Water System Master Plan

Water System Master Plan
April 2022

PREPARED FOR:
Village of Pewaukee
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Pewaukee, WI 53072

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I. INTRODUCTION

The Village of Pewaukee Water Utility is a municipally owned water utility that provides water service to residences and businesses within the corporate boundaries of the Village of Pewaukee. Located in central Waukesha County in southeast Wisconsin, the Village of Pewaukee Water Utility serves the needs of approximately 8,300 residents along with numerous commercial and industrial customers.

Drawing its water supply from five groundwater wells, the Village of Pewaukee Water Utility water system also consists of two elevated storage tanks, one standpipe, two ground level storage reservoirs, two supply pumping stations, one booster pumping station, and approximately 44 miles of transmission and distribution water mains. The water system is separated into two pressure zones to meet the service needs of the customers.

Located along Wisconsin Highway 16 and north of Interstate Highway 94, the Village of Pewaukee is within close proximity to the greater Milwaukee metropolitan area. Coupled with its smaller size and the Village has a lot to offer residence and business owners and provides the potential for future growth and development.

A. PURPOSE

This report summarizes the results of a water system planning study for the water utility. The primary purpose of the study was to evaluate the water needs and system expansion required to serve current and future Utility customers. Present and future water needs of the Village of Pewaukee Water Utility service area have been evaluated, and recommendations have been made concerning improvements necessary to maintain an adequate level of water service. This report will serve as a comprehensive plan to guide future expansion of the water system.

B. SCOPE

The planning approach used for the study began with an evaluation of the service area needs and characteristics. Current and future water needs were evaluated over a 20-year planning period with consideration given to projected future water needs extending to the year 2040.

This report utilizes a systematic approach to introduce and expand basic planning concepts. To start, a review of existing water system facilities is summarized in Chapter II. Population, community growth, and water consumption projections serve as the foundation for evaluating and identifying recommended improvements to the system and are introduced in Chapter III. The assumptions and conclusions presented in Chapter III were used to develop projections of water requirements that are presented in Chapter IV. The developed water requirements are utilized in Chapter V to summarize the evaluation of the water system supply and storage needs. Chapter VI summarizes the results of the water system network flow analysis, which uses computer software to simulate the operation of the distribution system and the pumping and storage facilities. Based upon the evaluations from the previous chapters recommended water system improvements are presented in Chapter VII, and a proposed capital improvements plan is presented in Chapter VIII.

Because needs change with time, comprehensive planning is a continuous function; therefore, the longer-term projections and improvements discussed in this report should be periodically reviewed, reevaluated, and modified, as necessary, to assure the adequacy of future planning efforts. Proper future planning will help assure that system expansion is coordinated and constructed in the most effective manner.

C. STUDY AREA

The study area is illustrated in Figure I-1 and consists of the Village of Pewaukee and surrounding area. Excluding the City of Pewaukee, the study area has physical or jurisdictional boundaries that may limit growth and represents the most logical and likely growth areas within the planning period. Consideration has been given to areas outside of the study area as identified by Utility and Village staff that may have the potential for long-term future development.

D. STUDY LIMITATIONS AND ASSUMPTIONS

The following limitations and assumptions underlie the work elements of this project.

1. The primary purpose of the study is to develop a system plan to guide the extension of adequate water supply services by the Village of Pewaukee Water Utility to existing and probable future development within the study area. The plan will identify water system infrastructure needed.

2. The study and plan produced are to be in sufficient depth to provide a sound basis for future facility planning. To this end, the study will review the general location, size, and capacity of major water transmission mains, pumping stations, and storage facilities and may recommend changes to existing facilities.

3. The plan is to be based upon previously developed land use and population information provided to Ruekert & Mielke, Inc. and may encompass areas outside the current sanitary sewer service area. The plan is to be designed to serve and support anticipated community needs based upon the current land use and population projections assuming complete development of the study area within the planning period. Thus, it may be necessary to secure regulatory approval to expand the sanitary sewer service area prior to extending water service into these areas.

4. Recommendations resulting from the planning efforts are to be consistent with current federal, state and local regulations regarding facility design.

5. This study includes a cursory investigation of distribution system water. The investigation is limited to a review of existing available water quality data and does not include any sampling, laboratory work, or pilot testing.

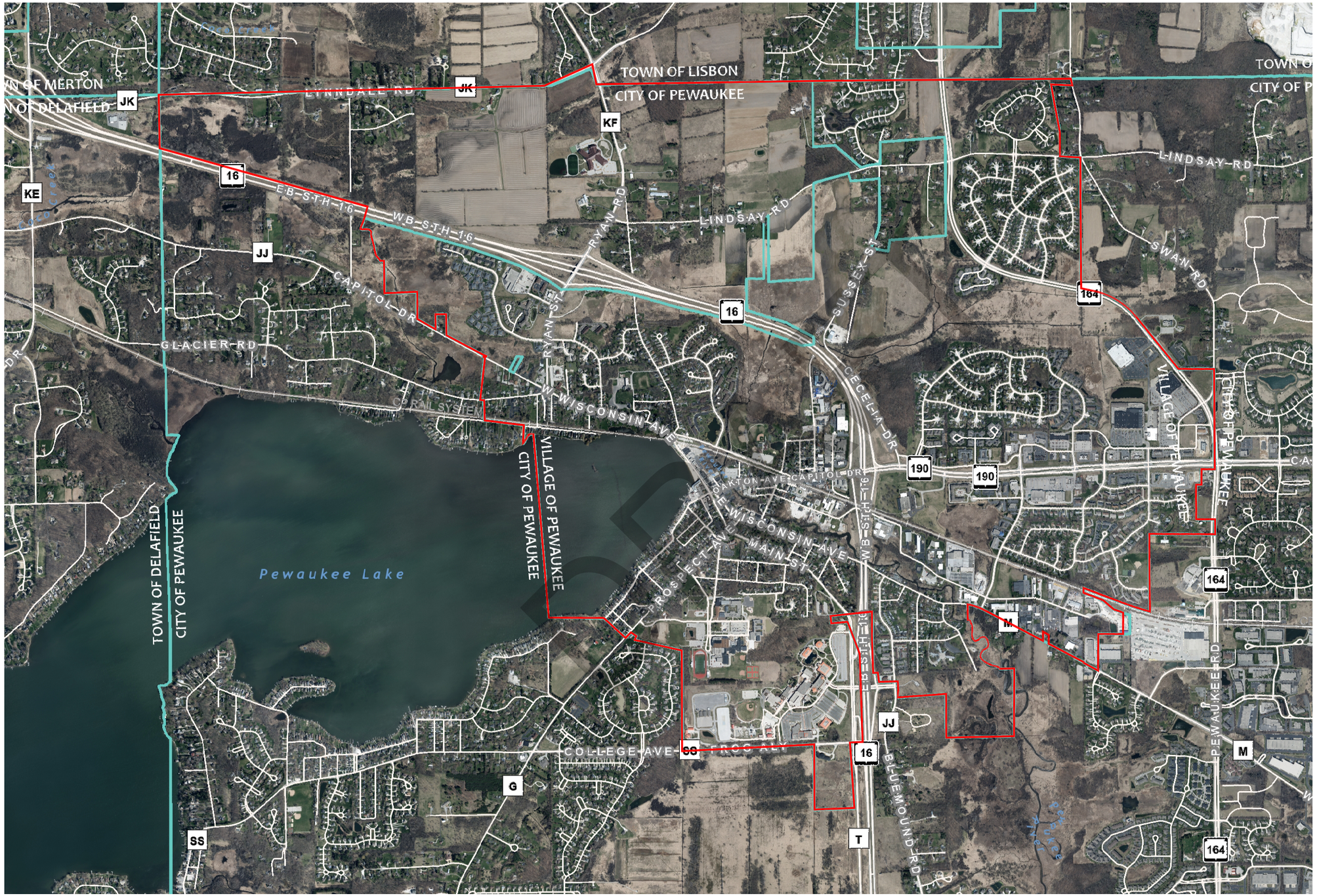

FIGURE I-1

VILLAGE OF PEWAUKEE
WAUKESHA COUNTY, WISCONSIN

LEGEND

STUDY AREA BOUNDARY

N
W E
S

0 1000 2000 4000
SCALE IN FEET

DATE: MAY 2022

SOURCE: R|M
BASEMAP SOURCE: WAUKESHA COUNTY PARKS AND LAND USE

Ruekert • Mielke
www.ruekertmielke.com

Apr 21, 2022 1:39pm PLOTTED BY: WBANCROFT SAVED BY: WBANCROFT
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XREFS: ..\Pewaukee Base.dwg; ..\Pewaukee Topo.dwg; ..\Village of Pewaukee Water Main System.dwg; ..\Pewaukee Water Main System.dwg; ..\Pewaukee Municipal Boundary.dwg; ..\Pewaukee Water Alternative-01.dwg; ..\Pewaukee Basin Boundaries-Alternative-01.dwg; ..\RM11x17.dwt

II. EXISTING WATER SYSTEM FACILITIES

This chapter presents a summary of the existing water system components of the Village of Pewaukee Water Utility water system. The various facilities operated and maintained by the Village of Pewaukee Water Utility include:

1. Five groundwater wells
2. Two elevated water storage tanks
3. One standpipe
4. Two ground level storage tanks
5. Two supply pumping stations
6. One booster pumping station
7. A network of transmission and distribution water mains

The general location and layout of the water system facilities are illustrated in Figure II-1. A schematic of the water system is illustrated in Figure II-2. The distribution system is separated into two pressure zones to help eliminate undesirable pressures that may otherwise result due to topographic variations that exist throughout the existing service area. The two pressure zones are referred to as:

1. Main Pressure Zone
2. Hawthorne Boosted Pressure Zone

A. Water System Pressure Zones

As mentioned above, the Village of Pewaukee Water Utility water distribution system consists of two pressure zones as illustrated in Figure II-1. As the Village of Pewaukee encompasses an area of variable topographical terrain, the pressure zones are necessary to provide water system pressure to all customers within more desirable limits.

1. Main Pressure Zone

The Main Pressure Zone is currently the largest pressure zone and serves all but a small portion on the northern part of the Village. Currently all of the groundwater wells are located within the Main Pressure Zone. The ground elevations currently served by the Main Pressure Zone are approximately 857 feet to 972 feet USGS.

2. Hawthorne Boosted Pressure Zone

The Hawthorne Booster Pressure Zone serves areas of higher elevation north of the Main Pressure Zone and serves the Hawthorne subdivision. The Hawthorne Boosted Pressure Zone currently serves elevations from approximately 935 feet to 1,000 feet USGS.

The Hawthorne Boosted Pressure Zone is small in size consisting of approximately 55 acres in total land area.

FIGURE II-1

Existing Water System

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Hydrant
- Booster Station
- Pump Station
- Tanks
- Well

Water Main

- 4 - Inch and Less
- 6 - Inch
- 8 - Inch
- 10 - Inch
- 12 - Inch
- 16 - Inch
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500

Feet

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Date: 4/24/2022

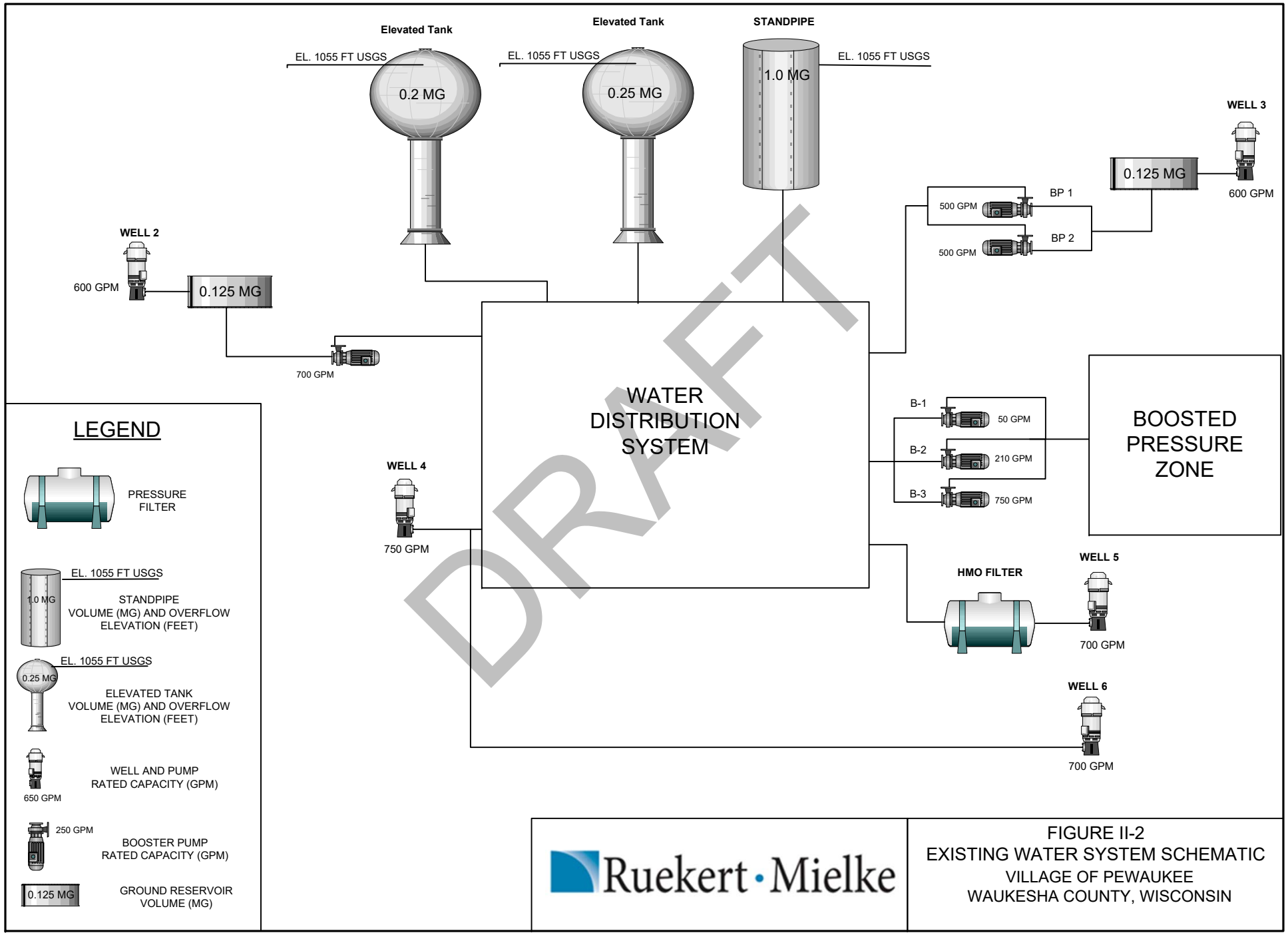

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FIGURE II-2
EXISTING WATER SYSTEM SCHEMATIC
VILLAGE OF PEWAUKEE
WAUKESHA COUNTY, WISCONSIN

B. Water Distribution System

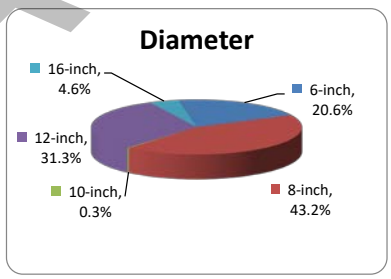
The water distribution system provides a means of transporting and distributing water from the water supply and storage facilities to the utility customers and other points of usage. The distribution system must be capable of conveying adequate quantities of water at reasonable water system pressures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

Utilizing the current inventory information in annual report prepared for the PSC the Village of Pewaukee Water Utility water distribution system, an inventory of the water distribution sytem was conducted. The water system is comprised of approximately 44 miles of water mains ranging in size from 4 inches to 16 inches in diameter as illustrated in Figure II-1. The current water main inventory is summarized in Table II-1. Of the approximately 44 miles of water main, approximately 36 percent are 12 inches and larger in diameter. These large diameter water mains represent the system's primary transmission facilities.

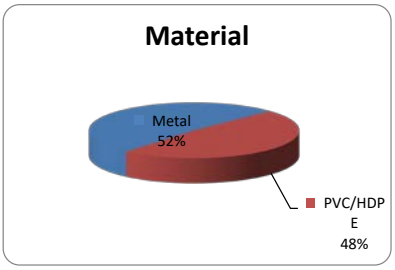
The current water main inventory based on pipe material is summarized in Table II-1. Of the nearly 44 miles of water mains, approximately 52 percent are metallic, being either ductile or cast iron.

Table II-1 - Water Main Size, Material, and Installation Date Distribution

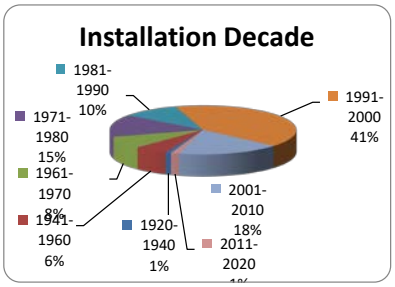
Diameter	Approximate Total Length	Percentage of Total
Less than 6	294 feet	0.1%
6-inch	47,967 feet	20.6%
8-inch	100,758 feet	43.2%
10-inch	602 feet	0.3%
12-inch	72,916 feet	31.3%
16-inch	10,630 feet	4.6%
Total	**233,167 feet**	**100%**



Material	Approximate Total Length	Percentage of Total
Metal	120,508 feet	52%
PVC/HDPE	112,659 feet	48%
Total	**233,167 feet**	**100%**



Installation Decade	Approximate Total Length	Percentage of Total
1920-1940	2,319 feet	1%
1941-1960	13,549 feet	6%
1961-1970	18,792 feet	8%
1971-1980	34,302 feet	15%
1981-1990	23,444 feet	10%
1991-2000	96,084 feet	41%
2001-2010	41,346 feet	18%
2011-2020	3,331 feet	1%
Total	**233,167 feet**	**100%**



The current water main inventory based on pipe installation is illustrated in Table II-1. Approximately 40percent of the existing water main was installed prior to 1990, while approximately 60 percent of the water main has been installed since 1990.

C. Water System Facilities

Table II-2 summarizes the water system facilities which are described in further detail in the following sections.

Table II-2 - Water System Facilities

Water System Facility	Description
Well 2	• Water Supply Facility includes Well, Well Pump, Ground Reservoir, and Supply Pump
Well 3	• Water Supply Facility includes Well, Well Pump, Ground Reservoir, and Supply Pumps
Well 4	• Water Supply Facility includes Well and Well Pump
Well 5	• Water Supply Facility includes Well, Well Pump and HMO Feed and Filtration Equipment
Well 6	• Water Supply Facility includes Well and Well Pump
200,000 Gallon Elevated Tank	• Elevated Water Storage Facility
250,000 Gallon Elevated Tank	• Elevated Water Storage Facility
1,000,000 Standpipe	• Elevated Water Storage Facility
Hawthorne Booster Station	• Water Booster Pumping Station

1. Water Supply

The Village of Pewaukee Water Utility currently maintains five groundwater wells to supply water for the needs of its customers. With a combined total design pumping capacity of 4.22 MGD the five wells provide an average of approximately 0.90 million gallons of water every day. Three of the wells discharge directly to the water distribution system, while two discharge to adjacent ground storage reservoirs. Table II-3 through Table II-11 summarize the water supply facilities.

2. Water Storage

The Village of Pewaukee Water Utility operates three water storage facilities which are located throughout the water distribution system. The combined storage capacity of all the facilities is 1,450,000 gallons. All three facilities are elevated tanks. Two are spheroid type tanks and the third facility is a standpipe. The elevated facilities are identified as follows:

200,000 gallon Elevated Storage Tank [Quinlan Drive] (Table II-8)

250,000 gallon Elevated Storage Tank [Lake Street] (Table II-9)

1,000,000 gallon Standpipe [Sunnyridge] (Table II-10)

3. Booster Pumping Facilities

The Village of Pewaukee Water Utility operates and maintains one booster pumping facility. The facility is intended to pump water from the main Pressure Zone into the Boosted Pressure Zone and serves as the source of supply for the Boosted Pressure

Zone. The facility is also equipped with a pressure reducing valve to allow water to return from the Boosted Pressure Zone to the Central Pressure Zone. The booster pumping facility is identified as follows:

Table II-3 - Well 2

Well 2 (125 Capitol Drive)		
Year Constructed		1955
Well Type		Drilled
Well Size:	Depth	1250 feet
	Diameter	12 inches
Static Water Level (Average)		505 feet
Pumping Water Level (Average)		572 feet
Well Pump		
Pump Type		Vertical Turbine
Pumping Design Rate		600 gpm
Pump Design Head		750
Motor HP		150 hp
Reservoir		
Capacity		125,000 gallons
HWL Elevation		
Depth		
Surface Dimensions (Dia. or L x W)		
Booster Pump		**Pump 1**
Pump Type		Vertical Turbine
Manufacturer		Byron Jackson
Model		12MQL 3 Stage
Pump Design Rate		700 gpm
Pump Design Head		225 feet
Motor Hp		75 hp
Water Treatment		
Sodium Hypochlorite Disinfection		
Iron sequestering with phosphate		
Fluoridation		
Standby Power		
Type		N/A
Fuel		N/A
Comments:		
Well pump and booster pump are each equipped with a variable frequency drive. Well bowl assembly replaced in 2019. Raw water contains combined radium and gross alpha particle activity. A packer was installed at a depth of 880 feet. Pump draws water below the packer. Water below packer has higher gross alpha particle activity. Well production limited to 300 gpm due to water level inhibition		

Table II-4 - Well 3

Well 3 (1004 Hickory Street)			
Year Constructed		1953	
Well Type		Drilled	
Well Size:	Depth	1128 feet	
	Diameter	16 inches	
Static Water Level (Average)		395 feet	
Pumping Water Level (Average)		580 feet	
Well Pump			
Pump Type		Submersible	
Pumping Design Rate		600 gpm	
Pump Design Head		710 feet	
Motor HP		150 hp	
Reservoir			
Capacity		125,000 gallons	
HWL Elevation			
Depth			
Surface Dimensions (Dia. or L x W)			
Booster Pump		**Pump 1**	**Pump 2**
Pump Type		Split Case	Split Case
Pump Design Rate		500 gpm	500 gpm
Pump Design Head		220 feet	220 feet
Motor Hp		50 Hp	50 Hp
Water Treatment			
Sodium Hypochlorite Disinfection			
Iron sequestration with phosphate			
Fluoridation			
Standby Power			
Type		N/A	
Fuel		N/A	

Comments: Booster Pumps are each equipped with a variable frequency drive.
Motor Control Center replaced in 2021.
Well pump rebuilt in 2018.

Table II-5 - Well 4

Well 4 (800 Main Street)		
Year Constructed		1978
Well Type		Drilled
Well Size:	Depth	1226 feet
	Diameter	inches
Static Water Level Average		432 feet
Pumping Level Average		532 feet
Well Pump		
Pump Type		Submersible
Pumping Design Rate		750 gpm
Pump Design Head		825 feet
Motor HP		200 hp
Reservoir		
Capacity		N/A
HWL Elevation		N/A
Depth		N/A
Surface Dimensions (Dia. or L x W)		N/A
Booster Pump		
Pump Type		N/A
Pump Design Rate		N/A
Pump Design Head		N/A
Motor Hp		N/A
Water Treatment		
Sodium Hypochlorite Disinfection		
Iron sequestration with phosphate		
Fluoridation		
Standby Power		
Type		
Fuel		

Comments: Well pump is equipped with a variable frequency drive.
Raw water is high in combined radium and gross alpha particle activity. Blends with water from Well 6.

Table II-6 - Well 5

Well 5 (1010 Quinlan Drive)		
Year Constructed		1996
Well Type		Drilled
Well Size:	Depth	790 feet
	Diameter	inches
Static Water Level Average		363 feet
Pumping Level Average		853 feet
Well Pump		
Pump Type		Submersible
Pumping Design Rate		500 gpm
Pump Design Head		833 feet
Motor HP		150 hp
Reservoir		
Capacity		N/A
HWL Elevation		N/A
Depth		N/A
Surface Dimensions (Dia. or L x W)		N/A
Booster Pump		
Pump Type		N/A
Pump Design Rate		N/A
Pump Design Head		N/A
Motor Hp		N/A
Water Treatment		
Radium Removal with HMO and pressure filtration		
Sodium Hypochlorite Disinfection		
Iron Sequestration with phosphate		
Fluoridation		
Standby Power		
Type		300 kW Generator
Fuel		Diesel
Comments: Well pump is equipped with a variable frequency drive. HMO Filtration system installed to remove combined radium. Well pump was rebuilt in 2015.		

Table II-7 - Well 6

Well 6 (460 Lake Street)		
Year Constructed		2006
Well Type		Drilled
Well Size:	Depth	153 feet
	Diameter	12 inches
Static Water Level Average		91.5 feet
Pumping Level Average		125.5 feet
Well Pump		
Pump Type		Vertical Turbine Line shaft
Pumping Design Rate		700 gpm
Pump Design Head		300 feet
Motor HP		75 hp
Reservoir		
Capacity		N/A
HWL Elevation		N/A
Depth		N/A
Surface Dimensions (Dia. or L x W)		N/A
Booster Pump		
Pump Type		N/A
Pump Design Rate		N/A
Pump Design Head		N/A
Motor Hp		N/A
Water Treatment		
Sodium Hypochlorite Disinfection		
Iron sequestration with phosphate		
Fluoridation		
Standby Power		
Type		150 kW Generator
Fuel		Natural Gas
Comments: Well pump is equipped with a variable frequency drive. Well pump was replaced in 2014. Well is susceptible to fouling. Capacity reduces to 290 gpm when fouled and improves to approximately 500 gpm after well rehab. Water from Well 6 blends with water from Well 4.		

Table II-8 – Quinlan Elevated Storage Tank

Quinlan	
Capacity	200,000 gallons
Year constructed	1996
Constructed by	Maguire Iron
Type	Spheroid
Construction material	Steel
Overflow elevation	1,055 feet
Diameter	Varies
Head range	30’-0”
Height to overflow	169’-6” feet
Comments	
Tank inspected in 2021.	

Quinlan

Table II-9 – Lake Street Elavated Storage Tank

Lake Street	
Capacity	250,000 gallons
Year constructed	1968
Constructed by	CB&I
Type	Spheroid
Construction material	Steel
Overflow elevation	1,055 feet
Diameter	Varies
Head range	32”-6”
Height to overflow	76.25 feet
Comments	
Tank inspected in 2021.	

Lake Street

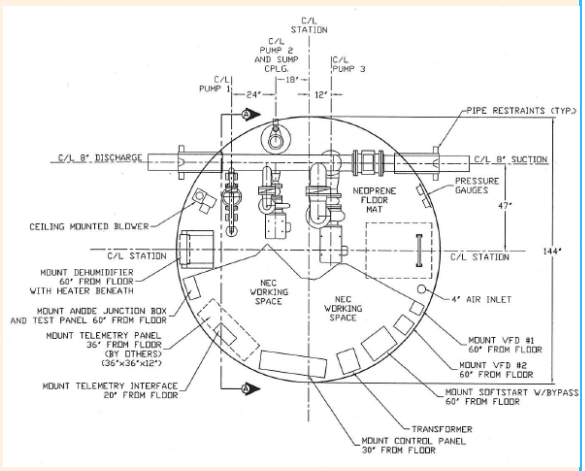
Table II-10 – Sunnyridge Standpipe

Sunnyridge Standpipe	
Capacity	1,000,000 gallons
Year constructed	1983
Constructed by	Prairie Tank.
Type	Standpipe
Construction material	Steel
Overflow elevation	1,055 feet
Diameter	Varies
Head range	68'-4"
Height to overflow	68.33 feet
Comments	
Tank inspected in 2021.	

STANDPIPE

Table II-11 – Hawthorne Booster Pump Station

Hawthorne Booster Pump Station			
Key Components/Features			
• Three Booster Pumps • Pumps from Main to Boosted pressure zone			
Booster Pumps			
Pump No.	1	2	3
Type	Vertical Multi-Stage	End Suction	End Suction
Manufacturer	Berkeley	Berkeley	Berkeley
Model	BVM8-30	B2TPMS	B5EPHS
Rated conditions			
Flow (gpm)	50	210	750
TDH (feet)	94	105	70
Motor Horsepower	3	10	20
Motor RPM	3450	3450	1750
Standby power	N/A		
Comments			
Facility consists of a prepackaged below grade pump station manufactured by USEMCO. Pumps 1 and 2 equipped with VFD units. Pump 3 equipped with soft start.			



III. POPULATION AND COMMUNITY GROWTH

This chapter summarizes the planning assumptions made regarding the Village of Pewaukee Water Utility. The population and community growth discussed here will be used as the basis for the service area water requirement projections presented in Chapter IV.

A. Population

There is generally a close relationship between a community's population and total water consumption volumes. As a community's population may fluctuate up or down it is anticipated that the water sales would also fluctuate. Therefore, future water sales can be expected to generally reflect future changes in service area population. Similarly, commercial, public, and industrial water consumption will also tend to vary proportionately with the growth of the community.

1. Total Population

Table III-1 summarizes historical population data and estimates of future population for the Village of Pewaukee. According to the United State Census Bureau, the 2020 population of the Village was approximately 8,238. Comparatively, the 2010 census population was 8,166. The population has therefore grown in recent years having seen an estimated increase of approximately 1 percent since the last census. In, 2013, the Wisconsin Department of Administration (WDOA) prepared population estimates in five-year increments beginning with 2015 and ending in 2040. The estimated future population from WDOA was projected to be 8,625 in 2020. The estimated future population from WDOA was projected to increase to approximately 9,335 persons by 2030 and 9,390 persons by 2040. Assuming a linear growth rate, the average increase in population each year through 2030 is anticipated to be approximately 71 persons (based upon a 2020 estimate of 8,625). The growth rate between 2030 and 2040 is anticipated to be approximately 5.5 persons annually.

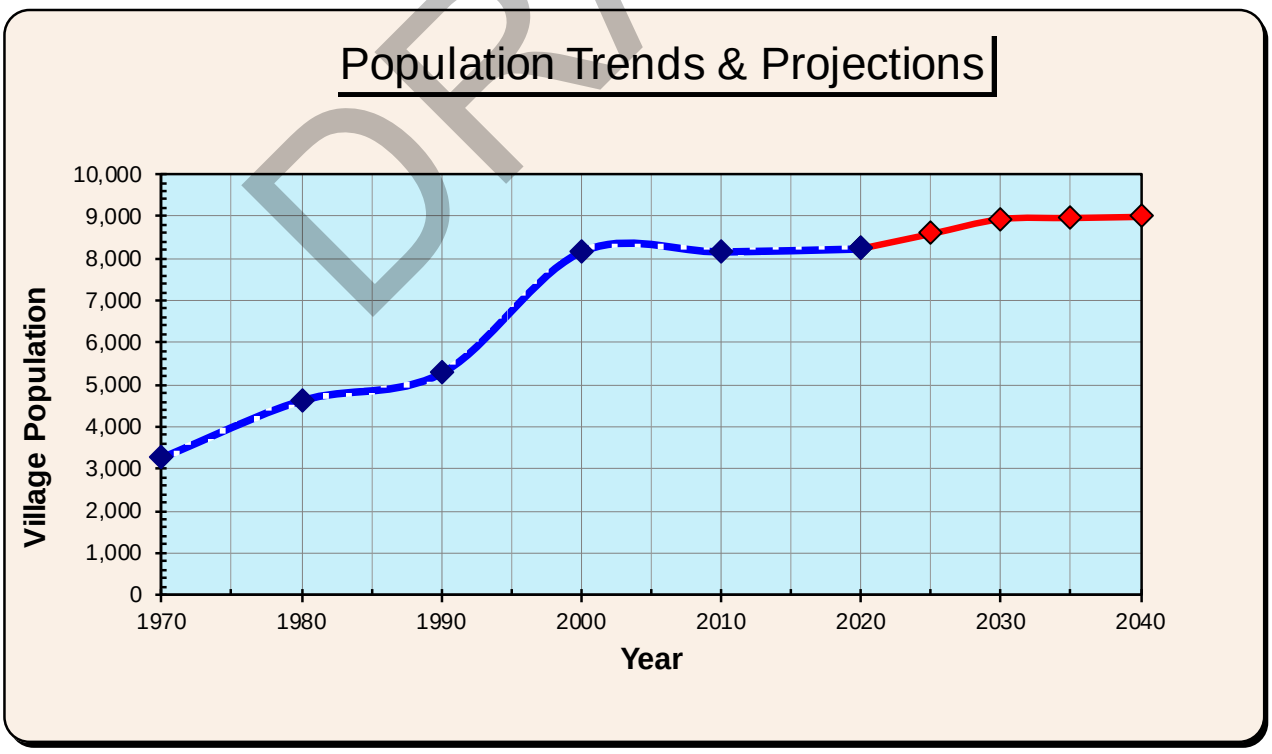
Utilizing the 2020 census population, and linear growth rate projections from the WDOA, the future population for 2030 would be estimated to be 8,948, and the future population for 2040 would be estimated to be 9,003.

Table III-1 - Population Trends & Projections

Year	Total	Percent Change
1970	3,271	---
1980	4,637	41.8%
1990	5,287	14.0%
2000	8,170	54.5%
2010	8,166	-0.05%
2020	8,238	0.9%
2025	**8,593**	4.3%
2030	**8,948**	4.1%
2035	**8,976**	0.3%
2040	**9,003**	0.3%

Notes

Source: Wisconsin Department of Administration and U.S. Census Bureau



B. Utility Service Area

Figure III-1 illustrates the existing zoning and anticipated future service area within the Village of Pewaukee for the water utility. The future utility service area consists of currently undeveloped commercial (Office and Service Business) and residential (R-5 Single-Family Residential) lands within the Village. The boundary of the Village represents the future utility service area illustrated in Figure III-1 was used for this study to identify the areas which are expected to develop by 2030 and 2035 and require municipal water services. For the purpose of preparing this study, it is assumed that the developable areas within the future utility service area will be 100 percent developed by the end of the planning period. (That is not to say that every parcel within the service area will be developed, but only that water service will be required throughout the entire service area.)

Figure III-2 illustrates the planned development and a potential service area outside the Village boundary. The future utility service area is within the corporate boundary of the City of Pewaukee and consists of planned commercial, residential, public and industrial lands. The boundary of the service is identified in Figure III-2 was used for this study to identify the area which is expected to be developed and require water service by 2040. The City of Pewaukee has indicated that service from the Village of Pewaukee is not anticipated, and the City will provide water service. For the purpose of preparing this study, it is assumed that the Village may be requested to serve this area in the future, and assumed that the developable areas within the future utility service area will be 100 percent developed by the end of the planning period. (That is not to say that every parcel within the service area will be developed, but only that water service will be required throughout the entire service area.) This service area will only be included to estimate water supply needs in the event that the City of Pewaukee requests service from the Village of Pewaukee.

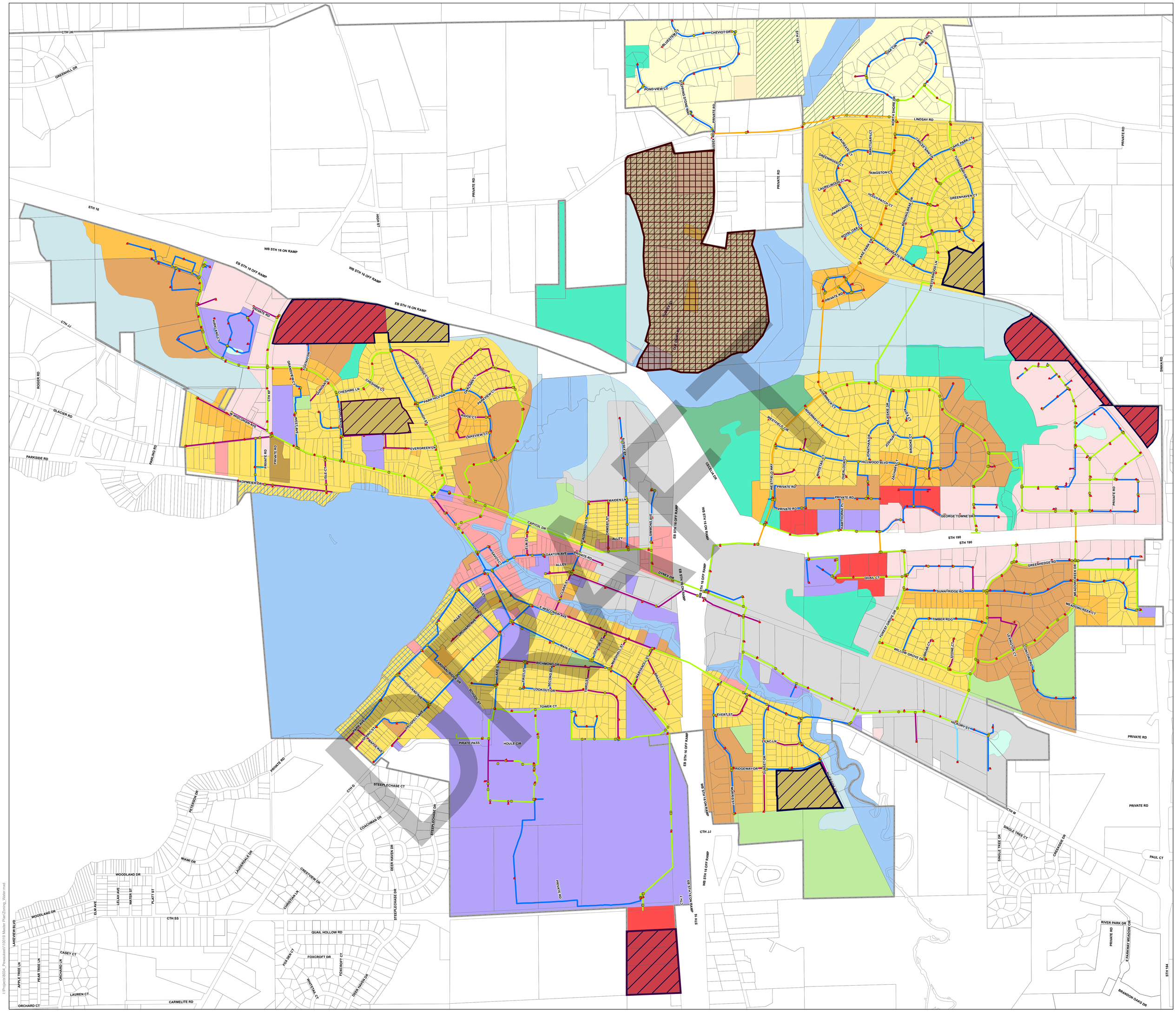
C. Land Use

For this study, zoning maps were reviewed for the Village of Pewaukee and that make up the anticipated future service area for the Water Utility. The zoning map represents the nature and extent of existing development within the current municipal limits and potential future developments through the year 2030. Table III-2 summarizes existing land use categorized by water service customer type for the Village of Pewaukee.

Table III-2 - Summary of Existing Land Use

Existing Water Service Land Use	2021
Residential	821.07
Multifamily	188.29
Commercial	280.74
Industrial	225.25
Public/Institutional	318.67
Total	1,833.01
Footnotes: Assumes Total land use is 2771.03 acres. The additional acres include areas not provided with water service including shoreland and general conservancy and parks and recreation as shown on Figure III-2.	

Figure III-1 2021 Zoning with Water Distibution Map



Hydrant
Main, Active
Hydrant, Active
4"
6"
8"
10"
12"
16"

Zone Code

- B-1 Community Business
- B-2 Downtown Business
- B-3 Office and Service Business
- B-5 Light Industrail
- C-1 Shoreland Wetland Conservancy
- C-2 General Conservancy
- 2030 Future Water Service Area
- FC Floodplain Conservancy
- FW Floodway
- IPS Institutional and Public Service
- P-1 / C-2 Park and Recreation / General Conservancy
- P-1 Park and Recreation
- R-1 Single-Family Residential (1 Acre Minimum)
- R-1 / OA Single-Family Residential (1 Acre Minimum) / Agricultural Overlay
- 2035 Future Water Service Area
- R-2 Single-Family Residential (0.50 Acre Minimum)
- R-5 Single-Family Residential (0.24 Acre Minimum)
- R-5 / LO Single-Family Residential (0.24 Acre Minimum) Lakefront Overlay
- R-6 Plex Residentail
- R-M Multi-Family Residential
- MH Mobile Home Residential
- Civil Division

N W E S

0 250 500 1,000 1,500
Feet

Ruekert • Mielke

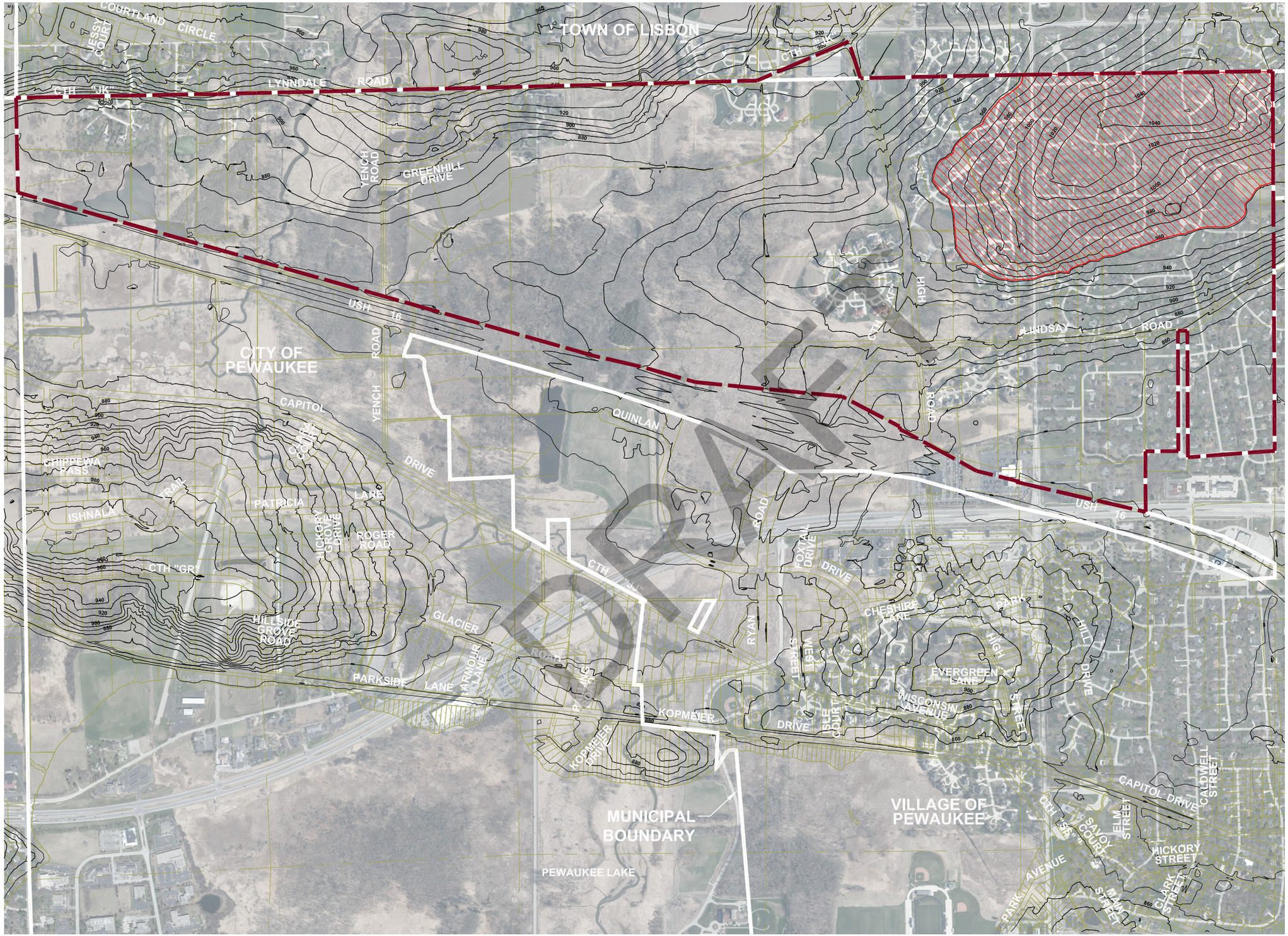


FIGURE III-2

POTENTIAL FUTURE WATER SERVICE AREA IN CITY OF PEWAUKEE

VILLAGE OF PEWAUKEE WAUKESHA COUNTY, WISCONSIN

LEGEND

- VILLAGE WATER SERVICE AREA IN CITY
- POTENTIAL BOOSTED ZONE

N
W E
S

0 500 1000 2000

SCALE IN FEET

DATE: MAY 2022

SOURCE: R|M

BASEMAP SOURCE: WAUKESHA COUNTY PARKS AND LAND USE

Ruekert • Mielke
www.ruekertmielke.com

Apr 21, 2022 12:58pm PLOTTED BY: WBANCROFT SAVED BY: WBANCROFT
G:\C3D_2018\8034_Village of Pewaukee\10019 Phase 106\dwg\Fig. III-2 Potential Future Water Service Area .dwg Layout1
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XREFS: ..\Pewaukee Base.dwg; ..\Pewaukee Topo.dwg; ..\Village of Pewaukee Water Main System.dwg; ..\Pewaukee Water Main System.dwg; G:\SYM\RM SQUARE_Full Color-Print.jpg; G:\SYM\RM SQUARE_Full Color-Print.jpg; ..\..\..\..\SYM\VillageOfPewaukeeLogo.gif; G:\SYM\RM SQUARE_Full Color-Print.jpg; ..\Pewaukee Basin Boundaries-Alternative-01.dwg; ..\Pewaukee Water Alternative-01.dwg; ..\Pewaukee Municipal Boundary.dwg; ..\Pewaukee Water Main System.dwg; ..\RM1117_Landscape.dwg

D. Future Growth and Pressure Zones

An important consideration when evaluating future growth is the relative growth within each pressure zone (or the need to establish new pressure zones). To estimate the likely growth of water demand by pressure zone, a review of the location of anticipated growth was completed. Figure III-3 illustrates the need for a new pressure zone and a potential need for a boosted pressure zone based upon limits of acceptable pressures under static conditions utilizing the hydraulic grade line (HGL) of the existing elevated storage tanks assuming a 10-foot operational variation in HGL. As illustrated in Figure III-2, it is anticipated that the potential service area in the City of Pewaukee can generally be served within an acceptable range of pressures from the existing main service zone, however there are some isolated areas within which potential service area that may not be adequately serviced from the anticipated existing main service zone which may require the creation of additional pressure zones. A more detailed evaluation of both existing and future pressures as well as service needs is included later in this report.

The expected increase in residential development is directly related to projections of population growth. Likewise commercial and public land uses are also expected to increase with increases in population. As a result, future water demand projections discussed in Chapter IV will be estimated from the land use projections as presented in this chapter. For this study, future growth was assumed to be directly related to the amount of developable acreage within the future service areas.

Using the available projected zoning and anticipated land use data provided coupled with unit consumption values (in Chapter IV) future demands will be computed by pressure zone.

1. 2030 Development/Population Growth

Based upon the analysis of existing residential lots and future developable residential lands, the 2030 service area development/population growth is anticipated to be distributed as follows:

Main Pressure Zone: 100 percent of development (198 acres)
Hawthorne Boosted Pressure Zone: No additional development

2. 2035 Development/Population Growth

Based upon the analysis of existing residential lots and future developable residential lands, the 2035 service area development/population growth is anticipated to be distributed as follows:

Main Pressure Zone: 100 percent of development (108 acres)
Hawthorne Boosted Pressure Zone: No additional development

3. 2040 Development/Population Growth

Based on the projected land use in Figure III-2, the 2040 service area within the City of Pewaukee corporate boundary is anticipated to be distributed as follows:

Main Pressure Zone: 337 Acres
Hawthorne Boosted Pressure Zone: No additional development
Potential Future Boosted Pressure Zone: 50 Acres

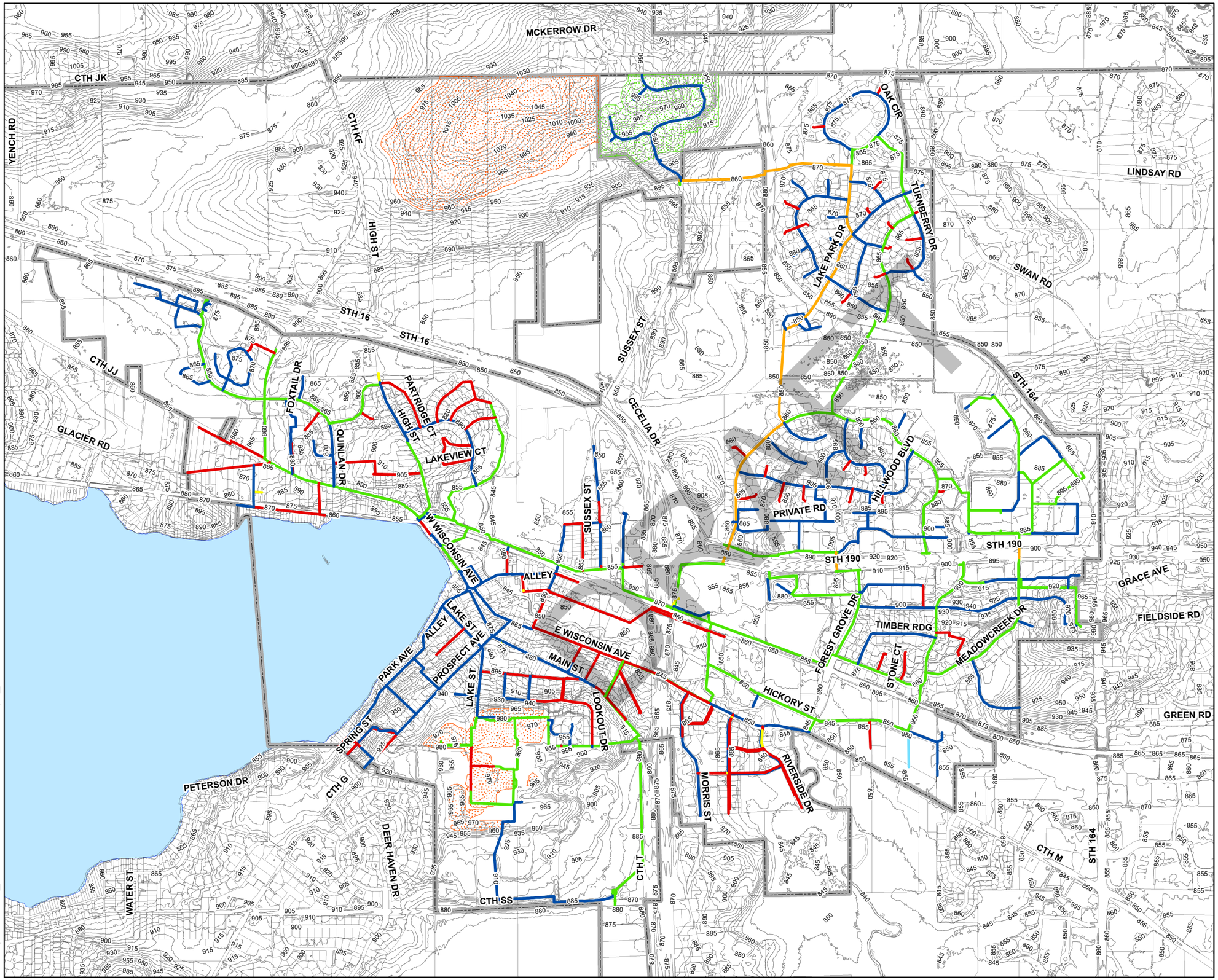

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Figure III-3

Existing Service Limits and Potential Service Areas

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Hawthorne Boosted Zone
- Unsuitable for Main Service Zone
- 5' Contours
- 4 - Inch and Less
- 6 - Inch
- 8 - Inch
- 10 - Inch
- 12 - Inch
- 16 - Inch
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500

Feet

Ruekert · Mielke

E. Summary

This chapter summarizes the primary assumptions regarding future growth of the Village of Pewaukee Water Utility service area. The present and future needs and characteristics of the identified service area will have a direct impact on the need for expansion of water system facilities; therefore, the conclusions discussed in this chapter were used as a primary basis for projecting future water needs, evaluating the adequacy of existing water system facilities, and identifying needs for future water system expansion. Table III-3 summarizes the assumptions for future growth for the Village of Pewaukee Water Utility service area that will be used to project future water requirements.

Table III-3 - Summary of Future Potential Growth

	Year 2040
Incremental Service Area Increase	692
Main Pressure Zone	
Future Residential Acres	454.9
Future Commercial Acres	89.3
Future Industrial Acres	68.5
Future Public Acres	19.3
Boosted Pressure Zone	
Future Residential Acres	50
Future Public Acres	10
Footnotes: Assumes complete development within the proposed 2040 utility service area as shown on Figure III-1, and III-2.	

IV. WATER REQUIREMENTS

Projections of customer demands serve as the basis for capital improvements planning. Several standard methods were used in this study to project water supply and storage needs based on estimates of population and community growth. This chapter summarizes the methodology used and the results of those projections.

A. Water Consumption History

To project future water requirements, it is first necessary to determine the water use characteristics of the utility customers. Geographical location as well as socio-economic factors often play a role in shaping how water is used at the local level. For example, communities located in areas of sandy soil may utilize more water for irrigation than communities located in moisture-retaining soils. Communities with agricultural businesses (i.e., canneries) or heavy manufacturing (paper mills, iron and steel production) often use more water than communities with only lighter manufacturing (i.e. fabricating or assembly plants). In order to determine the water characteristics of the Village, an analysis of past pumpage and water sales records for the period from 2010 to 2020 was conducted. The analysis included a review of both average and maximum day water pumpage along with the amount of water sold in each customer class. The results of this analysis are then utilized to project future water requirements when coupled with estimates of population and community growth discussed in Chapter III.

A summary of historical water sales and pumpage is provided in Table IV-1. Over the 11-year period of data summarized in the table, water sales have fluctuated from a low of 213 million gallons per year (MGY) in 2019 to a high of 269 MGY in 2012. Although water sales have fluctuated both up and down, the overall trend in sales over the past 11 years has been a slight decreased with 2020 water sales being approximately 7 percent less than sales in the 2010. Over the same period, total pumpage has increased and is currently approximately 10 percent greater than in it was in the late 2010.

A historical summary of Village of Pewaukee Water Utility customers served is provided in Table IV-2. Water sales to individual customer classes are summarized in Table IV-3. As seen in the tables, while the number of residential, commercial, and multifamily customers has had a small increase, sales to residential and commercial customers have remained relatively constant, and sales to multifamily customers has had a slight decrease. Also, while the number of industrial and public customers have remained relatively constant, sales to industrial and public customers have actually decreased.

As illustrated in Table IV-2 and Table IV-3, residential customers presently account for 77 percent of the utility's customers and approximately 43 percent of the total sales. Commercial and multifamily water use in 2020 accounted for approximately 20 percent of the customers and 49 percent of total sales. Metered industrial sales and public uses currently each account for approximately 2 percent and 1 percent of the customers respectively, and represent approximately 5 and 3 percent of total sales, respectively.

Table IV-1 - Historical Water Pumpage and Sales

Year	Estimated Population	Total Pumpage (MG)	Total Sales (MG)	Pumpage Sold (%)	Non-Revenue Water (%)	Water Losses (%)	Average Day		Maximum Day		Ratio of Maximum to Average Day Pumpage
							MGD	GPCD	MGD	Date	
2010	8,166	304	236	78%	22%	21%	0.832	101.8	1.961	Sept. 16	2.36
2011	8,159	302	245	81%	19%	18%	0.828	101.5	1.271	July 10	1.53
2012	8,165	322	269	83%	17%	16%	0.882	108.0	1.445	July 1	1.64
2013	8,170	304	241	79%	21%	20%	0.832	101.8	1.650	Sept. 12	1.98
2014	8,176	282	230	82%	18%	17%	0.772	94.4	1.077	Sept. 9	1.39
2015	8,182	271	231	85%	15%	13%	0.742	90.7	1.230	March 11	1.66
2016	8,187	279	231	83%	17%	16%	0.763	93.2	1.140	July 19	1.49
2017	8,193	279	232	83%	17%	14%	0.765	93.3	1.230	Sept 12	1.61
2018	8,199	318	225	71%	29%	25%	0.871	106.2	1.180	Sept. 28	1.36
2019	8,204	322	213	66%	34%	29%	0.882	107.6	1.119	June 6	1.27
2020	8,210	335	220	66%	34%	30%	0.918	111.8	1.438	July 6	1.57

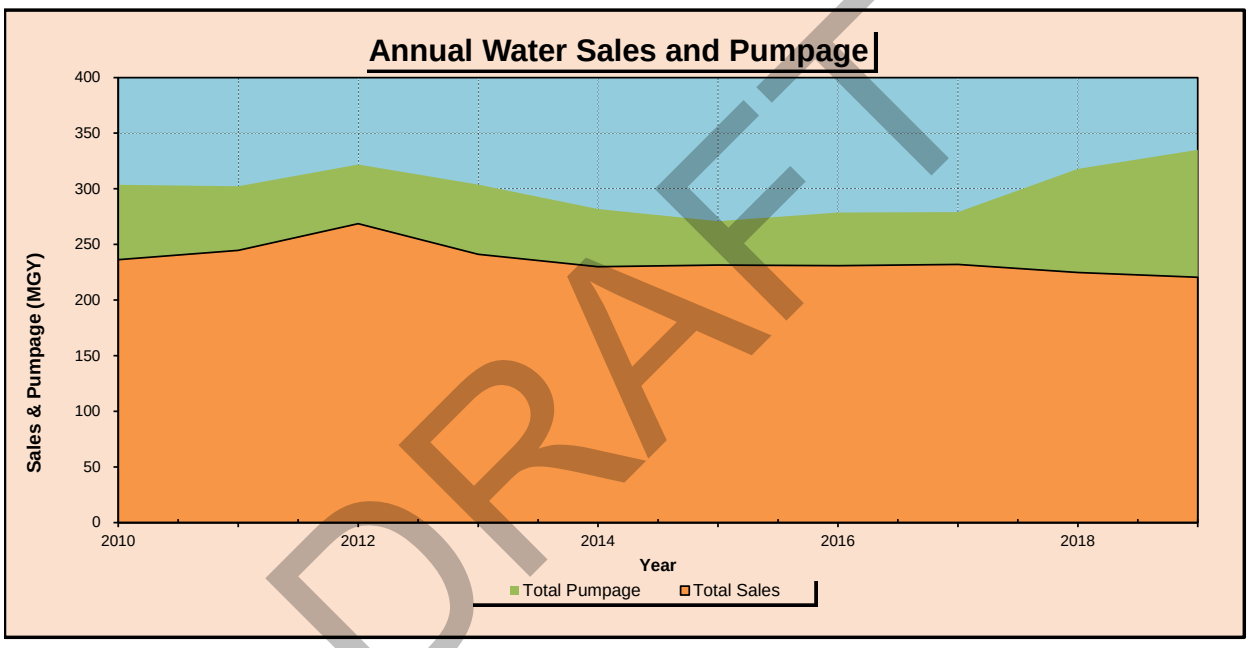


Table IV-2 - Historical Customer Summary

Year	Number of Customers					
	Residential	Commercial	Industrial	Public	Multifamily[1]	Total
2010	1,659	409	45	24		2,137
2011	1,667	409	47	24		2,147
2012	1,672	410	46	24		2,152
2013	1,682	412	46	24		2,164
2014	1,682	413	45	24		2,164
2015	1,683	168	46	26	248	2,171
2016	1,685	172	46	26	248	2,177
2017	1,687	173	46	26	248	2,180
2018	1,689	175	46	26	247	2,183
2019	1,686	178	45	26	247	2,182
2020	1,687	180	45	26	248	2,186

Notes:

1. Multifamily (previously considered commercial) was first established in 2013 and required in 2015

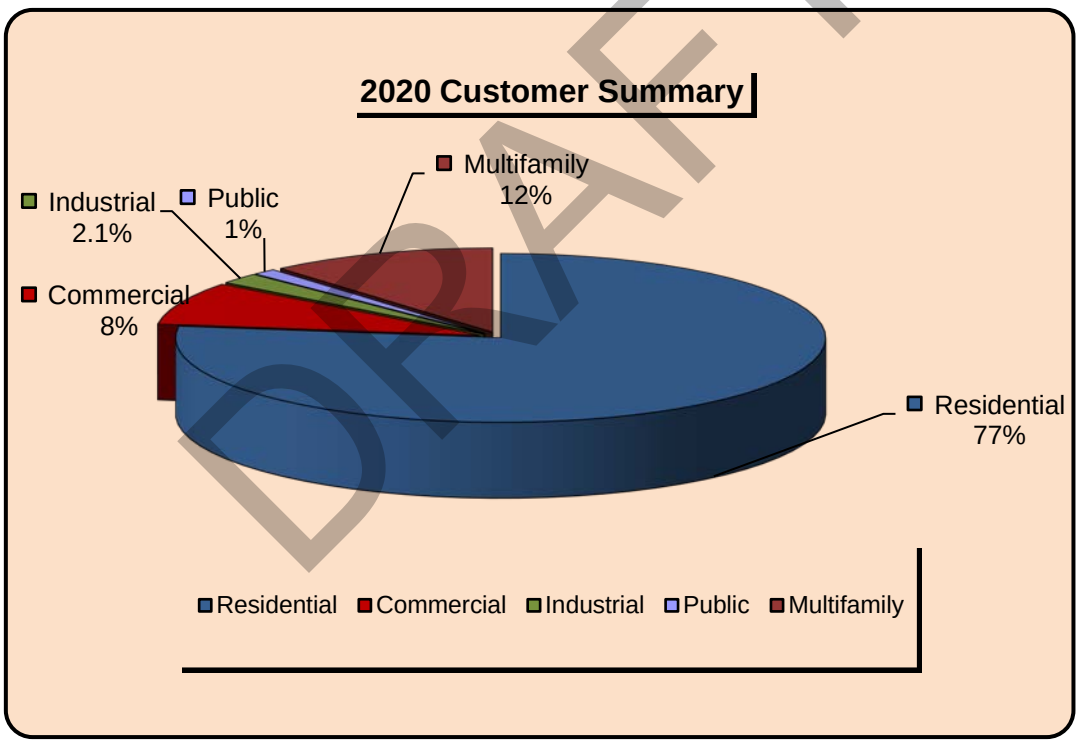
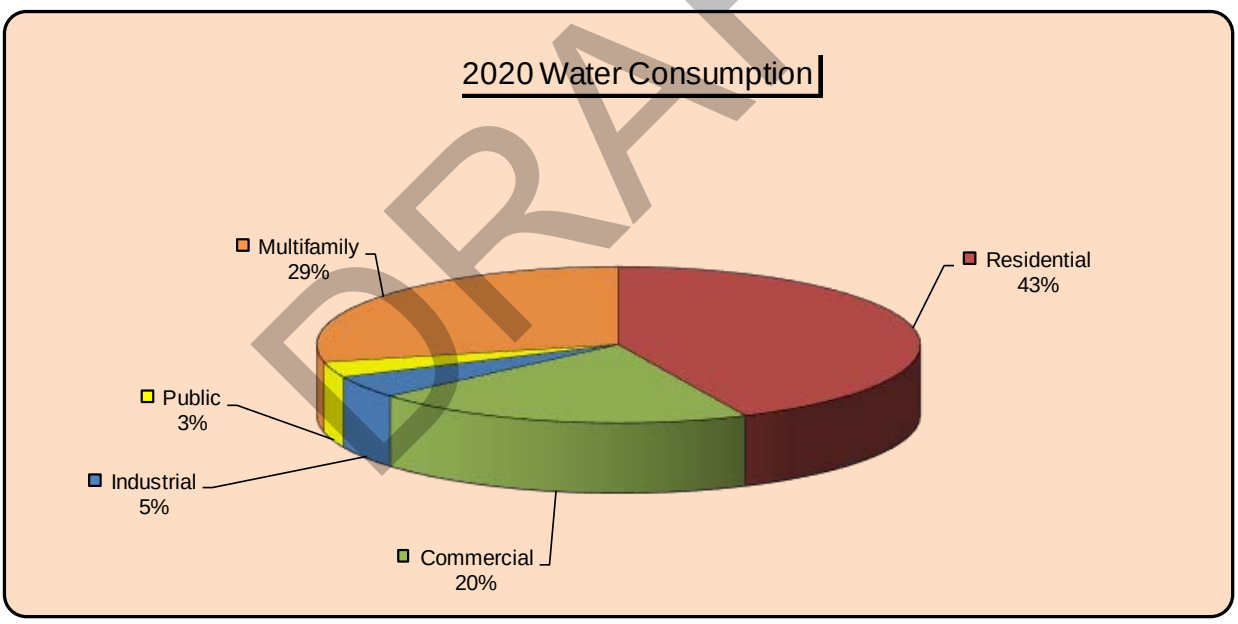


Table IV-3 - Water Consumption History

Year	Annual Water Sales (MGY) Resi-dential	Com-mercial	Indust-rial	Public	Multifamily[1]	Total Sales (MGY)	Total Pumpage (MGY)	% of Pumpage Sold
2010	93.45	118.92	10.73	13.15		236.25	303.56	78%
2011	97.01	122.19	11.37	14.14		244.70	302.23	81%
2012	100.71	126.73	11.68	29.48		268.60	321.77	83%
2013	92.95	120.16	15.34	12.58		241.02	303.71	79%
2014	93.01	113.97	10.08	12.81		229.87	281.83	82%
2015	94.72	46.13	9.84	12.70	68.10	231.49	270.87	85%
2016	92.33	49.75	8.06	13.75	67.01	230.89	278.65	83%
2017	89.56	53.90	9.54	13.23	65.73	231.96	279.06	83%
2018	87.44	51.85	7.88	13.00	64.62	224.79	317.84	71%
2019	85.10	46.31	6.88	12.25	62.37	212.90	322.09	66%
2020	95.04	45.17	7.04	10.15	63.09	220.49	334.94	66%

Notes:

1. Multifamily (previously considered commercial) was first established in 2013.



B. Unit Consumption Water Usage

Residential, commercial, and public water usage can often be correlated to a community's population. Sales to these customer classes will generally rise and fall in proportion to changes in population and thus make it useful for projecting future water sales. Unique to the Village of Pewaukee, however, is that not all residences of the Village are currently served by municipal water and therefore must be considered in the analysis. While commercial and public water usage can be attributed to the entire population, residential sales will be limited to only those customers of the water utility.

An analysis of per capita water consumption for the Village of Pewaukee Utility for each of the above customer classifications was made from the available sales records summarized in Table IV-3. Tabular results of the analysis are illustrated in Table IV-4. As can be seen from the figure and also in the table, per capita sales to residential, commercial, and public customers have followed generally consistent trends over the previous 10 years.

The apparent trend in per capita residential water usage illustrated in Table IV-4 is consistent with observed results for other Wisconsin municipal water utilities. Currently it is common for per capita trends to be declining or relatively flat. Beginning as far back as the 1970s, consumer awareness of the need for water conservation has increased, and in more recent years the implementation of water conservation measures has become even more common.

Although slightly declining, the Village of Pewaukee residential per capita consumption has remained fairly constant over the previous 11 years, averaging approximately 31.1 gallons per capita per day (gpcd). Likewise, the per capita consumption for commercial water sales has also remained relatively constant over the past 6 years with an average per capita consumption rate of 16.3 gpcd. Per capita consumption for public water uses has decreased increased over the past ten years. While public per capita consumption has averaged approximately 4.8 gpcd over that last 11 years, it has averaged approximately 4.2 gpcd over the past 8 years after the significant increase in 2012.

An analysis of per acre water consumption was also made for the Village of Pewaukee for each of the customer classifications. Table IV-5 summarizes the results of the analysis. Similar to the residential per service consumption trend, the Utility's residential per acre consumption has remained fairly constant over the previous 11 years, averaging approximately 310 gallons per acre per day (gpad). Commercial per acre consumption has seen a slight increase over during 2017 and 2018, but reduced in 2019 and 2020, and has averaged approximately 477 gpad. Industrial per acre consumption has had a moderate decrease over the last 11 years and has averaged 120 gpad. Public per acre consumption has decreased slightly with a sharp increase in 2012 and has averaged approximately 123 gpad over the last 11 years, and it has averaged approximately 108 gpad after the significant increase in 2012. Multifamily per acre consumption has shown a gradual decrease over the past 6 years and has averaged 948 gpad.

It is assumed that future per capita consumption and per acre consumption will remain relatively constant. When coupled with projections of future population the per capita consumption rates summarized in Table IV-4 will be utilized to estimate future water requirements for new development. When coupled with future land use, the per acre consumption rates summarized in Table IV-5 will be utilized to estimate future water requirements. The residential per capita consumption used to project future water demands is 31 gpcd, the commercial per capita consumption is projected at 16 gpcd, and the public per capita consumption is projected at 4.5 gpcd. The residential per acre consumption used to project future demands is 315 gpad, the commercial per acre consumption projected for future water demands is 500 gpad. The industrial per acre consumption used to project future demands is 120 gpad. The public per acre consumption to project future water demands is 110 gpad. The multifamily per acre consumption to project future water demands is 950 gpad.

Table IV-4 - Historical Per Capita Usage

Year	Estimated Total Retail Population	GALLONS PER CAPITA PER DAY						
		Resi-dential	Com-mercial	Indust-rial	Public	Multi-family	Total Metered	Total Pumpage
2010	8,166	31.4	39.9	3.6	4.4		79.3	101.8
2011	8,159	32.6	41.0	3.8	4.7		82.2	101.5
2012	8,165	33.8	42.5	3.9	9.9		90.1	108.0
2013	8,170	31.2	40.3	5.1	4.2		80.8	101.8
2014	8,176	31.2	38.2	3.4	4.3		77.0	94.4
2015	8,182	31.7	15.4	3.3	4.3	22.8	77.5	90.7
2016	8,187	30.9	16.6	2.7	4.6	22.4	77.3	93.2
2017	8,193	29.9	18.0	3.2	4.4	22.0	77.6	93.3
2018	8,199	29.2	17.3	2.6	4.3	21.6	75.1	106.2
2019	8,204	28.4	15.5	2.3	4.1	20.8	71.1	107.6
2020	8,210	31.7	15.1	2.3	3.4	21.1	73.6	111.8
Average		31.1	16.3	3.3	4.8	21.8	78.3	100.9

Notes
1. Commercial average is from 2015 through 2020

Table IV-5 - Historical Per Acre Usage

Year	GALLONS PER ACRE PER DAY				
	Resi-dential	Com-mercial	Indust-rial	Public	Multi-Family
2010	312	1161	130	113	
2011	324	1192	138	122	
2012	336	1237	142	254	
2013	310	1173	187	109	
2014	310	1112	123	110	
2015	316	450	120	110	991
2016	308	485	98	119	975
2017	299	526	116	114	956
2018	292	506	96	112	940
2019	284	452	84	106	907
2020	317	441	86	88	918
Average	310	477	120	123	948

Notes
1. Commercial average from 2015 through 2020

C. Industrial Water Usage

Tables IV-3 and IV-4 also summarize the annual industrial water sales and resulting per capita usage from 2010 to 2020. As seen in Table IV-4, per capita industrial sales have declined over the years. However, unlike other water sales components, sales to industrial customers do not necessarily correlate well with population but is more a function of business needs and activities. As such, it is often necessary to implement other means of estimating future water sales.

To understand why industrial water sales do not correlate well with population one should consider what is most likely to impact a business's need for water. While the size of the workforce can influence a company's water use, variations in water use are not generally population dependent but rather depend on the types of industries served and the level of production activity. Much more than population, fluctuations in water consumption for a particular industrial firm can be attributed to other factors including:

1. Changes in production schedules or operational capacity.
2. Changes in manufacturing processes.
3. Changes in the number of persons employed.
4. Addition or deletion of product lines.
5. Seasonal variation in cooling requirements.
6. Seasonal changes in business activity.
7. Implementation of conservation measures.

While industrial customers often represent a small percentage of the total number of customers (Table IV-2), these customers can represent a significant portion of the total water sales (Table IV-3). Consequently, changes in water consumption characteristics by these potential high volume water users could have an impact on total future water requirements. Estimates for future industrial water sales are discussed in specific detail later in this Chapter.

D. Non-revenue Water and Unaccounted For Water

There is generally a close relationship between the total gallons of water pumped and the gallons of water metered and sold to water utility customers. The total metered water sales are most often less than the amount of pumpage due to several factors including:

1. Unmetered water usage for firefighting.
2. Inaccuracies in water metering devices.
3. Unmetered public water usage.
4. Leakage within the distribution system.
5. Unmetered water usage for treatment processes and maintenance purposes, such as filter cleaning, hydrant flushing and water main repairs.

The difference between total pumpage and total water sales is termed "non-revenue water" and is usually expressed as a percentage. That portion of non-revenue water attributed to leakage, meter inaccuracies, and other unknown losses is often termed "unaccounted-for water" and can be an indicator of the condition of the water system. When a distribution system is very old or poorly maintained, the amount of unaccounted-for water often increases dramatically.

Over the last 11 years, the percentage of the total pumpage volume that is sold (metered) has been reported to be as low as 66 percent in 2019 and 2020 and as high as 85 percent in 2015. A summary of historical unaccounted-for water (Water Losses) volumes and pumpage sold is

provided in Table IV-1. The degree of fluctuation experienced in metered pumpage is common for public water utilities and can be influenced by the factors summarized above. For example, the percentage of total pumpage metered would be expected to decrease in years when unusual problems with leakage or meter stoppage occurred, or when unusually high water demands for fire protection occurred. As a very general rule, the percentage of unaccounted-for water should ideally be less than 15 percent.

Historically, the unaccounted-for water for the Village of Pewaukee Water Utility has varied and was near the ideal percentage during the period of 2014 through 2017. The water utility staff during the past year, have identified and repaired significant leaks in water services and water mains that have minimized unaccounted for water. For this study, it was assumed that the percentage of total pumpage unmetered in future years will be maintained at 20 percent.

It is important to note that quantifying unaccounted-for water simply as a percent of pumped water to billed water, while widely used and accepted, is limited in its ability to accurately indicate an appropriate or acceptable level of water loss. For example, if water conservation measures are implemented causing total consumption to decrease, and yet leakage and other unaccounted for water uses remain that same (as volume) then the percent of unaccounted-for water actually increases as a percent. This would mistakenly indicate that the level of water loss has gotten worse, while in actuality it has remained the same. Currently, the water industry is moving to new ways of estimating and reporting leakage and unaccounted-for water that are more comparative of the system conditions and provide benchmarks for acceptable levels of leakage.

E. Variations in Customer Demands and Pumpage

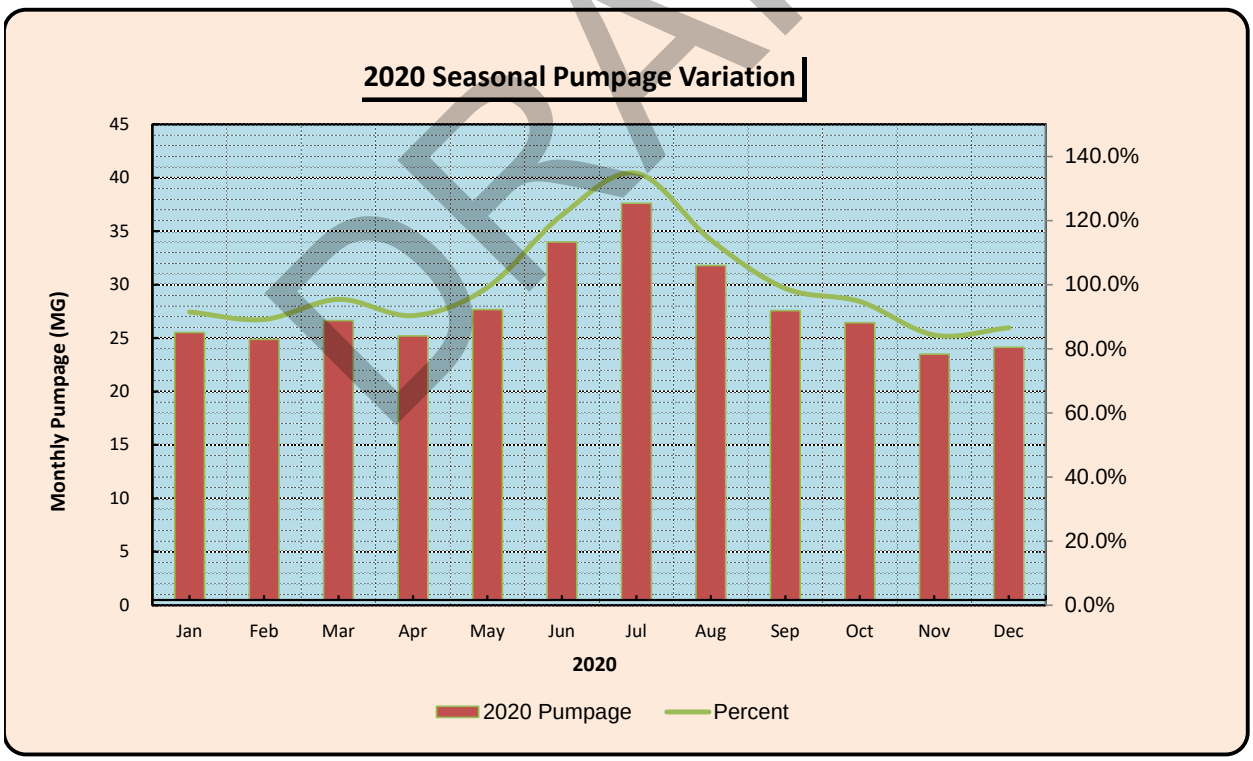
Water consumption is not constant throughout the calendar year and varies season to season, month to month, day to day and even hour to hour. It is important that the Village of Pewaukee Water Utility be able to meet the needs of its customers even during periods of increased water demand. To ensure that the needs of customers can be met at all times it is important to understand the variations that occur in water consumption and then quantify the variations in demand.

Seasonal fluctuations in water usage are important factors in the design and sizing of water supply and storage facilities. The seasonal nature of water consumption in the Village of Pewuakee Water Utility system can be demonstrated by an analysis of monthly pumpage. Variations in pumpage are often attributed to seasonal changes in customer demands, however, in smaller water systems, variations can be heavily influenced by artificial means, including refilling water storage facilities after maintenance activities, water main breaks, fighting fires, and flushing hydrants. In northern climates the maximum pumpage often occurs during the warmer summer months and the minimum pumpage during the colder winter months.

Monthly pumpage for the year 2020 is summarized in Table IV-6. While pumpage reported in 2020 varied between months, overall, the variation in pumpage is small and the total monthly pumpage is relatively constant. As summarized in Table IV-6, the maximum monthly pumpage in 2020 (37.62 MG) occurred in July, while the minimum monthly pumpage (23.507 MG) occurred in November. While the low pumpage reported in November is most likely the results of a reduction in customer demand, the pumpage volume reported in July is most likely the result of an increase in customer demand, in this case due to dry weather.

Table IV-6 - Seasonal Pumpage Variations

Month	2020 Monthly Pumpage (MG)	Percentage of Total Pumpage	Percentage of Average Pumpage
January	25.521	7.6%	91.4%
February	24.874	7.4%	89.1%
March	26.621	7.9%	95.4%
April	25.205	7.5%	90.3%
May	27.670	8.3%	99.1%
June	33.978	10.1%	121.7%
July	37.620	11.2%	134.8%
August	31.786	9.5%	113.9%
September	27.575	8.2%	98.8%
October	26.433	7.9%	94.7%
November	23.507	7.0%	84.2%
December	24.148	7.2%	86.5%
Total	**334.938**	**100.0%**	



Often a result of seasonal variations, maximum daily water demands usually occur during the summer months on hot days when additional water is used for watering lawns, gardening, washing, and industrial cooling. Understanding and quantifying the maximum day pumpage is of particular importance to water system planning, because water supply facilities must be sized to meet this demand. The maximum day demand is defined as the amount of water pumped during a single day of the year with the highest water usage. Maximum day demand is often expressed as a ratio (or factor) of the annual average day pumpage.

Table IV-7 presents the average and maximum day pumpage for each year from 2010 to 2021. With the exception of maximum day pumpage resulting from artificial demands caused by water main breaks, tank overflows, or hydrant flushing, the maximum day pumpage typically occurs during the meteorological summer months of June, July, August, or September.

Over the last 12 years, the maximum day pumpage ratio (ratio of maximum day to average day pumpage) has varied from a low of approximately 127 percent in 2019 to a high of 236 percent in 2010. The values shown in Table IV-7 are typical for similar communities, where design ratios of 200 to even 300 percent are common. This is due to the larger percent of the total water usage being consumed to meet the variable demands of residential and commercial customers as opposed to the more continuous water needs of industrial customers.

To gain a better understanding of expected fluctuations in customer demands for the Village of Pewaukee Water Utility, a statistical analysis was performed of historical maximum day to average day pumpage ratios. The results of this analysis are also summarized in Table IV-7. Two periods of analysis were examined: the entire period of 2010 to 2021 and the most recent 8-year period from 2014 to 2021.

For the years 2010 to 2021, the average maximum day demand ratio was approximately 1.63, with a standard deviation of 28 percent. In comparison, over the most recent 8-year period of 2014 to 2021, the average maximum day demand ratio was approximately 1.50, with a standard deviation of 14 percent. Therefore, the maximum to average day ratios for the Village of Pewaukee Water Utility have been both lower and less variable in recent years.

Table IV-6 also includes an analysis of expected maximum day pumpage ratios for various confidence levels. For example, based on the analysis of data from 2010 to 2021, there is a 90 percent chance in any given year that the actual maximum day pumpage ratio will be less than or equal to 1.99. Conversely, there is a 10 percent chance the actual ratio will exceed 1.99.

To evaluate future water supply and storage needs, a maximum day pumpage ratio of 1.99 was used for this study. This ratio provides a confidence level of approximately 99 percent based on maximum day pumpage ratios reported over the past 8-year analysis period.

Table IV-7 - Daily Pumpage Variations

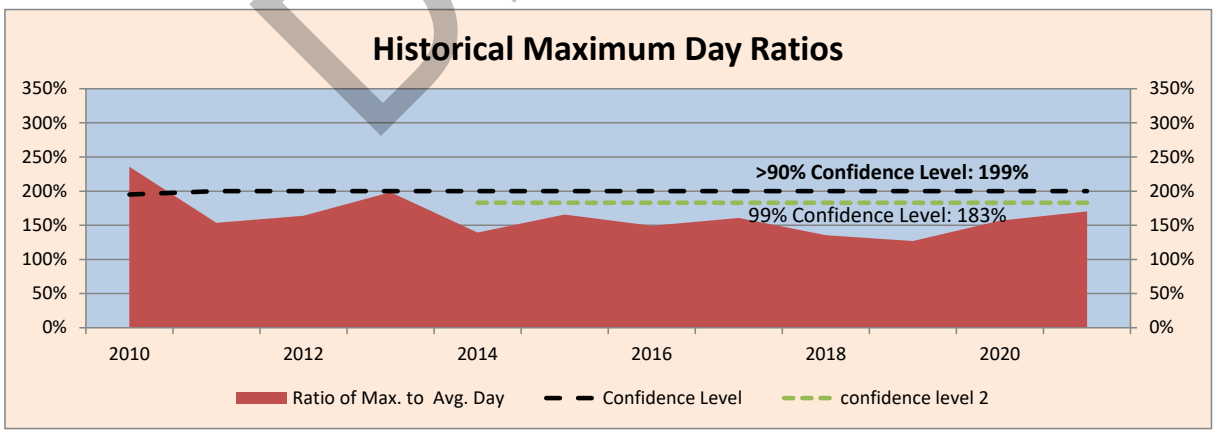
Year	Avg. Day Pumpage (MGD)	Max. Day Pumpage (MGD)	Date of Maximum Day	Ratio of Max. to Avg. Day	Year	Avg. Day Pumpage (MGD)	Max. Day Pumpage (MGD)	Date of Maximum Day	Ratio of Max. to Avg. Day
2010	0.83	1.961	Sept. 16	2.36	2018	0.87	1.180	Sept. 28	1.36
2011	0.83	1.271	July 10	1.53	2019	0.88	1.119	June 6	1.27
2012	0.88	1.445	July 1	1.64	2020	0.92	1.438	July 6	1.57
2013	0.83	1.650	Sept. 12	1.98	2021	0.81	1.382	June 14	1.70
2014	0.77	1.077	Sept. 9	1.39					
2015	0.74	1.230	March 11	1.66					
2016	0.76	1.140	July 19	1.49					
2017	0.76	1.230	Sept 12	1.61					

Notes: 1. Maximum day for 2013 was a result of flushing and main breaks

2. Second highest max day used resulting form normal demand. Max day occurred on December 16 resulting from filling stand pipe.

	2014 - 2021	2010 - 2021
Number of years of Data	8	12
Maximum Ratio - Max. to Avg. Day Pumpage	170%	236%
Minimum Ratio - Max. to Avg. Day Pumpage	127%	127%
Average Ratio Max. to Avg. Day Pumpage	151%	163%
Standard Deviation	14%	28%

Confidence Level (%)	Ratio of Max. to Avg. Day Pumpage 2014 - 2021	2010 - 2021
80%	163%	187%
85%	166%	192%
90%	169%	199%
95%	174%	209%
98%	180%	221%
99%	184%	229%



F. Hourly Demand Fluctuations

The hour-to-hour variation of customer demands is also an important characteristic used to evaluate water supply and storage requirements. Peak hour demand is important because storage facilities are usually designed to provide water to meet the peak hour demand requirement in excess of the demand equal to the maximum day pumpage. As with maximum day demands, peak hour demand is often expressed as a ratio of peak hour to average day demand for the year. Peak hour demand is defined as the hour of maximum demand that occurs on the maximum day.

According to AWWA Manual M32, typical ranges for peak hour factors in distribution systems of various sizes are 1.3 to 2.0 for peak hour to maximum day and 0.2 to 0.6 for minimum hour to maximum day. An analysis of the SCADA data was performed to calculate the actual peak hour demand factor during June 12, 2021, and June 15, 2021. The maximum day occurred on June 14, 2021. The maximum peak hour demand factor that occurred during this period was 1.6, which occurred on June 15, 2021. Based upon available data SCADA data, the peak hour demand factor is estimated to be 1.60 times the maximum day demand resulting in a total peak hour to average day ratio of 3.18.

G. Water Consumption and Pumpage Projections

Future sales and pumpage projections are based on assumptions of water demand, coupled with estimates of future population and community growth presented in Chapter III. A detailed summary of the individual components of projected water sales and pumpage requirements is provided in Table IV-8.

1. Residential Sales

Residential sales were projected based on current trends and assumptions regarding future development and per acre water consumption. For the current planning period, it is estimated that the residential consumption rate will remain approximately 315 gpad, resulting in total residential sales of 113 MGY by 2030, and 140 MGY by 2040 if the Village serves customers withing the City of Pewaukee north of HWY 16. Residential water sales are anticipated to account for approximately 47 percent of total water sales by 2040.

2. Public Sales

Future per acre sales to public customers were projected to be approximately 110 gpad throughout the planning period. By the year 2040, it is estimated that public sales will be approximately 14 MGY, or roughly 5 percent of total annual sales.

3. Commercial Sales

Future per acre consumption by commercial customers was projected to be approximately 500 gpad over the planning period. Total annual sales to commercial customers are expected to reach 68 MGY by 2040, or approximately 23 percent of total annual sales.

4. Multi-family Sales

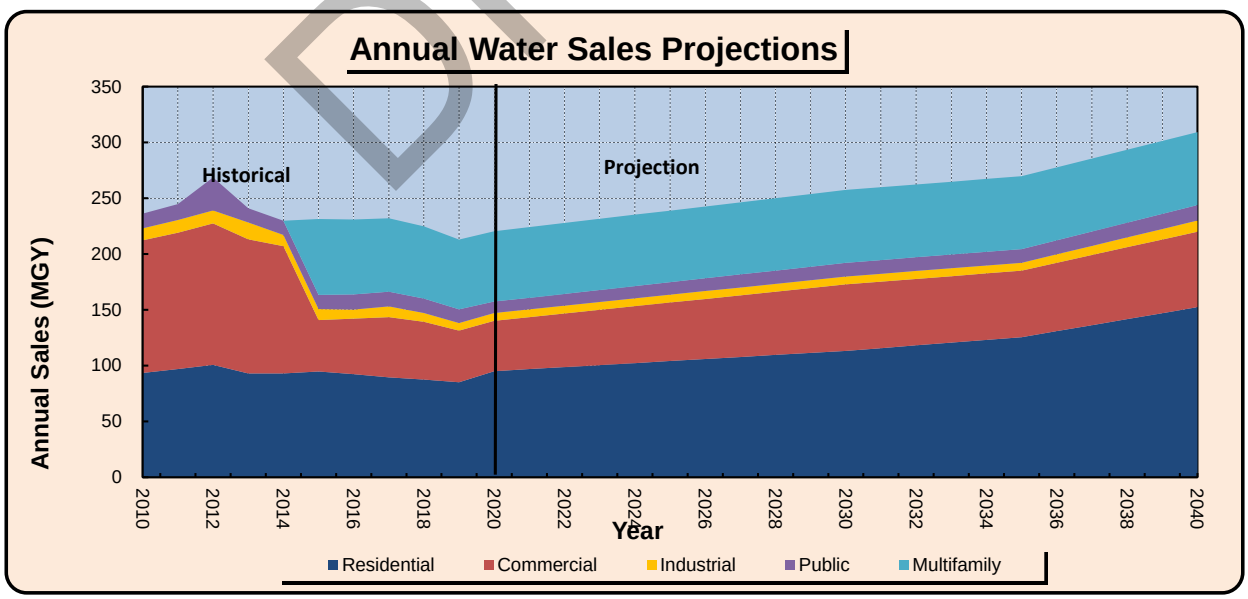
Future per acre sales to multi-family customers was projected to be approximately 950 gpad over the planning period. Total annual sales to multi-family customers are expected to reach 65 MGY by 2040, or approximately 22 percent of total annual sales.

Table IV-8 - Water Sales & Pumpage Projections

Customer Classification	Actual 2020/2021	Projected 2030	Projected 2035	Projected 2040
Population (Total)	8,238			
Est. Population Served	8,210			
Per Acre Sales (gpad)				
Residential Sales	317.0	315.0	315.0	315.0
Public Sales	88.0	110.0	110.0	110.0
Commercial Sales	441.0	500.0	500.0	500.0
Multi-Family Sales	918	950.0	950.0	950.0
Industrial Sales	86.0	120.0	120.0	120.0
Annual Sales (MGY)				
Residential Sales	95	113	126	152
Public Sales	10	12	12	14
Commercial Sales	45	60	60	68
Multi-family	63	65	65	65
Industrial Sales	7	7	7	10
TOTAL METERED SALES (MGY)	221	**257**	**270**	**309**
Non-revenue Water (MGY)	76	60	67	80
TOTAL PUMPAGE (MGY)	296	***320***	***337***	***390***

Note

1. Non-revenue water was projected at 20% of total pumpage for future years.



5. Industrial Sales to Existing Customers

Sales to existing industrial customers have generally decreased in recent years with total sales approximately 66 percent less in 2020 than ten years ago. While decreasing from previous years, industrial sales can still represent a significant portion of the total water sales. To project future industrial sales, it is assumed that the decreasing sales trend will taper off and industrial sales to existing customers will remain generally constant during the planning period. Therefore, it is assumed that future sales to existing industrial customers will remain at approximately 7 MGY through 2040.

6. Future Industrial Growth

A certain amount of industrial development is anticipated to support projected future community and regional growth in population. As illustrated in Figure III-2, planned industrial development exists outside the Village limits in the City of Pewaukee. The total undeveloped acres identified as either Industrial or Business Park land use is approximately 68.5.

To project future industrial sales, an estimate of existing industrial sales per acre was performed using available data regarding industrial land use acreage and metered water sales. Utilizing the land use data in from the zoning map, it is estimated that there are approximately 225.25 acres of industrial land currently receiving water service. Based upon a 2020 total metered sales volume of 7.04 MG, industrial water users are consuming approximately 85.6 gallons per acre per day (gpad).

Although historically a projected consumption rate of 1,500 gpad was not uncommon in water supply planning, currently values between 100 and 500 gpad are typical. Consumption rates less than 100 gpad are also not uncommon. Based upon recent patterns of industrial consumption throughout the industry, a value of between of approximately 100 and 200 gpad is believed to be reasonable estimate of future industrial water sales. For the purpose of future projections, it is assumed that future industrial sales will be approximately 120 gpad.

Future industrial water sales within the existing service area boundary are anticipated to grow by approximately 3 MGY as industrial land use areas are developed by 2040. As previously mentioned, due to the variability in industrial water use, it will be necessary to review and revise water needs projections during future planning efforts based on the actual types and quantity of industrial developments that may occur.

H. Summary of Total Demands and Pumpage Requirements

The total annual metered sales projections previously summarized in Table IV-8 were based on a summation of water sales projections for each major customer classification. An allowance was also made for unmetered miscellaneous water usage and losses (non-revenue water) to arrive at total pumpage projections.

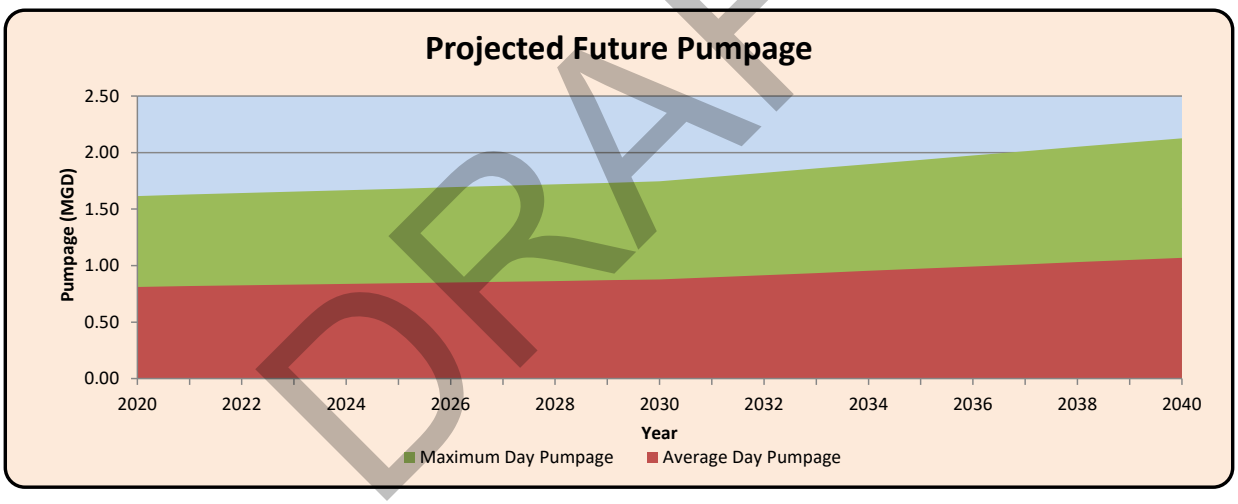
Table IV-9 summarizes projections of future water needs for average day, maximum day, and peak hour demands. Total annual pumpage is projected to increase from approximately 296 MGY (0.812 MGD) to approximately 370 MGY (1.01 MGD) by the year 2040. Table IV-9 also illustrates the projected water sales and pumpage through the planning period.

Table IV-9 - Future Pumpage Projections

	Actual 2020/2021	Projected 2030	Projected 2035	Projected 2040
Total Annual Retail Sales (MGY)	221	257	270	309
Total Annual Pumpage (MGY)	296	320	337	390
Average Day Pumpage (MGD)	0.812	0.877	0.923	1.068
Design Maximum Day Pumpage (MGD)	1.62	1.74	1.84	2.13
Design Peak Hour Demand (gpm)	1,800	1,940	2,040	2,360

Notes

1. Design maximum day pumpage projections were estimated using a ratio of maximum to average day pumpage of 199 percent.
2. Design peak hour demand projections were estimated using a ratio of peak hour demand to maximum day pumpage of 160 percent.



While the overall demand and pumpage requirements are important in determining supply and storage for the Village of Pewaukee Water Utility, determining water requirements by pressure zone ensures that adequate supply and storage are available where they are needed. Table IV-10 summarizes the projected water requirement by pressure zone based upon anticipated growth and development within each pressure zone during the planning period as presented in Chapter III.

Table IV-10 - Projected Water Sales by Pressure Zone

	Actual 2020/2021	Projected 2030	Projected 2035	Projected 2040
Total Population	8,238			
Population Served	8,210			
Residential Per Acre Sales (gpad)	317.0	**315**	**315**	**315**
Public Per Acre Sales (gpad)	88.0	**110**	**110**	**110**
Commercial Per Acre Sales (gpad)	441.0	**500**	**500**	**500**
Multi-family Sales (gpad)	918.0	**950**	**950**	**950**
Industrial Per Acre Sales (gpad)	86.0	**120**	**120**	**120**
Main Service Zone				
Residential Sales	0.25	0.30	0.33	0.39
Public Sales	0.03	0.03	0.03	0.04
Commercial Sales	0.12	0.16	0.16	0.19
Multi-family	0.17	0.18	0.18	0.18
Industrial Sales	0.02	0.02	0.03	0.03
	-			
Total Water Sales for Zone (MGD)	**0.59**	**0.70**	**0.74**	**0.82**
Hawthorne Boosted Zone				
Residential Sales	0.010	0.009	0.009	0.009
Total Water Sales for Zone (MGD)	**0.010**	**0.010**	**0.010**	**0.010**
Future Boosted Zone				
Residential Sales	-	-	-	0.016
Public Sales	-	-	-	0.001
Total Water Sales for Zone (MGD)	**0.000**	**0.000**	**0.000**	**0.017**
TOTAL METERED SALES (MGD)	**0.60**	**0.71**	**0.747**	**0.85**

Notes

1. Per acre sales from Table 4-8.
2. Total Metered Sales may not match with Table 4-8 due to estimates and rounding of variables in the calculations

V. SUPPLY AND STORAGE ANALYSIS

A critical step in the water system evaluation for the Village of Pewaukee Water Utility is an assessment of water supply and storage requirements. Water supply and storage needs are closely related. The primary criteria used in determining required supply rates and storage volumes include maximum day and peak hour demands, operational characteristics, and fire protection needs.

A. Water Supply Analysis

As it is frequently necessary to take a well and/or booster pump out of service for periods of days to even weeks for maintenance or repair, it is necessary to properly plan to ensure that demand requirements can be met even when a pumping unit may be out of service. It is then necessary to determine a reliable capacity that accounts for the uncertainty that all pumping units will be available. By excluding one pumping unit (for planning purposes, the largest capacity unit is typically used) the reliable capacity is then determined. Therefore, reliable capacity is defined as the total available delivery rate with the largest pumping unit out of service. For evaluating a municipal water system, the reliable supply capacity should at least equal maximum day pumpage requirements, assuming adequate storage is available. If this criterion is met, supply facilities will have adequate capacity to replenish storage during off-peak hours, while depletion of available storage occurs during peak demand hours.

For the Village of Pewaukee Water Utility, reliable pumping capacity needs to be evaluated for the following two specific requirements:

1. Supply capacity
2. System (Booster Pumping) capacity

Reliable water supply capacity is the capacity of the existing supply sources (well facilities and service pumps) to reliably supply maximum day demands from the aquifer to the water system. System capacity is the capacity of the existing water system to reliably deliver water to all parts of the service area and is usually associated with systems that operate with multiple pressure zones. Table V-1 summarizes the well pump and booster pump capacities used for the reliable water supply and system capacity evaluations. The following section discuss reliable water supply and system capacity in further detail for the existing water system.

Table V-1 - Existing Reliable Supply Capacity

SUPPLY SOURCE	Supply Capacity (gpm)	Supply Capacity (MGD)	Serivce Pump Capacity (gpm)	Serivce Pump Capacity (MGD)	Water To Distribution Capacity (gpm)	Water To Distribution Capacity (MGD)	Hawthorne Hill Booster Pump Capacity (gpm)	Hawthorne Hill Booster Pump Capacity (MGD)
Wells								
Well No. 2 [1]	600	0.86			300	0.43		
Well No. 3	600	0.86			600	0.86		
Well No. 4 [2]	750	1.08			435	0.63		
Well No. 5	500	0.72			500	0.72		
Well No. 6 [3]	700	1.01			500	0.72		
Booster Pumps								
Well No. 2 Booster			700	1.01	700	0.43		
Well No. 3 Booster Pump No. 1			500	0.72	500	0.72		
Well No. 3 Booster Pump No. 2			500	0.72	500	0.72		
Hawthorne Hill Booster Pump No. 1							50	0.07
Hawthorne Hill Booster Pump No. 2							210	0.30
Hawthorne Hill Booster Pump No. 3							750	1.08
Total Pumping Supply Capacity [4]	2,650	3.82	1,700	2.45	2,110	3.04	1010	1.45
Less: Largest Supply Unit [5]	1,450	2.09	700	1.01	935	1.35	750	1.08
Reliable Supply	**1,200**	**1.73**	**1,000**	**1.44**	**1,175**	**1.69**	**260**	**0.37**

Note

1. Well No. 2 pump capacity rated at 600 gpm. Actual pumping capacity reduced to 300 gpm due to well characteristics.
2. Well No. 4 pump rated for 750 gpm Well No. 4 water blends with water from Well 6 at a rate of 10 to 20 percent less than the output of Well 6
3. Well No. 6 pump rated at 700 gpm. Acutal pumping capacity is reduced to 500 gpm.
4. For Pumping Capacity - Assumes capacity of Well 2 is reduced to 6 hours of operation per day due to inhibition.
5. For Supply Capacity - Assumes Well No. 6 is out of service. Well No. 6 is required for Well No. 4 to operate for blending to meet MCL for Radionuclides. Well No. 4 will need to be out of service if Well No. 6 is out of service

1. Existing Reliable Supply Capacity

Based on the reliable water supply capacities of the existing wells (summarized in Table IV-1), reliable supply capacity evaluations were performed on the existing water system. As mentioned in Chapter II, supply sources are located only in the Main Pressure Zone. The Hawthorne Boosted Pressure Zone relies upon booster pumping capacity to transfer water from the Main Pressure Zone. The Main Pressure Zone must therefore have adequate reliable water supply capacity to meet the needs of not only the Main Pressure Zone, but also the Boosted Pressure Zone as well.

The reliable supply capacity evaluation for the current design maximum day is summarized in Table V-2. The table summarizes the maximum day demand requirement and the available reliable water supply capacity for the entire system. As shown in Table V-2, the total reliable supply capacity from the existing wells and service pumps is currently adequate to meet maximum day demands.

2. Existing Reliable System Capacity

As stated above, to meet the demand requirements of the Hawthorne Boosted Pressure Zone, it is necessary to transfer water from the Main Pressure Zone or add additional supply sources to those pressure zones. To ensure that there is adequate capacity to transfer water between pressure zones, a system capacity analysis was conducted that looks at meeting the needs of each individual pressure zone.

a. Main Pressure Zone

As mentioned above, with all of the supply sources being located in the Main Pressure Zone there is currently adequate reliable supply capacity to meet the needs of the Main pressures zone and Hawthorne pressure zone.

Table V-2 - Existing Recommended Reliable Supply Capacity

SUPPLY REQUIREMENTS	Water System 2021
Design Average Day Demand (gpm)	576
Design Maximum Day Demand (gpm)	1,146
Design Peak Hour Demand (gpm)	1,834
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	29

Notes
1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1

b. Boosted Pressure Zone

The Hawthorne Boosted Pressure Zone has no supply sources and relies upon the transfer of water from the Main Pressure Zone via booster pumps located at the Hawthorne Booster Pump Station. The existing reliable booster pumping capacity is summarized in Table V-1. The total amount of recommended reliable pumping capacity is determined in the same way as the reliable supply capacity described above.

The reliable booster pumping capacity for the Hawthorne Boosted Pressure Zone is based on the number of homes in the service area and the requirements established in NR 811.29 when no storage is provided. The pumping equipment must be sized to provide the peak hour flow. The reliable supply capacity of 260 gpm is suitable for approximately 70 homes in accordance with Figure 1 in the Appendix of NR 811. There are approximately 49 existing homes in the boosted zone. The pumping station has adequate reliable capacity to meet the current needs of the pressure zone.

3. Supply Reliability

For any water utility to serve its customers and protect the public welfare, water system facilities, equipment, and distribution systems must be reliable under all operating conditions. Reliability of utility services comprises a large part of the investment in plant and equipment.

The Wisconsin Administrative Code (WAC), Section NR 811.27, requires utilities to maintain, at a minimum, sufficient supply capacity to meet an average day demand with the use of auxiliary power sources. To meet this requirement pumping stations may be served by a power supply from at least two independent electrical substations or from a standby, auxiliary power source dedicated to water supply use. As a general rule, the Village of Pewaukee Water Utility should be able to reliably supply average day customer demands and maintain adequate fire protection using auxiliary power sources. Assuming adequate elevated water storage to provide fire protection, the Village of Pewaukee Water Utility must then only maintain adequate reliable supply to meet average day demands while using auxiliary power sources.

Currently the Village of Pewaukee Water Utility has standby power available at Well 5 and Well 6. With these facilities equipped with dedicated standby power sources, the system has sufficient auxiliary power to meet current average day pumpage requirements in the event of an emergency or other power interruption.

The Hawthorn Booster Station is provided with a single electrical service. A portable generator connection and manual transfer switch should be provided to ensure adequate service can be provided in the event of a power interruption.

B. Water Storage Analysis

1. Water Storage Needs

In addition to providing water for fire protection, system storage is used as a “cushion” to equalize fluctuations in customer demands, establish and maintain water system pressures, provide operational flexibility for water supply facilities, and improve water supply reliability. The primary criteria used in this study for evaluating storage volume

needs include average and peak hour demands, water supply capacities, and fire protection needs.

In general, storage facilities should be adequately sized to provide sufficient quantities of water for fire protection on days of maximum customer demands. Although storage requirements for fire protection are not anticipated to change over the planning period of this study, peak hour demands and reliable supply capacities will change as the community grows and improvements are implemented.

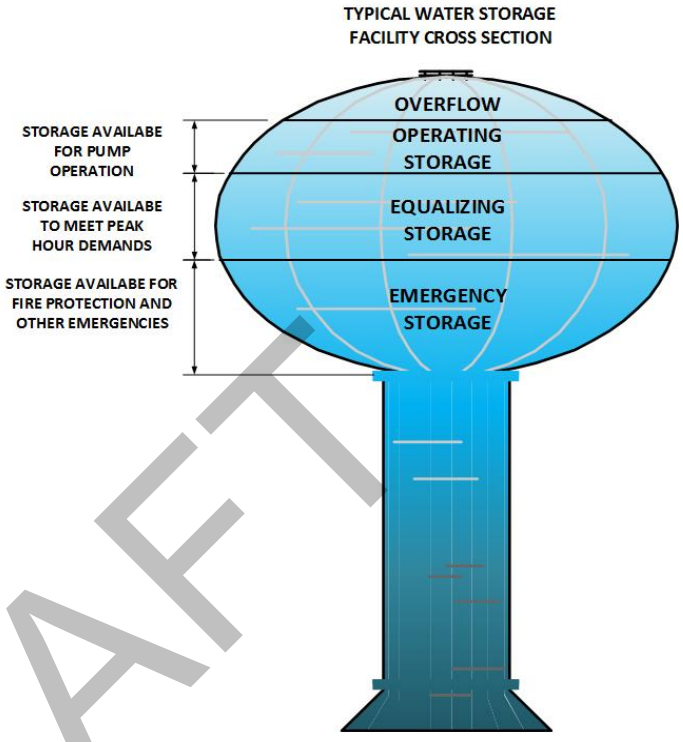


Figure V-1 Components of Distribution Storage

Figure V-1 illustrates general components of system storage. As customer demands exceed supply capacities during peak hour conditions, the excess demands must be met by depleting available storage. The amount of storage depleted is referred to as equalizing storage for peak hour requirements.

Storage should also be available for fire protection purposes. To assure a reliable supply for fire protection, this portion of storage should be reserved for emergency use only and should not be utilized to meet peak hour or operational requirements. Based upon the existing and anticipated future land uses within each pressure zone it is assumed that the maximum fire flow requirement for the Village Main Pressure Zone is 3,500 gpm for a duration of 3 hours, or the equivalent of 630,000 gallons and 750 gpm for a duration of 2 hours, or the equivalent of 90,000 gallons, for the Hawthorne Boosted Pressure Zone.

In most instances, it is desirable to provide additional storage for the purposes of operational needs. Operational storage allows for the control of pumps prior to the depletion of needed peak hour equalizing storage. Operational storage may be needed as a safety factor in emergencies or where customer demands are unpredictable and fluctuate widely. Operational storage may also be desired to take advantage of off-peak electrical rates for pumping. An additional storage volume of 30% of the equalizing storage volume is included for an operational cushion.

2. Effective Storage Volumes

The effective storage volume of a water storage facility is the amount of available water that can be utilized while meeting regulatory requirements for system pressure. The Wisconsin Department of Natural Resources (WDNR) requires that water system

pressures under normal operating conditions are above 35 psi and under emergency conditions, such as during a fire, system pressures must be maintained at a minimum pressure of 20 psi. To meet these requirements the water surface in the storage facility must be approximately 81 feet above the highest elevation area in the service area to maintain 35 psi and at least 46 feet to maintain 20 psi. These water column heights are based upon static conditions (assuming no head losses due to friction) so actual water column heights would be higher as friction losses are included. Based upon this evaluation, the effective volume of each existing storage facility is summarized in Table V-3. As can be seen in the table, 1.011 million gallons of the Utility's 1.45 million gallons total storage is effective. However, approximately 0.941 million gallons is ineffective for meeting peak hour equalizing requirements and can only be utilized to meet emergency (fire protection) needs.

3. Recommended Existing Water Storage Volumes

The following relationships between supply capacities and storage volumes are the primary criteria used to determine optimum storage volumes:

1. Reliable supply capacity should at least equal projected maximum day supply requirements.

2. Total available storage should be capable of meeting demands in excess of the maximum day demand as well as fire protection needs, assuming reliable supply capacity is adequate to meet maximum day requirements.

3. Based upon the above criteria, Table V-4 summarizes the existing supply and storage requirements for the Village of Pewaukee Water Utility. The table includes calculations for the water system as a whole. Storage for the Hawthorne Boosted Pressure Zone is provided by the Main pressure zone. Since the supply and storage for the Hawthorne Booster Zone is supplied by the Main pressure zone, a global review of available supply and storage capacity provides an adequate evaluation of available and recommended supply and storage capacities.

Table V-3 - Effective Storage Volumes

	.20 MG Spheroid	.25 MG Tower	1.0 MG Standpipe
Pressure Zone	Main	Main	Main
Design Volume (gallons)	200,000	250,000	1,000,000
Diameter (feet)	Varies	Varies	51.0
Head Range (feet)	30.0	32.50	68.00
Storage Volume per foot (gallons)	Varies	Varies	15,280
Overflow elevation (feet USGS)	1,055.0	1,055.0	1,055.0
Approximate Highest Elevation Served in Pressure Zone (feet USGS)	972	972	972
Approximate Hydraulic Grade Elevation needed to provide minimum 35 psi to all areas	1,053	1,053	1,053
Maximum Effective Peak Hour Storage Volume (gallons) [1]	*12,704*	*26,187*	*31,000*
Approximate Hydraulic Grade Elevation needed to provide minimum 20 psi to all areas	1,018	1,018	1,018
Additional Effective Fire Protection and Emergency Storage Volume (gallons) [2]	*187,296*	*223,813*	*530,000*
Total Effective Storage Volume (gallons)	**200,000**	**250,000**	**561,000**

Notes

1. Effective peak hour storage is considered the volume available which will continue to maintain adequate pressures in the distribution system at a minimum of 35 psi (under static conditions.) Volumes derived from storage tank gauging tables.
2. Effective fire protection and emergency storage is considered the volume available which will continue to maintain pressures in the distribution system at a minimum of 20psi (under static conditions.) Volumes derived from storage tank gauging tables.

Table V-4 - Existing Supply and Storage Requirements

SUPPLY REQUIREMENTS	Water System 2021
Design Average Day Demand (gpm)	576
Design Maximum Day Demand (gpm)	1,146
Design Peak Hour Demand (gpm)	1,845
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	29

STORAGE REQUIREMENTS	Water System 2021
Peak Hour Equalizing Need (gallons) [2]	163,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	140,000
Total Optimum Recommended Storage (gallons)	933,000
Available Effective Storage Capacity (gallons):	
Tower (26,187 gallons peak hour, 223,813 gallons fire flow)	250,000
Tower (12,704 gallons peak hour, 187,296 gallons fire flow)	200,000
Standpipe (31,000 gallons peak hour, 530,000 gallons fire flow)	561,000
Total Effective Storage Capacity (gallons)[5]	1,011,000
Additional Recommended Storage Capacity (gallons)	None
Existing Excess Available Storage Capacity (gallons)	78,000

Notes

1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is equal to the maximum day demand rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency. reserve storage supply.
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.

The existing optimum water storage requirement for the Village is 0.933 MG. The existing storage facilities provide 1.011 MG of available storage. However, the existing storage available for peak hour equalizing and reserve storage (0.069 MG) is less than the peak hour equalizing and reserve storage requirements (0.303 MG).

a. Alternative Supply and Storage Evaluation

As the total water requirements are a balance between both supply capacity and storage volumes, it is possible to utilize available supply (and storage) sources to reduce recommended individual pressure zone storage volumes. When excess reliable supply capacity exists and/or the hydraulic capabilities of the water system allow the transfer of water from one pressure zone to another it is possible to reduce storage requirements for individual pressure zones. Table V-5 summarizes the storage requirements when the following additional criteria are considered.

1) Where reliable pumping capacity exceeds maximum day demands, the excess reliable pumping capacity may offset total storage requirements in the following ways:

   a. Peak Hour Equalization Storage: The reliable pumping capacity in excess of the maximum day demand requirement may be utilized to offset peak hour equalizing storage.

   b. Fire Protection Storage: Excess reliable pumping capacity which exceeds the peak hour demand requirement may offset the required fire protection storage need for the duration of the maximum fire flow requirement for the pressure zone.

The excess supply capacity results in an offset of 30,000 gallons for peak hour storage, and utilizing additional storage from the ground reservoir at Well 3, and additional offset of 24,000 gallons for peak hour storage. However, the existing storage available and excess capacity and repumping capacity for peak hour equalizing and reserve storage (0.123 MG) is less than the peak hour equalizing and reserve storage requirements (0.303 MG).

Table V-5 - Alternative Existing Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2021
Design Average Day Demand (gpm)	576
Design Maximum Day Demand (gpm)	1,146
Design Peak Hour Demand (gpm)	1,845
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	29

STORAGE RECOMMENDATIONS	Water System 2021
Peak Hour Equalizing Need (gallons) [2]	163,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	140,000
Total Optimum Recommended Storage (gallons)	933,000
Available Effective Storage Capacity (gallons):	
Tower (26,187 gallons peak hour, 223,813 gallons fire flow)	250,000
Tower (12,704 gallons peak hour, 187,296 gallons fire flow)	200,000
Standpipe (31,000 gallons peak hour, 530,000 gallons fire flow)	561,000
Total Effective Storage Capacity (gallons)[5]	1,011,000
	None
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	30,000
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	None

Notes

1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is equal to the maximum day demand rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

C. Supply and Storage

The following sections evaluate the supply and storage requirements for each pressure zone. Tables V-4, along with Tables V-6, V-7 and V-8, summarize the existing and projected optimum supply and storage needs for the water system.

1. Main Pressure Zone

Currently all the supply wells are located within the Main Pressure Zone. The supply system is adequate to meet the existing design maximum day demand. The total volume of storage provided is adequate for the aggregate of peak hour equalizing, fire protection, and reserve storage for existing conditions. However, the high service elevations in the Main Pressure Zone along Tower Road result in a deficiency in available equalizing and reserve storage to provide normal service pressure.

For the projected planning year 2030, the existing reliable supply capacity is slightly deficient for the projected maximum day demand. The total volume of existing storage is adequate for the total aggregate of peak hour equalizing, fire protection, and reserve storage. The amount of existing equalizing and reserve storage is deficient to meet the projected conditions in 2035, and 2040. The deficiency in supply capacity results in an increase in equalizing storage and reserve storage needed for the projected conditions.

For the projected planning year 2035 and 2040, the existing reliable supply capacity is deficient for the projected maximum day demand. The total volume of existing storage is deficient by 0.05 MG in 2035 and 0.229 MG in 2040. The amount of existing equalizing and reserve storage is deficient to meet the projected conditions in 2035 and 2040. The deficiency in supply capacity results in an increase in equalizing storage and reserve storage needed for the projected conditions.

Table V-6 - 2030 Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2030
Design Average Day Demand (gpm)	609
Design Maximum Day Demand (gpm)	1,212
Design Peak Hour Demand (gpm)	1,939
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	(37)

STORAGE RECOMMENDATIONS	Water System 2030
Peak Hour Equalizing Need (gallons) [2]	212,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	149,000
Total Optimum Recommended Storage (gallons)	991,000
Available Effective Storage Capacity (gallons):	
Tower (26,187 gallons peak hour, 223,813 gallons fire flow)	250,000
Tower (12,704 gallons peak hour, 187,296 gallons fire flow)	200,000
Standpipe (31,000 gallons peak hour, 530,000 gallons fire flow)	561,000
Total Effective Storage Capacity (gallons)[5]	1,011,000
Subtotal Capacity Recommended (gallons)	None
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	None
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	None

Notes

1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is less than the maximum day rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

Table V-7 - 2035 Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2035
Design Average Day Demand (gpm)	640
Design Maximum Day Demand (gpm)	1,274
Design Peak Hour Demand (gpm)	2,038
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	(99)

STORAGE RECOMMENDATIONS	Water System 2035
Peak Hour Equalizing Need (gallons) [2]	290,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	163,000
Total Optimum Recommended Storage (gallons)	1,083,000
Available Effective Storage Capacity (gallons):	
Tower (26,187 gallons peak hour, 223,813 gallons fire flow)	250,000
Tower (12,704 gallons peak hour, 187,296 gallons fire flow)	200,000
Standpipe (31,000 gallons peak hour, 530,000 gallons fire flow)	561,000
Total Effective Storage Capacity (gallons)[5]	1,011,000
Subtotal Capacity Recommended (gallons)	72,000
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	None
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	48,000

Notes

1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is less than the maximum day rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

Table V-8 - 2040 Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2040
Design Average Day Demand (gpm)	701
Design Maximum Day Demand (gpm)	1,395
Design Peak Hour Demand (gpm)	2,232
Present Reliable Supply Capacity (gpm)[1]	1,175
Reliable Supply Capacity Excess or (Deficiency) (gpm)	(220)

STORAGE RECOMMENDATIONS	Water System 2040
Peak Hour Equalizing Need (gallons) [2]	444,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	190,000
Total Optimum Recommended Storage (gallons)	1,264,000
Available Effective Storage Capacity (gallons):	
Tower (26,187 gallons peak hour, 223,813 gallons fire flow)	250,000
Tower (12,704 gallons peak hour, 187,296 gallons fire flow)	200,000
Standpipe (31,000 gallons peak hour, 530,000 gallons fire flow)	561,000
Total Effective Storage Capacity (gallons)[5]	1,011,000
Subtotal Capacity Recommended (gallons)	253,000
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	None
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	229,000

Notes

1. Reliable Supply Capacity is Water Distribution Capacity from Table V-1
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is less than the maximum day rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

2. Hawthorne Boosted Pressure Zone

With a total reliable pumping capacity of 260 gpm, the Hawthorne Boosted Pressure Zone has adequate reliable pumping capacity to meet the existing and projected requirements of the existing boosted pressure zone through the planning period.

The reliable capacity of the booster pump station is designed to accommodate peak demands with no storage in the boosted pressure zone. Storage for the Hawthorne Boosted Pressure Zone is provided by the Main Pressure Zone.

3. Future Boosted Pressure Zone

The Future Boosted Pressure Zone presents a unique situation. Service outside the limits of the Village of Pewaukee has not been requested at this time. However, it is likely that a separate booster station will be needed to provide service to the future boosted pressure zone within the potential Village service area in the City of Pewaukee. This future booster station would need to accommodate the number of residential properties following the requirements of NR 811 and considering the future planned public customer. It is anticipated that storage would be provided by the Main Service Zone

D. Summary

This section summarizes the findings from the supply and storage evaluation of the Village of Pewaukee Water Utility water system. Major findings from this evaluation include the following:

1. The existing reliable supply capacity is adequate to meet current requirements when looked at aggregately for the entire water system.

2. Supply capacity is deficient for projected water pumpage volumes for planning years 2030, 2035 and 2040.

3. Of the total 1.011 MG of elevated water storage, only 0.069 MG is effective for meeting peak hour equalizing and reserve storage requirements based upon meeting minimum pressure requirements to current service area elevations.

4. The high elevations in the Main Pressure Zone at the west end of Tower Court and near the Pewaukee High School result in a deficiency in equalizing and reserve storage volume available in the existing storage facilities.

5. The existing available equalizing and reserve storage is deficient for the projected needs in planning years 2030, 2035 and 2040.

VI. WATER SYSTEM DEFICIENCY ANALYSIS

An important component of the Utility's master planning process was the evaluation of the existing water system and performing a deficiency analysis. This chapter summarizes the findings from this evaluation.

A. Existing System Deficiency Analysis

Water systems are analyzed, planned, and designed primarily through the application of basic hydraulic principles. Some important factors that must be considered when performing this analysis include:

1. The location and capacity of supply facilities
2. The location, sizing, and design of storage facilities
3. The location, magnitude, and variability of customer demands
4. Water system geometry and geographic topography
5. Minimum and maximum pressure requirements
6. Land use characteristics with respect to fire protection needs
7. Other operational criteria which define the manner in which the system can most efficiently be operated.

For this study, an evaluation of the Village of Pewaukee water system was performed to determine the adequacy of the system to supply existing and future water needs, and to supply water for fire protection purposes.

The system was evaluated based on the following criteria:

1. Pressure
2. Flow Capacity
3. Water Main Velocities and Headlosses
4. Water Quality
5. Reliability

The water system evaluation was based on compliance with state code requirements (Wisconsin Administrative Code NR 809 and NR 811) and standard water industry engineering practice.

B. Water System Pressures

The Village of Pewaukee water system model was used to evaluate existing water distribution system characteristics and identify deficiencies with respect to pressures and flow capacities. Water system pressure will vary within the service area based on differences in topographic elevations, as well as supply rates and customer demands. In general, as customer demands increase, pressures will decrease. Areas higher in topographic elevation will also tend to exhibit lower water system pressures.

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

The Wisconsin Administrative Code requires that municipal water systems be designed with a minimum pressure of 35 psi and a maximum pressure of 100 psi at all locations in the service area under normal operating conditions. Furthermore, water systems are required to be operated so that under fire flow conditions, the residual pressure in the system will not fall below 20 psi at any location. In addition, while system pressure up to 100 psi is allowable, the state plumbing code (SPS 382) requires that pressure reducing valves (PRVs) be installed on service lines where the incoming water pressure is in excess of 80 psi.

Figures VI-1, VI-2, and VI-3 illustrate water system pressure throughout the Village of Pewaukee water system for varying demand conditions. As indicated in the figures, system pressures may vary considerably around the existing service area from approximately 25 psi to approximately 90 psi.

The highest system pressures typically occur in the low topographical elevation areas. These high pressures are the result of a varying topography and occur most prominently during low demand period (average day compared to maximum day or peak hour).

Lower system pressures, as seen in the figures, are anticipated in only isolated areas within the water system. These low pressures can be attributed primarily to high elevations.

C. Fire Flow Capacities

Water system planning for fire protection is an important consideration. In most instances, water main sizes are designed specifically to supply desired fire flows.

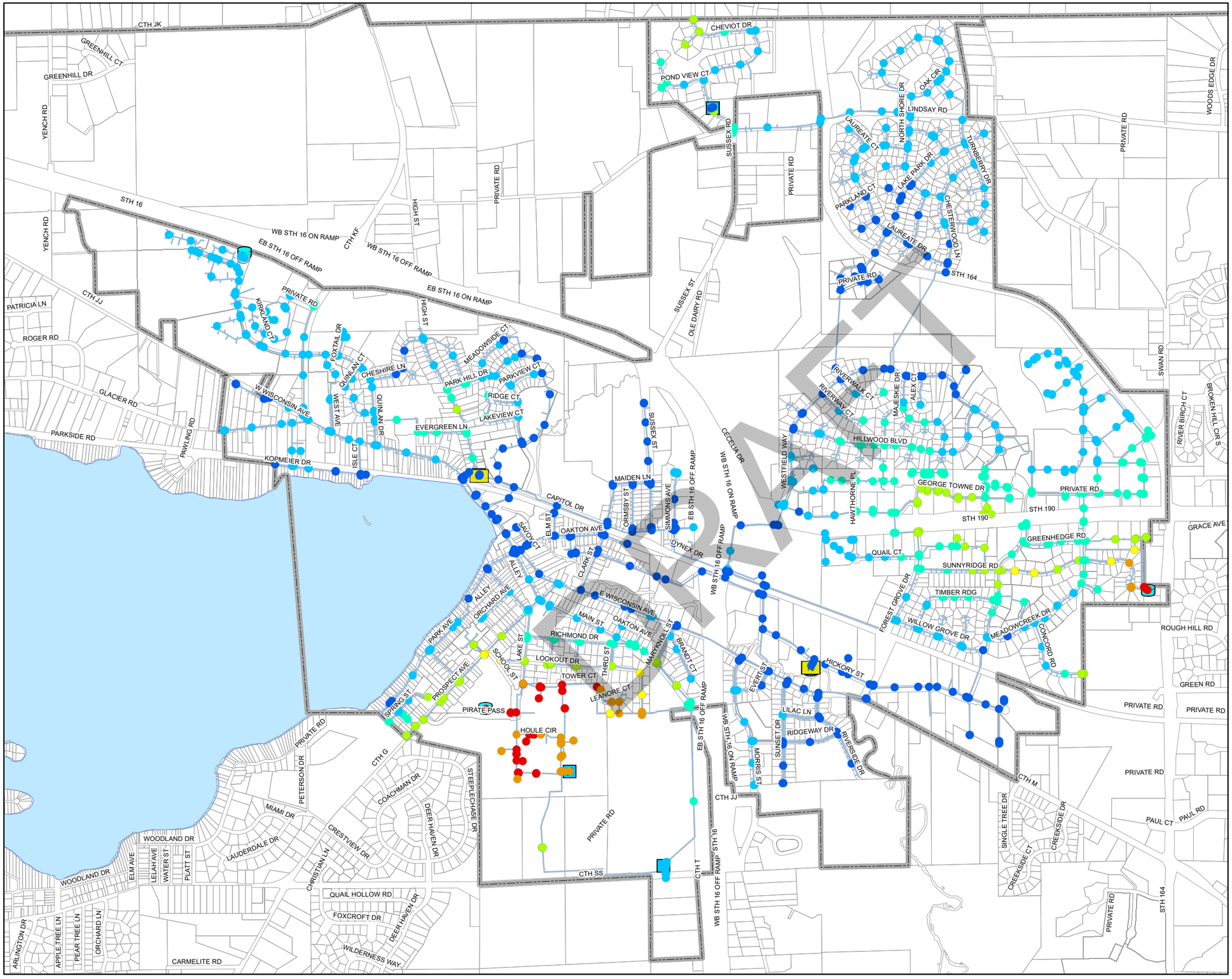
Fire protection needs vary with the physical characteristics of each building to be protected. For example, needed fire flows for a specific building can vary from 500 gpm to as high as 12,000 gpm. A building's recommended fire protection need is determined by many factors including habitation classification, separation distance between buildings, building height, materials of construction, size of the building, and the presence or absence of building sprinklers. Although a building may have a high fire protection need, the municipal fire insurance rating is determined based upon a maximum needed fire flow of up to 3,500 gpm.

If a specific building has a need for fire flow greater than this 3,500 gpm, the community's fire insurance rating will only be based on the water system's ability to provide 3,500 gpm.

Figure VI-4 illustrates the assumed fire flow required at existing fire hydrants based on zoning land use presented in Chapter III. Table VI-1 summarizes the assumptions for assigning fire flow requirements in the model.

Table VI-1 - Assumed Fire Flow Requirements by Land Use

Land Use	Fire Flow Requirement
Single and Two Family Residential (R1, R2, R5)	750 gpm
Multi-Family Residential (R6, RM, MH)	1,500 gpm
Institutional (IPS) and Commercial (B2 and B3)	2,500 gpm
Industrial (B5) and Commercial (B1)	3,500 gpm



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Village of Pewaukee

Figure VI-1

Average Day Demand System Pressure

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
Apriil, 2022

Pressure

- Less than 35 PSI
- 35 - 40 PSI
- 40 - 50 PSI
- 50 - 60 PSI
- 60 - 70 PSI
- 70 - 80 PSI
- Greater than 80 PSI
- Booster Station
- Pump Station
- Tanks
- Well
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500

Feet

Ruekert · Mielke

Figure VI-2

Maximum Day Demand System Pressure

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Pressure

- Less than 35 PSI
- 35 - 40 PSI
- 40 - 50 PSI
- 50 - 60 PSI
- 60 - 70 PSI
- 70 - 80 PSI
- Greater than 80 PSI
- Booster Station
- Pump Station
- Tanks
- Well
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500

Feet

Ruekert · Mielke

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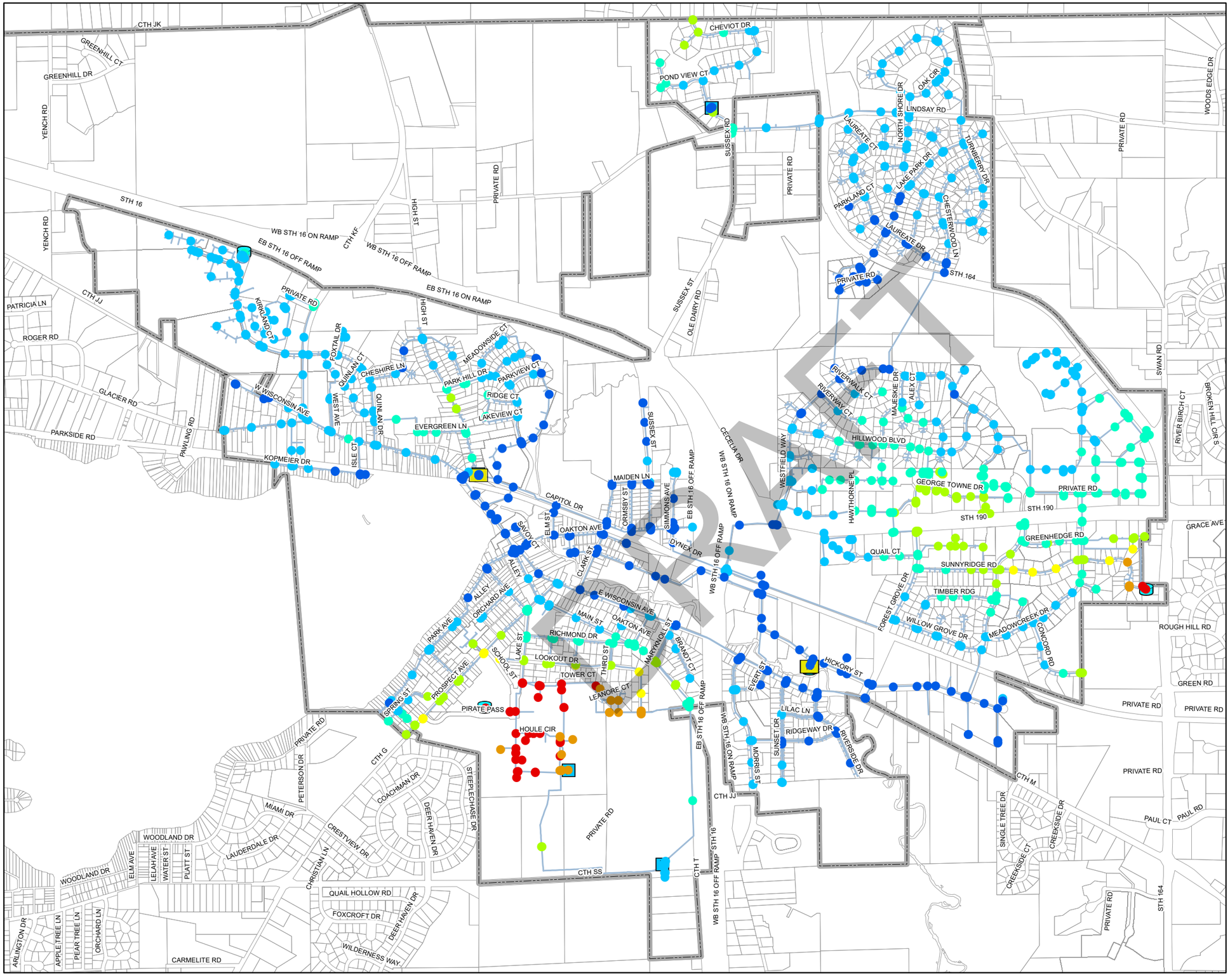

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Village of Pewaukee

Figure VI-3

Peak Hour Demand System Pressure

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Pressure

- Less than 35 PSI
- 35 - 40 PSI
- 40 - 50 PSI
- 50 - 60 PSI
- 60 - 70 PSI
- 70 - 80 PSI
- Greater than 80 PSI
- Booster Station
- Pump Station
- Tanks
- Well
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

Figure VI-4

Recommended Fire Flow

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Total Flow Needed

- 500 GPM
- 750 GPM
- 1,500 GPM
- 2,500 GPM
- 3,500 GPM
- PS Booster Station
- P Pump Station
- Tanks
- Well
- Water Main
- Civil Division

N
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0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

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Figure VI-5 illustrates the estimated available fire flow throughout the water system during maximum day water demand while maintaining a residual pressure of 20 psi throughout the system. As can be seen from the figure, available fire flows range considerably throughout the water system from 600 gpm to greater than 3,500 gpm.

Figure VI-6 identifies areas where potential fire flow deficiencies currently exist. Deficiencies were identified where the assumed fire flows identified in Table VI-1 were not met for a particular land use as determined from the available land use data.

As seen in Figure VI-6, deficiencies are found in isolated areas throughout the water system, most prevalently in high fire flow required land use areas such as in commercial and industrial and/or in areas served by older, small diameter water mains and at dead ends.

While this simple analysis provides insight into potential problems with providing adequate fire protection as mentioned above, other factors must also be considered such as a building's use of sprinkler systems, firewalls, fire retardant materials, or other means, which can substantially reduce presumed fire flow requirements. Therefore, a location identified as deficient in needed fire flow may have sufficient fire flow available to meet the specific requirements for structures located near that particular node.

Other deficiencies, as in many water systems, are the result of dead ends, small diameter water mains, and older water mains that tend to exhibit reduced flow capacity. These deficiencies may be corrected with a proactive water main replacement and improvement program.

D. Water Main Velocities and Headlosses

High headlosses are indicative of water mains that are exceeding their flow capacity. During gravity conditions (when well or booster pumps are off), headlosses within a water distribution system result in lower system pressure. During pumped conditions (elevated tank filling), headlosses can contribute to higher operating costs as it takes more power to overcome the energy losses occurring within the water mains. Mathematically, headloss is a function of velocity and high headlosses occur within water mains that exhibit high velocities. However, older water mains may also exhibit high headlosses due to the deterioration of the interior of the pipe even when velocities are within acceptable values.

To increase system pressures and minimize operating cost (pumping energy) it is desirable to minimize both velocity and headloss within the distribution system under normal operating conditions. AWWA Manual M32, Computer Modeling of Water Distribution Systems, Third Edition, includes guidelines for maximum recommended limits of pipe headloss and velocity. AWWA Manual M32 recommends that all pipe velocities should be less than 5 feet per second (fps) during normal operation. Additionally, M32 recommends headlosses in pipes less than 16-inches in diameter should be less than 5 to 7 feet per 1,000 feet of pipe during normal operating conditions. The recommended headloss limit for water main 16-inches in diameter and larger is 2 to 3 feet per 1,000 feet of pipe during normal operating conditions.

Generally speaking, high velocity/headloss water mains appear to be located in areas with limited loops or in close proximity to pumping and storage facilities where higher rates of flow are common.

Figure VI-5

Available Fire Flow

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Less than 500 GPM
- 500 GPM - 999 GPM
- 1,000 GPM - 1,500 GPM
- 1,500 GPM - 2,000 GPM
- 2,000 GPM - 2,500 GPM
- 2,500 GPM - 3,000GPM
- 3,000 GPM - 3,500 GPM
- Great than 3,500 GPM
- Booster Station
- Pump Station
- Tanks
- Well
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

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Figure VI-6

Fire Flow Adequacy

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Does not Meet Fire Flow
- Meets Fire Flow
- Booster Station
- Pump Station
- Tanks
- Well
- Water Main
- Civil Division

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0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

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Pipe flow velocities within the Village of Pewaukee distribution system are typically below 1 fps under average demand conditions. Even during periods of high demand, flow velocities do not exceed 5 fps. No water main exhibits either high velocity or headloss during peak hour demand conditions during model simulations utilizing existing control strategies.

E. Water Quality

Groundwater quality is expressed in terms of its chemical and physical characteristics. The quality of the water determines its suitability for use and the level of treatment required. The chemical characteristics of entry point water samples taken at Well No. 2, Well No. 3, and Well No. 5 and entry point 100 (blend of Wells 4 and 6) are summarized in Table VI-2, Table VI-3, and Table VI-4.

Water quality problems in the Village of Pewaukee are primarily aesthetic and are generally due to high concentrations of iron, dissolved solids, chlorides, and manganese. The groundwater meets the primary (health related) drinking water contaminant standards for inorganics of NR 809 of the Wisconsin Administrative Code.

The water at Well No. 2 has detectable levels of volatile organic compounds, moderate levels of iron, high levels of manganese and current test results indicate high activity for gross alpha particles. Currently, a packer is installed in the well to isolate the aquifer to draw water with lower combined radium activity.

Table VI-2 - Inorganic Concentrations

Characteristic	Concentration, mg/l				
	Village of Pewaukee				Drinking Water Standard
	Well No. 2	Well No. 3	Well No. 5	Entry Point 100	
Alkalinity, Total	240	240	280	270	--
Aluminum	ND	ND	ND	ND	0.05 to 0.2(2)
Antimony, Total	ND	ND	ND	ND	0.006(1)
Arsenic	ND	ND	ND	ND	0.010(1)
Barium	0.066	0.085	0.12	0.088	2.0(1)
Beryllium, Total	ND	ND	ND	ND	0.004(1)
Cadmium	ND	ND	ND	ND	0.005(1)
Calcium	88	72	64	90	--
Chloride	16	4.90	5.3	100	250(2)
Chromium	ND	0	ND	ND	0.1(1)
Fluoride	0.69	0.71	0.63	0.39	2.0(2)
Hardness	320	280	280	380	--
Iron	0.21	0.12	ND	0.26	0.3(2)
Magnesium	24	23	25	37	--
Manganese, ug/l	49	46	ND	49	50(2)
Mercury	ND	ND	ND	ND	0.002(1)
Nickel	0.001	0.00061	0.00084	0.0016	0.1(1)
Nitrate-Nitrite	ND	ND	ND	0.11	10(1)
Nitrite	ND	ND	ND	ND	1.0(1)
pH, s.u.	7.69	7.58	7.54	7.31	--
Residue, Total	470	330	290	500	500(2)
Selenium	ND	ND	ND	ND	0.05(1)
Silver, ug/l	ND	ND	ND	ND	0.100(2)
Sodium	25	12	12	43	--
Thallium, Total	ND	ND	ND	ND	0.002(1)
Zinc	ND	ND	ND	ND	5.0(2)

Sample Date – February 2017
ND = Not Detected
(1) – Primary Drinking Water Standard
(2) – Secondary Drinking Water Standard

Table VI-3 - Radiological Concentrations

Characteristic	Concentration, pCi/l				
	Village of Pewaukee				Drinking Water Standard
	Well No. 2[1]	Well No. 3[2]	Well No. 5[3]	Entry Point 100[3]	
Gross Alpha	17.2	6.16--	1.21	4.87	15
Radium-226	2.1	--	--	--	5
Radium – 226 & 228	3.23	3.98	ND	1.26	5

1. Sample Date – 8/10/2021
2. Sample Date- 2/11/2020
3. Sample Date – 2/23/2021

ND = Not Detected

Table VI-4 - Volatile Organic Concentrations

Characteristic	Concentration, ug/l				
	Village of Pewaukee				Drinking Water Standard
	Well No. 2	Well No. 3	Well No. 5	Entry Point 100	
Benzene	ND	ND	ND	ND	5
Bromodichloromethane	0.9	--	--	--	80
Bromoform	0.94	--	--	--	80
Carbon Tetrachloride	ND	ND	--	--	5
Chloromethane (Methylchloride)	ND	ND	ND	ND	--
Dibromochloromethane	1.6	--	--	--	80
O-Dichlorobenzene	ND	ND	ND	ND	600
P-Dichlorobenzene	ND	ND	ND	ND	75
1,2-Dichloroethane	ND	ND	ND	ND	5
1,1-Dichloroethylene	ND	ND	ND	ND	7
CIS-1,2-Dichloroethylene	ND	ND	ND	ND	70
Trans-1,2-Dichloroethylene	ND	ND	ND	ND	100
Dichloromethane	ND	ND	ND	ND	5
1,2-Dichloropropane	ND	ND	ND	ND	5
Ethylbenzene	ND	ND	ND	ND	700
Monochlorobenzene	ND	ND	ND	ND	100
Styrene	ND	ND	ND	ND	100
Tetrachloroethylene	ND	ND	ND	ND	5
Toluene	ND	ND	ND	ND	1,000
1,2,4-Trichlorobenzene	ND	ND	ND	ND	70
1,1,1-Trichloroethane	ND	ND	ND	ND	200
1,1,2-Trichloroethane	ND	ND	ND	ND	5
Trichloroethylene	ND	ND	ND	ND	5
Vinyl Chloride	ND	ND	ND	ND	0.2
Xylenes, Total	ND	ND	ND	ND	10,000

Sample Date – 4/7/2020
ND = Not Detected

The water at Well No. 3 has moderately high to high level of manganese. The treated water at Well No. 5 meets primary and secondary standards when using a Hydrous Manganese Oxide pressure filtration treatment system located at the well site.

The blended water from Wells 4 and 6 at Entry Point 100 has moderately high to high levels of iron and manganese.

One factor affecting water quality within a water system is the water age. As the water age increases the water quality can deteriorate. The rate at which the water quality deteriorates is dependent on water flow rate, finished water quality, pipe materials, and deposited materials. Water quality problems associated with water age include disinfection by-product formation, disinfectant decay, corrosion control effectiveness, taste and odor, nitrification, microbial regrowth, temperature changes, sediment deposition, and color. The disinfection byproducts

concentrations of water samples taken from the distribution system are summarized in Table VI-5. The concentration of disinfection byproducts are below the maximum contaminant levels and may indicate adequate water age.

Table VI-5 - Disinfection Byproducts Concentrations

Characteristic	Concentration, ug/l	
	Village of Pewaukee	
	Distribution System	Drinking Water Standard
Bromodichloromethane	2.2	80
Bromoform	0.92	80
Chloroform	2.9	80
Dibromoacetic Acid	0.23	
Dibromochloromethane	2	80
Dichloroacetic Acid	0.33	
HAA5	0.93	60
Monobromoacetic Acid	ND	
Monochloroacetic Acid	ND	
Trichloroacetic Acid	0.37	
TTHM	8.02	80

Sample Date – 8/3/2021
ND = Not Detected

E. System Reliability

Although water distribution systems are generally reliable, an important consideration in the design of a water distribution system is providing continued service to water utility customers even in the event of a water main failure and minimizing water main failures. There are several areas within the existing water distribution system that are not looped and served by only a single water main and are typically dead end streets. In the event of a water main failure customers within these areas would be without service. The majority of the water distribution system is looped. While typically these areas are generally small and isolated there are significant portions of the distribution system that are served by a single main. A significant area that is not looped includes the Hawthorne Boosted Zone. The area west of Ryan Road is served by a single water main; however, Well 5 and the Quinlan tank add reliability to this area in the event of a water main failure.

The Village has experienced several water main breaks in areas with cast iron water mains, or with ductile iron water mains with spoil bedding and backfill. These areas include Parkhill Drive, Quinlan Drive, Glacier Road, and West Wisconsin Avenue. The Village has identified water main replacements in the Village Capital Improvement Plan to address some areas susceptible to breaks

Storage facilities provide water for equalizing storage, fire protection and operational storage. Storage facilities are generally reliable and require routine inspections to assess condition to identify needs for maintenance and repair to ensure reliability. The Village recently had the ground storage reservoirs and elevated storage facilities inspected in dry conditions. Detailed inspection reports were provided by Dixon Engineering and identified deficiencies for each of the storage facilities. A summary of the recommendations and estimated costs improvements to correct the deficiencies identified during the inspections are included in Appendix C.

F. System Staffing

Staffing for a Water Utility includes engineering, operation and maintenance, and metering/billing/administrative personnel. The Village of Pewaukee has a combined utility department that includes the Water Utility and the Sewer Utility. The combined utility department has one full time Supervisor and four full time operators that split their duties between the water and sewer utilities. The Village Engineer dedicates approximately 50 percent of a full-time employee to the combined utility department. The Village Clerk/Treasurer dedicates approximately 30 percent of a full-time employee to the combined utility department. Considering that the combined utility staff split their time with the water and sewer utilities, the Water Utility is staffed with a Full Time Equivalent (FTE) of approximately 2.6 employees.

Each year the AWWA performs a Utility Benchmarking Survey for 58 key performance indicators. One of these indicators evaluated is the MGD of water produced per employee. Based on the 2020 and 2021 average water pumpage data in Table IV-7, the Village of Pewaukee Water Utility produced 0.35 and 0.31 MGD per employee respectively. The AWWA Utility Benchmarking survey for 2020 reported a median value of 0.17 MGD per employee for water utilities. The 75th percentile value was 0.25 MGD per employee and the 25th percentile value was 0.14 MGD per employee. The Village of Pewaukee Water Utility is in the upper quartile of the range surveyed by the AWWA (lower staffing based on typical water utilities). Based on the median value from the AWWA Utility Benchmarking survey for 2020, the FTE water utility employees for 2020 would be 5.4, and the FTE water utility employees for 2021 would be 4.82. Based on the 75th percentile value from the AWWA Utility Benchmarking survey for 2020, the FTE water utility employees for 2020 would be 3.68 and the FTE water utility employees for 2021 would be 3.28. It appears that the Village of Pewaukee Water Utility has a need for at least one additional FTE employee.

G. Summary

This chapter summarizes the findings from evaluation of the Village of Pewaukee Water Utility water distribution system. Major findings from this evaluation include the following:

1. Under normal operating conditions, the system provides pressure above the minimum required 35 psi and below the maximum 100 psi the majority of the service area. Pressures less than 35 psi under normal conditions were identified north of the High School and along Tower Road.
2. There are areas within the system where available fire flows are below recommended flows based upon surrounding land use.
3. There is no identified water main in the Village water system where velocities or head losses exceed industry standards during normal operations including during peak hour demand conditions.
4. The groundwater sources for Well 2 exceeds the maximum contaminant level for Gross Alpha particle activity and Well 4 exceeds the drinking water Maximum Contaminant Level for Combined Radium. The groundwater and treated water from all wells meet the primary

drinking water maximum contaminant levels Inorganic and Volatile Organic substances as identified in Chapter NR 809 of the Wisconsin Administrative Code.

5. Iron and manganese from Well 2 and combined water from Wells 4 and 6 are approaching the concentration of the secondary standard as identified in Chapter NR 809 of the Wisconsin Administrative Code.
6. There are portions of the water system with reduced reliability, being served by only a single water main.
7. The recent inspections of the storage facilities identified deficiencies and recommended maintenance to ensure compliance with code requirements and to ensure continued service.
8. The current staffing for the Water Utility is low in comparison to the median range for typical water utilities. Additional staffing will be needed as the system expands, additional facilities or treatment systems are placed in service, and additional needs for Lead and Copper Rule compliance monitoring becomes effective.

VII. RECOMMENDATIONS

This chapter presents an evaluation of water system improvements intended to address existing water system deficiencies identified in Chapters V and VI and improve overall water system operation. In addition, this chapter evaluates improvement alternatives necessary to serve future developments. The chapter concludes with recommended water system improvements that will meet the needs and requirements of the Village of Pewaukee Water Utility over the planning period.

This chapter details the evaluation of the following improvements:

- Evaluation of future pressure zones development
- Water supply improvements
- Distribution system improvements
- Distribution system expansion

A. Pressure Zone Development

A critical step in long-range planning for the Village of Pewaukee Water Utility is identifying the future needs of the service area coupled with an assessment of water supply and storage requirements. The topography of the Pewaukee area makes providing water service to some areas difficult; therefore, as development occurs, the Utility will need to decide if and how to provide service to each area.

The existing customers at 326 Lake Street and at 313, 319, 325, 335, 343, 353, and 361 Tower Court are located at ground elevations ranging from 966 feet to 972 feet in the main service zone. The ground elevation of the existing customers results in static pressures less than 35 psi when utilizing the typical control range of the elevated storage tanks. If the Village is to provide water service outside the corporate boundary to serve the potential 2040 service area, an additional pressure zone may need to be created to properly serve areas of higher elevations:

To ensure adequate service can be provided within the 2040 service area, an analysis of possible future pressure zone areas will need to be performed to identify potential issues, deficiencies, or concerns. It is worthwhile to note that the Utility will have to determine how to serve specific growth areas as future development occurs. During planning for future development, the information provided in this section should be reviewed with additional information available at that time to determine the best possible strategy to provide water service. A specific development may be served from one pressure zone initially and later converted to a different pressure zone as the water system continues to develop and grow. Additional considerations regarding pressure zone development are discussed below.

1. Proposed Pressure Zone Modifications

Figure III-3 in Chapter III illustrates the existing pressure zone service area limits. As is often the case, there are areas which can be adequately served from more than one pressure zone. There are also areas which are inadequately or only marginally served from the existing pressure zones within which the area lies. As is illustrated in Figure III-3, the delineation of pressure zones simply based upon topography can isolate local service areas thereby creating undesirable zone boundaries.

Currently the Village of Pewaukee water system consists of a Main Service Zone, and the Hawthorne Boosted Pressure Zone. Water from the Main Service Zone is supplied to the Boosted Pressure Zone.

As shown in Figure III-3, the area north of STH 16 and East of Ryan Road is currently in the City of Pewaukee and is a potential service area of the Village. This area would require service from a boosted pressure zone and will not be evaluated as part of this report since the City of Pewaukee has plans to provide service to this area.

The existing customers at 326 Lake Street and at 313, 319, 325, 335, 343, 353, and 361 Tower Court are located area included in the Main Service Zone. Chapter NR 810.10 of the Wisconsin Administrative Code allows the use of pressure boosting systems on individual services lines, limited to 10 individual system in a service zone. Chapter NR 810.10 requires that the individual booster system be owned and maintained by the public water system owner. The Utility does not desire to own and maintain any facilities within the premises of individual customer. An alternative is to construct a booster station to serve the customers along Tower Court to improve pressure under normal operating conditions.

The water services for customers along Tower Court are connected to the 8-inch diameter and 6-inch diameter water main on Lookout Drive. A small duplex booster station could be constructed in the future right of way at the intersection of First Street and Lookout Drive to provide improved pressures for all customers along Lookout Drive from First Street to approximately 240 feet east of Second street. Check valve vaults would be required to be installed on the 8-inch water main on Lookout Drive near First Street, on the 8-inch water main on Second Street, and on the 6-inch water main on Lookout Drive approximately 240 feet east of the intersection of Second Street. The check valve vaults would be used to isolate this area for increased pressure would also allow additional water to this area under fire flow demand conditions. The booster pumps would be sized to increase the pressure in the water main by a maximum of 20 psi (46 feet) to ensure the existing customers on the North Side of Lookout Drive do not experience excessive pressure.

B. Water Supply Improvements

As summarized in Chapter V, the Village currently has a deficiency in the system reliable supply capacity and will need additional capacity to meet future water demands. Currently, the water from Well No. 6 is blended with water from Well No. 4 prior to entering the distribution system to meet the MCL for combined radium. If Well No. 6 is out of service, the Village is unable to use Well No. 4 as the water would exceed the MCL for combined radium. Construction of a treatment facility to remove combined radium for Well No. 4 is recommended to improve the reliable capacity of the supply system. A treatment system at Well No. 4 would increase the reliable capacity of the existing system to 1,250 gpd when operating the wells for 20 hours per day. Table VII-1 summarize the recommended reliable supply capacity.

A new Hydrous Manganese Oxide (HMO) treatment facility at Well No. 4 would be constructed to treat the water from Well No. 4 prior to entering the distribution system. It is recommended that a pilot study be performed to assess a higher filtration surface loading rate filtration system. Conventional hydraulic surface loading rates to pressure filters are limited to 3.0 gpm/square foot. Pilot testing can be performed to document performance of a filtration system at hydraulic surface loading rates in the 6 to 8 gpm/square foot range. A higher hydraulic surface loading rate can reduce the size of the filtration equipment at a significant cost savings. For example, the equipment cost for a single horizontal pressure filter to treat a flow of 720 gpm at a 3.0.gpm/square foot hydraulic surface loading rate is approximately $490,000, and the equipment cost for 6 vertical pressure filters to treat a flow of 720 gpm at a 7.55 gpm/square foot hydraulic surface loading rate is approximately $295,000. The cost of a pilot study is estimated to be in the range of $15,000 to $20,000.

With the addition of an HMO treatment facility at Well No. 4, the reliable supply capacity is adequate to meet the projected supply needs for planning years 2030 and 2035, with Well No. 2 out of service and retained for emergency operation. In the event that water is provided by the Village to the area in the City of Pewaukee as shown in Figure III-3, the supply system would be deficient for planning year 2040. An additional well would be required to have adequate reliable supply capacity to meet the water needs for planning 2040. Since the City of Pewaukee is currently planning on providing water service to this area, an additional well is not recommended at this time.

Table VII-1 - Recommended Reliable Supply Capacity

SUPPLY SOURCE	Supply Capacity		Serivce Pump Capacity		Water To Distribution Capacity		Hawthorne Hill Booster Pump Capacity	
	(gpm)	(MGD)	(gpm)	(MGD)	(gpm)	(MGD)	(gpm)	(MGD)
Wells								
Well No. 2 [1]	600	0.86			0	0.00		
Well No. 3	600	0.86			600	0.86		
Well No. 4 [2]	750	1.08			650	0.94		
Well No. 5	500	0.72			500	0.72		
Well No. 6 [3]	700	1.01			400	0.58		
Booster Pumps								
Well No. 2 Booster			700	1.01	0	0.00		
Well No. 3 Booster Pump No. 1			500	0.72	500	0.72		
Well No. 3 Booster Pump No. 2			500	0.72	500	0.72		
Hawthorne Hill Booster Pump No. 1							50	0.07
Hawthorne Hill Booster Pump No. 2							210	0.30
Hawthorne Hill Booster Pump No. 3							750	1.08
Total Pumping Supply Capacity [4]	2,650	3.82	1,700	2.45	2,150	3.10	1010	1.45
Less: Largest Supply Unit [5]	1,450	2.09	700	1.01	650	0.94	750	1.08
Reliable Supply [(6)]	**1,200**	**1.73**	**1,000**	**1.44**	**1,250**	**2.23**	**260**	**0.37**

Note
1. Well No. 2 pump capacity rated at 600 gpm. Assumes out of service for emergency use only.
2 Well No. 4 pump rated for 750 gpm Assumes pumping capacity reduced to 650 gpm with treatment.
3. Well No. 6 pump rated at 700 gpm. Acutal pumping capacity is reduced to 400 gpm average due to fouling.
4. For Pumping Capacity - Only well pumps are considered as booster pump capacities exceed well pump capacities.
5. For Supply Capacity - Assumes Well No. 4 is out of service.
6. Water to distribution capacity estimated with 20 hours of operation per day.

C. Water Storage Improvements

As summarized in Chapter V, under current operational conditions there are existing storage deficiencies in the Pewaukee water system.

With the addition of a small boosted pressure zone to serve the customers along Lookout Drive, the available storage volume from the existing storage facilities would increase based on serving a revised maximum elevation. Table VII-2 summarizes the Optimized effective storage volume from the existing storage facilities.

Table VII-2 – Optimized Effective Storage Volumes

	.20 MG Spheroid	.25 MG Tower	1.0 MG Standpipe
Pressure Zone	Main	Main	Main
Design Volume (gallons)	200,000	250,000	1,000,000
Diameter (feet)	Varies	Varies	51.0
Head Range (feet)	30.0	32.50	68.00
Storage Volume per foot (gallons)	Varies	Varies	15,280
Overflow elevation (feet USGS)	1,055.0	1,055.0	1,055.0
Approximate Highest Elevation Served in Pressure Zone (feet USGS)	965	965	965
Approximate Hydraulic Grade Elevation needed to provide minimum 35 psi to all areas	1,046	1,046	1,046
Maximum Effective Peak Hour Storage Volume (gallons) [1]	*72,450*	*91,770*	*138,000*
Approximate Hydraulic Grade Elevation needed to provide minimum 20 psi to all areas	1,011	1,011	1,011
Additional Effective Fire Protection and Emergency Storage Volume (gallons) [2]	*127,550*	*158,230*	*530,000*
Total Effective Storage Volume (gallons)	**200,000**	**250,000**	**668,000**

Notes

1. Effective peak hour storage is considered the volume available which will continue to maintain adequate pressures in the distribution system at a minimum of 35 psi (under static conditions.) Volumes derived from storage tank gauging tables.
2. Effective fire protection and emergency storage is considered the volume available which will continue to maintain pressures in the distribution system at a minimum of 20psi (under static conditions.) Volumes derived from storage tank gauging tables.

Comparing Table V-3 with Table VII-2, it can be seen that the total effective storage volume of the standpipe increased by 107,000 gallons, and the volume of effective peak hour storage for each storage facility increased as a result of reducing the highest elevation served within the Main Service Area. The combined effective peak hour storage volume increases by 0.232 MG gallons for a total of 0.302 MG by constructing a booster station to serve the customers along Tower Road.

Tables VII-3, VII-4, and VII-5 summarize the supply and storage analysis with the recommended supply and storage/pressure zone improvements for the Village of Pewaukee for planning years 2030, 2035, and 2040. The recommended improvements satisfy the supply and storage needs for the planning years for 2030 and 2035.

D. Distribution System Improvements

1. Existing System Deficiencies

This section summarizes distribution system improvements that are recommended to strengthen the existing system, enhance supply reliability and improve flow capacity and fire protection to various parts of the Village.

As discussed in Chapter VI, there are several areas within the Village of Pewaukee water distribution system where the needed fire flows cannot be supplied. For isolated deficiencies, it is often not economical to recommend specific improvements as these deficiencies will eventually be corrected by annual water main replacements (replacing existing older small diameter mains) and /or distribution system growth (primarily as a result of looping existing dead end mains). Recommended water main improvements were identified in locations where more widespread deficiencies are found. The proposed deficiency improvements are shown in Figure VII-1. Table VII-6 summarizes the recommended water system improvements shown in Figure VII-1.

Chapter VI identified Hawthorne Boosted Zone was served by a single main a water main failure could result in loss of water to the water system customers. An emergency connection to the Village of Sussex water system in the Village of Lisbon recommended to enhance system reliability.

The Village of Pewaukee has previously identified targeted areas for water main replacement to address to replace water main to improve reliability in areas susceptible to breaks in their Capital Improvement Plan. The Village has also included maintenance and repair projects for the exiting water storage facilities based on recent inspections.

FIGURE VII-1

Water Distribution Improvements

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Segment A

Segment B

Segment C

- Hydrant
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Mains
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500

Feet

Ruekert · Mielke

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Table VII-3: 2030 Recommended Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2030
Design Average Day Demand (gpm)	609
Design Maximum Day Demand (gpm)	1,212
Design Peak Hour Demand (gpm)	1,939
Present Reliable Supply Capacity (gpm)[1]	1,250
Reliable Supply Capacity Excess or (Deficiency) (gpm)	38

STORAGE RECOMMENDATIONS	Water System 2030
Peak Hour Equalizing Need (gallons) [2]	172,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	142,000
Total Optimum Recommended Storage (gallons)	944,000
Available Effective Storage Capacity (gallons):	
Tower (72,450 gallons peak hour, 177,550 gallons fire flow)	250,000
Tower (91,770 gallons peak hour, 108,230 gallons fire flow)	200,000
Standpipe (138,000 gallons peak hour, 530,000 gallons fire flow)	668,000
Total Effective Storage Capacity (gallons)[5]	1,118,000
Subtotal Capacity Recommended (gallons)	None
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	41,000
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	None

Notes

1. Reliable Supply Capacity is with largest well (Well No. 4) out of service . Wells operated for 20 hours per day.
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is equal to the maximum day demand rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

Table VII-4: 2035 Recommended Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2035
Design Average Day Demand (gpm)	640
Design Maximum Day Demand (gpm)	1,274
Design Peak Hour Demand (gpm)	2,038
Present Reliable Supply Capacity (gpm)[1]	1,281
Reliable Supply Capacity Excess or (Deficiency) (gpm)	8

STORAGE RECOMMENDATIONS	Water System 2035
Peak Hour Equalizing Need (gallons) [2]	181,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	144,000
Total Optimum Recommended Storage (gallons)	955,000
Available Effective Storage Capacity (gallons):	
Tower (72,450 gallons peak hour, 177,550 gallons fire flow)	250,000
Tower (91,770 gallons peak hour, 108,230 gallons fire flow)	200,000
Standpipe (138,000 gallons peak hour, 530,000 gallons fire flow)	668,000
Total Effective Storage Capacity (gallons)[5]	1,118,000
Subtotal Capacity Recommended (gallons)	None
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	6,000
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	None

Notes

1. Reliable Supply Capacity is with largest well (Well No. 4) out of service . Wells operated for 20.5 hours per day.
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is equal to the maximum day demand rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

Table VII-5: 2040 Recommended Supply and Storage Requirements

SUPPLY RECOMMENDATIONS	Water System 2040
Design Average Day Demand (gpm)	701
Design Maximum Day Demand (gpm)	1,395
Design Peak Hour Demand (gpm)	2,232
Present Reliable Supply Capacity (gpm)[1]	1,250
Reliable Supply Capacity Excess or (Deficiency) (gpm)	(145)

STORAGE RECOMMENDATIONS	Water System 2040
Peak Hour Equalizing Need (gallons) [2]	199,000
Optimum Fire Protection Needs (gallons) [3]	630,000
Reserve Storage (gallons; 15% of Total) [4]	147,000
Total Optimum Recommended Storage (gallons)	976,000
Available Effective Storage Capacity (gallons):	
Tower (72,450 gallons peak hour, 177,550 gallons fire flow)	250,000
Tower (91,770 gallons peak hour, 108,230 gallons fire flow)	200,000
Standpipe (138,000 gallons peak hour, 530,000 gallons fire flow)	668,000
Total Effective Storage Capacity (gallons)[5]	1,118,000
Subtotal Capacity Recommended (gallons)	None
Less Excess Available Reliable System Supply Capacity for Peak Hour[6]	None
Repump Capacity from reservoir at Well 3 [7]	24,000
Total Additional Capacity Recommended (gallons)	None

Notes

1. Reliable Supply Capacity is with largest well (Well No. 4) out of service and operating wells for 20 hours per day
2. Peak hour storage is storage utilized to meet demands which exceed the maximum day demand rate assuming the reliable supply capacity is equal to the maximum day demand rate.
3. Optimum fire protection based on 3,500 gpm for 180 minutes.
4. Reserve storage is storage utilized to provide a start/stop range for pump operation and an emergency reserve storage supply
5. Total Effective Storage Capacity is limited to a total of the Optimum Fire Protection Needs plus peak hour available storage to mainain regulatory system pressures.
6. Supply Capacity Credit cannot exceed Peak Hour Equalization and is calculated utilizing the time of day demand curve and current supply capacity.
7. Additional capacity of 400 gpm for 60 minutes

Table VII-6 - Summary of Water distribution Improvements to Address Existing Deficiencies

SUMMARY OF WATER DISTRIBUTION IMPROVEMENTS TO ADDRESS EXISTING DEFICIENCIES

Segment	Location	Diameter	Approximate Length	Improvement
A	Hickory Street.	8-inch	2,950 feet	To help improve fire flows and improve overall hydraulic capacity.
B	Capital Drive west of Ryan Street	8-inch	1,300 feet	To help improve fire flows and improve overall hydraulic capacity.
C	Cheviot Drive	8-Inch	100 feet	Emergency connection with Village of Sussex water system to enhance reliability

As the Utility begins to grow into the future service area, it will be necessary to further expand the water transmission main system to adequately accommodate these new service areas. Figure VII-2 illustrates the recommended improvements to serve the 2035 service area. Where possible all major transmission mains identified in Figure VII-2 have been sized to meet projected future water system demands, and support system supply sources and storage facilities to serve outlying area land uses. Mains were sized to provide at least 3,500 gpm of flow capacity in industrial areas and 1,500 gpm in commercial areas at a residual pressure of 20 psi.

The mains shown in Figure VII-2 are only the recommended transmission mains. Smaller local service mains have not been shown. The transmission mains shown follow known or presumed locations for major streets or roads in the future urban service area. Adjustments in the actual location of these mains can be expected at the time the mains are required or as local needs dictate.

Water mains to serve developing residential land should be sized at a minimum of 8 inches in diameter. These mains will provide a minimum of 750 gpm at a 20 psi residual pressure in single-family areas. Fire flows of 1,500 gpm should be used as the criterion for multiple family developments. To demonstrate the effectiveness of the recommended improvements, Figures VII-3, VII-4, VII-5, and VII-6, illustrate recommended fire flows, available fire flows, fire flow adequacy, and maximum day demand pressures respectively, with the recommended improvements under projected 2035 demands conditions.

As the Village of Pewaukee water system expands, the Utility should continue to loop existing dead end mains to improve fire flows and help build strength to the areas where the system is expanding.

FIGURE VII-2

Proposed Expansion Improvements

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Hydrant
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Main
- 10" Proposed Main
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

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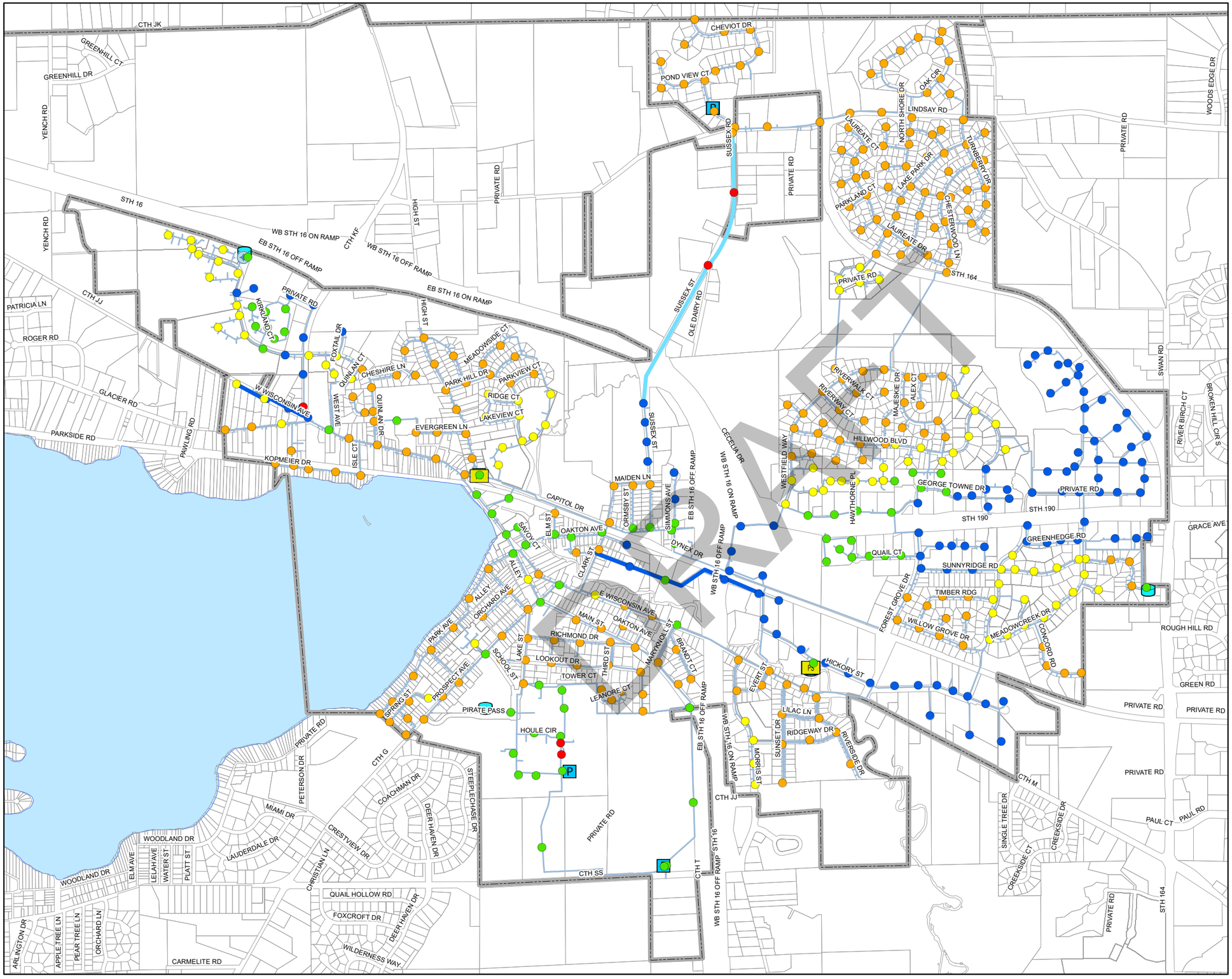

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Figure VII-3

Proposed Recommended Fire Flow

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Total Flow Needed

- 500 GPM
- 750 GPM
- 1,500 GPM
- 2,500 GPM
- 3,500 GPM
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Main
- 10" Proposed Main
- Water Main
- Civil Division

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W E
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0 750 1,500 3,000 4,500
Feet

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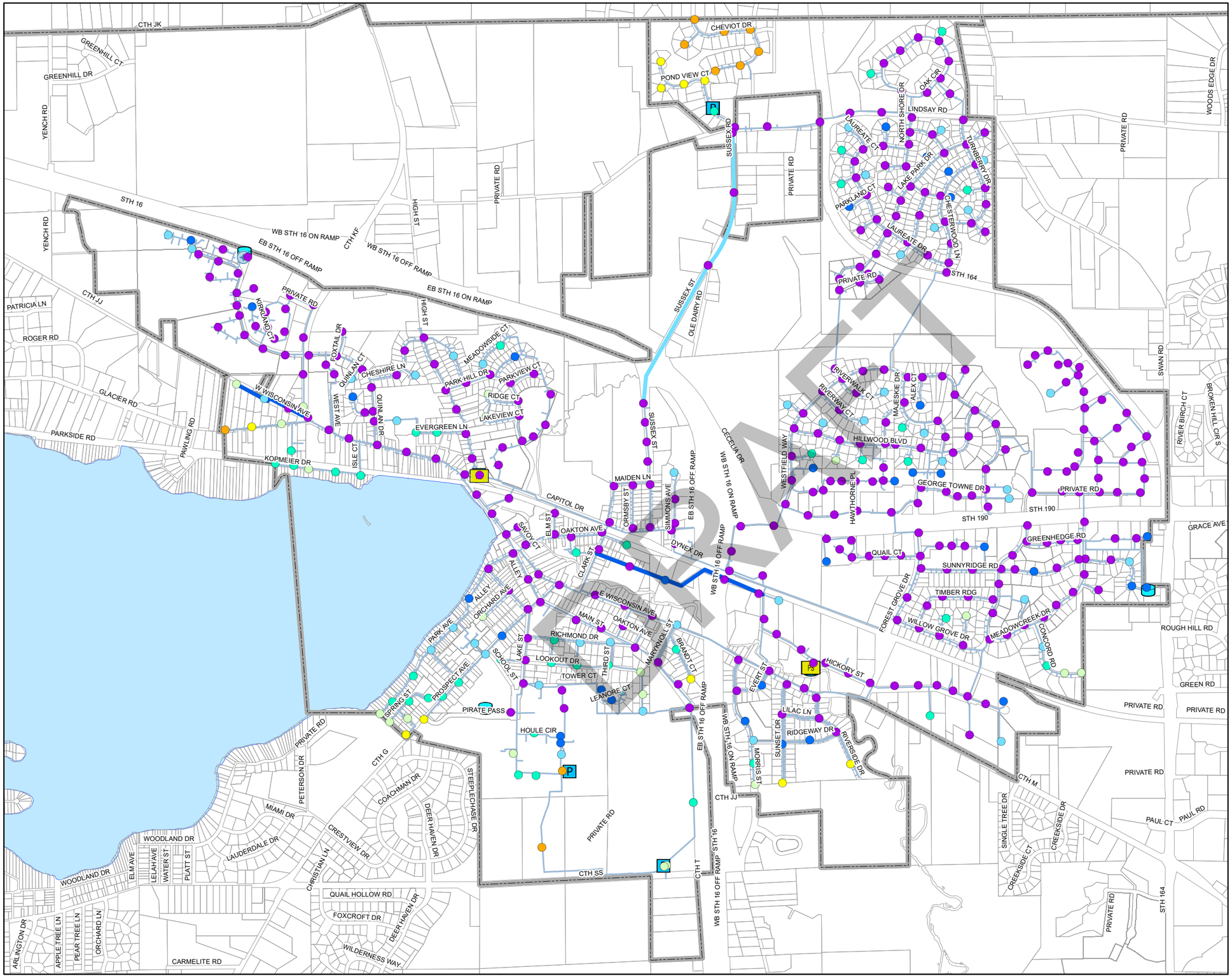

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Village of Pewaukee

Figure VII-4

Proposed Available Fire Flow

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Less than 500 GPM
- 500 GPM - 999 GPM
- 1,000 GPM - 1,500 GPM
- 1,500 GPM - 2,000 GPM
- 2,000 GPM - 2,500 GPM
- 2,500 GPM - 3,000GPM
- 3,000 GPM - 3,500 GPM
- Great than 3,500 GPM
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Main
- 10" Proposed Main
- Water Main
- Civil Division

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0 750 1,500 3,000 4,500
Feet

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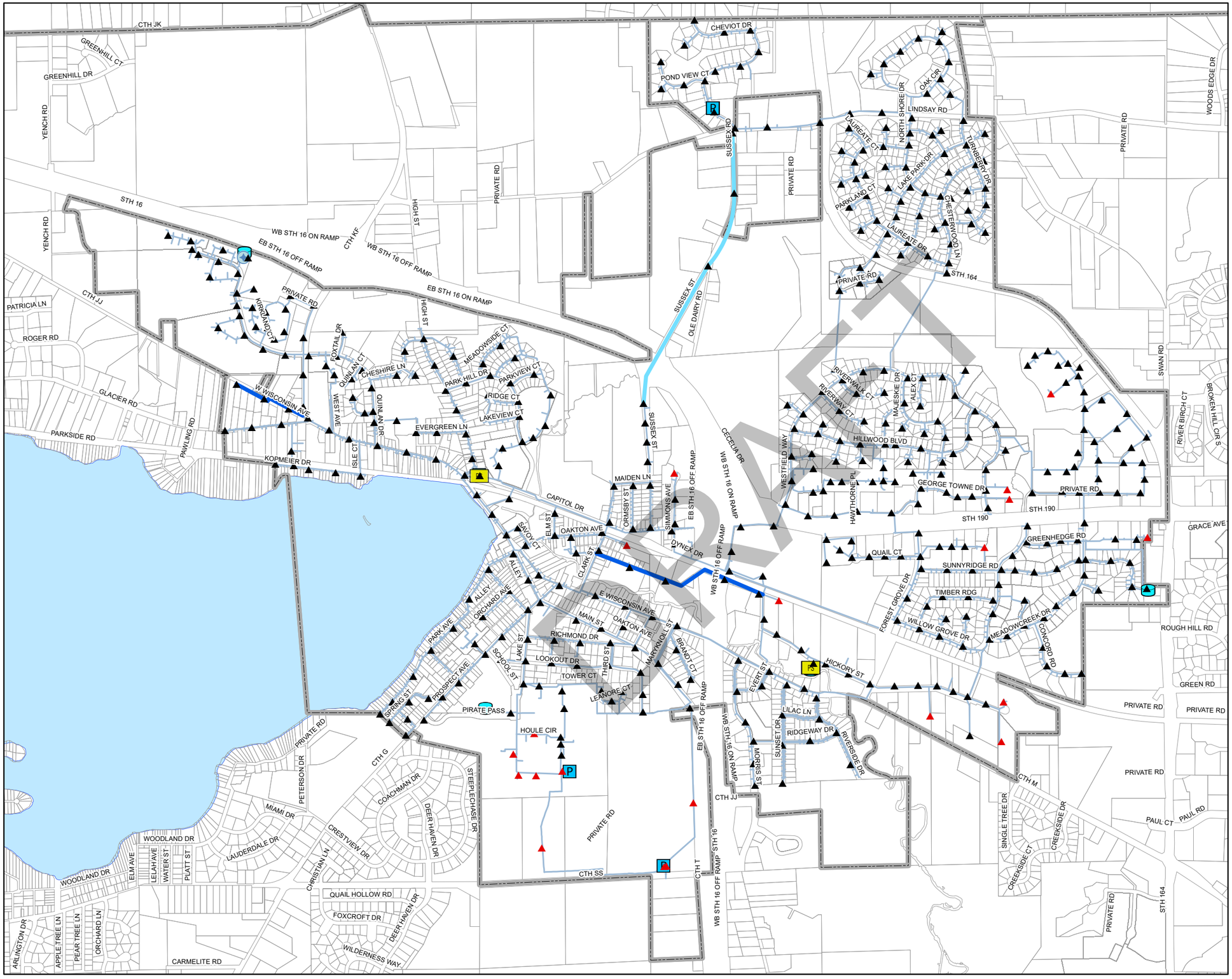

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Village of Pewaukee

Figure VII-5

Proposed Fire Flow Adequacy

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

- Does not Meet Fire Flow
- Meets Fire Flow
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Main
- 10" Proposed Main
- Water Main
- Civil Division

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0 750 1,500 3,000 4,500

Feet

Ruekert · Mielke

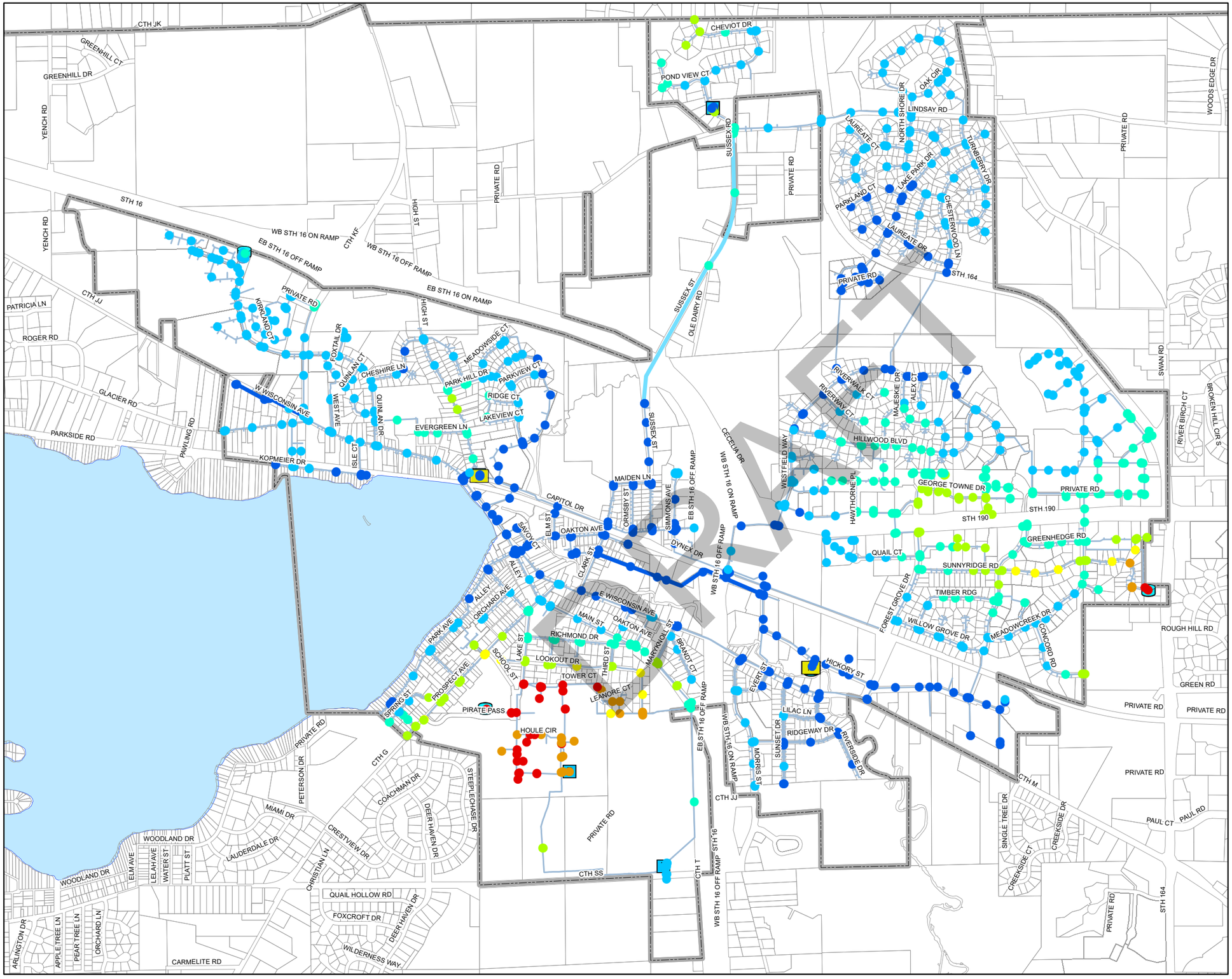

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Figure VII-6

Proposed Maximum Day Demand System Pressure

Village of Pewaukee
Water Utility
Waukesha County, Wisconsin
April, 2022

Pressure

- Less than 35 PSI
- 35 - 40 PSI
- 40 - 50 PSI
- 50 - 60 PSI
- 60 - 70 PSI
- 70 - 80 PSI
- Greater than 80 PSI
- Booster Station
- Pump Station
- Tanks
- Well
- 8" Proposed Main
- 10" Proposed Main
- Water Main
- Civil Division

N
W E
S

0 750 1,500 3,000 4,500
Feet

Ruekert · Mielke

2. Future Updates

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

The improvement plan is a guidance document that details existing conditions and recommendations for the future. The plan is based on future conditions as perceived in 2022. As time progresses, additional information will become available, and events will shape the development of the Village of Pewaukee area. The plan must be dynamic in response; it should be studied and used but also adjusted to conform to the changes and knowledge that will come with time. Updates should be made on a regular basis, probably every five to ten years.

VIII. CAPITAL IMPROVEMENTS PLAN

Chapter VIII summarizes the recommended water system improvements anticipated throughout the planning period. This chapter presents a proposed Water Utility capital improvements program. The recommended Capital Improvements Plan prioritizes system improvements and provides a schedule for the timing of construction. Budget cost estimates for each improvement are also included.

A. Recommended Capital Improvements

1. Supply

The construction of an HMO Filtration treatment facility is recommended to improve the present reliable supply capacity for future water demands. An additional 99 gpm of reliable supply capacity will be needed by the end of the 2035 planning period

2. Pressure Zone Development

The construction of a small boosted pressure zone is recommended to improve the level of service to the customers along Tower Road. A booster pump station will be required to meet the typical average, maximum day, and peak hour demands. Check valve vaults would be installed to establish the extents of the pressure zone and to allow water to flow from the main service zone to the boosted pressure zone to satisfy fire flow needs.

3. Storage

The development of the small boosted pressure zone increases the available equalizing storage volume of the existing elevated storage facilities. Only maintenance and repairs are needed to ensure reliability.

4. Distribution System

Figures VII-1 and VII-2 illustrate the proposed improvements to be completed by the year 2035. The figures illustrate recommended improvements to the existing distribution system and the recommended transmission mains required to serve the future service area. The improvements have been recommended to strengthen and expand the existing transmission main network, and support system expansion into future service areas.

To address existing deficiencies and provide water to developing areas in the Village, approximately 4,300 feet of water main replacements are recommended in the intermediate term. An additional 4,600 feet are recommended in the long term to provide service to future development.

The recommended improvements do not include all water mains needed for the expansion or development of all areas in the proposed water service area. Improvements associated with water mains to be installed to serve future developments or existing unserved developments are dependent on the location and size of the proposed development and will be determined on a case by case basis. Much of the cost of these improvements will be assessed to the benefitted properties.

B. Capital Improvements Plan

The proposed Capital Improvements Plan is presented in Table VIII-1. The plan presents budget cost estimates and a proposed schedule for the recommended system-wide improvements to be implemented over the planning period.

The proposed Capital Improvements Plan has been formulated based on all the information presented in this study. All the improvements have been developed and prioritized based on deficiencies identified in the existing water system, and the needs of the Utility's future service area. Improvements have been broken down into three categories:

- Short-term improvements (2022 – 2025)
- Intermediate-term improvements (2026 – 2030)
- Long-term improvements (2031 – 2035)

The actual construction cost for the recommended improvements may vary from the costs outlined in this report, depending on the year facilities are constructed, the rate of increase in future construction costs, and unforeseen conditions which could be encountered during design of the improvements.

In establishing priorities for these improvements, it will be necessary to take into consideration the availability of Utility financial resources and local Village needs to assure that the recommended improvements are implemented in an orderly, coordinated, and economical fashion.

Table VIII-1: Capital Improvements Plan

Short-Term Improvements (2022 – 2025)	**Estimated Cost[2,3]**
Distribution System Improvements	
Water Main Replacement E. Wisconsin Prospect to Maryknoll [4]	$ 440,000
Water Main Replacement Stone Ct. Briar Ct. Lexington Ct, Timber Ridge [4]	$ 15,000
Water Main Replacement Evergreen [4]	$ 285,000
Water Main Replacement Concord Road, Meadow Creek Ct. [4]	$ 10,000
Water Main Replacement Orchard Ave [4]	$ 170,000
Water Main Replacement Park Hill Drive [4]	$ 170,000
Water Main Replacement Glacier/Wisconsin West of Ryan [5]	$ 500,000
Well Rehab – Well 4, and Well 6 [4].	$ 290,000
Storage Facility Rehab -Quinlan, Well 3 Standpipe, Lake Street and Sunnyridge [4]	$1,190,000
Well 4 HMO Treatment	$1,675,900
Subtotal	**$4,745,900**
Engineering and Contingencies[1]	$1,423,800
Total	**$6,169,700**
Intermediate-Term Improvements (2026 – 2030)	
Distribution System Improvements	
Water Main Replacement Richmond Drive from Main St. to Like St. [4]	$ 300,000
Water Main Replacement Prospect Ave from Main St. to Maple [4]	$ 100,000
Water Main Loop Capital -Celia-Quail Ct. [4]	$ 150,000
Water Main Replacement Main Street from Prospect to Village Limit [4]	$ 80,000
Water Main Replacement Hickory Street from Clark to Village Hall [4]	$ 100,000
Water Main Replacement Kopmeier Drive from Kopmeier Rd to east end[4]	$ 285,000
Water Main Loop Glacier to Capito[4]l	$ 175,000
Water Main Replacement Sussex Street from Maiden to 300 feet North[4]	$ 75,000
Water Main Replacement – Hickory Street (2,950 Feet 8-inch)	$ 467,800
Booster Pump Station for customers on Tower Road	$ 305,300
Well Rehab -Well 5, Well 3 and Well 2[4]	$ 475,000
Subtotal	**$2,513,100**
Engineering and Contingencies[1]	$ 753,900
Total	**$3,267,000**
Long-Term Improvements (2031 – 2035)	
Distribution System Improvements	
Provide 10-inch on Sussex Street, crossing STH 16 to Lindsay Road (Approximately 4,600 feet of 10-inch diameter pipe)	$ 1,062,600
Subtotal	**$1,062,600**
Engineering and Contingencies[1]	$340,100
Total	**$1,402,700**

Footnotes:
[1] Assumes 30 percent for engineering, administrative, legal, and contingencies.
[2] Estimates do not include land purchase, if necessary.
[3]All costs are presented in 2022 dollars.
[4]Costs obtained from Village CIP for 2021 through 2030.
[5]Recommeded for correcting existing deficiency, cost obtained from Village CIP for 2021 through 2030.

C. Recommended Studies and Evaluations

Table VIII-2 summarizes the recommended studies and evaluations that the Utility should conduct over the long-term planning period in the event that the Village of Pewaukee would be requested to provide water service to the area in the City of Pewaukee as shown in Figure III-3.

Table VIII-2: Recommended Studies and Evaluations

Study	Purpose
Well Siting Study	Evaluate the potential for siting a new well to identify land requirements (location and size) so that land acquisitions can be made.

IX. APPENDIX A - GLOSSARY OF TERMS

Average Day Demand:	The average quantity of daily water usage in a municipal water system.
Elevated Storage:	A facility for storing water supplies above ground level at a specific elevation.
Flow Capacity:	The maximum flow rate that can be supplied by a water distribution system at a specified location and residual pressure (usually expressed as gpm).
Headloss	The energy loss as a result of friction caused by water passing along the interior surface of a pipe. (Usually expressed as feet of hydraulic head per 1,000 feet of pipe length, ft/1,000 ft)
Hydraulic Gradient:	The unconfined change in water surface elevation with respect to horizontal distance for a sloping water surface.
Maximum Day Demand:	The highest quantity of daily water usage in a municipal water system.
Maximum Day Ratio:	The ratio of maximum day to average day demand (usually expressed as a percentage).
Peak Hour Demand:	The daily rate of water usage during the hour of greatest water demand on a maximum usage day.
Peak Hour Demand Ratio:	The ratio of peak hour pumpage (expressed as a daily rate) to average day pumpage (usually expressed as a percentage).
Pipe Roughness Coefficient:	A coefficient (generally assumed to be constant) which describes the energy loss due to friction that will occur as water flows through a section of piping.
Reliable Supply Capacity:	The pumping capacity of a water supply facility with the largest pumping unit out of service.
Residual Pressure:	Pressure at a specified location in the water distribution system when water is being removed or flowed.
Static Pressure:	Normal pressure at a specified location in the water distribution system when no water is being removed or flowed.
Static Water Level:	The water level in a well when no water is being taken from the aquifer either by pumping or free flow (usually measured from ground surface or top of well casing).
Time-of-day Demand Curve:	A curve which describes changes in the quantities of water used by customers at different times of the day.
Total Dynamic Head:	The total energy that a pump must overcome to deliver a given flow rate including suction lift, discharge, and friction losses (usually expressed in feet of water).
Unaccounted-For Water:	The difference between the total volume of water pumped and the volume of water sold (expressed as gallons or as a percentage of total pumpage).

Water Balance:	A water balance displays how quantities of water flow into and out of the distribution system and to the customer. All data in the water balance is expressed as a volume per year.
Water Demand:	The amount of water required by a water user or users at a specific point or area within a water distribution system.
Water Distribution Main:	A water main which primarily extends water services and fire protection to an area.
Water Distribution System:	A facility usually consisting of a network of piping which is designed to distribute water from a given water supply to specific water users.
Water Supply System:	Facilities designed to collect and furnish a controlled supply of water for consumption or other water needs.
Water Transmission Main:	A large water main (generally 10-inch or larger) which is used to convey water between a water system's supply/storage facilities and service area.

X. APPENDIX B - LIST OF ABBREVIATIONS

fps	feet per second
gpcd	gallons per capita per day
gpd/acre	gallons per acre per day
gpm	gallons per minute
ft/1,000 ft	feet [of head] per 1,000 feet [of pipe length]
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
AWWA	American Water Works Association
DBPs	Disinfection Byproducts
FAA	Federal Aviation Administration
GAC	Granular Activated Carbon
GIS	Geographical Information System
GWR	Groundwater Rule
HGL	Hydraulic Grade Line
MG	Million Gallons
MGD	Million Gallons Per Day
MGY	Million Gallons Per Year
PSC	Public Service Commission
PRV	Pressure Reducing Valve
SCADA	Supervisory Control and Data Acquisition
TOD	Time of Day
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WI DOA	Wisconsin Department of Administration

XI. APPENDIX C – WATER STORAGE FACILITY INSPECTION REPORTS

Dixon Engineering, Inc.

Maintenance Inspection

250,000 Gallon Spheroid
(Lake Street)

Pewaukee, Wisconsin

Inspection Performed: September 15, 2021
Reviewed by Joseph T. Hoban P.E.: December 14, 2021

Phone (414) 529-1859
Fax (414) 282-7830
http://www.dixonengineering.net
Wisconsin@dixonengineering.net

Dixon Engineering, Inc.
4811 S. 76th St. Ste. 109, Greenfield, WI 53220

CONCLUSIONS:

1. The exterior coating is a urethane overcoat system. The coating is in good condition overall with no significant deterioration.

2. The dry interior coating is an epoxy system. Coating deterioration includes spot failures to the substrate with rust undercutting and rust bleedthrough. Most of the failures are on the bowl and access tube.

3. The wet interior coating is an epoxy system. The coating is in good condition overall with no significant deterioration.

RECOMMENDATIONS (GENERAL AND IMMEDIATE WORK):

Annually inspect the roof vent, hatches, and any other health or security items on the structure. The work could be performed by in-house personnel or contracted as part of a regular maintenance program.

Schedule regular cleanings and inspections of the tank by an independent third party once every five years as recommended by AWWA.

1. Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

RECOMMENDATIONS (IMMEDIATE WORK TO MEET WISCONSIN DNR REQUIREMENTS):

The Wisconsin DNR may allow some of the required changes to be delayed until the next paint project. These items are listed as immediate work since they are currently out of compliance.

1. Modify the overflow pipe discharge so it points downward to bring it into compliance with current Wisconsin DNR requirements. The estimated cost is $3,000.

2. Replace the screen at the overflow pipe discharge to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project or could be performed by in-house personnel.

3. Install a weather tight cover over the access tube air gap to meet current Wisconsin DNR requirements. The estimated cost is $3,000.

4. Install deflector bars at the end of the fill/draw pipe in the wet interior to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

5. Install a sample tap on the fill/draw pipe as required by the Wisconsin DNR. The estimated cost is $1,000.

RECOMMENDATIONS (WITH THE NEXT PAINT PROJECT):

Complete the recommended work in four years. The repairs and upgrades should be completed during the next major tank rehabilitation project when coating repairs are made.

1. High pressure water clean and overcoat the exterior with a urethane system. The estimated cost is $70,000.

2. Spot abrasive blast clean the topside of the platforms, the entire access tube, bowl, and other spot coating failures in the dry interior. Spot repaint all prepared surfaces with an epoxy coating system. The estimated cost is $25,000.

3. Coat the foundation to help prevent deterioration. The cost would be incidental to exterior painting.

4. Replace the damaged light fixtures in the dry interior. The estimated cost is $3,000.

5. Install a ladder extension at the condensate platform. The estimated cost is $2,000.

6. Install an aluminum cover over the fill/draw pipe insulation. The estimated cost is $3,000.

A DISCUSSION ON RESCUE AND RETRIEVAL OPERATIONS FROM ELEVATED STORAGE TANKS

Working on elevated water storage tanks is inherently dangerous. OSHA regulations give guidelines for the climbing on elevated structures. Contractors and Engineers/Consultants are responsible for their own employees, but even with safety training and proper equipment, accidents can occur. Most rescue squads are local or neighboring fire departments, with some departments having more experience than others. Water storage tanks are designed to store water and are not suited for rescue or retrieval convenience. We recommend that you meet with your local rescue personnel and draft a rescue plan. A copy of the plan should be kept at the tank and with the rescue crew.

OSHA does not require 30 inch manways or hatches but for rescue purposes 30 inch openings would allow enough room for a rescue basket with an injured person on it to pass through. Smaller openings may not be sufficient for retrieval.

Rescue personnel would gain access to the injured person using the existing ladders while attached to fall prevention devices. If possible, the basket would be lowered through the riser and out the opening in the bottom. If needed, the rescue crew would work from the roof inside a handrail. A tripod would be used to attach a winch to the basket. If the basket cannot fit through the riser then it would need to be raised to the roof.

From the roof it is possible to lower the basket over the side to ground level, but that would require a very large winch and increased loading on the attachment point. On a rainy, windy, or snowy day, the objective would be to get rescue personnel off the roof as soon as possible, so lowering through the dry interior is preferred. A helicopter rescue would need to be performed if it is not possible to lower the rescue basket down the dry interior.

Upgrades intended to make a rescue easier are included in this report. Dixon recommends 30 inch manways or hatches where possible and fall prevention devices on all ladders.

COST SUMMARY:

Exterior overcoat	$70,000
Dry interior partial repaint	25,000
Light fixtures	3,000
Overflow discharge modification	3,000
Ladder extension at the condensate platform	2,000
Access tube air gap seal	3,000
Sample tap	1,000
Fill/draw pipe insulation cover	3,000
Sub Total	$110,000
Engineering and Contingencies	$22,000
Total	$132,000

INSPECTION:

On September 15, 2021, Dixon Engineering Inc. performed a maintenance inspection on the 250,000 gallon spheroid (Lake Street) elevated water storage tank owned by the Village of Pewaukee, Wisconsin. Purposes of the inspection were to evaluate the interior and exterior coating's performance and life expectancy, assess the condition of metal surfaces and appurtenances, review safety and health aspects, and make budgetary recommendations for continued maintenance of the tank. All recommendations with budgeting estimates for repairs are incorporated in this report.

The inspection was performed by Josh Grover, Engineering Technician. The inspector was assisted by Lane Tremblay, ROV Operator, and Ryan Szczepaniak, Staff Technician.

A source of water for cleaning was provided by the Village. Sediment was flushed from the wet interior. Following the inspection, chlorine was added to disinfect the tank per AWWA Standard C652-19 Method No. 3. Photos are included with this report.

GENERAL INFORMATION:

The tank was built in 1968 by CB&I with a height to low-water level of 43.75 feet.

CONDITIONS AND RECOMMENDATIONS:

EXTERIOR COATING CONDITIONS:

Information on file with DIXON indicates that the exterior was last painted in 2010. The exterior was pressure washed and spot power tool cleaned to SSPC-SP11 condition. The coating applied was a urethane system.

The coating is in good condition overall with no significant deterioration. The coating is beginning to chalk and fade and there is loss of gloss. Surfaces have faded due to exposure to ultraviolet light which is a normal occurrence for an exterior coating system.

The bowl is covered with moderate mildew growth.

Good adhesion was noted on the ASTM X-cut test areas. If overcoating is not performed within the next two years, additional adhesion testing should be performed.

EXTERIOR COATING RECOMMENDATIONS:

Budget for overcoating in four years. The typical overcoat frequency for modern urethane systems is fifteen years. There is always a risk in overcoating the exterior, but we have had several successful projects when performed in the timeframe noted. The risk of poor adhesion of the overcoat system gets higher as the existing system gets older. Current adhesion showed the existing coating would support an additional coating system.

The recommended procedure is to high pressure water clean (5,000-10,000 psi) the exterior to remove any poorly adhered coating and any contaminants. Coating failures to the substrate would be spot power tool cleaned to bare metal (SSPC-SP11) condition. All sharp edges would be feathered into the surrounding coating.

The coating system would consist of a spot prime coat on the bare metal, a full coat of epoxy, and followed by two full coats of urethane. The urethane system offers excellent abrasion resistance with high gloss and sheen retention. The expected life of this system is fifteen years. The tank would be removed from service during the coating project. This is necessary to reduce condensation on the tank's surface. Urethane coatings have a minimum temperature requirement for application and are sensitive to moisture during the curing process. If moisture is present during the curing process, the appearance will become cloudy with little or no gloss. The estimated cost is $70,000.

DRY INTERIOR COATING CONDITIONS:

The dry interior on this structure is defined as the non-water contact surfaces, consisting of the basebell, riser, bowl, and access tube.

Information on file with DIXON indicated the dry interior was last painted in 2010. The dry interior was spot abrasive blast cleaned to SSPC-SP6 commercial condition. The coating applied was an epoxy system.

The basebell coating is in good condition with a few spot failures to the substrate with rust undercutting on the service door threshold.

The riser coating is in good condition with a few failures. Primary method of deterioration is spot failures to the substrate with rust undercutting. Most of the failures are on the riser stiffeners.

The coating on the topside of the platforms is in good condition with a few failures. Primary method of deterioration is spot failures to the substrate.

The bowl and access tube coating is in poor condition with numerous failures. Primary methods of deterioration are spot failures to the substrate with rust undercutting and extensive rust bleedthrough.

DRY INTERIOR COATING RECOMMENDATIONS:

Spot abrasive blast clean the dry interior to a commercial (SSPC-SP6) condition including the topside of the platforms, the entire access tube, the entire bowl, and other areas of failed coating. The prepared surfaces would be coated with an epoxy system. The work should be performed with an exterior painting project. The estimated cost is $25,000.

WET INTERIOR COATING CONDITIONS:

Information on file with DIXON indicated the wet interior was last painted in 2010. The wet interior was abrasive blast cleaned to SSPC-SP10 near-white condition. The coating applied was an epoxy system. The wet interior coating is in good condition overall with no significant deterioration.

The bowl was covered with approximately 8 inches of sediment that was flushed from the wet interior during the inspection.

The surfaces below the normal operating water level are covered with mineral staining which does not affect the integrity of the coating system.

WET INTERIOR COATING RECOMMENDATIONS:

The existing coating system has not deteriorated to the point where replacement is warranted. The cathodic protection system should adequately protect all areas below the high-water level where the coating has deteriorated. Reinspect in five years to update conditions and recommendations.

CATHODIC PROTECTION CONDITIONS:

The tank has a suspended impressed current cathodic protection system. Surfaces below the high-water level are protected by the submerged system that is suspended from arms attached to the access tube. The supporting ropes, arms, and anode wires appear to be in good condition with no visible damage.

CATHODIC PROTECTION RECOMMENDATIONS:

Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

PIT PIPING CONDITIONS:

There is a pit in the basebell that contains piping and valves. The pit has a metal grate and wooden cover that is in good condition. The piping is in good condition. The coating on the piping is in good condition with minor surface corrosion. Most of the coating failures are on the bolts.

FOUNDATION AND ANCHOR BOLT CONDITIONS:

The exposed concrete foundation is in good condition with no deterioration. The foundation is not coated.

There are anchor bolts evenly spaced on the baseplate around the basebell. The anchor bolts are in good condition with no steel loss from corrosion.

FOUNDATION AND ANCHOR BOLT RECOMMENDATIONS:

Coat the exposed concrete with an epoxy coating system to help prevent deterioration. The cost would be incidental to exterior painting.

GROUT CONDITIONS:

The grout between the baseplate and the foundation is in good condition with none damaged or missing.

ROOF HANDRAIL, PAINTER'S RAILING, AND ROOF RIGGING CONDITIONS:

There is a handrail on the roof surrounding the roof hatches and the vent. The handrail is in good condition. There is a painter's railing that surrounds the roof handrail. The painter's railing is in good condition.

There are enough roof rigging couplings for safety and staging lines during wet interior coating work.

LIGHTING/ELECTRICAL CONDITIONS:

The tank has a double aviation light with a photoelectric cell on the roof that appears to be in good condition. The light is operating properly.

There are light fixtures located in the dry interior. Three of the lights are missing globes and cages.

LIGHTING/ELECTRICAL RECOMMENDATIONS:

Replace the damaged light fixtures in the dry interior. The estimated cost is $3,000.

ANTENNA CONDITIONS:

There are four roof antennas attached to a free-standing mounting pole. The antenna cable routing is in good condition and does not interfere with climbing or tank operations. The cable penetrations through the basebell and access tube cover plate on the roof are sealed with caulk.

OVERFLOW PIPE CONDITIONS:

The overflow pipe extends along the access tube in the dry interior, down through the dry riser, and exits near the bottom of the basebell. The overflow pipe discharge is at an angle. The discharge end of the overflow pipe is screened. The screen is in fair condition. The screen is oversized and deformed. The pipe discharges to a splash pad. The air gap meets the required 12-24 inches. The discharge area is in good condition.

OVERFLOW PIPE RECOMMENDATIONS:

Immediately replace the screen at the overflow pipe discharge to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project or could be performed by in-house personnel.

Modify the overflow pipe discharge to bring it into compliance with current Wisconsin DNR requirements. The discharge must be in a downward position with a 12-24 inch air gap and must have a 4 mesh screen. The estimated cost is $3,000.

HATCH AND MANWAY CONDITIONS:

There is a 30 inch diameter roof hatch to the wet interior that is in good condition. The hinged cover is in good condition. There is a handhold next to the hatch to aid the climber while entering and exiting the opening. The hatch was not secured. The hatch neck curb height meets the minimum height requirement of 4 inches. The hatch cover lip meets the minimum height requirement of 2 inches. There was no gasket on the hatch. A gasket was installed on the roof hatch curb by the inspection crew.

There is a 24 inch diameter roof hatch into the dry interior that is in good condition. The hinged cover is in good condition. There is a handhold next to the hatch to aid the climber while entering and exiting the opening.

There is a 12 x 18 inch manway in the access tube to the wet interior that is in good condition. The manway gasket showed no signs of leakage and the bolts are in good condition.

There is a service door in the basebell that is in good condition. The door operated properly during the inspection.

There is a painter's hatch (bird hatch) at the top of the riser that is in good condition. There is a safety handhold above the hatch.

The condensate platform ladder opening is 30 inch diameter. The opening is equipped with a hinged cover. There is no safety handhold next to the opening.

The top platform ladder opening is 30 inch diameter. The opening is equipped with a hinged cover. There is a safety handhold next to the opening.

There is a rigging attachment point on the bowl for rescue retrieval line attachment.

HATCH AND MANWAY RECOMMENDATIONS:

Install a ladder extension at the condensate platform to assist entering and exiting the opening. The estimated cost is $2,000.

VENT CONDITIONS:

The roof vent is a pressure vacuum design that is in good condition. The pressure vacuum plate was found to be properly aligned. There is a large external screen intended to keep birds out and a smaller mesh screen on the interior intended to keep insects out. The screens are in good condition. There is a rain shield over the outer screen.

There is an access tube air gap on the roof that is not screened. This is a possible entry point for birds and/or insects to enter the wet interior, though there was no evidence of entry.

VENT RECOMMENDATIONS:

Install a weather tight cover over the access tube air gap to meet current Wisconsin DNR requirements. The estimated cost is $3,000.

LADDER CONDITIONS:

The dry interior ladders located in the basebell, riser, and access tube are in good condition. The ladders meet current OSHA size requirements. All ladders are equipped with rail-type fall prevention devices that are in good condition.

There is a wet interior ladder from the roof to the bowl that is in good condition. The ladder meets OSHA size requirements. The ladder is equipped with a rail-type fall prevention device that is in good condition.

FILL/DRAW PIPE CONDITIONS:

The tank fills and draws from a single pipe. The pipe routes through the dry interior, into the bottom of the bowl, and extends approximately 11 inches into the wet interior. There is not a deflector plate or bar over top of the pipe in the wet interior.

There is no sample tap on the fill/draw pipe.

There is a threaded coupling on the fill/draw pipe for future attachment of a chemical feed line.

FILL/DRAW PIPE RECOMMENDATIONS:

Install deflector bars at the end of the fill/draw pipe in the wet interior to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

Install a sample tap on the fill/draw pipe as required by the Wisconsin DNR. The estimated cost is $1,000.

EXPANSION JOINT CONDITIONS:

The fill/draw pipe is equipped with a bellow type expansion joint located in the pit. The expansion joint appears to be in good condition.

INSULATION CONDITIONS:

The fill/draw pipe is covered with rigid foam insulation. There is no cover over the insulation. The insulation seams are sealed with duct tape that has come loose in a few areas.

INSULATION RECOMMENDATIONS:

Install an aluminum cover over the fill/draw pipe insulation. The estimated cost is $3,000.

MUD VALVE CONDITIONS:

There is a mud valve located in the bottom of the tank to aid in removal of sediment during inspections and routine maintenance. The mud valve operated properly during the inspection.

CONDENSATE DRAIN CONDITIONS:

There is a condensate drain line that routes from the platform to the overflow pipe. There is a check valve in the line to stop backflow during overflow conditions.

WET INTERIOR METAL CONDITIONS:

The steel structure is in good condition overall.

DIXON ENGINEERING, INC.

STEEL TANK FIELD INSPECTION REPORT

PEDESTAL TANK

DATE: **September 15, 2021**

OWNER: **Village of Pewaukee**
CLIENT CODE: **49-68-10-01**
TANK NAME: **Lake Street**
LOCATION: Address: **300 School Street**
City: **Pewaukee**
State: **Wisconsin**
TANK SIZE: Capacity: **250,000 gallons**
Bottom (LWL): **43.75 feet (from nameplate)**
CONSTRUCTION:
Type: **Spheroid**
YEAR CONSTRUCTED: **1968**
MANUFACTURER: **CB&I**
CONTRACT NUMBER: **9-8148**
USE: **Potable water and fire protection**
Coating information below is from: **Dixon specification/project**

COATING HISTORY	EXTERIOR	WET INTERIOR	DRY INTERIOR
YEAR COATED	**2010**	**2010**	**2010**
CONTRACTOR	**Horizon Bros**	**Horizon Bros**	**Horizon Bros**
SYSTEM	**Urethane**	**Epoxy**	**Epoxy**
SURFACE PREPARATION	**SSPC-SP11**	**SSPC-SP10**	**SSPC-SP6 (spot)**
MANUFACTURER	**Tnemec**	**Tnemec**	**Tnemec**
HEAVY METAL COATING SAMPLES	**No**	**No**	**No**
HEAVY METAL BEARING	**Unknown**	**No**	**Unknown**

PERSONNEL: Lead inspector **Josh Grover**
Crew members **Lane Tremblay, Ryan Szczepaniak**
METHOD OF INSPECTION: **Dry**

SITE CONDITIONS

Fenced: **No**
Site large enough for contractor's equipment: **Yes**
Control building: **No**
Antenna control site: **No**
Power lines within 50 feet: **No**
Site drainage: **Away from tank**
Indications of underground leakage: **No**
Shrub, tree, etc. encroachment: **No**

EXPOSED PIPING

Location: **Tank base (in pit)**
Condition of structure: **Good**
Structure is: **Wet**
Pump present: **Yes**
Drain line present: **No**
Cover condition: **Good**
Locked: **No**
Pipe coating condition: **Good**
Describe coating: **Spot coating failures to substrate**
Condition of metal: **Good**
Piping comments: **There are minor spot coating failures on the bolts**

FOUNDATION

Foundation exposed: **Yes**
Exposed height: **0-3 inches**
Exposed foundation condition: **Good**
Damage or deterioration: **No**
Foundation coated: **No**
Grout condition: **Good**
Amount missing: **0 feet**
Undermining of foundation: **No**

EXTERIOR COATING

Basebell:

Topcoat condition: **Good**
Previous system condition: **Good**
Describe coating: **No significant coating deterioration**
Dry film thickness: **19-22 mils**
Adhesion: **3A**
Metal condition: **Good**

EXTERIOR COATING

Riser:

Topcoat condition: **Good**
Previous system condition: **Good**
Describe coating: **No significant coating deterioration**
Mildew growth: **No**
Metal condition: **Good**

Bowl:

Topcoat condition: **Good**
Previous system condition: **Good**
Describe coating: **No significant coating deterioration**
Mildew growth: **Yes – moderate**
Metal condition: **Good**

Sidewall:

Lettering: **No**
Logo: **No**
Topcoat condition: **Good**
Previous system condition: **Good**
Describe coating: **No significant coating deterioration**
Metal condition: **Good**

Roof:

Topcoat condition: **Good**
Previous system condition: **Good**
Describe coating: **No significant coating deterioration**
Dry film thickness: **18-23 mils**
Adhesion: **5A**
Metal condition: **Good**

EXTERIOR APPURTENANCES

Basebell Door:

Size: **30 x 60 inches**
Metal condition: **Good**

Anchor Bolts:

Number: **10**
Diameter: **1 ¾ inches**
Location: **Exterior**
Metal condition: **Good**

EXTERIOR APPURTENANCES

Overflow Pipe:

Diameter: **10 inches**
Metal condition: **Good**
Discharge orientation: **Angle**
Screen condition: **Fair - deformed**
Percent of screen open: **100**
Mesh size: **4**
Flap gate/duck bill check valve: **No**
Air gap: **Yes**
Lowest part of discharge to the ground distance: **14 inches**
Height to basebell penetration: **21 inches**
Overflow discharges to: **Concrete pad**
Condition: **Good**

Roof Handrail:

Diameter: **18 feet**
Height: **42.5 inches**
Midrail height: **23.5 inches**
Kick plate height: **4 inches**
Vertical post type: **Angle**
Size: **2.5 x 2.5 inches**
Top rail type: **Angle**
Size: **2.5 x 2.5 inches**
Midrail type: **Angle**
Size: **2.5 x 2.5 inches**
Metal condition: **Good**

Painter's Rail:

Diameter: **20 feet**
Are butt welds at braces: **Yes**
Metal condition: **Good**

Roof Rigging Points:

Number: **16**
Couplings covered: **Yes**
Covered with: **Plugs**
Metal condition: **Good**

Removable Cathodic Covers:

N/A

EXTERIOR APPURTENANCES

Wet Interior Roof Hatch:

Neck size: **30 inches**
Distance from center of the tank (to outer edge): **4.5 feet**
Shape: **Round**
Handhold at opening: **Yes**
Curb height: **4 inches**
Cover overlap: **2 inches**
Gasket on cover/neck curb: **Yes (installed by Dixon)**
Hatch security: **None**
Metal condition: **Good**

Dry Interior Roof Hatch:

Neck size: **24 inches**
Shape: **Round**
Handhold at opening: **Yes**
Hatch security: **Lock**
Metal condition: **Good**

Bolted Ventilation Hatch:

N/A

Access Tube Air Gap:

Screened/Covered: **No**

Roof Vent:

Number: **1**
Distance from center of the tank (to outer edge): **6.5 feet**
Type: **Pressure-vacuum**
Neck diameter: **30 inches**
Flange opening diameter: **24 inches**
Vertical screen/expanded metal condition: **Good**
Interior screen condition: **Good**
    Mesh size: **24**
Rain shield: **Yes**
Pressure plate condition: **Good**
    Plate free to move: **Yes**
    Plate screened: **No**
Height of the lowest screen above the roof: **24 inches**
Metal condition: **Good**

EXTERIOR APPURTENANCES

Aviation Lights:

Design: **Double red**
Location: **Free-standing mount**
Functioning: **Yes**
Globe condition: **Good**
Photoelectric cell: **Yes**
Location: **Roof**

Antennas:

Roof number: **4**
Attached to: **Free-standing pole**
Basebell cable penetrations sealed: **Yes**
Sealed with: **Caulk**
Roof cable penetrations sealed: **Yes**
Sealed with: **Caulk**
Antenna or cables interference: **No**

Electrical Components:

Electrical conduit condition: **Good**
Exposed wiring: **No**

DRY INTERIOR COATING

Basebell:

Coating condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Dry film thickness: **9-12 mils**
Metal condition: **Good**
Floor: **Stone**
Drain line present: **No**
Comments: **The spot coating failures are on the service door threshold**

Condensate Platform:

Platform design: **Full**
Coating condition: **Good**
Describe coating: **Spot coating failures to substrate**
Metal condition: **Good**
Ladder opening size: **30 inches**
Shape: **Round**
Opening covered: **Yes**
Handhold at opening: **No**
Drain: **Yes**

DRY INTERIOR COATING

Size: **2 inches**
Type: **To overflow**
Check valve: **Yes**

Riser above the Condensate Platform:

Coating condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Dry film thickness: **9-15 mils**
Metal condition: **Good**
Comments: **The coating failures are at the stiffeners**

Top Platform:

Platform design: **Partial**
Material: **Steel plate**
Coating condition: **Good**
Describe coating: **Spot coating failures to substrate**
Metal condition: **Good**
Ladder opening size: **30 inches**
Shape: **Round**
Opening covered: **Yes**
Handhold at opening: **Yes**
Handrail at platform
Height: **42 inches**
Midrail height: **21 inches**
Kick plate height: **4 inches**

Riser above the Top Platform:

Coating condition: **Good**
Describe coating: **No significant coating deterioration**
Dry film thickness: **10-15 mils**
Metal condition: **Good**

Bowl:

Coating condition: **Poor**
Describe coating: **Spot coating failures to substrate, rust undercutting, rust bleedthrough**
Metal condition: **Good**
Rigging lug above opening: **Yes**
Bowl comments: **There is extensive rust bleedthrough**

DRY INTERIOR COATING

Access Tube:

Diameter: **36 inches**
Topcoat condition: **Poor**
Prime coat condition: **Fair**
Describe coating: **Spot coating failures to substrate, rust undercutting, rust bleedthrough**
Dry film thickness: **10-13 mils**
Metal condition: **Good**
Access tube comments: **With overflow and manway crab bolts only approximately 11 inches of space to get through**

DRY INTERIOR APPURTENANCES

Electrical Components:

Lights functioning: **Yes**
Missing covers (globes and cages): **Yes**
Number missing both globes and cages: **3**
Additional lights needed: **No**
Electrical outlet/conduit condition: **Good**
Used during inspection: **No**

Sample Tap:

N/A

Threaded Coupling (for chemical feed on the fill/draw pipe):

Location: **In pit**
Condition: **Good**

Expansion Joint:

Location: **Bottom of fill pipe**
Accessible for inspection: **Yes**
Type: **Bellows**
Coating condition: **Not coated**
Metal condition: **Good**

Fill/Draw Pipe Insulation:

Insulation cover: **No**
Condition: **Good to fair**
Seams loose: **No**

DRY INTERIOR APPURTENANCES

Basebell Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Rail**
Function properly: **Yes**
Cage: **No**

Riser Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Rail**
Function properly: **Yes**
Cage: **No**

Painter's (bird) Hatch:

Handhold above hatch: **Yes**
Metal condition: **Good**
Hatch security: **Bolt**

Manway to Wet Interior:

Size: **12 x 18 inches**
Location: **In access tube**
Metal condition: **Good**

Mud Valve:

Number: **1**
Type: **Babco**
Discharge material: **Hose**
Discharge slope: **Downward**
Functioning properly: **Yes**
Metal condition: **Good**

DRY INTERIOR APPURTENANCES

Access Tube Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Rail**
Function properly: **Yes**

WET INTERIOR COATING

Roof:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Metal condition: **Good**
Lap seams: **Caulked**
Condition of lap seams: **Good**
Roof comments: **There is a small amount of rust staining**

Sidewall:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Mineral deposits: **Light**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Sidewall comments: **There is extensive mineral staining**

Access Tube:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Mineral deposits: **Light**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**

WET INTERIOR COATING

Tank Bottom:

Type: **Bowl**
Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Mineral deposits: **Moderate**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Sediment depth: **8 inches**

WET INTERIOR APPURTENANCES

Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Shape of side rails: **Flat**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Rail**
Function properly: **Yes**

Cathodic Protection:

Clips: **Yes**
Pressure fitting: **Yes**
Location of clips: **Bowl**
Type: **Arms off access tube**
Location of controls: **In basebell**
Ropes/arms damaged: **No**
Wires damaged: **No**

Roof Stiffeners:

N/A

Sidewall Stiffeners:

N/A

Overflow Pipe Inlet:

Type: **Vortex break**
Metal condition: **Good**

WET INTERIOR APPURTENANCES

Fill Pipe:

Diameter: **12 inches**
Height above the tank bottom: **7-11 inches**
Deflector over end: **No**
Metal condition: **Good**

Separate Draw Pipe:

N/A

Mixer:

N/A

Field Inspection Report is prepared from the contractor's viewpoint. It contains information the contractor needs to prepare his bid for any repair or recoating. The engineer uses it to prepare the engineering report. Cost estimates are more accurate if the contractor's problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site.

250,000 gallon spheroid (Lake Street) elevated water storage tank owned by the Village of Pewaukee, Wisconsin.

1) The concrete foundation is in good condition with no significant deterioration.

2) The anchor bolts are in good condition. There is no missing grout between the baseplate and foundation.

3) The service door operated properly during the inspection.

4) The overflow pipe discharges to a concrete splash pad.

5) The screen at the overflow discharge is intact but deformed and oversized.

6) There are no coating failures on the basebell.

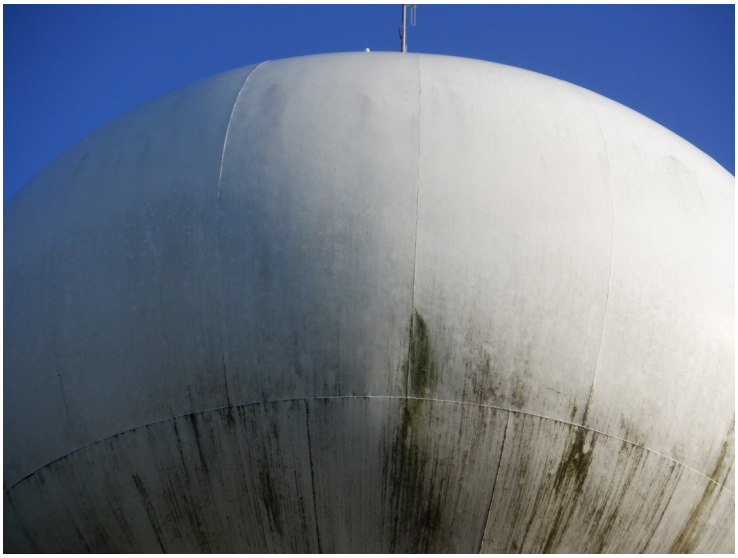
7) Same.

8) The riser coating is in good condition with no deterioration.

9) Same.

10) The bowl is covered with mildew growth but there are no visible coating failures.

11) Same.



12) The sidewall coating is in good condition overall.

13) Same.

14) The roof coating has faded but there is no significant deterioration.

15) Same.

16) Same.

17) The roof handrail and painter's railing are in good condition.

18) The wet interior roof hatch is in good condition. A gasket was installed on the hatch during the inspection.

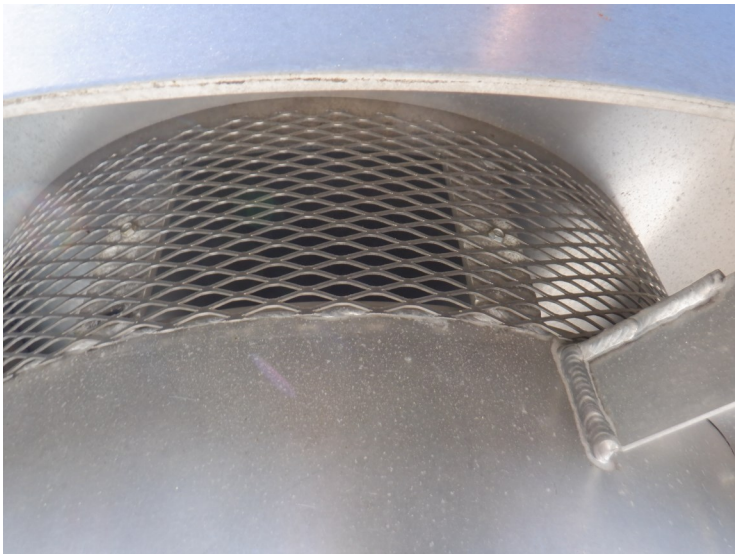
19) The dry interior roof hatch is in good condition.

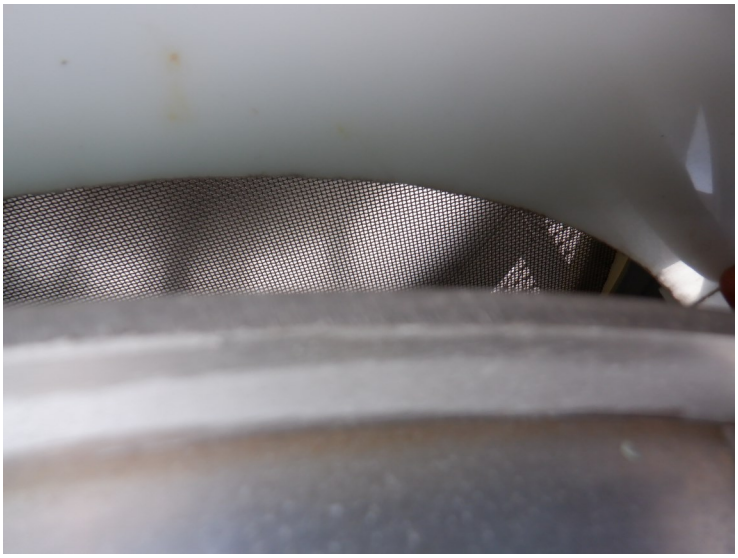
20) There is no cover over the access tube air gap.

21) The roof vent is in good condition.

22) The roof vent pressure plate was properly aligned and free to move.

23) The vertical roof vent screen is in good condition.





24) The interior roof vent screen is intact with no gaps.

25) The double aviation light was operating properly during the inspection.

26) The dry interior basebell coating is in good condition overall with no significant deterioration.

27) Same.

28) The is a check valve on the condensate platform drain.

29) The basebell ladder is in good condition. The ladder is equipped with a fall prevention device.

30) The ladder opening at the condensate platform is equipped with a hinged cover.

31) Minor coating failures on the condensate platform.

32) Same.

33) Coating failures along a stiffener in the dry riser.

34) Same.

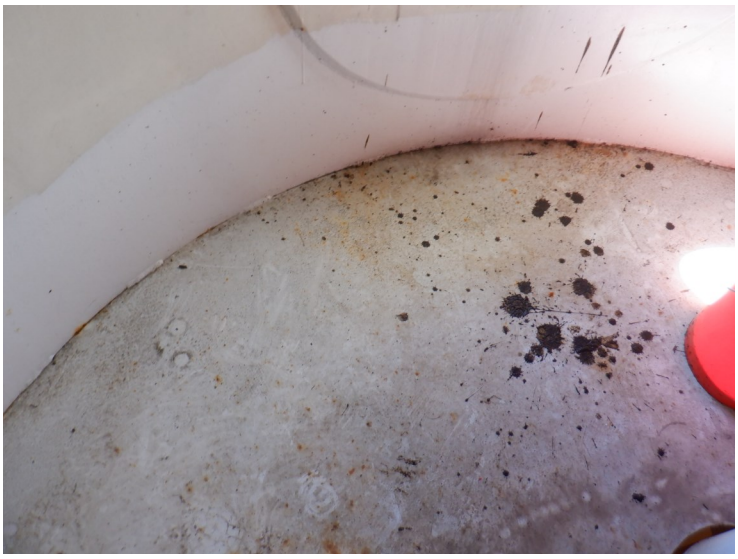
35) The dry riser coating is in good condition overall.

36) There is no cover over the fill/draw pipe insulation.

37) The riser ladder is in good condition. The ladder is equipped with a fall prevention device.

38) The ladder opening at the top platform is equipped with a hinged cover.

39) Minor coating failures on the top platform.



40) Coating on the top platform is in good condition overall.

41) There is a handhold above the painter's hatch at the top of the riser.

42) The mud valve operated properly during the inspection.

43) There is a rigging lug on the bowl above the top platform hatch.

44) Extensive rust bleedthrough on the bowl.

45) Same.

46) Extensive rust bleedthrough in the access tube.

47) Same.

48) Coating failures on the wet interior manway.

49) The access tube ladder is in good condition. The ladder is equipped with a fall prevention device.

50) Coating on the wet interior roof is in good condition with no significant deterioration.

51) Same.

52) Same.

53) There is heavy mineral staining on the wet interior sidewall but no coating failures.

54) Same.

55) Same.

56) There are no coating failures on the access tube in the wet interior.

57) Same.

58) The cathodic protection system appears to be in good condition.

59) The wet interior ladder is in good condition. The ladder is equipped with a fall prevention device.

60) The wet interior manway cover is in good condition.

61) The coating on the bowl is in good condition overall.

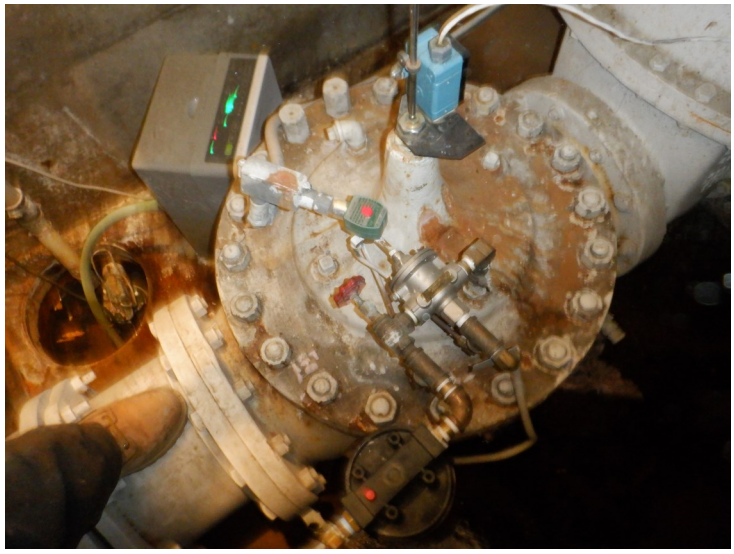
62) Same.

63) Same.

64) There are no deflector bars over the fill/draw pipe in the wet interior.

65) The mud valve operated properly during the inspection.

66) The cover over the pit in the basebell is in good condition.



67) Minor coating failures on the pit piping.

68) Same.

69) The bellows type expansion joint on the fill/draw pipe is in good condition.

Dixon Engineering, Inc.

Maintenance Inspection

200,000 Gallon Spheroid
(Quinlan Drive)

Pewaukee, Wisconsin

Inspection Performed: November 16, 2021
Reviewed by Joseph T. Hoban P.E.: December 14, 2021

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CONCLUSIONS:

1. The exterior coating is a urethane system. The coating is in good to fair condition overall. Coating deterioration includes spot failures to the substrate with rust undercutting, topcoat delamination, and erosion. There are numerous coating failures on the basebell and roof.

2. The dry interior coating is an epoxy system. Coating deterioration includes spot failures to the substrate and rust bleedthrough. Most of the failures are on the topside of the platforms, transition cone, and access tube.

3. The wet interior coating is an epoxy system. Below the high-water level coating deterioration includes spot failures to the substrate with rust undercutting and topcoat delamination on the bowl and sidewall. Above the high-water level coating is deteriorating at the roof panels.

RECOMMENDATIONS (GENERAL AND IMMEDIATE WORK):

Annually inspect the roof vent, hatches, and any other health or security items on the structure. The work could be performed by in-house personnel or contracted as part of a regular maintenance program.

Schedule regular cleanings and inspections of the tank by an independent third party once every five years as recommended by AWWA.

1. Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

RECOMMENDATIONS (IMMEDIATE WORK TO MEET WISCONSIN DNR REQUIREMENTS):

The Wisconsin DNR may allow some of the required changes to be delayed until the next paint project. These items are listed as immediate work since they are currently out of compliance.

1. Modify the overflow pipe discharge so it points downward and so the air gap is 12 to 24 inches to bring it into compliance with current Wisconsin DNR requirements. The estimated cost is $2,000.

2. Install a gasket on the wet interior roof hatch to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project or could be performed by in-house personnel.

3. Replace the roof vent with a pressure vacuum vent to meet current Wisconsin DNR requirements. The estimated cost is $6,000.

RECOMMENDATIONS (WITH THE NEXT PAINT PROJECT):

Complete the recommended work in one to two years. The repairs and upgrades should be completed during the next major tank rehabilitation project when coating repairs are made.

1. Abrasive blast clean the exterior inside a dust tight containment system and repaint with a urethane system. The estimated cost is $140,000 plus $100,000 for containment.

2. Spot abrasive blast clean the topside of the platforms, the entire access tube, transition cone, and other spot coating failures in the dry interior. Spot repaint all prepared surfaces with an epoxy coating system. The estimated cost is $30,000.

3. Abrasive blast clean the entire wet interior and repaint with an epoxy system. The estimated cost is $75,000.

4. Abrasive blast clean the pit piping and repaint with an epoxy system. The estimated cost is $5,000.

5. Recoat the foundation to help prevent deterioration. The cost would be incidental to exterior painting.

6. Install a painter's railing outside the existing roof handrail. The estimated cost is $6,000.

7. Install rigging couplings on the roof for temporary fall prevention of workers in the wet interior. The cost would be incidental to the next painting project.

8. Remove all antennas and antenna cables prior to abrasive blast cleaning and repainting. The cost is assumed to be the responsibly of the antenna owners.

9. Install a handhold at the wet interior roof hatch, access tube roof hatch, and painter's (bird) hatch. The handhold would assist the climber while entering and exiting the openings. The cost would be incidental to the next painting project.

10. Install a rigging lug on the transition cone above the top platform opening. The cost would be incidental to the next painting project.

11. Install a mud valve in the bottom of the tank. The estimated cost is $5,000.

A DISCUSSION ON RESCUE AND RETRIEVAL OPERATIONS FROM ELEVATED STORAGE TANKS

Working on elevated water storage tanks is inherently dangerous. OSHA regulations give guidelines for the climbing on elevated structures. Contractors and Engineers/Consultants are responsible for their own employees, but even with safety training and proper equipment, accidents can occur. Most rescue squads are local or neighboring fire departments, with some departments having more experience than others. Water storage tanks are designed to store water and are not suited for rescue or retrieval convenience. We recommend that you meet with your local rescue personnel and draft a rescue plan. A copy of the plan should be kept at the tank and with the rescue crew.

OSHA does not require 30 inch manways or hatches but for rescue purposes 30 inch openings would allow enough room for a rescue basket with an injured person on it to pass through. Smaller openings may not be sufficient for retrieval.

Rescue personnel would gain access to the injured person using the existing ladders while attached to fall prevention devices. If possible, the basket would be lowered through the riser and out the opening in the bottom. If needed, the rescue crew would work from the roof inside a handrail. A tripod would be used to attach a winch to the basket. If the basket cannot fit through the riser then it would need to be raised to the roof.

From the roof it is possible to lower the basket over the side to ground level, but that would require a very large winch and increased loading on the attachment point. On a rainy, windy, or snowy day, the objective would be to get rescue personnel off the roof as soon as possible, so lowering through the dry interior is preferred. A helicopter rescue would need to be performed if it is not possible to lower the rescue basket down the dry interior.

Upgrades intended to make a rescue easier are included in this report. Dixon recommends 30 inch manways or hatches where possible and fall prevention devices on all ladders.

COST SUMMARY:

Exterior repaint with containment	$240,000
Dry interior partial repaint	30,000
Wet interior repaint	75,000
Pit piping repaint	5,000
Roof painter's railing	6,000
Overflow discharge modification	2,000
Pressure vacuum roof vent	6,000
Mud valve	5,000
Sub Total	$369,000
Engineering and Contingencies	$74,000
Total	$443,000

Notes: Exterior coating is primarily for aesthetics and can be delayed since the next paint job cannot be an overcoat. While the appearance will deteriorate the structural integrity should not be impacted.

Exterior repainting will require temporary removal and relocation of the antennas and cables. This cost is not included in these estimates and is assumed to be the responsibility of the antenna owners. Cost is also not included for coordinating with the antenna carriers or for any redesign work needed for antenna mounting or cable routing.

INSPECTION:

On November 16, 2021, Dixon Engineering Inc. performed a maintenance inspection on the 200,000 gallon spheroid (Quinlan Drive) elevated water storage tank owned by the Village of Pewaukee, Wisconsin. Purposes of the inspection were to evaluate the interior and exterior coating's performance and life expectancy, assess the condition of metal surfaces and appurtenances, review safety and health aspects, and make budgetary recommendations for continued maintenance of the tank. All recommendations with budgeting estimates for repairs are incorporated in this report.

The inspection was performed by James Rowley, P.E. The inspector was assisted by Larry Houck and Ben Wozniak, Staff Technicians.

A source of water for cleaning was provided by the Village. Sediment was flushed from the wet interior. Following the inspection, chlorine was added to disinfect the tank per AWWA Standard C652-19 Method No. 3. Photos are included with this report.

GENERAL INFORMATION:

The tank was built in 1996 by Maguire Iron with a height to high-water level of 169 feet 6 inches.

CONDITIONS AND RECOMMENDATIONS:

EXTERIOR COATING CONDITIONS:

Information provided by the Owner to DIXON indicates that the exterior was last painted in 1997. The exterior was abrasive blast cleaned to SSPC-SP6 commercial condition. The coating applied was a urethane system.

The coating is in good to fair condition overall. The coating is beginning to chalk and fade and there is loss of gloss. Surfaces have faded due to exposure to ultraviolet light which is a normal occurrence for an exterior coating system.

The basebell coating is in fair condition with numerous failures. Primary method of deterioration is spot failures to the substrate with rust undercutting.

The riser and bowl coating is in good condition with a few failures. Primary method of deterioration is spot failures to the substrate with rust undercutting. The bowl is covered with moderate mildew growth.

The sidewall coating is in good condition with a few failures. Primary methods of deterioration are spot failures to the substrate and delaminated topcoat.

The roof coating is in fair condition with numerous failures. Primary methods of deterioration are spot failures to the substrate, delaminated topcoat, and erosion.

EXTERIOR COATING RECOMMENDATIONS:

Budget for total exterior coating removal and repainting in approximately one to two years or when aesthetics dictate. Fading will continue, and more rust spots will occur decreasing the tank's aesthetic appearance.

Remove the existing coating by dry abrasive blast cleaning the steel to a commercial (SSPC-SP6) condition and apply a urethane system. All blast work would be performed inside a dust tight containment system using negative air pressure.

Total removal is recommended because the coating failures are extensive and it is not practical to attempt to spot repair all failed areas.

The coating system would consist of a full prime coat on the bare metal, a full coat of epoxy, and followed by two full coats of urethane. The urethane system offers excellent abrasion resistance with high gloss and sheen retention. The expected life of this system is fifteen years. The system can be overcoated in fifteen years, and a second time approximately fifteen years after the first overcoat, extending the total life of the coating to approximately forty-five years before total removal would be necessary. The tank would be removed from service during the coating project. This is necessary to reduce condensation on the tank's surface. Urethane coatings have a minimum temperature requirement for application and are sensitive to moisture during the curing process. If moisture is present during the curing process, the appearance will become cloudy with little or no gloss. The estimated cost is $140,000 plus $100,000 for containment.

DRY INTERIOR COATING CONDITIONS:

The dry interior on this structure is defined as the non-water contact surfaces, consisting of the basebell, riser, transition cone, and access tube.

Information provided by the Owner to DIXON indicated the dry interior was last painted in 1997. The dry interior was abrasive blast cleaned to SSPC-SP6 commercial condition. The coating applied was an epoxy system.

The basebell coating is in good condition with a few failures. Primary method of deterioration is spot failures to the substrate with rust undercutting. Most of the failures are on the baseplate.

The riser coating is in good condition with a few failures. Primary methods of deterioration are spot failures to the substrate and rust bleedthrough. Most of the failures are on the stiffeners.

The coating on the topside of the platforms is in poor condition with extensive failures. Primary method of deterioration is spot failures to the substrate with rust undercutting.

The transition cone and access tube coating is in poor condition with extensive rust bleedthrough.

DRY INTERIOR COATING RECOMMENDATIONS:

Spot abrasive blast clean the dry interior to a commercial (SSPC-SP6) condition including the topside of the platforms, the entire access tube, the entire transition cone, and other areas of failed coating. The prepared surfaces would be coated with an epoxy system. The work should be performed with an exterior/wet interior painting project. The estimated cost is $30,000.

WET INTERIOR COATING CONDITIONS:

Information provided by the Owner DIXON indicated the wet interior was last painted in 1997. The wet interior was abrasive blast cleaned to SSPC-SP10 near-white condition. The coating applied was an epoxy system.

The roof coating is in poor condition with numerous failures. Primary methods of deterioration are spot failures to the substrate with rust undercutting, rust bleedthrough, and delaminated topcoat.

The sidewall coating is in poor condition with a few failures. Primary method of deterioration is spot failures to the substrate with rust undercutting. There is no significant coating damage at the high-water level which would be the area most affected by ice movement. Most of the coating failures are on the weld seams.

The access tube coating is in good condition with no significant deterioration.

The coating on the transition cone is in poor condition with numerous failures. Primary methods of deterioration are spot failures to the substrate with rust undercutting and delaminated topcoat.

The bowl was covered with approximately one inch of sediment that was flushed from the interior during the inspection.

WET INTERIOR COATING RECOMMENDATIONS:

Budget to repaint the wet interior in one to two years. Abrasive blast clean the entire wet interior to a near-white metal (SSPC-SP10) condition. Wet interior coating systems must be approved for potable water storage tanks contingent upon meeting requirements of NSF/ANSI 61.

Apply a three-coat epoxy system to the prepared surfaces. Epoxy coating systems are recommended in most applications because they have good adhesion and abrasion resistant qualities. The estimated cost is $75,000.

CATHODIC PROTECTION CONDITIONS:

The tank has a suspended impressed current cathodic protection system. Surfaces below the high-water level are protected by the submerged system that is suspended from arms attached to the access tube. The supporting ropes, arms, and anode wires appear to be in good condition with no visible damage.

CATHODIC PROTECTION RECOMMENDATIONS:

Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

PIT AND BUILDING PIPING CONDITIONS:

There is a pit in the basebell that contains piping and valves. The pit has a wooden cover that is in good condition. The piping is in good condition. The coating on the piping is in poor condition with extensive failure.

There is a building adjacent to the tank that contains piping and valves. The piping is above the floor. The piping is in good condition. The coating on the piping is in fair condition with general surface corrosion.

PIT AND BUILDING PIPING RECOMMENDATIONS:

Abrasive blast clean the piping in the pit to a commercial (SSPC-SP6) condition and repaint with an epoxy system. The estimated cost is $5,000.

Dixon typically does not recommend abrasive blast cleaning in the control building unless there is significant steel loss from corrosion on the piping. Even when thoroughly sealed there is a risk of the dust damaging the controls and/or motors. Spot coating repairs could be performed by in-house personnel as needed.

FOUNDATION AND ANCHOR BOLT CONDITIONS:

The exposed concrete foundation is in good condition with no deterioration. The top of the foundation is coated. The coating is in fair condition with some erosion.

There are anchor bolts evenly spaced on the baseplate around the basebell. The anchor bolts are in good condition with no steel loss.

FOUNDATION AND ANCHOR BOLT RECOMMENDATIONS:

Recoat the exposed concrete with an epoxy coating system to help prevent deterioration. The cost would be incidental to exterior painting.

GROUT CONDITIONS:

The grout between the baseplate and the foundation is in good condition with none damaged or missing.

ROOF HANDRAIL, PAINTER'S RAILING, AND ROOF RIGGING CONDITIONS:

There is a handrail on the roof surrounding the roof hatches and the vent. The handrail is in good condition. The handrail is being used for antenna mounting. There is not a painter's railing on the roof.

There are no roof rigging couplings for safety and staging lines during wet interior coating work.

ROOF HANDRAIL, PAINTER'S RAILING, AND ROOF RIGGING RECOMMENDATIONS:

Install a painter's railing outside the existing roof handrail. The railing gives the contractor a rigging point for staging. The estimated cost is $6,000.

Install rigging couplings on the roof under the new painter's railing for fall prevention of workers in the wet interior. The cost would be incidental to the next painting project.

LIGHTING/ELECTRICAL CONDITIONS:

The tank has a double aviation light with a photoelectric cell on the roof that is in good condition. The light is operating properly.

There are light fixtures located in the dry interior. The lights were operational during the inspection.

ANTENNA CONDITIONS:

There are fifteen roof antennas and miscellaneous antenna equipment attached to the handrail. There are six antennas and miscellaneous antenna equipment on the riser attached to mounting brackets below the painter's railing. The antenna cable routing is in good condition and does not interfere with climbing or tank operations. The cable penetrations through the basebell, riser, and access tube cover plate on the roof are sealed with rubber boots.

ANTENNA RECOMMENDATIONS:

Remove all antennas and antenna cables prior to abrasive blast cleaning and repainting. The cost is assumed to be the responsibly of the antenna owners.

OVERFLOW PIPE CONDITIONS:

The overflow pipe extends along the access tube in the dry interior, down through the dry riser, and exits near the bottom of the basebell. The overflow pipe discharge is at an angle. The discharge end of the overflow pipe is screened. The screen is in good condition but is oversized. The pipe discharges to a splash pad. The air gap does not meet the required 12-24 inches.

OVERFLOW PIPE RECOMMENDATIONS:

Modify the overflow pipe discharge so it points downward and so the air gap is 12 to 24 inches to bring it into compliance with current Wisconsin DNR requirements. The estimated cost is $2,000.

HATCH AND MANWAY CONDITIONS:

There is a 30 inch diameter roof hatch to the wet interior that is in good condition. The hinged cover is in good condition. There is no handhold next to the hatch to aid the climber while entering and exiting the opening. The hatch was not secured. The hatch neck curb height meets the minimum height requirement of 4 inches. The hatch cover lip meets the minimum height requirement of 2 inches. There was no gasket on the hatch.

There is a 30 inch diameter roof hatch into the dry interior that is in good condition. The hinged cover is in good condition. There is no handhold next to the hatch to aid the climber while entering and exiting the opening.

There is a 20 inch diameter manway in the transition cone to the wet interior that is in good condition. The manway gasket showed no signs of leakage and the bolt is in good condition.

There is a service door in the basebell that is in good condition. The door operated properly during the inspection.

There is a painter's hatch (bird hatch) at the top of the riser that is in good condition. There is no safety handhold above the hatch.

The platform ladder openings are 30 inch diameter. The openings are equipped with hinged covers. There are safety handholds next to the openings.

There is not a rigging attachment point on the transition cone for rescue retrieval line attachment.

HATCH AND MANWAY RECOMMENDATIONS:

Install a handhold at the wet interior roof hatch, access tube roof hatch, and painter's (bird) hatch. The handhold would assist the climber while entering and exiting the openings. The cost would be incidental to the next painting project.

Install a gasket on the wet interior roof hatch to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project or could be performed by in-house personnel.

Install a rigging lug on the transition cone above the top platform opening. The cost would be incidental to the next painting project.

VENT CONDITIONS:

The roof vent is a flow through design that is in fair condition. The screen is in fair condition. The screen mesh size is larger than the recommended 24 mesh. This is a possible entry point for insects, though none were observed inside the tank.

VENT RECOMMENDATIONS:

Replace the roof vent with a screened pressure vacuum vent to meet current Wisconsin DNR requirements. The new vent would have a movable plate that would allow air to flow in and out of the tank even if the screens become plugged or frosted over. The vent would have a rain shield to prevent rainwater from entering the storage tank during high winds. The estimated cost is $6,000.

LADDER CONDITIONS:

The dry interior ladders in the basebell, riser, and access tube are in good condition. The ladders meet current OSHA size requirements. The ladders are equipped with cable-type fall prevention devices that are in good condition.

There is a wet interior ladder from the roof to the bowl that is in good condition. The rungs above the high-water level are corroded with steel loss. The ladder meets OSHA size requirements. The ladder is equipped with a cable-type fall prevention device that is in good condition.

FILL/DRAW PIPE CONDITIONS:

The tank fills and draws from a single pipe. The pipe routes through the dry interior into the bottom of the transition cone and extends approximately 10 inches into the wet interior. There are deflector bars over top of the pipe in the wet interior. There is an abandoned pipe with a blind flange in the wet interior that extends up to near the high-water level.

There is a sample tap on the fill/draw pipe located in the building. The tap has a smooth end, faces downward, and is inside a heated room.

There is a threaded coupling on the fill/draw pipe in the pit for future attachment of a chemical feed line.

EXPANSION JOINT CONDITIONS:

The fill/draw pipe is equipped with a bellows type expansion joint located in the pit. The expansion joint appears to be in good condition.

INSULATION CONDITIONS:

The fill/draw pipe is covered with rigid foam insulation. The insulation is covered with an aluminum jacket. The cover is in good condition.

MUD VALVE CONDITIONS:

There is a threaded drain plug located in the bottom of the tank to aid in removal of sediment during inspections and routine maintenance. The pipe is routed to the overflow pipe and was not used during the inspection. The drain is only accessible from the wet interior.

MUD VALVE RECOMMENDATIONS:

Install a mud valve to aid with removal of sediment during regular maintenance inspections. Without a mud valve the sediment must be removed by sending it down the fill/draw pipe and flushing it out of a hydrant, which may not be possible on your tank. The estimated cost is $5,000.

CONDENSATE DRAIN CONDITIONS:

There is a condensate drain line that routes from the platform to the overflow pipe. There is a check valve in the line to stop backflow during overflow conditions. The line is in good condition. The drain opening appeared to be operational.

WET INTERIOR METAL CONDITIONS:

The steel structure is in good condition overall. No pitting was observed at the coating failures on the sidewall or transition cone.

DIXON ENGINEERING, INC.

STEEL TANK FIELD INSPECTION REPORT

PEDESTAL TANK

DATE: **November 16, 2021**

OWNER: **Village of Pewaukee**
CLIENT CODE: **49-68-10-04**
TANK NAME: **Quinlan Drive**
LOCATION: Address: **1010 Quinlan Drive**
City: **Pewaukee**
State: **Wisconsin**
TANK SIZE: Capacity: **200,000 gallons**
Bottom (LWL): **139 feet 6 inches (from nameplate)**
Overflow (HWL): **169 feet 6 inches (from nameplate)**
CONSTRUCTION:
Type: **Spheroid**
YEAR CONSTRUCTED: **1996**
MANUFACTURER: **Maguire Iron**
USE: **Potable water and fire protection**
Coating information below is from: **Coating information provided by Owner and an exterior coating sample taken for type (previous report)**

COATING HISTORY	EXTERIOR	WET INTERIOR	DRY INTERIOR
YEAR COATED	**1997**	**1997**	**1997**
CONTRACTOR	**Roberts Painting**	**Roberts Painting**	**Roberts Painting**
SYSTEM	**Urethane**	**Epoxy**	**Epoxy**
SURFACE PREPARATION	**SSPC-SP6**	**SSPC-SP10**	**SSPC-SP6**
MANUFACTURER	**Tnemec 140/74**	**Tnemec 140**	**Tnemec 140**
HEAVY METAL COATING SAMPLES	**No**	**No**	**No**
HEAVY METAL BEARING	**No**	**No**	**No**

PERSONNEL: Lead inspector **James Rowley**
Crew members **Ben Wozniak, Larry Houck**
METHOD OF INSPECTION: **Dry**

SITE CONDITIONS

Fenced: **No**
Site large enough for contractor's equipment: **Yes**
Control building: **Yes**
Antenna control site: **Yes**
Number: **3**
Type: **Building**
Location: **Adjacent to tank**
Would antenna sites interfere with containment: **Yes**
Power lines within 50 feet: **No**
Site drainage: **Away from tank**
Indications of underground leakage: **No**
Shrub, tree, etc. encroachment: **No**

EXPOSED PIPING

Location: **Tank base (in pit)**
Adjacent to tank (in building)
Condition of structure: **Good**
Structure is: **Dry**
Pump present: **Yes**
Drain line present: **No**
Cover condition: **Good, it is wood**
Locked: **No**
Pipe coating condition: **Poor**
Describe coating: **Spot coating failures to substrate, rust bleedthrough**
Condition of metal: **Good**
Piping comments: **There is a pit with piping and an adjacent building with piping**

FOUNDATION

Foundation exposed: **Yes**
Exposed height: **0-10 inches**
Exposed foundation condition: **Good**
Damage or deterioration: **No**
Foundation coated: **Top only**
Coating condition: **Fair**
Grout condition: **Good**
Amount missing: **0 feet**
Undermining of foundation: **No**

EXTERIOR COATING

Basebell:

Topcoat condition: **Fair**
Previous coat/system condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Dry film thickness: **14-17 mils**
Adhesion: **5A (tape did not adhere due to low temperature)**
Metal condition: **Good**
Basebell comments: **Coating failures throughout baseplate and anchor bolts. Spot coating failures throughout**

Riser:

Topcoat condition: **Good**
Previous coat/system condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Dry film thickness: **12-15 mils**
Adhesion: **Not taken**
Reason not taken: **Cold**
Mildew growth: **No**
Metal condition: **Good**

Bowl:

Topcoat condition: **Good**
Previous coat/system condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Mildew growth: **Yes**
Metal condition: **Good**

Sidewall:

Lettering: **No**
Logo: **No**
Topcoat condition: **Good**
Previous coat/system condition: **Good**
Describe coating: **Delaminating, spot coating failures to substrate**
Metal condition: **Good**

Roof:

Topcoat condition: **Fair**
Previous coat/system condition: **Good**
Describe coating: **Delaminating, spot coating failures to substrate, erosion**
Dry film thickness: **6-10 mils**

EXTERIOR COATING

Adhesion: **Not taken**
Reason not taken: **Cold**
Metal condition: **Good**
Roof comments: **Coating failures due to antenna abrasion from hoisting equipment**

EXTERIOR APPURTENANCES

Basebell Door:

Size: **34 x 80 inches**
Metal condition: **Good**

Anchor Bolts:

Number: **20**
Diameter: **1¾ inches**
Location: **Exterior**
Metal condition: **Good**

Overflow Pipe:

Diameter: **8 inches**
Metal condition: **Good**
Discharge orientation: **Angle**
Screen condition: **Good**
Percent of screen open: **100**
Mesh size: **4**
Flap gate/duck bill check valve: **No**
Air gap: **Yes**
Lowest part of discharge to the ground distance: **10 inches**
Height to basebell penetration: **35 inches**
Overflow discharges to: **Concrete pad**
Condition: **Poor**
Overflow comments: **Discharges to concrete pad with pipes that routes under driveway and discharges to riprap**

Roof Handrail:

Diameter: **12 feet**
Height: **42 inches**
Midrail height: **24 inches**
Kick plate height: **4 inches**
Vertical post type: **Angle**
Size: **2 x 2 inches**
Top rail type: **Angle**

EXTERIOR APPURTENANCES

Size: **2½ x 2 inches**

Midrail type: **Plate**

Size: **¼ x 2 inches**

Metal condition: **Good**

Painter's Rail:

N/A

Roof Rigging Points:

N/A

Removable Cathodic Covers:

N/A

Wet Interior Roof Hatch:

Neck size: **30 inches**

Distance from center of the tank (to outer edge): **5 feet**

Shape: **Round**

Handhold at opening: **No**

Curb height: **16½ inches**

Cover overlap: **6 inches**

Gasket on cover/neck curb: **No**

Hatch security: **None**

Metal condition: **Fair**

Hatch comments: **There are 4 mesh screens in the hatch curb. Coating is in poor condition and there is some steel loss from corrosion**

Dry Interior Roof Hatch:

Neck size: **30 inches**

Shape: **Round**

Handhold at opening: **No**

Hatch security: **None**

Metal condition: **Good**

Hatch comments: **There are 4 mesh screens in the hatch curb**

Bolted Ventilation Hatch:

N/A

EXTERIOR APPURTENANCES

Roof Vent:

Number: **1**
Distance from center of the tank (to outer edge): **5½ feet**
Type: **Flow-through**
Neck diameter: **24 inches**
Flange opening diameter: **24 inches**
Screen condition: **Fair**
Mesh size: **2**
Rain shield: **Yes**
Height of the lowest screen above the roof: **17½ inches**
Metal condition: **Good**

Aviation Lights:

Design: **Double red**
Location: **Free-standing mount**
Functioning: **Yes**
Globe condition: **Good**
Photoelectric cell: **Yes**
Location: **Roof**

Antennas:

Roof number: **15**
Attached to: **Handrail**
Riser number: **6**
Attached to: **Mounting frames**
Basebell cable penetrations sealed: **Yes**
Sealed with: **Rubber boots and covered with doghouse**
Upper riser cable penetrations sealed: **Yes**
Sealed with: **Rubber boots**
Roof cable penetrations sealed: **Yes**
Sealed with: **Rubber boots**
Antenna or cables interference: **No**

Electrical Components:

Electrical conduit condition: **Good**
Exposed wiring: **No**

DRY INTERIOR COATING

Basebell:

Coating condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**

DRY INTERIOR COATING

Dry film thickness: **13-15 mils**
Metal condition: **Good**
Floor: **Stone**
Drain line present: **No**
Comments: **Coating failures throughout the baseplate**

Condensate Platform:

Platform design: **Full**
Coating condition: **Poor**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Metal condition: **Good**
Ladder opening size: **30 inches**
Shape: **Round**
Opening covered: **Yes**
Handhold at opening: **Yes**
Drain: **Yes**
Size: **2 inches**
Type: **To overflow**
Check valve: **Yes**
Platform comments: **Approximately 90% of the coating is gone**

Riser above the Condensate Platform:

Coating condition: **Good**
Describe coating: **Spot coating failures to substrate, rust bleedthrough**
Dry film thickness: **15-20 mils**
Metal condition: **Good**
Comments: **Coating failures are mainly at stiffeners**

Top Platform:

Platform design: **Full**
Material: **Steel plate**
Coating condition: **Poor**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Metal condition: **Good**
Ladder opening size: **30 inches**
Shape: **Round**
Opening covered: **Yes**
Handhold at opening: **Yes**
Top platform comments: **Approximately 90% of coating is gone**

DRY INTERIOR COATING

Riser above the Top Platform:

Coating condition: **Good**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Dry film thickness: **11-13 mils**
Metal condition: **Good**

Transition Cone:

Coating condition: **Poor**
Describe coating: **Rust bleedthrough**
Metal condition: **Good**
Rigging lug above opening: **No**

Access Tube:

Diameter: **42 inches**
Coating condition: **Poor**
Describe coating: **Rust bleedthrough**
Dry film thickness: **9-14 mils**
Metal condition: **Good**

DRY INTERIOR APPURTENANCES

Electrical Components:

Lights functioning: **Yes**
Missing covers (globes and cages): **No**
Additional lights needed: **No**
Electrical outlet/conduit condition: **Good**
Used during inspection: **No**

Sample Tap:

Location: **In building**
Pipe diameter greater than ¼ inch: **Yes**
12 inches or more above the floor: **Yes**
Down turned: **Yes**
Smooth end: **Yes**
In heated room: **Yes**
Condition: **Good**
Sample tap comments: **There are two sample taps in the building**

Threaded Coupling (for chemical feed on the fill/draw pipe):

Location: **In pit**
Condition: **Good**

DRY INTERIOR APPURTENANCES

Expansion Joint:

Location: **Bottom of fill pipe**
Accessible for inspection: **Yes**
Type: **Bellows**
Coating condition: **Fair**
Metal condition: **Good**

Fill/Draw Pipe Insulation:

Insulation cover: **Yes**
Type: **Aluminum**
Condition: **Good**
Seams loose: **No**

Basebell Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Cable**
Function properly: **Yes**
Cage: **No**

Riser Ladder:

Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Cable**
Function properly: **Yes**
Cage: **No**

Painter's (bird) Hatch:

Handhold above hatch: **No**
Metal condition: **Good**
Hatch security: **Pin**

DRY INTERIOR APPURTENANCES

Manway to Wet Interior:

Size: **20 inch diameter**
Location: **In transition cone**
Metal condition: **Fair**

Drain Pipe:

Discharge material: **Pipe**
Discharge slope: **Downward**
Metal condition: **Good**
Mud valve comments: **There is a threaded drain plug that is accessible only from the wet interior**

Access Tube Ladder:

Toe clearance: **Less than 7 inches**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Cable**
Function properly: **Yes**

WET INTERIOR COATING

Roof:

Topcoat condition: **Poor**
Primer coating condition: **Poor**
Describe coating: **Delaminating, spot coating failures to substrate, rust undercutting, rust bleedthrough**
Metal condition: **Good**
Lap seams: **Welded**
Condition of lap seams: **Good**
Roof comments: **Coating failures throughout and at weld burns**

Sidewall:

Topcoat condition: **Poor**
Primer coating condition: **Poor**
Describe coating: **Spot coating failures to substrate, rust undercutting**
Mineral deposits: **Moderate**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**

WET INTERIOR COATING

Sidewall comments: **A few large (approximately 4 x 24 inch) spot coating failures at weld seams**

Access Tube:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Mineral deposits: **Moderate**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**

Tank Bottom:

Type: **Transition cone**
Topcoat condition: **Poor**
Primer coating condition: **Poor**
Describe coating: **Delaminating, spot coating failures to substrate, rust undercutting**
Mineral deposits: **Moderate**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Sediment depth: **1 inch**

WET INTERIOR APPURTENANCES

Ladder:

Toe clearance: **Less than 7 inches**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Shape of side rails: **Flat**
Metal condition: **Poor – steel loss from corrosion on top 6 rungs**
Fall prevention device: **Yes**
Type: **Cable**
Function properly: **Yes**

Cathodic Protection:

Clips: **Yes**
Pressure fitting: **Yes**
Location of clips: **Access tube**
Type: **Arms off access tube**

WET INTERIOR APPURTENANCES

Location of controls: **In basebell**
Ropes/arms damaged: **No**
Wires damaged: **No**

Roof Stiffeners/Painters Railing:

N/A

Sidewall Stiffeners:

N/A

Overflow Pipe Inlet:

Type: **Weir box**
Metal condition: **Good**

Fill/Draw Pipe:

Diameter: **12 inches**
Height above the tank bottom: **10 inches**
Deflector over end: **Yes**
Type: **Bars**
Metal condition: **Good**
Fill/Draw pipe comments: **There is an abandoned pipe with a blind flange in the wet interior that extends up to near the high-water level**

Mixer:

N/A

Field Inspection Report is prepared from the contractor's viewpoint. It contains information the contractor needs to prepare his bid for any repair or recoating. The engineer uses it to prepare the engineering report. Cost estimates are more accurate if the contractor's problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site.

200,000 gallon spheroid (Quinlan Drive) elevated water storage tank owned by the Village of Pewaukee, Wisconsin.

1) The foundation, grout, and anchor bolts are in good condition.

2) Same.

3) The service door operated properly during the inspection.

4) The overflow pipe discharges to a splash pad.

5) The screen at the overflow pipe discharge is intact with no gaps.

6) Coating failures on the baseplate.

7) Coating failures on the basebell.

8) Same.

9) Same.

10) The basebell coating is in fair condition overall.

11) Coating failures on the riser.

12) The riser coating is in good condition overall.

13) Same.

14) A few coating failures on the bowl.

15) Same.

16) The bowl is covered with moderate mildew growth.

17) Coating failures on the sidewall.

18) The sidewall coating is in good condition overall.

19) Same.

20) Coating failures on the roof.

21) Same.

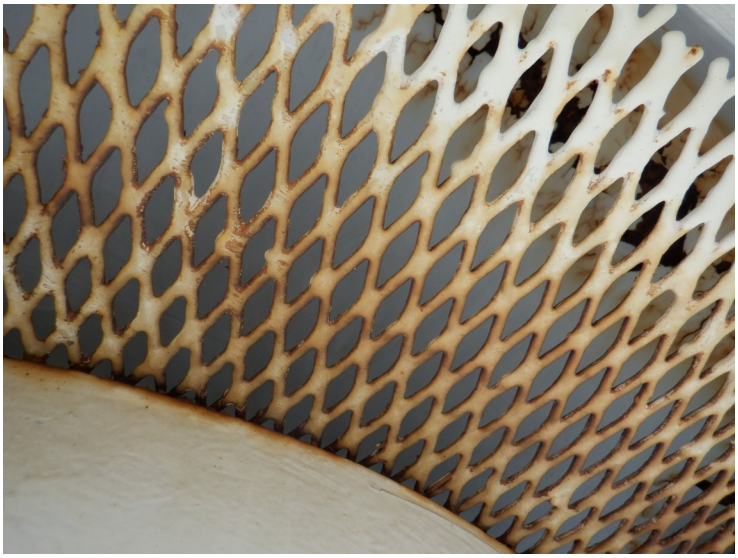
22) Same.

23) The roof handrail is in good condition. There are antennas attached to the roof handrail. There is not a painter's railing on the roof

24) There is not a gasket on the wet interior roof hatch.

25) The dry interior roof hatch is in good condition.

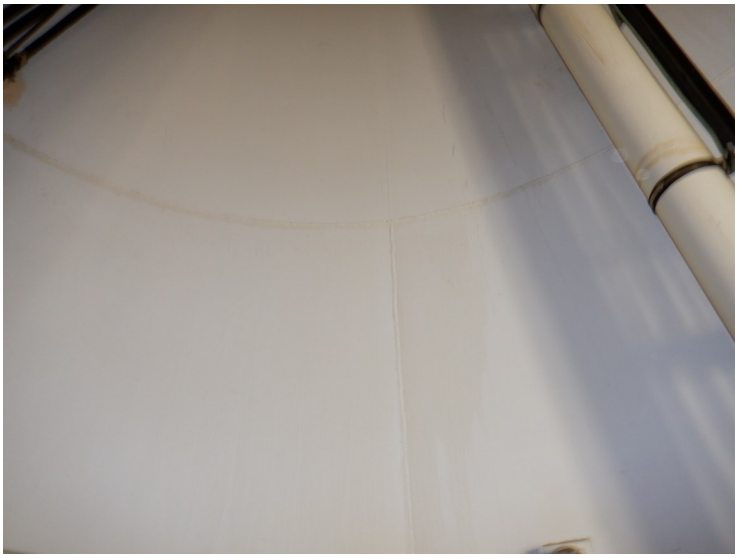
26) The roof vent is in fair condition.



27) The roof vent screen is intact with no gaps.

28) The aviation light was operating properly during the inspection.

29) Coating failures on the baseplate in the dry interior.



30) The dry interior basebell coating is in good condition overall.

31) Same.

32) The basebell ladder is in good condition. The ladder is equipped with a fall prevention device.

33) There is a check valve on the condensate platform drain.

34) The ladder opening in the condensate platform is equipped with a hinged cover.

35) Coating failure on the condensate platform.

36) Same.

37) Coating failure on a stiffener in the dry riser.

38) Same.

39) The dry riser coating is in good condition overall.

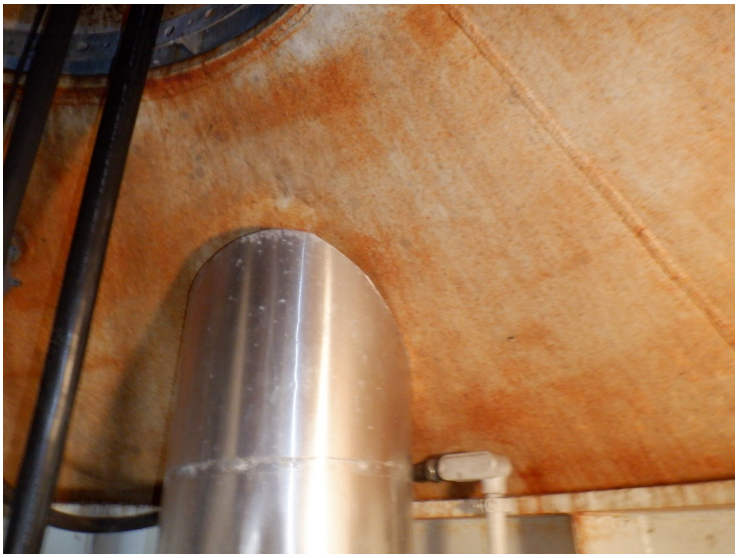
40) The fill/draw pipe insulation and aluminum cover are in good condition.

41) The riser ladder is in good condition. The ladder is equipped with a fall prevention device.

42) The ladder opening at the top platform is equipped with a hinged cover.

43) Coating failure on the top platform.

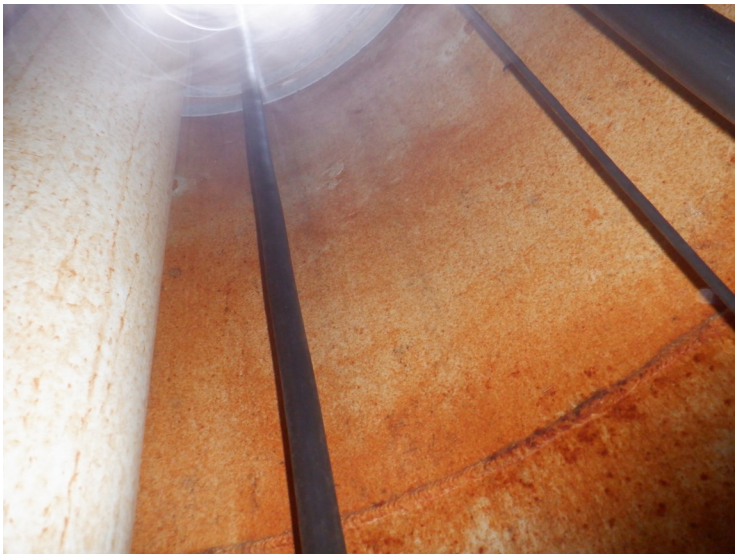
44) Same.



45) Rust bleedthrough on the transition cone.

46) Coating failures on the wet interior manway. The manway is in the transition cone.

47) There is a drain pipe routed to the overflow pipe.



48) Rust bleedthrough in the access tube.

49) Same.

50) The access tube ladder is in good condition. The ladder is equipped with a fall prevention device.

51) Coating failures on the wet interior roof.

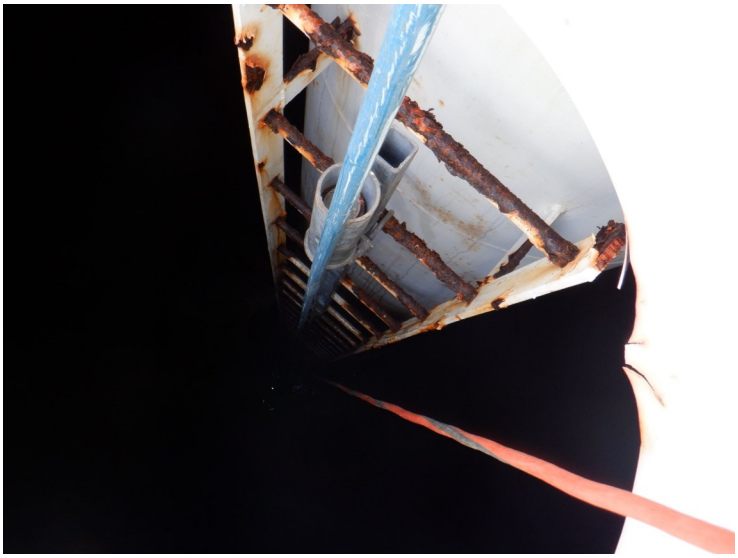
52) Same.

53) Same.

54) The wet interior sidewall coating is in poor condition overall.

55) Same.

56) There is an abandoned pipe with a blind flange in the wet interior that extends up near the high-water level.



57) Steel loss from corrosion on the top rungs of the wet interior ladder.

58) The wet interior ladder is in good condition overall. The ladder is equipped with a fall prevention device.

59) There is no significant coating deterioration on the access tube.

60) The cathodic protection system appears to be in good condition.

61) Coating failures in the transition cone.

62) Same.

63) There is a threaded drain plug in the bowl.me.

64) There are deflector bars over the fill/draw pipe in the wet interior.

65) The wooden cover on the pit is in good condition.

66) Coating failures on the pit piping.

67) Same.

68) The bellow type expansion joint is in good condition.

69) Coating on the piping in the building is in fair condition.

70) Same.

71) The sample tap in the building is in good condition.

Dixon Engineering, Inc.

Maintenance Inspection

125,000 Gallon Concrete Reservoir (Well 2)

Pewaukee, Wisconsin

Inspection Performed: November 15, 2021
Reviewed by James V. Rowley P.E.: December 15, 2021

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CONCLUSIONS:

1. The coating on the exterior roof hatches is an unknown system. The coating is in fair condition overall. Coating deterioration includes erosion. The coating failures are minor.

2. The interior concrete is in good condition overall with no significant deterioration.

3. The interior concrete coating is presumed to be an elastomeric system. The coating is in fair condition overall. Coating deterioration includes spot failures, delamination, and erosion. There are a few coating failures on the floor and sidewall.

4. The interior metal appurtenances are not coated.

RECOMMENDATIONS (GENERAL):

Annually inspect the roof vent, hatches, and any other health or security items on the structure. The work could be performed by in-house personnel or contracted as part of a regular maintenance program.

Schedule regular cleanings and inspections of the reservoir by an independent third party once every five years as recommended by AWWA.

RECOMMENDATIONS (IMMEDIATE WORK TO MEET WISCONSIN DNR REQUIREMENTS):

The Wisconsin DNR may allow some of the required changes to be delayed until the next paint project. These items are listed as immediate work since they are currently out of compliance.

1. Modifying the overflow discharge is not practical for this structure. A waiver should be sought from Wisconsin DNR for this non-compliance issue.

2. Install an extension on the roof vent so the screen is 24 inches above the ground to meet current Wisconsin DNR requirements and remove the other finial ball "vent". The work can be performed by in-house personnel.

RECOMMENDATIONS (WITH THE NEXT REHABILITATION PROJECT):

Complete the recommended work in one to two years. The repairs and upgrades should be completed during the next major rehabilitation project.

Best pricing for this work would be obtained if combined with another larger repair or repainting project.

1. Coat the exterior appurtenances with a urethane system. The estimated cost is $3,000.

2. Abrasive blast clean the exposed rebar in the wet interior and coat with an epoxy system. The estimated cost is $5,000.

3. Abrasive blast clean the wet interior piping and repaint with an epoxy system. The piping could be allowed to deteriorate and then be replaced once it no longer operates properly, replacement could be performed by in-house personnel. The estimated cost to repaint the piping is $10,000.

4. The drainage around the reservoir should be verified before starting a long-term project where the chance for heavy rain can elevate the ground water. Drains, if present, should be tested for proper operation and cleaned or repaired as needed. Work can be performed by in-house personnel.

COST SUMMARY:

Wet interior piping repaint	$10,000
Wet interior roof rebar repaint	5,000
Exterior appurtenance repaint	3,000
Sub Total	$18,000
Engineering and Contingencies	$4,000
Total	$22,000

Note: Best pricing for this work would be obtained if combined with another larger repair or repainting project. The Engineering portion of the Engineering and Contingencies estimate is included with the presumption that rehabilitation of this structure will be included with another project. The Engineering estimate would be significantly larger if this work is performed as a stand-alone project.

INSPECTION:

On November 15, 2021, Dixon Engineering, Inc., performed a maintenance inspection on the 125,000 gallon concrete reservoir (Well 2) owned by the Village of Pewaukee, Wisconsin. Purposes of the inspection were to evaluate the interior and exterior coatings' performance and life expectancy, assess the condition of concrete surfaces and the reservoir's appurtenances, review safety and health aspects and make budgetary recommendations for continued maintenance of the reservoir. All recommendations, with budgeting estimates for repairs, are incorporated in this report.

The inspection was performed by James Rowley, P.E. The inspector was assisted by Larry Houck and Ben Wozniak, Staff Technicians.

A source of water for cleaning was provided by the Village. Sediment was flushed from the wet interior. Following the inspection, chlorine was added to disinfect the reservoir per AWWA Standard C652-19 Method No. 3. Photos are included with this report.

GENERAL INFORMATION:

The original construction date is unknown. The reservoir has a sidewall height of 14 feet 1 inch, a length of 55 feet, and width of 24 feet. The reservoir is underground. The sidewall and floor were cast-in-place and the roof is constructed of precast concrete planks.

CONDITIONS AND RECOMMENDATIONS:

EXTERIOR STRUCTURE AND COATING CONDITIONS:

The roof and sidewalls are not visible; the reservoir is underground. No evidence of settling or deformation was noted on the soil cover. Only the roof hatch curbs are exposed and are in good condition.

The exterior metal appurtenances include the roof hatches, overflow pipe, and roof vent. The roof hatches are coated. The coating is in fair condition. The coating on the overflow pipe is in poor condition. The roof vent is not coated.

EXTERIOR STRUCTURE AND COATING RECOMMENDATIONS:

Coat the exterior metal appurtenances with a urethane system. The estimated cost is $3,000.

INTERIOR STRUCTURE AND COATING CONDITIONS:

The roof is in good condition overall with no significant deterioration. There is some rusting at the surface from rebar chair bases and rebar.

The soil on top of the roof was not saturated with water prior to the inspection to test for leaks. No leaks were detected during the inspection.

The sidewalls and floor are in good condition overall with no cracks or spalls. The floor was covered with approximately one inch of sediment that was flushed from the interior during the inspection.

It is not known when the wet interior was last coated. The coating is likely an elastomeric system. The coating is located on the floor and sidewalls and is in fair condition. There are areas of delamination, spot failures, and erosion.

Overall adhesion of the coating is good. Adhesion was tested using a low-pressure power washer. With poor adhesion it would be possible to notice the coating fluctuate and loose coating could be completely removed during cleaning. This is a crude form of testing, yet the least destructive.

The wet interior metal appurtenances include the fill pipe, draw pipe, overflow pipe, and ladder cleats. The appurtenances are not coated.

INTERIOR STRUCTURE AND COATING RECOMMENDATIONS:

The interior concrete structure has not deteriorated to the point of needing repairs.

Abrasive blast clean the exposed rebar in the wet interior and coat with an epoxy system. The repair is intended to extend the life of the structure by protecting the exposed rebar. The exposed rebar is due to lack of concrete cover during construction. The rebar near the surface has expanded and created a spall exposing the steel. There may be more exposed areas that will appear in the future. The estimated cost is $5,000.

Abrasive blast clean the wet interior piping and repaint with an epoxy system. The piping could be allowed to deteriorate and then be replaced once it no longer operates properly, replacement could be performed by in-house personnel. The estimated to repaint the piping is $10,000.

PUMPHOUSE PIPING CONDITIONS:

There is a pumphouse adjacent to the reservoir that contains piping and valves. The piping is above the floor. The piping is in good condition. The coating on the piping is in good condition with no significant deterioration.

SITE DRAINAGE CONDITIONS:

Drawings were not available for review during the inspection. It is unknown if the reservoir was constructed with drainage piping.

DRAINAGE RECOMMENDATIONS:

The drainage around the reservoir should be verified before starting a long-term project where the chance for heavy rain can elevate the ground water. Drains, if present, should be tested for proper operation and cleaned or repaired as needed. Work can be performed by in-house personnel.

OVERFLOW PIPE CONDITIONS:

The overflow pipe exits the upper sidewall, routes below grade to daylight, and discharges near the ground. The overflow pipe discharge is vertical. The discharge end of the overflow pipe is screened. The screen is in good condition. The pipe discharges to a catch basin. The air gap does not meet the required 12-24 inches. The discharge area is in good condition.

OVERFLOW PIPE RECOMMENDATIONS:

Modifying the overflow discharge is not practical for this structure. A waiver should be sought from Wisconsin DNR for this non-compliance issue.

HATCH AND MANWAY CONDITIONS:

There are two 24 inch square roof hatches that are in good condition. The covers are in good condition. The roof hatch curb extends 24 inches above the ground. The hatch was secured with a padlock. There are gaskets on the hatches that are in good condition.

VENT CONDITIONS:

There is a goose neck roof vent that is in good condition. The screen is in good condition.

There is second vent that routes through the pumphouse and exits the roof. The vent is capped with a finial ball with no screen.

VENT RECOMMENDATIONS:

Install an extension on the water storage tank roof vent so the screen is 24 inches above the ground to meet current Wisconsin DNR requirements and remove the other finial ball "vent". The work can be performed by in-house personnel.

LADDER CONDITIONS:

There are ladder cleats from the roof to the floor that are in good condition.

FILL/DRAW PIPE CONDITIONS:

The fill pipe penetrates through and stubs at the roof.

The reservoir draws from a separate pipe. The draw pipe penetrates through the roof and extends approximately 15 inches above the floor. It is a suction pipe that extends from the roof. There is not a deflector plate or bar over top of the pipe in the wet interior.

There is a sample tap on the fill pipe located in the pumphouse. The tap has a smooth end, faces downward, and is inside a heated room.

DIXON ENGINEERING, INC.
CONCRETE TANK FIELD INSPECTION REPORT

DATE: **November 15, 2021**

OWNER: **Village of Pewaukee**
CLIENT CODE: **49-68-10-05**
TANK NAME: **Well 2**
LOCATION: Address: **125 Capitol Drive**
City: **Pewaukee**
State: **Wisconsin**
TANK SIZE: Capacity: **125,000 gallons**
Length: **55 feet (measured)**
Width: **24 feet (measured)**
Sidewall height: **14 feet 1½ inches (measured)**
CONSTRUCTION: **Cast-in-place floor and precast roof**
Type of roof: **Flat**
Layout: **Below grade**
YEAR CONSTRUCTED: **Unknown**
MANUFACTURER: **Unknown**
CONTRACT NUMBER: **Unknown**
USE: **Potable water and fire protection**
PERSONNEL: Lead inspector **James Rowley**
Crew members **Ben Wozniak, Larry Houck**
METHOD OF INSPECTION: **Dry**

SITE CONDITIONS

Fenced: **No**
Site large enough for contractor's equipment: **Yes**
Control building: **Yes**
Power lines within 50 feet: **Yes (estimated distance 40 feet)**
Are power lines attached to the structure: **No**
Site drainage: **Away from tank**
Indications of underground leakage: **No**
Shrub, tree, etc. encroachment: **No**

EXPOSED PIPING

Location: **Adjacent to tank (in building)**
Condition of structure: **Good**
Structure is: **Dry**
Pump present: **Yes**
Drain line present: **Yes**
Pipe coating condition: **Good**

EXPOSED PIPING

Describe coating: **No significant coating deterioration**
Condition of metal: **Good**

FOUNDATION:

Foundation exposed: **No**

DRAINAGE

Access manholes: **No**

EXTERIOR - GENERAL

Roof/Sidewall not exposed

EXTERIOR APPURTENANCES:

Overflow Pipe:

Diameter: **8 inches**
Metal condition: **Good**
Coating condition: **Poor**
Discharge orientation: **Vertical**
Screen condition: **Good**
Percent of screen open: **5**
Mesh size: **24**
Flap gate/duck bill check valve: **No**
Air gap: **Yes**
Lowest part of discharge to the ground distance: **9½ inches**
Height to penetration: **10 inches**
Overflow discharges to: **Catch basin with drain**
Condition: **Good**

Sample Tap:

Location: **In building**
Pipe diameter greater than ¼ inch: **Yes**
12 inches or more above the floor: **Yes**
Down turned: **Yes**
Smooth end: **Yes**
In heated room: **Yes**
Condition: **Good**

Threaded Coupling (for chemical feed on the fill/draw pipe):

Location: **In building**
Condition: **Good**

EXTERIOR APPURTENANCES:

Roof Hatch:

Neck size: **24 inches**
Hatch 24 inches or more above grade: **Yes**
Curb height: **24 inches**
Cover overlap: **3 inches**
Gasket on cover: **Yes**
Hatch security: **Lock**
Coating condition: **Fair**
Metal condition: **Good**
Hatch comments: **Hatch cover is coated aluminum**

Secondary Roof Hatch:

Neck size: **24 inch**
Hatch 24 inches or more above grade: **Yes**
Curb height: **24 inches**
Cover overlap: **3 inches**
Gasket on cover: **Yes**
Hatch security: **Lock**
Coating condition: **Fair**
Metal condition: **Good**
Hatch comments: **Hatch cover is coated aluminum**

Ventilation:

Number: **1**
Type: **Goose neck**
Location: **Roof**
Size: **5 inches**
Vent material: **Steel**
Coating condition: **Not coated**
Material condition: **Good**
Screen condition: **Good**
Mesh size: **24**
Percent of screen open: **100**
Height of the screen above the ground: **21½ inches**

Vent comments: **There is an additional vent in the west chamber that routes through the roof, through the building, and out the building roof. There is a finial ball on top and no screen. Estimated to be 8 inch diameter pipe**

WET INTERIOR GENERAL

Concrete condition: **Good**
Rusting at surface: **Yes**
Location: **Roof**
Type: **Rebar chair base and rebar at surface**
Coating present: **Yes**
Location: **Entire sidewall and floor**
Type of coating: **Likely elastomeric**
Coating condition: **Fair**
Describe coating: **Delaminating, spot failures to substrate, erosion**

WET INTERIOR ROOF

Cracking:
Number of cracks: **None**

Spalling:
Number of areas spalled: **None**

Interior roof comments: **Some exposed rebar and chairs in the east chamber (approximately 25 sq. feet of exposed rebar area)**

WET INTERIOR SIDEWALL

Cracking:
Number of cracks: **None**

Spalling:
Number of areas spalled: **None**

WET INTERIOR FLOOR

Cracking:
Number of cracks: **None**

Spalling:
Number of areas spalled: **None**

WET INTERIOR APPURTENANCES

Cleats:
Material: **Metal**
Toe clearance: **Less than 7 inches**
Width of cleats: **Less than 16 inches**
Thickness of rungs: **1 inch**

WET INTERIOR APPURTENANCES

Shape of rungs: **Square**
Coating condition: **Not coated**
Material condition: **Good**
Fall prevention device: **No**

Roof Beams:

N/A

Columns:

N/A

Overflow:

Type of inlet: **Stubs at wall**
Condition: **Good**
Coating condition: **Not coated**

Fill Pipe:

Diameter: **8 inches**
Height above floor: **14 feet**
Configuration: **Stubs at roof**
Deflector on end: **No**
Coating condition: **Not coated**
Metal condition: **Good**

Separate Draw Pipe:

Diameter: **8 inches**
Height above floor: **15 inches**
Deflector over end: **No**
Removable silt ring: **No**
Coating condition: **Not coated**
Metal condition: **Good**
Draw pipe comments: **Suction line from roof**

Drain Pipe:

N/A

Sump:

Sump Size: **36 x 36 x 5 inches**

Sediment:

Sediment depth: **⅛-1 inch**
Sediment distribution: **Uniform**

WET INTERIOR APPURTENANCES

Could sediment distribution indicate a leak: **No**

Mixer:

N/A

Miscellaneous Appurtenances:

Description: **Level indicator**

Condition: **Good**

CRACK GRADES

Crack Grade	Width
1	Tight, no separation
2	Tight to up to fingernail width
3	Fingernail width up to 1/8 inch
4	1/8 up to 1/4 inch
5	Greater than 1/4 inch

Field Inspection Report is prepared from the contractor's viewpoint. It contains most of the information the contractor needs to prepare his bid for any repairs or repainting. The Engineer uses it to prepare the engineering report. Cost estimates are more accurate if contractor problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site

1) 125,000 gallon underground concrete water storage reservoir (Well 2) owned by the Village of Pewaukee, Wisconsin.

2) The overflow pipe discharges to a catch basin.

3) The screen at the overflow discharge is intact with no gaps or holes.

4) The goose neck roof vent is in good condition.

5) The roof vent screen is intact.

6) The roof hatch curb is more than 24 inches above grade.

7) The roof hatch covers are in good condition with some coating erosion.

8) The ladder cleats from the roof to the floor are in good condition.

9) Rusting at the surface of the wet interior roof.

10) Same.

11) The fill pipe stubs at the wet interior roof.

12) The concrete sidewalls are in good condition with no significant deterioration.

13) Elastomeric coating failures on the wet interior sidewall.

14) Same.

15) The metal wet interior appurtenances are not coated.

16) The wall to floor joint is in good condition.

17) There is no deterioration of the concrete floor.

18) There is some erosion of the elastomeric coating on the floor.

19) Coating on the piping in the pumphouse is in good condition overall.

20) Same.

21) The sample tap in the pumphouse is in good condition.

Dixon Engineering, Inc.

Maintenance Inspection

1,000,000 Gallon Standpipe (Sunnyridge)

Pewaukee, Wisconsin

Inspection Performed: December 14, 2021
Reviewed by Joseph T. Hoban P.E.: December 21, 2021

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CONCLUSIONS:

1. The exterior coating is a urethane overcoat system. The coating is in good condition overall. Coating deterioration includes spot failures to the substrate with rust undercutting and topcoat delamination. There are only a few coating failures throughout.

2. The wet interior coating is an epoxy system. The coating is in good condition overall. Below the high-water level coating deterioration includes spot failures to the substrate and blistering on the sidewall. Above the high-water level coating is deteriorating at the rigging couplings.

RECOMMENDATIONS (GENERAL AND IMMEDIATE WORK):

Annually inspect the roof vent, hatches, and any other health or security items on the structure. The work could be performed by in-house personnel or contracted as part of a regular maintenance program.

Schedule regular cleanings and inspections of the tank by an independent third party once every five years as recommended by AWWA.

1. Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

RECOMMENDATIONS (IMMEDIATE WORK TO MEET WISCONSIN DNR REQUIREMENTS):

The Wisconsin DNR may allow some of the required changes to be delayed until the next paint project. These items are listed as immediate work since they are currently out of compliance.

1. Modify the overflow pipe discharge so it points downward to bring it into compliance with current Wisconsin DNR requirements. The estimated cost is $3,000.

2. Current Wisconsin DNR requirements state that the ladder start 12 feet above the ground. Since the ladder is properly secured with a vandal guard it may be possible that a waiver may be granted for this non-compliance item.

3. Install deflector bars at the end of the fill/draw pipe in the wet interior to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

4. Replace the threaded sample tap on the fill/draw pipe with a smooth ended sample tap to meet current Wisconsin DNR requirements. The work can be performed by in-house personnel.

5. Install a threaded coupling on the fill/draw pipe for a chemical feed line to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

RECOMMENDATIONS (WITH THE NEXT PAINT PROJECT):

Complete the recommended work in four years. The repairs and upgrades should be completed during the next major tank rehabilitation project when coating repairs are made.

1. High pressure water clean and overcoat the exterior with a urethane system. The estimated cost is $110,000.

2. Coat the foundation to help prevent deterioration. The cost would be incidental to exterior painting.

3. Install a 30 inch diameter sidewall manway. The estimated cost is $10,000.

4. Replace the fall prevention device on the exterior ladder. The estimated cost is $4,000.

COST SUMMARY:

Exterior overcoat	$110,000
Overflow discharge modification	3,000
30 inch sidewall manway	10,000
Fall prevention device	4,000
Sub Total	$127,000
Engineering and Contingencies	$26,000
Total	$153,000

INSPECTION:

On December 14, 2021, Dixon Engineering Inc. performed a maintenance inspection on the 1,000,000 gallon water storage standpipe (Sunnyridge) owned by the Village of Pewaukee, Wisconsin. Purposes of the inspection were to evaluate the interior and exterior coating's performance and life expectancy, assess the condition of metal surfaces and appurtenances, review safety and health aspects, and make budgetary recommendations for continued maintenance of the tank. All recommendations with budgeting estimates for repairs are incorporated in this report.

The inspection was performed by Josh Grover, Engineering Technician. The inspector was assisted by Ben Wozniak and Mike Pickett, Staff Technicians.

A source of water for cleaning was provided by the Village. Sediment was flushed from the wet interior. Following the inspection, chlorine was added to disinfect the tank per AWWA Standard C652-19 Method No. 3. Photos are included with this report.

GENERAL INFORMATION:

The tank was built in 1983 by Prairie Tank with a sidewall height of 68 feet 4 inches and a diameter of 51 feet.

CONDITIONS AND RECOMMENDATIONS:

EXTERIOR COATING CONDITIONS:

Information on file with DIXON indicates that the exterior was last painted in 2010. The exterior was pressure washed and spot power tool cleaned to SSPC-SP11 condition. The coating applied was a urethane system.

The sidewall coating is in good condition with a few failures. Primary methods of deterioration are spot failures to the substrate with rust undercutting and delaminated topcoat. The sidewall is covered with light mildew growth.

The roof coating is in good condition with a few failures. Primary methods of deterioration are spot failures to the substrate with rust undercutting and delaminated topcoat.

Adhesion testing was not performed due to cold temperatures and wet conditions. Testing in cold temperatures and in wet conditions could cause inaccurate results. Adhesion testing should be performed before overcoating.

EXTERIOR COATING RECOMMENDATIONS:

Budget for overcoating in four years. The typical overcoat frequency for modern urethane systems is fifteen years. There is always a risk in overcoating the exterior, but we have had several successful projects when performed in the timeframe noted. The risk of poor adhesion of the overcoat system gets higher as the existing system gets older.

The recommended procedure is to high pressure water clean (5,000-10,000 psi) the exterior to remove any poorly adhered coating and any contaminants. Coating failures to the substrate would be spot power tool cleaned to bare metal (SSPC-SP11) condition. All sharp edges would be feathered into the surrounding coating.

The coating system would consist of a spot prime coat on the bare metal, a full coat of epoxy, followed by two full coats of urethane. The urethane system offers excellent abrasion resistance with high gloss and sheen retention. The expected life of this system is fifteen years. The system can be overcoated again in fifteen years, extending the total life of the coating to approximately forty-five years before total removal would be necessary. The tank would be removed from service during the coating project. This is necessary to reduce condensation on the tank's surface. Urethane coatings have a minimum temperature requirement for application and are sensitive to moisture during the curing process. If moisture is present during the curing process, the appearance will become cloudy with little or no gloss. The estimated cost is $110,000.

WET INTERIOR COATING CONDITIONS:

Information on file with DIXON indicated the wet interior was last painted in 2010. The wet interior was abrasive blast cleaned to SSPC-SP10 near-white condition. The coating applied was an epoxy system.

The roof coating is in good condition with a few failures. Primary method of deterioration is spot failures to the substrate.

There are minor coating failures on the roof panels but most of deterioration is at the roof rigging couplings and on the stiffeners.

The sidewall coating is in good condition with numerous failures. Primary methods of deterioration are spot failures to the substrate and blisters. There is no significant coating damage at the high-water level, but there are scratches in the heavy mineral staining which would be the area most affected by ice movement. Most of the coating failures are near the weld seams on the lower sidewall panels.

The coating on the floor is in good condition with no failures. The floor was covered with approximately 2 inches of sediment that was flushed from the interior during the inspection.

The surfaces below the normal operating water level are covered with mineral staining which does not affect the integrity of the coating system.

WET INTERIOR COATING RECOMMENDATIONS:

The existing coating system has not deteriorated to the point where replacement is warranted. The cathodic protection system should adequately protect all areas below the high-water level where the coating has deteriorated. Reinspect in five years to update conditions and recommendations. Long term budget to repaint in ten years. The estimated cost is $160,000.

CATHODIC PROTECTION CONDITIONS:

The tank has a suspended impressed current cathodic protection system. Surfaces below the high-water level are protected by the submerged system that is suspended from ropes attached to the sidewall and floor. The supporting ropes and anode wires appear to be in good condition with no visible damage.

CATHODIC PROTECTION RECOMMENDATIONS:

Continue to maintain the cathodic protection system. The cost would be dependent on your contract with your cathodic vendor.

PIT PIPING CONDITIONS:

There is a pit adjacent to the tank that contains piping and valves. The pit has a metal hatch that is in good condition. The piping is in good condition. The coating on the piping is in good condition with minor coating failures. Most of the coating failures are on the bolts and flanges.

FOUNDATION CONDITIONS:

The exposed concrete foundation is in good condition. There is minor deterioration with some cracking and exposed aggregate from weathering. The foundation is not coated.

FOUNDATION RECOMMENDATIONS:

Coat the exposed concrete with an epoxy coating system to help prevent further deterioration. The cost would be incidental to exterior painting.

GROUT CONDITIONS:

The grout between the baseplate and the foundation is in good condition with none damaged or missing.

ROOF HANDRAIL AND ROOF RIGGING CONDITIONS:

There is a handrail that routes around the roof hatch and runs from the sidewall ladder to a circular railing that surrounds the vent. The roof handrails are in good condition.

There are enough roof rigging couplings for safety and staging lines during wet interior coating work.

LIGHTING/ELECTRICAL CONDITIONS:

The tank has a double aviation light on the roof that appears to be in good condition. The light is operating properly. There is a photocell that will switch the lights on when it's dark outside.

ANTENNA CONDITIONS:

There are thirty-one antennas and miscellaneous antenna equipment attached to the sidewall. The antenna cable routing is in good condition and does not interfere with climbing or tank operations.

OVERFLOW PIPE CONDITIONS:

The overflow pipe exits the upper sidewall extends down along the exterior of the sidewall and discharges near the ground. The overflow pipe discharge is at an angle. The end of the pipe is equipped with a screened flap gate that is in good condition. The pipe discharges to a splash pad. The air gap meets the required 12-24 inches. The discharge area is in good condition.

OVERFLOW PIPE RECOMMENDATIONS:

Modify the overflow pipe discharge so it points downward to bring it into compliance with current Wisconsin DNR requirements. The estimated cost is $3,000.

HATCH AND MANWAY CONDITIONS:

There is a roof hatch to the wet interior that is in good condition. The hinged cover is in good condition. The hatch was secured with a padlock. The hatch neck curb height meets the minimum height requirement of 4 inches. The hatch cover lip meets the minimum height requirement of 2 inches. A gasket was installed on the roof hatch curb by the inspection crew.

There are two 24 inch diameter manways in the sidewall that are in good condition. The manway gaskets showed no signs of leakage and the bolts are in good condition.

HATCH AND MANWAY RECOMMENDATIONS:

Install a 30 inch manway in the sidewall. Average rescue baskets will not pass through the existing manway. The estimated cost is $10,000.

VENT CONDITIONS:

The roof vent is a pressure vacuum design that is in good condition. The pressure vacuum plate was found to be properly aligned. There is a large external screen intended to keep birds out and a smaller mesh screen on the interior intended to keep insects out. The screens are in good condition. There is a rain shield over the outer screen.

LADDER CONDITIONS:

The exterior sidewall ladder starts approximately 8 feet 8 inches above the ground and extends up to a small platform near the top of the sidewall. The platform is in good condition. The ladder meets OSHA size requirements. The ladder is caged and equipped with a rail-type fall prevention device that is in fair condition. The fall prevention rail is coated making it difficult to use properly. There is a vandal guard on the sidewall ladder that is in good condition. There are chains at the opening in the center handrail opening.

There are roof stairs that route from the sidewall to the center handrail. The stairs are in good condition.

There is no ladder in the wet interior.

LADDER RECOMMENDATIONS:

Replace the fall prevention device on the exterior sidewall ladder. The estimated cost is $4,000.

Current Wisconsin DNR requirements state that the ladder start 12 feet above the ground. Since the ladder is properly secured with a vandal guard it may be possible that a waiver may be granted for this non-compliance item.

FILL/DRAW PIPE CONDITIONS:

The tank fills and draws from a single pipe. The fill/draw pipe penetrates through floor and extends approximately 7 ½ inches into the tank. There is not a deflector plate or bar over top of the pipe in the wet interior.

There is a sample tap on the fill/draw pipe located in the pit. The tap has a threaded end, faces downward, and is inside a heated room.

There is not a threaded coupling on the fill/draw pipe for future attachment of a chemical feed line.

FILL/DRAW PIPE RECOMMENDATIONS:

Install deflector bars at the end of the fill/draw pipe in the wet interior to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

Replace the threaded sample tap on the fill/draw pipe with a smooth ended sample tap to meet current Wisconsin DNR requirements. The work can be performed by in-house personnel.

Install a threaded coupling on the fill/draw pipe for a chemical feed line to meet current Wisconsin DNR requirements. The cost would be incidental to the next painting project.

WET INTERIOR METAL CONDITIONS:

The steel structure is in good condition overall. No significant pitting was observed at the coating failures on the sidewall.

The interior roof is supported by radial stiffeners that are in good condition with no significant corrosion. The connections at the sidewall are bolted and are in good condition.

DIXON ENGINEERING, INC.
STEEL TANK FIELD INSPECTION REPORT
STANDPIPE TANK

DATE: **December 14, 2021**

OWNER: **Village of Pewaukee**
CLIENT CODE: **49-68-10-03**
TANK NAME: **Sunnyridge Tank**
LOCATION: Address: **1515 Sunnyridge Road**
City: **Pewaukee**
State: **Wisconsin**
TANK SIZE: Capacity: **1,000,000 gallons**
Diameter: **51 feet (from nameplate)**
Sidewall height: **68 feet 4 inches (nameplate)**
CONSTRUCTION: **Welded**
Type: **Standpipe**
Type of roof: **Hemisphere**
YEAR CONSTRUCTED: **1983**
MANUFACTURER: **Prairie Tank**
CONTRACT NUMBER: **8342**
USE: **Potable water and fire protection**
Coating information below is from: **Dixon specification/project**

COATING HISTORY	EXTERIOR	WET INTERIOR
YEAR COATED	**2010**	**2010**
CONTRACTOR	**Horizon Bros**	**Horizon Bros**
SYSTEM	**Urethane**	**Epoxy**
SURFACE PREPARATION	**SSPC-SP11**	**SSPC-SP10**
MANUFACTURER	**Tnemec**	**Tnemec**
HEAVY METAL COATING SAMPLES	**No**	**No**
HEAVY METAL BEARING	**Unknown**	**No**

PERSONNEL: Lead inspector **Josh Grover**
Crew members **Mike Pickett, Ben Wozniak**
METHOD OF INSPECTION: **Dry**

SITE CONDITIONS

Fenced: **No**
Site large enough for contractor's equipment: **Yes**
Control building: **No**
Antenna control site: **Yes**
Number: **4**
Type: **Buildings, platforms**
Would antenna sites interfere with containment: **No**
Power lines within 50 feet: **No**
Site drainage: **Away from tank**
Indications of underground leakage: **No**
Shrub, tree, etc. encroachment: **No**

EXPOSED PIPING:

Location: **Adjacent to tank (in pit)**
Condition of structure: **Good**
Structure is: **Dry**
Pump present: **Yes**
Drain line present: **No**
Hatch condition: **Good**
Locked: **Yes**
Pipe coating condition: **Good**
Describe coating: **Spot coating failures to substrate**
Condition of metal: **Good**

FOUNDATION

Foundation exposed: **Yes**
Exposed height: **4-7 inches**
Exposed foundation condition: **Good**
Damage or deterioration: **Yes**
Type of damage: **Cracks, exposed aggregate**
Severity: **Minor**
Crack location: **Random**
Total cracking: **3 feet (0 feet need repair)**
Foundation coated: **No**
Type of baseplate gap filler: **Grout**
Condition: **Good**
Amount missing: **0 feet**
Undermining of foundation: **No**

EXTERIOR COATING

Sidewall:

Lettering: **No**
Logo: **No**
Topcoat condition: **Good**
Previous coat condition: **Good**
Describe coating: **Delaminating, spot coating failures to substrate, rust undercutting**
Dry film thickness: **10-13 mils**
Adhesion: **Not taken**
Reason not taken: **Wet, cold**
Metal condition: **Good**
Bottom shell steel thickness: **0.760 inch**
Sidewall comments: **There are approximately ten small spot coating failures that are ¼ inch diameter or less and one spot of delamination that is 2 inch diameter on the baseplate**

Roof:

Topcoat condition: **Good**
Previous coat condition: **Good**
Describe coating: **Delaminating, spot coating failures to substrate, scratches**
Dry film thickness: **10-14 mils**
Adhesion: **Not taken**
Reason not taken: **Wet, cold**
Metal condition: **Good**
Roof comments: **There is delamination on the center handrail, several scratches in the topcoat at roof edge, antenna spot coating failures that are 1-2 inch diameter under the step off platform**

EXTERIOR APPURTENANCES

Sidewall Manways

Number: **2**
Size: **24 inches**
Cover attachment: **Davit arm, bolt**
Metal condition: **Good**

Anchor Bolts:

N/A

EXTERIOR APPURTENANCES

Overflow Pipe:

Diameter: **8 inches**
Metal condition: **Good**
Discharge orientation: **Angle**
Screen condition: **Good**
Percent of screen open: **100**
Mesh size: **4**
Flap gate check valve: **Yes, screened**
Condition: **Good**
Air gap: **Yes**
Lowest part of discharge to the ground distance: **12 inches**
Height to elbow: **29 inches**
Overflow discharges to: **Concrete pad**
Condition: **Good**

Sample Tap:

Location: **In pit**
Pipe diameter greater than ¼ inch: **Yes**
12 inches or more above the floor: **Yes**
Down turned: **Yes**
Smooth end: **No - threaded**
In heated room: **Yes**
Condition: **Good**

Threaded Coupling (for chemical feed on the fill/draw pipe):

N/A

Sidewall Ladder:

Height to start of ladder: **8 feet 8 inches**
Toe clearance: **7 inches or greater**
Width of rungs: **16+ inches**
Thickness of rungs: **¾ inch**
Shape of rungs: **Round**
Metal condition: **Good**
Fall prevention device: **Yes**
Type: **Rail**
Function properly: **No (coated)**
Cage: **Yes**
Diameter: **28 inches**
Vandal guard: **Yes**

EXTERIOR APPURTENANCES

Condition: **Good**

Step-off Platforms:

Dimensions: **28 x 36 inches**
Railing height: **41 inches**
Midrail height: **22 inches**
Kick plate height: **4 inches**
Opening for access: **Yes**
Size: **28 inches**
Handhold at opening: **Yes**
Opening security: **None**
Metal condition: **Good**
Step-off platform comments: **There are chains at the opening to center handrail**

Roof Stairs:

Design: **Fixed**
Metal condition: **Good**
Toe clearance: **7 inches or greater**
Width of rungs: **19 x 30 inches**
Thickness of rungs: **1 inch**
Shape of rungs: **Rectangle**
Fall prevention device: **No**
Cage: **No**
Roof stairs comments: **The stairs are galvanized grating**

Roof Handrail:

At the edge of the roof at the sidewall ladder: **Yes**
Location: **One side of ladder at the wet interior hatch**
Along stairs to the center: **Yes**
Location: **One side**
Circular section: **Yes**
Diameter: **26 feet**
Railing height: **42 inches**
Midrail height: **23 inches**
Kick plate height: **4 inches**
Vertical post type: **Angle**
Size: **2 ½ x 2 ½ inches**
Top rail type: **Angle**
Size: **2 ½ x 2 ½ inches**
Midrail type: **Angle**

EXTERIOR APPURTENANCES

Size: **2 ½ x 2 ½ inches**

Metal condition: **Good**

Roof handrail comments: **Delamination along the top and midrail on the center handrail**

Painter's Rail:

N/A

Roof Rigging Points:

Number: **31**

Couplings covered: **Yes**

Covered with: **Plugs**

Metal condition: **Good**

Rigging comments: **There are a couple of plugs that are plastic but most are metal**

Removable Cathodic Covers:

N/A

Wet Interior Roof Hatch:

Neck size: **30 inches**

Distance from center of the tank (to outer edge): **23 feet**

Shape: **Round**

Handhold at opening: **No**

Curb height: **4 inches**

Cover overlap: **2 inches**

Gasket on neck curb: **Yes (installed by Dixon)**

Hatch security: **Lock**

Metal condition: **Good**

Bolted Ventilation Hatch:

N/A

Roof Vent:

Number: **1**

Distance from center of the tank (to outer edge): **0 feet**

Type: **Pressure-vacuum**

Neck diameter: **20 inches**

Flange opening diameter: **30 inches**

Vertical expanded metal condition: **Good**

EXTERIOR APPURTENANCES

Mesh size: **2**
Interior screen condition: **Good**
Mesh size: **24**
Rain shield: **Yes**
Pressure plate condition: **Good**
Plate free to move: **Yes**
Plate screened: **No**
Height of the lowest screen above the roof: **22 inches**
Metal condition: **Good**

Aviation Lights:

Design: **Double red**
Location: **Free-standing mount**
Functioning: **Yes**
Globe condition: **Good**
Photoelectric cell: **Yes**
Location: **Roof**
Aviation light comments: **Both LED lights are on**

Antennas:

Roof number: **0**
Sidewall number: **31**
Attached to: **Welded frames**
Cable runs: **Along sidewall**
Antenna or cable interference: **No**

Electrical:

Electrical conduit condition: **Good**
Exposed wiring: **No**

WET INTERIOR COATING

Roof:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **Spot coating failures to substrate**
Metal condition: **Good**
Lap seams: **Caulked**
Condition of lap seams: **Good**
Roof comments: **There are only a few small spot coating failures mainly at the couplings**

WET INTERIOR COATING

Sidewall:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **Spot coating failures to substrate, blisters**
Mineral deposits: **Heavy**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Sidewall comments: **There are 200+ blisters with a few broken on the lower sidewall. There are two areas where mineral staining is scraped away to paint, possibly due to ice movement**

Floor:

Topcoat condition: **Good**
Primer coating condition: **Good**
Describe coating: **No significant coating deterioration**
Mineral deposits: **Light**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Sediment depth: **2 inches**

WET INTERIOR APPURTENANCES

Ladder:

N/A

Cathodic Protection:

Clips: **Yes**
Pressure fitting: **Yes**
Location of clips: **Sidewalls, floor**
Type: **Ring**
Location of controls: **In pit**
Ropes damaged: **No**
Wires damaged: **No**

Roof Stiffeners:

Orientation: **Radial with support ring**
Number of stiffener support rings: **1**
Number of ring stiffeners: **24**
Stiffener shape: **Angle**

WET INTERIOR APPURTENANCES

Dimensions: **3 x 5 inches x 23 feet long (estimated)**
Stiffener condition: **Good**
Connection at sidewall: **Welded**
Coating condition: **Good**
Metal condition: **Good**

Sidewall Stiffener:

N/A

Overflow Pipe Inlet:

Type: **Elbow**
Metal condition: **Good**

Fill Pipe:

Diameter: **12 inches**
Height above floor: **½ inch**
Configuration: **Stubs through the floor**
Deflector on end: **No**
Metal condition: **Good**
Fill pipe comments: **There is a 7 inch removable silt ring**

Separate Draw Pipe:

N/A

Drain Pipe:

N/A

Sump:

N/A

Mixer:

N/A

Field Inspection Report is prepared from the contractor's viewpoint. It contains information the contractor needs to prepare his bid for any repair or recoating. The engineer uses it to prepare the engineering report. Cost estimates are more accurate if the contractor's problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site.

1,000,000 gallon standpipe (Sunnyridge) located in the
Village of Pewaukee, Wisconsin.

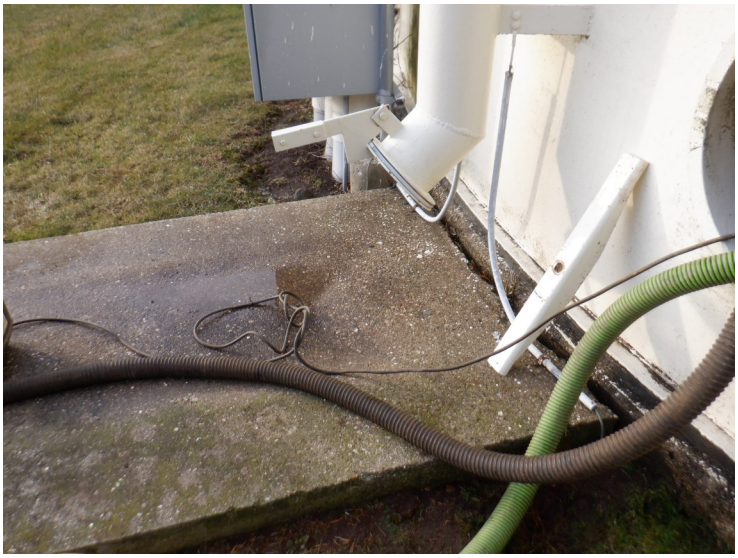
1) The foundation is in good condition overall.

2) There are minor cracks and exposed aggregate on the foundation.

3) The grout between the baseplate and the foundation is in good condition with none missing or damaged.

4) The cathodic protection pressure fitting is in good condition.

5) The overflow pipe discharges to a concrete splash pad.



6) The screened flap gate is in good condition.

7) The screen is in good condition.

8) The two sidewall manways are in good condition.

9) Same.

10) The sidewall ladder vandal guard is in good condition.

11) The sidewall ladder and cage are in good condition.

12) The sidewall ladder fall prevention device is coated.

13) The coating on the sidewall is in good condition overall.

14) Same.

15) There is a small spot of delamination on the baseplate.

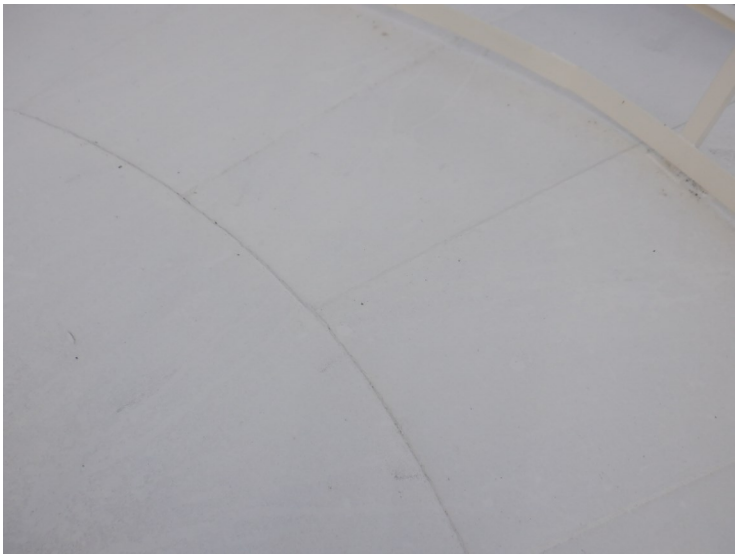
16) There are several small spot coating failures on the sidewall.

17) Same.

18) Same.

19) There are antennas mounted at the top of the sidewall.

20) The coating on the roof is in good condition overall.

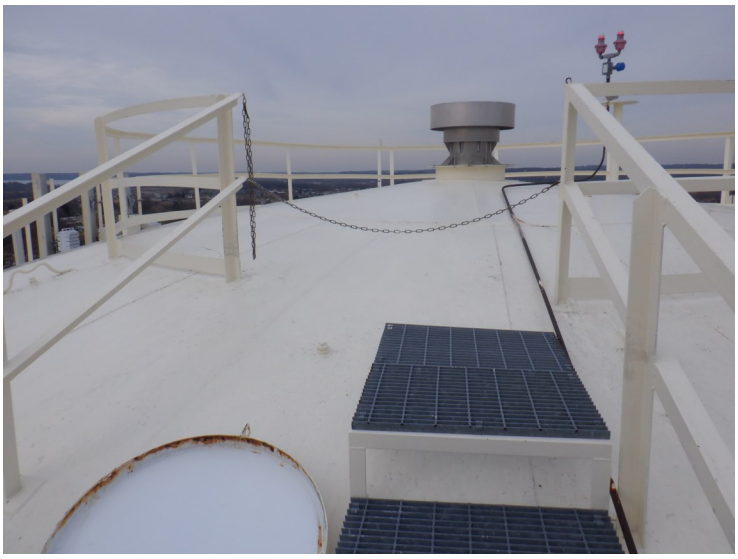


21) Same.

22) Spot coating failures on the roof.

23) The step-off platform is in good condition.

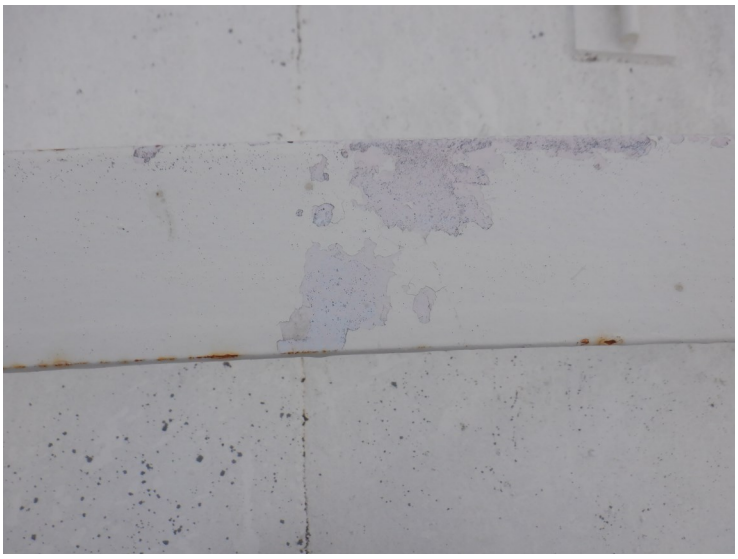
24) The steps to the center of the roof are in good condition.



25) There are safety chains at the opening to the center handrail.

26) The step-off platform and roof hatch are surrounded by a handrail that is in good condition.

27) The center handrail is in good condition.



28) There is delamination along the handrail.

29) The roof rigging couplings are in good condition.

30) Some of the roof rigging couplings have safety clips that are in good condition.

31) The double aviation light is in good condition.

32) Same.

33) The roof vent is in good condition.

34) The vertical expanded metal screen is in good condition.

35) The pressure plate is in good condition.

36) The interior screen is in good condition.

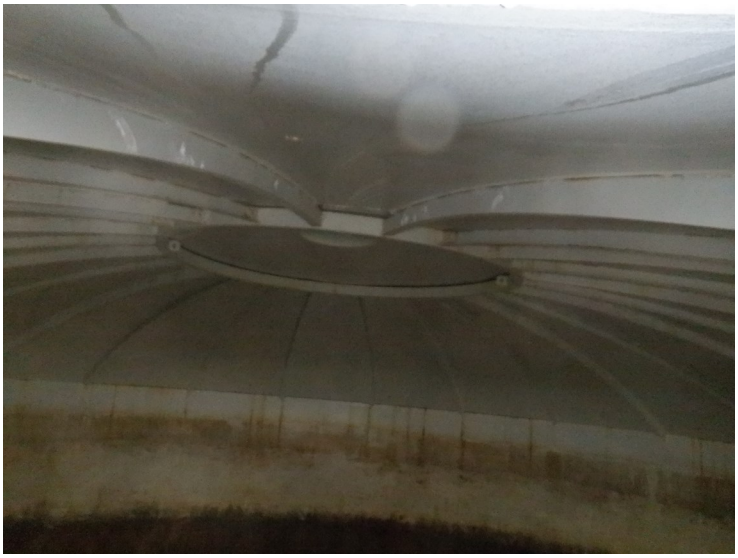
37) The roof hatch is secured with a padlock.

38) The roof hatch is in good condition.

39) A roof hatch gasket was installed by the inspection crew.

40) The coating on the roof is in good condition overall.

41) Same.



42) Same.

43) The roof stiffeners are in good condition.

44) Same.

45) The overflow elbow is in good condition.

46) The coating on the sidewall is in good condition overall.

47) There is heavy mineral staining on the sidewall.

48) There are scratches in the mineral staining near the high-water level.

49) The scratches could be a sign of ice movement.

50) There are blisters in the sidewall coating on the lower sidewall panels.

51) Same.

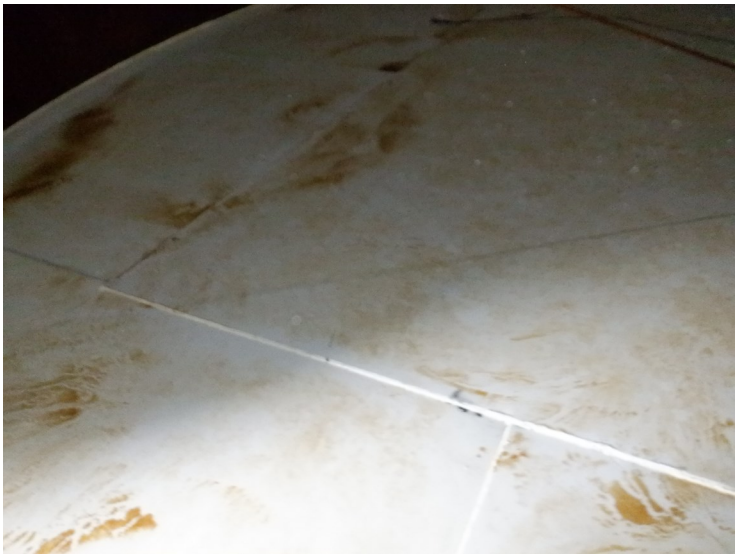
52) There are cathodic protection clips on the sidewall.

53) The manway covers are held by a davit arm that is in good condition.

54) The cathodic protection pressure fitting has a deflector plate around it.

55) The coating on the floor is in good condition.

56) Same.



57) Same.

58) There are cathodic clips on the floor.

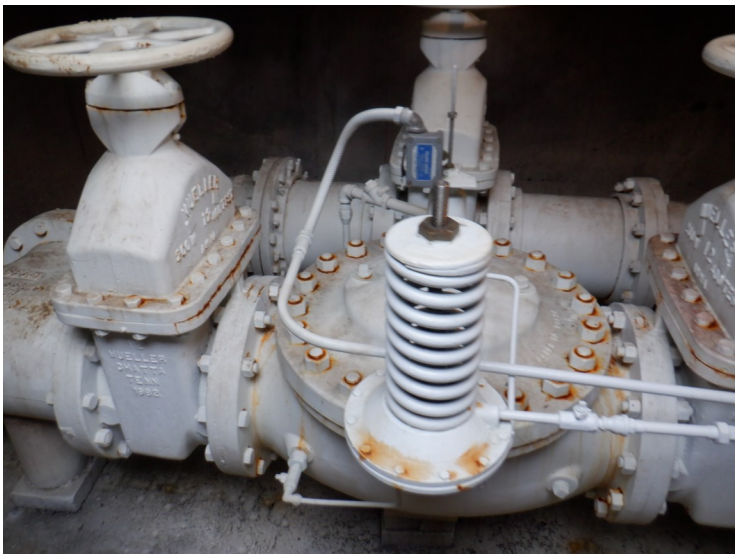
59) The cathodic protection system appears to be in good condition.

60) The fill/draw pipe is in good condition. There is not a deflector plate or bar over the top of the pipe.

61) There is a pit adjacent to the tank. The pit has a metal hatch that is in good condition.

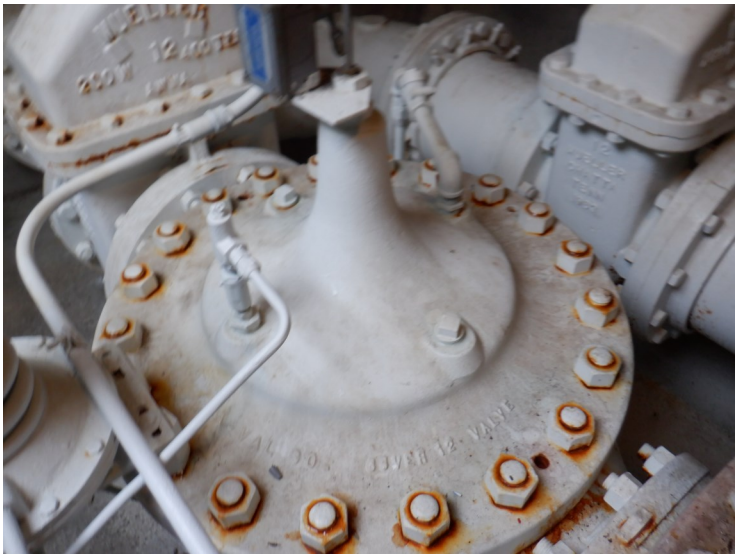
62) There is a sump pump in the pit.

63) The sample tap is in good condition but has a threaded end.



64) The coating on the piping is in good condition overall.

65) There are spot coating failures on the bolts and flanges.



66) Same.