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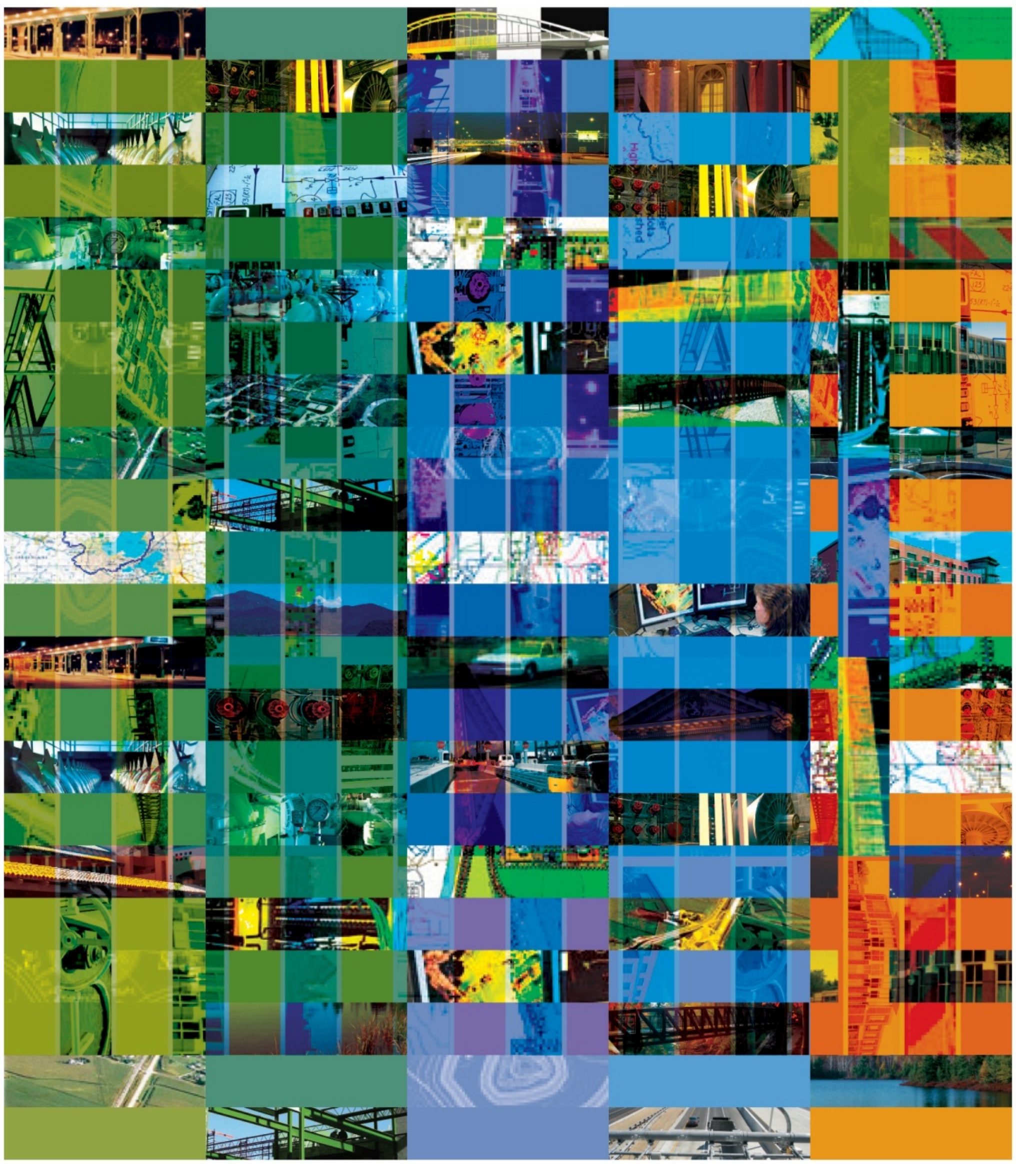

Report

Village of

Lannon, WI

December 2019

STRAND ASSOCIATES®

Report for
Village of Lannon, Wisconsin

Water System Study

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December 2019

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APPENDICES

EXECUTIVE SUMMARY

As the Village of Lannon (Village) continues to proactively plan for future growth of the service area, water system improvements and routine maintenance are needed to build redundancy into the system and keep pace with increasing water demands due to system build-out and future growth.

The Village water system currently supplies water to 141 service connections that, on average, consume a total of 29,000 gallons per day (gpd). On days of maximum water use, the system supplies approximately 72,000 gpd. The existing water system includes one shallow limestone-aquifer well with a capacity of 250 gallons per minute (gpm), a ground-level storage reservoir, and booster pump facility.

Certain areas within the Village are still served by private wells. Many private wells have recently tested positive for coliform and *E.coli* bacteria. The Village should construct additional water main to provide water service to residents impacted by contaminated private wells. It is estimated that approximately 150 residential customers would connect to approximately 2.5 miles of new water main. These improvements should take place within the next three years.

Future growth was estimated based on the Village's 2018 Comprehensive Land Use Plan and compared against other sources of population estimates. Based on the future growth and system build-out of existing residents, projected maximum day water demands for design years 2024 and 2035 are estimated to increase to 271,000 gpd and 705,000 gpd, respectively.

An additional source of water is currently needed as a redundant source of supply and to satisfy growing demands. As additional customers connect to the system, a third source of supply will be needed around the year 2028 based on future growth estimates. Alternatives for adding supply include a shallow limestone-aquifer well, similar to the existing well, a deep sandstone-aquifer well, and an interconnection with the Village of Menomonee Falls. Because of issues with an interconnection with the Village of Menomonee Falls, and concerns about water quality and capacity of a shallow limestone-aquifer well, a deep sandstone-aquifer well is recommended. A deep sandstone well will likely require treatment for iron and radium removal.

Water storage is generally needed to satisfy periods of high water use including peak hourly demands and firefighting events. The existing reservoir and booster station provides enough capacity to fight a small residential fire, but the reservoir may run out of water if a larger commercial building fire were to happen. As the water system expands, more water storage will be also be needed. Additional storage volume of at least 250,000 gallons is needed to maintain enough fire flow and satisfy peak daily demands. Alternatives for additional storage include a reservoir and booster station or an elevated tank. Costs for each alternative are similar, but the additional operation and maintenance (O&M) associated with a booster station make the elevated tank the recommended improvement.

A computerized hydraulic model was updated and calibrated to simulate existing system and future build-out scenarios. Section 5 describes the process used to calibrate the hydraulic model. The model was used to simulate a new elevated tank in the system with two different overflow elevations. It was determined that a high-pressure zone and booster station would be needed to supply Lannon Village Hills if a water tower is constructed at a height to match that of the Village of Menomonee

Falls system. If the water tower is constructed at a higher elevation, a high-pressure zone is not needed.

The Village water system has struggled with non-revenue water since the system was established in 2008 and exceeds the limits set by the Wisconsin Public Service Commission. Non-revenue water is water that gets pumped to the distribution system but, for a variety of reasons, does not get billed to a customer. Typical causes of non-revenue water include meter inaccuracies, hydrant flushing, and water main leaks. Section 6 shows the results from a water audit and provides recommendations on how to reduce the amount non-revenue water.

Section 7 presents an implementation schedule and anticipated costs for the recommended improvements. Major improvements include a new well facility, elevated tank, and water main extensions. The well facility project starts with a well site investigation, drilling the well, then constructing the well facility. The entire process typically takes about two years. Elevated tank construction also takes approximately two years. Starting the process in spring 2020, with site development tasks such as site survey and soil borings, will put the project on track for completion in fall 2022.

The anticipated cost for a deep sandstone-aquifer well with a treatment facility, a new 250,000-gallon elevated tank, and 2.5 miles of water main, including professional services and contingencies, is $11.7 million and is summarized below.

Project	Anticipated Cost	Anticipated Construction Years
Deep-Aquifer Sandstone Well and Treatment Facility	$3.0 million	2021 to 2022
250,000-Gallon Elevated Tank	$2.3 million	2021 to 2022
Water Main Improvements	$6.4 million	2020 to 2021
Total Cost	**$11.7 million**	

Summary of Water System Improvements

SECTION 1
INTRODUCTION

The Village of Lannon, Wisconsin (Village), is a community of approximately 1,200 people located in Waukesha County in southeastern Wisconsin.

The municipal water system is owned by the Village and is operated by CTW, a well installer and maintenance provider. The water system contains one pressure zone, one well, two booster pumps, one ground-level storage facility, and approximately 3.5 miles of water main ranging in size from 6 to 16 inches in diameter. As of 2018, there were approximately 141 water services.

1.01 PURPOSE AND SCOPE

The purpose of this Water System Study report is to assess the current distribution system performance, review existing supply and storage capacity, analyze the water system's ability to meet future demands, and develop a capital improvements plan for future system improvements. This report will allow system improvements to be implemented in an adequate and economical method.

The scope of the report includes the following elements:

1. Prepare a brief inventory of existing water system supply components. Incorporate recent correspondence from the Wisconsin Department of Natural Resources (WDNR) and any comments from the water system operator.

2. Tabulate historical data from reports made to the Wisconsin Public Service Commission (PSC) since 2008. Use gathered data, population projections, and anticipated future growth areas to estimate current, year 2024 and year 2035 water demands.

3. Evaluate ability of existing infrastructure to meet average day demands, maximum day demands and maximum day water plus fire demands for each plan year.

4. Update and calibrate the water system model and incorporate current storage facility, pump, hydrant, valve, and supervisory control and data acquisition (SCADA) information into the model.

5. Conduct four field hydrant flow tests throughout the system during periods of low water demand. Perform a steady-state calibration of the water model to industry-accepted standards using field hydrant flow testing results and SCADA records.

6. Simulate current and future demands using water system model. Evaluate capacity of the distribution system to meet current and future maximum day and peak hour water demands using steady state scenarios. Evaluate system improvements needed to meet current and future needs.

7. Prepare an Opinion of Probable Project Cost (OPPC) and implementation schedule for water system improvements developed from the system capacity and model analysis efforts.

1.02 ABBREVIATIONS AND DEFINITIONS

amsl	above mean sea level
AWWA	American Water Works Association
Chemrite	Chemrite Copac
CIP	Capital Improvements Plan
gcd	gallons per customer per day
GIS	geographical information system
gpad	gallons per acre per day
gpd	gallons per day
gpm	gallons per minute
HGL	hydraulic grade line
hp	horsepower
ISO	Insurance Services Office
MG	million gallons
mgd	million gallons per day
MSL	mean sea level
OPPC	opinion of probable project cost
PSC	Public Service Commission
psi	pounds per square inch
REC	residential equivalent connections
SCADA	supervisory control and data acquisition
SEWRPC	Southeast Wisconsin Regional Planning Commission
TIF	tax incremental finance
VFD	variable frequency drive
WDNR	Wisconsin Department of Natural Resources
WDOA	Wisconsin Department of Administration
WEGS	Water, Electric, Gas, and Sewer
Village	Village of Lannon

SECTION 2
SYSTEM INVENTORY

2.01 SYSTEM OVERVIEW

Figure 2.01-1 shows a map of the current distribution system with locations of water facilities. The Village owns one well, one below-ground reservoir, one hydro-pneumatic tank and two booster pumps that supply water through approximately 3.5 miles of water main ranging from 6 to 16 inches in diameter. The well, two booster pumps, and the hydro-pneumatic tank are located in the same facility. CTW, a local well contractor, is the licensed operator for the water system. Table 2.01-1 summarizes the quantity of water main in the distribution system as reported to the Wisconsin PSC at the end of 2018.

Water Main Diameter (inches)	Length (feet)	Percentage of Total
6	90	0.5%
8	5,102	27.7%
12	11,829	64.1%
16	1,419	7.7%
Total	**18,440**	**100.0%**

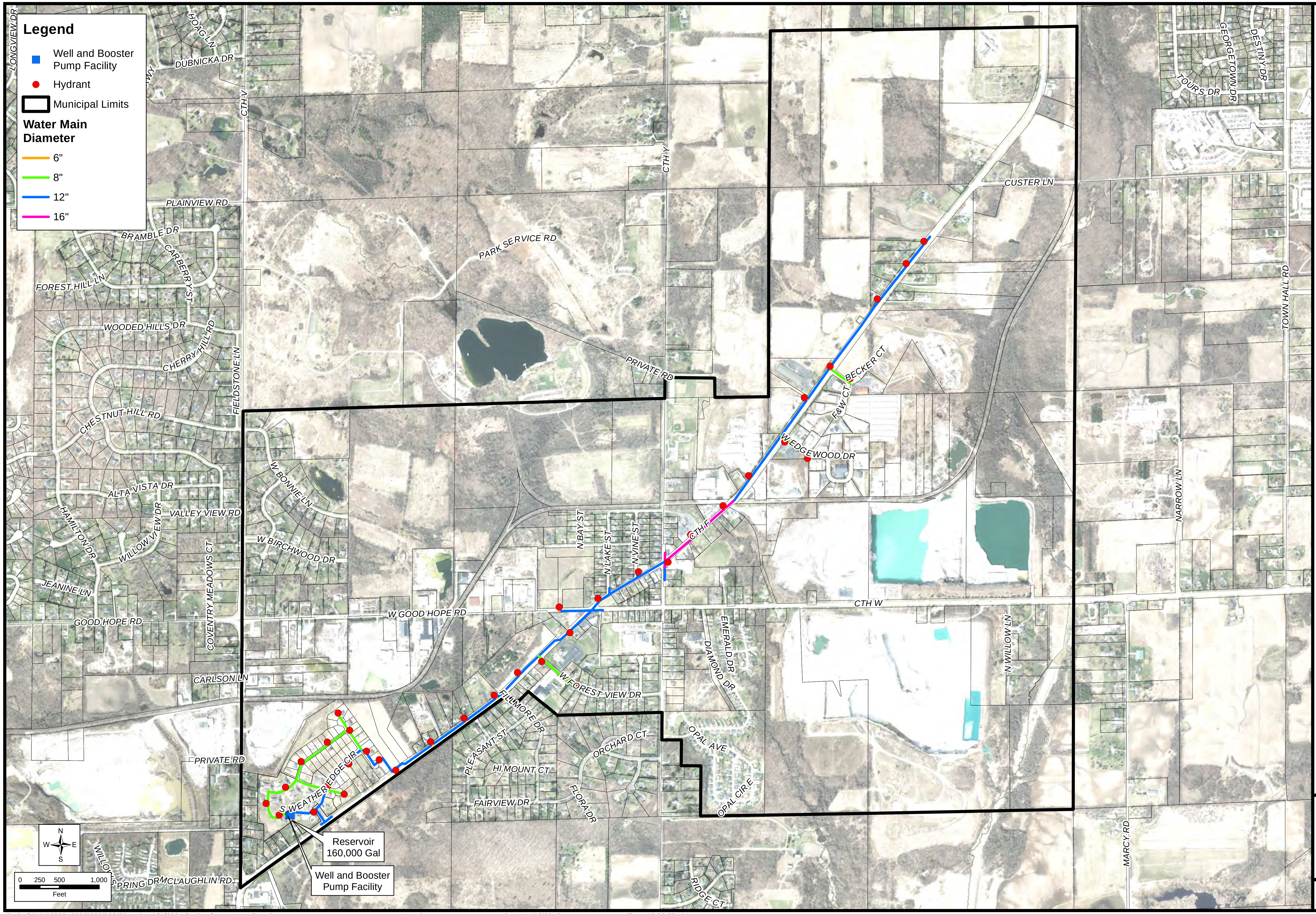
Table 2.01-1 Existing Distribution System Water Main Inventory

2.02 WELL SUPPLY

The Village has one groundwater well (Well No. 1) that was constructed in 2007 and has a reported rated capacity of 250 gallons per minute (gpm). The well pump is designed for a maximum output of 300 gpm and is driven by a 30 horsepower (hp) motor, which was replaced in 2019. The motor is fitted with a variable frequency drive (VFD). Currently, the VFD runs at 37 Hz and the resulting flow is approximately 150 gpm. Well No. 1 is metered and pumps to the 160,000-gallon below-ground reservoir. Sodium hypochlorite is injected before the reservoir for disinfection purposes. The injection location was recently relocated in 2019 further downstream of the meter as it was suspected that the injection feed was interfering with the flow meter. The discharge piping was modified, and the meter was replaced as part of that project. Figure 2.02-1 shows a photograph of the well facility and Figure 2.02-2 shows a photograph of the well pump discharge piping.

The total amount of water that can be withdrawn from a source with the largest pumping unit out of service is referred to as the firm capacity. Therefore, the firm well supply firm capacity of the Village is 0 gpm and another source of supply is required. The guidance document *Guidance for Municipal Drinking Water Source Capacity Determination* published by WDNR in 2018 considers "a water system that relies on only one source to not have adequate source capacity."

CTW indicates that anticipated common well failures could be fixed within three days. During an outage, supply would have to come from storage to meet demands. Depending on the demands in the system, the Village might not be able to provide enough supply during a well outage. See Section 4 for a capacity evaluation. Contact the Village for the most recent Emergency Response Plan that should be considered until additional supply or storage is added to the system.



WATER DISTRIBUTION SYSTEM

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 2.01-1
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Figure 2.02-1 Well and Booster Facility

Figure 2.02-2 Well Discharge Piping

2.03 BOOSTER PUMPS

There are two booster pumps with 30 hp motors fitted with VFDs located in the well facility. Water from the booster pumps is metered and is pumped out of the adjacent below-ground reservoir to the distribution system. The current capacities of the two booster pumps are listed in Table 2.03-1 in gpm and million gallons per day (mgd). The total current booster pump capacity is 1,100 gpm, or 1.584 mgd. The firm booster pump capacity assuming the largest booster pump out of service is 550 gpm or 0.792 mgd. There is space in the well and booster pump facility for an additional booster pump adjacent to the two existing booster pumps. The Village has been considering installing a 1,000-gpm fire pump at this location. Neither of the existing booster pumps have had any maintenance performed on them since being installed. Figure 2.03-1 shows a photograph of the booster pumps and Figure 2.03-2 shows a photograph of the entry point to the distribution system.

Booster No.	Current Capacity (gpm)	Current Capacity (mgd)
1	550	0.792
2	550	0.792
Total Capacity	1,100	1.584
Firm Capacity	550	0.792

Table 2.03-1 Existing Booster Pump Capacity

Figure 2.03-1 Booster Pumps

Figure 2.03-2 Distribution System Entry

2.04 STORAGE

System storage includes one concrete below-ground reservoir and one hydro-pneumatic pressure tank. The reservoir is located to the south of the well and booster pump facility. The reservoir was constructed in 2007 and has a storage capacity of 160,000 gallons. The reservoir contains baffle walls intended to increase chlorine contact time. The reservoir was last inspected on February 2, 2019.

The pneumatic pressure tank has a capacity 5,500 gallons and sets the hydraulic grade line (HGL) in the distribution system. The tank is located in the well and booster pump facility and is connected to the system downstream of the booster pumps. The tank was last inspected on August 26, 2015. The setpoints of the booster pumps are such that the pressure tank has a maximum pressure of 70 pounds per square inch (psi) and minimum pressure of 62 psi. This correlates to a HGL that ranges between 1,045 feet and 1,064 feet. The corresponding average pressure in the distribution system ranges between 65 and 81 psi and is discussed in more detail in Section 5 of this report. Once the HGL in the system drops below the minimum set point, one booster pump turns on at full speed. If the pressure drops below 58 psi (1,036 feet HGL) while one booster pump is running, the second booster pump turns on. Figure 2.04-1 shows a photograph of the pneumatic pressure tank and Figure 2.04-2 shows a photograph of the below-ground reservoir area.

Figure 2.04-1 Pneumatic Pressure Tank

Figure 2.04-2 Below-Ground Reservoir

SECTION 3
HISTORICAL AND PROJECTED DEMANDS

3.01 GENERAL

This section presents historic water demands for the Village and develops a projection of future water demands. Water demand rate terminology used in this report is defined as follows:

Average Day Demand: The total volume of water produced in a year divided by the number of days in the year.

Maximum Day Demand: The greatest volume of water pumped in a single day over the course of one year.

Fire Demand: The estimated amount of water required to fight a fire. This demand is generally specified as a rate of flow in gpm for a given time period in hours. The estimated fire demand is added to the domestic demand during the average hour of the maximum day to obtain the demand on a day that a major fire occurs. Fire demand generally increase the volume of storage that must be available on a maximum day.

Estimation of future water demands is not precise. A forecast of future water demand can be obtained by projecting average day demand based on population or customer growth and current water use within the service area. Future maximum day demands are then estimated by analyzing past ratios of maximum to average day demand and applying the resulting factor to average day water use projections.

3.02 WATER SALES AND PUMPAGE

A. Water Use Records

Historical water use records were obtained from the Wisconsin PSC *Water, Electric, Gas, and Sewer (WEGS) Annual Report* for the years 2008 through 2018. Appendix A summarizes the historical water pumpage and sales data. Table 3.02-1 presents the number of customers in each category as shown in the PSC reports since 2008. Only a small portion of the Village is currently served by the existing water distribution system. As of 2018, there are only 141 customers that purchase water from the Village. The existing Village water system is primarily residential with a few commercial and public customers. Approximately 131 of the estimated 528 households (25 percent) are connected to the distribution system. The number of residential

Year	Residential	Commercial	Public
2008	39	0	3
2009	45	1	3
2010	65	1	3
2011	66	7	3
2012	66	6	3
2013	66	6	3
2014	66	7	3
2015	84	7	3
2016	105	7	3
2017	113	7	3
2018	131	7	3

Table 3.02-1 Number of Customers by Category

customers has been generally increasing while the number commercial and public customers have remained constant.

B. Sales to Pumpage Ratio

Figure 3.02-1 presents sales to pumpage ratios since 2008. Sales will typically be less than pumpage because of unaccounted for water, unmetered sales, leakage, water main breaks, and hydrant flushing. The sales to pumpage ratio, also known as efficiency, has ranged from 0.37 to 1.09. The highest ratio of 1.09 occurred in the second year that the distribution system was in operation. This was caused by the water meter for the well not being calibrated properly and has since been fixed. The lowest sales to pumpage ratio of 0.37 occurred in 2016. There was a slight decline in efficiency from 2010 to 2016 with a sudden increase in 2017 and continuation in 2018. The low sales to pumpage ratios are likely because the overall water sales are very low. A small water main leak can have a large impact on the sales to pumpage ratio. It is a priority for the Village to increase the sales to pumpage ratio in the future. This could potentially be completed by fixing any leaking mains and improving tracking of non-revenue water. It is also expected that the sales to pumpage ratio decreases as the system expands and the overall sales increases. Projecting future demands, a sales to pumpage ratio of 0.8 will be used for the 2024 and 2035 design years. A value of 0.6 will be used for 2019 based on last year's sales to pumpage ratio.

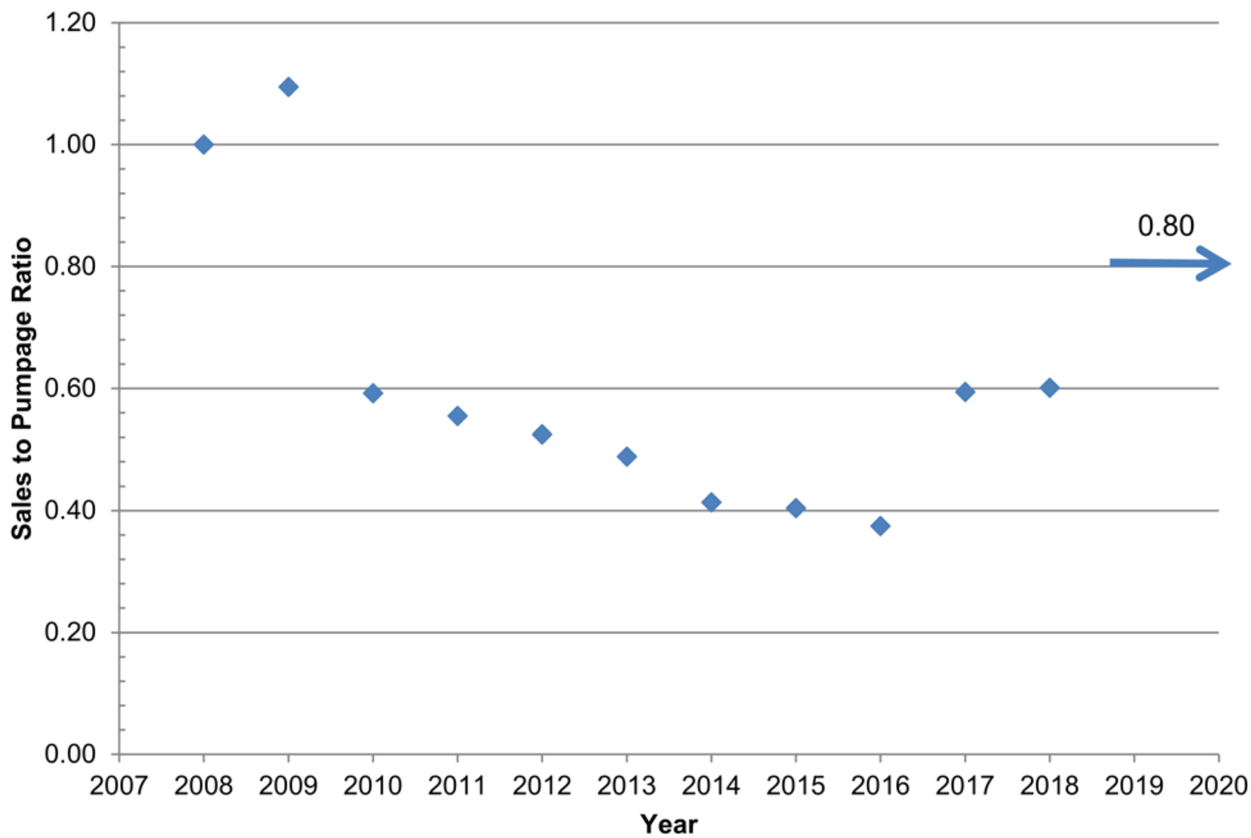


Figure 3.02-1 Sales to Pumpage Ratios

C. Maximum to Average Day Demand Ratio

Figure 3.02-2 presents maximum day to average day ratios since 2008. The values range from 2.21 to 10.53. The higher ratios occurred during the first few years of system operation whereas the past four years have been the lowest. The high ratios occurred due to system construction and hydrant flushing. Because the background system demand was so low, a day of hydrant flushing brings significant demand to the system and high maximum to average day ratios. As noted on the WEGS reports, the maximum day pumpage occurred during days when hydrant flushing occurred. Once the system increases in background demand, maximum day to average day demand ratios will likely decrease. Values above 2.5 are not typically expected for well-established residential distribution systems. An average of the last three years, or a value of 2.5, will be used to forecast future maximum day demands.

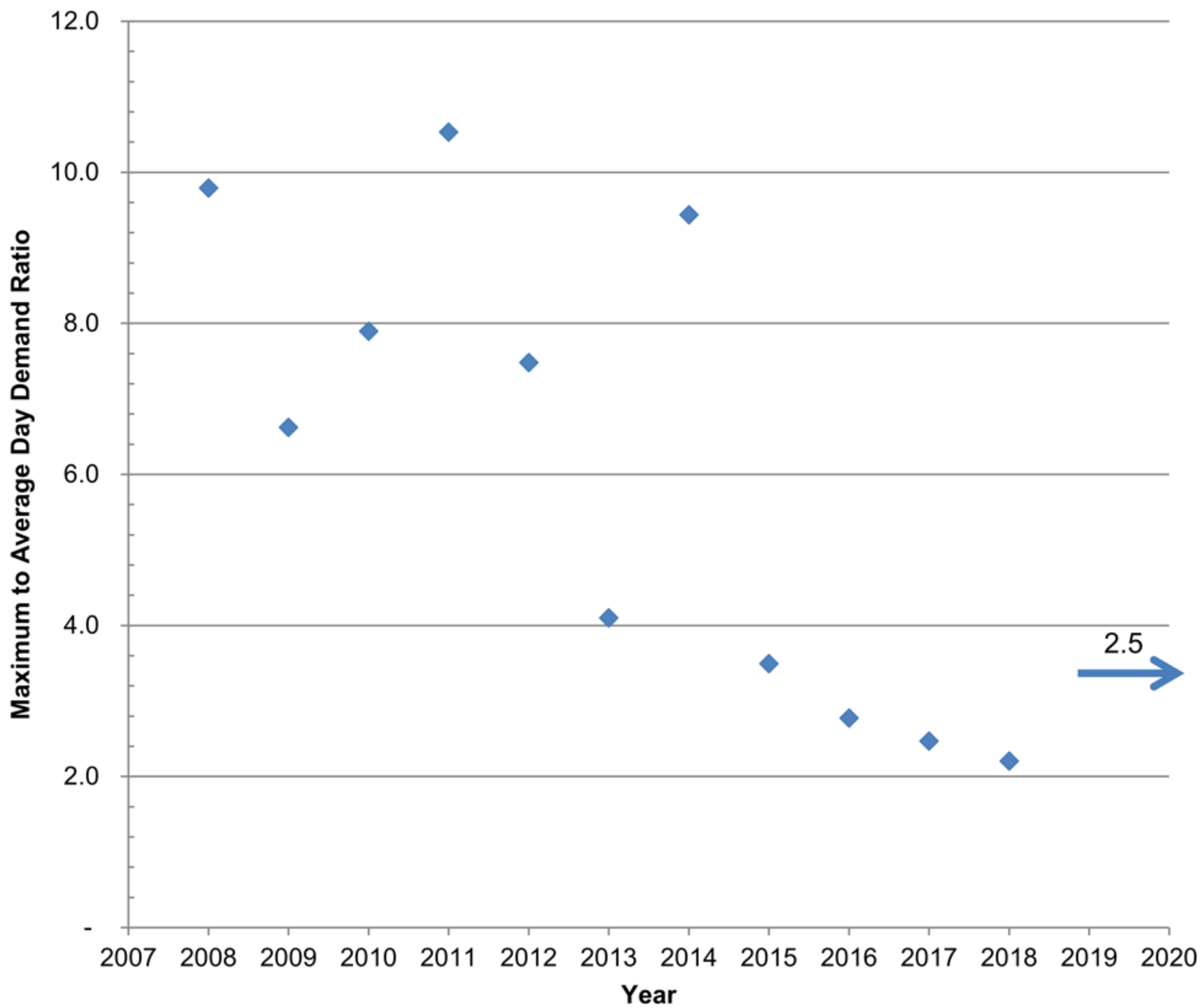


Figure 3.02-2 Maximum to Average Day Demand Ratios

D. Residential Sales

Figure 3.02-3 presents the residential sales per customer per day since 2008. Sales per customer is calculated by taking the total sales for each category and dividing by the number of meters for each category for that year. The number of residential customers has increased an average of 16 percent each year for the past three years. Residential sales per customer reached a maximum of 122 gallons per customer per day in 2016 and have since slightly declined. An average of the last three years is 116 gallons per customer per day and will be used to project the usage for the existing 131 residential customers, or approximately 15,200 gallons per day. Future growth will also use this number to project demands.

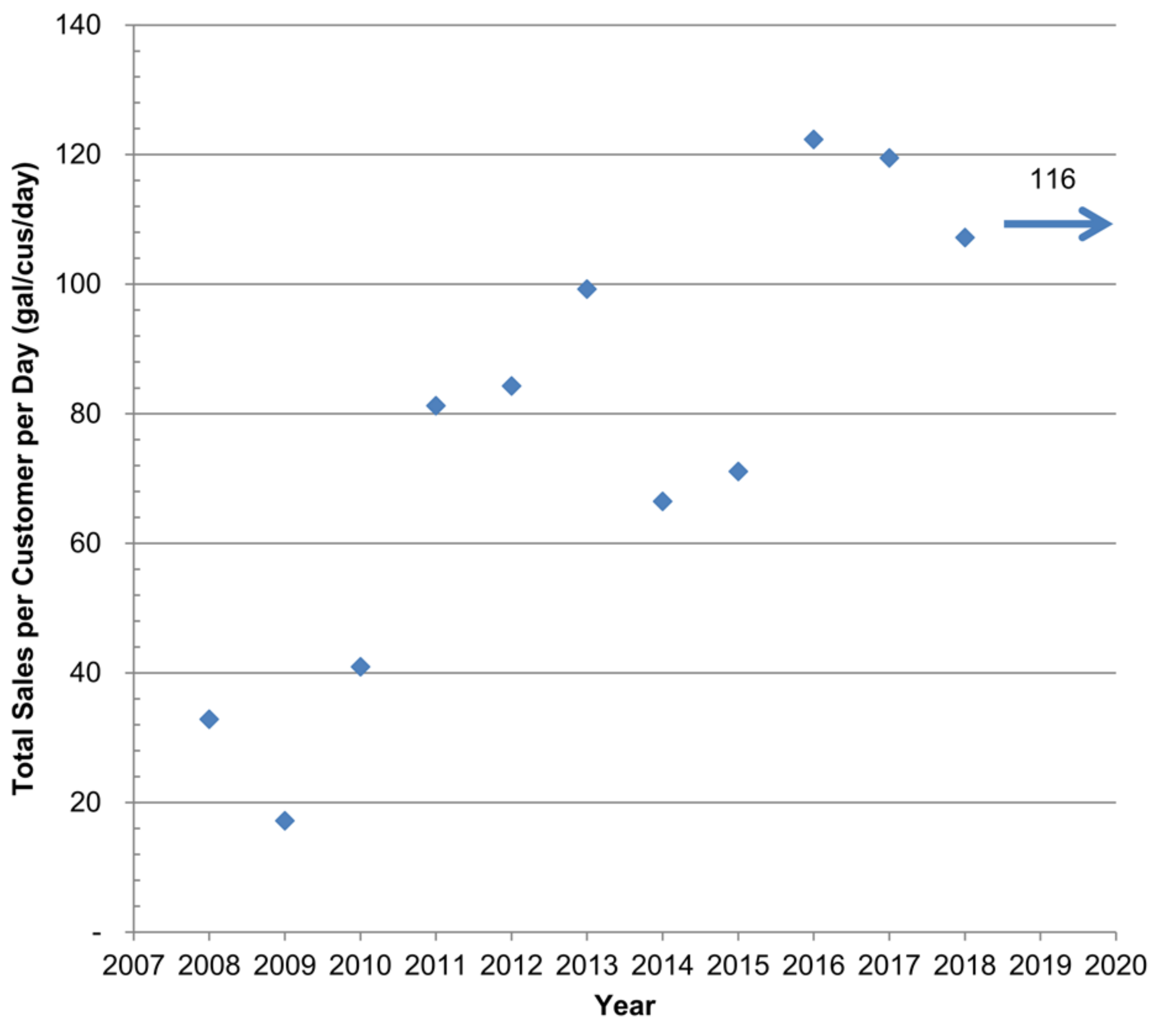


Figure 3.02-3 Per Customer Sales–Residential

E. Commercial Sales

Figure 3.02-4 presents the commercial sales per customer per day since 2008. The number of commercial customers has remained the same for the past 5 years. Commercial sales per customer were sporadic for the first few years after the utility was created, but have since stabilized and have been slowly increasing since 2011 to a recent maximum of 114 gallons per customer per day. An average of the last three years is 107 gallons per customer per day and will be used to project the usage for the existing 7 commercial customers, or approximately 750 gallons per day.

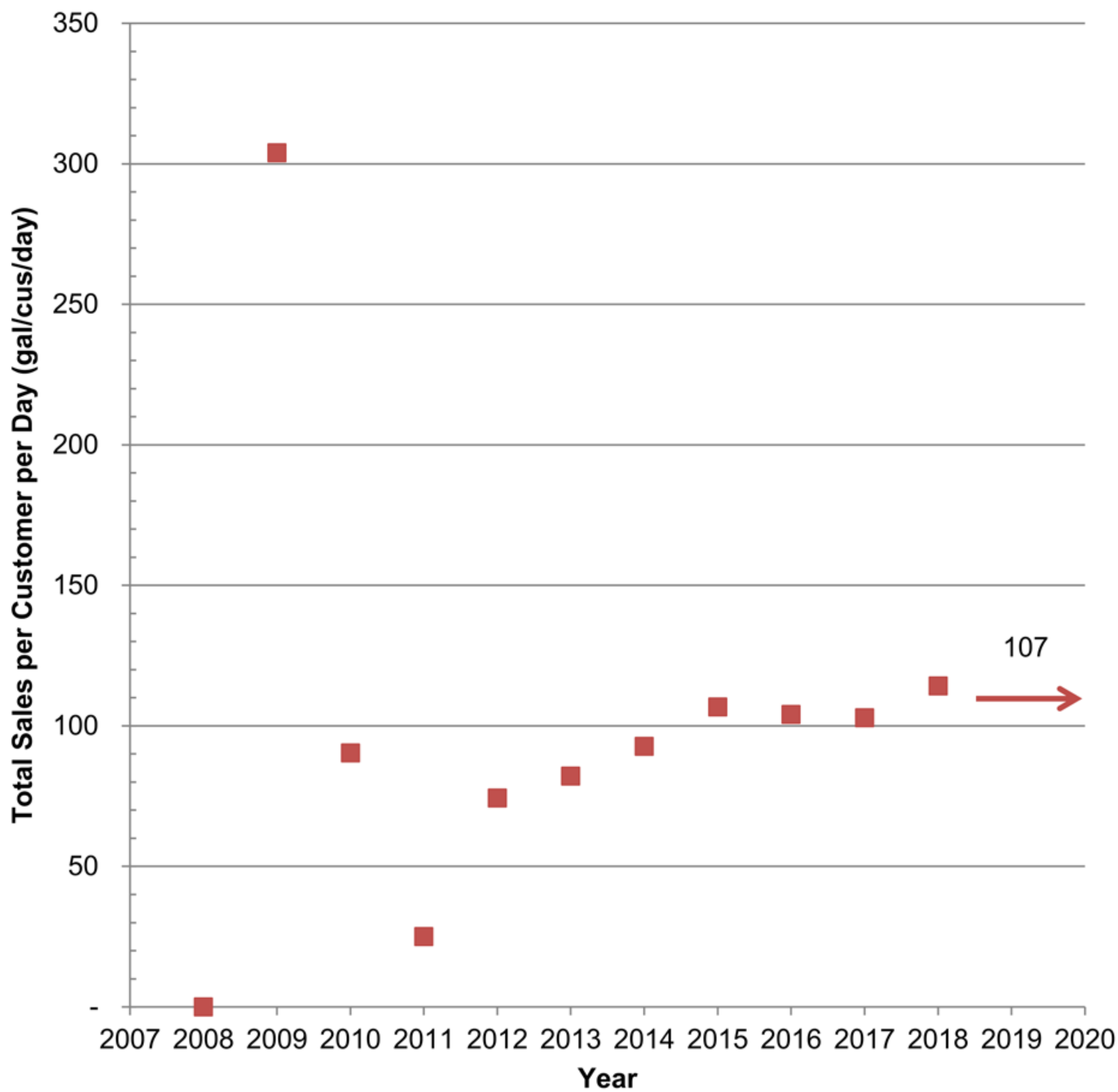


Figure 3.02-4 Per Customer Sales–Commercial

F. Public Sales

Figure 3.02-5 presents public sales per customer per day since 2008. The number of public customers has remained the same since the utility was created. Public sales per customer per day were sporadic for the first few years when the utility was created, but have since stabilized and have been slowly decreasing since 2015 to a recent minimum of 320 gallons per customer per day. An average of the last three years is 421 gallons per customer per day and will be used to project the usage for the existing 3 public commercial customers, or approximately 1,260 gallons per day.

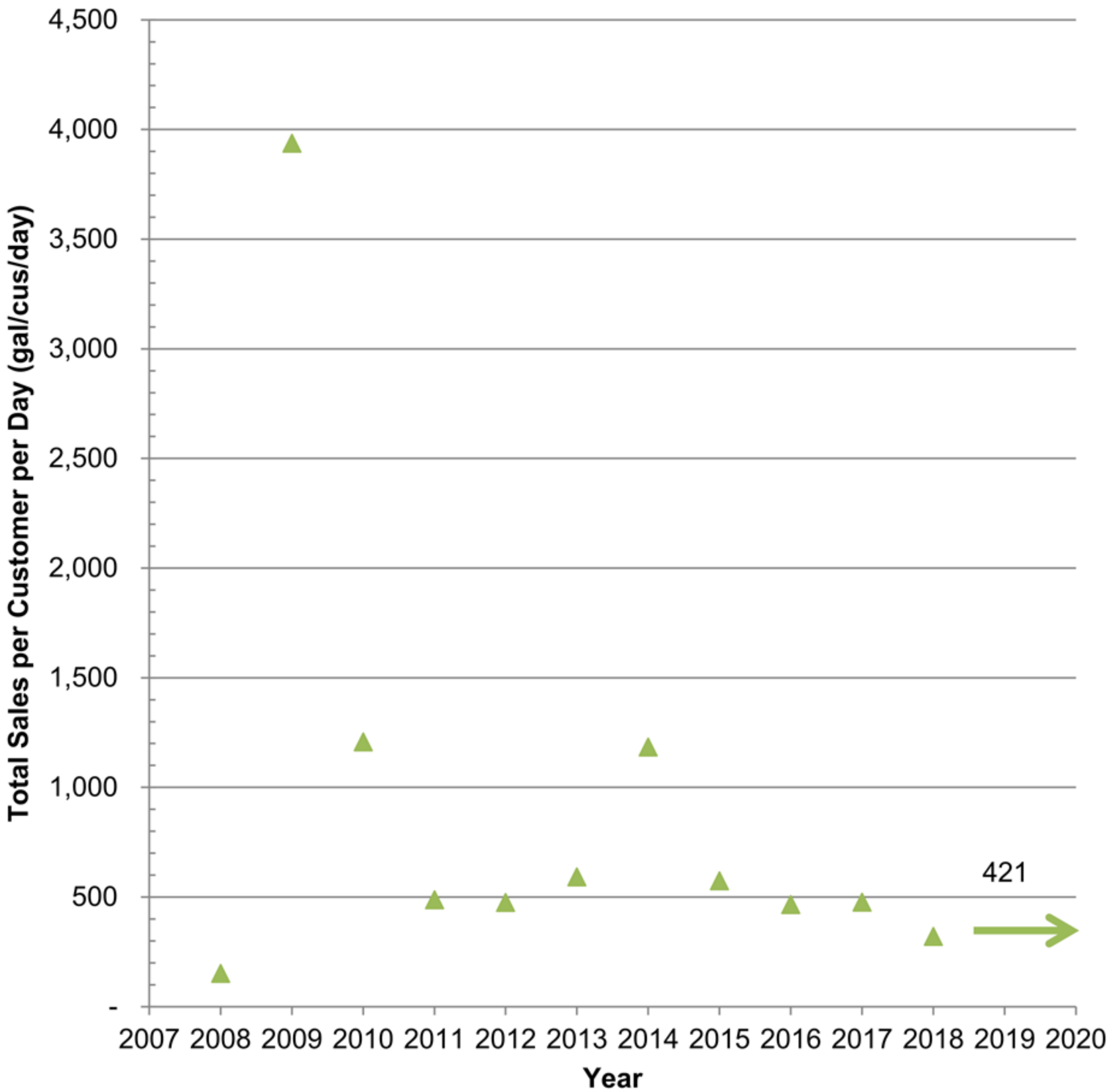


Figure 3.02-5 Per Customer Sales–Public

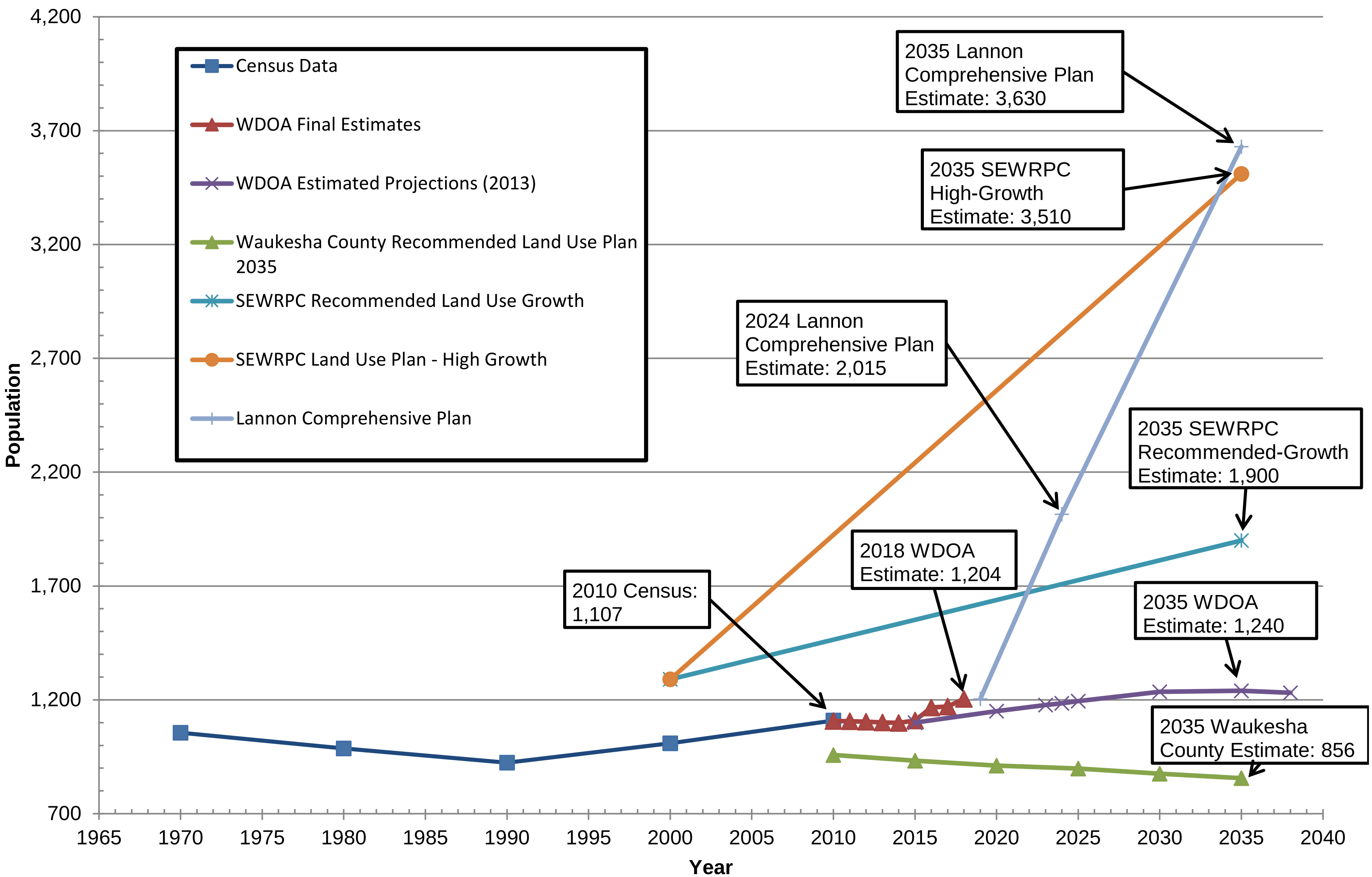
3.03 POPULATION PROJECTIONS

Population projects shown in this report are for comparative and perspective purposes only. Future water demand was calculated based on future customers discussed in the next section. Figure 3.03-1 presents the historical census data from 1970 to 2010 in addition to several population projections from different sources. It also shows the current estimated population and a 2035 population projection from the Wisconsin Department of Administration (WDOA) Demographics Services Center. Southeastern Wisconsin Regional Planning Commission (SEWRPC) also published recommended-growth and high-growth population projections for the Village's sanitary sewer service area, which encompassed the Village in 2010. Finally, the Waukesha County Recommended Land Use Plan also contains population projections for 2035.

The Census data shows a slight decline in population from the 1970s to the 1990s only to begin increasing thereafter. The 2010 Census showed the Village at its greatest population of 1,107. The WDOA estimated the total population to decrease after 2010 for a few years followed by a significant increase starting in 2016. In 2013, the WDOA projected the population to increase and then top out in 2035 with a population of 1,240. The 2018 WDOA estimate of 1,204 is higher than an interpolated value from the previous WDOA projections. SEWRPC population projections for the sanitary sewer service area projects a significant increase in population whereas the Waukesha County Land Use Plan projects the population to decrease.

While there is much variability in the published projections of these entities, which are more focused on regional growth, in addition to them being nearly ten years old, the Village completed a Comprehensive Land Use Plan in 2018 to understand its anticipated growth on a parcel by parcel basis. The Village land use plan is based on residential densities. These densities were applied to buildable acreage at various sites in the Village to develop a growth projection. Based on that analysis, the Village is expected to grow to a population of 3,645 by 2035 as represented in the Lannon Comprehensive Plan trendline in Figure 3.03-1. See the following section for details.

Figure 3.03-1 Population Projections



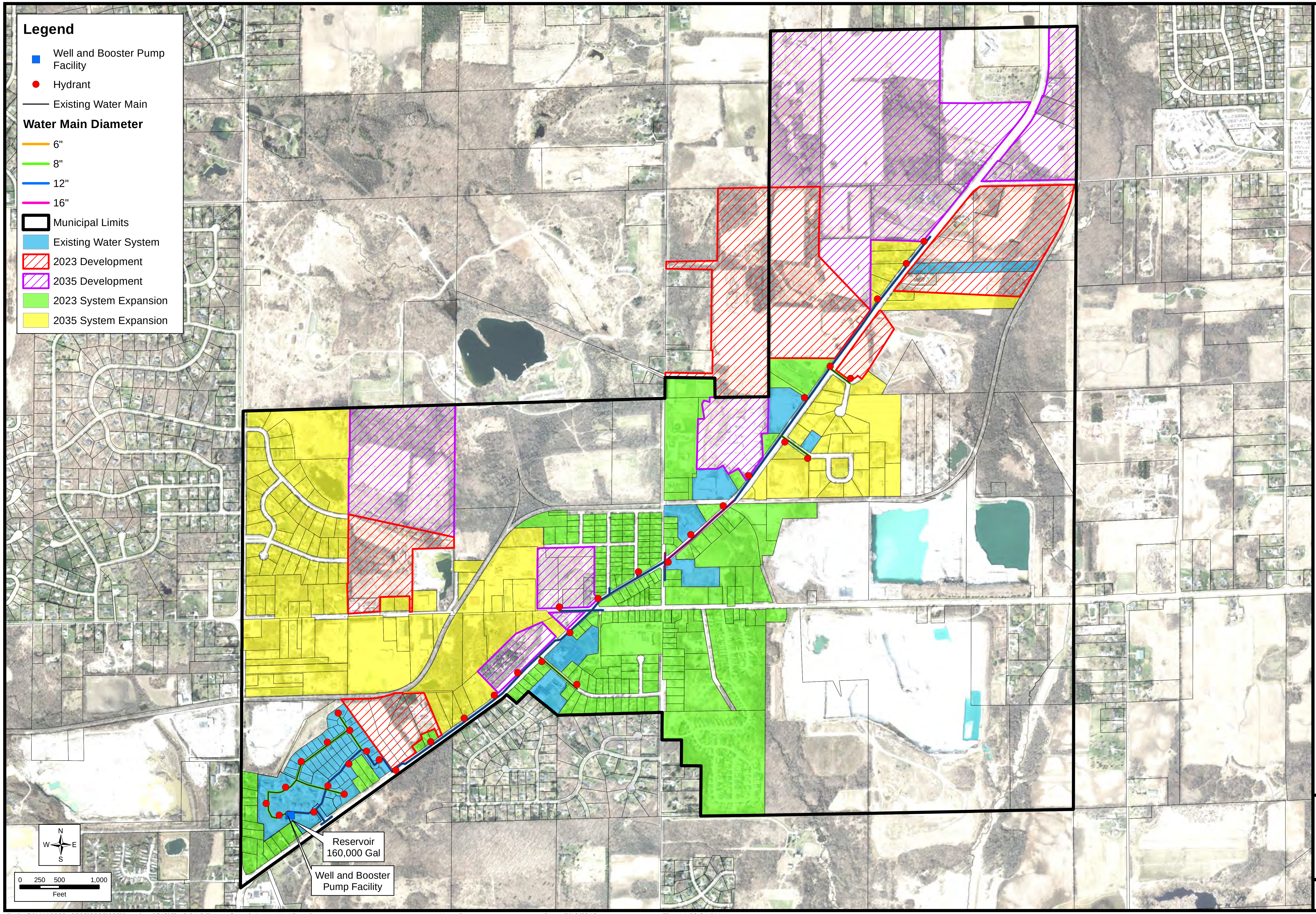
3.04 FUTURE GROWTH

The Village adopted a Comprehensive Plan Amendment to the existing *Recommended Land Use Plan for Waukesha County–2035* in June 2018. The amendment was prepared by Vandewalle & Associates and contains a future land use map that displays areas for planned neighborhoods. Appendix B contains a copy of the amendment.

There are several developers planning to construct single-family, multi-family, and mixed-use buildings throughout the Village, primarily in the planned neighborhood areas shown in the Comprehensive Plan Amendment. The developers have indicated an approximate number of units and when they are being planned for construction. The Village also indicated areas of commercial development. The projected commercial demand was calculated using the amount of proposed development area and multiplying it by a land-use demand factor. Figure 3.04-1 displays the Future Land Use Map from the amendment that shows all residential, commercial, and public areas to be developed and/or added to the water system.

In 2018, there were several private wells, including the well providing water to the Lannon Elementary School, that tested positive for coliform and *E.coli* bacteria. Through the end of October 2018, 33 of 55 wells tested at the Waukesha County Laboratory were positive for coliform and 12 were positive for *E.coli*. The positive tests results have prompted interest in existing residential, commercial, and public facilities to convert to the Village's public water system. It is assumed that all residents will convert to the water distribution system by 2035 as additional water main is constructed.

The Land Use Map, in addition to knowledge of potential developers for the area, was used to create a future growth map that displays what parcels are scheduled to be developed for each design year. Figure 3.04-2 shows the future growth areas that illustrate the developments anticipated to be constructed and areas of the existing Village to be connected to the water distribution system.



FUTURE GROWTH AREAS

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 3.04-2
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Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 3.04-2 Future Growth Areas 11x17.mxd User: Danc Date: 7/10/2019 Time: 1:00:34 PM

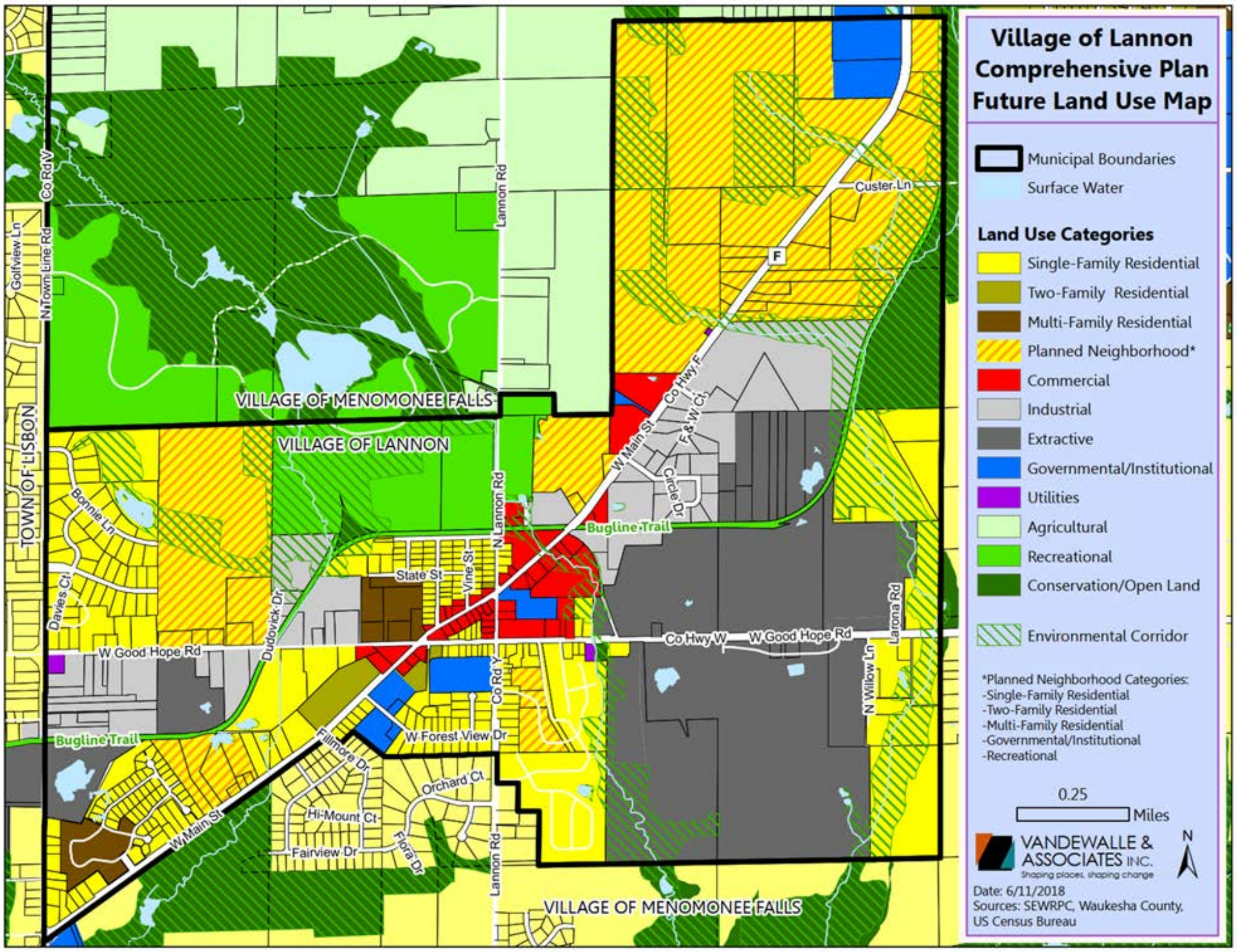


Figure 3.04-1 Future Land Use Map–Vandewalle & Associates

A. Residential

Residential customer projections were developed to estimate the residential demand in the system based on future growth and existing residents that may connect to the distribution system. The number of existing customers, as shown in Table 3.02-1, was used to develop sales per customer for residential demand. The number of future residential customers is summarized below.

1. Private Well Conversion

There are approximately 397 existing households that are currently using private wells for water supply. It is assumed that approximately 150 of these households will connect to either existing or proposed water main within the next five years. The remaining households are anticipated to connect by 2035. The number of households, or future customers, was multiplied by the residential sales per customer value of 116 to get the projected water demand.

2. Development

There are significant residential developments planned in the northern and western parts of the Village. Two tax incremental finance (TIF) districts have been established. Approximately 386 residential units are anticipated to be developed in the next five years and a total of 1,249 units are anticipated to be developed by 2035. The number of units was multiplied by the residential sales per customer value to get the projected water demand.

B. Commercial/Light Industrial

1. Private Well Conversion

There are approximately 47 existing commercial or light industrial facilities that are currently using private wells for water supply. It is assumed that all of these facilities will connect to either existing or proposed water main by 2035. Sanitary sewer billing was obtained for each of these facilities and a residential equivalent connection (REC), or amount of usage compared to an average residential sewer connection, was calculated for each facility. All existing commercial facilities not currently connected to the water system combined for a total of 58 RECs. To estimate the amount of water demand each facility would require, it was assumed that one REC equates to the amount of water that one residential customer would consume. Therefore, the number of RECs was multiplied by the estimated residential sales per customer value of 116 gallons per customer per day to get the projected commercial water demand.

2. Development

The Village indicated approximately 4 acres of land is anticipated to be developed for commercial use between 2018 and 2023. An additional 2 acres of land is anticipated to be developed between 2023 and 2029. Using the Southeast Wisconsin Regional Planning Commission (SEWRPC) 1,500 gallons per acre per day (gpad) estimate for the average day water usage for commercial facilities, approximately 6,000 gallons of commercial demand will be added to the system by 2024 and an additional 3,000 gallons of commercial demand will be added to the system by 2035.

C. Public

1. Private Well Conversion

There are only two public facilities currently not being served by the existing water system: Hamilton Elementary School and Lannon Village Park. The additional water use from the elementary school was calculated using the number of RECs from the sanitary sewer billing data and converting to public customers, similar to how the commercial customers were calculated. Both facilities are anticipated to be connected before 2024. The Lannon Village Park does not have public sanitary sewer and an assumed REC of one was given. Hamilton Elementary School had an estimated 10.5 RECs. The total number of RECs was multiplied by the estimated residential sales per customer value of 116 gallons per customer per day to get the projected public water demand. The Hamilton Elementary School is anticipated to be connected to the distribution system by the end of 2019.

2. Development

According to the future land use map, there are no additional public facilities planned for future development.

D. Summary of Future Demand

Table 3.04-1 presents the estimated additional water demand for each type of development or private well conversion for each of the design years.

	2024	**2035**
Residential–Conversion	17,280	46,050
Residential–Development	44,780	144,880
Subtotal (gpd)	**62,060**	**190,930**
Commercial–Conversion	6,000	6,000
Commercial–Development	-	9,730
Subtotal (gpd)	**6,000**	**15,730**
Public–Conversion	1,330	**1,330**
Public–Development	-	-
Subtotal (gpd)	**1,330**	**1,330**
Total Demand (gpd)	**69,390**	**207,990**

Table 3.04-1 Summary of Future Additional Water Demand (gallons)

3.05 2019 PROJECTED DEMANDS

Demand projections were calculated using the water use trends developed in the previous sections. The projected 2019, 2024, and 2035 demands will be used in the following sections where demands will be compared to available supply.

A. 2019 Average Day

The projected 2019 average day pumpage was calculated by multiplying the design number of customers for each category by the projected total per customer sales per day and dividing by the corresponding sales to pumpage ratio (0.6). The estimated average day pumpage is approximately 28,700 gpd, or 20 gpm.

B. 2019 Maximum Day

1. Domestic

The 2019 maximum day pumpage is estimated to be approximately 71,750 gpd, or 50 gpm by applying the maximum to average day demand ratio of 2.5 to the 2019 average day pumpage.

2. Domestic Plus Fire

The Insurance Services Office (ISO) typically recommends basic fire flow requirements that are based on the amount of water a municipality should be able to supply. The required fire flow for individual buildings can range from a minimum 500 gpm for two hours for residential districts to a maximum of 12,000 gpm for four hours for large industrial complexes. The maximum basic fire flow requirement the ISO will credit a community that contains industrial-type facilities is 3,500 gpm for a duration of three hours. The Village does not contain any large industrial facilities currently served by the water system; however, it does contain some commercial facilities that are rated for 2,500 gpm.

The PSC produces a list titled *ISO Fire Flow Data for Select Wisconsin Utilities* that provides recommended fire flows and durations. It also contains the 5th highest rated fire flow and duration for a building in each community according to ISO. While the PSC recommends a 500 gpm fire flow for two hours, the ISO 5th highest needed fire flow is 2,500 gpm for two hours in the Village. A 2,500 gpm fire flow for two hours will be assumed for this study.

The total volume of water required to fight a fire on the 2019 maximum day is estimated as follows:

Domestic Maximum Day	72,000 gallons
Fire (2 hours at 2,500 gpm)	300,000 gallons
Total	372,000 gallons

Water for firefighting demands can come from a combination of excess well capacity and water storage facilities.

3.06 2024 PROJECTED DEMANDS

A. 2024 Average Day

The projected 2024 average day pumpage was calculated by adding the estimated future additional demand to the 2019 average day sales and dividing by the projected sales to pumpage ratio (0.8). The estimated average day pumpage is approximately 108,250 gpd, or 75 gpm.

B. 2024 Maximum Day

1. Domestic

The 2024 maximum day pumpage is estimated to be approximately 270,625 gpd, or 188 gpm by applying the maximum to average day demand ratio of 2.5 to the 2024 average day pumpage.

2. Domestic Plus Fire

A fire flow demand of 2,500 gpm for a duration of two hours was used for calculation purposes. Basic fire flow requirements are based on the amount of water the Village should be able to supply on the day of maximum domestic demand.

The total volume of water required to fight a fire on the 2024 maximum day is estimated as follows:

Domestic Maximum Day	270,625 gallons
Fire (2 hours at 2,500 gpm)	300,000 gallons
Total	570,625 gallons

3.07 2035 PROJECTED DEMANDS

A. 2035 Average Day

The projected 2035 average day pumpage was calculated by adding the estimated future growth demand to the 2024 average day sales and dividing by the projected sales to pumpage ratio (0.8). The estimated average day pumpage is approximately 282,000 gpd, or 196 gpm.

B. 2035 Maximum Day

1. Domestic

The 2035 maximum day pumpage is estimated to be approximately 705,000 gpd, or 490 gpm by applying the maximum to average day demand ratio of 2.5 to the 2035 average day pumpage.

2. Domestic Plus Fire

A fire flow demand of 2,500 gpm for a duration of two hours was used for calculation purposes. Basic fire flow requirements are based on the amount of water the Village should be able to supply on the day of maximum domestic demand.

The total volume of water required to fight a fire on the 2035 maximum day is estimated as follows:

Domestic Maximum Day	705,000 gallons
<u>Fire (2 hours at 2,500 gpm)</u>	<u>300,000 gallons</u>
Total	1,005,000 gallons

Figure 3.07-1 presents projected average and maximum day demands for 2024 and 2035. The increase in both average and maximum day demand is because of the anticipated development and service to existing structures being added to the water system.

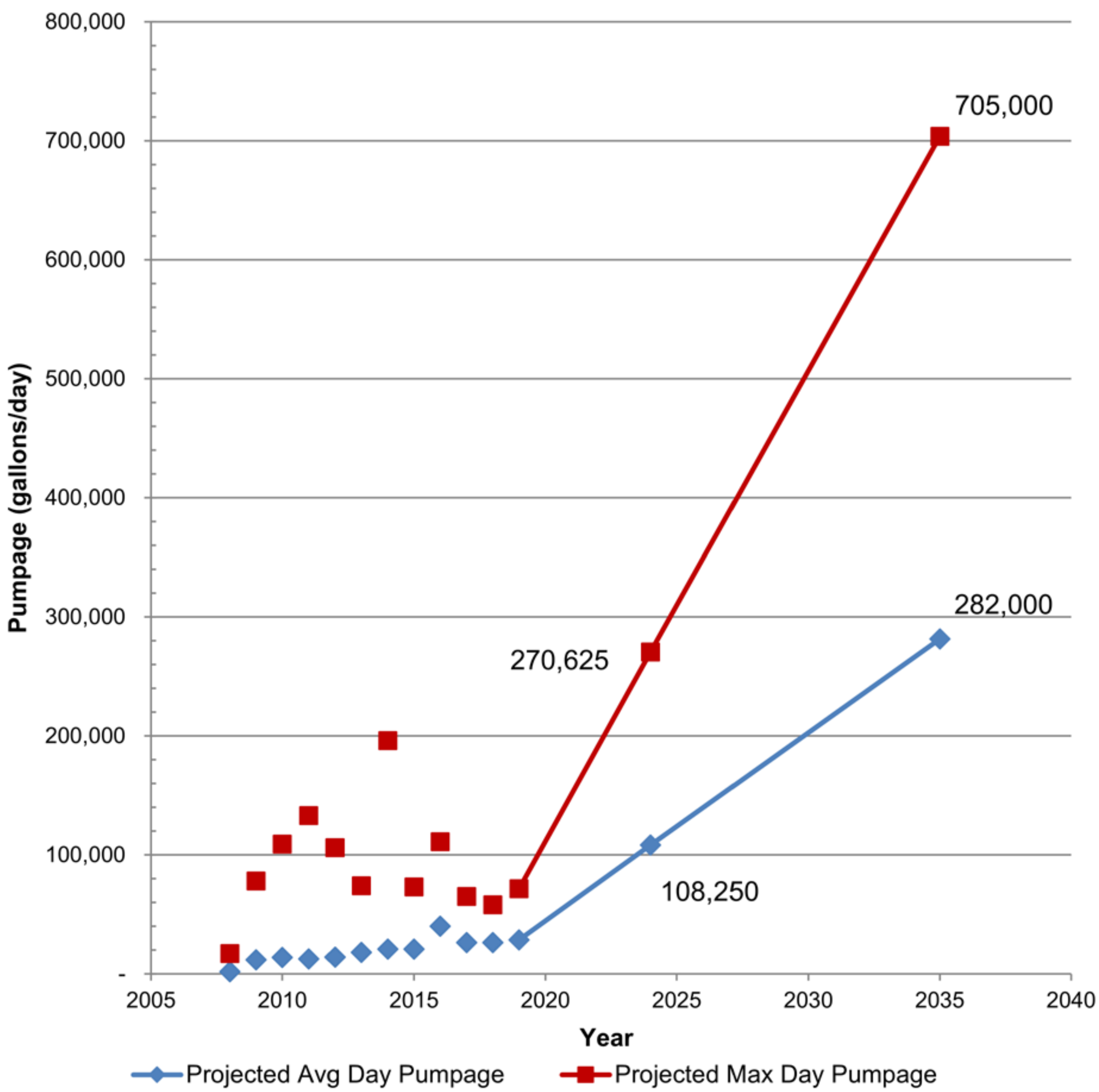


Figure 3.07-1 Projected Average and Maximum Day Pumpage

SECTION 4
ADDITIONAL REQUIRED CAPACITY

4.01 GENERAL

A. General

Days of maximum demand can and do occur on several days in succession, especially during the warm summer months. As a result, water withdrawn from storage during any one maximum day must be replaced before the following day to ensure an adequate supply of water for the next day. Therefore, total demand on the maximum day determines the minimum amount of water that must be available the next day. It is recommended the system be designed to meet maximum day domestic demands with the most critical source unit out of service.

If the firm pump capacity is less than the maximum day demand, storage will be depleted and an inadequate amount of water may exist for the following day. Alternatively, if the firm capacity meets or exceeds the total demands, all storage facilities may be refilled during any 24-hour period and water will be available to meet the following potential maximum day demands.

If the firm capacity just equals the maximum day domestic demand, the amount of storage required would be equal to fire requirements plus peak domestic storage demands. Water withdrawn from storage facilities to meet fire demand need not be replaced the same day or the day following the fire. However, it is recommended to replenish the storage as soon as possible.

Prudent operation of a water utility requires that firm system capacity always be in excess of system demands. Therefore, recommended system improvements may be deferred until they become necessary, or they may have to be implemented sooner if demands increase at a rate faster than projected.

B. Capacity Evaluation Discussion

As noted in Section 4.01, well maintenance, emergency repairs, well contamination, or other unforeseen conditions can all create circumstances where the source supply is unavailable. Because a well being offline is a fairly common, and not always planned occurrence, the firm source capacity is used in water system master planning and capacity evaluations. The 2019 capacity evaluation presented in Section 4.01 has limitations because the firm source capacity is zero. The capacity evaluation for the 2019 average day, 2019 maximum day, and 2019 maximum day plus fire demand conditions are all limited by the amount of water in the reservoir because there is no source replenishing the reservoir. The current system 2024 and 2035 capacity evaluations have similar limitations; whereas the additional source conditions do not have those limitations. The current system fire demand condition evaluations have the most limitations because they assume the reservoir is 80 percent full when the maximum day plus fire demand condition begins. A reservoir 80 percent full is a typical assumption when there is a firm supply replenishing the reservoir; without a firm source of supply, there is no basis for that assumption as the reservoir could be empty when a fire scenario occurs. The most recent Emergency Response Plan should address how the Village will handle these scenarios. Ultimately, the Village needs a second source of supply immediately.

C. Additional Source Assumptions

For the purpose of this evaluation, each additional source is assumed to be 500 gpm or greater. Section 4.06 discusses source of supply alternatives considered.

4.02 2019 CAPACITY EVALUATION

A. 2019 Average Day

The estimated 2019 average day demand equals 20 gpm. Firm supply capacity is 0 gpm assuming the Village's only well out of service. The Village can still supply the water system with the booster pumps and ground-level storage to meet 2019 average day demands. Dividing the amount of active storage with 20 percent being allocated for operational needs (128,000 gallons), the Village is able to supply approximately four and a half 2019 average day demands from storage. An additional source or an emergency interconnect is highly recommended because certain well maintenance work items or emergency repairs require additional time to be completed. If the well is out of service for longer than five days, the Village will have a water deficit and an alternative source will be needed to meet demands.

B. 2019 Maximum Day

The estimated 2019 maximum day demand equals 50 gpm. Firm supply capacity equals 0 gpm. The Village is able to supply approximately two 2019 maximum day demands from storage. If the well is out of service for longer than two consecutive maximum demand days, the Village will have a water deficit.

C. 2019 Maximum Day Plus Fire–2,500 gpm for Two Hours

The total amount of water available to satisfy the maximum day plus fire demand is equal to the firm supply capacity plus the water available from useable storage.

The below-ground reservoir has a capacity of 160,000 gallons. Assuming that 20 percent of the existing storage (32,000 gallons) is allocated for operational needs and the fire event takes place immediately after the supply source is offline, the total amount of storage available to meet projected hourly demands and fire protection is 128,000 gallons.

A demand rate of 2,550 gpm (50 gpm domestic demand plus 2,500 gpm fire demand) for two hours must be satisfied to provide the necessary fire protection. Because a fire can start at any time during the day, maximum day domestic use must be taken into account when calculating available capacity.

Storage from the reservoir is available only at the capacity of the two booster pumps and is equal to 1,100 gpm. Over 120 minutes, this equals a pumped volume of 132,000, which is greater than the 128,000 gallons of usable storage in the reservoir. Therefore, the reservoir capacity is only equal to the rate at which the reservoir can drain over two hours.

Maximum Day Demand	- 50 gpm
Fire Demand	- 2,500 gpm
Firm Supply Capacity	+ 0 gpm
Elevated Storage	+ 0 gpm
Reservoir Capacity*	+ 1,067 gpm
Total	- 1,483 gpm

*Reservoir Capacity = 128,000/120 minutes

During a 120-minute fire event, the system is projected to have a deficit of 1,483 gpm or approximately 177,960 gallons. Additional storage and/or supply capacity is needed to meet the projected 2019 maximum day plus fire demand. These approximations also assume the fire occurs during the beginning of a well out-of-service event as the reservoir capacity would continue to be reduced the longer the well is out of service.

D. 2019 Maximum Day Plus Fire–500 gpm

A typical residential fire flow is 500 gpm. Given the maximum day demand equals 50 gpm and the reservoir capacity equals 128,000 gallons, the available storage could provide fire flow for a 500-gpm residential fire for approximately four hours under firm supply condition. If the well is assumed to be operating, the available storage could provide ample fire flow for a 500-gpm residential fire for approximately seven hours.

4.03 2024 CAPACITY EVALUATION

The 2024 capacity evaluation includes a comparison between the available storage with an additional source and available storage without an additional source. It is assumed that private wells located near the Village well have been converted to the water system, and the well can operate at the design condition of 300 gpm.

A. 2024 Average Day

The estimated 2024 average day demand equals 75 gpm. Current firm supply capacity equals 0 gpm. The Village is able to supply approximately one 2024 average day demand from storage. If the well is out of service for longer than one average demand day, the Village will have a water deficit.

If the Village adds a second source with a capacity greater than the existing well, firm supply capacity then equals the existing well capacity of 300 gpm and the Village will have a reserve well supply of 225 gpm and no additional supply capacity is required to meet 2024 average day demands.

Initial storage requirements based on WDNR NR 811.62 indicate that an average day supply under normal operating conditions must be available when only one well is available to serve the water system. According to the projected demands, storage equal to the average day demand, plus 20 percent to account for operational uses, is 135,000 gallons in 2024. No additional storage capacity is required to meet 2024 average day demands.

B. 2024 Maximum Day

The estimated 2024 maximum day demand equals 188 gpm. Current firm supply capacity equals 0 gpm. The Village is able to supply approximately eleven hours of demand during 2024 maximum day demands from storage. If the well is out of service for longer than eleven hours during a maximum demand day, the Village will have a water deficit.

If the Village adds a second source with a capacity greater than the existing well, firm supply capacity equals 300 gpm and the Village has a reserve source supply of 112 gpm and no additional supply capacity is required to meet 2024 maximum day demands.

C. 2024 Maximum Day Plus Fire

A demand rate of 2,688 gpm (188 gpm domestic demand plus 2,500 gpm fire demand) for two hours must be satisfied to provide the necessary fire protection. Because a fire can start at any time during the day, domestic use must be taken into account when calculating available capacity.

Assuming an additional source is added to the system, storage from the reservoir is available only at the capacity of the two booster pumps that is in excess of the well pump because the well pumps directly to the reservoir. Subtracting the existing well capacity from the booster pump capacity equals 800 gpm. Over 120 minutes, this equals a pumped volume of 96,000, which is less than the 128,000 gallons of usable storage in the reservoir. Therefore, the reservoir capacity is estimated a rate of 800 gpm.

As noted previously, current system evaluation assumes the fire event occurs immediately after the single supply source is offline.

	Current System	Additional Source
Maximum Day Demand	- 188 gpm	-188 gpm
Fire Demand	- 2,500 gpm	- 2,500 gpm
Firm Supply Capacity	+ 0 gpm	+ 300 gpm
Elevated Storage	+ 0 gpm	+ 0 gpm
Reservoir Capacity	+1,067 gpm*	+ 800 gpm**
Total	- 1,621 gpm	-1,588 gpm

*Reservoir Capacity = 128,000/120 minutes
**Reservoir Capacity = 1,100 gpm - 300 gpm

During a 120-minute fire event, the system is projected to have a deficit of 1,621 gpm or approximately 194,520 gallons with only the existing well as a source. If an additional source is added, the system is projected to have a deficit of 1,588 gpm or approximately 190,560 gallons. Additional storage is needed regardless if another source is added to the system to meet the projected 2024 maximum day plus fire demand.

4.04 2035 CAPACITY EVALUATION

The 2035 capacity evaluation includes a comparison between the available storage with an additional source and available storage without an additional source.

A. 2035 Average Day

The estimated 2035 average day demand equals 196 gpm. Current firm supply capacity equals 0 gpm. The Village is able to supply approximately eleven hours of a 2035 average day demand from storage. If the well is out of service for longer than eleven hours during a 2035 average day, the Village will have a water deficit.

If the Village adds a second source with a capacity greater than the existing well, firm supply capacity then equals the existing well capacity of 300 gpm. With the additional source, the Village has a firm supply capacity surplus of 104 gpm and no additional firm supply capacity is required to meet 2035 average day demands.

According to the projected demands, storage equal to the average day demand, plus 20 percent to account for operational uses, is 352,800 gallons in 2035. Assuming no additional sources have been completed at this time, additional storage capacity is required to meet 2035 average day demands.

B. 2035 Maximum Day

The estimated 2035 maximum day demand equals 490 gpm. Current firm supply capacity equals 0 gpm. The Village is able to supply approximately four hours of demand during 2035 maximum day demands from storage. If the well is out of service for longer than four hours during a maximum demand day, the Village will have a water deficit.

If the Village adds a second source with a capacity greater than the existing well, firm supply capacity equals 300 gpm and the Village has a firm well supply deficit of 190 gpm and additional firm supply capacity is required to meet 2035 maximum day demands.

If the Village adds a third source, assuming the second additional source has a capacity of 500 gpm, and the third source has a capacity of 500 gpm, the Village would have enough capacity to meet 2035 maximum day demands. This could be met by various combinations of new well supply or interconnections with neighboring systems.

Using linear interpolation of the projected customer growth, the estimated maximum day demand is projected to exceed firm supply capacity in 2028, assuming the second source had been installed prior to 2028. Therefore, a third source would be needed if growth occurs at the projected rate.

C. 2035 Maximum Day Plus Fire

A demand rate of 2,990 gpm (490 gpm domestic demand plus 2,500 gpm fire demand) for two hours must be satisfied to provide the necessary fire protection. Because a fire can start at any time during the day, maximum day domestic use must be taken into account when calculating available capacity.

As noted previously, current system evaluation assumes the fire event occurs immediately after the single supply source is offline.

	Current System	Additional Source	2 Additional Sources
Maximum Day Demand	- 490 gpm	- 490 gpm	- 490 gpm
Fire Demand	- 2,500 gpm	- 2,500 gpm	- 2,500 gpm
Firm Supply Capacity	+ 0 gpm	+ 300 gpm	+ 800 gpm
Elevated Storage	+ 0 gpm	+ 0 gpm	+ 0 gpm
Reservoir Capacity	+ 1,067 gpm*	+ 800 gpm**	+ 800 gpm**
Total	- 1,923 gpm	- 1,890 gpm	- 1,390 gpm

*Reservoir Capacity = 128,000/120 minutes
**Reservoir Capacity = 1,100 gpm - 300 gpm

During a 120-minute fire event, the system is projected to have a deficit of 1,923 gpm or approximately 230,760 gallons with only the existing well as a source. If one additional source is added, the system is projected to have a deficit of 1,890 gpm or approximately 226,800 gallons. If two additional sources are added, the system is projected to have a deficit of 1,390 gpm or approximately 167,000. This number may change less depending on the smallest capacity of the two additional sources. Additional storage is needed regardless if one or two sources are added to the system to meet the projected 2035 maximum day plus fire demand.

4.05 SUMMARY OF REQUIRED CAPACITY

Table 4.05-1 presents additional capacity required for each design year. It's assumed that the existing well is out of service and the reservoir has 20 percent removed for operational purposes. Average day and maximum day demands need to be met with additional supply. The additional required capacity required for maximum day plus fire can be met with either supply or storage improvements.

Design Year	Average Day	Maximum Day	Maximum Day plus Fire
2019	20 gpm	50 gpm	1,483 gpm
2024	75 gpm	188 gpm	1,621 gpm
2035	196 gpm	490 gpm	1,923 gpm

Table 4.05-1 Summary of Additional Capacity Required

4.06 OPTIONS FOR ADDITIONAL SUPPLY

The Village only has one groundwater well to supply water to the system. The guidance document *Guidance for Municipal Drinking Water Source Capacity Determination* recently published by WDNR states that a water system that relies on one source does not have adequate source capacity. A redundant source of water is required immediately to allow for long-term well servicing due to maintenance or emergency. In addition to having a redundant source, the 2035 capacity evaluation shows additional firm source capacity is required to meet maximum day demands by 2035. Options to provide additional supply include shallow-aquifer wells, deep-aquifer wells potentially with treatment, interconnections with neighboring communities, or a combination of any of these alternatives. Brief evaluations of the options are below.

A. Shallow Limestone Aquifer Well

Shallow wells, like the Village's existing well, are an option for additional sources of supply. The existing shallow well was drilled approximately 340 feet below grade and pumps water from the unconfined Niagara limestone aquifer. The well is cased to 15 feet below the sand-and-gravel aquifer and has a rated capacity of 250 gpm, which is currently limited to reduce the draw-down for nearby private-wells. The well capacity has the potential to increase to the well pump design 300 gpm. It is assumed that constructing another shallow aquifer well would provide similar yields of 300 gpm.

One well is required immediately to have a redundant source. An additional well would be needed by 2028 to meet projected 2035 maximum day demands. While the Village's current well has always provided safe water, shallow wells are generally more susceptible to water quality impacts from bacteria and could be impacted by nearby rock quarries that present a potential route for contamination. Several nearby private wells have experienced water quality issues that draw from the same aquifer. The OPPC for drilling a shallow limestone aquifer well and constructing a well facility is approximately $1,500,000, which includes 35 percent for contingencies and technical services.

B. Deep Sandstone Aquifer Well

Constructing one or more deep sandstone aquifer wells is an alternative to shallow limestone aquifer wells. Sandstone aquifer well capacities tend to be greater than shallow limestone aquifer wells. Nearby sandstone aquifer wells tend to produce capacities above 500 gpm, but additional pump testing would be required to determine the actual well capacity. Deep aquifer wells also tend to have elevated levels of iron and radium that may require treatment. One well is required immediately to have a redundant source. An additional well would be needed by 2028 to meet projected 2035 maximum day demands. The OPPC for drilling a deep sandstone aquifer well and constructing a facility that includes treatment is approximately $2,500,000, which includes 35 percent contingencies and technical services.

C Interconnection

Interconnecting with an adjacent community is an alternative for the Village. This assumes the adjacent community has excess water system capacity to provide to the Village. Depending on several factors including the Great Lakes Watershed Divide boundaries, lake water allocations, system hydraulic gradients, permitting by the WDNR, and creating separate service areas, an interconnection may be a possible alternative. Additional hydraulic studies would be needed to determine the feasibility of the interconnection. One interconnection, either a direct or an emergency connection, would be required immediately to have a redundant source. Depending on available capacity of the interconnection, only one additional interconnection would be needed by 2028 to meet projected 2035 maximum day demands. The OPPC to construct a water main that extends from the Village to the Village of Menomonee Falls' distribution system and a metering station is approximately $1,900,000, which includes 35 percent contingencies and technical services.

4.07 OPTIONS FOR ADDITIONAL STORAGE

The only storage in the existing system is the 160,000-gallon reservoir. As shown in the 2019 Capacity Evaluation in a previous section, additional storage is required to meet current maximum day demands plus fire.

Once additional sources of supply are constructed, storage requirements should be based on the capacity evaluation in the previous sections. Assuming 20 percent of future storage would be used for operational uses, a storage facility with a minimum 250,000-gallon capacity should be constructed to meet 2035 maximum day plus fire demands.

Alternatives to meet storage requirements include either a ground-level reservoir or an elevated tank. It was assumed that storage capacity from an interconnected source is not available to the Village.

A. Reservoir and Booster Station

Constructing another reservoir and booster station could provide the required storage. Depending on where an additional source would be connected to in the system, water entering the new ground-level reservoir would need to be pumped to the distribution system, which increases operation costs compared to an elevated tank. Additional pumps and equipment would need to be maintained which increases maintenance costs compared to an elevated tank. System hydraulics would still vary, as seen in the existing system, because the existing pressure tank would still hold the hydraulic gradient in the system.

B. Elevated Tank

An elevated tank could provide the required storage while not substantially increasing operation costs and would cost less to maintain than a reservoir and booster station. An elevated tank could also provide hydraulic benefits to the system by keeping a more consistent gradient in the system especially during fire flow events.

Depending on which additional sources are implemented, the elevated tank height could be constructed either to service the entire Village limits with one pressure zone or to match the existing Village of Menomonee Falls system gradient if an interconnection is the selected source of supply. If the tank is constructed to match the existing Village of Menomonee Falls system gradient, an additional high-pressure zone will be required as further discussed in Section 5. If the tank is constructed to serve the entire Village limits, additional improvements would be needed to the existing booster pumps to maintain the existing station capacity as used in this analysis.

4.08 SUPPLY AND STORAGE ALTERNATIVES

the following alternatives for adding capacity were formed based on the different source and storage options. Each opinion of probable project cost (OPPC) includes 35 percent for contingencies and technical services.

A. Alternative 1

Alternative 1 includes constructing a deep sandstone aquifer well with treatment facility and an elevated tank with a minimum capacity of 250,000 gallons immediately, and constructing another deep sandstone aquifer well with treatment facility by 2028. The elevated tank would be constructed at an overflow elevation to service the entire Village limits. Table 4.08-1 presents an OPPC for Alternative 1. The cost opinions include 35 percent contingencies and technical services.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Deep Sandstone-Aquifer Well with Treatment	~ 500 gpm	Immediately	3,000,000
Elevated Tank	250,000 gal	Immediately	$2,270,000
Booster Pump Improvements		Immediately	$75,000
Deep Sandstone-Aquifer Well with Treatment	~ 500 gpm	2028	$3,300,000
		Total OPPC	$8,345,000

Table 4.08-1 Alternative 1 Capacity Improvements OPPC

B. Alternative 2

Alternative 2 includes constructing a shallow limestone aquifer well facility and an elevated tank with a minimum capacity of 250,000 gallons immediately, and constructing another a shallow sandstone aquifer well facility by 2028. The elevated tank would be constructed at an overflow elevation to service the entire Village limits. Table 4.08-2 presents an OPPC for Alternative 2. The cost opinions include 35 percent contingencies and technical services.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Shallow Limestone-Aquifer Well Facility	~ 300 gpm	Immediately	$1,500,000
Elevated Tank	250,000 gal	Immediately	$2,270,000
Booster Pump Improvements		Immediately	$75,000
Shallow Limestone-Aquifer Well Facility	~ 300 gpm	2028	$1,500,000
		Total OPPC	$5,345,000

Table 4.08-2 Alternative 2 Capacity Improvements OPPC

C. Alternative 3

Alternative 3 includes constructing a direct interconnection with the Village of Menomonee Falls and an elevated tank with a minimum capacity of 250,000 gallons immediately. Based on current land elevations, water will not be able to be supplied to the Lannon Village Hills neighborhood located in the west part of the Village under enough pressure once the water system is constructed in that area. An additional booster pumping station would need to be constructed to provide adequate pressure. A deep sandstone aquifer well with treatment facility would be constructed by 2028. The elevated tank would be constructed at an overflow elevation of 1,030 above mean sea level (amsl) to match the gradient of the Village of Menomonee Falls' system. Table 4.08-3 presents an OPPC for Alternative 3. The cost opinions include 35 percent contingencies and technical services.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Elevated Tank	250,000 gal	Immediately	$2,120,000
Interconnection	> 300 gpm	Immediately	$1,900,000
Deep Sandstone–Aquifer Well with Treatment	~ 500 gpm	2028	$2,500,000
Booster Pumping Station	1,500 gpm	Before 2035	$2,010,000
		Total OPPC	$9,030,000

Table 4.08-3 Alternative 3 Capacity Improvements OPPC

SECTION 5
COMPUTER MODELING

5.01 GENERAL

This section summarizes the services completed in updating and calibrating the Village's water system model, including the results of the model calibration and system-wide pressures and available fire flows.

5.02 MODEL UPDATE

A computer model of the Village's water distribution system was previously created but not calibrated. The scope of this project is to update the model and then calibrate it to industry accepted standards. The model was previously created using Geographic Information System (GIS) shape files provided by the Village. This included water main diameter and length. Hydrant location was manually entered into the model. Well, booster pump, and storage facility information were added separately to the model from information provided by the Village and System Operator. Each model junction, defined as a point where one or more pipes connect, was assigned an elevation by importing 2-foot topographic contours using the model's Terrain Extractor tool.

Water demands were entered using 2019 projected average and maximum day demands using information from the past ten years gathered from the Wisconsin PSC annual reports. The 2019 projected average demand is 20 gpm. The 2019 projected maximum day demand is 50 gpm.

5.03 MODEL CALIBRATION

To successfully calibrate the computer model, predicted results in the model were confirmed against observed conditions in the distribution system. This was completed by performing field testing of hydrant flows in various parts of the distribution system. Four flow tests were completed on October 22, 2018. Test locations were chosen to provide data that was thought to be representative of the distribution system.

The flow test used one monitoring hydrant and one flowing hydrant. The monitoring hydrant was used to observe the static pressure when the flowing hydrant was closed, and to observe residual pressure when the flowing hydrant was open. A pressure gauge was attached to the monitoring hydrant and air was purged from the hydrant and gauge manifold before taking a static pressure reading.

After the flowing hydrant was fully opened using a single outlet, the residual pressure reading was taken at the monitoring hydrant. After obtaining all of the readings, the hydrants were closed and the caps were replaced.

The flow from the hydrants was calculated after the field tests were completed. The flow from each outlet was determined based on the pitot gauge reading observed and the diameter of the hydrant outlet. Discharge rates were obtained using the equation in Figure 5.03-1. Only one 2 1/2-inch diameter hydrant outlet was used. Therefore, a C-factor of 0.90, which assumes a full and relatively smooth flow from the hydrant outlet, was used.

$$Q = 29.83 * C * D^2 * P^{0.5}$$

where Q = flow (gpm)
C = c-factor (unitless)
D = diameter (inches)
P = pressure (psi)

Figure 5.03-1 Hydrant Flow Equation

The model was calibrated from a steady-state perspective by modifying the roughness coefficients of the pipes, or C-factors, within the distribution system based on size, location, and age. As a starting point, all C-factors were set to 130 to simulate brand new piping. A computer model is typically considered to be calibrated when the static and residual pressures predicted by the model at the specific flow test locations are within 5 psi of the field measurements.

Real-time operating data was obtained from a system operator during each field flow test and was used to set the boundary condition of system pressure at the hydro-pneumatic tank. The model was then used to simulate the flow tests under the observed conditions. Table 5.03-1 presents the flows and pressures measured in the field compared to the final model-simulated pressures at the testing locations in the distribution system under both static and residual flow conditions. Table 5.03-2 presents the HPR static pressures measured in the field compared to the final model-simulated pressures at each hydrant location. Table 5.03-3 presents the HPR residual pressures measured in the field compared to model-simulated pressures.

Test Number	Flowing Hydrant Location	Field Static Pressure (psi)	Modeled Static Pressure (psi)	Field Residual Pressure (psi)	Modeled Residual Pressure (psi)	Field Measured Fire Flow (gpm)
1	19461 West Main Street	80.0	80.0	57.5	57.5	1,165
2	19865 West Edgewood Drive	70.0	68.3	54.0	51.7	1,118
3	20765 West Forest View Drive	70.5	70.5	65.5	65.4	1,130
4	End of Keystone Court	78.5	77.9	62.0	62.4	1,215

Table 5.03-1 Final Model Calibration Results–Test Hydrants

Test Number	HPR 1 Field Static Pressure (psi)	HPR 1 Modeled Static Pressure (psi)	HPR 2 Field Static Pressure (psi)	HPR 2 Modeled Static Pressure (psi)	HPR 3 Field Static Pressure (psi)	HPR 3 Modeled Static Pressure (psi)
1	74.3	75.5	77.3	77.0	72.8	72.7
2	69.8	71.5	73.1	73.0	68.7	68.7
3	67.5	68.5	70.6	70.0	67.0	65.7
4	73.8	75.5	77.1	77.0	73.3	72.7

Table 5.03-2 Final Model Calibration Results–HPR Static Pressures

Test Number	HPR 1 Field Residual Pressure (psi)	HPR 1 Modeled Residual Pressure (psi)	HPR 2 Field Residual Pressure (psi)	HPR 2 Modeled Residual Pressure (psi)	HPR 3 Field Residual Pressure (psi)	HPR 3 Modeled Residual Pressure (psi)
1	52.8	55.3	59.1	60.3	63.2	64.7
2	54.8	55.7	59.6	58.9	62.8	62.7
3	61.7	64.1	65.0	65.6	66.1	66.7
4	59.0	61.4	62.2	62.9	59.3	59.7

Table 5.03-3 Final Model Calibration Results–HPR Residual Pressures

Differences between the model-simulated and field-collected static and residual pressures were within 5 psi with no C-factor adjustments. Because the water system is approximately ten years old or newer, it is likely that the pipes have a relatively high C-factor. Through hydrant flow testing and HPR pressure verification, the model was considered calibrated.

5.04 2019 MODEL ANALYSIS

A. General

The current day 2019 water model was analyzed under various demand and flow conditions. Two general types of steady-state simulations were performed with the model: domestic (non-fire) and fire flow.

A steady-state simulation evaluates the operation behavior of the system at a specific point in time under steady-state (unchanging) conditions. Using this type of analysis, the behavior or pump, tank, and supply/storage relationships can be determined. It can be useful for determining pressures and flow rates within the distribution system main supporting fire hydrants under various demand conditions.

A fire flow simulation provides an instantaneous snapshot of the amount of water available at hydrants within the system while still maintaining 20 psi residual pressure. The model simulates a separate fire event at each junction in the system and increases the flow until either the hydrant itself or any point in the system reaches the 20 psi residual pressure threshold. Very high available fire flows (over 5,000 gpm) are not considered realistic but indicate areas of very strong hydraulic connectivity.

B. Average Day–Domestic Demand

The 2019 maximum day domestic demand condition, equaling 20 gpm, was modeled using a steady-state analysis with no booster pumps operating and the pressure tank set in between the lowest and highest-pressure setting (1054.5 feet). This resulted in an average pressure condition. The model projected system operating pressures to be between approximately 65 and 81 psi, as shown by the pressure contours generated by the model in Figure 5.04-1. Areas of lower pressures appear to be on the eastern side of Main Street throughout the Village. This is primarily caused by higher land elevations. Areas of higher pressure, although not excessive, occur toward the southern end of the Village. Similarly, the higher pressures are caused by lower ground elevations.

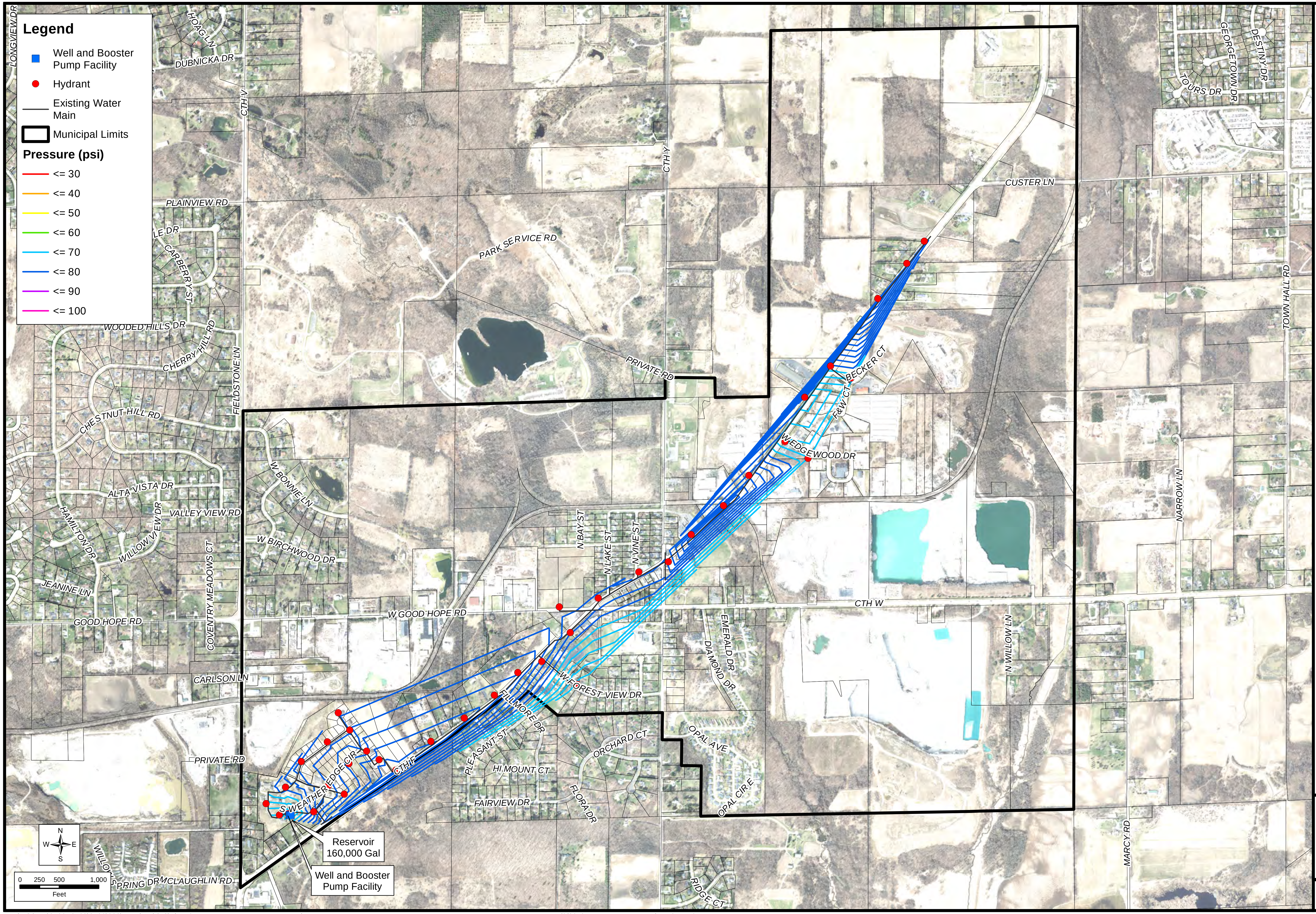
C. Maximum Day–Domestic Demand

The 2019 maximum day domestic demand condition, equaling 50 gpm, was modeled using a steady-state analysis with no booster pumps operating and the pressure tank set in between the lowest and highest-pressure setting (1054.5 feet). The model projected system operating pressures to be between approximately 65 and 81 psi, as shown by the pressure contours generated by the model in Figure 5.04-2. The areas of lowest and highest pressure appear to be in the same locations as the average day.

D. Maximum Day–Domestic Demand with Fire Flow

The model was operated in a similar manner to the maximum day domestic-only scenario when simulating available fire flows throughout the distribution system and is anticipated to provide a conservative estimate for planning purposes. The model projected available fire flow, which was based on a minimum 20 psi residual pressure threshold, ranged from approximately 2,000 gpm to greater than 5,000 gpm, as shown by the available fire flow contours generated by the model, which can be seen in Figure 5.04-3.

The hydrant with the lowest modeled available fire flow of 2,016 gpm is a hydrant located at the intersection of Becker Drive and F and W Court. This is because of higher land elevations and being located adjacent to a dead-end water main. Several areas with other low available fire flows are in similar locations. Several hydrants were modeled to have an available fire flow of 5,000 gpm or greater. These hydrants are generally located near the pumping station and those near Main Street. It should be noted that this amount of fire flow is typically not available from a single hydrant because of hydrant and hydrant lead head losses, but signifies a strong hydraulic connection within the distribution system.



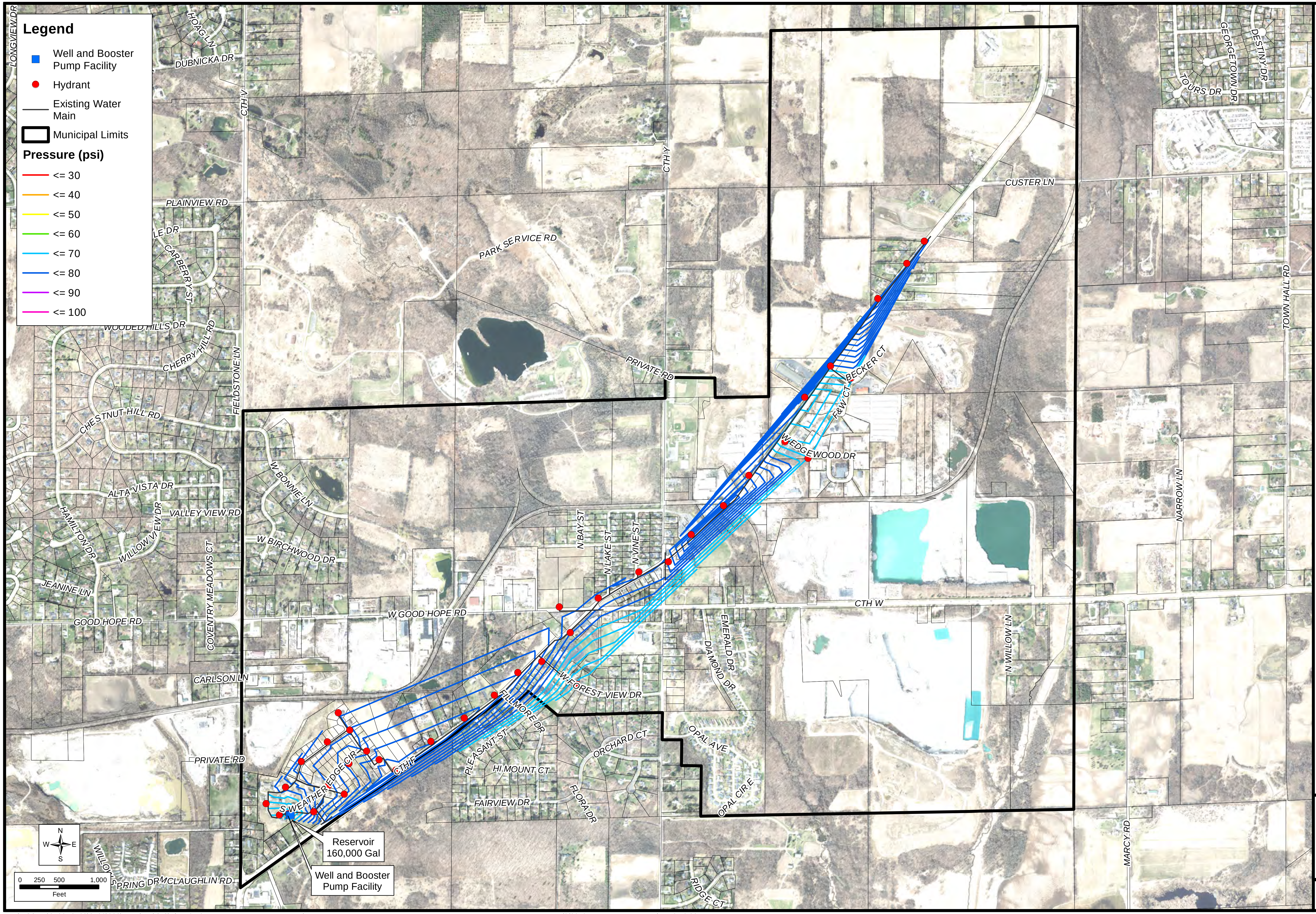
2019 AVERAGE DAY DEMAND PRESSURE CONTOURS

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

STRAND ASSOCIATES®

FIGURE 5.04-1
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.04-1 Ave Day Pressure 11x17.mxd User: natee Date: 7/9/2019 Time: 3:44:46 PM



2019 MAXIMUM DAY DEMAND PRESSURE CONTOURS

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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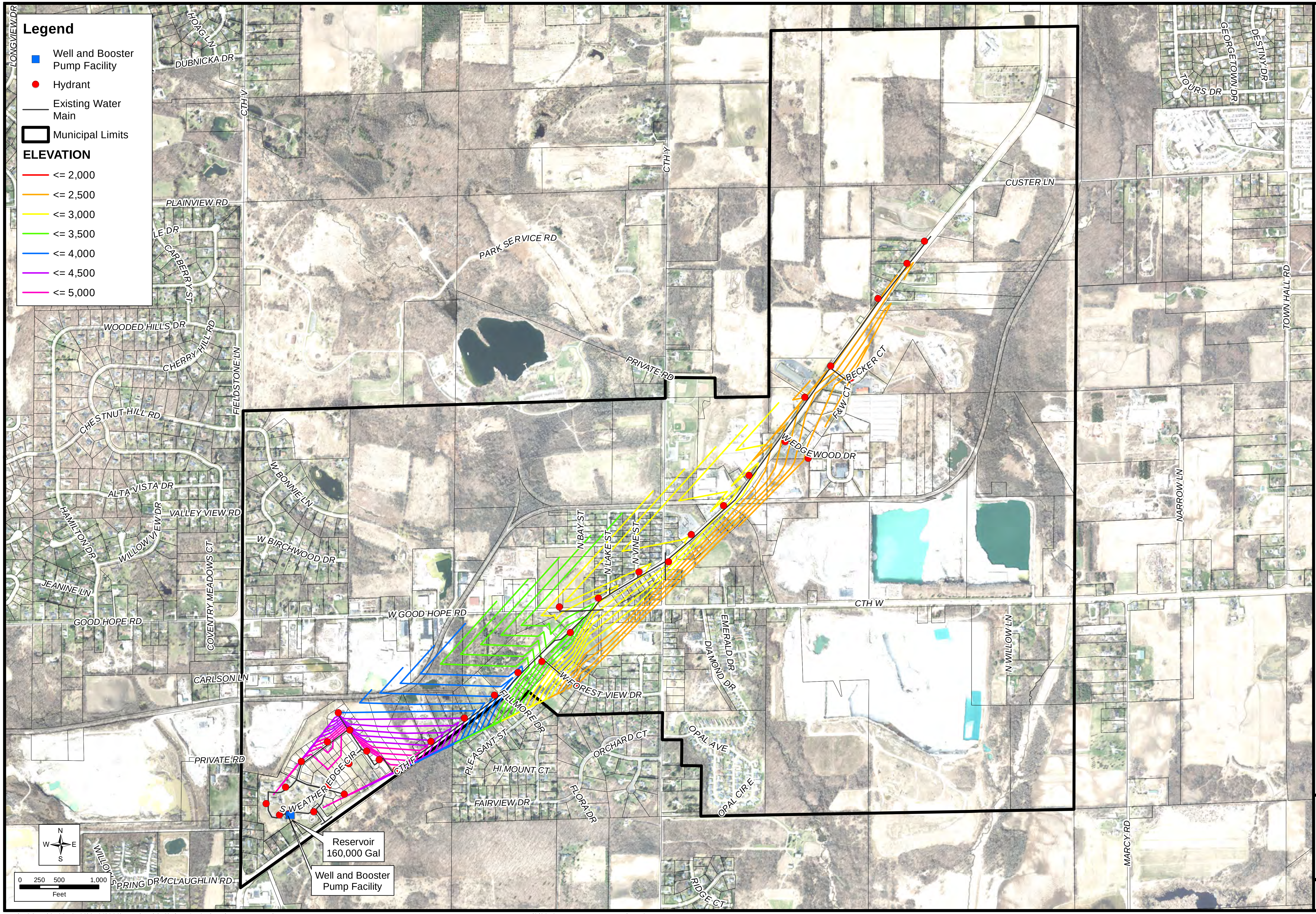
FIGURE 5.04-2
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.04-2 Max Day Pressure 11x17.mxd User: natee Date: 7/9/2019 Time: 3:46:38 PM



2019 MAXIMUM DAY DEMAND PLUS FIRE AVAILABLE FIRE FLOW CONTOURS

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 5.04-3
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.04-3 Fire Flow 11x17.mxd User: natee Date: 7/9/2019 Time: 3:47:44 PM

5.05 2024 MODEL ANALYSIS–ELEVATED TANK OVERFLOW AT 1,080 FEET AMSL

A. Expansion of the Distribution System

A 2024 water system model was created to simulate future demands and additional infrastructure. The 2024 water model was also analyzed using domestic (non-fire) and fire flow demand conditions. Infrastructure improvements are divided into new developments and conversion of existing private wells.

There are prioritized water main projects that should be installed in order to convert existing residents from private wells to the existing water distribution system. These street projects are shown in Figure 5.05-1.

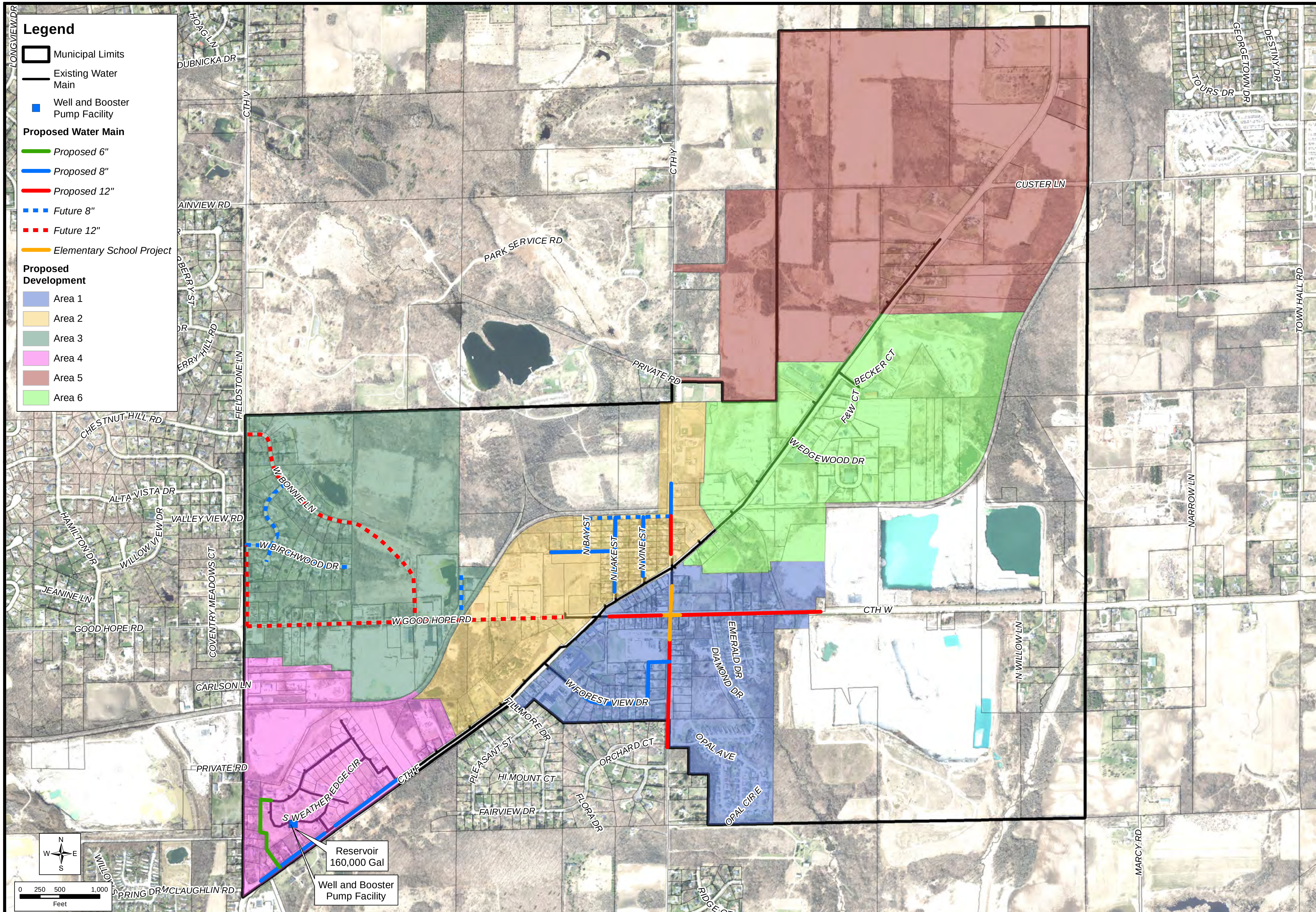
Other infrastructure improvements were added based on locations shown in the Village's Future Land Use Map. A broad schematic of water main was added to the water model distribution system to generally represent future development in the areas and develop future fire flow and pressure contour projections. The difference in demand from 2019 to 2024 was allocated to these new areas by spreading the demand evenly to each future model node. Upon future development, the projected fire flows and pressures might not fully represent future conditions. When future road and development designs are completed, the model should be updated to determine actual future conditions.

This analysis assumes the same well, booster pumps, and reservoir storage as current day. It also includes a 250,000-gallon elevated tank with an overflow elevation of 1,080 feet to match the existing hydraulic gradient of the system. The existing hydro-pneumatic pressure tank is assumed to be out of service as it is not needed with the elevated tank. See Figure 5.05-2 for a map of the future water main that was modeled.

The Village has existing drawings for an elevated tank in the Village's north side that was designed in 2008, but the facility was never constructed. The new elevated tank was modeled in the same location as shown on these drawings. The tank was originally designed to have an overflow elevation to match the neighboring community's gradient of 1,030 feet and a range of 32.5 feet. However, this analysis used a tank of the same size and location, but with an overflow elevation of 1,080 feet. This elevation was determined to optimize the pressure range within Village limits between the lowest and highest ground elevation areas while staying within the WDNR regulated working pressure range.

B. Average Day–Domestic Demand

The 2024 maximum day domestic demand condition, equaling 75 gpm, was modeled using a steady-state analysis. System conditions include no booster pumps operating, the pressure tank isolated (inactive), and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 45 and 95 psi, as shown by the pressure contours generated by the model in Figure 5.05-3. The area of lowest pressure appear to be near Lannon Village Hills where elevations are generally greater than the rest of the Village. The areas



PRIORITY WATER MAIN

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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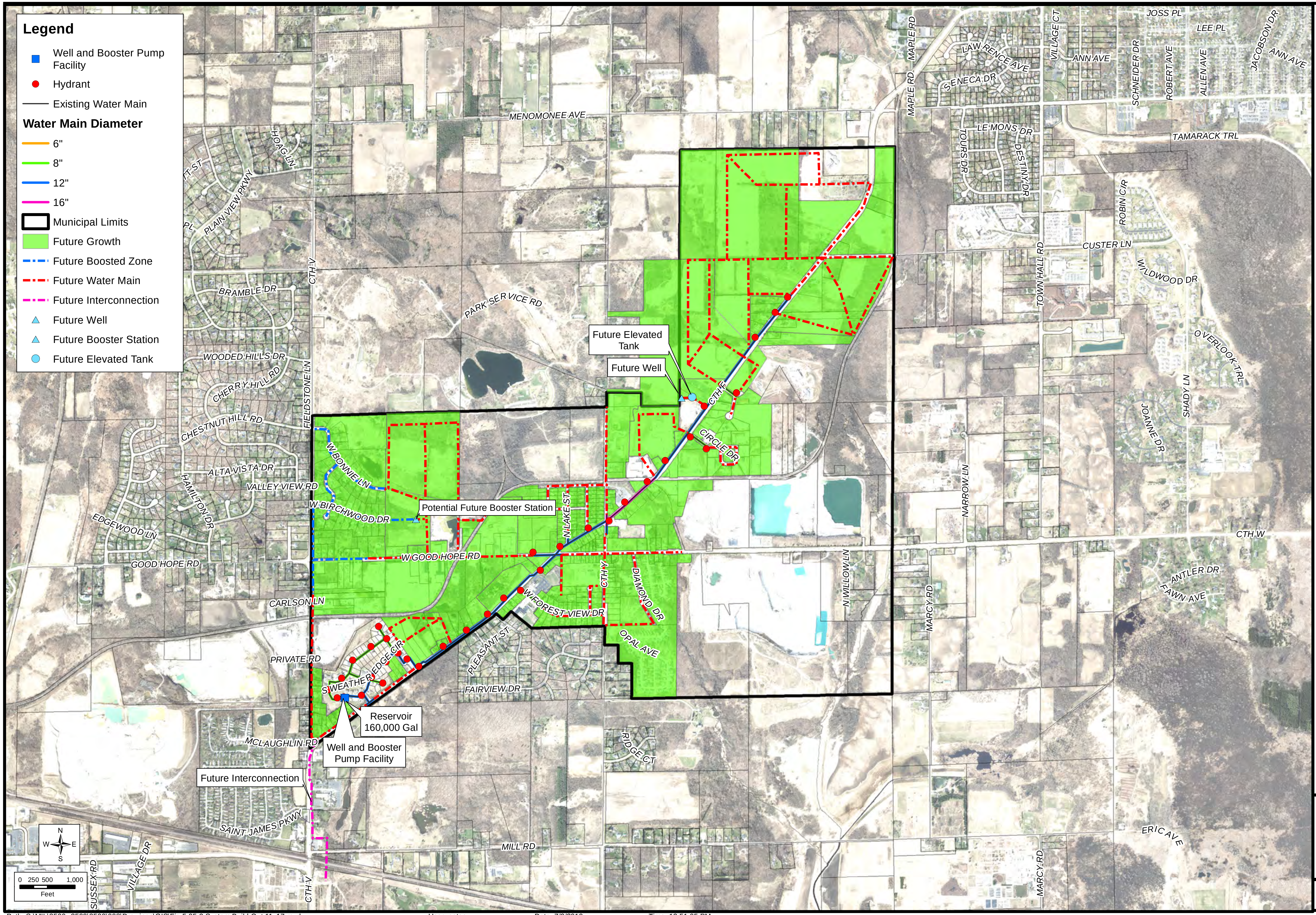
FIGURE 5.05-1
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.05-1 Priority Water Main 11x17.mxd User: natee Date: 7/9/2019 Time: 1:28:43 PM



WATER SYSTEM FULL BUILD OUT

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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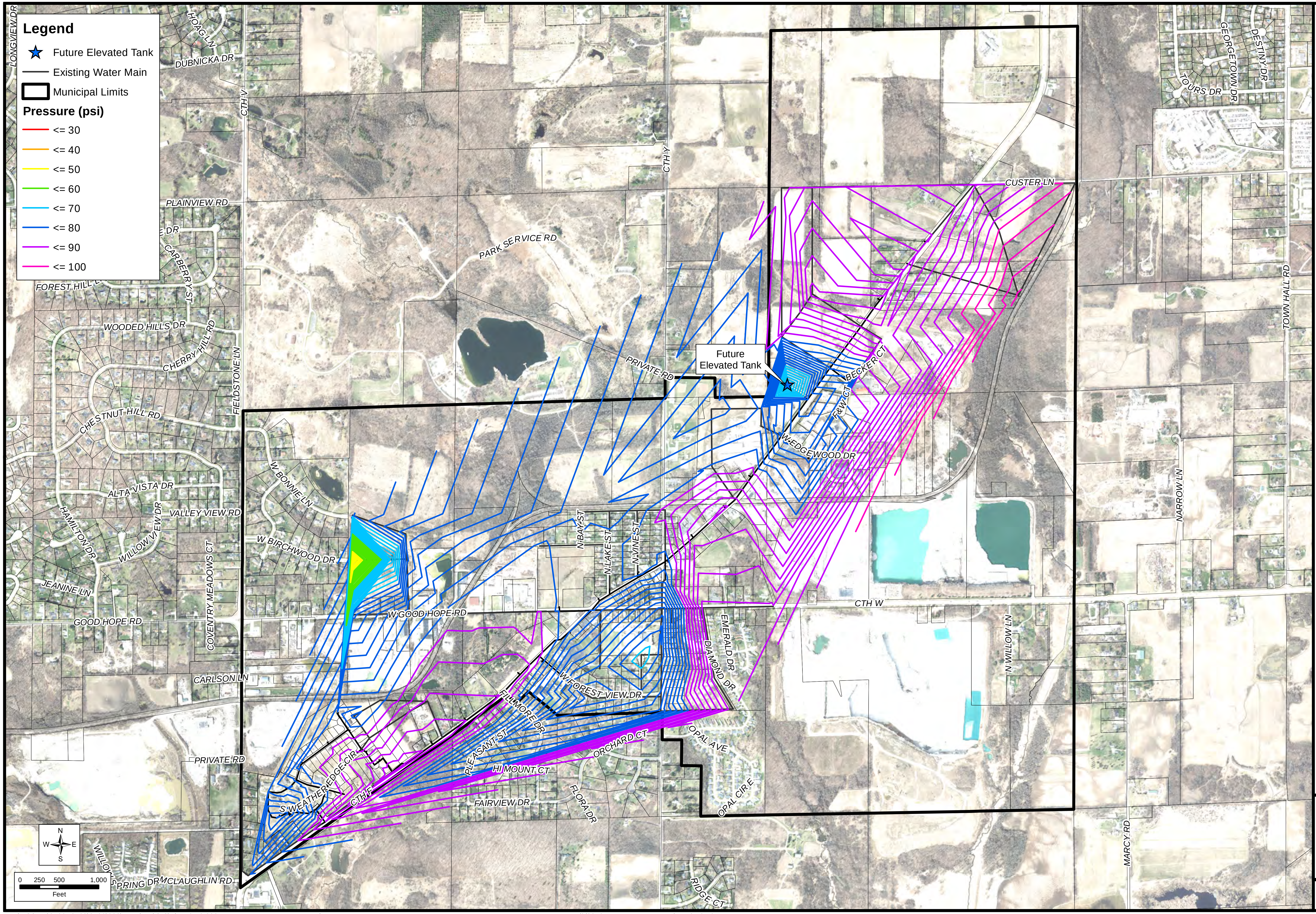
FIGURE 5.05-2
3500.008



2024 AVERAGE DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 5.05-3
3500.008

of highest pressure, although not excessive, occur in the northeastern part of the Village near the Fox River.

C. Maximum Day–Domestic Demand

The 2024 maximum day domestic demand condition, equaling 188 gpm, was modeled using a steady-state analysis with no booster pumps operating, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 45 and 95 psi, as shown by the pressure contours generated by the model in Figure 5.05-4. The areas of lowest and highest pressure appear to be in the same places as the average day.

D. Maximum Day–Domestic Demand with Fire Flow

The 2024 maximum day domestic demand condition plus fire flow was modeled using a steady-state analysis with no booster pumps operating, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected available fire flow, which ranged from approximately 1,437 gpm to greater than 5,000 gpm, as shown by the available fire flow contours generated by the model, which can be seen in Figure 5.05-5.

The hydrant with the lowest available fire flow is located at the end of the existing development of West Birchwood Drive in the west part of the Village. This is primarily caused by the water main terminating in a dead-end and higher ground elevations.

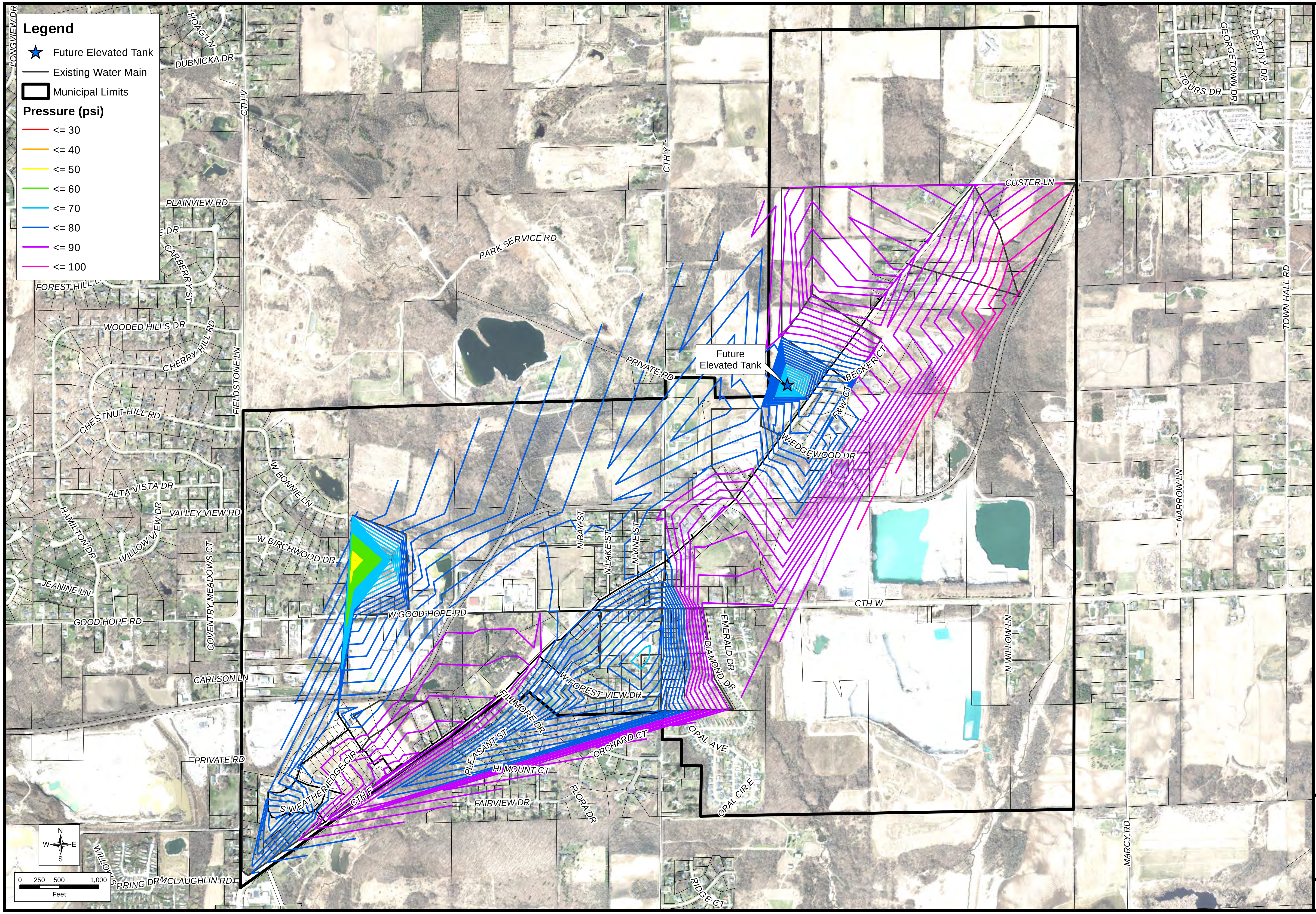
5.06 2024 MODEL ANALYSIS–ELEVATED TANK OVERFLOW AT 1,030 FEET AMSL

A. Expansion of the Distribution System

A second growth scenario was run, which included the same distribution growth as Section 5.05, but with the new elevated tank constructed with an overflow elevation of 1,030 feet to match the neighboring community's hydraulic grade. All demand junctions were allocated with the same demand. The scenario was analyzed using domestic (non-fire) and fire flow demand conditions. For this analysis, it assumed that no wells or sources of supply are operating. Therefore, adding the additional supply sources to the model was not necessary.

B. Average Day–Domestic Demand

The 2024 maximum day domestic demand condition, equaling 75 gpm, was modeled using a steady-state analysis. System conditions include no booster pumps operating, the pressure tank isolated (inactive), and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 23 and 74 psi, as shown by the pressure contours generated by the model in Figure 5.06-1. The area of lowest pressure appears to be near Lannon Village Hills where elevations are generally higher than the rest of the Village and result in pressures below the minimum required distribution system pressures. A booster station is required in this area to increase the pressures. The booster station would connect the suction side to the existing distribution system and would require emergency power. With the booster station operating



2024 MAXIMUM DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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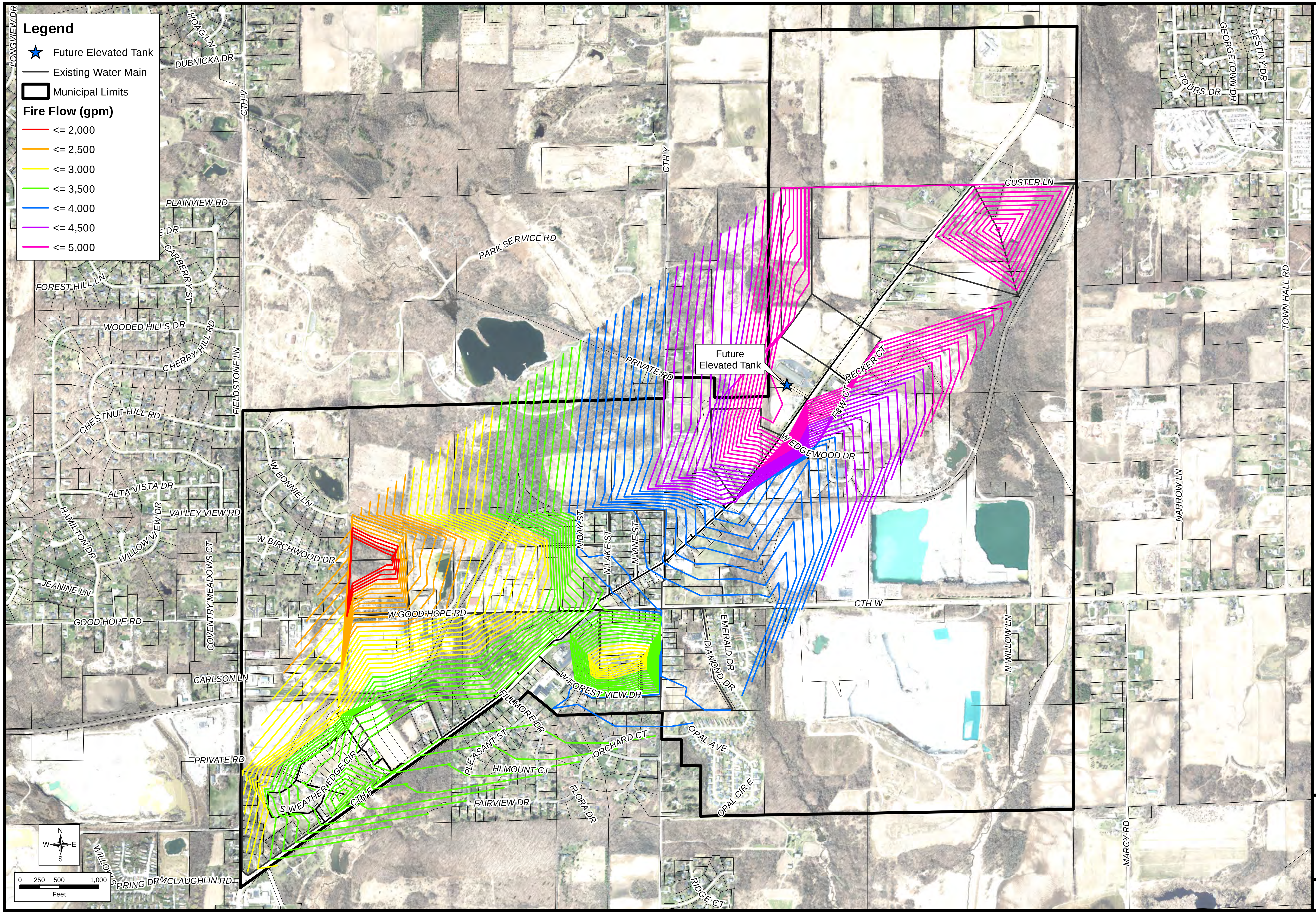
FIGURE 5.05-4
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.05-4 2024 Max Day Pressure 11x17.mxd User: natee Date: 7/9/2019 Time: 3:52:06 PM



2024 MAXIMUM DAY AVAILABLE FIRE FLOW CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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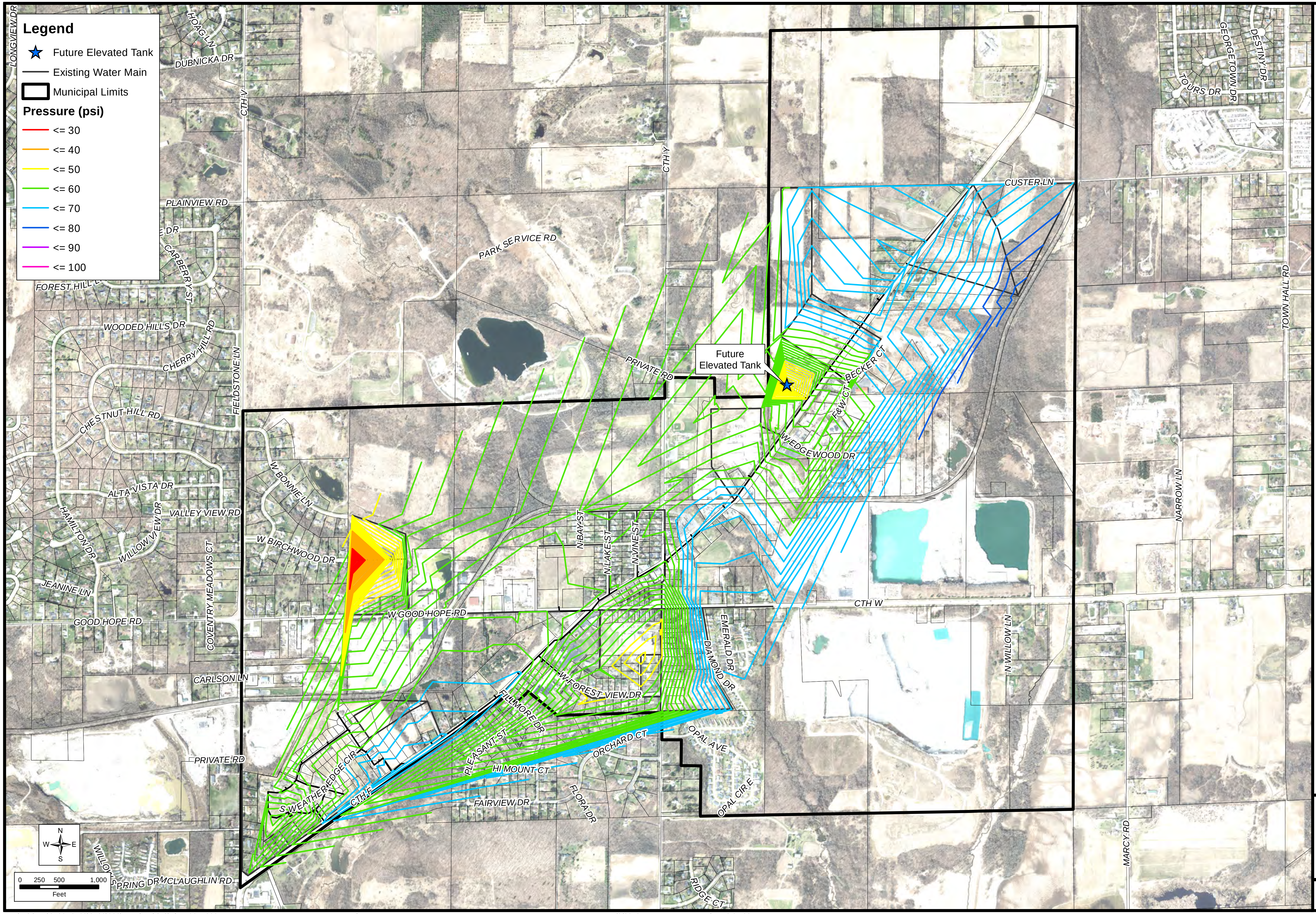
FIGURE 5.05-5
3500.008



2024 AVERAGE DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

STRAND ASSOCIATES®

FIGURE 5.06-1
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.06-1 2024 Ave Day Pressure No Booster11x17.mxd User: natee Date: 7/9/2019 Time: 3:24:38 PM at a gradient of 1,088 feet, operating pressures are between 41 and 74 psi with the area of lowest pressure appearing near the elevated tank where ground elevations are higher. Figure 5.06-2 shows the pressure contours with the booster station operating.

C. <u>Maximum Day–Domestic Demand</u>

The 2024 maximum day domestic demand condition, equaling 188 gpm, was modeled using a steady-state analysis with no booster pumps operating in the main zone, the new booster station operating in the high zone, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 41 and 74 psi, as shown by the pressure contours generated by the model in Figure 5.06-3. The areas of lowest and highest pressure appear to be in the same places as the average day.

D. <u>Maximum Day–Domestic Demand with Fire Flow</u>

The 2024 maximum day domestic demand condition plus fire flow was modeled using a steady-state analysis with no booster pumps operating in the main zone, the new booster station operating in the high zone, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected available fire flow, which ranged from approximately 1,900 gpm to greater than 5,000 gpm, as shown by the available fire flow contours generated by the model, which can be seen in Figure 5.06-3. The hydrant with the lowest available fire flow is located within the new boosted zone. The low flow is dictated by the ground elevation of the suction pipe from the main zone. The hydrant with the lowest available fire flow in the main zone of 1,995 gpm is located at the end of North Parkview Drive and is located on the end of an 8-inch water main.

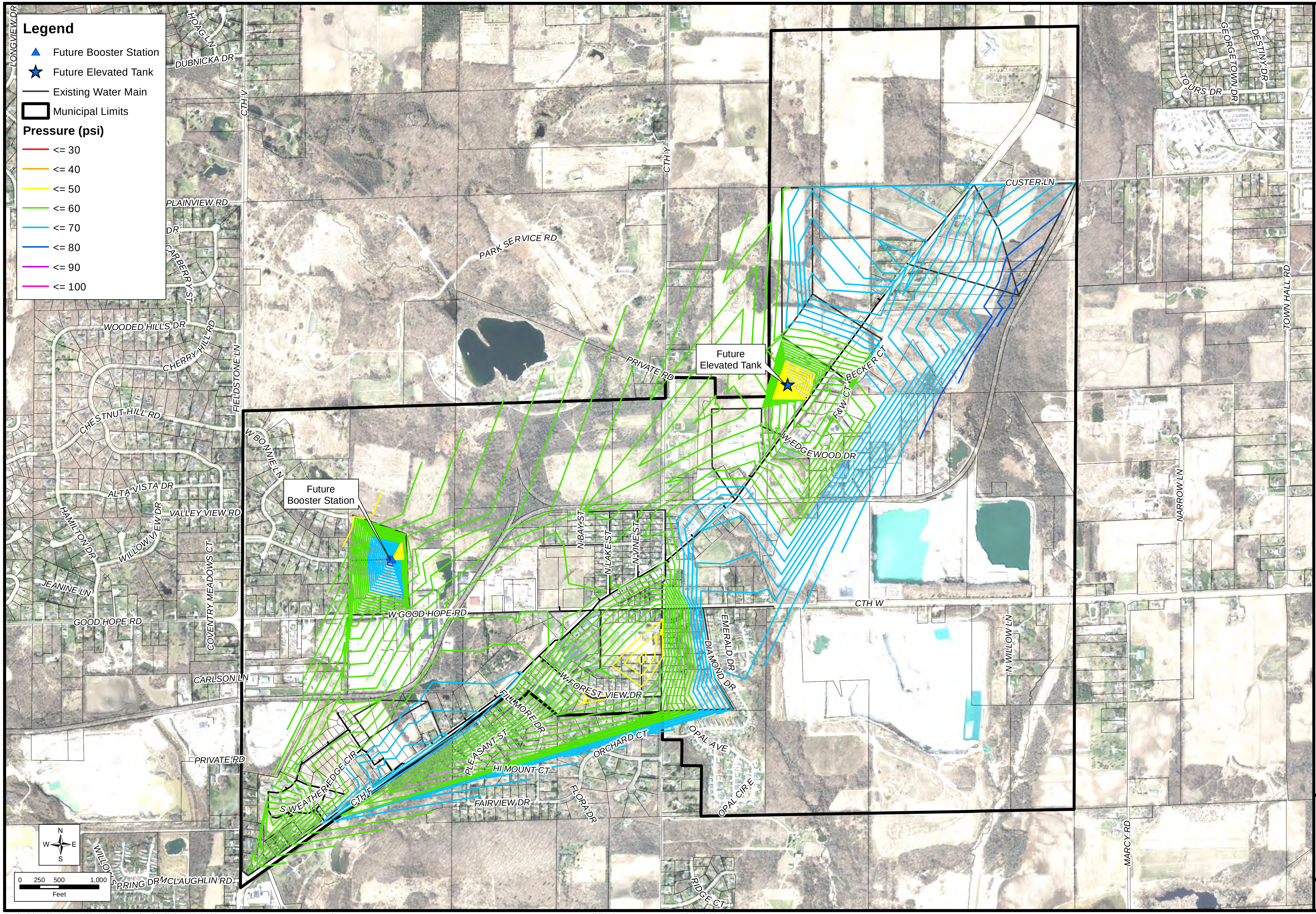
5.07 2035 MODEL ANALYSIS–ELEVATED TANK OVERFLOW AT 1,080 FEET AMSL

A. <u>Expansion of the Distribution System</u>

A 2035 water system model was created to simulation future demands and additional infrastructure. The 2035 water model was also analyzed using domestic (non-fire) and fire flow demand conditions. The additional water main shown in Figure 5.05-1 was added to the model to simulate future growth between 2024 and 2035. This analysis assumes the well, booster pumps, reservoir, and elevated tank are active. Two additional supply sources would have been added to meet the demands by this time. For this analysis, it assumed that no wells or sources of supply are operating. Therefore, adding the additional supply sources to the model was not necessary.

B. <u>Average Day–Domestic Demand</u>

The 2035 maximum day domestic demand condition, equaling 188 gpm, was modeled using a steady-state analysis. System conditions include no booster pumps operating, the pressure tank isolated (inactive), and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 42 and 95 psi, as shown by the pressure contours generated by the model in Figure 5.07-1. The area of lowest pressure appear to be east of the intersection of Davies Drive and West Birchwood Drive and are caused by higher ground



2024 AVERAGE DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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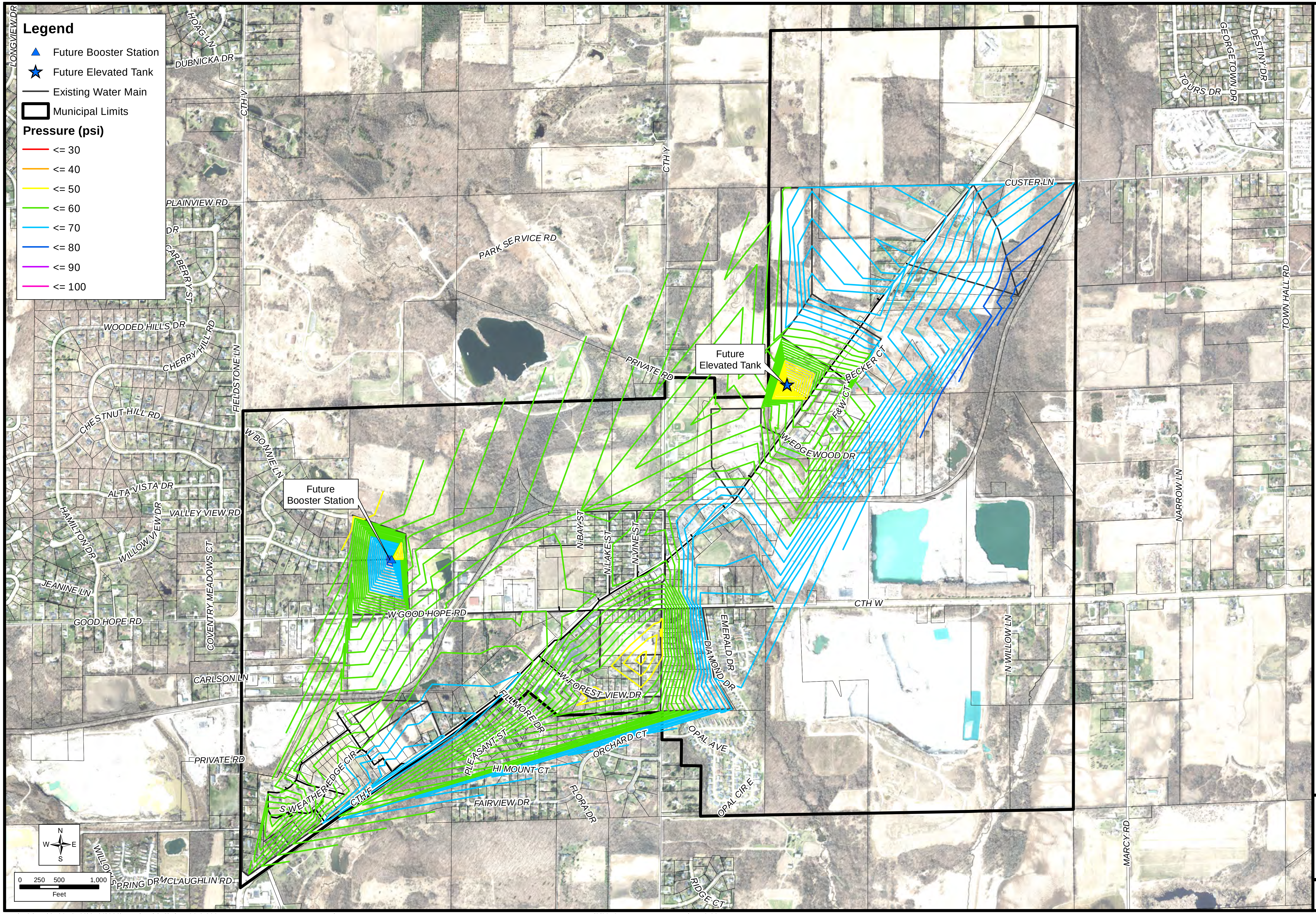
FIGURE 5.06-2
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.06-2 2024 Ave Day Pressure MF 11x17.mxd User: natee Date: 7/9/2019 Time: 3:26:29 PM



2024 MAXIMUM DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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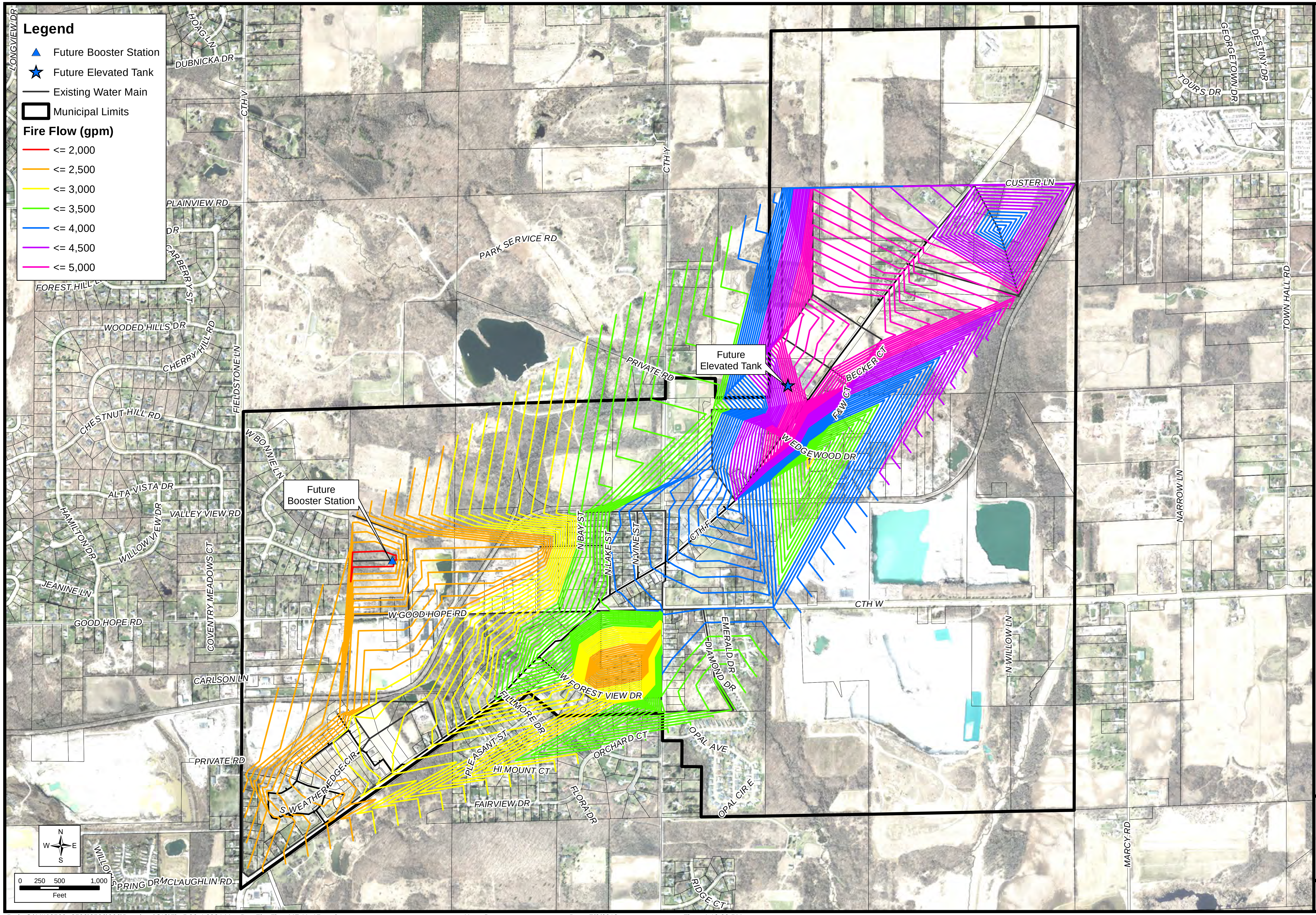
FIGURE 5.06-3
3500.008



2024 MAXIMUM DAY AVAILABLE FIRE FLOW CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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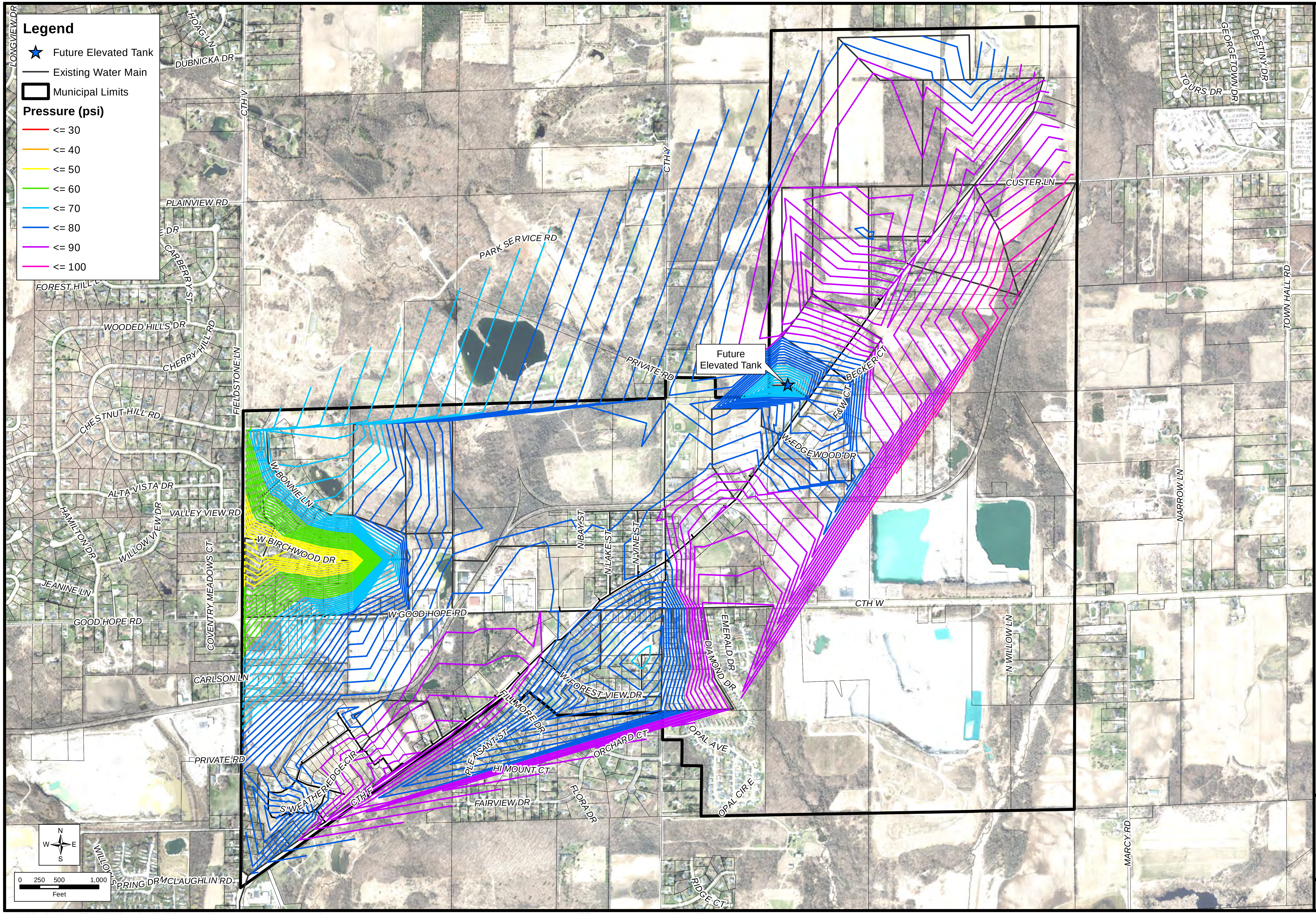
FIGURE 5.06-4
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.06-4 2024 Max Day Fire Flow MF 11x17.mxd User: Danc Date: 7/9/2019 Time: 1:19:39 PM



2035 AVERAGE DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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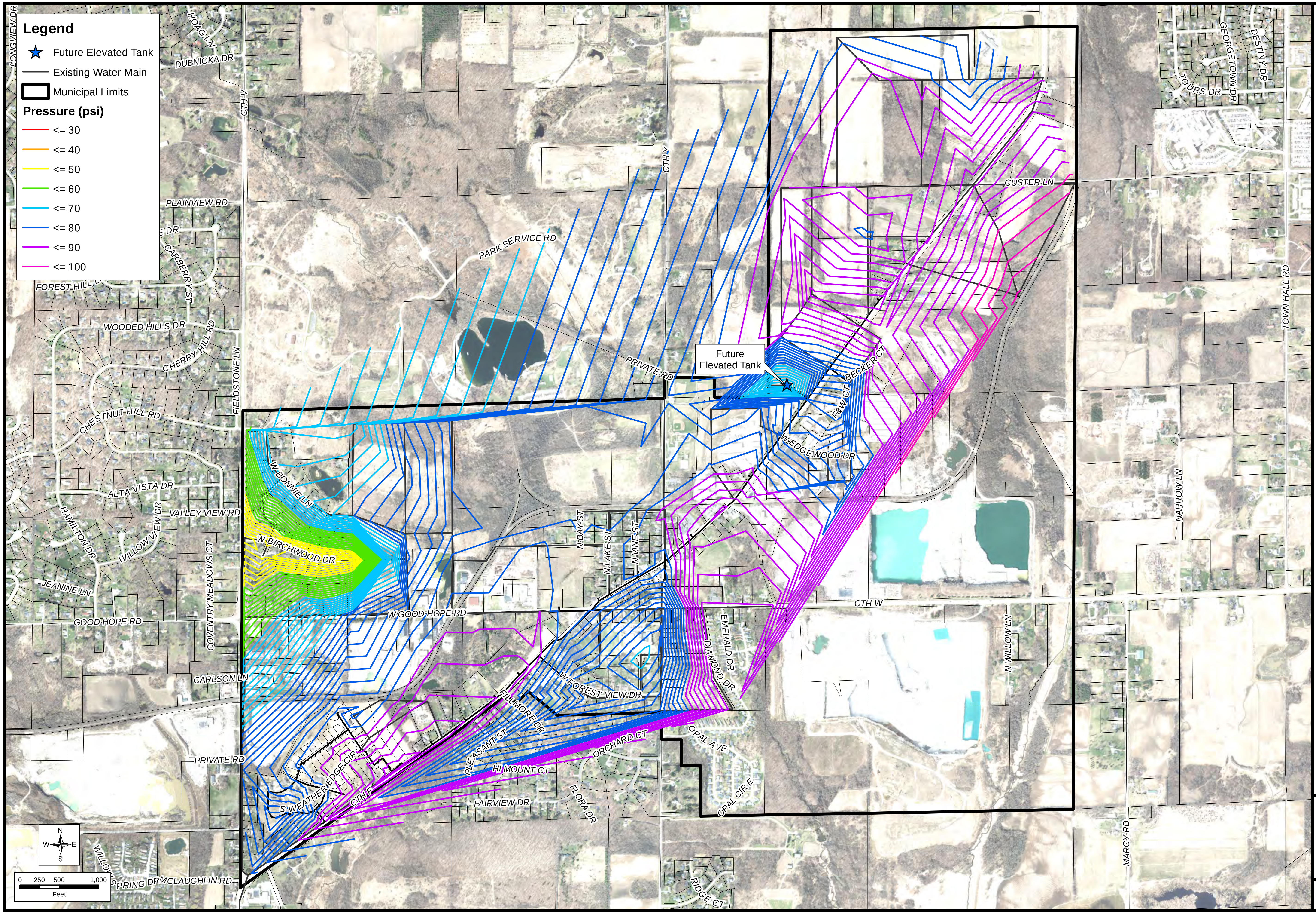
FIGURE 5.07-1
3500.008



2035 MAXIMUM DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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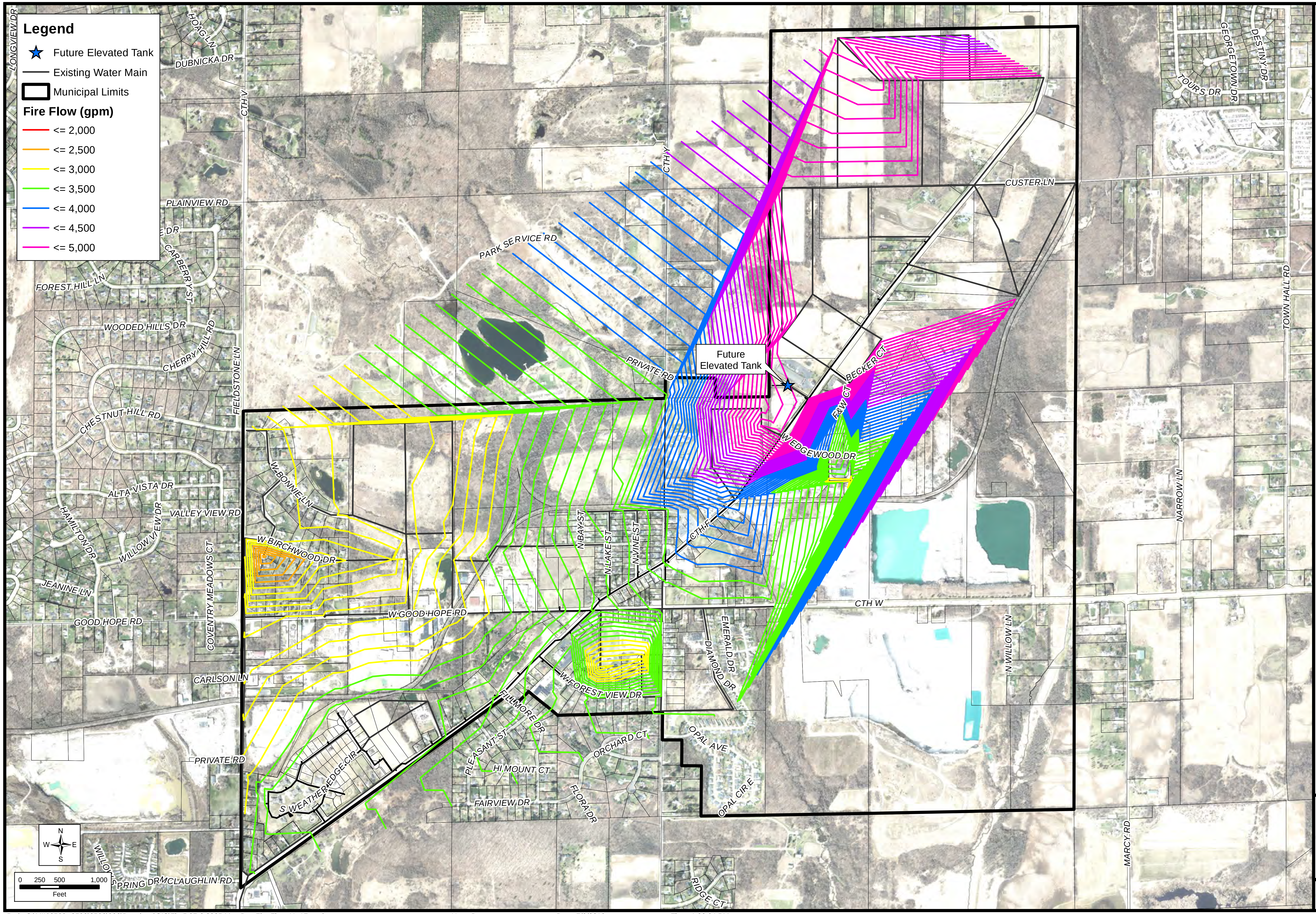
FIGURE 5.07-2
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.07-2 2035 Max Day Pressure 11x17.mxd User: natee Date: 7/9/2019 Time: 3:32:14 PM



2035 MAXIMUM DAY AVAILABLE FIRE FLOW CONTOURS
ELEVATED TANK OVERFLOW AT 1,080 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 5.07-3
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.07-3 2035 Max Day Fire Flow 11x17.mxd User: Danc Date: 7/9/2019 Time: 1:32:04 PM elevations. The areas of highest pressure, although not excessive, occur in the northeastern part of the Village near the Fox River and are caused by lower ground elevations.

C. Maximum Day–Domestic Demand

The 2035 maximum day domestic demand condition, equaling 490 gpm, was modeled using a steady-state analysis with no booster pumps operating, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 42 and 95 psi, as shown by the pressure contours generated by the model in Figure 5.06-4. The areas of lowest and highest pressure appear to be in the same places as the average day.

D. Maximum Day–Domestic Demand with Fire Flow

The 2035 maximum day domestic demand condition plus fire flow was modeled using a steady-state analysis no booster pumps operating in the main zone, the new booster station operating in the high zone, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected available fire flow, which ranged from approximately 2,247 gpm to greater than 5,000 gpm, as shown by the available fire flow contours generated by the model, which can be seen in Figure 5.06-5. The area with the lowest available fire flow occurred at the end of Davies Court along a dead-end 8-inch water main.

5.08 2035 MODEL ANALYSIS–ELEVATED TANK OVERFLOW AT 1,030 FEET AMSL

A. Expansion of the Distribution System

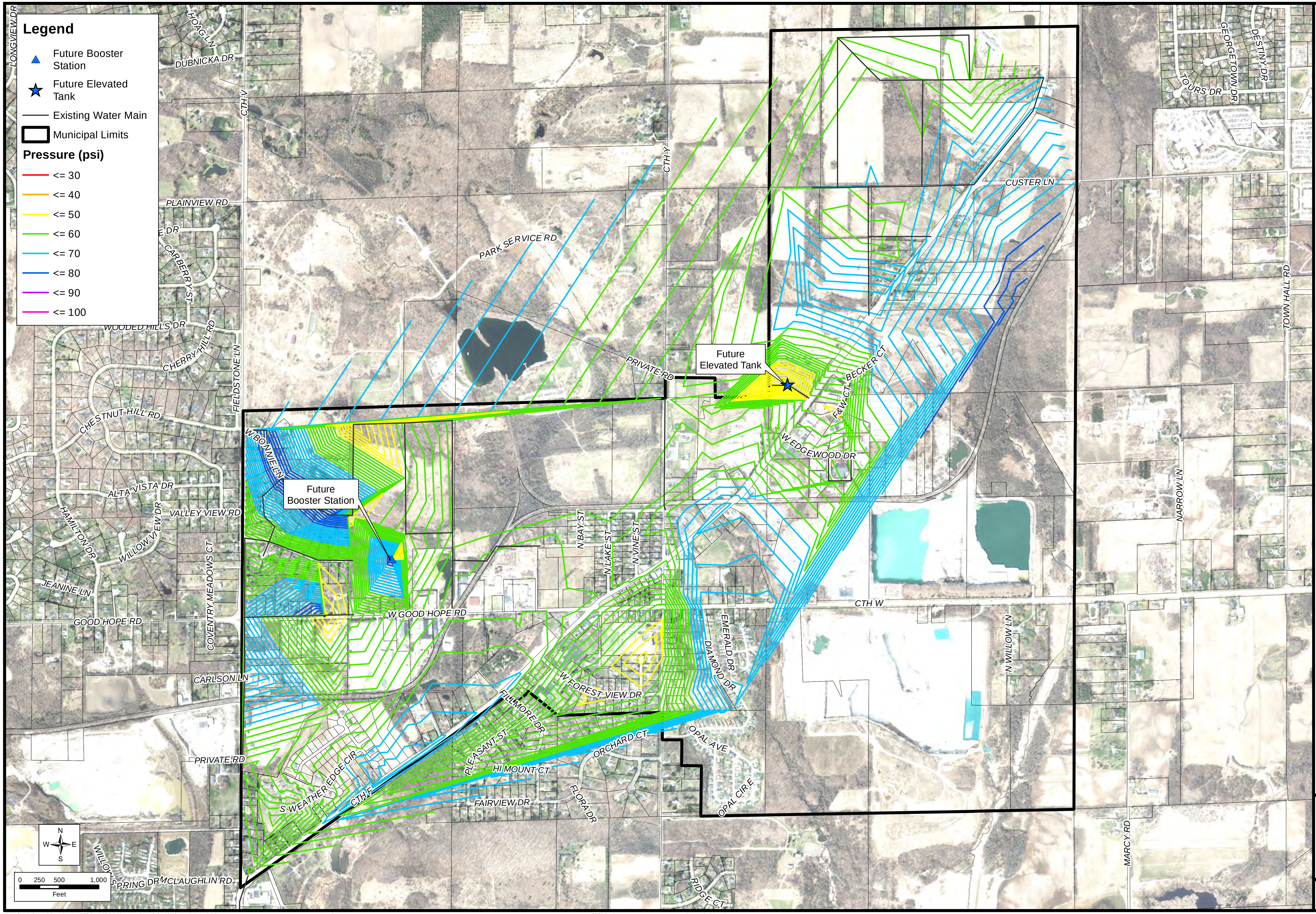
A second growth scenario was run, which included the same distribution growth as section 5.07 but with the new elevated tank constructed with an overflow elevation of 1,030 feet to match the neighboring community's hydraulic grade. All demand junctions were allocated with the same demand. The scenario was analyzed using domestic (non-fire) and fire flow demand conditions.

B. Average Day–Domestic Demand

The 2035 maximum day domestic demand condition, equaling 188 gpm, was modeled using a steady-state analysis. System conditions include no booster pumps operating, the pressure tank isolated (inactive), and the new elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 41 and 79 psi, as shown by the pressure contours generated by the model in Figure 5.08-1. The area of lowest pressure appears to be near the new elevated tank and is caused by higher ground elevations. The areas of highest pressure, although not excessive, occur in the new boosted zone and are controlled. by the setpoint of the booster station.

C. Maximum Day–Domestic Demand

The 2035 maximum day domestic demand condition, equaling 198 gpm, was modeled using a steady-state analysis with no booster pumps operating, the pressure tank isolated, and the new



2035 AVERAGE DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

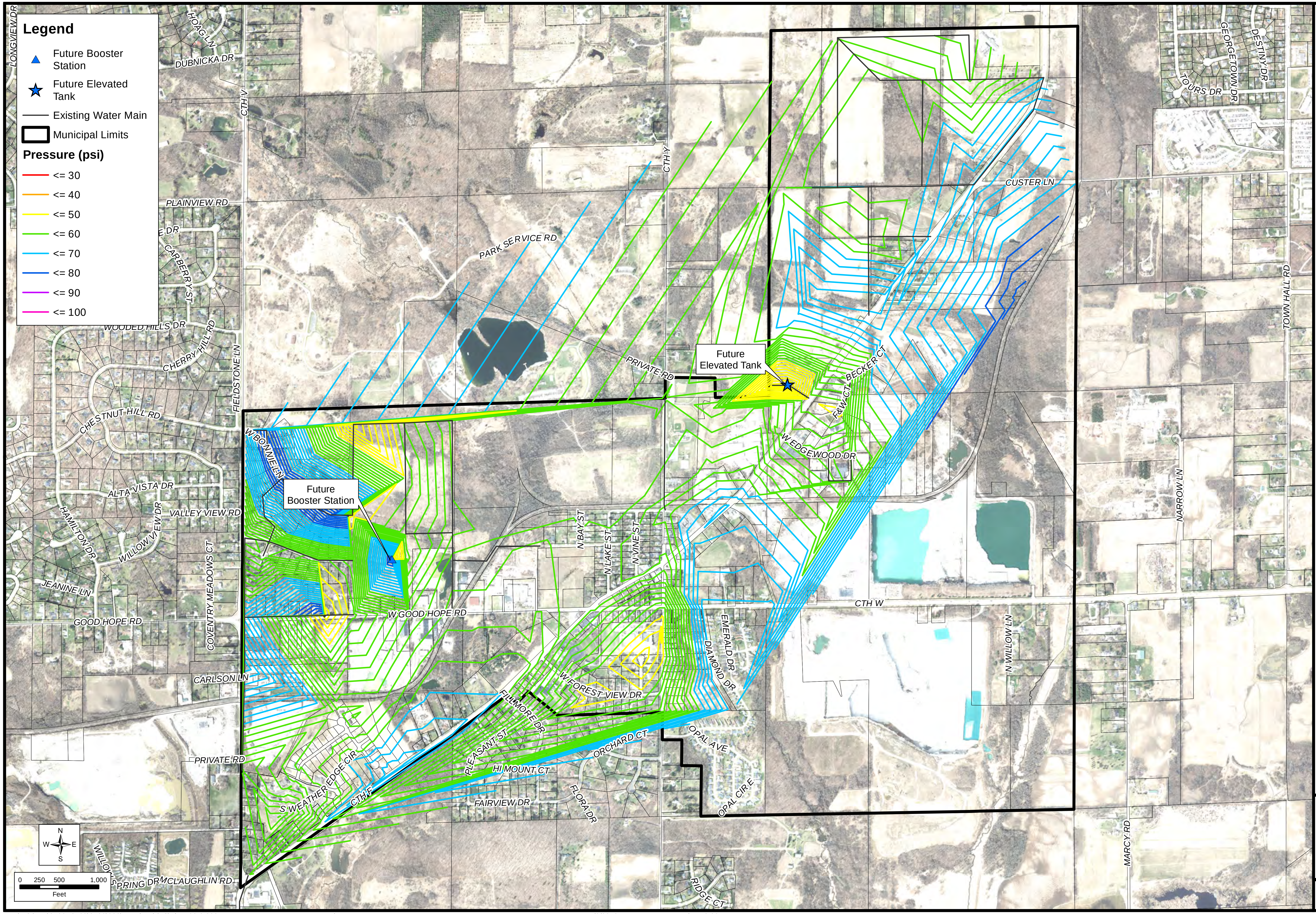
STRAND ASSOCIATES®

FIGURE 5.08-1
3500.008

elevated tank set to 10 feet below overflow. The model projected system operating pressures to be between approximately 41 and 79 psi, as shown by the pressure contours generated by the model in Figure 5.08-2. The areas of lowest and highest pressure appear to be in the same places as the average day.

D. Maximum Day–Domestic Demand with Fire Flow

The 2023 maximum day domestic demand condition plus fire flow was modeled using a steady-state analysis with no booster pumps operating, the pressure tank isolated, and the new elevated tank set to 10 feet below overflow. The model projected available fire flow, which ranged from approximately 1,639 gpm to greater than 5,000 gpm, as shown by the available fire flow contours generated by the model, which can be seen in Figure 5.08-3. The area with the lowest available fire flow is located along County Highway V in the southwestern portion of the Village and is caused by a long dead-end length of water main and higher ground elevation.



2035 MAXIMUM DAY DEMAND PRESSURE CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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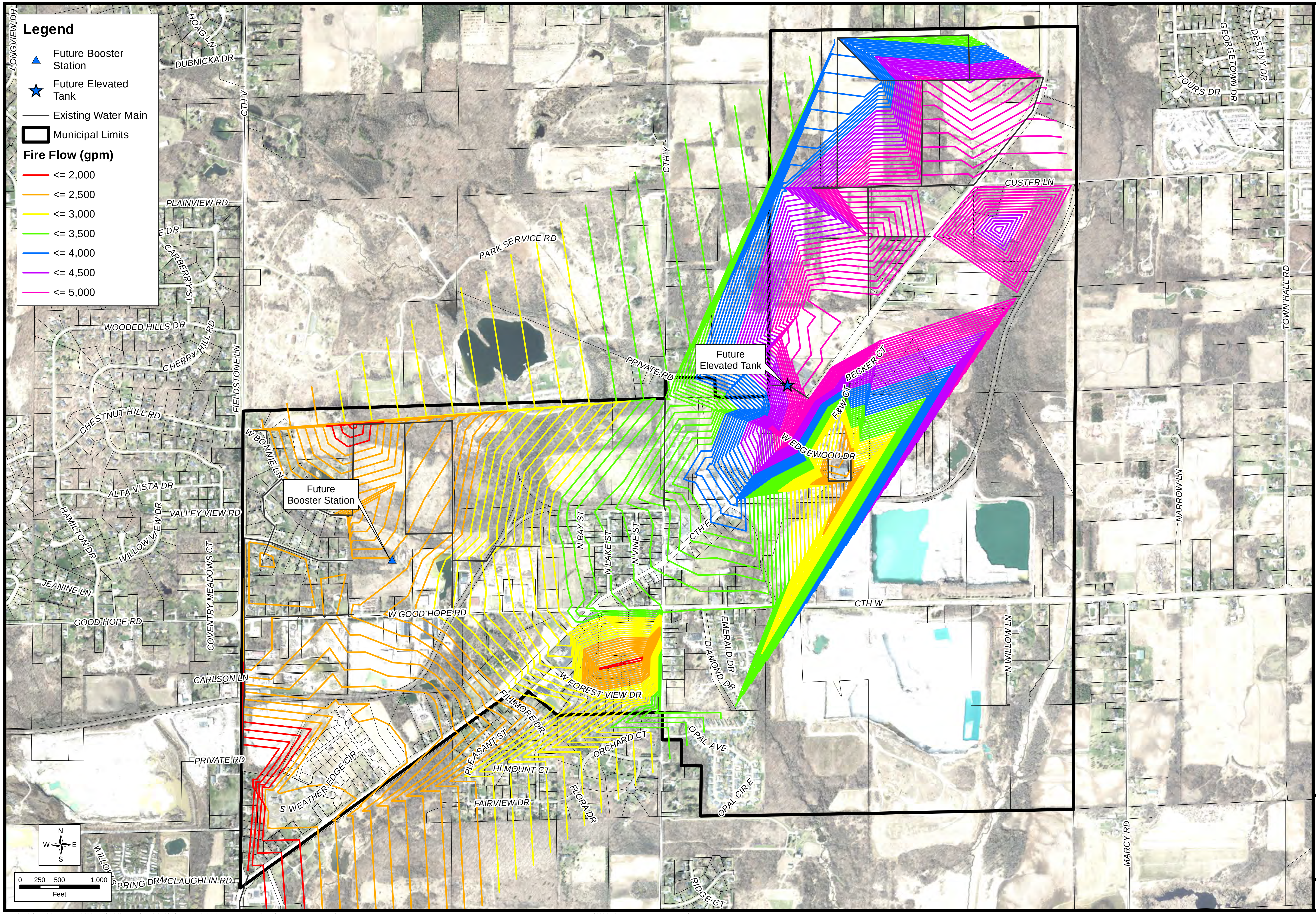
FIGURE 5.08-2
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.08-2 2035 Max Day Pressure MF 11x17.mxd User: natee Date: 7/9/2019 Time: 3:36:11 PM



2035 MAXIMUM DAY AVAILABLE FIRE FLOW CONTOURS
ELEVATED TANK OVERFLOW AT 1,030 FEET

WATER SYSTEM STUDY
VILLAGE OF LANNON
WAUKESHA COUNTY, WISCONSIN

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FIGURE 5.08-3
3500.008

Path: S:\MIL\3500--3599\3500\008\Drawings\GIS\Fig 5.08-3 2035 Max Day Fire Flow MF 11x17.mxd User: Danc Date: 7/8/2019 Time: 4:53:14 PM

SECTION 6
WATER AUDIT AND WATER LOSS CONTROL PLAN

6.01 GENERAL

The 2018 Sanitary Survey completed by the WDNR states that the Village has a high percentage of water loss in the system and exceeds the limits set by the PSC. As shown in Figure 3.02-1, the sales to pumpage ratio for the past few years was around 0.4. According to PSC 185.85(4), a Class D utility shall keep non-revenue water below 30 percent, and water loss below 25 percent. According to the information provided in the 2017 WEGS report, the Village did not meet either of these requirements with a non-revenue water of 39 percent of net water supplied and total water loss of 38 percent of net water supplied. As regulated by the PSC, a water loss control plan is required. This section represents the control plan.

6.02 WATER AUDIT

Produced water can be divided into two categories: revenue and non-revenue water. Revenue water consists of billed authorized users or billed metered and unmetered users. Non-revenue water consists of three categories: unbilled authorized users, apparent losses, and real losses. The water loss control plan will strategize ways to reduce the current values in each of the non-revenue water categories.

The American Water Works Association (AWWA) created water auditing software to assist water systems in evaluating the current state of the water system by analyzing water system data. The software then generates a validity score, based on several input parameters, that evaluates the system on a scale from 0 to 100. It also provides priority areas for attention.

A water audit of the Village's system was completed using the AWWA software for the 2017 calendar year. Data was obtained using the 2017 PSC report, discussions with the water system operator, and other information provided by the Village. The results of the audit are shown as a water balance summary in Figure 6.02-1.

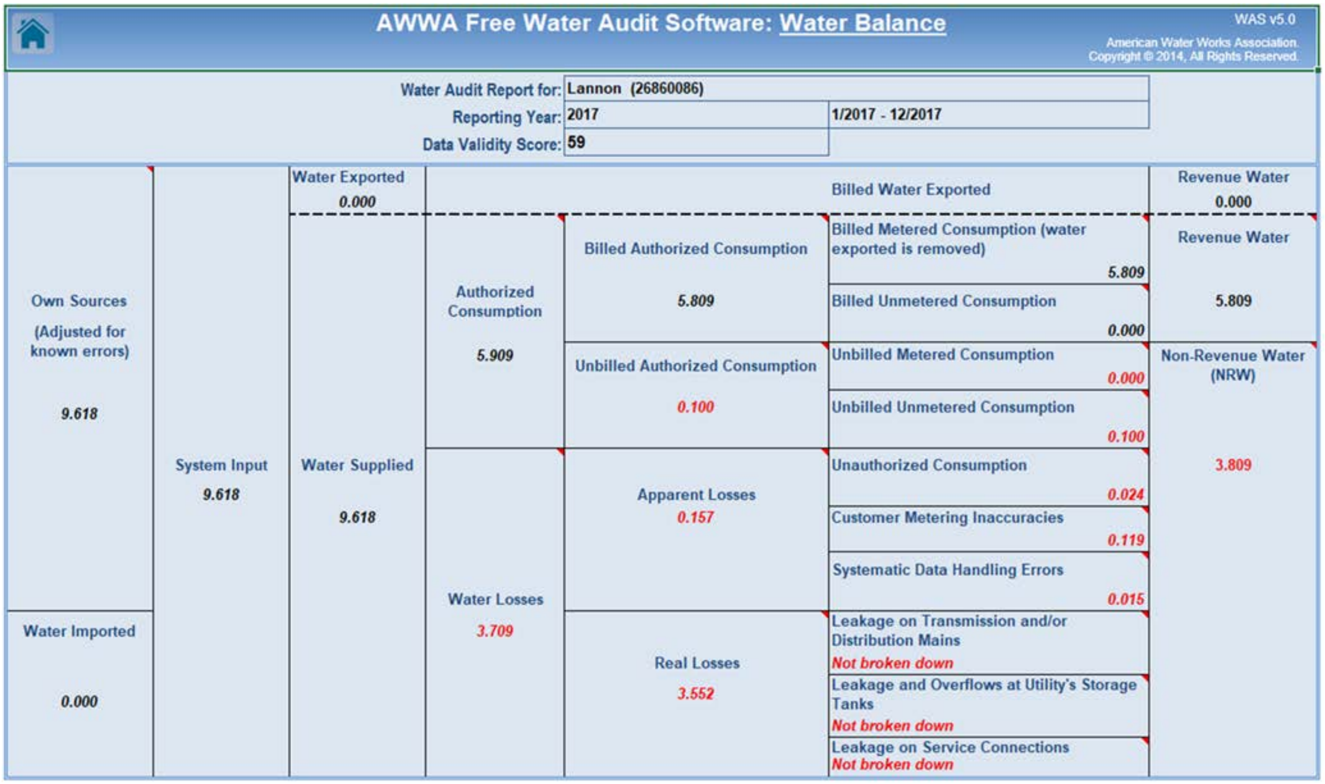


Figure 6.02-1 Water Balance Summary

As shown in Figure 6.02-1, the Village scored 59 out of 100 for 2017. Real losses account for the majority, approximately 93 percent, of the Village's non-revenue water. This equates to approximately 37 percent of all water supplied. Real losses include leakage coming from both transmission water mains and water service connections.

Apparent losses only account for approximately 4 percent of non-revenue water; however, unauthorized consumption (illegal water use from hydrants, illegal connections, and meter bypasses) and customer metering inaccuracies may be a greater issue than the software estimates. Similarly, unbilled unmetered consumption may also be greater because of hydrant use being undocumented and under-estimated.

In addition to volumetric values and percentages, the AWWA software provides a dollar amount to losses for the system to understand the financial impacts of water loss. The Village had an annual cost of $3,115 in 2017 for real losses. This value is derived from the Village's variable production cost, or the cost to produce and supply water, which is determined by calculating unit costs for water treatment and power used to supply water. Figure 6.02-2 shows the Village's performance indicators based on financial and operational efficiency.

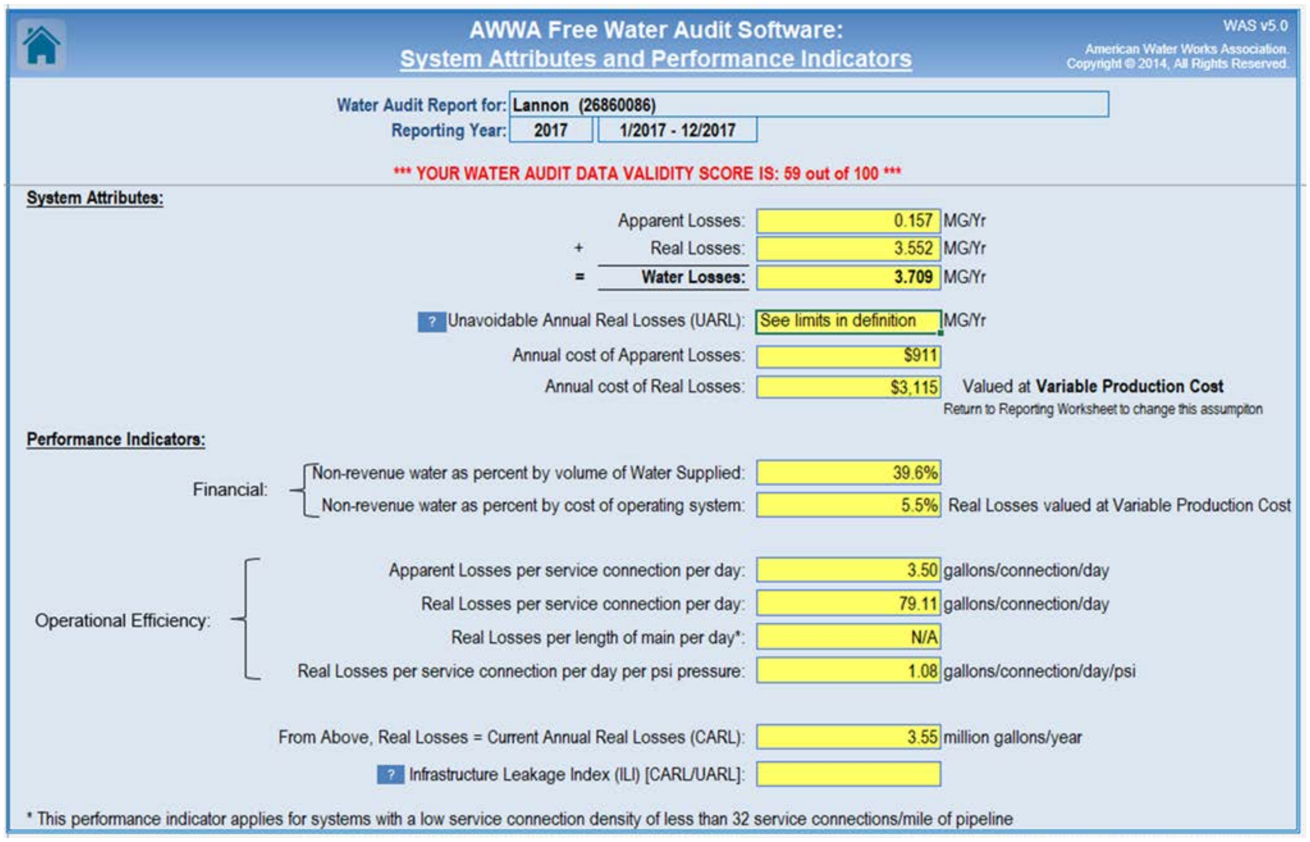


Figure 6.02-2 System Attributes and Performance Indicators

6.03 WATER LOSS CONTROL PLAN

This report will serve as the Village's suggested water system improvement plan to identify several ways to reduce water loss. It is recommended that the following actions be improved or implemented for both short- and long-term sustainability for the Village's water system:

1. Find real losses in the water system.

2. Improve and monitor water meter accuracy and accountability (both well meter and customer meters).

3. Improve unbilled unmetered consumption data and recording for hydrants within the system.

A. <u>Real Losses</u>

Real losses are the largest problem and should be corrected to improve water loss and non-revenue water in the Village. The Village has attempted to identify leaks in the system and has encountered and corrected a few in previous years. The PSC has required a leak detection study to find and address suspected leaks in the system. The leak detection study will scan the existing distribution system and listen for any leaks occurring in water mains and service connections.

It is recommended that a system-wide leak test be completed after corrections to the well meter have occurred. A leak detection study would take a couple of days and would cost approximately $5,000 to perform. After the study is complete, any leaks encountered would be investigated further and corrected.

B. Meter Accuracy and Accountability

CTW previously tested the existing well pump meter on June 12, 2018, by placing a calibrated meter downstream of the existing flow meter. 15,000 gallons of water flowed through both meters and the registered value in the meters was compared. The existing 4-inch Badger magnetic flow meter showed readings 4.92 percent higher than the readings on the calibrated meter. CTW suspects the poor readings are caused by the chemical injection location being too close upstream and is interfering with the meter. CTW has since relocated the injection location and replaced the water meter with a Badger M2000 4-inch diameter meter with serial number 49425727. It is recommended to monitor the results of the new meter.

The Village does not currently test existing customer meters. Rather, the Village of Menomonee Falls currently is contracted to repair, test, and read customer water meters. The Village of Menomonee Falls also obtains the billing information from the meters and provides it to the Village. The average age of the meters is approximately eight years old with very few of the meters ever being replaced or recalibrated.

It is recommended that the Village improve meter accuracy and accountability. The well flow meter needs to be calibrated once every two years. Customer meters need to be bench tested to determine their accuracy. It is recommended that the Village incorporates a meter testing and replacement program as the existing meters are starting to get close to their expected life span and might not be recording accurately. This will need to be coordinated with the Village of Menomonee Falls, or an in-house program should be created.

C. Unbilled Unmetered Consumption

The only unbilled unmetered consumption in 2017 was 100,000 gallons of hydrant flushing reported on the WEGS report. The Village currently flushes hydrants annually and estimates the amount of water used.

There are several residents located along the existing distribution system that are not identified as an existing customer. It is possible that a service connection was illegally installed when the water main was being constructed and a water meter was never installed.

It is recommended that the Village incorporates a better method to document the amount of water used during hydrant testing. Using a hydrant flow meter is much more accurate than calculating based on estimated flow and duration. Reporting procedures should be reviewed to make sure all non-revenue water is reported.

6.04 WATER LOSS CONTROL PLAN SUMMARY

Water loss and non-revenue water is a problem for the Village. The Village needs to incorporate measures to reduce the amount of non-revenue water within the system. Real losses need to be found in the system by performing a leak detection study. Both the well meter and customer meters need to be tested and calibrated as recommended to accurately measure the water flowing in the system. Procedures need to be incorporated to understand how much unbilled unmetered water is being consumed for hydrant flushing activities and find any existing service connections that might not be metered.

SECTION 7
CONCLUSIONS AND RECOMMENDATIONS

7.01 SOURCE CAPACITY AND SYSTEM DEMANDS

A. 2019

The estimated 2019 maximum day demand equals 50 gpm. The current system firm source capacity with the largest well out of service is 0 gpm. An additional source of supply is needed to meet maximum day demand under firm source capacity. It is recommended to construct an additional supply source as soon as feasibly possible to provide a redundant source of supply.

B. 2024

The estimated 2024 maximum day demand equals 188 gpm. By 2024, it is assumed that the Village will have incorporated an additional source of supply and firm capacity will increase to 300 gpm and no additional source capacity is needed at this time.

C. 2035

The estimated 2035 maximum day demand equals 490 gpm which exceeds the assumed 300 gpm firm source capacity by 190 gpm. An additional source of supply equal to or greater than 190 gpm is estimated to be needed by 2028 when the maximum day demands exceed 300 gpm.

7.02 STORAGE CAPACITY

A. 2019

The total amount of usable reservoir storage is currently 128,000 gallons. Under firm supply conditions, the Village can supply approximately two maximum demand days from storage. During a maximum day plus fire demand condition under firm supply capacity, the system is projected to have a deficit of 177,960 gallons. Additional storage in the form of an elevated tank is recommended to meet maximum day plus fire demands.

B. 2024

Assuming no additional storage or source capacity is constructed by 2024, the Village can supply approximately 11 hours of maximum day demands under firm supply conditions. Assuming an additional source is constructed by 2024, the system is projected to have a deficit of 190,560 gallons during a maximum day plus fire demand condition under firm supply capacity and additional storage is required.

C. 2035

Assuming no additional storage or source is constructed by 2035, the Village can supply approximately four hours of maximum day demands under firm supply conditions. Assuming two additional sources have been constructed by 2035, the system is projected to have a deficit of 167,000 gallons during a maximum day plus fire demand condition under firm supply capacity and additional storage is required.

Considering the 2019, 2024, and 2035 storage capacity evaluations, a 250,000-gallon elevated tank should be constructed to meet maximum day plus fire conditions for both current and future design years.

7.03 NON-REVENUE WATER

The ratio of water sold to the volume of water pumped is defined as the sales to pumpage ratio. The volume of water between these two valves can be defined as non-revenue water. Historically, annual sales to pumpage ratio has been between 0.4 and 0.6 (approximately 40 to 60 percent non-revenue water).

A water audit was completed using AWWA auditing software. The Village scored 59 out of 100 using 2017 data and was estimated to be losing approximately $3,115 per year for the real loses. The software provided three priority areas for attention: volume from own sources, customer metering inaccuracies, and billed metered.

A water loss control plan was created and identified three items that should be improved or implemented. These items include finding real losses in the water system, improving and monitoring water meter accuracy and accountability, and improving unbilled unauthorized consumption data. A full system leak detection study is recommended after these items have been completed.

7.04 DISTRIBUTION SYSTEM

A. 2019

In general, water modeling indicates that the distribution system provides adequate pressures to all locations under simulated demand conditions. Pressures range from 65 psi to 81 psi. Fire flow availability at existing hydrants range from 2,000 gpm to 5,000 gpm based on distribution system hydraulics, but are limited by booster pump capacity to approximately 1,100 gpm.

B. 2024

After incorporating future growth areas, existing infrastructure areas, and construction of an elevated tank, the distribution system experiences different pressures compared to 2019 because the hydraulic gradient in the system changes to the elevated tank. Pressures range from 45 psi to 95 psi with the elevated tank overflow of 1,080 feet and from 41 to 74 psi with the elevated tank overflow of 1,030 and booster station. Pressures in the boosted zone range from 51 to 78 psi. Fire flow availability with implementation of the elevated tank ranges from 1,400 gpm to over 5,000 gpm with the elevated tank overflow of 1,080 feet and from 1,900 gpm to over 5,000 gpm with the elevated tank overflow of 1,030 feet.

C. 2035

After further incorporating future growth areas and existing infrastructure areas, the distribution system experiences pressures and fire flows similar to those in 2024. Pressures range from 42 to 95 psi with the elevated tank overflow of 1,080 feet and from 41 to 79 psi with the elevated tank overflow of 1,030 feet.

Fire flow availability range from about 2,250 gpm to over 5,000 gpm with the elevated tank overflow of 1,080 feet and 1,650 to over 5,000 gpm with the elevated tank overflow of 1,030 feet and booster station.

7.05 CAPITAL IMPROVEMENTS PLAN (CIP)

A CIP for the various water system improvements was created through 2035 and is shown in Tables 7.05-1 through 7.05-4 depending on the type of project. An approximate year or range of years is provided for each project. The projected schedule of project implementation may change as development occurs in the Village.

A. Distribution System

The distribution improvements shown in Table 7.05-1 should be constructed to convert the existing residents and businesses from private wells to the municipal water system. See Figure 5.05-1 for a map of the improvements.

Project	OPPC*	Planned Construction Year(s)	Approximate Number of Added Services
Elementary School Water Main	Under Construction 2019		
Area 1 Water Main	$2,680,000	2020-2021	68
Area 2 Water Main	$2,040,000	2020-2021	67
Area 4 Water Main	$1,190,000	2020-2021	16
Area 1 Mill and Overlay	$288,000	2020-2021	--
Area 2 Mill and Overlay	$201,000	2020-2021	--
Total	**$6,399,000**		**151**

*All project cost opinions are in 2019 dollars and include 35 percent contingencies and technical services

Table 7.05-1 Distribution Improvements OPPC and Schedule

B. Storage and Supply Alternatives

Table 7.05-2 through 7.05-5 display the three alternatives for storage and supply and provide OPPCs for each.

1. Alternative 1–1,080-foot Overflow Tank and Two Deep Sandstone Aquifer Wells with Treatment Facilities

The total OPPC to construct an elevated tank with an overflow of 1,080 feet, and two deep sandstone aquifer wells with treatment facilities is $8,345,000. The elevated tank and one well facility should be constructed immediately and the second well should be constructed in 2028.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Deep Sandstone-Aquifer Well with Treatment	~ 500 gpm	Immediately	$3,000,000
Elevated Tank	250,000 gal	Immediately	$2,270,000
Booster Pump Improvements		Immediately	$75,000
Deep Sandstone-Aquifer Well with Treatment	~ 500 gpm	2028	$3,000,000
		Total OPPC	$8,345,000

Table 7.05-2 Alternative 1 Capacity Improvements OPPC

2. Alternative 2–1,080-foot Overflow Tank and Two Shallow Limestone Aquifer Well Facilities

The total OPPC to construct an elevated tank with an overflow of 1,080 feet, and two shallow limestone aquifer well facilities is $5,345,000. The elevated tank and one well facility should be constructed immediately and the second well should be constructed in 2028.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Shallow Limestone-Aquifer Well Facility	~ 300 gpm	Immediately	$1,500,000
Elevated Tank	250,000 gal	Immediately	$2,270,000
Booster Pump Improvements		Immediately	$75,000
Shallow Limestone-Aquifer Well Facility	~ 300 gpm	2028	$1,500,000
		Total OPPC	$5,345,000

Table 7.05-3 Alternative 2 Capacity Improvements OPPC

3. Alternative 3–1,030-foot Overflow Tank, Interconnection, Booster Pumping Station, and a Deep Sandstone Aquifer Well with Treatment Facility

The total OPPC to construct an elevated tank with an overflow of 1,030 feet, an interconnection with the Village of Menomonee Falls, deep sandstone aquifer well with treatment facility, and a booster pumping station is $9,030,000.

Improvement	Anticipated Capacity	Anticipated Time of Construction	OPPC
Elevated Tank	250,000 gal	Immediately	$2,120,000
Interconnection	> 300 gpm	Immediately	$1,900,000
Deep Sandstone–Aquifer Well with Treatment	~ 1,000 gpm	2028	$3,000,000
Booster Pumping Station	1,500 gpm	Before 2035	$2,010,000
		Total OPPC	$9,030,000

Table 7.05-4 Alternative 3 Capacity Improvements OPPC

4. Recommended Alternative

Alternative 1 is the recommended group of alternatives based on several considerations. The deep-aquifer sandstone wells were selected based on higher well capacity and improved water quality and quantity compared to the shallow limestone aquifers. An elevated tank at an overflow elevation of 1,080 feet creates a single-zoned water system with no additional O&M costs for a boosted zone. It also provides opportunities to potentially have interconnections with other neighboring communities.

C. Miscellaneous

The Village has expressed interest in pursuing low-interest loan and grant funding opportunities for the major capacity and water main improvement projects. Additional applications and reports are anticipated to be required and an OPPC to apply to these funding agencies is $75,000.

When an additional source and an elevated tank are constructed, additional SCADA improvements will be needed at the existing well and booster pumping facility. An OPPC for these improvements is approximately $150,000.

CTW has expressed concern with the existing site layout of the existing well and booster pumping facility. Currently, there is no accessible walkway to the existing chemical facility. When an operator needs to refill the chemicals, he or she needs to step over rocks to get to the loading platform. Site work modifications are recommended to provide a better access. The OPPC for the site improvements is $10,000 and should be completed in the next five years.

It is also recommended to perform a distribution system leak study to reduce water loss in the system. The OPPC to perform a leak detection study is $5,000 and should be completed in the next five years.

D. Summary of Plan

Table 7.05-5 shows the recommended improvements and the costs required for each year for the next five years.

Table 7.05-5 CIP Summary Schedule

	Project Year				
Project Description	**2019**	**2020**	**2021**	**2022**	**2023**
Distribution System					
Water Main Design and Construction		$ 3,200,000	$ 3,200,000		
Storage Improvements					
Elevated Tank Design (Engineering)		$ 80,000			
Elevated Tank Construction (Construction)			$ 1,055,000	$ 1,055,000	
Elevated Tank Administration (Engineering)			$ 40,000	$ 40,000	
Booster Station Improvements				$ 75,000	
Supply Improvements					
Well 2 Design and Facility Design (Engineering)		$ 175,000			
Well 2 Drilling (Construction)		$ 400,000			
Well 2 Drilling Administration (Engineering)		$ 15,000			
Well 2 Facility Bid and Construction (Construction)			$ 1,155,000	$ 1,155,000	
Well 2 Facility Administration (Engineering)			$ 50,000	$ 50,000	
Miscellaneous					
Funding Applications and Reports	$ 75,000				
SCADA Improvements			$ 50,000	$ 100,000	
Well 1 Facility Improvements					$ 10,000
Leak Detection					$ 5,000
Annual Totals	**$ 75,000**	**$ 3,870,000**	**$ 5,550,000**	**$ 2,475,000**	**$ 15,000**
5-Year CIP Total	**$ 11,985,000**				

APPENDIX A
HISTORIC WATER PUMPAGE AND SALES DATA

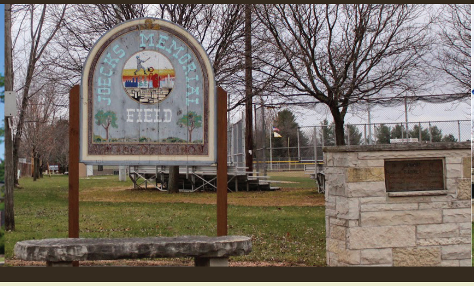
HISTORIC WATER PUMPAGE AND SALES DATA

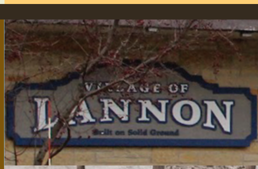
Year	Annual Pumpage (gal)	Average Day Pumpage (gpd)	Maximum Day Pumpage (gpd)	Average Day Sales (gpd)	Sales to Pumpage Ratio	Maximum to Average Day Ratio	Accounted for Water (gal)	Unaccounted for Water (gpd)
2008	634,000	1,736	17,000	1,736	1.00	9.79	0	0
2009	4,301,000	11,775	78,000	12,890	1.09	6.62	-407,000	-1,115
2010	5,041,000	13,802	109,000	8,172	0.59	7.90	2,056,000	5,633
2011	4,612,000	12,627	133,000	7,003	0.55	10.53	2,054,000	5,627
2012	5,175,000	14,168	106,000	7,436	0.52	7.48	2,459,000	6,737
2013	6,588,000	18,037	74,000	8,816	0.49	4.10	3,368,000	9,227
2014	7,586,000	20,769	196,000	8,589	0.41	9.44	4,449,000	12,189
2015	7,626,000	20,879	73,000	8,441	0.40	3.50	4,543,000	12,447
2016	14,603,000	39,981	111,000	14,973	0.37	2.78	9,134,000	25,025
2017	9,618,000	26,333	65,000	15,650	0.59	2.47	3,902,000	10,690
2018	9,605,000	26,297	58,000	15,800	0.60	2.21	3,834,000	10,504

APPENDIX B
LANNON COMPREHENSIVE PLAN AMENDMENT

LANNON COMPREHENSIVE PLAN AMENDMENT

ADOPTED: JUNE 11, 2018





PREPARED BY VANDEWALLE & ASSOCIATES INC.

VILLAGE OF LANNON, WISCONSIN

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Introduction

Relationship to Waukesha County Comprehensive Plan

This document is an amendment to the *Recommended Land Use Plan for Waukesha County – 2035* contained in the *Comprehensive Development Plan for Waukesha County*, adopted February 24, 2009. The land use plan map included in this document is intended to serve as the Village's official Future Land Use Map, as required by Wis. Stat. 66.1001(2)(h). The 2018 Future Land Use Map should be reflected in the forthcoming ten-year update of the *Comprehensive Development Plan for Waukesha County.*

The 2018 Future Land Use Map and accompanying text included in this document will be described hereafter in this document as the "2018 Plan Amendment."

The 2018 Plan Amendment reflects a number of intentional policy changes by the Village of Lannon. These policy changes relate to the following sections of the 2009 County Plan:

- The Land Use Element (Chapter 7) of the 2009 County Plan includes the *Recommended Land Use Plan for Waukesha County – 2035* and a text description of the land use categories included on that map. The *Recommended Land Use Plan* and related descriptions will be superseded by the 2018 Plan Amendment.
- Environmental Corridor data has been updated to reflect the latest information from the Southeastern Wisconsin Regional Plan Commission (2010).

In the above locations and in all other locations where contradictions between the 2018 Plan Amendment and the 2009 County Plan exist, the 2018 Plan Amendment will supersede the 2009 County Plan.

Planning Process

Public Participation

Section 66.1001(4) of the Wisconsin Statutes requires that the Village Board adopt a public participation plan that includes written procedures that are "designed to foster public participation, including open discussion, communication programs, information services, and public meetings for which advance notice has been provided, in every stage of the preparation of a comprehensive plan." The public participation plan was adopted by resolution of the Lannon Village Board on September 11, 2017. The major public involvement steps included the following:

- The 2018 Plan Amendment and related issues were discussed at two joint meetings of the Plan Commission and Village Board (September 20 and October 2, 2017), which were noticed, open to the public, and included an opportunity for public comment.
- A Public Hearing was held on November 16, 2017.

Additionally, the draft Plan Amendment was available for public review at Village Hall, and opportunities for written comments to be submitted by the public to the Village were provided.

Plan Review and Adoption

On November 16, 2017, the Village Plan Commission and Village Board held a joint public hearing to hear comments on adopting the *Comprehensive Development Plan for Waukesha County* as the Village's official Comprehensive Plan in accordance with Wis. Stat. 66.1001. Following the public hearing, the Village Plan Commission recommended the *Comprehensive Development Plan for Waukesha County* to the Village Board, and the Village Board adopted the Plan by ordinance.

After adopting the *Comprehensive Development Plan for Waukesha County*, the Village Plan Commission and Village Board held a joint public hearing to hear comments on the proposed 2018 Plan Amendment.

On June 11, 2018, the Village Plan Commission recommended the 2018 Plan Amendment to the Village Board. On June 11, 2018, the Village Board adopted the 2018 Plan Amendment by ordinance.

Recommended Future Land Use Map

Future Land Use Pattern

The Future Land Use Map is the centerpiece of the Village's land use policy and provides the Comprehensive Plan's land use policy direction. The Future Land Use Map in this 2018 Plan Amendment replaces the *Recommended Land Use Plan* for the Village of Lannon in the 2009 *Comprehensive Development Plan for Waukesha County*. The Future Land Use Map was prepared based on an analysis of a variety of factors, including development trends, location and availability of vacant land in the Village, adjacent development, input from Village officials, and environmental constraints.

The Future Land Use Map and related guidance described below should be used as a basis to update the Village's regulatory land use tools such as the Zoning Ordinance and Zoning Map. They should also be used as a basis for all public and private sector development decisions including annexations, zoning map amendments (rezonings), subdivisions, extension of municipal utilities, and other public or private investments. Changes in land use to implement the recommendations of this Plan Amendment will generally be initiated by property owners and private developers. This Plan Amendment does not compel property owners to change the use of their land.

Not all land shown for development on the Future Land Use Map will be immediately appropriate for rezoning and other land use approvals following adoption of this Plan Amendment. Given service demands and other factors, it will be essential to consider the amount, mix, and timing of development in order to keep development manageable and sustainable. Where necessary, the Village advocates the phased development of land that focuses growth in areas and types that advance the vision of the community and that can be efficiently served with transportation facilities, utilities, public services, and other community facilities.

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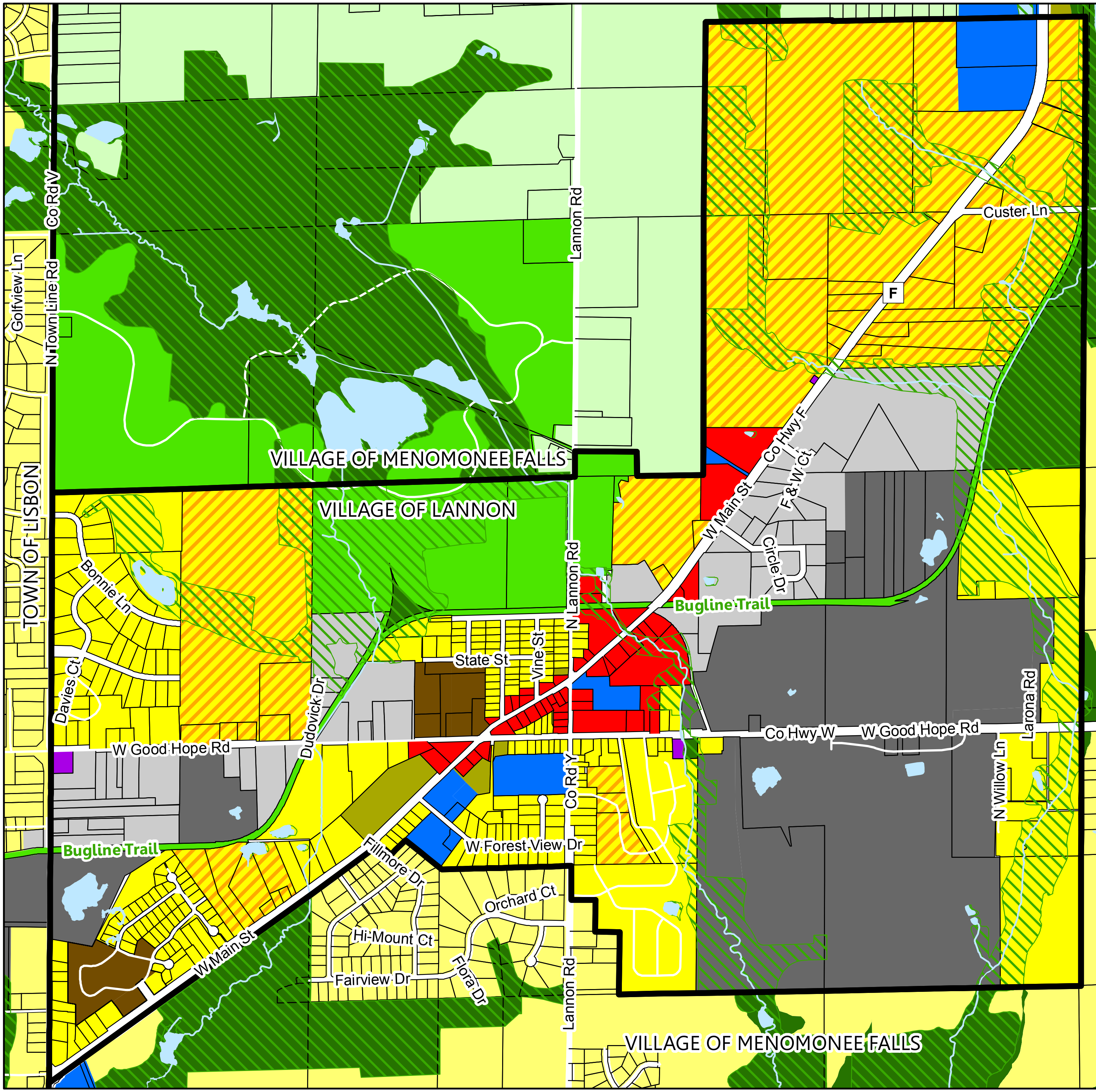

Village of Lannon Comprehensive Plan Future Land Use Map

Municipal Boundaries

Surface Water

Land Use Categories

- Single-Family Residential
- Two-Family Residential
- Multi-Family Residential
- Planned Neighborhood*
- Commercial
- Industrial
- Extractive
- Governmental/Institutional
- Utilities
- Agricultural
- Recreational
- Conservation/Open Land
- Environmental Corridor

*Planned Neighborhood Categories:
-Single-Family Residential
-Two-Family Residential
-Multi-Family Residential
-Governmental/Institutional
-Recreational

0.25 Miles

N

VANDEWALLE & ASSOCIATES INC.
Shaping places, shaping change

Date: 6/11/2018
Sources: SEWRPC, Waukesha County, US Census Bureau

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Future Land Use Map Categories

Each of the future land use categories shown on the Future Land Use Map is described below. Each land use category description summarizes where that type of land uses should be promoted, the appropriate zoning district(s) to implement that category, policies related to future development in areas designated by that category, and overall approaches for achieving the Village's overall vision for the future.

The Village's Planned Unit Development (PUD) zoning districts are intended to accommodate the relaxation of certain development standards of the underlying zoning district. In exchange for this flexibility, the Village holds development within a PUD to a higher standard of development that reflects policies established the Village's Comprehensive Plan and other adopted plans and policies. A PUD may be appropriate for many of the future land use categories described above.

Single-Family Residential: Sewered single-family residential on lots ranging from 6,000 to 19,999 square feet. Recommended Village zoning districts include ROP Residential, R-1, R-2, R-3, NR-1, NR-2, and NR-3.

The Village should consider amending the Zoning Ordinance to create one or more zoning districts, including NR-4, that enable smaller lot single-family development (6,000 to 15,000 square feet per lot) as permitted by right.

Two Family Residential: Two family residential development, including duplexes and zero-lot-line duplexes. Recommended Village zoning districts include RD and NRD.

Multi-Family Residential: Residential development, including apartment buildings with densities averaging 8 dwelling units per acre or higher. Development in this category should include top quality building materials and design, generous landscaping, functional outdoor space, and other resident amenities. The recommended Village zoning district is RM.

The Village should consider amending the Zoning Ordinance to establish design standards for multi-family development that address site layout, exterior building materials, façade articulation, lighting, landscaping, open space, and screening of equipment.

Planned Neighborhood: A carefully planned mixture of predominantly Single-Family Residential development, which may be combined with one or more of the following future land use categories: Two Family Residential, Multi-Family Residential, Governmental/ Institutional, and Recreational. Overall, the density of residential uses shall be a minimum of three dwelling units per acre. The suggested balance of residential development consists of at least 64 percent single-family units (minimum), up to 36 percent two family units (maximum), and up to 20 percent multi-family units (maximum). See pages 9-10 for more information about the target residential balance. Recommended zoning districts include ROP Residential, R-1, R-2, R-3, NR-3, NR-4, RD, NRD, RM, I (Institutional and Public Service), and B-1.

The Village should consider amending the Zoning Ordinance to establish a minimum density of three dwelling units per acre for Planned Neighborhood development.

Commercial: Land devoted to high quality indoor retail, commercial, office, and/or service activities. This category also includes related off-street parking. Recommended Village zoning districts include B-1, B-2, OS, and ROP Business.

Industrial: High quality indoor manufacturing, wholesaling, assembly, and storage uses, including contractor storage yards, with associated office and off-street parking. Development in this category should include adequate landscaping and limited signage. Recommended Village zoning districts include LI and BP.

Extractive: Areas devoted primarily to the extraction of sand, gravel and stone, and related activities. Future land use designation following the cessation of extraction activity will be determined in a future Comprehensive Plan amendment process. The recommended zoning district is Q.

Governmental/Institutional: Areas for government, public, or private institutional buildings, facilities and grounds such as schools, churches, libraries, hospitals, health and special-care facilities, cultural facilities, nonprofit organizations, and police and fire stations. Small institutional uses may be permitted in other land use categories. The recommended zoning district is I (Institutional and Public Service).

Utilities: Areas for essential utility and communication facilities. The recommended zoning district is I (Institutional and Public Service).

Agricultural: Agricultural uses, farmsteads, open lands and single-family residential development with densities at 1 dwelling per 20 or more acres. This category is not mapped or planned within the Village of Lannon municipal limits.

Recreational: Park and open space facilities devoted to both active and passive recreation, such as playgrounds, golf courses, athletic fields, trails, picnic areas, natural areas, and related recreational activities. The recommended Village zoning district is P-1, although FP, C-1, and C-2 may be applicable in some cases.

Environmental Corridor (Overlay Category): Systems of open space that include environmentally sensitive lands and natural resources requiring protection from disturbance and development, and lands needed for open space and recreational use, based mainly on drainageways, stream channels, floodplains, wetlands, and other resource lands and features. As an overlay category, there is no applicable zoning district, although it is commonly associated with FP, C-1, and C-2 zoning.

Conservation/Open Land: Lands adjacent to, but outside, identified environmental corridors and isolated natural resource areas, including lands within the 100-year recurrence interval floodplain, open lands within existing County or State park and open space sites, and lands covered by soils with a high water table, poorly drained soils, or organic soils. The recommended Village zoning district is C-2.

Planned Neighborhood and Residential Density and Balance

A Planned Neighborhood is a carefully planned mixture of predominantly residential development with a focus on a minimum density of three dwelling units per acre in order to provide a tax base that supports the infrastructure necessary to serve these developments. The residential use can be comprised of one or more of the following land use categories: single-family residential, two family residential, multi-family residential, institutional, neighborhood-serving commercial, and park and open space facilities. This approach results in a mix of residential dwelling units and density types and provides opportunities for a wide variety of different housing products. It allows for carefully planned multi-family development while preventing large complexes.

Suggested Residential Balance in Planned Neighborhoods:

Minimum 64% Single-Family
Maximum 36% Two Family
Maximum 20% Multi-Family

The Village's residential growth areas are shown on the Future Land Use Map as the "Planned Neighborhood" category. This approach gives the Village control of the timing and quantity of multi-family development, as the exact land use pattern would be determined as projects are proposed and rezoned. The Village's suggested residential balance would be applied to the Village's residential growth area overall, i.e., the undeveloped land within the Village's municipal limits. The new growth area would be zoned to achieve the suggested balance overall so that individual projects can implement the residential zoning most advantageous for the specific environmental and site conditions, i.e. depth of bedrock, so long as each project satisfies the minimum density. The Village's suggested residential balance for the growth area is 64 percent single-family units, no more than 36 percent two family units, and no more than 20 percent multi-family units. (The percentage of single-family is minimum, while the percentages of two family and multi-family are maximums.) See Figure 1. The suggested residential balance only applies to areas shown for Planned Neighborhood on the Future Land Use Map.

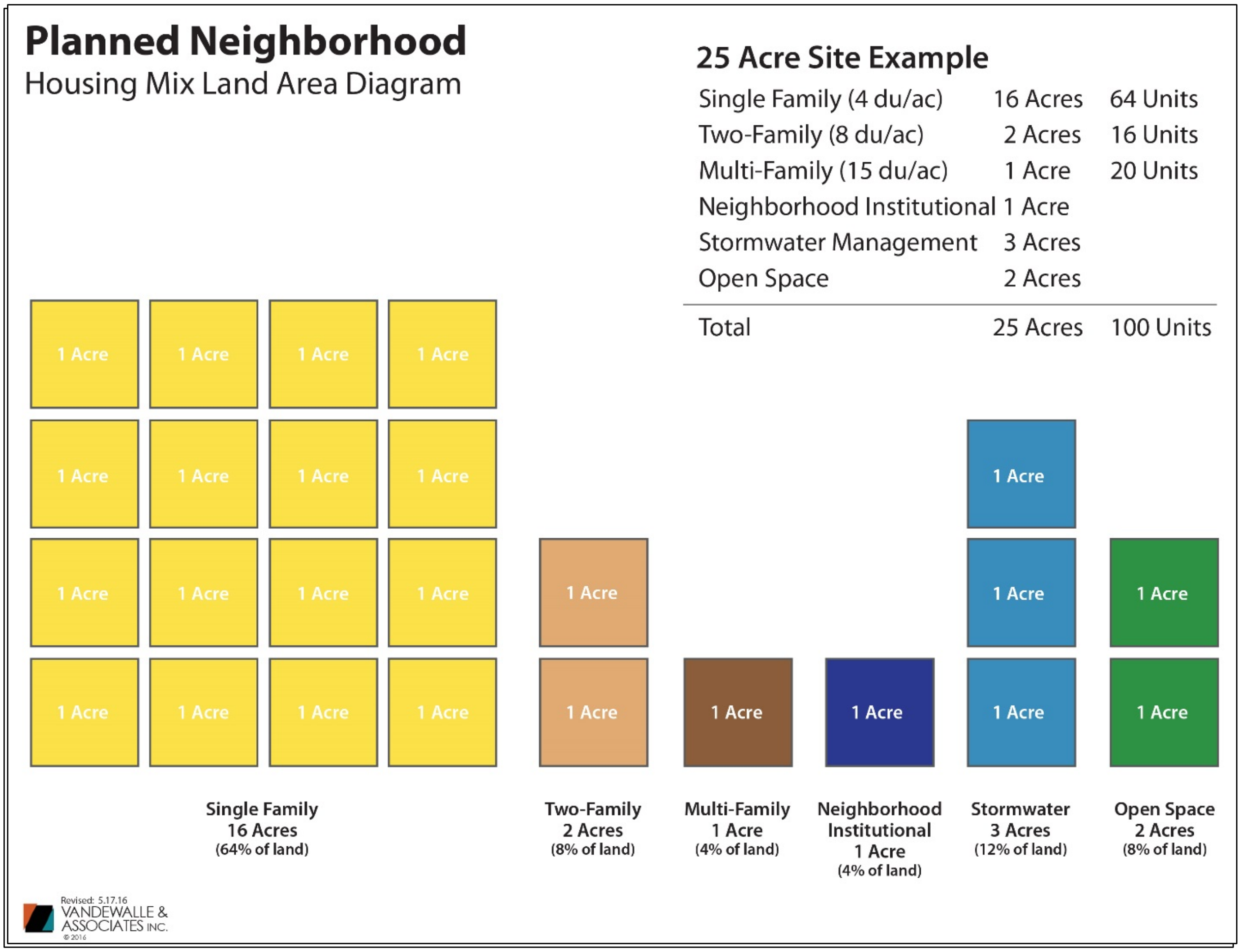
Typically, Planned Neighborhoods compel a multi-family developer to partner with a single-family developer in order to enable the multi-family units he or she would like to build. The suggested residential balance also tends to increase the overall caliber of multi-family development, as single-family developers will insist on quality development constructed with attractive and long-lasting materials to ensure that the nearby single-family lots are marketable.

By mapping residential growth areas as "Planned Neighborhood," a variety of housing types are allowed. This approach has the advantage of distributing the potential profits associated with multi-family development among all of the landowners in the Planned Neighborhood area.

Senior Housing Developments

Within Planned Neighborhoods, multi-family development restricted to residents 55 or over will be exempt from the suggested residential balance. As the baby boomer population ages, the Village will need more housing options for individuals who are looking to downsize from their single-family homes but who wish to continue living in Lannon.

Figure 1: Example Residential Balance within a Planned Neighborhood, by Land Area



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