City of Eagle Lake
Comprehensive Infrastructure Planning Study
March 2006

Section 3 – Water System Plan

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1.0 Purpose of the Water System Plan

The purpose of this Water System Plan is to provide guidance to the City of Eagle Lake, as well as existing and future landowners, in preparing for future growth and development. This report summarizes the findings of the water system analysis portion of the Comprehensive Infrastructure Planning Study. The objectives of the Water System Plan are as follows:

- Perform an evaluation of the water system's supply and storage capacity and their ability to meet the projected water needs for a 20-year planning period.
- Make a preliminary determination of the trunk watermain improvements that will be required for a 20-year planning period.
- Identify corridors and preliminary sizing for trunk watermains that will serve the ultimate development of the study area.

2.0 Existing Water System

2.1 Water Supply and Treatment

The City of Eagle Lake currently obtains water from wells drilled into underground aquifers. The water is pumped into the distribution system using a 195 GPM and a 350 GPM pump. The Table 2.1 summarizes the existing well data.

Table 2.1 – Existing Well Data

Parameter	Well No. 1	Well No. 2
Unique Number	211763	209943
Year of Construction	1950	1973
Pumping Capacity (gpm)	195	350
Total Depth (ft)	399	270
Static Water Level (ft)	84	54
Pumping Water Level (ft)	86	58
Aquifer	Multiple	Prairie du Chien

The water is currently being treated with polyphosphate for iron and manganese sequestration, chlorine for disinfection, and fluoride for dental health.

2.2 Water Storage Facilities

The city's distribution system operates on a single pressure zone utilizing a 300,000 gallon elevated storage tank. The tank is a welded steel, single pedestal, spheroid shaped tower with an overflow elevation of 1150-ft. The tower is located near the intersection of 3rd Street and C.S.A.H. 17 and was constructed in 1995.

2.3 Water Distribution Network

The existing water distribution system consists of ductile iron (DIP) and polyvinyl chloride (PVC) pipe ranging in size from 4-inch to 12-inch diameter.

The existing water system is shown on Figure 2.1.

3.0 Evaluation of Existing Water System

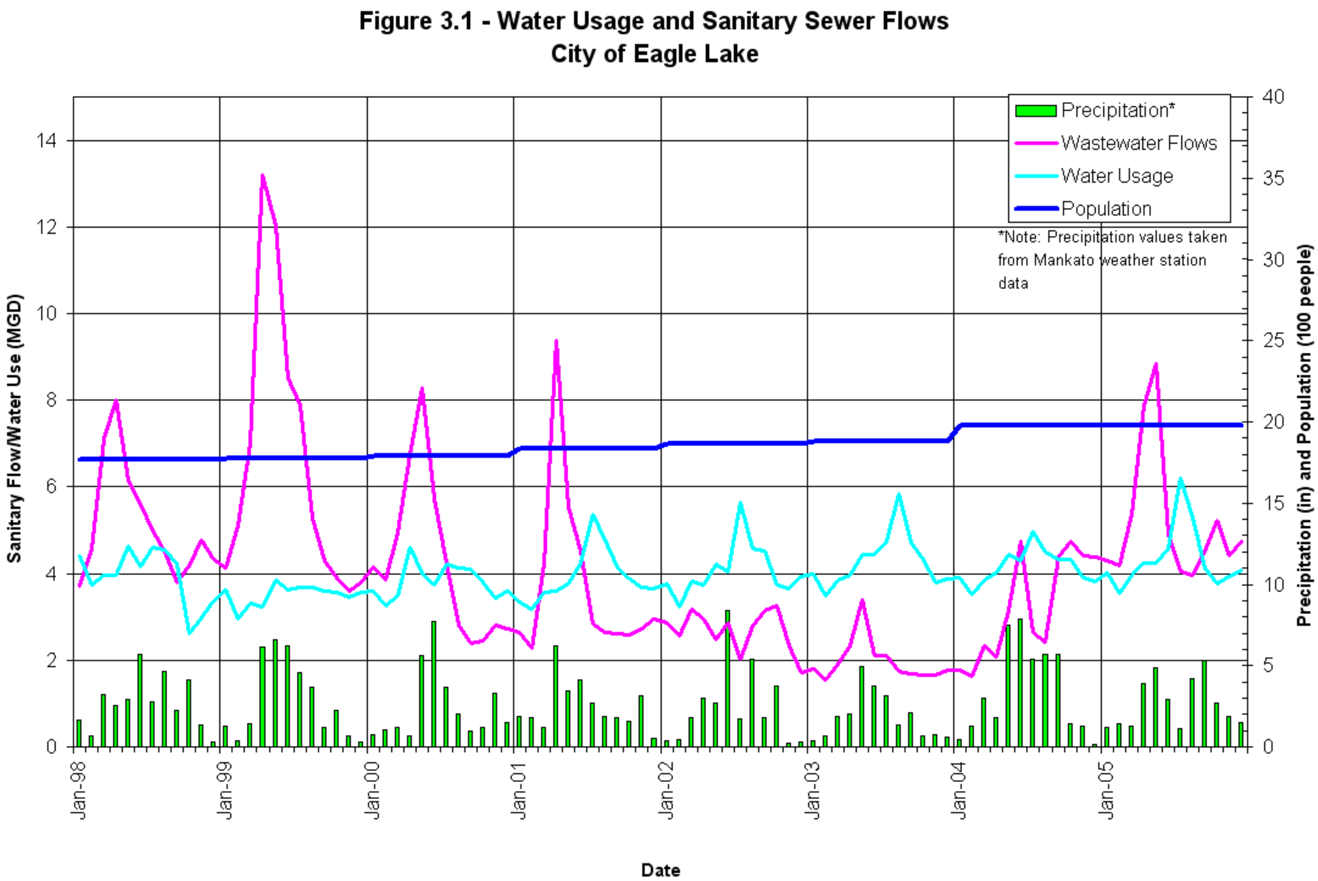
3.1 Water Use

Table 3.1 shows historical water use for the years 2002 through 2005, separated into water sales, well pumpage, and unaccounted for water use. Unaccounted for water use would consist mostly of watermain breaks and possible meter discrepancies. Typical unaccounted water use ranges from 10-15%. The low numbers, all <6%, are indicative of a well maintained an operated water supply system. It should be noted that the 2005 numbers actually indicate a surplus in water sales. This should be monitored in 2006 to determine if there is a metering problem.

Table 3.1 – Historical Water Use

	2002				2004		
	Water Sales	**Well Pumpage**	**Unaccounted**		**Water Sales**	**Well Pumpage**	**Unaccounted**
Jan	3,574,300	3,771,000	196,700	**Jan**	3,709,000	3,891,000	182,000
Feb	3,518,200	3,223,000	-295,200	**Feb**	3,760,000	3,514,000	-246,000
March	2,929,800	3,811,000	881,200	**March**	3,547,000	3,860,000	313,000
April	3,762,800	3,725,000	-37,800	**April**	3,835,000	4,019,000	184,000
May	3,643,600	4,221,000	577,400	**May**	4,095,900	4,442,000	346,100
June	4,117,700	4,036,000	-81,700	**June**	3,858,800	4,303,000	444,200
July	4,559,600	5,654,000	1,094,400	**July**	4,188,200	4,984,000	795,800
Aug	4,846,100	4,569,000	-277,100	**Aug**	4,516,500	4,501,000	-15,500
Sept	4,553,100	4,515,000	-38,100	**Sept**	4,087,700	4,312,000	224,300
Oct	3,452,000	3,722,000	270,000	**Oct**	3,829,700	4,331,000	501,300
Nov	3,695,200	3,648,000	-47,200	**Nov**	3,965,400	3,916,000	-49,400
Dec	3,574,200	3,934,000	359,800	**Dec**	3,602,300	3,827,000	224,700
Total	**46,226,600**	**48,829,000**	**2,602,400**	**Total**	**46,995,500**	**49,900,000**	**2,904,500**
	2003				**2005**		
Jan	3,824,700	3,981,000	156,300	**Jan**	3,825,200	4,021,000	195,800
Feb	3,564,400	3,477,000	-87,400	**Feb**	3,800,600	3,551,000	-249,600
March	3,536,500	3,845,000	308,500	**March**	3,825,600	3,956,000	130,400
April	3,681,200	3,952,000	270,800	**April**	3,702,400	4,253,000	550,600
May	3,777,400	4,434,000	656,600	**May**	3,235,800	4,253,000	1,017,200
June	4,363,100	4,426,200	63,100	**June**	4,970,200	4,590,052	-380,148
July	3,570,300	4,746,900	1,176,600	**July**	5,360,100	6,217,000	856,900
Aug	5,780,600	5,847,000	66,400	**Aug**	8,456,900	5,289,000	-3,167,900
Sept	5,510,300	4,721,000	-789,300	**Sept**	4,192,200	4,135,000	-57,200
Oct	4,145,500	4,327,000	181,500	**Oct**	4,447,000	3,751,000	-696,000
Nov	3,868,200	3,795,000	-73,200	**Nov**	1,686,300	3,935,000	2,248,700
Dec	3,676,500	3,880,500	204,000	**Dec**	6,216,900	4,085,000	-2,131,900
Total	**49,298,700**	**51,432,600**	**2,133,900**	**Total**	**53,719,200**	**52,036,052**	**-1,683,148**

Figure 3.1 shows the City's total water use on a monthly basis from 1998 to 2005, as compared to sanitary sewer flows and precipitation data.



As the figure shows, water use is typically higher in the summer months and lower in the winter months. This is due to outdoor water use such as lawn watering. In the springtime and early summer, the wastewater flows spike dramatically due to groundwater infiltration and inflow.

It should be noted that there appears to be some discrepancy between the water usage data and the wastewater flow data from August 2000 to September 2004. Between these months the water usage is lower than the wastewater flow through the winter months. This is unexpected due to the fact that there is typically very little outdoor water use during the winter months and the majority of the water should be flowing into the sanitary sewer. As shown in Table 3.1, water sales are within 6% of water pumpage. This would indicate that the water supply well meters are accurate. However, monthly wastewater flows appear to have dropped significantly from August 2000 to September 2004 without a corresponding significant drop in rainfall. Therefore, it appears that there may have been an issue with the wastewater metering during this time period. Given the wastewater flow data from 2005, it appears that the problem has been corrected.

Using this historical data, as well as assumed water use data for the various land uses shown on the City's Land Use Plan, the water demand for the 20-year growth area and the ultimate area were projected as shown in Table 3.2.

Table 3.2 – Projected Water Demand

Year	Population	Annual Water Pumpage (million gal)	Ave. Day Water Use (gal)	Max Day Water Use (gal)	Ratio of Average to Max	Ave. Day Water Use 16 hr Pumping (gpm)	Max Day Water Use 20 hr Pumping (gpm)	Ave. Daily Water Use Per Capita* (gpd)
1998	1808	47.2	129,364	235,000	1.8	135	196	72
1999	1828	42.1	115,501	174,000	1.5	120	145	63
2000	1787	45.9	125,803	204,000	1.6	131	170	70
2001	1837	47.1	129,079	250,000	1.9	134	208	70
2002	1866	48.8	133,778	281,000	2.1	139	234	72
2003	1879	51.4	140,911	298,000	2.1	147	248	75
2004	1974	49.9	136,712	239,000	1.7	142	199	69
2005	2025	52.0	142,564	390,000	2.7	149	325	70
2015	2551	74.4	204,080	510,200	2.5	213	425	80
2025	3297	96.3	263,760	659,400	2.5	275	550	80
Ultimate	14334	863.2	2,365,110	5,912,775	2.5	2,464	4,927	165**

*Note: Daily water use includes industrial and commercial demand.
**Per Capita water is shown as rising considerably under ultimate development conditions due to commercial and industrial land use.

As the table shows, from 1998 to 2005, the total per capita water use has averaged 70 gpd. This is representative of a City whose water use mostly residential. As the City grows, if commercial and industrial development takes place according to the land use plan, the per capita water use will rise considerably due to the non-residential water use. For the 20-year projections, a conservative value of 80 gpd was used. For the Ultimate projection, a value of 165 gpd was used. This value represents a considerable commercial and industrial water demand and would be a conservative estimate. If future commercial and industrial businesses are low-water using businesses, this value may be lower.

Maximum day water use represents the peak flow during the summertime when water use is at its highest. The ratio of average day use to maximum day use from 1998 to 2005 averaged 1.9. A conservative value of 2.5 was used for the projections.

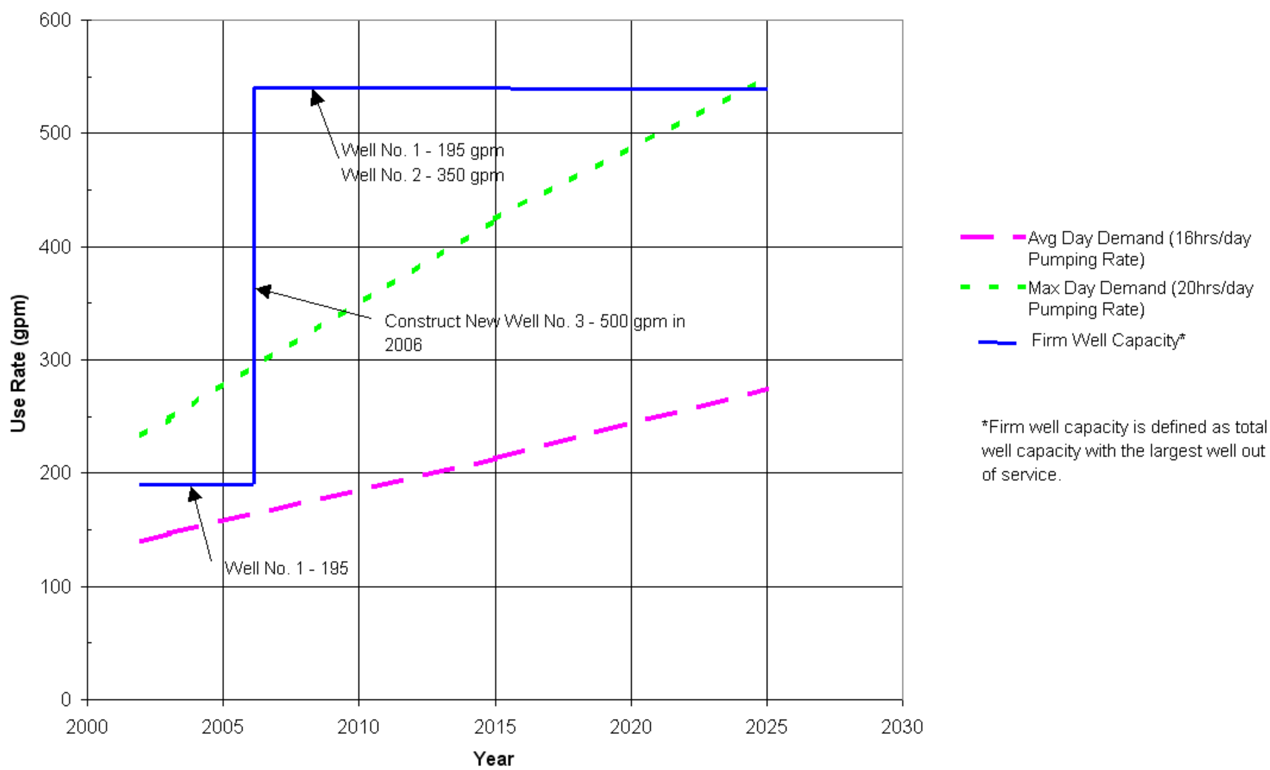
3.2 Water Supply

According to the Recommended Standards for Water Works[1], a City's water supply capacity should equal or exceed the maximum day demand with the largest producing well out of service. The capacity of a water supply system with the largest well out of service is also referred to as "firm capacity." A shown in Table 3.2, in 2002 through 2004 the City's maximum day water use averaged 227 gpm. The City's firm capacity is 195 gpm (Well No. 1, 195 gpm, running, Well No. 2, 350 gpm, out of service), which is below the maximum day water use for the past. Therefore, the City will need a new well to accommodate additional growth.

[1] Recommended Standards for Water Works, 2003 Edition, Great Lakes-Upper Mississippi River Bord of State and Provincial Public Health and Environmental Managers

Figure 3.2 shows the City's current and future average and maximum day water demands compared to the firm well capacity.

Figure 3.2 - Firm Well Capacity



As the figure shows, a new 500 gpm well will provide the City with sufficient firm well capacity to meet the maximum day demand for the 20-yr growth period.

3.3 Water Treatment

Drinking water quality is regulated by the United States Environmental Protection Agency (USEPA) through the Safe Drinking Water Act (SDWA) of 1974 and its amendments in 1986 and 1996. The SDWA has two standards; primary and secondary. The National Primary Drinking Water Regulations (NPDWRs) regulate contaminants that pose a threat to public health. National Secondary Drinking Water Regulations (NSDWRs) pertain to contaminants that affect the aesthetics of drinking water, such as taste, color, and odor. The secondary standards are considered a reasonable goal for a water supply, but are not federally enforced.

The City's wells are currently pumping from the Prairie du Chien aquifer. Currently, the City's water meets all of the primary regulations. The two major contaminants of concern from a secondary standpoint are iron and manganese. A recent test of the City's water revealed the following raw concentrations of iron and manganese as compared to the secondary standards:

Table 3.3 – Iron and Manganese Data

Parameter	Test Results (mg/l)	Secondary Standard (mg/l)
Raw Iron	0.6	0.3
Raw Manganese	0.18	0.05

Iron and manganese, when precipitated out of solution, cause staining problems with laundry and bathroom fixtures. The City currently adds polyphosphate at both of its wells. Polyphosphate is a chemical that will keep iron and manganese in solution for a period of time and prevent it from precipitating. The results shown in Table 3.3 show the raw concentrations of iron and manganese prior to the addition of polyphosphate. As long as the total concentration of iron and manganese is less than 1 mg/l, polyphosphate should be a cost-effective method of treatment for iron and manganese. According to City staff, complaints regarding aesthetic water quality have been minimal; therefore, it appears that the sequestration treatment method is currently effective.

However, it should be noted that treatment by sequestration with polyphosphate is only effective for short detention times. If the water is detained in the system for an extended period of time, such as in a water tower, iron and manganese may precipitate out of solution even with the addition of polyphosphate. In the future, if detention time becomes an issue, or if the concentrations of iron or manganese rise, the City may need to investigate treatment by filtration.

It should also be noted that the Prairie du Chien aquifer may have a limit on the total amount of water that the City will ultimately be able to pump. If City water demand keeps growing, in the future, the City may need to drill wells into the Mount Simon aquifer, which has radium and other water quality issues. This would make water treatment by filtration a necessity.

3.4 Water Storage

Water storage is necessary in a water distribution system for two primary reasons; fire fighting storage, equalization storage.

When a fire occurs, a fire truck will pump water from a hydrant to extinguish the fire. Typical pumping rates for fire fighting purposes range from 750 gpm to 5,000 gpm. If a city's well pumps are not large enough to supply these flow rates, then it is necessary to withdraw the water from storage. For example, if the City had no water storage, and a fire truck were to attempt to pump 1500 gpm from a hydrant, the well pumps would only be able to supply approximately 495 gpm (Well No. 1 and No. 2 running). Therefore the remaining water would need to come from storage. Currently, the City's 300,000 gallon elevated water storage tank provides fire fighting storage.

Under normal conditions, the City's water supply is provided by its well pumps, which cycle on and off throughout the day. The well pumps are adequate to provide enough flow to meet the water demand during a typical day. However, in cases where the demand exceeds the pump capacity (such as the peak day or peak hour) additional water volume must be provided from storage to meet the required demand. This is called equalization storage. Currently, the City's 300,000 gallon elevated storage tank provides equalization storage.

Table 3.4 shows the water storage requirement calculations, including fire storage and equalization storage, during the maximum day demand, for current and future conditions.

Table 3.4 – Water Storage Requirements

		2005	2025	Ultimate Area	
1	Fire Demand (gpm)	2,000	2,000	2,000	Typical fire flow requirements vary from 750-1,500 gpm in residential areas to 2,000 to 5,000 gpm in commercial/industrial areas. A flow of 2,000 gpm is used for these water storage calculations.
2	Estimated Population	2,025	3,297	14,334	
3	Max. Day Demand (gpm)	338	550	4,927	[Population (Row 2) x 80* gpcd x 2.5 peaking factor]/[20 hrs/day x 60 min/hr] *Note: 165 gpcd used for ultimate development
4	Peak Usage (gpm)	2,338	2,550	6,927	Row 1 + Row 3
5	Firm Pumping Supply (gpm)	545	1,045	5,500	Maximum pumping supply available with largest well out of service. For 2005, assumes Well No. 1 (195 gpm) and Well No. 2 (350 gpm) are running and backup power is available. For 2025, assumes Well No. 1 (195 gpm), Well No. 2 (350 gpm) and Well No. 3 (500 gpm) are running and backup power is available. For Ultimate Area, assumes 5,500 gpm of well capacity is available with backup power.
6	Withdrawal from Storage (gpm)	1,793	1,505	1,427	Row 4 - Row 5
7	Fire Flow Duration (hrs)	2	2	2	Recommended fire flow duration for fire flow less than 3,000 gpm.
8	Fire Demand Storage (gallons)	215,100	180,540	171,278	Row 6 x Row 7
9	Emergency Storage (gallons)	97,200	158,256	1,419,066	Emergency storage is typically 20% of maximum day demand.
10	Total Storage Needed (gallons)	312,300	338,796	1,590,344	Row 8 + Row 9
11	Current Available Storage (gallons)	300,000	300,000	300,000	Includes existing 300,000 gallon elevated storage tank.
12	Net Storage Deficit (gallons)	12,300	38,796	1,290,344	Row 10 - Row 11
13	Rounded Net Storage Deficit (gallons)	0	0	1,500,000	

As the table shows, the City has adequate water storage capacity for the 20-yr growth period assuming that the City determines that a 2,000-gpm fire flow is adequate. It should be noted that there are areas within the City that have a recommended fire flow that is greater than 2,000 gpm. Section 3.5 will discuss needed fire flow requirements for the various land uses within the City.

Regardless of the fire flow that is provided, additional storage will be needed for the ultimate growth area.

3.5 Water Distribution System

In evaluating an existing system or planning a proposed system, it is important to establish operational scenarios against which the system will be compared. Most systems are quite capable of meeting the average day conditions. Only when the system is subjected to a stressed condition do the deficiencies begin to appear. For evaluating a distribution system, it is common to check the system under the following conditions:

- Peak Hour Demand
- Maximum Day Demand Plus Required Fire Flow

Trunk watermain sizes are typically governed by the fire flow requirements since the required fire flows are much higher than the peak hour water demand.

To simulate these conditions, the water distribution system for the City was modeled using Haestad Methods, Inc. WaterCAD software. The computer network model is used to analyze steady state flows for pipe distribution systems. The information required for the model includes data such as diameter, length, and Hazen-Williams C Factor (the pipe roughness factor) for each pipe in the system. Other data required includes ground elevation of pipe junctions, elevated storage water level, and water demand on the system. The computer network model was calibrated using hydrant flow test data obtained on October 11, 2005 by Bolton & Menk, Inc staff. The flow test data is included in the appendix.

The computer network model calculated the residual pressure and available fire flow for each junction. Residual pressure is defined as the water pressure in the system under non-fire flow demands. Available fire flow is defined as the amount of water that can be pumped from the system at any point in the distribution system while maintaining a 20-psi residual pressure at all points of the distribution system. For modeling purposes, the water tower was assumed to be full at elevation 1150.0-ft.

Figure 3.3 shows the Existing Pressure Contours, and Figure 3.4 shows the Existing Available Fire Flow Contours. As the figures show, the City's current distribution system provides pressures ranging from 58-psi to 70-psi with the water tower full at elevation 1150.0-ft. Available fire flows in the City range from 1,000-gpm to 4,750 gpm. Detailed data from the computer model is included in the appendix.

According to the Recommended Standards for Water Works, acceptable operating pressures within a distribution system range from 60-psi to 80-psi. Typical maximum and minimum pressures are 35-psi and 90-psi. Therefore, the City's distribution system is currently providing acceptable pressure, as shown in Figure 3.3.

According to the Insurance Services Office, needed fire flows for residential areas are calculated based on the distance between buildings, as shown in Table 3.5.

Table 3.5 – Needed Fire Flows in Residential Areas

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
More than 100	500
31 to 100	750
11 to 30	1,000
10 or less	1,500

As shown in Table 3.4, the City's water supply and storage system is capable of supporting a 2,000 gpm fire flow for a duration of 2 hours on the maximum day. Therefore, the water distribution system should be capable of providing a fire flow of at least 2,000 gpm.

As shown in Figure 3.4, the City's current water distribution system meets this requirement in the majority of the City with the only exception being the far southeast portion. Therefore, the City's water distribution system, in conjunction with the water supply and storage system, is able to provide adequate fire flow for residential needs for the majority of the City.

Needed fire flows for individual commercial and industrial buildings can range from a minimum of 500 gpm to a maximum of 12,000 gpm. Actual needed fire flows for individual buildings is dependent on building construction, occupancy, proximity to adjacent buildings, and whether or not the building has sprinkler protection. Since performing individual classifications on existing buildings is outside the scope of this study, and determining actual needed fire flows for future development areas is not possible until buildings are constructed, assumptions need to be made regarding needed fire flow for commercial and industrial areas. Table 3.6 shows the assumptions made for needed fire flow for the various land use classifications in the City, assuming sprinkler protection is not used for commercial and industrial buildings.

Table 3.6 – Needed Fire Flow Assumptions

Land Use	Needed Fire Flow (gpm)
Low Density Residential	1,000
Medium Density Residential	1,000
Limited High Density Residential	2,000
High Density Residential	2,000
Commercial*	3,500
Light Industrial*	3,500
Heavy Industrial*	4,000
School*	2,000-3,500

*Flows are for buildings without sprinkler protection. Typical needed fire flows for building sprinkler protection dependent on several factors, but are typically less than 1,000-gpm.

It should be noted that even if the water distribution system can accommodate the needed fire flows shown in Table 3.6, the water supply system needs to be sized to provide the necessary volume to sustain the needed fire flows.

Table 3.7 shows the needed fire flow durations for various flow rates.

Table 3.7 – Needed Fire Flows Durations

Needed Fire Flow (gpm)	Duration (hours)
Less than 3,000	2
3,000 to 3,500	3
Greater than 3,500	4

As discussed in Section 3.4, the City's water storage system is only able to support a 2,000-gpm fire flow. As shown in Figure 3.4, there are several areas in the City where the water distribution system is unable to meet the needed fire flows shown in Table 3.6 for commercial and industrial land uses. Therefore, if the City desires to accommodate needed fire flows for residential and commercial land uses, improvements to both the water storage and water distribution systems will be required. However, it should be noted that the needed fire flows shown in Table 3.6 do not account for the use of sprinkler protection in commercial and industrial buildings. Needed fire flows for most buildings with sprinkler protection are typically below 1,000-gpm. Therefore, if the City decides not to provide the needed fire flows shown in Table 3.6 for commercial and industrial areas, those buildings would have the option of installing a sprinkler system to avoid higher insurance rates.

4.0 Proposed Improvements

4.1 Water Supply

As discussed in Section 3.2, the City needs a new well with a capacity of at least 500 gpm to accommodate existing needs as well as the 20-yr growth needs. Two alternatives have been proposed to the City for the construction of the new well.

4.1.1 Alternative No. 1 – New Well and Well House

A new well could be located at the old water tower site (near Well No. 1), or in one of the new subdivisions in the southeast or southwest parts of the City. A new well house would be needed at these locations for the metering, chemical feed, and control purposes. The estimated cost for Alternative No. 1 is shown in Table 4.1.

Table 4.1 – Estimated Cost - New Well-Alternate No. 1

Item	Estimated Cost
New Well and Well Pump	$170,000
New Well House	$100,000
Piping, Valves, Meter	$60,000
Chemical Feed System	$25,000
Heating & Ventilation	$20,000
Electrical & Controls	$40,000
Painting	$20,000
Site Piping	$25,000
Site Restoration	$10,000
Subtotal	**$470,000**
Contingencies, Engineering, Construction Administration	$122,000
Estimated Total Project Cost	**$592,000**

4.1.2 Alternative No. 2 –New Well and Expand Existing Well House

The new well would be located near Well No. 2 in the City Park. A new 8-inch watermain would be extended from the new well to the well house expansion. The existing well house would be renovated to provide adequate space for the additional chemical feed. The existing 8-inch watermain running from the well house to the system will be replaced with a 10-inch watermain.

The estimated cost for Alternative No. 2 is shown in Table 4.2.

Table 4.2 – Estimated Cost - New Well-Alternate No. 2

Item	Estimated Cost
New Well and Well Pump	$170,000
Addition to the Well House	$40,000
Piping, Valves, Meter	$60,000
Chemical Feed System	$8,000
Heating & Ventilation System	$10,000
Electrical & Controls	$40,000
Painting	$10,000
Site Piping & Site Restoration	$48,000
Subtotal	**$386,000**
Contingencies, Engineering, Construction Administration	$104,000
Estimated Total Project Cost	**$490,000**

Alternative No. 2 is the lower cost option of the two alternatives evaluated. This option does not add more chemical storage tanks and an additional chlorination system as in Alternative No. 1. This alternative requires that the new well be at least 250 feet away from the existing Well No. 2 to reduce the interference between the wells when both of the wells are pumped simultaneously. Therefore, the site piping cost for this alternative is higher than that for Alternative No. 1.

As discussed in Section 3.3, it should also be noted that the Prairie du Chien aquifer may have a limit on the total amount of water that the City will ultimately be able to pump. If City water demand keeps growing, in the future, the City may need to drill wells into the Mount Simon aquifer, which has radium and other water quality issues. This would make water treatment by filtration a necessity. Alternative No. 2 is advantageous if the City were to consider a water treatment facility in the future. Keeping the City's wells in a centralized location would eliminate the need to construct long lengths of raw watermain from the wells to the treatment plant location.

Given the construction cost and future water treatment possibilities, we recommend that the City consider Alternative No. 2 for construction of a new well to increase the City's water supply capacity to accommodate existing needs as well as the 20-yr growth needs.

To accommodate the ultimate growth area, the City will need to increase its water supply capacity to approximately 5,500 gpm. This could be accomplished through the construction of additional groundwater supply wells. As additional wells are added, the capacity of the Prairire du Chien aquifer should be monitored to insure that the aquifer has the capacity to provide the necessary water supply.

4.2 Water Storage

As discussed in Section 3.4, the City's current 300,000 gallon elevated storage tank has sufficient capacity to meet domestic and a 2,000-gpm fire fighting demand for projected growth over the next 20-years, assuming a new well is constructed to increase firm capacity, and provisions for backup power at all of the wells are made. If the City desires to provide additional fire fighting flows to its customers, additional water storage will be needed. However, since the current water storage system meets the necessary residential fire fighting demand, and can provide the necessary sprinkler demand for commercial and industrial users, we recommend that no additional water storage is needed for the 20-yr growth period.

Beyond 20-years, additional water storage will be necessary. Additional water storage could be provided in the form of new elevated storage tanks, or ground storage at a future water treatment plant if treatment by filtration becomes a necessity. As shown in Table 3.4, the total amount of additional storage needed for the ultimate growth area is 1,500,000 gallons. This projection assumes that the City's water supply system will be able to provide 5,500 gpm of pumping capacity.

4.3 Water Distribution System

As discussed in Section 3.5, the water distribution system must be able to accommodate the peak hourly demand, and the maximum day demand combined with the fire demand. In the past, it was typical for water distribution systems to be built with 6-inch and even 4-inch diameter pipes as the minimum size. This was adequate to accommodate the peak hour demand, but is inadequate for the much larger fire flow demands. To accommodate fire flows, it is recommended that the minimum watermain size be 8-inch diameter, with the exception of hydrant leads. However, additional 10-inch and 12-inch diameter trunk watermain will also be needed within the system to maintain adequate fire flows.

20-year Growth Area Improvements

For the 20-yr growth period, there are no improvements to the City's existing water distribution system that are necessary to maintain adequate pressure and fire flow while accommodating growth.

To accommodate the projected 20-yr growth areas shown in Figure 6.1 in Section 1 of the Plan, trunk watermain improvements will be necessary. The improvements are listed as follows and are shown on Figure 4.1:

- 10-inch watermain extension through Eagle Ridge II & III
- 10-inch watermain extension through Eagle Heights
- 10-inch watermain extension through Coves of Eagle Lake

Note that the watermain layout shown in Figure 4.1 is schematic in nature. The actual location of the trunk watermain can be modified to follow platted streets within the proposed subdivisions. The remainder of the streets within the subdivisions should have 8-inch watermain.

Ultimate Growth Area Improvements

For the ultimate growth area, a system of 10-inch trunk watermain will be required. Figure 4.1 shows the general layout of the trunk watermain. As subdivisions are constructed within the ultimate growth area, the actual location of the trunk watermain should be modified to follow platted streets within the subdivisions. The remainder of the streets should have 8-inch watermain.

Figure 4.2 shows the residual pressure within the water distribution system following full build out of the ultimate growth area. Figure 4.3 shows the available fire flows within the water distribution system following full build out of the ultimate growth area. It should be noted that although the future water distribution system will be able to provide fire flows ranging from 2,750 gpm to 4,750 gpm, additional water storage will be necessary as described in Section 4.2 to provide the necessary volume to sustain these flows for the required duration.

Suggested Existing System Improvements

As the City pursues other infrastructure replacement projects such as sanitary sewer, storm sewer, and street reconstructions, there are several improvements that are recommended to eliminate undersized watermain and complete trunk watermain loops within the existing City limits. These improvements do not need to be completed within any specific time period, but should be noted when infrastructure replacement projects are proposed. Those improvements are listed as follows and are shown on Figure 4.4:

- Complete 12-inch watermain loop along alley adjacent to RR tracks between Third Street and Second Street.
- Complete 12-inch watermain loop along Second Street from LeRay Avenue to LeSueur Avenue.
- Replace 4-inch watermain along Lakeview Drive from LeRay Avenue to just north of Eagle Avenue
- Replace 6-inch and 8-inch watermain along LeSueur Avenue from Thomas Drive to Agency Street.
- Replace 6-inch and 8-inch watermain along Linda Drive and Thomas Drive from Linda Court to Joan Lane
- Replace 6-inch watermain along Agency Street from CSAH 17 to Thomas Drive.

- Replace 4-inch watermain along Blace Avenue from Agency Street to Perry Street.
- Replace all existing 6-inch watermain (excepting hydrant leads) with 8-inch watermain.

5.0 Cost Estimates for 20-yr Improvements and Financing

According to the recommendations in this study, the following improvements to the City's water system will be necessary within the next 20-years:

- Construct 10-inch Trunk Watermain Improvements within Eagle Ridge II & III, Eagle Heights, and Coves of Eagle Lake
- Construct Well No. 3 – 500 gpm

For the trunk watermain improvements, it is typical for cities to require that the developer pay for the minimum watermain size, and for the city to pay for the incremental cost of oversizing. As discussed in Section 4.3, the minimum watermain size for the City is 8-inch diameter. Therefore, the City would be responsible for the incremental increase in cost from an 8-inch watermain to a 10-inch watermain. Table 5.1 shows the City's share of the over sizing cost for the 20-yr development areas.

Table 5.1 Estimated 20-yr Watermain Oversizing Cost

Development Area	Estimated Developable Area (Acres)	Oversize Unit Cost 8-inch to 10-inch	Estimated Length of 10-inch Pipe (LF)	City Share of Trunk Watermain Oversize Cost
Eagle Ridge II & III	44	$4.50	2,908	$13,086
Eagle Heights	372	$4.50	9,887	$44,492
Coves of Eagle Lake	103	$4.50	5,986	$26,937
Total	**519**	**$4.50**	**18,781**	**$84,515**

A common method of financing improvements that are necessary to accommodate development is to apply an area charge to developments as they are platted. In the case of the water system improvements, this charge would be referred to as a Water Area Charge (WAC). The WAC would consist of a charge per acre of developable property within a proposed subdivision.

Table 5.2 shows the total City cost for the 20-yr improvements.

Table 5.2 Estimated Cost, 20-yr Improvements	
Item	**Estimated Cost**
Trunk Watermain Oversizing	$84,515
Well No. 3	$490,000
Total	**$574,515**

The estimated total expected developable area for the 20-yr growth period is 519-acres. If the City desired to recoup the entire cost of the 20-yr improvements through a WAC fee applied to the expected development, then the WAC fee would need to be set at a minimum of $1,100 per acre. To account for variations in the estimated watermain length and the amount of developable acreage, and to build a fund balance as soon as possible, we recommend that the WAC fee be set at a minimum of $2,000 per developable acre.

APPENDIX

Hydrant Flow Test Data

WaterCAD Output