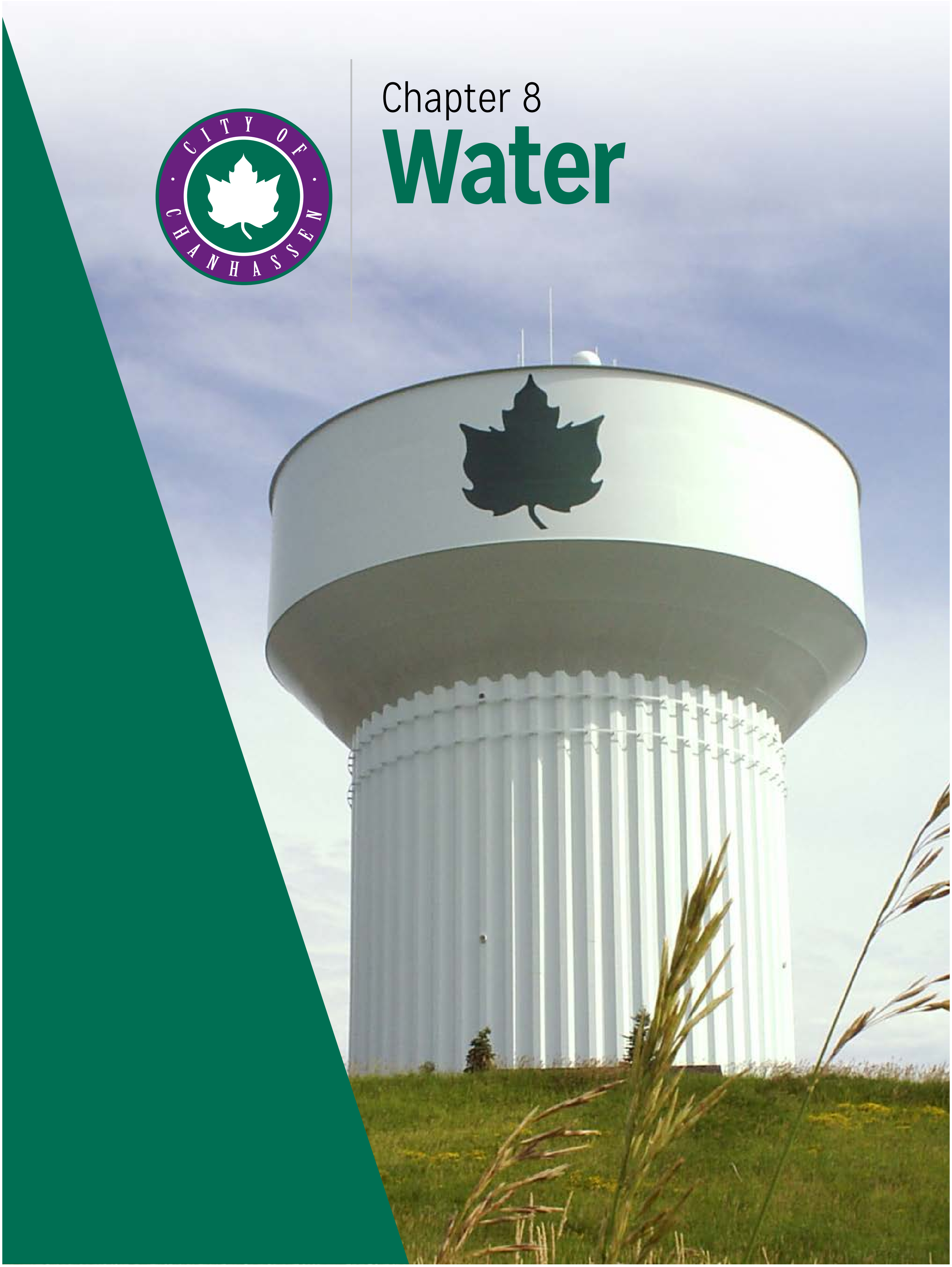
Chapter 8
Water



8 | Comprehensive Water System Plan

8.1 | Introduction

Current and projected growth and development in Chanhassen, has created a need for improvements to the water system in order to meet anticipated water demands. The water distribution system has been expanded and improved in the decade since the last comprehensive water plan was completed. Now, the water system can be re-evaluated in light of recent improvements and the need for water system improvements can be re-evaluated. The updated water system model can be used to analyze demands, available supply capacity and storage, and available flow rates and pressures throughout the distribution system.

For this purpose, SEH has updated the city's existing water with water main, PRV, treatment and storage improvements that have occurred since the last model update. Additionally, we have processed updated demand data to geo-located water demands in the system so that they are modeled in the area of occurrence. Furthermore, regions of future development expected to create additional system demands were identified with the help of city staff, along with potential water system improvements that will allow the system to meet these expected demands.

The computer model was updated using WaterGEMS v8i. The resulting product is a tool that can be used for hydraulic analysis of the water system and scenario planning. The model can also be built-upon in the future if so desired to analyze water chemistry/water quality throughout the distribution system. In recent years, the city has utilized the model as a valuable tool for:

- Identification of future locations of critical supply and storage facilities so land can be purchased and/or set aside before development begins in the designated area.
- Provide a long range plan for water system upgrades/expansion so that proposed construction projects include properly sized water mains to allow for future development needs.
- Identify deficiencies in the water system and corresponding improvements to reduce or eliminate these deficiencies.

8.2 | Existing Facilities

The Chanhassen water system is composed of storage, supply, treatment and distribution components as described in the following paragraphs. Storage, supply and treatment facilities are listed in the tables below.

Storage

Storage facilities on a water system allow a more constant supply during variable demand conditions. During high demands when water customers are using a greater volume of water, part of that demand can be met by storage reserves in addition to direct pumping from wells. During low demand conditions, the well pumps can continue to operate with excess supply going to fill storage for later withdrawal.

In addition to this operational function, storage tanks can serve as an emergency water source in the case of a supply failure (i.e. power outage, well maintenance, etc.); they also increase the amount of water available during a fire and they stabilize water system pressures.

Table 8.1 | Existing Water Storage Facilities

Facility	Pressure Zone	Volume (MG)	Useable Volume (MG)	Overflow Elevation (ft)	Style
Arboretum	Low	1.50	1.50	1120	Fluted Column - Elevated
Lake Lucy	Low	3.50	1.75	1120	Steel- Ground Storage Tank
Minnetonka Middle School - West	High	0.75	0.75	1200	Composite - Elevated
East WTP Clearwell	Low	0.20	0.20	NA	Concrete - Below Grade
Storage Capacity		5.95	**4.20**		

Source: City Records

Supply and Treatment

Raw (untreated) water is currently supplied to Chanhassen by means of 12 wells as listed in Table 8.2. These wells utilize the Prairie Du Chien – Jordan aquifer with the exception of wells 5, 6 and 11, which draw water from the glacial drift aquifer.

Of these 12 wells, seven pump into the east water treatment plant with the remainder pumping groundwater directly into the distribution system. The treatment plant uses a gravity filtration process to remove iron and manganese from the groundwater.

Of the wells pumping directly into the distribution system, wells 3, 15, and 9 pump into the main pressure zone, while wells 7 and 8 pump into the high zone. These wells will eventually feed the new west water treatment plant. Due to a reduction in capacity, Wells 5 and 6 were deactivated in 2008 and are not included in the well summary.

The firm well pumping capacity is that which can be supplied reliably even during maintenance activities or an emergency situation where the largest well pump might be out of service. This figure is often used for design and planning purposes, since it represents a worst-case scenario. The total operational supply capacity for Chanhassen is currently 10,600 gpm assuming the well capacities shown in Table 2 while the "firm" supply capacity is 9,350 gpm.

The east water treatment plant has a filtration capacity of 6,000 gpm as is noted in Table 8.3. There are four high service pumps that draw from the clearwell at the treatment plant, each with a capacity of 2,000 gpm. Therefore, the firm pumping capacity of the plant is 6,000 gpm.

Table 8.2 | Existing Water Production Wells

Well Name	Pressure Zone	Theoretical Capacity	Operational Capacity (gpm)	Operational Capacity (MGD)	Treatment
Well 3	Main	1,000	800	1.2	
Well 7	High	1,350	1,000	1.4	
Well 8	High	1,300	1,000	1.4	
Well 9	Main	1,000	750	1.1	
Well 15	Main	1,100	1,000	1.4	
Well 2	Main	1,000	700	1.0	
Well 4	Main	1,100	850	1.2	
Well 10	Main	1,200	700	1.0	
Well 11	Main	500	100	0.1	
Well 12	Main	1,450	1,250	1.8	
Well 13	Main	1,400	1,200	1.7	
Well 14	Main	1,450	1,250	1.8	
Total Well Capacity			**10,600**	**15.3**	
Firm Well Capacity			**9,350**	**13.8**	
Total Treated Well Capacity			**6,050**	**8.7**	
Firm Well Capacity (Treated)			**4,800**	**6.9**	
Treatment Capacity			**6,000**	**8.6**	

Source: City Records

Table 8.3 | Water Treatment Facilities

Facility	Pressure Zone	Max. Operational Capacity (gpm)	Max. Operational Capacity (MGD)
East Water Treatment Plant	Main	6,000	8.6
West Water Treatment Plant	Main	6,000	8.6
Anticipated Treatment Capacity		**12,000**	**17.3**

Source: City Records

Distribution System

The Chanhassen water system is comprised of water mains ranging in size from 6 inches to 24 inches in diameter. The system has been designed with larger trunk main loops with smaller branch mains.

The system serves an elevation range of approximately 850 feet to 1080 feet. Pressures in the distribution system are correlated with elevations with properties at higher elevations receiving lower pressure and vice-versa. Because services at relatively high elevations have unacceptably low pressures when served by the low pressure zone, a high pressure zone has been created in the northwestern part of the city, east of Lake Minnewashta. This pressure zone is served by separate wells and a storage tank as discussed in the preceding sections.

Water from the high zone can also serve demand on the low zone by passing through pressure reducing valves (PRVs) on the distribution system. These PRVs are shown in Appendix A - Figure 1. Under normal conditions, the PRVs between the high and low pressure zone remain closed. Additional PRVs are located throughout the system and maintain system pressure to the other low pressure zones. As noted earlier, areas of low land elevation have higher pressures in relation to the existing water storage tanks. When pressures exceed 80-90 psi, it is recommended to reduce these pressures to more usable levels. The Lake Riley, Inter Bluff and Lower bluff pressure zones are all service areas with lower land elevations. These areas have PRVs regulating pressure within the zone. Some of the pressure zones identified for future service have in ground vaults ready for installation of PRVs when additional development requires. Table 8.4 below provides a list of existing system PRVs and their operational status.

Table 8.4 | Existing PRV Station

Facility	Inlet Pressure Zone/HGL	Outlet Pressure Zone	Number of Valves	Valve Sizes (dia.,inch)	Housing	Status
Camden	Low	Inter Bluff	4.00		Concrete BG	Active
HWY7 & 41	High	Low	3.00	2,4,6		Active
101& 96th	Low	Inter Bluff	1.00	12		Not Active
Kiowa	Low	Lake Rielly	3.00	12,3,1.5	Concrete	Active
Lyman & Springfield	Low	Lake Rielly	1.00	12	Concrete	Active
Monk Ct	Low	Lake Rielly	3.00	12,3,1.5	Concrete	Active
Pioneer Pass	Low	Inter Bluff	1.00	12,3,1.5	Concrete	Not Active
Powers	Low	Inter Bluff	1.00	12,3,1.5	Concrete	Active
Foxwood	Low	Inter Bluff	1.00	12,3,1.5	Concrete	Active

Source: City Records

8.3 | Current Water Demand Trends

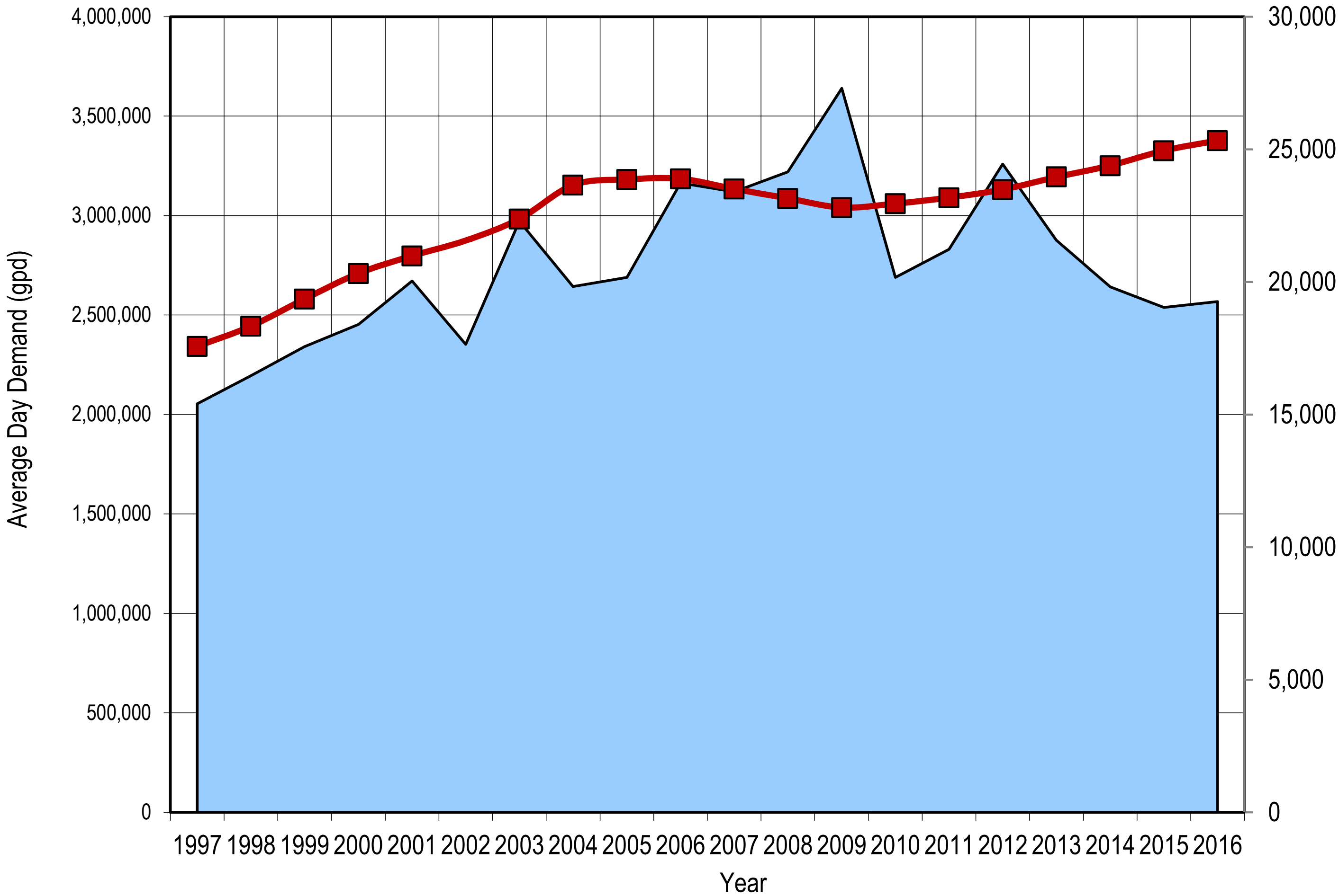
Chanhassen water utility records indicate that in 2016 the average daily (AD) water demand for the complete system was 2,570,000 gallons (1,783 gpm). The maximum day (MD) demand for 2016 was 6,200,000 gallons (4,328 gpm). Table 8.5 presents water demands in Chanhassen from 2007 to 2016. The average day demands over this period are also presented in graphical format in the Figure 8.1.

Table 8.5 | Recent Historical Average Water Use

		Average Day Water Sold					Water Pumped		
		Residential	Commercial	Industrial	Other	Total	Average Day Pumped(MGD)	Per Capita Water Pumped(gpd)	Unaccounted Water (%)
2007	23,066	1.95	0.31	0.21	0.02	2.49	3.12	135.3	20%
2008	23,578	2.02	0.38	0.24	0.04	2.67	3.22	136.6	17%
2009	24,481	2.27	0.45	0.43	0.07	3.21	3.64	148.8	12%
2010	24,699	1.89	0.46	0.26	0.06	2.66	2.70	109.2	1%
2011	23,179	2.05	0.42	0.23	0.06	2.76	2.83	122.3	3%
2012	23,484	2.38	0.48	0.29	0.08	3.23	3.26	138.8	1%
2013	23,840	2.09	0.44	0.26	0.05	2.85	2.88	120.7	1%
2014	24,432	1.85	0.30	0.21	0.18	2.54	2.64	108.2	4%
2015	24,951	1.83	0.38	0.23	0.06	2.50	2.54	101.7	2%
2016	25,332	1.73	0.31	0.17	0.29	2.50	2.57	101.4	3%
Average		**2.05**	**0.42**	**0.27**	**0.08**	**2.82**	**2.94**	**122.29**	**4%**
Average Per Capita Water Use (gpd)		**83.19**	**16.27**	**10.48**	**3.78**	**113.72**			
% of Total		**73%**	**15%**	**10%**	**3%**				

Source: DNR Water Use Records, City Records

Table 8.1 | Recent Historical Average Water Use



8.4 | Peaking Demand Factors

Peaking factors are ratios to the average day demand rate which are used in analysis of water systems. They are representative of temporal variation in water demands.

A maximum day peaking factor for a water system is the ratio of the MD demand rate to the AD demand rate. It normally indicates the magnitude of seasonal differences in water demands. For example, if demands on a system increase substantially during the summer due to lawn irrigation, the peaking factors will also be large. Typical MD peaking factors range from 2.0 to 3.0.

Larger systems generally have lower maximum day peaking factors. However, predominantly residential municipalities, especially in metropolitan areas, generally have higher peaking factors due to lawn irrigation demands. Recent MD peaking factors for Chanhassen are shown in Table 8.6. From the peak demand information that was available, it can be seen that the seasonal demand pattern in Chanhassen is within the typical range.

This historical information is useful, not only to assess the capacity of existing water system facilities, but also to anticipate future needs. For future demand projections, a MD peaking factor of 3.1 was assumed in this report, which was the highest of the previous fifteen years.

Table 8.6 | Recent Historical Max Day Water Use and Peak Factors

Year	Average Day (MGD)	Maximum Day (MGD)	Maximum Day (gpm)	Maximum Day to Average Day Ratio (Peak Factor)
2002	2.4	5.1	3,527	2.2
2003	3.0	8.9	6,169	3.0
2004	2.6	5.9	4,093	2.2
2005	2.7	7.8	5,396	2.9
2006	3.2	9.8	6,803	3.1
2007	3.1	9.2	6,392	3.0
2008	3.2	8.5	5,926	2.7
2009	3.6	8.3	5,771	2.3
2010	2.7	6.4	4,410	2.4
2011	2.8	6.7	4,618	2.3
2012	3.3	7.9	5,503	2.4
2013	2.9	7.4	5,146	2.6
2014	2.6	7.2	4,979	2.7
2015	2.5	6.3	4,391	2.5
2016	2.6	6.2	4,328	2.4
15 Yr. Average	**2.9**	**7.4**	**5,163**	**2.6**
15 Yr. Max	**3.6**	**9.8**	**6802.8**	**3.1**

Source: DNR Water Use Records, City Records

Table 8.7 | Historical Average Day & Per Capita Water Use

Year	Total Population	Average Day Water Pumped (MGD)	Average Day per capita Water Use (gpd)
2000	20,321	2.4	119.6
2001	20,982	2.7	126.8
2002	21,561	2.4	109.0
2003	22,376	3.0	132.7
2004	23,431	2.6	112.7
2005	23,652	2.7	113.3
2006	23,864	3.2	132.0
2007	23,506	3.1	132.7
2008	23,153	3.2	139.1
2009	22,806	3.6	159.6
2010	22,952	2.7	117.2
2011	23,179	2.8	122.1
2012	23,484	3.3	138.8
2013	23,954	2.9	120.1
2014	24,388	2.6	108.4
*2015	25,194	2.5	100.7
*2016	25,194	2.6	101.9
5 Year Average		**2.8**	**114.0**
5 - Year Max		**3.6**	**138.8**
*State Demographer population estimate for 2015			

Source: DNR Water Use Records, City Records

8.5 | Demand Distribution

Water demands are variable throughout the day and the year. On an annual basis, the heaviest demand conditions (maximum day demands) occur during the summer, when residential irrigation and other outdoor water use activities increase.

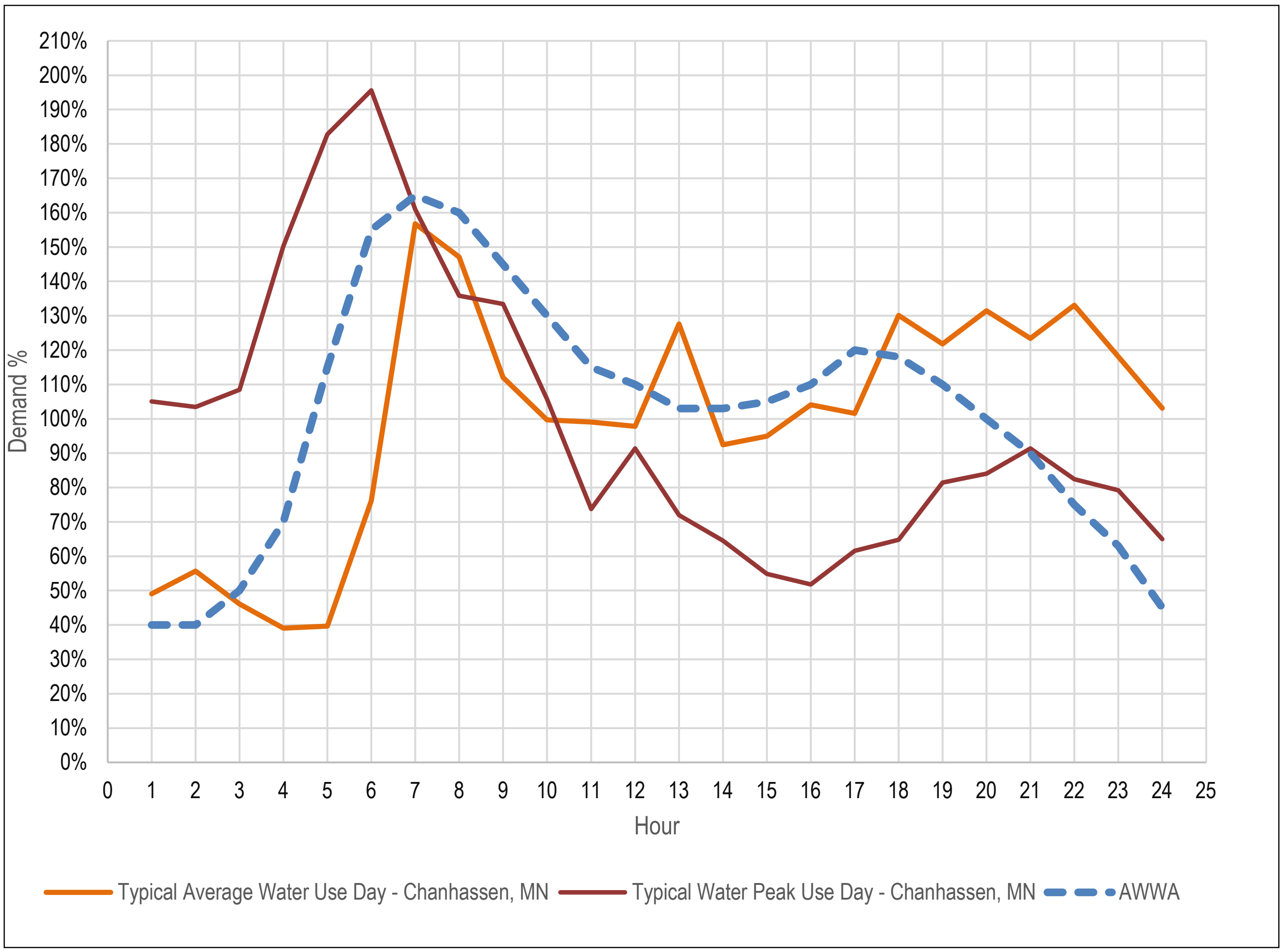
Water demands also vary over the course of a given day. Figure 8.2 represents the results of typical hourly demand distribution graph for total water use in the City of Chanhassen. This was calculated for a typical average day as well as a maximum day. For comparison purposes, a typical curve developed by the America Water Works Association (AWWA) for residential water use is also included on the graph as a reference. In general, commercial and industrial water uses are typically more constrained and predictable.

All three curves depict low water demand during the early morning periods. It shows increasing demand during the day with a slight decrease in the late morning periods. By late afternoon, demands level off then increase again during the evening hours, likely when residents are home and utilizing more water. As can be seen in the figure, for the peak day data, the peak hour occurs earlier in the morning, this is likely due to automated irrigation within the city for both commercial and residential customers.

As discussed briefly in Section 8.2, storage reservoirs are used to supplement the supply of treated water during the peak usage hours within each day. During the early morning periods when demand is low, the system is able to produce water in excess of the demand. This excess is used to fill the storage reservoirs.

When the demand rate exceeds the production rate, stored water in the reservoirs is used to make up for the deficit. The storage reservoirs will start to fill when the demand decreases below the total supply capacity.

Figure 8.2 | Typical Hourly Demand



8.6 | Analysis of the Existing Water System

All utility-owned pipes 4 inches in diameter and larger were included in the computer model of the distribution system. Water pumping records from 2016 were used to represent current demands on the system. Storage and supply facilities were modeled based on specifications supplied by city staff. Additional calibration can be conducted in the future, after construction of short-term water system improvements, to improve its accuracy for future use.

System Pressure Calculations

Pressures in the future system under average day demands were calculated by the computer model. Due to the elevation changes in Chanhassen and the creation of separate pressure zones, the pressures in the system are highly variable. The model calculates pressures in the range of 40 – 110 psi throughout the existing water system.

Higher pressures exist on the southern and eastern parts of the distribution system, where elevations are relatively low, with the exception of the reduced pressure zone around Lake Riley. In this zone, the pressure is maintained at a lower level through the use of pressure reduction valves.

Industry standard recommends that the normal working pressure in water distribution systems be approximately in the range of 50 to 80 psi and not less than 35 psi. In addition, pressures in excess of 100 psi in the distribution system should be reuced by pressure reducing valves. The Minnesota Plumbing Code requires that building plumbing systems not exceed 80 psi.

Many of the areas with pressures greater than 100 psi are localized on the system (they are limited to the fringes of the existing distribution system). Expansion of the distribution system to the south will require the use of pressure reducing valves as discussed later in this report. Where pressures exceed 80 psi, individual homes or businesses should install pressure reducing valves on the service line near the entrance to the building, as recommended by the Minnesota Plumbing Code.

Lake Lucy Road and Powers Boulevard – Analysis of Low Pressures During High Demand Conditions

As reported by city staff and mentioned in the previous comprehensive water plan, pressures in the area around the Lake Lucy Reservoir are low during peak demands. This effect is also observed in the computer model. Areas of relatively high elevations are present in the area. Elevations range from about 960 feet in the vicinity of the intersection of Lake Lucy Road and Powers Boulevard to approximately 1040 feet in certain locations. Most of the high elevations are found on the south and east side of the intersection.

It appears from the computer modeling results that there are about 50 homes that may drop below 35 psi during high demands when levels in the Lake Lucy Reservoir are low. If levels in the reservoir drop to 50% of capacity that corresponds to a water elevation of 1105 feet (15 feet below overflow). At this level, any water service above an elevation of about 1024 feet would drop below 35 psi. As stated previously, industry standard recommends that pressures remain about 35 psi under normal operating conditions, which includes periods of relatively high demand.

Since this is primarily an elevation issue, distribution system replacements or upgrades are not expected to have a significant effect in improving pressures in the area. The following three options are presented here for dealing with this pressure issue:

» Do nothing. The pressures do not appear to be critically low, and residents have adapted to conditions as they are.

» Install individual booster pumps on homes that require higher pressure.

» Create a small boosted pressure zone. A small booster station operating on a closed system is possible in the area. The city would need to conduct a detailed study of the issue to determine the optimal way to create such a system while maintaining circulation in the water system to prevent stagnation and the creation of dead ends that would limit fire protection capabilities.

Pressure Zone Analysis

As part of the comprehensive water plan update, the establishment of the pressure zone boundaries was revisited. Since the last comprehensive water plan was completed, pressure reducing valves/vaults have been installed as the system has expanded, which in turn define the boundaries of the pressure zones. As the system evolves, it is generally a good idea to revisit the pressure zone development, identify potential changes and review improvements so the ultimate system provided is optimized. For example, the previous plan identified potential options for definition of the pressure zones. Now that new water main has been installed and pressure reducing valve vaults have been placed, this boundary had changed slightly. As part of this update, a system wide contour map was updated to show parcels of land that can be served by the various pressure zones (see Appendix A - Figure A1).

The high and low pressure zones are defined by the elevated water storage tanks that exist in these zones, with HGL's of 1200' and 1120' respectively, these tanks maintain pressures of 40-80 psi to the majority of the service areas.

The boundary of the high pressure zone has been clearly defined and does not have a very high potential to be changed or modified in the future. The low/main pressure zone, which is essentially the default pressure zone for the majority of the system, serves the remaining areas with the exception of the Lake Riley Pressure zone which is essentially a reduced pressure zone, served by PRVs from the main zone. In the past, this type of pressure zone had issues with large changes in flow. For example, when hydrants are flowed in this zone and shut off, pressure tends to bounce and transients are not very easily dissipated. This head resulted in water main breaks and water heater failure in some homes.

In general, closed water pressure zones (without elevated storage or a standpipe) can experience difficulty with major flow changes as water is not compressible. When a valve is suddenly shut off (or a PRV throttled back), the water flowing in a corresponding pipe is suddenly forced to stop. Because of this, high pressure builds up immediately behind the shut off valve and low pressure forms in front of it. The momentum of the water is suddenly transferred into the physical system piping. As a result, a high-pressure region of water "piles up" in the pipe. This high pressure region then travels back along the pipe in the form of a wave. The border of the high-pressure zone is referred to as a pressure wave or transient. Such a pressure wave only exists for a short period of time, but can cause damage to piping and fittings. Transients are not very well understood and are not always accounted for in the design of a water distribution system.

A previous comprehensive water plan identified five potential alternate water pressure zones, with two of the zones (Lake Riley and Interbluff) having similar hydraulic grade lines. In light of recent development, and construction of new PRV facilities, a new pressure zone configuration was developed. The primary goal of the pressures zone restructuring was to sustain ideal pressures at all service elevations, simplify zone configurations, and reduce the number of PRVs required to sustain pressure.

Available Fire Flow

Available fire flows were calculated using the computer model with a residual pressure of 20 psi. According to the American Water Works Association (AWWA), the minimum fire flow available at any given point in a system should not be less than 500 gpm at a residual pressure of 20 psi. This minimum criterion represents the amount of water required to provide for two standard hose streams on a fire in a typical residential area for residential dwellings with spacing greater than 100 feet. The distance between buildings and the corresponding recommended fire flow for residential areas is summarized in Table 8.8.

Table 8.8 | Typical Fire Flow Requirements

Land Use	Building Separation (feet)	Available fire flow @ 20 psi (gpm)
Single & Two Family Residential	>100	500
Single & Two Family Residential	30-100	750
Single & Two Family Residential	11-30	1000
Single & Two Family Residential	<10	1500
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+

Source: Insurance Services Office

For commercial and industrial buildings, the needed fire flow rate varies considerably and is based on several characteristics of individual buildings such as:

» Type of construction
» Type of business that is using the property (occupancy)
» Proximity and characteristics of nearby properties
» Presence or absence of a fire sprinkling system

While the fire flow requirements of commercial and industrial properties should be evaluated on a case-by-case basis, a general rule of thumb is that a municipal water system should aim to provide 3500 gpm to this type of land use. The Insurance Services Office (ISO), in determining a City's fire insurance classification, only considers flow rates up to 3500 gpm.

Available fire flows throughout the Chanhassen water system are highly variable due primarily to topographical changes. Available flow rates in the model range from about 500 gpm in some locations to greater than 5000 gpm in others. Areas of potential concern include commercial, industrial or high-density residential land uses where the available flow rate at the water main is less than 3500 gpm. The previous comprehensive water plan identified three distinct locations that had less than desirable available fire flow, as calculated by the water model. Since the previous evaluation, improvements to the water system, including a new water tower have strengthened the water system. Subsequently, the areas of concern in relation to limited fire flow have been remedied. In short, major fire flow deficiencies were not identified as part of this analysis. However, this evaluation is not intended as a comprehensive building by building fire flow analysis, rather a comparison of computer modeling results with land uses across the existing water distribution system.

8.7 | Analysis of the Existing Water System

Future sales and pumpage projections can be based on assumptions of water demands that can be expected according to future land use or population data. Two different means for water use demand projections are documented and compared below.

Projected Water Demands - By Projected Population

Previously in this report, per capita average day water use was calculated. The maximum for this figure for the past 5 years was found to be 139 gallons per day per person. This figure was then multiplied by projected population data. The resulting projected water average and max day demand data is shown below in table 8.9.

Table 8.9 | Projected Water Consumption - By Population

Year	Population	Average Day Per Capita Water Pumped (gal)	Average Day Water Pumped (MGD)	Maximum Day to Average Day Ratio	Projected Maximum Day Water Demand (MGD)	Projected Maximum Day Water Demand (gpm)	Projected Main Zone Maximum Day Water Demand (gpm)	Projected High Zone Maximum Day Water Demand (gpm)
2015	24,655		3.4		**10.6**	7,389	6,429	961
2020	26,700		3.7		**11.5**	8,002	6,962	1,040
2025	29,200		4.1		**12.6**	8,752	7,614	1,138
2030	31,700		4.4		**13.7**	9,501	8,266	1,235
2035	34,400		4.8		**14.8**	10,310	8,970	1,340
2040	37,100		5.1		**16.0**	11,119	9,674	1,446
See Table 4 for Per capita water use projection and table 5 for max day to average day ratio								

Source: DNR Water Use Records, State demographer, Met Council Thrive 2040 Forecast

Projected Water System Demands - By Future Land Use

The city's comprehensive plans developed a projected land use map. This map provides for an assumption of future land uses for planning purposes. This projected map also provides for an opportunity to compare the change in land use acreage from exiting uses to projected uses. This information can then be utilized to estimate future water usage based on associated land use changes. Table 8.10 below documents land use changes estimated in the city's most recent comprehensive plan and equated existing average day water use to existing land use. The estimate of average day water use per acre developed from historical data is then applied to future land use estimates.

Table 8.10 | Projected Additional Water Consumption - Future Land Use

Upper Main Pressure Zone Development									
Land use	**Total Acres**	**Res. Units per Acre**	**Units**	**Pers. per Unit**	**Demand per Person (gpd)**	**Demand per Acre (gpd)**	**Projected AD Demand (gpd)**	**Projected AD Demand (MGD)**	**Projected MD Demand (MGD)**
Residential Medium Density (RMD)	260.0	8		2.5	100	2,000	390,000	0.39	1.2
Residential Large Lot (RLL)	120.0	0.4		2.5	100	100	9,000	0.01	0.0
Residential Low Density (RLD)	680.0	4		2.5	100	1,000	510,000	0.51	1.6
Residential High Density (RHD)	40.0	16		2.5	100	4,000	120,000	0.12	0.4
Office / Industrial	200.0					2,000	300,000	0.30	0.9
Office	60.0					2,000	90,000	0.09	0.3
Mixed Use	21.5					3,000	48,285	0.05	0.1
Commercial	0.9					2,000	1,380	0.00	0.0
Existing Residential to Connect to Water System (REX)	0.0		411	2.5	100		102,750	0.10	0.3
						Totals for Upper Main Zone	**1,571,415**	**1.6**	**4.9**
Low Area Planned Development									
Land Use	**Total Developable Acres**	**Res. Units per Acre**	**Units**	**Pers. per Unit**	**Demand per Person (gpd)**	**Demand per Acre (gpd)**	**Projected AD Demand (gpd)**	**Projected AD Demand (MGD)**	**Projected MD Demand (MGD)**
Residential Large Lot (RRL)			78	2.5	100		19,500	0.02	0.1
Residential Low Density (RLD)			39	2.5	100		9,750	0.01	0.0
Residential Low Density (RLD)	162	2		2.5	100	500	81,000	0.08	0.3
Residential High Density (RHD)	33.2	12		2.5	100	3,000	99,600	0.10	0.3
Office	53.4					1,500	80,100	0.08	0.2
Office Industrial	61					1,500	91,500	0.09	0.3
*Existing Gedney Demands							180,000	0.18	0.6
						Totals for Low Area	**561,450**	**0.56**	**1.74**
						Totals for Main Pressure Zone	**2,132,865**	**2.13**	**6.61**
High Zone Planned Development									
Land use	**Total Acres**	**Res. Units per Acre**	**Units**	**Pers. per Unit**	**Demand per Person (gpd)**	**Demand per Acre(gpd)**	**Projected AD Demand (gpd)**	**Projected AD Demand (MGD)**	**Projected MD Demand (MGD)**
Residential Low Density (RMD)	40	4		2.5	125		50,000	0.05	0.2
Residential Med Density (RMD)	19	8		2.5	125		47,500	0.05	0.1
Existing Residential Lots			49	2.5	125		15,313	0.02	0.0
						Totals for High Zone	**112,813**	**0.11**	**0.35**
						Total System (Additional Demand)	**2,245,678**	**2.25**	**6.96**

Table 8.11 | Projected Water Consumption - By Land Use

Area	Existing Average Day (MGD)	Future Land Use Average Day (MGD)	Projected Maximum Day Water Use (MGD)	Projected Maximum Day Water Use (gpm)
Main Pressure Zone	2.50	2.13	14.37	9,982
High Pressure Zone	0.37	0.11	1.95	1,353
Total	**2.88**	**2.25**	**16.32**	**11,335**
Existing AD calculated from current 6-year average, Peak factor= 3.1 for main zone, 4.0 for high pressure zone, See table 8.10 for calculations				

8.7 | Future Water System Facilities

The city is currently planning the construction of new water system facilities to accommodate future water needs. In addition to normal water uses, system facilities are often sized for fire protection needs, including additional storage facilities ex. water tanks and supply.

Facilities (wells and a future west water treatment plant) and water mains are planned to expand and improve water delivery. The following sections of this report discuss the estimated need for future water system facilities, based on the demand projections presented in Table 8.11.

Future Distribution System

In Appendix A - Figure 7, a proposed trunk water main layout has been drawn as part of the future water system vision. The future mains include 12-inch loops helping to balance the future water system by allowing large volumes of water to flow between supply, storage and points of use. These trunk main loops will be required to effectively transport water to the extremities of the proposed expansion areas. Looping is recommended wherever possible to minimize dead-ends in the water system.

Dead-ends or branched water systems are less reliable since water must come from one direction. This forces the utility to shut off water to some customers during repairs or maintenance. In addition, larger head losses (or pressure losses) are experienced on dead-ends than on looped systems. This can limit available flow rates during fire protection activities.

In addition to future system improvements, the existing system could be improved by eliminating dead ends that are relatively long or less than 8 inches in diameter. This work should be coordinated with future street replacement projects to reduce costs where possible.

Due to the fact that much of the future service area on the south end of the city already contains residential development, it is difficult to provide trunk main looping to serve the proposed developments on the far south end of the future service area, such as those proposed between the Hennepin County Regional Trail Corridor and Flying Cloud Drive. The proposed distribution system serves these developments using long dead end mains for this reason.

If possible, the city should consider looping these segments to improve system hydraulics. A connection may be possible on the eastern extent of the future main shown on Flying Cloud Drive to the proposed 12-inch main on Deerbrook Drive.

Pressure Zones

The Chanhassen water distribution system serves a range of elevations that prevents the entire system from being served on a single pressure zone. In order to keep pressures at acceptable levels throughout the system, there are currently three separate pressure zones in the system. The pressure zones are defined by different hydraulic grade, which allows pressures to remain in a more acceptable range. The pressure zone boundaries are shown on Appendix A - Figure 2.

As part of the water comprehensive plan update, a review of the pressure zone boundaries was completed by analyzing citywide land elevations with resulting reasonable pressures within each defined pressure zone. The result of this analysis is shown in Appendix A. In short, the current pressure zone plan could be optimized to simplify operations. The map shown in Appendix A, Figure A1 is defined to show which pressure zone would be best suited to serve varying land elevations. In those areas that may have sops that fall out of tolerance, individual PRVs could be installed if the water pressure in the street exceeds 80 psi.

The largest zone is the low pressure zone, which is currently served by the east water treatment plant; wells 3, 4 and 9; and the Lake Lucy and Arboretum storage tanks. The hydraulic grade of this zone is determined by an overflow elevation of 1120 feet for the storage tanks.

The high pressure zone is located roughly between Hazeltine Blvd. and Galpin Blvd., north of Arboretum Blvd. This zone is currently served by wells 7 and 8 and an elevated storage tank, Melody Hill, which has an overflow elevation of 1200 feet.

Future developments on the south end of town are at relatively low elevation compared with the rest of the city. As the distribution system expands into this area, the water pressure in the mains will need to be reduced through the use of pressure reducing valves, similar to the way in which the Lake Riley Pressure Zone is currently served.

In light of recent development and construction of new PRV facilities, a new pressure zone configuration was developed. The primary goal of the pressures zone restructuring was to sustain ideal pressures at all service elevations, simplify zone configurations, and reduce the number of PRVs required.

In the future, it appears that the existing Lake Riley Pressure Zone could be merged with the Interbluff Pressure Zone and served but a single elevated storage tank. Not only would this simplify system operations, and reduce the reliance on PRV stations, but pressures in these zones would be sustained by a storage vessel which would ease pressure transients and better serve major changes in flow, reducing the possibility of pressure spikes. Appendix A - Figure 7, represents a potential location for an elevated storage tank for the new combined Interbluff/Lake Riley Pressure Zone.

Future Supply Facilities

Firm supply capacity, which is the amount of water that can be reliably supplied with the largest well out of service, should be greater than or equal to the maximum day demand. When projected maximum day demands reach firm capacity, it is an indication that additional water supply capacity is needed.

The projected 2040 maximum day demand for Chanhassen is approximately 11,120 (16.0 MGD) gpm. As mentioned in previous studies, the city should plan to serve the maximum day demand with firm capacity, defined here as the supply capacity with the largest distribution system well out of service and the largest well supplying the east water treatment plant out of service.

The total system capacity with wells 2, 3, 4, 7, 8, 9, 10, 12, 13 and 14 will be 8,850 gpm. The firm capacity will be 7,450 gpm. To meet ultimate demand projections, there will be a well capacity need of approximately 3,700 (11,120 gpm – 7,450). Based on previous well capacities, that will equate to four additional wells to meet projected maximum day demands. It is suggested that three additional wells serve the future west water plant while one additional well should be constructed to serve the east water treatment plant.

Table 8.12 | Future Water System Supply Needs

Year	Maximum Day Water Pumped (MGD)	Existing Firm Supply Capacity (MGD)	Additional Supply Capacity Recommended (MGD)	Additional Supply Capacity Recommended (gpm)
Existing 5 Year Average	7.0	10.7	0.0	0
2020	11.5		0.8	552
2025	12.6		1.9	1302
2030	13.7		3.0	2051
2035	14.8		4.1	2860
2040	16.0		5.3	3669

Source: DNR Water Use Records, State demographer

Future Storage Facilities

In order to determine the water storage needs of a community, average daily demands, peak demands, and emergency needs must be considered. For many communities, fire protection needs tend to be the controlling factor when calculating needed storage volume. Table 8.13 shows the calculations used to determine future water storage volume requirements for the total system in Chanhassen. These calculations consider ultimate development of the proposed expansion areas.

Water storage facilities should be able to supply 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 pump out of service. The calculations in Table 8.13 assume that 75% of storage volume is available for firefighting, maximum day demands are occurring on the system and the well with the greatest capacity is out of service.

It appears, based on the demand projections used here, that Chanhassen will need about 1.0 million gallons of future additional storage for the system as a whole.

There is a trade-off between storage volume for fire protection and water quality. If the storage volume becomes too much greater than average day demands, it can result in longer tank residence times and increased water age. With age, water can lose its chlorine residual and develop taste and odor problems as well as a potential for bacterial contamination.

Previously, 750,000 gallons of elevated storage was recommended for the high zone. Since this recommendation was made, the new 750,000 gallon tank has been constructed.

With this tank in place, the projected additional storage need for the water system as a whole is around 1.0MG, which could be constructed in the main zone or as discussed later, in the proposed combine Interbluff Zone. Proposed locations for the future 1.0 MG tank is shown in Appendix A - Figure 7.

Table 8.13 | Complete System Water Storage Requirements

	Existing System	2030 Projection	2040 Projection
Average Day Demand	2,568,510	4,399,370	5,148,790
Maximum Day Demand	6,232,000	13,638,048	15,961,249
Maximum Day Demand (gpm)	4,328	9,471	11,084
Peak Hour Demand (gpm)	8,439	16,100	18,843
Existing Storage Volume (gal)	4,200,000	4,200,000	4,200,000
Well Pump Firm Capacity (gpm)	7,450	7,450	7,450
Requirement No.1 Storage Volume Recommended (Min. Total Storage) (gal)	2,568,510	4,399,370	5,148,790
Requirement No.2 Storage Volume Recommended (Min. Total Storage) (gal)	1,973,467	3,182,211	3,724,291
Requirement No.3 Storage Volume Recommended (Min. Elevated Storage) (gal)	68,000	994,000	1,284,000
Additional Storage Required (gallons)	**(1,630,000)**	**200,000**	**900,000**
Assumes Supply Remains Constant			

8.8 | Analysis of the Proposed System Layout

The computer model of the distribution system was used to calculate pressures and available fire flows as was done previously for the existing system. Much of the new development is expected to the south of the existing water system, where elevations decrease as discussed in previously sections. When PRVs are set in the model to correspond to the recommended hydraulic grades and are located as shown in Appendix A - Figure 7, pressures and available flows for fire protection appear to be adequate to support the proposed land uses, based on the criteria presented in Section 8.4.

Extended Period Simulation

As part of the previous comprehensive plan, an extended period simulation (EPS) was conducted using the model to analyze system operations during several days of maximum day demands. The primary purpose of this simulation was to check for cumulative system imbalances that are not evident in standard simulations and to verify if system operations can be maintained under high demand conditions.

The locations of supply and storage facilities and the sizes of distribution system pipes contribute to imbalances. Considerable distances between supply and storage locations and inadequately sized water mains can contribute to a reduced storage-replenishment rate and the inability to refill the towers at night during low demand periods.

Once again, we have conducted a 72-hour water model simulation to review the possible water tower site A location. We have simulated a 72-hour period with three consecutive maximum day (MD) demand conditions. This time period was chosen since most supply and distribution system deficiencies will be exposed in three days of operations with MD demands. For example, if tanks are unable to refill daily under high demand conditions, a trend will emerge in tank level data produced by the EPS.

The model was simulated with a new tank located at site A, feeding the combined Interbluff/Lake Riley zone. The simulation found that it is feasible to sustain water system pressures with this type of configuration. The existing main pressure zone tanks operate and float at similar water levels/water elevations while the proposed tank sustains more consistent pressures in the lower pressure zone.

8.9 | Conclusions and Recommendations

Supply Environments

Firm supply capacity (the supply capacity with the largest pump out of service) should be greater than maximum day demands. The city is currently in the midst of constructing the west water treatment plant, which is estimated to have a capacity equal to the recently constructed east water treatment plant (6,000 gpm). In order to fully utilize these two plants, it is estimated that four new wells will be necessary during the life of this plan to meet projected water demands based on projected development in the city.

Distribution System Improvements

Trunk main looping should be a priority in the expansion of the service area and in water main replacement projects. The proposed layout of trunk water mains in this report would provide water supply and fire protection capabilities to existing and projected service areas. In addition, recommended trunk mains will connect water supply and storage facilities with points of use on the system.

The city can also work towards the eventual combination of the Lake Riley and Interbluff pressure zones, which may be the most ideal location for a new elevated storage tank.

Storage Improvements

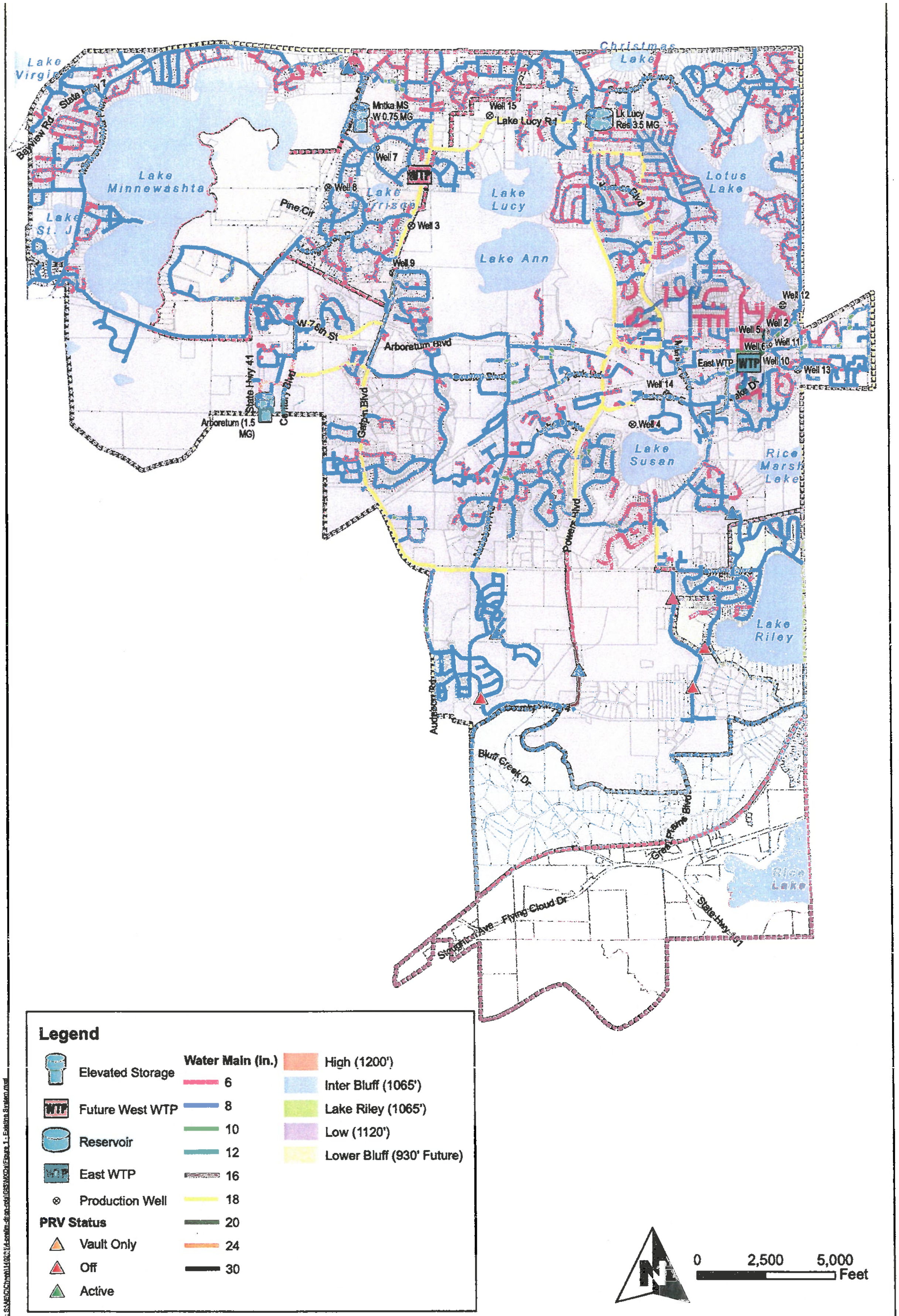
The volume of water storage needed in Chanhassen is dictated by daily demands as well as fire protection. Currently, storage capacity is meeting system needs. Projected demands will create a need for one additional 1.0 MG elevated water storage tank over the life of this plan. A new concept, which places a new tank in the combined Lake Riley/Interbluff lower pressure zone which will help supply these pressure zones with water as well as stabilize system pressures.

Report and Model Update

This report should be reviewed on an annual basis. Changes in development type or densities can have significant impacts on a water system's performance, especially during drought conditions or emergencies such as fires. A report update should be planned for approximately 5 to 10 years dependent on development pressure.

The water system model produced as part of this project is a valuable tool in assisting with design and construction of Chanhassen water system components. It can be easily updated on an annual basis and used to evaluate the impacts of proposed developments or project phasing. A copy of the computer model will be provided to the city.

APPENDIX A



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FAX: (888) 908-8136
TF: (800) 325-2055
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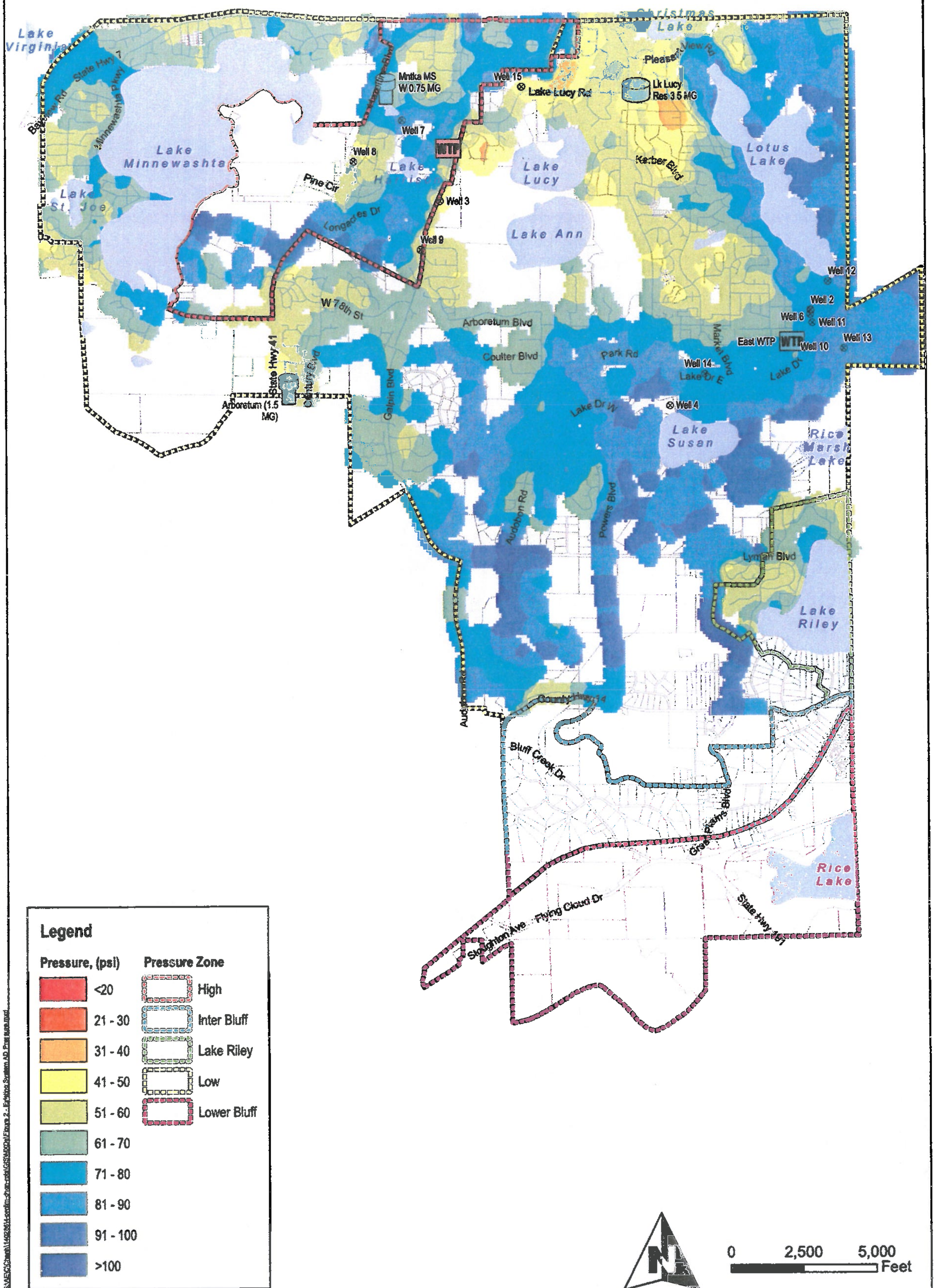
Print Date: 5/26/2017

Map by: JEM
Projection: Carver
Source: WaterCAD

Existing Water System Model Map
2017 Comprehensive Water Plan Update
Chanhassen, Minnesota

Figure 1



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Existing Average Day Demand System Pressure
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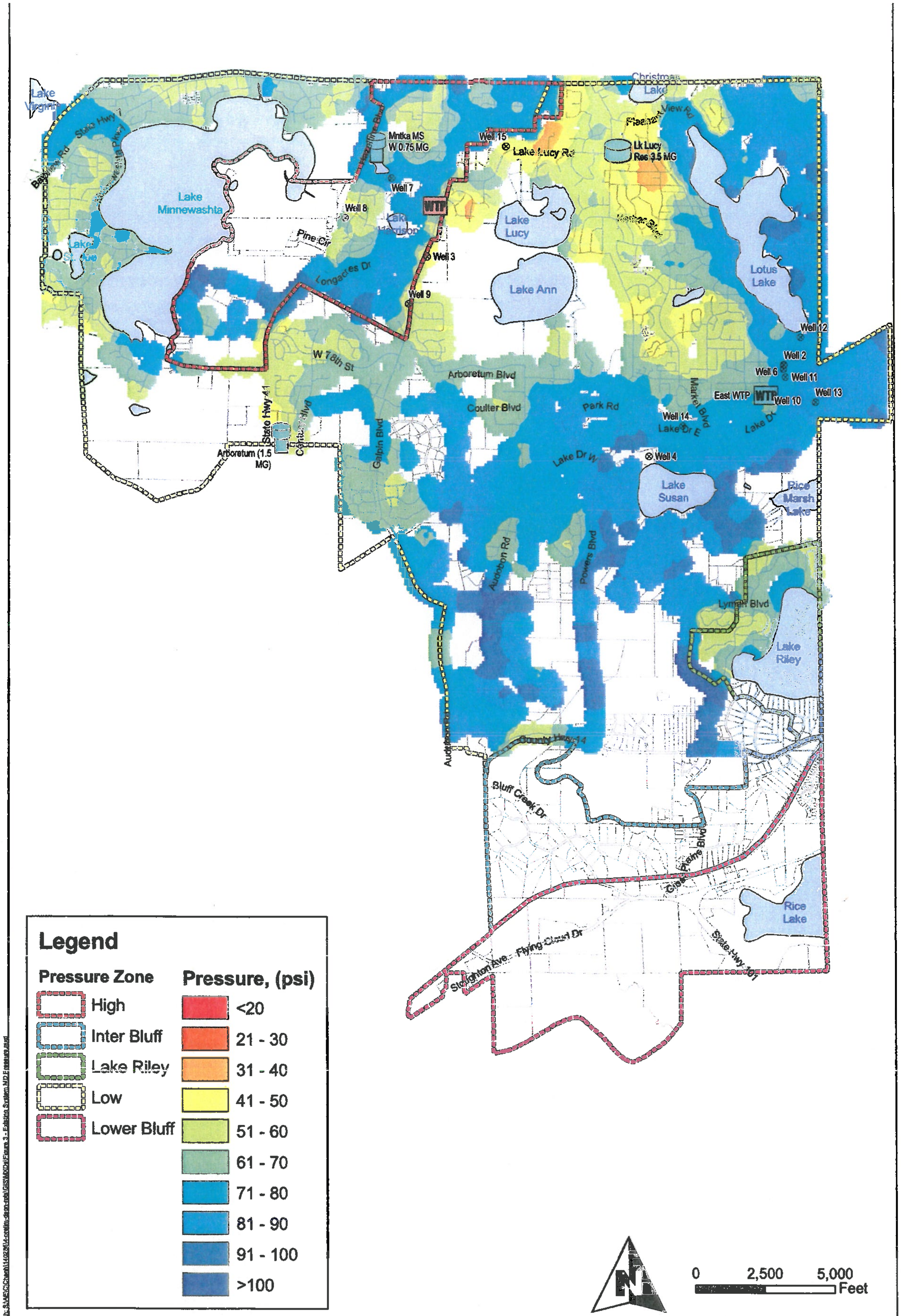
Chanhassen, Minnesota

Figure 2



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Existing Max Day Demand System Pressure
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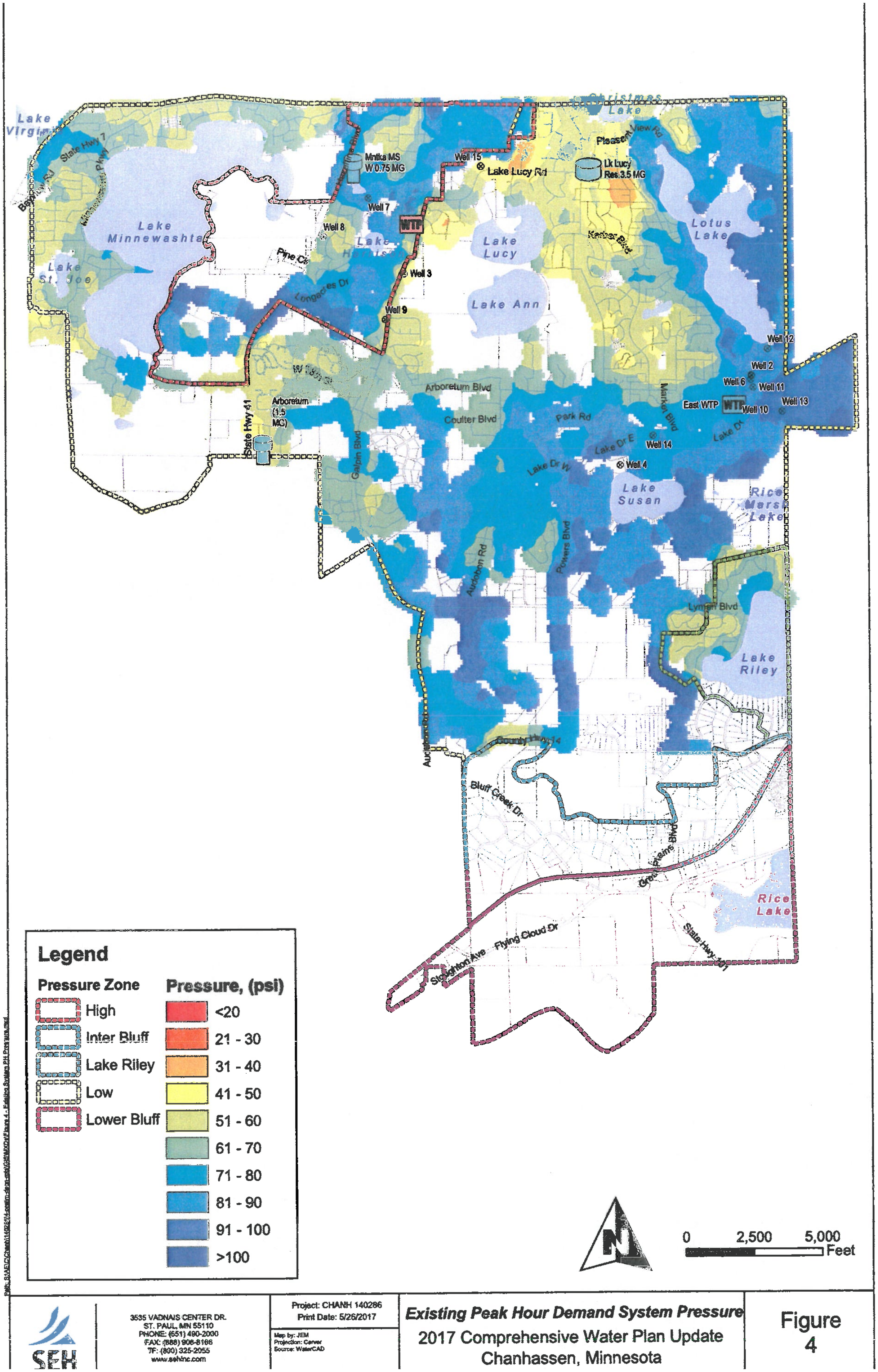
Chanhassen, Minnesota

Figure 3



Lake Virginia
State Hwy 7
Lake Minnewashta
Lake St. Joe
Mntka MS W 0.75 MG
Well 15
Lake Lucy Rd
Lk Lucy Res.3.5 MG
Pleasant View Rd
Christmas Lake
Well 7
Well 8
WTP
Lake Lucy
Lotus Lake
Kerber Blvd
Pine Cir
Longacres Dr
Well 3
Well 9
Lake Ann
Well 12
Well 2
Well 6
Well 11
Well 13
East WTP
WTP
Well 10
Arboretum Blvd
Arboretum (1.5 MG)
State Hwy 41
Galpin Blvd
Coulter Blvd
Park Rd
Market Blvd
Lake Dr E
Well 14
Lake Dr
Lake Dr W
Well 4
Lake Susan
Rice Marsh Lake
Audubon Rd
Powers Blvd
Lyman Blvd
Lake Riley
County Hwy 14
Bluff Creek Dr
Great Plains Blvd
Rice Lake
Flying Cloud Dr
Stoughton Ave
State Hwy 101
Legend
Pressure Zone
High
Inter Bluff
Lake Riley
Low
Lower Bluff
Pressure, (psi)
<20
21 - 30
31 - 40
41 - 50
51 - 60
61 - 70
71 - 80
81 - 90
91 - 100
>100
N
0
2,500
5,000
Feet
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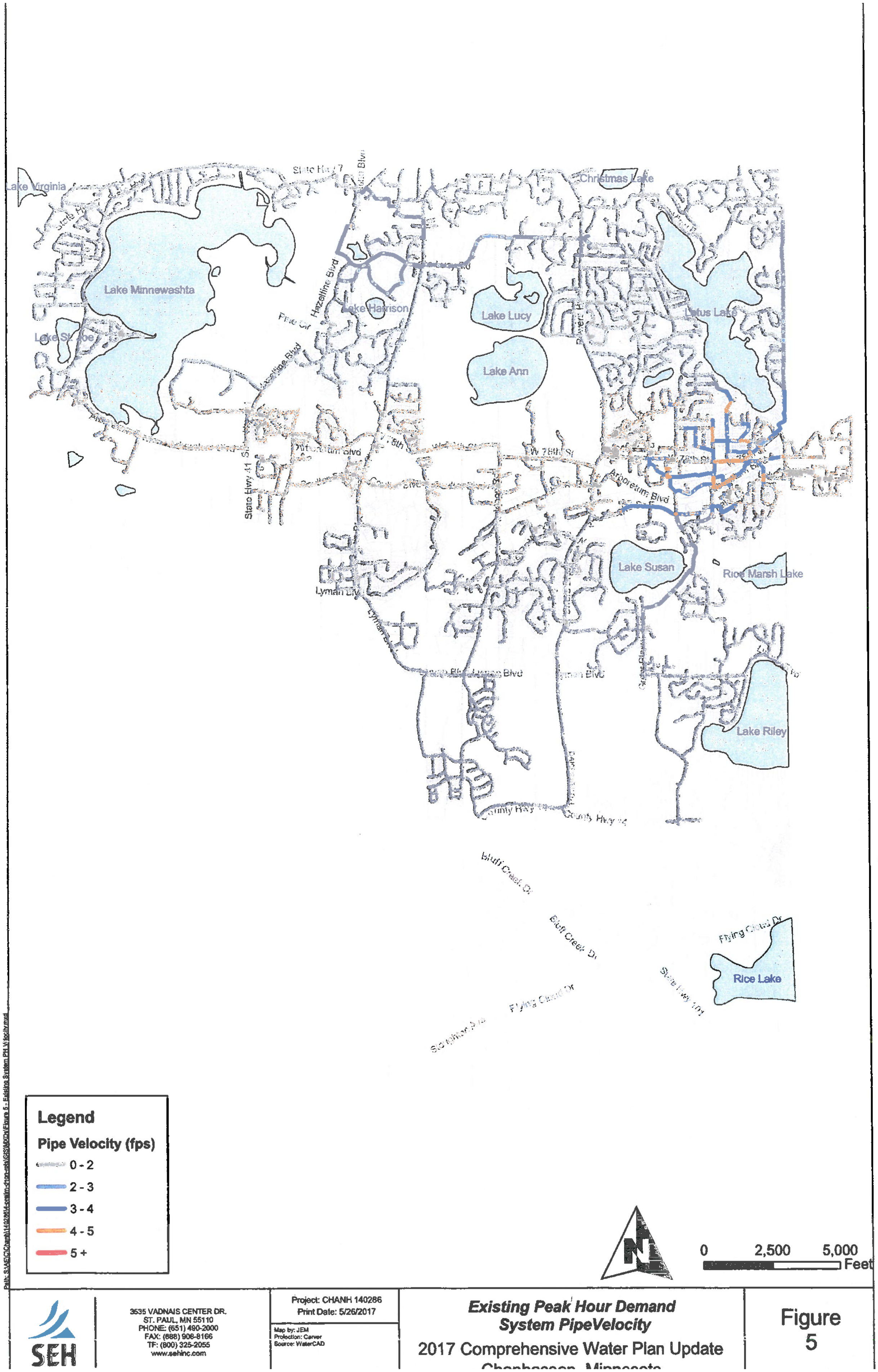
Source: WaterCAD
Existing Peak Hour Demand System Pressure
2017 Comprehensive Water Plan Update
Chanhassen, Minnesota
Figure
4


Lake Virginia
Lake Minnewashta
Lake St. Joe
Lake Harrison
Christmas Lake
Lake Lucy
Lake Ann
Lotus Lake
Lake Susan
Rice Marsh Lake
Lake Riley
Rice Lake
State Hwy 7
Hazeltine Blvd
State Hwy 41
Arboretum Blvd
W 78th St
Lyman Blvd
Bluff Creek Dr
Flying Cloud Dr
Legend
Pipe Velocity (fps)
0 - 2
2 - 3
3 - 4
4 - 5
5 +
0
2,500
5,000
Feet
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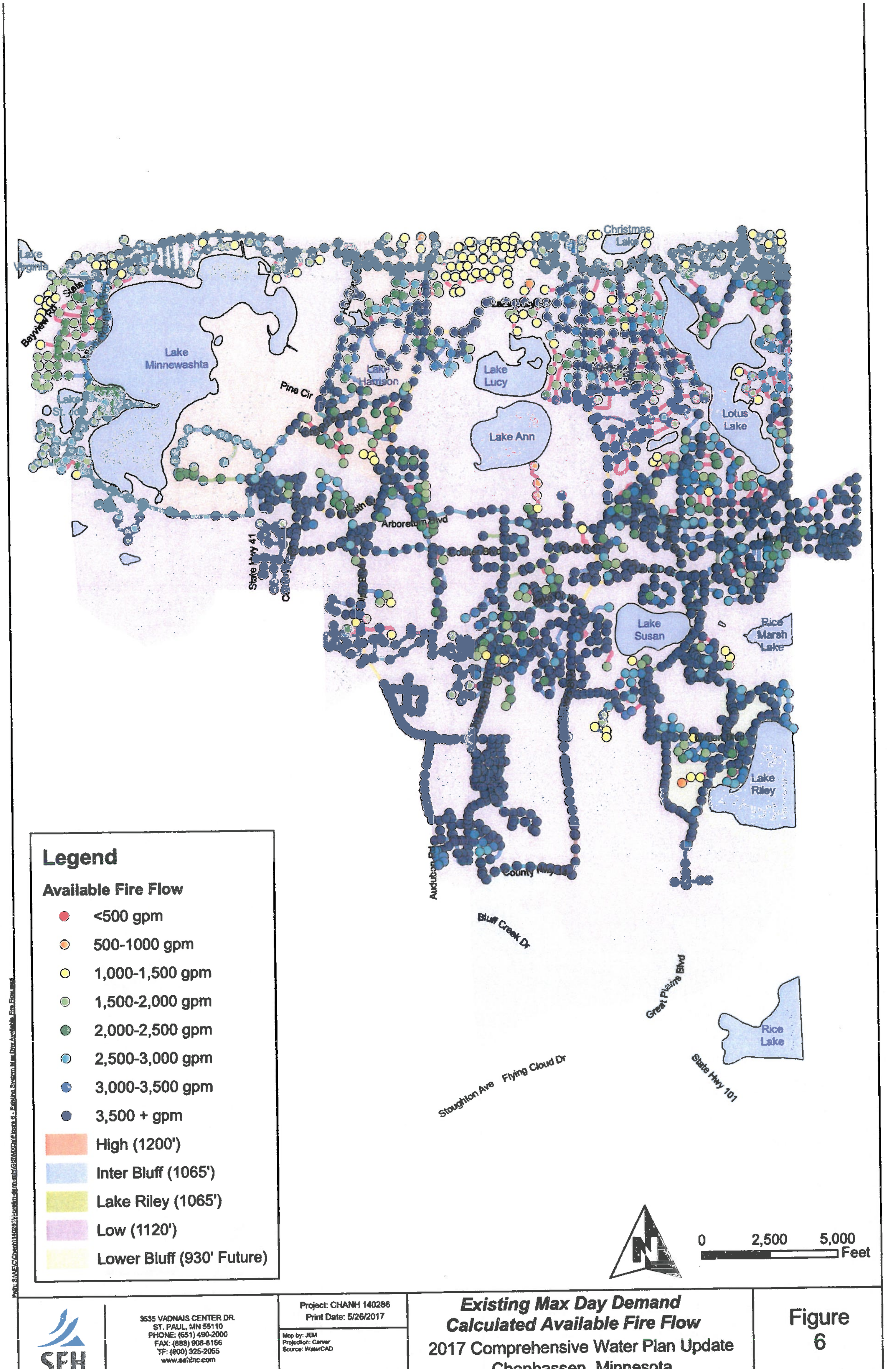
Existing Peak Hour Demand
System PipeVelocity
2017 Comprehensive Water Plan Update
Chanhassen, Minnesota
Figure
5



Christmas Lake
Lake Virginia
Baywood Rd
Lake Minnewashta
Pine Cir
Lake Harrison
Lake Lucy
Lake Ann
Lotus Lake
Arboretum Blvd
State Hwy 41
Lake Susan
Rice Marsh Lake
Lake Riley
Audubon Rd
Bluff Creek Dr
Great Plains Blvd
Rice Lake
State Hwy 101
Stoughton Ave
Flying Cloud Dr
Legend
Available Fire Flow
<500 gpm
500-1000 gpm
1,000-1,500 gpm
1,500-2,000 gpm
2,000-2,500 gpm
2,500-3,000 gpm
3,000-3,500 gpm
3,500 + gpm
High (1200')
Inter Bluff (1065')
Lake Riley (1065')
Low (1120')
Lower Bluff (930' Future)
0
2,500
5,000
Feet
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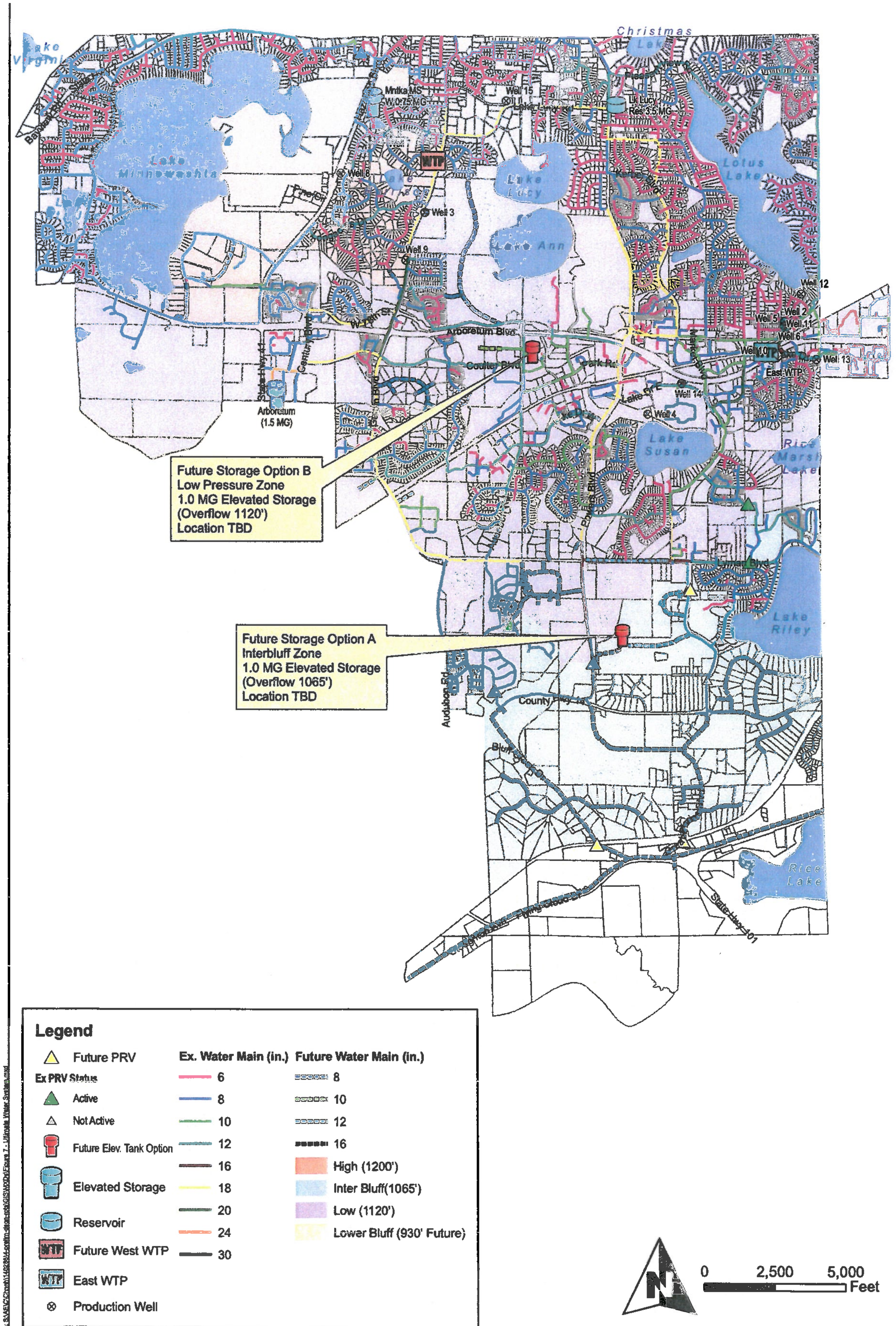
Existing Max Day Demand
Calculated Available Fire Flow
2017 Comprehensive Water Plan Update
Chanhassen, Minnesota
Figure 6



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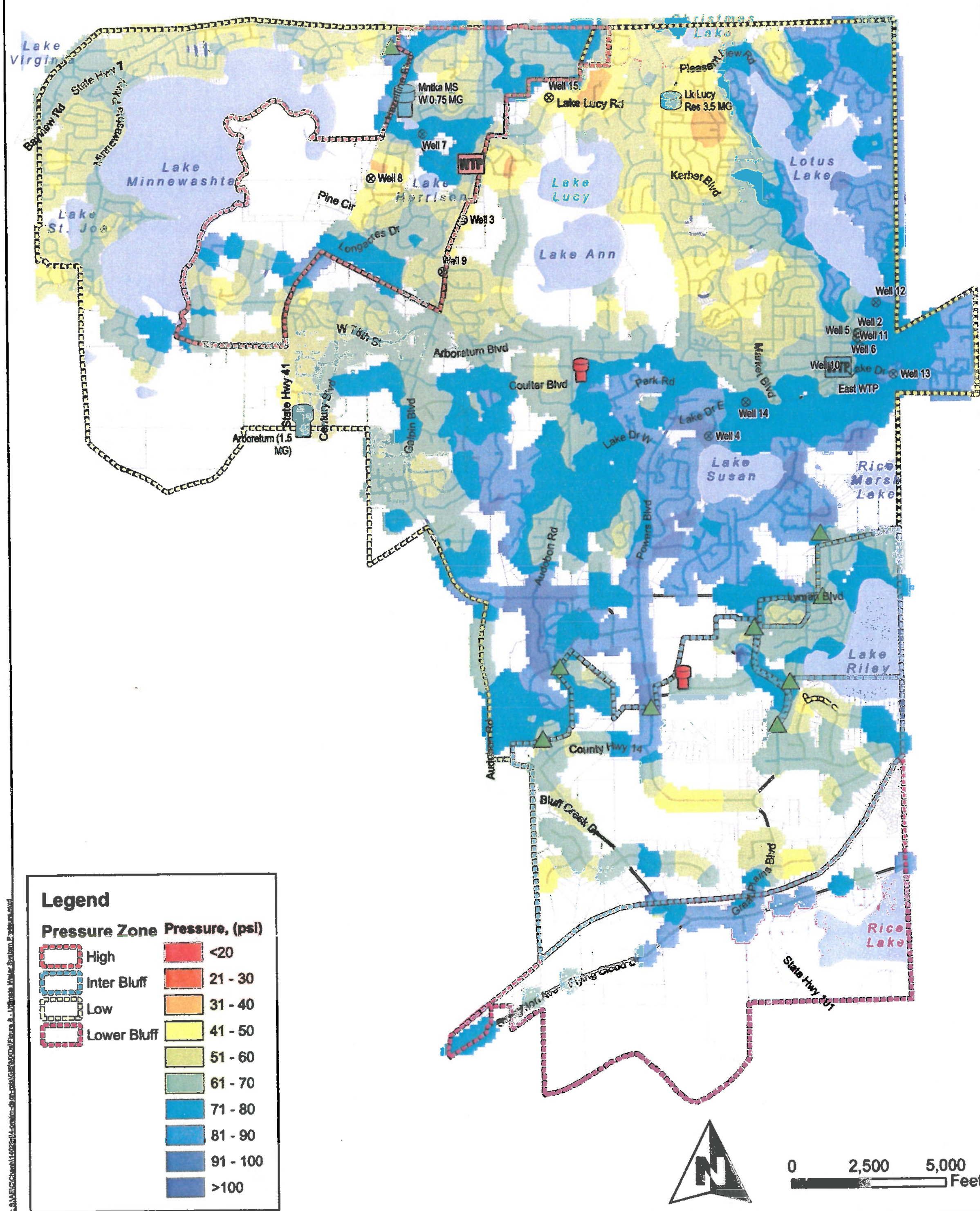
Ultimate Water System Vision

2017 Comprehensive Water Plan Update
Chanhassen, Minnesota

Figure
7



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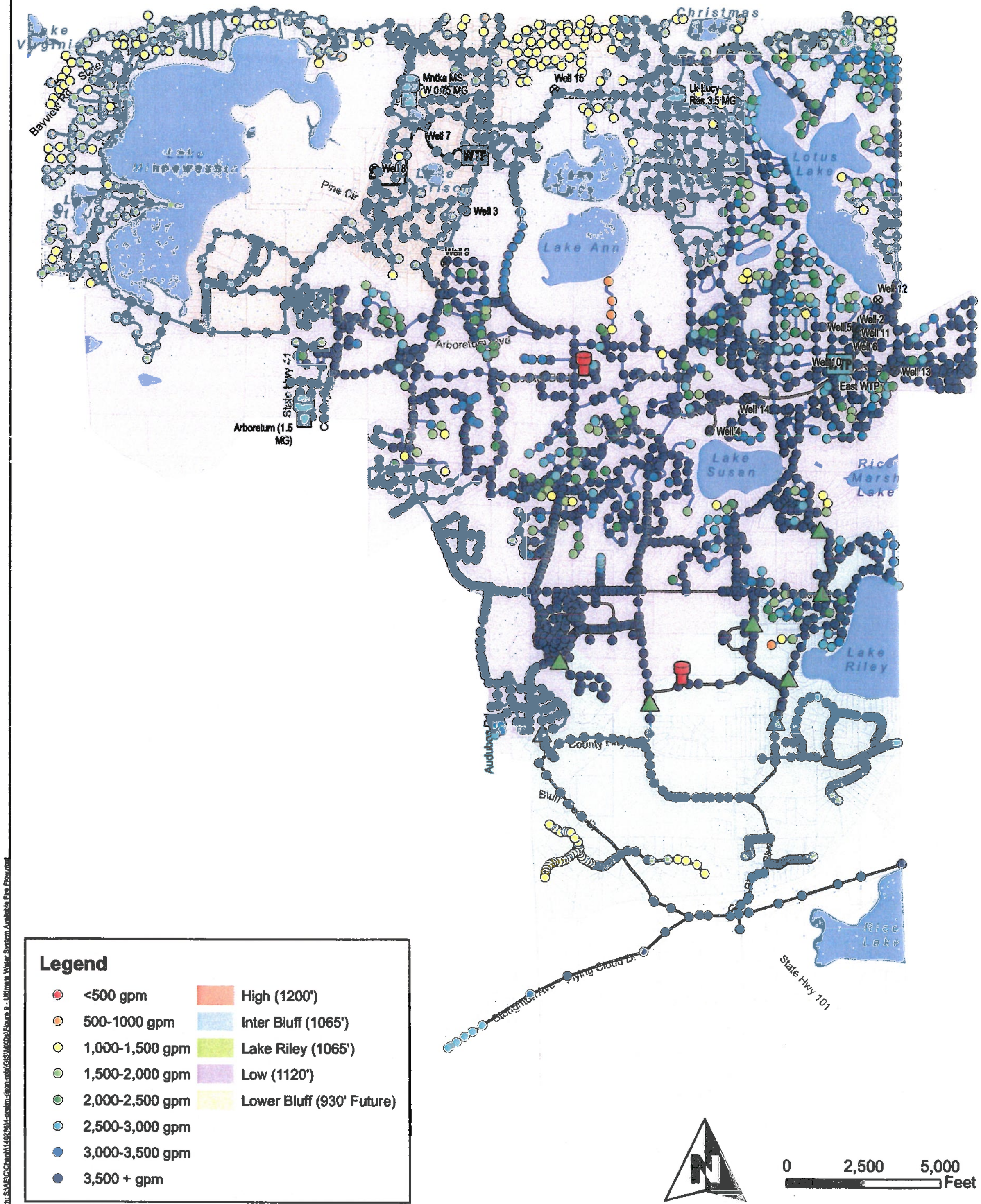

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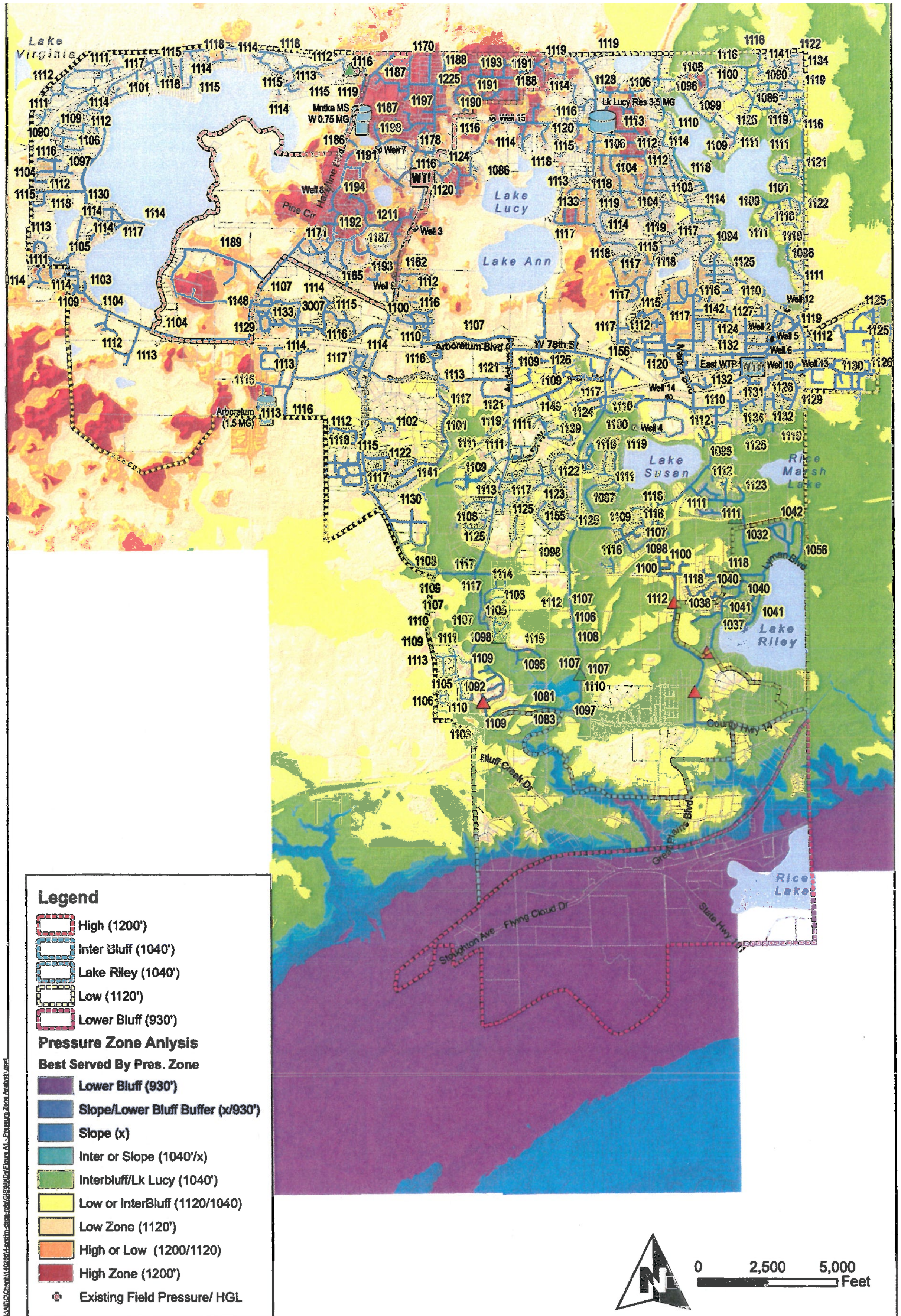
Projection: Carver
Source: WaterCAD
Model Notes: Modeled with 1 MG EWST in place at Water Tower site option A.

Ultimate Water System
Calculated Available Fire Flow
2017 Comprehensive Water Plan Update
Chanhassen, Minnesota

Figure
9



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Source: WaterCAD

Pressure Zone Analysis
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Figure A1