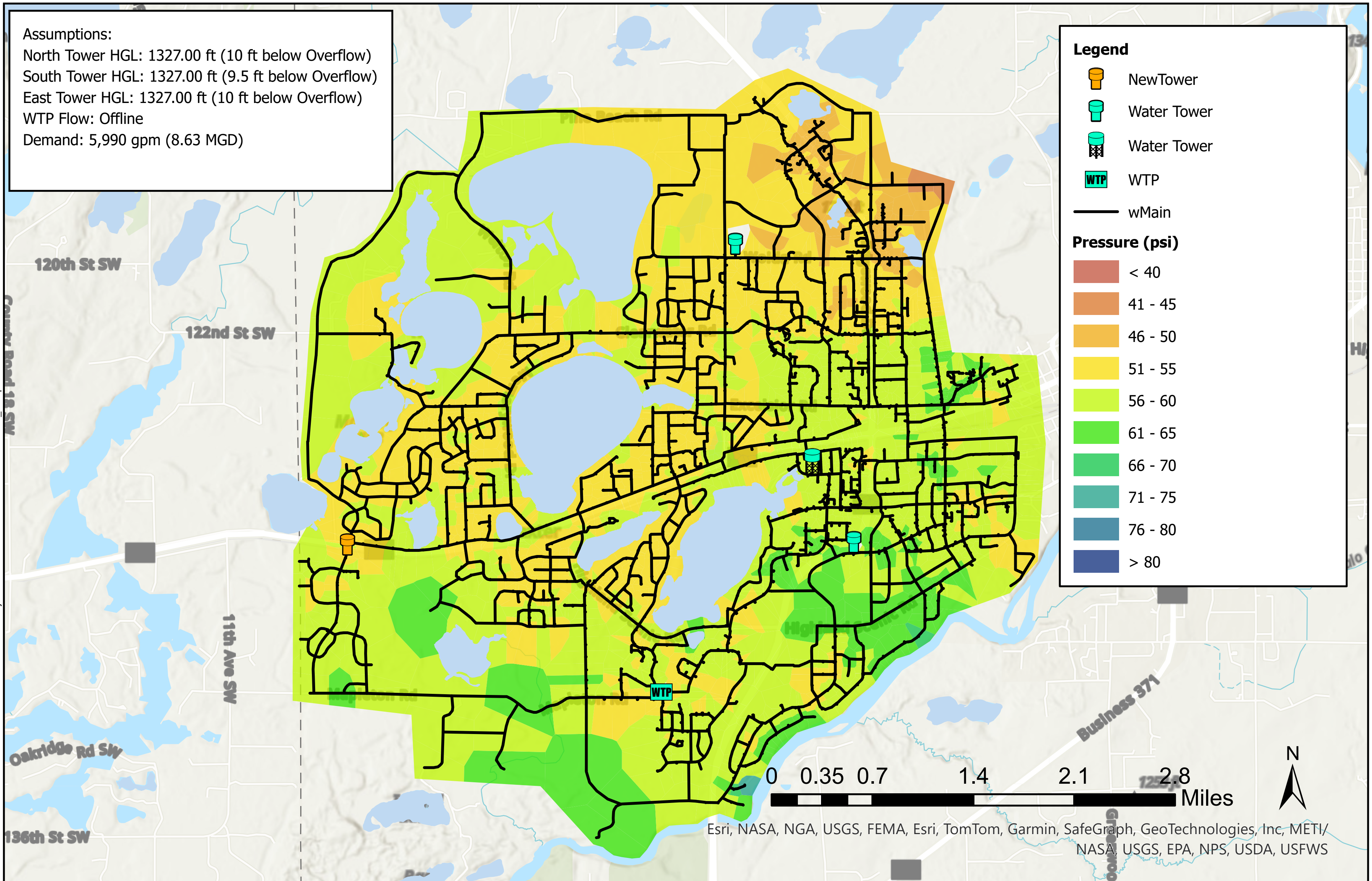
PEAK HOUR DEMAND - WTP ONLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure E.5



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Projection:
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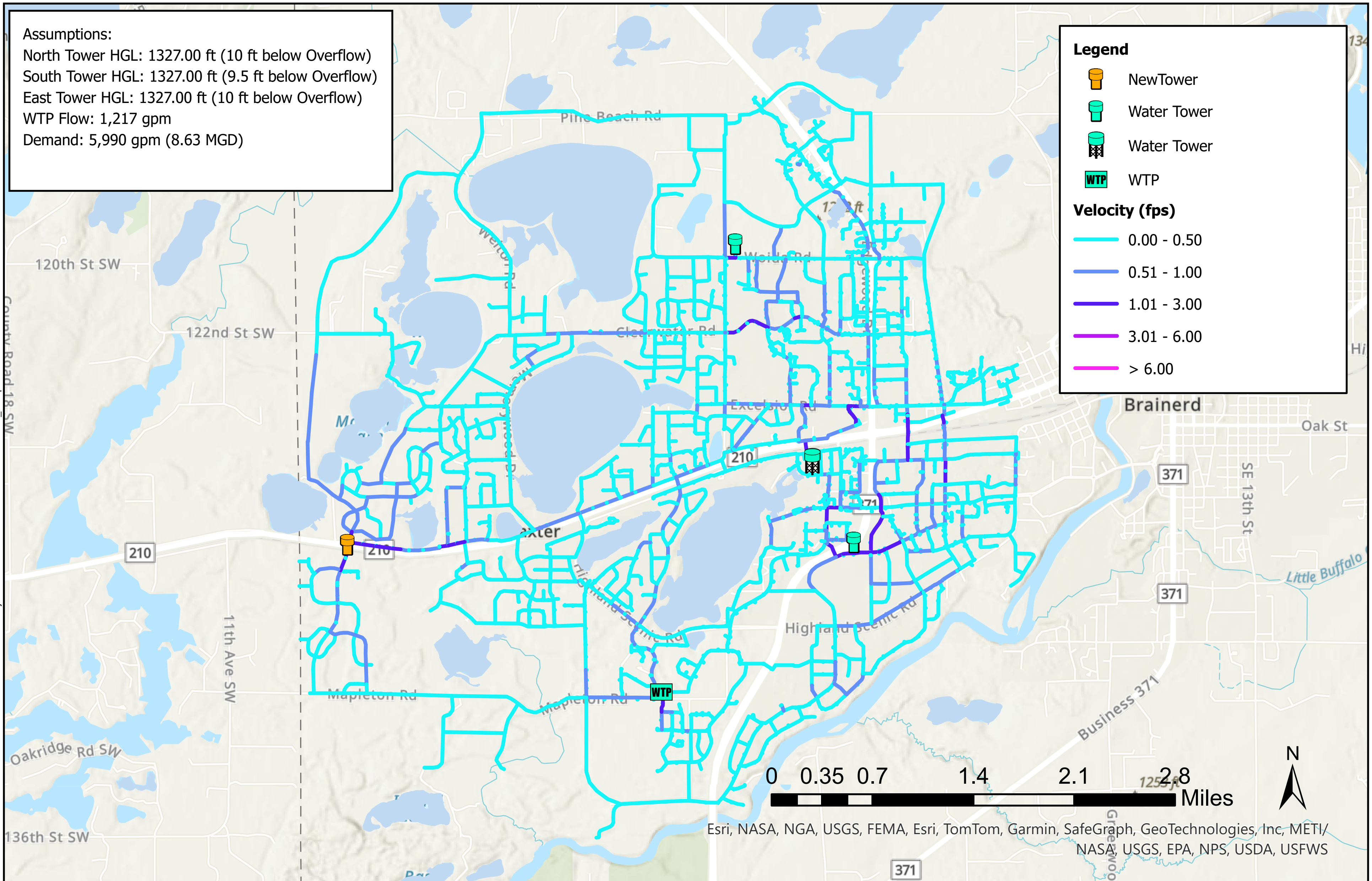
ULTIMATE SYSTEM PRESSURE
PEAK HOUR DEMAND - WTP OFFLINE

2024 Baxter Water Model
Baxter, Minnesota

Figure
E.6



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ULTIMATE SYSTEM VELOCITY PEAK HOUR DEMAND - WTP ONLINE

2024 Baxter Water Model
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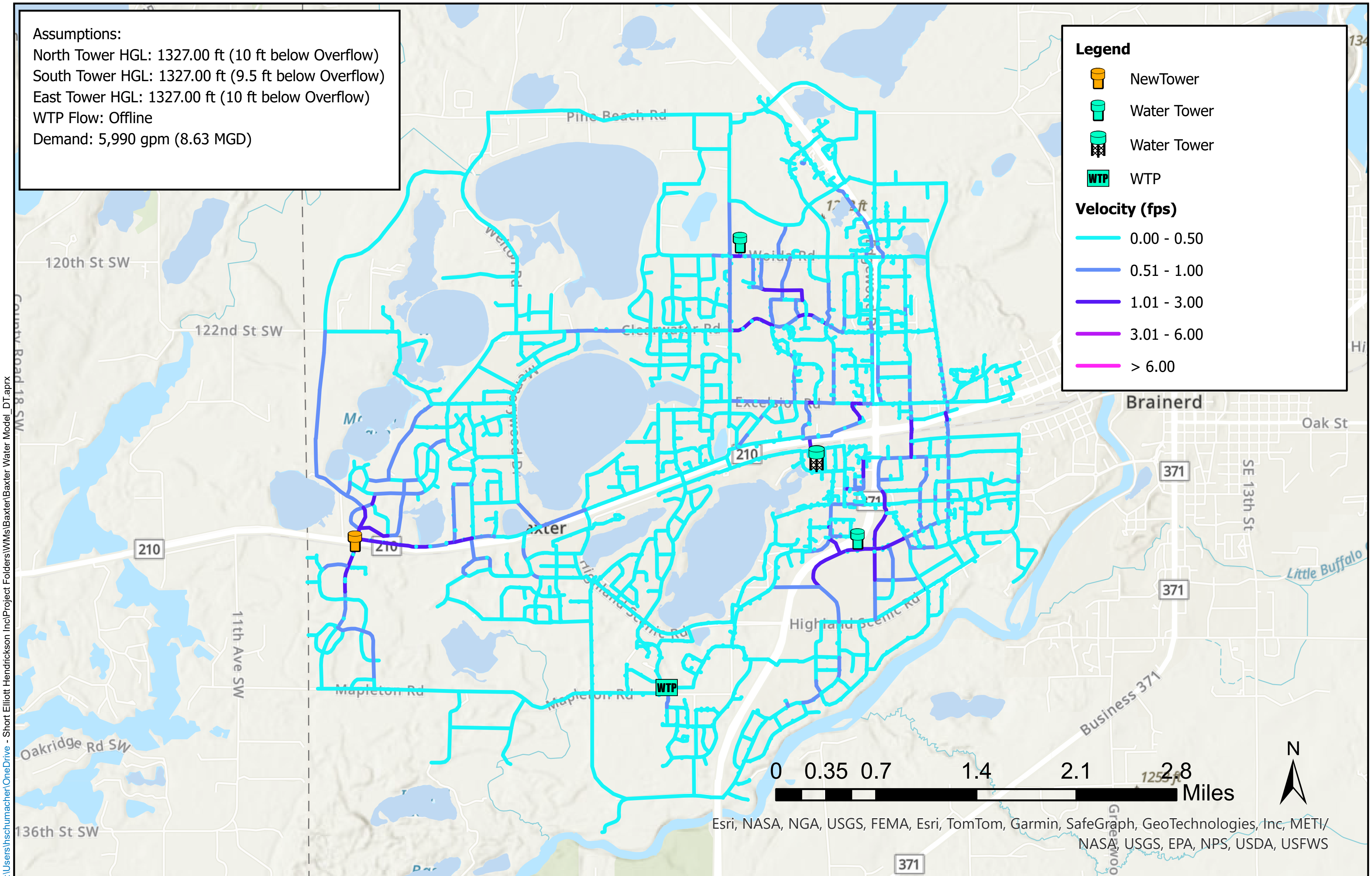
Figure E.7



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PEAK HOUR DEMAND - WTP OFFLINE

2024 Baxter Water Model
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Figure E.8

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