2030 COMPREHENSIVE PLAN

City of Lake Elmo, Minnesota

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ST. PAUL, MINNESOTA

APRIL 2009

2030 COMPREHENSIVE WATER SYSTEM PLAN

CITY OF LAKE ELMO, MINNESOTA

I hereby certify that this plan 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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CITY OF LAKE ELMO, MINNESOTA
PROJECT NO. 12782.001

TABLE OF CONTENTS

PAGE NO.

SECTION 4. EXISTING WATER SYSTEM AND PERFORMANCE

SECTION 5. FUTURE WATER SYSTEM

LIST OF TABLES

PAGE NO.

LIST OF FIGURES

PAGE NO.

APPENDIX

2030 COMPREHENSIVE WATER SYSTEM PLAN
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SECTION 1. EXECUTIVE SUMMARY

1.1 Executive Summary and Recommendations

The City of Lake Elmo owns, operates and maintains a municipal water supply and distribution system. The 2030 Comprehensive Water System Plan has two primary purposes. The first purpose is to evaluate and report on the ability of the existing water system facilities to reliably serve the City's current water needs. The second purpose is the development of a Comprehensive Water Plan that identifies the future service objectives for the water system together with a plan to logically and economically expand that water system to meet those objectives.

This Plan has been prepared to meet the water supply system requirements for the City of Lake Elmo through the year 2030, and to meet the requirements of the regulatory agencies. The Minnesota Department of Health (MDH), the Metropolitan Council, and the Department of Natural Resources (DNR) each have mandates which this Plan fulfills. Noteworthy mandates include providing a safe reliable drinking water meeting the established drinking water standards, water conservation, and basic fire protection. Recommended system improvements have been developed using the performance criteria of Ten State Standards, Recommended Standards for Waterworks, as published by the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers.

Earlier plans for the City limited the municipal water supply service area to the Old Village with two additional localized water service areas consisting of the Lake Jane water system interconnect with the City of Oakdale, and the Eagle Point Business Park interconnect with the City of Oakdale. However in 2005, with the discovery of PFC contamination in the Tablyn Park/Lake Elmo Heights neighborhoods, just south of TH 5, significant investments in water system infrastructure were made by the City to extend a safe drinking water supply across the City to these neighborhoods; infrastructure that was partially funded by 3M.

To improve public confidence, the underlying objectives of the water system changed substantially, with the understanding that the City may need to be readily available to be extended to various parts of the City in response to real or perceived health safety issues. The goal now is to serve the existing population desiring public water supply while preparing the system to allow people to connect as development occurs or existing areas request service.

In this plan, the existing water system facilities were evaluated to identify system deficiencies and the improvements necessary to correct these deficiencies. Capital improvements were also included in response to the PFOA and PFOS aquifer contamination plumes in the Torre Pines, Cardinal Ridge, Cardinal View and Whistling Valley neighborhoods. The anticipated water service areas were then identified through the 2030 planning year together with the tabulation of the future water system demands. Water system demands were based on the land use and population estimates of the 2005 Comprehensive Plan Update. Analysis of the existing and future water system were conducted using the criteria explained in Section 3 of this plan. All improvements proposed by this plan complement the current system, provide for the safety and health of its customers, and attempt to recommend water service at affordable and competitive rates. The specific recommendations below are intended to identify action items that should can be taken over the next few years as part of the implementation of this Comprehensive Water System Plan.

Recommendation No. 1 - Correct Existing Deficiencies

Two capital improvement projects have been identified as critical in order to provide a safe and reliable water supply to the existing customer base. The Capital Improvement Plan identified these two projects to be constructed as soon as funding can be appropriated. The two improvement projects are Well and Pumphouse No. 4 and the Keats Avenue Trunk Watermain Extension.

Well No. 4 is needed to provide a backup Well to Well No. 2 and to provide additional “firm” well capacity. Currently, if Well No. 2 failed there would be no water supply to the Intermediate pressure zone. Well No. 1 has limited capacity at 500 GPM and cannot provide adequate pressure to the higher pressure zone (Elevated Tank No. 2). The emergency Lake Jane Oakdale interconnection has very limited supply capability due to the small diameter piping. Neither source has the ability to meet the basic water demands in the Intermediate pressure zone. Well No. 4 would be a 1,000 GPM well designed to serve the Intermediate pressure zone with a pressure reducing valve to allow for supply to the Old Village Area. At a minimum, the City should immediately begin the process of siting the well location and pursue any land acquisition that may be needed.

The Keats Avenue Trunk Watermain Extension project is needed to complete a core part of the City's distribution network, providing a critical loop in the distribution system and a more functional and reliable distribution path from Well No. 2 to the demand points in the service area. The improvement is needed to meet supply and fire flow demands of the existing system and to increase supply reliability of the entire water system. The Keats Avenue Trunk Watermain Extension was part of the original system design when the decision was made to extend water service across town to the Tablyn Park/Lake Elmo Heights neighborhoods. The connection project was delayed due to staff turnover and potential funding deficiencies. The distribution network is currently operating in a temporary condition, routing the water supply from Well No. 2 through the Low pressure zone.

Recommendation No. 2 - Seek Funding Assistance for the SW Area Watermain Extension Project

Following a presentation to the City Council in October 2008, the Council identified the SW Area Watermain Extension Project as a No. 1 priority. As a matter of Public Health, this watermain extension project is needed to provide a safe public drinking water to residents in southwestern Lake Elmo where PFOA and PFOS groundwater contamination has been found which exceeds established Health Risk Levels (HLV). Neighborhoods include Torre Pines, Cardinal Ridge, Cardinal View, and the Whistling Valley subdivisions.

The project has significant cost and benefits only 135 properties. The project is not feasible without significant outside financial assistance. Therefore, it is recommended that a city task force be formed with the objective of seeking financial assistance for this project.

Recommendation No. 3 - Continue the use of Well No. 1 and Elevated Tank No. 1, but Plan for their replacement

It is recommended that Well No. 1 and Elevated Tank No. 1 be utilized as long as they remain productive and reliable facilities for the Old Village water system. Once significant work or reconditioning becomes needed, they should be abandoned and razed.

Well No. 1 was constructed in 1960 and as a multi-aquifer well, no longer meets the current well code. Under this configuration, the City is permitted to continue to use Well No. 1, however the City must bring the well into compliance with current code whenever the well is reconditioned or increased in capacity. As a small production well, only 500 GPM, it is not cost effective to further invest in this well once significant reconditioning becomes needed.

The City must maintain a plan to replace this well on short notice. Well No. 1 currently requires additional monitoring and the Minnesota Department of Health (MDH) could force Lake Elmo to abandon the well if there is any evidence of potential contamination. This is due to the fact that the well obtains water from multiple aquifers and the MDH needs to prevent contamination from moving between these aquifers. Once Well No. 4 is constructed and placed into service (Recommendation No. 1), Well No. 1 can be abandoned on short notice.

Elevated Tank No. 1 is a small capacity tower at 75,000 gallons. The current City water system has substantially outgrown this tank, with the tank serving only a minimal function for the Old Village water system area. As the water system continues to expand, additional storage facilities will be needed, and once constructed, they will render Elevated Tank No. 1 redundant and obsolete. The maintenance cost of refurbishing this tower would be better invested in other towers located on the system.

Recommendation No. 4 - Request the necessary review to update the ISO rating

The current Insurance Services Organization (ISO) community fire rating for Lake Elmo is a 6 on a 1–10 scale with 1 being the best. This rating is used by insurance companies when determining the annual insurance costs that are charged for residential, commercial, and institutional buildings throughout the community. Lower ratings result in lower insurance rates for property owners. The ISO rating can be limited by water system deficiencies and/or deficiencies with the local fire department facilities or capabilities. Lake Elmo has made recent investments to improve the municipal water system. Following the completion of the additional improvements of Well No. 4 and the Keats Avenue Trunk Watermain Extension projects, the City should pursue an ISO review to lower the fire rating for the community.

Recommendation No. 5 - Defer the final decision on Well No. 3

This plan recommends that Well No. 3 be abandoned due to the discovery of PFC contamination. However, it is recommended that this final decision be deferred until the MDH requires the City to adandon the well, or until the water system supply decisions for the Eagle Point water system area are more certain. By deferring the decision on this well, the City leaves open the possibility of using this well, either alone or in conjunction with the City of Oakdale, with a Water Treatment Plant being constructed to treat the PFC contaminate.

Recommendation No. 6 - Negotiate a multi-year interim water supply contract with the City of Oakdale

The simplest and most financially viable interim solution for providing water service to the southern half of Lake Elmo is to negotiate a multi-year interim contract with the City of Oakdale. Through a current interconnect and annual service agreement with Oakdale the City water supply is purchased for the Eagle Point Business park area. If an acceptable multi-year agreement can be established, this arrangement could provide an economical interim solution for serving both the South High pressure zone located in the southwest quadrant of the City and possibly the South Low pressure zone located in the southeast quadrant. A multi-year contract may be negotiated at a lower rate providing income to the City from the Eagle Point users. As the Lake Elmo water system matures, it may become more economical to construct a tank in the southwest quadrant with the trunk watermain piping necessary along Inwood Avenue, to connect the south water service areas to the north water service areas of the City, forming an independent City water supply system.

Recommendation No. 7 - Future Southeast Quadrant Water System

In order to provide a municipal water supply to support development in the southeast quadrant of the City, beginning with the MCES Sewer connection at Lake Elmo Avenue and Hudson Boulevard, it is recommended that Well and Pumphouse No. 5 be constructed in the general location shown on Figure 1 at the end of this section. The actual well site will need to be reviewed and approved by the MDH to assure that the Well will not negatively impact the PFC plume.

Well No. 5 can be equipped with a temporary pressure tank located in the Pumphouse until the water demands in the service area support the construction of Elevated Tank

No. 3. The temporary pressure tank configuration would be similar to the City's construction of Well No. 2. If the MDH denies the siting of a municipal well in the southeast quadrant, then the water supply to this area must be provided through a long trunk watermain extension from the Eagle Point water system or from the Old Village Area water system with the trunk watermain upgraded to a 16-inch diameter pipe. Well No. 5 would then be located in the northern part of the City, shown as 5A on Figure 1, to support to the overall demands of the City water system.

Recommendation No. 8 - Maintain a Flexible and Responsive Water System Capital Improvement Plan

It is recommended that the 2009-2030 Capital Improvement Plan and the 2030 Comprehensive Water System Plan outlined in Table No. 1 following these recommendations and Figure No. 1, be used as the general guide for expanding the system in response to future needs and demands. At the same time, the Plan must remain flexible by design in order to remain both economical and responsive to the unique and complex requirements and conditions of the City.

Lake Elmo has the potential to require the water system to simultaneously expand in several different geographic locations and in one of four different pressure zones. This variability means that the order in which some of the capital improvements, in particular the future wells and storage tanks, may change if the anticipated development sequence and patterns vary. The recommended capital infrastructure may also vary depending on whether an acceptable multi-year interim agreement can be established with the City of Oakdale. In particular, the water system may need to be extended to serve the Village Area development, the southeast quadrant of the City and the southwest quadrant, all separate geographic areas in multiple pressure zones that potentially require different water supply sources and distribution connections. The water system must be capable of serving the southern part of the city, primarily south of 10th Street using a water supply well field located in the northeast quadrant in the event that Well No. 5 cannot be constructed in the location shown in Figure 1. Then, if feasible, the Plan must be flexible to change if a well can be established south of 10th Street. In addition, the water system must be capable of being expanded in the north half of the city (between Stillwater Blvd. and TH 36) in response to various open space developments, which will not necessarily develop in a contiguous manner.

Additional considerations for a flexible water system Plan include:

- The water system must be readily responsive to new and changing circumstances regarding aquifer contamination and well advisories.
- Capital improvements may be required on short notice to replace Well No. 1 and/or Elevated Tank No. 1.
- If a multi-year interim purchase agreement is established with the City of Oakdale, it may alter the timing and need for certain supply and storage facilities. This cost benefit analysis must be completed at the time that negotiations are taking place.

Recommendation No. 9 - Improve Water Conservation

Better progress must be achieved in meeting DNR conservation benchmarks through increased enforcement of current conservation measures and/or through the implementation of additional conservation measures. Measures may include public education, higher water billing rates targeted toward lawn sprinkling, or additional water use restrictions.

The City must complete a Water Supply Plan for the Department of Natural Resources (MnDNR) and adopt a water conservation rate structure meeting DNR approval by January 1, 2010. As part of these efforts, City staff must diligently pursue and acquire additional water appropriations. Current water use exceeds the permitted water appropriations and the City cannot construct a new well until the appropriation permit has been updated.

TABLE NO. 1

2009-2030 WATER SYSTEM CAPITAL IMPROVEMENT PLAN

Year	Capital Improvement	Trigger Event	Estimated Cost
ASAP	Well and Pumphouse No. 4 *Construct new well to feed the Intermediate Pressure Zone including watermain connection and a PRV to the Low Service Area*	Current user demand exceeds 'Firm' Well Capacity and system lacks reliable backup *(Well was needed in 2007)*	$885,000
ASAP	Keats Avenue Trunk Watermain *Construct 16-inch trunk watermain along Keats Avenue to connect Well No. 2 with Elevated Tank No. 2 through the Intermediate Pressure Zone*	Critical trunk watermain supply route to Elevated Tank No. 2	$1,200,000
2012	Booster Station No. 1 *Construct Booster Station with variable frequency drives and indoor emergency generator (project only needed if Inwood Avenue Trunk Watermain is constructed to 10th Street)*	Funding Availability for SW Area Watermain Extension Project	$700,000 *(Generator Add: $250,000)*
2014	Elevated Tank No. 1A *Construct 500,000 gallon elevated storage tank to replace existing Elevated Tank No. 1. Remove Tank No. 1*	Village Area development outpacing available storage and expected deterioration of existing elevated tank	$1,600,000
2015	Well and Pumphouse No. 5 *Construct Well No. 5 to feed the Low Pressure Zone in the southeast quadrant (New Water Supply Source). Well No. 5 will require a temporary pressure tank until Elevated Tank No. 3 is constructed.* *OR* *Construct Well No. 5A to feed the Intermediate Pressure Zone. Adjust pump at Well No. 4 to feed only North Low Pressure Zone*	New water source for development in the southeast quadrant south of 10th Street OR Demand Exceeds 'Firm' Well Capacity for water system	$960,000 (includes pressure tank) $885,000
2019	Elevated Tank No. 3 *Construct 750,000 gallon elevated storage tank to serve South Low Pressure Zone*	Storage requirements to support continued development in the South Low Pressure Zone	$1,700,000
2025	Elevated Tank No. 4 *Construct 500,000 gallon elevated storage tank to serve the South High Pressure Zone*	Storage requirements to support development in South High Pressure Zone	$1,550,000
2028	Well and Pumphouse No. 6 *Construct Well No. 6 (Intermediate Pressure Zone) and Abandon Well No. 1.*	Total system demand exceeds 'Firm' Well Capacity and expected need to recondition Well No. 1	$955,000

**Trigger events are graphically represented in Figures 5 and 6 of this report.*

***Cost estimates are based on 2009 construction costs and include a 10% contingency and 25% for Engineering, Administration, Finance, and Legal.*

Figure 1

SECTION 2. PURPOSE AND BACKGROUND

2.1 Purpose

The purpose of this Plan is to provide the City of Lake Elmo with the framework necessary to provide a safe public drinking water supply to existing residents and businesses, and to efficiently and economically maintain and expand the municipal water system to serve the community needs through the year 2030. This Plan has been prepared to meet the requirements of the regulatory agencies, including the Minnesota Department of Health (MDH), the Metropolitan Council, and the Department of Natural Resources (DNR), each having mandates which this Plan fulfills. The Plan provides recommendations for guiding the efficient development of the municipal water system including a Capital Improvement Plan for the major facilities with projected costs and year needed.

A thorough review of the water system has been completed in order to generate this Plan. Water supply needs for the current customer base and the potential future users were projected and tabulated. The Plan than addresses the supply and storage requirements for the system as a whole, as well as provides a plan for the sizing and location of the trunk watermain network and facility components. For a multiple pressure zone water system such as the one required for Lake Elmo, each zone must be individually reviewed on a subsystem basis. Each zone needs to be designed to serve the basic needs of the consumers within the zonal boundaries. In addition, each zone must fit into the concepts of the entire system. Multiple pressure zones generally lead to more complex water systems.

2.1.1. Design Period and Planning Area

The water system concepts and capital improvements recommended by this Plan focus on the time frame between 2009 and 2030. The planning area includes the corporate City limits for the City of Lake Elmo. Interconnections and water supply with neighboring communities have also been considered as part of this planning effort.

2.2 Background

2.2.1 Land Use

This Plan is based on the 2005 Comprehensive Land Use Plan and population projections, where the City is expecting to maintain its rural character throughout most of the City. Growth is anticipated to occur primarily in the southern parts of the City between Hudson Boulevard and 10th Street, and in the Village Area located along Stillwater Boulevard (TH 5). The remaining areas of the City will continue to develop as Rural Residential "Open Space" type developments. However, due to the discovery of PFC contamination in 2005 the City must remain responsive to providing a safe public drinking water supply to most areas and should require new developments to be served by the municipal water system.

The land use plan plays a key role in managing growth within the City. The comprehensive plan, as well as the sewer, water, transportation, and surface water infrastructure plans are based on the forecasts and development information presented in the land use discussions. The 2005 Comprehensive Land Use Plan utilized in preparing this comprehensive report is shown in Figure 2.

2.2.2. Population

The City of Lake Elmo is anticipating a future 2030 population of roughly 24,000. Table No. 2 provides the population growth in 5-year increments as identified in the 2005 Comprehensive Plan. This table further shows the anticipated population that is expected to be served by the municipal water system.

TABLE NO. 2

ESTIMATED POPULATION FORECAST

Year	Total Population	Population Served by Water System
2010	9,952	6,616
2015	14,064	9,783
2020	18,403	12,951
2025	21,895	16,118
2030	24,000	19,286

In order to develop a water system that can be incrementally constructed to service the changing needs of the City through the Planning period, it is important to understand the growth and distribution of the population that must be served by the system. This projection was provided by the City Planning staff and is shown graphically in Figure 3 and is summarized for each water pressure zone in Table No. 3. This data provides the existing number of housing units and employees that are expected in each geographic area of the City for the year 2005 and the year 2030, subtotaled for each water pressure zone. To accomplish this exercise, the planners utilized the Transportation Analysis Zone (TAZ) areas that had already been delineated and projected for the purposes of the Comprehensive Transportation Plan. Figure 3 shows this population distribution relative to both the TAZ area boundaries and the zonal boundaries for each anticipated water pressure zone. Figure 3 also shows the areas that will not necessarily be served by the municipal water system by the year 2030. These areas have been excluded as areas that have already substantially developed using private wells and will not be required to connect to the City water system unless requested by the residents or required in the future for public health and safety reasons.

TABLE NO. 3
HOUSEHOLDS AND EMPLOYEES BY WATER PRESSURE ZONE

	2005		**2030**	
PRESSURE ZONE	**HOUSEHOLDS**	**EMPLOYEES**	**HOUSEHOLDS**	**EMPLOYEES**
NORTH LOW (Village Area)	525	1,031	1,576	2,381
INTERMEDIATE (Tank No. 2)	586	213	1,303	260
SOUTH LOW (Lake Elmo & 10th St.)	56	386	2,381	6,759
SOUTH HIGH (Eagle Point Area)	142	900	1,808	4,800
NORTH HIGH				
TOTAL WATER CUSTOMERS	**1,309**	**2,530**	**7,068**	**14,200**
TOTAL HOUSEHOLDS & EMPLOYEES	**2,780**	**2,619**	**8,747**	**14,292**

Figure 2

Figure 3

SECTION 3. WATER SYSTEM PERFORMANCE CRITERIA

This Section of the Plan develops the performance criteria under which the water system will be evaluated and designed. This involves an evaluation of historic population, projection of future growth, a Plan of per capita water consumption including water use patterns and trends, seasonal peaks in water consumption, and the impact of major users. This Section will form the “design basis” for the Water System Plan.

3.1 Water Use

Historical well appropriation records provide a valuable source of information for the prediction of future water needs. City records were reviewed over the past ten years to assist in the establishment of design parameters for this Plan. For this purpose the water use records include the water supply from the City of Oakdale to provide a comprehensive review.

3.1.1. Average and Peak Day Demand

Average day demand and peak day demand are commonly used as design criteria for water systems. Average day demand is the amount of water that will be consumed on an average day each year. Peak day demand is the amount of water consumed on the day with the highest rate of water consumption for the year. Historical well production data is used to calculate the average day demand and peak day demand.

Well production demands are one measurement of the amount of water needed to satisfy the supply demands of the customers. Well production in the City of Lake Elmo should always be greater than water sales/consumption. This difference is due to leakage from the system, watermain flushing, meter inaccuracy, and other un-metered uses.

3.1.2. Water Conservation

Public water suppliers that service more than 1,000 people are required to have a Water Emergency and Conservation Plan approved by the Department of Natural Resources (DNR) (Minnesota Statutes 103G.291). This plan name has been changed to Water Supply Plan, which will be used throughout this report. The Water Supply Plan addresses water use, water supply, emergencies and conservation measures. These plans were first required in 1996 and must be updated every ten years. Minnesota Statutes 103G.291, requires public water suppliers to implement demand reduction measures before seeking approvals to construct new wells or increases in authorized volumes of water. Minnesota Rules 6115.0770, require water users to employ the best available means and practices to promote the efficient use of water. Conservation programs can be cost effective when compared to the generally higher costs of developing new sources of supply or expanding water and/or water treatment plant capacities. The Water Supply Plan must address supply and demand reduction measures and allocation priorities and must identify alternative sources of water for use in an emergency. The supply and demand reduction measures set by the DNR are used along with historical well production figures to serve as design criteria for the water system. The benchmarks consist of;

1) Unaccounted for water <10%,
2) Residential Demand < 75 Gallons Per Capita Per Day (GPCD),
3) Decreasing Total Per Capita Demand, and
4) Peak Day Demand to Average Day Demand Ratio < 2.6.

In 2007, the City of Lake Elmo adopted the Water Emergency and Conservation Plan (now titled Water Supply Plan). The DNR has requested modifications to this plan which will be completed later in 2009.

3.2 Fire Flow Consideration

The Insurance Services Office (ISO) publishes a report that quantifies the magnitude and duration of fire suppression water requirements for individual structures, and summarizes these in a Needed Fire Flow Report. These estimated water requirements are primarily for major commercial, industrial, and public buildings, and consider several factors including the size and age of the structure, exposure to adjacent structures, construction materials, occupancy types, stored materials, and other similar factors. Identification of these locations allows for a representative evaluation of the fire capacity need through the distribution system because it is based on actual fire flow needs within the City. Lake Elmo's top 15 individual structure fire flow demands are shown in Table No. 9 in Section 4 of this report.

Typical fire flow delivery rates required for a single family residence ranges from 750-1,500 GPM. High density residential buildings (i.e., townhomes, quadhomes, apartment buildings) generally require 1,500-2,500 GPM and commercial, institutional areas typically range from 2,500-6,000 GPM depending on building age, construction type, and stored materials. Buildings which are provided with internal sprinkler systems usually have greatly reduced fire flow needs.

The distribution network for the water system should be designed to deliver the minimum residential fire flow of 1,000 GPM to all points on the system. It should also be designed to deliver 3,500 GPM for a 3-hour duration to commercial, industrial and institutional areas. It is expected that individual properties with fire suppression requirements in excess of this criteria would need to privately supplement this need. City direction for this plan was to provide for only the basic water system demands. Therefore a 2,500 GPM, 2-hour duration fire flow has been used as the design criteria for this Plan in commercial and institutional areas and to determine the system storage requirements. For most of the City of Lake Elmo, a fire flow demand of 2,500 GPM for 2 hours is adequate and fulfills a basic level of fire suppression.

3.3 Water Quality and Treatment Requirements

The EPA maintains a list of primary and secondary drinking water standards and provides maximum acceptable concentrations for each contaminate. Primary contaminates are regulated by the EPA and Minnesota Department of Health and treatment is required if the maximum acceptable concentration is exceeded in the raw water supply. Recommended secondary standards are non-health related. These standards are provided as a guide and attempt to define the threshold for when the aesthetic quality of the drinking water becomes unacceptable to the general public.

Table No. 10 in Section 4 of this report lists the concentration levels for iron and manganese that is found in Well No. 1 and Well No. 2. This data indicates that the iron concentration found in Well No. 2 is almost three times the EPA guideline. The manganese concentrations found in both Well No. 1 and 2 are also three times the EPA guideline. Typically these concentrations are high enough to diminish the aesthetic quality of the water such that the City will receive complaints on a regular basis. Complaints will typically increase during times of system maintenance, such as hydrant flushing, when flows can be reversed in the system which in turn flushes out particulate accumulations. Residents may experience discolored fixtures and laundry or experience added wear and tear on residential plumbing. In addition, the high levels of manganese will accumulate in the distribution system over time causing deterioration in water quality and creating a need to increase system flushing and maintenance. The manganese will also accumulate in water meters decreasing their accuracy and resulting in lower water sales being recorded and lost revenue to the City.

While the overall quality of Lake Elmo's well water is good, the aesthetic quality of the well water is affected by the elevated levels of manganese and iron. However, records indicate that the City does not receive sufficient complaints or experience operation and maintenance concerns sufficient to justify the pursuit of conventional treatment.

3.4 Water Distribution System

3.4.1. Piping Network

In order to determine the existing capabilities of the watermain system, a WaterCAD model was developed using current WaterCAD distribution system modeling software. The model was created to simulate the existing system's response to various conditions. Specifically, these conditions include average daily demand, peak day demand, and average day withdrawal plus the design fire flow demand. Each condition stresses the system differently and helps to identify actual conditions of operations which cause poor levels of performance.

3.4.2. Pressure Requirements

Water pressure needs are subject to individual preference. Satisfactory pressure for some may be viewed as inadequate for others. Municipal water providers are often caught between balancing increasing customer demand for water pressure and regulatory demands for conservation and demand reduction.

A reasonable range for normal working pressure is 50 to 70 pounds per square inch (psi). The Minnesota Department of Health requires that during a fire or other emergency withdrawal condition, minimum pressures cannot be less than 20 psi. A maximum pressure of 80 psi has been established to avoid over-pressure problems with consumers' appliances and plumbing systems.

Water booster stations can be installed to supply additional pressure to areas with pressures below acceptable levels or to boost water from a lower pressure zone to a higher pressure zone. Pressure Reducing Valves (PRV) can be installed to reduce pressures for those areas of the City that may experience pressures that exceed the 80 psi threshold. Pressure reducing stations are also designed to serve a pressure zone with lower elevations with a back-up water supply from an adjacent pressure zone at higher elevations.

3.4.3. Supply or Connection to Adjacent Communities

The City of Lake Elmo Water System is interconnected in two locations with the neighboring City of Oakdale as shown on Figure 1. These interconnections are important to the reliable operation of a water system, enabling the Cities to back-up their water supply to safeguard against failure of a well, an extreme fire event, or to perform maintenance. Several things affect the compatibility of system interconnects, including any differences in water quality and hydraulic grade lines (overflow elevations). A significant difference in hydraulic grade lines between the two communities may limit water flow to only one direction. Historically, this has not been a problem with Oakdale.

The Annual and Per Capita Consumption, Table No. 20 in the Appendix, includes water consumption supplied by the Eagle Point Oakdale interconnection. The Lake Jane Oakdale interconnection normally remains closed but is available as needed. It was utilized by residential customers prior to the construction of Tank No. 2 and watermain infrastructure in 2005.

Lake Elmo may want to consider planning an interconnection with the City of Oak Park Heights. A nearby water system is in place in both communities. Also, there are no major obstacles between the water systems that would add significant cost to the project.

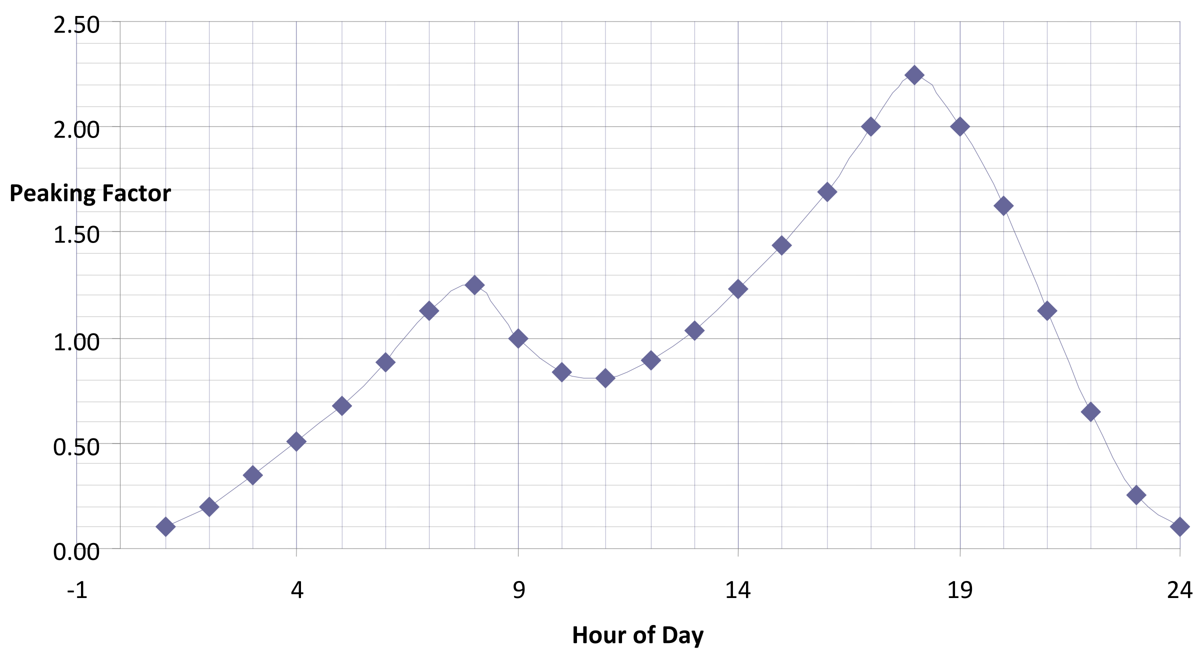
3.5 Water Storage Requirements

Water storage is provided in a municipal water system for three main reasons. The first is to provide for smooth pumping operations, minimizing the frequent starting and stopping of large electric motors. The second reason is to provide reserve storage for emergency events such as fighting fires, power outages, mechanical failure, and other events where the supply is unable to meet the instantaneous demand, or is lost altogether. Finally water storage provides equalization volume to buffer the water supply when demand exceeds production, such as during peaking events.

3.5.1. Peak Day versus Peak Hour with Fire Flow

Pumping facilities are designed to have sufficient "firm" capacity to supply the peak day demand. The peak day demand is the highest water production day of the year. Although it appears that the peak day rate enables one to establish the minimum design requirements for a system, it must be realized that the consumption rate over the period of a day follows a diurnal pattern as shown in Figure No. 4, Typical Diurnal Consumption Pattern. As a result, there are times during the peak day that the rate of consumption will actually exceed the "firm" pumping capacity (i.e., peak hour, peak minute, etc.). Typically, the peak hour can be more than double the peak day rate. At this point, when demand exceeds "firm" pumping capacity, it becomes necessary to utilize storage capacity to even-out or "equalize" these instantaneous peaks. This prevents the need to provide pumping facilities to "pump on-demand" to meet the peak hour or peak minute demand, which would be costly and under utilize a large part of the well production capacity.

FIGURE NO. 4
TYPICAL DIURNAL CONSUMPTION PATTERN



Minimum storage requirements have been established by "Ten States Standards"[1], which indicate storage volume should have sufficient capacity to meet domestic and fire flow demands. Domestic demands can be equated to the average daily consumption. The fire flow requirements for each commercial building in the City are established by the Insurance Services Organization (ISO). The ISO's guidelines indicate the storage and distribution system shall be capable of supplying fire flows required in the City during a peak water use day. There are twelve buildings with fire flow demands in the range of 3,000 GPM to 6,000 GPM in the ISO Needed Fire Flow Report. As growth occurs in the community, new structures will be constructed with interior sprinkler systems which make the associated building fire flow demand 2,500 GPM or less. The existing structures with higher demands can choose to independently add fire sprinkler systems lower their property insurance rates. Therefore, this Plan has based the minimum storage requirements sufficient to meet the average day demand, and supply a fire demand of 2,500 GPM for two hours.

3.6 Analysis of the Water Distribution System

A computer model of the existing Lake Elmo Water System was created to analyze the current and projected status of the system. The computer model was based on the existing system as explained in section 3.4.1. The Ten States Standards recommends the minimum size of watermain for providing fire protection and serving fire hydrants to be six inches in diameter, with larger mains required if necessary for providing satisfactory fire flow. In addition, velocities in long watermain segments should typically be less than five feet per second (fps), but are acceptable up to about 10 fps during emergency withdrawal conditions of short duration. These standards where used in the analysis of the existing system and the design of the future water system.

3.7 Summary of Analysis and Design Criteria

This Section establishes the design parameters under which the existing and future water system will be evaluated and/or designed. While these criteria are largely based on historical information, which is not totally reflective of trends, it is considered to be the most reliable basis for projecting future water use patterns. Although the design

[1] Recommended Standards for Water Works, 2007, Great Lakes, Upper Mississippi Board of State Public Health and Environment Managers.

parameters shown in Table No. 4 are used for analysis and design, assumptions are also made that the City conservation goals will reduce these parameters in the future.

Table No. 4 breaks down the design criteria used for the future water system. Assumptions where made that the peak day water demands would decrease as conservation measures enacted by the City take effect. Currently the average peak day demands are 3.6 times the average day water demand in gallons per capita per day. This number is a median average from the last 10 years of data. The number has increased the last three years with the inclusion of the consumption fed by the southern Oakdale connection. Looking forward, the per capita average day demand will not change significantly. This is the number of gallons produced on average per resident. Average day water demand may be reduced if further conservation measures are enacted. Also, Table 4 shows how the total Average Day Water Demand will increase over time as recorded in both gallons per day and gallons per minute.

TABLE NO. 4
DESIGN AND PERFORMANCE CRITERIA

CRITERIA / YEAR	***2008***	***2010***	***2020***	***2030***	***Ultimate***
Population Served by Water System	4,281	6,616	12,951	19,286	24,054
Average Day Demand					
Residential Use (GPCD)	70	75	75	75	75
Non-Residential (GPCD)	28	22	18	15	12
Total Demand (GPCD)	98	97	93	90	87
Total (GPD) *Gallons per day*	420,523	642,116	1,209,614	1,730,431	2,089,909
Total (GPM) *Gallons per minute*	292	446	840	1,202	1,451
Peak Day Demand					
Peak Day: Average Day Ratio	3.5	3.6	3.2	2.8	2.6
Total (GPD) *Gallons per day*	1,294,128	2,311,618	3,870,765	4,845,207	5,433,763
Total (GPM) *Gallons per minute*	899	1,605	2,688	3,365	3,773
Pressure Requirements					
Normal Working	50-70 psi / Minimum: 35 psi				
Minimum, at Fire Flow	20 psi				
Maximum Pressure	80 psi				

The Peak Day Water Demand section provides the Peak Day to Average Day ratio, which is the peak gallons per day divided by the average gallons per day. This figure is reduced over time as population increases and per capita demand decreases due to conservation measures. Also under the Peak Day Water Demand are gallons per day and gallons per minute. These numbers increase as the population projections increase from 2005 to 2030. Storage requirements are discussed in Section 3.5 and pressure requirements are detailed in Section 3.4.2. These design criteria are implemented in Section 5 with additional descriptions of the future water system requirements.

SECTION 4. EXISTING WATER SYSTEM

4.1 Existing Water System

The Lake Elmo public water supply system has two separate water subsystems. The Old Village - Lake Jane water system, which is the primary water system covering the north half of the City, and the Eagle Point water system located in the southwest corner of the City serving the Eagle Point Business Park.

The Old Village water system was originally constructed in the 1960's to serve the Old Village urban core. It consisted of a 500 GPM well (Well No. 1) and a 75,000 gallon elevated tank (Elevated Tank No. 1). Tank No. 1 was recently cleaned in 2007. A second public water subsystem (Lake Jane water system) was created to address VOC contamination discovered from the former Washington County landfill. Small diameter watermain was extended from an interconnect with the City of Oakdale to serve homes located in the vicinity of the former landfill on the west side of the City and north of Stillwater Boulevard (TH 5).

In 2000, the City expanded the Old Village water system service area to the City's northeast quadrant. This expansion was in response to the request for public drinking water from several new developments in the area, coupled with the need by the City to locate a second water supply well (Well No. 2 constructed in 2001). Then in 2005, PFC contamination was discovered in the Tablyn Park/Lake Elmo Heights neighborhoods, just south of Stillwater Boulevard (TH 5). The Minnesota Department of Health implemented a rigorous well testing program in the City that continues today. To address the PFC contamination, the City extended the Old Village water system across the City to the west and interconnected the Old Village and Lake Jane water systems. Elevated Tank No. 2 was constructed and over 200 homes were connected to City water in the Tablyn Park/Lake Elmo Heights neighborhoods and along 31st Street, Janero Avenue, and Jamley Avenue.

The Eagle Point water system was constructed to serve the commercial properties located in the Eagle Point Business Park. Watermain was extended throughout the development with two interconnects established with the City of Oakdale. Well No. 3 was then constructed by Lake Elmo to replace the Oakdale interconnects. Upon completion of the well construction, PFC contamination was discovered in the well, hence Well No. 3 was never placed in use.

The Eagle Point water system is not connected to the Old Village - Lake Jane water system. They remain separated by approximately two miles with half of that distance extending through an area of low density open space developments. However, these developments are also the areas where PFC contamination exists in concentrations that exceed Health Risk Levels (HRL). Specifically, the PFCs identified in this area of Lake Elmo include perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) which remain the PFCs of greatest concern for the Minnesota Department of Health.

As it exists today, the City's water supply system includes two active wells, two elevated storage tanks and a system of trunk and lateral watermains ranging in size from 4 inches to 16 inches. The Old Village - Lake Jane water system has two pressure zones. The Eagle Point water system, if interconnected, would be a third pressure zone. The average 2008 water use throughout the City was 420,524 GPD (gallons per day) with a peak use of 1,294,128 GPD.

By 2030, it is anticipated that the water system will need to provide for an average day demand of 1,730,000 GPD and peak demand of 4,845,000 GPD.

4.1.1 Water Use by Category

Categorical water use can provide insight into consumption trends and patterns within a City, and be a valuable source of information when predicting future water needs. Changes in the amount of water used within a category can result in fundamental changes in daily and yearly demand patterns seen by the system. Annual water sales by category are presented for a typical year in Table No. 5.

TABLE NO. 5
HISTORICAL WELL PRODUCTION BY CATEGORY

Year	Residential		Commercial		Other	
1996	15,013,562	72%	4,173,220	20%	1,743,800	8%
1997	15,946,323	71%	4,992,417	22%	1,572,260	7%
1998	17,852,827	76%	4,051,930	17%	1,443,820	6%
1999	19,148,704	75%	4,938,310	19%	1,447,900	6%
2000	2,124,442	79%	5,479,329	21%	0	0%
2001	30,666,365	80%	7,747,527	20%	68,700	<1%
2002	32,980,154	84%	6,390,426	16%	47,500	<1%
2003	55,795,884	90%	5,914,691	10%	55,000	<1%
2004	49,136,487	89%	6,075,660	11%	26,100	<1%
2005	45,617,833	88%	6,064,404	12%	106,388	<1%
2006	70,115,610	75%	23,787,126	25%	139,133	<1%
2007	107,892,707	71%	43,004,240	28%	756,182	<1%
2008	109,571,442	77%	32,925,365	23%	119,704	<1%
10 Year Average:		**81%**		***19%***		***0%***

**Note: This is based on production from the wells owned by Lake Elmo and from the 2006 - 2008 Oakdale consumption data.

It should be noted that a new trend emerged in 2006 with the commercial percentage of water use increasing significantly compared to prior years. This trend coincides with the beginning of the Eagle Point water system from the southern Oakdale interconnection. Prior to 2006, the City of Lake Elmo had a high ratio of residential to commercial usage, averaging 86% of the total consumption for the 5-year period from 2001-2006. With the inclusion of the Eagles Point water system, this ratio has dropped to 75% of the overall consumption. Future demand patterns are expected to continue to show a commercial usage of at least 20%, based on the projected commercially-zoned areas south of 10th Street. This pattern was utilized in projecting the average day and peak day demands for the water system.

4.1.2 Major Water Users

A major user is defined as a customer that consumes 5% or more of the total production. As shown in Table No. 6, Lake Elmo currently does not have a customer that meets this threshold.

TABLE NO. 6
2008 TOP WATER USERS

RANK	GALLONS CONSUMED IN 2008	CONSUMER	PERCENTAGE OF TOTAL WATER PUMPED IN 2008
1	5,005,000	Bremer Financial	3.25%
2	2,407,500	United Properties Irrigation	1.56%
3	2,369,380	Wildwood Lodge	1.54%
4	2,110,100	Machine Shed	1.37%
5	1,620,000	Health East	1.05%
6	1,471,504	Eagle Point Office Center 2	0.96%
7	1,446,000	C & C TerraMinnesota LLC	0.94%
8	1,355,000	Rasmussen College	0.88%
9	1,226,000	United Properties Irrigation	0.80%
10	1,214,000	United Properties Irrigation	0.79%
11	1,046,331	Lake Elmo Inn	0.68%
12	1,017,500	Lake Elmo Bank	0.66%
13	1,003,234	Carriage Station Office Park	0.65%
14	983,000	Rock Point Church	0.64%
15	969,550	Lake Elmo Elementary	0.63%
16	632,000	Lake Elmo Event Center	0.41%
17	502,000	Browning & Wolf	0.33%
18	439,730	Prairie Ridge Office Park	0.29%
19	291,600	Stillwater Investments	0.19%
20	280,620	Gorman's Restaurant	0.18%

4.1.3 Unaccounted-For Water Use

All water systems will lose water to system leakage, watermain flushing, and other un-metered uses. As a result, the water pumped to the system will always be greater than the water sold from the system. Unaccounted water has averaged 8% over the last five years in the City.

Unaccounted-for water greater than 10% should be investigated. Most water utilities, as part of their ongoing meter maintenance program, institute a meter change-out program to retire older meters more susceptible to under-registration of water consumption. The results of a change-out program would be expected to result in the drop of unaccounted-for water over several years and increase revenues to the utility from the sale of water. Some cities choose to limit their change out program to only the significant water users where the effort is likely to have the greatest impact.

In addition, many water utilities implement a leak detection program where their watermains are investigated annually. Early identification and correction of small leaks will enable a utility to minimize costly repairs of large watermain failures, and to avoid premature expansion of wells and storage facilities.

4.1.4 Water Conservation

In August 2007, the City received a letter with comments from the Department of Natural Resources (DNR) in response to their review of Lake Elmo's proposed Water Supply Emergency and Conservation Plan. This Plan identified specific goals for the City to target and meet DNR water conservation measures as shown in Table No. 7. The DNR has verbally agreed to allow the City to respond to their comments after the completion and adoption of this Comprehensive Water System Plan.

Water usage specific to these measures should be monitored yearly and tracked to ensure the success of the water conservation goals. The City currently does not meet the DNR's benchmarks but has initiated steps to begin working towards these goals.

One of the more difficult DNR conservation goals for more rural, newly developing areas is the Peak Day to Average Day Ratio. The DNR has established this water conservation goal at 2.6. Historically, Lake Elmo has shown a wide variation in this ratio (ranging from 2.3 to 4.2), with an average of 3.4. Over the past three years, with the start of the Eagle Point Business Park, the Peak Day to Average Day ratio has increased to 3.8. The Peak Day increases are typically experienced in new development areas where turf establishment creates heavier water demands.

For the purposes of projecting water use for this Plan, a Peak Day to Average Day ratio of 3.6 was selected for the year 2010. A sliding scale was then used in anticipation that the City will successfully lower the Peak Day to Average Day ratio over time through the implementation of conservation measures established in the City's conversation plan. The scale drops the ratio 0.2% over successive five year periods. In 2030, the ratio is estimated to be 2.8. While this ratio does not fully meet the DNR's goal; it shows good faith and diligence towards meeting the goal by the time the City has reached ultimate build-out. Maturation of nearby local communities has previously demonstrated that this ratio will naturally become easier to meet after the majority of the development has been established.

TABLE NO. 7
CONSERVATION GOALS

Unaccounted Water	
Average annual volume unaccounted water for the last 5 years	9,144,000 gallons
Average percent unaccounted water for the last 5 years	8 percent
AWWA recommends that unaccounted water not exceed 10%. Describe goals to reduce unaccounted water if the average of the last 5 years exceeds 10%.	
Residential Gallons Per Capita Demand (GPCD)	
Average residential GPCD use for the last 5 years	68 GPCD
In 2002, average residential GPCD use in the Twin Cities Metropolitan Area was 75 GPCD. Describe goals to reduce residential demand if the average for the last 5 years exceeds 75 GPCD.	
Total Per Capita Demand: is the trend in overall per capita demand over the past 10 years increasing or decreasing? If total GPCD is increasing, describe the goals to lower overall per capita demand or explain the reasons for the increase.	Increasing
Peak Demands	
Average maximum day to average day ratio	3.4
If peak demands exceed a ratio of 2.6, describe the goals for lowering peak demands.	

4.1.5 Department of Natural Resources Appropriation

In 1961, the DNR issued the original groundwater appropriation permit to Lake Elmo. The last amendment to the permit was issued by the DNR in 2002. The current authorization is 60 million gallons per year (MGY). In 2008, the City pumped 128 million gallons and exceeded appropriations. As part of the 2007 MnDNR Annual Report of Water Use, the City of Lake Elmo requested the permitted volume be amended to 150 MGY. This request occurred in February 2008. The request has not been approved. The City should follow up with the DNR to increase water appropriation volumes or decrease well pumping to minimize exceeding permitted amounts. As a growth community, appropriation revisions can be an ongoing process. Additional appropriations must be acquired before a new well can be constructed.

4.1.6 Wellhead Protection Plan

The primary goal of the Wellhead Protection Plan is to ensure a safe and reliable drinking water supply to the community. The Wellhead Protection Plan includes two parts. Part I was approved by the Minnesota Department of Health (MDH) on April 10, 2007, and includes a Wellhead Protection Area, a Drinking Water Supply Management Area, and a Vulnerability Assessment. Part II was approved by the MDH on October 28. 2008, and focuses on a Potential Contaminant Source Management Strategy, an Evaluation Program, and an Alternative Water Supply/ Contingency Plan.

The Plan addresses land use management within the drinking water supply areas to mitigate potential contamination of the water supply and to prevent contaminates from reaching the wellhead. The City began the implementation of the approved Wellhead Protection Program in November 2008.

4.2 Water Supply Facilities

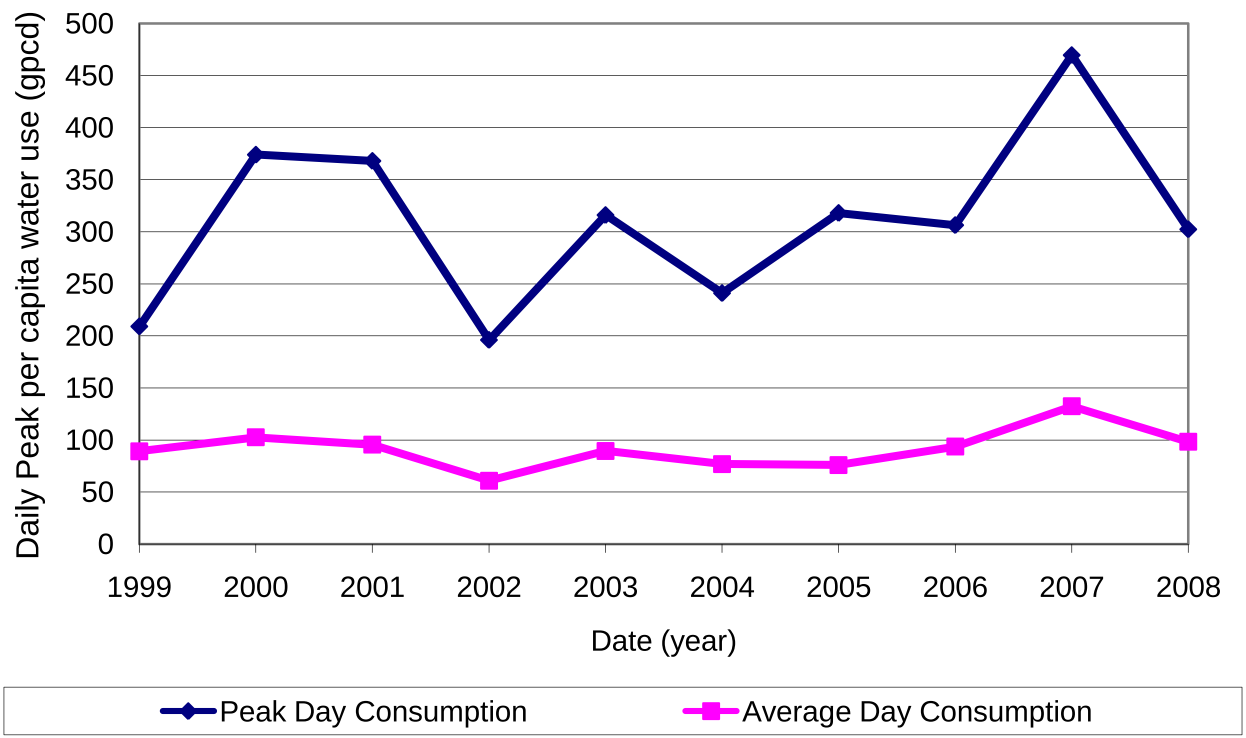
The existing water system consists of two water supply wells as described in section 4.2.2 of this Plan and located as shown on Figure No. 1.

4.2.1 Well Production

The average and peak day well production volumes and the computed per capita well production rates are summarized in Table No. 20, located in the Appendix. Data has been reported for the period of 1996 - 2008. Figure No. 5 on the following page depicts the historic well production by average day demand and peak day demand. Starting in 2006, this data includes the water consumption supplied by Oakdale to the Eagle Point business park. The addition of the consumption supplied by Oakdale must be included to provide an accurate assessment of how much water was consumed by all Lake Elmo water customers.

Well production facilities are designed to have sufficient “firm” capacity to supply the peak day demand of the system. The “firm” capacity is defined as the capacity that would be available if the highest capacity well were removed from service due to maintenance or failure. Peak day consumption during this period averaged approximately 302 GPCD. As can be seen, this number is just an arithmetic average, with actual values varying by year. The highest value of 470 GPCD, or 156% of the average peak, was achieved in 2007. The lowest value of 196 GPCD, or 65% of the average peak was achieved in 2002. Peak day demand is critical in planning the well production requirements for a water system. Average day well production is the average amount of water produced each year over the population served by the water system. The highest value of 112 GPCD occurred in 2007, while the lowest value of 61 GPCD occurred in 2002.

FIGURE NO. 5
HISTORIC WELL PRODUCTION



4.2.2 Existing Wells

Well No. 1 - DNR Unique ID No. 208448, was constructed in 1960. The well is 20 inches in diameter and is drilled to a total depth of 805 feet. Well No. 1 is a multiple-aquifer well, since it appropriates water from more than one geologic formation. The main aquifers that supply water to this well are the Jordan, Franconia-Ironton-Galesville and the Mount Simon/Hinckley formations. The well currently has a pumping rate of 500 GPM. The DNR has indicated to Lake

Elmo their preference to have this well abandoned because it does not comply with the current well code. The DNR is concerned that any future contamination experienced in one aquifer in the vicinity of Well No. 1 could be quickly threaten multiple water sources through this connection.

Well No. 2 - DNR Unique ID No. 603085, was constructed in 2001. The well is 18 inches in diameter, extends to a depth of 285 feet, and draws from the Prairie du Chien and Jordan aquifers. The well currently has a pumping rate of 1,000 GPM.

Well No. 3 - DNR Unique ID No. 655910, was constructed in 2002. The well is 24 inches in diameter, extends to a depth of 422 feet, and draws from the Prairie du Chien and Jordan aquifers. Well No. 3 was never placed in service due to the detection of PFC contamination and the real or perceived public health and safety issue associated with this detection. Eventually the City will need to determine the feasibility of using this well by treating the water supply or the well should be abandoned.

TABLE NO. 8

EXISTING WELLS

Well No.	Status	Pumping Rate (GPM)	Annual Production Capacity (MGY)	Aquifer Formation	Year Constructed	Static Level, ft	Draw Down ft
1	Active	500	263	Multiple	1960	119	40
2	Active	1,000	526	PDC-Jordan	2001	53	28
3	Inactive	1,000	526	PDC-Jordan	2002	125	23

Firm Capacity – The firm pumping rate is used as an indication of the system's ability to meet peak demands with the largest capacity well removed from service for maintenance, failure, or an emergency event. The City is currently appropriating its water supply from two active wells to supply water to the City's customers. When pumping at their current rated capacity, the combined capacity of the two wells is approximately 1,500 GPM, with a "firm" capacity of 500 GPM when the largest supply facility, Well No. 2, is removed from service.

The City water demands have exceeded the Firm Capacity of the water system since 2005, indicating the City is long overdue for the construction of the next water supply well. In 2008, the Peak Day Demand was 899 GPM, or 180% of the firm capacity requirement. Based on the projected water demands outlined in Table No. 4, Section 3 of this report, the estimated Peak Day Demand for the year 2010 will be 1,605 GPM, or roughly 320% of the Firm capacity. The City water supply is highly vulnerable to not meeting basic supply requirements if Well No. 2 experiences a problem and must be taken out of service, in particular during a peak demand period during summer months. This supply capacity deficit is further exacerbated by the multiple pressure zone system in Lake Elmo since Well No 1 cannot provide full pumping capacity to the intermediate pressure zone system that is supplied by Well No. 2. Per Ten State Standards and to ensure that sufficient “firm” pumping capacity is available to the system, construction of a new well should be initiated as soon as possible.

4.2.3 Peak Day Demand

Over the past 13 years, the peak day demand for water use has been 2.3 to 4.2 times higher than the average day demand. This can be seen in Table No. 20 in the Appendix. In addition, as shown in Table No. 21 in the Appendix, total water use in the summer months has historically been 1.4 to 5.0 times higher than total water use in the winter. When looking at this summer to winter water use ratio over the past three years, the summer usage is 4.1 to 5.0 times higher than winter use. The majority of this increased summer demand can typically be attributed to lawn irrigation.

Trying to keep up with varying peak demands of this magnitude requires municipalities to construct additional water supply facilities much sooner than would otherwise be required. If a City is treating its water supply, this also means constructing new, or expanding existing treatment facilities to keep up with these peak demands which are largely driven by discretionary uses. A logical alternative is for the City to manage its peak day water use by discouraging the customer base from using large water volumes for residential landscape irrigation. This is typically accomplished through even-odd day, and time-of-day watering restrictions. Discretionary use can also be addressed through an incremental or progressive water rate structure, where exceeding certain thresholds of water use will result in high water bills to the customer. While these methods will not completely eliminate the need for additional wells, it could defer their implementation and/or reduce the total future capacity requirements of these facilities. The City’s management of the peak day demands will have high returns and lessen the amount of required infrastructure. To address peak day demands the City should implement conservation measures as outlined in the 2007 Water Supply Plan and as required by the Department of Natural Resources (DNR). The demand reduction measures include a public education program as well as an evaluation of the water rate structure, sprinkling ordinance, and their impact on water conservation. In 2007 the City of Lake Elmo evaluated the water rate structure, adopted an odd/even and time of day sprinkler ordinance, and increased the public education program through newsletters and the City website. The DNR has requested further measures be covered and adopted by the end of 2009.

4.3 Available Fire Flows

The minimum fire flow demand requirements for the fifteen highest demand structures in the City are summarized in Table No. 9. Typically, municipal water systems are designed to deliver up to 3,500 GPM for a 3-hour duration.

TABLE NO. 9
TOP 15 FIRE FLOW DEMANDS FOR INDIVIDUAL STRUCTURES

			GPM*
1	Dresser Lumber Bldg 1-7	11320 Upper 33 St	6,000
7	Lake Elmo Hardwood Bldg 1-3	11320 33 St	6,000
14	Lake Elmo Hardwood Bldg 5-7	11320 33 St	5,500
15	Dresser Lumber Bldg 1-7	11320 Upper 33 St	5,500
21	Dresser Lumber Bldg 1-1/1-2	11320 Upper 33 St	5,000
24	Lake Elmo Hardwood Bldg 8-9	11320 33 St	5,000
25	Summit Ski/Snowboard – 5 Tenents	9242 Hudson Blvd	4,500
30	Multi-Occupancy – 4 Tenents	3687 Layton Ave	4,000
32	Fury Dodge Chrysler	11144 Stillwater Blvd	3,500
33	Dolar S Marine Bldg 2	9200 Hudson Blvd	3,000
34	Aroma Sys Inc.	11490 Hudson Blvd	3,000
35	Dresser Lumber Bldg 1-3	11320 Upper 33 St	3,000
38	Gisela Lee Interiors	3479 Lake Elmo Ave	2,500
40	Lake Elmo Hardwood Bldg 4	11320 33 St	2,500
41	Dolar S Marine Bldg 1	9200 Hudson Blvd	2,500

* Gallons Per Minute

Lake Elmo's water system is currently operating using a temporary configuration, with Well No. 2 supplying the Intermediate pressure zone (Tank No. 2) and Well No. 1 supplying the North Low pressure zone (Village Area). These two zones will not be interconnected as designed until Well No. 4 and the Keats Avenue Trunk Watermain line are constructed and placed into operation. The Intermediate pressure zone has an existing fire flow supply capacity of 2,500 GPM using Tank No. 2 at 750,000 gallons of storage and Well No. 2 pumping at 1,000 GPM. This supply however cannot be transferred to the Village Area during a fire event. The Village Area fire flow supply capacity is only 500 GPM which is considered deficient for even a residential fire or to support a larger commercial or institutional facility with a fire sprinkling system installed.

4.4 Water Treatment

The City of Lake Elmo water supply is provided by the Prairie du Chien and Jordan Sandstone, and the Mount Simon and Franconia-Ironton-Galesville aquifers. These water sources are considered abundant, meet all health requirements of the Minnesota Department of Health, and have iron and manganese levels that have been reasonably accepted by the consumers.

The City of Lake Elmo does not treat its water for iron and/or manganese removal, softening, or any other conventional treatment processes. However, the City does provide chemical addition at the wellhead. The chemical addition consists of fluoridation. Fluoride addition is mandatory and it is added to the finished water in accordance with Minnesota Health Department (MDH) rules. The addition of fluoride has been shown to reduce dental decay. Monitoring for effectiveness is accomplished by reporting the amount of fluoride injected into the water supply and regular testing for fluoride in the distribution system. The MDH recommends that a residual fluoride concentration of 0.9-1.5 mg/L be maintained across the distribution system.

While iron and manganese do not pose a health problem at the levels found in the Lake Elmo groundwater, they do exceed the Secondary Maximum Contaminant Levels (SMCL) of the Safe Drinking Water Act. The SMCLs were established to set limits for contaminants which reduce the aesthetic quality but that do not have any adverse public health effects. They are not enforceable by regulatory agencies.

4.4.1 Historical and Existing Water Quality

Table No. 10 below shows the iron and manganese levels at each well compared to the Environmental Protection Agency (EPA) recommended secondary (non-health related) levels of 0.3 mg/L for iron and 0.05 mg/L for manganese. The sampling data provided for Well No. 2 was completed when the well was constructed.

TABLE NO. 10
RAW WATER CONTENT OF IRON AND MANGANESE DATA

	Well No. 1	Well No. 2	EPA Guideline	Well No 1 Sample Date	Well No. 2 Sample Date
Iron (mg/L)	0.06	0.844	0.30	02/1975	08/30/2001
Manganese (mg/L)	0.14	0.0184	0.05	02/1975	08/30/2001

The Consumer Confidence Report (CCR) issued annually by the MDH noted radon as a potential future contaminant. Currently, Minnesota does not list a Maximum Contaminant Level (MCL) in association with radon in drinking water. Minnesota plans to adopt an Indoor Air Program after the Radon Rule is finalized. This issue should be monitored and addressed at the proper time.

4.5 Water Distribution System

The water distribution system consists of all the components necessary to convey water from the water sources or storage facilities to the individual point(s) of demand. These demands are generated independently by all of the serviced customers and by public needs such as water from hydrants for fire-fighting, skating rink flooding, watermain maintenance, and flushing. While the major component of any system is the buried watermains, the total system also includes hydrants, valves, services and meters, and supplemental pumping facilities as required. A distribution system's adequacy is based solely on its ability to reliably deliver water, at an appropriate rate and pressure, to each and every demand point in the system.

4.5.1 Piping and Distribution Network

The City of Lake Elmo's water distribution system piping network consists of 10-inch through 16-inch diameter trunk transmission mains, and 4-inch through

8-inch diameter lateral distribution piping. In general the Lake Elmo piping network is poorly looped and poorly interconnected meaning there is greater potential for water quality problems, higher vulnerability to service interruption due to watermain breaks and diminished fire flow capabilities. A poorly looped system also demands increased maintenance for the operators and likely leads to customer complaints. Future expansion of the system should focus on creating a looped pipe network and avoid creating additional “dead-end” conditions. Looping provides for improved circulation of water, improved water quality, increased flow capacity, and redundancy.

The water distribution system is shown on the Existing and Future Water System Map, Figure No. 1. Most of the City watermains were constructed of cast or ductile iron pipe and conform to the American Water Works Association (AWWA) standards for watermain materials and installation. In addition, most of the recently installed watermains were constructed from High Density Polyethelene (HDPE) pipe to allow for the mains to be installed via directional drilling. Ten States Standards recommend that the minimum size of watermain providing fire protection should be at least six inches in diameter. Table No. 11 below shows the breakdown of pipe sizes and the length of watermain pipe in the system for each pipe diameter.

The larger diameter watermain, including the 8-inch, 12-icnh and 16-inch pipes, were all constructed within the past decade and should be suitable to serve the community for a very long time. Many of the smaller diameter pipes were constructed back in the 1960’s and 1970’s and may require replacement within the next 10 to 15 years. In particular, the 4-inch diameter watermain constructed as part of the Lake Jane water system should be considered undersized and a replacement plan should be developed for these watermain segments.

In addition, the 8-inch watermain line in the Old Village along Lake Elmo Avenue from 30th Street to Stillwater Boulevard (TH 5) should be upgraded to a new 12-inch trunk watermain in conjunction with any street improvements completed along Lake Elmo Avenue. This new 12-inch line will connect to the 16-inch piping near proposed Well No. 4. This section of pipe is mentioned specifically because of its age and its need to carry fire flow demands to various points in the Old and New Village.

TABLE NO. 11
WATERMAIN INVENTORY BY PIPE DIAMETER

Watermain Size (Inches)	***Length (Feet)***	***Length (Miles)***
4″	4,118	0.8
6″	16,005	3.1
8″	42,920	8.1
12″	18,039	3.4
16″	39,576	7.5
TOTALS	**120,028**	**22.9**

4.5.2 Pressure

Static water pressure is defined as the pressure that would be measured under a no-flow, system full condition and is determined solely by the tank overflow and individual ground elevations. This pressure is the maximum pressure achievable at any given location without the intervention of a supplemental energy source, such as pumping. The dynamic pressure, or normal water pressure, can be defined as the static pressure minus the friction and energy losses resulting from the flow of water through the distribution mains, or the gain in pressure due to pumping.

This Plan has established a normal operating pressure for the Lake Elmo Water System between 50 - 70 psi, and not less than 35 psi. Additionally, 20 psi is established as the minimum pressure to be maintained at all points in the distribution system under fire flow conditions, and 80 psi is set as the maximum.

4.5.3 Pressure Zones

Pressure zones are naturally set by ground elevation differences within the boundaries of the City. The City of Lake Elmo has three main pressure zones as listed below and shown in Figure No. 1, Existing and Future Water System map.

1) High Pressure Zone (Served by Oakdale).
2) Intermediate Pressure Zone (Served by Tank No. 2).
3) Low Pressure Zone (Served by Tank No. 1).

At this time, the High pressure zone is essentially the Eagle Point Business Park. In the future this area around the southwest corner of the City will develop into the South High pressure zone. Both the High and the Low pressure zones have been divided into the north and south portions in this Plan. The North High pressure zone has been excluded from this Plan but the boundary has been set by ground elevations.

4.5.4 Booster Stations/Reducing Stations

The City currently has a reducing station on 50th Street to allow the pressure to be reduced from the Intermediate pressure zone to the Low pressure zone as shown on Figure No. 1. The reducing station is in place due to the relation of the overflow elevation of Tank No. 2 in the Intermediate pressure zone to the ground elevation in the Low pressure zone. The reducing station is designed to allow the pressure reducing valve to be in or out of service.

4.5.5 Connections to Adjacent Communities (Interconnections)

The City of Lake Elmo water system is interconnected with the neighboring City of Oakdale. These interconnections are important to the reliable operation of a water system and for supply back-up. In the past, the northern Oakdale interconnection served residents near Lake Jane whom were affected by the contamination from the Washington County landfill. Currently, the southern Oakdale interconnection provides the water supply for the Eagle Point Business Park.

Several things affect the compatibility of water system interconnections, including differences in water quality and hydraulic grade lines (overflow elevations). Combining treated and untreated water can result in instability of the combined water, leading to calcification of watermains and home plumbing systems, chlorine odors (if one community chlorinates and the other does not), and possible overall degradation of water quality. A significant difference in hydraulic grade lines between the two communities may limit water flow to only one direction. Table No. 12 and Table No. 13 below detail each of the interconnections and how they function.

TABLE NO. 12
ELEVATED TANK OVERFLOW ELEVATIONS OF ADJACENT COMMUNITIES

City	Nearest Water Tower
Oakdale	1,230 ft

TABLE NO. 13

CONNECTIONS WITH ADJACENT COMMUNITIES (INTERCONNECTIONS)

CITY	LOCATION	PIPE SIZE (INCHES)	OPERATION
Oakdale	Ideal Avenue and Lake Jane Trail	6 inch	Manually (Auto capable)
Oakdale	Eagle Point Business Park	12 inch	Manually

4.5.6 Computer Model

In order to determine the existing capabilities of the watermain system, a WaterCAD model was developed using current WaterCAD distribution system modeling software. The model was created to simulate the existing system's response to various conditions. Specifically, these conditions include average daily demand, peak day demand, and average day withdrawal plus the design fire flow demand. Each condition stresses the system differently and helps to identify actual conditions of operations which cause poor levels of performance. The model should be updated annually to reflect any new water system pipe and facilities that have been added and the system performance should continue to be monitored to verify that the desired operational performance criteria remains intact.

4.6 Water Storage Facilities

Water storage facilities are vital components of a water system, serving several important functions. These functions include the capacity to meet peak demands that exceed the well pumping capacity, maintain system pressure, and provide for smooth pumping operation by minimizing the amount of starting and stopping that may be required as the customers' demands vary. Storage facilities are equally important when providing water during emergency conditions such as power outages, supply facility breakdowns, and fire-fighting needs.

The City of Lake Elmo has two elevated water storage tanks. Tank No. 1 is located west of Lake Elmo Avenue in the northern portion of the Low pressure zone. More precisely it is at the end of Langly Court. Tank No. 1 was recently cleaned in 2007. The maintenance performed should allow the structure to serve the Low pressure zone until a replacement tower becomes necessary. Tank No. 2 was constructed in 2005 and is located adjacent to the public works facility and services the Intermediate pressure zone. Each tank is described in Table 14 below and shown in Figure 1.

TABLE NO. 14

STORAGE TANKS

Tank	Capacity (gallons)	Overflow Elevation (feet)
Elev. Tank No. 1	75,000	1,057
Elev. Tank No. 2	750,000	1,125

Storage capacity becomes necessary to even-out or “equalize” instantaneous peak demands on the system when the system demand exceeds “firm” pumping capacity. This prevents the need to provide pumping facilities to “pump on-demand” to meet the peak hour or peak minute demand, which would be costly and under utilize a large part of the water system facilities. Ten States Standards recommend storage facilities not be oversized to prevent potential water quality deterioration problems.

Table No. 15 establishes peak day equalization based on the diurnal consumption plus fire reserve storage capacity for the year 2008. Based on the 2008 peak day demand of 1.29 MGD, a total of 900,000 gallons were required in storage to equalize a peak day event with a fire reserve of 300,000 gallons. The fire reserve that was available for that peak day demand was only 150,000 gallons or 50% of the required reserve capacity for a fire event (1,200 GPM for two hours). In 2008, the City of Lake Elmo began falling behind the recommended storage capacity needed to equalize the system. Part of the reason for this deficit is that the City does not have adequate water supply capacity. Additional water supply capacity would reduce this equalization storage volume. The Capital Improvement Plan in this report recommends the construction of Well No. 4 as soon as possible. The increase in firm capacity provided by Well No. 4 would defer the need for additional storage at this time. Without Well No. 4, the storage deficit would almost double by the year 2010. Analysis for the years 2005, 2010, 2015, 2020, 2025, and 2030, plus the Ultimate demand are shown in the Appendix.

TABLE NO. 15
YEAR 2008 - EQUALIZATION AND FIRE STORAGE ANALYSIS

PEAK DAY DEMAND				1.29	MGD
FIRM PUMPING NEEDED				896	GPM
FIRM PUMPING AVAILABLE				500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	30,000	3,763	3,763	26,238
2	0.09	60,000	4,838	8,600	51,400
3	0.07	90,000	3,763	12,363	77,638
4	0.09	120,000	4,838	17,200	102,800
5	0.29	150,000	15,588	32,788	117,213
6	0.50	180,000	26,875	59,663	120,338
7	0.85	210,000	45,688	105,350	104,650
8	1.08	240,000	58,050	163,400	76,600
9	1.40	270,000	75,250	238,650	31,350
10	0.97	300,000	52,138	290,788	9,213
11	1.71	330,000	91,913	382,700	-52,700
12	1.08	360,000	58,050	440,750	-80,750
13	0.93	390,000	49,988	490,738	-100,738
14	1.07	420,000	57,513	548,250	-128,250
15	0.90	450,000	48,375	596,625	-146,625
16	1.80	480,000	96,750	693,375	-213,375
17	1.94	510,000	104,275	797,650	-287,650
18	2.27	540,000	122,013	919,663	-379,663
19	2.09	570,000	112,338	1,032,000	-462,000
20	2.09	600,000	112,338	1,144,338	-544,338
21	1.60	630,000	86,000	1,230,338	-600,338
22	0.59	660,000	31,713	1,262,050	-602,050
23	0.27	690,000	14,513	1,276,563	-586,563
24	0.25	720,000	13,438	1,290,000	-570,000
Equalization Storage, Gallons					602,050
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					902,050

4.7 System Operation

4.7.1 SCADA Control System

The City of Lake Elmo has a SCADA control system. SCADA (Supervisory Control and Data Acquisition) systems have become the municipal standard for water systems in recent years. SCADA systems typically consist of a central, computer-based control system that communicates with each “remote” facility (i.e., well, tank, lift station, etc.) through one of several types of telemetry. The radio based telemetry system removes the City’s dependence on and cost to lease phone lines. The use of radio SCADA systems can control operations such as starting and stopping equipment, monitoring for intrusion or facility failure, and alarming a failure which could result in a potentially dangerous situation or costly infrastructure damage. Additional benefits include data storage, report generation, and trending to establish important operating information for historical, design, and report preparation.

4.7.2 Backup Power

Back-up power generation increases the reliability of the water supply system during emergency situations. The City has one back-up power generator that is trailer mounted and can be connected to either well. The generator is manufactured by Caterpillar, model 4001E, and delivers 165 KW.

4.7.3 Unaccounted Water

The Lake Elmo water distribution system un-metered water use averages less than 10%. This amount of “un-metered” or “other” water use is well within the confines of what is considered reasonable, and no action is required to reduce these levels. However, from a billing and revenue standpoint, the City may want to monitor the impact of iron and manganese on meter registration, and if it proves to be significant, consider a meter change out program beginning with the major water users.

4.8 System Maintenance

Routine maintenance emphasizes regular service intervals for supply facilities, exercising of distribution system components, repair of hydrants, distribution mains and valves, and regular flushing as warranted.

As a water system ages, system maintenance can be expected to increase. The water storage tanks will eventually require repainting. A well-conceived preventive maintenance routine will extend the life of the existing facilities, save money, and help maintain reliable service to the City’s customers. Table No. 16 below shows several “major” maintenance items and typical recurrence intervals.

TABLE NO. 16
TYPICAL "MAJOR" MAINTENANCE ITEMS

Maintenance Item	***Typical Frequency***
Water Distribution System Leak Detection	As needed or biannually
Well and Pump Rehabilitation	5 - 10 years
Water Storage Tank Inspection	5 - 10 years
Water Storage Tank Repainting	15 – 20 years
Water Treatment Plant Filter Inspection	1 - 2 years
Water Treatment Plant Rehabilitation	10 - 20 years

5.1 Future Water Use

5.1.1 System Demands

Population and peak day water use can be used to determine the peak day per capita water demand. This parameter is expressed in units of gallons per capita per day (GPCD), and can vary from year to year, becoming larger in drought years and smaller in wet years due to the variation in irrigational and recreational uses. Estimating per capita demands plays an important role in projecting future water system needs, and will determine how large the water system infrastructure must be, as well as when and where the water mains are required.

When projecting future water use, population and per capita consumption are not the only variables that can influence the magnitude of future demands. Consideration must also be given to changing trends in the amount of commercial and industrial development presently served, as well as their anticipated future requirements. There are no known major water users planning to locate in Lake Elmo at the time of this report. Thus, future commercial and industrial, as well as residential, irrigation, and other water use is assumed to remain consistent with historical trends.

It is generally assumed that as Lake Elmo grows and matures, the peak day per capita water use will decrease, as reflected in Table No. 17. This is due to increased water conservation efforts, better resource management, and maturing lawns and landscaping. By projecting population, and establishing anticipated peak per capita consumption rates, supply and storage demands were figured and used to design the future system. Table No. 17 contains estimates for peak day demands through the design period.

TABLE NO. 17
PROJECTED PEAK DAY DEMAND

Year	Estimated Population	Projected Peak Day Per Capita Consumption (GPCD)	Peak Day Demand (Gallons)
2010	6,616	349	2,311,618
2020	12,951	299	3,870,765
2030	19,286	251	4,845,208
Ultimate	24,054	226	5,433,763

*GPCD = Gallons per Capita Day

5.1.2 Water Conservation

Water conservation measures are perhaps the primary tool that Cities have to better manage customer water use. Section 4.1.4 outlines the water conservation goals and the 2007 Water Supply Plan outlines the measures that the City should implement to reduce the demands on the water system. If the reduction in per capita consumption figures shown in Table No. 17 are not met, additional infrastructure may be needed, or proposed infrastructure may need to be built on an accelerated schedule. The per capita consumption should therefore be monitored each year to track trends in water consumption. Based on the progress towards these trends, conservation goals may have to be re-evaluated to identify their effectiveness on water consumption. These same water conservation goals will also satisfy DNR requirements.

5.2 Water Supply Facilities

Currently the "combined" water production capacity for Lake Elmo is 1,500 GPM, with a firm well capacity (largest well out of service) of 500 GPM. Table No. 18 below shows the future firm well pumping capacity needed to supply water for a peak day. These projected demands are based on the assumption that the City successfully reduces their peak day to average day ratio, working towards the DNR benchmark of 2.6. This Plan provides a target ratio of 2.8 in 2030.

TABLE NO. 18
FUTURE FIRM WELL PUMPING CAPACITY NEEDED

Year	Population Served	Peak Day Demand (Gallons)	Peak Day Demand (GPM)	Existing Firm Well Capacity (GPM)	Additional Well Capacity Needed (GPM)
2008	4,281	1,294,128	899	500	399
2010	6,616	2,311,618	1,605	500	1,105
2015	9,783	3,167,780	2,200	500	1,700
2020	12,951	3,870,765	2,688	500	2,188
2025	16,118	4,427,574	3,075	500	2,575
2030	19,286	4,845,207	3,365	500	2,865
Ultimate	24,054	5,433,763	3,773	500	3,273

It is anticipated that the City will need a total of 4 to 5 wells by the year 2030 to meet the Peak Day Demand of 3,365 GPM. Figure No. 6 graphically represents the water supply capacity needs for the City for the planning period of 2005-2030. This figure identifies the water customer population "Triggers" that should be used to guide the City for adding new wells to the system. In addition, new wells may need to be accelerated in schedule in order to serve new developing areas due to Lake Elmo's multi-pressure zones and separated geographic development areas.

Well No. 1 is a multi-aquifer well and is not in compliance with the current well code 4725.2020. Therefore, it cannot be modified or redeveloped to increase its capacity unless it is brought into compliance. The DNR has indicated to the City a preference to have this well abandoned to avoid interconnections between aquifers. The abandonment preference is based on protecting the well supply for the population within the region as a whole. The well can be brought into compliance by casing off the Jordan and Franconia-Ironton-Galesville formations and only pumping water from the Mount Simon formation. It is not expected that bringing the well into compliance will be an economical decision for this low capacity well.

Therefore, it is recommended that Well No. 1 remain active until replacement is necessary or the well requires major maintenance investments. Once the City has added sufficient well capacity to render this well obsolete, the well should be taken out of service and abandoned. The Capital Improvement Plan included in this report recommends this occur in the year 2028.

FIGURE 6

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5.3 Water Treatment Facilities

The existing water quality for the Lake Elmo water supply is compliant with all known maximum primary contaminate levels regulated by the EPA, meaning that no enhanced treatment is required by regulatory agencies at this time. The water supply does exceed the recommended secondary (non-health related) levels established by the EPA for manganese and iron. However, with no strong history of operation and maintenance concerns or water quality complaints by customers there does not seem to be sufficient justification to plan for conventional water treatment of the City supply wells. Therefore, the Capital Improvement Plan in this report does not include any Water Treatment Facilities. Should the City begin to receive an increase in the number or nature of water quality complaints, the addition of polyphosphates in an attempt to sequester the dissolved iron and manganese should first be considered. If polyphosphate were to prove ineffective, the City should then pursue a feasibility study to evaluate the efficiency of treating for the removal of iron and manganese by oxidation and filtration.

5.4 Water Distribution System

Water distribution facilities cannot be easily or economically increased in capacity once they are buried and assessed. Therefore, it is necessary that an accurate estimate of the water system capacity at full build-out be used to generate future infrastructure needs required to serve the future demand. As the water system is expanded, it is essential that the mains be sized on the basis of future demand, which is calculated using full build-out, future land use, and population projections.

5.4.1. Piping and Distribution Network

A computer model was constructed to simulate the additional demands and determine what added stress is placed on the existing watermain pipe network. The model is also used to help analyze the performance of the new and existing distribution system as it is incrementally expanded to accommodate future connections and users. The model aids in the efficient and economic layout of the future trunk watermain system. Figure 1, Existing and Future Water System, provides the framework and outlines where the large diameter watermain pipes need to be constructed to deliver the basic water service demands in an economical and efficient manner. The intent is to show general locations and looping required to maintain redundancy in the system. The actual implementation and placement of the watermains should be integrated in consideration with other utility issues, such as actual development patterns, roadway locations, and environmental concerns.

Most of the future trunk watermain shown in Figure No. 1 can be installed by the various private development projects as they are built out and turned over to the City. The cost for this watermain would then be paid in part or in full by the developers. The City would typically cost-share to have the trunk watermain lines increased in size from a minimum 8-inch pipe diameter. This is determined on a case by case basis. However, a few of the major trunk watermain lines located in areas not planned for future development may need to be constructed and paid for by the City. This could include the Keats Avenue Trunk Watermain Extension, the Inwood Avenue Trunk Watermain Extension and the Lake Elmo Avenue Trunk Watermain Extension, if this line is ever needed.

As discussed in Section 4, the existing trunk watermain network is not sufficiently looped. Additional watermain connections should be added to the system to strengthen and “loop” the existing trunk network. Poorly looped distribution systems have a greater potential for water quality problems, higher vulnerability to service interruption due to watermain breaks and diminished fire flow capabilities. A poorly looped system also demands increased maintenance for the operators and likely leads to customer complaints. Future expansion of the system should focus on creating a looped pipe network and avoid creating additional “dead-end” conditions. In particular, the City needs to construct the 16-inch diameter Keats Avenue Trunk Watermain Extension as soon as funds become available. This project is discussed in more detail in the following section.

Many of the smaller diameter pipes in the network were constructed back in the 1960’s and 1970’s and may require replacement within the next 10 to 15 years. In particular, the 4-inch diameter watermain constructed as part of the Lake Jane water system should be considered undersized and a replacement plan should be developed for this watermain. In addition, the 8-inch watermain line in the Old Village along Lake Elmo Avenue from 30th Street to Stillwater Boulevard (TH 5) should be upgraded to a new 12-inch trunk watermain in conjunction with any street improvements completed along Lake Elmo Avenue. This new 12-inch line will connect to the 16-inch piping near proposed Well No. 4. This section of pipe is mentioned specifically because of its age and its need to carry fire flow demands to various points in the Old and New Village.

5.4.2 Future Capital Improvements to the Existing System

Table No. 1, 2009-2030 Water System Capital Improvement Plan, identifies the Keats Avenue Trunk Watermain Extension project to be completed as soon as possible. In addition, the City Council has identified the Southwest Area Watermain Extension project as a top priority project. These projects are described in detail below.

Project 1 - Keats Avenue Trunk Watermain Extension:

This project has been previously identified in the City's Water CIP but has not yet been constructed. This watermain extension project will complete a core part of the City's distribution network, providing a critical loop in the distribution system and a more functional and reliable distribution path from Well No. 2 to Tank No. 2 and the demand points in the service area. The improvement is needed to meet supply and fire flow demands of the existing system and to increase supply reliability of the entire water system.

Due to the need to provide water to various areas of the City to address PFC contamination the water system was expanded quickly in response to this public health issue. The watermain network was therefore developed linearly rather than in a looped pattern which would provide for redundant ways to serve various areas of the City. Therefore, the City's water supply system is vulnerable to interruption for large areas of the City if certain key watermain pipes are out of service. The Keats Avenue Trunk Watermain Extension remains part of the original system expansion plans to complete the water system project as designed. Without this extension the system remains incomplete and operating in a temporary configuration.

The City's largest and most reliable well, Well No. 2, is located in the far northeast quadrant of the City. The water supply from Well No. 2 must push across the entire City through an unlooped pipe network using temporary routes of smaller diameter and older pipe. If any portion of the approximately 2.5 mile watermain route is closed, disconnecting Well No. 2 from the rest of the system, Well No. 1 cannot provide sufficient water supply capacity to the higher pressure zone customers in the Intermediate pressure zone. The Intermediate pressure zone includes the northeast quadrant, extends to the western area of the City, and includes Tank No. 2.

A separate project, Water Supply Well and Pump House No. 4 (separate PPL application), would provide some supply redundancy for some circumstances. It will be located to supply both the high and low pressure systems, but it is still connected to the western area of the City by a single watermain. In addition, it does not provide a redundant watermain for the northeast quadrant of the City.

Project 2 - Southwest Area Watermain Extension:

As a matter of Public Health, this project includes the extension of trunk and lateral watermains and the construction of a water booster station to extend municipal water service to residential homes in the southwest area of the City of Lake Elmo. This watermain extension project is needed to provide safe public drinking water to residents in southwestern Lake Elmo where PFC groundwater contamination has been found which exceeds established Health Risk Levels (HRL).

Currently there are over 135 properties subject to contaminated drinking water due to the presence of PFOS and PFOA in the groundwater. Granular Activated Carbon (GAC) filters have been installed and are in use as a short term measure to protect residents in the area. Bottled water has also been distributed to some homes as a safety precaution. The Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health (MDH) state these filters are not a reliable long term solution. The agencies remain actively involved in an extensive well testing program to montior and track the contamination plumes and impacts to public health.

This project proposes the extension of trunk and lateral watermain to provide municipal drinking water for each of the existing properties in the contamination area. A 16-inch trunk watermain is proposed to be extended from the Tablyn Park/Lake Elmo Heights neighborhoods directly north and adjacent to this area. The watermain would be installed through directional drilling technologies to avoid costly restoration of the existing roadways. Lateral watermain will continue into the subdivisions of Torre Pines, Parkview Estates, Cardinal Ridge, Cardinal

View, and Whistling Valley. Service connections will be extended to the property line of each residential home for future connection by each homeowner.

Prior to the discovery of the PFC contamination and subsequent MDH and MPCA inquires and investigations, the region was intended for Rural Residential "Open Space" type development. This development plan consisted of larger rural residential lots each having a private water supply well and either individual or community on-site wastewater treatment systems. There was originally no plan to construct a municipal water supply system to serve this part of the City. Consequently, with the discovery of the PFC Contamination, the extension of a municipal water supply system is now necessary but is cost prohibitive without outside finanical assistance.

5.4.3. Pressure

All pressure parameters discussed in Section 4.5.4 should be maintained and should serve as the performance criteria for the water system.

5.4.4. Booster and Reducing Stations

Booster stations are constructed when supplemental pressure is needed to support areas located at higher elevations or at the extremities of the distribution system, or to supply water from a lower pressure zone to a higher pressure zone. These facilities should be considered for areas experiencing pressures less than 35 psi. Reducing stations are installed to relief pressures to those areas that are greater than 80 psi, either due to low elevations relative to the zonal storage tank, or to supply water from a higher pressure zone to a lower pressure zone.

A booster station is proposed to be constructed near Inwood Avenue and 28th Street to supply water to the South High pressure zone shown in Figure No. 1. This booster station must be constructed together with the Southwest Area Watermain Extension project described above. A booster station may also be needed in the northwest quadrant of the City, near Demontreville and Trunk Highway 36 (North High pressure zone), if the residents in this area ever request to connect to the municipal water system. Since this area is excluded from the 2030 water service population, this second booster station is not shown on Figure 1.

Reducing stations will be required on the distribution system at most interconnection points between pressure zones. Figure 1 shows two new reducing stations south of 10th street, between the South High and South Low pressure zones, and two new reducing stations along Lake Elmo Avenue, north of Stillwater Boulevard, between the Intermediate and North Low pressure zones.

5.4.5. Supply or Connections to Adjacent Communities (Shared Resources)

Lake Elmo maintains two valuable interconnections to the City of Oakdale. As the Lake Elmo water system expands near other communities, additional interconnections should be explored and opportunities to share water sources and facilities should be pursued.

The proposed water system in this Plan is intended to define a future water system that is owned and operated independently by the City of Lake Elmo. However the system layout is intended to remain flexible to be responsive to potential shared water facility opportunities. Through initial meetings with Oakdale staff, it appears that there may be opportunities to continue to purchase water from Oakdale as the Lake Elmo water system expands in the southwest quadrant of the City. Water quality, costs and alignment of shared goals would need to be explored further to determine the viability of this interconnect for long term use. In addition, an interconnection with the City of Oak Park Heights may warrant similar consideration.

5.5 Water Storage Facilities

Minimum storage requirements have been established by "Ten States Standards"[2], which indicate that storage volume should have sufficient capacity to meet domestic and fire flow demands. Domestic demands can be equated to the average daily consumption, or having sufficient storage for one day of domestic use. Fire flow requirements were discussed in Section 3 of this report to establish the fire flow design criteria for the Lake Elmo water system. From this analysis a fire flow demand of 2,500 GPM for a two hour duration was deemed adequate. Therefore, this Plan has based the

[2] Recommended Standards for Water Works, 2007, Great Lakes, Upper Mississippi Board of State Public Health and Environment Managers.

minimum storage requirements on a storage volume sufficient to meet the peak day demand and supply a fire demand of 2,500 GPM for two hours.

Based on this design criteria, Table No. 19 below summarizes the water storage capacity that is needed for the years 2010, 2020 and 2030. Storage requirements were determined using the equalization method discussed in Section 4 and assumes that the firm well capacities are available as recommended by the well capacity trigger chart shown on Figure 6.

TABLE NO. 19
PEAK DAY EQUALIZATION STORAGE CAPACITY REQUIREMENTS

Year	Equalization Storage (Gallons)	Fire Reserve Storage (Gallons)	Storage Capacity Required (Gallons)
2010	441,350	300,000	741,350
2020	733,950	300,000	1,033,950
2030	863,917	300,000	1,163,917
Ultimate	1,106,910	300,000	1,406,910

It is anticipated that the City will need a total of four elevated storage tanks by the year 2030 to provide the basic water service needs of the system and to support each localized pressure zone and geographic region. Because it will take three pressure zones to properly serve the range of ground elevation within the City, one storage tank should be constructed in each pressure zone. The existing Elevated Tank No. 1 in the North Low pressure zone should be removed from service once a new elevated tank is constructed in the same zone to replace it.

Figure No. 7 graphically represents the system storage requirements for the City for the planning period of 2005-2030. This figure identifies the water customer population “Triggers” that should be used to guide the City for adding new storage tanks to the system.

FIGURE 7

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5.6 Capital Improvement Plan

Table No. 1, 2009-2030 Water System Capital Improvement Plan summarizes the primary infrastructure improvements for the existing water system and future water system that have been discussed in Sections 4 and 5. Together with Figure No. 1, this Plan provides the framework for guiding the system expansion and provides the estimated facility costs that will be necessary to construct the water system as proposed. The City should review the water core fund balances and projected revenue to determine if the Water Availability Connection Charges (WAC) are sufficient.

This Plan indicates the year that each facility will be needed based on the 2005 Comprehensive Plan population growth projections. However, Figure 4 and Figure 5 also provide this information by water customers on the system to define when these facilities need to be constructed if the population projections are slower or faster than predicted.

TABLE NO. 1

2009-2030 WATER SYSTEM CAPITAL IMPROVEMENT PLAN

Year	Capital Improvement	Trigger Event	Estimated Cost
ASAP	Well and Pumphouse No. 4 *Construct new well to feed the Intermediate Pressure Zone including watermain connection and a PRV to the Low Service Area*	Current user demand exceeds 'Firm' Well Capacity and system lacks reliable backup *(Well was needed in 2007)*	$885,000
ASAP	Keats Avenue Trunk Watermain *Construct 16-inch trunk watermain along Keats Avenue to connect Well No. 2 with Elevated Tank No. 2 through the Intermediate Pressure Zone*	Critical trunk watermain supply route to Elevated Tank No. 2	$1,200,000
2012	Booster Station No. 1 *Construct Booster Station with variable frequency drives and indoor emergency generator (project only needed if Inwood Avenue Trunk Watermain is constructed to 10th Street)*	Funding Availability for SW Area Watermain Extension Project	$700,000 *(Generator Add: $250,000)*
2014	Elevated Tank No. 1A *Construct 500,000 gallon elevated storage tank to replace existing Elevated Tank No. 1. Remove Tank No. 1*	Village Area development outpacing available storage and expected deterioration of existing elevated tank	$1,600,000
2015	Well and Pumphouse No. 5 *Construct Well No. 5 to feed the Low Pressure Zone in the southeast quadrant (New Water Supply Source). Well No. 5 will require a temporary pressure tank until Elevated Tank No. 3 is constructed.* *OR* *Construct Well No. 5A to feed the Intermediate Pressure Zone. Adjust pump at Well No. 4 to feed only North Low Pressure Zone*	New water source for development in the southeast quadrant south of 10th Street OR Demand Exceeds 'Firm' Well Capacity for water system	$960,000 (includes pressure tank) $885,000
2019	Elevated Tank No. 3 *Construct 750,000 gallon elevated storage tank to serve South Low Pressure Zone*	Storage requirements to support continued development in the South Low Pressure Zone	$1,700,000
2025	Elevated Tank No. 4 *Construct 500,000 gallon elevated storage tank to serve the South High Pressure Zone*	Storage requirements to support development in South High Pressure Zone	$1,550,000
2028	Well and Pumphouse No. 6 *Construct Well No. 6 (Intermediate Pressure Zone) and Abandon Well No. 1.*	Total system demand exceeds 'Firm' Well Capacity and expected need to recondition Well No. 1	$955,000

**Trigger events are graphically represented in Figures 5 and 6 of this report.*

***Cost estimates are based on 2009 construction costs and include a 10% contingency and 25% for Engineering, Administration, Finance, and Legal.*

5.7 Recommendations

This Plan makes nine specific recommendations for the City to implement over the next few years that will help the City to begin Plan implementation and to respond to immediate issues and concerns. In particular these recommendations are consistent with the proposed 2030 master water system plan while maintaining the flexibility to respond to the aquifer and geographic complexities in Lake Elmo.

The following recommendations are summarized below with more detailed discussions provided in the Executive Summary of this report:

1. Recommendation No. 1 – Correct existing deficiencies by constructing two capital improvement projects have been identified as critical in order to provide a safe and reliable water supply to the existing customer base. The two improvement projects are Well and Pumphouse No. 4 and the Keats Avenue Trunk Watermain Extension. Both projects should be constructed as soon as funding can be appropriated. At a minimum, the City should immediately begin the process of siting the well location and pursue any land acquisition that may be needed.

2. Recommendation No. 2 – Seek funding assistance for the Southwest Area Watermain Extension Project. As a matter of Public Health, this watermain extension project is needed to provide a safe public drinking water to residents in the Torre Pines, Cardinal Ridge, Cardinal View, and Whistling Valley subdivisions. This project is in response to the discovery of PFOA and PFOS groundwater contamination which exceeds established Health Risk Levels (HLV). It is recommended that a city task force be formed with the objective of seeking financial assistance for this project.

3. Recommendation No. 3 – Continue the use of Well No. 1 and Elevated Tank No. 1, but Plan for their replacement. It is recommended that Well No. 1 and Elevated Tank No. 1 be utilized as long as they remain productive and reliable facilities for the Old Village water system, however the City must remain ready to replace these aged and under sized facilities once significant work or reconditioning is necessary.

4. Recommendation No. 4 – Request the necessary review to update the ISO rating to improve property insurance in the City by taking advantage of recent and proposed capital expenditures in the near future.

5. Recommendation No. 5 – Defer the final decision on Well No. 3 until the MDH requires the City to abandon the well, or until the water system supply decisions for the Eagle Point water system area are more certain.

6. Recommendation No. 6 – Negotiate a multi-year interim water supply contract with the City of Oakdale. This arrangement could provide an economical interim solution for serving both the South High pressure zone located in the southwest quadrant of the City and possibly the South Low pressure zone located in the southeast quadrant.

7. Recommendation No. 7 – Investigate the potential of constructing Well No. 5 in the southeast quadrant of the City to more efficiently and economically provide water supply for development in that area.

8. Recommendation No. 8 – It is recommended that the 2009-2030 Capital Improvement Plan and the 2030 Comprehensive Water System Plan outlined in Table No. 1 and Figure 1 be used as the framework and guide for expanding the water system in response to future needs and demands. Incrementally review this plan to re-evaluate its application after significant development activities.

9. Recommendation No. 9 – Improve Water Conservation. Better progress must be achieved in meeting DNR conservation benchmarks through increased enforcement of current conservation measures and/or through the implementation of additional conservation measures. The City must complete a Water Supply Plan for the Department of Natural Resources (DNR) and adopt a water conservation rate structure meeting DNR approval by January 1, 2010. As part of these efforts, City staff must diligently pursue and acquire additional water appropriations. Current water use exceeds the permitted water appropriations and the City cannot construct a new well until the appropriation permit has been updated.

APPENDIX

EQUALIZATION AND FIRE STORAGE ANAYLSIS

FOR

2005, 2010, 2015, 2020, 2025, 2030, ULTIMATE

2005 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				0.66	MGD
FIRM PUMPING NEEDED				459	GPM
FIRM PUMPING AVAILABLE				500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	27,540	1,928	1,928	25,612
2	0.09	55,080	2,479	4,407	50,673
3	0.07	82,620	1,928	6,335	76,285
4	0.09	110,160	2,479	8,813	101,347
5	0.29	137,700	7,987	16,800	120,900
6	0.50	165,240	13,771	30,571	134,669
7	0.85	192,780	23,410	53,982	138,798
8	1.08	220,320	29,745	83,727	136,593
9	1.40	247,860	38,558	122,285	125,575
10	0.97	275,400	26,715	149,000	126,400
11	1.71	302,940	47,096	196,097	106,843
12	1.08	330,480	29,745	225,842	104,638
13	0.93	358,020	25,614	251,455	106,565
14	1.07	385,560	29,470	280,925	104,635
15	0.90	413,100	24,788	305,713	107,388
16	1.80	440,640	49,575	355,288	85,353
17	1.94	468,180	53,431	408,718	59,462
18	2.27	495,720	62,520	471,238	24,482
19	2.09	523,260	57,562	528,800	-5,540
20	2.09	550,800	57,562	586,362	-35,562
21	1.60	578,340	44,067	630,429	-52,089
22	0.59	605,880	16,250	646,678	-40,798
23	0.27	633,420	7,436	654,115	-20,695
24	0.25	660,960	6,885	661,000	-40
Equalization Storage, Gallons					138,798
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					438,798

2010 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				2.31	MGD
FIRM PUMPING NEEDED -				1,604	GPM
FIRM PUMPING AVAILABLE				1,500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	90,000	6,738	6,738	83,263
2	0.09	180,000	8,663	15,400	164,600
3	0.07	270,000	6,738	22,138	247,863
4	0.09	360,000	8,663	30,800	329,200
5	0.29	450,000	27,913	58,713	391,288
6	0.50	540,000	48,125	106,838	433,163
7	0.85	630,000	81,813	188,650	441,350
8	1.08	720,000	103,950	292,600	427,400
9	1.40	810,000	134,750	427,350	382,650
10	0.97	900,000	93,363	520,713	379,288
11	1.71	990,000	164,588	685,300	304,700
12	1.08	1,080,000	103,950	789,250	290,750
13	0.93	1,170,000	89,513	878,763	291,238
14	1.07	1,260,000	102,988	981,750	278,250
15	0.90	1,350,000	86,625	1,068,375	281,625
16	1.80	1,440,000	173,250	1,241,625	198,375
17	1.94	1,530,000	186,725	1,428,350	101,650
18	2.27	1,620,000	218,488	1,646,838	-26,838
19	2.09	1,710,000	201,163	1,848,000	-138,000
20	2.09	1,800,000	201,163	2,049,163	-249,163
21	1.60	1,890,000	154,000	2,203,163	-313,163
22	0.59	1,980,000	56,788	2,259,950	-279,950
23	0.27	2,070,000	25,988	2,285,938	-215,938
24	0.25	2,160,000	24,063	2,310,000	-150,000
Equalization Storage, Gallons					441,350
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					741,350

2015 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				3.17	MGD
FIRM PUMPING NEEDED -				2,201	GPM
FIRM PUMPING AVAILABLE				2,500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	132,060	9,246	9,246	122,814
2	0.09	264,120	11,888	21,133	242,987
3	0.07	396,180	9,246	30,379	365,801
4	0.09	528,240	11,888	42,267	485,973
5	0.29	660,300	38,304	80,571	579,729
6	0.50	792,360	66,042	146,613	645,748
7	0.85	924,420	112,271	258,883	665,537
8	1.08	1,056,480	142,650	401,533	654,947
9	1.40	1,188,540	184,917	586,450	602,090
10	0.97	1,320,600	128,121	714,571	606,029
11	1.71	1,452,660	225,863	940,433	512,227
12	1.08	1,584,720	142,650	1,083,083	501,637
13	0.93	1,716,780	122,838	1,205,921	510,859
14	1.07	1,848,840	141,329	1,347,250	501,590
15	0.90	1,980,900	118,875	1,466,125	514,775
16	1.80	2,112,960	237,750	1,703,875	409,085
17	1.94	2,245,020	256,242	1,960,117	284,903
18	2.27	2,377,080	299,829	2,259,946	117,134
19	2.09	2,509,140	276,054	2,536,000	-26,860
20	2.09	2,641,200	276,054	2,812,054	-170,854
21	1.60	2,773,260	211,333	3,023,388	-250,128
22	0.59	2,905,320	77,929	3,101,317	-195,997
23	0.27	3,037,380	35,663	3,136,979	-99,599
24	0.25	3,169,440	33,021	3,170,000	-560
Equalization Storage, Gallons					665,537
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					965,537

2020 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				3.87	MGD
FIRM PUMPING NEEDED -				2,688	GPM
FIRM PUMPING AVAILABLE				2,500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	150,000	11,288	11,288	138,713
2	0.09	300,000	14,513	25,800	274,200
3	0.07	450,000	11,288	37,088	412,913
4	0.09	600,000	14,513	51,600	548,400
5	0.29	750,000	46,763	98,363	651,638
6	0.50	900,000	80,625	178,988	721,013
7	0.85	1,050,000	137,063	316,050	733,950
8	1.08	1,200,000	174,150	490,200	709,800
9	1.40	1,350,000	225,750	715,950	634,050
10	0.97	1,500,000	156,413	872,363	627,638
11	1.71	1,650,000	275,738	1,148,100	501,900
12	1.08	1,800,000	174,150	1,322,250	477,750
13	0.93	1,950,000	149,963	1,472,213	477,788
14	1.07	2,100,000	172,538	1,644,750	455,250
15	0.90	2,250,000	145,125	1,789,875	460,125
16	1.80	2,400,000	290,250	2,080,125	319,875
17	1.94	2,550,000	312,825	2,392,950	157,050
18	2.27	2,700,000	366,038	2,758,988	-58,988
19	2.09	2,850,000	337,013	3,096,000	-246,000
20	2.09	3,000,000	337,013	3,433,013	-433,013
21	1.60	3,150,000	258,000	3,691,013	-541,013
22	0.59	3,300,000	95,138	3,786,150	-486,150
23	0.27	3,450,000	43,538	3,829,688	-379,688
24	0.25	3,600,000	40,313	3,870,000	-270,000
Equalization Storage, Gallons					733,950
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					1,033,950

2025 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				4.43	MGD
FIRM PUMPING NEEDED -				3,076	GPM
FIRM PUMPING AVAILABLE				2,500	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	150,000	12,921	12,921	137,079
2	0.09	300,000	16,613	29,533	270,467
3	0.07	450,000	12,921	42,454	407,546
4	0.09	600,000	16,613	59,067	540,933
5	0.29	750,000	53,529	112,596	637,404
6	0.50	900,000	92,292	204,888	695,113
7	0.85	1,050,000	156,896	361,783	688,217
8	1.08	1,200,000	199,350	561,133	638,867
9	1.40	1,350,000	258,417	819,550	530,450
10	0.97	1,500,000	179,046	998,596	501,404
11	1.71	1,650,000	315,638	1,314,233	335,767
12	1.08	1,800,000	199,350	1,513,583	286,417
13	0.93	1,950,000	171,663	1,685,246	264,754
14	1.07	2,100,000	197,504	1,882,750	217,250
15	0.90	2,250,000	166,125	2,048,875	201,125
16	1.80	2,400,000	332,250	2,381,125	18,875
17	1.94	2,550,000	358,092	2,739,217	-189,217
18	2.27	2,700,000	419,004	3,158,221	-458,221
19	2.09	2,850,000	385,779	3,544,000	-694,000
20	2.09	3,000,000	385,779	3,929,779	-929,779
21	1.60	3,150,000	295,333	4,225,113	-1,075,113
22	0.59	3,300,000	108,904	4,334,017	-1,034,017
23	0.27	3,450,000	49,838	4,383,854	-933,854
24	0.25	3,600,000	46,146	4,430,000	-830,000
Equalization Storage, Gallons					1,075,113
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					1,375,113

2030 Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				4.85	MGD
FIRM PUMPING NEEDED -				3,368	GPM
FIRM PUMPING AVAILABLE				3,000	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	180,000	14,146	14,146	165,854
2	0.09	360,000	18,188	32,333	327,667
3	0.07	540,000	14,146	46,479	493,521
4	0.09	720,000	18,188	64,667	655,333
5	0.29	900,000	58,604	123,271	776,729
6	0.50	1,080,000	101,042	224,313	855,688
7	0.85	1,260,000	171,771	396,083	863,917
8	1.08	1,440,000	218,250	614,333	825,667
9	1.40	1,620,000	282,917	897,250	722,750
10	0.97	1,800,000	196,021	1,093,271	706,729
11	1.71	1,980,000	345,563	1,438,833	541,167
12	1.08	2,160,000	218,250	1,657,083	502,917
13	0.93	2,340,000	187,938	1,845,021	494,979
14	1.07	2,520,000	216,229	2,061,250	458,750
15	0.90	2,700,000	181,875	2,243,125	456,875
16	1.80	2,880,000	363,750	2,606,875	273,125
17	1.94	3,060,000	392,042	2,998,917	61,083
18	2.27	3,240,000	458,729	3,457,646	-217,646
19	2.09	3,420,000	422,354	3,880,000	-460,000
20	2.09	3,600,000	422,354	4,302,354	-702,354
21	1.60	3,780,000	323,333	4,625,688	-845,687
22	0.59	3,960,000	119,229	4,744,917	-784,917
23	0.27	4,140,000	54,563	4,799,479	-659,479
24	0.25	4,320,000	50,521	4,850,000	-530,000
Equalization Storage, Gallons					863,917
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					1,163,917

Ultimate Lake Elmo Equalization Data Project No. 12782.001

PEAK DAY DEMAND				5.85	MGD
FIRM PUMPING NEEDED -				3,773	GPM
FIRM PUMPING AVAILABLE				4,000	GPM
HR	**DIST.**	**PRODUCTION**	**DEMAND**	**SUM DEMAND**	**STORAGE**
1	0.07	226,380	17,063	17,063	209,318
2	0.09	452,760	21,938	39,000	413,760
3	0.07	679,140	17,063	56,063	623,078
4	0.09	905,520	21,938	78,000	827,520
5	0.29	1,131,900	70,688	148,688	983,213
6	0.50	1,358,280	121,875	270,563	1,087,718
7	0.85	1,584,660	207,188	477,750	1,106,910
8	1.08	1,811,040	263,250	741,000	1,070,040
9	1.40	2,037,420	341,250	1,082,250	955,170
10	0.97	2,263,800	236,438	1,318,688	945,113
11	1.71	2,490,180	416,813	1,735,500	754,680
12	1.08	2,716,560	263,250	1,998,750	717,810
13	0.93	2,942,940	226,688	2,225,438	717,503
14	1.07	3,169,320	260,813	2,486,250	683,070
15	0.90	3,395,700	219,375	2,705,625	690,075
16	1.80	3,622,080	438,750	3,144,375	477,705
17	1.94	3,848,460	472,875	3,617,250	231,210
18	2.27	4,074,840	553,313	4,170,563	-95,723
19	2.09	4,301,220	509,438	4,680,000	-378,780
20	2.09	4,527,600	509,438	5,189,438	-661,838
21	1.60	4,753,980	390,000	5,579,438	-825,458
22	0.59	4,980,360	143,813	5,723,250	-742,890
23	0.27	5,206,740	65,813	5,789,063	-582,323
24	0.25	5,433,120	60,938	5,850,000	-416,880
Equalization Storage, Gallons					1,106,910
			Rate, gpm	Duration, Hrs.	
Required Fire Flow Storage, Gallons			2,500	2	300,000
Total Required System Storage, Gallons (Rounded)					1,406,910

TABLE NO. 20
ANNUAL AND PER CAPITA CONSUMPTION

Year	Population Served	Average Day Well Production (gallons)	Average Day Well Production (gpcd)	Oakdale Average Day Consumption (gallons)	Total Average Day Consumption (gpcd)	Peak Day Well Production (gallons)	Peak Day Well Production (gpcd)	Oakdale Peak Day Consumption (gallons)	Total Peak Day Consumption (gpcd)	Total Peak to Average Ratio
1996	716	64,726	90	N/A	90	157,000	219	N/A	219	2.4
1997	741	68,054	92	N/A	92	N/A	N/A	N/A	N/A	N/A
1998	776	79,138	102	N/A	102	N/A	N/A	N/A	N/A	N/A
1999	785	69,913	89	N/A	89	164,200	209	N/A	209	2.3
2000	800	82,010	103	N/A	103	299,300	374	N/A	374	3.6
2001	1156	110,419	96	N/A	96	425,900	368	N/A	368	3.9
2002	1919	116,768	61	N/A	61	376,900	196	N/A	196	3.2
2003	1982	177,339	89	N/A	89	625,400	316	N/A	316	3.5
2004	1992	153,272	77	N/A	77	479,100	241	N/A	241	3.1
2005	2007	152,377	76	N/A	76	660,867	318	N/A	318	4.2
2006	2919	224,929	77	48,388	94	813,000	279	81,099	306	3.3
2007	3639	387,846	107	93,857	132	1,450,300	399	258,759	470	3.5
2008	4281	352,016	82	68,508	98	1,155,800	270	138,328	302	3.1
	13-Year Average =		88		92		290		302	3.3

TABLE NO. 21
SEASONAL VARIATION

Year	Summer Use (GPD)	Winter Use (GPD)	Discretionary Use (GPD)	Summer to Winter Ratio
1996	79302	58,065	21,237	1.4
1997	74099	54,340	19,759	1.4
1998	105505	64,663	40,842	1.6
1999	95158	55,276	39,882	1.7
2000	105002	55,911	49,091	1.9
2001	168772	64,291	104,481	2.6
2002	185593	72,905	112,688	2.5
2003	318277	87,333	230,944	3.6
2004	263868	88,170	175,698	3.0
2005	279486	82,199	197,290	3.4
2006	472779	94,424	378,355	5.0
2007	807766	160,862	646,904	5.0
2008	726361	175,645	550,716	4.1
	13-Year Average =		197,530	2.9

** Oakdale consumption not included in this chart. The monitoring of the water usage through the Oakdale connection is performed quarterly and it does line-up with the summer and winter reporting periods.