REPORT

Water Infrastructure Master Plan

City of Bloomington, IL

November 2019

CDM Smith

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Section 1

Introduction

1.1 Introduction

The City of Bloomington retained CDM Smith to develop a Water Infrastructure Master Plan to assist with strategic and capital planning. The goals of the Water Infrastructure Master Plan were to develop a 20-year capital improvement program to:

- Meet water demands.
- Improve the resiliency of existing infrastructure.
- Ensure compliance with current and potential future regulations.
- Better understand the needs and priorities of the entire water system.
- Provide cost estimates for the recommended improvements to guide the City's capital planning efforts.

To accomplish these goals, CDM Smith prepared a water demand forecast; conducted a condition assessment of the existing water treatment plant, pump stations, and storage facilities; evaluated water quality and treatment practices at the water treatment plant; conducted a condition assessment of the water distribution system; and, performed a benchmarking study of staffing within the Public Works Water Division.

1.2 Report Organization

The Water Infrastructure Master Plan consists of the individual technical memoranda prepared over the course of the project. The project is organized into the following sections:

Section 2 – Executive Summary provides a high-level summary of the conclusions from the water demand study, the facility and distribution system condition assessments, water quality and regulatory analysis, and the benchmarking study.

Section 3 – Water Supply and Demand provides a forecast of future water demands based upon historical and projected population and land use trends.

Section 4 – Water Quality and Regulatory Review provides a summary of the existing raw and treated water quality, current and potential future water quality regulations, and recommended improvements to improve treated water quality.

Section 5 – Water Treatment Plant, Storage and Pump Station Assessment provides an assessment of the existing facilities, including the water treatment plant, storage facilities, and pump stations with recommended improvements.

Section 6 – Water Treatment Plant Hydraulic Capacity Analysis provides an assessment of the hydraulic conditions at the water treatment plant.

Section 7 – Distribution System Evaluation and Assessment provides an assessment of the existing distribution system and recommends potential infrastructure improvements.

Section 8 – Benchmarking of Water Division Staffing discusses the benchmarking study performed to evaluate staffing levels throughout the department, including water treatment operations, distribution system staff, and maintenance staff.

Section 9 – Water Infrastructure Master Plan Project Summary provides a summary of the recommended improvements across the entire Public Works Water Division.

Section 2

Executive Summary

2.1 What is the City's Infrastructure?

"The City of Bloomington's water system provides safe and reliable drinking water for Bloomington and approximately 50 percent of the population of the County outside of Bloomington."

The City of Bloomington (City) Water Treatment Plan (WTP) was originally constructed in 1929. Filter building expansions occurred in 1952 and 1964. In 1986, the Bloomington WTP underwent a major expansion/upgrade, including the addition of what is now called the Main Process Building. Additional treatment basins and a treatment basin building were added in 1999.

The City commissioned CDM Smith to complete a Water Infrastructure Master Plan, which includes an assessment of the existing WTP, pump stations, and storage facilities to identify problems arising from the aging infrastructure and equipment. The Water Infrastructure Master Plan also included an evaluation of water demands.

The water demand forecast indicates a maximum day demand of approximately 21 million gallons per day (MGD) in 2040, assuming population growth based on economic development and a maximum day ratio of 1.7. The existing plant has a rated capacity of 24 MGD; however, it is projected that the WTP would have difficulty meeting this rated capacity without significant upgrades and modifications, due primarily to hydraulic bottlenecks within the WTP. Hydraulic calculations suggest that the current maximum plant capacity is approximately 17.5 MGD. Therefore, while the existing water treatment facilities have sufficient capacity to meet current demands, improvements to the WTP will be necessary in order to meet the expected demands in 2025 and beyond.

In addition, safe yield analysis for the existing lakes previously completed by the City identified the need for additional water supply through groundwater sources to complement the existing lakes. Groundwater blended with surface water would also provide a measure to lower effluent nitrate levels.

A summary of the primary problems identified by this study are listed below.

Water Supply

- Safe yield analysis for existing lakes shows the need for additional supply through groundwater sources (wells).

Water Quality

- Rising nitrate levels in the surface water sources.
- Taste and odor complaints.
- Areas in the distribution system that need additional water quality monitoring.

Water Treatment Plant and Pump Stations

- Aging infrastructure or infrastructure that does not meet current standards.
- Equipment approaching end of service life.
- Hydraulic bottlenecks that limit capacity.
- Improvements at Division Street and Enterprise pump stations.

Distribution System

- Pipes with a high risk of failure.
- Areas in the system where fire flow demand cannot be maintained.
- Areas of low pressure concern for the 2040 forecasted demand.

This Water Infrastructure Master Plan identifies components of the City's water infrastructure, both at the WTP and within the distribution system, that will require investment in the next 20 years.

In addition, the Master Plan reviewed current staffing levels across all areas of the Public Works Water Division (Section 8) and identified the need for additional staff to implement the recommendations of the Master Plan.

2.2 Goals and Suggested Improvements

The goals of the Water Infrastructure Master Plan were to develop a 20-year capital improvement program to:

- Meet water demands.
- Improve the resiliency of existing infrastructure.
- Ensure compliance with current and potential future regulations.
- Better understand the needs and priorities of the entire water system.
- Provide cost estimates for the recommended improvements to be used in a future rate study.

This Water Infrastructure Master Plan recommends a program of capital improvements for the next 20 years for the entire City of Bloomington water system to allow the City to maintain its existing infrastructure and equipment, as well as plan for the future, and outlines the need for the following improvements:

Water Quality and Regulatory Improvements

- Investigate additional groundwater supplies to allow blending for nitrate compliance and study the implications of blending throughout the WTP and distribution system.

- Add a powdered activated carbon (PAC) facility at the WTP to address taste and odor complaints.
- Completion of a Risk and Resiliency Assessment as required by the Community Water System Risk and Resilience Act.

Facilities Improvements

- Improvements to ventilation and the heating, ventilation, and air conditioning (HVAC) system.
- Upgrade aging infrastructure at the Old Plant Building and raw water pump station.
- Recarbonation bypass piping to alleviate hydraulic bottlenecks.
- Replace and combine Division Street and Enterprise pump stations.
- Increase security at remote facilities.
- Add back-up power at all pumping stations.

Water Distribution System Improvements

- Replace or rehabilitate extreme, high- and medium-risk water mains.
- Make improvements to meet fire flow needs in all parts of the distribution system.
- Add additional water quality monitoring stations.

Staffing Improvements

- Additional staff needed to implement the recommendations of the Master Plan.

2.3 Total Program Cost

The estimated cost of improvements, over a 20-year period, is approximately $147 million.

Table 2-1. Summary of Recommended 20-Year Capital Improvement Costs

Project Description	Estimated Cost
Water Quality and Regulatory Improvements	$11,000,000
Facilities Improvements	$79,000,000
Water Distribution System Improvements	$52,750,000
Additional Staff to Implement 20-year Capital Program (Approximate)	$9,000,000
Total (Rounded)	**$152,000,000**

The largest cost component is the Facilities Improvements, which includes a $59 million upgrade to the Old Plant Building. This project would involve demolition of existing infrastructure, a new raw water pump station, recarbonation bypass piping, ammonia upgrades, and construction of a new filtration building. These upgrades will alleviate existing hydraulic bottlenecks, allowing the plant to operate at a capacity to meet future demand. Additionally, the continued repair and rehabilitation of the existing, aging infrastructure and equipment may outweigh the cost-benefit ratio of a new filter addition. The projects included in this upgrade are described further in **Section 5**.

2.4 Addressing Existing System Deficiencies

To identify the existing problems and accomplish the goals of the Water Infrastructure Master Plan, CDM Smith prepared a water demand forecast; conducted a condition assessment of the existing WTP, pump stations, and storage facilities; evaluated water quality and treatment practices at the WTP; conducted a condition assessment of the water distribution system; and, performed a benchmarking study of staffing within the water division.

Figure 2-1 shows the results of the distribution system risk assessment. Pipes with rating of 4 and 5 (highlighted in red and magenta) are at high and extreme risk of failure and should be prioritized for replacement or rehabilitation. A more detailed explanation of the process for determining the risk scores is described in **Section 7**.

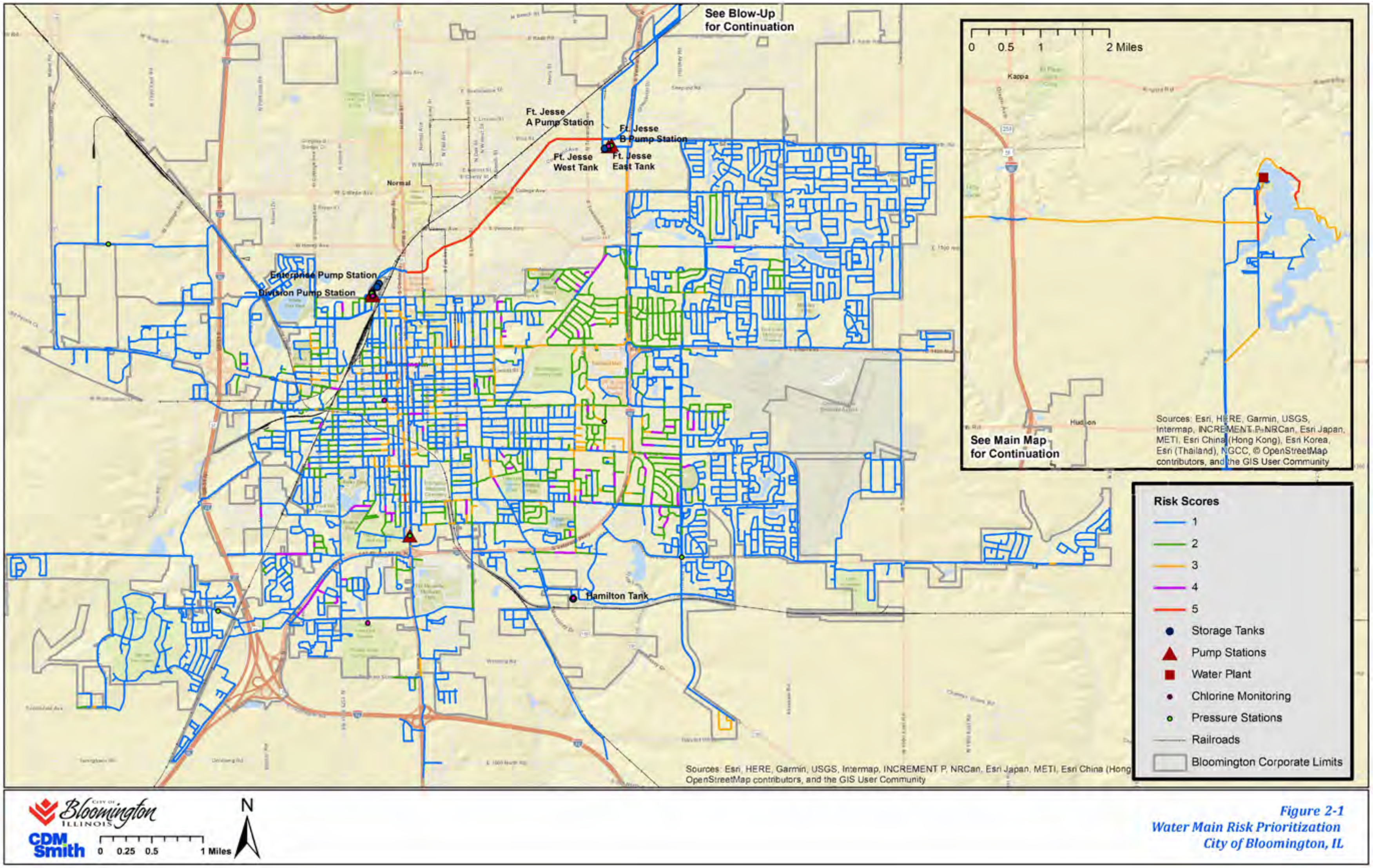

Figure 2-1. Water Main Risk Prioritization

2.5 Regulatory Considerations

2.5.1 United States Environmental Protection Agency

Drinking water is federally regulated by the United States Environmental Protection Agency (EPA) under the authority of the Safe Drinking Water Act (SDWA). The SDWA was established by Congress in 1974 to protect human health by regulating the nation's public drinking water supply. The SDWA was extensively amended in 1986 and in 1996 and its regulations have been adopted by the Illinois Environmental Protection Agency (IEPA) which has been given primacy by the EPA for enforcing these regulations in Illinois.

The EPA has enacted several regulations since the 1996 SDWA amendments. The regulations that are particularly relevant to the City of Bloomington include the NPDWR Phase II Rule, Interim Enhanced Surface Water Treatment Rule (IESWTR), Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules (D/ DBPR), revisions to the Lead and Copper Rule (LCR), Fluoride Rule, and Filter Backwash Recycling Rule (FBRR). These regulations require that water systems meet MCLs and/or use certain treatment techniques to protect against adverse health effects regarding turbidity, primary and secondary disinfection, disinfection by-products (DBPs), corrosion by-products, fluoride, and nitrate.

These water quality regulations have been in place for many years and are likely to remain in effect in the near future. These regulations are described further in **Section 4**. The Water Division is currently in compliance with current drinking water regulations.

2.5.2 America's Water Infrastructure Act of 2018

The America's Water Infrastructure Act of 2018, also called the Community Water System Risk and Resilience Act (CWSRRA), was recently passed. The CWSRRA requires water system serving at least 3,300 people to conduct a risk and resilience assessment of their system to malevolent acts and natural hazards and create or revise an Emergency Response Plan (ERP) addressing the findings of the assessment. The assessment should cover:

- Risks to the system from malicious acts and natural hazards.
- Resilience of pipes, conveyance infrastructure, source water quality and intake, treatment processes, storage and distribution facilities, and computer or other automated systems used by the utility.
- Monitoring practices.
- Stabilization of account management, including invoicing and payroll.
- Use, storage, and handling of various chemicals by the system.
- Operation and maintenance of the system.

An ERP must be created or revised following the assessment to address its findings. Finally, a certification verifying completion of the assessment and ERP must be sent to the EPA by December 31, 2020 for utilities serving between 50,000 and 100,000 people. The assessment, ERP, and certification should be renewed every five years.

Section 3

Water Supply and Demand

3.1 Introduction

The City of Bloomington Water Infrastructure Master Plan calls for the development of a water demand forecast for the Public Works Water Division service area to the year 2040. This Section describes the data sources and forecast methodology used in developing the forecast. This included analyzing historical water use, identification of applicable population projections, and development of a water demand forecast.

Two workshops were conducted in June and September 2017. The first workshop presented an overview of water demand forecasting methodologies and a discussion of available data. The second workshop presented the profile of historical and current water use, available population projections, and the water demand forecast.

3.2 Profiles of Current Water Use

3.2.1 Total Water Production

Total monthly water pumpage (production) data was available from January 1980 to May 2017 for full calendar years. This information included the monthly average pumpage in million gallons per day (MGD) and the monthly maximum pumpage in MGD. The monthly average pumpage is shown in **Figure 3-1**.

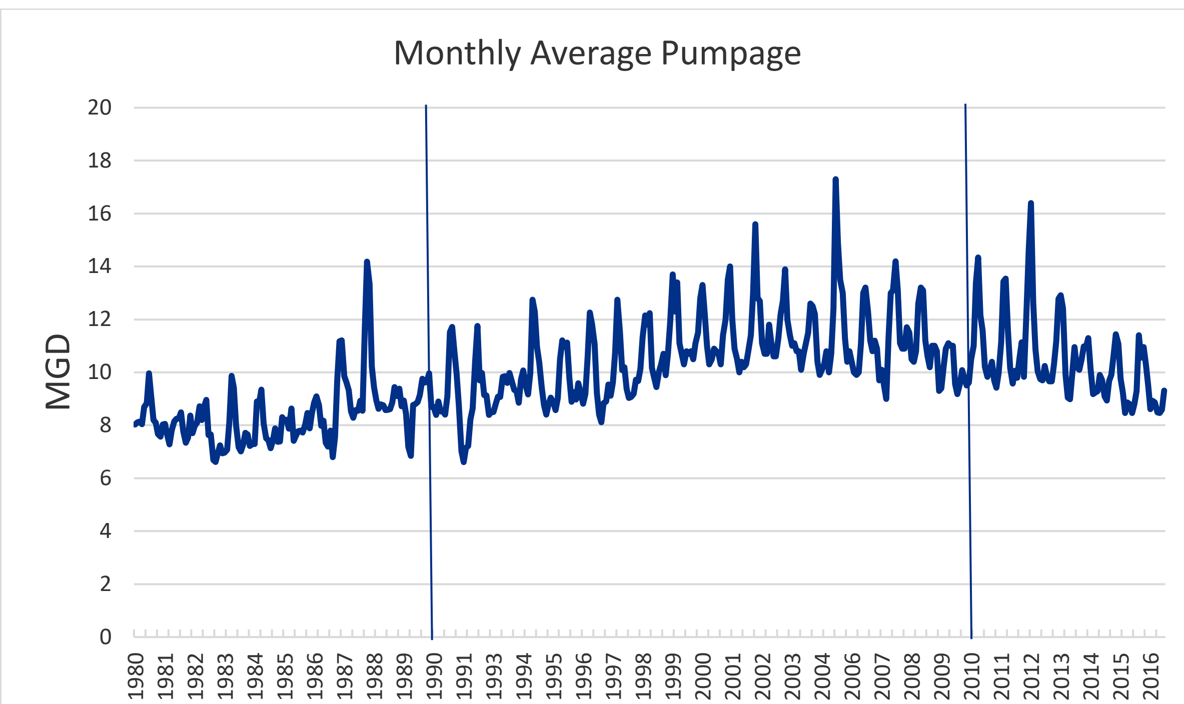

Figure 3-1. Historical Monthly Total MGD

The annual seasonal variation between winter and summer pumpage is clearly visible in the graph. The bottom or trough point of each year indicates the trend in non-seasonal water demand. This trend increases throughout the 1980s and again in a period from approximately 1996 to 2003. This upward trend in non-seasonal demand is generally associated with growth within the service area. This non-seasonal trend appears to change to a downward trend in about 2003 and continue downward with some variation through 2016. Significant events during this time period include:

1. More efficient indoor water fixtures.
2. Changing attitudes regarding water conservation.
3. Drought restrictions imposed during the summer of 2005 with some possible residual effect.
4. The economic recession between 2008 and 2009 with some lasting impact.
5. A city-wide meter replacement program that began in 2004.
6. The discovery and repair of a major leak in the system.
7. The reduction in water demand from the closing of the paint shop at the Mitsubishi plant and the eventual closing of the entire plant.

The summer peak in monthly average pumpage is strongly influenced by summer weather conditions in the service area. In general, the summer peak month average pumpage is approximately 1.2 times the annual average. Note that the annual average is calculated as a 12-month running average of the prior 12 months. In cooler and wetter summers, this summer-to-annual ratio is lower and in hotter and drier summers this summer-to-annual ratio is higher. In July 2005, the monthly average pumpage was 1.49 times the 12-month average. A discussion of the monthly maximum day use is described later in this Section.

From 1980 to 2016, the population of the City of Bloomington has been increasing. Given the increasing population and the decrease in total water use in the last decade, the water use per capita (gallons per capita per day) has declined since about 2004. **Figure 3-2** illustrates the city-wide total per capital water use from 1980 to 2016. Per capital water use was around 170 gallons per capita per day (GPCD) until about 2004. By 2016, per capita water use had dropped to approximately 122 GPCD.

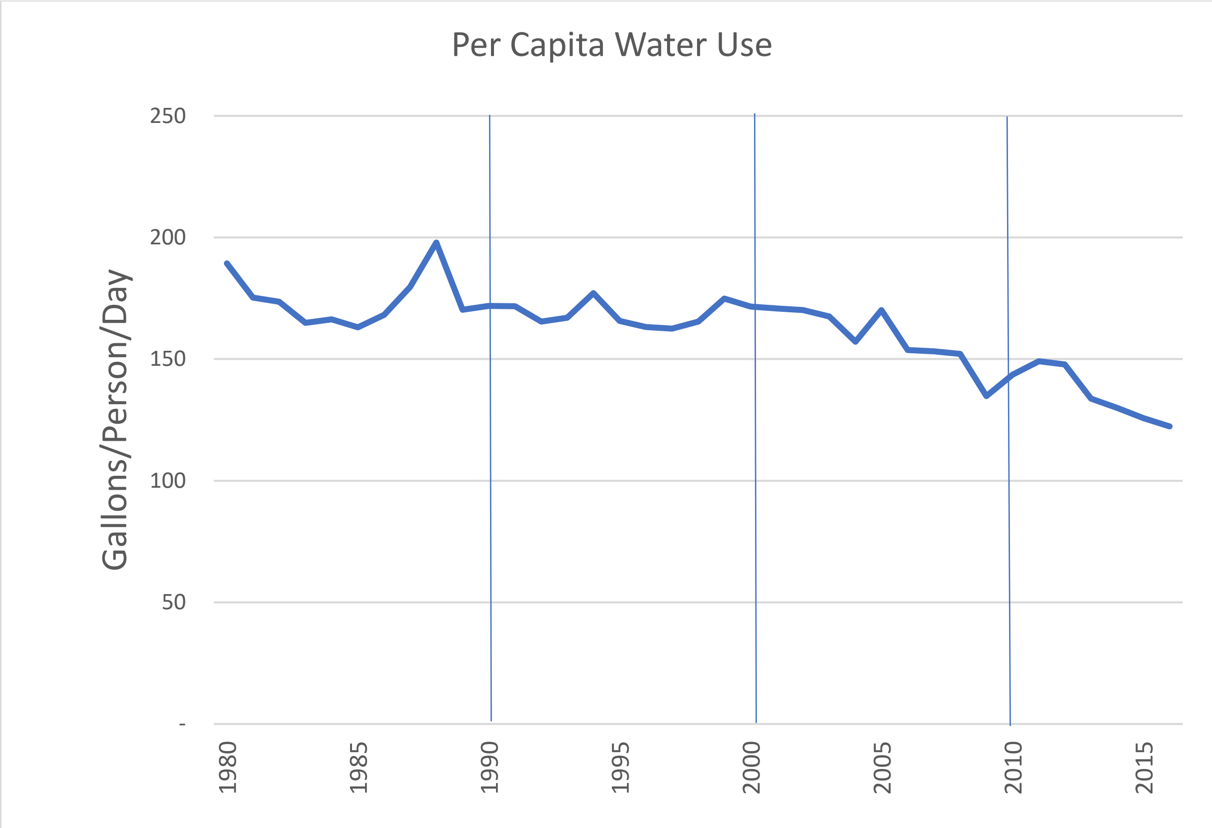

Figure 3-2. Historical Total Water Use Per Capita

3.2.2 Water Consumption

Monthly water sales information was obtained from January 2009 through May 2017 for full calendar years. This information included the number of billed accounts and billed consumption (in cubic feet) by customer code. The City of Bloomington classifies water customers by meter size. In addition, customers are classified as:

- Inside city limits.
- Outside city limits.
- Tax exempt.
- Wholesale.

The water volume billed each month was converted from cubic feet per month to gallons per day (GPD) for each customer code. The monthly billed volume was adjusted to represent the month of consumption rather than the month billed. In addition, the customer codes were grouped into six (6) major water customer sectors for planning purposes:

1. Residential (less than 1-inch) inside city limits.
2. Residential (less than 1-inch) outside city limits.

3. Commercial (tax exempt and 1-inch to 4-inch) inside city limits.
4. Commercial (1-inch to 6-inch) outside city limits.
5. Industrial.
6. Wholesale.

Table 3-1 shows the grouping of meter codes into these major sectors along with the average billed consumption, number of accounts, and consumption per account between 2009 and 2017. Non-Revenue Water (NRW) is included in this table as a water use sector to provide a full accounting of all water. NRW is defined and discussed later in this section.

Table 3-1. Sector Classification of Meter Accounts

Sector	Abbreviation	Definition	Average Number of Accounts (2009-2016)
Residential – Inside City	RES-in	Inside City, less than 1-inch meters	27,305
Residential – Outside City	RES-out	Outside City, less than 1-inch meters	487
Commercial – Inside City	COM-in	Inside City, exempt meters and 1-inch to 4-inch meters [1]	2,624
Commercial – Outside City	COM-out	Outside City, 1-inch to 6-inch meters	87
Industrial	IND	8-inch meters	1
Wholesale	WH	Bloomington Township Crestwicke Bloomington Township Village of Hudson Village of Towanda Inside City Limits, 6-inch meters [2]	29
Non-Revenue Water	NRW	Production minus billed consumption	

Notes:
[1] Some 4-inch meters serve industrial users
[2] Some 6-inch meters serve commercial users

The monthly water usage for the six (6) customer sectors is shown in **Figure 3-3** from January 2009 through May 2017. The residential inside city sector use and the commercial inside city sector use are the larger use sectors and both of these sectors show a distinct seasonal use pattern. The winter month volumes of residential inside city use is fairly consistent at approximately 3.5 MGD while the winter month volumes of the commercial inside city sector indicates a steady decline throughout the time period. Residential outside city, commercial outside city, and industrial use are minimal. Wholesale use is modest and relatively consistent.

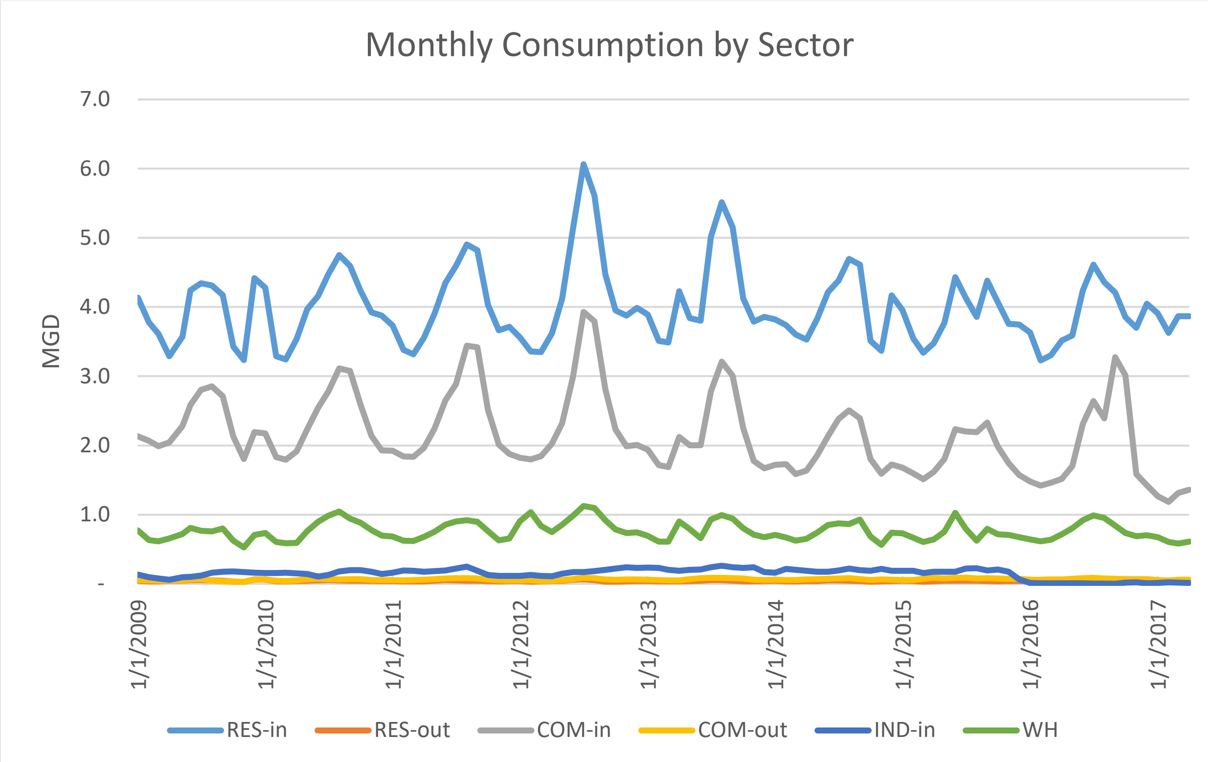

Figure 3-3. Monthly Consumption by Sector in MGD (2009-2017)

Among the residential accounts (less than 1-inch meters), the number of inside city accounts has increased from approximately 26,300 in 2009 to approximately 28,700 in 2017. The number of outside city accounts has increased slightly from approximately 490 in 2009 to approximately 500 in 2017. The average consumption in GPD per account for these two residential sectors is shown in **Figure 3-4**. The residential inside city water consumption averages approximately 147 GPD per account with a typical range between 120 and 185 GPD, although consumption exceeded 200 GPD in July and August 2012. Average consumption per account among the residential outside city accounts is a very modest 86 GPD per account in a range of 60 to 132 GPD.

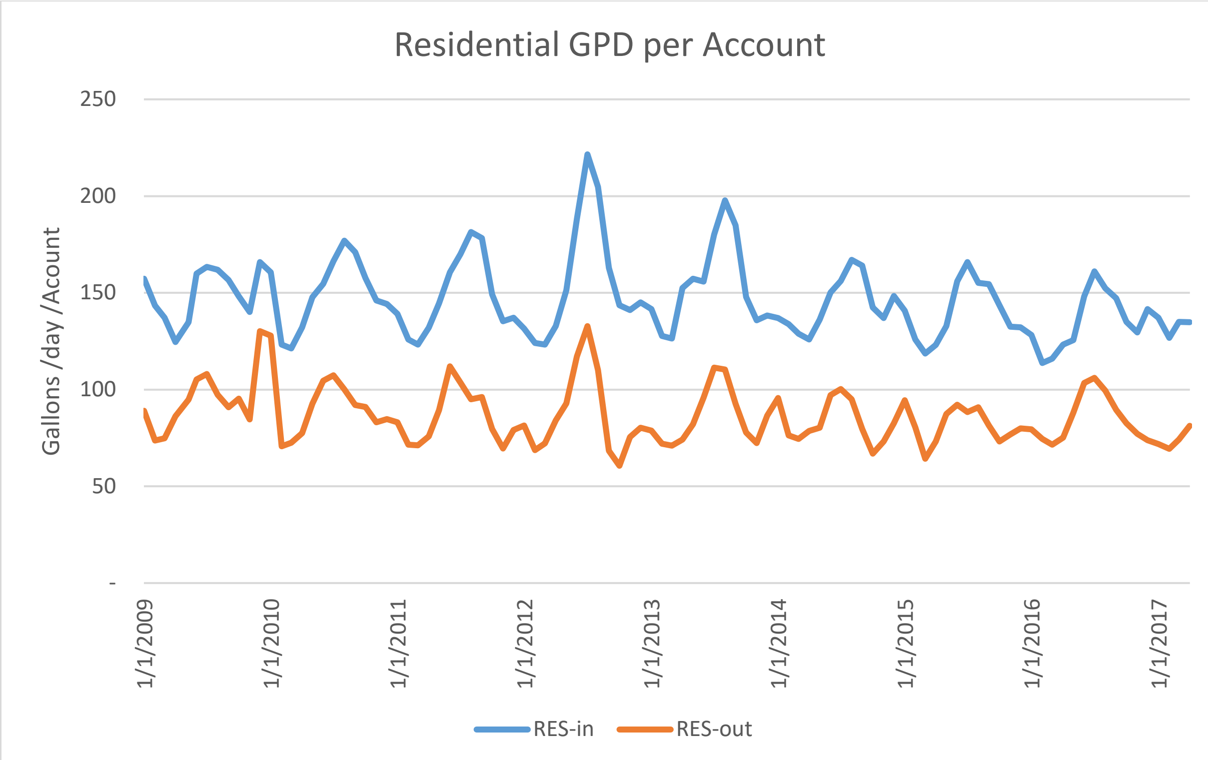

Figure 3-4. Monthly Residential Consumption per Account (2009-2017)

The lowest winter month consumption typically occurs in later winter after the holidays. The residential inside city accounts have a low month average consumption of approximately 123 GPD per account, which is a good indicator of average indoor water use. As a point of reference, two national studies of single-family indoor water use conducted in 1999 and 2014 showed an average indoor water use of 173 GPD and 138 GPD per household, respectively, in those years. Thus, average residential indoor water use in the City of Bloomington is more conservative than the national average.

Among the commercial sector accounts, the number of inside city accounts has increased from approximately 2,500 in 2009 to approximately 2,700 in 2017. The number of outside city accounts has increased slightly from approximately 80 in 2009 to approximately 86 in 2017. The average consumption in GPD per account for these two commercial sectors is shown in **Figure 3-5**. The commercial inside city water consumption averages approximately 821 GPD per account with a general downward trend from 2009 to 2017. Average consumption per account among the commercial outside city accounts is approximately 755 GPD per account with a slight upward trend over the same time period.

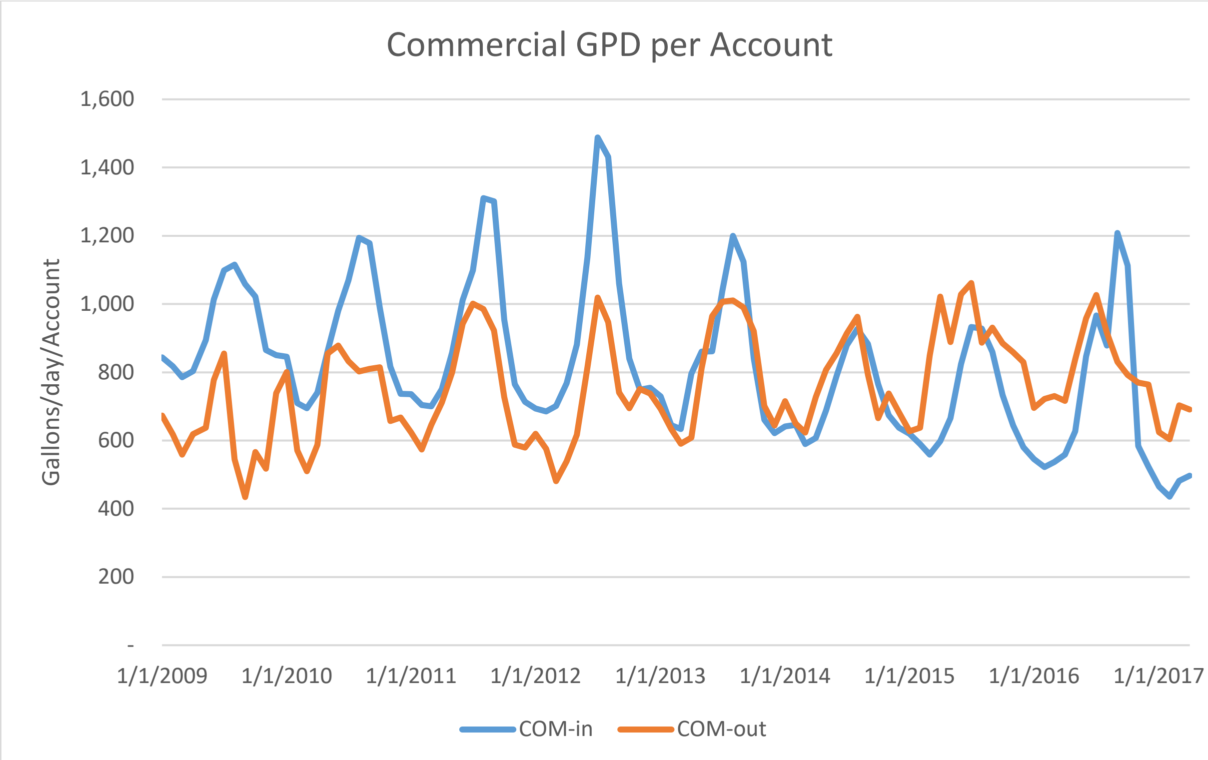

Figure 3-5. Monthly Commercial Consumption per account (2009-2017)

The meters classified as commercial inside city accounts include all tax-exempt meters (schools, parks, churches, swimming pools, libraries, etc.) and inside city meters from 1-inch to 4-inch in diameter.

3.2.3 Non-Revenue Water

The City of Bloomington bills water customers on a monthly basis. Therefore, the billed consumption in any given month is a partial representation of water that is actually consumed in that month and partially representative of consumption in the prior month. Therefore, the total water volume billed each month was adjusted to reflect the month of consumption by calculating an average of the given month and the month prior. This adjusted consumption was then aligned with the monthly pumpage data as shown in **Figure 3-6**.

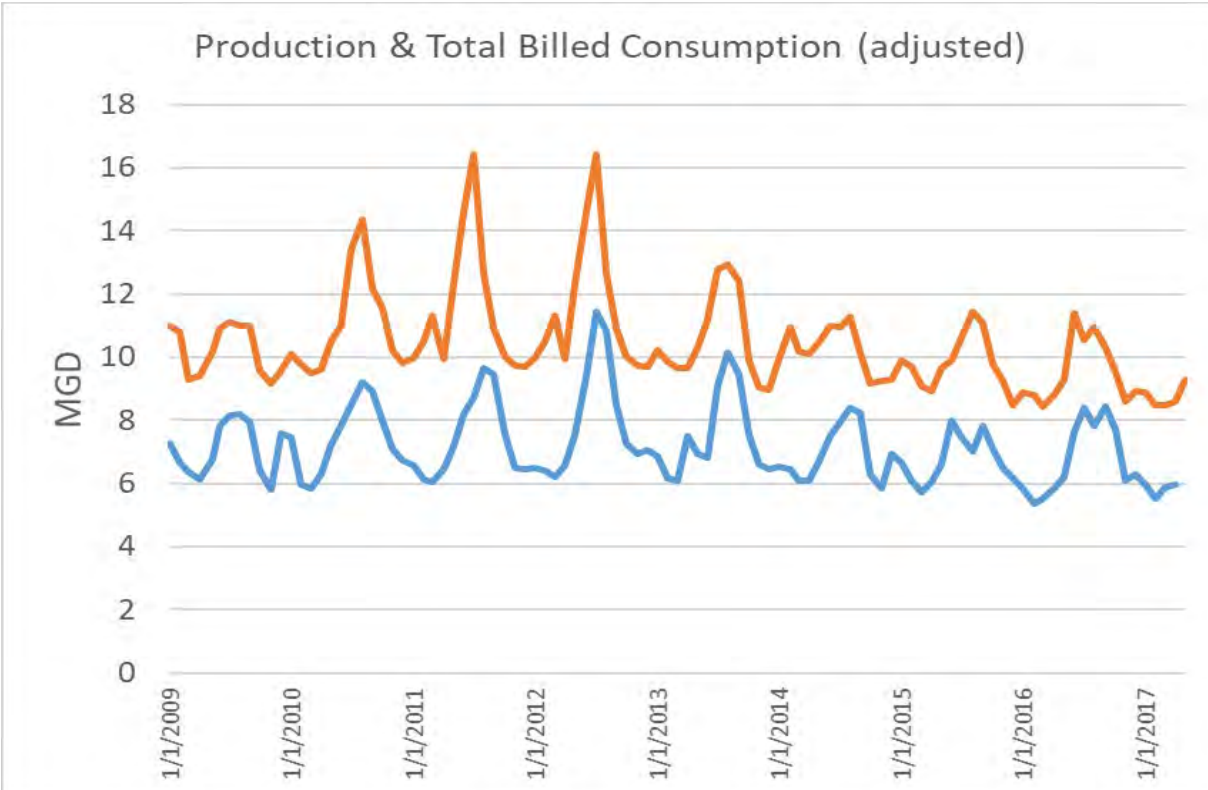

Figure 3-6. Total Production and Total Consumption (Adjusted) by Month (2009-2017)

On an annual basis between 2009 and 2017, the difference between consumption and production averages approximately 32 percent of production as shown in **Figure 3-7** where the NRW is broken out among unbilled usage (9 percent), line breaks and line flushing (4 percent), and losses due to system leakage (19 percent). These percentages of system water losses were estimated by the City of Bloomington Public Works Water Division, as summarized in **Table 3-2**. Note that any pressurized system, such as the City's water distribution system, will experience leakage. Thus, some portion of the system leakage is referred to as 'unavoidable real loss,' which is loss that may be expected of a system of a given size, number of connections, operating pressure, and other factors. Without proper maintenance, the water losses of a pressurized system will increase over time. The water loss control program of the City Public Works Water Division has actually reduced system losses over time through meter testing and replacement, leak detection, line replacement, and other operations.

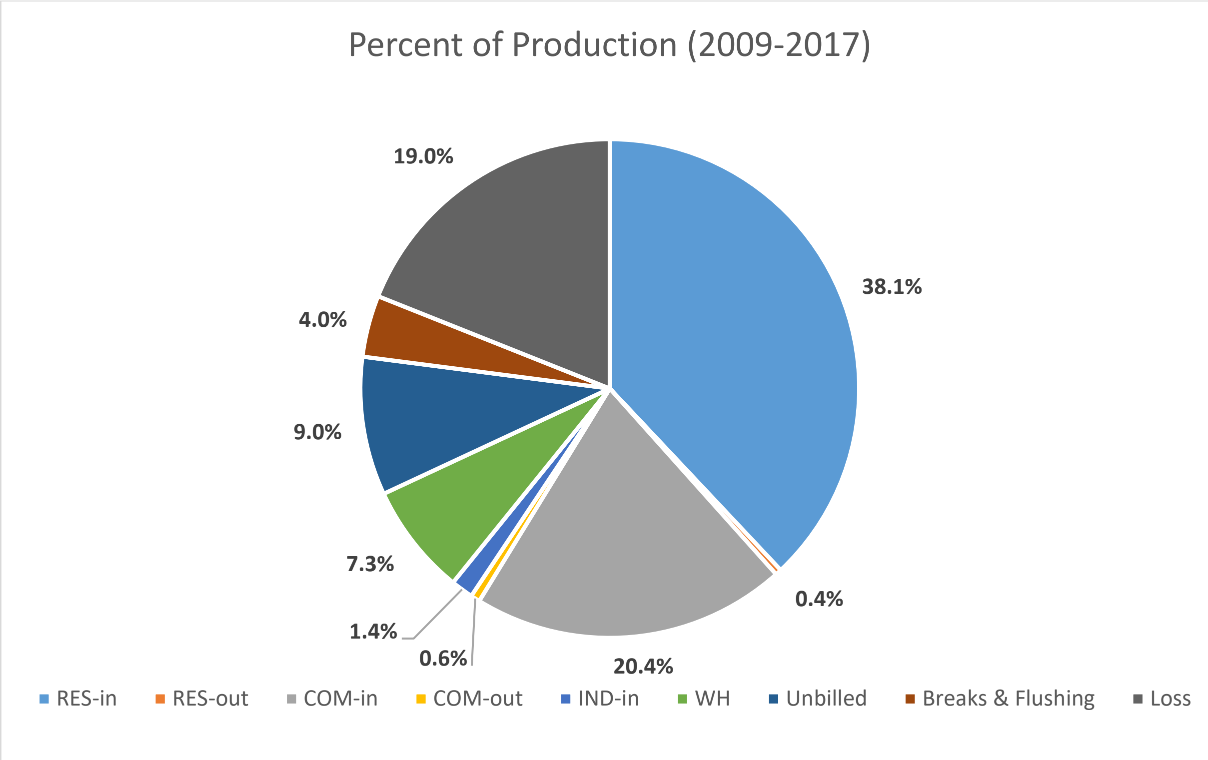

Figure 3-7. Average Percent of Production by Sector and Non-Revenue Water (2009-2017)

Table 3-2. Estimated Water Losses

Water Loss	% of Total Production
Distribution System Leakage	17%
Hydrant Leakage	2%
Breaks	2%
Flushing	1%
Water Quality Flushing	2%
Meter Inaccuracy	6%
Unauthorized Use	3%

3.2.4 Maximum Day Water Use

Monthly water production records at the treatment plant record the monthly average volume (average MGD from the daily average pumpage) and the monthly maximum day volume (highest of all daily maximum pumpage). The data presented in **Figure 3-1** and **Figure 3-6** are the monthly average volumes. **Figure 3-8** shows a comparison of the monthly average day use and the monthly maximum use from 1980 to 2016. The highest maximum day pumpage occurred in June 2005 at 21.6 MGD.

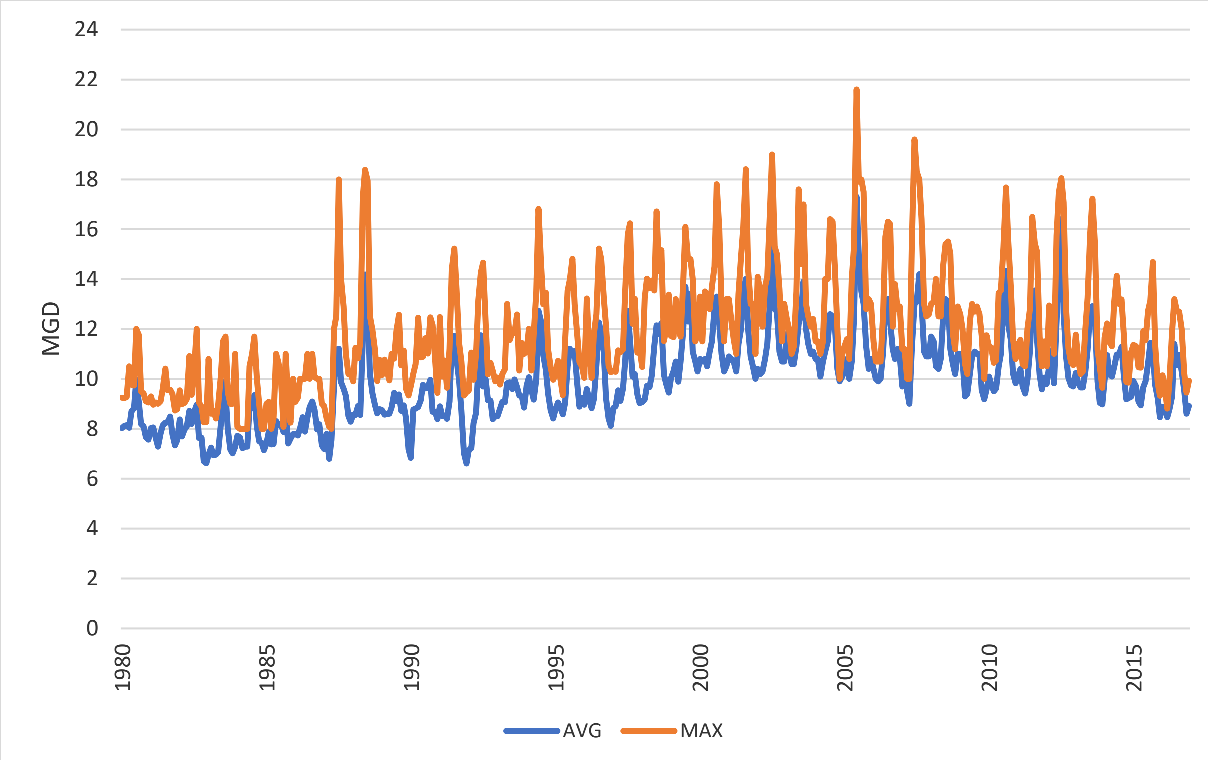

Figure 3-8. Historic Monthly Average and Maximum Day Use (1980-2016)

Table 3-3 lists the calendar year average annual use for the year in MGD from 1980 to 2016 along with the maximum day use recorded in each year. From these two values, a ratio of the maximum day to annual average day use is calculated for each year. Those years in which the maximum day ratio exceeds 1.7 are highlighted. The highest maximum day ratio occurred in 1987 at 2.0 and the second highest occurred in 1988 at 1.8. Since 1990, the maximum day ratio has not exceeded 1.8, although the maximum day use set a record in 2005.

Table 3-3. Historic Annual Maximum Day Use (1980-2016)

Year	Calendar Year AVG	Max Day	Annual Max Ratio	Year	Calendar Year AVG	Max Day	Annual Max Ratio
1980	8.4	12.0	1.43	2001	11.4	18.4	1.61
1981	7.9	10.4	1.32	2002	11.6	19.0	1.63
1982	7.9	12.0	1.51	2003	11.6	17.6	1.51
1983	7.7	11.7	1.53	2004	11.1	16.4	1.48
1984	7.9	11.7	1.49	2005	12.1	21.6	1.78
1985	7.8	11.0	1.40	2006	11.2	16.3	1.46
1986	8.2	11.0	1.34	2007	11.3	19.6	1.73
1987	8.9	18.0	2.02	2008	11.4	15.5	1.36
1988	10.0	18.4	1.84	2009	10.3	13.0	1.27
1989	8.7	12.6	1.44	2010	11.0	17.7	1.61
1990	8.9	12.5	1.40	2011	10.8	16.5	1.53
1991	9.1	15.2	1.66	2012	11.5	18.1	1.57
1992	9.0	14.7	1.62	2013	10.6	17.2	1.63
1993	9.3	13.0	1.39	2014	10.2	14.1	1.38
1994	10.1	16.8	1.66	2015	9.8	14.7	1.50
1995	9.7	14.8	1.53	2016	9.5	13.2	1.38
1996	9.8	15.2	1.56	Maximum	12.1	21.6	2.02
1997	10.0	16.2	1.63	95th Percentile	11.6	19.1	1.79
1998	10.4	16.7	1.61	90th Percentile	11.4	18.4	1.69
1999	11.3	16.1	1.43	75th Percentile	11.2	17.6	1.62
2000	11.3	17.8	1.58	Average	9.9	15.3	1.54

3.2.5 Population Projections

Population projections to the year 2040 for the City of Bloomington were obtained from the McLean County Regional Planning Commission (MCRPC). These projections were previously developed for the City's Comprehensive Plan and are being used in the forthcoming Long-Range Plan.

A population projection to 2040 based upon the historic (1970 to 2010) growth rate, as applied to the 2010 Census, resulted in a 2040 projected population of 114,277. However, this projection over-estimated the 2015 population and was more influenced by the high population growth from 1980 to 2000 than by the more recent slower population growth associated with the Great Recession. Thus, the MCRPC deemed this historic trend scenario to be a high scenario.

The MCRPC contracted an economic study resulting in a 'slow-growth' population projection. This projection estimated a 2040 population of only 83,290, with a peak population of 83,885 occurring in 2035. The MCRPC deemed this pessimistic scenario to be a low scenario.

The MCRPC then developed an 'economic development' scenario starting with the 'slow-growth' population projection and gradually increasing the population growth rate over time to allow for economic growth and an increase in student housing over time. This scenario estimates a 2040 population of 104,877 and is deemed to be the preferred planning scenario. These three population planning scenarios are listed in **Table 3-4** and shown and **Figure 3-9**.

Table 3-4. Population Projections for the City of Bloomington

Scenario	2015	2020	2025	2030	2035	2040
Historic Growth Trend (High)	82,264	88,393	94,872	101,552	108,069	114,277
Economic Development	78,405	81,541	85,618	90,755	97,108	104,877
Slow Growth (Low)	78,405	80,386	82,113	83,424	83,885	83,290

Source: McLean County Regional Planning Commission. 2015

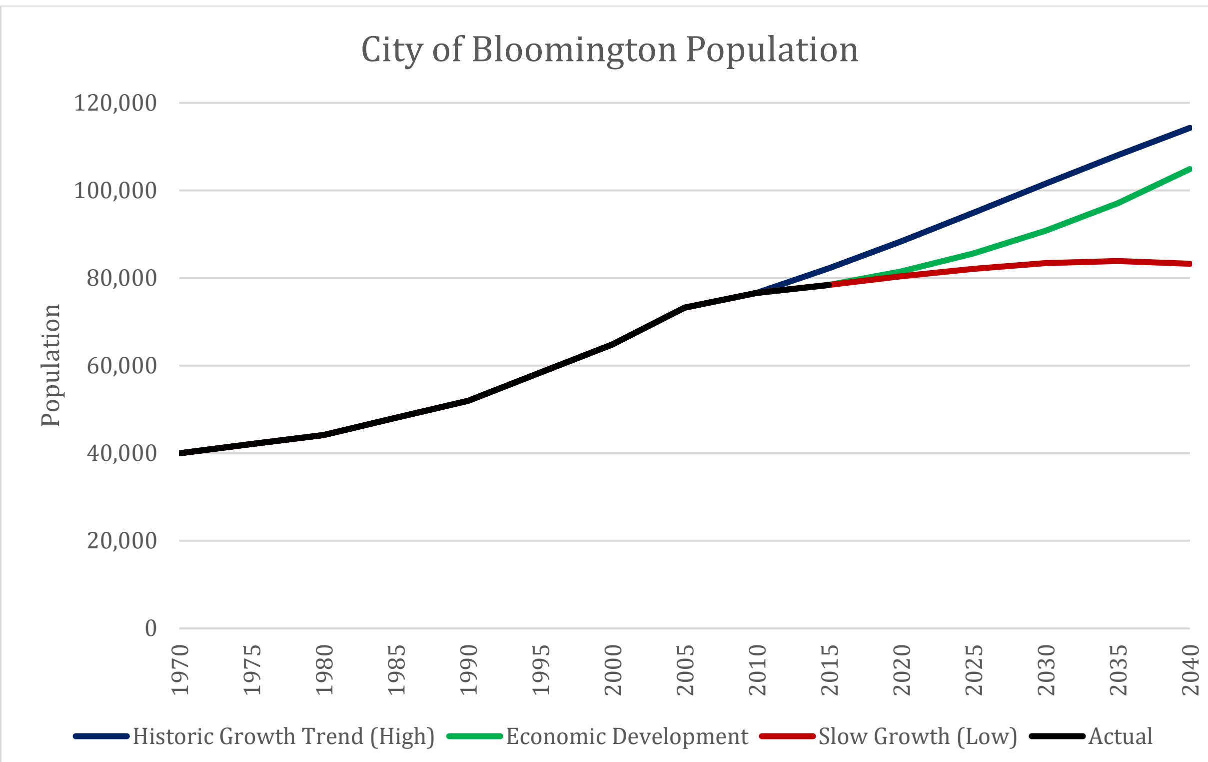

Figure 3-9. City of Bloomington Population Projections to 2040

Population projections were not available on a smaller geographic scale. However, land use data is available in GIS that shows the land use code (residential, commercial, institutional, industrial) for each parcel within the City of Bloomington. The Bloomington Public Works Water Division is in the process of geo-locating all customers by meter location and service address in GIS. An overlay of land use data with customer location may help refine the assignment of metered water use among customer sectors. This combination of spatial data will also pinpoint the outside city customers. Matching customer water use and population by census track provides information on the variation of per capita water use across the service area. Matching customer water use with land use codes provides information on the variation in water use by land use type. This information will be useful in future plan efforts.

As part of the Bloomington Comprehensive Plan, the MCRPC has a GIS layer that illustrates parcels within the city limits that have the potential for in-fill and redevelopment. When overlaid with the water service system, this information may be helpful in identifying areas of potential increased water use. In addition, the MCRPC has a GIS layer called "Emerging Areas" that indicates potential residential (R), non-residential (NR), and undefined "future" (F) development, as shown in **Figure 3-10**. The identified non-residential potential is generally concentrated on the east side both east and south of the airport. Areas identified as potential residential growth are east, south, and southwest of current development.

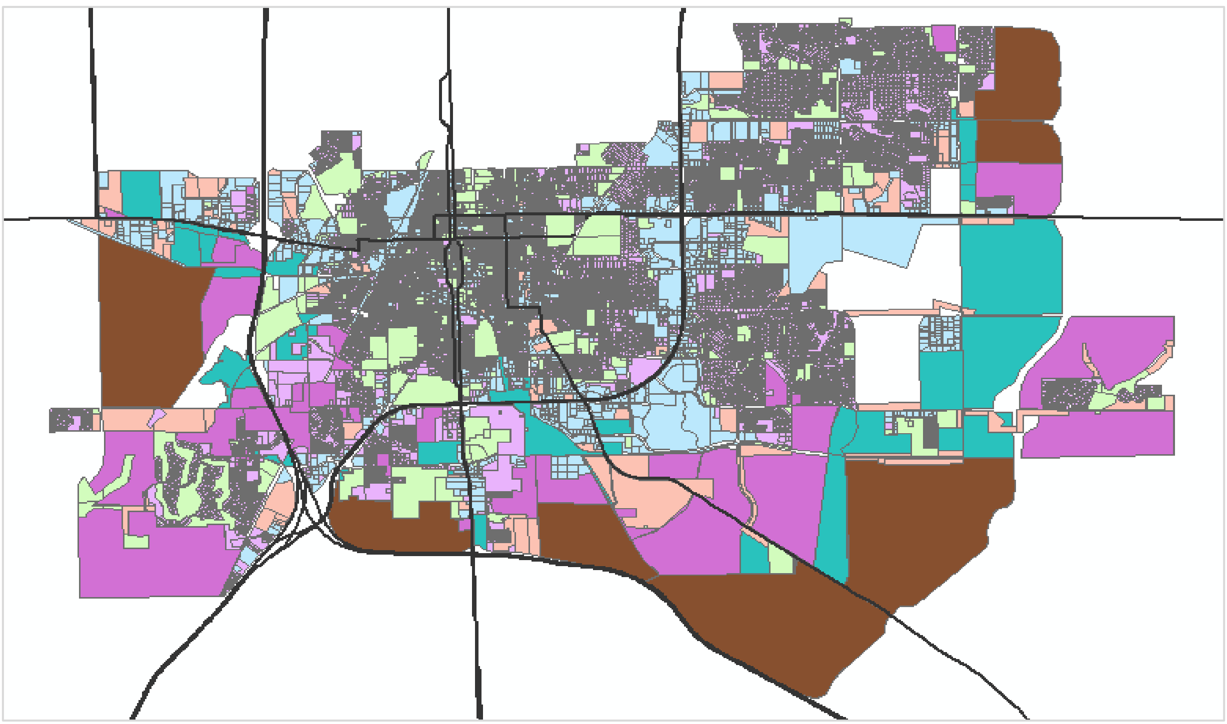

Figure 3-10. MCRPC Suggested Areas of Growth

3.3 Forecast Methodology and Assumptions

The forecast methodology is to apply the rate of projected population growth to the current water consumption for some of the customer sectors. Water use is assumed to increase proportional to population growth among the residential-inside city, commercial-inside city, industrial, and wholesale sectors. Water use among residential-outside city and commercial-outside city sectors is assumed to remain at current levels. With these assumptions, the water demand by sector is projected from current (2015) levels out to year 2040. Note that the forecast is formatted in an Excel spreadsheet in such a way that these assumptions or the projected population growth rate can be changed.

The spreadsheet model also includes an estimate of NRW. As discussed above, NRW is currently estimated at 32 percent of total water production. Given the sum of estimated water demand by sector in a future year and an assumed NRW percent of total production, the NRW volume in that future year can be estimated from the formula:

NRW volume = (sum of sector volumes) x (% NRW / (1 - % NRW))

Thus, the estimated NRW volume can be added to the sum of sector volumes to provide the estimated total water production in a given year.

For the initial water demand forecast, it is assumed that the current trend in gradually decreasing NRW will continue. That is, funding for meter replacement, line replacement, and break repairs will be sufficient to maintain and improve upon the current levels of loss.

Apparent losses can be reduced through stricter data management practices, enforcement, and a program of meter testing and replacement. The reduction of apparent loss leads to increased revenues at minimal cost to the utility as this water becomes properly metered and billed.

The reduction of real loss does not directly increase revenue (except that more water is available within the system, and operating costs may be reduced); however, there are real water savings. There is a point at which the cost of reducing real loss should not exceed the cost of the water saved. That is, it is economical to address real loss as long as the cost of reducing real loss is less than the cost of the treated water being lost.

For the expected or baseline water demand forecast scenario, it is assumed that the current level of 32 percent NRW will decrease to 24 percent NRW by 2040 as meters are tested and replaced and leaky sections of water mains are replaced over time.

3.4 Water Demand Forecast

The water demand forecast is based on the Economic Development population growth scenario and a gradual reduction of NRW as a percentage of total production. Alternative forecasts were also developed based on the High and Low population growth scenarios.

3.4.1 Annual Average Demand

The baseline water demand forecast of annual average water demand, given the assumptions described in the preceding section, are summarized in **Table 3.5**. The residential-inside city, commercial-inside city, industrial, and wholesale water demand increase by approximately 34 percent from 2017 to 2040. Total water demand increases approximately 21 percent from 10.4 MGD to approximately 12.6 MGD in 2040.

Table 3-5. City of Bloomington Water Demand Forecast (MGD)

Sector	Base Period ('09-'17)	2020	2025	2030	2035	2040
RES-in	4.00	4.16	4.36	4.63	4.95	5.35
RES-out	0.04	0.04	0.04	0.04	0.04	0.04
COM-in	2.15	2.23	2.35	2.49	2.66	2.87
COM-out	0.06	0.06	0.06	0.06	0.06	0.06
IND-in	0.15	0.15	0.16	0.17	0.18	0.20
WH	0.76	0.79	0.83	0.88	0.94	1.02
NRW	3.24	3.25	3.16	3.09	3.04	3.01
TOTAL	**10.40**	**10.70**	**10.97**	**11.36**	**11.89**	**12.56**

Alternatives to this baseline forecast were estimated given the MCRPC High and Low population projections. The assumption regarding the decreasing percentage of future NRW remains the same for all three forecasts. These three forecasts are summarized in **Table 3-6**. The Low population scenario shows no growth in water demand, which is not useful in long-range planning. The High population scenario assumes a future population based on a continuation of the historic growth trend. This results in a 2040 water demand estimate of 13 MGD, which is 3.8 percent higher than the baseline (Economic Development) scenario. The High scenario demand forecast is assumed to be a reasonable margin of error to bracket the upper limit of the forecast for planning purposes. The low, expected and high forecast scenarios are illustrated in **Figure 3-11**.

Table 3-6. Alternative Water Demand Forecasts (MDG)

Scenario	Base Period ('09-'17)	2020	2025	2030	2035	2040
Historic Growth Trend (High)	10.40	11.05	11.58	12.11	12.60	13.04
Economic Development	**10.40**	**10.70**	**10.97**	**11.36**	**11.89**	**12.56**
Slow Growth (Low)	10.40	10.55	10.53	10.46	10.29	10.00

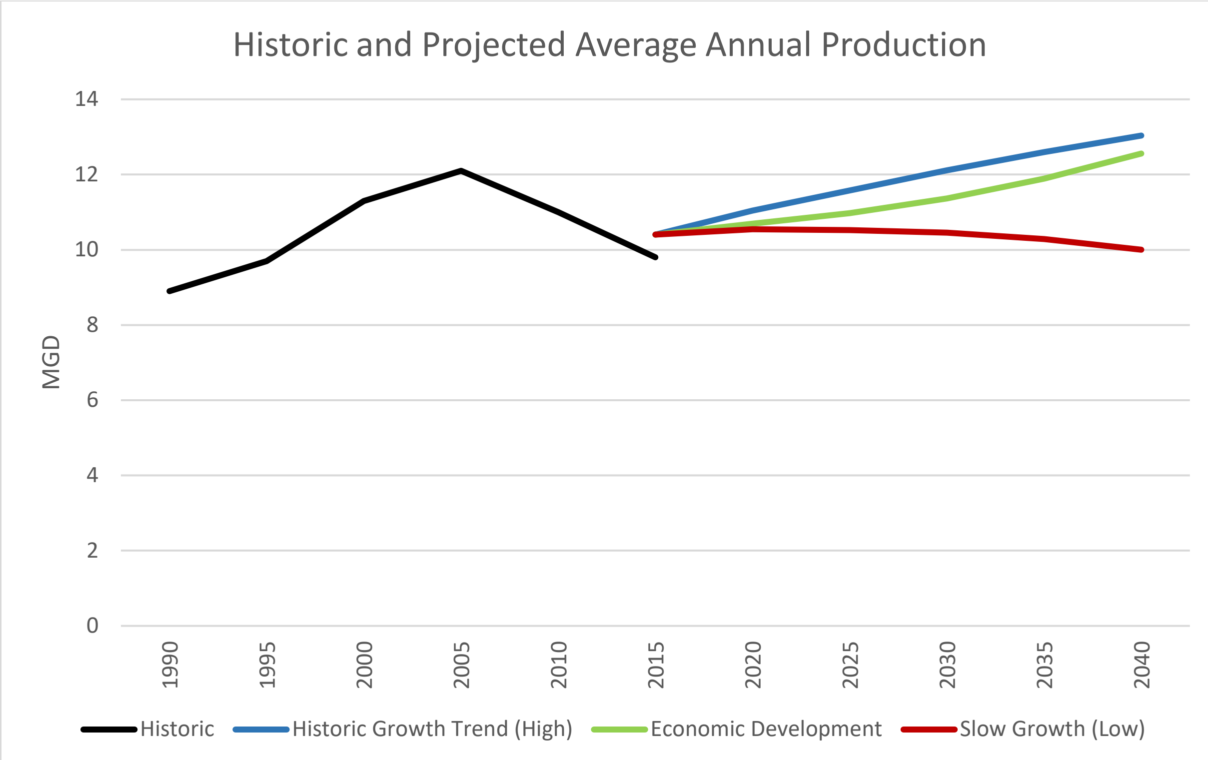

Figure 3-11. City of Bloomington Water Demand Forecast (MGD)

3.4.2 Maximum Day Demand

Monthly water production records at the treatment plant record the monthly average volume (average MDG from the daily average pumpage) and the monthly maximum day volume (highest of all daily maximum pumpage). The monthly average day use and the monthly maximum use from 1980 to 2016 are discussed in **Section 3.2.4** above. The highest maximum day pumpage occurred in June 2005 at 21.6 MGD. In that same month, the monthly average pumpage was 17.3 MGD. Thus, the maximum to average ratio for that month was 1.25 (meaning that the maximum pumpage for the month was 1.25 times higher than the average for the month).

Looking at similar monthly maximum to monthly average ratios indicates that the highest such ratio of 1.61 occurred in July 1987 when the maximum was 18.0 MGD and the monthly average was 11.7 MGD. Similar high monthly maximum to monthly average ratios of 1.53 occurred in February 1992 (likely due to leaks from frozen water lines) and 1.51 in both July 1992 and June 2007.

Using the monthly maximum to monthly average ratio as the metric, the highest maximum ratio of 1.61 occurred in 1987. It may be reasonable to assume that water use has changed since 1987 and that a maximum monthly ratio of 1.6 may no longer be reasonable for the future. However, ratios of 1.53 and 1.51 have occurred in more recent years. Thus, it is reasonable to assume a maximum monthly ratio of 1.51 for future planning purposes. Since 1990, the average monthly ratio (i.e., the average across all months from 1990 to 2016) is 1.2. This suggests a 50 percent likelihood of the monthly maximum ratio in the highest summer month will exceed 1.2 times the monthly average day demand of the month. There is about 1 percent of the monthly maximum ratio exceeding 1.5 times the monthly average demand. However, the water demand forecast presented above is an annual average day water demand and does not provide a monthly demand forecast. Applying a monthly maximum ratio to an annual average demand will result in an under-estimation of the likely maximum day demand.

An alternative, and perhaps more common approach for calculating the maximum day ratio, is to compare the maximum day pumpage throughout a given year with the annual average pumpage of that year. Unfortunately, this is also referred to as the maximum day ratio and may lead to some confusion. **Section 3.2.4** above discusses the historic calendar year average annual use, the maximum day use, and the ratio of the maximum day to annual average annual use from 1980 to 2016. The highest annual maximum day ratio occurred in 1987 at 2.0 and the second highest occurred in 1988 at 1.84, followed by 1.78 in 2005 and 1.73 in 2007. Using the same assumption that water use has likely changed since the 1980s, it is assumed that an annual maximum day ratio greater than 1.8 is not likely to occur in the future.

From 1990 to 2016, the average of all annual maximum day ratios is 1.54. This indicates there is approximately 50 percent probability that the annual maximum day demand will be greater than 1.5 times the annual average day demand. Based on the data from 1990 to 2016, there is approximately 40 percent probability that the annual maximum day demand will exceed 1.6 times the annual average demand, and a 7 percent probability that the annual maximum day demand will exceed 1.7 times the annual average demand.

Table 3-7 provides a summary of the water demand forecast for the year 2040 under the three population growth scenarios and three levels of annual maximum day ratios of 1.5, 1.6, and 1.7. The combination of the High population growth scenario with an annual maximum day ratio of 1.7 results in a maximum day forecast of 22.2 MGD in the year 2040. Thus, even with higher than anticipated growth and a low probability annual maximum day ratio, the maximum day demand in 2040 is likely to be less than 23 MGD. These alternative annual maximum day forecasts are shown with the alternative annual average day forecasts for the baseline, Low, and High scenario projections in **Figure 3-12**.

Table 3-7. Summary of Alternative Forecasts for 2040 with a Range of Annual Maximum Day Ratios

Scenario	2040 Annual Average	2040 with 1.5 Maximum Day	2040 with 1.6 Maximum Day	2040 with 1.7 Maximum Day
Historic Growth Trend (High)	13.04	19.55	20.86	22.16
Economic Development	12.56	18.84	20.09	21.35
Slow Growth (Low)	10.00	15.00	16.00	17.00

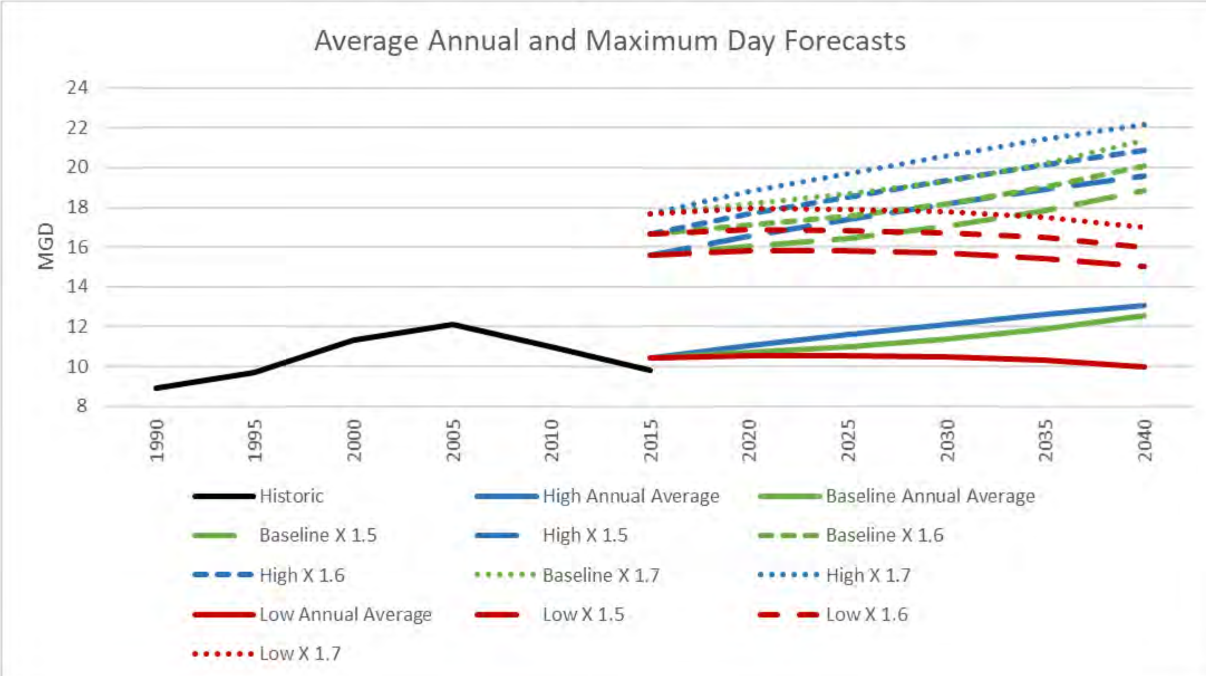

Figure 3-12. Summary of Baseline, Low and High Forecasts with a Range of Annual Maximum Day Ratios

3.4.3 Water Demand Forecast Conclusions

The average daily water use for each of the major water use sectors was determined from a base period of 2009 – 2017 as shown in **Table 3-8**. Population projections to the year 2040 for the City of Bloomington were obtained from the McLean County Regional Planning Commission (MCRPC). MCRPC developed three projections based upon assumptions of (a) a continuation of the 1980-2000 growth trend, (b) an economic development scenario and (c) an assumption of slow growth. These three population projections were used as the basis of a high, expected and low water demand forecast.

Water use among the residential inside city, commercial inside city, industrial, and wholesale sectors is assumed to increase proportionally to population growth for each of the three growth scenarios. Water use among the residential-outside city and commercial-outside city sectors is assumed to remain at current levels. The current level of non-revenue water as 32 percent of total production is assumed to decrease to 24 percent of total production by 2040 as meters are tested and replaced and leaky sections of water mains are replaced over time.

Table 3-8. Base Period Water Use by Sector

Sector	Base Period ('09-'17) GPD	% of Total
Residential – Inside City	3,996,722	38%
Residential – Outside City	41,997	0%
Commercial – Inside City	2,148,963	21%
Commercial – Outside City	63,216	1%
Industrial	148,116	1%
Wholesale	762,688	7%
Non-revenue Water	3,240,839	31%
TOTAL	10,402,540	100%

The baseline water demand forecast of annual average water demand given the expected growth population scenario increases approximately 21 percent from 10.4 MGD to about 12.6 MGD in 2040. The high population scenario results in a 2040 water demand estimate of 13 MGD while the low population indicates a slight decline in water demand.

Monthly water production from 1990 to 2016 indicates there is approximately 50 percent probability that the annual maximum day demand will be greater than 1.5 times the annual average day demand. Similarly, there is approximately 40 percent probability that the annual maximum day demand will exceed 1.6 times the annual average demand, and a 7 percent probability that the annual maximum day demand will exceed 1.7 times the annual average demand.

Applying a maximum day ratio of 1.7 to the expected growth scenario forecast results in an estimated 21.3 MGD maximum day demand in 2040. The combination of the high population growth scenario with a maximum day ratio of 1.7 results in a maximum day forecast of 22.2 MGD in the year 2040.

For the purpose of this Master Plan, an average day demand of 12.5 MGD and a maximum day demand of 21.3 MGD (using the Economic Development scenario for the year 2040 and a demand ratio of 1.7) were used for the analysis.

3.5 Water Demand Forecast Comparison to Safe Yield

Table 3-9 presents the safe yield analysis previously conducted of the City's water supply sources in 2010 by Wittman Hydro Planning Associates. The Wittman report predicted the safe yield based upon the 1939-1941 drought. The safe yields were then reduced over time due to predicted reductions in storage volume in the reservoirs caused by sedimentation.

Table 3-9. Safe Yield Analysis of the City of Bloomington Water Supply

Year	Lake Bloomington (MGD)	Evergreen Lake (MGD)	Evergreen Lake with Mackinaw River Pumping Pool (MGD)	Total (MGD)
2008	5.1	8.4	9.4	14.5
2028	4.8	7.6	8.5	13.3

As noted above, the economic development scenario predicted an average day demand in 2040 of 12.5 MGD and a maximum day demand of 21.3 MGD based upon a 1.7 ratio between the maximum and average day demands. The Wittman report established a minimum performance measure for safe yield of 100 percent of the projected average demand and a desired performance measure of 125 percent of the projected average demand. The projected average day demand in 2040 of 12.5 MGD is less than the projected 2028 safe yield of 13.3 MGD indicating compliance with the minimum safe yield performance measure. However, an additional 2.5 MGD of capacity is required to meet the desired safe yield performance measure of 125 percent of the projected average demand.

The Wittman report indicated several options for increasing the safe yield of the City's water supplies, including the development of groundwater sources. As discussed further in **Section 4**, the City is already in the process of developing 1.8 MGD of groundwater capacity (0.9 MGD per well). The development of two additional wells, resulting in a firm groundwater capacity of 2.7 MGD, would increase the overall safe yield of the City's water supplies to 16.0 MGD, which is larger than 125 percent of the projected average demand and satisfies the desired safe yield performance measure. The estimated costs and recommendations regarding additional groundwater supplies are discussed further in **Section 4**.

Section 4

Water Quality and Regulatory Review

4.1 Introduction

The purpose of this Section is to:

- Outline current, proposed, and potential future water quality regulations that impact the City of Bloomington.
- Propose water quality goals that will set forth the criteria for the analysis of any potential future upgrades or modifications to the treatment process at the Water Treatment Plant (WTP).
- Provide an analysis of raw and finished water quality.
- Provide treatment options for compliance with water quality regulations.

4.2 Summary of Drinking Water Quality Regulations

Drinking water is federally regulated by the United States Environmental Protection Agency (EPA) under the authority of the Safe Drinking Water Act (SDWA). The SDWA was established by Congress in 1974 to protect human health by regulating the nation's public drinking water supply. The SDWA was extensively amended in 1986 and 1996 and its regulations have been adopted by the Illinois Environmental Protection Agency (IEPA) which has been given primacy by the EPA for enforcing these regulations in Illinois.

The SDWA has set primary and secondary standards for contaminants in potable water systems. The National Primary Drinking Water Regulations (NPDWR) are legally enforceable standards that apply to all public water systems and consist of maximum contaminant level goals (MCLGs), which are non-enforceable goals, as well as maximum contaminant levels (MCLs). MCLs are enforceable limits set as close to the MCLGs as practical, considering cost and feasibility of attainment. National Secondary Drinking Water Regulations (NSDWR), also referred to as secondary standards, are federally non-enforceable guidelines regulating contaminants that may cause human cosmetic effects (such as skin or tooth discoloration) or aesthetic effects in drinking water (such as taste, odor, or color). Compliance with secondary standards is recommended but not legally enforced.

4.2.1 Existing Regulations

The EPA has enacted several regulations since the 1996 SDWA amendments. The regulations that are particularly relevant to the City of Bloomington include the NPDWR Phase II Rule, Interim Enhanced Surface Water Treatment Rule (IESWTR), Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules (D/DBRP), revisions to the Lead and Copper Rule (LCR), Fluoride Rule, and Filter Backwash Recycling Rule (FBRR). These regulations require that water systems meet MCLs and/or use certain treatment techniques to protect against adverse health effects in regard to turbidity, primary and secondary disinfection, disinfection by-products (DBPs), corrosion by-products, fluoride, and nitrate.

The contaminants relevant to the Bloomington WTP and the controlling regulations are summarized in **Table 4-1**. **Table 4-2** provides a legend for all abbreviations in the tables in this Section.

Table 4-1. Existing Drinking Water Regulations Applicable to the Bloomington Water Treatment Plant

Category	Federal Regulation	EPA/IEPA Regulatory Baseline
Turbidity	IESWTR LT2ESWTR FBRR	▪ ≤ 0.3 NTU in 95% of CFE measurements each month. ▪ Maximum 1 NTU in CFE. ▪ ≤ 0.5 NTU in IFE after 4 hours of continuous operation. ▪ ≤ 1 NTU in IFE at any time. ▪ Collect and report information to IEPA on filter backwash recycle practices.
Primary Disinfection	SWTR LT2ESWTR	▪ 3-log Giardia reduction required across plant. ▪ 4-log virus reduction required across plant. ▪ 2.5-log Giardia, 2-log virus and 3-log *Cryptosporidium* removal credit by conventional treatment. ▪ 0.5-log Giardia and 2-log virus inactivation CT credit by chemical disinfection for conventional treatment. ▪ 0 to 2.5-log additional *Cryptosporidium* reduction credit depending on assigned “treatment bin” in “microbial toolbox”.
Microbial Quality in the Distribution System	SWTR TCR/RTCR Stage 1 D/DBPR Stage 2 D/DBPR	▪ <5% monthly samples positive for total coliform. ▪ No E. Coli detections. ▪ Chlorine residual > 0.2 mg/L at distribution system entry point. ▪ Chlorine residual detectable in 95% of monthly samples. ▪ Chlorine residual < 4 mg/L RAA.
Disinfection By-Products	Stage 1 D/DBPR Stage 2 D/DBPR	▪ Identification of IDSE locations. ▪ TTHM ≤ 80 ug/L LRAA of quarterly samples. ▪ HAA5 ≤ 60 ug/L LRAA of quarterly samples. ▪ Enhanced coagulation for TOC removal. ▪ Bromate ≤ 10 ug/L RAA of monthly samples. ▪ Chlorite: 1.0 mg/L monthly average.
Corrosion By-Products	LCR	▪ Lead <0.015 mg/L in 90th percentile. ▪ Copper <1.3 mg/L in 90th percentile. ▪ Optimized corrosion control practices as defined by LCR.
pH	NSDWR	▪ pH 6.5 – 8.5.
Fluoride	Fluoride Rule	▪ CDC health guidance value: 0.7 mg/L. ▪ 2 mg/L secondary standard. ▪ 4 mg/L MCL.
Nitrate	NPDWR Phase II Rule	▪ Nitrate < 10 mg/L.

Table 4-2. Legend for Tables

Acronym	Description
CECs	Chemicals of emerging concern
CFE	Combined filter effluent
CT	Product of disinfectant concentration (C) times contact time (T)
CWSRRA	Community Water System Risk and Resilience Act
D/DBPR	Disinfectant/Disinfection By-Products Rule (Stages 1, 2, and 3)
DAF	Dissolved air flotation
EDCs	Endocrine disrupting compounds
EPA	United States Environmental Protection Agency
ERP	Emergency Response Plan
GAC	Granular activated carbon
HAA5	Five regulated Haloacetic Acids
HAA9	Nine Haloacetic Acids
IDSE	Initial Distribution System Evaluation
IESWTR	Interim Enhanced Surface Water Treatment Rule
IFE	Individual filter effluent
LCR	Lead and Copper Rule
LRAA	Locational running annual average
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LT3ESWTR	Long Term 3 Enhanced Surface Water Treatment Rule
MCL	Maximum Contaminant Level
NPDWR	National Primary Drinking Water Regulations
NSDWR	National Secondary Drinking Water Regulations
PAC	Powdered Activated Carbon
PPCPs	Pharmaceutical and personal care products
RAA	Running annual average
Reg-Det3	Third Regulatory Determination
RTCR	Revised Total Coliform Rule
SWTR	Surface Water Treatment Rule
TCR/RTCR	Total Coliform Rule/Revised Total Coliform Rule
TOC	Total Organic Carbon
TTHM	Total Trihalomethanes
UCMR4	Fourth Unregulated Contaminant Monitoring Rule
UFRV	Unit Filter Run Volume
UV_{254}	Ultraviolet Absorbance at 254 nm

4.2.2 Potential Future Regulations

Table 4-3 presents possible changes to existing regulations and possible new regulations that are relevant to the City of Bloomington. Potential changes include tightening of filter effluent requirements, treatment of spent filter backwash water before it is returned to the head of the plant, establishing a minimum disinfectant residual throughout the distribution system, expanding the haloacetic acid (HAA) regulation to include all nine brominated and chlorinated HAAs, lowering the bromate MCL, setting MCLs for nitrosamines, chlorate and perchlorate, and lowering the action level for lead.

Cyanotoxin formation has been a concern over the past decade, especially in lakes and reservoirs. Ten cyanotoxins are currently listed in the EPA's fourth Unregulated Contaminants Monitoring Rule (UCMR 4). It is possible that the EPA will issue health advisories for several of them. A number of other chemicals of emerging concern (CECs), such as endocrine disrupting compounds (EDCs) and pharmaceutical and personal care products (PPCPs) are also the subject of much research and are listed in UCMR 4, but it is unlikely that a regulation will be proposed in the near future.

The America's Water Infrastructure Act of 2018, also called the Community Water System Risk and Resilience Act (CWSRRA), was recently passed. The CWSRRA requires water systems serving at least 3,300 people to conduct a risk and resilience assessment of their system to malevolent acts and natural hazards and create or revise an Emergency Response Plan (ERP) addressing the findings of the assessment. The assessment should cover:

- Risks to the system from malicious acts and natural hazards.
- Resilience of pipes, conveyance infrastructure, source water quality and intake, treatment processes, storage and distribution facilities, and computer or other automated systems used by the utility.
- Monitoring practices.
- Stabilization of account management, including invoicing and payroll.
- Use, storage, and handling of various chemicals by the system.
- Operation and maintenance of the system.

An ERP must be created or revised following the assessment to address its findings. Finally, a certification verifying completion of the assessment and ERP must be sent to the EPA by December 31, 2020 for utilities serving between 50,000 and 100,000 people. The assessment, ERP, and certification should be renewed every five (5) years.

Table 4-3. Potential Future Water Regulations Applicable to the Bloomington Water Treatment Plant

Category	Federal Regulation	EPA/IEPA Regulatory Baseline
Turbidity	LT3ESWTR? Revised FBRR	▪ Same as existing regulations for turbidity with potential tighter limits on IFE and CFE performance. ▪ Potential requirements for treatment of filter backwash water.
Primary Disinfection	LT3ESWTR?	▪ Same as existing regulations. AND ▪ 3-log Crypto disinfection credit when using UV? ▪ Revision of assigned Crypto credits for different "treatment bins"?
Microbial Quality in the Distribution System	RTCR2?	▪ Same as existing regulations. AND ▪ Minimum disinfectant residual throughout distribution system (i.e., >0.1 or 0.2 mg/L free chlorine).
Disinfection By-Products	Stage 3 D/DBPR? UCMR4 Reg-Det3	▪ TTHM ≤ 80 ug/L LRAA of quarterly samples. ▪ HAA9 ≤ 80 ug/L LRAA of quarterly samples? ▪ Enhanced coagulation for TOC removal. ▪ Bromate ≤ 5 ug/L RAA of monthly samples? ▪ Chlorite ≤1.0 mg/L monthly average. ▪ NDMA: future Federation regulation likely (i.e., 10 ng/L?) ▪ Perchlorate: future Federal regulation likely (i.e., 6-15 ug/L?). ▪ Chlorate: future Federal regulation likely (i.e., 0.21 mg/L?).
Corrosion By-Products	Revised LCR	▪ Lead <0.010 mg/L in 90th percentile? ▪ Copper <1.3 mg/L in 90th percentile. ▪ Optimized corrosion control practices as defined by LCR.
Nitrate	NPDWR Phase II Rule	▪ Same as existing regulation.
Fluoride	Fluoride Rule	▪ Same as existing regulation. ▪ Fluoride below 1.4 mg/L.

Cyanotoxins	UCMR4
	Reg-Det3
		▪ 10-day health advisories:
		  ▪ children <6 years 0.3 ug/L for microcystins and 0.7 ug/L for cylindrospermopsin.
		  ▪ children >6 years and adults 1.6 ug/L for microcystins and 3.0 ug/L for cylindrospermopsin.

CECs/EDCs/PPCPs	UCMR4 Reg-Det3	▪ No Federal regulation expected, although a requirement to install GAC might be considered for vulnerable water supplies.
Risk and Resilience Assessment	CWSRRA	▪ Conduct an assessment of risks and resilience of the system in regard to malevolent acts and natural hazards. ▪ Prepare an emergency response plan that incorporates findings from the risk and resilience assessment. ▪ Submit a certification of completion to the EPA by December 31, 2020. ▪ Renew or revise the assessment every five years.

4.3 Water Quality Goal Setting Process

The development and selection process for setting water quality goals for the WTP involved the following steps:

- Identify existing and future water quality regulations applicable to the WTP (see **Table 4-1** and **Table 4-3**).
- Identify key water quality and treatment considerations based on a review of Lake Bloomington and Evergreen Lake raw quality data in combination with the water quality regulations review.
- Establish two categories of water quality goals:
  - Current Goals: Regulatory baseline, considering EPA and IEPA regulations, and how they apply to existing water treatment processes.
  - Future Goals: Industry best practices based on progressing-utility operations (i.e., American Water Works Association's (AWWA) Partnership for Safe Water, etc.), potential new regulations, process optimization, and enhanced water treatment process implementation.

4.3.1 Recommended Initial Water Quality Goals

Table 4-4 summarizes the processes alternatives considered to address the water quality and operational goals relevant at the WTP. All of the recommended water quality goals are already achieved by the WTP, with the exception of those noted below. The bullets below outline the reasoning for each of these goals.

- Turbidity Goals: For turbidity, the goals are expressed in terms of the combined filter effluent (CFE) and each individual filter effluent (IFE), filter run time and productivity (unit filter run volume (UFRV)), and filter backwash water. To achieve these goals, process options consist of: lime softening with ferric sulfate coagulant and a cationic polymer added with low doses of chlorine for purposes of aiding coagulation, and dual media filtration with granular activated carbon (GAC) over sand. The filters are expected to operate in a biological mode because there is no residual disinfectant in the water as it is applied to the filters. To meet the specific goals with the selected process alternatives, acidification of the turbidity samples may be required to remove lime carryover from the softening process as allowed by the EPA.
- Primary Disinfection: For primary disinfection, chlorine is used to meet CT requirements, with a margin of safety of 50 percent as the goal, i.e., the CT achieved after the application of free chlorine should be 50 percent higher than the required CT for the given pH, chlorine residual, and temperature ($CT_{actual}/CT_{required} = 1.5$). The requisite CTs can be achieved in the reservoir, after filtration. Primary disinfection is currently achieved with a margin of safety of greater than 50%.
- Nitrate: The Lake Bloomington and Evergreen Lake water supplies are subject to agricultural runoff that is high in nitrate. A goal to not exceed 80 percent of the nitrate MCL

of 10 mg N/L is suggested. The goal should be achievable through blending of different source water supplies depending upon nitrate concentrations. Development of a groundwater source will provide Bloomington with an additional source that consistently contains low nitrate concentrations will assist in meeting the goal when seasonal surface water concentrations are high. Advanced treatment technologies, such as ion exchange and low-pressure reverse osmosis, are also other alternatives.

- Microbial Quality in the Distribution System: Secondary chlorination with chloramines is used for control of microbial quality in the distribution system, after primary disinfection is achieved with free chlorine in the finished water reservoir. The operational goal to assure that microbial quality is acceptable is that there should be no detection of total coliform bacteria or *E. Coli* during the monthly monitoring program conducted in accordance with the requirements of the revised TCR. An operational goal of a minimum detectable residual (i.e., greater than 0.5 mg/L for total chlorine) at all locations is suggested. It should be noted that the City's standard practice is to target a minimum detectable residual of 2.0 mg/L.

- Disinfection By-Products (DBPs): For DBPs, the goal is to not exceed 80 percent of the MCL for THMs and HAA5. Additionally, the goal is to comply with the TOC removal requirements specified in the enhanced coagulation matrix in the D/DBP Rules. If necessary, consideration should be given to enhancing TOC removal beyond the requirements specified in the enhanced coagulation matrix.

- Corrosion Control: The water quality and operational goal for corrosion by-products is to meet the corrosion control indices established by the U.S. EPA and IEPA. For homes exceeding the lead action level of 0.015 mg/L, a detailed follow-up is required. The treatment alternative to meet this goal is the corrosion control strategy directed by IEPA.

- Taste and Odor Control: For taste and odor, the recommended water quality goals should be a taste and odor threshold number (TON) of less than 3, no objectionable taste and odor year-round, and maximum geosmin and MIB concentrations of 10 ng/L for each. Typically, a biological filtration process utilizing GAC media will allow these goals to be met. To assure the specified goals are met, it is recommended that a routine sampling program for threshold odor number, geosmin, and MIB be implemented. Powdered activated carbon can is recommended to be added to the raw water to assist in taste and odor removal. The City currently utilizes an informal qualitative assessment by select staff with adequate sensitivity as a screening test followed by analysis by a contract laboratory.

- Fluoride: The operational goal for fluoride is to meet the target dose based on daily monitoring, recognizing that the U.S. EPA recommends a concentration of 0.7 mg/L based on relatively recent reports from the Centers for Disease Control and Prevention (CDC).

Table 4-4. Recommended Initial Water Quality and Operational Goals

Water Quality Category	Water Quality and Operational Goals	Treatment Process Alternatives	Potential Treatment Refinements/Optimization
Turbidity	▪ Regulatory compliance. ▪ Turbidity ≤ 0.10 NTU for CFE, 95% of the time. ▪ Turbidity ≤ 0.30 NTU for IFE, 95% of the time. ▪ Filter runtime of 72+ hours. ▪ UFRV of 9,000 $gal/ft^2/run$. ▪ Limit filter recycle flows to < 5% of incoming plant flow.	▪ Preoxidation with chlorine, ferric sulfate coagulant with cationic polymer prior to lime softening. ▪ GAC/sand biofiltration ▪ Equalization and filter backwash recycle to head of plant. ▪ Equalization and filter backwash clarification and recycle to head of plant.	▪ Optimize coagulants. ▪ Optimize softening process. ▪ Optimize Cl_2 dose for preoxidation. ▪ Optimize filter media selection and depth for longer run times and higher UFRV. ▪ Optimize filter backwash sequence, clarification and recycle flows.
Primary Disinfection	▪ Chlorine Inactivation Ratio of 1.5 (CT_{calc}/CT_{req}).	▪ None.	▪ Optimize Cl_2 dose and contact time for CT compliance. ▪ Optimize pH to maximize CT with Cl_2. ▪ Develop automated control strategy for chlorine CT compliance.
Nitrate	▪ Nitrate 80% of MCL (8 mg N/L).	▪ Source water blending. ▪ Ion exchange. ▪ Low pressure reverse osmosis membranes. ▪ Biological denitrification.	▪ Source water quality management plan with local authorities to limit nitrate use in the watershed. ▪ Source water blending (vary surface water sources based upon nitrate concentrations). ▪ Source water blending (blend new groundwater source with existing surface water supplies). ▪ Explore other treatment alternatives should the raw water quality continue to degrade.
Microbial Quality in the Distribution System	▪ Operational goal of 0 detects in distribution system for Total Coliform and E. Coli. ▪ Maintain minimum total chlorine residual in distribution system greater than 2.0 mg/L.	▪ None.	▪ Distribution system flushing to minimize water age where appropriate.

Water Quality Category	Water Quality and Operational Goals	Treatment Process Alternatives	Potential Treatment Refinements/Optimization
Disinfection By-Products	▪ Meet TOC removal requirements. ▪ TTHM/HAA5 80% of MCL (64/48 ug/L). ▪ UV_{254} after filtration ≤ 0.03 cm^{-1}.	▪ Lime softening with biological filtration. ▪ Minimal doses of Cl2 for preoxidation prior to softening.	▪ Exceed TOC removal requirements of the enhanced coagulation matrix (unless exempted). ▪ Optimize free chlorine contact time and pH. ▪ Reduce water age in distribution system.
Corrosion By-Products	▪ Meet corrosion control indices established by EPA and IEPA.	▪ Implement corrosion control strategy, as directed by IEPA.	▪ Optimize corrosion control chemicals to meet corrosion control indices and pH targets.
Taste and odor	▪ TON <3. ▪ No objectionable taste and odor year round. ▪ Geosmin < 10 ng/L ▪ MIB < 10 ng/L.	▪ PAC addition. ▪ GAC biofiltration.	▪ Initiate routine sampling program for threshold odor number, geosmin, MIB.
Fluoride	▪ Meet fluoride dose target based on daily monitoring.	▪ Fluoride chemical feed system.	▪ 0.7 mg/L target (based on EPA risk assessment).

4.3.2 Potential Future Goals and Treatment Process Alternatives

Table 4-5 summarizes potential future water quality and operational goals and alternative processes to achieve each goal. It is possible that the EPA will make rule changes during their congressionally-mandated Six-Year Review currently scheduled for 2022 (i.e., there may be a third Long-Term Enhanced Surface Water Treatment Rule (LT3ESWTR), a third Disinfectants/ Disinfection By-Products Rule (Stage 3 D/DBPR), a revised Filter Backwash Rule (FBRR), another Revised Total Coliform Rule (TCR), and another Revised Lead and Copper Rule (LCR)). Additionally, the findings from the fourth Unregulated Contaminants Monitoring Rule (UCMR 4) may lead to the third Regulatory Determination (Reg-Det3), but it is likely that such new regulations are many years away. **Table 4-6** outlines new goals currently under discussion, which would be prudent to anticipate for the WTP.

For turbidity, more stringent goals are anticipated for individual filter effluent, including filter productivity, and chemical and residuals handling costs. Algae removal may be an additional treatment goal. Treatment alternatives to achieve these more stringent goals would be deep-bed GAC filtration, dissolved air floatation (DAF), and treatment of filter backwash water by high rate clarification.

Primary disinfection goals may include addition of 3-log *Cryptosporidium* inactivation beyond the removal credit achieved by conventional treatment, thereby providing an additional barrier for disinfection. Alternative processes to achieve this target may involve implementation of an ozone system to achieve disinfection credit in addition to UV irradiation following filtration.

The water quality and operational goals for microbial quality in the distribution system are expected to remain the same. Operational improvements to meet these goals may include reservoir mixing and automatic flushing devices to reduce water age in the distribution system.

DBP goals may include enhanced TOC removal beyond the requirements of the enhanced coagulation matrix; inclusion of all nine HAAs as part of the MCL for HAAs; and establishment of goals for chlorate, perchlorate, and new nitrogen-containing DBPs. Treatment alternatives to meet the initial water quality and operational goals include optimized lime softening, deep-bed GAC filtration, and DAF.

The water quality goal for cyanotoxins is driven by health advisory limits. Preoxidation with ozone, GAC filtration, and DAF are the recommended treatment alternatives. For CECs such as endocrine disruptors (EDs) and pharmaceutically active compounds, the water quality goal would be to meet the regulatory limits. Ozonation and biological filtration with GAC media are expected to be the technologies of choice for effective removal of these compounds.

Table 4-5. Potential Future Water Quality and Operational Goals Considered to Address the Water Quality and Operational Goals

Water Quality Category	Water Quality and Operational Goals	Treatment Refinements/Optimization
Turbidity	▪ Turbidity ≤ 0.10 NTU in IFE, 95% of the time. ▪ Filter runtime of 96+ hours. ▪ UFRV of 11,000 gal/ft^2/run. ▪ 20% reduction in coagulant and residuals handling costs. ▪ Enhanced algae/diatom removal.	▪ Optimization of lime softening process. ▪ Deep-bed GAC filtration. ▪ High-rate clarification treatment of filter backwash recycle flows.
Primary Disinfection	▪ Chlorine Inactivation Ratio of 1.5 (CT_{calc}/CT_{req}). ▪ 3-log *Cryptosporidium* disinfection credit. ▪ Multiple barrier disinfection strategy.	▪ Ozonation for CT. ▪ Post-filter UV for *Cryptosporidium*/Giardia inactivation.
Nitrate	▪ No change to initial goals.	▪ Ion exchange. ▪ Blend with groundwater sources. ▪ Biological nitrate removal.
Microbial Quality in the Distribution System	▪ No change to initial goals.	▪ Install reservoir mixing systems and automatic flushing devices for improved chlorine residual stability and reduction in water age.
Disinfection By-Products	▪ No change to initial goals, plus: ▪ Meet 80% of future regulatory limits for NDMA, chlorite, perchlorate and chlorate.	▪ Optimize lime softening. ▪ Deep-bed GAC filtration. ▪ Operate preoxidation and post-chlorination processes to minimize NDMA formation, if required. ▪ Implement nitrogenous DBP control strategy (if required).

Water Quality Category	Water Quality and Operational Goals	Treatment Refinements/Optimization
Corrosion By-Products	▪ Consider < 0.010 mg/L action level for lead.	▪ Implement corrosion control strategy, as directed by IEPA.
Taste and Odor	▪ No change to initial goal.	▪ None.
Cyanotoxins	▪ Meet health advisory limits.	▪ Preoxidation with ozone. ▪ GAC filtration. ▪ Dissolved air flotation (DAF).
CECs/EDCs/PPCPs	▪ Meet future regulatory limits.	▪ Provide ozone and biological filtration with GAC media for effective removal of these compounds.

4.3.3 Summary – Water Quality and Operational Goal Matrix

Table 4-6 summarizes the recommended water quality goals based on the discussion above. The categories are based on the contaminants believed to be of greatest relevance for the City of Bloomington, taking into account existing and potential future regulations, raw water quality, the experiences of other utilities treating surface water in central Illinois, existing WTP treatment processes, and best practices in the waterworks industry. Should the City of Bloomington introduce well water to the treatment process, additional water quality and operational goals should be included in response to the well water's high levels of radionuclides, boron, chloride, and sulfate.

Table 4-6. Recommended Water Quality and Operational Goals

Water Quality Category	Treatment Refinements/Optimization
Turbidity	▪ Regulatory compliance. ▪ Turbidity ≤ 0.10 NTU for CFE, 95% of the time. ▪ Turbidity ≤ 0.30 NTU for IFE, 95% of the time. ▪ Filter runtime of 72+ hours. ▪ UFRV of 9,000 gal/ft^2/run. ▪ Limit filter recycle flows to < 5% of incoming plant flow.
Nitrate	▪ Continue meeting 80% of nitrate MCL (8 mg N/L).
Microbial Quality in the Distribution System	▪ Operational goal of 0 detects in distribution system for Total Coliform and E. Coli. ▪ Maintain minimum total chlorine residual in distribution system greater than 2.0 mg/L.
Disinfection By-Products	▪ Meet TOC removal requirements per enhanced coagulation matrix. ▪ TTHM/HAA5 80% of MCL (64/48 ug/L). ▪ UV_{254} after filtration ≤ 0.03 cm^{-1}.
Corrosion By-Products	▪ Meet corrosion control indices established by EPA and IEPA.
Fluoride	▪ Meet fluoride dose target based on daily monitoring.
Radionuclides	▪ Maintain finished water alpha particle concentration below 12 pCi/L (80% of the MCL). ▪ Maintain finished water combined radium concentration below 4 pCi/L (80% of the MCL).
Inorganic Constituents	▪ Maintain finished water boron concentration below 1.0 mg/L. ▪ Maintain finished water chloride concentration below 250 mg/L. ▪ Maintain finished water sulfate concentration below 250 mg/L.

4.4 Raw Water Quality

The Bloomington WTP currently draws from two surface water sources: Lake Bloomington and Evergreen Lake. The nearby Mackinaw River is used when necessary and in accordance with Army Corps of Engineers permit requirements as a tertiary raw water source. The Mackinaw River water quality has been excluded from this analysis.

Water from Lake Bloomington and Evergreen Lake are occasionally blended at the head of the treatment plant to meet water quality and production requirements. Two groundwater wells were constructed to enable blending of groundwater with surface water should the nitrate concentration in the surface water exceed acceptable limits. The groundwater wells also introduce an additional supply of water to increase the safe yield of Bloomington's water sources. At the time of this report, the groundwater wells have been drilled but are not yet operational.

Key raw water quality data for Lake Bloomington, Evergreen Lake, Groundwater Well 1, and Groundwater Well 2 is shown in **Table 4-7**.

Table 4-7. City of Bloomington Raw Water Quality

Water Quality Category	Lake Bloomington	Evergreen Lake	Groundwater Well 1 [1]	Groundwater Well 2 [1]
pH [2]	7.83 – 8.67		7.72	No data
Hardness [2]	146 - 328 mg/L as $CaCO_3$		139 mg/L as $CaCO_3$	No data
Alkalinity [2]	90 - 265 mg/L as $CaCO_3$		212 mg/L as $CaCO_3$	No data
Turbidity [2]	2.3 - 10.3 NTU		0.65 NTU	0.99 NTU
Nitrate[3]	0.17 - 14 mg/L NO_3-N Peaks during May-June	0.06 - 15 mg/L NO_3-N Peaks during May-June	Non-detect	No data
Fluoride [2]	Non-detect - 0.5 mg/L		2.4 mg/L	2.52 mg/L
Chloride	No data	No data	580 mg/L	560 mg/L
Sulfate	No data	No data	210 mg/L	190 mg/L
Total Organic Carbon [4]	2 - 4 mg/L	3 - 4 mg/L	No data	No data
Cryptosporidium [5]	Non-detect - 0.178 oocysts/L		No data	No data
Total Chromium [6]	Non-detect - 0.2 µg/L	0.2 µg/L	No data	13 µg /L
Chromium (VI) [6]	0.05 - 0.12 µg/L	0.11 µg/L	No data	No data
Iron	No data	No data	76 - 86 µg /L	150 µg /L
Manganese	No data	No data	2.5 µg /L	2.9 µg /L
Boron	No data	No data	1.2 mg/L	1.2 mg/L
***Cyanotoxins* [7]**				
Cylindrospermopsin	Non-detect - 0.21 µg/L	Non-detect - 0.17 µg/L	No data	No data
Anatoxin-a	Non-detect - 0.186 µg/L	Non-detect - 0.255 µg/L	No data	No data
Microcystin[8]	Non-detect - 1.49 µg/L. Typically < 1 µg/L.	Non-detect – 0.65 µg/L. Typically < 1 µg/L	No data	No data

Water Quality Category	Lake Bloomington	Evergreen Lake	Groundwater Well 1 [1]	Groundwater Well 2 [1]
Taste and Odor [8, 9]				
Geosmin	Non-detect – 1,200 ng/L. Typically < 60 ng/L	Non-detect - 160 ng/L Typically < 30 ng/L	No data	No data
2-methylisoborneol	Non-detect - 99 ng/L. Typically < 20 ng/L	Non-detect - 430 ng/L Typically < 10 ng/L	No data	No data
Radionuclides				
Gross alpha	No data	No data	21.7 - 29.6 pCi/L	15 pCi/L
Gross beta	No data	No data	10.9 - 13.2 pCi/L	18.9 pCi/L
Radium 226	No data	No data	10.5 - 13 pCi/L	6.28 pCi/L
Radium 228	No data	No data	1.3 - 1.8 pCi/L	2.39 pCi/L
Uranium	No data	No data	0.229 µg/L	0.208 µg/L

Notes:

[1] Groundwater Well 1 data is from a sampling event on November 7, 2017. Groundwater Well 2 data is from a sampling event on March 20, 2018.

[2] Data was collected from a blend of Lake Bloomington and Evergreen Lake raw water. pH, hardness, turbidity, and fluoride data are the range of monthly averages from 2014-2017. Turbidity excludes one outlier of 25.6 NTU from January 2016. Alkalinity data is the range of monthly averages from 2001-2017.

[3] Data was collected from Lake Bloomington intake, Evergreen Lake intake, and Evergreen Lake tributary from January 2010 through December 2018 on a weekly basis.

[4] Data was collected at the intake on a monthly basis from 2014-2018.

[5] Cryptosporidium was detected in 1 out of 24 source water samples in 2016. The source water where it was detected is not specified.

[6] Surface water chromium data was collected in four sampling events in January 2012 and from January 2013 to March 2013.

[7] Cyanotoxin data was collected during the summers of 2015 through 2017.

[8] Showing results using ELISA test method. Maximum detection was 8.3 µg/L using Tailgate Test.

[9] Taste and odor data were collected from November 2004 through February 2019.

4.4.1 Nitrate

Nitrate is currently the largest concern in the raw water sources used by the City of Bloomington. Nitrate enters Lake Bloomington, Evergreen Lake, and their tributaries primarily through contamination from agricultural runoff. The tributaries typically have the highest levels of nitrate, while Lake Bloomington consistently has higher nitrate than Evergreen Lake. **Figure 4-1** shows how nitrate varies seasonally in Lake Bloomington and Evergreen Lake intakes, peaking in May through July. Lake Bloomington's intake nitrate concentration seasonal peak has been above 10 milligrams of nitrogen per liter (mg N/L) in four years from 2010 through 2018. Nitrate levels in an unspecified Evergreen Lake tributary has reached 15 mg N/L on multiple occasions since January 2014. Surface water nitrogen has followed similar trends in previous years. The City is concerned that the levels of nitrate within Evergreen Lake and Lake Bloomington may increase in the future. The Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for nitrate is set at 10 mg N/L. The current water treatment process used at the Bloomington WTP does not remove nitrate. The City closely monitors the raw water nitrate concentration during late spring and early summer. The City can switch the raw water source between Lake Bloomington and Evergreen Lake if one of them exceeds 10 mg N/L.

Occurrences of drought can have a profound effect on nitrate concentration in Bloomington's source waters. During a period of drought, Bloomington's watershed accumulates fertilizers containing nitrate. When it rains, the nitrogen-rich runoff enters Lake Bloomington and Evergreen Lake tributaries. Nitrate-rich tributaries coupled with a lower volume of water in Lake Bloomington and Evergreen Lake due to drought causes exceptionally high levels of nitrate in the source water. Bloomington's current strategy of controlling finished water nitrate cannot protect against these scenarios because both sources of raw water are impacted.

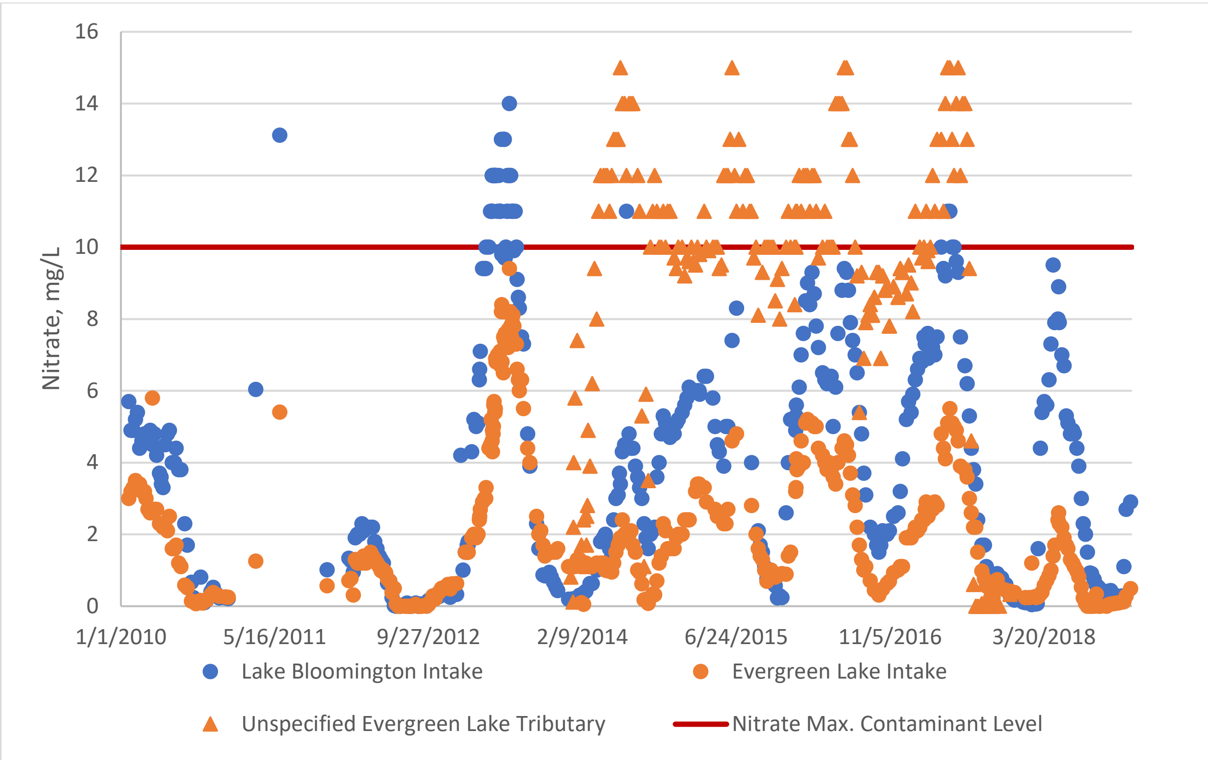

Figure 4-1. Seasonal Variation of Nitrate Concentration in Lake Bloomington and Evergreen Lake (January 2010 through December 2018)

4.4.2 Hardness, Alkalinity, and pH

Hardness of the raw water entering the Bloomington WTP can range from around 150 to above 300 milligrams per liter of calcium carbonate (mg/L as $CaCO_3$) and can be classified as hard to very hard.

The total alkalinity of the raw water is considered moderate, typically ranging from 100-200 mg/L as $CaCO_3$. Because total alkalinity is generally lower than hardness in the source water, some of the hardness is non-carbonate hardness and will not be removed in a standard lime softening process. However, the carbonate hardness is high enough for lime to effectively soften the water to an acceptable level of hardness.

Typical raw water pH ranges from 8 to 8.5. In this range, the alkalinity is mostly in the bicarbonate and carbonate form. The pH is raised during the lime softening process, then lowered by recarbonation.

4.4.3 Cyanotoxins

Cyanotoxins pose a potential risk for Bloomington's surface water sources, as they do for any surface water susceptible to algal blooms. Health advisory levels set by the EPA for two cyanotoxins are shown in **Table 4-8**. The City began monitoring cyanotoxins in their source and finished water in 2006. A two-stage screening process was implemented to save on testing costs at an independent lab. The samples are first analyzed with test strips an ELISA test kit. The samples that test positive in the first stage, which is known to produce false positives, are sent to an independent lab for testing by an LCMS method. Microcystins, cylindrospermopsin, and anatoxin-a have been detected in Bloomington's raw water; however, microcystins are the only cyanotoxin that has been detected above the EPA's drinking water health advisory in the raw water. Cyanotoxins have been successfully removed by the existing treatment process and have not been detected in finished water samples by the independent lab. Use of nitrogen and phosphorus fertilizers in the watershed creates a nutrient-rich agricultural runoff that enters Bloomington's source waters. Increasing use of these fertilizers could lead to eutrophication of Lake Bloomington and Evergreen Lake and increase the frequency of algal blooms.

Table 4-8. Environmental Protection Agency Health Advisory Levels for Cyanotoxins

Age	EPA Health Advisory Level	
	Microcystins	Cylindrospermopsin
Less than 6 years	0.3 µg/L	0.7 µg/L
6 years and above	1.6 µg/L	3.0 µg/L

4.4.4 Groundwater Quality

The City of Bloomington installed two groundwater wells within the St. Peter aquifer. In addition to supplementing the surface water sources' safe yield, the wells are anticipated to provide a source water that is free from nitrates and consistent year-round that can be used for blending with the surface water sources. Data from one round of sampling from Well 1 showed no measurable presence of nitrate, as expected. However, the water from Well 1 and Well 2 does contain radionuclides that exceed some EPA MCL limits for drinking water. Other water quality parameters that were found to exceed their EPA or IEPA limits were chloride, fluoride, and boron. As a result, use of the well water would likely require treatment for these parameters or blending with the lake sources to lower the finished water concentrations to acceptable levels. Well 1 had similar hardness and alkalinity to the surface water sources while the pH was slightly lower. Well 1 and Well 2 sampling also shows chloride to sulfate mass ratio (CSMR) of 2.7-2.9. This relatively high CSMR indicates this groundwater has the potential to be more corrosive than the current surface water.

4.5 Finished Water Quality

Finished water is delivered from the Bloomington WTP to customers in Bloomington, Towanda, Hudson, and Bloomington Township. The City of Bloomington provides safe drinking water to its customers as consumer confidence reports dating back to 2014 show no violation of EPA or IEPA drinking water regulations. A summary of the key water quality parameters is below in **Table 4-9**.

Table 4-9. City of Bloomington Historical Finished Water Quality

Water Quality Category	Finished Water	Primary MCL	Secondary MCL
pH [1]	8.8 – 9.2	None	6.5 – 8.5
Hardness [1]	72 – 139 mg/L as $CaCO_3$	None	None
Alkalinity [1]	31 – 112 mg/L as $CaCO_3$	None	None
Turbidity [1]	95th percentile: 0.10 – 0.31 NTU	95th percentile: 0.3 NTU	None
Chlorine [1]	3.0 – 4.6 mg/L	4.0 mg/L	None
Nitrate [1]	0.6 – 9.2 mg N/L	10 mg N/L	None
Fluoride [1]	0.7 – 1.1 mg/L	1.4 mg/L	2.0 mg/L
Chloride [2]	31 – 48 mg/L	None	250 mg/L
Sulfate [2]	19 – 38 mg/L	None	250 mg/L
Total dissolved solids [2]	180 – 330 mg/L	None	500 mg/L
Lead [3]	LCR: 2.1 – 3.9 µg/L Non-LCR: Non-detect – 2.1 µg/L	15 µg/L	None
Copper [3]	LCR: 0.059 – 0.078 mg/L	1.3 mg/L	None
Total Organic Carbon [4]	1.2 – 2.8 mg/L	None	None
Sodium [5]	10 – 18 mg/L	None	None
Iron [5]	0.01 – 0.039 mg/L	None	0.3 mg/L
Manganese [5]	0.002 mg/L	None	0.05 mg/L
Barium [5]	0.011 – 0.046 mg/L	2.0 mg/L	None
Atrazine [6]	Non-detect – 1.1 µg/L	3 µg/L	None
Arsenic [5]	1.6 µg/L	10 µg/L	None
Total Chromium [7]	1.6 – 2.5 µg/L	100 µg/L	None
Chromium (VI) [7]	1.5 – 2.4 µg/L	100 µg/L	None
Cyanotoxins [8]			
Cylindrospermopsin	Non-detect	None	None
Anatoxin-a	Non-detect	None	None
Microcystin	Non-detect	None	None
Taste and Odor [9]			
Geosmin	Non-detect – 64 ng/L Typically ranges from 5 – 20 ng/L	None	None
2-methylisoborneol	Non-detect – 21 ng/L Typically <10 ng/L	None	None
Radionuclides [5]			
Gross alpha	0.941 pCi/L	15 pCi/L	None
Combined radium	1.075 pCi/L	5 pCi/L	None
Disinfectant/Disinfection Byproducts [5]			
HAA5	26 – 33 µg/L	60 µg/L	None
TTHM	35 – 46 µg/L	80 µg/L	None
Chloramines	3.2 – 3.5 mg/L	4.0 mg/L	None
Corrosion Index	**Bloomington Finished Water**		**Recommended**
Aggressive Index	12.6		> 12

Water Quality Category	Finished Water	Primary MCL	Secondary MCL
Ryznar Index	7.68		6.5 – 7.0
Langelier Index	0.68		> 0
Calcium Carbonate Precipitation Potential	5.35 mg/L		4 – 10 mg/L
Larson's Ratio	1.4		< 5.0

Notes:

[1] Range of monthly averages at the WTP outlet. pH, hardness, turbidity, and fluoride data were collected from 2014-2017. Alkalinity and chlorine data were collected from 2001-2017. Nitrate data was collected from January 2010 - December 2018.
[2] Data collected once in January from 2006-2017 from the WTP outlet.
[3] Sampled in the distribution system. LCR data is 90th percentile valve spanning 2014-2017.
[4] TOC data was collected once monthly from January 2014 to March 2018.
[5] Data is from 2014-2017 annual consumer confidence reports.
[6] Atrazine is sampled 2-4 times annually from 2014-2018.
[7] Sampled from distribution system in four sampling events in January 2012 and January 2013 through March 2013.
[8] Cyanotoxins were non-detect in all finished water samples tested in an independent lab using the LCMS method.
[9] Taste and odor compounds were measured from November 2004 to November 2006 and April 2017 to February 2019. Data were not available in the years 2007 through 2016.

4.5.1 Nitrate

The City of Bloomington's surface water sources (Lake Bloomington and Evergreen Lake) contain seasonally-high levels of nitrate. To ensure the finished water nitrate does not exceed 10 mg N/L, the City switches their raw water source between Lake Bloomington and Evergreen Lake. This nitrate control strategy could fail if the nitrate concentration in both surface water sources exceeds 10 mg N/L. Since the January 2010, the highest finished water nitrate level measured was 9.2 mg N/L. The Bloomington WTP has no process that can significantly lower nitrate. **Figure 4-2** compares finished water nitrate level to that of both raw water sources and the EPA MCL.

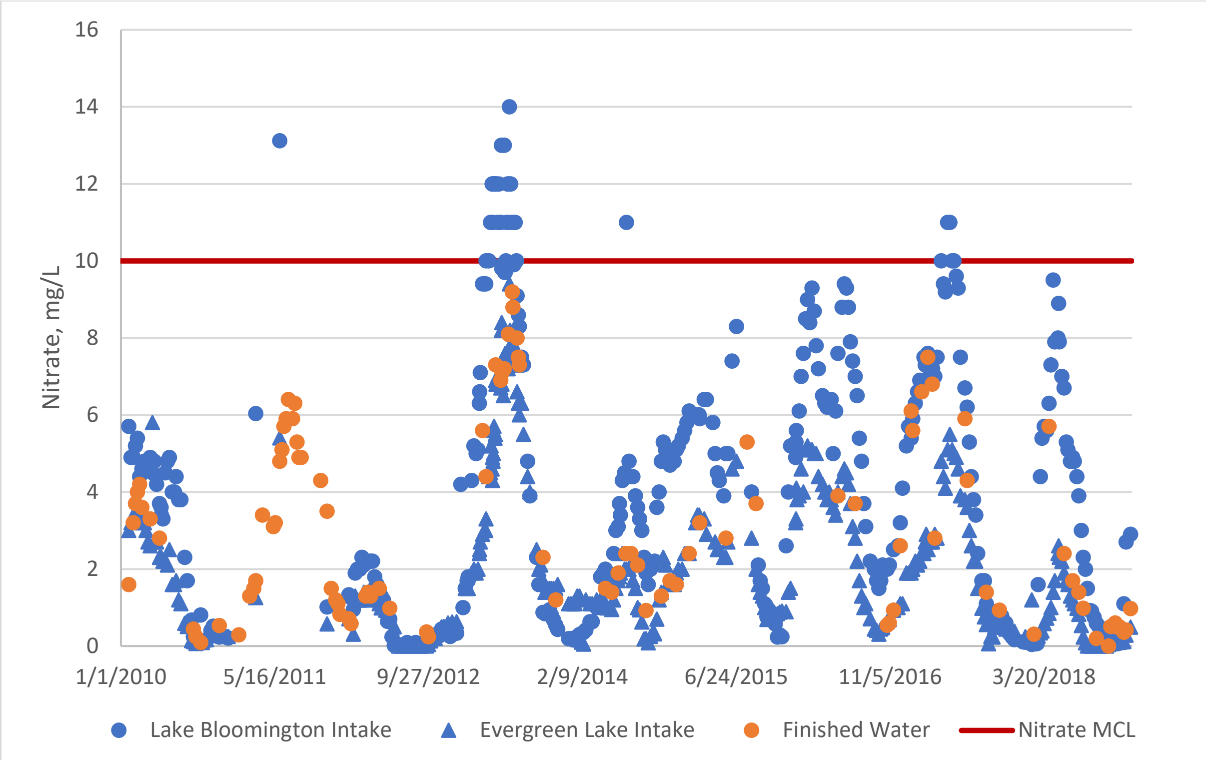

Figure 4-2. Raw and Finished Water Nitrate Concentrations in Relation to Nitrate MCL

While the strategy of alternating the source water between Lake Bloomington and Evergreen Lake has been successful for achieving acceptable levels of nitrate, this strategy may fail in the future if nitrate levels rise. **Section 4.6** discusses potential strategies for increasing the reliability for the City of Bloomington to achieve compliance with the nitrate standard.

4.5.2 Hardness, Alkalinity, and pH

The Bloomington WTP uses lime softening to reduce the finished water hardness to a target range of 80 to 120 mg/L as $CaCO_3$. The typical range of alkalinity in the finished water is 50 to 100 mg/L as $CaCO_3$. During treatment, alkalinity is removed in the softening and recarbonation processes. Hardness and alkalinity do not have any primary or secondary drinking water standards. Reducing hardness can be beneficial to the distribution system and building plumbing systems, as very hard water can cause problematic scale to build up.

Finished water pH is consistently between 8.8 and 9.2. pH is raised during the lime softening process and lowered by recarbonation – lowering pH, along with adding sodium hexametaphosphate, is necessary to prevent further calcium carbonate precipitation in the downstream treatment processes and in the distribution system.

4.5.3 Lead and Copper

The EPA mandated Lead and Copper Rule (LCR) sets a lead action level of 15 µg/L and a copper action level of 1.3 mg/L. Compliance sampling is conducted on "high risk" homes every three years. In order to be compliant with the LCR, the 90th percentile lead and copper concentrations must be below their action limit. Consumer confidence reports dating back to 2002 show no violations of the LCR within the City's system. Lead and copper are absent from water leaving the treatment plant but can enter the water through corrosion of service lines and plumbing fixtures. The City controls finished water pH and alkalinity to limit corrosion in the distribution system and building plumbing systems. Corrosion indices listed in **Table 4-10** are in a favorable non-corrosive range and tends to form a protective calcium scale. Caution should be taken whenever a change is made to water quality, such as blending new groundwater sources with existing surface water sources as the blend may alter the corrosivity of the finished water supply. Since the groundwater from Well 1 and Well 2 have lower pH and high CSMR, adding the groundwater to the raw water blend could increase the corrosivity of the finished water. The impact of groundwater on the corrosion control strategy should be carefully examined during planning, study, and design effort related to incorporating groundwater into the treatment.

Due to the recent increased awareness of lead in our public water supplies, the EPA is reexamining the Lead and Copper Rule and may propose lowering the 90th percentile concentration allowable in the system. It is likely that the 90th percentile concentration will be lowered to 10 µg/L and there has been some discussion by individual states of lowering the 90th percentile concentration to 5 µg/L. As displayed in **Table 4-10**, past LCR data shows that City of Bloomington will still be in compliance should the EPA lower the 90th percentile concentration to 10 µg/L. The City of Bloomington's 90th percentile lead concentration has exceeded 5 µg/L in the past, so if the IEPA were to lower the 90th percentile concentration to 5 µg/L, the City of Bloomington might consider a different corrosion control strategy such as treatment with phosphoric acid or removal of lead service lines.

Table 4-10. Lead Sampling Results

<table>
<tr><th colspan="3">LCR Monitoring 90th Percentile</th></tr>
<tr><th>Monitoring Period</th><th colspan="2">90th Percentile Lead</th></tr>
<tr><td>2002 – 2004</td><td colspan="2">1 µg/L</td></tr>
<tr><td>2005 – 2007</td><td colspan="2">6 µg/L</td></tr>
<tr><td>2008 – 2010</td><td colspan="2">2.4 µg/L</td></tr>
<tr><td>2011 – 2013</td><td colspan="2">2.6 µg/L</td></tr>
<tr><td>2014 – 2016</td><td colspan="2">2.1 µg/L</td></tr>
<tr><td>2017 – present</td><td colspan="2">3.9 µg/L</td></tr>
<tr><th colspan="3">Non-LCR Monitoring</th></tr>
<tr><th>Sample Site</th><th>Date</th><th>Lead Concentration</th></tr>
<tr><td>Site 1</td><td>8/1/2016</td><td>1.4 µg/L</td></tr>
<tr><td>Site 2</td><td>6/12/2017</td><td>2.1 µg/L</td></tr>
<tr><td>Site 3</td><td>8/10/2017</td><td>Non-detect</td></tr>
<tr><td>Site 4</td><td>10/5/2017</td><td>Non-detect</td></tr>
<tr><td>Site 5</td><td>11/30/2017</td><td>1.1 µg/L</td></tr>
<tr><td>Site 6</td><td>1/29/2018</td><td>Non-detect</td></tr>
<tr><td>Site 7</td><td>2/2/2018</td><td>Non-detect</td></tr>
<tr><th colspan="3">Lead Service Line Replacement Pilot Project</th></tr>
<tr><th>Residence</th><th>Pre or Post Construction</th><th>Lead Concentration</th></tr>
<tr><td rowspan="2">Residence 1</td><td>Pre</td><td>Non-detect</td></tr>
<tr><td>Post</td><td>Non-detect</td></tr>
<tr><td rowspan="2">Residence 2</td><td>Pre</td><td>Non-detect</td></tr>
<tr><td>Post</td><td>Non-detect</td></tr>
<tr><td rowspan="2">Residence 3</td><td>Pre</td><td>2.2</td></tr>
<tr><td>Post</td><td>1.5</td></tr>
<tr><td rowspan="2">Residence 4</td><td>Pre</td><td>Non-detect</td></tr>
<tr><td>Post</td><td>1.2</td></tr>
<tr><td rowspan="2">Residence 5</td><td>Pre</td><td>1</td></tr>
<tr><td>Post</td><td>Non-detect</td></tr>
<tr><td rowspan="3">Residence 6</td><td>Pre</td><td>Non-detect</td></tr>
<tr><td>Post</td><td>20</td></tr>
<tr><td>Post</td><td>2.3</td></tr>
<tr><td rowspan="2">Residence 7</td><td>Pre</td><td>2</td></tr>
<tr><td>Post</td><td>2.1</td></tr>
</table>

4.5.4 Turbidity

Finished water turbidity is consistently kept under 0.3 NTU. Turbidity indicates filter effectiveness and high turbidities may signal the presence of pathogenic microbes, so the EPA limits the turbidity to 1 NTU in all samples and 0.3 NTU as the 95th percentile for the samples in any month for treatment plants that use conventional filtration. The finished water turbidity is usually in the range of 0.1 to 0.2 NTU; however, the 95th percentile for January 2016 and April

2016 were both 0.31 NTU. Further analysis determined that these spikes in turbidity were caused by calcium carbonate that formed as a result of an issue with overfeeding lime upstream of filtration and did not violate turbidity guidelines. Turbidity in the form of calcium carbonate is not a risk to public health as opposed to turbidity caused by organic materials or sediment that passes through the water treatment process.

4.5.5 Taste and Odor

Taste and odor issues are subjective to the consumer's sensitivity to taste and smell and can be difficult to quantify. Regardless, the EPA set a secondary standard for odor at 3 TON. Presence of geosmin and 2-methylisoborneol (MIB) can cause taste and odor issues. Historic finished water geosmin and MIB data are shown in **Figure 4-3**. From November 2017 to February 2018, geosmin was measured between 10 and 30 ng/L. This aligns with consumer complaints about taste and odor from the same period of time and corresponds to spikes in Lake Bloomington and Evergreen Lake geosmin concentrations. In September 2018, there was a spike in MIB to 21 ng/L. GAC filter media, which is used at the Bloomington WTP, can remove taste and odor-causing compounds. However, the effectiveness of GAC media decreases over time, resulting in the need to periodically replace the GAC media to restore its treatment effectiveness. According to a 2004 study on Bloomington's GAC usage, Bloomington changes the GAC in their filters every 2-3 years, which is more frequent than the manufacturer's 4-year performance guarantee.

If taste and odor issues persist beyond treatment with GAC, CDM Smith recommends the City add powdered activated carbon (PAC) downstream of the raw water pump station. PAC is often used to combat taste and odor issues and there is a bonus of additional organic contaminant removal. The existing PAC system should be replaced. PAC is typically added at a concentration of 10-15 mg/L. To achieve this range, the feed should feed 35-52 lb/hr of PAC slurry assuming a flow rate of 10 MGD.

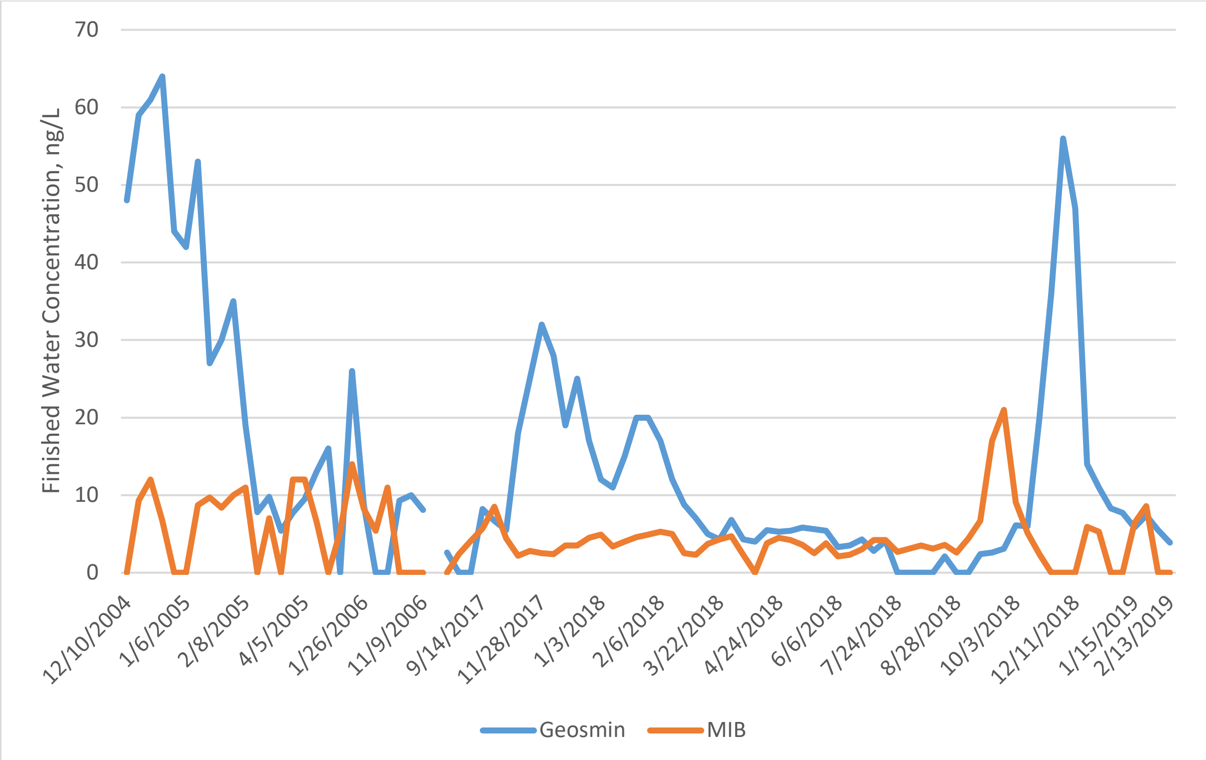

Figure 4-3. Geosmin and MIB Concentration in Finished Water from December 2004 to November 2006 and August 2017 to February 2019

4.5.6 Disinfection Byproducts

EPA drinking water standards limits the sum of the five most common haloacetic acids (HAA5) to 60 µg/L and total trihalomethanes (TTHMs) to 80 µg/L. These compounds are the by-product of chlorine disinfectant reacting with organic carbon. The annual consumer confidence reports show that the City of Bloomington finished water complies with these standards; typical HAA5 concentration is around 30 µg/L and typical TTHM concentration is between 35 and 45 µg/L. Total organic carbon (TOC) concentration is related to disinfection by-product (DBP) formation. Higher TOC concentration will increase the amount of DBPs that form. The City of Bloomington finished water has TOC in the 1.0 to 2.5 mg/L range. Finished water TOC should be monitored closely as a sudden rise could create a DBP issue.

The Stage 1 Disinfection By-Product Rule (DBPR) sets TOC removal requirements based on source water TOC and alkalinity. Lake Bloomington and Evergreen Lake typically have TOC between 2.0 and 4.0 mg/L and alkalinity above 120 mg/L as $CaCO_3$. At these levels, the Stage 1 DBPR requires 15 percent TOC removal during treatment. Occasionally, the source water TOC is above 4.0 mg/L or the alkalinity dips below 120 mg/L as $CaCO_3$. In these rare instances, the Stage 1 DBPR requires 25 percent to 35 percent TOC removal. The WTP consistently achieves greater than 35 percent TOC removal, so meeting the Stage 1 DBPR requirements is typically not a concern throughout the normal range of source water TOC and alkalinity levels.

The water treatment plant adds ammonia to form chloramines as the secondary disinfectant. While chloramines reduce THAA and TTHM formation, they form a different class of DBPs called nitrosamines. Nitrosamines are not regulated by the EPA or IEPA but are on the EPA's contaminant candidate list for potential future regulations. One sample from 2010 shows concentrations of N-nitrosodimethylamine (NDMA), a common nitrosamine, at 5.4 to 5.6 ng/L. NDMA may be regulated in the future and the most commonly cited potential future MCL is 10 ng/L. It appears that Bloomington will be below the MCL; however, future study may be needed should this regulation become reality.

4.6 Long-Term Nitrate Compliance Strategies

The following alternative long-term strategies were identified that could increase the reliability for the City of Bloomington to comply with finished water quality standards for nitrate:

- Upgrade the Bloomington WTP to remove nitrate using ion exchange treatment.
- Implement blending of well water with the source water at the head of the Bloomington WTP.
- Implement blending of well water with the filtered water at the Bloomington WTP.
- Implement blending of treated water with the filtered water at the Bloomington WTP.
- Upgrade the Bloomington WTP to remove nitrate using biological denitrification.

Each of these alternative strategies is discussed in more detail below. Because the groundwater is predicted to have a higher corrosive tendency than the surface water sources, the viability of the options that implement blending of ground water with surface water is dependent on determining that the finished blended water will not introduce any corrosion-related issues.

4.6.1 Upgrade the Bloomington WTP to Remove Nitrate Using Ion Exchange Treatment

Under this strategy, a new ion exchange treatment system would be added to the existing Bloomington WTP after filtration, as shown in **Figure 4-4**. Since ion exchange can remove a high percentage of nitrate (90 percent to 95 percent), only a portion of the filtered water would need to be treated with ion exchange to achieve a blended finished water with an overall nitrate concentration that is reliably less than the regulatory standard.

The ion exchange system would consist of ion exchange media within a pressure vessel. Ion exchange systems need to be periodically regenerated using a sodium chloride solution. This regeneration process creates a liquid brine waste high in nitrates, sodium, and chloride that must be disposed of, typically to the sanitary sewer. Based upon the location of the Bloomington WTP, brine disposal is expected to be challenging. Disposal via a sanitary sewer would require construction of a 15-mile force main that connects the water treatment plant to the wastewater treatment plant. Bloomington's other disposal option is to use tanker trucks to transport the brine to an independent treatment facility. Both disposal options incur high capital or recurring costs.

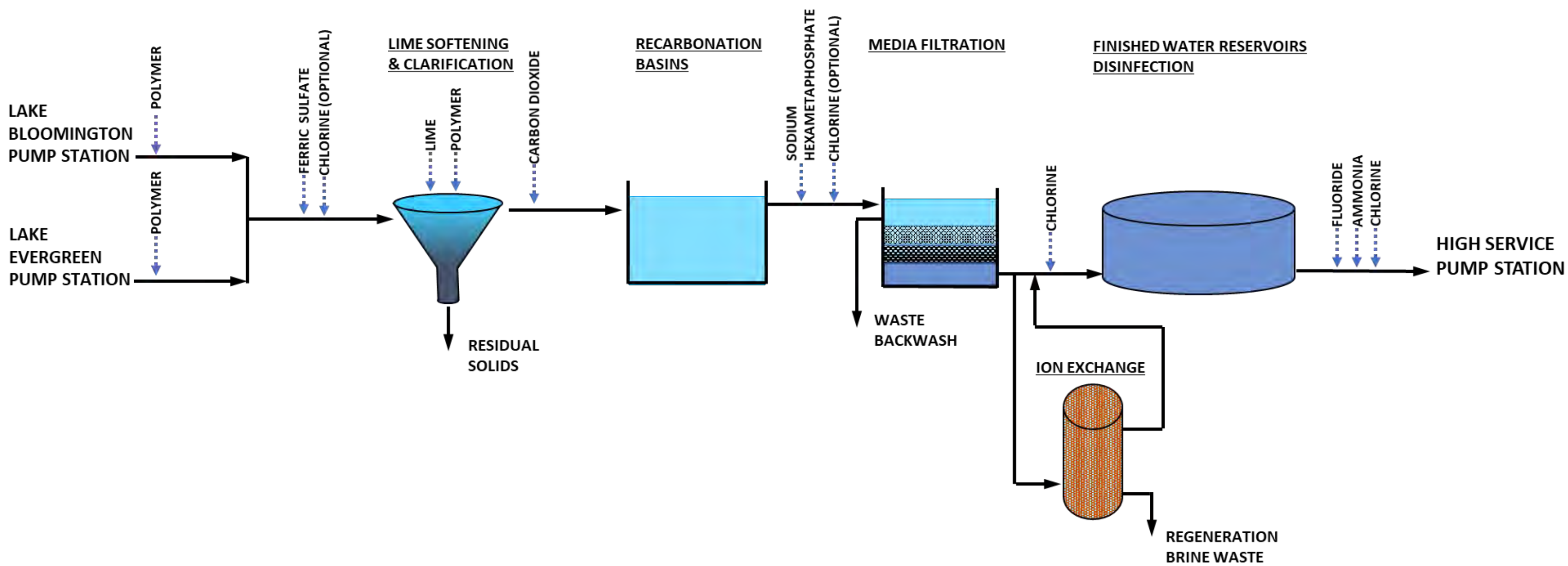

Figure 4-4. City of Bloomington Water Treatment Process Schematic with the Addition of Ion Exchange for Nitrate Removal

4.6.2 Implement Blending of Well Water with the Source Water at the Head of the Bloomington WTP

Under this strategy, groundwater would be pumped to the Bloomington WTP where it would be blended with the surface water coming from Lake Bloomington and/or Evergreen Lake and receive the full lime softening/filtration treatment, as shown in **Figure 4-5**. Since the groundwater has a naturally low level of nitrate concentration, it would lower the nitrate concentration in the blended water. Through the lime softening process, the hardness contribution from the well water would be reduced. The lime softening process would also remove many of the radioactive contaminants that are present in the groundwater. The impact of these radioactive contaminants on the sludge produced by the softening process would need to be evaluated further.

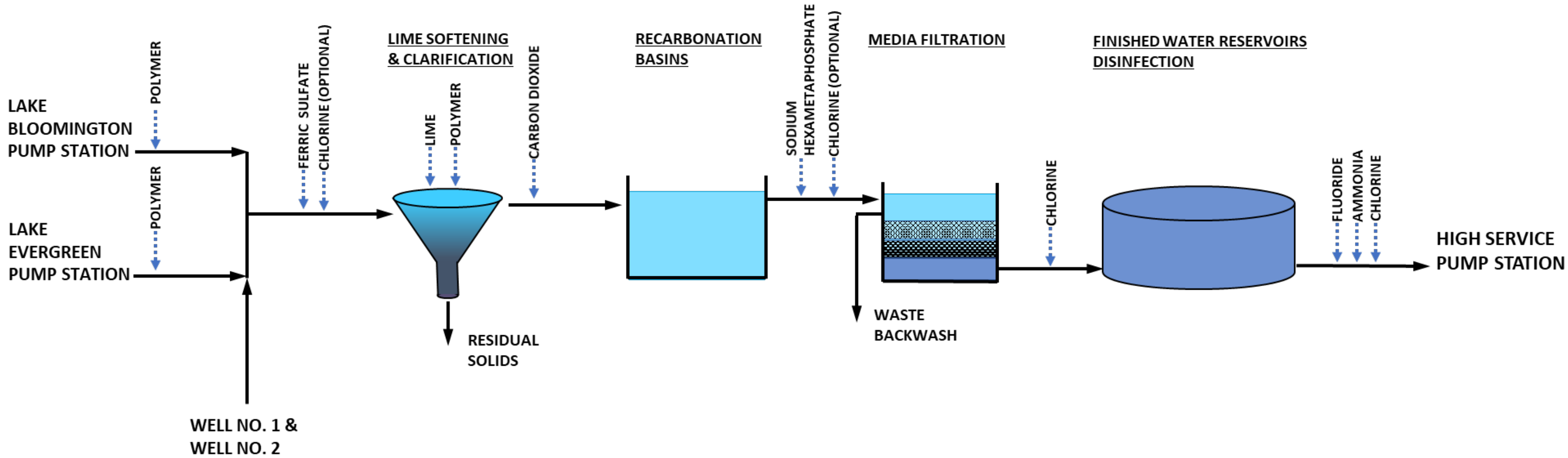

Figure 4-5. City of Bloomington Water Treatment Process Schematic with the Addition of Groundwater to the Head of the Treatment Process

WaterPro modeling software was used to predict key parameters of the blended water quality. **Table 4-11** contains the estimated raw water quality parameters if 8.2 million gallons per day (MGD) of the City of Bloomington's surface water from Lake Bloomington or Evergreen Lake is blended with 1.8 MGD of groundwater from Well 1 and Well 2. The average value of each parameter was used in the blend model except for nitrate, in which the maximum value from 2010-2018 was used. Note that **Table 4-12** does not predict finished water quality – it is only the raw water quality being fed at the head of the treatment plant.

Table 4-11. Predicted Water Quality of Blending 8.2 MGD Surface Water and 1.8 MGD Groundwater

Parameter	Result
TDS [1]	521 mg/L
pH [1]	8.13
Total alkalinity [1]	166 mg/L as $CaCO_3$
Total calcium [1]	48.4 mg/L
Nitrate [2]	12.3 mg/L
Chloride [3]	135 mg/L
Sulfate [3]	51.4 mg/L
Magnesium	16.5 mg/L
Fluoride[2]	0.9 mg/L
Boron	0.2 mg/L
DIC	40.3 mg/L as C
Gross alpha	4.0 pCi/L
Gross beta	2.6 pCi/L
Radium 226 and 228	2.2 pCi/L
Uranium	0.04 µg/L
Corrosion Indices	
Aggressive Index	12.4
Ryznar Index	7.21
Langelier Saturation Index	0.46
Calcium Carbonate Precipitation Potential	9.61 mg/L as $CaCO_3$
Larson Ratio	1.5

Notes:

[1] Groundwater data was only available from Well 1.
[2] Input the highest concentration measured in the City of Bloomington's surface water between 2010-2018.
[3] Raw water data was unavailable. Estimated to be approximately the same as the finished water concentration.

Table 4-12 shows that blending the raw surface water with the two existing wells will not bring raw water nitrate below the EPA MCL of 10 mg N/L under the worst-case nitrate condition and average demand conditions (roughly estimated at 10 MGD). To ensure nitrate stays below 10 mg N/L, Bloomington will need to construct additional groundwater wells. Assuming each groundwater well can produce 0.9 MGD, a total of four (4) wells with a combined flow of 3.6 MGD will need to be in service to meet the nitrate MCL under worst case conditions and average demand conditions. To meet the maximum demand (estimated at 20.1 MGD), a total of eight (8) wells are required to be in operation. It is also recommended that an additional well is kept on standby for redundancy. The cost of introducing a single new well to the treatment process is approximately $1 million, making the estimated cost of adding seven (7) new wells approximately $7 million, excluding the cost to connect the wells to the water treatment plant (estimated at $3 million). **Table 4-12** shows the predicated raw water quality with four wells in service for a flow of 10 MGD.

Table 4-12. Predicted Raw Water Quality of Blending 6.4 MGD Surface Water and 3.6 MGD Groundwater

Parameter	Result
TDS [1]	692 mg/L
pH [1]	8.00
Total alkalinity [1]	176 mg/L as $CaCO_3$
Total calcium [1]	44.8 mg/L
Nitrate [2]	9.6 mg/L
Chloride [3]	231 mg/L
Sulfate [3]	84.1 mg/L
Magnesium	15.9 mg/L
Fluoride[2]	1.2 mg/L
Boron	0.4 mg/L
DIC	43.0 mg/L as C
Gross alpha	8.0 pCi/L
Gross beta	5.2 pCi/L
Radium 226 and 228	4.3 pCi/L
Uranium	0.08 µg/L
Corrosion Indices	
Aggressive Index	12.3
Ryznar Index	7.40
Langelier Saturation Index	0.30
Calcium Carbonate Precipitation Potential	6.96 mg/L as $CaCO_3$
Larson Ratio	2.3

Notes:

[1] Groundwater data was only available from Well 1.
[2] Input the highest concentration measured in the City of Bloomington's surface water between 2010-2018.
[3] Raw water data was unavailable. Estimated to be approximately the same as the finished water concentration.

Blending the raw surface water with groundwater is not expected to have a large impact on the operation of the City of Bloomington's lime softening process. Raw water calcium and magnesium are predicted to be slightly lowered with the blend, but not by a large amount. The groundwater wells already contain approximately 2.5 mg/L of fluoride, meaning the City of Bloomington would need to lower the fluoride being fed to stay below the EPA MCL of 4 mg/L. However, blending the surface and groundwater will raise the raw water's corrosivity prior to the softening process. While combined radium and alpha particles come close to exceeding their MCL of 5 pCi/L and 15 pCi/L, respectively, their concentrations are expected to be lowered in the lime softening process, since lime softening is considered one of the best available treatment options for reduction of radionuclides.

The corrosion indices of the existing raw water firmly classify it as non-corrosive. Increases in chloride and sulfate and lowering pH with the blend will move the water closer to the corrosive classification but will still be overall non-corrosive. Corrosion indices are imperfect measures of a water's corrosivity. Conducting a bench scale test using water treatment plant piping can give the City of Bloomington a more definitive answer to the blended water's impact of corrosion. Implementing this nitrate control strategy is contingent on the determination that blending the raw water sources will not create corrosion-related issues in water treatment plant and distribution system piping.

4.6.3 Implement Blending of Well Water with Filtered Water at the Bloomington WTP

Under this strategy, groundwater would be pumped to the Bloomington WTP where it would be blended with the filtered water ahead of the CT contact basin, as shown in **Figure 4-6**. After blending the water would be treated with chlorine, ammonia, and fluoride, but the groundwater would receive no other treatment. Since the well water has a naturally low level of nitrate concentration, it would lower nitrate concentration in the blended water. The well water would increase the levels of radionuclides in the finished water, although it is expected that a blend ratio could be achieved such that both nitrate levels and radionuclide levels would be within acceptable levels. The groundwater would also slightly increase the hardness levels in the blended water. **Table 4-13** shows the estimated water quality parameters of the blended filtered water assuming the Bloomington WTP treats 8.2 MGD of surface water and adds 1.8 MGD of well water. The average value of each parameter was used in the blend model except for nitrate, in which the maximum value from 2010-2018 was used.

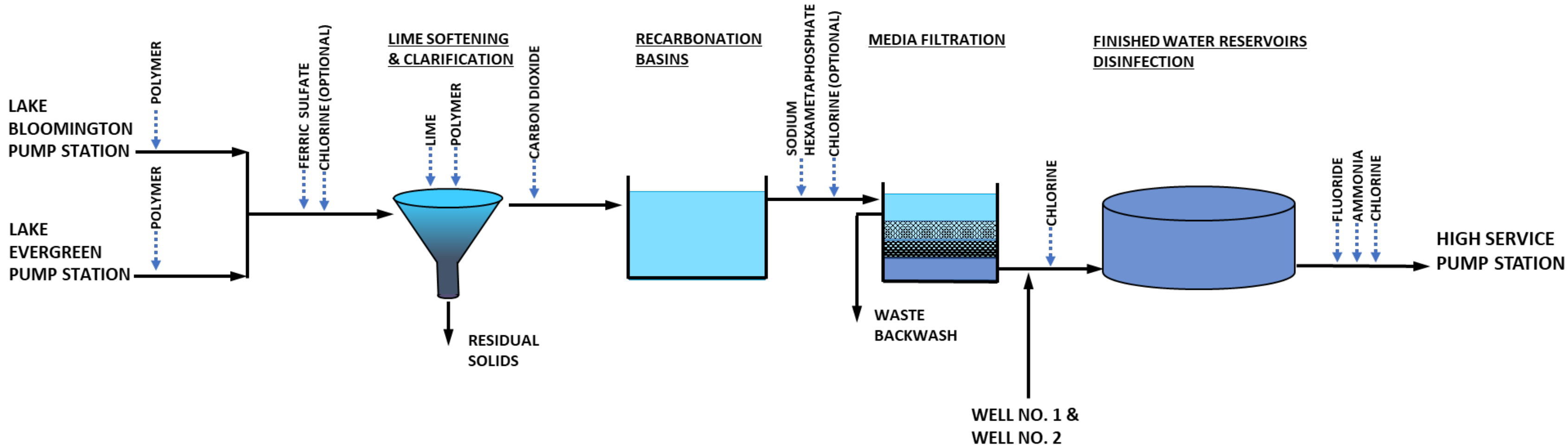

Figure 4-6. City of Bloomington Water Treatment Process Schematic with the Addition of Untreated Groundwater to the Filtered Water

Table 4-13. Predicted Finished Water Quality of Blending 8.2 MGD Filtered Water and 1.8 MGD Groundwater

Parameter	Result
TDS [1]	398 mg/L
pH [1]	8.53
Total alkalinity [1]	84.1 mg/L as $CaCO_3$
Total calcium [1]	28.7 mg/L
Nitrate [2]	7.5 mg/L
Chloride	135.4 mg/L
Sulfate	54.1 mg/L
Magnesium	8.7 mg/L
Fluoride	1.4 mg/L
Boron	0.2 mg/L
DIC	19.96 mg/L as C
Gross alpha	4.0 pCi/L
Gross beta	2.6 pCi/L
Radium 226 and 228	2.2 pCi/L
Uranium	0.04 µg/L
Corrosion Indices	
Aggressive Index	12.3
Ryznar Index	7.83
Langelier Saturation Index	0.35
Calcium Carbonate Precipitation Potential	2.88
Larson Ratio	2.9

Notes:

[1] Groundwater data was only available from Well 1.

[2] Input the highest concentration measured in the City of Bloomington's finished water between 2010 and 2018.

If, in the future, the levels of nitrate in the filtered water increase to the levels currently measured in the source waters, then the blend ratio needs to adjust. For example, 15 mg N/L was once measured in an Evergreen Lake tributary. If the filtered water nitrate gets as high at 15 mg N/L, then a total of 3.6 MGD of groundwater would need to be blended with the filtered water to bring the nitrate to an acceptable level. As discussed in **Section 4.6.2**, additional wells would need to be added for capacity and redundancy, and the total cost of adding the wells and associated infrastructure is approximately $10 million. **Table 4-14** shows the predicted water quality when 3.6 MGD of groundwater is blended with 6.4 MGD of surface water.

Table 4-14. Predicted Finished Water Quality of Blending 6.4 MGD Filtered Water and 3.6 MGD Groundwater

Parameter	Result
TDS [1]	596 mg/L
pH [1]	8.14
Total alkalinity [1]	112.2 mg/L as $CaCO_3$
Total calcium [1]	29.4 mg/L
Nitrate [2]	5.9 mg/L
Chloride	231 mg/L
Sulfate	86.1 mg/L
Magnesium	9.8 mg/L
Fluoride [2]	1.7 mg/L
Boron	0.4 mg/L
DIC	27.2 mg/L as C
Gross alpha	8.0 pCi/L
Gross beta	5.2 pCi/L
Radium 226 and 228	4.3 pCi/L
Uranium	0.08 µg/L
Corrosion Indices	
Aggressive Index	12.0
Ryznar Index	7.99
Langelier Saturation Index	0.08
Calcium Carbonate Precipitation Potential	0.91
Larson Ratio	2.7

Notes:

[1] Groundwater data was only available from Well 1.

[2] Input the highest concentration measured in the City of Bloomington's finished water between 2010 and 2018.

Blending Bloomington's current finished water with raw groundwater will have several impacts on the distribution system water quality aside from the lower level of nitrate. Primarily, introducing raw groundwater to the finished water would expose consumers to radionuclides at levels higher than blended groundwater with raw surface water because a portion of the radionuclides would not be removed during lime softening. The fluoride in the blend is predicted to exceed the IEPA limit of 1.4 mg/L due to the high level of fluoride in the groundwater and the fluoride dose applied during treatment. The City may be required to lower their fluoride dose to stay below the IEPA limit. Blending groundwater with the existing finished water will introduce radionuclides to the finished water, but the proposed groundwater-to-finished water blend ratios are low enough for the predicted levels of radionuclides to remain below their EPA MCLs. When the groundwater-to-finished water blend ratio is increased to approximately 4.0 MGD:6.0 MGD, then the blended finished water is expected to exceed the combined radium MCL of 5.0 pCi/L. Bloomington should regularly monitor radionuclides in the ground water should this blending strategy be implemented.

The finished water corrosion indices, which are mostly impacted by the lower pH and higher levels of chloride and sulfate, indicate that the finished water blend will be more corrosive than the current finished water. Indices such as Calcium Carbonate Precipitation Potential and the Ryznar Index are outside of their recommended range for corrosion prevention. The Aggressive Index is on the edge of being moderately corrosive in the blending scenario shown in **Table 4-14**. Should Bloomington further consider implementing this blending strategy, conducting a bench scale test using lead and unlined iron pipe in their distribution system is highly recommended to gain a better understanding of the impact their finished water quality change will have on corrosion. If a corrosive tendency is observed in the blended water, Bloomington can investigate a corrosion inhibitor such as a blended phosphate or phosphoric acid. Blended phosphate is considered a better deterrent for iron release while phosphoric acid is a better deterrent for lead release. The implementation of this nitrate control strategy is contingent on the determination that the blended water will not create corrosion-related issues in the distribution system.

4.6.4 Implement Blending of Treated Well Water with the Filtered Water at the Bloomington WTP

Under this strategy, water from Well 1 and Well 2 would be pumped to the Bloomington WTP where some or all of the water would be treated with reverse osmosis (RO) to remove radionuclides to acceptable levels. Treated well water would then be blended with the filtered water ahead of the CT contact basin, as shown in **Figure 4-7**. After blending the water would be treated with chlorine, ammonia, and fluoride. The treated well water would have low levels of nitrate and hardness such that it would lower nitrate and hardness concentration in the blended water. WaterPro cannot model RO treatment and cannot be used to predict the finished water quality under this strategy. However, RO would significantly remove dissolved constituents such as chloride, sulfate, and hardness ions and radionuclides present in the groundwater wells. RO treatment generates a continuous brine waste stream that would need to be disposed of. Presence of radionuclides in the RO brine can eliminate disposal options such as deep well injection or sanitary sewer disposal. As discussed in **Section 4.6.1**, the brine can be disposed of by construction a 15-mile force main to the wastewater treatment plant or by trucking the brine to a disposal facility. Like the other blending alternatives, implementation of this nitrate control strategy depends on the determination that the finished water blend will not create corrosion-related issues in the distribution system.

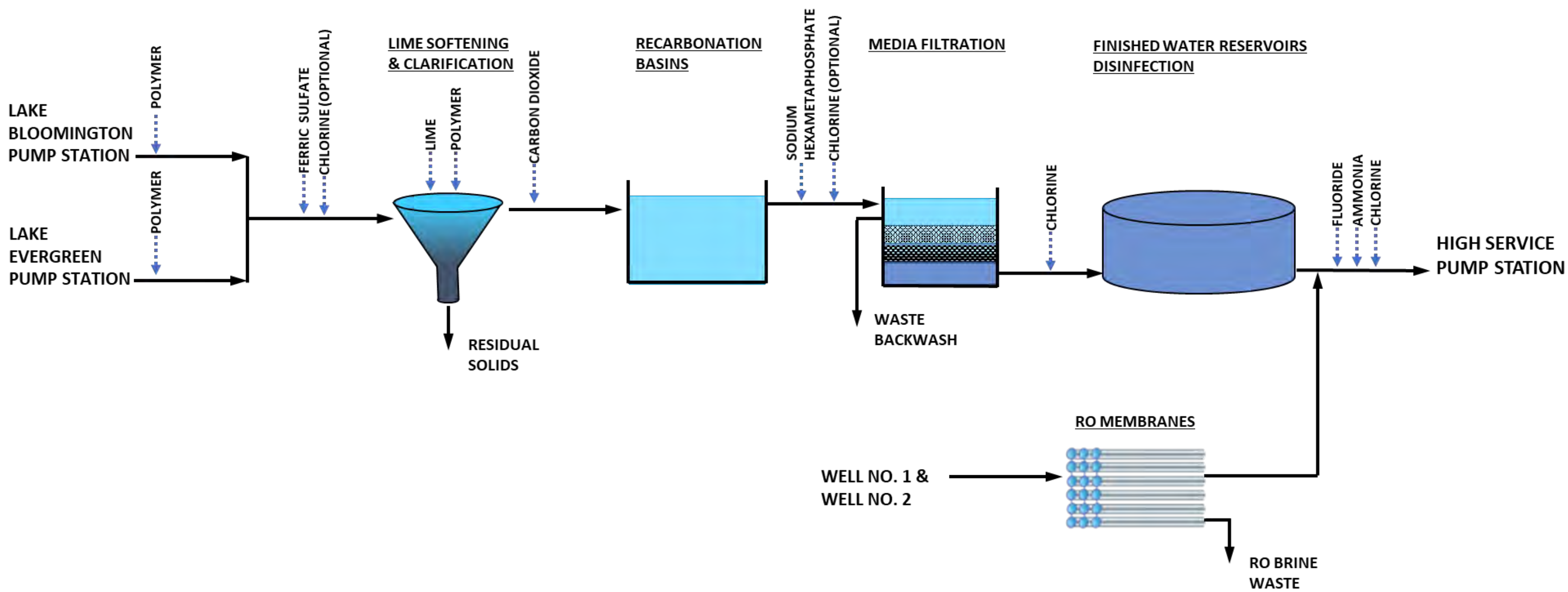

Figure 4-7. City of Bloomington Water Treatment Process Schematic with the Addition of Reverse Osmosis Treated Groundwater to the Filtered Water

4.6.5 Add Biological Nitrate Removal Post-Filtration

Under this strategy, a portion of the City of Bloomington's filtered water will pass through a biological denitrification process where nitrate is converted to nitrogen gas, which can be safely released to the atmosphere. The process will consist of an open bioreactor that contains a biocatalyst media. The biocatalyst is a porous polymeric composite containing denitrifying bacteria. During operation, the biocatalyst is suspended in the tank and is in contact with the water allowing denitrification to occur. A schematic of the City of Bloomington's water treatment process including biological nitrate removal is shown in **Figure 4-8**.

Biological denitrification has low operating costs; however, it can be challenging to operate it seasonally and maintain a healthy biomass for conversion of nitrate to nitrogen gas. The reactor startup time can take days or weeks following a dormancy period. The bioreactors are unable to immediate treat sudden spikes in nitrate should they occur while the reactor is dormant. Using historical nitrate data and regularly monitoring the source waters and their tributaries, the City can predict when a spike in nitrate is likely to occur and resume operation of the bioreactor weeks in advance. The bioreactor can also operate year-round including during periods of low nitrate as the biocatalyst can adapt to changing influent conditions. A low amount of concentrated waste is generated compared to the other nitrate removal processes presented in this section.

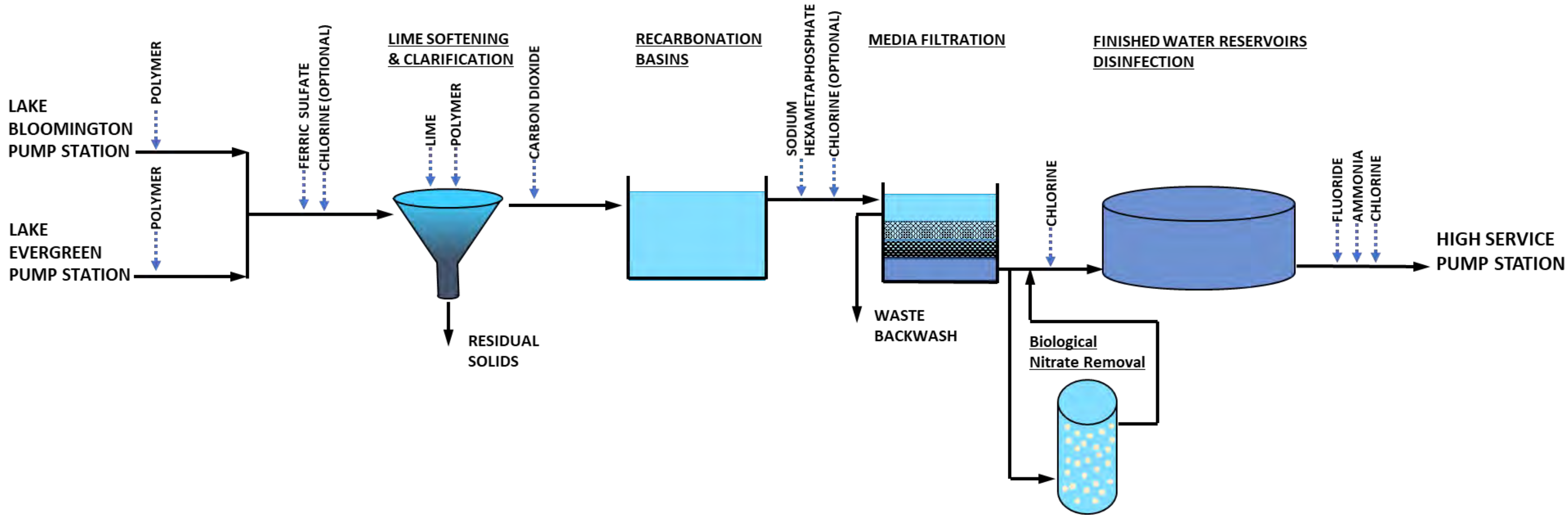

Figure 4-8. City of Bloomington Water Treatment Process Schematic with the Addition of Biological Nitrate Removal to the Finished Water

4.6.6 Comparison of Nitrate Compliance Alternatives

Table 4-15 presents a comparison of the advantages and disadvantages of the nitrate compliance alternatives. **Table 4-16** presents a capital cost comparison of each alternative.

Table 4-15. Advantages and Disadvantages of Proposed Nitrate Control Strategies

Alternative	Advantages	Disadvantages
Upgrade WTP with Ion Exchange	▪ Does not severely alter finished water quality. ▪ Might only need to be operated on a seasonal basis.	▪ Adding new treatment process incurs high capital and recurring costs. ▪ Creates brine waste that needs to be disposed of. ▪ Does not increase safe yield of water supply.
Blend Well Water with Source Water at the Head of the WTP	▪ Low cost. ▪ Lime softening can remove a portion of the radionuclides present in the groundwater. ▪ Increases safe yield of water supply.	▪ High chloride to sulfate ratio and lower pH in the finished water can cause corrosion issues in the distribution system. ▪ Changing influent water quality could impact performance of lime softening and filtration processes. ▪ Radionuclides would be present in the softening sludge.
Blend Untreated Well Water with Filtered Water in the WTP	▪ Low cost. ▪ Lime softening, and filtration performance will not be affected. ▪ Increases safe yield of water supply.	▪ High chloride to sulfate ratio and lower pH in the finished water can cause corrosion issues in the distribution system. ▪ Radionuclides present in the groundwater can create regulatory compliance issues.
Blend RO Treated Well Water with Filtered Water in the WTP	▪ Removes impurities that are harmful to health (radionuclides) and that impact distribution system corrosion (chloride and sulfate). ▪ RO-softened groundwater could ease the lime softening requirements for the surface water. ▪ Increases safe yield of water supply.	▪ Adding new treatment process incurs high capital and recurring costs. ▪ Creates a brine waste that needs to be disposed of.
Biological Nitrate Removal	▪ Low cost. ▪ No concentrated waste stream. ▪ Relatively low maintenance and operating cost. Biocatalyst can be used for several years.	▪ Adding new treatment process incurs high capital cost. ▪ Startup can take days to weeks making it ineffective against unexpected spikes in nitrate if left dormant. ▪ Does not increase safe yield of water supply.

Table 4-16. Cost Comparison of Proposed Nitrate Control Strategies

Alternative	Capital Cost Estimate
Upgrade WTP with 7.0 MGD of Ion Exchange (includes brine disposal costs estimated at $20 million)	$35,000,000
Blend Well Water with Source Water at the Head of the WTP [1]	$10,000,000
Blend Untreated Well Water with Filtered Water in the WTP	$10,000,000
Blend RO Treated Well Water with Filtered Water in the WTP (includes brine disposal costs estimated at $20 million)	$30,000,000
Biological Nitrate Removal	$10,000,000

Notes:

[1] Cost assumes that presence of radionuclides in the softening sludge does not change disposal requirements.

Based upon discussions held during the workshop on April 2, 2019, the recommendation was to blend additional groundwater with the surface water at the head of the Bloomington WTP. This option was the most cost-effective method for reducing nitrate and not introducing radionuclides into the finished water. Additionally, the groundwater sources would provide additional water supply and resiliency during drought conditions by increasing the overall safe yield. Studies to determine the impact of blending on corrosion in the distribution system and radionuclides on disposal of the softening sludge is recommended.

4.7 Summary

Based upon the analysis of water quality and compliance with current and potential future regulations, the following improvements/projects are recommended:

- Add a powdered activated carbon system to remove taste and odors from the water. Estimated capital cost of $500,000.
- Add additional groundwater supplies to allow blending at the head of the water treatment plant for nitrate compliance and increase the safe yield of the water supply. Estimated capital cost of $10,000,000.
- Sludge disposal study to determine impact of radionuclides. Estimated cost of $50,000.
- Conduct a distribution system corrosion study to verify the impacts of the groundwater blending with surface water. Estimated cost of $100,000.
- Conduct the risk and resiliency assessment as required per the new regulations. Estimated cost of $100,000.

Section 5

Water Treatment Plant, Storage and Pump Station Assessment

5.1 Introduction

CDM Smith conducted a condition assessment of various water facilities for the City of Bloomington, including the Bloomington Water Treatment Plant (WTP), Mackinaw River Pump Station, Evergreen Lake Pump Station, Division Street Pump Station, Enterprise Zone Pump Station, Fort Jesse Road Pump Stations A and B, Main Street Booster Pump Station, and Lime Sludge Lagoons. As part of this condition assessment, a dive inspection was performed on the 5-million-gallon (MG) and 10 MG reservoirs at the Division Street facility. This Section summarizes the condition of the structures outlined above, proposed improvements, and additional details for projects identified by the City of Bloomington staff.

CDM Smith also conducted performance testing (where feasible and allowed by the City of Bloomington staff) of the pumps at the Bloomington WTP (High and Low Lift), Evergreen Lake Pump Station, Fort Jesse Pump Stations A and B, Division Street Pump Station, and Enterprise Zone Pump Station. CDM Smith also conducted a regulatory review for the water system. Results of the pump performance testing and the regulatory review are presented in separate sections.

5.2 Exiting Water Treatment Plant Background

The Bloomington WTP is a lime softening treatment plant with conventional filtration. The Bloomington WTP primarily treats surface water from Lake Bloomington and Evergreen Lake. However, the facility has the ability to transfer water from the Mackinaw River to Evergreen Lake when necessary and in accordance with ACOE permit requirements. The Bloomington WTP was originally constructed in 1929. Filter building expansions occurred in 1952 and 1964. The latter expansion also added a softening basin and recarbonation basins. In 1986, the Bloomington WTP underwent a major expansion/upgrade, including the addition of what is now called the Main Process Building. This expansion added additional filters, high lift pumps, two ClariCone® treatment basins, and a filtered water reservoir. Two additional ClariCone® treatment basins and a building over all four ClariCone® treatment basins were added in 1999. As part of this expansion, the original Dorr-Oliver clarifiers were removed from service and abandoned.

Major components of the treatment process and water supply system for the Bloomington WTP include:

- Intakes and Source Water Pumps
- Softening / Clarification
- Recarbonation
- Filtration
- Filtered Water Reservoir
- High Service Pumps
- Chemical Storage and Feed Systems
- Residuals
- Remote Facilities

These systems are described in **Section 5.4**.

5.3 Approach

A multidiscipline CDM Smith team performed site assessments of the Bloomington WTP between October 3, 2017 and October 5, 2017 and the remote pump station facilities between October 10, 2017 and October 11, 2017. This team included representatives from process, civil, electrical, architectural, mechanical, and structural to examine the Bloomington WTP condition. A CDM Smith specialist in the discipline of system controls and integration visited the Bloomington WTP and remote sites on December 18, 2017. These assessments consisted of a plant walk-through with the operators for all disciplines involved, review of plant records on equipment and unit processes, and conversations with operators regarding operational status of equipment.

CDM Smith and Collins Engineering performed a dive inspection of the 5 MG and 10 MG reservoirs at the Division Street location on January 22, 2018. The divers performed a visual and audible sounding of the reservoirs and communicated via radio communication to describe the findings to an engineer located in a truck. The findings were recorded and a report summarizing the findings was provided (included in **Appendix A**).

CDM Smith and ME Simpson performed pump testing by collecting flow, head, and wire to water efficiency measurements, and compared these values with the original or existing pump curves. Pump testing was completed on the Low Service Pumps at the Bloomington WTP, Low Service Pumps at Evergreen Lake, High Service Pumps, Fort Jesse Pumps A and B, Division Street Pumps, and Enterprise Zone Pumps. Of the 27 pumps at the facilities, 20 were tested, and the remaining 7 pumps were not able to be tested due to the pumps not being available for testing or testing was not feasible.

Based on a review of the above information, a list of projects was developed and assessed a rating class based on the priority of the improvement. A conceptual planning-level cost estimate was developed for each project (0%-2% project definition) in 2019 dollars. The expected accuracy range is -30 percent to +50 percent. Costs were escalated above equipment costs to include undeveloped design details, engineering, and contractors' fees. Costs will need to be escalated further to account for inflation based upon the actual implementation schedule.

As part of the condition assessment, assets were classified based upon their condition and intended use as follows:

- Problem Class 1: A condition in which failure of a primary item of equipment or structure is imminent, and its failure would directly result in loss of a significant portion of plant capacity, jeopardize water quality, jeopardize the safety of personnel, or cause further damage to equipment or other structures.

- Problem Class 2: A condition in which failure of a backup unit of equipment or structure is imminent, and failure to attend to the problem would result in loss of backup capacity, jeopardize the safety of personnel, or cause further damage to equipment or other structures (e.g., a device providing the first level of backup, such as an engine generator or the third pump in a bank of three pumps in which two pumps will be required to meet peak requirements).

- Problem Class 3: A condition of failure or imminent failure in some ancillary equipment or structure (e.g., leaking window frames), the failure of which will not impair the process or safety, but may lead to deterioration which could result in increasing repair costs if not attended to in a timely manner.
- Problem Class 4: Improvement which has not been made but which would result in protecting the status quo with regard to water quality, water quantity, or safety (e.g., updating lighting fixtures).
- Problem Class 5: Anything which should be corrected or improved, which is not listed above, and the failure of which does not imperil water quality, water quantity, or safety (e.g., removal of equipment which is not in use).

Each condition assessment finding was also classified by function categories, which are as follows:

- O (Operational Items): Items that directly affect the production or quality of water and the expense of remediation would be covered under a capital improvement project.
- N (Non-Operational Items): Items that do not directly affect the production or quality of water and the expense for remediation would be covered under a capital improvement project.
- M (Maintenance Items): Items that the expense for remediation would be covered under a maintenance budget, as opposed to being treated as an individual capital project under the capital budget.

5.4 Condition Assessment Findings

This Section presents the detailed findings from the site visits and interviews with City of Bloomington staff.

5.4.1 General Performance

WTP staff indicated that the current WTP capacity is limited by hydraulic bottlenecks that would need to be addressed to meet projected water demands. The current average day finished water pumping is approximately 10.4 million gallons per day (MGD), and the recorded daily maximum pumping in 2016 was 13.2 MGD. The projected maximum day flow for the planning year 2040 is 21.3 MGD. The plant has a rated capacity of 24 MGD; however, it is projected that the WTP would have difficulty meeting this rated capacity without significant upgrades and modifications, due primarily to hydraulic bottlenecks within the Bloomington WTP. Hydraulic calculations suggest that the current maximum plant capacity is approximately 17.5 MGD.

5.4.2 Intakes and Source Water Pumps

The Bloomington WTP has the capability to receive source water from either Lake Bloomington or Evergreen Lake. Under normal operation, Evergreen Lake is the primary source used to supply the Bloomington WTP. Bloomington WTP staff report increased tastes and odors from occasional algal spikes in the source water during the summer period, typically coming from Lake Bloomington. During these events, Bloomington WTP staff typically minimizes the amount of source water that is pulled from Lake Bloomington to minimize tastes and odors, impacts to the treatment process, and chemical usage. Under emergency conditions, and in accordance with the Army Corps of Engineers permit, the water plant has the ability to transfer water to Evergreen Lake from the Mackinaw River.

5.4.2.1 Lake Bloomington Supply System

The Bloomington WTP is located on the shore of Lake Bloomington. Water can flow from the lake into the Low Lift Pump Station through two 20-inch diameter intake pipes, each located to pull water from a different lake depth. Each intake pipe is equipped with a fixed barrel-type strainer to prevent large debris from entering the intake pipes. In addition, a thermal destratifier was installed in 1991 to mix and aerate the water near the intakes to maintain a uniform dissolved oxygen level in the source water.

The Low Lift Pump Station is equipped with two horizontal centrifugal pumps and one end suction centrifugal pump, as shown in **Table 5-1**. The firm capacity (i.e., capacity with the largest pump out of service) of the pump station is 15,400 gpm (22.18 MGD). Source water from Lake Bloomington is pumped to the 36-inch raw water header pipe. Raw water flow from Lake Bloomington is measured using a raw water flow meter that is currently non-functional. Cationic polymer is added to the low lift discharge piping and the Lake Bloomington Low Lift Pump Station.

Table 5-1. Lake Bloomington Low Lift Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	7,000 gpm	Horizontal Centrifugal	1977	Allis-Chalmers	Constant Speed
2	8,400 gpm	End Suction Centrifugal	1987	Patterson	Variable Speed
3	10,400 gpm	Horizontal Centrifugal	2001	Patterson	Variable Speed

The Low Lift Pump Station structures are aging and in need of rehabilitation. Some of the equipment, such as variable frequency drives (VFDs), have reached the end of their anticipated reliable life and are in need of replacement. Various valves and instruments appear to be non-functioning. The layout of the Low Lift Pump Station also does not comply with the latest recommendations or standards from the Hydraulic Institute (HI), which can result in shortened equipment lift, increased maintenance requirements, and the inability of pump suppliers to warranty replacement pumps in this configuration. Detailed findings from the assessment are presented in **Appendix B** and **Appendix C**.

It is CDM Smith's recommendation to eventually replace the existing pump station with a new pump station that meets HI standards.

5.4.2.2 Evergreen Lake Supply System

The Evergreen Lake Pump Station is located on the shore of Evergreen Lake. Water can flow from the lake into the pump wetwell through six 30-inch diameter inlet structures located to pull water from two different lake depths. Each inlet structure has a fixed barrel-type strainer to prevent large debris from entering the intake wetwell. In addition, a thermal destratifier was installed in 1991 to mix and aerate the water near the intakes to maintain a uniform dissolved oxygen level in the source water.

The Evergreen Lake Pump Station is equipped with three vertical turbine pumps, as shown in **Table 5-2**, that convey source water to the Bloomington WTP. The firm capacity of the pump station is 9,300 gpm (13.39 MGD). Source water from Evergreen Lake is pumped to the 20-inch raw water header pipe (inside the pump station and then increases to 30-inch outside the pump station). Raw water flow from Evergreen Lake is measured using a raw water flow meter that is currently non-functional. Cationic polymer is added to the low lift discharge piping.

Table 5-2. Evergreen Lake Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	5,800 gpm	Vertical Turbine	1986	Byron-Jackson	Variable Speed
2	3,500 gpm	Vertical Turbine	1967	Byron-Jackson	Variable Speed
3	8,400 gpm	Vertical Turbine	1986	Byron-Jackson	Variable Speed

The structures and equipment at the Evergreen Lake Pump Station are generally in fair to good condition, although some equipment, such as the Limitorque valve actuators and the flow meters, are not reliable and/or not functional. Detailed findings from the assessment of the Evergreen Lake Pump Station are presented in **Appendix B** and **Appendix C**.

5.4.2.3 Softening/Clarification

Lime softening and clarification treatment processes are used to remove hardness and turbidity from the raw source water. The source water pumped from Lake Bloomington and/or Evergreen Lake combines in a 36-inch raw water header pipe as it travels to the static mixer vault where ferric sulfate coagulant and chlorine can be added. Control valves split the flow following the static mixer between the online clarifiers. Lime softening/clarification of source water is performed in four helical-flow solids contact clarifiers (ClariCones®). The North ClariCones® have a diameter of 51'-6" each. The South ClariCones® are larger at 64'-0" diameter, each.

Lime slurry is added to the center of each clarifier to raise the pH for softening. Anionic polymer is added to the sludge blanket in the Clari-Cone to assist in clarification of solids within the treatment units. Sludge is withdrawn through the sludge collection hopper in the center of each ClariCone®. The collection hopper conveys sludge out the bottom of each clarifier where it is then pumped to the sludge lagoons as described below.

An additional clarifier (Infilco Accelator) is not currently in use.

Table 5-3. Bloomington Water Treatment Plant Clarifiers

Clarifier No.	Rated Capacity	Diameter (Surface / Lowest Slurry Concentration Line)	Approximate Loading Rate at Slurry Concentration Line [1]	Type	Year Installed
1 (North)	5.25 MGD	51'-6" / 51'-6"	1.75 gpm/sf	Helical Upflow Solids Contact Clarifier (ClariCone®)	1986
2 (North)	5.25 MGD	51'-6" / 51'-6"	1.75 gpm/sf	Helical Upflow Solids Contact Clarifier (ClariCone®)	1986
3 (South)	7.0 MGD	64'-0" / 59'-6"	1.75 gpm/sf	Helical Upflow Solids Contact Clarifier (ClariCone®)	1999
4 (South)	7.0 MGD	64'-0" / 59'-6"	1.75 gpm/sf	Helical Upflow Solids Contact Clarifier (ClariCone®)	1999

Note:

[1] The ClariCones at the Bloomington WTP are rated based on the diameter of the cone at the slurry concentration line. For Clarifiers Nos. 1 and 2, this is equal to the diameter of the clarifier while for Clarifiers Nos. 3 and 4 this is equal to a diameter slightly smaller than that of the clarifier.

Section 4.2.5 of the Recommended Standards for Water Works, commonly known as the Ten States Standards applies to solids contact clarifiers. (The Ten States Standards are incorporated into the Illinois regulations by reference.) Per the Ten States Standards Subsection 4.2.5.13, contact clarifier unit loading rates at the slurry concentration line shall not exceed 1.75 gpm/sf (gallons per minute per square foot of process area) for units operated as softeners. The existing ClariCones® clarification rates fall within the allowable limits of the Ten States Standards for softeners.

The total rated capacity of the four ClariCones® is 24.5 MGD. In addition, Bloomington WTP staff report that the Bloomington WTP has historically treated capacities up to 22 MGD when the Infilco Accelator unit was still in service. However, since the Infilco Accelator unit is not currently in service, the Bloomington WTP softening process has not been able to treat this elevated capacity. It appears that the capacity limitation results from hydraulic bottlenecks within the existing piping between the ClariCones® and recarbonation basins, as discussed further below.

While the ClariCone® clarifier basins appear, and are all reported to be, generally in good condition, many of the associated instruments and appurtenances are non-functional or in need of maintenance. Detailed findings from the assessment of the softening/clarification processes are presented in **Appendix B** and **Appendix C**.

5.4.2.4 Recarbonation

Recarbonation is performed to lower the pH after the softening process and to stabilize water to stop precipitation of calcium carbonate in the downstream processes. Aqueous carbon dioxide is dosed in the clarifier effluent piping below the effluent drop box of each ClariCone®. The Bloomington WTP currently targets a pH of 9.0 after recarbonation. Carbon dioxide is dosed to pace the effluent flow rate of each bank of ClariCones® and trimmed to obtain the target pH. The pH meter for each bank of ClariCones® is located approximately 25 to 30 feet downstream of each carbon dioxide dosage point. Sodium hexametaphosphate is added to the effluent from the recarbonation basins to sequester calcium and further reduce post precipitation of calcium carbonate within the filters.

Water is then conveyed to two parallel, circular, and open Recarbonation Basins. Each Recarbonation Basin contains an influent weir and diffuser chamber where gaseous carbon dioxide diffusers were originally located. The effluent of each Recarbonation Basin has a serpentine V-notch "finger weir."

The recarbonation basins were determined to be a major hydraulic bottleneck that limits the maximum achievable production rate for the Bloomington WTP (see **Section 6**). The bottleneck is attributable to the height of the recarbonation basin influent weirs and the large amount of lime solids that have precipitated in the recarbonation basin influent piping. Precipitation of lime solids downstream of carbon dioxide addition indicates that the water is not being fully stabilized in the recarbonation process. Bloomington WTP staff also reported that insufficient mixing may be provided between the carbon dioxide addition point and the pH meter thus potentially resulting in inaccurate dosing of carbon dioxide. The City of Bloomington is considering installing recarbonation basin bypass piping to overcome the hydraulic bottleneck. CDM Smith recommends discussing this improvement with Illinois Environmental Protection Agency (IEPA) to determine if IEPA will allow elimination of the detention time after recarbonation. CDM Smith also recommends performing a recarbonation study to investigate improving water stability downstream of the softening process and mixing of carbon dioxide.

5.4.2.5 Filtration

Following recarbonation, the settled water is filtered to remove particles, including many waterborne pathogens. The filter basins are located within two separate areas of the Bloomington WTP: The Old Plant Building (West Filters) and the Main Process Building (East Filters), as shown in **Table 5-4**.

Table 5-4. Bloomington Water Treatment Plant Filters

Location	Reported Capacity (each filter)	Surface Area	Loading Rate	Media	Filter Nos.	Year Installed
Old Plant Building (West Filters)	0.5 to 0.75 MGD	435 sq-ft (sf)	0.8 to 1.2 gpm/sf	19-inches GAC 12-inches sand	2 – 4 (Filter 1 out of service)	1929
					5 – 8	1952
					6 – 11 (Filter 12 out of service)	1964
Main Process Building (East Filters)	2.5 to 3.0 MGD	462.25 sf	3.75 to 4.5 gpm/sf	24-inches GAC 12-inches sand	13 – 18	1986

Old Plant Building (West Filters)

The 12 West Filters are located in the Old Plant Building. Bloomington WTP staff have reported that the maximum capacity of each filter is approximately 0.5 MGD to 0.75 MGD with a corresponding surface loading rate of 0.8 gpm/sf to 1.2 gpm/sf. However, individual filters appeared to be operating at higher rates during the site visit. Two filters (Filter 1 and Filter 12) are currently removed from service for repairs. The current total capacity of the West Filters is estimated to be approximately 7.5 MGD.

Filter media consists of 19 inches of granular activated carbon (GAC) over 12 inches of sand. The original four filter basins were constructed in 1929, with four additional filter basins constructed in 1952 and again in 1964. The original filter underdrains have not been replaced since they were constructed. Backwash is provided by duty/standby vertical turbine backwash pumps. The backwash pumps take water from the clearwell in the Old Plant Building. Each backwash pump has a rated capacity of 8,700 gpm. The filters are normally backwashed after approximately every 70 hours of operation. Auxiliary wash is performed with a fixed nozzle surface wash system.

The Old Plant Building is in need of significant improvements and/or replacement. The following deficiencies were identified with the West Filters:

- The existing flow meters are inaccurate causing the control algorithm to produce inconsistent filter flow between filters and throughout filter runs (e.g., flow surges), which increase the risk for turbidity breakthrough.
- The primary factor limiting the total capacity of the West Filters appears to be hydraulic bottlenecks on the water flow to the filters.
- The existing filters provide inadequate freeboard for recommended filter backwash procedures leading to reduced backwash effectiveness and potential media loss during backwash.
- The filter pipe gallery has limited headroom for operation and maintenance.
- The surface wash system needs to be replaced.
- The West Filters are installed on an uneven hydraulic grade line from the East Filters which results in a hydraulic imbalance between the two banks of filters. This also limits the filter runtimes and the performance of the East Filters.

Detailed findings from the assessment of the Old Plant Building are presented in **Appendix B** and **Appendix C**.

Main Process Building (East Filters)

The Main Process Building has six gravity, dual-media filters. Bloomington WTP staff have reported that the maximum capacity of each filter is approximately 2.5 MGD to 3.0 MGD with a corresponding surface loading rate of 3.75 gpm/sf to 4.5 gpm/sf. The current total capacity of the East Filters is estimated to be approximately 18 MGD. Filter media consists of 24 inches of GAC over 12 inches of sand. The filters were originally constructed in 1986. The filter underdrains were recently replaced with Leopold Type XA plastic block laterals. Auxiliary wash is performed with a surface wash system with sweeps. Backwash is provided by two backwash pumps, each with a rated capacity of 4,600 gpm. It is expected that both backwash pumps would need to be operated simultaneously to obtain adequate supply for a standard high-rate backwash. The filters are normally backwashed after approximately every 70 hours of operation.

The following deficiencies were reported with the East Filters:

- The 8-inch diameter effluent piping on the East Filters creates an extreme hydraulic bottleneck at higher plant flows and greatly reduces available filtering head.
- Many of the valve and instruments associated with the main process building filters are non-functional and in need of rehabilitation or replacement.
- The filter troughs are not level or set at the same elevation. This leads to uneven and less-effective backwash.
- Backwash supply piping does not appear to have adequate air release, potentially resulting in air being introduced at an uncontrolled rate into the filter underdrains during backwash. This can lead to filter underdrain failure.
- Filter air scour should be considered for auxiliary wash to provide a deeper, more thorough cleaning of the bed.
- There is no standby pumping capacity for high-rate filter backwash.
- The ability to filter to waste is not available.

A filter study is recommended to ascertain additional improvements required for the East Filters. Detailed findings from the assessment of the main process building filters are presented in **Appendix B** and **Appendix C**.

5.4.2.6 Filtered Water Reservoir

Filtered water flows into a 2 MG filtered water reservoir. Chlorine is added to the filtered water ahead of the reservoir. Baffles were added in 2000 to increase the baffle factor and provide greater credit for chlorine contact time for primary disinfection. The reservoir contains north and south chambers that operate in parallel. The filtered water reservoir was reported to be generally in good condition; however, it was unable to be taken out of service for a detailed inspection.

5.4.2.7 High Service Pumps

Finished water flows from the filtered water reservoir into the high service pump wetwell. The High Service Pump Station is equipped with four vertical turbine pumps, as shown in **Table 5-5**. The firm capacity of the pump station is 24,800 gpm (35.7 MGD). The pumps were initially installed in 1987, although new impellers were added to upgrade the pumps in 2005. The High Service Pump station was reported to be generally in good condition.

Table 5-5. High Service Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	5,500 gpm	Vertical Turbine	1987 (Upgraded 2005)	Johnston Pump Co.	Constant Speed
2	8,500 gpm	Vertical Turbine	1987 (Upgraded 2005)	Johnston Pump Co.	Variable Speed
3	10,800 gpm	Vertical Turbine	1987 (Upgraded 2005)	Peerless	Constant Speed
4	10,800 gpm	Vertical Turbine	1987 (Upgraded 2005)	Peerless	Constant Speed

5.4.2.8 Chemical Storage and Feed Systems

Significant deficiencies were found for many of the chemical storage and feed systems, including lack of compliance with IEPA regulations or the Ten States Standards. Several of the chemical storage areas appear to lack adequate ventilation. Other key deficiencies include lack of chemical containment, lack of calibration columns, lack of day tanks, and lack of safety provisions. Detailed findings from the assessment of the chemical storage and feed areas are presented in **Appendix B** and **Appendix C**.

Lime

Lime slurry is added to the center of each clarifier to raise the pH for lime softening and to assist in the clarification process. The lime slurry is produced in batches by lime slakers within the Main Process Building. There are two 100-ton lime silos that store the lime prior to being fed to the 15-ton day tank and then the lime slakers. Batch lime slakers were installed in 2000 to generate lime slurry stored in two 1,100-gallon slurry tanks. Pumps convey the lime slurry to the clarifiers. The lime slurry piping loop is reported to require frequent maintenance due to design issues and the fact that the lime system does not currently include provision to de-grit the slurry.

Ferric Sulfate

Ferric sulfate is added to the raw water ahead of the clarifiers to assist with the removal of total organic carbon and to assist with the clarification process. The ferric storage and feed system includes two bulk storage tanks, transfer pumps, a day tank, and a metering pump.

Carbon Dioxide

Carbon dioxide is injected into the effluent drop box of each clarifier to lower the settled water pH to stabilize the water and reduce precipitation of calcium carbonate downstream of the clarifiers.

Chlorine

Chlorine solution for disinfection and to control biogrowth can be added to four locations within the Bloomington WTP: (1) the head of the treatment process at the static mixers; (2) the clarified water at the effluent from the recarbonation basins; (3) the filtered water at the influent to the finished water reservoir; and/or, (4) the finished water at the discharge from the high service pumps. The target combined chlorine residual for water leaving the plant is between 3.5 and 4.0 milligram per liter (mg/L).

Chlorine solution is prepared onsite from chlorine gas that is delivered and stored in one-ton cylinders. Duty/standby vacuum regulators control the flow of chlorine gas from the gas cylinders to the four chlorinators (500 ppd capacity, each). Chlorine ejectors mix the chlorine gas into pressurized make-up water that conveys the chlorine solution to the application points.

Chlorine safety equipment consists of a chlorine gas detector and escape pack respirators located at the storage room. There is no ambient gas monitor and alarm at the chemical injection point within the pipe gallery of the Main Process Building. Current industry best practices are to provide a gas scrubber where gas chlorine is used or to convert to a more inherently safer technology, such as sodium hypochlorite.

Ammonia

Ammonia is added at the High Service Pump wetwell to convert the free chlorine residual to chloramines (aka combined chlorine) prior to sending the water to the distribution system. Chloramines provide a more stable form of residual disinfectant that limits the formation of regulated disinfection byproducts, such as trihalomethanes and haloacetic acids. Ammonia is stored onsite in two storage tanks (1,000 gallon and 750 gallon). A 500 ppd ammoniator controls the feed rate of ammonia to the ammonia ejectors.

The ammonia system is currently installed outside of the main Bloomington WTP buildings in an abutting wooden frame shed without adequate ventilation. There is no ambient gas monitor and alarm within the feed shed or at the chemical injection point within the high service pump room.

The existing ammonia feed system does not comply with Ten States Standards and should be replaced.

Cationic Polymer

Cationic polymer is added at both the Lake Bloomington Low Lift Pump Station and the Evergreen Lake Pump Station. Cationic polymer is pumped directly from 55-gallon drums using a single chemical feed pump at each location. Back-up cationic polymer feed pumps are reported to be available as shelf spares.

Anionic Polymer

Anionic polymer is added to the top of clarifiers to aid in the clarification process. Anionic polymer is pumped directly from a 300-gallon intermediate bulk container (IBC) without full containment.

Hydrofluosilicic Acid

Hydrofluosilicic acid is added at the High Service Pump wetwell to provide fluoridation of the finished water. The fluoride storage and feed system is located within the fluoride room and includes two 2,000-gallon bulk storage tanks and two metering pumps. A 350-gallon day tank located within the fluoride room is not currently in use.

Sodium Hexametaphosphate

Sodium hexametaphosphate is added at the effluent from the recarbonation basins to limit calcification on the filters. Granular sodium hexametaphosphate is dissolved into water and pumped directly from an 80-gallon mixing tank.

Powdered Activated Carbon (PAC)

The PAC feed system has been decommissioned and is no longer added as part of the treatment process.

5.4.2.9 Residuals

Clarified solids from the ClariCones® are pumped to three sludge lagoons located to the west of the Bloomington WTP site. Sludge is allowed to settle and accumulate within the lagoons. Decant from the lagoons is periodically pumped back to the head of the treatment process at the Bloomington WTP.

Waste filter backwash water from both the Old Filter Plant and the Main Process Building is collected in the 539,000-gallon Reclamation Basin and is pumped at a reduced rate to the head of the treatment process or to the sludge lagoons.

5.4.2.10 Remote Facilities

Generally, site security provisions, such as security fencing and video surveillance, appear to be lacking at many of the remote site facilities. In addition, many of the facilities are aging and in need of rehabilitation.

Fort Jesse Pump Station A

Fort Jesse Pump Station A was constructed in 1973 and contains four horizontal split-case pumps with varying capacity, as shown in **Table 5-6**. The firm capacity of the pump station is 9,350 gpm (13.46 MGD). The pumps convey water from the Fort Jesse storage tanks to the distribution system.

Table 5-6. Fort Jesse Pump Station A

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	3,125 gpm	Horizontal Centrifugal	1973 (Upgraded 1993)	Allis-Chalmers	Constant Speed
2	3,125 gpm	Horizontal Centrifugal	1973 (Upgraded 1993)	Allis-Chalmers	Constant Speed
3	3,100 gpm	Horizontal Centrifugal	1993	ITT - Ac	Constant Speed
4	3,125 gpm	Horizontal Centrifugal	1973 (Upgraded 1993)	Allis-Chalmers	Constant Speed, with Engine Backup

The brick framed pump station building is approximately 1,500 square feet with an elevated walkway on the west and north sides that drops down to the pump pit.

The motor control center (MCC) is aging and may need to be replaced. Accuracy and functionality of various instruments and gauges should be evaluated. Detailed findings from the assessment of the Fort Jesse Pump Station A are presented in **Appendix B** and **Appendix C**.

Fort Jesse Pump Station B

Fort Jesse Pump Station B was constructed in 1993 and contains three horizontal split-case pumps, as shown in **Table 5-7**. The firm capacity of the pump station is 8,600 gpm (12.38 MGD). The pumps convey water from the Fort Jesse storage tanks to the distribution system.

Table 5-7. Fort Jesse Pump Station B

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	4,500 gpm	Horizontal Centrifugal	1993	ITT - Ac	Constant Speed
2	4,300 gpm	Horizontal Centrifugal	1993	ITT - Ac	Variable Speed
3	4,300 gpm	Horizontal Centrifugal	1993	ITT - Ac	Variable Speed

The pump station is a masonry framed building with a wood truss roof of approximately 2,200 square feet. The building also contains a control room and chlorine feed system, and storage. The chlorine feed system includes 1,000 ppd chlorinator that feeds from 150-lb chlorine gas cylinders.

Symptoms of cavitation were reported, suggesting a potentially serious hydraulic condition that should be evaluated further. Accuracy and functionality of various instruments and gauges should be evaluated. Detailed findings from the assessment of the Fort Jesse Pump Station B are presented in **Appendix B** and **Appendix C**.

Division Street Pump Station

The Division Street Pump Station was originally constructed in 1952 and contains four pumps, as shown in **Table 5-8**. The firm capacity of the pump station is 7,637 gpm (11.0 MGD). The pumps are in the basement level and are accessed via an elevated walkway, and all are constant speed pumps. The original motors and electrical equipment are located on the first floor. The pumps convey water from the Division Street Reservoirs to the distribution system.

Table 5-8. Division Street Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	2,430 gpm	Vertical Split Case	1997	Aurora	Constant Speed
2	2,430 gpm	Vertical Split Case	1997	Aurora	Constant Speed
3	2,777 gpm	Vertical Split Case	1993	Aurora	Constant Speed
4	2,777 gpm	Vertical Split Case	1993	Aurora	Constant Speed

The brick and precast building has approximately 1,300 square feet on both the main floor and basement.

Accuracy and functionality of various instruments and gauges should be evaluated. The pump drive shafts are failing and in need of replacement. The motors for Pump No. 3 and Pump No. 4

have been reported to be undersized. Detailed findings from the assessment of the Division Street Pump Station are presented in **Appendix B** and **Appendix C**.

Enterprise Zone Pump Station

The Enterprise Zone Pump Station was constructed in 1987, and contains three pumps, as shown in **Table 5-9**. The firm capacity of the pump station is 3,471 gpm (5.00 MGD). The pumps convey water from the Division Street Reservoirs to the isolated, high-pressure zone in the distribution system.

Table 5-9. Enterprise Zone Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	2,777 gpm	Vertical Turbine	1987	Fairbanks-Morse	Variable Speed
2	694 gpm	Vertical Turbine	1987	Fairbanks-Morse	Constant Speed
3	2,777 gpm	Vertical Turbine	1987	Fairbanks-Morse	Variable Speed

The 600 square foot wood and masonry-framed building is located to the north of the Division Street Pump Station and houses three vertical turbine shaft pumps which pull from the clearwell below. One pump has a capacity of 750 gpm while the other two have capacities of 2,780 gpm. The building also includes the pump's associated electrical and HVAC equipment.

The pump station wetwell is covered with grating that is vulnerable to contamination and does not meet Ten States Standards or IEPA regulations for potable water structures. In addition, the grating also makes the pump station vulnerable to flooding. The floor of the wetwell is not raised 6 inches above grade. Grade does not slope away from wetwell. The MCC and UPS are approaching the end of their expected reliable life. Additionally, the MCC does not have a main disconnecting means. Detailed findings from the assessment of the Enterprise Zone Pump Station are presented in **Appendix B** and **Appendix C**.

Main Street Booster Station

The Main Street Booster Station is an underground prefabricated structure with three pumps, as shown in **Table 5-10**. The pumps take suction from the nearby 12-inch diameter water main and boost the pressure to the south and southwest portions of the distribution system.

Table 5-10. Main Street Pump Station

Pump No.	Rated Capacity	Type	Year Installed	Manufacturer	Drive
1	750 gpm	Horizontal centrifugal	2008	Aurora	Variable Speed
2	500 gpm	Horizontal centrifugal	2008	Aurora	Constant Speed
3	750 gpm	Horizontal centrifugal	2008	Aurora	Variable Speed

The walls of the booster station are galvanized steel with a concrete floor. An access hatch provides egress into the booster station.

The current pumps in the station have been reported to be oversized for customer demand, but adequately sized for fire flow demands, within the pressure zone. Accuracy and functionality of various instruments and gauges should be evaluated. Detailed findings from the assessment of the Main Street Pump Station are presented in **Appendix B** and **Appendix C**.

Division Street Reservoirs

There are two finished water storage reservoirs at the Division Street location: a 5 MG reservoir and a 10 MG reservoir. The 5 MG reservoir is a square tank with sides 194'-4" long and a depth of 20'-10". Circular columns support a flat slab with drop panels and column capitals at the top and bottom slabs. The access hatch at the southwest corner has been fitted with a prefabricated FRP vent and instrument structure. Three additional hatches are present for access.

The 10-MG reservoir is a circular tank with a diameter of 302'-0" and a varying depth of 15'-0" at the exterior wall and 25'-6" at the center. The roof slab was added to the open top tank in 1952 and a 6-inch base slab was placed over the original. The roof slab is supported by circular columns with drop panels and column capitals. Access hatches are located at four locations evenly spaced around the perimeter. There is a prefabricated FRP vent and instrument structure located at an opening in the roof in the center of the reservoir. A newer hatch was added at the southern location. Each reservoir at this location is buried by approximately 12 inches of soil fill.

Fort Jesse Water Storage Tanks

To the south of Fort Jesse Pump Station A are two 2 MG storage tanks constructed in 1973 and 1991. These tanks are above grade, circular storage tanks with a steel shell and ring-wall foundation. Each tank has a diameter of 126 feet and a high-water elevation of approximately 22 feet.

The tank roof vents do not appear to conform to the recommendations of AWWA D100 for self-correcting, frost free operation. Detailed findings from the assessment of the Fort Jesse Water Storage Tanks are presented in **Appendix B** and **Appendix C**.

Hamilton Elevated Water Storage Tank

The elevated storage tank is a composite structure: cast-in-place concrete cylindrical pedestal with a welded steel storage tank. The storage tank has a capacity of 2 MG and the pedestal base contains storage and a valve room.

The overflow piping for the tank appears to be undersized for the system. The swing check valves on the outlet piping is non-functional. Detailed findings from the assessment of the Hamilton Elevated Water Storage Tanks are presented in **Appendix B** and **Appendix C**.

Northeast Elevated Water Storage Tank

The Northeast Elevated Storage Tank is a single pedestal steel, elevated water storage tank with a capacity of 400,000 gallons. Although the tank is new and appears to be in good condition, the tank has not been placed in service pending completion of associated improvements to the water mains that supply water to the Fort Jesse storage tanks and Division Street reservoir. Detailed findings from the assessment of the Northeast Elevated Water Storage Tank are presented in **Appendix B** and **Appendix C**.

5.5 Project Summaries

5.5.1 Recommended Projects

Table 5-11 summarizes the number of projects in each discipline by condition and functional category. **Table 5-12** provides the cost of each project by condition and functional category. **Appendix B** has a complete list of the projects by discipline along with a conceptual cost estimate for each. **Appendix C** has a complete list of projects by facility.

Table 5-11. Number of Projects by Problem Class and Functional Category

Discipline	Problem Class / Functional Category	1	2	3	4	5	Total
Site Civil	O	1	0	0	2	0	3
	M	0	0	0	0	4	4
	N	0	0	0	1	2	3
Architectural	O	0	0	0	1	0	1
	M	0	0	0	13	26	39
	N	0	0	10	7	8	25
Structural	O	0	0	0	0	0	0
	M	0	0	0	5	27	32
	N	0	0	0	1	0	1
Process	O	2	15	20	12	4	53
	M	0	0	3	14	18	35
	N	0	3	5	2	5	15
HVAC	O	0	0	0	0	0	0
	M	0	0	0	18	0	18
	N	3	0	3	15	0	21
Plumbing	O	0	0	0	0	0	0
	M	0	0	1	20	0	21
	N	0	0	0	1	2	3
Electrical	O	4	14	7	3	1	29
	M	0	0	2	1	2	5
	N	0	2	0	12	2	16
Instrumentation & Control (I&C)	O	0	0	0	6	1	7
	M	0	0	0	2	0	2
	N	0	0	1	3	0	4
Totals	**O**	**7**	**29**	**27**	**24**	**6**	**93**
	M	**0**	**0**	**6**	**73**	**77**	**156**
	N	**3**	**5**	**19**	**422**	**19**	**88**

CDM Smith

Table 5-12. Cost of Projects by Problem Class and Functional Category

Discipline	Problem Class / Functional Category	1	2	3	4	5	Total
Site Civil	O	$90,000	$0	$0	$0	$0	$90,000
	M	$0	$0	$0	$0	$1,000,000	$1,000,000
	N	$0	$0	$0	$40,000	$200,000	**$240,000**
Architectural	O	$0	$0	$0	$100.000	$0	$100,000
	M	$0	$0	$0	$250,000	$300,000	$550,000
	N	$0	$0	$1,400,000	$40,000	$200,000	**$1,640,000**
Structural	O	$0	$0	$0	$0	$0	$0
	M	$0	$0	$0	$110,000	$420,000	$530,000
	N	$0	$0	$0	$20,000	$0	**$20,000**
Process	O	$80,000	$24,300,000	$2,880,000	$16,170,000	$210,000	$43,700,000
	M	$10,500,000	$0	$580,000	$150,000	$210,000	$11,440,000
	N	$0	$20,000	$100,000	$70,000	$80,000	**$270,000**
HVAC	O	$0	$0	$0	$0	$0	$0
	M	$0	$0	$0	$210,000	$0	$210,000
	N	$150,000	$0	$100,000	$500,000	$0	**$750,000**
Plumbing	O	$0	$0	$0	$0	$0	$0
	M	$0	$0	$10,000	$30,000	$0	$40,000
	N	$0	$0	$0	$20,000	$20,000	**$40,000**
Electrical	O	$500,000	$8,200,000	$2,700,000	$300,000	$300,000	$12,000,000
	M	$0	$0	$30,000	$10,000	$10,000	$50,000
	N	$0	$3,300,000	$0	$700,000	$100,000	**$4,100,000**
Instrumentation	O	$0	$200,000	$0	$380,000	$100,000	$680,000
	M	$0	$0	$0	$10,000	$0	$10,000
	N	$0	$0	$250,000	$20,000	$0	**$270,000**
Totals	O	**$670,000**	**$32,700,000**	**$5,600,000**	**$17,000,000**	**$610,000**	**$56,600,000**
	M	**$10,500,000**	**$0**	**$620,000**	**$770,000**	**$1,940,000**	**$13,830,000**
	N	**$150,000**	**$3,320,000**	**$1,900,000**	**$1,420,000**	**$600,000**	**$7,390,000**

Table 5-13. Summary of Project Costs by Site

Problem Class / Discipline	1	2	3	4	5	Total
Bloomington WTP	$633,000	$35,740,000	$6,791,000	$14,811,000	$1,621,000	$59,595,000
Mackinaw PS	$0	$0	$187,000	$176,000	$228,000	$591,000
Evergreen Lake PS	$0	$241,000	$1,000	$143,000	$29,000	$413,000
Division Street PS	$960,000	$1,006,000	$550,000	$82,000	$93,000	$2,690,000
Enterprise PS	$10,550,000	$0	$10,000	$35,000	$79,000	$10,674,000
Fort Jesse A	$0	$253,000	$25,000	$28,000	$57,000	$363,000
Fort Jesse B	$0	$504,000	$455,000	$5,000	$90,000	$1,053,000
Fort Jesse Tanks	$0	$0	$0	$0	$373,000	$373,000
Main Street BS	$0	$0	$25,000	$3,000	$8,000	$36,000
Lime Sludge Lagoons	$0	$0	$0	$2,640,000	$0	$2,640,000
Hamilton Road Tank	$0	$0	$1,335,000	$11,000	$8,000	$1,354,000
NE Elevated Tank	$0	$0	$0	$0	$1,000	$1,000
Totals	**$12,143,000**	**$37,744,000**	**$9,379,000**	**$17,934,000**	**$2,587,000**	**$79,787,000**

Below is a list of the projects that were ranked as a top priority. This first group of projects were identified as highest priority because they represent a safety issue or impairment to equipment.

Table 5-14. High Priority Projects

Project/ Item No.	Discipline	Finding	Location	Recommendation	Functional Category
B-05-02	HVAC	No chlorine gas scrubber for chlorine rooms.	WTP Main Process Building	Add a chlorine scrubber or replace chlorine gas with sodium hypochlorite.	N
D-05-01	HVAC	Many of the exhaust systems serving chemical and process rooms are not directly routed to the outdoors. Rather, exhaust air is collected from the spaces by exhaust fans located in a common room. The exhaust fan discharge is then routed through the interior spaces of the plant before being discharged. Leaks in the ductwork could result in chemically impacted air discharging into various interior spaces. This is especially critical for exhaust from the chlorine rooms.	WTP Main Process Building	Perform study to determine new route of exhaust systems so that ductwork does not run through other spaces and goes directly outside.	N

Project/ Item No.	Discipline	Finding	Location	Recommendation	Functional Category
B-07-05	Electrical	The variable frequency drive for LLP#2 is in fair/poor condition. This VFD has been in service for ~30 years and has exceeded its anticipated reliable useful life. The plant staff has indicated that this VFD needs to be replaced. Plant staff have recently replaced this VFD. The variable frequency drive for LLP#3 is in good/fair condition. This VFD has been in service for ~15 years. The plant staff has indicated that this VFD cannot be operated in auto due to the failure of the analog control board and replacement parts are not available.	Old Plant Building	Due to the age of the VFDs and the difficulty in obtaining replacement parts for the VFDs, it is recommended that both of these VFDs be replaced.	O
E-04-01	Process	Pump station has grating over the wetwell that may allow contamination of potable water and does not meet 10 States Standards or IEPA standards for potable water structures. The grating also makes the pump station vulnerable to flooding. Floor of wetwell is not 6 inches above grade. Grade does not slope away from wetwell.	Enterprise Pump Station	In accordance with 10 States Standards, the station does not meet the minimum requirements of the standards in that the floor is to be drained in a manner that the quality of the potable water will not be endangered. The floor of the pump station should be at least six inches above finished grade. Suction well should be watertight to prevent contamination. The top of the clearwell should be above the high-water level at the underground 5 MG and 10 MG reservoirs to prevent flooding concerns.	O
B-04-31	Process	Ammonia feed system does not meet 10 States Standards	Ammonia Feed System	Replace the ammonia feed system.	O

Project/ Item No.	Discipline	Finding	Location	Recommendation	Functional Category
D-07-03	Electrical/ Process	The City staff indicated that there is an issue with the size of the motors for Pumps No. 3 and 4 at the Division Street Pump Station. The motors appear to be undersized.	Division Street Pump Station	Evaluate the pumps at the Division Street Pumping Station. If changes need to be made to the motor sizes based on the pumping evaluation, it is recommended to install induction motors instead of wound rotor motors and replace all four motors at the same time. Also, it is recommended that the motor control center be replaced at the same time.	O

This second group was also rated as a Problem Class 1 but represent projects deemed to have a slightly lower priority than the projects listed above. The findings at the Enterprise Zone Pump Station below should also be considered with the recommendations listed in the table above. A larger project could also include combining the Division Street and Enterprise Zone Pump Stations.

Table 5-15. High Priority Projects for Capital Planning

Project/ Item No.	Discipline	Finding	Location	Recommendation	Functional Category
B-05-06	HVAC	The existing ventilation fan for the Fluoride Room does not appear to be adequately sized to provide recommended air changes for this room.	Main Process Building	Investigate and, if needed, upgrade ventilation system for the Fluoride Room.	N
E-07-01	Electrical	The MCC is in fair/poor condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Additionally, the MCC is the service entrance equipment for the pump station and does not have a main disconnect switch.	Enterprise Zone Pump Station	Due to the age and condition of this MCC, and due to lack of main disconnect switch, it is recommended to replace this MCC.	O
E-07-02	Electrical	The UPS has been in service for ~30 years and has reached the end of its expected reliable life.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the UPS be replaced.	O

Project/ Item No.	Discipline	Finding	Location	Recommendation	Functional Category
B-04-04 to 07	Process	Low Service Pump Station condition is poor and does not meet HI Standards.	Low Service Pump Station	Address immediate needs with low cost capital projects like pump replacement, valve replacement, new gauges, but long-term, the City should consider installing new HI compliant Pump Station.	O

Table 5-16. High Cost Projects for Capital Planning

Project/ Item No.	Discipline	Finding	Recommendation	Estimated Cost	Problem Class	Functional Category
LSL-04-01	Process	Lagoons are nearing capacity.	More aggressively remove lime sludge and evaluate options such as letting additional contracts than to only 1 company.	$2,400,000	4	O
Civil/General	General	Site security not found at most remote sites.	Installation of security cameras and security fencing at all remote sites.	$200,000	3	N
B -07-04	Electrical	The existing unit substation "U2' and motor control center MCC-P2 at the Old Plant is in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the existing unit substation "U1" and motor control center "MCC-P1"	$1,200,000	2	O
B-07-02	Electrical	The primary service voltage for the WTP is 2400V. The electric utility (Ameren) has indicated that there are not many (if any) replacement transformers that still have a 2400V secondary. Further, the 2400V service is an ungrounded system.	Consider upgrading the primary service voltage to either 480V or 4160V. This service upgrade will also need to be discussed with Ameren to determine what options they have to offer.	$1,900,000	2	N

Project/ Item No.	Discipline	Finding	Recommendation	Estimated Cost	Problem Class	Functional Category
B-07-01	Electrical	No standby power for the low lift pumps from 2000Kw generator. The existing 500Kw engine generator in the Old Plant Building provides standby power for the low lift pumps and is approaching the end of its useful life. (continued below) No automatic transfer scheme in place to transfer the plant to the engine generators upon a loss of utility power.	Option 1: Consolidate the standby power needs for the WTP with a single diesel engine generator. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the entire plant (Old Plant Building and Main Process Building) to the engine generator.	$3,000,000	2	O
			Option 2: Keep the existing 2000Kw diesel engine generator at the Main Process Building and either retrofit the existing 480V switchgear (LVS3) or provide a new 480V switchgear and/or automatic transfer switch. Provide a new diesel engine generator at the Old Plant Building with new switchgear and automatic transfer equipment.	$2,000,000		
B-07-06	Electrical	The existing medium voltage switchgear "MVSP" and motor control centers "MCC-P3", "MCC-P4", and "MCC-P4E" at the Main Process Building are in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the electrical equipment at the Old Plant Building.	$1,600,000	2	O
B-07-22	Electrical	HSP #2 is the only high service pump with a variable speed drive, capable of operating at the range of lower flow rates currently required. It is operated continuously, more than 90 percent of the time.	Provide additional VFDs for the high service pumps. High Service Pump No. 1 is 480V, but the other two high service pumps (No. 3 and No. 4) are medium voltage motors. A medium voltage VFD would be required for these pumps.	$1,300,000	3	O

Project/ Item No.	Discipline	Finding	Recommendation	Estimated Cost	Problem Class	Functional Category
D-07-02	Electrical	The medium voltage diesel engine generator and transfer controller at the Division Street Pump Station are in fair condition. The engine generator is approaching the end of its expected life. The transfer controller has reached the end its expected life.	Recommend that the engine generator and transfer controller be replaced in conjunction with the replacement of the medium voltage switchgear.	$1,100,000	2	O
D-07-03	Electrical/ Process	The City staff indicated that there is an issue with the size of the motors for Pumps Nos. 3 and 4 at the Division Street Pump Station. The motors appear to be undersized.	Evaluate the pumps at the Division Street Pump Station. Also, it is recommended that the motor control center be replaced at the same time.	$1,000,000	2	O
E-07-07	Process	Regulatory issues at Enterprise Zone Pump Station. Several items do not meet the 10 State Standards.	Recommend an evaluation of the pump station to consider replacement. In addition, it may be prudent to consider replacement of the Division Street Pump Station to join it with a new combined pump station.	$5-10M	1	O
B-04-44 & 45	Process	Multiple process issues found at Old Plant building filters.	Construct new west filters improvements (Main Plant expansion). Add air scour and filter to waste to Main Plant.	$22M	2	O
B-04-25	Process	Recarbonation bottleneck and carbonation issues.	Recarbonation and water stability study and demolition of recarbonation tanks, Infilco Accelerator, and Hydro-Treaters.	$2M	2	O
B-04-31	Process	Ammonia Feed System.	Replace ammonia feed system.	$1.1M	1	O
B-04-48	Process	Low Service Pump Station poor condition and does not meet HI Standards.	Replace Low Service Pump Station.	$10M	3/4	O

5.6 Project Prioritization

This section provides greater detail on several of the highest priority project improvements that were identified during the condition assessment.

5.6.1 Enterprise Zone Pump Station

5.6.1.1 Regulatory Issues

The condition assessment of the Enterprise Zone Pump Station noted several deficiencies that did not meet the Ten States Standards. The deficiencies have a direct impact to the potential for water contamination and worker safety. A summary of the assessment is outlined below.

- No concrete top slab or concrete curb over clearwell to prevent water infiltration. No protection over clearwell can lead to potential water contamination.
- In addition, the level of the slab appeared to be below the high water level of the reservoirs. This has led to flooding in the pump station and, again, the potential for water contamination.
- Grade outside the pump station slopes toward the building. Under heavy rainfall, the runoff could flow into the pump station and potentially contaminate the clearwell.
- The flooding also presents a worker safety issue with the electrical equipment placed directly on the slab without a curb. This is a severe safety issue when coupled with the potential for flooding and grade slope.
- Other electrical deficiencies were noted such as not having a disconnect for the MCC.
- The pump station does not meet the fire rating required between electrical rooms.
- Additionally, the building has begun to deteriorate, and several architectural issues were noted.
- A full list of the projects noted in the Enterprise Pump Station is provided in **Appendix B** and **Appendix C**.

The issues noted in this section all have serious ramifications and the pump station should be considered for a full evaluation to determine how best to replace or rehabilitate it to meet the Ten States Standards and to alleviate the noted safety and architectural issues.

5.6.1.2 Combined Division Street Pump Station and Enterprise Zone Pump Station

The pumps, motors, and electrical equipment at the Division Street Pump Station are all functional but are approaching the end of their useful life. The Enterprise Zone Pump Station has several regulatory issues. The deficiencies at both pump stations require evaluations into how to improve operations and safety at each. Considering the proximity of the Division Street Pump Station to the Enterprise Zone Pump Station could make consolidation of the two pump stations more convenient and efficient for staff.

CDM Smith recommends an evaluation be performed to: (1) to remedy the deficiencies noted at the Enterprise Zone Pump Station; and, (2) to evaluate combining the Division Street and Enterprise Zone Pump Stations.

5.6.2 Improve Ventilation in Main Process Building

5.6.2.1 Chlorine Gas Ventilation

The emergency ventilation systems serving the chlorine application room and chlorine storage room each consist of an outside air louver and an exhaust duct. Each exhaust duct is connected to a dedicated exhaust fan which is remotely located in a separate interior room of the plant. The exhaust ducts travel through other spaces of the plant before connecting to their respective fans. The exhaust fan discharge ducts are also routed through interior spaces of the plant before discharging to the outdoors. The emergency exhaust fans are activated automatically by chlorine sensors upon detection of high chlorine concentrations, or manually by start switches located both outside of the spaces on the building exterior and inside the rooms. It is recommended that these systems be replaced with a chlorine scrubber system or the Bloomington WTP convert to sodium hypochlorite.

5.6.2.2 Chlorine Scrubber

If the Bloomington WTP continues the use of gas chlorine, a dry chlorine scrubber system should be implemented for the chlorine application room and chlorine storage room. Both rooms could be served by a common scrubber, or each can be served by a dedicated scrubber. A dry chlorine scrubber system can be supplied as a package including all components such as scrubber vessel, media, fan, motors, and controls all assembled on a common mounting base. A scrubber system could possibly be located outdoors at-grade outside of the chlorine rooms on the west side of the building.

5.6.2.3 Fluoride Room Ventilation

The ventilation system serving the Fluoride Room did not appear to be adequate to provide recommended frequency of air changes for safe operation within this room. In addition, high odors were observed during the site visit. The existing ventilation system consists of a tube axial exhaust fan and a supply air grille. The exhaust fan discharges directly to the outdoors and the supply air is provided by an air handling unit which also serves other rooms. It is recommended that a study be conducted to evaluate the operation and condition of the ventilation equipment serving this room and determine if adequate ventilation is provided.

5.6.3 Electrical Upgrades to Main Process Building and Old Plant Building

5.6.3.1 Aging Electrical Gear

The existing electrical equipment at the Bloomington WTP is functional but is either approaching or has already reached the end of its design life and is becoming more difficult to maintain due to lack of availability of replacement parts.

Additionally, as electrical equipment ages, the insulation system becomes less effective and its condition must be monitored more closely, resulting in an increase in the frequency of maintenance and subsequent cost. The risk of a “run to failure” approach could have very negative consequences in terms of replacement cost and the ability to operate the plant.

Equipment failure forces decisions to be made under duress, reduces options, and increases replacement costs due to rush orders.

5.6.3.2 Standby Power Alternatives

The 2000kW generator does not have an automatic transfer scheme in place to transfer the plant to the engine generators upon a loss of utility power. A 480V feeder from the Main Process Building to the Old Plant Building provides standby power to some 480V and 208/120V loads when the 2000kW engine generator is operating. However, this feeder does not provide standby power for the low lift pumps. An existing 500kW engine generator located in the Old Plant Building provides standby power for the low lift pumps.

The existing 500kW diesel engine generator installed at the Old Plant Building was noted to have been installed in the mid-1970s. A service record or exercise schedule was not kept for this generator and the current condition is unknown.

While the visual condition of the 500kW generator appeared to be in good condition, it is approaching the end of its useful life. The existing 2000kW diesel engine generator was installed approximately 15 years ago and is in good condition.

Two alternatives have been considered for standby power: consolidate standby power with a single diesel engine generator; and maintain the existing 2000kW generator and retrofit or replace switchgear to include all critical loads.

Option 1

The standby power needs for the plant could be consolidated with a single diesel engine generator. The kW requirements for the new diesel engine generator will be dependent on the plant loads that will need to operate during a loss of power and could be either 480V or medium voltage (2400V or 4160V). The voltage for the new engine generator would be partially dependent on any modifications being made to the electrical distribution systems at both the Old Plant Building and New Process Building. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the entire plant (Old Plant Building and Main Process Building) to the engine generator.

Option 2

The existing 2000kW diesel engine generator was in good condition at the time of our inspection and could remain in service for an extended period of time. It is recommended to either retrofit the existing 480V switchgear (LVS3) or provide a new 480V switchgear and/or automatic transfer switch that will automatically start the 2000kW engine generator upon a loss of utility power and transfer the Main Process Building to the engine generator.

Additionally, the existing 500kW diesel engine generator at the Old Plant Building has reached the end of its useful life and replacement is recommended. Along with replacement of the generator, it is also recommended to replace the switchgear and include an automatic transfer equipment start the new engine generator upon a loss of utility power and transfer the Old Plant Building to the engine generator. The new diesel engine generator at the Old Plant Building could be omitted and additional loads from the 2000kW generator could be transferred to the low lift pumps; however, we would recommend a study to confirm that the 2000kW generator has the capacity to handle the additional load.

5.6.3.3 Grounded Electrical System

The majority of the WTP is operating on an ungrounded 2400V medium voltage service. Ameren has indicated that 2400V transformers may not be available in the near future or are in very short supply. It has been recommended to consider upgrading the plant to a more common grounded system. Currently, some parts of the plant operate on 480V service; however, the pumps and other major electrical components operate on the ungrounded 2400V service.

Two common voltages for grounded systems are 480V and 4160V, low voltage and medium voltage, respectively. In general, the decision to utilize 4160V in lieu of 480V distribution is typically based on two factors: total operating load of the plant and motor horse powers for the driven equipment. When the total operating load of the plant is larger than 2500kVA, 4160V distribution becomes more economical due to the increase in cable sizes and sets required for the 480V. Motors larger than 300 HP are typically fed from a medium voltage system (4160V) to avoid excessive voltage drop when starting a motor across the line. Reduced voltage starting may be required on 480V but is not likely with a 4160V system. Motor manufacturers have a preferred size for each voltage level, and it may increase the cost of the particular piece of equipment when selecting outside the preferred range.

Directly comparing the 480V to the 4160V systems result in the following:

- 480V equipment is generally less expensive when compared to 4160V.
- Step down transformers are not required for 480V at the plant; however, they would be required with a 4160V system.
- Cable sizes would be larger, and more sets required for 480V. Challenges may arise identifying suitable conduit routes through the plant for the increase in conduit size and quantity.
- As mentioned earlier, larger horsepower motors on a 480V service will experience larger inrush current and may cause a voltage dip when started across the line. Reduced voltage starters may be required, increasing the overall equipment costs.

5.6.4 Addition to New Plant Filters (Decommissioning Old Plant Building)

5.6.4.1 Aging Infrastructure

The condition assessment of the Old Plant Building noted several deficiencies throughout the structure for all disciplines. Most notably, was the hydraulic imbalance of the filters and the influent flow over the weirs. In addition, the electrical equipment in this building is nearing the end of its life. A summary of the assessment is outlined below.

- Several architectural deficiencies were noted such as roof and window replacement, tuck-pointing, and life safety issues. The filter basins do not have handrails, guardrails, or curbs which presents a safety hazard.

- Filters 1 and 12 are currently removed from service reducing the total filtration capacity.
- The existing filters provide inadequate freeboard for recommended filter backwash procedures leading to media loss during backwash.
- The surface wash did not appear to be functional in several of the filters. The remainder of the piping should be inspected to confirm it is in good operating condition. In the long-term, replacement of the surface wash system with air scour should be considered.
- The filter piping and valves are aged and in need of replacement. The underdrains are original with the plant construction. The underdrain laterals were visible in a filter that was out of service and were confirmed to be corroded and in need of replacement.
- The filter flow meters and rate of flow control devices do not function properly. The plant is thus not able to accurately determine how much flow is produced by the West Filters. The filter flows are not constant between filters and throughout the filter run which increases the risk for turbidity breakthrough. Staff have reported that they are not comfortable operating the filters above 0.5 MGD (~0.8 gpm/sf) due to the risk of breakthrough. The inability to determine the exact filter flow further exacerbates this risk.
- The inefficiencies in flow metering and control require the filters to normally operate well below the Ten States Standards maximum allowable loading rate of 4 gpm/sf.
- CDM Smith was not able to verify the filter media effective size, however the West Filters do contain 12" of sand, which meets Ten States Standards. Any filter upgrades shall consider at least 12" of 0.5 mm sand in accordance with Ten States Standards and IEPA requirements.
- The filter pipe gallery has limited headroom for operation and maintenance.
- The West Filters are installed on an uneven hydraulic grade line from the East Filters which results in a hydraulic imbalance between the two banks of filters.
- The calibrated hydraulic model determined that piping from the recarbonated basin to the West Filters is a hydraulic bottleneck and needs to be replaced (see **Section 6**). Visual inspection is recommended to confirm the inside condition of the piping.
- Ancillary building systems such as HVAC and electrical also require replacement or refurbishment.

A full list of the projects noted in the Old Plant Building can be found in **Appendix B** and **Appendix C**. Destructive testing or intrusive investigations such as filter digs, or assessment of piping interiors was not conducted.

5.6.4.2 Consolidation of Infrastructure

A concrete structure, such as the Old Plant Building, is typically designed for a maximum life span of 100 years. The original filter building is approaching 90 years old, and given the age, is approaching the end of its typical design life. In addition, several process related issues were noted as part of the condition assessment. The cumulating repair or rehabilitation of architectural, structural, HVAC, electrical, and process related items may outweigh the cost-benefit ratio of a new filter addition.

As a result of the many deficiencies noted with the West Filters, CDM Smith recommends that the Bloomington WTP consider abandonment of the existing filters and replacement with new West Filters. The new filters could be considered as a new structure or as an addition to the Main Process Building. New filters would provide the plant with the following:

- A uniform filter design.
- Elimination of hydraulic bottlenecks in the piping to the West Filters.
- Elimination of the uneven hydraulic grade line between the two banks of filters.
- Installing new filters as an addition to the Main Process Building will result in consolidated facilities. The filtration process would be consolidated to one location, improving O&M.
- Operational flexibility.
- Modern filter underdrain and backwash system.
- Additional space to improve low lift pumping and/or intake facilities.

CDM Smith recommends that a Filter Study be performed to outline the basis of design for new filters to replace the existing West Filters. The study should investigate the feasibility of adding filters to the Main Process Building structure or constructing a new Filter Building. Also included in the study should be an evaluation of required improvements to the East Filters and identifying infrastructure in good condition and capable of reuse. An architectural programming study would also be recommended to establish areas of improvements to the plant such as the Control Room and Laboratory and general functions of the plant and plant staff.

It is important to note that several projects (primarily electrical) for the Old Plant Building would be redundant if the City elected to build a new facility right away, however since the timing is unknown and the electrical projects are considered medium to high priority, these projects are assumed to be short-term rehabilitation projects while the long-term would assume a new facility would replace the Old Plant Building that would include new filters as well. This should be further evaluated during the recommended Filter Study.

We anticipate a filter expansion project to be in the order of $20 million for an estimated 12 MGD in new capacity. In general, costs for new plants or plant expansions have ranged in the order of $3 to $4 per gallons per day of treated capacity.

5.6.4.3 Recarbonation Improvements

The recarbonation process has long been a hydraulic bottleneck at the Bloomington WTP (see **Section 6**). The study identified the following deficiencies in the recarbonation process:

- Piping between the softening basins and the recarbonation basins has been substantially plated with calcium carbonate lime solids, reducing the hydraulic capacity.

- The height of the weirs in the recarbonation basins and the reduced hydraulic capacity of the influent pipe restrict flow between the ClariCones® and the recarbonation basins.
- During lower flows, the effluent of the recarbonation basin drops several feet causing a great deal of air entrainment in the piping to the filters.

CDM Smith recommends conducting a recarbonation and water stability study to determine the following:

- Evaluate the available mixing of carbon dioxide and the current pH meter location with respect to the dosage location.
- Determine process improvements, such as increasing the carbon dioxide dosage to prevent post-precipitation of calcium solids. CDM Smith also recommends cleaning or replacing the piping that has already sustained severe lime solids buildup.
- Consider abandoning the Recarbonation Basins in favor of basin bypass piping. This operation will need to be discussed with IEPA since it does not conform to Ten States Standards recommendations for recarbonation detention time. If the IEPA requires recarbonation detention time, new recarbonation basins should be considered as part of the new filter construction (see **Section 4.4.2**).
- Determine what to do with the existing Recarbonation Basins in the event they are abandoned.

5.6.5 Evaluate Security at the Water Treatment Plant and Remote Facilities

When evaluating security at water facilities, it should be divided into three categories: (1) protecting the raw water source; (2) protecting the water treatment plant; and, (3) protecting the remote facilities and distribution system.

5.6.5.1 Protecting the Raw Water Source

Bloomington currently takes steps in line with industry standards to protect its water source. Grab samples of raw water are collected every weekday to be tested for pH, alkalinity, hardness, turbidity, and fluoride. Online turbidity monitors are in the process of being installed in the low lift pump stations to monitor raw water turbidity. In addition, devices are being installed near each intake to monitor pH, turbidity, specific conductivity, dissolved oxygen, total dissolved solids, and temperature. During summer months, buoys are sent into the source water to continually monitor pH, turbidity, specific conductivity, dissolved oxygen, algae, and temperature in the source waters. Testing the water as it enters the plant is considered to meet the standard of care to ensure that if unusual contaminants are present, it is discovered upon entry. However, there wasn't any evidence of a video camera at the Lake Bloomington intake or the Evergreen Lake intake. Additionally, the Evergreen Lake Pump Station was fully accessible to the public and minimal security measures are in place. It is recommended to provide a security fence around the perimeter of the site and install CCTV to monitor the area. Access to the surrounding shoreline should be coordinated with the McLean County Department of Parks and Recreation. Source water is protected from a watershed perspective to minimize contaminants and nutrients from entering the two lakes.

5.6.5.2 Protecting the Water Treatment Plant and Remote Facilities

Bloomington's protection of the water treatment facility is in line with industry standards. The plant has a high fence around the property, and a system to buzz in visitors at the front door; however, video cameras were not present during our visit. In several locations it is recommended to install CCTV at multiple locations around the plant to monitor activities.

Several of the remote facilities, including the Evergreen Lake Pump Station, Main Street Pump Station, Hamilton Tank, and Northeast Tank, lack a defined perimeter around the site, and fencing around them. Also, none of the remote sites have cameras or CCTV equipment.

5.6.5.3 Distribution System Water Quality Protection

The water distribution system does currently have five online monitors that provide continuous water quality updates for chlorine residual. Three additional monitors for chlorine residual, turbidity, pH, or other water quality parameters are recommended. These should be added in areas of high water age or water quality concerns.

Online monitors can provide monitoring of critical water quality parameters to alert staff of changes in water quality. Single units are available that will take continual readings of chlorine, pH, turbidity, temperature, conductivity, and pressure. Any changes in these parameters can alert Bloomington WTP staff for further investigation. Further discussion of distribution system water quality is provided in Section 7.

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Section 6

Water Treatment Plant Hydraulic Capacity Analysis

6.1 Introduction

The City of Bloomington operates a surface water treatment plant (WTP) nominally rated for 24 million gallons per day (MGD) based on previous process studies. CDM Smith was contracted by the City to develop the 2040 Water Infrastructure Master Plan of the City of Bloomington's WTP and pumping infrastructure. As part of the 2040 Water Infrastructure Master Plan, CDM Smith developed a hydraulic model and conducted hydraulic analysis of the Bloomington WTP with the following objectives:

- Determine the maximum hydraulic capacity and ability to treat the worst-case scenario 2040 maximum daily demand of 22.16 MGD. Although 21.3 MGD was selected in Section 3 based on the Economic Development scenario, the WTP hydraulic capacity was evaluated based on the 22.16 MGD as the worse-case demand and to account for some plant use and backwash water use. Note that the worst-case maximum day demand was used in the hydraulic capacity analysis to determine the required improvements should the highest growth trend occur with the largest maximum to average day demand ratio.
- Confirm hydraulically limiting unit processes.
- Determine the hydraulic benefits of current proposed recarbonation bypass piping arrangement.

This Section summarizes the results of this analysis and present recommendations and conclusions for plant improvements to meet future 2040 demands.

6.2 Background

Figure 6-1 shows a process flow diagram of the Bloomington WTP. The Bloomington WTP treats a blend of surface water from Lake Bloomington and Evergreen Lake using lime softening/clarification, recarbonation, conventional dual-media filtration with granular activated carbon (GAC), and chlorine/chloramine disinfection.

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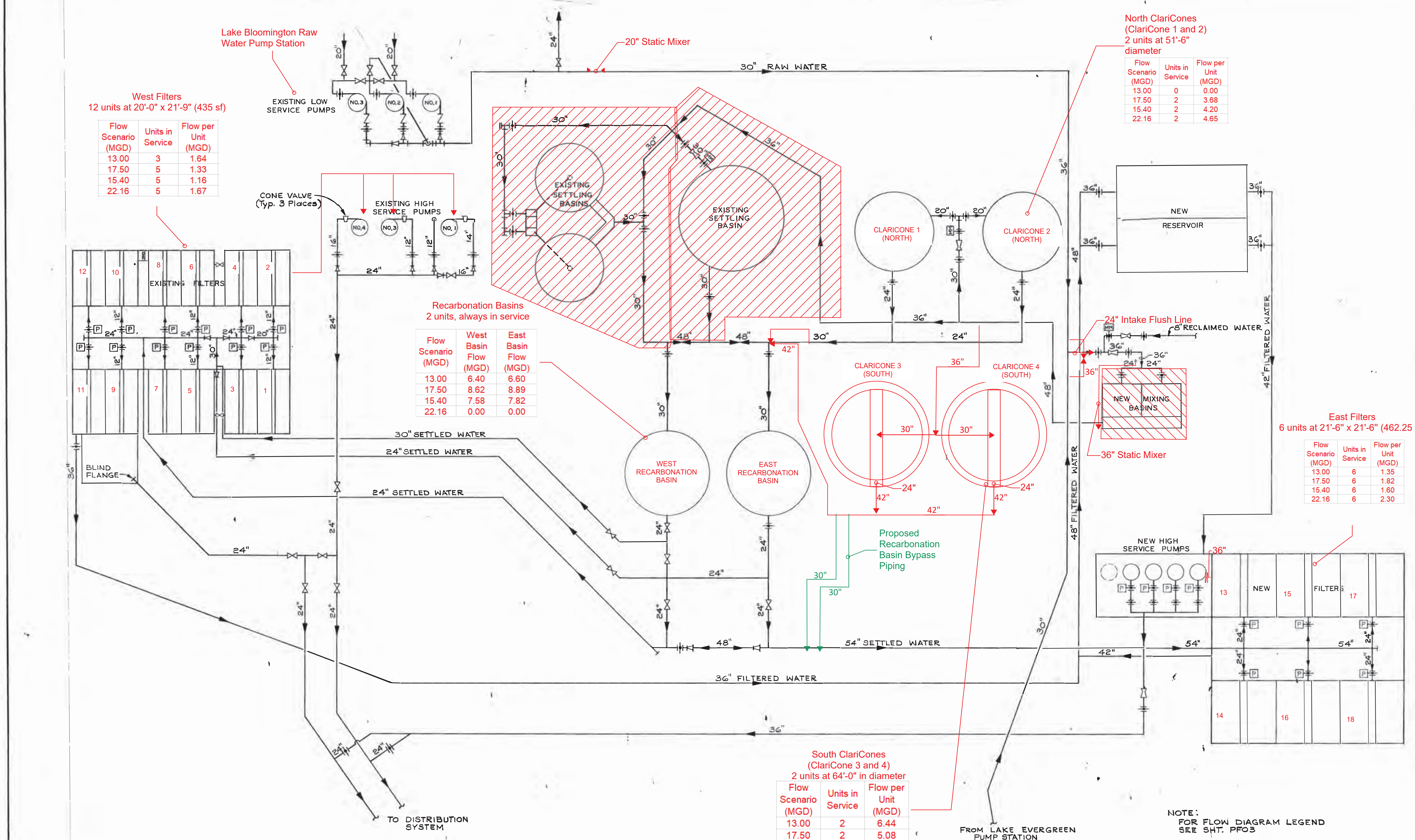

West Filters
12 units at 20'-0" x 21'-9" (435 sf)

Flow Scenario (MGD)	Units in Service	Flow per Unit (MGD)
13.00	3	1.64
17.50	5	1.33
15.40	5	1.16
22.16	5	1.67

North ClariCones
(ClariCone 1 and 2)
2 units at 51'-6" diameter

Flow Scenario (MGD)	Units in Service	Flow per Unit (MGD)
13.00	0	0.00
17.50	2	3.68
15.40	2	4.20
22.16	2	4.65

Recarbonation Basins
2 units, always in service

Flow Scenario (MGD)	West Basin Flow (MGD)	East Basin Flow (MGD)
13.00	6.40	6.60
17.50	8.62	8.89
15.40	7.58	7.82
22.16	0.00	0.00

East Filters
6 units at 21'-6" x 21'-6" (462.25 sf)

Flow Scenario (MGD)	Units in Service	Flow per Unit (MGD)
13.00	6	1.35
17.50	6	1.82
15.40	6	1.60
22.16	6	2.30

South ClariCones
(ClariCone 3 and 4)
2 units at 64'-0" in diameter

Flow Scenario (MGD)	Units in Service	Flow per Unit (MGD)
13.00	2	6.44
17.50	2	5.08
15.40	1	7.01
22.16	2	6.43

Figure 6-1. Bloomington WTP Process Flow Diagram

NO.	DATE	DESCRIPTION	APPROVED

REVISIONS

DESIGNED M.K.
DRAWN M.B.
CHECKED M.W.
DATE 3/86

PRC Engineering
CONSULTING ENGINEERS

CITY OF BLOOMINGTON, ILLINOIS
WATER TREATMENT PLANT
EXPANSION AND REHABILITATION

SCALE
NONE

RAW WATER, SETTLED WATER, FILTERED WATER & HIGH SERVICE PUMP DISCHARGE FLOW DIAGRAMS

SHEET PF01
OF 5 SHEETS
prc
PROJECT NO. 02-2941

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The raw water pumps convey water from Lake Bloomington and Evergreen Lake Raw Water Pump Stations to the WTP. Mixing of coagulant is performed in two static mixers. The Lake Bloomington raw water line includes a 20-inch static mixer and the 36-inch combined raw water line includes a 36-inch static mixer. Cationic polymer is fed at each of the low-lift pump station discharges and ferric sulfate is fed at the static mixer in the combined raw water line. Raw water is pumped all the way to the contact clarifiers (ClariCones®).

Lime softening/clarification is performed in four helical flow solids ClariCones®. The North ClariCones®, constructed in 1986, are smaller with a diameter of 51'-6". The 64'-0" diameter South ClariCones® were constructed in 1998. The flow split to the North and South ClariCones® is performed by throttling the influent valves to maintain the desired hydraulic balance.

Recarbonation is performed in the effluent pipe of each ClariCone® by adding aqueous carbon dioxide. Water is then conveyed to two parallel, circular, and open Recarbonation Basins. Each Recarbonation Basin contains an influent weir and diffuser chamber where the old gaseous carbon dioxide diffusers were previously located. The effluent of each Recarbonation Basin has a serpentine V-notch "finger weir."

Dual media filtration with GAC and sand takes place in two parallel banks of filters; the West Filters and East Filters. The 12 West Filters are 435 square feet (sf) each and were constructed in phases with four filters constructed in 1929, 1952, and 1964. The six East Filters are slightly larger at 462.25 sf each and were constructed in 1986. Under each bank of filters are post-filter clearwells from which water flows by gravity to the reservoirs and High Service Pump Station.

The plant was constructed in various phases over the course of its operation. This has resulted in some inefficiencies in the hydraulic operation of the facility including:

- Bloomington WTP staff have reported that the piping between the ClariCones® and Recarbonation Basins are heavily plated with lime solids, decreasing the cross-sectional area of the piping and increasing the hydraulic resistance. Photos of this piping showing the degree of plating are included in **Appendix F**. The piping between the ClariCones® and Recarbonation Basins runs through a congested area, the bends also create additional hydraulic resistance in this pipeline.

- Recarbonation was originally performed by feeding gas carbon dioxide into the Recarbonation Basins. The weir elevations at the basins were likely set to provide sufficient depth over the diffusers to maintain effective dissolution and mixing of the carbon dioxide. The height of the influent weir creates a backpressure on the ClariCones® when operating at higher flow rates and compounded with the effects of the plating in the piping creates a bottleneck between the ClariCones® and Recarbonation Basins.

- Similarly, to maintain depth in the Recarbonation Basin, the effluent weir is also set unnecessarily high; approximately 4 feet above the measured operating level in the filters. However, despite the nearly 4-foot drop, losses are high in the Recarbonation Basin effluent pipes which creates hydraulic bottleneck at high flows. Further, the crown of the settled water piping between the recarbonated water and filters is above the normal operating level in the filters which the plant staff have reported that at times can create air entrainment in the piping to the filters.

- The West Filters are 1.5 feet lower than the East Filters. In order to prevent overflows at the West Filters the East Filters operate at a lower level reducing the amount of available filtration head. Imprecise control of the West Filter production leads to fluctuating filter flow setpoints which create a risk for turbidity spikes.

6.3 Model Development and Assumptions

A hydraulic model of the Bloomington WTP was constructed in Visual Hydraulics. The Visual Hydraulics model included all unit process between the ClariCones® and the post-filter clearwells. The capacity of the raw water system was assessed in other parts of the study and is not discussed as part of this report. Bloomington WTP staff have reported that control of the overall treatment plant flow rate is often significantly impaired by the hydraulic conditions and control limitations between the low-lift pump stations and the ClariCones®. Because of the unique flow paths through the Bloomington WTP, each parallel unit process was modeled. For example, both the West Filters and East Filters, West Recarbonation Basins and East Recarbonation Basins, and North ClariCones® and South ClariCones® were modeled in parallel.

Development of the model carried the following assumptions:

- Pressure flow was assumed between all unit processes. The Hazen-Williams equation was used for all pressure pipe flow.
- Open channel flow was assumed for open basins and channels. The Manning's equation was used for open channel flow.
- Manufacturer K-values are assumed for valves, ductile iron, and cast-iron elbow fittings. Steel elbow fittings use K-values obtained from the Hydraulic Institute. K-values for tees were obtained from Miller (1990)[1].
- With the exception of the Recarbonation Basins, the hydraulics within unit processes were not modeled. Clean bed headlosses were calculated for the filters to compare to the calibrated operating level to obtain the available filtering head. The ClariCone® and filter rate of flow controller hydraulics were not modeled.
- Neither the raw water or high service pump stations were modeled in any WTP hydraulics scenarios.

The following flow scenarios were modeled:

- 22.16 MGD – Projected worse-case 2040 maximum day demand.

[1] Miller, D.S. (1990). *Internal Flow Systems: Design and Performance Prediction, 2nd Edition.* Gulf Publishing Company, Houston, Texas.

- 17.5 MGD – Approximate current maximum hydraulic capacity of the Bloomington WTP (as modeled and not including pumping). Bloomington WTP staff have reported that historically the ClariCones® would begin to overflow around 17 MGD.
- 15.4 MGD – Maximum hydraulic capacity of the Bloomington WTP with one of the large South Claricones® out of service, as modeled and determined in this study.
- 13 MGD – Calibration condition and approximately equal to the projected 2040 average day demand (12.56 MGD).

6.4 Model Calibration

CDM Smith performed a calibration of the hydraulics model at 13 MGD plant flow to correlate the modeling with actual plant operations. The draft version of this report modeled two calibration conditions at 10 MGD and 15 MGD based on previous calibration test. The model subsequently recalibrated at a flow of 13 MGD. The calibration condition of 13 MGD is reported herein.

Table 6-1 shows the measured water surface elevations along with the calculated water surface elevations at each calibration location. Measured water surface elevations were obtained by CDM Smith during a field visit to the plant on August 28, 2018.

Table 6-1. Measured Water Surface Elevations (WSEL) During Calibration [1]

Process/Basin	Measurement Location	13 MGD	
		Measured WSEL	Calculated WSEL
Softening / ClariCone® 2 (North ClariCone®)	Upstream of weir at effluent drop box	Not in Operation	NA
Softening / ClariCone® 4 (South ClariCone®)	Upstream of weir at effluent drop box	745.19	745.14
West Recarbonation Basin	Influent weir box	742.44	742.43
West Recarbonation Basin	Upstream of effluent weir	741.86	741.86
West Recarbonation Basin	Effluent Channel	740.63	740.56
East Recarbonation Basin	Influent weir box	742.48	742.43
East Recarbonation Basin	Upstream of effluent weir	741.83	741.83
East Recarbonation Basin	Effluent Channel	740.86	740.83
West Filters	Filter 11	737.57	Set at 737.57
East Filters	Filter 16	737.98	Set at 737.98

Notes:

[1] See Appendix D for photos of each calibration location, reference elevations, and measured distances from reference elevation to water surface.

Figure 6-1 shows the number of basins for each process in service during each scenario. To complete the calibration of the model, adjustments were made to the piping characteristics and/or basin flows until the measured and calculated water surface elevations were within approximately 1 inch of each other (0.083 ft). The following was observed and adjusted during the calibration:

- During the revised 13 MGD calibration scenario only the two South ClariCones® were modeled. The model was calibrated to the measured water surface in the ClariCones®. The weirs of both ClariCones® were submerged. The water surface elevation was used as the furthest upstream value in the model and thus the ClariCone® process hydraulics and effects of the adjustable launder are not modeled.

- Piping between the ClariCones® and Recarbonation Basins – The original model assumed a Hazen-Williams C factor of approximately 100 and the nominal hydraulic diameters of the pipes shown on the drawings. This resulted in a freefall condition in the effluent drop box and both ClariCones®, which based on the onsite calibration was not observed. Appendix F shows photos of the interior of the softened water piping which shows heavy plating of lime solids resulting in a reduced pipe diameter and increased roughness. During the calibration, CDM Smith adjusted the softened water piping to model approximately 1.5 pipe diameters less than the nominal pipe diameter with a C factor of 55 to account for the effects of lime precipitation. This resulted in calibrated water surface elevations consistent with the measurements in the effluent of the ClariCones® as shown in **Table 6-1**. Any changes made to piping in the South ClariCone® effluent were made to North ClariCone® effluent piping as well for modeling flow scenarios with the North ClariCones® in service.

- Flows between the Recarbonation Basins were adjusted to bring the calibrated and measured elevations within acceptable tolerances. The flow splits between the East and West Recarbonation Basins showed marginally more flow going to the East Basin (~50.8 percent East/49.2 percent West).

- The Recarbonation Basin effluent piping manifold was modeled in order to properly model the flow split to the two filter banks. During calibration the East Filters were producing 8.1 MGD (~62 percent of the plant flow). Previous studies have reported hydraulic bottlenecks in the recarbonated water piping manifold and in the piping to the West Filters. To calibrate the model to the observed water surface elevations, the piping was modeled with approximately 1 pipe diameter smaller than the installed conditions and a C factor of 52. These changes were also made in the yard piping to the West Filters.

- As previously discussed, the rate of flow control valve hydraulics was not modeled as they do not impact the overall plant hydraulics. However, Bloomington WTP staff have reported operational issues with the control valves and control operations on the West Filters. During calibration, only three West Filters were operating, each at a flow of approximately 1.64 MGD. Because the flow meters on each filter do not work, it was not possible to confirm the actual flow per filter. Flow was obtained by subtracting the total plant flow (13 MGD) from the production rate of the East Filters (8.1 MGD). The water surface elevations were measured in Filter 11 and Filter 16, the furthest hydraulic filter in the West Filters and East Filters, respectively.

6.5 Model Results

Figure 6-2 shows the hydraulic profile through the Bloomington WTP at the following flow conditions:

- 22.16 MGD – Projected 2040 maximum day demand.
- 17.5 MGD – Approximate current maximum hydraulic capacity of the Bloomington WTP (as modeled and not including pumping). Bloomington WTP staff have reported that historically the ClariCones® would begin to overflow around 17 MGD.
- 15.4 MGD – Maximum hydraulic capacity of the Bloomington WTP with one of the large South Claricones® out of service, as modeled and determined in this study.
- 13 MGD – Calibration condition and approximately equal to the projected 2040 average day demand (12.56 MGD).

The calibrated model demonstrates that the maximum flow through the plant in its current configuration is approximately 17.5 MGD. This condition was modeled with all ClariCones® in service. With one of the South ClariCones® out of service, the maximum hydraulic capacity is approximately 15.4 MGD. Under both these conditions, water begins to overflow the South ClariCones®. If the model is run in the current plant configuration at 22.16 MGD; both North ClariCones® and South ClariCones® are overflowing. The primary causes for the hydraulic bottleneck is the softened water piping and the height of the weirs at the Recarbonation Basin. For the 15.4, 17.5 and 22.16 MGD conditions the plant hydraulic capacity is less that the capacity at the permitted clarifier loading rate of 1.75 gpm/sf indicating the hydraulics are the limiting factor in plant production.

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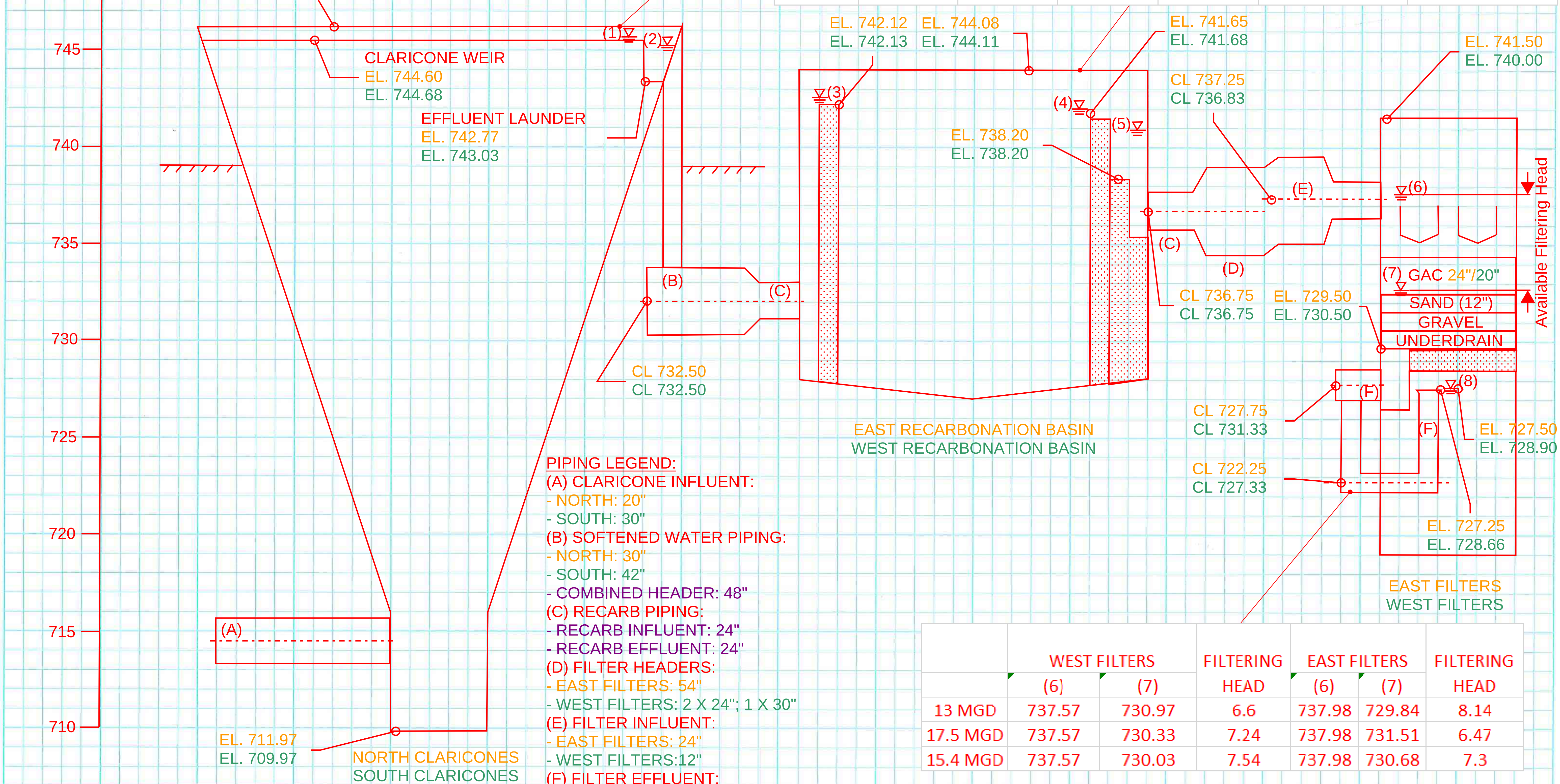
	NORTH CLARICONE		SOUTH CLARICONE	
	(1)	(2)	(1)	(2)
13 MGD	-	-	745.14	745.12
17.5 MGD	745.88	745.86	745.76	745.74
15.4 MGD	745.89	745.87	745.83	745.81

	WEST RECARBONATION BASIN		EAST RECARBONATION BASIN		WEST EXIT RECARB. CHAMBER	EAST EXIT RECARB. CHAMBER
	(3)	(4)	(3)	(4)	(5)	(5)
13 MGD	742.43	741.86	742.43	741.83	740.56	740.83
17.5 MGD	742.51	742.15	743.04	742.97	742.14	742.96
15.4 MGD	742.47	741.87	742.46	741.93	741.21	741.89



	WEST FILTERS		FILTERING HEAD	EAST FILTERS		FILTERING HEAD
	(6)	(7)		(6)	(7)	
13 MGD	737.57	730.97	6.6	737.98	729.84	8.14
17.5 MGD	737.57	730.33	7.24	737.98	731.51	6.47
15.4 MGD	737.57	730.03	7.54	737.98	730.68	7.3

Figure 6-2. Hydarulic Profile through the Bloomington WTP

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6.5.2 Modeled Improvements

6.5.2.1 Recarbonation Bypass Piping

The City of Bloomington is aware of the hydraulic bottleneck between the ClariCones® and Recarbonation Basins. The City has considered installing a piped bypass of the Recarbonation Basins to address this issue. **Appendix E** shows an example of a proposed layout of this piping. CDM Smith modeled this improvement in Visual Hydraulics in order to determine the hydraulic feasibility and impacts of installing a piped bypass around the Recarbonation Basins to alleviate the hydraulic bottleneck. The City is currently investigating alternative piping arrangements which were not modeled hydraulically at this time. **Figure 6-3** shows the resulting hydraulic profile for the Recarbonation Bypass piping condition.

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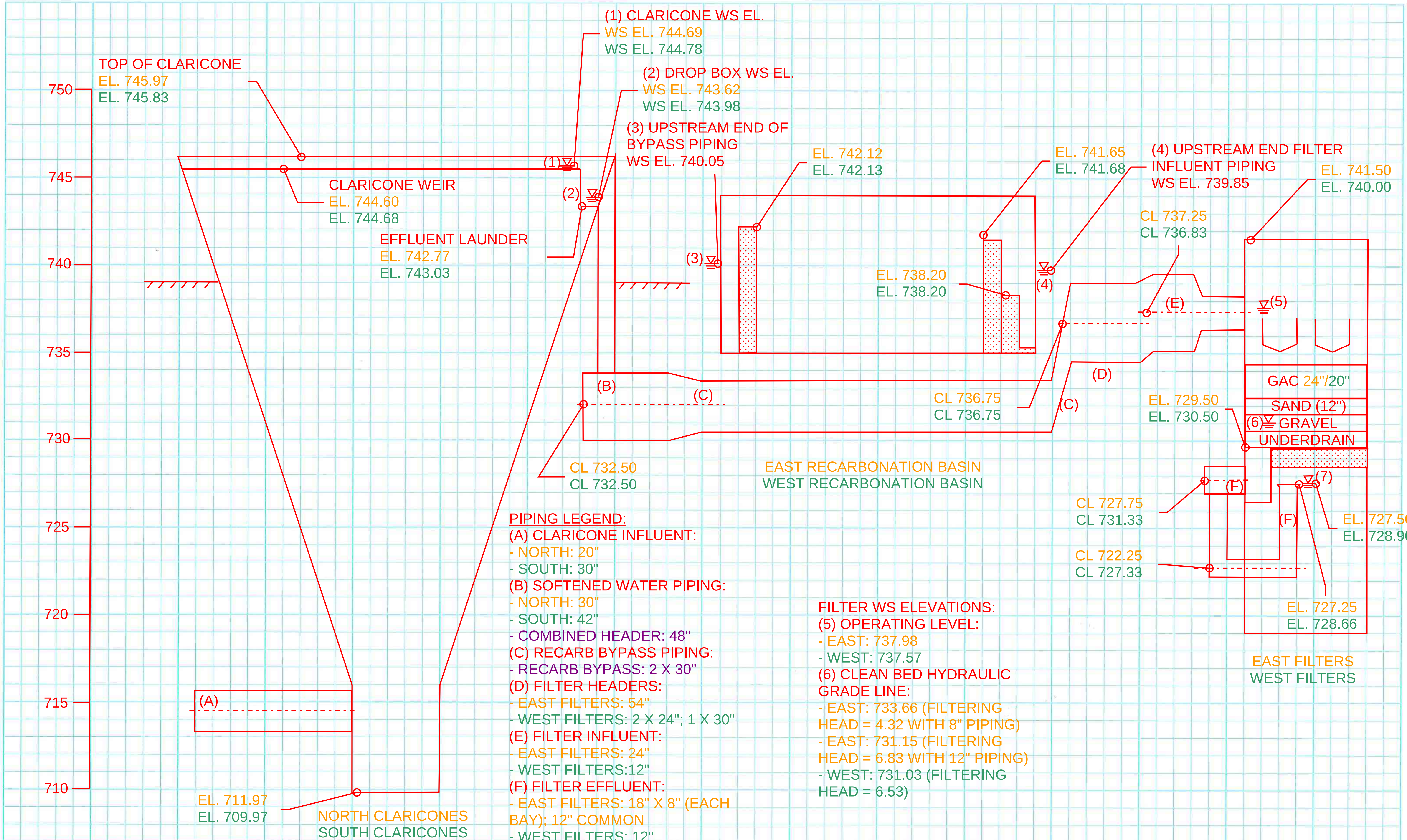

Figure 6-3. Hydraulic Profile for Recarbonation Bypass Piping

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As shown in **Figure 6-3**, the entire 22.16 MGD flow can be bypassed through this piping. This modeling assumes a Hazen-Williams C factor of 100 in the new bypass piping. Under this condition, the recarbonation bypass piping cannot operate in parallel to the basins since the hydraulic grade line does not rise high enough the go over the basin influent weirs. Operation of the bypass piping would thus effectively fully bypass the Recarbonation Basins. Using a throttling valve in the bypass line in order to induce headloss and operate the basins in parallel with the bypass is not recommended as the high degree of turbulence would shear floc and decrease floc filterability.

Ten States Standards lists the following design and operating requirements for Recarbonation Basins in Section 4.9.1, carbon dioxide addition:

- Total detention time of 20 minutes.
- Two compartments with a depth that will provide a diffuser submergence of not less than 7.5 feet nor greater submergence than recommended by the manufacturer as follows:
  - A mixing compartment having a detention time of at least three minutes.
  - A reaction compartment.

Installation of the bypass piping does not meet Ten States Standards recommendations and therefore a variance will need to be sought from the Illinois Environmental Protection Agency (IEPA) prior to operating the bypass. In CDM Smith's opinion, the Ten States Standards recommendations apply to gas diffuser systems and not necessarily aqueous carbon dioxide feed systems, such as that used by the City of Bloomington. CDM Smith has experience in Illinois with obtaining IEPA approval for in-line recarbonation with aqueous carbon dioxide solution. CDM Smith has also worked with other utilities around the country that have implemented similar recarbonation systems and practices.

The large degree of lime solids plating downstream of the ClariCones® is also indicative of a water stability issue in which the pH of the water may not be low enough to prevent post precipitation of carbon dioxide. To prevent plating of lime solids in the newly installed piping it is recommended that the City of Bloomington also investigate and address water stability in the recarbonated water prior to designing and installing the bypass piping. Further, mixing analysis with computational fluid dynamics (CFD) is recommended in the piping downstream of the carbon dioxide addition point to verify that sufficient mixing is provided with the new piping arrangement.

6.5.2.2 Filter Improvements

Because of the hydraulic grade differences between the West Filters and East Filters, it is currently not possible to raise the filter operating level to take advantage of additional filtering head to increase filter run times. CDM Smith recommends that future filter improvements assume higher filter operating levels up to WSEL of 740.00; the max WSEL for the East Filters as shown on the drawings.

Table 6-2 lists the filtration flows and rates for all flow scenarios. The IEPA and Ten States Standards for Waterworks (2012 Edition) recommend a maximum filtration rate of 4.0 gpm/sf, unless piloting is performed to demonstrate that the filters can operate under higher rates. In CDM Smith's experience, the IEPA has followed these recommendations when permitting facilities for operation. Typical filtration rates at Illinois WTPs where CDM Smith has worked range between 1.0 and 5.0 gpm/sf.

Table 6-2. Filtration Rates for Hydraulic Scenarios

Plant Flow (MGD)	East Filter Flow (MGD)	East Filter Filtration Rate [1] (gpm/sf)	East Filter Filtration Rate during Backwash (gpm/sf)	West Filter Flow (MGD)	West Filter Filtration Rate (gpm/sf) [2]
22.16	2.30	3.46	4.15	1.67	2.67
17.50	1.82	2.73	3.28	1.33	2.12
15.40	1.60	2.40	2.88	1.16	1.85
13.00	1.35	2.03	2.43	1.64	2.62

See **Figure 6-1** for number of units in service at each condition

Notes:

[1] East Filter area = 462.25 sf

[2] West Filter area = 435 sf

Based on reports from Bloomington WTP staff, the filtration rates shown for the West Filters at the 22.16 and 13.00 MGD conditions are the maximum that these filters can operate. Based on the operating rates of the West Filters shown in **Table 6-2** it is evident that these filters underperform in comparison to the IEPA limits and industry standards.

Figure 6-2 and **Figure 6-3** show the available filter head for all modeled scenarios. Normal filter operation typically requires a minimum of 6 to 8 feet of available filtering head (ideally 8 feet minimum). For the West Filters, the available filtering head is less at the 13 MGD condition because only three filters were operating during the calibration. Under all conditions modeled, the available filtering head is above 6 feet. However, the high losses between the recarbonation basins and the filters impact the amount of available filtering head as well as the limitations with the current filter control method. Further, there is currently no means to control the amount of flow through each filter to a reasonable degree and thus the rapid flow rate changes can accelerate fouling of the bed and premature termination of the filter run due to the lower available filtering head. During periods of high demand this can greatly stress plant operations.

In order to improve filter operations and remove hydraulic inefficiencies at the higher 2040 demand flows, the City of Bloomington should consider replacing the West Filters.

The East Filters function within the IEPA recommended filtration rates at all conditions except when one of the larger East Filters goes into backwash. However, CDM Smith recommends replacing the 8-inch diameter effluent piping with 12-inch piping to remove the hydraulic bottleneck downstream of the East Filters. An additional 2.5 feet of filtering head a the 22.16 MGD condition can be gained if this change is made. If the level in the East Filters were increased to 740.00, as recommended for the East Filters if the West Filters are replaced, then the available filtering head would be 8.85 feet at 22.16 MGD; well within the recommended range. If new West Filters are constructed, CDM Smith recommends the filtration capacity of the new facility be designed to produce 22.16 MGD at 4.0 gpm/sf with one filter out of service in tandem with the

East Filters, unless future pilot or full-scale testing is performed to demonstrate that higher filtration rates are possible.

6.6 Conclusions and Recommendations

The preliminary hydraulic analysis concludes the following:

- The elevation of the Recarbonation Basin influent weirs and the lime solids precipitate in the piping between the ClariCones® and Recarbonation Basins limit the maximum hydraulic capacity of the Bloomington WTP to 17.5 MGD with all ClariCones® in service and 15.4 MGD with one South ClariCone® out of service. This is less than the plant flow based on the rated capacity of the clarifiers (1.75 gpm/sf) indicating that hydraulics are a bottleneck to plant production.

- The high losses in the filter influent piping to the West Filters, along with the inefficient hydraulic control, limit the amount those filters can produce. Inability to measure flow and target a flow setpoint impacts to filter operations and runtime and potentially water quality.

- The 8-inch diameter effluent piping on the East Filters creates an extreme hydraulic bottleneck at higher plant flows and greatly reduces available filtering head.

- The installation of Recarbonation Basin bypass piping similar to the concept shown in Appendix E allows the plant to treat up to 22.16 MGD; the 2040 projected maximum demand. This piping provides a full hydraulic bypass of the Recarbonation Basins.

Based on the above conclusions, CDM Smith recommends the following:

- Consider abandoning the Recarbonation Basins in favor of the bypass piping. This operation will need to be discussed with the IEPA since it does not conform to Ten States Standards recommendations for recarbonation. Prior to making this process change, the City of Bloomington should also evaluate the mixing of carbon dioxide in the bypass piping.

- Consider performing a water stability study to ascertain the degree of post precipitation of lime solids and investigate process improvements to mitigate precipitation, such as increasing the carbon dioxide dosage. This study should also investigate the overall impacts of these process improvements on finished water quality and determine if post conditioning chemicals, such as caustic soda, are required to maintain consistent finished water pH in the event carbon dioxide dosage is increased. CDM Smith also recommends cleaning or replacing the piping that has already sustained severe lime solids buildup.

- To eliminate the filtration rate limitations, hydraulic grade differences between the two banks of filters, and increase available driving head; CDM Smith recommends abandoning the West Filters and constructing a new bank of filters parallel to the East Filters at the same elevation. CDM Smith also recommends replacing the 8-inch filter effluent piping with 12-inch piping. The elimination of the Recarbonation Basins may allow for space for the new West Filters.

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Section 7

Distribution System Evaluation and Assessment

7.1 Introduction

The objective of this Section is to conduct an evaluation and assessment of the City of Bloomington's water distribution system. This analysis relies on the City's existing hydraulic model as well as a risk-based assessment of the distribution system. Evaluation results provide strategic guidance for water main replacement while also identifying critical system improvements such as pipe upsizing and pipe looping to improve fire flows and water age.

7.2 Basis of Analysis

The following basis of analysis was established for this study and incorporated into the hydraulic model evaluation:

- A minimum system pressure of 35 psi is required throughout the City.
- A minimum fire flow of 500 gpm was established for the system except for critical areas that were identified by the Fire Department as requiring 1,000 gpm.
- Evaluate areas that high excessive water age and maintain a total chlorine residual above 1.0 mg/L (based on IEPA regulations). Total chlorine residual should ideally be above 2.0 mg/L.
- Minimize water main breaks to achieve less than 15 breaks for every 100-miles.

The above goals are consistent with the AWWA Partnership for Safe Water Distribution System Optimization Program.

7.3 Hydraulic Modeling

CDM Smith used the City of Bloomington's existing calibrated distribution system hydraulic model to evaluate the system and identify pressure and flow deficiencies. Model results were used to quantify hydraulic risks in the system. CDM Smith used model results to identify recommended improvements.

It is important to note that the existing Route 66 Elevated Tank (Northeast Elevated Tank), which is not currently in use, is not shown on the Figures nor was used in the analysis.

7.3.1 Modeling Approach

The City of Bloomington's hydraulic model was developed in 2018. This model has been calibrated and is updated by the City. CDM Smith obtained the current version of the model on January 15, 2019. The current model includes 6,469 nodes and 7,714 pipe assets. CDM Smith ran the model using WaterGEMS v10.01.01.04.

CDM Smith ran several hydraulic model simulations to understand hydraulic deficiencies in the system. Model simulations include (note that the water demands used in the analysis may differ slightly from other sections due to rounding):

- **Current Average Day Flow (2018)** – Ran extended period simulation of the current system to observe minimum average day system pressures and typical system operations. A steady-state simulation was run with the same demands to observe average system pressures (11.5 MGD).
- **Current Maximum Day Flow (2018)** – Ran extended period simulation of today's system to observe minimum max day system pressures and system operations (19.5 MGD).
- **Peak Hour Flow (2018)** – This is a steady-state model that uses max day demand multiplied by a 1.33 peaking factor (25.9 MGD).
- **Low Day Flow (2018)** – Water age simulations were run with low demand. All demands were multiplied by 0.8 to simulate low day demands (8.1 MGD).
- **Fire Flows (2018)** – Fire flow simulations were run under the maximum day demands to understand fire flow deficiencies.
- **Average Day Demand (ADD) Flow 2040** – Ran extended period simulation of today's system to observe minimum average day system pressures and typical system operations. A steady-state simulation was run with the same demands to observe average system pressures (12.5 MGD).
- **Maximum Day Demand Flow (MDD) 2040** – Ran extended period simulation of today's system to observe minimum max day system pressures and operations (21.3 MGD).
- **Peak Hour Flow (2040)** – This is a steady-state model that uses max day demand multiplied by a 1.33 peaking factor (28.3 MGD).
- **Low Day Flow (2040)** – Water age simulations were run with low demand. All demands were multiplied by 0.8 to simulate low day demands (8.8 MGD).
- **Fire Flows (2040)** – Fire flow simulations were run under the maximum day demands to understand fire flow deficiencies.

7.3.2 Model Results

7.3.2.1 Residual Pressures

The hydraulic model was used to simulate current and future demand conditions to evaluate pressure, fire flow, and water age. **Figure 7-1A** and **7-1B** shows the pressure results for the current maximum day demand and 2040 maximum day demand analysis, respectively. The model provides for different operating controls to maintain a certain level in the Hamilton Tank with different pumps being utilized to maintain the set operating levels. Pressures in the Hamilton Zone are dictated by the hydraulic grade in the Hamilton Tank and the pumps at Fort Jesse and Division Pump Stations. There is enough pumping capacity at the Fort Jesse and Division Street pump stations to maintain pressure in the system above 35 psi and maintain a reasonable water level in the Hamilton Tank.

Pressure results with firm capacity pumping (all but largest out of service) are is shown in **Figure 7-1**. The pumping stations are critical to maintain a minimum 35 psi of pressure, and this requires the City to have adequate back-up power capacity at all pump stations. Back-up power requirements are addressed in **Section 5**.

Pressure analysis also show low pressure in the transmission mains between the WTP, Fort Jesse and Division. This is being addressed separately by the City with the installation of pressure regulating valves before each reservoir or tank to maintain the required pressure in the system.

Based on this analysis, there are no distribution piping improvements related to pressure issues.

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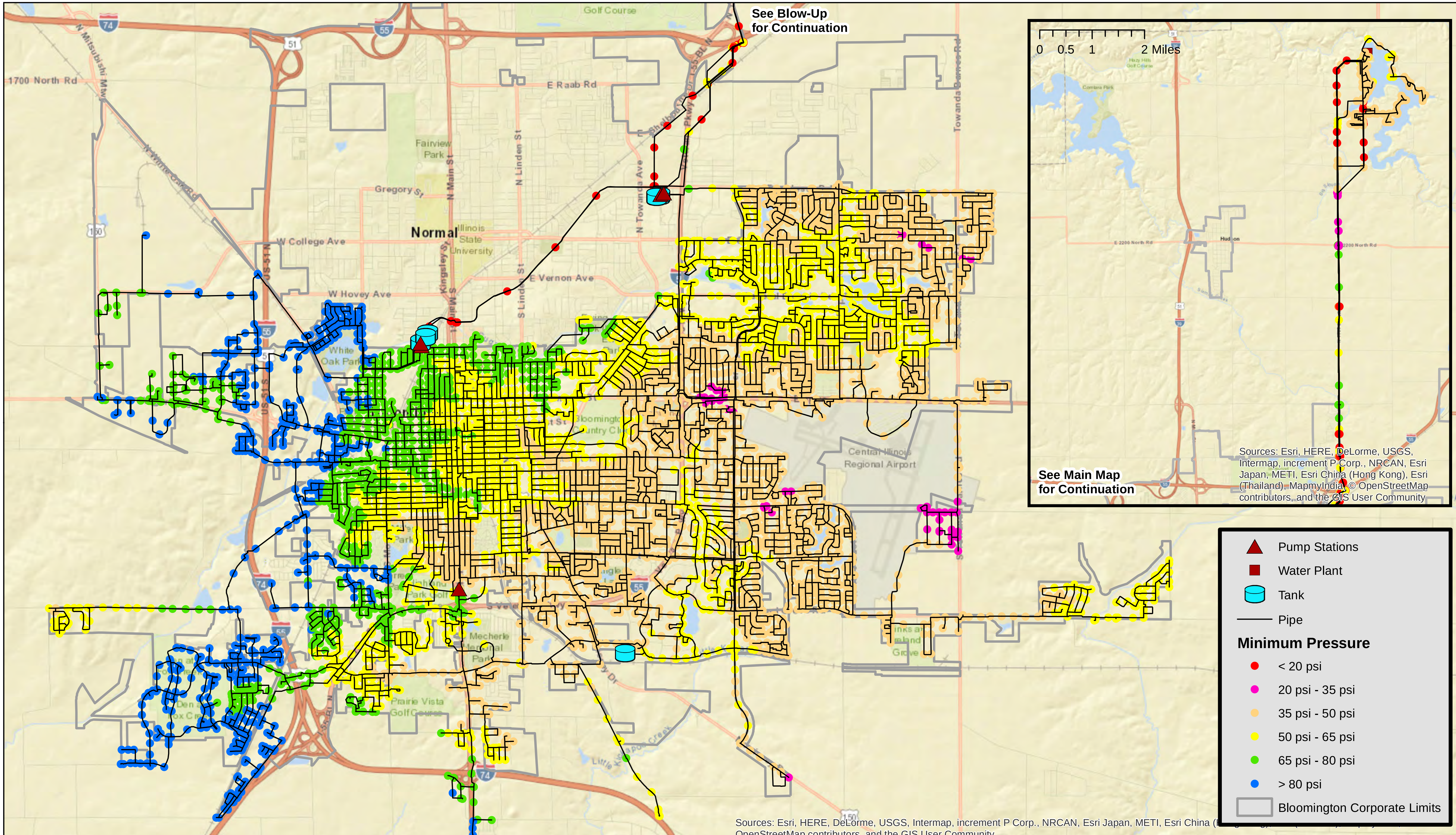

City of Bloomington Illinois

CDM Smith

0 0.275 0.55 1.1 Miles

N

Figure 7-1A
2018 MDD Minimum Pressures - Existing
Water Main System
City of Bloomington, IL

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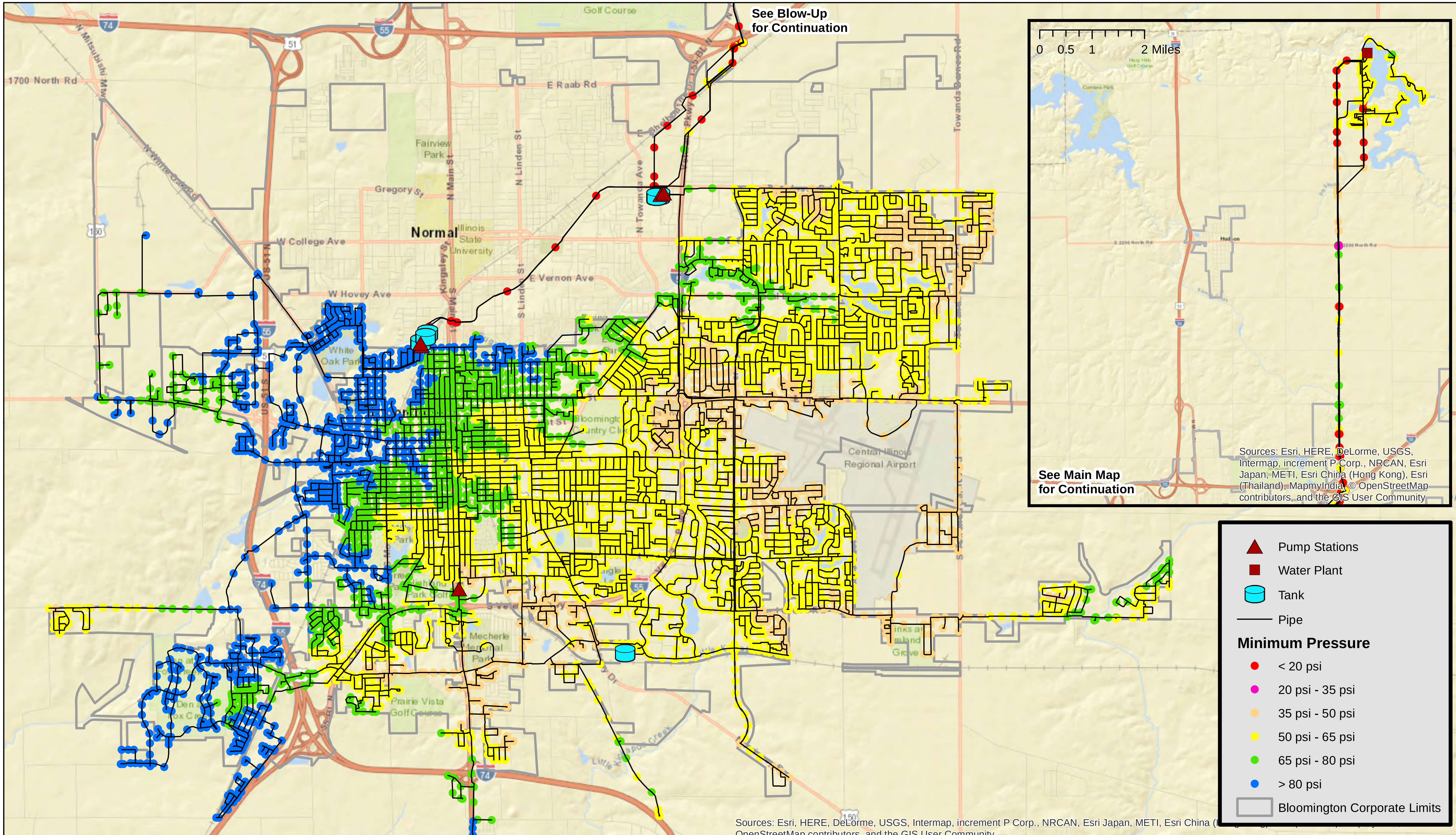

0 0.275 0.55 1.1 Miles

N

Figure 7-1B
2040 MDD Minimum Pressures at Firm Capacity - Existing Water Main System
City of Bloomington, IL

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7.3.2.2 Fire Flow Analysis

Using MDD conditions, a fire flow analysis was performed with the hydraulic model. Generally, a minimum fire flow of 500 gpm was required throughout the system. Through coordination with the Bloomington Fire Department, the City provided a GIS polygon showing areas of fire flow requirements based on building type. The City identified areas needing the additional fire flow of 1,000 gpm. **Figure 7-2** shows 2018 fire flow nodes that failed to meet required fire flow demand (500 gpm or 1,000 gpm in shaded areas as identified by the City) as magenta circles (500 gpm required) or blue circles (1,000 gpm required). Most of the failed fire flow nodes are located at the end of a 4-in or smaller water line.

Section 7.4 lists pipes that need to be upsized or looped to address the fire flow deficiencies shown in **Figure 7-2**. Domestic or non-fire flow lines (as identified by the City) with fire flow deficiencies are not included as requested by the City.

7.3.2.3 Water Age and Water Quality Analysis

Water age analysis was simulated under current low day demand conditions and current distribution system operational conditions. **Figure 7-3** shows the water age map for the water distribution system highlighting areas of water age over 300 hours. As can be seen, there are a number of high-water age regions that reflect dead ends or low water usage areas. Currently, the City of Bloomington has five water quality monitoring stations that monitor for chlorine residual. Additional water quality monitoring stations are recommended for the high-water age areas, especially areas staff reported having water quality complaints and challenges.

There are various water quality parameters that can be used to monitor water quality in the distribution system. **Table 7-1** provides a list of parameters most applicable to the City.

Table 7-1. List of Potential Water Quality Parameters

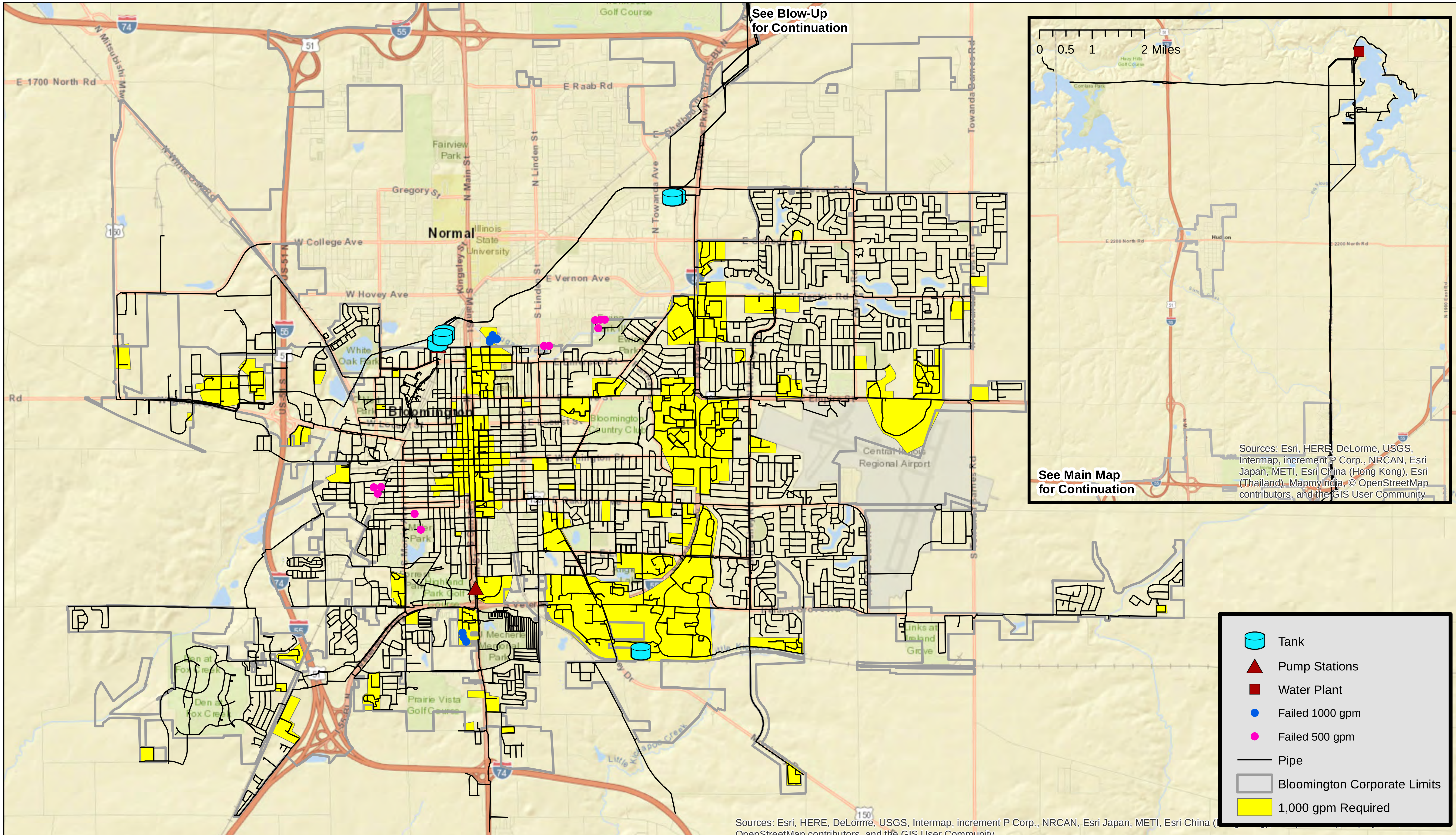
Water Quality Parameter	Why Important	Critical Points in System
Total Chlorine Residual (mg/L)	Regulatory Limit (1.0 mg/L) Decrease in residual can signal potential for biological activity or contamination	Grab sample locations showing low chlorine residual High water age sites Sensitive customers
pH	Can impact water corrosivity Drift in pH can indicate potential water stability problems and/or potential contamination	Grab sample locations showing large pH drifts; High lead sites Sensitive customers
Specific Conductance	Can be used as a surrogate to total dissolved solids Can indicate potential chemical contamination	Sensitive customers
Temperature	A sudden change in temperature can indicate potential cross-connection or other contamination	Sensitive customers
Turbidity	Increase of turbidity can indicate hydraulic upsets or intrusion of contaminants	Areas of potential flow reversal; sensitive customers

Hach and other instrument companies make a single distribution system water quality panel that measures the above parameters in addition to pressure. This distribution system panel can be linked to the PLC located at the remote site that can transmit the data to a main SCADA system for monitoring and data storage/analysis. Certain data can be used as triggers, such as:

- pH drift of 0.3 or higher.
- Chlorine residual dropping below a certain set value.
- Sudden turbidity change (from repeat samples).
- Sudden change in conductivity (from repeat samples).
- Sudden change in temperature (from repeat samples).

The above triggers can set off alarms for staff to review the data and respond to the situation. When deciding where to locate water quality monitors, CDM Smith looked at water quality records, areas of complaints reported by staff, modeled water age, and pressure zones. **Figure 7-3** shows locations the City identified as having water, sewer, and power and they generally coincide with sites that need to be monitored based on review of historical data and water age. All are reasonable candidates for water quality monitoring. The cost of each water quality monitoring panel is approximately $25,000.

CDM Smith also evaluated distribution system improvements (looping) that can reduce the water age at those areas. Those improvements were incorporated into the water distribution system improvements shown in Section 7.4. However, areas of dead ends were not shown to be looped given the high cost. As such, additional water quality monitoring is recommended.



City of Bloomington Illinois

CDM Smith

0 0.25 0.5 1 Miles

N

Figure 7-2
2018 Fire Flow - Failed Nodes
Water Main System
City of Bloomington, IL

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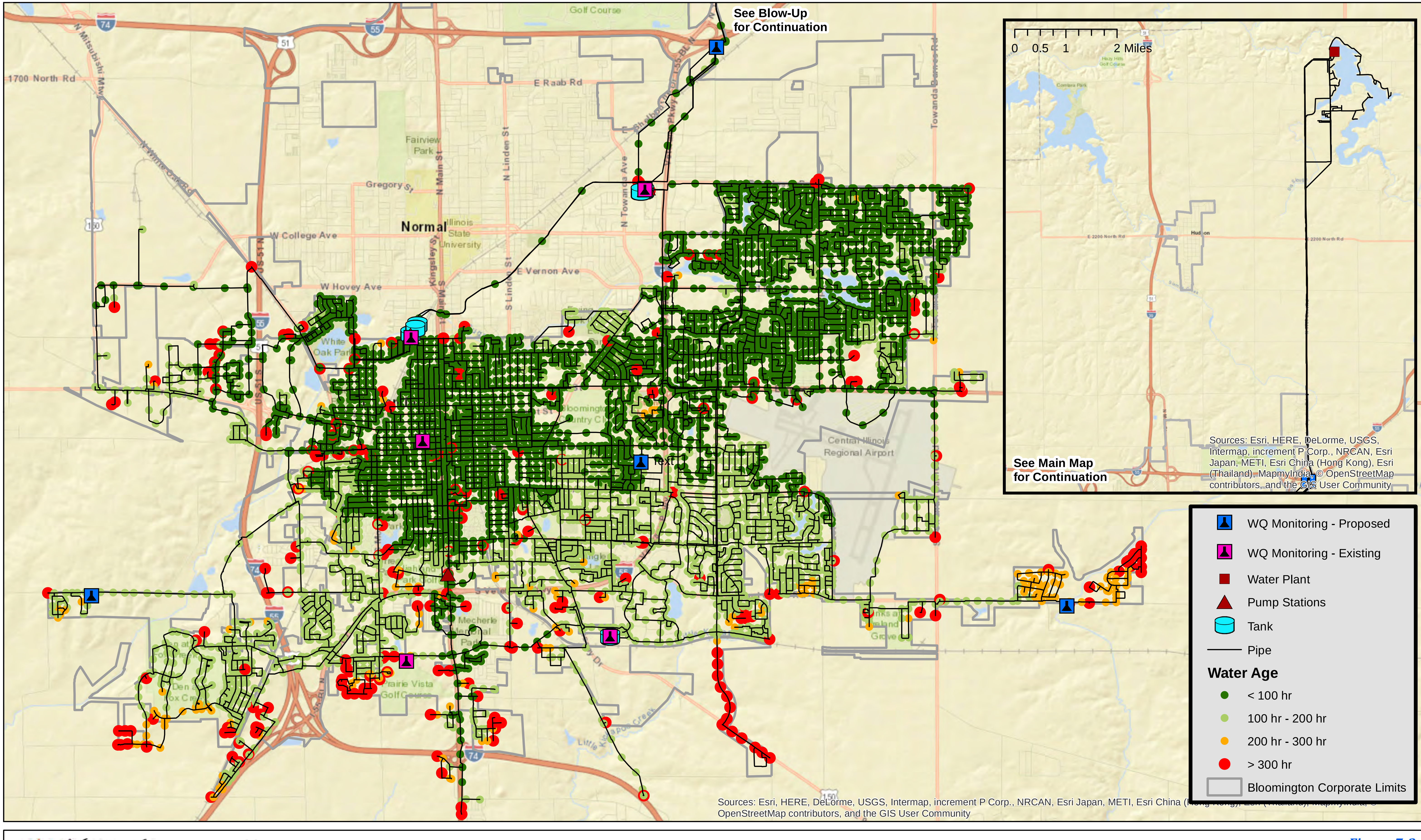

City of Bloomington Illinois

CDM Smith

Figure 7-3
2018 Low Day Water Age
Water Main System
City of Bloomington, IL

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7.3.3 Storage Analysis

The City of Bloomington has multiple storage facilities, including below grade, elevated, and standpipe storage tanks located throughout the City. **Table 7.2** summarizes the existing storage facilities. There is currently only one usable elevated tank and that is the Hamilton 2 MG elevated tank that maintains pressure in the City.

Table 7-2. City of Bloomington Storage Tanks

Tank/Reservoir	Age	Capacity	Style and Material	Current Condition	Usable Storage
Division Street	1950s	10 MG 5 MG	Underground Concrete	Fair	Assume 67% to avoid cavitation (10 MG)
Hamilton Road	1996	2 MG	Elevated Composite	Fair	2 MG
Fort Jesse	1991 1973	2 MG 2 MG	Ground Storage Tanks	Fair	4 MG
Northeast Elevated	2008	0.4 MG	Elevated spheroid	Good	Not in service

CDM Smith evaluated storage using Ten Standards recommendation of one day average day demand and also using industry standards for storage needs.

Ten State Standards Recommendation

Ten State Standards recommend storage for one average day demand or in this case 11.5 MG for current and 12.5 MG for future. Based on the above table, the City meets this criterion.

Industry Standard Storage Recommendations

Based on industry standard practice, water is stored in tanks for three purposes: equalization, fire-fighting and emergency storage. Each of these elements was be evaluated separately.

Equalization Storage

Equalization storage is water that is used to supplement pumping operations during periods when demands are higher than pumping rates. The amount of equalization storage required is unique to every water system. For systems such as the City of Bloomington, it is common for the pumped supply into the system to be designed to meet the peak day demand. Equalization storage would then provide additional water to meet usage in excess of the peak day demand such as the peak hour demand. The larger the system, the more difficult and expensive it becomes to provide enough elevated storage to meet the balancing storage requirements. Thus, in large systems, pump stations are designed to supply water in excess of the peak day demand. Equalization storage is commonly estimated to be 25 percent of the peak day demand.

Equalization storage is commonly estimated to be 25 percent of the peak day demand. CDM Smith utilized the peak day demands calculated in **Table 7-3** to estimate the equalization storage required, as shown in **Table 7-5** below.

Fire Flow Storage

Fire-fighting storage is water stored to provide a specific fire flow for a specified duration. Specific fire flow and specific time durations vary significantly by community. Fire flow requirements are dependent on the type of customer (residential, commercial or industrial) and the building construction.

The Bloomington Fire Chief indicated that a fire flow of 1000 gpm is desirable in critical areas of the distribution system, thus 1000 gpm is used to estimate the required firefighting storage volume. Based on this requirement, the required fire flow is as follows:

Fire Fighting Storage = 1000 gpm x 3 hours x 60 min/hr
= 180,000 gallons

Emergency Storage

Emergency storage is water stored for emergency situations such as source of supply failures, major transmission main failures, pump failures, electrical power outages, or natural disasters. The amount of emergency storage included with a particular water system is at an owner's discursion, typically based on an assessment of risk and the desired degree of system dependability. During emergency situations, customers will significantly decrease water usage to the benefit of the water system. On average, a reserve volume of fifteen to twenty-five-percent of the tank volume is an adequate amount. CDM Smith suggests twenty-five percent of the tank volume as emergency storage for this analysis.

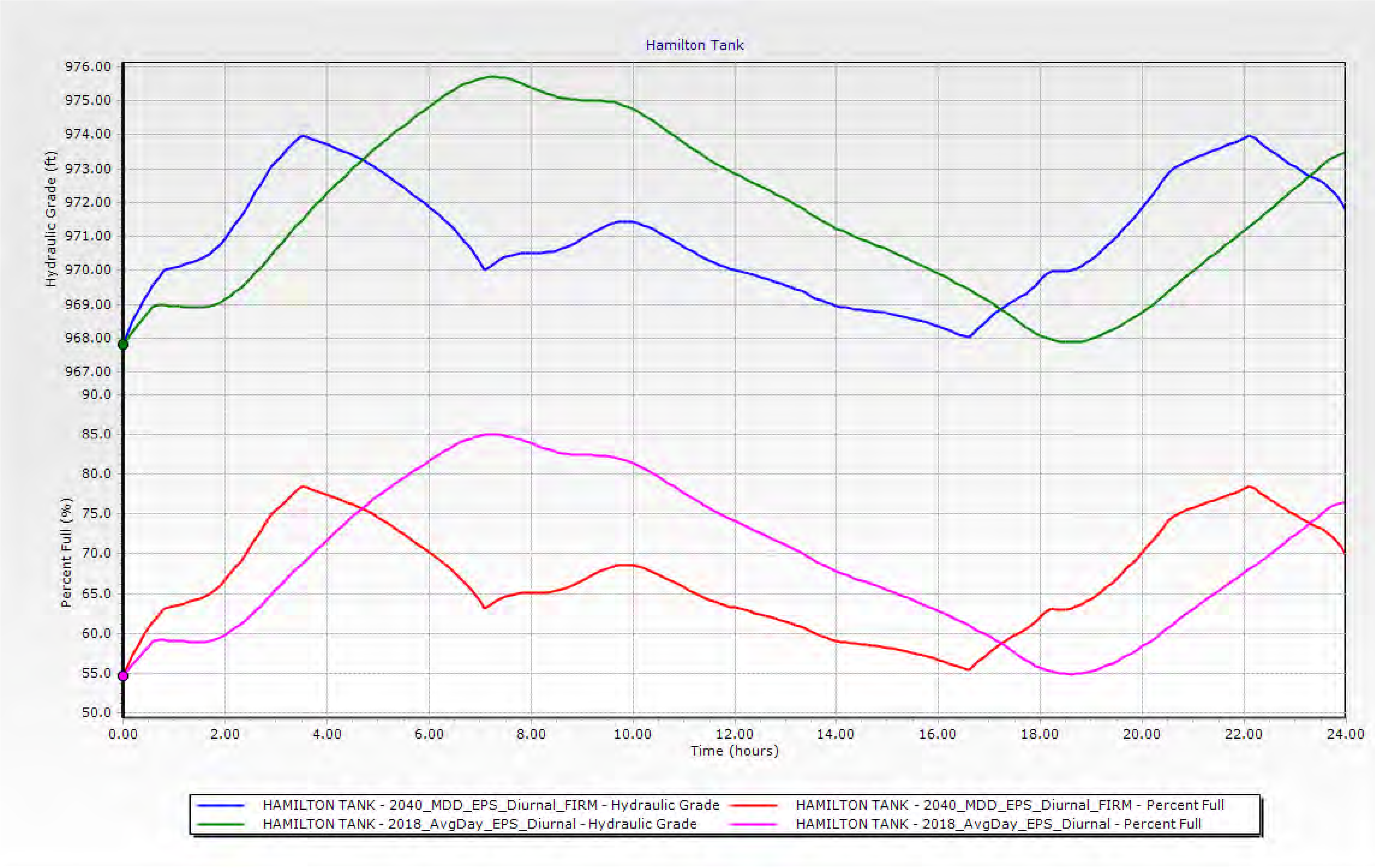
Based on the above three criteria, the following storage needs are identified:

- Equalization = 25% of peak day (2040) of 21.3 = 5.3 MG
- Fire Fighting = 1000 gpm times (3 hours of 180 minutes) = 0.18 MG
- Emergency = 25% of available storage or 25% or 16 MG = 4 MG

Based on the above analysis, the storage needs are approximately 9.5 MG, which is within the available storage. However, the analysis assumes that the existing tanks and pump stations all have back-up power and can be used in an emergency. If adequate back-up power capacity is not available at any of the pump stations, then additional storage is required.

CDM Smith also simulated ADD and MDD extended period simulations to evaluate Hamilton tank fluctuations to determine if additional storage is needed for the system. In the 2018 ADD and 2040 MDD simulations, the Hamilton Tank's water level drops to 55 percent and all distribution system pressures are above 35 psi (See **Figure 7-4**). This shows adequate operation of the Hamilton Tank and water turnover to minimize water age.

Figure 7-4. Hamilton Tank Water Level 2018 ADD and 2040 MDD 24-Hour Simulations



7.4 Hydraulic Improvements

As a result of the fire flow analysis, there are 18 pipe improvements that are suggested to increase capacity to meet fire flow requirements throughout the system. Fifteen (15) of these improvements are to increase an existing pipe diameter of 4-inch or less to a 6-inch diameter pipe. The other three improvements suggested are loop closures. A list of the 15 pipe improvements can be found in **Table 7-3**. Pipe improvement selections were made in concert with the risk assessment completed in parallel with the modeling work (**Section 7.5**). The total length of pipe recommended to be upsized is approximately 4,640 feet. The length of new pipe recommended for looping is 4,350 feet. The cost for these improvements is shown in **Table 7.6**.

Table 7-3. Recommended Pipe Improvements

Model ID	Location	GIS-ID	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Reason for Project
1423	University Ave.	P-7245	4	6	16	Industry Standard
3948	University Ave.	P-4581	4	6	81	Industry Standard
17212	Sherman St.	P-8059	4	6	260	Industry Standard
17213	Sherman St.	P-5139	4	6	295	Industry Standard
16387	White Pl.	P-7520	4	6	505	Industry Standard
10423	Norbloom Ave.	P-5227	4	6	427	Fire Flow (420 gpm)
10707	Briarwood Ave.	P-5223	4	6	430	Fire Flow (447 gpm)
11662	Miller Park	P-2927	4	6	532	Fire Flow (416 gpm)
16924	W. Elm St.	P-7963	4	6	282	Fire Flow (428 gpm)
16925	W. Elm St.	P-3001	4	6	279	Fire Flow (428 gpm)
17110	W. Jackson St.	P-8025	4	6	334	Fire Flow (414 gpm)
17111	W. Jackson St.	P-3197	4	6	342	Fire Flow (414 gpm)
9399	Packard St.	P-3370	4	6	365	Fire Flow (386 gpm)
17113	Packard St.	P-8026	4	6	257	Fire Flow (483 gpm)
17114	Packard St.	P-3359	4	6	234	Fire Flow (483 gpm)
Proposed	E. Division St. from Hwy 51 to Franklin Ave.	NA	NA	6	955	Fire Flow & Water Age
Proposed	From Ethel Pkwy to Eisenhower Dr.	NA	NA	6	2540	Fire Flow & Water Age
Proposed	Tracy Dr. to S. Main St.	NA	NA	6	960	Fire Flow & Water Age

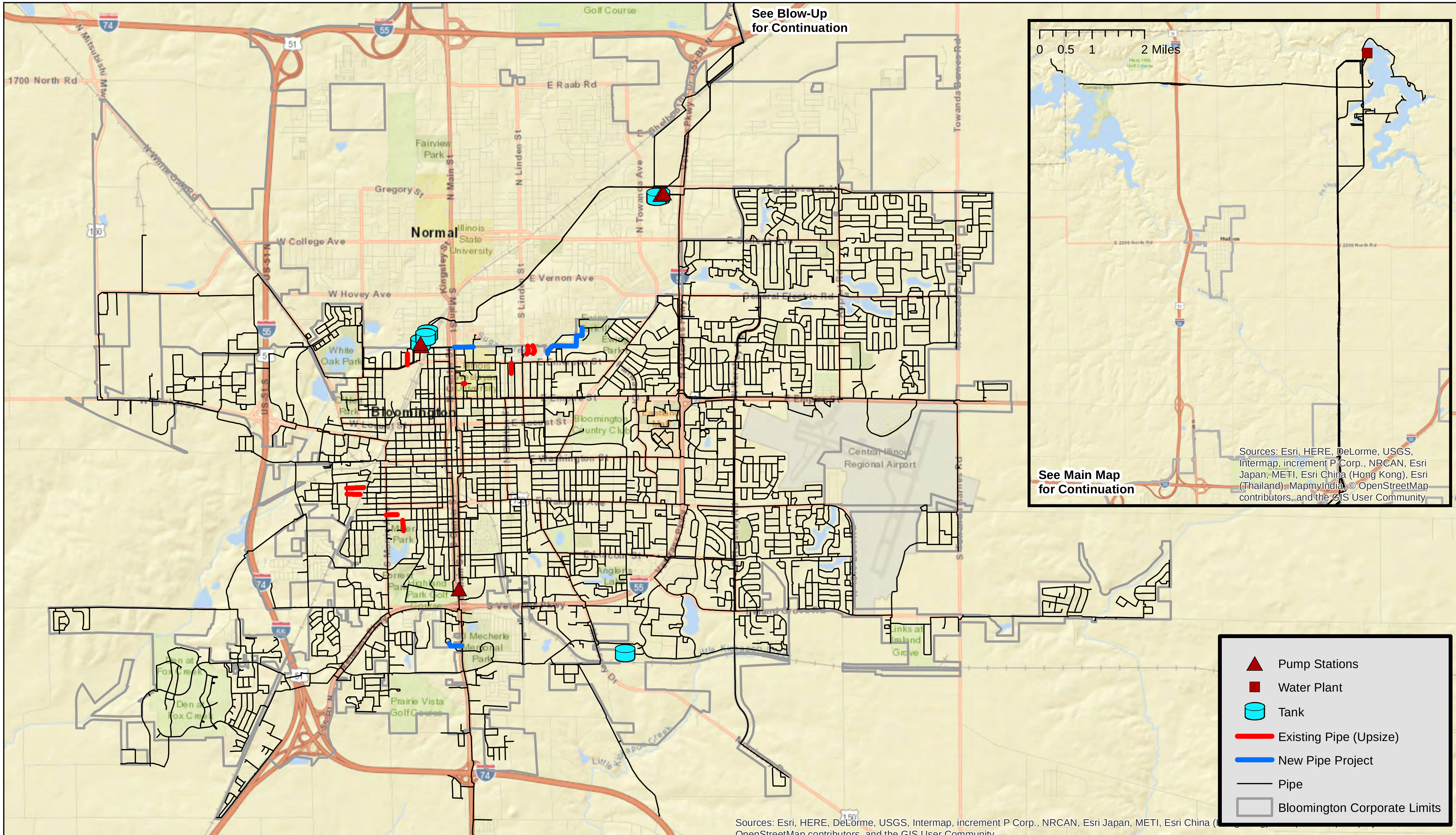


Figure 7-5
Proposed Pipe Projects
Water Main System
City of Bloomington, IL

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7.5 Risk Assessment

CDM Smith leveraged ArcGIS data and institutional knowledge to conduct a risk assessment of all pipes in the City of Bloomington distribution system. Risk ratings were assigned to approximately 450 miles of distribution pipe (i.e., 7,543 pipe segments in the City of Bloomington geodatabase). Risk ratings are assigned using a five-point scale to identify pipes with high risk due to the probability of failure (PoF) and consequence upon failure (CoF).

- **Probability of Failure (PoF) Evaluation** – A probability of failure rating is the rating of a pipe's potential to fail (e.g., collapse) in the near-term. Probability of failure is related to a pipe's known or estimated condition.
- **Consequence of Failure (CoF) Evaluation** – A consequence of failure rating is an evaluation of a pipe's criticality in the system. If there is a high consequence to the community or environment if a pipe fails, it will be rated as 'highly critical' and receive a high consequence of failure rating.

The process of calculating PoF and CoF scores are detailed in **Section 7.5.1** to **Section 7.5.6**. Results are detailed in **Section 7.5.7**.

7.5.1 Probability of Failure

The PoF evaluation involves scoring each pipe in the system using evaluation criteria, or PoF factors, with the goal of identifying pipes with a higher likelihood of failing relative to other pipes in the system. PoF factors for this study are based upon available GIS data, hydraulic model data and staff knowledge.

PoF factors used for this evaluation are as follows:

- **Age of Asset** – Pipe age often correlates with condition; newer pipes are typically in better condition than older pipes. City of Bloomington staff have identified that pipes constructed 40 to 79 years ago typically have a higher likelihood of failure relative to older and new pipes. Therefore, pipes that have approached or exceeded their intended design life, or were installed 40 to 79 years ago, receive a high 'age of asset' PoF score.
- **Material** – Certain pipe materials perform better than others. City of Bloomington staff identified that cast-iron pipes tend to have more condition issues relative to other materials in the system.
- **Break History** – Previous breaks in a pipe provide a physical indicator of weak or deteriorated pipe. The City provided GIS data plotting the location of 1,081 water main breaks occurring between 2003 and 2018. The location of water main breaks is shown in **Figure 7-6**. These breaks were associated with pipe segments and segments with a history of breaks receive a higher PoF score.
- **Water Main Velocities** – Higher velocities can scour the inside of a water main. Conversely, low velocities can result in stagnant water and debris settlement. Pipes with very high or low velocities receive a higher PoF score.

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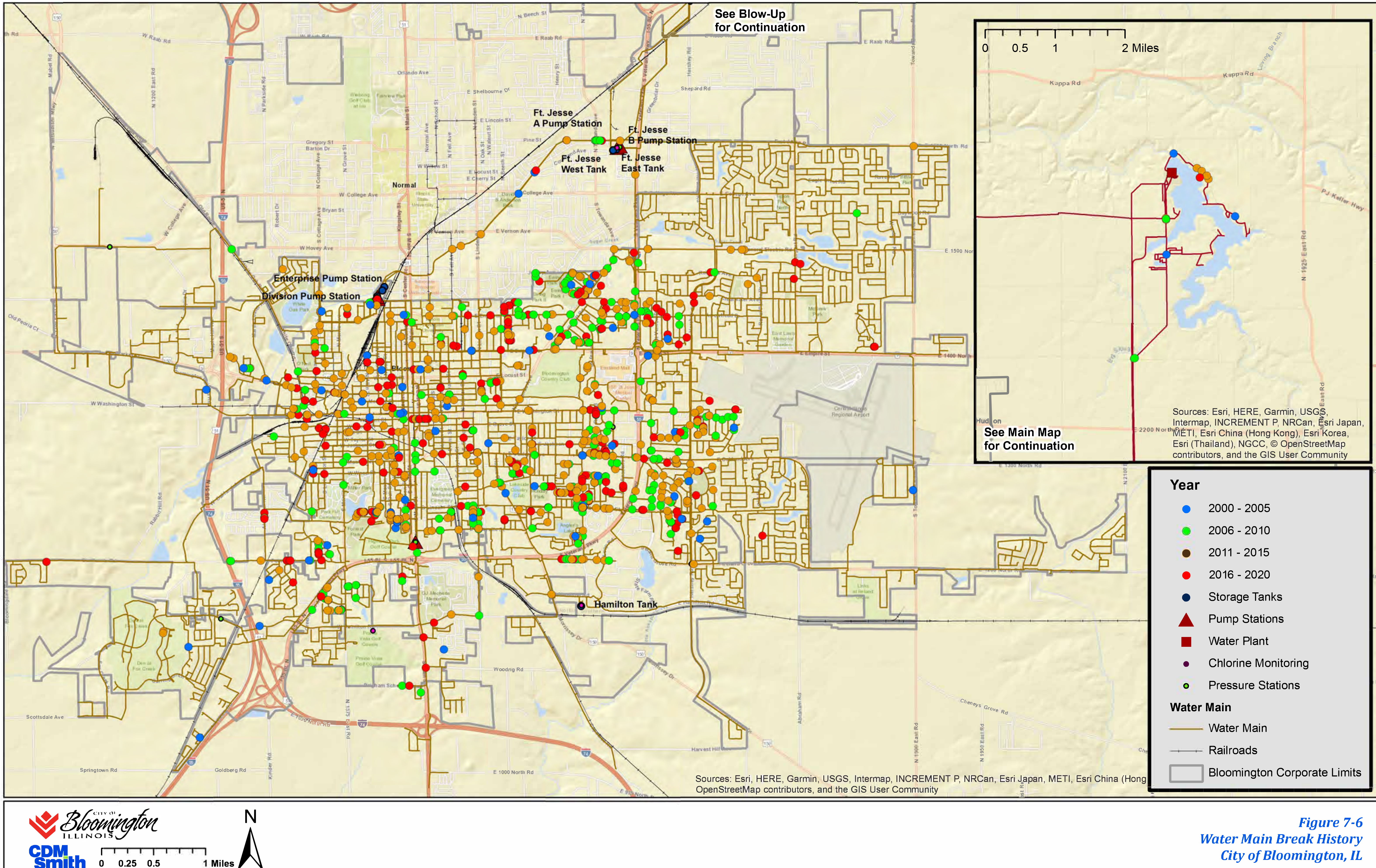

Figure 7-6
Water Main Break History
City of Bloomington, IL

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The City of Bloomington identified approximately 25 percent of the water main breaks as being caused by localized occurrences of external corrosion. The system-wide extent of corrosion and its impact on the service life of active pipes is currently not known. Consequently, external corrosion was not used as a PoF factor. Note that the City of Bloomington plans to investigate external corrosion further in the near future. A summary of common inspection technologies is provided in **Section 7.5.9**.

Table 7-4 presents PoF factors and weighting for the City of Bloomington distribution system. Refer to **Section 7.4.3** for additional information on how these weights/scores are used to calculate a PoF score for each pipe.

Table 7-4. Probability of Failure Factors for the Bloomington Water System

Probability of Failure Factor	Weighting	Breakpoint Score			
		5	3	1	0
Physical Attributes					
Age	4	40 – 79 Years	>80 Years	20 - 39 Years	<20 Years or No Data
Material	5	Cast Iron	Ductile Iron, Galvanized Iron, Steel	Concrete, Copper, HDPE	Other Material or No Data
Known Condition Concerns					
Break History	10	5 and Greater	3 – 4 Breaks	1 – 2 Breaks	No Breaks
Internal and External Stressors					
Water Main Velocities (Average 2018 Model)	1	>10 fps or <0.5 fps	10 – 8 fps	2 – 0.5 fps or No Model Data	2 – 8 fps

7.5.2 Consequence of Failure Factors

The CoF evaluation involves assessing each pipe using a series of CoF factors to identify pipes with a severe consequence upon failure. CoF factors are identified based on GIS data and hydraulic model results. CoF factors are selected to be consistent with a triple bottom line (e.g., social / ecological / financial) understanding of system risk.

CoF factors used in this study are as follows:

Social Impact

- **Proximity to Railroads** – Failed pipe under and adjacent to railroads have a higher CoF because of the potential for public disruption, required multi-agency coordination, and cost to repair.

- **Proximity to Roads** – Failed pipe under or adjacent to roads have a higher CoF because of the potential for public disruption, required multi-agency coordination, and cost to repair.

- **Proximity to Sensitive Receptors (Hospitals)** – Sensitive receptors are pipes serving people who may be sensitive to water and sewer outages. Hospital location data was digitized into the GIS system; proximity to hospitals is used as a CoF factor because service outages risk the health of patients.

- **Low / Negative Pressures** – Pipes with low pressure do not meet service standards. If pressure is negative, the pipe is at risk of groundwater infiltration.

Ecological Impact

- **Flooding Potential (Diameter)** – Magnitude of water released upon pipe failure was estimated based on pipe diameter. It is assumed that larger pipes typically convey higher flows. If a pipe was identified as having potential for a large release upon failure, it receives a higher CoF score.

Financial Impact

- **Difficult Access Upon Failure** – Staff identified pipes that are difficult to access. If it will be difficult and/or costly to access a section of pipe upon failure, the pipe is rated as being more critical to protect.

- **Hydraulic Criticality** – Water mains that are extremely critical to the hydraulics of the system were identified and receive a higher CoF score.

Table 7-5 presents CoF factors and weighting for the City of Bloomington water system. Refer to **Section 7.3** for additional information on using weighting/scoring to calculate a CoF score.

Table 7-5. Consequence of Failure Factors for the Bloomington Water System

Consequence of Failure Factor	Weighting	Breakpoint Score			
		5	3	1	0
SOCIAL IMPACT					
Public Safety / Permitting/ Rights of Way					
Proximity to Railroads	3	0 – 25 ft from Railroad	NA	NA	>25 ft from Railroad
Proximity to Interstate Road	10	0 – 25 ft from Road	NA	NA	>25 ft from Road
Proximity to Highway or Freeway	8	0 – 25 ft from Road	NA	NA	>25 ft from Road
Proximity to Major Collector	5	0 – 25 ft from Road	NA	NA	>25 ft from Road
Proximity to Minor Arterial or Minor Collector	2	0 – 25 ft from Road	NA	NA	>25 ft from Road
Human Exposure					
Proximity to Sensitive Receptors (Hospitals)	5	0 – 50 ft from Sensitive Receptor	NA	NA	>50 ft from Sensitive Receptor
Low / Negative Pressure (2018 Average Model)	3	<=20 psi	Low (21 psi – 35 psi)	NA or No Model Data	>35 psi
ECOLOGICAL IMPACT					
Environmental Impact					
Flooding Potential (Diameter)	2	>=30-in	14-in to 24-in	6-in to 12-in	<=4-in
FINANCIAL IMPACT					
Repair Considerations					
Difficult Access Upon Failure	8	Identified by Staff as Difficult Access	NA	NA	Not Identified as Difficult Access
Hydraulic Criticality	10	Extremely Critical to Hydraulics of the System	NA	NA	Not Critical to Hydraulics of the System

7.5.3 Scoring Approach

PoF and CoF ratings are calculated for each pipe segment as follows:

Identify Assets to Evaluate

- **Identify Discrete Pipe Assets** – Pipe assets are identified in the City of Bloomington GIS as individual segments in the Bloomington water system geodatabase. In general, a water pipe is defined as the pipe between valve structures or major fittings (e.g., 90° bend).

Conduct the Probability of Failure Evaluation

- **Evaluate Each Segment for Each Probability of Failure Factor** – Assign a score to each asset for each PoF factor listed in **Table 7-4**.

- **Calculate a Raw Probability of Failure Score** – Sum the scores from each PoF factor to develop a single raw PoF score for each asset. Refer to the calculation in **Section 7.5.4** for an example of calculating a raw score.

- **Develop a Probability of Failure Rating for Each Asset** – Consider the raw PoF scores for each asset. Break these scores into five scoring ranges of PoF (e.g., raw scores of 0 to 36 receive a rating of 1 – Low Probability of Failure). Assign a PoF rating of 1 to 5 for each asset. Refer to **Section 7.5.5** for the raw scores associated with each rating.

Conduct the Consequence of Failure Evaluation

- **Evaluate Each Segment for Each Consequence of Failure Factor** – Assign a score to each asset for each CoF factor listed in **Table 7-5**.

- **Calculate a Raw Consequence of Failure Score** – Sum the scores from each CoF factor to develop a single raw CoF score for each asset. Refer to the calculation in **Section 7.5.4** for an example of calculating a raw score.

- **Develop a Consequence of Failure Rating for Each Asset** – Consider the raw CoF scores for each asset. Break these scores into five ranges of CoF (e.g., raw scores of greater than 82 receive a rating of 5 – High Consequence of Failure). Assign a CoF rating of 1 to 5 for each asset.

Develop a Risk Matrix

- **Develop a Risk Matrix** – Combine the five-point PoF and CoF scores into a 5x5 risk matrix. If a section of pipe requires work AND its PoF and CoF ratings are high, this pipe would present a large risk to the system and should be addressed in the near-term.

7.5.4 Example Raw Score Calculation

Figure 7-7 shows an example raw CoF score calculation. This calculation process is identical for calculating PoF scores.

Water Pipe X is:

- Located more than 25 ft from a railroad (0 points with a weight of 3)
- Located more than 25 ft from an Interstate Road (0 points with a weight of 10)
- Located more than 25 ft from a Highway or Freeway (0 points with a weight of 8)
- Located below a Major Collector (5 points with a weight of 2)
- Located 20 ft from a Minor Arterial road (5 points with a weight of 5)
- Located 40 ft from a medical facility / sensitive receptor (5 points with a weight of 5)
- Has a pressure of 15 psi (5 points with a weight of 3)
- Is a 24-in water main (3 points with a weight of 2)
- Has not been identified as having difficult access upon failure (0 points with a weight of 8)
- Has been identified as hydraulically critical (5 points with a weight of 10)

RAW CoF SCORE = (0 x 3) + (0 x 10) + (0 x 8) + (5 x 2) + (5 x 5) + (5 x 5) + (5 x 3) + (3 x 2) + (0 x 8) + (5 x 10) = 131 points

Figure 7-7. Example Raw Consequence of Failure Score Calculation

7.5.5 Converting Raw Score to Five-Point Rating

Raw scores were converted into a five-point PoF and CoF rating. Breakpoints for each rating were set to provide an inverse exponential distribution that would identify a small percent of pipes at the highest rating (i.e., PoF or CoF = 5) and more than 50 percent of the pipes at the lowest rating (i.e., PoF or CoF = 1). **Table 7-6** and **Table 7-7** summarize raw score breakpoints.

Table 7-6. Probability of Failure Raw Score Breakpoints

PoF Rating	Raw Score
1	< 26
2	26 – 45
3	46 – 51
4	52 - 65
5	> 65

Table 7-7. Consequence of Failure Raw Score Breakpoints

CoF Rating	Raw Score
1	< 28
2	28 – 43
3	44 – 68
4	69 – 82
5	> 82

7.5.6 Risk Matrix

Individual PoF and CoF scores for each pipe were plotted in a 5 x 5 risk matrix. The risk matrix is developed with the following assumptions:

- Pipes with a high PoF and CoF rating (i.e., scores of 4 or 5) are assumed to be extreme risk. High-risk pipes are identified in the risk profile by the color red. Pipes that have scores that plot in the red box should be either inspected, rehabilitated or replaced in the next five years.
- Pipes with a high probability of failure but low consequence of failure have a high overall risk. These pipes are identified in the risk profile by the color pink. These pipes should be inspected, rehabilitated or replaced in the next ten years.
- Pipes with a moderate probability of failure and moderate consequence of failure have a moderate overall risk. These pipes are identified in the risk profile by the color orange. Pipes that plot in the orange box should be inspected, rehabilitated or replaced in the next twenty years.
- Lower risk pipes are identified in the risk profile by the colors blue and green. Based on risk, these pipes are a lesser priority for rehabilitation or replacement.

Figure 7-8 presents the risk matrix for the Bloomington water system. Risk ratings for individual pipes in the water system are presented in **Figure 7-9**. A larger map (22 x 34) is provided in **Appendix G**. In addition, a geodatabase with risks scores is provided to the City of Bloomington with this memorandum.

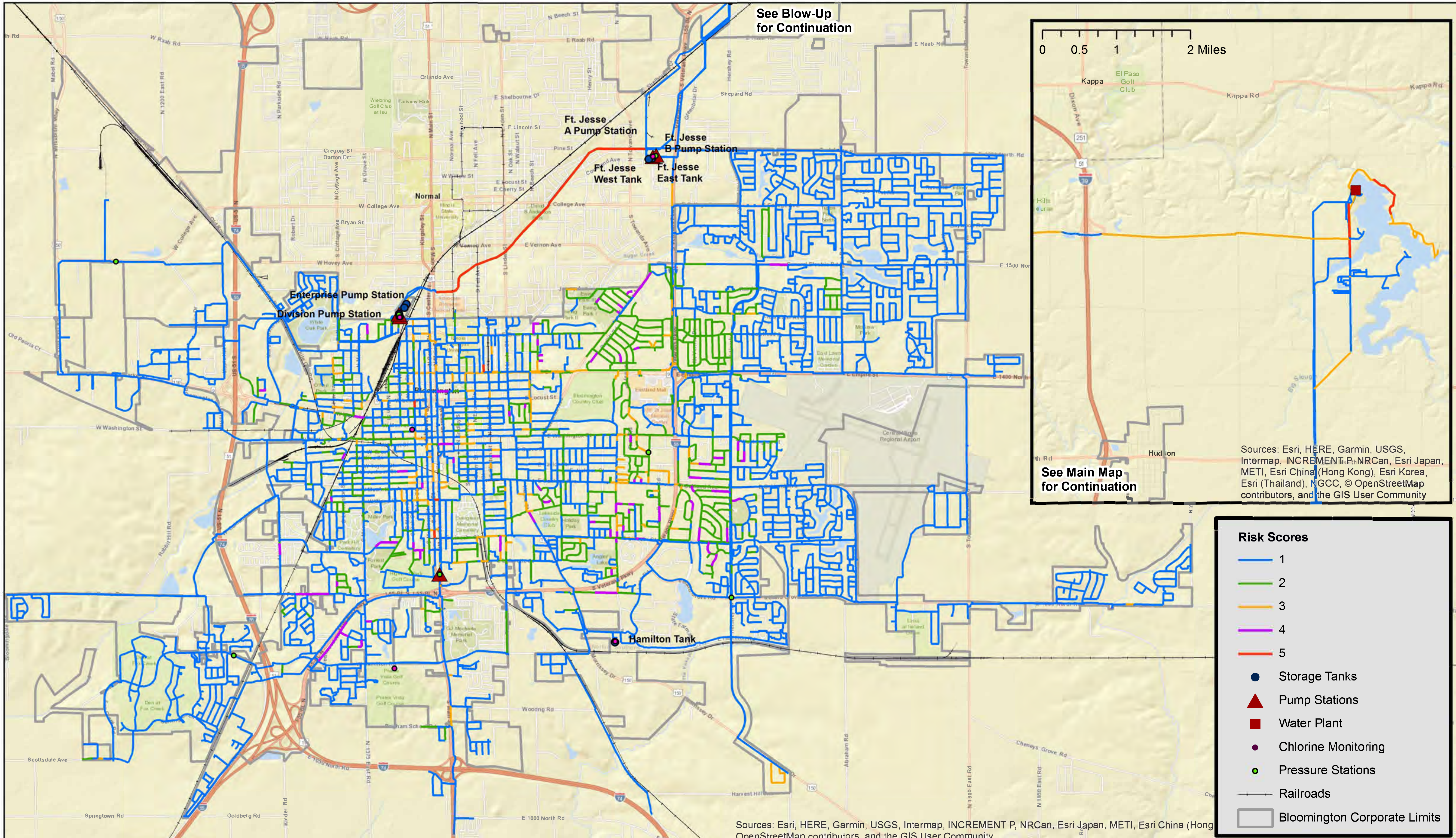
Probability of Failure

Consequence of Failure

	Low (1)	M. Low (2)	Medium (3)	M. High (4)	High (5)
High (5)	1-5	2-5	3-5	4-5	5-5
M. High (4)	1-4	2-4	3-4	4-4	5-4
Medium (3)	1-3	2-3	3-3	4-3	5-3
M. Low (2)	1-2	2-2	3-2	4-2	5-2
Low (1)	1-1	2-1	3-1	4—1	5-1

Red – Extreme Risk
Purple – High Risk
Orange – Medium Risk
Green – Low Risk
Blue – Negligible Risk

Figure 7-8. Risk Matrix



City of Bloomington Illinois

CDM Smith

0 0.25 0.5 1 Miles

N

Figure 7-9
Water Main Risk Prioritization
City of Bloomington, IL

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7.5.7 Risk Profile

The CDM Smith Team assessed risk for approximately 451 miles of water pipes (7,543 individual pipe assets). Assessed pipes are identified in the GIS database as 'Active' and owned by the City of Bloomington. **Figure 7-10** and **Figure 7-11** present the risk profile for Bloomington Distribution System.

Risk	Length (Miles)	% of System
1 – Negligible	355.8	78.9 %
2 – Low	62.6	13.9%
3 – Medium	21.4	4.7%
4 – High	6.9	1.5%
5 - Extreme	4.1	1.0%
TOTAL	450.8	100%

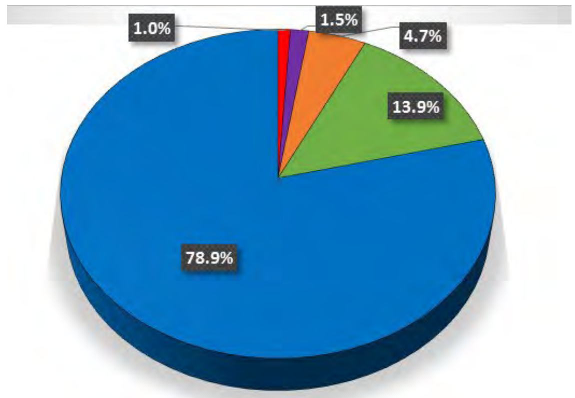

Figure 7-10. Water Main Risk Profile

Probability of Failure

Consequence of Failure	Low (1)	M. Low (2)	Medium (3)	M. High (4)	High (5)
High (5)	6.0 miles	8.7 miles	1.9 miles	0.4 miles	3.2 miles
M. High (4)	7.5 miles	6.5 miles	4.5 miles	0.2 miles	0.3 miles
Medium (3)	18.9 miles	15.6 miles	6.8 miles	2.6 miles	0.2 miles
M. Low (2)	9.5 miles	14.2 miles	7.3 miles	5.6 miles	0.7 miles
Low (1)	205.1 miles	63.8 miles	35.6 miles	19.7 miles	6.0 miles

Red – Extreme Risk
Purple – High Risk
Orange – Medium Risk
Green – Low Risk
Blue – Negligible Risk

Figure 7-11. Water Main Prioritization Matrix

Approximately 1 percent (4.1 miles) of the water system was rated as an extreme risk. These pipes should be prioritized for replacement or rehabilitation in the near-term. Approximately 1.5 percent (6.9 miles) of the water system was rated as a high risk. These pipes should be prioritized for replacement or rehabilitation after the extreme risk pipes have been addressed.

7.5.7.1 Liability Risk Cost

The system's liability risk was quantified using risk assessment results and budgetary-level water main replacement costs. **Table 7-8** summarizes the liability risk per risk level. Note that this summary includes a separate row for pipe replacements related to hydraulic model results (e.g., replacement + upsizing or new pipes).

Table 7-8. Estimate of Replacement Cost per Risk Level (including Model-Related Improvements)

Risk	Length (Miles)	% of System	Schedule for Action	Approximate Replacement Cost ($)	Annual Cost
5 - Extreme	4.1	1.0%	0 – 5 Years	$6.3M	$1.8M/yr (Over 5 Years)
4 – High	6.9	1.5%	6 – 10 Years	$10.6M	$7.7M/yr (Over 5 years)
3 – Medium	21.4	4.7%	10 – 20 Years	$33.0M	$3.4M/yr (Over 10 years)
2 – Low	62.6	13.9%	20 – 40 Years	$96.6M	$3.7M/yr (Over 20 years)
1 – Negligible	355.8	78.9%	No Schedule	$548.9M	NA
Total (Risk)	450.8	100%	NA	$695.4M	NA
Model/Fire Flow-Related	1.7	0.4%	Pipe Upsizing or Additional Lines	$2.7M	NA

7.5.8 Rehabilitation / Replacement Recommendations

Pipe risk, as defined by this study's risk assessment should be a key consideration when developing capital projects. When it is cost-effective, the City of Bloomington should rehabilitate or replace extreme risk and high-risk pipes. Incorporate risk assessment results as follows:

1. **Hydraulic Improvement Projects** – When developing hydraulic improvement projects (**Section 7.4**), CDM Smith prioritized upsizing pipes with extreme and high-risk. Replacing high-risk pipes would reduce the system's risk profile while also mitigating hydraulic concerns.
2. **Other Capital Projects** – Each year, overlay known road and sewer repair projects with the risk assessment GIS data. If extreme and high-risk distribution mains are in road and sewer project areas, coordinate with the other project and target pipes for replacement.
3. **Distribution Main Replacement** – If funding is available for distribution main replacement, prioritize extreme and high-risk pipes for replacement.

7.5.9 Inspection Technologies

Pressure pipe inspection is a rapidly evolving field; technology options and accuracy improve each year. Advancements in miniaturization of electronics and computer processors, along with new research in water distribution system infrastructure life cycle, have led to new and emerging technologies. This section summarizes the state of the industry for metal water main inspections as of Spring 2019.

7.5.9.1 Direct Inspection – Pipe Out of Service

The techniques chosen for investigating the physical condition of water mains depends on the size and material of the pipeline. Investigation techniques can be further divided into those that require the main be taken out of service and those that can be performed while the main remains in service. Techniques that require the main to be taken out of service are briefly described below. Note that some technologies apply to investigation of mains both in-service and out of service. Techniques that require a main to be taken out of service are typically used inside the main and include:

- Remote field/electromagnetics (internal eddy current testing).
- Internal visual inspection.
- Ultrasonic smart pig.
- Magnetic flux leakage pig.
- Acoustic resonance technology (ART).

Remote Field/Electromagnetics (Eddy Current Testing)

Electromagnetic eddy current testing can detect surface and subsurface defects in metallic pipe. In this technique, an energized coil produces an electromagnetic field near the pipe wall. The eddy currents in the pipe wall create a magnetic field which is opposed to the coil's magnetic field. The eddy currents are distorted by defects in the pipe wall that change the impedance in the coil. From the impedance changes, the pipe wall defects including fractures, erosion and corrosion can then be mapped. Eddy Current Testing can be applied at the external or internal surface of a pipe.

For smaller diameter pipe (16-inch and smaller) where manned access is not feasible, unmanned inspections can be performed on a dewatered pipe where the equipment is driven through on a small robotic tractor. A version of this technique called Remote Field Eddy Current (RFEC) is used in the oil and gas industry to inspect steel pipe.

Disadvantages of this technique include pipe shut-down time for dewatering, cleaning and inspection. In dense urban areas, adjacent utilities can cause electromagnetic interference.

Internal Visual Inspection

This technique requires the pipe be dewatered. Inspection is performed with a closed-circuit television (CCTV) camera in a similar manner to how a gravity sewer is inspected. The requirement for dewatering makes this method expensive for most mains. There is, however, a relatively recent technology that allows for a CCTV camera inspection of a main without taking it out of service, as discussed further this section for pipes in-service. Manual inspections using a CCTV camera look for internal cracking; specifically, longitudinal cracking that may be a precursor to failure, as well as tuberculation.

Ultrasonic Smart Pig

An approach to measure the wall thickness in situ is by using ultrasonic devices attached to a remotely controlled device, known as a pig, which is pushed through the pipe with water pressure. The pig reads reflected ultrasound as it moves through the pipe and provides a continuous profile of the pipe wall thickness. The pig is usually inserted by excavating and cutting out a small section of the line. Alternately, a pig launching connection could be installed.

These devices are typically available in diameters of 6-inch to 36-inch. The pipe usually must be cleaned of tuberculation deposits prior to inspection. Sometimes erroneous readings occur when there are multiple pipe wall layers such as cement linings or external coatings. Bends with sharp angles such as 90 degrees, as well as butterfly valves, are a problem for the pig to navigate.

Magnetic Flux Leakage Pig

Another continuous approach to measure the wall thickness in situ for metallic pipe is by using magnetic flux leakage (MFL) density sensors attached to a remotely controlled pig that is pushed/pulled through the pipe. The pipe is temporarily magnetized so that the pig can read variations in magnetic flux between the pipe and the pig to determine flux leakage through the pipe walls. That information is then converted to measure loss of pipe wall thickness. The process can also detect delamination, weld porosity, circumferential cracks, etc., but it is unable to detect axial cracks.

The pig is usually inserted by excavating and cutting out a small section of the line. Alternately, a pig launching connection could be installed. These devices are typically available in 6-inch to 36-inch size and require a "same-size" insertion/launching connection. The pipe usually must be cleaned of tuberculation deposits prior to inspection.

Recent advances have improved the quality of data from "smart pigging" to allow for steel, cast iron or ductile iron pipes with up to 1-inch of mortar lining to be inspected. Constant contact with the pipe wall during inspection is no longer required to accurately detect pipe wall defects. Butterfly valves and bends with sharp angles such as 90 degrees can be problematic for the pig to navigate if less than 1.5 times the pipe inside diameter.

Acoustic Resonance Technology

A continuous approach using acoustic resonance technology (ART) for metallic pipe assessment was developed in Europe by a company called Breivoll Inspection Technologies (BIT). The ART is based on half-wave resonance where low frequency broadband acoustic pulses are emitted by the scanner inside the pipe. The scanner is towed through the pipe with a cable. No contact with the pipe wall is needed and tuberculation need not be removed, but it can only navigate bends of 11 degrees or less. Pipe thickness, internal and external corrosion and surface anomalies can be identified with this technique.

The pipe is usually cut to insert the device and the line is then filled with water as a medium for the acoustic emissions. The smallest size tool currently available is for 12-inch diameter pipe, but smaller tools are under development. Sometimes internal cement linings can interfere with the assessment of external corrosion.

7.5.9.2 Direct Inspection – Pipe In Service

Direct investigation techniques that can be performed while the main remains in service can be further subdivided into those techniques that can be done without excavation or minimal excavation and those that require excavation to uncover a portion of the main.

Techniques that can be performed while the main remains in service and that do not require excavation or only require vacuum extraction holes include:

- Remote field/electromagnetics (eddy current testing).
- Internal video inspection.
- Ultrasonics.
- Magnetic flux leakage.
- Acoustics.
- Electromagnetic distress detection.

Investigation techniques that can be performed while the main remains in service, but require test pit excavation for external examination include:

- External sonic/ultrasonic testing.
- Pitting depth analysis.
- Broadband electromagnetics (BEM).
- Magnetic Flux Leakage Detection.
- Obtaining and examining pipe coupons.

Remote Field/Electromagnetics (Eddy Current Testing)

Electromagnetic eddy current testing can detect surface and subsurface defects in metallic pipe. In this technique, an energized coil produces an electromagnetic field near the pipe wall. The eddy currents in the pipe wall create a magnetic field which is opposed to the coil's magnetic field. The eddy currents are distorted by defects in the pipe wall that change the impedance in the coil. From the impedance changes, the pipe wall defects can then be mapped including fractures, erosion and corrosion. It can be applied at the external or internal surface of a pipe. In recent years, research projects have developed small systems than can enter through fire hydrants or other openings (e.g., SeeSnake by Pipeline Inspection and Condition Analysis Corporation (PICA)) and traverse bends and butterfly valves. PICA has both a free swimming device and a device towed by cable that are capable of assessing metallic pipe up to 24 inches in diameter. Direct contact with the pipe wall is not required.

Pure Technologies has a new technology called PureEM "Pipe Diver" for thin wall cast iron and ductile iron pipe which is a free-swimming device that detects changes in the electromagnetic field of pipe. Cast iron pipe greater than ½ inch wall thickness is too thick for the PureEM pipe diver. It can identify the size of a defect, the amount of wall loss, and broad areas of corrosion.

Internal Video Inspection

Pure Technologies has adapted its Sahara leak detection system (formerly by PPIC) to also deploy a small camera with lighting directly into a live main. With this system, the camera is inserted through at 2-inch tap in the main while the main is in service. Next, a small parachute is remotely deployed that uses the flow of water to move the tethered camera along in the pipe. The video tends to be a bit shaky while the camera is moving. However, this disadvantage has been overcome by viewing freeze frames, much like a slide show. The technology is capable of viewing mains as small as 10 inches in diameter. However, the distance investigated is limited typically by the drag of the cable. Typically, the video can reveal information about the level of tuberculation, visual cracks, offset or open joints, and failure or delamination of pipe linings. The actual pipe metallic pipe wall itself is often obscured by the tuberculation or linings.

Wachs Water Services, who was recently acquired by Pure Technologies, and Game Consultants, also have a video technology, the JD7 Investigator, which can be inserted into a live main through a fire hydrant or a 2-inch tapping. The device is pushed along in the pipe with flexible rod. The self –propelled system can turn corners such as a tee and can travel against flow. The unit can also include a hydrophone for leak detection and transmitter for pipe location in addition to a video camera. It is typically used in mains 4-inch to 12-inch in diameter. For pipe larger than 12-inch diameter, the LDS1000 system is available, but it cannot be launched via fire hydrants. It requires a 2-inch or larger tapping and has a small parachute for propulsion like the Sahara system described above.

Ultrasonics

Both Wachs Water Services and Game Consultants are licensed to employ a new ultrasonic pipe condition assessment technology that can be launched through fire hydrants, 2-inch to 6-inch taps, pressure fittings, and air valves, etc. The device is pushed along in the pipe with flexible rod and the inspection length is about 330 feet for smaller diameter pipes. The device is the JD7 PipeScan+™ technology by JD7 Pipeline Services LTD from Great Britain, and it provides multiple point wall thickness measurements, corrosion and flaw identification, lining thickness, 3D pipe dimensional profiling and CCTV inspection for water mains ranging from 4-inch to 12-inch. The data collected allows for a more accurate analysis of remaining life of the pipe, measurement of liner thicknesses and pipe profiles.

Magnetic Flux Leakage Pig

Another continuous approach to measure the wall thickness in situ in metallic pipe is by using MFL density sensors attached to a remotely controlled pig that is pushed/pulled through the live pipe. The pipe is temporarily magnetized so that the pig can read variations in magnetic flux between the pipe and the pig to determine flux leakage through the pipe walls that is then converted to measure loss of pipe wall thickness. The process can also detect delamination, weld porosity, circumferential cracks, etc., but it is unable to detect axial cracks. It can also identify pitting and areas of broad corrosion. The pig is usually inserted by excavating and cutting out a small section of the line. Alternately, a pig launching connection or tapping sleeve and valve could be installed. Pure Technologies currently offers MFL apparatuses for 8-inch to 12-inch pipe that can be either free swimming or winched through the live pipeline. It can penetrate cement linings up to 1-inch thick. Constant contact with the pipe wall during inspection is no longer required to accurately detect pipe wall defects. Bends with sharp angles such as 90 degrees can be problematic for the pig to navigate if less than 1.5 times the pipe inside diameter.

Acoustics

Echologics Engineering Inc., now owned by Mueller Corporation, developed an acoustic leak detection technology in a collaborative research effort with the National Research Council of Canada (NRC). A spin-off of this was the "ePulse" technology that uses acoustics to measure the remaining average minimum wall thickness or relative stiffness on many types of pipes, including cast and ductile iron pipe in all sizes. In 2006, pilot testing of this new was performed at 11 sites in the City of Hamilton, Canada. The basis for the new technology is the measurement of the speed at which acoustic signals are transmitted through the water column along a section of pipe. Typically, fire hydrants are flowed to induce acoustic signals in pipes. The acoustic signals are subsequently measured by acoustic sensors spaced out at two separate points along the pipe on fire hydrants, valves or air releases. The acoustic propagation velocity is computed between sensors and based on pipe stiffness, an average minimum wall thickness of the pipe segment between sensor points is calculated.

Typical distances for evaluation are about 300 feet to 500 feet. A limitation is that pipe wall thickness may vary along the stretch of pipe being evaluated, but by keeping the length short the results are likely to be more consistent with the actual pipe condition. For mains where there are no hydrants, vacuum extraction holes might be needed to magnetically attach sensors to the pipe. Vibration devices can also be attached in a similar manner to induce acoustic signals when hydrants are not available.

Electromagnetic Distress Detection

Pure Technologies has developed new electromagnetic distress detection technology which is a pipe wall assessment tool (PWA), called PurePWA. The technology can be deployed as either a free swimming or tethered device that measures the Velari Effect, or the change in the magnetic field. The technology is primarily a screening tool which identifies areas of stress caused by wall pitting, poor bedding, heavy loading, joints, changes in pipe material, bends and fittings. In addition, the data can be plotted to GIS with aerial overlay to determine the possible causes of observed anomalies.

The new PWA technology can be paired with either the Sahara system (tethered) or the SmartBall system (free swimming) to obtain information about potential leaks in conjunction with the PWA tool. With the Sahara system, a sensor is inserted through at 2-inch tap in the main while the main is in service. Next a small parachute is remotely deployed that uses the flow of water to move the tethered sensor along in the pipe. The sensor, reportedly, can report on stressed pipe areas and detect leaks as small as 0.005 gallons per minute. The position of the sensor can be tracked at ground surface to within about 18-inches of its location, so finding the leak afterward for repair is easy. The technology is capable of measuring pipe stress and leakage in mains as small as 10 inches in diameter. However, the distance investigated is limited typically by the drag of the cable.

The SmartBall PWA system uses a free-swimming foam ball that is inserted into a live main that is 10 inches in diameter or larger. Inside the foam ball is a 2.5-inch aluminum core containing electromagnetic detection equipment and acoustic instruments capable of detecting and locating areas of pipe stress and very small leaks. The ball is typically inserted and extracted through a 4-inch opening. It is capable of 15 hours of travel during which it communicates with receivers on valves and other appurtenances. The system calculates the locations of points of pipe stress or leaks by detecting acoustic pulses emitted by the ball at the receivers attached to pipe appurtenances. The locations of the pipe stress or the leaks relative to the receiver positions are determined by analyzing arrival times of the pulses and flow rate. When the ball is retrieved at a down-gradient location, the information about the location of leaks is downloaded and post-processed. The system has the advantage of being able to go long distances and pass through open valves such as butterfly valves. Results can be influenced, however, by unsteady flow rates that impact the travel speed of the ball in the pipe.

External Sonic/Ultrasonic Testing

This technology involves using an ultrasonic thickness device to determine the thickness of the pipe wall around the circumference of the pipe in cast iron and ductile iron mains. A trench is excavated so that the ultrasonic device can be manually applied around the main. This testing may also be performed at locations where the pipe is already exposed such as an air release valve. Any exterior pipe coatings must be removed, and the pipe must be cleaned before the device is applied. A coupon of the main is sometimes taken to calibrate the ultrasonic testing device. The disadvantage of ultrasound is that the readings are taken at isolated points as opposed to a full pipe scan.

Another ultrasonic technology used in test pits, employs guided ultrasonic waves that are propagated along pipes for long distances. When the waves meet an anomaly or pipe feature, the waves reflect back to transducer. The distance to the defect is calculated by time of flight. The amplitude of the signature determines the size of the defect. For bell and spigot pipe, it is usually limited to one pipe length outside of the pit, as pipe bells reflect the waves back. Linings and coatings are problematic for accurate readings.

Pitting Depth Analysis

This approach takes place in test pits and is usually combined with other analyses such as External Sonic/Ultrasonic Testing. The pipe is typically exposed from 180 degrees to 360 degrees of circumference. The pipe wall is then cleaned to bare metal and a grid is usually marked on the pipe wall. At each grid intersection, a pitting depth gauge or similar device is used to measure the depth of the pitting observed.

Broadband Electromagnetics

BEM uses a range of electromagnetic frequencies to detect a variety of thicknesses in ductile and cast iron pipe. The main benefit of BEM is that it can survey very accurately through ferrous pipe coatings and linings. BEM is able to scan the whole exposed section of pipe for a full picture of pipe condition (loss of metal, cracks, etc.), not just a number of isolated points. A combination of investigation pits and keyhole excavations may be used in conjunction with an available tool for remotely working down keyhole excavations to scan the upper part of the exposed pipe in the keyhole.

Magnetic Flux Leakage Technology

With MFL used externally, the pipe is temporarily magnetized so that the device can read variations in magnetic flux between the pipe and the device to determine magnetic leakage through the pipe walls that is then converted to measure loss of pipe wall thickness. The process can also detect delaminations, weld porosity, circumferential cracks, etc., but it is unable to detect axial cracks. If the pipe wall is first sand blasted, depths of pitting can also be accurately determined. Echologics has exclusive USA rights to Great Britain's Advanced Engineering Solutions Limited's (AESL) MFL technology, called SmartCAT™. For an exposed section of pipe, the device can examine a 1-meter length of pipe for 360 degrees around the circumference.

Coupons/Cross Sections

Coupons and cross sections are pipe samples that are taken from selected locations to determine the amount of internal or external corrosion in cast and ductile iron pipe. The disadvantage to taking coupons is that it provides information only at the location where the coupon was taken, and often corrosion is not uniform across the full length of the pipe. Several different types of analysis can be performed on pipe samples. Examination of the depth of internal and external graphitization, and pitting provides an indication of remaining pipe life and degree of corrosion. This data should be collected in conjunction with a soil analysis to determine whether there is a connection between ambient soil conditions and corrosion and graphitization. Strength testing to determine the Modulus of Rupture using either the Talbot Strip Test or the preferred Ring Test and tensile strength are also very useful. From these tests, the existing strength of a main can be compared with the original design strength.

7.5.9.3 Indirect Inspection Techniques

Indirect techniques do not directly examine the physical condition of pipe wall. Instead, these techniques collect data about parameters that can be related to a physical condition. Often a desktop analysis of historical leak history information along with pipe age and material data can be used with or without statistical models to predict the condition of mains. Another parameter, leakage, can determine mains with frequent leakage issues. Frequent leakage may be an indicator of joint or pipe wall problems that can lead to failure. Soil corrosion parameter analysis can be used to predict the likelihood of external corrosion of metallic pipe that can lead to failure. Finally, transient pressure analysis that determines the presence and severity of pressure transients can indicate areas of concern in the distribution system with respect to potential pipe failure.

Desktop Technologies

Failure forecasting using (linear extended Yule process) LEYP and/or other statistical tools provides an indirect method of pipe condition assessment. This approach is suitable for developing system-wide assumptions about pipe condition, differentiated by break/leak history, age, material or other characteristics. Using failure forecasting in conjunction with collecting physical condition assessment data provides a basis for establishing probabilities of failure, an essential part of the process for prioritizing capital projects by risk; confirming LEYP results; and for larger mains, monitoring the change in condition over time.

Leak Detection Technologies

Conventional acoustic leak detection requires that a special listening device to be in contact with the water main at hydrants or gate valves to hear the sound of water leaking from the main. Another acoustic approach listens for leaks at the ground surface over the mains. Both of these techniques are impacted by background noises in nearby sewers and drains, as well as traffic on the street. There are, however, relatively new technologies that can listen for leaks from within the main itself. These technologies, Sahara system and Smart Ball by Pure Technologies, use hydrophone sensor technology that travels in the main while it is still in service. Other technologies involve mobile or fixed acoustic sensors, acoustic fiber optics, thermal sensing, thermography, ground penetrating radar, and chemical detection.

Pure Technologies – Sahara

A sensor is inserted through at 2-inch tap or larger in the main while the main is in service. Next a small parachute is remotely deployed that uses the flow of water to move the tethered sensor along in the pipe. The sensor, reportedly, can detect leaks as small as 0.005 gallons per minute. The position of the sensor can be tracked at ground surface to within about 18-inches of its location, therefore finding the leak afterward for repair is more precise. The technology is capable of measuring leakage in mains as small as 10-inches in diameter. However, the system cannot maneuver through butterfly valves, which are often found on large mains and the distance investigated is limited typically by the drag of the cable.

Pure Technologies – SmartBall

The SmartBall system uses a free swimming foam ball that is inserted into a live main that is 10-inches in diameter or larger. Inside the foam ball is a 2.5-inch aluminum core containing acoustic instruments capable of detecting and locating very small leaks. The ball is typically inserted and extracted through a 4-inch opening. It is capable of 15 hours of travel during which it communicates with receivers on valves and other appurtenances. The system calculates the locations of leaks by detecting acoustic pulses emitted by the ball at the receivers attached to pipe appurtenances. The locations of the leaks relative to the receiver positions are determined by analyzing arrival times of the pulses and flow rate. When the ball is retrieved at a down-gradient location, the information about the location of leaks is downloaded and post-processed. The system has the advantage of being able to go long distances and pass through open valves such as butterfly valves. Results can be influenced, however, by unsteady flow rates that impact the travel speed of the ball in the pipe.

Thermography

Especially in winter, water leaking from a water main can be warmer than the surrounding ground. This leakage can create warmer saturated zones below the ground surface. The converse is true in summer months. These saturated zones can be detected by a technique called thermography that uses an infra-red device to detect the different in temperature of leakage just below the ground surface. The limitation of this method is in areas of high groundwater or when leakage moves down and away from the pipe instead of saturating the ground near the surface.

Ground Penetrating Radar (GPR)

This technique typically sends electromagnetic waves into the ground that bounce off objects and reflect back to a receiver. A picture of below ground objects, rocks and voids is obtained. It has also been successful in detecting leaks. A trained experienced operator is required to identify leaks and the ground penetrating radar (GPR) unit must travel over the pipe location. Therefore, the location of the pipe needs to be known or identified with the GPR and it needs to be accessible.

7.6 Additional Distribution System Recommendations

The City has established the following distribution system practices:

- Current City practice is to replace lead services during water main replacement projects and during service line and water main repair work whenever they are encountered.
- Current City practice is to exercise and test public fire hydrants on an annual basis and to require property owners to exercise and test private fire hydrants.
- The City has maintained a periodic leak detection program for decades and for the last several years increased that to an ongoing annual program, utilizing leak noise correlator technology, which currently covers one quarter of the water system per year.
- The City is nearing completion on a large meter and turbine meter change out program and transitioning to an ongoing meter maintenance program that will change out all meters before they reach a threshold level of minimum acceptable accuracy. A program and facilities for meter testing and calibration is planned to refine the parameters used to determine the change out frequency.
- The City is beginning a field water quality testing plan for nitrification parameters and laboratory testing for bacteriological parameters relevant to ammonia oxidizing bacteria and nitrifying bacteria within the distribution system. The goal of these efforts is to develop a better understanding of the annual growth and development cycle and the spatial distribution of the bacteriological populations in the water system biofilm so as to develop a nitrification action plan that is specific to the City's system and will provide effective responses to the annual nitrification cycle.

The following distribution system related items are recommended:

- The City should implement an annual Unidirectional Flushing Program in order to clean, improve water quality, and restore capacity in distribution mains.
- Pending legislation related to lead service lines and proposed revisions to the Lead and Copper Rule may push to require replacement of all lead service lines. The City should continue to monitor regulatory changes.
- The City should implement a valve exercise program with a portion of City valves that are replaced annually.

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Section 8

Benchmarking of Water Division Staffing

8.1 Introduction

One component of the City of Bloomington Water Infrastructure Master Plan is the benchmarking of staffing levels in the Public Works Water Division against other similar utilities based upon various national surveys. Benchmarking metrics may be used to track internal performance and goals of the utility over time. This Section describes the American Water Works Association (AWWA) metrics for evaluating water utility staff, the 2018 AWWA utility survey staffing benchmarks, and results of applying these metrics to the City of Bloomington Public Works Water Division staff.

Benchmarking provides a set of standardized metrics for comparing one's own performance to that of others. In the case of water utilities, benchmarking metrics are derived from a sample of utilities which can then be used to see how one's own metrics compare to those of a larger group. However, no other water utility has the exact same composition, service area and customer base as the Bloomington Public Works Water Division. Therefore, the best use of benchmarking metrics is in developing a standardized metric that can be used over time to monitor one's own performance.

The AWWA Benchmarking Survey covers areas of organizational development, business operations, customer relations, and water operations. However, this benchmarking evaluation for the City of Bloomington is focused on an assessment of staffing levels. The benchmarking performance indicators for staffing consist of the total number of full-time employees (FTEs), the ratio of number of accounts to FTEs, the ratio of water production to FTEs and the percentage of staff by job category.

In terms of other benchmarking metrics like water quality, the City of Bloomington is comparable to utilities of similar size and water quality. In terms of benchmarking related to annual spending on water infrastructure, the City does recognize that its annual spending on capital projects especially water mains is lower than utility peers of similar age and size, but this is being addressed as part of the Master Plan implementation.

8.2 Benchmarking Current Staffing Levels

The City of Bloomington Public Works Water Division currently has 52 full-time employees (FTEs). **Figure 8-1** shows the 75th percentile, median, and 25th percentile of three categories water utilities in the 2018 benchmark survey.

First, the AWWA benchmark survey reports data for water utilities, wastewater utilities, and combined utilities. The data reported only for water utilities is compared with the City of Bloomington staff metrics. This category is labeled "Water Utility". Secondly, metrics for a subset of these utilities that have a population served from 50,001 to 100,000 are shown and labeled "Population Served". Third, a second subset of the Water Utility sample that is in the central US region is labeled as "Region". This region includes utilities from Iowa, Illinois, Indiana, Ohio, Michigan, Wisconsin, Minnesota, South Dakota, North Dakota, and Ontario, Canada. The comparison in **Figure 8-1** shows that the Public Works Water Division staff are below median in comparison with the sample of water utilities and the regional subset, but nearly on par with the 75th percentile of utilities with the same range of population served.

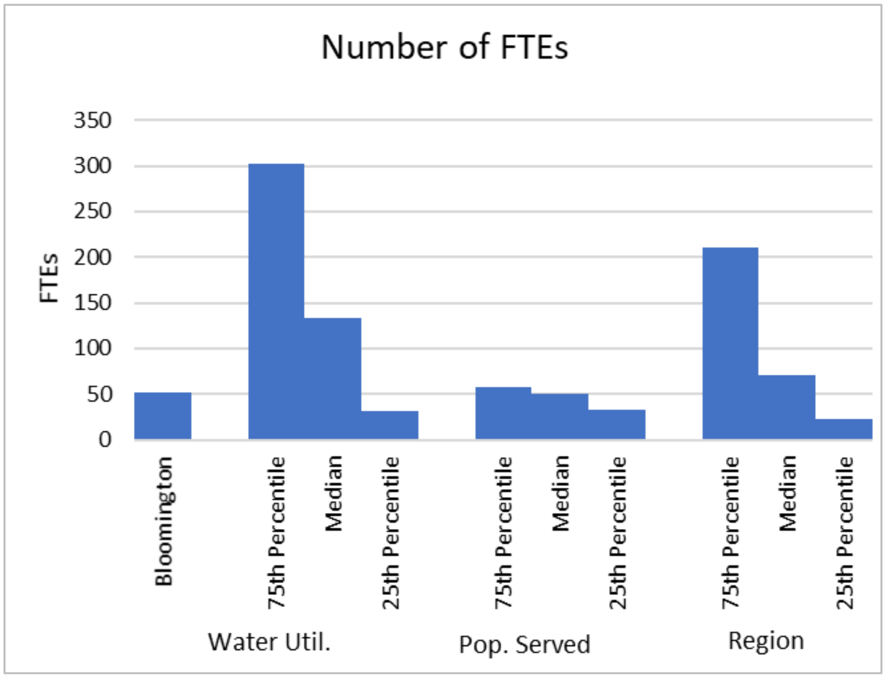

Figure 8-1. Comparison of Total Full-Time Employees

The ratio of number of accounts to FTEs is about 620 accounts per FTE, while the ratio of water production to FTEs is 0.20 MGD per FTE. **Figure 8-2** shows the Bloomington ratio of number of accounts to FTEs relative to the same metric for other water utilities in the AWWA 2018 Benchmarking Survey. As illustrated in **Figure 8-2**, Bloomington's metric of accounts per FTE is similar to the 75th percentile of the water utilities (sample size (N) of 45 utilities) and the 75th percentile of water utilities of similar population served (N = 15) yet is near the median relative to water utilities in the same geographic region (N = 14).

Figure 8-3 shows that Bloomington's metric of water production in MGD per FTE is similar to the median of the water utilities (N = 50), slightly below the median of water utilities of similar population served (N = 17) and is slightly below the 25th percentile relative to water utilities in the same geographic region (N = 22).

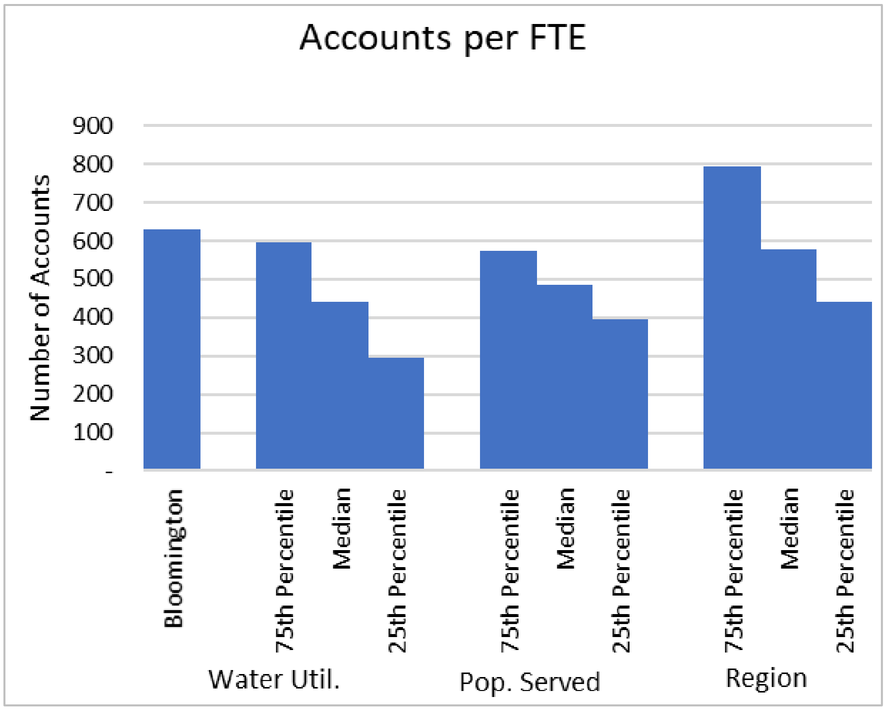

Figure 8-2. Comparison of Number of Accounts per Full-Time Employee

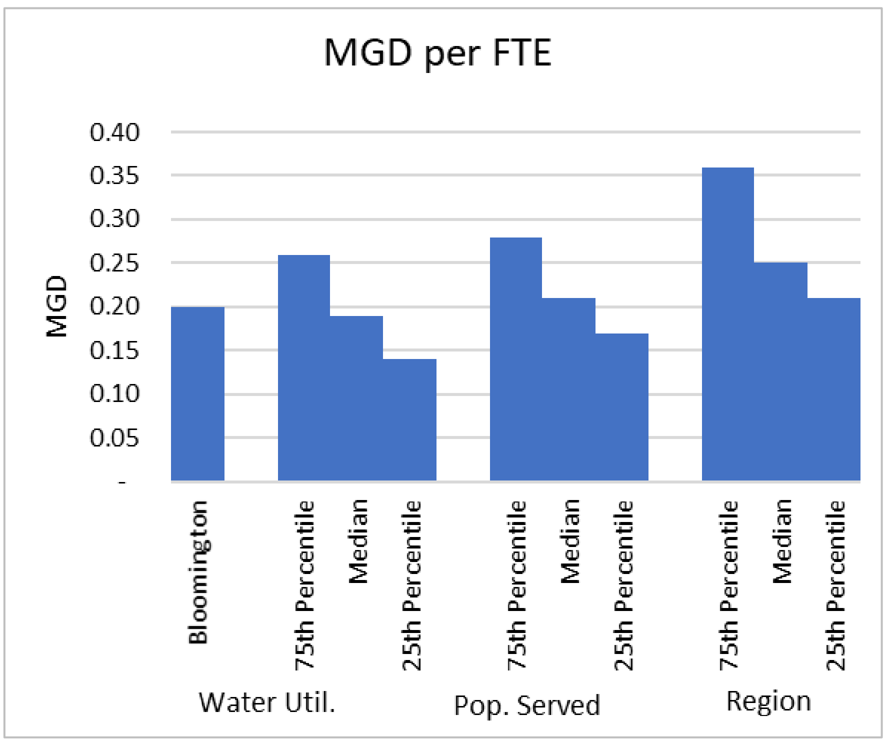

Figure 8-3. Comparison of Water Production in MGD per Full-Time Employee

The AWWA Benchmarking Survey uses the staffing categories shown in **Table 8-1** for tracking the percentage of FTEs for water services. The two primary staffing categories are: Operations & Maintenance; and Management, Engineering, Customer Services & Other. There are three secondary job categories under operations & maintenance and sixteen secondary categories under management, engineering, customer services & other for a total of nineteen secondary job categories.

Table 8-1. AWWA Staff Categories for Benchmarking Water Utilities

FTE Category
Operations & Maintenance
Water Supply
Water Treatment
Water Transmission & Distribution
Management, Engineering, Customer Services, & Other
Engineering
Utility Planning
Lab Services/ Compliance
Customer Service/ Call Center
Customer Billing
Public Relations
Finance
Human Resources
IT
Facilities
Fleet
Legal/ Administrative
Safety
Risks/ Claims
Security
Other

Source: AWWA 2018, Table 1-2B

The 2018 organizational chart for the Bloomington Public Works Water Division shows 52 FTEs among more than 30 job titles.

The City of Bloomington job titles are listed in **Table 8-2** with the corresponding number of FTEs, as derived from the organizational chart. Also shown in **Table 8-2** is an assignment of one of the two primary AWWA job categories and one of the 19 secondary AWWA job categories to each of the Bloomington Public Works Water Division job titles. Part-time positions are counted as 0.5 FTE.

CDM Smith

Table 8-2. City of Bloomington Job Titles with Corresponding AWWA Job Categories

Bloomington FTE Category	FTEs	AWWA Job Categories	
		General	Specific
Public Works Director	0.5	Management, Engineering, Customer Services	Legal / Administrative
Assistant Public Works Director	0.5	Management, Engineering, Customer Services	Legal / Administrative
Operations Manager	1.0	Management, Engineering, Customer Services	Legal / Administrative
Staff Engineer	2.0	Management, Engineering, Customer Services	Engineering
Staff Engineer	0.5	Management, Engineering, Customer Services	Engineering
Management Analyst	0.25	Management, Engineering, Customer Services	Engineering
GIS Intern	1.0	Management, Engineering, Customer Services	Engineering
Meter Services - Superintendent	1.0	Operations & Maintenance	Water Transmission & Distribution
Meter Services - Crew Leader	1.0	Operations & Maintenance	Water Transmission & Distribution
Meter Services	3.0	Operations & Maintenance	Water Transmission & Distribution
Meter Reader	1.0	Operations & Maintenance	Water Transmission & Distribution
Office Manager	0.25	Management, Engineering, Customer Services	Customer Service / Call Center
Support Staff IV	2.25	Management, Engineering, Customer Services	Customer Service / Call Center
Property Manager	0.5	Management, Engineering, Customer Services	Facilities
Property Manager	0.5	Management, Engineering, Customer Services	Facilities
Water Purification - Superintendent	1.0	Operations & Maintenance	Water Treatment
Laboratory Supervisor	1.0	Management, Engineering, Customer Services	Lab Services / Compliance
Lab Technician	1.0	Management, Engineering, Customer Services	Lab Services / Compliance
Lake Facilities - Crew Leader	1.0	Operations & Maintenance	Water Supply
Lake Facilities - Equipment Operator	2.0	Operations & Maintenance	Water Supply
Lake Facilities - Coutesy Patrol	1.0	Management, Engineering, Customer Services	Facilities
Lake Facilities - Lake Parks Maintenance	1.0	Management, Engineering, Customer Services	Facilities
Water Plant Operator	4.0	Operations & Maintenance	Water Treatment
Water Plant Relief Operator	3.0	Operations & Maintenance	Water Treatment
Mechanical Maintenance - Superintendent	0.5	Operations & Maintenance	Water Transmission & Distribution
Mechanical Maintenance - Superintendent	0.5	Operations & Maintenance	Water Treatment
Pump Station - Crew Leader	1.0	Operations & Maintenance	Water Transmission & Distribution
Pump Station - Maintenance	2.0	Operations & Maintenance	Water Transmission & Distribution
Mechanic - Crew Leader	1.0	Operations & Maintenance	Water Treatment
Mechanic	1.0	Operations & Maintenance	Water Treatment
Mechanic - Utility Worker	1.0	Operations & Maintenance	Water Treatment
Electrician	1.0	Operations & Maintenance	Water Treatment
Electrician	1.0	Operations & Maintenance	Water Transmission & Distribution
Water Distribution - Superintendent	1.0	Operations & Maintenance	Water Transmission & Distribution
Water Maintenance - Crew Leader	2.0	Operations & Maintenance	Water Transmission & Distribution
Water Maintenance	7.0	Operations & Maintenance	Water Transmission & Distribution
Hydrant Maintenance	0.5	Operations & Maintenance	Water Transmission & Distribution
Water Maintenance - JULIE Crew Leader	1.0	Management, Engineering, Customer Services	Engineering
Water Maintenance - JULIE Technician	1.0	Management, Engineering, Customer Services	Engineering
TOTAL	52		

The Bloomington Public Works Water Division FTEs organized by the AWWA job categories and corresponding percent of FTEs per job category are shown in **Table 8-3**.

Table 8-3. Benchmarking of City of Bloomington 2018 Public Works Water Division Staff

FTE Category	BWD FTE	%
Operations & Maintenance	36.5	70.5%
Water Supply	3	5.8%
Water Treatment	12.5	24.2%
Water Transmission & Distribution	21	40.6%
Management, Engineering, Customer Services, & Other	15.25	29.5%
Engineering	5.75	11.1%
Utility Planning		
Lab Services/Compliance	2	3.9%
Customer Service/Call Center	2.5	4.8%
Customer Billing		
Public Relations		
Finance		
Human Resources		
IT		
Facilities	3	5.8%
Fleet		
Legal/Administrative	2	3.9%
Safety		
Risks/Claims		
Security		
Other		

Figures 8-4 through **8-13** illustrate the comparison of the Bloomington FTEs by AWWA job category in comparison to the water utility benchmarks, water utilities within the same population served benchmark and water utilities within the same geographic region.

In the 2018 Benchmark Survey, the median response with respect to the percent of total staff listed under operations and maintenance was 43.9 percent, with a range from the 25th percentile response of 36.5 percent up to the 75th percentile response of 53.5 percent. Note that this range of responses is for water utilities of all sizes, which may introduce potential bias when compared with the City of Bloomington data. The median response with respect to the percent of total staff listed under management, engineering, customer services & other was 55.2 percent, with a range from the 25th percentile response of 46.1 percent up to the 75th percentile response of 63.8 percent. Under each of these primary job categories are the median and percentile responses for each of the secondary job categories.

The Bloomington Public Works Water Division has a slightly higher percentage of staff (70.5 percent) in operations & maintenance (**Figure 8-4**). Although this percentage is above the 75th percentile among the water utilities in the same range of population served it is aligned with the

75th percentile regionally. It is also important to note that Bloomington is unique in terms of the number and age of the facilities it operates, and the responsibilities it has in terms of operation and maintenance. The percent of staff in water supply is slightly above the median of all water utilities and is at the median for utilities in the same population served range (**Figure 8-5**). The high percentage of staff in operations and maintenance is due in part to the high percentage of staff designated for water treatment, pumping (**Figure 8-6**) and water distribution (**Figure 8-7**).

Conversely, there is a low percentage of staff (30.5 percent) in management, engineering, customer service and other categories. Bloomington is at or below the 25th percentile relative to the benchmark groups (**Figure 8-8**). The percent of staff in engineering is higher than the 75th percentile relative to water utilities and regionally but only slightly above the median of water utilities with similar population served (**Figure 8-9**). The percent of staff for lab services and compliance is just below the median of the three benchmark groups (**Figure 8-10**) while the percent of staff for customer service is below the 25th percentile of all three groups (**Figure 8-11**). Bloomington FTEs assigned to facilities is high relative to the benchmark groups (**Figure 8-12**); however, for the City of Bloomington this category includes staff that patrol the lakes and maintain and manage property around the lakes. The percent of Bloomington staff for legal and administrative services is near the median of all three benchmark groups (**Figure 8-13**).

This section has compared the staffing of the Bloomington Public Works Water Division to a sample of other water utilities using a set of standardized metrics. However, no other water utility has the exact same composition, service area and customer base as the Bloomington Public Works Water Division. Therefore, the best use of the benchmarking metrics presented in this section would be to use these metrics over time (e.g., annually) to monitor the staffing goals of the Bloomington Public Works Water Division with recognition of staffing needs of new projects.

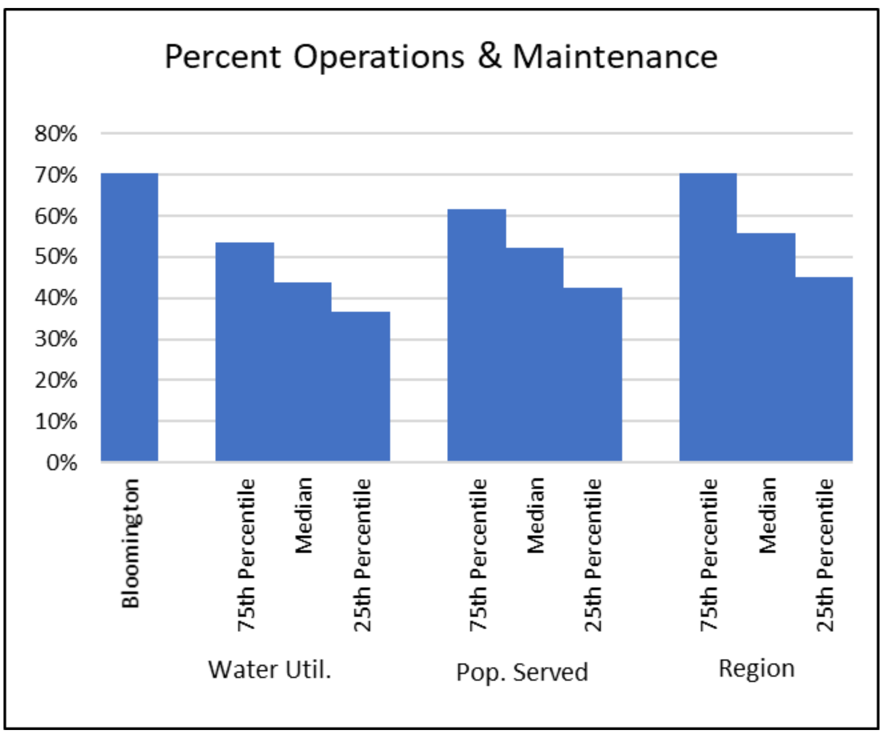

Figure 8-4. Comparison of Percent of Full-Time Employees in Operations and Maintenance

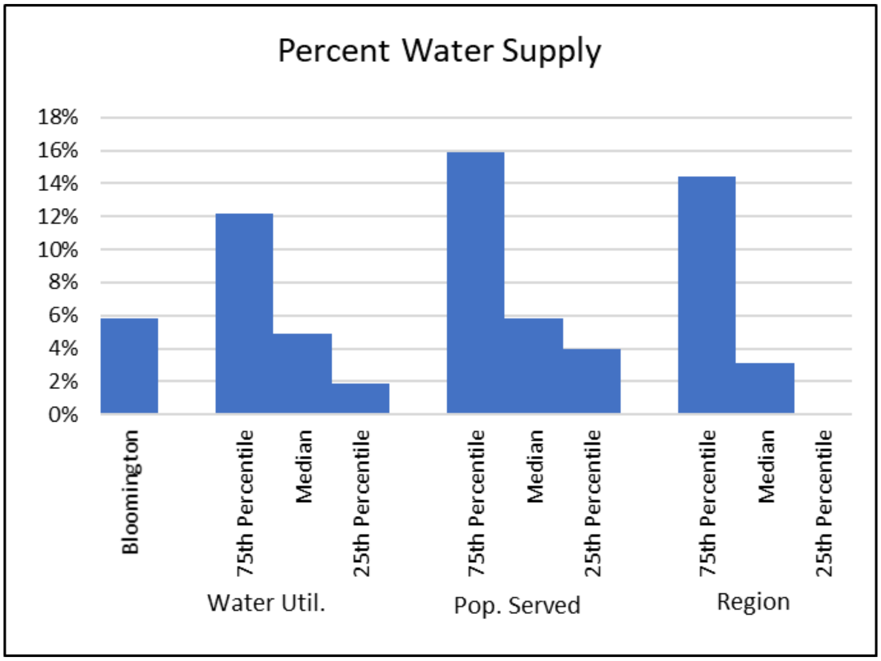

Figure 8-5. Comparison of Percent of Full-Time Employees in Water Supply

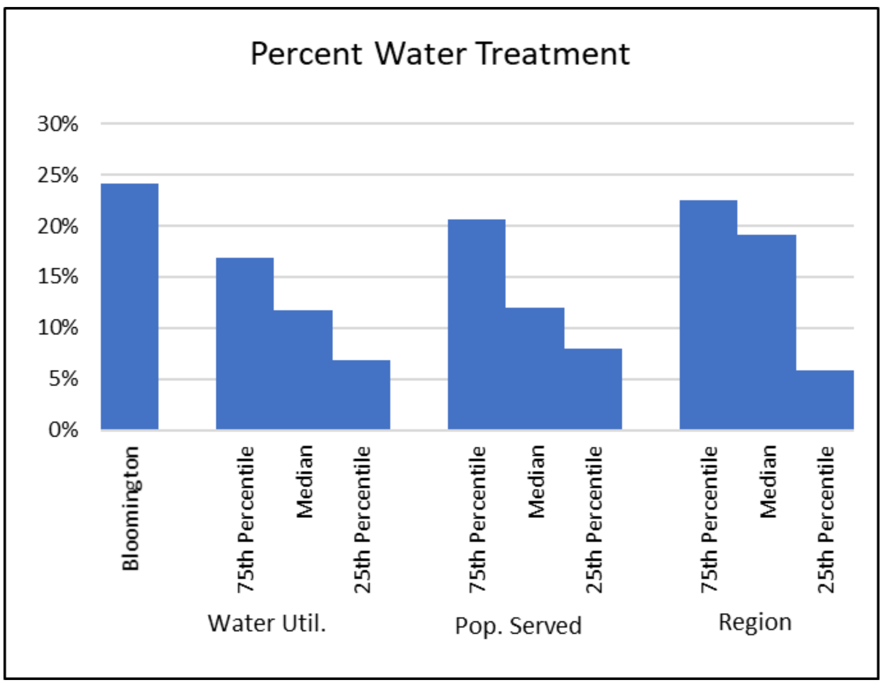

Figure 8-6. Comparison of Percent of Full-Time Employees in Water Treatment

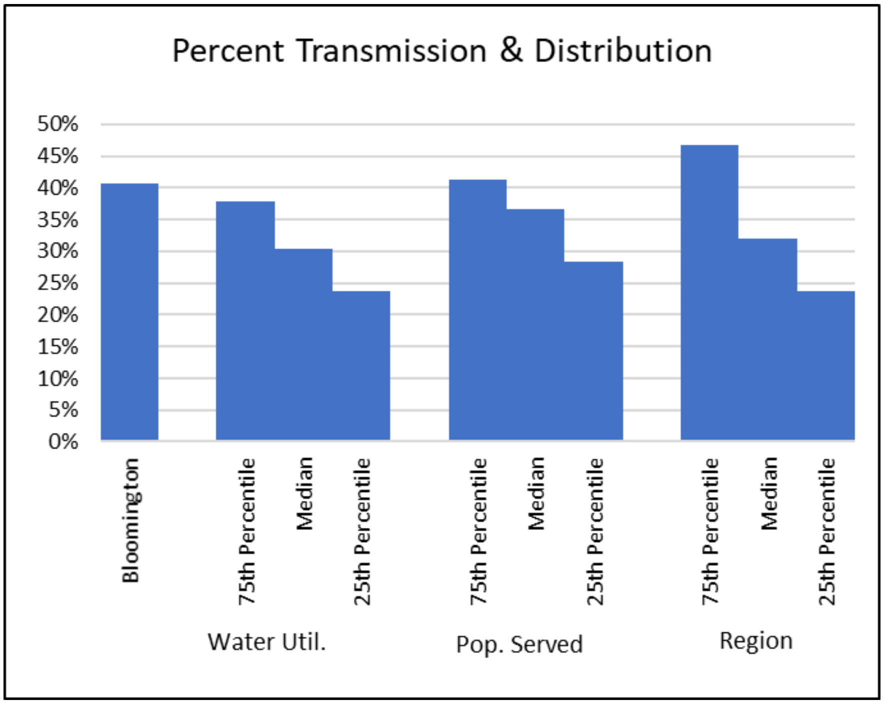

Figure 8-7. Comparison of Percent of Full-Time Employees in Transmission and Distribution

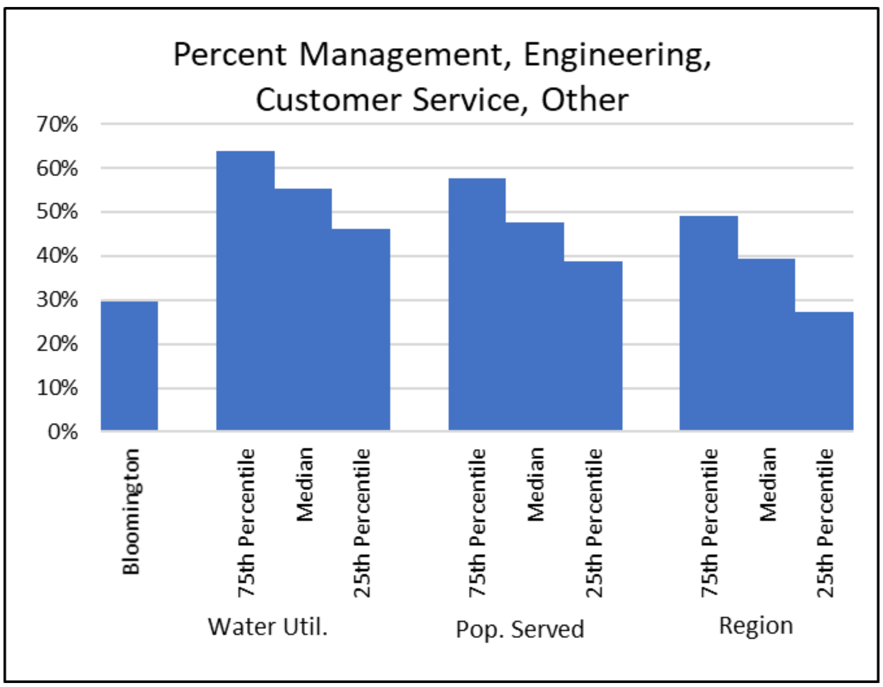

Figure 8-8. Comparison of Percent of Full-Time Employees in Management, Engineering, Customer Service, and Other

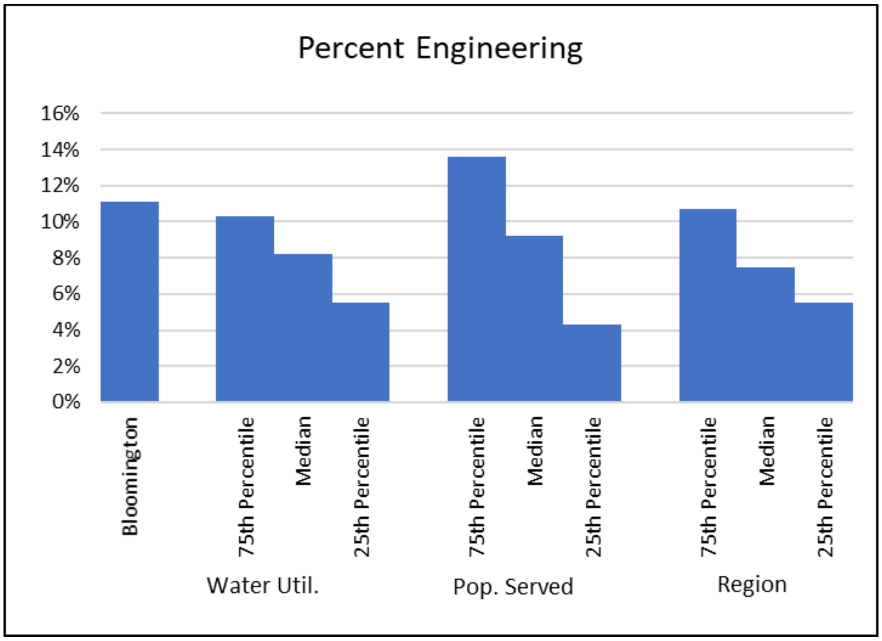

Figure 8-9. Comparison of Percent of Full-Time Employees in Engineering

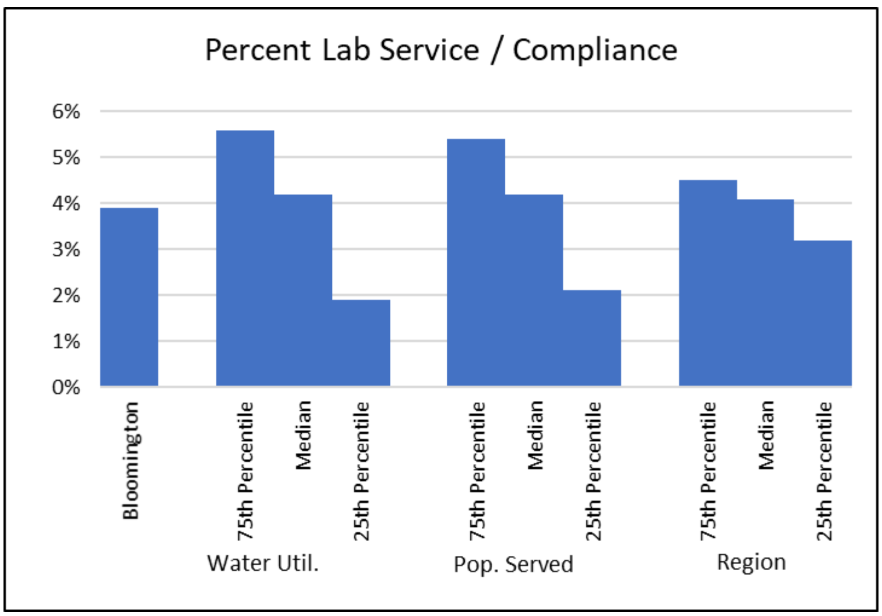

Figure 8-10. Comparison of Percent of Full-Time Employees in Lab Services and Compliance

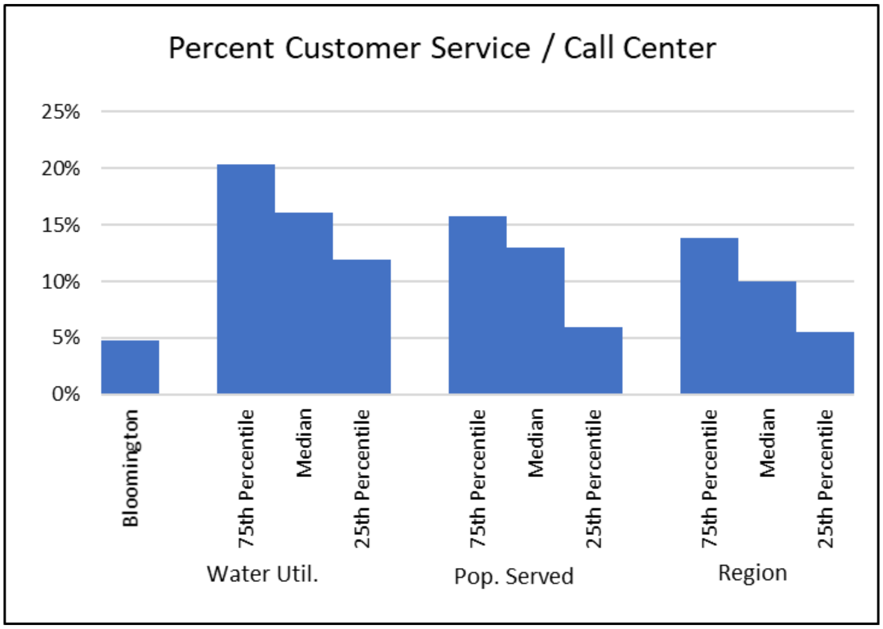

Figure 8-11. Comparison of Percent of Full-Time Employees in Customer Service and Call Center

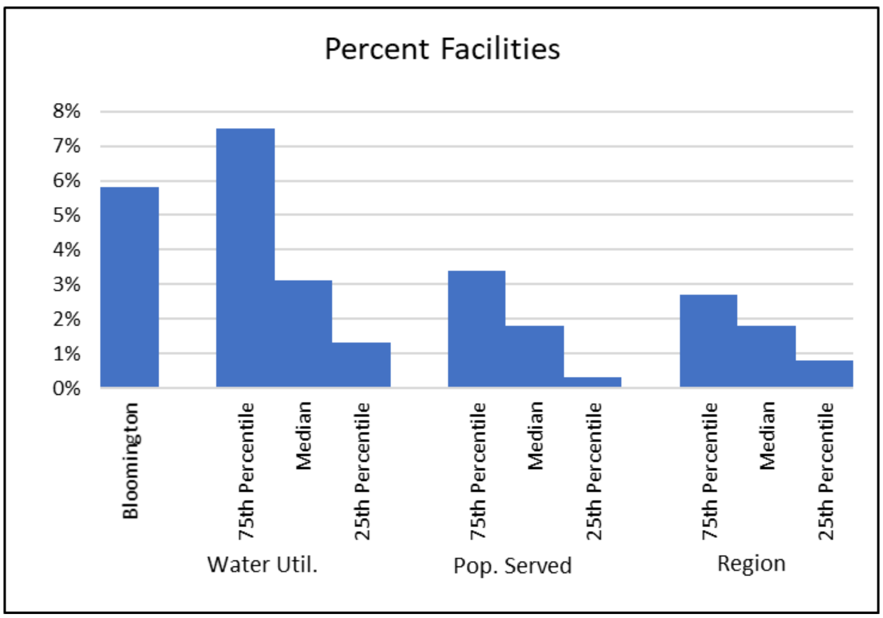

Figure 8-12. Comparison of Percent of Full-Time Employees in Facilities

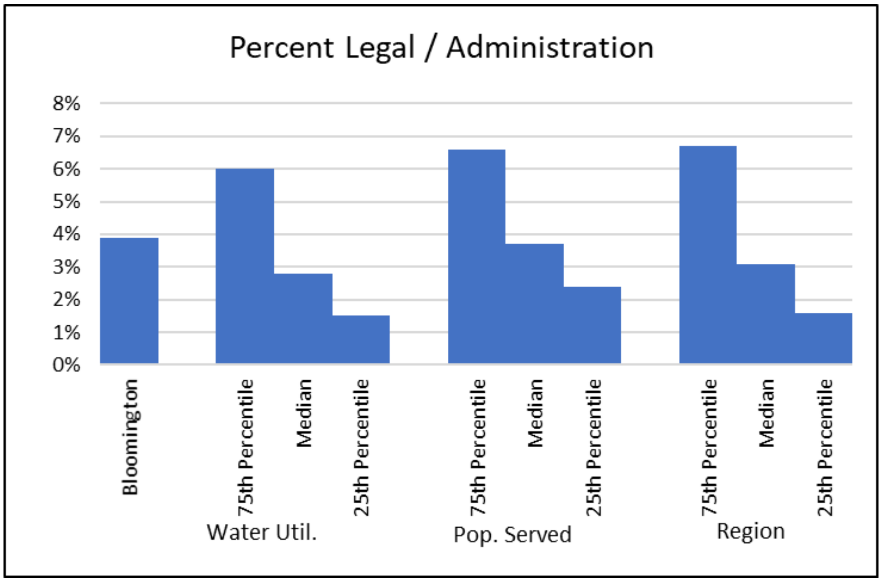

Figure 8-13. Comparison of Percent of Full-Time Employees in Legal and Administration

8.3 Staff Required for Capital Improvements

If all of the recommendations outlined in this Water Infrastructure Master Plan are implemented, the City will embark on approximately a $150 million capital improvement program over the next 20 years. To implement a capital program of this size and complexity, most utilities will outsource much of the work to outside consultants and contractors to avoid the challenges associated with hiring, training and retaining qualified staff with the varied areas of expertise required. Even with the majority of the work outsourced to consultants and contractors, there is a significant amount of coordination and oversight required for successful implementation of the program. The City is not currently staffed to handle the additional workload associated with this program.

Therefore, CDM Smith recommends that the City consider adding the following positions to the Engineering Department:

- Program Manager: Responsible for overall implementation of the City's capital improvement program. This individual would carry the overall coordination responsibility in terms of coordination between projects, balancing funds and impacts on the City. It may be beneficial for the City to hire this individual on a contract basis, as they may have limited duties once the program is completed.

- Facilities/Water Treatment Project Manager/Engineer: Responsible for organizing and implementing the improvements within the water treatment plant and remote facilities. Duties would involve coordination with outside consultants to complete the design and construction oversight of these improvements, coordination between the City's operations/maintenance staff and the outside consultants, coordination with the City's purchasing division for bidding various improvement packages to general contractors, and oversight of the general contractors completing the improvements. Once the capital program is complete, this position could remain and continue to serve as the facilities engineer.

- Distribution System Project Manager/Engineer: Responsibilities are similar to the Facilities/Water Treatment Engineer, except the Distribution System Engineer's focus is on rehabilitation and replacement of buried assets located within the distribution system. This person can oversee the work of consultants assigned water distribution related projects and can coordinate with other City departments and utilities. Once the capital program is complete, this position could remain and continue to serve as the distribution system engineer.

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Section 9

Water Infrastructure Master Plan Project Summary

The tables below summarize the recommended projects for the water quality and regulatory improvements (**Table 9-1**), facilities improvements (**Table 9-2**), and the water distribution system improvements (**Table 9-3**) to provide an overview of the 20-year capital needs for the entire City of Bloomington water system. **Table 9-4** totals all of the recommended improvements to provide the 20-year recommended capital expenditures. Note that all costs in the Water Infrastructure Master Plan are presented in 2019 dollars and will need to be adjusted for inflation once they are prioritized after the rate study is complete and an overall annual budget for capital improvements is established. Project summary sheets are included at the end of this section for all of the major improvements listed in the tables below.

Table 9-1. Water Quality and Regulatory Improvements

Project Description	Estimated Cost
New PAC Facility at the Water Treatment Plant to Remove Taste and Odor Compounds	$500,000
Additional Groundwater Supplies to Allow Blending for Nitrate Compliance	$10,000,000
Sludge Disposal Study	$50,000
Distribution System Corrosion Study	$100,000
Risk and Resiliency Assessment	$100,000
Water Stability Study	$100,000
Total (Rounded)	**$11,000,000**

Refer to Sections 4 and 6 for additional details.

Table 9-2. Facilities Improvements

Project Description	Estimated Cost
Water Treatment Plant Immediate Improvements (includes ventilation issues and chlorine gas scrubber)	$800,000 (all HVAC upgrades) $300,000 (Scrubber and chlorine ducting)
Water Treatment Plant Upgrade Project (includes all recommended rehabilitation work, new raw water pump station, and new filtration building)	Priority Projects: Recarb/infilco demo $1.65M Filter Demo $2.2M (Add $1.25M for original plant demo) New Raw Water PS $10M Recarb Bypass Piping ($550,000) Ammonia upgrades $1.1M Total for all WTP upgrades is $59M
Division Street and Enterprise Pump Station Replacement	$10,000,000
Other Pump Stations and Remote Facilities	$6,900,000
Pump Station Backup Power	$2,000,000
Total	**$79,000,000**

It is important to note that several projects (primarily electrical) for the Old Plant Building would be redundant if the City elected to build a new facility right away, however since the timing is unknown and the electrical projects are considered medium to high priority, these projects are assumed to be short-term rehabilitation projects while the long-term would assume a new facility would replace the Old Plant Building that would include new filters as well. This should be further evaluated during the recommended Filter Study.

Refer to Sections 5 and 6 and Appendices B, C, and E for additional details. While the cost of the WTP improvements are significant, a simple $3 to $4/gallon for a new WTP would yield a $72M to $96M cost, which is significantly more than estimated costs presented above for the WTP portion.

Table 9-3. Water Distribution System Improvements

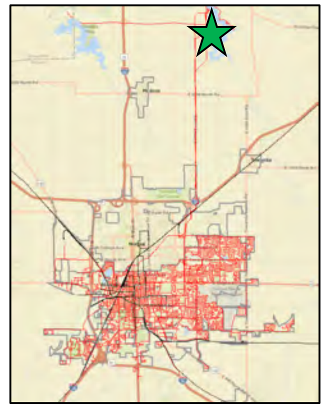
Project Description	Estimated Cost
Extreme Risk Main Replacement (approximately 4.1 miles (1.0% of system))	$6,300,000
High Risk Main Replacement (approximately 6.9 miles (1.5% of system))	$10,600,000
Medium Risk Main Replacement (approximately 21.4 miles (4.7% of system))	$33,000,000
Fire Flow Related Improvements	$2,700,000
Water Quality Monitoring Stations	$150,000
Total (Rounded)	**$52,750,000**

Refer to Section 7 and Appendix G for additional details.

Table 9-4. Summary of Recommended 20-Year Capital Improvement Costs

Project Description	Estimated Cost
Water Quality and Regulatory Improvements	$11,000,000
Facilities Improvements	$79,000,000
Water Distribution System Improvements	$52,750,000
Total (Rounded)	**$142,750,000**

POWDERED ACTIVATED CARBON (PAC) FACILITY



Asset Type: PAC Feed System

Project Type: Design and Construction

Project Location: Bloomington WTP

EXISTING SYSTEM

- Existing system uses granular activated carbon (GAC) media in filters. GAC is used to remove taste and odor-causing compounds.
- While geosmin and 2-methylisoborneol (MIB) levels are usually low, occasional spikes still occur in the system.

PROJECT LOGISTICS

Present Worth Estimate – $500,000

Priority Rating – 3 of 5

PROJECT PLAN

- Add a powdered activated carbon (PAC) slurry feed system at the intake to feed 35-52 lb/hr of PAC slurry. Feed rates assume a flow rate of 10 MGD.
- Planning level evaluation assumes a 30-day storage silo, feed hopper, wetting cone, and mixing eductor. Verify and advance the design.

PROJECT DRIVERS

- Geosmin and MIB spikes cause taste and odor complaints from consumers.
- Existing GAC filter media decreases in effectiveness over time. Diminished effectiveness of the existing system will drive construction of a new process.

COORDINATION REQUIRED

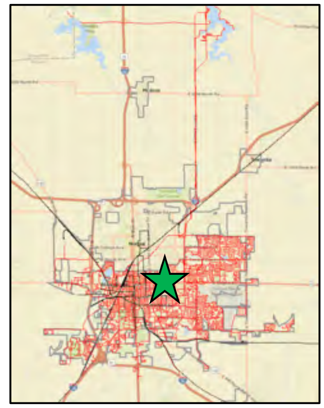
- Coordinate construction with existing WTP operations.
- Coordinate performance with compliance and other regulatory requirements.
- Coordinate maintenance and operations during construction and start-up.

ADDITIONAL GROUNDWATER SUPPLY WELLS

Asset Type: Wells

Project Type: Design and Construction

Project Location: To Be Located



EXISTING SYSTEM

- All raw water entering the WTP originate from two surface lakes. Lakes have seasonally high nitrate concentrations.
- Two groundwater wells have been drilled, but are not yet operational.

PROJECT LOGISTICS

Present Worth Estimate – $10M

Priority Rating – 4 of 5

PROJECT PLAN

- Drill seven additional wells. It is assumed that each well can produce 0.9 MGD. Seven wells will meet nitrate MCL under maximum demand conditions with one well reserved for redundancy.
- Connect new wells to the water treatment plant.

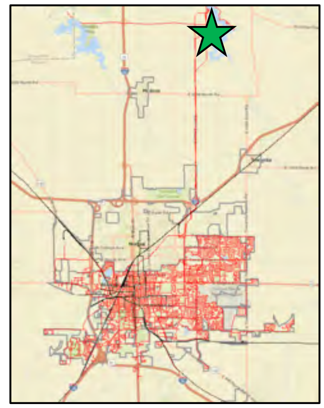
PROJECT DRIVERS

- Establishing new wells will allow for blending of raw water for nitrate compliance if nitrate levels in surface water continue to rise.

COORDINATION REQUIRED

- Identify the location in the water treatment process where groundwater blending will need to occur.
- A corrosion study is needed to determine if introducing groundwater will increase corrosion in the distribution system.
- If groundwater is to be blended at the head of the plant, further study is needed to determine the impact of radionuclides present in groundwater on the lime softening sludge.

SLUDGE DISPOSAL STUDY



Asset Type: Sludge Processing and Disposal

Project Type: Study

Project Location: Bloomington WTP

EXISTING SYSTEM

- Raw water is softened by adding lime slurry to the clarifiers.
- Slurry residual is pumped from the softening process to lagoons.

PROJECT LOGISTICS

Present Worth Estimate – $50,000

Priority Rating – 4 of 5

PROJECT PLAN

- If groundwater is added to the head of the Water Treatment Plant, radionuclides may be introduced to the system. This study evaluates impacts of adding groundwater containing radionuclides to the treatment system.
- A key conclusion of this study is to identify how sludge with radionuclides needs to be properly disposed.

PROJECT DRIVERS

- Adding groundwater to the head of the water treatment process allows for better nitrate compliance. Groundwater testing identifies the presence of radionuclides. Radionuclides may be present in softened sludge.

COORDINATION REQUIRED

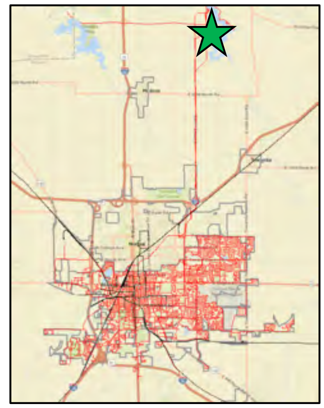
- Determine a location where groundwater will be added to the treatment process. This study is only needed if groundwater is added prior to softening.
- Coordinate results from this study into the project to establish additional groundwater supply wells.
- Sludge sampling may contain hazardous waste. Disposal of samples obtained for this study will need to be properly disposed of.

WATER STABILITY STUDY

Asset Type: Process Improvements

Project Type: Study

Project Location: Bloomington WTP



EXISTING SYSTEM

- Recarbonation process is a hydraulic bottleneck at the Bloomington WTP due to buildup of lime solids and weir height.

PROJECT LOGISTICS

Present Worth Estimate – $100,000

Priority Rating – 4 of 5

PROJECT PLAN

- Conduct a water stability study to:
    - Evaluate the available mixing of carbon dioxide the current pH meter location with respect to the dosage location;
    - Identify process improvements, such as increasing carbon dioxide dosage to prevent post-precipitation of calcium solids; and
    - Evaluate the option to abandon existing Recarbonation Basins in favor of bypass piping.

PROJECT DRIVERS

- Existing recarbonation process was identified as a hydraulic bottleneck due to the height of influent weirs and precipitation of lime solids built up in influent piping. This water stability study is needed to determine the best solution to this problem.

COORDINATION REQUIRED

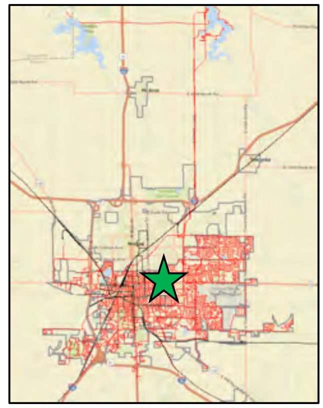
- Study should be completed before recarbonation improvements are made.
- Coordination is needed with IEPA if bypass piping is being considered as it would not meet Ten States Standards design and operating requirements for Recarbonation Basins.

DISTRIBUTION SYSTEM CORROSION STUDY

Asset Type: Water Mains

Project Type: Study

Project Location: Distribution System



EXISTING SYSTEM

- The existing system uses only conveys treated surface water.
- Groundwater samples show a relatively high chloride to sulfate mass ratio (CSMR).

PROJECT LOGISTICS

Present Worth Estimate – $100,000

Priority Rating – 4 of 5

PROJECT PLAN

- Conduct a bench scale test within the water treatment plant to determine if higher CSMR and lower pH of finished water would result in corrosion-related issues in the water treatment plant and distribution system piping.
- Consider any whether any existing corrosion in the distribution system would be advanced by introducing groundwater.

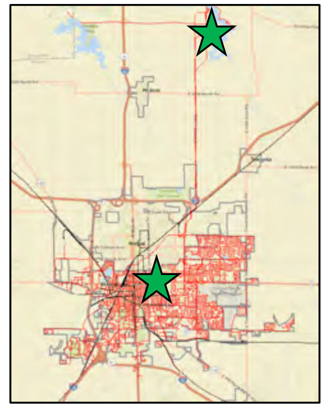
PROJECT DRIVERS

- Blending groundwater with surface water is currently being considered as a nitrate control strategy.
- The impact of introducing groundwater into the distribution system would need to be evaluated to confirm this practice would not increase damage to the distribution system.

COORDINATION REQUIRED

- Determine a location where the groundwater needs to be added to the treatment process.
- Coordinate results with the study to treat softening sludge.
- Coordinate results of this study with nitrate control strategies. The decision to blend groundwater as a nitrate control strategy is contingent upon the results of this study.
- Identify feasible locations to excavate and sample pipe condition.
- Identify optimal inspection technologies and methods.

WATER TREATMENT PLANT AND DISTRIBUTION SYSTEM RISK AND RESILIENCY ASSESSMENT



Asset Type: All Assets

Project Type: Study

Project Location: Bloomington WTP and Distribution System

EXISTING SYSTEM

- America's Water Infrastructure Act of 2018 was recently passed.
- Current requirements state that an emergency response plan must be in place.

PROJECT LOGISTICS

Present Worth Estimate – $100,000

Priority Rating – 5 of 5

PROJECT PLAN

- Conduct a desktop level and systematic assessment of system risks and resiliency.
- The assessment should cover:
  - Risks to the system from malicious acts and natural hazards;
  - Resilience of pipes, conveyance infrastructure, source water quality and intake, treatment processes, storage and distribution facilities, and computer or other automated systems;
  - Monitoring practices;
  - Stabilization of account management, including invoicing and payroll;
  - Use, storage, and handling of chemicals; and
  - Operation and maintenance of system.
- Prepare an emergency response plan following the assessment to address its findings.
- Review, and revise if necessary, the assessment and emergency response plan every five years.

PROJECT DRIVERS

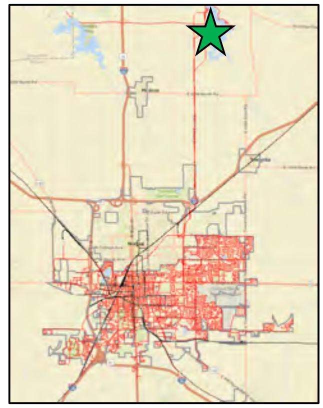
- This study is required by the Community Water System Risk and Resilience Act.
- Certification and verification of completion must be submitted to the EPA by 12/31/20.
- Completion of the emergency response plan must be submitted within 6 months of the assessment.

COORDINATION REQUIRED

- Submit documentation and results to the EPA.
- Renew this certification every five years.
- Coordinate results with operations, maintenance and administration as required.

City of Bloomington Illinois

WTP IMMEDIATE IMPROVEMENTS- HVAC UPGRADE



Asset Type: HVAC System

Project Type: Design and Construction

Project Location: Bloomington WTP

EXISTING SYSTEM

- Chemical storage areas lacks adequate ventilation.
- Existing exhaust systems are not directly routed outdoors.

PROJECT LOGISTICS

Present Worth Estimate – $800,000

Priority Rating – 5 of 5

PROJECT PLAN

- Upgrade HVAC system.
- Reroute the exhaust system so ductwork discharges outside without being routed through internal spaces.
- Upgrade ventilation system for the Fluoride Room.

PROJECT DRIVERS

- Leaks could result in chemically impacted air discharged into interior spaces.
- Proper ventilation of chemical systems is required.

COORDINATION REQUIRED

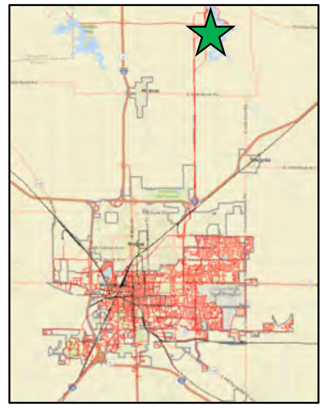
- Evaluate the system to identify the optimal layout for the new exhaust system.
- Coordinate HVAC upgrades with additional improvements required as part of the chlorine scrubber project.

WTP IMMEDIATE IMPROVEMENTS-GAS SCRUBBER

Asset Type: Scrubber and Chlorine Ducting

Project Type: Design and Construction

Project Location: Bloomington WTP



EXISTING SYSTEM

- Chlorine emergency ventilation system consists of outside air louver and exhaust duct.
- Exhaust duct travels through interior spaces before reaching outside.
- Activated automatically by sensors or manually by switches.

PROJECT LOGISTICS

Present Worth Estimate – $300,000

Priority Rating – 5 of 5

PROJECT PLAN

- Install a dry chlorine gas scrubber for chlorine application room and chlorine storage room.
- The scrubber system could be located outdoors at-grade outside of chlorine room on west side of building.

PROJECT DRIVERS

- A gas scrubber is not provided in all rooms where gas chlorine is used. The current industry best practice is to provide a gas scrubber where gas chlorine is used.

COORDINATION REQUIRED

- Coordinate exhaust routing with other HVAC and ductwork improvements.
- Coordinate maintenance and operations during construction and start-up.

City of Bloomington Illinois

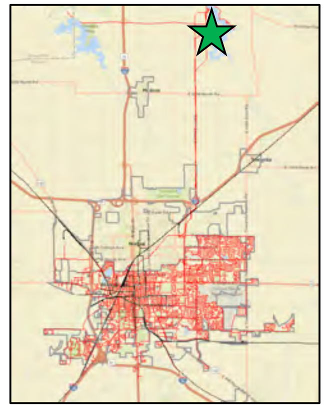
August 2019

RECARBONATION BASIN AND INFILCO DEMOLITION

Asset Type: Recarbonation Basins

Project Type: Demolition

Project Location: Bloomington WTP



EXISTING SYSTEM

- Two parallel, circular, open Recarbonation Basins containing influent weir and diffuser chamber with serpentine v-notch “finger weir” effluent.
- Infilco Accelator clarifier unit is not in use.

PROJECT LOGISTICS

Present Worth Estimate – $1.65M

Priority Rating – 2 of 5

PROJECT PLAN

- Abandon and demolish existing Recarbonation Basins and unused Infilco Accelator if replaced with bypass piping.

PROJECT DRIVERS

- Existing recarbonation process was identified as a hydraulic bottleneck due to the height of influent weirs and precipitation of lime solids built up in influent piping. Bypass piping solves the hydraulic bottleneck and eliminates the need for the existing basins.
- Demolition of unused infrastructure creates more available space for new filters or other projects.

COORDINATION REQUIRED

- Variance is needed from IEPA as bypassing piping does not meet Ten States Standards for recarbonation detention time.
- Coordinate with West Filter demolition and construction.
- This project should be considered as part of overall Old Plant Building upgrade project.
- Recarbonation bypass piping needs to be constructed prior to demolition.

City of Bloomington Illinois

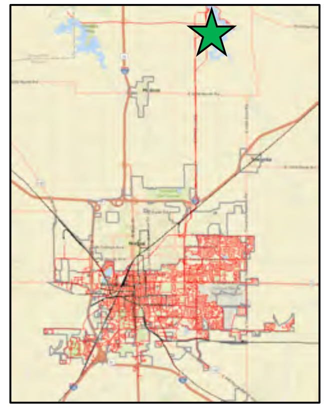
August 2019

FILTER DEMOLITION

Asset Type: Filters

Project Type: Demolition

Project Location: Bloomington WTP



EXISTING SYSTEM

- The old plant building houses twelve filters and is approaching 90 years old.
- Filters 1 and 12 are currently removed from service.

PROJECT LOGISTICS

Present Worth Estimate – $3.45M

Priority Rating – 3 of 5

PROJECT PLAN

- Abandon and demolish West Filters.
- Demolish the Old Plant Building.
- Replace the with new filters (Future Project).

PROJECT DRIVERS

- Existing Old Plant Building and West Filters need significant modifications.
- Process and architectural related needs were identified in the old plant building.
- Rehabilitation costs for existing structure may outweigh cost-benefit ratio of a new filter addition.
- Unused buildings require demolition per the fire marshal.

COORDINATION REQUIRED

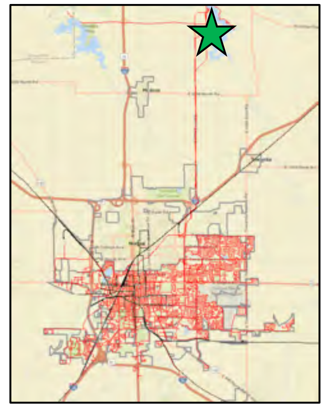
- Conduct a study to identify filter improvement needs.
- Determine whether existing clearwells should remain in place or if they should be included in the demolition project.
- Coordinate demolition with other projects in the Old Plant Building.

RAW WATER PUMP STATION

Asset Type: Pump Station

Project Type: Design and Construction

Project Location: Bloomington WTP



EXISTING SYSTEM

- The Low Lift Pump Station has two horizontal centrifugal pumps and one end suction centrifugal pump.
- Pumps are used to draw water from Lake Bloomington and convey through the treatment plant.

PROJECT LOGISTICS

Present Worth Estimate – $10M

Priority Rating – 3 of 5

PROJECT PLAN

- Replace existing Low Lift Pump Station with a new pump station. Design the pump station to meet current Hydraulic Institute (HI) standards.
- Replace intake pipes from Lake Bloomington and connect pipes to the new pump station.

PROJECT DRIVERS

- The existing pump station is approaching its design life. The structure and equipment are aging.
- There are nonfunctioning valves and equipment in the existing pump station.
- The pump station's current layout does not meet Hydraulic Institute (HI) standards.

COORDINATION REQUIRED

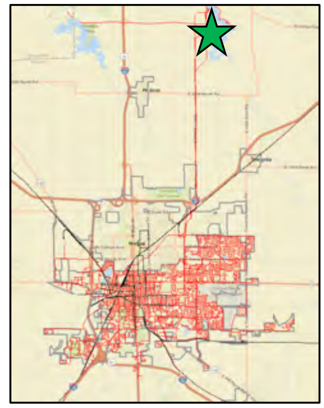
- Coordinate with other large scale master plan projects including decommissioning the Old Plant Building.
- Ensure that a supply of raw water to the treatment plant is maintained during construction.

WATER TREATMENT PLANT REHABILITATION

Asset Type: Process

Project Type: Construction

Project Location: Bloomington WTP



EXISTING SYSTEM

- The old plant building houses twelve filters and is approaching 90 years old
- Filters 1 and 12 are currently removed from service
- Aging infrastructure and equipment was found throughout the Old Plant Building.

PROJECT LOGISTICS

Present Worth Estimate – $42M

Priority Rating – 4 of 5

PROJECT PLAN

- Construct new West Filters.
- Replace VFDs in the Old Plant Building and replacement of aging electrical equipment.
- Add air scour and filter to waste to Main Plant.
- Rehabilitation of miscellaneous structural, architectural, process and building mechanical items.

PROJECT DRIVERS

- Existing Old Plant Building and West Filters need significant modifications.
- Process, architectural and electrical related needs were identified in the old plant building.
- Rehabilitation costs for existing structure may outweigh cost-benefit ratio of a new filter addition.

COORDINATION REQUIRED

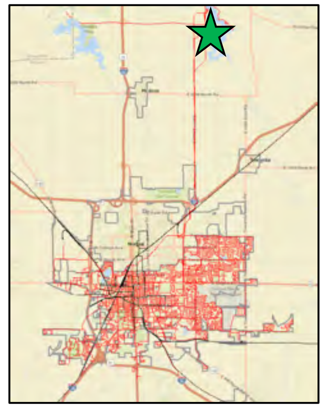
- Conduct a study to identify filter improvement needs.
- Conduct an architectural programming study to determine other areas of improvement that could be included.
- Coordinate with all other projects recommended in Old Plant Building.

RECARBONATION BYPASS PIPING

Asset Type: Process Piping

Project Type: Design and Construction

Project Location: Bloomington WTP



EXISTING SYSTEM

- Water is dosed with aqueous carbon dioxide.
- Water is then conveyed to two parallel, circular, open Recarbonation Basins.

PROJECT LOGISTICS

Present Worth Estimate – $550,000

Priority Rating – 4 of 5

PROJECT PLAN

- Construct piping to bypass the Recarbonation Basins.

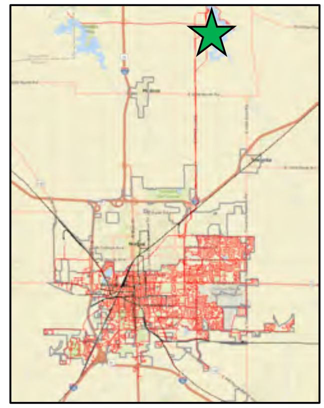
PROJECT DRIVERS

- Existing Recarbonation Basins are identified as hydraulic bottlenecks due to the height of the influent weirs and precipitation of lime solids on the influent piping.

COORDINATION REQUIRED

- Perform a recarbonation study to investigate and improve water stability downstream and a mixing analysis with CFD to verify sufficient mixing is achieved downstream of carbon dioxide addition with new piping.
- Coordination is needed with IEPA to get a variance as bypass piping would not meet Ten States Standards design and operating requirements for Recarbonation Basins.
- Coordinate with other projects in Old Plant Building and replacement of West Filters.

AMMONIA SYSTEM UPGRADES



Asset Type: Ammonia Feed System

Project Type: Design and Construction

Project Location: Bloomington WTP

EXISTING SYSTEM

- Ammonia system currently installed outside main Bloomington WTP buildings in a wooden frame shed without adequate ventilation.
- No ambient gas monitor and alarm is within the feed shed or at the injection point.

PROJECT LOGISTICS

Present Worth Estimate – $1.1M

Priority Rating – 5 of 5

PROJECT PLAN

- Replace the ammonia feed system.

PROJECT DRIVERS

- The current system does not comply with Ten States Standards and does not have adequate ventilation.

COORDINATION REQUIRED

- Coordinate with other projects as part of larger Water Treatment Plant Upgrade Project in the Old Plant Building.

DIVISION STREET AND ENTERPRISE ZONE PUMP STATION REPLACEMENT

Asset Type: Pump Stations

Project Type: Design and Construction

Project Location: Division Street and Enterprise Pump Station

EXISTING SYSTEM

- Enterprise Zone Pump Station:
  - Constructed in 1987.
  - The pump station contains 3 pumps to convey water from the Division Street Reservoirs.
- Division Street Pump Station:
  - Constructed in 1952.
  - The pump station contains four pumps to convey water from the Division Street Reservoirs.

PROJECT LOGISTICS

Present Worth Estimate – $10M

Priority Rating – 4 of 5

PROJECT PLAN

- Replace the Division Street and Enterprise Pump Stations with a single pump station.

PROJECT DRIVERS

- The Enterprise Zone Pump Station was inspected and found to not meet Ten States Standards.
- Motors at the Division Street Pump Station may be undersized.
- As pump stations are currently located adjacent to each other, combining pump stations into a single pump station will allow for more efficient staff usage and maintenance.

COORDINATION REQUIRED

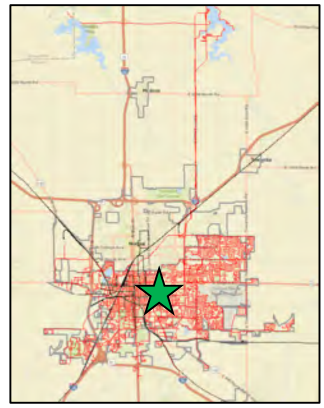
- Maintain flow to zones that are served by the two pump stations during construction.
- It may be possible to integrate improvements with the 5MG and 10MG Division Street Reservoir work.

OTHER PUMP STATIONS AND REMOTE FACILITIES

Asset Type: Pump Stations

Project Type: Design and Construction

Project Location: Other Pump Stations



EXISTING SYSTEM

- Site security provisions require enhancements at remote facilities.
- Some facilities are aging and need rehabilitation.

PROJECT LOGISTICS

Present Worth Estimate – $6.9M

Priority Rating – 2 of 5

PROJECT PLAN

- Install security cameras with CCTV and security fencing at all remote sites.

PROJECT DRIVERS

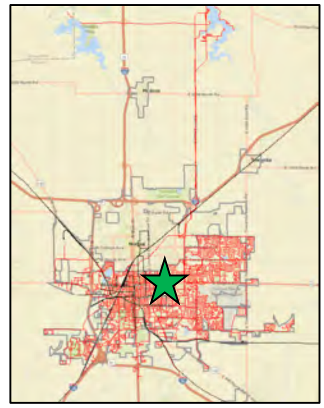
- Increased security is needed at remote sites.

WATER MAIN REPLACEMENT (EXTREME RISK RATING)

Asset Type: Water Mains

Project Type: Design and Construction

Project Location: Distribution System



EXISTING SYSTEM

- Risk assessment was conducted for all pipes in the City of Bloomington distribution system.
  - 451 miles of pipe (7,543 pipe segments) were assessed.
  - 4.1 miles (1.0% of system) were identified as having an extreme risk.

PROJECT LOGISTICS

Present Worth Estimate – $6.3M

Priority Rating – 5 of 5

PROJECT PLAN

- Replace or rehabilitate pipes that were identified as having an extreme risk.

PROJECT DRIVERS

- Extreme risk pipes have a high probability of failure combined with a high consequence of failure.
- Replacement or rehabilitation of pipes prevents more costly damage if the pipe fails.

COORDINATION REQUIRED

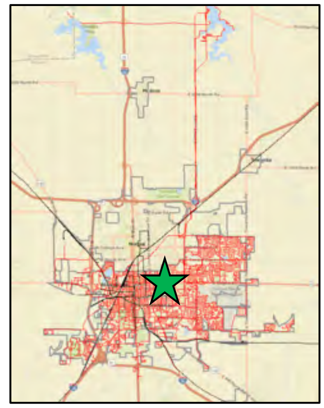
- Coordinate with other capital projects such as road and sewer repair projects to include replacement of extreme risk pipes.

WATER MAIN REPLACEMENT (HIGH RISK RATING)

Asset Type: Water Mains

Project Type: Design and Construction

Project Location: Distribution System



EXISTING SYSTEM

- Risk assessment was conducted for all pipes in the City of Bloomington distribution system.
  - 451 miles of pipe (7,543 pipe segments) were assessed.
  - 6.9 miles (1.5% of system) were identified as having a high risk.

PROJECT LOGISTICS

Present Worth Estimate – $10.6M

Priority Rating – 4 of 5

PROJECT PLAN

- Replace or rehabilitate pipes that were identified as having a high risk.

PROJECT DRIVERS

- High risk pipes have a high probability of failure combined with a medium to low consequence of failure.
- Replacement or rehabilitation of pipes prevents more costly damage if the pipe fails.

COORDINATION REQUIRED

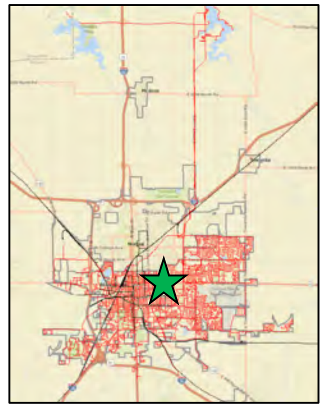
- Coordinate with other capital projects such as road and sewer repair projects to include replacement of extreme risk pipes.

WATER MAIN REPLACEMENT (MEDIUM RISK RATING)

Asset Type: Water Mains

Project Type: Design and Construction

Project Location: Distribution System



EXISTING SYSTEM

- Risk assessment was conducted for all pipes in the City of Bloomington distribution system.
  - 451 miles of pipe (7,543 pipe segments) were assessed.
  - 21.4 miles (4.7% of system) were identified as having a medium risk.

PROJECT LOGISTICS

Present Worth Estimate – $33M

Priority Rating – 3 of 5

PROJECT PLAN

- Replace or rehabilitate pipes that were identified as having a medium risk.

PROJECT DRIVERS

- Medium risk pipes have a medium to moderately high probability of failure combined with a moderately low to high consequence of failure.
- Replacement or rehabilitation of pipes prevents more costly damage if the pipe fails.

COORDINATION REQUIRED

- Coordinate with other capital projects such as road and sewer repair projects to include replacement of extreme risk pipes.

City of Bloomington Illinois

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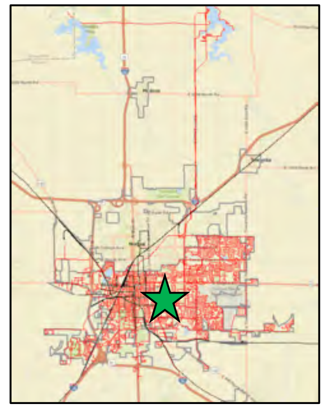
FIRE FLOW RELATED IMPROVEMENTS

Asset Type: Water Mains

Project Type: Design and Construction

Project Location: Distribution System



EXISTING SYSTEM

- Hydraulic model was created of the existing distribution system.
- Fire flow was not sustainable in portions for the distribution system.

PROJECT LOGISTICS

Present Worth Estimate – $2.7M

Priority Rating – 5 of 5

PROJECT PLAN

- 64 total pipe improvements are suggested to meet fire flow requirements.
- 60 improvements are to upsize 4" or smaller pipe to 6" diameter pipe
  - Total length of pipe to be upsized is approximately 4,640 feet.
- 4 improvements are loop closures
  - Length of pipe needed for looping is 4,350 feet.

PROJECT DRIVERS

- Hydraulic model identified nodes that failed to meet fire flow demand of 500 gpm (or 1,000 gpm in designated areas) under maximum day demand conditions.

COORDINATION REQUIRED

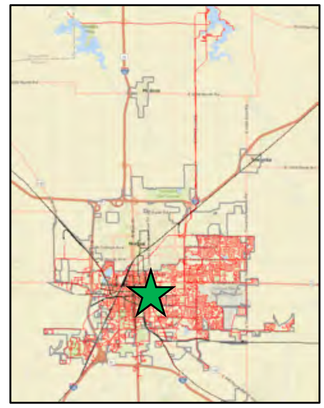
- Coordinate with other capital improvement projects such as road construction and sewer repair projects.
- The improvements suggested also considered the risk assessment results to prioritize extreme and high-risk pipes for replacement.

WATER QUALITY MONITORING STATIONS

Asset Type: Water Mains

Project Type: Design and Construction

Project Location: Distribution System



EXISTING SYSTEM

- The City currently has five residual chlorine monitoring stations.

PROJECT LOGISTICS

Present Worth Estimate – $150,000

Priority Rating – 3 of 5

PROJECT PLAN

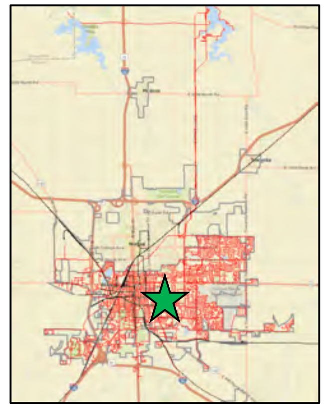
- Add three additional water quality monitoring stations to measure chlorine residual, turbidity, pH, or other parameters in areas of high water age.

PROJECT DRIVERS

- Provide additional monitoring of water quality parameters to alert staff to changes for further investigation.

COORDINATION REQUIRED

- Decisions needed on parameters to be monitored and best locations to place monitoring stations.



PUMP STATION BACKUP POWER

Asset Type: Pump Stations

Project Type: Design and Construction

Project Location: Division Street and Fort Jesse B Pump Stations

EXISTING SYSTEM

- Backup power is not currently installed at all pump stations.

PROJECT LOGISTICS

Present Worth Estimate – $2M

Priority Rating – 3 of 5

PROJECT PLAN

- Evaluate back-up power needs.
- Install backup power at the Division Street Pump Station.
- Install backup power Ft. Jesse B Pump Station.

PROJECT DRIVERS

- Backup power is required in order to maintain a pressure of 35 psi through the distribution system at all times.

COORDINATION REQUIRED

- Further study is needed to determine backup power needs.

Appendix A

Division St 5 MG and 10 MG Reservoir Structural Inspection

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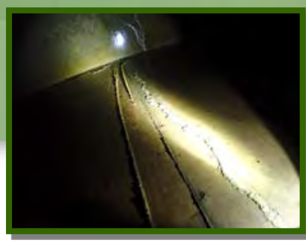
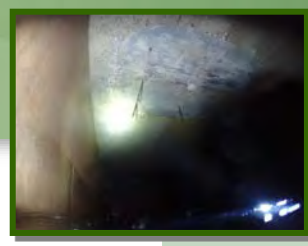




INVESTIGATION REPORT
FOR
THE DIVISION ST.
5 MG POTABLE WATER RESERVOIR

January 22, 2018

Prepared for:

City of Bloomington Illinois

Prepared by:

COLLINS ENGINEERS INC.

2033 West Howard Avenue

Milwaukee, Wisconsin 53221

414.236.1644 • www.collinsengr.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Project: Investigation of the Division St. 5 Million Gallon Potable Water Reservoir in Bloomington, Illinois.

Purpose of Project: To perform a visual and tactile inspection of all below and above water surfaces on the interior of the Division St. 5MG Tank.

Inspection Team:
Team Leader – Roy Forsyth, P.E., CWI – Collins Engineers, Inc.
Team Member – Chris Hartzell, P.L.S., CWI – Collins Engineers, Inc.
Team Member – Marc Stern, E.I.T. – Collins Engineers, Inc.
Team Member – Rod Breen, E.I.T. – Collins Engineers, Inc.

Inspection Date(s): January 22, 2018
Access location: Southeast Roof Hatch
Access Mode: Surface Supplied Air Diving/ Confined Space Entry

Summary of Findings:

- Exterior
  - Roof access hatches were located at the southeast, northeast, and northwest corners of the tank. The hatches did not have a seal or gasket in place. See Picture 2.
  - The roof was covered with soil and was planted with well-established grass.
  - The soil on the roof was very saturated indicating poor drainage on the site and the possibility for unintended surcharge loading on the roof slab.
- Interior
  - Fine silty sand sediment deposits were present throughout the tank floor, ranging from a dusting to 1/4 in. thick near the center of the tank. Thicker sediment was present within a 1 ft perimeter of the columns where the sediment was up to 1 in. deep.
  - All concrete columns were in good condition with no defects noted.
  - Several vertical cracks were noted on the interior wall surface (primarily on the East and North Walls). The cracks were typically up to ½ in. wide and had been repaired with a caulk material.
  - The top slab was typically in good condition with only very minor hairline cracking with efflorescence noted. No active leakage was observed.

- There was an approximately 120 ft long piece of joint filler failing just east of the G column line. The joint did not exhibit any signs of active leakage.

Summary of Recommendations:

- The sediment does not appear to affect the functionality of the reservoir at this time and should only be monitored.
- Install gaskets at all roof hatches.
- Re-inspect following any repairs and within every 5 years thereafter.

1.0 INTRODUCTION

1.1 Purpose and Scope

This report consists of the results of an inspection of the Division St. 5 Million Gallon Potable Water Storage Tank located in the City of Bloomington, Illinois. Collins Engineers, Inc. (Collins) conducted the inspection, as a subconsultant to CDM Smith on January 22, 2018. The purpose of the investigation was to assess the interior condition of the tank.

1.2 General Description of the Structure

The 5 million gallon potable water tank is located at the north end of the property near the intersection of W Division St. and S Adelaide St. The tank is below grade, square shaped reinforced concrete structure with dimensions of approximately 185 ft. The interior concrete surfaces consisted of uncoated concrete. The interior of the structure was accessed through a hatch located at the southeast quadrant of the roof slab and permanent ladder affixed to the wall of the structure below the access hatch. The tank is serviced by a 24 in. diameter steel inlet pipe located at the center of the west wall, and a 24 in. diameter transfer pipe at the south wall that leads to the 10 million gallon reservoir. Refer to and Figure 1 in Appendix A for a Location Map. Refer to Photograph 1 in Appendix B for an overall view of the structure and Photograph 2 for a view of the access hatch. Refer to Photographs 3 and 4 for views of the influent pipe and transfer pipe, respectively.

1.3 Method of Investigation

A four-person team consisting of one professional engineer-diver, two engineer-divers and one professional land surveyor-diver conducted the underwater inspection. The inspection team utilized surface supplied air diving equipment with hard-wire communications and dive helmets to perform the below water inspection. Additionally, a vulcanized rubber dry suit with interlocking helmet yoke specifically designed and dedicated for use in potable water diving operations was utilized. To minimize risk of the water contamination, prior to entering the water, all diving equipment, tools and photography equipment were disinfected with a pressure washer and tap water solution containing a minimum of 200 mg/L of free chlorine in accordance with AWWA C652-11. A visual and tactile inspection was performed on the interior surfaces of the tank with particular attention given to areas of distress or previous repair. Photographs were taken to document the general conditions and observed deficiencies.

2.0 EXISTING CONDITIONS

2.1 Water Tank Exterior

Overall, the tank's exterior was in fair condition with no defects of immediate structural significance noted. The surface area of the roof slab, was covered with soil and grass. The soil on the roof was very saturated indicating poor drainage on the site and the possibility for unintended surcharge loading on the roof slab.

Roof access hatches were located at the southeast, northeast, and northwest corners of the tank. The hatches did not have a seal or gasket in place which could allow for insects or rodents to enter through the gap.

2.2 Water Tank Interior

The tank's floor slab was generally in good condition with no defects of structural significance observed. Fine silty sand sediment deposits were present throughout the tank floor, ranging from a dusting to 1/4 in. thick near the center of the tank. Thicker sediment was present within a 1 ft perimeter of the columns where the sediment was up to 1 in. deep.

The exposed steel pipe sections in the tank were generally in fair condition with minor corrosion present. The interface between the pipes and floor/walls were sealed with no obvious signs of leakage. Refer to Photographs 3 and 4 for views of the influent pipe and transfer pipe, respectively.

All concrete columns were in good condition with no defects noted. The concrete on the interior of the tank wall was not covered with a paint coating above or below the waterline and was generally in good to fair condition. Several vertical cracks were noted on the interior wall surface (primarily on the East and North

Walls). The cracks were typically up to ½ in. wide and had been repaired with a caulk material. Refer to Photographs 5 and 6 for views of the patched wall cracks.

The underdeck of the top slab was typically in good condition with only very minor hairline cracking with efflorescence noted. No active leakage was observed. There was an approximately 120 ft long piece of joint filler failing just east of the G column line. The joint did not exhibit any signs of active leakage. Refer to Photograph 7 for a view of the underdeck joint deterioration.

There was also a previously discovered area of patched concrete with delamination and 6 exposed and corroded reinforcing bars that measured approximately 7 ft wide by 5 ft long with up to 2 in. maximum penetration located at the underdeck between Columns C-9 and D-9. Refer to Photograph 8 for a view of the delaminated concrete underdeck patch.

3.0 EVALUATION AND RECOMMENDATIONS

Overall, the Division St. 5 Million Gallon Tank was generally in good condition. In order to promote the long-term serviceability of the structure, as well as to minimize potential for water contamination, consideration should be given to installing a gasket on the access hatches.

The minor amount of sediment is not believed to be affecting the operational capabilities of the tank and did not significantly hinder the inspection. Similarly, the delaminated concrete underdeck patch and the sealed wall cracks are minor and do not require corrective measures at this time.

Lastly, it is recommended that the water tank be re-inspected within a maximum interval of five (5) years. Since sediment has not been an issue at this location, engineer-divers can perform future routine inspections in accordance with AWWA and ADCI Standards.

Respectfully Submitted,
COLLINS ENGINEERS, INC.

Roy A. Forsyth, P.E.
Project Manager

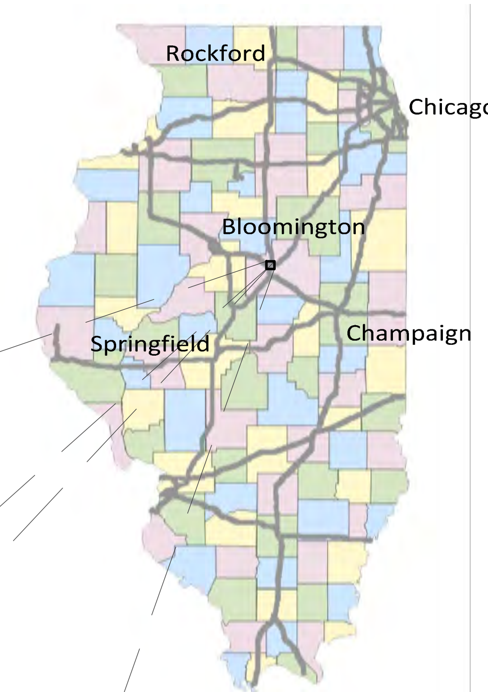
APPENDIX A – FIGURES

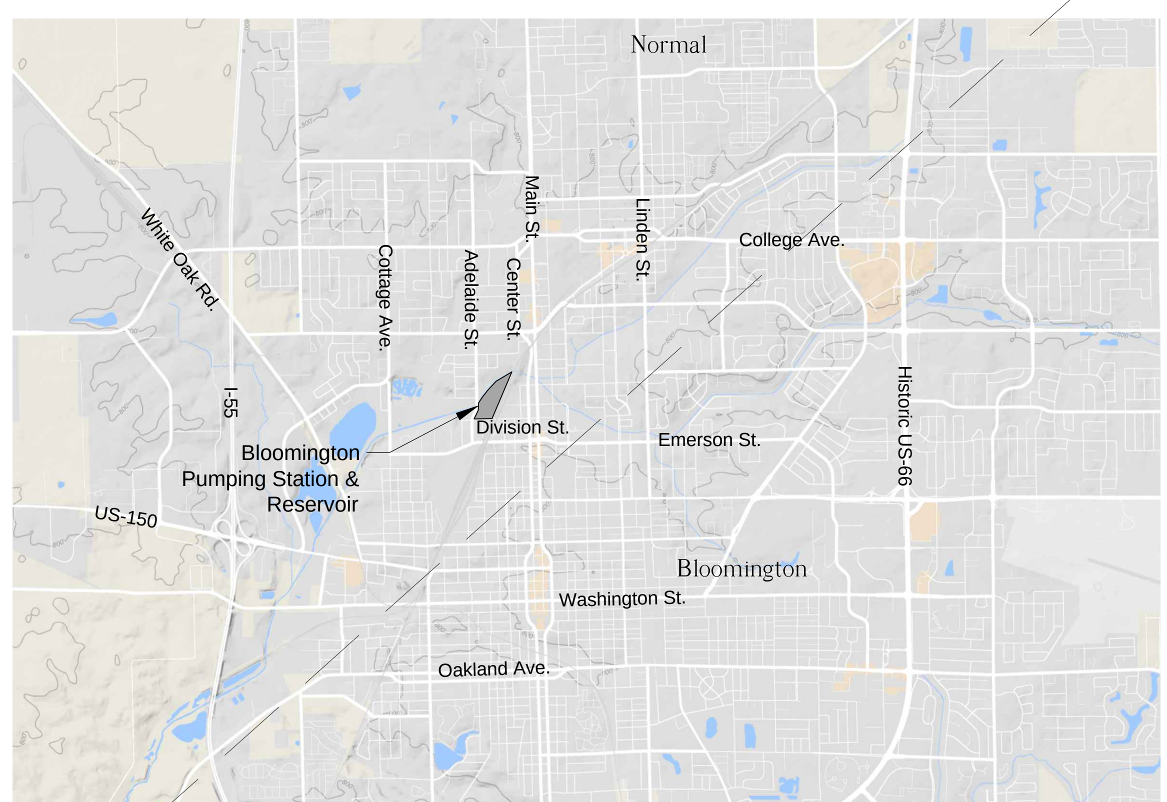
BLOOMINGTON WATER DEPARTMENT

5 MG WATER RESERVOIR INSPECTION - PUMPING STATION & RESERVOIR

INTERIOR INSPECTION

BLOOMINGTON, WI





N

1 VICINITY MAP

SCALE: 1" = 6000'

0 2500' 5000'

INDEX OF DRAWINGS

SHEET NO.	SHEET TITLE
A–1	Title Sheet
A–2	5MG Underwater Inspection

AGENCY/CLIENT:

BLOOMINGTON WATER DEPARTMENT
603 DIVISION ST.
BLOOMINGTON, IL 61707

CIVIL ENGINEER/INSPECTOR:

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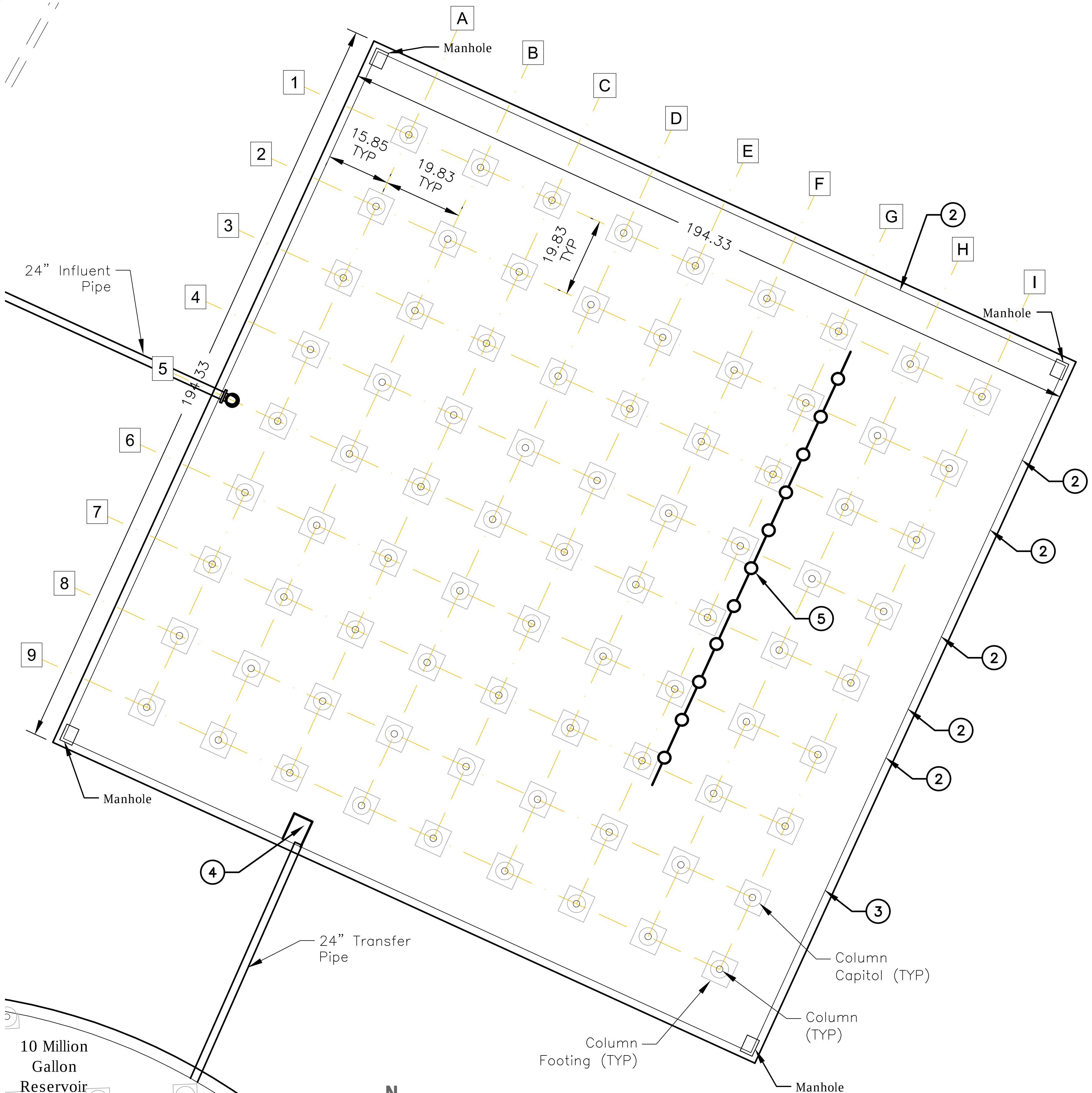
Bloomington Water Department

Title Sheet
5MG Reservoir
Bloomington Water Department
Bloomington, IL

CEI PROJECT: 60–10737
INSPECTED BY: RAF/CSH/MJS
DRAWN BY: CSH
CHECKED BY: RAF
DATE: 1–22–2018
SHEET NO: A-1



1 UNDERWATER INSPECTION

SCALE: 1" = 40'

0 20' 40'

LEGEND:

2 – Indicates directional numbering of Bents

B – Indicates directional numbering of Rows

INSPECTION NOTES:

1. Fine silty sand deposits were present throughout the tank floor, ranging from a dusting to ¼ in. thick near the center of the tank. Thicker sediment was present within a 1 ft. perimeter of the columns where the sediment was up to 1 in. deep.
2. Vertical crack up to ½ in. wide and full wall height filled with repair caulk.
3. Vertical full wall height hairline crack in east wall.
4. Area of patched concrete with delamination and 6 exposed and corroded reinforcing bars that measured approximately 7 ft wide by 5 ft long with up to 2 in.maximum penetration.
5. A 120 ft long piece of joint filler failing just east of the G column line with no signs of active leaking.

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Bloomington Water Department

Underwater Inspection
5MG Reservoir
Bloomington Water Department
Bloomington, IL

CEI PROJECT
60-10737

INSPECTED BY:
RAF/CSH/MJS

DRAWN BY:
CSH

CHECKED BY:
RAF

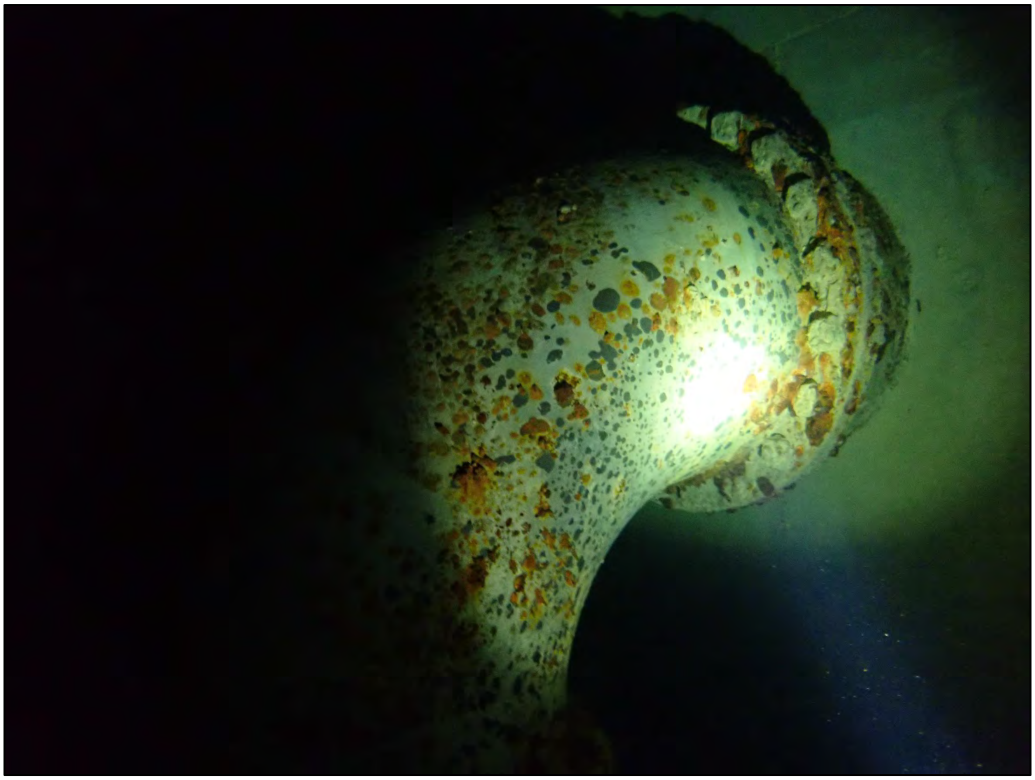
DATE:
1-22-2018

SHEET NO:
A-2

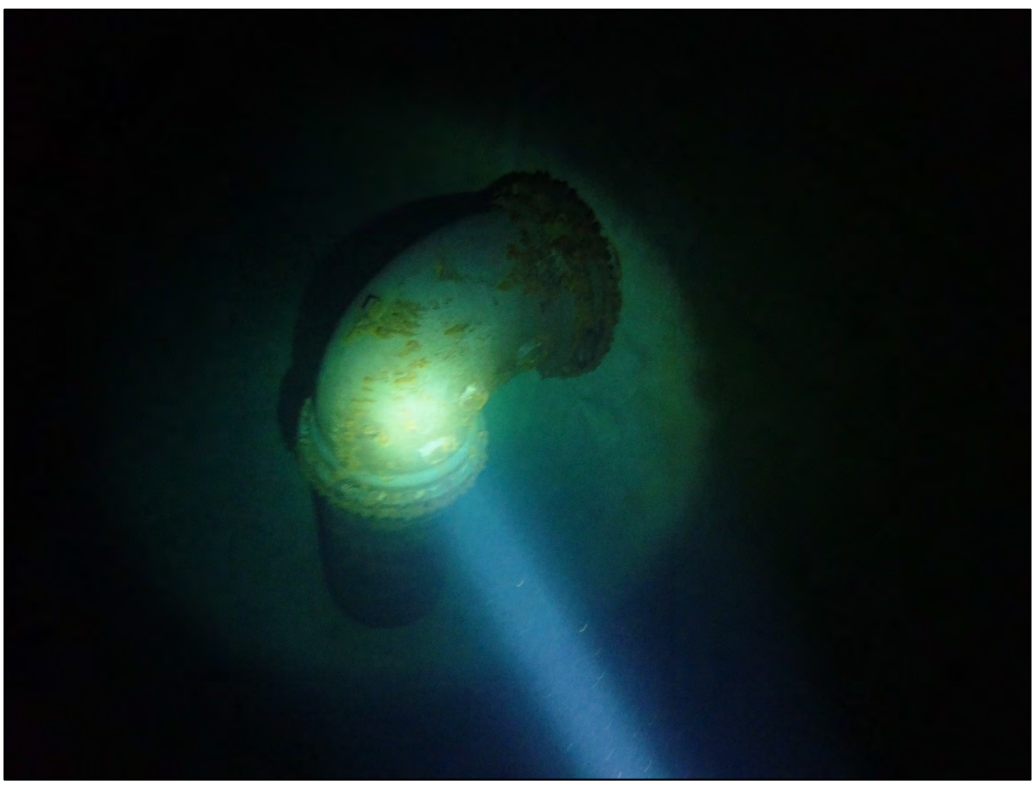
APPENDIX B – INSPECTION PHOTOGRAPHS

Photograph 1: Overall view of site, looking down.

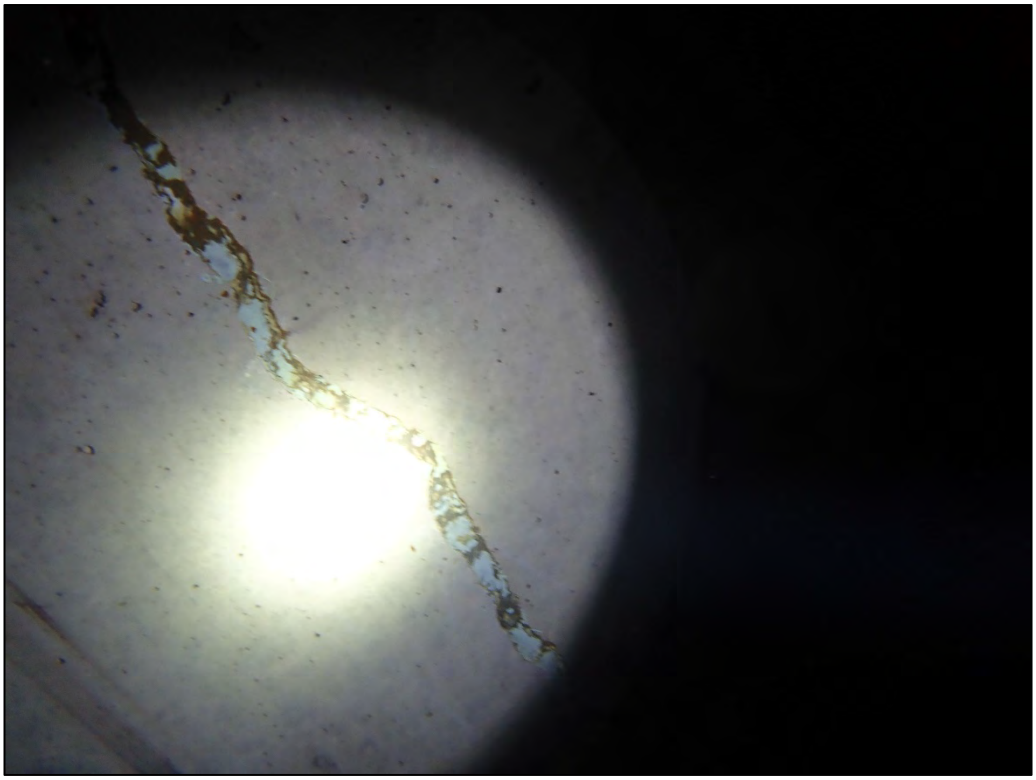
Photograph 2: Typical access hatch opening with permenant ladder.



Photograph 3: Typical condition of influent pipe at west wall.

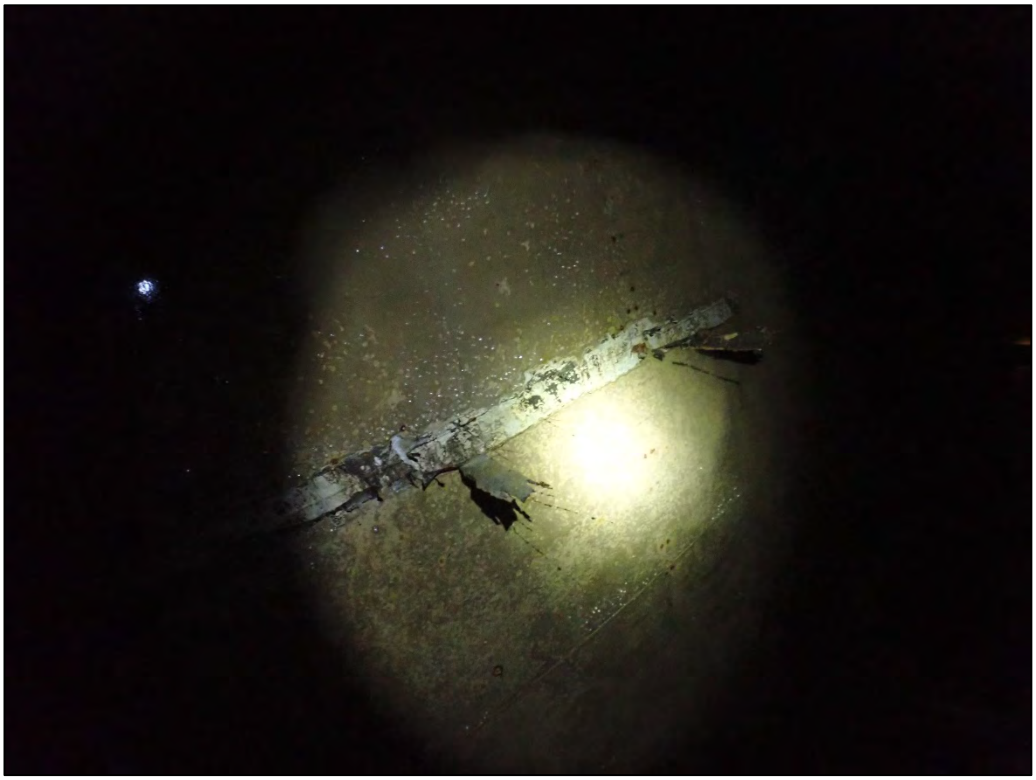


Photograph 4: Typical condition of transfer pipe at south wall.



Photograph 5: View of typical patched vertical wall crack.

Photograph 6: View of typical patched vertical wall crack.



Photograph 7: View of deteriorated underdeck joint seal.

Photograph 8: View of the underdeck patch between Columns C-9 and D-9.

INVESTIGATION REPORT
FOR
THE DIVISION ST.
10 MG POTABLE WATER RESERVOIR

January 22, 2018

Prepared for:

City of Bloomington Illinois

Prepared by:

COLLINS ENGINEERS INC.

2033 West Howard Avenue

Milwaukee, Wisconsin 53221

414.236.1644 • www.collinsengr.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Project: Investigation of the Division St. 10 Million Gallon Potable Water Reservoir in Bloomington, Illinois.

Purpose of Project: To perform a visual and tactile inspection of all below and above water surfaces on the interior of the Division St. 10MG Tank.

Inspection Team: Team Leader – Roy Forsyth, P.E., CWI – Collins Engineers, Inc.
Team Member – Chris Hartzell, P.L.S., CWI – Collins Engineers, Inc.
Team Member – Marc Stern, E.I.T. – Collins Engineers, Inc.
Team Member – Rod Breen, E.I.T. – Collins Engineers, Inc.

Inspection Date(s): January 22, 2018
Access location: South Roof Hatch
Access Mode: Surface Supplied Air Diving/ Confined Space Entry

Summary of Findings:

- Exterior
  - Roof access hatches were located at the south, east, north, and west corners of the tank. All hatches except the south hatch did not have a seal or gasket in place. See Picture 2.
  - The roof was covered with soil and was planted with well-established grass.
  - The soil on the roof was very saturated indicating poor drainage on the site and the possibility for unintended surcharge loading on the roof slab.
- Interior
  - Fine silty sand sediment deposits were present throughout the tank floor, ranging from a dusting to 1/4 in. thick near the center of the tank.
  - All concrete columns were in good condition with no defects noted.
  - The concrete walls were covered with an unknown material from the floor to 1 ft above the water level. The coating was approximately ½ in. thick and was heavily textured. The material may possibly be either sediment or some sort of sprayed on coating.
  - The top slab was typically in good condition with no cracking or active leakage observed.
  - There was an 8 in. wide area of concrete section loss with 4 in. penetration and no exposed reinforcing steel located from 3 to 9 o' clock around the 24 in. diameter suction pipe.

- There was an 8 in. diameter steel pipe protruding from the ceiling near Column A-7 with a 6 in. wide spall around the perimeter. The spall had 4 in. max penetration with exposed and heavily corroded reinforcing steel.

Summary of Recommendations:

- The sediment does not appear to affect the functionality of the reservoir at this time and should only be monitored.
- Install gaskets at the east, north, and west roof hatches.
- Re-inspect following any repairs and within every 5 years thereafter.

1.0 INTRODUCTION

1.1 Purpose and Scope

This report consists of the results of an inspection of the Division St. 10 Million Gallon Potable Water Storage Tank located in the City of Bloomington, Illinois. Collins Engineers, Inc. (Collins) conducted the inspection, as a subconsultant to CDM Smith on January 22, 2018. The purpose of the investigation was to assess the interior condition of the tank.

1.2 General Description of the Structure

The 10 million gallon potable water tank is located at the south end of the property near the intersection of W Division St. and S Adelaide St. The tank is a below grade, circular shaped reinforced concrete structure measuring approximately 300 ft in diameter. The interior concrete surfaces of the floor, columns, and underdeck consisted of uncoated concrete. The concrete walls were covered with an unknown material from the floor to 1 ft above the water level. The coating was approximately ½ in. thick and was heavily textured. The coating material may possibly be either sediment or some sort of sprayed on coating.

The interior of the structure was accessed through a hatch located at the south quadrant of the roof slab and permanent ladder affixed to the wall of the structure below the access hatch. The tank is serviced by a 24 in. diameter steel inlet pipe located at the northwest quadrant wall, a 24 in. diameter suction pipe at the southwest quadrant wall, and a 24 in. diameter transfer pipe that leads to the 5 million gallon reservoir. Refer to and Figure 1 in Appendix A for a Location Map. Refer to Photograph 1 in Appendix B for an overall view of the structure and Photograph 2 for a view of the access hatch.

1.3 Method of Investigation

A four-person team consisting of one professional engineer-diver, two engineer-divers and one professional land surveyor-diver conducted the underwater inspection. The inspection team utilized surface supplied air diving equipment with hard-wire communications and dive helmets to perform the below water inspection. Additionally, a vulcanized rubber dry suit with interlocking helmet yoke specifically designed and dedicated for use in potable water diving operations was utilized. To minimize risk of the water contamination, prior to entering the water, all diving equipment, tools and photography equipment were disinfected with a pressure washer and tap water solution containing a minimum of 200 mg/L of free chlorine in accordance with AWWA C652-11. A visual and tactile inspection was performed on the interior surfaces of the tank with particular attention given to areas of distress or previous repair. Photographs were taken to document the general conditions and observed deficiencies.

2.0 EXISTING CONDITIONS

2.1 Water Tank Exterior

Overall, the tank's exterior was in fair condition with no defects of immediate structural significance noted. The surface area of the roof slab, was covered with soil and grass. The soil on the roof was very saturated indicating poor drainage on the site and the possibility for unintended surcharge loading on the roof slab.

Roof access hatches were located at the south, east, north, and west edges of the tank. All hatches except the south hatch did not have a seal or gasket in place which could allow for insects or rodents to enter through the gap.

2.2 Water Tank Interior

The concrete walls were covered with an unknown material from the floor to 1 ft above the water level. The coating was approximately ½ in. thick and was heavily textured. The material may possibly be either sediment or some sort of sprayed on coating. See Picture 3 for a view of the wall coating. There was an 8 in. wide area of section loss with 4 in. penetration and no exposed reinforcing steel located from 3 to 9 o' clock around the 24 in. diameter suction pipe. See Picture 4 for a view of concrete section loss and pipe penetration.

All concrete columns were in good condition with no defects noted. The top slab underdeck was typically in good condition with no cracking or active leakage observed. There was an 8 in. diameter steel pipe protruding from the ceiling near Column A-7 with a 6 in. wide spall around the perimeter. The spall had 4 in. max penetration with exposed and heavily corroded reinforcing steel. Refer to Photograph 5 for a view of the underdeck pipe penetration and spall.

The tank's floor slab was generally in good condition with no defects of structural significance observed. Fine silty sand sediment deposits were present throughout the tank floor, ranging from a dusting to 1/4 in. thick near the center of the tank. There was a large concrete block measuring approximately 4 ft in each dimension located on the tank floor between Columns 8-F and 8-G. Refer to Photographs 6 for a view of the concrete block.

The exposed steel pipe sections in the tank were generally in fair condition with minor corrosion present. The interface between the pipes and floor/walls were sealed with no obvious signs of leakage. Refer to Photographs 7 through 9 for views of the influent pipe, suction pipe, and transfer pipe, respectively.

3.0 EVALUATION AND RECOMMENDATIONS

Overall, the Division St. 10 Million Gallon Tank was generally in good condition. In order to promote the long-term serviceability of the structure, as well as to minimize potential for water contamination, consideration should be given to installing a gasket on the east, north, and west access hatches.

The minor amount of sediment is not believed to be affecting the operational capabilities of the tank and did not significantly hinder the inspection. Similarly, the minor concrete spalls do not require corrective measures at this time.

Lastly, it is recommended that the water tank be re-inspected within a maximum interval of five (5) years. Since sediment has not been an issue at this location, engineer-divers can perform future routine inspections in accordance with AWWA and ADCI Standards.

Respectfully Submitted,
COLLINS ENGINEERS, INC.

Roy A. Forsyth, P.E.
Project Manager

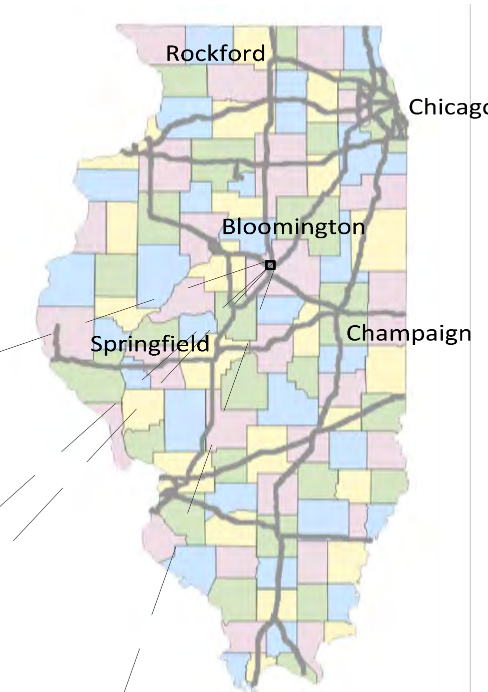
APPENDIX A – FIGURES

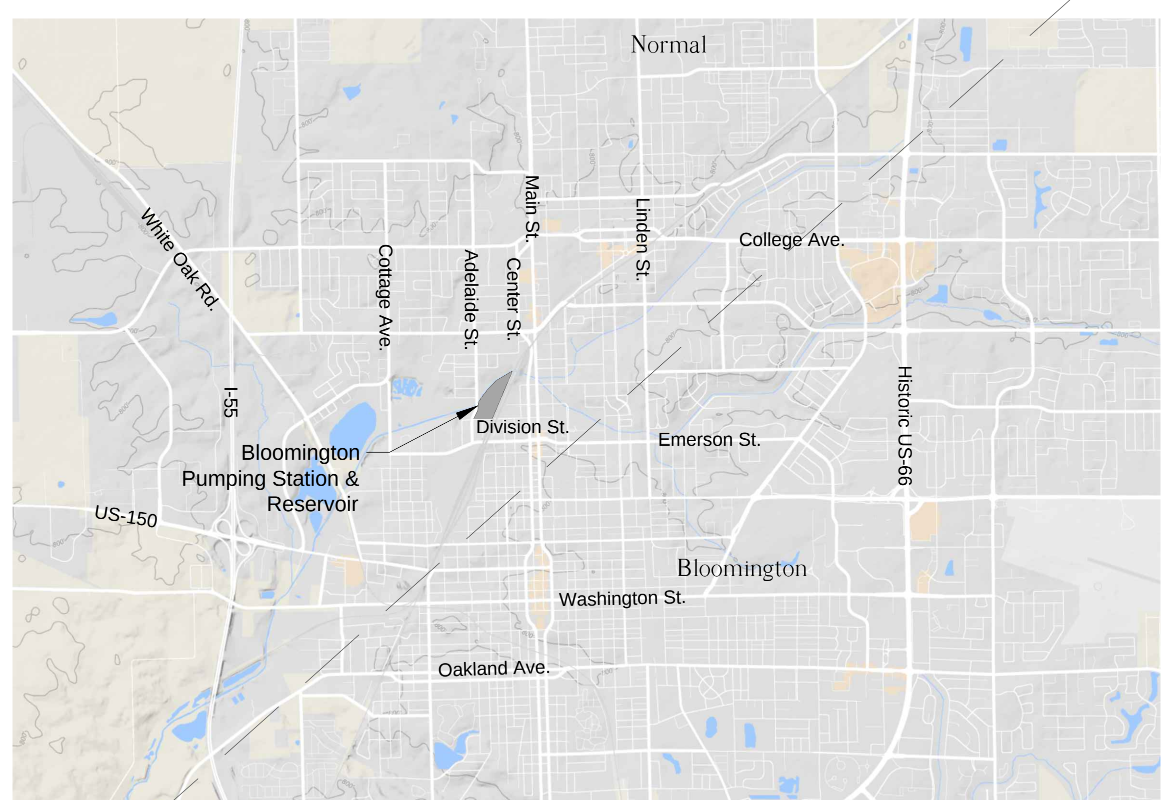
BLOOMINGTON WATER DEPARTMENT

10 MG WATER RESERVOIR INSPECTION - PUMPING STATION & RESERVOIR

INTERIOR INSPECTION

BLOOMINGTON, WI





N

1 VICINITY MAP

SCALE: 1" = 6000'

0 2500' 5000'

INDEX OF DRAWINGS

SHEET NO.	SHEET TITLE
A–1	Title Sheet
A–2	10 MG Underwater Inspection

AGENCY/CLIENT:

BLOOMINGTON WATER DEPARTMENT
603 DIVISION ST.
BLOOMINGTON, IL 61707

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Bloomington Water Department

Title Sheet
10 MG Reservoir
Bloomington Water Department
Bloomington, IL

CEI PROJECT: 60–10737
INSPECTED BY: RAF/CSH/MJS
DRAWN BY: CSH
CHECKED BY: RAF
DATE: 1–22–2018
SHEET NO: A-1

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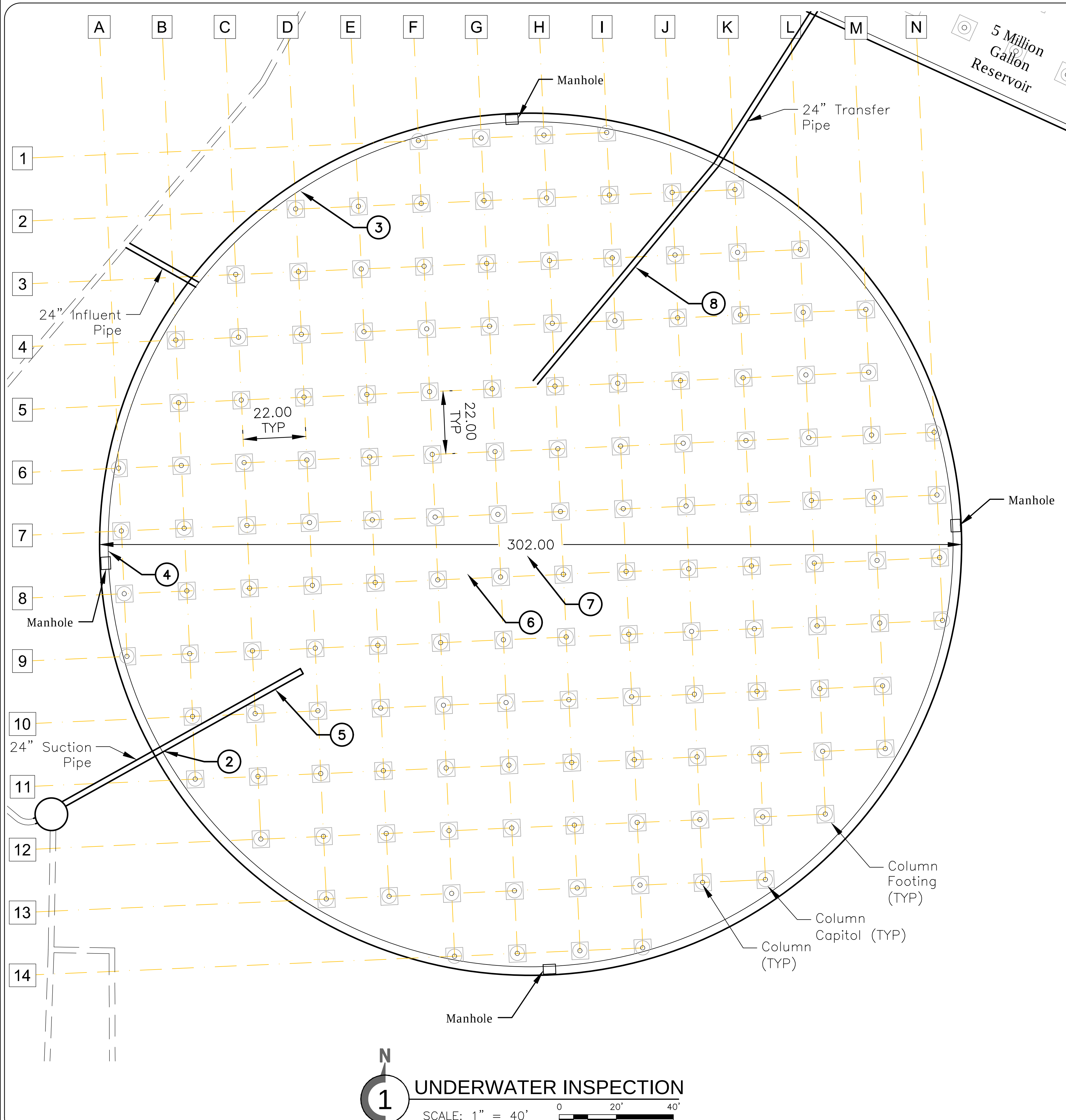

LEGEND:

2 – Indicates directional numbering of Bents

B – Indicates directional numbering of Rows

INSPECTION NOTES:

1. Approximately ½" thick heavily textured coating on tanks walls from bottom to 1' above water level.
2. 8" wide spall with 4" of penetration and no exposed steel from 3–9 o'clock around the suction pipe.
3. 30" dia at column D–2 comes out of wall, turns vertical and stops short of ceiling.
4. 8" dia pipe protruding from ceiling near column A–7 with 6" wide spall around perimeter. Spall had 4" max penetration with exposed and heavily corroded steel.
5. Suction pipe painted coating in good shape, hardware has approximately 25% section loss. Pipe is recessed in floor.
6. 4' cube of concrete on bottom of tank.
7. Metal pipe approximately 8" dia with perforations, comes up from floor and exits through ceiling.
8. 30" dia steel pipe on floor, painted coating in tact over 95%, few rust nodules.

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Bloomington Water Department

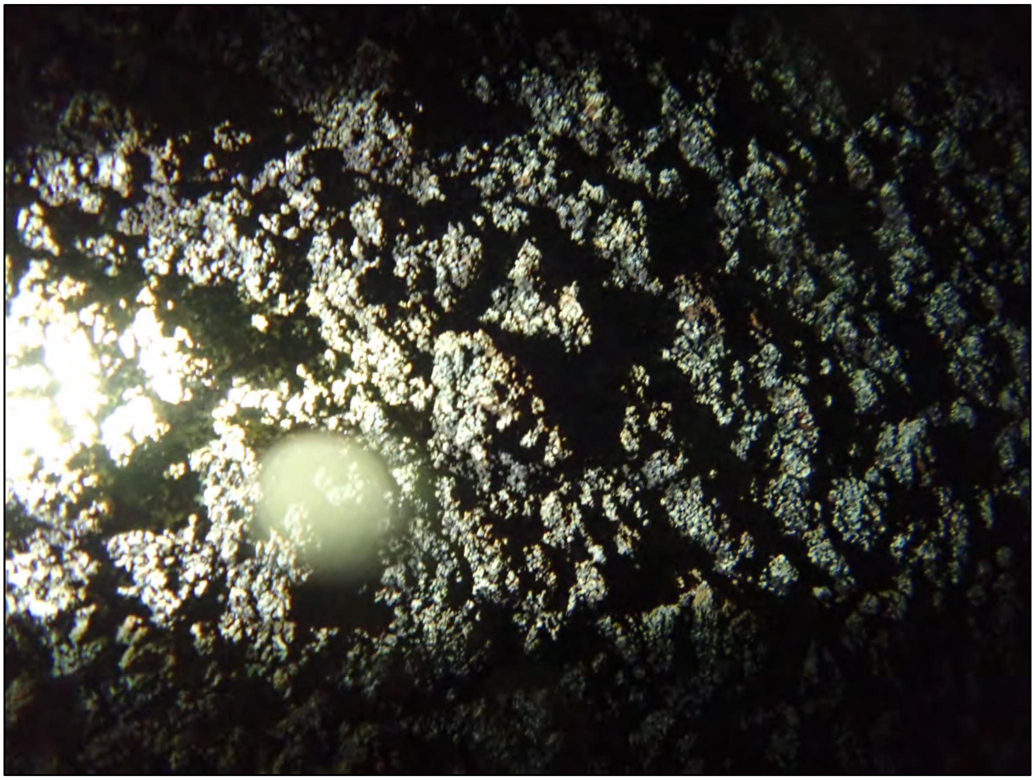
Underwater Inspection
10MG Reservoir
Bloomington Water Department
Bloomington, IL

CEI PROJECT 60–10737
INSPECTED BY: RAF/CSH/MJS
DRAWN BY: CSH
CHECKED BY: RAF
DATE: 1–22–2018
SHEET NO: A-2

APPENDIX B – INSPECTION PHOTOGRAPHS

Photograph 1: Overall view of site, looking down.

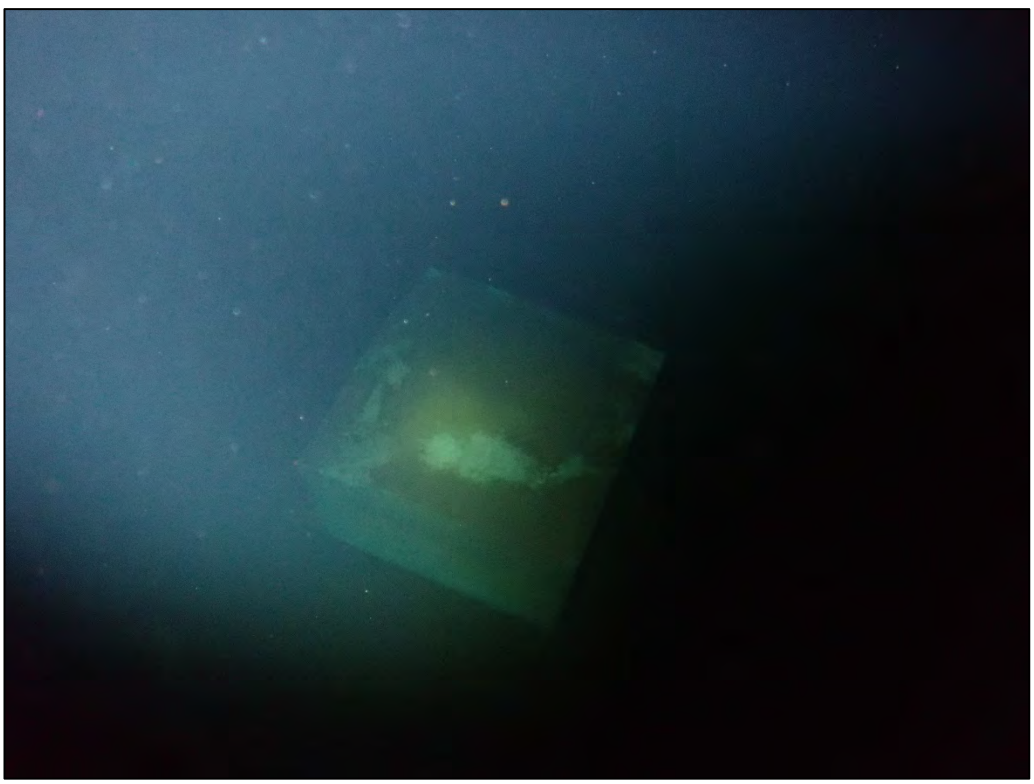
Photograph 2: Typical access hatch opening with permenant ladder..



Photograph 3: Typical texture and condition of coating material on wall.

Photograph 4: Concrete section loss around bottom of suction pipe.

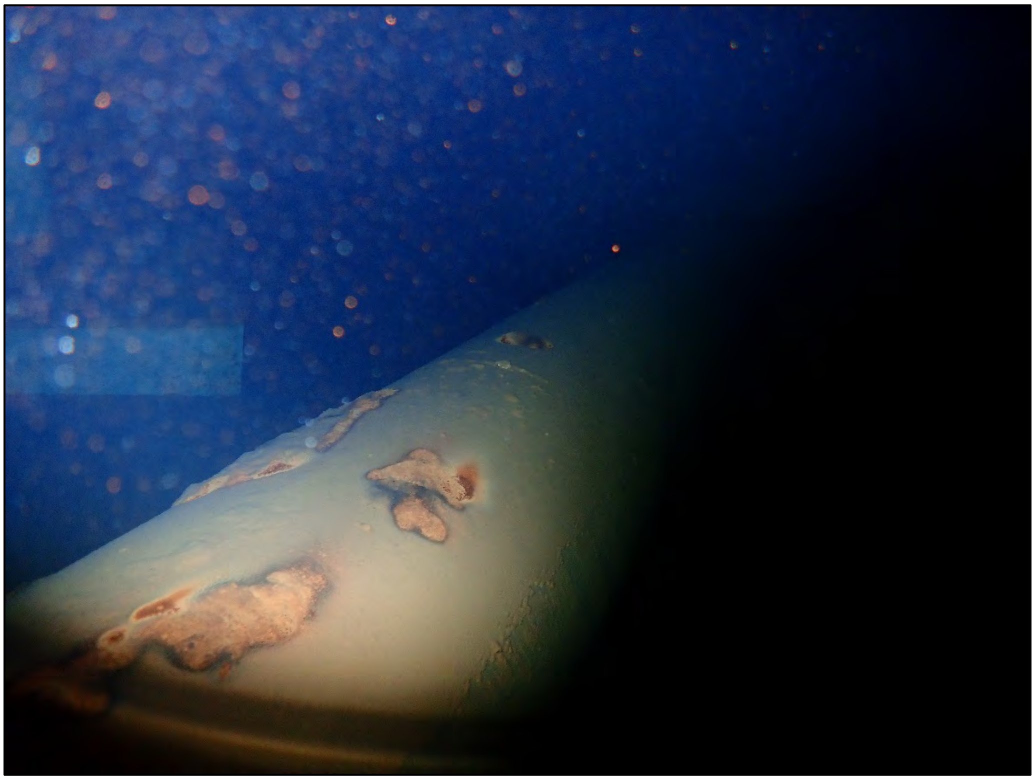
Photograph 5: Spall with corroded reinforcing steel at Pipe protrusion in underdeck.



Photograph 6: View of concrete block on floor near center of tank.

Photograph 7: View of suction pipe located 2 ft above waterline.

Photograph 8: Typical view of suction pipe.



Photograph 9: Typical view of transfer pipe.

Appendix B

Condition Assessment Summary by Discipline

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Bloomington WTP Facility Plan

Codes and Abbreviations

Key Code

Facility Designation	Area Designation at Water Treatment Plant	Discipline Designation
B = Bloomington WTP	Intake and Screens	
M = Mackinaw PS, ETC	Low Service Pumps	01 = Civil/Site
EL = Evergreen Lake PS	Old Plant Building	02 = Architectural
D = Division Street PS	Clarifier Buildling/Claricone 1, 2, 3, or 4	03 = Structural
DR = Division St Reservoirs	West Recarbonation Basins	04 = Process
E = Enterprise Zone PS	East Recarbonation Basins	05 = HVAC
FJA = Fort Jesse PS A	Chemical Feed Building	06 = Plumbing
FJB = Fort Jesse PS B	Main Process Building	07 = Electrical
MPS = Main Street PS	Main Process Building/Filters	08 = I&C
LSL = Lime Sludge Lagoons	Main Process Building/High Service Pump Room	
H = Hamilton Road Elevated Tank	Main Process Building/Chemical Rooms	
FJ = Fort Jesse Tanks	Main Process Building/Lime Storage Room	
NE = Northeast Elevated Tank	Main Process Building/Electrical Room	
	Main Process Building/Shop	
	Reservoir	
	Reclaim Basin	

Problem Class

Identify problem class of each proposed improvement.

Class 1 – a condition in which failure of a primary item of equipment or structure is imminent, and its failure would directly result in loss of a significant portion of plant capacity, jeopardize water quality, jeopardize the safety of personnel, or cause further damage to equipment or other structures.

Class 2 – a condition in which failure of a backup unit of equipment or structure is imminent, and failure to attend to the problem world result in loss of backup capacity, jeopardize the safety of personnel, or cause further damage to equipment or other structures (e.g., a device providing the first level of backup, such as an engine generator or the third pump in a bank of three pumps in which two pumps will be required to meet peak requirements).

Class 3 – a condition of failure or imminent failure in some ancillary equipment or structure (e.g., leaking window frames), the failure of which will not impair the process or safety, but may lead to deterioration which could result in increasing repair costs if not attended to in a timely manner.

Class 4 – an improvement which has not been made but which would result in protecting the status quo with regard to water quality, water quantity or safety (e.g., updating lighting fixtures).

Class 5 – anything which should be corrected or improved, which is not listed above and the failure of which does not imperil water quality, water quantity, or safety (e.g., removal of equipment which is not in use).

Functional Categories

Classify the problems by functional categories

O – Operational Items – items that directly affect the production or quality of water and the expense of remediation would be covered under a capital improvement project.

N – Non-Operational Items – items that do not directly affect the production or quality of water and the expense for remediation would be covered under a capital improvement project.

M – Maintenance Items – items that the expense for remediation would be covered under a maintenance budget, as opposed to being treated as an individual capital project under the capital budget.

Table 1 - Summary List of Civil/Site Projects									
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-01-1	Existing pavement was in poor condition, some parking areas were unpaved.	Parking Lot	Replace paved areas in poor condition as planned.	5	M	$715,400	$71,540	$786,940	
B-01-2	Exposed gas distribution main.	Yard	Bury gas main as planned, and restore finished surface	5	M	$5,000	$500	$5,500	
B-01-3	Assess location of all yard piping. At various locations valves that were shown on plans could not be found.	Yard	Full topographic and utility survey with underground utility locates and some potholing to determine exactly where all pipe and valves located.	4	N	$35,000	$3,500	$38,500	
B-01-4	Security fence was in fair condition.	Yard	Consider replacement in 10-15 years.	5	M	$105,000	$10,500	$115,500	
EL-01-1	Erosion adjacent to retaining walls.	Yard	Correct gullies and add erosion mat for steel slope.	5	M	$800	$80	$880	
H-01-01	Assess the condition of the corrosion control and protection system	Yard	Assess CP system.	5	N	$20,000	$2,000	$22,000	
	Air valves and air-vacuum valves along the pipeline from the WTP to the Division St Reservoirs vent below grade within concrete vaults. Each vault is equipped with a vent to atmosphere at about 3-feet above grade. With the valve venting into the below-grade enclosure, the possibility exists for groundwater within the vault to be drawn into the transmission main when vacuum is being relieved.	Transmission Mains	Excavate to remove flat slab top and expose existing ARV piping. Remove existing ARV valve and piping as do not know condition. Replace ARV valve and piping. New piping to connect to ARV, extend to surface and gooseneck down.	1	O	$80,000	$8,000	$88,000	
General	Security at all remote sites was lacking.	Remote Sites	Assess security features at all remote sites.	5	N	$160,000	$16,000	$176,000	
				TOTAL =		$2,000,000		$2,000,000	

Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
Table 2 - Summary List of Architectural Projects								
B-02-01	Existing shingle roof is showing wear, some are damamged or missing; according to building staff it is slated for replacement with standing seam metal roof.	Main Process Building - Exterior	Replace roof as planned	3	N	$450,000	$500,000	
B-02-02	Roof gutters are leaking at seams and dripping, downspouts are missing extensions	Main Process Building - Exterior	Include gutter replacment with roofing replacement job; provide downspouts with extensions to direct water away from foundation	4	N	-	-	cost included in B-02-01
B-02-03	Exterior brick masonry in good condition	Main Process Building - Exterior	Plan for repointing in 20 years	4	M	$150,000	$150,000	
B-02-04	Exterior doors and frames are rusting in some locations, missing or damaged weatherseals in others.	Main Process Building - Exterior	Replace exterior rusted hollow metal doors and frames, replace weatherseals where missing, reset concrete pads with proper subbase to restore door function.	4	M	$30,000	$30,000	Some weatherseals missing or damaged at exterior doors; at Chlorine room, door rubs on heaved sidewalk; hollow metal door and frames are typically rusting at ground floor; at hight lift pump door does not open close easily, missing threshhold and weatherseals.
B-02-05	Expansion joints at upper levels are failing, those at ground level have been replaced	Main Process Building - Exterior	Reseal brick expansion joints, recaulk at windows and louvre openings	4	M	$2,000	$2,000	
B-02-06	Exterior wood-framed shed for Anhydrous Ammonia is in poor condition: wood is rotting, hollow metal door is rusted through, and plywood ceiling is damaged with insulation exposed.	Main Process Building - Exterior	Refer to process recommendations	3	N	-	-	Reference Process recommendation B-04-31
B-02-07	Exterior wooden stairs at generator enclosure are water damaged and curling up at th ends, creating a tripping hazard	Main Process Building - Exterior	Replace wooden stair boards	4	M	$2,000	$2,000	
B-02-08	Solid surface window sills are stained and a few are broken	Main Process Building - Throughout	Replace solid surface sills	5	M	$2,000	$2,000	
B-02-09	Windows left open without screens installed, significant quantity of bugs found inside	Main Process Building - Throughout	Install insect screens. Consider implementing HVAC improvements to provide climate controlled environment.	4	M	-	-	See HVAC comments and improvements.
B-02-10	Multiple pipe penetrations through the 2-hr rated wall are not fire-stopped	Main Process Building - Electrical Room	Firestop penetrations	4	M	$2,000	$2,000	Life Safety

Table 2 - Summary List of Architectural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-02-11	Second egress door (interior) swings in, and does not have code-required panic hardware	Main Process Building - Electrical Room	Replace hollow metal door/frame/hardware with out-swinging B-rated door with panic hardware.	4	N	$3,000	$3,000	Life Safety Refer to electrical issue B-07-13.
B-02-12	Insufficient clearance at medium voltage main disconnect panel	Main Process Building - Electrical Room	Provide sufficient clearances at time of electrical renovation.	4	N	-	-	Life Safety
B-02-13	Concrete floor pitting at Electrical Room, Lime Storage Room	Main Process Building - Electrical Room	Refer to Structural item B-03-11	5	M	-	-	Consider bi annual maintenance program. Cost included in Structural B-03-11
B-02-14	At the time of the walkthrough, objects were stored on the Stair No. 1 landing, and stair door was propped open compromising its fire rating.	Main Process Building	Remove stored objects from stairway; do not prop open fire rated doors.	4	M	$0	$0	Life Safety
B-02-15	A range, with no range hood, and refrigerators are stored in corridor adjacent to electrical and control room	Main Process Building	Remove items from corridor as it reduces required path of egress	4	M	$0	$0	Life Safety
B-02-16	Paint on metal decking and upper portion of CMU wall is peeling	Main Process Building - Lime Storage Room	Scrape and paint	5	M	$15,000	$15,000	
B-02-17	2nd floor door does not shut properly; door hardware to chlorine room is calcifying	Main Process Building - Lime Storage Room	Replace interior doors/frames/hardware	4	M	$3,000	$3,000	
B-02-18	Overhead door at Old Amonia/New Shop room is damaged	Main Process Building - Shop	Replace overhead door.	5	M	$2,000	$2,000	
B-02-19	Bathrooms and drinking fountain have insufficient manuevering clearances and mounting heights to meet ADA accessibility requirements.	Main Process Building	Recommended renovation for ADA compliance	5	N	$130,000	$150,000	ADA
B-02-20	Ceiling tiles in corridors and office areas are sagging.	Main Process Building	Replace ceiling tiles with water resistant type in existing grid	5	M	$4,000	$4,000	

Table 2 - Summary List of Architectural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-02-21	Vinyl composition tile flooring is worn.	Main Process Building - Offices	Replace vinyl composition tile flooring.	5	M	$1,500	$1,500	
B-02-22	Laminate counters are water damaged and chipping.	Main Process Building	Replace countertops.	5	M	$2,000	$2,000	
B-02-23	Existing standing seam metal roof (approx 19 years old) has active leaks at ridge and near exterior walls, evidenced by stained and failing insulation underneath.	Clarifier Building	Option 1: Replace existing metal roof; Option 2: Coat roof with high performance topcoat to repair and extend roof's life.	3	N	$575,000	$600,000	Recommend replacement
B-02-24	Exterior hollow metal doors and frames are rusting	Clarifier Building	Replace (2) exterior doors and frames.	4	M	$6,000	$6,000	
B-02-25	Wall insulation is peeling away in spot locations	Clarifier Building	Replace insulation, isolated locations	5	M	$1,000	$1,000	
B-02-26	Flat roof flashing varies from good to poor condition.	Old Plant Building	Replace flat roof, including re-shingle access hatches.	3	N	$100,000	$110,000	
B-02-27	Roof leaking over shop area, as evidenced by ponding water and water infiltration on the interior peeling paint and mold.	Old Plant Building	Provide roof membrane/seal outdoor mezzanine area and clean out/modify scupper.	3	N	$20,000	$25,000	
B-02-28	Single pane windows in wood frames in poor condition at original building.	Old Plant Building	Replace windows and frames with insulated units.	3	N	$50,000	$60,000	
B-02-29	Masonry in fair to good condition; some efflorescence at boiler stack, ivy covering at low lift tower, localized areas of minor damage.	Old Plant Building	Plan for repointing in 10 years.	5	M	$130,000	$130,000	
B-02-30	The exterior platform at the west end of the building in poor condition. The hollow metal doors, wooden lintel above, and wood framed shed underneath are also in poor condition.	Old Plant Building	Rebuild platform and provide exterior exit stairway to ground level; remove shed; replace hollow metal exit doors with B-label doors; replace timber lintel.	3	N	$10,000	$10,000	Life Safety Door replacement cost only. Refer to Structural item B-03-3 & B-03-4.

Table 2 - Summary List of Architectural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-02-31	No exit sign at outdoor exit door from corridor near low lift pump or at east stairwell.	Old Plant Building	Provide egress signage and emergency lighting. Life Safety study.	3	N	$10,000	$12,000	Life Safety
B-02-32	Metal Shop / Garage area does not have an exit without egressing through Switchgear area.	Old Plant Building	Create opening for egress door from garage / metal shop.	3	N	$15,000	$20,000	Life Safety
B-02-34	Mezzanine guard rail is 36 inches high.	Old Plant Building	Replace or extend guardrail to code-required height of 42 inches.	4	N	$5,000	$7,500	Life Safety
B-02-35	Peeling paint on concrete roof planks in filter additions.	Old Plant Building	Scrape and repaint w/ water resistant paint.	4	M	$35,000	$35,000	
B-02-36	Ceiling tiles are stained.	Old Plant Building	Replace or remove ceiling tiles.	5	M	$5,000	$5,000	
EL-02-01	Wooden stairs and fence at exterior generator enclosure are weathering; fence boards are curling.	Evergreen Lake	Replace damaged boards.	4	M	$2,000	$2,000	
EL-02-02	Door hardware is damaged or broken throughout, door frames are beginning to rust.	Evergreen Lake	Replace doors/frames/hardware.	4	M	$15,000	$15,000	
EL-02-03	Railing height does not meet code minimum height.	Evergreen Lake	Refer to Structural item EL-03-1	4	N	-	-	Refer to Structural item EL-03-1
EL-02-04	Masonry in good condition.	Evergreen Lake	Plan for repointing in 10 years.	5	M	$18,000	$25,000	
EL-02-01	Existing built-up roof in fair condition; cap stone is eroding away exposing asphalt to UV degredation in locations.	Evergreen Lake	Redistribute ballast stone to cover/protect roof, plan for replacement in 5-10 years.	4	N	$16,000	$17,500	

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Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
EL-02-05	Floors pitting and peeling.	Evergreen Lake	Patch concrete and recoat floors.	5	M	$3,000	$3,000	
EL-02-06	Plant requested a polymer storage building.	Evergreen Lake	Pre-engineered fiberglass structure would be recommended for this use.	4	O	$75,000	$5,000	Costs include concrete foundation slab for a 20x12 FRP building with heat, receptacles, and lights.
FJA-02-01	Existing windows are single-pane operable, sealant is cracking.	Fort Jesse PS A	Re-seal windows, recommend replacing with insulated units.	5	M	$10,000	$10,000	
FJA-02-02	Stoops heaving at entry doors.	Fort Jesse PS A	Reset stoops with proper subbase.	5	M	$1,000	$1,000	
FJA-02-03	Lintels at overhead door and windows are beginning to rust.	Fort Jesse PS A	Scrape and paint lintels.	5	M	$1,000	$1,000	
FJA-02-04	Toilet room not ADA accessible.	Fort Jesse PS A	Recommend creating accessible toilet facilities.	5	N	$15,000	$17,000	
FJA-02-05	Existing shingle roof is in good condition.	Fort Jesse PS A	Plan for roof replacement in 10 years.	5	M	$26,000	$28,000	
FJB-02-01	Window caulk cracking.	Fort Jesse PS B	Reseal windows.	5	M	$1,000	$1,000	
FJB-02-02	Lintels at overhead door and windows are beginning to rust.	Fort Jesse PS B	Scrape and paint lintels.	5	M	$1,000	$1,000	
FJB-02-03	No signage at bathroom	Fort Jesse PS B	Install signage	5	M	$0	$0	

Table 2 - Summary List of Architectural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
FJB-02-04	Ceiling paint peeling in garage and mechanical room.	Fort Jesse PS B	Scrape and repaint ceiling.	5	M	$3,000	$3,000	
FJB-02-05	Existing shingle roof is in good condition.	Fort Jesse PS B	Plan for roof replacement in 10 years.	5	M	$26,000	$28,000	
M-02-01	Exterior soffit damaged.	Mackinaw PS	Replace exterior soffit.	5	M	$1,000	$1,000	
M-02-02	Minor cupping of roof shingles.	Mackinaw PS	Replace roof in 5 years.	5	M	$2,500	$2,500	
H-02-01	Exterior hollow metal door with louvre is beginning to rust, missing weatherseal, and bent at bottom corner.	Hamilton Elevated Tank	Replace hollow metal door.	5	M	$3,000	$3,000	
E-02-01	Exterior hollow metal doors are rusting.	Enterprise Zone PS	Replace hollow metal doors.	5	N	$6,000	$6,000	Consider replacement of pump station ($150,000)
E-02-02	Garage doors beginning to rust.	Enterprise Zone PS	Replace sectional garage door.	5	N	$10,000	$10,000	Consider replacement of pump station.
E-02-03	Wooden framing and fascia boards beginning to rot.	Enterprise Zone PS	Repair / replace fascia boards.	5	N	$1,000	$1,000	Consider replacement of pump station.
E-02-04	Door between electrical room and pump room has a 3-hr fire rating; however, partition wall with openings does not provide any fire rating.	Enterprise Zone PS	Replace door and wall with approved materials meeting minimum fire rating.	3	N	$10,000	$10,000	Consider replacement of pump station.
E-02-05	Large amounts of sediment on existing built-up roof with ballast stone. Roof is in poor condition and ponds at the middle.	Enterprise Zone PS	Replace roofing membrane and ballast.	4	N	$7,500	$7,500	Consider replacement of pump station.

Table 2 - Summary List of Architectural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
E-02-06	CMU walls show signs of water infiltrations	Enterprise Zone PS	Repoint exterior wall, rout and seal cracks.	5	N	$3,000	$3,000	Consider replacement of pump station.
D-02-01	Shingle roof was not accessible at the time of the walkthrough. Calcification noted at edges of concrete planks on interior.	Division St PS	Replace shingle roof, refer to structural item D-03-1.	5	M	$17,500	$17,500	
D-02-02	Exit door was stuck closed due to air pressure differential.	Division St PS	Refer to HVAC item D-05-03.	5	M	$0	$0	
D-02-03	Basement windows are single pane, one is missing and boarded over.	Division St PS	Replace windows with operable insulated units.	5	N	$5,000	$5,000	
				TOTAL =		$2,040,000	$2,114,000	

Table 3 - Summary List of Structural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-03-1	Concrete delamination along east face of original filter building (100 sf visible)	Old Plant (original filters)	Remove delaminated concrete, patch with repair material.	4	M	$20,000	$25,000	
B-03-2	Concrete delamination along east face of filter building 1952 addition (25 sf)	Old Plant (1952 addition)	Remove delaminated concrete, patch with repair material.	4	M	$0	$0	Included in B-04-01
B-03-11	Epoxy floor coating has failed in several locations including Electrical and Flouride Rooms and Lime Blower Room.	New Plant	Remove as necessary and recoat damaged areas.	4	M	$10,000	$10,000	Prolonged exposure will degrade concrete, recommond to recoat within 1 year.
EL-03-1	Guardrail at north and south retaining wall do not meet code minimum requirements for height, top rail, and spacing between mid-rails.	Evergreen Lake PS	Replace guardrails.	4	M	$10,000	$12,500	
D-03-1	Delamination noted on precast panels on roof structure. Spalling has occurred in multiple areas.	Division Street PS	Concrete appears to be adequate at this time; however, long term replacement should be considered.	4	M	$50,000	$55,000	
B-03-3	Steel platform at north of filter building is exhibiting corrosion. Removable guardrail is experiencing significant deflection under applied loads. Anchors exhibiting section loss. Support angle pullling away from building.	Old Plant	Remove platform. Add stairwell to create additional exit.	5	M	$15,000	$17,500	Confirm with Arch if additional exit is needed. Good idea anyways.
B-03-4	Timber lintel above double door on north exit is experiencing dry rot.	Old Plant	Replace with steel lintel and waterproofing.	5	M	$10,000	$12,500	Confirm duplicate with Arch.
B-03-5	Peeling paint on concrete substrate in Backwash Pump Room.	Old Plant	Scrape paint.	5	M	$0	$0	
B-03-6	Minor corrosion noted on steel members in filters 6-12.	Old Plant	Scrape and paint.	5	M	$15,000	$15,000	Not imperative, 5-10 years
B-03-7	Checking noted on timber purlins above the decommissioned high lift pumps.	Old Plant	Continued monitoring.	5	M	$0	$0	
B-03-8	Significant checking noted at end of timber roof purlin.	Old Plant	Further investigation.	5	M	$0	$5,000	Checking may not be crucial to the structure. Further investigation required to determine extent and impact.

Table 3 - Summary List of Structural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-03-9	Minor corrosion on exterior monorail columns.	New Plant	Scrape and paint.	5	M	$2,000	$2,000	
B-03-10	Minor corrosion on monorail splice in chlorine storage room.	New Plant	Scrape and paint.	5	M	$1,000	$1,000	
B-03-12	Mislocated bolts at top level of Stair 1. Bolts were field bent to allow installation and connection of stair stringers.	New Plant	Provide new connection with adhesive anchors.	5	M	$5,000	$7,500	
B-03-13	Minor corrosion noted on galvanized steel grating in Pipe Gallery.	New Plant	Scrape and coat with cold galvanizing paint.	5	M	$0	$0	
B-03-14	Leaking filter tank wall in Stair No. 3.	New Plant	Inject with hydrophobic polyurethane grout.	5	M	$1,000	$1,000	Engineering included with other repairs.
B-03-15	Minor corrosion on lime storage and slaker tanks.	New Plant	Scrape and paint as part of normal maintenance.	5	M	$0	$0	
B-03-16	Cracked masonry pilaster at column A.1/8a in Lime Storage Room.	New Plant	Masonry covers steel column and provides only protection to it. Cracking is likely caused by displacement in column. Recommend to rout and seal crack.	5	M	$2,000	$2,000	
B-03-17	Cracked cmu at control joint on south wall of Lime Storage Room.	New Plant	Rout and seal crack.	5	M	$2,000	$2,000	
B-03-18	Surface rust on Claricones.	New Plant	Scrape and paint.	5	M	$0	$0	
B-03-19	Surface corrosion on pump bases in Control Building within Clarifier Building	New Plant	Scrape and paint. Wire brushing may be necessary to remove corrosion.	5	M	$0	$0	

Table 3 - Summary List of Structural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
M-03-1	Minor corrosion on bridge crane frame	Mackinaw River PS	Scrape and paint	5	M	$5,000	$5,000	
EL-03-1	Delamination at southwest corner at top of concrete wall.	Evergreen Lake PS	No work necessary at this time.	5	M	$0	$0	
D-03-2	Corrosion noted on walkway bases.	Division Street PS	Scrape and paint walkway bases.	5	M	$0	$0	
D-03-3	Unistrut support columns for controls are severely corroded or exhibit significant or entire section loss.	Division Street PS	Replace with stainless steel unistrut members.	5	M	$1,000	$1,000	
E-03-1	Concrete spall at southeast corner.	Enterprize Zone PS	No work necessary at this time.	5	M	$0	$0	
FJ-03-1	Gaps are present under tank base and top of foundation.	Fort Jesse Tanks 1 and 2	Recommend to add non-shrink grout or sealant between tank base and foundation.	5	M	$10,000	$10,000	
FJ-03-2	Surface corrosion noted on both tanks in isolated locations. Typically where coating has been replaced.	Fort Jesse Tanks 1 and 2	Recommend to remove coating and scrape and recoat.	5	M	$300,000	$330,000	Interior and exterior coating systems at these tanks are beyond their service life. Given the age, it is likely the coatings may contain lead. Recommend a full interior and exterior blast and repaint with containment. May consider recoating in 5-10 years. Repair pitting during repainting.
FJA-03-1	Foundation cracks on southeast corner. Cracks are not reflected on the inside.	Fort Jesse PS A	No work necessary at this time. Continue to monitor cracks, crack injection may be necessary in the future if deterioration worsens.	5	M	$0	$0	
FJB-03-1	Cracks at corners of hatch on north side.	Fort Jesse PS B	Continued monitoring, cracks at this time to not impact capacity or operation of hatch.	5	M	$0	$0	
FJB-03-2	Step cracking at south overhead door lintel.	Fort Jesse PS B	Tuckpointing face brick and rout and seal cmu.	5	M	$4,000	$4,000	

Table 3 - Summary List of Structural Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
NE-03-1	Lower end of the interior access ladder isn't anchored and there is no structure available to anchor it.	Northeast Elevated Tank	Add concrete pad and metal stock to anchor end of ladder.	5	M	$1,000	$1,000	
				TOTAL =		$459,000	$520,000	

Table 4 - Summary List of Process Projects									
Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-07-14	The Destrat pump is a submersible pump and fails after approximately one year of service. This has improved since the VFD was installed for this pump. The plant staff indicated that it would be beneficial to install a new pump with a motor that is easily accessible.	Source Water	Install up to four new destratification pumps. Options include solar (Solarbee) or a shore driven system. Recommend study as part of engineering fees to determine type of system.	4	M	$220,000	$30,000	$250,000	
B-07-17	The plant staff mentioned that there was an issue with the pumps located in the Sludge Vault. When there is not any backpressure on the pumps, they will seize.	Sludge Vault	Study pump operation and provide recommendation	2	O	$0	$25,000	$25,000	Includes costs for Sludge Vault study as well as a study to evaluate the sludge lines.
B-04-1	Inspect intake lines and associated strainers. Verify support piles remain on solid footing, and condition of pipes. Evaluate traveling screens. Evaluate if screen is sufficiently protected from potential of dragging anchors.	Intakes and Screens	Perform condition assessment.	2	O		$50,000	$50,000	
B-04-2	When operating at rated capacity of 22mgd from Lake Bloomington, velocity in 20" inlet piping can be well above minimum recommended by the Hydraulic Institute especially if one pipe (deeper pipe) in service during low lake level conditions. Inlet piping undersized for this velocity.	Intakes and Screens	Increase size of inlet piping.	3	O	$300,000	$30,000	$330,000	
B-04-3	Lake Bloomington and Lake Evergreen water meters did not appear to be functioning.	Yard/Raw water meters	Verify meters operational and calibrated.	3	O	$15,000	$1,500	$16,500	
B-04-4	Pump No. 1 is a horizontal split case centrifugal pump installed in 1977. Depending on results of pump performance test, pump replacement should be considered. Motor newer. Assume poor efficiency due to wear.	Low Service Pump Room	Replace pump.	4	O	$200,000	$20,000	$220,000	
B-04-5	Verify all pump suction and discharge pressure gauges functional and calibrated. Recommend compound gauge on all suction piping, pressure gauge on discharge piping, and consideration of a recording gauge for the low service pumps.	Low Service Pump Room	non-operational/non-calibrated pressure gauges.	4	O	$10,000	$1,000	$11,000	
B-04-6	Pump #3 valve inoperable.	Low Service Pump Room	Rebuild or replace valve.	3	O	$25,000	$2,500	$27,500	
B-04-7	Develop maintenance procedures for all pumps to track where operate on pump performance curve and monitor runtime hours to develop scheduled maintenance/replacement program	Low Service Pump Room	Implement maintenance program.	4	M		$25,000	$25,000	
B-04-8	Abandoned mixing tanks appear to still receive water. The source of water was to be cut and capped to the tanks, but it appears that only a valve may have been closed which may leak. These abandoned tanks should be completely disconnected from the water treatment system.	Main Process Building	Inspect pipe to locate source of connection	5	N	$10,000	$1,000	$11,000	
			Remove connection, and seal pipe.	5	N	$25,000	$2,500	$27,500	
B-04-9	Chlorine feed point in pipe gallery should have ambient gas monitor and alarm.	Main Process Building	Install gas monitor and alarm	2	N	$5,000	$500	$5,500	

Table 4 - Summary List of Process Projects									
Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-04-10	Existing air scour system is not currently under operation.	Main Process Building/Filters	Perform a pilot study to evaluate benefit of air scour system. Evaluation would be in accordance with the AWWARF Filter Maintenance and Operational Guidance Manual. Prepare memorandum of study and results.	3	O	$50,000	$0	$50,000	
B-04-11	Filter 13 through 18 troughs are not level or set at same elevation. This has the potential of negatively impacting the effectiveness of the filter backwash process.	Main Process Buildings/Filters	Survey the elevations of the troughs to identify what improvements are needed.	3	O		$10,000	$10,000	Survey in 2019 as part of information gathering for design improvements
B-04-12	Air relief is insufficient at the backwash supply piping resulting in air being introduced into the filter bottom during backwash.	Main Process Buildings/Filters	Install air release valves on backwash supply piping	4	O	$10,000	$1,000	$11,000	
B-04-13	Inspect each of the differential pressure gauges from all filters to verify calibrated and functioning.	Main Process Buildings/Filters	Implement maintenance program.	4	M	$5,000	$500	$5,500	
B-04-14	Clean and inspect all slurry discharge lines from the slurry concentrator to the control building for each Claricone.	Clarifier Building	Condition assessment. Removal, transport, and dispose of collected materials to sludge lagoons.	4	M	$30,000	$3,000	$33,000	
B-04-15	Consider adding a second slurry discharge pump at each control building to allow one pump to be taken out of service for maintenance and repair.	Clarifier Building	Add secondary pump.	4	N	$50,000	$5,000	$55,000	
B-04-16	None of the ClariCone analysis instruments appear to be functioning to sample for pH, turbidity, sludge blanket level, level transmistter to control chemical usage and other process control parameters. Typically operators only view sludge blanket depth from access bridge.	Clarifier Building	Repair and maintain analysis instruments to maximize utilization of the Claricones.	4	M	$25,000	$2,500	$27,500	
B-04-17	The Infilco Accelator unit has been removed from the water treatment process. Considered removal of obsolete process structure.	Clarifier Building	Demolish Infilco Accelator, backfill, regrade, and restore surface.	5	N	$0	$0	$0	Removed, part of B-04-46.
B-04-18	ClariCones 1 and 2 have a central flow meter, so the volume going to each claricone is unknown. Consider adding flow meters to each influent line to accurately determine flow to each Claricone.	Clarifier Building	Add at least one flow meter to either #1 or #2.	5	O	$60,000	$6,000	$66,000	
B-04-22	Blowdown rate at ClariCones 1 through 4 can't be controlled to a low enough flow rate to avoid wasting an excessive volume of process water during blowdown cycle. When an excessive volume of sludge is wasted from the sludge concentrator, the sludge thickening process is disrupted.	Clarifier Building	Evaluate options to provide a greater range for sludge blowdown	5	O		$15,000	$15,000	
B-04-23	Grout floors in lower cylindrical section of ClariCones appear to be insufficient to prevent accumulation of large grit as evidenced by the need for plant staff to drain and clean out the bottom of the ClariCones.	Clarifier Building	Evaluate options for improving grit removal from clarifiers	5	O		$10,000	$10,000	
B-04-24	Anionic polymer storage tanks and feed systems don't have containment.	Clarifier Building	Provide drum containment system	3	O	$500	$50	$550	

Table 4 - Summary List of Process Projects									
Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-04-25	Hydraulic bottleneck appears to occur at recarbonation basins east and west. Specific reason for backup should be evaluated as it may be due to lime buildup on the walls of the 30" influent piping. Basin surface is also open to atmosphere.	Recarbonation Basins	Evaluate the recarbonation basins. Perform a condition assessment and potential cleaning of influent piping. Potential removal of recarbonation basins.	2	O		$25,000	$25,000	
B-04-26	Surface wash in old filter building does not appear to be operational for some of the filters.	Old Plant Building/Filters	Replace/Repair surface wash.	2	O	$300,000	$30,000	$330,000	
B-04-27	Appears to be hydraulic imbalance of old filters based on flows from some filters from the influent weir.	Old Plant Building/Filters	Evalute Hydraulics of filters using field data and model and produce report	3	N		$25,000	$25,000	
B-04-28	Treatment HGL is about 18-inches higher than it should be to allow the filter influent weirs to operate properly. This results in significant maldistribution of the inlet flow in this set of filters. The operating HGL at filters 13 through 18 is such that filters 1 through 12 will overflow to the operating floor if filters are operated in effluent flow rate control mode.	Old Plant Building/Filters	Evalute Hydraulics of filters using field data and model and produce report	3	N		$25,000	$25,000	
B-04-29	The CO_2 storage unit supplies gas with only primary pressure regualtion to the obsolete feed panel in this building. Supply piping to the new CO_2 feed systems are tapped onto this old feed system inside the building.	Chemical Feed Building	Upgrade CO2 system to meet current best practices	3	O	$30,000	$25,000	$55,000	
B-04-30	There is a live 150 psi carbon dioxide feed piping inside this building with no ambient gas detector in service. Much of this piping is copper with soldered joints.	Chemical Feed Building	Upgrade CO2 system to meet current best practices	3	O	$30,000	$25,000	$55,000	
B-04-31A	Gas ammoniators in a wooden shed on the north side of the New Water Treatment Plant. There should be a leak detection system in all areas the ammonia is piped, and the room should have an emergency air exhaust system with elevated intake according to 10 State Standards. In addition it should be considered if an emergency gas scrubber is required should it be considered a risk to the public.	Main Process Building/Chemical Rooms	Evaluate shed, leak detection and air exhaust. Consider scubber in recommendation report.	1	O		$25,000	$25,000	
B-04-31B	Replace Ammonia Feed System	Main Process Building/Chemical Rooms	Existing ammonia feed system does not comply with 10SS and is in need of replacement	2	O	$1,000,000	$100,000	$1,100,000	
B-04-31C	Ammonia feed system	Main Process Building/Chemical Rooms	Study to identify options or alternatives for ammonia fee system	2	0		$25,000		Eng fee includes study to determine best solution for feed point.
B-04-32	Fluoride Room: No containment provided for storage tanks.	Main Process Building/Chemical Rooms	Install containment curbs around bulk and day tanks	3	N	$15,000	$1,500	$16,500	
B-04-33	Fluoride Room: Day tank not in use.	Main Process Building/Chemical Rooms	Rehabilitate/replace fluoride day tank	4	N	$10,000	$1,000	$11,000	
B-04-34	Fluoride Room: There is no calibration column to verify the accuracy of the fluoride feed rate.	Main Process Building/Chemical Rooms	Install calibration column	2	O	$2,000	$200	$2,200	
B-04-35	Ferric Room: No containment provided for storage tanks.	Main Process Building/Chemical Rooms	Install containment curbs around bulk and day tanks	3	N	$15,000	$1,500	$16,500	

Table 4 - Summary List of Process Projects									
Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-04-36	Ferric Room: No online standby pump installed.	Main Process Building/Chemical Rooms	Install a standby ferric metering pump.	2	O	$10,000	$1,000	$11,000	
B-04-37	Ferric Room: There is no calibration column to verify the accuracy of the fluoride feed rate.	Main Process Building/Chemical Rooms	Install calibration column	2	O	$2,000	$200	$2,200	
B-04-38	Ammonia feed system and enclosure do not meet Ten States and Mechanical Code wrt ventilation. Should be leak detection in all areas ammonia piped.	Main Process Building/Chemical Rooms	Upgrade ammonia system to meet current best practices.	3	O	$50,000	$5,000	$55,000	
B-04-39	No ammonia ambient gas monitor and alarm. Should be leak detection in all areas ammonia piped.	Main Process Building/Chemical Rooms	Install gas monitor and alarm	2	N	$5,000	$500	$5,500	
B-04-40	Lime slurry feed loop requires frequent maintenance due to design issues and the lime system doesn't include de-gritting of the slurry.	Main Process Building/Chemical Rooms	Evaluate slaker improvements for better grit removal	5	N		$10,000	$10,000	
B-04-40	Feed point inside high service room includes ammonia solution piping in the high service room without an	Main Process Building/High Service	Install gas monitor and alarm	2	N	$5,000	$500	$5,500	
B-04-41	Recarbonation and Water Stability Study	Clarifier Building	Study to Determine Options	2	O	$0	$60,000	$60,000	
B-04-42	Recarbonation Bypass Piping and Existing Recarbonated Water Piping Replacement Project	Clarifier Building	Replace Piping	2	O	$500,000	$50,000	$550,000	The City has already planned this work, but included in CIP anyways.
B-04-43	Filter Improvements Study	Old Plant Building/Filters	Study to Determine Options	2	O	$0	$80,000	$80,000	
B-04-44	Design of West Filter Improvements	Old Plant Building/Filters	Design of improvements	2	O	$0	$2,000,000	$2,000,000	Construction costs detailed in B-04-45. Costs include an architectural programming meeting to discuss Main Process Building in relation to filter addition. Costs may include new lab, control room, and admin area within new addition.
B-04-45	Construction of New West Filter Improvements	Old Plant Building/Filters	Construction	2	O	$20,000,000	$0	$20,000,000	Engineering costs detailed in B-04-45. Includes work to rehab Old Plant filters prior to construction.
B-04-46	Demolition of Existing Recarbonation Basin	Process	Remove existing basin	4	O	$1,500,000	$150,000	$1,650,000	Costs include demo of Recarbonation Basins, Infilco Accelerator, and Hydro-Treaters and include capping of piping.
B-04-47	East Filter Piping Improvements	Main Process Building/Filters	Piping Improvements	5	O	$100,000	$10,000	$110,000	

Table 4 - Summary List of Process Projects									
Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
B-4-48	New Low Service Pump Station	Low Service Pump Room	New Pump Station	4	O	$10,000,000	$1,000,000	$11,000,000	Cost of new Low Service Pump Station
B-04-49	Old Plant no longer needed after potential construction of filters to Main Plant.	Old Plant Building/Filters	Demo filters as part of the building additions constructed in 1952 and 1964. Keep original construction for historical purposes.	3	M				Add $XX for demo of the original structure.
B-04-50	No platform above lime slakers.	Main Plant/Lime Storage Room	Add railed platform across the top of both lime silos and removable platform acrosss the top of the lime slakers to improve routine maitenance tasks.	3	M	$75,000	$0	$75,000	IEPA inspection finding.
B-04-51	Sodium Hexametaphosphate system in poor condition.	Main Plant/Chemical System	Replace system.	3	O	$500,000	$50,000	$550,000	
B-04-52	No backup chlorine gas feed system present.	Main Plant/Chemical System	Study to determine options to improve chlorine gas storage and feed systems to provide sufficient redundancy for increased reliability and ease of maintenance.	3	O	$0	$25,000	$25,000	
B-04-53	No flow meters on ammonia system or chloring gas feed systems.	Main Plant/Chemical System	Add mass flow meters on systems to allow monitoring of feed rates.	3	O	$50,000	$15,000	$65,000	
B-04-54	PAC storage and feed sytem appears to have been decommissioned.	Main Plant/Chemical Room	Study to determine feed point, dosing and contact time for new PAC system.	3	O	$0	$25,000	$25,000	
B-04-55	No tank mixer on liquid lime storage tank. WTP staff has indicated the tank suffers from slurry separation.	Main Plant/Lime Storage Room	Add tank mixer to prevent slurry separation and improved hose pumps to allow use of t his tank as an emergency backup calcium hydroxide storage and feed system.	4	O	$200,000	$50,000	$250,000	
B-04-56	Plant has indicated a need to use clarifier effluent make-up water supply to the carbon dioxide pressure solution feed systems.	Clarifier Building	Would reduce the capacity burden on filtration, disinfection, and high-lift pumping processess presented by the current practice of using a finshed water supply to the carbon dioxide feed systems and eliminatethe chlorine carry-over to the GAC filter media and ammonia carry-over o the disinfection process.	3	O	$200,000	$15,000	$215,000	
B-04-57	Inline mixer in rapid mix basin is currently offline.	Main Plant	Remove rapid mix basins to allow for easier access and ability to perform jar tests and other plant optimization work.	4	O	$10,000	$100,000	$110,000	

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Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
LSL-04-1	Lagoons are nearing capacity.	Lagoons	More aggressively remove lime sludge, and evaluate options such as letting additional contracts than to only 1 company	4	O	$2,400,000	$240,000	$2,640,000	Costs are assumed to be spread over multiple years for multiple contracts for the three lagoons.
M-04-1	Source water has limited capacity to adequately feed pumps.	Mackinaw River Pump Station	Consider abandoning station due to source water volume restrictions.	4	O	$150,000	$15,000	$165,000	
EL-04-01	Limitorque actuators not reliable. Operator must visit station to confirm valve position and adjust valves accordingly.	Evergreen Lake Pump Station	Replace all three valves and actuators. Rewire and integrate.	4	O	$75,000	$7,500	$82,500	
EL-04-02	Cationic polymer storage tanks and feed systems don't have containment.	Evergreen Lake Pump Station	Provide drum containment system	3	O	$500	$50	$550	
EL-04-03	No online standby cationic polymer pump installed.	Evergreen Lake Pump Station	Install a standby polymer metering pump.	2	O	$5,000	$500	$5,500	
EL-04-04	No mixing at cationinc polymer injection point.	Evergreen Lake Pump Station	Evaluate options for improving mixing/diffusion of cationic polymer injection	2	O		$15,000	$15,000	
FJA-04-1	Stuffing box from P2 has what appears to be an excessive drip. Reason for drip should be investigated (i.e packing worn, shaft imbalance, etc.)	Fort Jesse Pump Station A	Replace packing. Perform condition assessment of pump.	4	M	$10,000	$1,000	$11,000	
FJA-04-2	Verify all pump suction and discharge pressure gauges functional and calibrated. Some gauges missing or appeared not properly operating.	Fort Jesse Pump Station A	Calibrate/replace gauges as necessary. Consider compound gauges on suction side, and standard gauges on discharge side	4	M	$5,000	$500	$5,500	
FJA-04-3	Stuffing box from P1 has what appears to be an excessive drip. Reason for excessive drip should be inbestigated (i.e. packing worn, shaft impalance, etc.)	Fort Jesse Pump Station A	Condition assessment of pump and replace packing	4	M	$10,000	$1,000	$11,000	
FJB-04-4	Operator indicated that pumps exhibit symptoms of cavitation (a gravel and rock sound typically indicates cavitation on suction side). Hydraulic system should be modeled to determine under what conditions cavitation is occurring which can result in mechanical damage and limit the allowable operating range of the pumps. Some potential causes, for example, could be straight pipe length distance from short radius elbow and butterfly valve upstream of pump inlet appear to be less than minimum recommended by the Hydraulic Institute (5 pipe diameters for elbow and 2 for butterfly valve). It is also noted that exansion joints are located immediately upstream and downstream of each pump.	Fort Jesse Pump Station B	Perform a condition assessment of pumping system.	3	N		$15,000	$15,000	Working with Peter Lynch
FJB-04-5	Silent check vales noted in pump station.	Fort Jesse Pump Station B	Inspect the silent check valves. Consider alternate pump check valves which have indicators to show they are open or closed.	5	N		$25,000	$25,000	
FJB-04-6	Pressure monitors don't have charts. Charts should be installed or an automated device installed.	Fort Jesse Pump Station B	Install charts or replace gauges.	4	M	$1,000	$100	$1,100	Working with Peter Lynch

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Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
FJB-04-7	Prime on top half of pump appears to be leaking which will result in corroding bolts joining the top and bottom halves of the pump.	Fort Jesse Pump Station B	Repair primer to stop leak.	4	M	$1,000	$100	$1,100	Working with Peter Lynch
FJB-04-08	Paint flaking off piping.	Fort Jesse Pump Station B	Apply touchup paint to piping as necessary.	5	M	$2,000	$200	$2,200	
FJB-04-09	Confirm pump station flow meter calibrated.	Fort Jesse Pump Station B	Calibrate meter.	5	M	$5,000	$500	$5,500	
FJB-04-10	Meter vault sump pump piping broken.	Fort Jesse Pump Station B	Replace and protect piping to minimize future disturbance.	5	M	$1,000			
FJB-04-11	Perform a study of the options for flow meter replacement and associated piping improvements should be conducted to remove inaccuracies of meter.	Fort Jesse Pump Station B	Study to Determine Options	5	M	$0	$20,000	$20,000	Richard recommended study in note adjacent to FJB-04-09
FJ-04-1	The tank roof vents do not appear to conform to AWWA D100 recommendations for self-correcting, frost free operation. Replacement vents should be included in the budget costs for tank painting.	Fort Jesse Tanks 1 and 2	Replace vents	5	M	$15,000	$1,500	$16,500	
FJ-04-2	Based on available information, the tanks could benefit from installation of silt stops and anti-vortex baffles. The cost for these improvements should be included in tank painting.	Fort Jesse Tanks 1 and 2	Install silt stops and baffles	5	M	$15,000	$1,500	$16,500	
MPS-04-1	Surficial rust noted on piping.	Main Street Pump Station	Prime and paint piping at locations of welds and other locations.	5	M	$2,000	$200	$2,200	
MPS-04-2	Verify all gauges calibrated.	Main Street Pump Station	Implement maintenance program.	5	M	$5,000	$500	$5,500	Talk with April
MPS-04-3	The current pumps in the station appear to be oversized for customer usage within the pressure zone. Investigation has determined that a number of connections to lower-pressure zones were inadvertantly open. With these valves closed, the pump station could not operate at low flows.	Main Street Pump Station	Evaluate options for improving pump performance at lower flows.	3	O		$25,000	$25,000	
H-04-1	12" Cla-Val position appeared to have been reversed.	Hamilton Road Elevated Tank	Verify valve in proper condition	5	M		$5,000	$5,000	
H-04-2	Overflow piping and inlet valves are sized for 2100 gpm but the tank is often operated at a fill rate well in excess of this rate creating high headloss through the intake piping and elevated system pressures.	Hamilton Road Elevated Tank	Evaluate alternatives to reduce fill rate.	4	O		$5,000	$5,000	
H-04-3	Swing check valve on the outlet line was damaged and is currently non-functional.	Hamilton Road Elevated Tank	Repair / replace the swing check valve	4	M	$5,000	$500	$5,500	
H-04-4	The tank is nonfunctional due to the hydraulic grade line in the transmission mains being at or below the bottom capacity line (BCL) of the tank.	Northeast Elevated Tank	Evaluate options for improving tank operation.	3	O		$15,000	$15,000	
H-04-5	Coating is deteriorating	Hamilton Road Elevated Tank	Combine valves and add corrosion protection and new coating system	3	O	$1,300,000	$0	$1,300,000	

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Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
E-04-1	No top slab over clearwell, opens potential to contamination and flooding through grating. Floor was not 6 inches above grade. Grade does not slope away from clearwell. Maintenance staff may have to stand in water to service electrical equipment under flood conditions.	Enterprise Pump Station	In accordance with 10 State Standards the station does not meet the minimum requirements of the standards in that the floor is to be drained in a manner that the quality of the potable water will not be endangered. The floor of the pump station should be at least six inches above finished grade. Suction well should be watertight to prevent contamination.	1	O		$50,000	$50,000	
E-04-2	Flow meter was not found at the time of our site visit.	Enterprise Pump Station	All pump stations are required to be metered by 10 State Standards. Meter should be calibrated if it exists.	5	M		$5,000	$5,000	Consider replacement of pump station.
E-04-3	Pump P3 motor appears to run hot based on feel.	Enterprise Pump Station	Evaluate pump and pumping process	4	M		$10,000	$10,000	Consider replacement of pump station.
E-04-4	Two 30-inch butterfly valves at wet well influent don't close reliably and leak up to 900 gpm when closed.	Enterprise Pump Station	Replace two 30-inch butterfly valves	5	M	$20,000	$2,000	$22,000	
E-04-5	The 12-inch silent wafer check valves at the discharge of Pump 1 and Pump 3 are leaking.	Enterprise Pump Station	Replace the check valves	5	M	$20,000	$2,000	$22,000	
E-04-6	Provide throttling at air relief valves to reduce the hydraulic shock when the discharge pipe is filled on startup of Pumps 1, 2 & 3.	Enterprise Pump Station	Evaluate alternatives to reduce hydraulic shock	5	M		$10,000	$10,000	
E-04-7	Regulatory issues at PS. Several items do not meet 10 State Standards, and multiple defficiencies were noted.	Enterprise Pump Station	Recommend an evaluation of the pump station to consider replacement. In addition, it may be prudent to consider replacment of the Division Street Pump Station to join it with a new combined pump station.	1	M	$5-10M	$500,000	$10,500,000	
D-04-1	Pump station pressure recording gauges paper had appeared to not have been replaced for a long time.	Division Street Pump Station	Recording gauges should be calibrated, paper replaced and fully operational. Recording gauges required by 10 State Standards. Consider automated gauges.	4	M	$1,000	$100	$1,100	Cost included in K-05-01
D-04-2	The current drive shafts at each of the four pumps are failing at less than two years service and create a difficult service and repair burden at current staffing levels.	Division Street Pump Station	Replace the drive shafts at each of the four pumps with units designed for longer service life.	5	M	$40,000	$4,000	$44,000	
D-04-3	Provide OSHA compliant and safe access to operate valve hand wheels at the pump station discharge header.	Division Street Pump Station	Evaluate alternatives to improve valve operation.	5	M		$10,000	$10,000	
D-04-4	Provide OSHA compliant and safe access to pump drive shaft bearings and universal-joints during maintenance and replacement operations.	Division Street Pump Station	Evaluate alternatives to improve pump maintenance.	5	M		$10,000	$10,000	
D-04-5	Provide suction and discharge gauges at each of four pumps.	Division Street Pump Station	Install gauges	5	M	$5,000	$500	$5,500	

Table 4 - Summary List of Process Projects

Project ID No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Engineering Cost	Estimated Project Cost	Notes
DR-04-1	Shed on top of 5MG reservoir is in poor shape. No overflow was present and no dedicated vents for either reservoir. Overflow on 10MG and drain at 5MG may not meet cross-connection or screening requiremets in 10SS. Access hatches do not conform to IEPA standards.	Division Street Reservoirs	Replace shed with fiberglass building. Add overflow to 5MG and confirm cross-connection and drains meet 10SS. Add dedicated vents and replace hatches.	3	M	$500,000	$50,000	$500,000	Eng fees include study for overflows, cross-connections, and drains.
General	No pump maintenance program appeared to be implemented.	Pumps	Recommend a pump maintenance program to understand baseline values for power consumption, temperature change, leakage, pressure (suction and discharge), vibration, noise characterisitcs, lubricant condition, shaft position, rate of flow, speed, and bearing wear at a minimum in accordance with the Hydraulic Institute standards for the centrifical pumps	4	M		$10,000	$10,000	
					Total =	$40,100,000	$5,200,000	$55,200,000	

Table 5 - Summary List of HVAC Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-05-01	Many of the exhaust systems serving chemical and process rooms are not directly routed to the outdoors. Rather, exhaust air is collected from the spaces by exhaust fans located in a common room. The exhaust fan discharge is then routed through the interior spaces of the plant before being discharged. This is especially critical to the chlorine rooms.	Main Process Building	Perform study to determine new route of exhaust systems so that ductwork does not run through other spaces and goes directly outside.	1	N	$0	$25,000	
B-05-02	No scrubber for chlorine rooms.	Main Process Building	Add a chlorine scrubber.	1	N	$100,000	$110,000	See B-05-01 regarding chlorine room exhuast.
B-05-03	Corrosion observed on exhaust system ducts serving lime room, chlorine room, ferric room, and other chemical and process areas. Corrosion in the ductwork can cause exhaust leakage and cross contamination into other spaces the duct passes through.	Main Process Building	Replace ductwork.	4	M	$50,000	$55,000	Consider exhuast system study. See B-05-01
B-05-04	Most of the air handling units are not regularly operated and appeared neglected.	Main Process Building	Perform general servicing/upgrades of air handling units and operate to provide building ventilation.	4	N	$100,000	$100,000	
B-05-05	Operator room cooling system utilizes flexible duct that penetrates through the elecrical room without fire dampers.	Main Process Building	Replace flexible duct at penetrations and install sheet metal duct and fire dampers.	4	N	$25,000	$25,000	
B-05-06	The ventilation in the Flouride Room did not seem adequate.	Main Process Building	Upgrade ventilation system.	1	N	$10,000	$11,000	
B-05-07	Several of the dampers and actuators associated with the air handling units and with outside air louvers were disconnected and nonfunctional.	Main Process Building	Replace actuators.	4	M	$25,000	$25,000	
B-05-08	Exhaust fans are not regularly operated.	Main Process Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$25,000	$25,000	
B-05-09	Boilers are near the end of expected service life.	Main Process Building	Replace boilers.	3	N	$50,000	$55,000	
B-05-10	The HVAC controls are outdated and did not appear fully functional.	Main Process Building	Upgrade HVAC control system.	4	N	$100,000	$110,000.0	

Table 5 - Summary List of HVAC Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-05-11	The boilers do not contain a water treatment system. This can accelerate boiler fouling.	Main Process Building	Install a chemical treatment system for the boiler water.	3	N	$10,000	$11,000	
B-05-12	Boiler circulating and distribution pumps appeared neglected.	Main Process Building	Perform general servicing/upgrades.	4	M	$20,000	$20,000	
B-05-13	Dust control for lime storage and conveying is inadequate as evidenced by the quantity of lime dust accumulation inside the lime rooms, on the roofing above the lime rooms, and at the exterior of the building adjacent to the lime areas.	Main Process Building	Upgrade ventilation system in Lime Storage Room to improve duct control.	4	N	$10,000	$11,000	
B-05-14	Exhaust fans are not regularly operated.	Clarifier Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$5,000	$5,000	

Table 5 - Summary List of HVAC Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-05-15	Air handling units are not regularly operated.	Clarifier Building	Perform general servicing/upgrades and regularly operate the unit to provide building ventilation.	4	M	$20,000	$20,000	
B-05-16	The HVAC controls are outdated and did not appear fully functional.	Clarifier Building	Upgrade HVAC control system.	4	N	$25,000	$27,500	
B-05-17	Several of the dampers and actuators associated with outside air louvers were disconnected.	Clarifier Building	Repair dampers and replace actuators.	4	M	$5,000	$5,000	
B-05-18	Exhaust fans are not regularly operated.	Old Plant Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$10,000	$10,000	
B-05-19	The air handlnig units appeared seldomly used and neglected.	Old Plant Building	Perform general servicing/upgrades and regularly operate to provide building ventilation.	4	N	$50,000	$50,000	
B-05-20	Boiler circulating and distribution pumps appeared neglected.	Old Plant Building	Perform general servicing/upgrades.	4	M	$10,000	$10,000	
B-05-21	Some hot water piping is not insulated.	Old Plant Building	Provide insulation.	4	M	$5,000	$5,000	
B-05-22	Several of the dampers and actuators associated with the air handling units and with outside air louvers were disconnected and nonfunctional.	Old Plant Building	Replace actuators.	4	M	$15,000	$15,000	
B-05-23	The HVAC controls are outdated and did not appear fully functional.	Old Plant Building	Upgrade HVAC control system.	4	N	$50,000	$55,000	
B-05-24	The new boilers do not contain a water treatment system. This can accelerate boiler fouling.	Old Plant Building	Install a chemical treatment system for the boiler water.	3	N	$10,000	$11,000	
B-05-25	The air conditioning condenser does not function and had an open panel with exposed wiring.	Old Plant Building	Repair/replace air condenser.	4	N	$5,000	$5,000	
B-05-26	The outside refrigerant lines on the air conditioning system were uninsulated.	Old Plant Building	Provide pipe insulation.	4	M	$1,000	$1,000	
LE-05-01	Plant staff indicated that plans are in place to upgrade the HVAC system, which includes replacement of the air handling unit and condenser.	Evergreen Lake Pump Station	Perform project as indicated.	4	N	$0	$0	
M-05-01	Electric heater was operating but the thermostat wiring was not connected. The space also had portable space heaters.	Mackinaw Pumping Station	Replace electric unit heater and controls.	4	N	$3,000	$3,000	

Table 5 - Summary List of HVAC Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
M-05-02	The exhaust fan and outside air damper controls did not appear functional.	Mackinaw Pumping Station	Replace controls for exhaust fan and damper at outside air louver.	4	N	$3,000	$3,000	
MPS-05-01	The exhaust system requires an occupant to enter the space to operate.	Main Street Booster Pump Station	Relocate exhaust fan disconnect switch near the hatch entry.	4	M	$1,000	$1,000	
MPS-05-02	The exahust fan appears to be past its expected service life.	Main Street Booster Pump Station	Replace exhaust fan.	4	N	$1,000	$1,000	
E-05-01	Cooling in the pump room seems inadequate.	Enterprise Zone Pump Station	Upgrade exhaust fan cooling system with DX system.	4	N	$10,000	$11,000	
E-05-02	The outside air louvers on the overhead door that serve the pump room do not contain dampers. This can cause cold air infiltration during the winter time.	Enterprise Zone Pump Station	Install motorized dampers.	4	N	$1,000	$1,000	
D-05-01	Diesel storage tank corroded.	Division Street Pump Station	Repaint tank	4	M	$2,000	$2,000	
D-05-02	Diesel storage tank piping corroded.	Division Street Pump Station	Paint piping.	4	M	$500	$500	
D-05-03	The outside air dampers associated with the exhaust system don't appear to fully open upon actuation. A negative space pressure occurs when both exhaust fans are operating.	Division Street Pump Station	Service outside air damper actuators and replace as needed.	4	M	$5,000	$5,000	
D-05-04	The outside air louver and damper above the stairs is not easily maintainable.	Division Street Pump Station	Install sheet metal collar to allow side removal of the louver screen.	4	M	$1,000	$1,000	
D-05-05	Lower level gas unit heater flue is uninsulated at personnel height on upper level. This can be pose a safety issue with a hot surface.	Division Street Pump Station	Insulate flue below 8'-0" AFF.	4	M	$500	$500	
D-05-06	The furance and air conditioning system appears to be past is expected service life.	Division Street Pump Station - Sale House	Replace furnace and air conditioning system.	4	N	$5,000	$5,500	
				TOTAL =		$800,000	$837,000	

Table 6 - Summary List of Plumbing Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-06-01	Sections of plumbing water lines in chemical rooms appeared corroded.	Main Process Building	Replace piping and provide insulation for protection.	4	M	$5,000	$5,000	
B-06-02	Exposed drain lines from abandoned sink in office/break room.	Main Process Building	Renovate plumbing in space with new sink.	5	N	$5,000	$5,000	
B-06-03	Emergency showers appeared neglected.	Main Process Building	Perform general servicing and regularly test to ensure operability.	4	M	$1,000	$1,000	
B-06-04	Reduced pressure principle backflow preventer on the CW supply to the PAC feed room is leaking and inaccessible, located above other conduit and piping at the corridor ceiling.	Main Process Building	Replace backflow preventer and relocate to more suitable location.	4	M	$10,000	$10,000	
B-06-05	Reduced pressure principle backflow preventer on the CW supply to the chemical water booster pump is inaccessible, located high overhead.	Main Process Building	Relocate backflow preventer to more suitable location.	4	M	$5,000	$5,000	
B-06-06	Floor drains in chlorine storage and feed areas are connected to building plumbing.	Main Process Building	Disconnect floor drain piping from building sanitary system and separate into independent process waste system.	4	N	$20,000	$20,000	
B-06-07	Emergency showers appeared neglected.	Clarifier Building	Perform general servicing and regularly test to ensure operability.	4	M	$1,000	$1,000	
B-06-08	Sump in lower level is open and can be tripping hazard.	Old Plant Building	Provide grating.	4	M	$500	$500	
B-06-09	Sump pump in lower level appears past its expected service life.	Old Plant Building	Replace pump.	4	M	$500	$550	
B-06-10	Gas leak observed at the meter and regulator.	Old Plant Building	Repair leaks.	3	M	$1,000	$1,000	
B-06-11	Domestic water heater past expected service life.	Old Plant Building	Replace water heater.	4	M	$3,000	$3,300	
B-06-12	No expansion tank observed at domestic water heater.	Old Plant Building	Add expansion tank.	4	M	$1,500	$1,650	
B-06-13	Some domestic water piping around the water heater was not insulated.	Old Plant Building	Add pipe insulation.	4	M	$500	$500	

Table 6 - Summary List of Plumbing Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-06-14	Bathroom fixtures in Locker room (urinal, water closet, shower, sink) abandoned.	Old Plant Building	Replace with new fixtures.	5	N	$5,000	$5,500	
FJA-06-01	The sump cover is corroded.	Fort Jesse Pump Station A	Replace in-kind.	4	M	$500	$500	
FJA-06-02	Floor drains near main pumps are blocked.	Fort Jesse Pump Station A	Cleanout floor drain grating.	4	M	$50	$50	
FJB-06-01	Corrosion observed on natural gas service piping.	Fort Jesse Pump Station B	Paint piping.	4	M	$100	$100	
FJB-06-02	Meter vault sump pump discharge piping disconnected.	Fort Jesse Pump Station B	Repair piping. Replace PVC with galvanized steel.	4	M	$500	$500	
FJB-06-03	RPZ backflow preventers discharge directly to floor.	Fort Jesse Pump Station B	Pipe backflow preventer discharge to wet well.	4	M	$500	$500	
FJB-06-04	Domestic water heater past expected service life.	Fort Jesse Pump Station B	Replace water heater.	4	M	$1,000	$1,000	
E-06-01	No permanent sump pump system. Sump pump discharge consists of fire hose.	Enterprise Zone Pump Station	Install more permanent sump pump system with piping.	4	M	$1,000	$1,100	
E-06-02	Service water line not insulated.	Enterprise Zone Pump Station	Add pipe insulation.	4	M	$100	$100	
D-06-01	The backflow preventer is bypassed for the domestic water.	Division Street Pump Station - Sale House	Replumb so that backflow preventer is not bypassed.	4	M	$500	$500	
D-06-02	Corrosion observed on natural gas service piping.	Division Street Pump Station - Sale House	Paint piping.	4	M	$100	$100	
				TOTAL =		$64,000	$64,450	

Table 7 - Summary List of Electrical Projects

Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
B-07-1	There is a 480V feeder from the Main Process Building to the Old Plant Building, which provides standby power to some 480V and 208/120V loads when the 2000kW engine generator is operating. This feeder does not provide standby power for the low lift pumps. The existing 500kW engine generator in the Old Plant Building provides standby power for the low lift pumps . The existing 500kW diesel engine generator installed at the Old Plant Building has been installed in the mid-1970s and is approaching the end of it's useful life. The existing 2000kW diesel engine generator was installed approximately 15 years ago and is in good condition. There is not any automatic transfer scheme in place to transfer the plant to the engine generators upon a loss of utility power.	Old Plant Building and Main Process Building	Option 1: Consolidate the standby power needs for the WTP with a single diesel engine generator. The kW requirements for the new diesel engine generator will be dependent on the plant loads that will need to operate during a loss of power. The new diesel engine generator can be either 480V or medium voltage (2400V or 4160V). The voltage for the new engine generator would be partially dependent on any modifications being made to the electrical distribution systems at both the Old Plant Building and New Process Building. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the entire plant (Old Plant Building and Main Process Building) to the engine generator.	2	O	$2,680,000	$0	$268,000	$2,948,000	$0	Per CAT Quotes: Option 1A-MV Equipment ($1,240,000) - 2500 kW/3125 kVA, 4160V /w 24-h fuel tank, indoor diesel generator (726k); - 1200A, 5kV MV switchgear and automatic transfer control (514k) - cost adder for outdoor enclosure - $200k - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.) Option 1B-LV Equipment ($1,040,000) - 2500 kW/3125 kVA, 480V/w 24-h fuel tank, indoor diesel generator (684k); - 4000A, 480V switchgear and automatic transfer control (356k) - cost adder for outdoor generator - $200k - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.) Note: For budgetary purpose assume Option 1A
			Option 2: Keep the existing 2000kW diesel engine generator at the Main Process Building and either retrofit the existing 480V switchgear (LVS3) or provide a new 480V switchgear and/or automatic transfer switch that will automatically start the 2000kW engine generator upon a loss of utility power and transfer the Main Process Building to the engine generator. Provide a new diesel engine generator at the Old Plant Building to replace the aging 500kW, 480V diesel engine generator. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the Old Plant Building to the engine generator.	2	O	$0	$1,778,000	$177,800	$0	$1,955,800	1) 480V Generator and Switchgear (433K) 500 kW, 480V, 60Hz, 0.8 PF, indoor/w 24-h fuel tank diesel generator ($102k) Cost Adders: 1A) Outdoor factory skin tight SA enclosure, 72dba @23', motorized louvers ($49k) 1B) include 480V switchgear and automatic transfer switch (between utility and gen set) ($282k) 2) Replace 480V switchgear (LVS3) and add automatic transfer control for existing 2000 kW generator ($356k) Note: For budgetary purpose, use Items 2 and 3 - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)

Table 7 - Summary List of Electrical Projects											
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
B-07-2	The primary service voltage for the WTP is 2400V. The electric utility (Ameren) has indicated that there are not may (if any) replacement transformers that still have a 2400V secondary. Further, the 2400V service is an ungrounded system.	Old Plant Building and Main Process Building	Consider upgrading the primary service voltage to either 480V or 4160V. Due to some of the larger high service pump loads (>500hp), it would be recommended to stay with a medium voltage distribution system (4160V) due to quantity and sizing of the cables needed to operate these loads at 480V. The two 600hp, 2400V high service pump motors at the plant will need to be replaced with 4160V motors. This service upgrade will also need to be discussed with Ameren to determine what options they have to offer.	2	N	$1,672,000	$1,672,000	$167,200	$1,839,200	$1,839,200	Note: If the existing 2400V power system is replaced with 4160V system, then the following new equipment is required: - 3500 kVA, 35/4.16kV, outdoor, oil filled, copper windings, padmounted transformer (80K) - by utility (not included) - 1200 A, 4160V, 4 sections, outdoor (NEMA3R) switchgear (180k-estimate $45k/section); - 1200, 4160V, 5 sections, indoor, switchgear (175k-estimate $35k/section); -500kVA, 4160-480V, dry-type, indoor, copper, transformer (22k) - 300 kVA, 4160-480V outdoor, copper, transfomer (17k); - 750 kVA, 4160-480V, indoor, dry-type, copper, transfomer(30k) - 150 kVA, 4160-240V, outdoor, copper, transformer (12k) - (2)-600hp, 4.16kV motors (150k each) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-3	The existing unit substation "U1", motor control center "MCC-P1", and the integrated distribution center are in fair condition. This equipment has been in service for ~40 years and has reached the end of its expected life.	Old Plant Building	Due to the age of the unit substation "U1", motor control center "MCC-P1", and the integrated distribution center, it is recommended to upgrade this equipment in the Old Plant Building.	2	O	$750,000	$750,000	$75,000	$825,000	$825,000	Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. two (2) low lift pumps) and miscellaneous loads - New 4160-480V Unit Substation ($150k) - New 480V MCC, 7 section, back-to-back ($125k) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-4	The existing unit substation "U2' and motor control center MCC-P2 is in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Old Plant Building	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the existing unit substation "U1" and motor control center "MCC-P1".	2	O	$1,080,000	$1,080,000	$108,000	$1,188,000	$1,188,000	Included spare parts for 10 years (10,000/year) until equipment is replaced. Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. one (1) low lift pump; backwash pumps) and miscellaneous loads - New 1200A, 4.16kV, 4 section Medium Voltage Switchgear ($140k-estimate $35k per section) - New 4160V-480V Unit Substation ($150k) - New 480V MCC, 5 section, back-to-back ($100k) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)

Table 7 - Summary List of Electrical Projects											
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
B-07-5	The variable frequency drive for LLP#2 is in fair/poor condition. This VFD has been in service for ~30 years and has reached the end of its expected life. The plant staff has indicated that this VFD needs to be replaced. The variable frequency drive for LLP#3 is in good/fair condition. This VFD has been in service for ~15 years. The plant staff has indicated that this VFD cannot be operated in auto due to the failure of the analog control board and replacement parts are not available.	Old Plant Building	Due to the age of the VFDs and the difficultly in obtaining replacement parts for the VFDs, it is recommended that both these VFDs be replaced.	1	O	$420,000	$420,000	$42,000	$462,000	$462,000	Assumed replacement of the LLP2 & LLP3 LV VFDs: 2 x 480V, 250HP VFDs ($80k each) add labor, conduit, wiring
B-07-6	The existing medium voltage switchgear "MVSP" and motor control centers "MCC-P3", "MCC-P4", and "MCC-P4E" are in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Main Process Building	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the electrical equipment at the Old Plant Building.	2	O	$1,370,000	$1,370,000	$137,000	$1,507,000	$1,507,000	Included spare parts for 10 years and minor maintenance work as needed ($20,000/year). Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. high service pumps; backwash pumps) and miscellaneous loads -New 1200A, 4.16kV, 5 section Medium Voltage Switchgear/MCC ($175k-estimate $35k per section) - New 2000kVA, 4160V-480V Transformer ($80k) - (2) New 480V MCC, 6 section, back-to-back ($115k each) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-7	Low Voltage Switchgear "LVS3" located in the Main Process Building is in good/excellent condition. This switchgear has been in service for ~15 years.	Main Process Building	The existing Low Voltage Switchgear "LVS3" does not need to be replaced at this time. However, we recommend replacing the switchgear in conjuction with the upgrade of the standby power system.	4	O	$0	$0	$0	$0	$0	**Costs included in the project#: B-07-1**
B-07-8	The variable frequency drive for HSP#2 is in excellent condition. This VFD has only been in service for ~5 years.	Main Process Building	There is no need to replace the existing VFD for HSP#2 at this time. The only reason to consider replacing this VFD is if the City would like this VFD to be the same make/model as the VFDs being replaced for LLP#2 and LLP#3 in the Old Plant Building.	4	O	$200,000	$200,000	$20,000	$220,000	$220,000	**City to decide if there is a preference to have same type of VFD as LLP#2 &3** For budgetary purpose assume $100k for a new VFD replacement; add cost for labor, assume reuse conduit/wire
B-07-9	The panelboard in the Chemical Feed Building is in fair/poor condition.	Chemical Feed Building	The panelboard in the Chemical Feed Building should be replaced.	3	O	$50,000	$50,000	$5,000	$55,000	$55,000	Assume 200A, 480V, 65 kAIC, 42 ckts, Panelboard
B-07-10	There are not any ground detection lights on Unit Substation "U2" located in the Old Plant Building.	Old Plant Building	Ground detection lights should be added to this unit substation. If the voltage is changed to a grounded system (either 480V or 4160V), then ground detection lights would no longer be required.	4	N	$10,000	$10,000	$1,000	$11,000	$11,000	Include 4160/120V transf, Basler BE1-59N ground fault overvoltage relay & resistor
B-07-11	The convenience receptacles installed in the Pipe Galleries and Chemical Rooms are not GFCI type receptacles.	Old Plant Building and Main Process Building	Recommend replacing all receptacles in these areas with GFCI type receptacles.	4	N	$5,000	$5,000	$500	$5,500	$5,500	Assume 50 GFCI receptacle are installed

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Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
B-07-12	The chlorine storage room does not have a chlorine scrubber system installed to react to a chlorine leak; The room ventilation does not automatically turn on when the room is being occupied.	Main Process Building	Upgrade the HVAC system controls so that the room exhaust fan operates when the door is opened and the room is occupied. Consider adding a chlorine scrubber for this room.	4	N	$0	$0	$0	$0	$0	See B-05-02. Consider adding a chlorine scrubber.
B-07-13	The interior entrance door for the Electrical Room swings in and is not equipped with panic hardware. This is a Code violation.	Main Process Building	This door swing needs to be reversed to swing out and panic hardware needs to be installed. Investigate whether existing door can be modified or if new door will be required.	4	N	$0	$0	$0	$0	$0	See B-02-11. Cost inserted from B-02-11
B-07-14	The Destrat pump is a submersible pump and fails after approximately one year of service. This has improved since the VFD was installed for this pump. The plant staff indicated that it would be beneficial to install a new pump and motor outside instead of being submersible (e.g. mounted on the grass/pavement near shoreline).	Old Plant Building	Recommend investigating the installation of a non-submersible pump and motor to replace the existing submersible motor.	4	N	$20,000	$20,000	$2,000	$22,000	$22,000	Install one pump (process is not included)
B-07-15	The plant staff indicated that there were areas of the Clarifier Building where local disconnects were not provided for equipment. As long as the upstream feeder can be locked out at the MCC, this is not a Code violation, but having local disconnect switches would benefit the equipment maintenance activities.	Clarifier Building; Other areas of the plant	Install local disconnect switches for equipment that do not presently have one.	4	N	$50,000	$50,000	$5,000	$55,000	$55,000	Assume 25 x Siemens 100A, 3-pole, 480V, fused, single throw disconnect switch, NEMA 4X, stainless steel enclosure; The final quantity/total cost to be determine later
B-07-16	The plant staff indicated that performing maintenance on the motors and equipment in the Sludge Vault is difficult due to the lack of space inside. This poses a safety and maneuverability issue inside the vault. The plant staff suggested installing submersible pumps on a rail.	Sludge Vault	Investigate alternative layouts for these pumps within the vault that will allow for safer maintenance activities.	3	O	$20,000	$20,000	$2,000	$22,000	$22,000	Assume two (2) Goulds GS submersible pump, 10 HP - 10 GPM - 460Volts - 3 Phase - 3 Wire - Control Boxes Included: **Structural & process cost not included for modifications.**
B-07-17	The plant staff mentioned that there was an issue with the pumps located in the Sludge Vault. When there is not any backpressure on the pumps, they will seize.	Sludge Vault	Investigate issue with pump operation to determine best course for correction.	2	O	$0	$0	$0	$0	$0	**Process to include cost; further investigation is required**
B-07-18	There was no fire alarm system installed at the plant.	Entire WTP	A fire alarm system should be provided for all of the buildings at the plant.	4	N	$450,000	$450,000	$90,000	$540,000	$540,000	Life safety related Assumed cost for three(3) buildings (includes communication & fire alarm system, sound system 100 outlets, boxes, conduit & wires) See B-07-23 inserted by J. Meyer in October, 2018
B-07-19	The plant staff mentioned that there was not any rotation in the operation of the process equipment (e.g. High Service Pump #2 operates all of the time, only one lime slaker is operated, etc.).	WTP and Remote Sites	Recommend rotating the operations of the equipment and alternate between different pumps and process equipment. This will help ensure all equipment is operational and it will be available if there is an equipment failure.	3	M	$0	$0	$1,000	$1,000	$1,000	Assume no additional equipment; cost with maintenance personnel (assume 2 people x 8 hours)

Table 7 - Summary List of Electrical Projects											
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
B-07-20	There is not record of periodic exercising of the standby engine generators.	WTP and Remote Sites	Recommend exercising the standby engine generators monthly to confirm proper operation. Ideally, the engine generators should run loaded. Transfer the plant or pumping station loads to the generator if possible.	4	M	$0	$0	$1,000	$1,000	$1,000	Assume no additional equipment; cost with maintenance personnel (assume 2 people x 8 hours)
B-07-21	Some areas from WTP and the remote sites do not have surveillance system	WTP and Remote Sites	Recommend installation of security cameras systems for all sites	2	N	$1,300,000	$1,300,000	$130,000	$1,430,000	$1,430,000	Locations & quantities to be discussed with client Assumed cost for one site (include 16 outdoor vandal proof, dome security cameras, 32-channel network recorder, 18TB hard drive, 4000 ft CAT5 cable, Port SOE Switch, Port POE Switch, 22" LCD Monitor)-$40k per site/13 sites -add cost for labor, conduit, wiring
B-07-22	HSP #2 is the only high service pump with a variable speed drive, capable of operating at the range of lower flow rates currently required. It is operated continuously, more than 90 percent of the time.	Main Process Building	Provide additional VFDs for the high service pumps. High Service Pump No. 1 is 480V, but the other two high service pumps (No. 3 and No. 4) are medium voltage motors. A medium voltage VFD would be requried for these pumps.	3	O	$1,100,000	$1,100,000	$110,000	$1,210,000	$1,210,000	Cost for three new VFDs. For budgetary purpose, assume $100k for a new 480V VFD and $200k for 4160V VFD; add cost for labor, conduit, wiring This cost is for new VFDs only. Please note that there is limited space at the facility and medium voltage VFDs are large. A new conditioned room will need to be designed for new VFDs and conduits will need to be routed through this plant from the main swtchgear to the VFD and from the VFD to the pump. This will be a multi-discipline project. The project cost (construction and engineering) would increase depending on the requried building improvements (arch, struct, HVAC) necessary. An alternate approach would be to replace the high service pump motors with 480V motors and install 480V VFDx. A study of this approach would need to be done in order to determine the feasibilty of this design. This study would include an evalutation of the 480V disctribution system in the Main Process Buildling.
B-07-23	There was no fire alarm system installed at the plant.	Entire WTP	An assessment/study of the fire alarm system needs should be provided for all of the buildings at the plant.	4	N	$0	$0	$20,000	$0	$0	Life safety related Assumed cost for three(3) buildings (includes communication & fire alarm system, sound system 100 outlets, boxes, conduit & wires) See B-07-23 inserted by J. Meyer in October, 2018
B-07-24	Detailed Electrical Replacement Study of the Old Plant	Old Plant Building	Study	2	O			$75,000			

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EL-07-1	The medium voltage motor control center is in fair/poor condition. Additionally, the working clearances for the existing 2400V motor control center located at the Evergreen Lake Pumping Station does not meet Code. It is noted that this equipment is being removed as part of a future project that is presently in the design phase. The plant staff indicated that the new VFDs will be installed where this existing 2400V motor control center is presently installed.	Evergreen Lake Pumping Station	There is not a lot of space between the wall and the pump. Recommend that the working clearances being provided for the new VFDs be confirmed.	5	N	$0	$0	$0	$0	$0	Assume that the ongoing project should address this clearance issue
EL-07-2	The variable frequency drive for Low Lift Pump No. 3 is in good/fair condition. This VFD has been in service for ~15 years. This VFD is the same model as the VFD for LLP#3 at the WTP, where the plant staff indicated that replacement parts are not available.	Evergreen Lake Pumping Station	If the replacement of this VFD is not part of the future project, recommend that this VFD be replaced. NOTE: This was replaced as part of the current project and costs were removed.	2	O	$0	$0	$0	$0	$0	**TBD with client** 450 HP, 460V VFD (100k) - add cost for labor, assume reuse conduit/wire
EL-07-3	No remote autotransfer switch noted on generator. Currently operators manually switch to back-up power.	Evergreen Lake Pumping Station	Add an autotransfer switch with NEMA 3R enclosure to be located outdoors without an additional enclosure.	3	O	$200,000	$200,000	$20,000	$220,000	$220,000	
M-07-1	The motor control center is in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life.	Mackinaw Pumping Station	It is recommended that this motor control center be replaced within the next ten (10) years, or if there is an upgrade being done at the pumping station.	3	O	$170,000	$170,000	$17,000	$187,000	$187,000	One MCC is replaced, 4 section ($60k) -add cost for labor, conduit, wiring Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
M-07-2	There are two conduit LBs on the exterior of the building that are missing covers.	Mackinaw Pumping Station	Recommend installing the covers on these LBs.	5	M	$500	$500	$0	$500	$500	
M-07-3	No VFD for pumps.	Mackinaw Pumping Station	Adding a VFD may allow for more controlled pumping from the pool.	5	O	$200,000	$200,000	$20,000	$220,000	$220,000	
FJA-07-1	The existing motor control center is in fair/good condition. This equipment has been in service for ~40 years and has reached the end of its expected life. Replacement parts are no longer available, however replacement buckets are still available. There was a new vertical section added to this motor control center that was installed ~25 years ago.	Fort Jesse Pump Station A	Due to the age of this motor control center, and due to limited replacement parts available (full buckets only), it is recommended to replace this MCC.	2	O	$230,000	$230,000	$23,000	$253,000	$253,000	One MCC is replaced, 7 section ($90k) -add cost for labor, conduit, wiring. Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
FJA-07-2	One of the pumps has a diesel engine backup. There is an underground diesel fuel tank for this diesel engine.	Fort Jesse Pump Station A	It is recommended to exercise this diesel engine periodically to confirm proper operation. Additionally, the integrity of the underground diesel fuel tank should be inspected. Recommend to perform an underground inspection to verify a leaking tank.	3	M	$0	$0	$25,000	$25,000	$25,000	Environmental engineering study and report as well as a drilling company to identify a leaking tank. Review permit and reporting with OSFM.

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FJB-07-1	The motor control centers are in good condition. This equipment has been in service for ~25 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Fort Jesse Pump Station B	This equipment should be replaced within the next ten (10) to fifteen (15) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the electrical equipment at the Fort Jesse Pump Station A..	3	O	$400,000	$400,000	$40,000	$440,000	$440,000	(2) MCCs, 5 sections ($75k each) -add cost for labor, conduit, wiring Failure is not immanent, but the failure of this equipment will result in a loss of both For Jesse Pump Stations.
FJB-07-2	The two VFDs are in fair condition. This equipment has been in service for ~25 years and has reached the end of its expected life. Replacement parts may no longer be available for this equipment.	Fort Jesse Pump Station B	Due to the age of these VFDs, and due to limited replacement parts available, it is recommended to replace these VFDs and associated isolation transformers.	2	O	$420,000	$420,000	$84,000	$504,000	$504,000	Two new 350hp, 480V VFDs ($100k each)
MPS-07-1	One of the lighting fixtures is missing its gasketed cover.	Main Street Booster Pump Station	Replace the missing gasketed cover for the lighting fixture.	5	M	$100	$100	$0	$100	$100	
MPS-07-2	The convenience receptacles installed in the Main Street Booster Pumping Station are not GFCI type receptacles. The receptacles and switches do not have weatherproof covers.	Main Street Booster Pump Station	Replace the receptacles with GFCI type receptacles. Install weatherproof covers over the receptacles and switches.	4	N	$500	$500	$0	$500	$500	Assume ten(10) GFCI receptacle are installed
E-07-1	The motor control center is in fair/poor condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Additionally, the motor control center is the service entrance equipment for the pump station and does not have a main disconnecting means.	Enterprise Zone Pump Station	Due to the age and condition of this motor control center, and due to lack of main disconnecting means, it is recommended to replace this MCC.	1	O	$0	$0	$0	$0	$0	Recommend study to replace pump station.
E-07-2	The UPS is in good condition. This equipment has been in service for ~30 years and has reached the end of its expected life.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the UPS be replaced.	1	O	$0	$0	$0	$0	$0	Recommend study to replace pump station.
E-07-3	The reduced voltage starter for Pump #2 (housed in the existing VFD enclosure) is in fair condition. It is noted that the VFDs for Pumps #1 and #3 have been replaced recently and are in excellent condition.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the reduced voltage starter for Pump #2 be replaced with another reduced voltage starter or VFD. The VFDs for Pumps #1 and #3 should remain.	2	O	$0	$0	$0	$0	$0	Recommend study to replace pump station.
E-07-4	All of the electrical equipment (motor control center, VFDs, UPS) are mounted on the floor and not on a concrete housekeeping pad. This station is capable of flooding and water has reached the bottom of the equipment.	Enterprise Zone Pump Station	All new equipment should be mounted on a concrete pad due to the possibility of flooding in this pump station.	1	O	$0	$0	$0	$0	$0	Recommend study to replace pump station.
E-07-5	Provide GFCI protected circuits for receptacles and equipment in wet areas. With the possibility of wet well overflow and water throughout the pump station, the entire pump station is potentially a wet area.	Enterprise Zone Pump Station	Replace all receptacles with GFCI type and replace circuit breakers in the 120/208V panelboard with GFCI circuit breakers as needed for other loads.	4	O	$0	$0	$0	$0	$0	Recommend study to replace pump station.

Table 7 - Summary List of Electrical Projects

Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost (Raw Cost per Quotes) **Option 1**	Estimated Construction Cost (Raw Cost per Quotes) **Option 2**	Estimated Engineering Cost	Estimated Project Cost **Option 1 (MV)**	Estimated Project Cost **Option 2 (LV)**	Notes
D-07-1	The medium voltage motor control center located in the Division Street Pump Station is in good condition. This equipment has been in service for ~25 years and is approaching the end of its expected life. Replacement parts are still available for this equipment. Additionally, this motor control center is the service entrance equipment and does not have a main disconnecting means for the utility feeder or for the generator feeder. The working clearance in the front and rear of the medium voltage does not meet Code.	Division Street Pump Station	This equipment should be replaced within the next ten (10) to fifteen (15) years. The replacement equipment should have main disconnecting means for the utility and generator feeders. The Code required working clearance will need to be taken into account when determining the location of the new medium voltage motor control center.	3	O	$500,000	$500,000	$50,000	$550,000	$550,000	- New 1200A, 2.4kV motor control center ($200k) - add cost for labor, conduit, wire Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
D-07-2	The medium voltage diesel engine generator and transfer controller are in fair condition. The engine generator and transfer controller have been in service for ~30 years. The engine generator is approaching the end of its expected life. The transfer controller has reached the end its expected life.	Division Street Pump Station	Recommend that the engine generator and transfer controller be replaced in conjunction with the replacement of the medium voltage switchgear.	2	O	$914,000	$914,000	$91,400	$1,005,400	$1,005,400	Per CAT Quotes: - 500 kW/625kVA, 2400V/ w 24-h fuel tank diesel generator (150k); - 1200A, 2400V switchgear and automatic transfer control (282k) CAT to confirm the price
D-07-3	The City staff indicated that there is an issue with the size of the motors for Pumps No. 3 and 4 at the Division Street Pump Station. The motors appear to be undersized.	Division Street Pump Station	Evaluate the pumps at the Division Street Pumping Station. If changes need to be made to the motor sizes based on the pumping evaluation, it is recommended to install induction motors instead of wound rotor motors amd replace all four motors at the same time. Also, it is recommended that the motor control center be replaced at the same time.	2	O	$800,000	$800,000	$160,000	$960,000	$960,000	For budgetary cost assume: - four (4) motors rated at 250hp, 2.4 kV, TEFC, Class F, 1725 rpm ($100k each). - cost does not include replacmenet of motor control center. Additional cost of $550k is estimate for that work.
D-07-4	There is a second utility feeder serving a 240/120V single phase panelboard in this pumping station. This was likely done due to the limited capacity on the 2400V-480V transformer installed in the medium voltage motor control center.	Division Street Pump Station	Recommend eliminating the second feeder and install a larger 2400V-480V transformer in the pumping station to accommodate all of the pumping station loads. We recommend replacement at the same time as the medium voltage motor control center.	5	N	$70,000	$70,000	$7,000	$77,000	$77,000	Transfomers size to be confimed. Assume one(1) 225 kVA, 2400/480V, dry-type, 60Hz, 220C, copper, transfomer and one(1) 75 kVA, 480/240V single phase, dry-type, copper
D-07-5	The 480V panelboard installed in the rear of the medium voltage motor control center is missing its cover.	Division Street Pump Station	Provide a replacement cover for this panelboard.	4	N	$100	$100	$0	$100	$100	
D-07-6	The convenience receptacles installed in the Pipe Gallery of the Division Street Pumping Station are not GFCI type receptacles.	Division Street Pump Station	Replace the receptacles with GFCI type receptacles.	4	N	$500	$500	$0	$500	$500	Quantity to be confirmed. Assume ten(10) GFCI receptacle are installed
D-07-7	There was no emergency lighting or exit sign at the main entrance to the pumping station	Division Street Pump Station	An emergency lighting fixture and exit sign should be installed at the main entrance.	4	N	$500	$500	$0	$500	$500	Include fixture & sign, charger, wire, conduit, etc.
D-07-08	Division Street/Enterprise Electrical Study	Division Street Pump Station	Peform detailed study of the Division Street Pump Station	2	O			$45,000			JPM provided cost for DS Pump Station. To be verified with MK.
					Total =	$ 15,083,200	$ 14,181,200	$ 2,019,900	$ 16,785,300	$ 15,793,100	

Table 8 - Summary List of Instrumentation Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-08-1	Install level instruments on each filter and integrate into backwash sequence and operational control. Level signals should be integrated with SCADA.	Filtration	Installation new level instrumentation.	5	O	$50,000	$75,000	
B-08-2	Integrate additional monitoring and controls signals for generators, compressors, boilers, clearwell level, high service pumps, and raw water pumps in the SCADA system to provide remote monitoring capability.	Multiple location on Plant	Modify wiring for equipment to provide remote status signals (Running, Fault, Speed Indication, etc.) for equipmnent.	3	N	$150,000	$250,000	
B-08-3	Integrate chemical systems into the SCADA system to provide capabiity for remote monitoring and control of equipment. Phosphate chlorine (other than scales), fluoride, and ammonia system is not on SCADA. Carbon dioxide system volumes are not on SCADA. Several daytank and storage tank levels are not integrated with SCADA.	Chemical Systems	Modify wiring for equipment and instrumentation to provide signals for integration into the SCADA system.	4	O	$250,000	$350,000	
B-08-4	Replace existing level sensor on clearwell and install a 2nd level sensor for redundancy. Integrate both level sensors into the SCADA system for remote monitoring.	Clearwell	Replace existing level sensor and install 2nd level sensor.	4	O	$10,000	$15,000	
B-08-5	36" magnetic flowmeters from Lake Evergreen and low lift pumps are not functional and 20-30 years off.	Flowmeter Vaults	Replace both flowmeters.	2	O	$100,000	$120,000	
B-08-6	SCADA master plan implementation	Main Plant	SCADA improvements as recommended by outside consultant	3	O	$2,000,000	$0	
M-08-1	SCADA/Control cabinet is nonfunctional with several components missing.	Mackinaw River PS	Not part of scope, cabinet should be reviewed / replaced under SCADA Master Plan project.	-	-	-	-	
M-08-2	River level gauging station is nonfunctional. Sensing line has silted in.	Mackinaw River PS	Replace instrument and integrate into SCADA	4	N	$2,500	$5,000	
EL-08-1	Lake RF level instrument is nonfunctional.	Evergreen Lake PS	Replace instrument and integrate into SCADA	4	N	$2,500	$5,000	
EL-08-2	Flow meter is nonfunctional.	Evergreen Lake PS	Replace instrument and integrate into SCADA	4	N	$3,000	$5,000	

Table 8 - Summary List of Instrumentation Projects								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
EL-08-3	No calibration column at cationic polymer.	Evergreen Lake PS	Modify piping to provide calibration column	4	M	$1,500	$3,500	
D-08-1	Replace DP sensor/transmitter, block & balance manifold, and sensor lines at each of the two venturi flowmeters at the pump station discharge lines. This will replace obsolete, non-functioning equipment and adequate maintenance in the future to include routine flushing and air purging at sensor lines.	Division Street Pump Station	Replace instruments	4	O	$5,000	$6,000	
D-08-2	Replace gauge pressure sensor / transmitters at each of two pump station discharge connections to distribution system and install a suction gauge pressure sensor / transmitter at each of the two pump station suction connections. This will allow accurate monitoring, recording, and logging of pump station operation in the SCADA system.	Division Street Pump Station	Replace instruments	4	O	$3,000	$4,000	
E-08-1	Replace DP sensor/transmitter, block & balance manifold, and sensor lines at the venturi flowmeter at the pump station discharge. This will replace obsolete, non-functioning equipment and adequate maintenance in the future to include routine flushing and air purging at sensor lines.	Enterprize Zone PS	Replace instruments	4	O	$3,000	$4,000	
				TOTAL =		$2,580,500	$842,500	

Appendix C

Condition Assessment Summary by Facility

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Bloomington WTP Facility Plan

Codes and Abbreviations

Key Code

Facility Designation	Area Designation at Water Treatment Plant	Discipline Designation
B = Bloomington WTP	Intake and Screens	
M = Mackinaw PS, ETC	Low Service Pumps	01 = Civil/Site
EL = Evergreen Lake PS	Old Plant Building	02 = Architectural
D = Division Street PS	Clarifier Buildling/Claricone 1, 2, 3, or 4	03 = Structural
DR = Division St Reservoirs	West Recarbonation Basins	04 = Process
E = Enterprise Zone PS	East Recarbonation Basins	05 = HVAC
FJA = Fort Jesse PS A	Chemical Feed Building	06 = Plumbing
FJB = Fort Jesse PS B	Main Process Building	07 = Electrical
MPS = Main Street PS	Main Process Building/Filters	08 = I&C
LSL = Lime Sludge Lagoons	Main Process Building/High Service Pump Room	
H = Hamilton Road Elevated Tank	Main Process Building/Chemical Rooms	
FJ = Fort Jesse Tanks	Main Process Building/Lime Storage Room	
NE = Northeast Elevated Tank	Main Process Building/Electrical Room	
	Main Process Building/Shop	
	Reservoir	
	Reclaim Basin	

Problem Class

Identify problem class of each proposed improvement.

Class 1 – a condition in which failure of a primary item of equipment or structure is imminent, and its failure would directly result in loss of a significant portion of plant capacity, jeopardize water quality, jeopardize the safety of personnel, or cause further damage to equipment or other structures.

Class 2 – a condition in which failure of a backup unit of equipment or structure is imminent, and failure to attend to the problem world result in loss of backup capacity, jeopardize the safety of personnel, or cause further damage to equipment or other structures (e.g., a device providing the first level of backup, such as an engine generator or the third pump in a bank of three pumps in which two pumps will be required to meet peak requirements).

Class 3 – a condition of failure or imminent failure in some ancillary equipment or structure (e.g., leaking window frames), the failure of which will not impair the process or safety, but may lead to deterioration which could result in increasing repair costs if not attended to in a timely manner.

Class 4 – an improvement which has not been made but which would result in protecting the status quo with regard to water quality, water quantity or safety (e.g., updating lighting fixtures).

Class 5 – anything which should be corrected or improved, which is not listed above and the failure of which does not imperil water quality, water quantity, or safety (e.g., removal of equipment which is not in use).

Functional Categories

Classify the problems by functional categories

O – Operational Items – items that directly affect the production or quality of water and the expense of remediation would be covered under a capital improvement project.

N – Non-Operational Items – items that do not directly affect the production or quality of water and the expense for remediation would be covered under a capital improvement project.

M – Maintenance Items – items that the expense for remediation would be covered under a maintenance budget, as opposed to being treated as an individual capital project under the capital budget.

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-01-1	Existing pavement was in poor condition, some parking areas were unpaved.	Parking Lot	Replace paved areas in poor condition as planned.	5	M	$715,400	$786,940	
B-01-2	Exposed gas distribution main.	Yard	Bury gas main as planned, and restore finished surface	5	M	$5,000	$5,500	
B-01-3	Assess location of all yard piping. At various locations valves that were shown on plans could not be found.	Yard	Full topographic and utility survey with underground utility locates and some potholing to determine exactly where all pipe and valves located.	4	N	$35,000	$38,500	
B-01-4	Security fence was in fair condition.	Yard	Consider replacement in 10-15 years.	5	M	$105,000	$115,500	
B-02-01	Existing shingle roof is showing wear, some are damamged or missing; according to building staff it is slated for replacement with standing seam metal roof.	Main Process Building - Exterior	Replace roof as planned	3	N	$450,000	$500,000	
B-02-02	Roof gutters are leaking at seams and dripping, downspouts are missing extensions	Main Process Building - Exterior	Include gutter replacment with roofing replacement job; provide downspouts with extensions to direct water away from foundation	4	N	-	-	cost included in B-02-01
B-02-03	Exterior brick masonry in good condition	Main Process Building - Exterior	Plan for repointing in 20 years	4	M	$150,000	$150,000	
B-02-04	Exterior doors and frames are rusting in some locations, missing or damaged weatherseals in others.	Main Process Building - Exterior	Replace exterior rusted hollow metal doors and frames, replace weatherseals where missing, reset concrete pads with proper subbase to restore door function.	4	M	$30,000	$30,000	Some weatherseals missing or damaged at exterior doors; at Chlorine room, door rubs on heaved sidewalk; hollow metal door and frames are typically rusting at ground floor; at hight lift pump door does not open close easily, missing threshhold and weatherseals.
B-02-05	Expansion joints at upper levels are failing, those at ground level have been replaced	Main Process Building - Exterior	Reseal brick expansion joints, recaulk at windows and louvre openings	4	M	$2,000	$2,000	
B-02-06	Exterior wood-framed shed for Anhydrous Ammonia is in poor condition: wood is rotting, hollow metal door is rusted through, and plywood ceiling is damaged with insulation exposed.	Main Process Building - Exterior	Refer to process recommendations	3	N	-	-	Reference Process recommendation B-04-31
B-02-07	Exterior wooden stairs at generator enclosure are water damaged and curling up at th ends, creating a tripping hazard	Main Process Building - Exterior	Replace wooden stair boards	4	M	$2,000	$2,000	
B-02-08	Solid surface window sills are stained and a few are broken	Main Process Building - Throughout	Replace solid surface sills	5	M	$2,000	$2,000	
B-02-09	Windows left open without screens installed, significant quantity of bugs found inside	Main Process Building - Throughout	Install insect screens. Consider implementing HVAC improvements to provide climate controlled environment.	4	M	-	-	See HVAC comments and improvements.
B-02-10	Multiple pipe penetrations through the 2-hr rated wall are not fire-stopped	Main Process Building - Electrical Room	Firestop penetrations	4	M	$2,000	$2,000	Life Safety

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-02-11	Second egress door (interior) swings in, and does not have code-required panic hardware	Main Process Building - Electrical Room	Replace hollow metal door/frame/hardware with out-swinging B-rated door with panic hardware.	4	N	$3,000	$3,000	Life Safety Refer to electrical issue B-07-13.
B-02-12	Insufficient clearance at medium voltage main disconnect panel	Main Process Building - Electrical Room	Provide sufficient clearances at time of electrical renovation.	4	N	-	-	Life Safety
B-02-13	Concrete floor pitting at Electrical Room, Lime Storage Room	Main Process Building - Electrical Room	Refer to Structural item B-03-11	5	M	-	-	Consider bi annual maintenance program. Cost included in Structural B-03-11
B-02-14	At the time of the walkthrough, objects were stored on the Stair No. 1 landing, and stair door was propped open compromising its fire rating.	Main Process Building	Remove stored objects from stairway; do not prop open fire rated doors.	4	M	$0	$0	Life Safety
B-02-15	A range, with no range hood, and refrigerators are stored in corridor adjacent to electrical and control room	Main Process Building	Remove items from corridor as it reduces required path of egress	4	M	$0	$0	Life Safety
B-02-16	Paint on metal decking and upper portion of CMU wall is peeling	Main Process Building - Lime Storage Room	Scrape and paint	5	M	$15,000	$15,000	
B-02-17	2nd floor door does not shut properly; door hardware to chlorine room is calcifying	Main Process Building - Lime Storage Room	Replace interior doors/frames/hardware	4	M	$3,000	$3,000	
B-02-18	Overhead door at Old Amonia/New Shop room is damaged	Main Process Building - Shop	Replace overhead door.	5	M	$2,000	$2,000	
B-02-19	Bathrooms and drinking fountain have insufficient manuevering clearances and mounting heights to meet ADA accessibility requirements.	Main Process Building	Recommended renovation for ADA compliance	5	N	$130,000	$150,000	ADA
B-02-20	Ceiling tiles in corridors and office areas are sagging.	Main Process Building	Replace ceiling tiles with water resistant type in existing grid	5	M	$4,000	$4,000	
B-02-21	Vinyl composition tile flooring is worn.	Main Process Building - Offices	Replace vinyl composition tile flooring.	5	M	$1,500	$1,500	
B-02-22	Laminate counters are water damaged and chipping.	Main Process Building	Replace countertops.	5	M	$2,000	$2,000	
B-02-23	Existing standing seam metal roof (approx 19 years old) has active leaks at ridge and near exterior walls, evidenced by stained and failing insulation underneath.	Clarifier Building	Option 1: Replace existing metal roof; Option 2: Coat roof with high performance topcoat to repair and extend roof's life.	3	N	$575,000	$600,000	Recommend replacement
B-02-24	Exterior hollow metal doors and frames are rusting	Clarifier Building	Replace (2) exterior doors and frames.	4	M	$6,000	$6,000	
B-02-25	Wall insulation is peeling away in spot locations	Clarifier Building	Replace insulation, isolated locations	5	M	$1,000	$1,000	

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-02-26	Flat roof flashing varies from good to poor condition.	Old Plant Building	Replace flat roof, including re-shingle access hatches.	3	N	$100,000	$110,000	
B-02-27	Roof leaking over shop area, as evidenced by ponding water and water infiltration on the interior peeling paint and mold.	Old Plant Building	Provide roof membrane/seal outdoor mezzanine area and clean out/modify scupper.	3	N	$20,000	$25,000	
B-02-28	Single pane windows in wood frames in poor condition at original building.	Old Plant Building	Replace windows and frames with insulated units.	3	N	$50,000	$60,000	
B-02-29	Masonry in fair to good condition; some efflorescence at boiler stack, ivy covering at low lift tower, localized areas of minor damage.	Old Plant Building	Plan for repointing in 10 years.	5	M	$130,000	$130,000	
B-02-30	The exterior platform at the west end of the building in poor condition. The hollow metal doors, wooden lintel above, and wood framed shed underneath are also in poor condition.	Old Plant Building	Rebuild platform and provide exterior exit stairway to ground level; remove shed; replace hollow metal exit doors with B-label doors; replace timber lintel.	3	N	$10,000	$10,000	Life Safety Door replacement cost only. Refer to Structural item B-03-3 & B-03-4.
B-02-31	No exit sign at outdoor exit door from corridor near low lift pump or at east stairwell.	Old Plant Building	Provide egress signage and emergency lighting. Life Safety study.	3	N	$10,000	$12,000	Life Safety
B-02-32	Metal Shop / Garage area does not have an exit without egressing through Switchgear area.	Old Plant Building	Create opening for egress door from garage / metal shop.	3	N	$15,000	$20,000	Life Safety
B-02-34	Mezzanine guard rail is 36 inches high.	Old Plant Building	Replace or extend guardrail to code-required height of 42 inches.	4	N	$5,000	$7,500	Life Safety
B-02-35	Peeling paint on concrete roof planks in filter additions.	Old Plant Building	Scrape and repaint w/ water resistant paint.	4	M	$35,000	$35,000	
B-02-36	Ceiling tiles are stained.	Old Plant Building	Replace or remove ceiling tiles.	5	M	$5,000	$5,000	
B-03-1	Concrete delamination along east face of original filter building (100 sf visible)	Old Plant (original filters)	Remove delaminated concrete, patch with repair material.	4	M	$20,000	$25,000	
B-03-2	Concrete delamination along east face of filter building 1952 addition (25 sf)	Old Plant (1952 addition)	Remove delaminated concrete, patch with repair material.	4	M	$0	$0	Included in B-04-01
B-03-3	Steel platform at north of filter building is exhibiting corrosion. Removable guardrail is experiencing significant deflection under applied loads. Anchors exhibiting section loss. Support angle pullling away from building.	Old Plant	Remove platform. Add stairwell to create additional exit.	5	M	$15,000	$17,500	Confirm with Arch if additional exit is needed. Good idea anyways.
B-03-4	Timber lintel above double door on north exit is experiencing dry rot.	Old Plant	Replace with steel lintel and waterproofing.	5	M	$10,000	$12,500	Confirm duplicate with Arch.
B-03-5	Peeling paint on concrete substrate in Backwash Pump Room.	Old Plant	Scrape paint.	5	M	$0	$0	
B-03-6	Minor corrosion noted on steel members in filters 6-12.	Old Plant	Scrape and paint.	5	M	$15,000	$15,000	Not imperative, 5-10 years

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-03-7	Checking noted on timber purlins above the decommissioned high lift pumps.	Old Plant	Continued monitoring.	5	M	$0	$0	
B-03-8	Significant checking noted at end of timber roof purlin.	Old Plant	Further investigation.	5	M	$0	$5,000	Checking may not be crucial to the structure. Further investigation required to determine extent and impact.
B-03-9	Minor corrosion on exterior monorail columns.	New Plant	Scrape and paint.	5	M	$2,000	$2,000	
B-03-10	Minor corrosion on monorail splice in chlorine storage room.	New Plant	Scrape and paint.	5	M	$1,000	$1,000	
B-03-11	Epoxy floor coating has failed in several locations including Electrical and Flouride Rooms and Lime Blower Room.	New Plant	Remove as necessary and recoat damaged areas.	4	M	$10,000	$10,000	Prolonged exposure will degrade concrete, recommond to recoat within 1 year.
B-03-12	Mislocated bolts at top level of Stair 1. Bolts were field bent to allow installation and connection of stair stringers.	New Plant	Provide new connection with adhesive anchors.	5	M	$5,000	$7,500	
B-03-13	Minor corrosion noted on galvanized steel grating in Pipe Gallery.	New Plant	Scrape and coat with cold galvanizing paint.	5	M	$0	$0	
B-03-14	Leaking filter tank wall in Stair No. 3.	New Plant	Inject with hydropholic polyurethane grout.	5	M	$1,000	$1,000	Engineering included with other repairs.
B-03-15	Minor corrosion on lime storage and slaker tanks.	New Plant	Scrape and paint as part of normal maintenance.	5	M	$0	$0	
B-03-16	Cracked masonry pilaster at column A.1/8a in Lime Storage Room.	New Plant	Masonry covers steel column and provides only protection to it. Cracking is likely caused by displacement in column. Recommend to rout and seal crack.	5	M	$2,000	$2,000	
B-03-17	Cracked cmu at control joint on south wall of Lime Storage Room.	New Plant	Rout and seal crack.	5	M	$2,000	$2,000	
B-03-18	Surface rust on Claricones.	New Plant	Scrape and paint.	5	M	$0	$0	
B-03-19	Surface corrosion on pump bases in Control Building within Clarifier Building	New Plant	Scrape and paint. Wire brushing may be necessary to remove corrosion.	5	M	$0	$0	
B-04-1	Inspect intake lines and associated strainers. Verify support piles remain on solid footing, and condition of pipes. Evaluate traveling screens. Evaluate if screen is sufficiently protected from potential of dragging anchors.	Intakes and Screens	Perform condition assessment.	2	O		$50,000	
B-04-2	When operating at rated capacity of 22mgd from Lake Bloomington, velocity in 20" inlet piping can be well above minimum recommended by the Hydraulic Institute especially if one pipe (deeper pipe) in service during low lake level conditions. Inlet piping undersized for this velocity.	Intakes and Screens	Increase size of inlet piping.	3	O	$300,000	$330,000	

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-04-3	Lake Bloomington and Lake Evergreen water meters did not appear to be functioning.	Yard/Raw water meters	Verify meters operational and calibrated.	3	O	$15,000	$16,500	
B-04-4	Pump No. 1 is a horizontal split case centrifugal pump installed in 1977. Depending on results of pump performance test, pump replacement should be considered. Motor newer. Assume poor efficiency due to wear.	Low Service Pump Room	Replace pump.	4	O	$200,000	$220,000	
B-04-5	Verify all pump suction and discharge pressure gauges functional and calibrated. Recommend compound gauge on all suction piping, pressure gauge on discharge piping, and consideration of a recording gauge for the low service pumps.	Low Service Pump Room	non-operational/non-calibrated pressure gauges.	4	O	$10,000	$11,000	
B-04-6	Pump #3 valve inoperable.	Low Service Pump Room	Rebuild or replace valve.	3	O	$25,000	$27,500	
B-04-7	Develop maintenance procedures for all pumps to track where operate on pump performance curve and monitor runtime hours to develop scheduled maintenance/replacement program	Low Service Pump Room	Implement maintenance program.	4	M		$25,000	
B-04-8	Abandoned mixing tanks appear to still receive water. The source of	Main Process Building	Inspect pipe to locate source of connection	5	N	$10,000	$11,000	
			Remove connection, and seal pipe.	5	N	$25,000	$27,500	
B-04-9	Chlorine feed point in pipe gallery should have ambient gas monitor and alarm.	Main Process Building	Install gas monitor and alarm	2	N	$5,000	$5,500	
B-04-10	Existing air scour system is not currently under operation.	Main Process Building/Filters	Perform a pilot study to evaluate benefit of air scour system. Evaluation would be in accordance with the AWWARF Filter Maintenance and Operational Guidance Manual. Prepare memorandum of study and results.	3	O	$50,000	$50,000	
B-04-11	Filter 13 through 18 troughs are not level or set at same elevation. This has the potential of negatively impacting the effectiveness of the filter backwash process.	Main Process Buildings/Filters	Survey the elevations of the troughs to identify what improvements are needed.	3	O		$10,000	Survey in 2019 as part of information gathering for design improvements
B-04-12	Air relief is insufficient at the backwash supply piping resulting in air being introduced into the filter bottom during backwash.	Main Process Buildings/Filters	Install air release valves on backwash supply piping	4	O	$10,000	$11,000	

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B-04-13	Inspect each of the differential pressure gauges from all filters to verify calibrated and functioning.	Main Process Buildings/Filters	Implement maintenance program.	4	M	$5,000	$5,500	
B-04-14	Clean and inspect all slurry discharge lines from the slurry concentrator to the control building for each Claricone.	Clarifier Building	Condition assessment. Removal, transport, and dispose of collected materials to sludge lagoons.	4	M	$30,000	$33,000	
B-04-15	Consider adding a second slurry discharge pump at each control building to allow one pump to be taken out of service for maintenance and repair.	Clarifier Building	Add secondary pump.	4	N	$50,000	$55,000	
B-04-16	None of the ClariCone analysis instruments appear to be functioning to sample for pH, turbidity, sludge blanket level, level transmistter to control chemical usage and other process control parameters. Typically operators only view sludge blanket depth from access bridge.	Clarifier Building	Repair and maintain analysis instruments to maximize utilization of the Claricones.	4	M	$25,000	$27,500	
B-04-17	The Infilco Accelator unit has been removed from the water treatment process. Considered removal of obsolete process structure.	Clarifier Building	Demolish Infilco Accelator, backfill, regrade, and restore surface.	5	N	$0	$0	Part of Project B-04-46
B-04-18	ClariCones 1 and 2 have a central flow meter, so the volume going to each claricone is unknown. Consider adding flow meters to each influent line to accurately determine flow to each Claricone.	Clarifier Building	Add at least one flow meter to either #1 or #2.	5	O	$60,000	$66,000	
B-04-22	Blowdown rate at ClariCones 1 through 4 can't be controlled to a low enough flow rate to avoid wasting an excessive volume of process water during blowdown cycle. When an excessive volume of sludge is wasted from the sludge concentrator, the sludge thickening process is disrupted.	Clarifier Building	Evaluate options to provide a greater range for sludge blowdown	5	O		$15,000	
B-04-23	Grout floors in lower cylindrical section of ClariCones appear to be insufficient to prevent accumulation of large grit as evidenced by the need for plant staff to drain and clean out the bottom of the ClariCones.	Clarifier Building	Evaluate options for improving grit removal from clarifiers	5	O		$10,000	
B-04-24	Anionic polymer storage tanks and feed systems don't have containment.	Clarifier Building	Provide drum containment system	3	O	$500	$550	

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B-04-25	Hydraulic bottleneck appears to occur at recarbonation basins east and west. Specific reason for backup should be evaluated as it may be due to lime buildup on the walls of the 30" influent piping. Basin surface is also open to atmosphere.	Recarbonation Basins	Evaluate the recarbonation basins. Perform a condition assessment and potential cleaning of influent piping. Potential removal of recarbonation basins.	2	O		$25,000	
B-04-26	Surface wash in old filter building does not appear to be operational for some of the filters.	Old Plant Building/Filters	Replace/Repair surface wash.	2	O	$0	$0	
B-04-27	Appears to be hydraulic imbalance of old filters based on flows from some filters from the influent weir.	Old Plant Building/Filters	Evalute Hydraulics of filters using field data and model and produce report	3	N		$25,000	
B-04-28	Treatment HGL is about 18-inches higher than it should be to allow the filter influent weirs to operate properly. This results in significant maldistribution of the inlet flow in this set of filters. The operating HGL at filters 13 through 18 is such that filters 1 through 12 will overflow to the operating floor if filters are operated in effluent flow rate control mode.	Old Plant Building/Filters	Evalute Hydraulics of filters using field data and model and produce report	3	N		$25,000	
B-04-29	The CO_2 storage unit supplies gas with only primary pressure regualtion to the obsolete feed panel in this building. Supply piping to the new CO_2 feed systems are tapped onto this old feed system inside the building.	Chemical Feed Building	Upgrade CO2 system to meet current best practices	3	O	$30,000	$55,000	
B-04-30	There is a live 150 psi carbon dioxide feed piping inside this building with no ambient gas detector in service. Much of this piping is copper with soldered joints.	Chemical Feed Building	Upgrade CO2 system to meet current best practices	3	O	$30,000	$55,000	
B-04-31A	Gas ammoniators in a wooden shed on the north side of the New Water Treatment Plant. There should be a leak detection system in all areas the ammonia is piped, and the room should have an emergency air exhaust system with elevated intake according to 10 State Standards. In addition it should be considered if an emergency gas scrubber is required should it be considered a risk to the public.	Main Process Building/Chemical Rooms	Evaluate shed, leak detection and air exhaust. Consider scubber in recommendation report.	1	O		$25,000	

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B-04-31B	Replace Ammonia Feed System	Main Process Building/Chemical Rooms	Existing ammonia feed system does not comply with 10SS and is in need of replacement	2	O	$1,000,000	$1,100,000	
B-04-31C	Ammonia feed system.	Main Process Building/ Chemical Rooms	Study to identify options or alternatives for ammonia feed system.	2	O	$0	$25,000	
B-04-32	Fluoride Room: No containment provided for storage tanks.	Main Process Building/Chemical Rooms	Install containment curbs around bulk and day tanks	3	N	$15,000	$16,500	
B-04-33	Fluoride Room: Day tank not in use.	Main Process Building/Chemical Rooms	Rehabilitate/replace fluoride day tank	4	N	$10,000	$11,000	
B-04-34	Fluoride Room: There is no calibration column to verify the accuracy of the fluoride feed rate.	Main Process Building/Chemical Rooms	Install calibration column	2	O	$2,000	$2,200	
B-04-35	Ferric Room: No containment provided for storage tanks.	Main Process Building/Chemical Rooms	Install containment curbs around bulk and day tanks	3	N	$15,000	$16,500	
B-04-36	Ferric Room: No online standby pump installed.	Main Process Building/Chemical Rooms	Install a standby ferric metering pump.	2	O	$10,000	$11,000	
B-04-37	Ferric Room: There is no calibration column to verify the accuracy of the fluoride feed rate.	Main Process Building/Chemical Rooms	Install calibration column	2	O	$2,000	$2,200	
B-04-38	Ammonia feed system and enclosure do not meet Ten States and Mechanical Code wrt ventilation. Should be leak detection in all areas ammonia piped.	Main Process Building/Chemical Rooms	Upgrade ammonia system to meet current best practices.	3	O	$50,000	$55,000	
B-04-39	No ammonia ambient gas monitor and alarm. Should be leak detection in all areas ammonia piped.	Main Process Building/Chemical Rooms	Install gas monitor and alarm	2	N	$5,000	$5,500	
B-04-40	Lime slurry feed loop requires frequent maintenance due to design issues and the lime system doesn't include de-gritting of the slurry.	Main Process Building/Chemical Rooms	Evaluate slaker improvements for better grit removal	5	N		$10,000	
B-04-40	Feed point inside high service room includes ammonia solution piping in the high service room without an ambient gas monitor and alarm.Should be leak detection in all areas ammonia piped.	Main Process Building/High Service Pump Room	Install gas monitor and alarm	2	N	$5,000	$5,500	
B-04-41	Recarbonation and Water Stability Study	Clarifier Building	Study to Determine Options	2	O	$0	$60,000	
B-04-42	Recarbonation Bypass Piping and Existing Recarbonated Water Piping Replacement Project	Clarifier Building	Replace Piping	2	O	$500,000	$550,000	The City has already planned this work, but included in CIP anyways.

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B-04-43	Filter Improvements Study	Old Plant Building/Filters	Study to Determine Options	2	O	$0	$80,000	
B-04-44	Design of West Filter Improvements	Old Plant Building/Filters	Design of improvements	2	O	$0	$2,000,000	Construction costs detailed in B-04-45. Costs incldue an architectural programming meeting to discuss Main Process Building in relation to filter addition. Additions may be new control room, laboratory, and admin space.
B-04-45	Construction of New West Filter Improvements	Old Plant Building/Filters	Construction	2	O	$20,000,000	$20,000,000	Engineering costs detailed in B-04-45
B-04-46	Demolition of Existing Recarbonation Basin	Process	Remove existing basin	4	O	$1,500,000	$1,650,000	Costs include demo of Recarbonation Basins, Infilco Accelerator, and Hydro-Treaters and include capping of piping.
B-04-47	East Filter Piping Improvements	Main Process Building/Filters	Piping Improvements	5	O	$100,000	$110,000	
B-04-48	New Low Service Pump Station	Low Service Pump Room	New Pump Station	4	O	$9,000,000	$10,000,000	Cost of new Low Service Pump Station
B-04-49	The Destrat pump is a submersible pump and fails after approximately one year of service. This has improved since the VFD was installed for this pump. The plant staff indicated that it would be beneficial to install a new pump with a motor that is easily accessible.	Source Water	Install up to four new solar (SolarBee) destratification pumps.	4	M	$220,000	$240,000	
B-04-50	The plant staff mentioned that there was an issue with the pumps located in the Sludge Vault. When there is not any backpressure on the pumps, they will seize.	Sludge Vault	Study pump operartion and provide recommendation	2	O	$0	$5,000	
B-04-51	Old Plant no longer needed after potential consturction of filters to Main Plant.	Old Plant Building Filters	Demo filters as part of the building additions constructed in 1952 and 1964. Keep original construction for historical purposes.	3	M	$2,000,000	$2,200,000	Add $1,250,000 for demo of the original structure.
B-04-52	No platform above lime slakers	Main Plant/Lime Storage Room	Add railed platform across the top of both lime silos and removable platform across the top of the lime slakers to improve routine maintenance tasks.	3	M	$75,000	$75,000	IEPA inspection finding.
B-04-53	Sodium Hexametaphosphate system in poor condition.	Main Plant/ Chemical System	Replace system.	3	O	$500,000	$550,000	
B-04-54	No backup clhorine gas feed system present.	Main Plant/ Chemical System	Sutdy to detemine options to improve clhorine gas storage and feed systems to provide sufficient redundancy for increased reliability and ease of maintenance.	3	O	$0	$25,000	
B-04-55	No flow meters on ammonia system or chlorine gas feed systems.	Main Plant/ Chemical System	Add mass flow meters on systems to allow monotoring of feed rates.	3	O	$50,000	$65,000	
B-04-56	PAC storage and feed system appears to have been decommissioned	Main Plant/ Chemical System	Study to determine feed point, dosing, and contact time for new PAC system.	3	O	$0	$25,000	

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B-04-57	No tank mixer on liquid lime storage tank. WTP staff has indicated the tank suffers from slurry separation.	Main Plant/ Lime Storage Room	Add tank mixer to prevent slurry separation and improved hose pumps to allow use of this tank as an emergency backup calcium hdroxide storage and feed system.	4	O	$200,000	$250,000	
B-04-58	Plant has indicated a need to use clarifier effluent make-up water supply to the carbon dioxide pressure solution feed systems.	Clarifier Building	Would reduce the capacity burden on filtration disinfection, and high-lift pumping processess prsented by the curent practice of using a finsihed water supply to the carbon dioxide feed systems and eliminate the chlorine carry-over to the GAC filter media and ammonia carry-over to the disinfection process	3	O	$200,000	$215,000	
B-04-59	Inline mixer in rapid mix basin is currently offline.	Main Plant	Remove rapid mix basins to alow for easier access and ability to perform jar tests and other plant optimization work.	4	O	$100,000	$110,000	
B-05-01	Many of the exhaust systems serving chemical and process rooms are not directly routed to the outdoors. Rather, exhaust air is collected from the spaces by exhaust fans located in a common room. The exhaust fan discharge is then routed through the interior spaces of the plant before being discharged. This is especially critical to the chlorine rooms.	Main Process Building	Perform study to determine new route of exhaust systems so that ductwork does not run through other spaces and goes directly outside.	1	N	$0	$25,000	
B-05-02	No scrubber for chlorine rooms.	Main Process Building	Add a chlorine scrubber.	1	N	$100,000	$110,000	See B-05-01 regarding chlorine room exhuast.
B-05-03	Corrosion observed on exhaust system ducts serving lime room, chlorine room, ferric room, and other chemical and process areas. Corrosion in the ductwork can cause exhaust leakage and cross contamination into other spaces the duct passes through.	Main Process Building	Replace ductwork.	4	M	$50,000	$55,000	Consider exhuast system study. See B-05-01
B-05-04	Most of the air handling units are not regularly operated and appeared neglected.	Main Process Building	Perform general servicing/upgrades of air handling units and operate to provide building ventilation.	4	N	$100,000	$100,000	
B-05-05	Operator room cooling system utilizes flexible duct that penetrates through the elecrical room without fire dampers.	Main Process Building	Replace flexible duct at penetrations and install sheet metal duct and fire dampers.	4	N	$25,000	$25,000	
B-05-06	The ventilation in the Flouride Room did not seem adequate.	Main Process Building	Upgrade ventilation system.	1	N	$10,000	$11,000	
B-05-07	Several of the dampers and actuators associated with the air handling units and with outside air louvers were disconnected and nonfunctional.	Main Process Building	Replace actuators.	4	M	$25,000	$25,000	
B-05-08	Exhaust fans are not regularly operated.	Main Process Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$25,000	$25,000	

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B-05-09	Boilers are near the end of expected service life.	Main Process Building	Replace boilers.	3	N	$50,000	$55,000	
B-05-10	The HVAC controls are outdated and did not appear fully functional.	Main Process Building	Upgrade HVAC control system.	4	N	$100,000	$110,000.0	
B-05-11	The boilers do not contain a water treatment system. This can accelerate boiler fouling.	Main Process Building	Install a chemical treatment system for the boiler water.	3	N	$10,000	$11,000	
B-05-12	Boiler circulating and distribution pumps appeared neglected.	Main Process Building	Perform general servicing/upgrades.	4	M	$20,000	$20,000	
B-05-13	Dust control for lime storage and conveying is inadequate as evidenced by the quantity of lime dust accumulation inside the lime rooms, on the roofing above the lime rooms, and at the exterior of the building adjacent to the lime areas.	Main Process Building	Upgrade ventilation system in Lime Storage Room to improve duct control.	4	N	$10,000	$11,000	
B-05-14	Exhaust fans are not regularly operated.	Clarifier Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$5,000	$5,000	
B-05-15	Air handling units are not regularly operated.	Clarifier Building	Perform general servicing/upgrades and regularly operate the unit to provide building ventilation.	4	M	$20,000	$20,000	
B-05-16	The HVAC controls are outdated and did not appear fully functional.	Clarifier Building	Upgrade HVAC control system.	4	N	$25,000	$27,500	
B-05-17	Several of the dampers and actuators associated with outside air louvers were disconnected.	Clarifier Building	Repair dampers and replace actuators.	4	M	$5,000	$5,000	
B-05-18	Exhaust fans are not regularly operated.	Old Plant Building	Perform general servicing/upgrades and regularly operate exhaust fans to provide building ventilation.	4	M	$10,000	$10,000	
B-05-19	The air handlnig units appeared seldomly used and neglected.	Old Plant Building	Perform general servicing/upgrades and regularly operate to provide building ventilation.	4	N	$50,000	$50,000	
B-05-20	Boiler circulating and distribution pumps appeared neglected.	Old Plant Building	Perform general servicing/upgrades.	4	M	$10,000	$10,000	
B-05-21	Some hot water piping is not insulated.	Old Plant Building	Provide insulation.	4	M	$5,000	$5,000	
B-05-22	Several of the dampers and actuators associated with the air handling units and with outside air louvers were disconnected and nonfunctional.	Old Plant Building	Replace actuators.	4	M	$15,000	$15,000	
B-05-23	The HVAC controls are outdated and did not appear fully functional.	Old Plant Building	Upgrade HVAC control system.	4	N	$50,000	$55,000	
B-05-24	The new boilers do not contain a water treatment system. This can accelerate boiler fouling.	Old Plant Building	Install a chemical treatment system for the boiler water.	3	N	$10,000	$11,000	

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B-05-25	The air conditioning condenser does not function and had an open panel with exposed wiring.	Old Plant Building	Repair/replace air condenser.	4	N	$5,000	$5,000	
B-05-26	The outside refrigerant lines on the air conditioning system were uninsulated.	Old Plant Building	Provide pipe insulation.	4	M	$1,000	$1,000	
B-06-01	Sections of plumbing water lines in chemical rooms appeared corroded.	Main Process Building	Replace piping and provide insulation for protection.	4	M	$5,000	$5,000	
B-06-02	Exposed drain lines from abandoned sink in office/break room.	Main Process Building	Renovate plumbing in space with new sink.	5	N	$5,000	$5,000	
B-06-03	Emergency showers appeared neglected.	Main Process Building	Perform general servicing and regularly test to ensure operability.	4	M	$1,000	$1,000	
B-06-04	Reduced pressure principle backflow preventer on the CW supply to the PAC feed room is leaking and inaccessible, located above other conduit and piping at the corridor ceiling.	Main Process Building	Replace backflow preventer and relocate to more suitable location.	4	M	$10,000	$10,000	
B-06-05	Reduced pressure principle backflow preventer on the CW supply to the chemical water booster pump is inaccessible, located high overhead.	Main Process Building	Relocate backflow preventer to more suitable location.	4	M	$5,000	$5,000	
B-06-06	Floor drains in chlorine storage and feed areas are connected to building plumbing.	Main Process Building	Disconnect floor drain piping from building sanitary system and separate into independent process waste system.	4	N	$20,000	$20,000	
B-06-07	Emergency showers appeared neglected.	Clarifier Building	Perform general servicing and regularly test to ensure operability.	4	M	$1,000	$1,000	
B-06-08	Sump in lower level is open and can be tripping hazard.	Old Plant Building	Provide grating.	4	M	$500	$500	
B-06-09	Sump pump in lower level appears past its expected service life.	Old Plant Building	Replace pump.	4	M	$500	$550	
B-06-10	Gas leak observed at the meter and regulator.	Old Plant Building	Repair leaks.	3	M	$1,000	$1,000	
B-06-11	Domestic water heater past expected service life.	Old Plant Building	Replace water heater.	4	M	$3,000	$3,300	
B-06-12	No expansion tank observed at domestic water heater.	Old Plant Building	Add expansion tank.	4	M	$1,500	$1,650	
B-06-13	Some domestic water piping around the water heater was not insulated.	Old Plant Building	Add pipe insulation.	4	M	$500	$500	
B-06-14	Bathroom fixtures in Locker room (urinal, water closet, shower, sink) abandoned.	Old Plant Building	Replace with new fixtures.	5	N	$5,000	$5,500	

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B-07-1	There is a 480V feeder from the Main Process Building to the Old Plant Building, which provides standby power to some 480V and 208/120V loads when the 2000kW engine generator is operating. This feeder does not provide standby power for the low lift pumps. The existing 500kW engine generator in the Old Plant Building provides standby power for the low lift pumps . The existing 500kW diesel engine generator installed at the Old Plant Building has been installed in the mid-1970s and is approaching the end of it's useful life. The existing 2000kW diesel engine generator was installed approximately 15 years ago and is in good condition. There is not any automatic transfer scheme in place to transfer the plant to the engine generators upon a loss of utility power.	Old Plant Building and Main Process Building	Option 1: Consolidate the standby power needs for the WTP with a single diesel engine generator. The kW requirements for the new diesel engine generator will be dependent on the plant loads that will need to operate during a loss of power. The new diesel engine generator can be either 480V or medium voltage (2400V or 4160V). The voltage for the new engine generator would be partially dependent on any modifications being made to the electrical distribution systems at both the Old Plant Building and New Process Building. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the entire plant (Old Plant Building and Main Process Building) to the engine generator.	2	O	$2,680,000	$2,948,000	Per CAT Quotes: Option 1A-MV Equipment ($1,240,000) - 2500 kW/3125 kVA, 4160V /w 24-h fuel tank, indoor diesel generator (726k); - 1200A, 5kV MV switchgear and automatic transfer control (514k) - cost adder for outdoor enclosure - $200k - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.) Option 1B-LV Equipment ($1,040,000) - 2500 kW/3125 kVA, 480V/w 24-h fuel tank, indoor diesel generator (684k); - 4000A, 480V switchgear and automatic transfer control (356k) - cost adder for outdoor generator - $200k - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.) Note: For budgetary purpose assume Option 1A
			Option 2: Keep the existing 2000kW diesel engine generator at the Main Process Building and either retrofit the existing 480V switchgear (LVS3) or provide a new 480V switchgear and/or automatic transfer switch that will automatically start the 2000kW engine generator upon a loss of utility power and transfer the Main Process Building to the engine generator. Provide a new diesel engine generator at the Old Plant Building to replace the aging 500kW, 480V diesel engine generator. A new switchgear and automatic transfer equipment would automatically start the new engine generator upon a loss of utility power and transfer the Old Plant Building to the engine generator.	2	O	$1,778,000	$1,955,800	1) 480V Generator and Switchgear (433K) 500 kW, 480V, 60Hz, 0.8 PF, indoor/w 24-h fuel tank diesel generator ($102k) Cost Adders: 1A) Outdoor factory skin tight SA enclosure, 72dba @23', motorized louvers ($49k) 1B) include 480V switchgear and automatic transfer switch (between utility and gen set) ($282k) 2) Replace 480V switchgear (LVS3) and add automatic transfer control for existing 2000 kW generator ($356k) Note: For budgetary purpose, use Items 2 and 3 - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)

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Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-07-2	The primary service voltage for the WTP is 2400V. The electric utility (Ameren) has indicated that there are not may (if any) replacement transformers that still have a 2400V secondary. Further, the 2400V service is an ungrounded system.	Old Plant Building and Main Process Building	Consider upgrading the primary service voltage to either 480V or 4160V. Due to some of the larger high service pump loads (>500hp), it would be recommended to stay with a medium voltage distribution system (4160V) due to quantity and sizing of the cables needed to operate these loads at 480V. The two 600hp, 2400V high service pump motors at the plant will need to be replaced with 4160V motors. This service upgrade will also need to be discussed with Ameren to determine what options they have to offer.	2	N	$1,672,000	$1,839,200	Note: If the existing 2400V power system is replaced with 4160V system, then the following new equipment is required: - 3500 kVA, 35/4.16kV, outdoor, oil filled, copper windings, padmounted transformer (80K) - by utility (not included) - 1200 A, 4160V, 4 sections, outdoor (NEMA3R) switchgear (180k-estimate $45k/section); - 1200, 4160V, 5 sections, indoor, switchgear (175k-estimate $35k/section); -500kVA, 4160-480V, dry-type, indoor, copper, transformer (22k) - 300 kVA, 4160-480V outdoor, copper, transfomer (17k); - 750 kVA, 4160-480V, indoor, dry-type, copper, transfomer(30k) - 150 kVA, 4160-240V, outdoor, copper, transformer (12k) - (2)-600hp, 4.16kV motors (150k each) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-3	The existing unit substation "U1", motor control center "MCC-P1", and the integrated distribution center are in fair condition. This equipment has been in service for ~40 years and has reached the end of its expected life.	Old Plant Building	Due to the age of the unit substation "U1", motor control center "MCC-P1", and the integrated distribution center, it is recommended to upgrade this equipment in the Old Plant Building.	2	O	$750,000	$825,000	Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. two (2) low lift pumps) and miscellaneous loads - New 4160-480V Unit Substation ($150k) - New 480V MCC, 7 section, back-to-back ($125k) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-4	The existing unit substation "U2' and motor control center MCC-P2 is in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Old Plant Building	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the existing unit substation "U1" and motor control center "MCC-P1".	2	O	$1,080,000	$1,188,000	Included spare parts for 10 years (10,000/year) until equipment is replaced. Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. one (1) low lift pump; backwash pumps) and miscellaneous loads - New 1200A, 4.16kV, 4 section Medium Voltage Switchgear ($140k-estimate $35k per section) - New 4160V-480V Unit Substation ($150k) - New 480V MCC, 5 section, back-to-back ($100k) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-07-5	The variable frequency drive for LLP#2 is in fair/poor condition. This VFD has been in service for ~30 years and has reached the end of its expected life. The plant staff has indicated that this VFD needs to be replaced. The variable frequency drive for LLP#3 is in good/fair condition. This VFD has been in service for ~15 years. The plant staff has indicated that this VFD cannot be operated in auto due to the failure of the analog control board and replacement parts are not available.	Old Plant Building	Due to the age of the VFDs and the difficultly in obtaining replacement parts for the VFDs, it is recommended that both these VFDs be replaced.	1	O	$420,000	$462,000	Assumed replacement of the LLP2 & LLP3 LV VFDs: 2 x 480V, 250HP VFDs ($80k each) add labor, conduit, wiring
B-07-6	The existing medium voltage switchgear "MVSP" and motor control centers "MCC-P3", "MCC-P4", and "MCC-P4E" are in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Main Process Building	This equipment should be replaced within the next ten (10) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the electrical equipment at the Old Plant Building.	2	O	$1,370,000	$1,507,000	Included spare parts for 10 years and minor maintenance work as needed ($20,000/year). Failure is not immanent; however, the failure of this equipment will result in a loss of process equipment (e.g. high service pumps; backwash pumps) and miscellaneous loads -New 1200A, 4.16kV, 5 section Medium Voltage Switchgear/MCC ($175k-estimate $35k per section) - New 2000kVA, 4160V-480V Transformer ($80k) - (2) New 480V MCC, 6 section, back-to-back ($115k each) - add labor, ductbank, conduit, wiring - cost does not include building improvements (arch, struct, HVAC, etc.)
B-07-7	Low Voltage Switchgear "LVS3" located in the Main Process Building is in good/excellent condition. This switchgear has been in service for ~15 years.	Main Process Building	The existing Low Voltage Switchgear "LVS3" does not need to be replaced at this time. However, we recommend replacing the switchgear in conjuction with the upgrade of the standby power system.	4	O	$0	$0	Costs included in the project#: B-07-1
B-07-8	The variable frequency drive for HSP#2 is in excellent condition. This VFD has only been in service for ~5 years.	Main Process Building	There is no need to replace the existing VFD for HSP#2 at this time. The only reason to consider replacing this VFD is if the City would like this VFD to be the same make/model as the VFDs being replaced for LLP#2 and LLP#3 in the Old Plant Building.	4	O	$200,000	$220,000	For budgetary purpose assume $100k for a new VFD replacement; add cost for labor, assume reuse conduit/wire
B-07-9	The panelboard in the Chemical Feed Building is in fair/poor condition.	Chemical Feed Building	The panelboard in the Chemical Feed Building should be replaced.	3	O	$50,000	$55,000	Assume 200A, 480V, 65 kAIC, 42 ckts, Panelboard
B-07-10	There are not any ground detection lights on Unit Substation "U2" located in the Old Plant Building.	Old Plant Building	Ground detection lights should be added to this unit substation. If the voltage is changed to a grounded system (either 480V or 4160V), then ground detection lights would no longer be required.	4	N	$10,000	$11,000	Include 4160/120V transf, Basler BE1-59N ground fault overvoltage relay & resistor

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-07-11	The convenience receptacles installed in the Pipe Galleries and Chemical Rooms are not GFCI type receptacles.	Old Plant Building and Main Process Building	Recommend replacing all receptacles in these areas with GFCI type receptacles.	4	N	$5,000	$5,500	Assume 50 GFCI receptacle are installed
B-07-12	The chlorine storage room does not have a chlorine scrubber system installed to react to a chlorine leak; The room ventilation does not automatically turn on when the room is being occupied.	Main Process Building	Upgrade the HVAC system controls so that the room exhaust fan operates when the door is opened and the room is occupied. Consider adding a chlorine scrubber for this room.	4	N	$0	$0	See B-05-02. Consider adding a chlorine scrubber.
B-07-13	The interior entrance door for the Electrical Room swings in and is not equipped with panic hardware. This is a Code violation.	Main Process Building	This door swing needs to be reversed to swing out and panic hardware needs to be installed. Investigate whether existing door can be modified or if new door will be required.	4	N	$0	$0	See B-02-11. Cost inserted from B-02-11
B-07-14	The Destrat pump is a submersible pump and fails after approximately one year of service. This has improved since the VFD was installed for this pump. The plant staff indicated that it would be beneficial to install a new pump and motor outside instead of being submersible (e.g. mounted on the grass/pavement near shoreline).	Old Plant Building	Recommend investigating the installation of a non-submersible pump and motor to replace the existing submersible motor.	4	N	$20,000	$22,000	Install one pump (process is not included)
B-07-15	The plant staff indicated that there were areas of the Clarifier Building where local disconnects were not provided for equipment. As long as the upstream feeder can be locked out at the MCC, this is not a Code violation, but having local disconnect switches would benefit the equipment maintenance activities.	Clarifier Building; Other areas of the plant	Install local disconnect switches for equipment that do not presently have one.	4	N	$50,000	$55,000	Assume 25 x Siemens 100A, 3-pole, 480V, fused, single throw disconnect switch, NEMA 4X, stainless steel enclosure; The final quantity/total cost to be determine later
B-07-16	The plant staff indicated that performing maintenance on the motors and equipment in the Sludge Vault is difficult due to the lack of space inside. This poses a safety and maneuverability issue inside the vault. The plant staff suggested installing submersible pumps on a rail.	Sludge Vault	Investigate alternative layouts for these pumps within the vault that will allow for safer maintenance activities.	3	O	$20,000	$22,000	Assume two (2) Goulds GS submersible pump, 10 HP - 10 GPM - 460Volts - 3 Phase - 3 Wire - Control Boxes Included: **Structural & process cost not included for modifications.**

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-07-17	The plant staff mentioned that there was an issue with the pumps located in the Sludge Vault. When there is not any backpressure on the pumps, they will seize.	Sludge Vault	Investigate issue with pump operation to determine best course for correction.	2	O	$0	$0	Process included cost; further investigation is required
B-07-18	There was no fire alarm system installed at the plant.	Entire WTP	A fire alarm system should be provided for all of the buildings at the plant.	4	N	$450,000	$540,000	Life safety related Assumed cost for three(3) buildings (includes communication & fire alarm system, sound system 100 outlets, boxes, conduit & wires) See B-07-23 inserted by J. Meyer in October, 2018
B-07-19	The plant staff mentioned that there was not any rotation in the operation of the process equipment (e.g. High Service Pump #2 operates all of the time, only one lime slaker is operated, etc.).	WTP and Remote Sites	Recommend rotating the operations of the equipment and alternate between different pumps and process equipment. This will help ensure all equipment is operational and it will be available if there is an equipment failure.	3	M	$0	$1,000	Assume no additional equipment; cost with maintenance personnel (assume 2 people x 8 hours)
B-07-20	There is not record of periodic exercising of the standby engine generators.	WTP and Remote Sites	Recommend exercising the standby engine generators monthly to confirm proper operation. Ideally, the engine generators should run loaded. Transfer the plant or pumping station loads to the generator if possible.	4	M	$0	$1,000	Assume no additional equipment; cost with maintenance personnel (assume 2 people x 8 hours)
B-07-21	Some areas from WTP and the remote sites do not have surveillance system	WTP and Remote Sites	Recommend installation of security cameras systems for all sites	2	N	$1,300,000	$1,430,000	Locations & quantities to be discussed with client Assumed cost for one site (include 16 outdoor vandal proof, dome security cameras, 32-channel network recorder, 18TB hard drive, 4000 ft CAT5 cable, Port SOE Switch, Port POE Switch, 22" LCD Monitor)-$40k per site/13 sites -add cost for labor, conduit, wiring

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-07-22	HSP #2 is the only high service pump with a variable speed drive, capable of operating at the range of lower flow rates currently required. It is operated continuously, more than 90 percent of the time.	Main Process Building	Provide additional VFDs for the high service pumps. High Service Pump No. 1 is 480V, but the other two high service pumps (No. 3 and No. 4) are medium voltage motors. A medium voltage VFD would be requried for these pumps.	3	O	$1,100,000	$1,210,000	Cost for three new VFDs. For budgetary purpose, assume $100k for a new 480V VFD and $200k for 4160V VFD; add cost for labor, conduit, wiring This cost is for new VFDs only. Please note that there is limited space at the facility and medium voltage VFDs are large. A new conditioned room will need to be designed for new VFDs and conduits will need to be routed through this plant from the main swtchgear to the VFD and from the VFD to the pump. This will be a multi-discipline project. The project cost (construction and engineering) would increase depending on the requried building improvements (arch, struct, HVAC) necessary. An alternate approach would be to replace the high service pump motors with 480V motors and install 480V VFDx. A study of this approach would need to be done in order to determine the feasibilty of this design. This study would include an evalutation of the 480V disctribution system in the Main Process Buildling.
B-07-23	There was no fire alarm system installed at the plant.	Entire WTP	An assessment/study of the fire alarm system needs should be provided for all of the buildings at the plant.	4	N	$0	$0	Life safety related Assumed cost for three(3) buildings (includes communication & fire alarm system, sound system 100 outlets, boxes, conduit & wires) See B-07-23 inserted by J. Meyer in October, 2018
B-07-24	Detailed Electrical Replacement Study of the Old Plant	Old Plant Building	Study	2	O			
B-08-1	Process controls at the ClariCones (primarily influent piping design, effluent weirs, flow meters & valves) do not allow for a typical turn-down ratio for these treatment units. Combined with the inadequate control of low lift pumping rate, this inflexibility of treatment rate at the ClariCones results in a limited ability to control treatment flow rate and pace customer usage.	Clarifier Building	Replace/Repair instruments. See Process recommendation B-04-16.	4	M	-	-	
B-08-1	Install level instruments on each filter and integrate into backwash sequence and operational control. Level signals should be integrated with SCADA.	Filtration	Installation new level instrumentation.	5	O	$50,000	$75,000	

Table 1 - Summary List of Projects at Bloomington WTP								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
B-08-2	Integrate additional monitoring and controls signals for generators, compressors, boilers, clearwell level, high service pumps, and raw water pumps in the SCADA system to provide remote monitoring capability.	Multiple location on Plant	Modify wiring for equipment to provide remote status signals (Running, Fault, Speed Indication, etc.) for equipmnent.	3	N	$150,000	$250,000	
B-08-3	Integrate chemical systems into the SCADA system to provide capabiity for remote monitoring and control of equipment. Phosphate chlorine (other than scales), fluoride, and ammonia system is not on SCADA. Carbon dioxide system volumes are not on SCADA. Several daytank and storage tank levels are not integrated with SCADA.	Chemical Systems	Modify wiring for equipment and instrumentation to provide signals for integration into the SCADA system.	4	O	$250,000	$350,000	
B-08-4	Replace existing level sensor on clearwell and install a 2nd level sensor for redundancy. Integrate both level sensors into the SCADA system for remote monitoring.	Clearwell	Replace existing level sensor and install 2nd level sensor.	4	O	$10,000	$15,000	
B-08-5	36" magnetic flowmeters from Lake Evergreen and low lift pumps are not functional and 20-30 years off.	Flowmeter Vaults	Replace both flowmeters.	2	O	$100,000	$120,000	
B-08-6	SCADA master plan implementation	Main Plant	SCADA improvements as recommended by outside consultant	3	O	$2,000,000	$0	

Table 2 - Summary List of Projects at Mackinaw Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
M-02-02	Minor cupping of roof shingles.	Mackinaw PS	Replace roof in 5 years.	5	M	$2,500	$2,500	
M-03-1	Minor corrosion on bridge crane frame	Mackinaw River PS	Scrape and paint	5	M	$5,000	$5,000	
M-04-1	Source water has limited capacity to adequately feed pumps.	Mackinaw River Pump Station	Consider abandoning station due to source water volume restrictions.	4	O	$150,000	$165,000	
M-05-01	Electric heater was operating but the thermostat wiring was not connected. The space also had portable space heaters.	Mackinaw Pumping Station	Replace electric unit heater and controls.	4	N	$3,000	$3,000	
M-05-02	The exhaust fan and outside air damper controls did not appear functional.	Mackinaw Pumping Station	Replace controls for exhaust fan and damper at outside air louver.	4	N	$3,000	$3,000	
M-07-1	The motor control center is in good condition. This equipment has been in service for ~30 years and is approaching the end of its expected life.	Mackinaw Pumping Station	It is recommended that this motor control center be replaced within the next ten (10) years, or if there is an upgrade being done at the pumping station.	3	O	$170,000	$187,000	One MCC is replaced, 4 section ($60k) -add cost for labor, conduit, wiring Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
M-07-2	There are two conduit LBs on the exterior of the building that are missing covers.	Mackinaw Pumping Station	Recommend installing the covers on these LBs.	5	M	$500	$500	
M-07-3	No VFD for pumps.	Mackinaw Pumping Station	Adding a VFD may allow for more controlled pumping from the pool.	5	O	$200,000	$220,000	
M-08-1	SCADA/Control cabinet is nonfunctional with several components missing.	Mackinaw River PS	Not part of scope, cabinet should be reviewed / replaced under SCADA Master Plan project.	-	-	-	-	
M-08-2	River level gauging station is nonfunctional. Sensing line has silted in.	Mackinaw River PS	Replace instrument and integrate into SCADA	4	N	$2,500	$5,000	

Table 3 - Summary List of Projects at Evergreen Lake Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
EL-01-1	Erosion adjacent to retaining walls.	Yard	Correct gullies and add erosion mat for steel slope.	5	M	$800	$880	
EL-02-01	Wooden stairs and fence at exterior generator enclosure are weathering; fence boards are curling.	Evergreen Lake	Replace damaged boards.	4	M	$2,000	$2,000	
EL-02-02	Door hardware is damaged or broken throughout, door frames are beginning to rust.	Evergreen Lake	Replace doors/frames/hardware.	4	M	$15,000	$15,000	
EL-02-03	Railing height does not meet code minimum height.	Evergreen Lake	Refer to Structural item EL-03-1	4	N	-	-	Refer to Structural item EL-03-1
EL-02-04	Masonry in good condition.	Evergreen Lake	Plan for repointing in 10 years.	5	M	$18,000	$25,000	
EL-02-01	Existing built-up roof in fair condition; cap stone is eroding away exposing asphalt to UV degredation in locations.	Evergreen Lake	Redistribute ballast stone to cover/protect roof, plan for replacement in 5-10 years.	4	N	$16,000	$17,500	
EL-02-05	Floors pitting and peeling.	Evergreen Lake	Patch concrete and recoat floors.	5	M	$3,000	$3,000	
EL-03-1	Guardrail at north and south retaining wall do not meet code minimum requirements for height, top rail, and spacing between mid-rails.	Evergreen Lake PS	Replace guardrails.	4	M	$10,000	$12,500	
EL-03-1	Delamination at southwest corner at top of concrete wall.	Evergreen Lake PS	No work necessary at this time.	5	M	$0	$0	
EL-04-01	Limitorque actuators not reliable. Operator must visit station to confirm valve position and adjust valves accordingly.	Evergreen Lake Pump Station	Replace all three valves and actuators. Rewire and integrate.	4	O	$75,000	$82,500	
EL-04-02	Cationic polymer storage tanks and feed systems don't have containment.	Evergreen Lake Pump Station	Provide drum containment system	3	O	$500	$550	
EL-04-03	No online standby cationic polymer pump installed.	Evergreen Lake Pump Station	Install a standby polymer metering pump.	2	O	$5,000	$5,500	
EL-04-04	No mixing at cationinc polymer injection point.	Evergreen Lake Pump Station	Evaluate options for improving mixing/diffusion of cationic polymer injection	2	O		$15,000	
EL-05-01	Plant staff indicated that plans are in place to upgrade the HVAC system, which includes replacement of the air handling unit and condenser.	Evergreen Lake Pump Station	Perform project as indicated.	4	N	$0	$0	

Table 3 - Summary List of Projects at Evergreen Lake Pump Station

Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
EL-07-1	The medium voltage motor control center is in fair/poor condition. Additionally, the working clearances for the existing 2400V motor control center located at the Evergreen Lake Pumping Station does not meet Code. It is noted that this equipment is being removed as part of a future project that is presently in the design phase. The plant staff indicated that the new VFDs will be installed where this existing 2400V motor control center is presently installed.	Evergreen Lake Pumping Station	There is not a lot of space between the wall and the pump. Recommend that the working clearances being provided for the new VFDs be confirmed.	5	N	$0	$0	Assume that the ongoing project should address this clearance issue
EL-07-2	The variable frequency drive for Low Lift Pump No. 3 is in good/fair condition. This VFD has been in service for ~15 years. This VFD is the same model as the VFD for LLP#3 at the WTP, where the plant staff indicated that replacement parts are not available.	Evergreen Lake Pumping Station	If the replacement of this VFD is not part of the future project, recommend that this VFD be replaced.	2	O	$200,000	$220,000	**TBD with client** 450 HP, 460V VFD (100k) - add cost for labor, assume reuse conduit/wire
EL-08-1	Lake RF level instrument is nonfunctional.	Evergreen Lake PS	Replace instrument and integrate into SCADA	4	N	$2,500	$5,000	
EL-08-2	Flow meter is nonfunctional.	Evergreen Lake PS	Replace instrument and integrate into SCADA	4	N	$3,000	$5,000	
EL-08-3	No calibration column at cationic polymer.	Evergreen Lake PS	Modify piping to provide calibration column	4	M	$1,500	$3,500	

Table 4 - Summary List of Projects at Division Street Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
D-02-01	Shingle roof was not accessible at the time of the walkthrough. Calcification noted at edges of concrete planks on interior.	Division St PS	Replace shingle roof, refer to structural item D-03-1.	5	M	$17,500	$17,500	
D-02-02	Exit door was stuck closed due to air pressure differential.	Division St PS	Refer to HVAC item D-05-03.	5	M	$0	$0	
D-02-03	Basement windows are single pane, one is missing and boarded over.	Division St PS	Replace windows with operable insulated units.	5	N	$5,000	$5,000	
D-03-1	Delamination noted on precast panels on roof structure. Spalling has occurred in multiple areas.	Division Street PS	Concrete appears to be adequate at this time; however, long term replacement should be considered.	4	M	$50,000	$55,000	
D-03-2	Corrosion noted on walkway bases.	Division Street PS	Scrape and paint walkway bases.	5	M	$0	$0	
D-03-3	Unistrut support columns for controls are severely corroded or exhibit significant or entire section loss.	Division Street PS	Replace with stainless steel unistrut members.	5	M	$1,000	$1,000	
D-04-2	The current drive shafts at each of the four pumps are failing at less than two years service and create a difficult service and repair burden at current staffing levels.	Division Street Pump Station	Replace the drive shafts at each of the four pumps with units designed for longer service life.	5	M	$40,000	$44,000	
D-04-3	Provide OSHA compliant and safe access to operate valve hand wheels at the pump station discharge header.	Division Street Pump Station	Evaluate alternatives to improve valve operation.	5	M		$10,000	
D-04-4	Provide OSHA compliant and safe access to pump drive shaft bearings and universal-joints during maintenance and replacement operations.	Division Street Pump Station	Evaluate alternatives to improve pump maintenance.	5	M		$10,000	
D-04-5	Provide suction and discharge gauges at each of four pumps.	Division Street Pump Station	Install gauges	5	M	$5,000	$5,500	
D-05-01	Diesel storage tank corroded.	Division Street Pump Station	Repaint tank	4	M	$2,000	$2,000	
D-05-02	Diesel storage tank piping corroded.	Division Street Pump Station	Paint piping.	4	M	$500	$500	
D-05-03	The outside air dampers associated with the exhaust system don't appear to fully open upon actuation. A negative space pressure occurs when both exhaust fans are operating.	Division Street Pump Station	Service outside air damper actuators and replace as needed.	4	M	$5,000	$5,000	

Table 4 - Summary List of Projects at Division Street Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
D-05-04	The outside air louver and damper above the stairs is not easily maintainable.	Division Street Pump Station	Install sheet metal collar to allow side removal of the louver screen.	4	M	$1,000	$1,000	
D-05-05	Lower level gas unit heater flue is uninsulated at personnel height on upper level. This can be pose a safety issue with a hot surface.	Division Street Pump Station	Insulate flue below 8'-0" AFF.	4	M	$500	$500	
D-05-06	The furance and air conditioning system appears to be past is expected service life.	Division Street Pump Station - Sale House	Replace furnace and air conditioning system.	4	N	$5,000	$5,500	
D-06-01	The backflow preventer is bypassed for the domestic water.	Division Street Pump Station - Sale House	Replumb so that backflow preventer is not bypassed.	4	M	$500	$500	
D-06-02	Corrosion observed on natural gas service piping.	Division Street Pump Station - Sale House	Paint piping.	4	M	$100	$100	
D-07-1	The medium voltage motor control center located in the Division Street Pump Station is in good condition. This equipment has been in service for ~25 years and is approaching the end of its expected life. Replacement parts are still available for this equipment. Additionally, this motor control center is the service entrance equipment and does not have a main disconnecting means for the utility feeder or for the generator feeder. The working clearance in the front and rear of the medium voltage does not meet Code.	Division Street Pump Station	This equipment should be replaced within the next ten (10) to fifteen (15) years. The replacement equipment should have main disconnecting means for the utility and generator feeders. The Code required working clearance will need to be taken into account when determining the location of the new medium voltage motor control center.	3	O	$500,000	$550,000	- New 1200A, 2.4kV motor control center ($200k) - add cost for labor, conduit, wire Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
D-07-2	The medium voltage diesel engine generator and transfer controller are in fair condition. The engine generator and transfer controller have been in service for ~30 years. The engine generator is approaching the end of its expected life. The transfer controller has reached the end its expected life.	Division Street Pump Station	Recommend that the engine generator and transfer controller be replaced in conjunction with the replacement of the medium voltage switchgear.	2	O	$914,000	$1,005,400	Per CAT Quotes: - 500 kW/625kVA, 2400V/ w 24-h fuel tank diesel generator (150k); - 1200A, 2400V switchgear and automatic transfer control (282k) CAT to confirm the price

Table 4 - Summary List of Projects at Division Street Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
D-07-3	The City staff indicated that there is an issue with the size of the motors for Pumps No. 3 and 4 at the Division Street Pump Station. The motors appear to be undersized.	Division Street Pump Station	Evaluate the pumps at the Division Street Pumping Station. If changes need to be made to the motor sizes based on the pumping evaluation, it is recommended to install induction motors instead of wound rotor motors amd replace all four motors at the same time. Also, it is recommended that the motor control center be replaced at the same time.	1	O	$800,000	$960,000	For budgetary cost assume: - four (4) motors rated at 250hp, 2.4 kV, TEFC, Class F, 1725 rpm ($100k each). - cost does not include replacmenet of motor control center. Additional cost of $550k is estimate for that work.
D-07-4	There is a second utility feeder serving a 240/120V single phase panelboard in this pumping station. This was likely done due to the limited capacity on the 2400V-480V transformer installed in the medium voltage motor control center.	Division Street Pump Station	Recommend eliminating the second feeder and install a larger 2400V-480V transformer in the pumping station to accommodate all of the pumping station loads. We recommend replacement at the same time as the medium voltage motor control center.	5	N	$70,000		Transfomers size to be confimed. Assume one(1) 225 kVA, 2400/480V, dry-type, 60Hz, 220C, copper, transfomer and one(1) 75 kVA, 480/240V single phase, dry-type, copper
D-07-5	The 480V panelboard installed in the rear of the medium voltage motor control center is missing its cover.	Division Street Pump Station	Provide a replacement cover for this panelboard.	4	N	$100	$100	
D-07-6	The convenience receptacles installed in the Pipe Gallery of the Division Street Pumping Station are not GFCI type receptacles.	Division Street Pump Station	Replace the receptacles with GFCI type receptacles.	4	N	$500	$500	Quantity to be confirmed. Assume ten(10) GFCI receptacle are installed
D-07-7	There was no emergency lighting or exit sign at the main entrance to the pumping station	Division Street Pump Station	An emergency lighting fixture and exit sign should be installed at the main entrance.	4	N	$500	$500	Include fixture & sign, charger, wire, conduit, etc.
D-07-08	Division Street/Enterprise Electrical Study	Division Street Pump Station	Peform detailed study of the Division Street Pump Station	2	O			Process included costs.
D-08-1	Replace DP sensor/transmitter, block & balance manifold, and sensor lines at each of the two venturi flowmeters at the pump station discharge lines. This will replace obsolete, non-functioning equipment and adequate maintenance in the future to include routine flushing and air purging at sensor lines.	Division Street Pump Station	Replace instruments	4	O	$5,000	$6,000	

Table 4 - Summary List of Projects at Division Street Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
D-08-2	Replace gauge pressure sensor / transmitters at each of two pump station discharge connections to distribution system and install a suction gauge pressure sensor / transmitter at each of the two pump station suction connections. This will allow accurate monitoring, recording, and logging of pump station operation in the SCADA system.	Division Street Pump Station	Replace instruments	4	O	$3,000	$4,000	

Table 5 - Summary List of Projects at Enterprise Zone Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
E-02-01	Exterior hollow metal doors are rusting.	Enterprise Zone PS	Replace hollow metal doors.	5	N	$6,000	$6,000	Consider replacement of pump station ($150,000)
E-02-02	Garage doors beginning to rust.	Enterprise Zone PS	Replace sectional garage door.	5	N	$10,000	$10,000	Consider replacement of pump station.
E-02-03	Wooden framing and fascia boards beginning to rot.	Enterprise Zone PS	Repair / replace fascia boards.	5	N	$1,000	$1,000	Consider replacement of pump station.
E-02-04	Door between electrical room and pump room has a 3-hr fire rating; however, partition wall with openings does not provide any fire rating.	Enterprise Zone PS	Replace door and wall with approved materials meeting minimum fire rating.	3	N	$10,000	$10,000	Consider replacement of pump station.
E-02-05	Large amounts of sediment on existing built-up roof with ballast stone. Roof is in poor condition and ponds at the middle.	Enterprise Zone PS	Replace roofing membrane and ballast.	4	N	$7,500	$7,500	Consider replacement of pump station.
E-02-06	CMU walls show signs of water infiltrations	Enterprise Zone PS	Repoint exterior wall, rout and seal cracks.	5	N	$3,000	$3,000	Consider replacement of pump station.
E-03-1	Concrete spall at southeast corner.	Enterprize Zone PS	No work necessary at this time.	5	M	$0	$0	
E-04-1	No top slab over clearwell, opens potential to contamination and flooding through grating. Floor was not 6 inches above grade. Grade does not slope away from clearwell. Maintenance staff may have to stand in water to service electrical equipment under flood conditions.	Enterprise Pump Station	In accordance with 10 State Standards the station does not meet the minimum requirements of the standards in that the floor is to be drained in a manner that the quality of the potable water will not be endangered. The floor of the pump station should be at least six inches above finished grade. Suction well should be watertight to prevent contamination.	1	O		$50,000	
E-04-2	Flow meter was not found at the time of our site visit.	Enterprise Pump Station	All pump stations are required to be metered by 10 State Standards. Meter should be calibrated if it exists.	5	M		$5,000	Consider replacement of pump station. Talk with Brandon
E-04-3	Pump P3 motor appears to run hot based on feel.	Enterprise Pump Station	Evaluate pump and pumping process	4	M		$10,000	Consider replacement of pump station.
E-04-4	Two 30-inch butterfly valves at wet well influent don’t close reliably and leak up to 900 gpm when closed.	Enterprise Pump Station	Replace two 30-inch butterfly valves	5	M	$20,000	$22,000	
E-04-5	The 12-inch silent wafer check valves at the discharge of Pump 1 and Pump 3 are leaking.	Enterprise Pump Station	Replace the check valves	5	M	$20,000	$22,000	
E-04-6	Provide throttling at air relief valves to reduce the hydraulic shock when the discharge pipe is filled on startup of Pumps 1, 2 & 3.	Enterprise Pump Station	Evaluate alternatives to reduce hydraulic shock	5	M		$10,000	

Table 5 - Summary List of Projects at Enterprise Zone Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
E-04-7	Regulatory issues at PS. Several items do not meet 10SS and multiple defficiencies were noted.	Enterprise Pump Station	Recommend an evaluation of the pump station to consider replacement. In addition, it may be prudent to consider replacement of the Division Street Pump Station to join it with a new combined pump station.	1	M	$5-10M	$10,500,000	
E-05-01	Cooling in the pump room seems inadequate.	Enterprise Zone Pump Station	Upgrade exhaust fan cooling system with DX system.	4	N	$10,000	$11,000	
E-05-02	The outside air louvers on the overhead door that serve the pump room do not contain dampers. This can cause cold air infiltration during the winter time.	Enterprise Zone Pump Station	Install motorized dampers.	4	N	$1,000	$1,000	
E-06-01	No permanent sump pump system. Sump pump discharge consists of fire hose.	Enterprise Zone Pump Station	Install more permanent sump pump system with piping.	4	M	$1,000	$1,100	
E-06-02	Service water line not insulated.	Enterprise Zone Pump Station	Add pipe insulation.	4	M	$100	$100	
E-07-1	The motor control center is in fair/poor condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Additionally, the motor control center is the service entrance equipment for the pump station and does not have a main disconnecting means.	Enterprise Zone Pump Station	Due to the age and condition of this motor control center, and due to lack of main disconnecting means, it is recommended to replace this MCC.	1	O	$0	$0	Recommend study to replace pump station.
E-07-2	The UPS is in good condition. This equipment has been in service for ~30 years and has reached the end of its expected life.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the UPS be replaced.	1	O	$0	$0	Recommend study to replace pump station.
E-07-3	The reduced voltage starter for Pump #2 (housed in the existing VFD enclosure) is in fair condition. It is noted that the VFDs for Pumps #1 and #3 have been replaced recently and are in excellent condition.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the reduced voltage starter for Pump #2 be replaced with another reduced voltage starter or VFD. The VFDs for Pumps #1 and #3 should remain.	2	O	$0	$0	Recommend study to replace pump station.

Table 5 - Summary List of Projects at Enterprise Zone Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
E-07-4	All of the electrical equipment (motor control center, VFDs, UPS) are mounted on the floor and not on a concrete housekeeping pad. This station is capable of flooding and water has reached the bottom of the equipment.	Enterprise Zone Pump Station	All new equipment should be mounted on a concrete pad due to the possibility of flooding in this pump station.	1	O	$0	$0	Recommend study to replace pump station.
E-07-5	Provide GFCI protected circuits for receptacles and equipment in wet areas. With the possibility of wet well overflow and water throughout the pump station, the entire pump station is potentially a wet area.	Enterprise Zone Pump Station	Replace all receptacles with GFCI type and replace circuit breakers in the 120/208V panelboard with GFCI circuit breakers as needed for other loads.	4	O	$0	$0	Recommend study to replace pump station.
E-07-1	The motor control center is in fair/poor condition. This equipment has been in service for ~30 years and is approaching the end of its expected life. Additionally, the motor control center is the service entrance equipment for the pump station and does not have a main disconnecting means.	Enterprise Zone Pump Station	Due to the age and condition of this motor control center, and due to lack of main disconnecting means, it is recommended to replace this MCC.	1	O	$0	$0	Recommend study to replace pump station.
E-07-2	The UPS is in good condition. This equipment has been in service for ~30 years and has reached the end of its expected life.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the UPS be replaced.	1	O	$0	$0	Recommend study to replace pump station.
E-07-3	The reduced voltage starter for Pump #2 (housed in the existing VFD enclosure) is in fair condition. It is noted that the VFDs for Pumps #1 and #3 have been replaced recently and are in excellent condition.	Enterprise Zone Pump Station	Due to the age of the equipment, it is recommended that the reduced voltage starter for Pump #2 be replaced with another reduced voltage starter or VFD. The VFDs for Pumps #1 and #3 should remain.	2	O	$0	$0	Recommend study to replace pump station.
E-07-4	All of the electrical equipment (motor control center, VFDs, UPS) are mounted on the floor and not on a concrete housekeeping pad. This station is capable of flooding and water has reached the bottom of the equipment.	Enterprise Zone Pump Station	All new equipment should be mounted on a concrete pad due to the possibility of flooding in this pump station.	1	O	$0	$0	Recommend study to replace pump station.

Table 5 - Summary List of Projects at Enterprise Zone Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
E-07-5	Provide GFCI protected circuits for receptacles and equipment in wet areas. With the possibility of wet well overflow and water throughout the pump station, the entire pump station is potentially a wet area.	Enterprise Zone Pump Station	Replace all receptacles with GFCI type and replace circuit breakers in the 120/208V panelboard with GFCI circuit breakers as needed for other loads.	4	O	$0	$0	Recommend study to replace pump station.
E-08-1	Replace DP sensor/transmitter, block & balance manifold, and sensor lines at the venturi flowmeter at the pump station discharge. This will replace obsolete, non-functioning equipment and adequate maintenance in the future to include routine flushing and air purging at sensor lines.	Enterprize Zone PS	Replace instruments	4	O	$3,000	$4,000	

Table 6 - Summary List of Projects at Fort Jesse Pump Station A								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	14	Estimated Project Cost	Notes
FJA-02-01	Existing windows are single-pane operable, sealant is cracking.	Fort Jesse PS A	Re-seal windows, recommend replacing with insulated units.	5	M	$10,000	$10,000	
FJA-02-02	Stoops heaving at entry doors.	Fort Jesse PS A	Reset stoops with proper subbase.	5	M	$1,000	$1,000	
FJA-02-03	Lintels at overhead door and windows are beginning to rust.	Fort Jesse PS A	Scrape and paint lintels.	5	M	$1,000	$1,000	
FJA-02-04	Toilet room not ADA accessible.	Fort Jesse PS A	Recommend creating accessible toilet facilities.	5	N	$15,000	$17,000	
FJA-02-05	Existing shingle roof is in good condition.	Fort Jesse PS A	Plan for roof replacement in 10 years.	5	M	$26,000	$28,000	
FJA-03-1	Foundation cracks on southeast corner. Cracks are not reflected on the inside.	Fort Jesse PS A	No work necessary at this time. Continue to monitor cracks, crack injection may be necessary in the future if deterioration worsens.	5	M	$0	$0	
FJA-04-1	Stuffing box from P2 has what appears to be an excessive drip. Reason for drip should be investigated (i.e packing worn, shaft imbalance, etc.)	Fort Jesse Pump Station A	Replace packing. Perform condition assessment of pump.	4	M	$10,000	$11,000	
FJA-04-2	Verify all pump suction and discharge pressure gauges functional and calibrated. Some gauges missing or appeared not properly operating.	Fort Jesse Pump Station A	Calibrate/replace gauges as necessary. Consider compound gauges on suction side, and standard gauges on discharge side of pump.	4	M	$5,000	$5,500	
FJA-04-3	Stuffing box from P1 has what appears to be an excessive drip. Reason for excessive drip should be inbestigated (i.e. packing worn, shaft impalance, etc.)	Fort Jesse Pump Station A	Condition assessment of pump and replace packing	4	M	$10,000	$11,000	
FJA-06-01	The sump cover is corroded.	Fort Jesse Pump Station A	Replace in-kind.	4	M	$500	$500	
FJA-06-02	Floor drains near main pumps are blocked.	Fort Jesse Pump Station A	Cleanout floor drain grating.	4	M	$50	$50	

Table 6 - Summary List of Projects at Fort Jesse Pump Station A								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	14	Estimated Project Cost	Notes
FJA-07-1	The existing motor control center is in fair/good condition. This equipment has been in service for ~40 years and has reached the end of its expected life. Replacement parts are no longer available, however replacement buckets are still available. There was a new vertical section added to this motor control center that was installed ~25 years ago.	Fort Jesse Pump Station A	Due to the age of this motor control center, and due to limited replacement parts available (full buckets only), it is recommended to replace this MCC.	2	O	$230,000	$253,000	One MCC is replaced, 7 section ($90k) -add cost for labor, conduit, wiring. Failure is not immanent; however, the failure of this equipment will result in a loss of this pumping station.
FJA-07-2	One of the pumps has a diesel engine backup. There is an underground diesel fuel tank for this diesel engine.	Fort Jesse Pump Station A	It is recommended to exercise this diesel engine periodically to confirm proper operation. Additionally, the integrity of the underground diesel fuel tank should be inspected. Recommend to perform an underground inspection to verify a leaking tank.	3	M	$0	$25,000	Environmental engineering study and report as well as a drilling company to identify a leaking tank. Review permit and reporting with OSFM.

Table 7 - Summary List of Projects at Fort Jesse Pump Station B								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
FJB-02-01	Window caulk cracking.	Fort Jesse PS B	Reseal windows.	5	M	$1,000	$1,000	
FJB-02-02	Lintels at overhead door and windows are beginning to rust.	Fort Jesse PS B	Scrape and paint lintels.	5	M	$1,000	$1,000	
FJB-02-03	No signage at bathroom	Fort Jesse PS B	Install signage	5	M	$0	$0	
FJB-02-04	Ceiling paint peeling in garage and mechanical room.	Fort Jesse PS B	Scrape and repaint ceiling.	5	M	$3,000	$3,000	
FJB-02-05	Existing shingle roof is in good condition.	Fort Jesse PS B	Plan for roof replacement in 10 years.	5	M	$26,000	$28,000	
FJB-03-1	Cracks at corners of hatch on north side.	Fort Jesse PS B	Continued monitoring, cracks at this time to not impact capacity or operation of hatch.	5	M	$0	$0	
FJB-03-2	Step cracking at south overhead door lintel.	Fort Jesse PS B	Tuckpointing face brick and rout and seal cmu.	5	M	$4,000	$4,000	
FJB-04-4	Operator indicated that pumps exhibit symptoms of cavitation (a gravel and rock sound typically indicates cavitation on suction side). Hydraulic system should be modeled to determine under what conditions cavitation is occurring which can result in mechanical damage and limit the allowable operating range of the pumps. Some potential causes, for example, could be straight pipe length distance from short radius elbow and butterfly valve upstream of pump inlet appear to be less than minimum recommended by the Hydraulic Institute (5 pipe diameters for elbow and 2 for butterfly valve). It is also noted that exansion joints are located immediately upstream and downstream of each pump.	Fort Jesse Pump Station B	Perform a condition assessment of pumping system.	3	N		$15,000	Working with Peter Lynch
FJB-04-5	Silent check vales noted in pump station.	Fort Jesse Pump Station B	Inspect the silent check valves. Consider alternate pump check valves which have indicators to show they are open or closed.	5	N		$25,000	
FJB-04-6	Pressure monitors don't have charts. Charts should be installed or an automated device installed.	Fort Jesse Pump Station B	Install charts or replace gauges.	4	M	$1,000	$1,100	Working with Peter Lynch
FJB-04-7	Prime on top half of pump appears to be leaking which will result in corroding bolts joining the top and bottom halves of the pump.	Fort Jesse Pump Station B	Repair primer to stop leak.	4	M	$1,000	$1,100	Working with Peter Lynch

Table 7 - Summary List of Projects at Fort Jesse Pump Station B								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
FJB-04-08	Paint flaking off piping.	Fort Jesse Pump Station B	Apply touchup paint to piping as necessary.	5	M	$2,000	$2,200	
FJB-04-09	Confirm pump station flow meter calibrated.	Fort Jesse Pump Station B	Calibrate meter.	5	M	$5,000	$5,500	
FJB-04-10	Meter vault sump pump piping broken.	Fort Jesse Pump Station B	Replace and protect piping to minimize future disturbance.	5	M	$1,000		
FJB-04-11	Perform a study of the options for flow meter replacement and associated piping improvements should be conducted to remove inaccuracies of meter.	Fort Jesse Pump Station B	Study to Determine Options	5	M	$0	$20,000	Richard recommended study in note adjacent to FJB-04-09
FJB-06-01	Corrosion observed on natural gas service piping.	Fort Jesse Pump Station B	Paint piping.	4	M	$100	$100	
FJB-06-02	Meter vault sump pump discharge piping disconnected.	Fort Jesse Pump Station B	Repair piping. Replace PVC with galvanized steel.	4	M	$500	$500	
FJB-06-03	RPZ backflow preventers discharge directly to floor.	Fort Jesse Pump Station B	Pipe backflow preventer discharge to wet well.	4	M	$500	$500	
FJB-06-04	Domestic water heater past expected service life.	Fort Jesse Pump Station B	Replace water heater.	4	M	$1,000	$1,000	
FJB-07-1	The motor control centers are in good condition. This equipment has been in service for ~25 years and is approaching the end of its expected life. Replacement parts are still available for this equipment.	Fort Jesse Pump Station B	This equipment should be replaced within the next ten (10) to fifteen (15) years. It is recommended that this equipment be replaced in conjunction with the upgrade of the electrical equipment at the Fort Jesse Pump Station A..	3	O	$400,000	$440,000	(2) MCCs, 5 sections ($75k each) -add cost for labor, conduit, wiring Failure is not immanent, but the failure of this equipment will result in a loss of both For Jesse Pump Stations.
FJB-07-2	The two VFDs are in fair condition. This equipment has been in service for ~25 years and has reached the end of its expected life. Replacement parts may no longer be available for this equipment.	Fort Jesse Pump Station B	Due to the age of these VFDs, and due to limited replacement parts available, it is recommended to replace these VFDs and associated isolation transformers.	2	O	$420,000	$504,000	Two new 350hp, 480V VFDs ($100k each)

Table 8 - Summary List of Projects at Fort Jesse Reservoirs								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
FJ-03-1	Gaps are present under tank base and top of foundation.	Fort Jesse Tanks 1 and 2	Recommend to add non-shrink grout or sealant between tank base and foundation.	5	M	$10,000	$10,000	
FJ-03-2	Surface corrosion noted on both tanks in isolated locations. Typically where coating has been replaced.	Fort Jesse Tanks 1 and 2	Recommend to remove coating and scrape and recoat.	5	M	$300,000	$330,000	Interior and exterior coating systems at these tanks are beyond their service life. Given the age, it is likely the coatings may contain lead. Recommend a full interior and exterior blast and repaint with containment. May consider recoating in 5-10 years. Repair pitting during repainting.
FJ-04-1	The tank roof vents do not appear to conform to AWWA D100 recommendations for self-correcting, frost free operation. Replacement vents should be included in the budget costs for tank painting.	Fort Jesse Tanks 1 and 2	Replace vents	5	M	$15,000	$16,500	
FJ-04-2	Based on available information, the tanks could benefit from installation of silt stops and anti-vortex baffles. The cost for these improvements should be included in tank painting.	Fort Jesse Tanks 1 and 2	Install silt stops and baffles	5	M	$15,000	$16,500	

Table 9 - Summary List of Projects at Main Street Booster Pump Station								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
MPS-04-1	Surficial rust noted on piping.	Main Street Pump Station	Prime and paint piping at locations of welds and other locations.	5	M	$2,000	$2,200	
MPS-04-2	Verify all gauges calibrated.	Main Street Pump Station	Implement maintenance program.	5	M	$5,000	$5,500	Talk with April
MPS-04-3	The current pumps in the station appear to be oversized for customer usage within the pressure zone. Investigation has determined that a number of connections to lower-pressure zones were inadvertantly open. With these valves closed, the pump station could not operate at low flows.	Main Street Pump Station	Evaluate options for improving pump performance at lower flows.	3	O		$25,000	
MPS-05-01	The exhaust system requires an occupant to enter the space to operate.	Main Street Booster Pump Station	Relocate exhaust fan disconnect switch near the hatch entry.	4	M	$1,000	$1,000	
MPS-05-02	The exahust fan appears to be past its expected service life.	Main Street Booster Pump Station	Replace exhaust fan.	4	N	$1,000	$1,000	
MPS-07-1	One of the lighting fixtures is missing its gasketed cover.	Main Street Booster Pump Station	Replace the missing gasketed cover for the lighting fixture.	5	M	$100	$100	
MPS-07-2	The convenience receptacles installed in the Main Street Booster Pumping Station are not GFCI type receptacles. The receptacles and switches do not have weatherproof covers.	Main Street Booster Pump Station	Replace the receptacles with GFCI type receptacles. Install weatherproof covers over the receptacles and switches.	4	N	$500	$500	Assume ten(10) GFCI receptacle are installed

Table 10 - Summary List of Projects at Lime Sludge Lagoons								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
LSL-04-1	Lagoons are nearing capacity.	Lagoons	More aggressively remove lime sludge, and evaluate options such as letting additional contracts than to only 1 company	4	O	$2,400,000	$2,640,000	

Table 11 - Summary List of Projects at Hamilton Road Elevated Tank								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
H-02-01	Exterior hollow metal door with louvre is beginning to rust, missing weatherseal, and bent at bottom corner.	Hamilton Elevated Tank	Replace hollow metal door.	5	M	$3,000	$3,000	
H-04-1	12" Cla-Val position appeared to have been reversed.	Hamilton Road Elevated Tank	Verify valve in proper condition	5	M		$5,000	
H-04-2	Overflow piping and inlet valves are sized for 2100 gpm but the tank is often operated at a fill rate well in excess of this rate creating high headloss through the intake piping and elevated system pressures.	Hamilton Road Elevated Tank	Evaluate alternatives to reduce fill rate.	4	O		$5,000	
H-04-3	Swing check valve on the outlet line was damaged and is currently non-functional.	Hamilton Road Elevated Tank	Repair / replace the swing check valve	4	M	$5,000	$5,500	
H-04-4	The tank is nonfunctional due to the hydraulic grade line in the transmission mains being at or below the bottom capacity line (BCL) of the tank.	Northeast Elevated Tank	Evaluate options for improving tank operation.	3	O		$15,000	
H-04-5	Coating is deteriorating	Hamilton Road Elevated Tank	Combine valves and add corrosion protection and new coating system	3	O	$1,300,000	$1,320,000	

Table 12 - Summary List of Projects at Northeast Elevated Tank								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
NE-03-1	Lower end of the interior access ladder isn't anchored and there is no structure available to anchor it.	Northeast Elevated Tank	Add concrete pad and metal stock to anchor end of ladder.	5	M	$1,000	$1,000	

Table 13 - Summary List of Projects - General								
Project/ Item No.	Finding	Area in Plant	Recommendation	Problem Class	Functional Category (O, N, or M)	Estimated Construction Cost	Estimated Project Cost	Notes
H-01-01	Assess the condition of the corrosion control and protection system	Yard	Assess CP system.	5	N	$20,000	$22,000	
General	Air valves and air-vacuum valves along the pipeline from the WTP to the Division St Reservoirs vent below grade within concrete vaults. Each vault is equipped with a vent to atmosphere at about 3-feet above grade. With the valve venting into the below-grade enclosure, the possibility exists for groundwater within the vault to be drawn into the transmission main when vacuum is being relieved.	Transmission Mains	Excavate to remove flat slab top and expose existing ARV piping. Remove existing ARV valve and piping as do not know condition. Replace ARV valve and piping. New piping to connect to ARV, extend to surface and gooseneck down.	1	O	$80,000	$88,000	
General	Security at all remote sites was lacking.	Remote Sites	Assess security features at all remote sites.	5	N	$160,000	$176,000	
General	No pump maintenance program appeared to be implemented.	Pumps	Recommend a pump maintenance program to understand baseline values for power consumption, temperature change, leakage, pressure (suction and discharge), vibration, noise characterisitcs, lubricant condition, shaft position, rate of flow, speed, and bearing wear at a minimum in accordance with the Hydraulic Institute standards for the centrifical pumps	4	M		$10,000	

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Appendix D

Calibration Locations

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CDM Smith

Claricone 4 Effluent Weir

Reference elevation: 744.85
Measured WS El: 745.19
Unit Flow: 6.44 MGD
Total Plant Flow: 13 MGD

East Recarb Basin Influent Chamber

Reference elevation: 744.11 (East) and 744.10 (West)
Measured WS El: 742.51 (East) and 742.44 (West)
Total Plant Flow: 13 MGD

East Recarb Effluent Channel

Reference elevation: 744.11 (East) and 744.10 (West)
Measured WS El in Basin: 741.83 (East) and 741.86 (West)
Measured WS El in Effluent Channel: 740.86 (East) and 740.63 (West)
Total Plant Flow: 13 MGD

Filter 11

Reference elevation: 740.42
Measured WS El in Gullet: 737.62
Measured WS El in Filter: 737.57
Estimated Filter 11 Flow: 1.64 MGD
Total Plant Flow: 13 MGD

Filter 16

Reference elevation: 745.47
Measured WS El in Filter: 737.98
Filter 16 Flow: 1.35 MGD
Total Plant Flow: 13 MGD

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Appendix E

Proposed Bypass Piping

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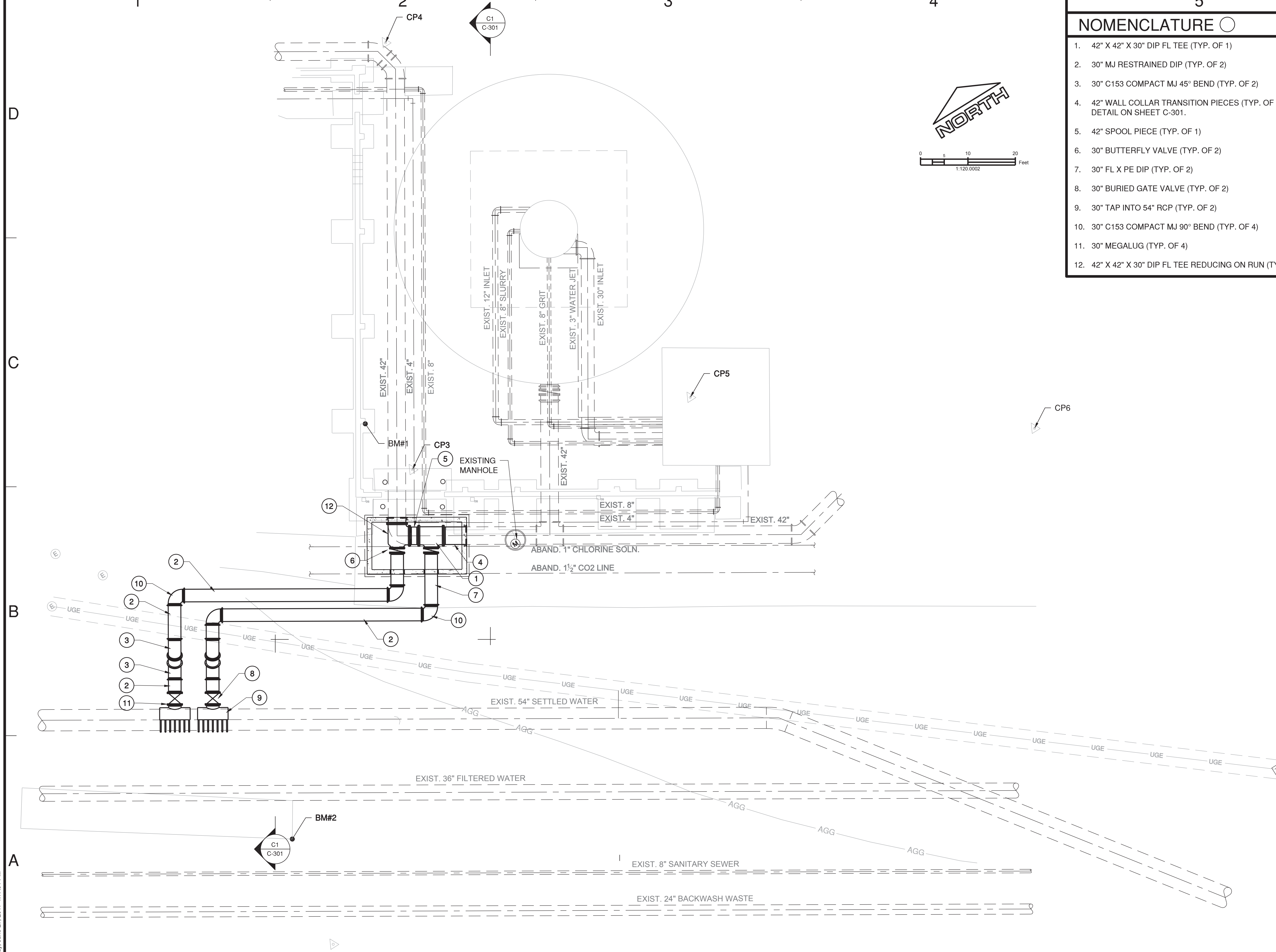

NOMENCLATURE

1. 42" X 42" X 30" DIP FL TEE (TYP. OF 1)
2. 30" MJ RESTRAINED DIP (TYP. OF 2)
3. 30" C153 COMPACT MJ 45° BEND (TYP. OF 2)
4. 42" WALL COLLAR TRANSITION PIECES (TYP. OF 2) SEE DETAIL ON SHEET C-301.
5. 42" SPOOL PIECE (TYP. OF 1)
6. 30" BUTTERFLY VALVE (TYP. OF 2)
7. 30" FL X PE DIP (TYP. OF 2)
8. 30" BURIED GATE VALVE (TYP. OF 2)
9. 30" TAP INTO 54" RCP (TYP. OF 2)
10. 30" C153 COMPACT MJ 90° BEND (TYP. OF 4)
11. 30" MEGALUG (TYP. OF 4)
12. 42" X 42" X 30" DIP FL TEE REDUCING ON RUN (TYP. OF 1)

CMT

License No. 184-000613

CONSULTANTS

60% SUBMITTAL
JUNE 2017

RECARBONATION TANK BYPASS PIPING

OWNER

Bloomington ILLINOIS

CITY OF BLOOMINGTON

BLOOMINGTON, ILLINOIS

MARK	DATE	DESCRIPTION

PROJECT NO: 17001-04-00
CAD DWG FILE: 170010400-C-102.DWG
DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:

SHEET TITLE

PROPOSED PIPING PLAN

C-102

SHEET OF

Path: J:\Bloomington\IL\17001-04-00_RecarbonationTankBypassPiping\Draw\Sheets\170010400-C-102.dwg
Date: Tuesday, June 27, 2017 4:17:51 PM

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Appendix F

Photos of Softened Water Piping Interior

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48" Softened Water
Piping, Modeled C
Factor = 55


Build up of lime solids creating reduced pipe diameter

Appendix G

Water System Improvements Map

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City of Bloomington Illinois

CDM Smith

0 0.25 0.5 1 Miles

N

Appendix G

Water Main Risk Prioritization

City of Bloomington, IL

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Appendix H

Pump Performance Testing Results

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Memorandum

To: *Robert Yehl, P.E., Water Director*
City of Bloomington Water Dept

From: *CDM Smith*

Date: *May 16, 2019*

Subject: *Pump Performance Testing Results*
Technical Memorandum

Introduction

CDM Smith and M.E. Simpson conducted pump performance testing on the City of Bloomington's (City's) low-lift, high service, and booster pumps at the following locations: Lake Bloomington Low Lift Pumps, Evergreen Lake Low Lift Pumps, Water Treatment Plant High Service Pumps, Division Street Pump Station, Fort Jesse A Pump Station, Fort Jesse B Pump Station, and Enterprise Zone Pump Station. Performance testing is a common procedure that determines how well a pump operates compared to its original manufacturer specifications and allows for assessment of the condition of its internal components without any disassembly. In this instance, data collected from the performance tests were used to compare to the original factory performance test for each pump tested.

The power requirements, where power readings were collected, were also calculated to estimate their efficiencies over a range of flow rates. Knowing the efficiency at different operating conditions will help the City determine their ideal pump operation.

Performance Testing Procedure

Performance tests are conducted in a controlled setting to eliminate potential sources of error. Several parameters are measured to calculate total dynamic head (TDH) and efficiency such as suction head (water level in the wet well for vertical turbine pumps or pressure gauges for horizontal split case pumps), discharge head, flow rate, current, and voltage. The pump is run over a range of flow rates to collect enough data points for the performance and efficiency curves by operating the discharge control valve.

The performance testing was conducted by subcontractor M.E. Simpson under the guidance of CDM Smith personnel. In a typical performance test, the pump's suction and discharge head are measured at varying flow rates. Suction and discharge head were measured from a pressure tap close to the pump's suction or discharge end using a calibrated pressure gauge provided by M.E. Simpson for horizontal split case pumps as shown in Appendix H1. For vertical turbine pump tests, suction head was measured directly from a nearby wet well. The flow rate was measured using a calibrated pitot tube provided by M.E. Simpson. The flow rate was adjusted by closing the control valve on the discharge manifold. Pump tests were initiated with the discharge valve fully open, and then gradually closed to collect data at a minimum of five flow rates. The operator on duty would determine when the valve should not be further closed. Local flow meter data was also recorded for each of the measurements. Voltage and current data were collected when it was available.

TDH was calculated from the data collected to create the pump curves. TDH is calculated as the sum of the suction head, discharge head, and velocity head shown in the equation below.

$$TDH = hs + hd + \frac{V^2}{2g}$$

Where hs is suction head, hd is discharge head, V is discharge velocity, and g is the acceleration due to gravity. For vertical turbine pumps, suction head was measured from the water level in the wet well to the pump's centerline elevation (pump datum). For horizontal split case pumps, the suction and discharge pressure were measured via a gauge from a pressure tap, and the pressure was converted to feet of head using the following equation.

$$h = P_g * 2.31 + Z_d$$

Where h is the head in ft, P_g is the pressure gauge reading in pound per square inch (psi), 2.31 is the conversion factor for psi to ft. of H_2O, and Z_d is the distance from the center of the pressure gauge to the pump datum.

Pump efficiency was calculated as the ratio of discharge water horsepower (whp) to the motor's break horsepower (bhp) as shown in the equation below.

$$Efficiency = \left(\frac{whp}{bhp}\right) * 100\%$$

Brake horsepower is product of the motor's input horsepower and the motor efficiency. When available, motor efficiency was recorded from the motor nameplates. Water horsepower is calculated using water horsepower and flow rate. Equations for brake horsepower and water horsepower are shown below.

$$bhp = ihp * Em$$

$$whp = \frac{Q * TDH * SG}{3960}$$

Where ihp is the motor's input horsepower, Em is motor efficiency, Q is flow rate, and SG is the water's specific gravity. Finally, the input horsepower was calculated for a three phase motor using the following equation.

$$ihp = \frac{v * a * pf * 1.73}{1000} * 1.341$$

The average voltage (v) and average amperage (a) of each phase were measured. The power factor (pf) was provided on the motor nameplate when available.

Specific details on the performance testing conducted at each site are presented below as excerpts from the M.E. Simpson report in Appendix H1.

Lake Bloomington Low Lift Pumps
Testing was performed on Pumps #1 and #3. Pump #2 was out of service and could not be tested. The suction head on both pumps was measured from a pressure tap on the influent of Pump #1 because there was no pressure tap on the suction end of Pump #3. Discharge head was measure from the pressure taps on the discharge end of each pump. Flow rate was measured from a pitot tap at the water treatment plant. Voltage and current measurements for Pump #1 could not be collected because the electrical panel could not be opened. Voltage and current data were only collected for Pump #3.

Evergreen Lake Low Lift Pumps
All three pumps in the Evergreen Lake Low Lift Pump Station were tested. The suction head was directly measured as the water surface elevation in Evergreen Lake. Discharge head was measured from pressure taps located on the discharge end of each of the pumps. Flow measurements were collected from a pitot tap located in the water treatment plant approximately six miles away from the pump station. Electrical data was not collected because voltage was unable to be measured from the motors' electrical panel.

Water Treatment Plant High Service Pumps
All four of the water treatment plant's high service pumps were tested. The suction head was measured from the wet well in an access hatch located in the pump room. The discharge head was measured from a pressure tap located on the discharge end of each pump. Flow rate was measured from a pitot tap downstream of the plant's effluent flow meter. Voltage and current data were collected for Pumps #2, #3, and #4 but could not be collected for Pump #1.

Division Street Pump Station
Pumps #1, #2, and #3 were tested while Pump #4 was not due to a malfunction of the motor's soft-starter. Suction head was measured from a single tap on the common manifold for all four pumps. Discharge head was measured from the pressure taps located on the discharge end of each pump. Flow measurements collected from the pitot tap were deemed unreliable, so local flow meter readings were used instead. In addition, there was a leak in an isolation valve on the effluent line that impacted measurements from the local flow meter and pitot tap. Figure 1 shows the velocity profile prepared by M.E. Simpson. The profile does not resemble the parabolic shape expected in a laminar flow condition. Voltage could not be measured, so electrical data was not collected.

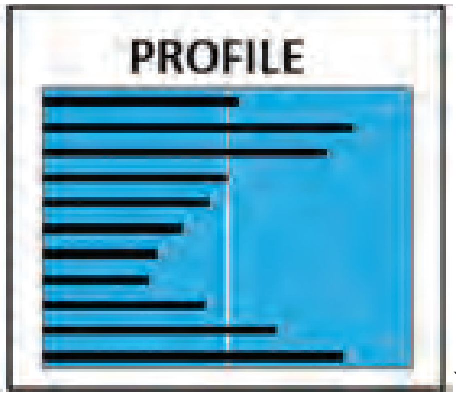


Figure 1: Velocity profile of Division Street Pump Station's effluent line as measured by the pitot rod. The horizontal axis represents the water's velocity and the vertical axis represents the position in the pipe interior.

Fort Jesse A Pump Station
Pumps #1, #2, and #4 were tested while Pump #3 was not due to a damaged flex coupling that could fail during the testing process. Suction head was measured from a single tap on the common manifold for all pumps. Discharge head was measured from the pressure taps located on the discharge end of each pump. Flow rate was measured from a pitot tap on the influent line inside of the pump station.

Fort Jesse B Pump Station
All three pumps at the Fort Jesse B pump station were tested. Suction and discharge heads were measured from pressure taps located on the influent and effluent of each pump. The flow rate was measured from a pitot tap on the pump station's effluent line.

Enterprise Pump Station
All three pumps were tested at the Enterprise Pump Station but the flow data for Pump #2 was unusable, so only Pumps #1 and #3 test results are presented. Pump #2 could not produce a high enough flow velocity in the effluent pipe for the pitot rod to get an accurate flow rate measurement. In addition, the local flow meter reading did not change as the control valve was closed, so the local flow measurements were also unreliable. Suction head was measured directly from the wet-well inside of the pump station and discharge head was measured from the pressure tap on the discharge end of each pump.

Performance Testing Results

The results of the field performance test for each pump tested is presented below. The field performance tests results are compared to the original factory performance test results. A theoretical performance curve showing a 20% reduction in pump performance from the factory test is included as well. The City should consider repairing or replacing pumps whose performance is at or below the theoretical 20% performance reduction curve.

Lake Bloomington Low Service Pumps

Figures 2 and 3 show the results of the performance tests performed at the Lake Bloomington Low Lift Pump Station on February 9, 2018. As shown in Figure 2, Pump #1 has experienced minimal degradation in performance since it was installed. At flow rates between 3,000 to 6,000 gpm, the TDH is around 5% to 10% lower than the factory performance test. Tests at higher flow rates of approximately 7,000 gpm show no discernable degradation in performance when compared to the factory test. Efficiency could not be calculated for Pump #1 because voltage and current data were unavailable during the test.

As shown in Figure 3, Pump #3 test results show a greater degradation in performance compared to Pump #1. The TDH has dropped by 6% to 12% from the factory testing results. Lower flow rates of 3,000 gpm to 4,000 gpm experienced a lesser drop in performance than higher flow rates of around 8,000 gpm. However, the test results for Pump #3 are skewed due to the location used for measuring the suction head. There was no available pressure tap directly on the suction end of Pump #3, and the suction head was measured from the Pump #1 suction tap. The test results also show a 20% drop in magnitude of efficiency at low flow rates. The difference in efficiency from the original curve is gradually reduced as the flow rate increases. At around 7,500 gpm, the pump started to operate at an improved efficiency from when it was originally installed. Polynomial regression indicates that the optimal flow rate for Pump #3 is around 8,000 gpm.

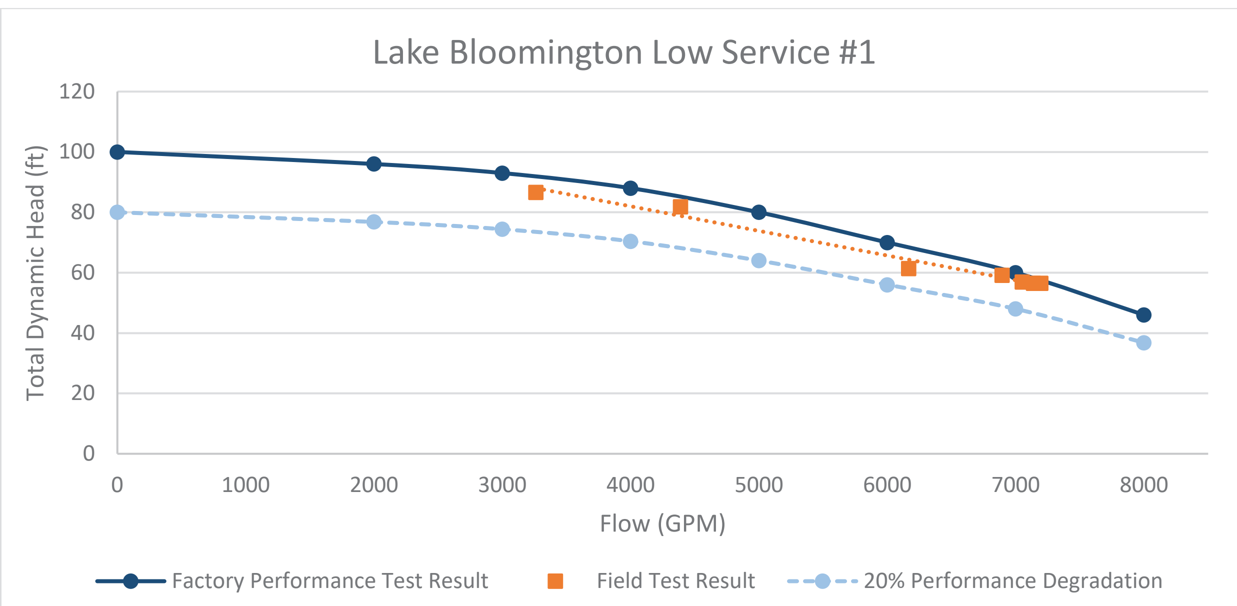


Figure 2: Original and updated performance curves for Lake Bloomington Low Service Pump #1. Complete results of the factory performance tests are shown in Figure H2-1.

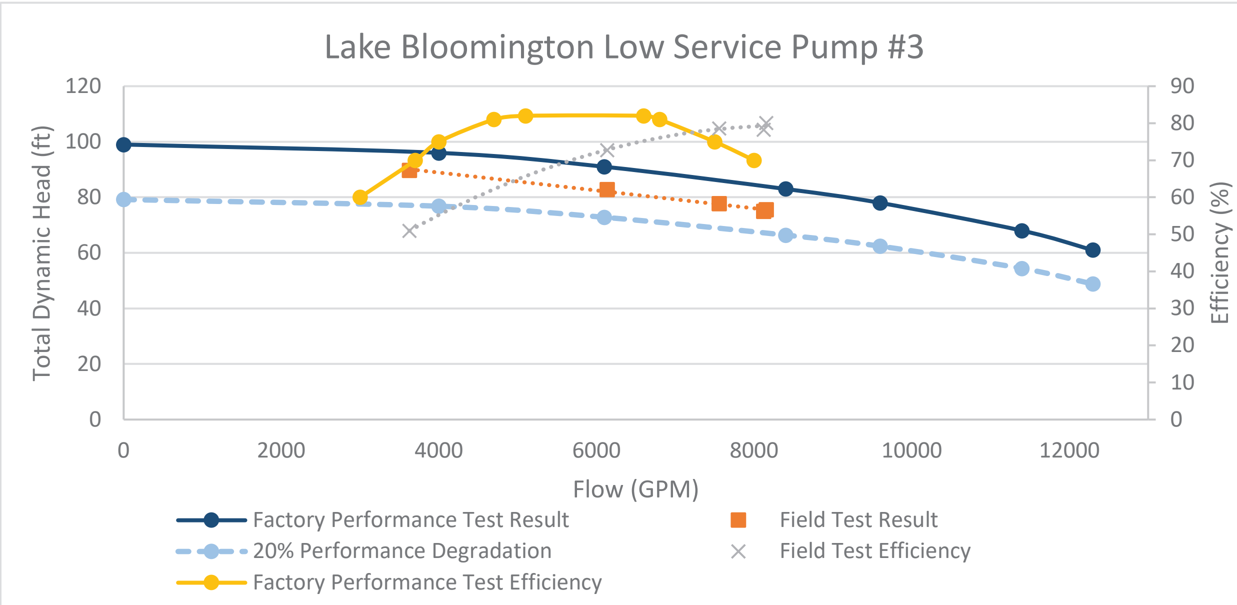


Figure 3: Original and updated performance and efficiency curves for Lake Bloomington Low Service Pump #3. Complete results of the factory performance tests are shown in Figure H2-2.

Evergreen Lake Low Service Pumps

Figures 4, 5, and 6 show the results of the performance tests conducted on the Evergreen Lake Low Service Pumps on February 14, 2018. All three of the Evergreen Lake Low Service pumps were tested. Closing the discharge control valve did not significantly impact flow rate while testing Pumps #1 and #3, causing the data to cluster together. Because the data was clustered together, performance was only measured over a narrow range of flow conditions for Pumps #1 and #3. The change in Pump #1 performance is negligible. Pump #1 performance has slightly improved at flow rates around 1,600 gpm and slightly decreased at higher flow rates around 2,500 to 3,000 gpm since the original test was conducted. On the other hand, the performance of Pumps #2 and #3 shows a larger degradation to around 80% of their factory performance baseline since they were installed. Pump #2's TDH at flow rates around 2,500 gpm has dropped below 80% of the TDH recorded during factory testing.

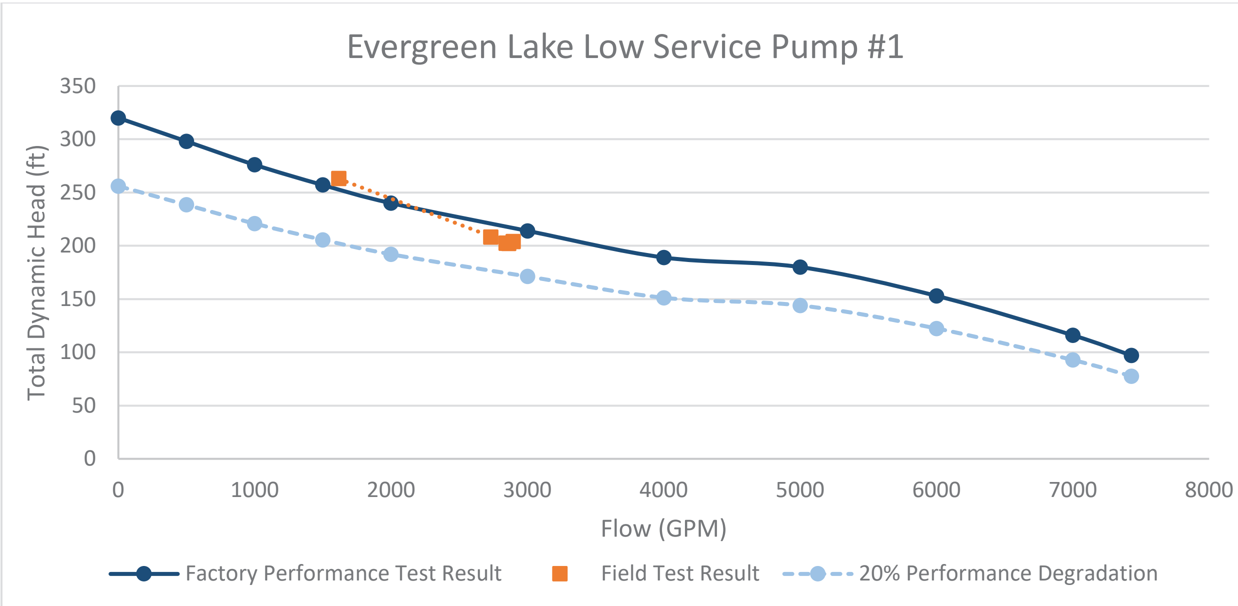


Figure 4: Original and updated performance curves for Evergreen Lake Low Service Pump #1. Complete results of the factory performance tests are shown in Figure H2-3.

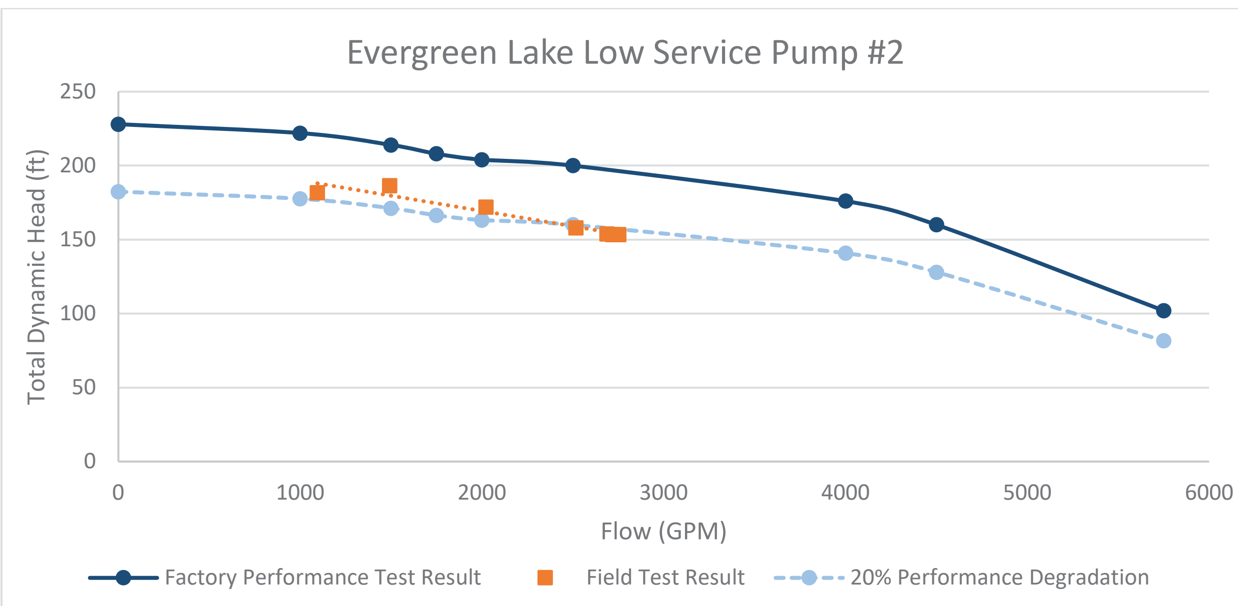


Figure 5: Original and updated performance curves for Evergreen Lake Low Service Pump #2. Complete results of the factory performance tests are shown in Figure H2-4.

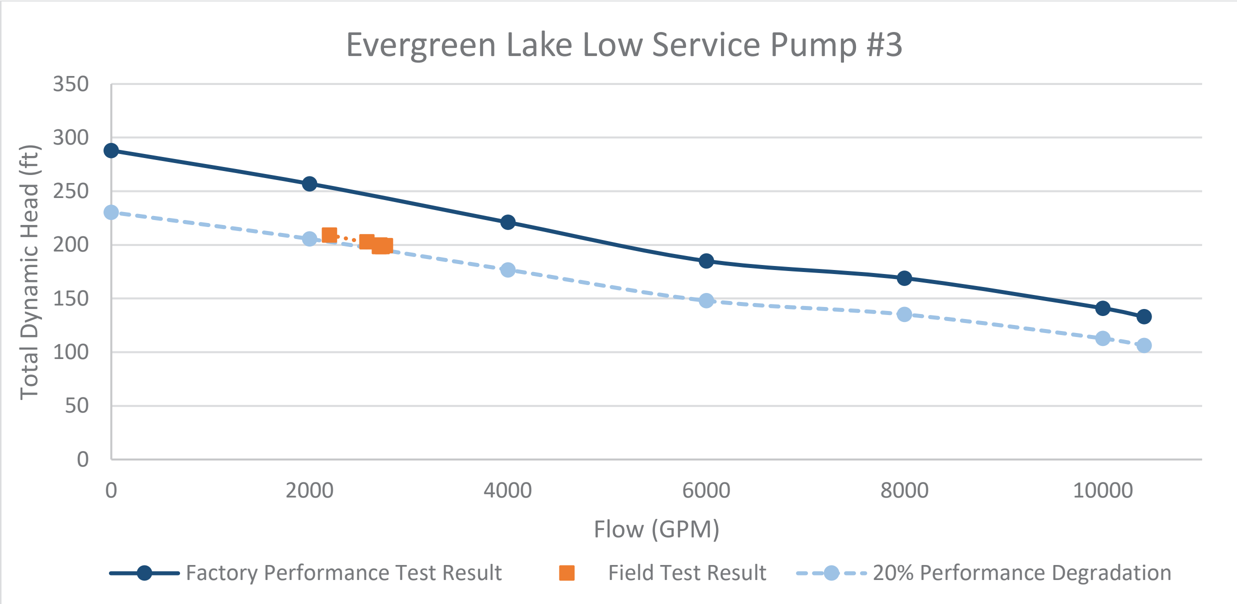


Figure 6: Original and updated performance curves for Evergreen Lake Low Service Pump #3. Complete results of the factory performance tests are shown in Figure H2-5.

WTP High Service Pumps

Figures 7, 8, and 9 show the results of the performance tests conducted on the Bloomington WTP High Service pumps on February 8, 2018. All four pumps were tested. Pumps #1 and #2 expressed a similar trend in performance. Their performance is within a 20% margin of the factory performance testing at their lowest tested flow rates. However, as their flow rate is increased, their performance degradation meets or exceeds the 20% threshold. Pumps #3 and #4 have the same factory performance curve and their results are presented together in Figure 9. The results for Pumps #3 and #4 show no decrease in performance and both pumps can reach the same TDH that was achieved during their original factory performance tests.

Efficiency was only measured for Pumps #3 and #4. While voltage and current data were collected for Pump #2, the motor efficiency and power factor could not be read off of the motor's nameplate so pumping efficiency could not be calculated. Neither Pump #3 or #4 showed a change in efficiency compared to the original factory performance testing. Polynomial regression of the measured efficiency vs flow rate data shows that the optimal flow rates for Pumps #3 and #4 are 9,800 gpm and 9,500 gpm respectively.

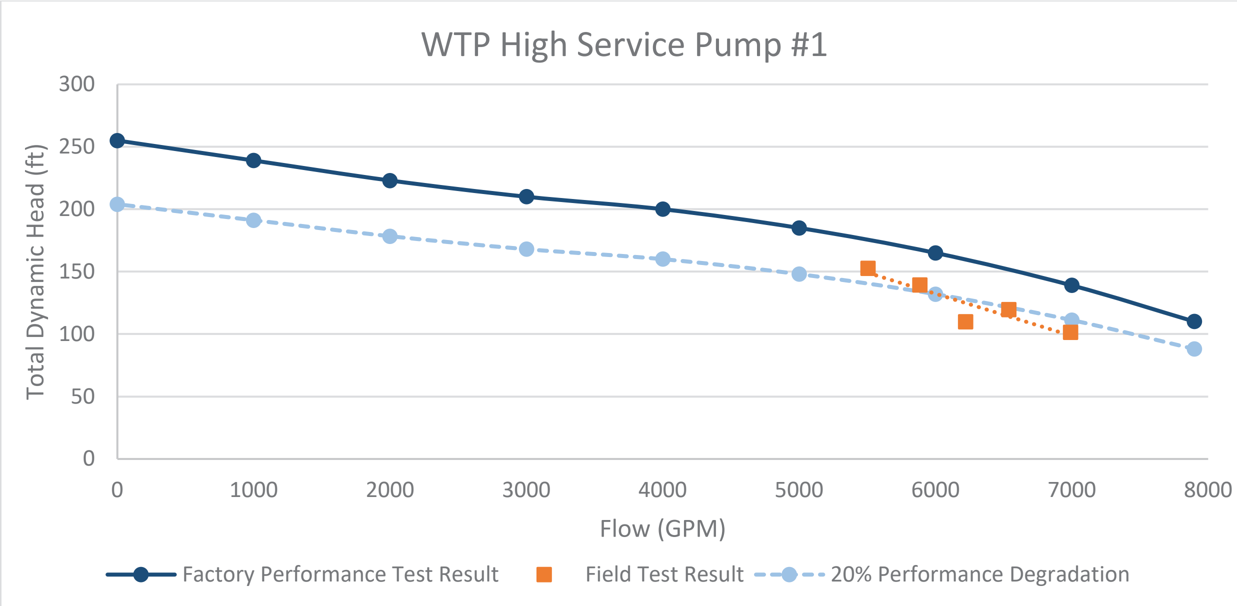


Figure 7: Original and updated performance curves for WTP High Service Pump #1. Complete results of the factory performance tests are shown in Figure H2-6.

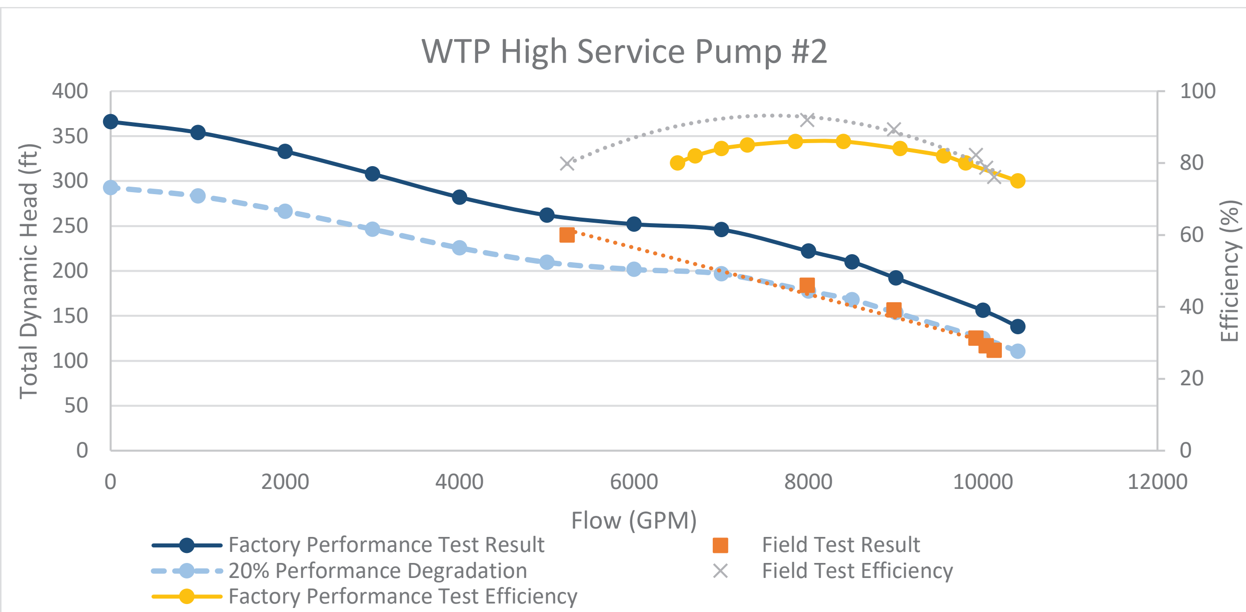


Figure 8: Original and updated performance and efficiency curves for WTP High Service Pump #2. Complete results of the factory performance tests are shown in Figure H2-7.

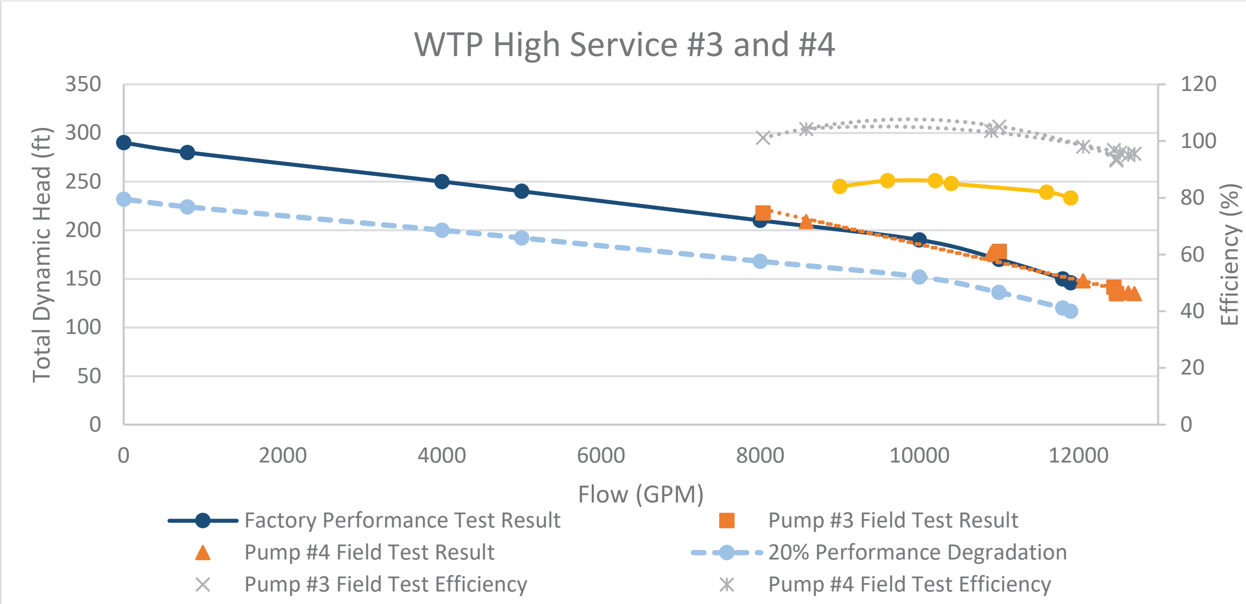


Figure 9: Original and updated performance and efficiency curves for WTP High Service Pump #3. Complete results of the factory performance tests are shown in Figure H2-8. Note: Power factor or voltage readings appear to be off based on efficiencies higher than 90%.

Division Street Pump Station

Figures 10 and 11 show the results of the performance tests conducted at the Division Street Pump Station on February 12, 2018. Only Pump #1, #2, and #3 were tested because there were mechanical issues in turning on Pump #4. In addition, the pitot data collected while testing Pump #1, #2, and #3 yielded an uneven velocity profile. The velocity profile indicated a turbulent flow condition at the location of the pitot rod, which could have been caused by a partially closed valve upstream of the pitot tap. As a result, the pitot data was deemed unreliable so the flow readings from the local flow meter were used in its place. The local flow meter's accuracy is unknown. Pumps #1 and #2 have the same factory performance curve and their results are presented together in Figure 10. Pumps #1 and #2 performance has degraded by around 5% to 10% since their original factory test. Pump #1 performance has been reduced the most at flow rates between approximately 1,300 gpm and 2,000 gpm, while Pump #2 experienced the largest reduction in performance at flow rates between 800 gpm and 1,800 gpm. Pump #3 exhibited no performance degradation. None of the data points for any pump show a performance decrease greater than 20%.

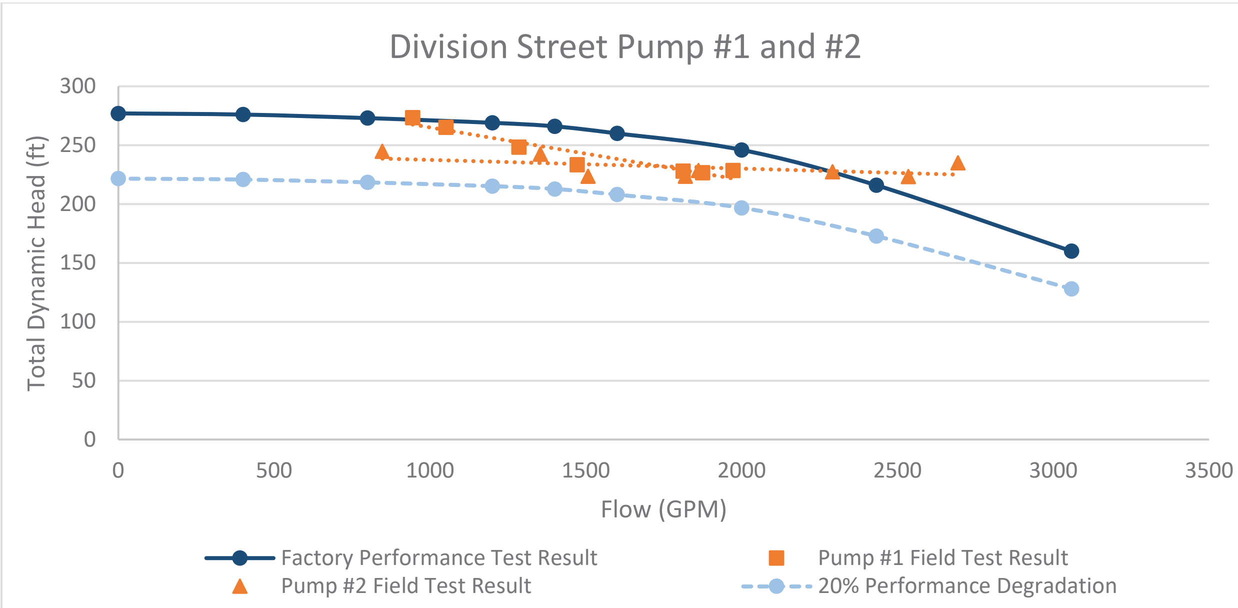


Figure 10: Original and updated performance curves for Division Street Pump Station Pump #1. Complete results of the factory performance tests are shown in Figure H2-9.

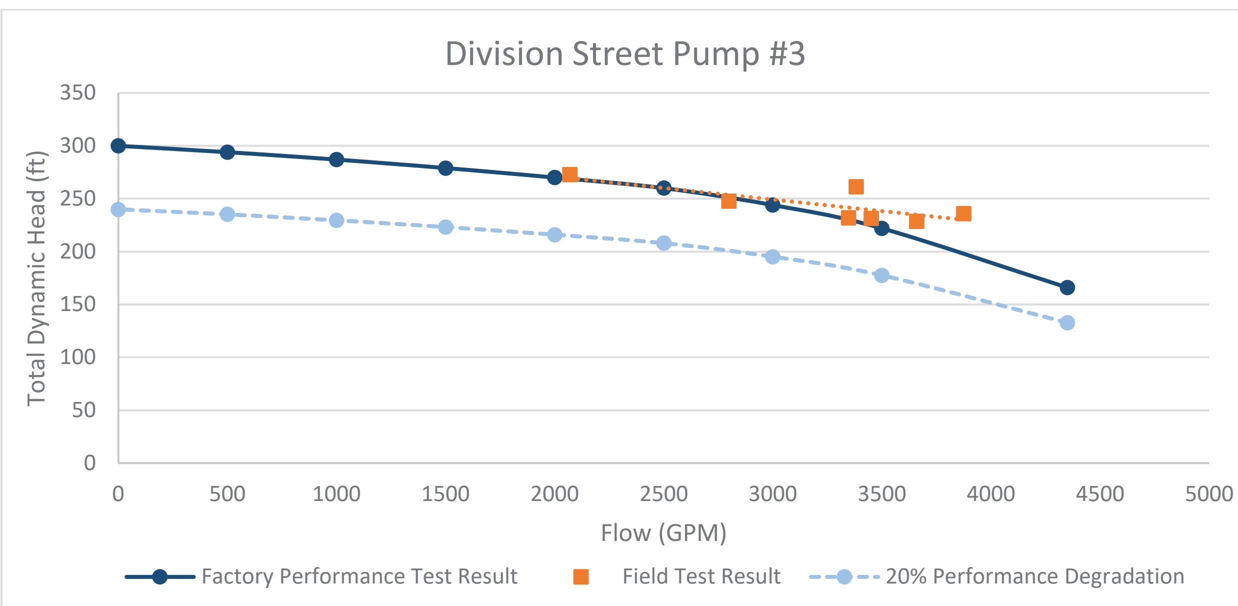


Figure 11: Original and updated performance curves for Division Street Pump Station Pump #3. Complete results of the factory performance tests are shown in Figure H2-10.

Fort Jesse A Pump Station

Figure 12 shows the results of the performance tests conducted at the Fort Jesse A Pump Station on February 7, 2018. Only Pumps #1, #2, and #4 were tested. Pumps #1, #2, and #4 have the same factory performance curve so their results are presented together in Figure 12. The three pumps follow a similar trend – there is minimal change in performance from the original factory test at flow rates between 1,400 gpm and 2,500 gpm, while there is a 5% to 10% drop in performance beyond 2,500 gpm.

Each pump also exhibited a large drop in efficiency in the range of flow rates tested. The efficiency of each pump is approximately 15% to 25% lower than the factory performance efficiency. Polynomial regression of the updated efficiency results estimate the optimal flow rate for Pumps #1, #2, and #4 to be 2,900 gpm, 3,300 gpm, and 3,100 gpm respectively.

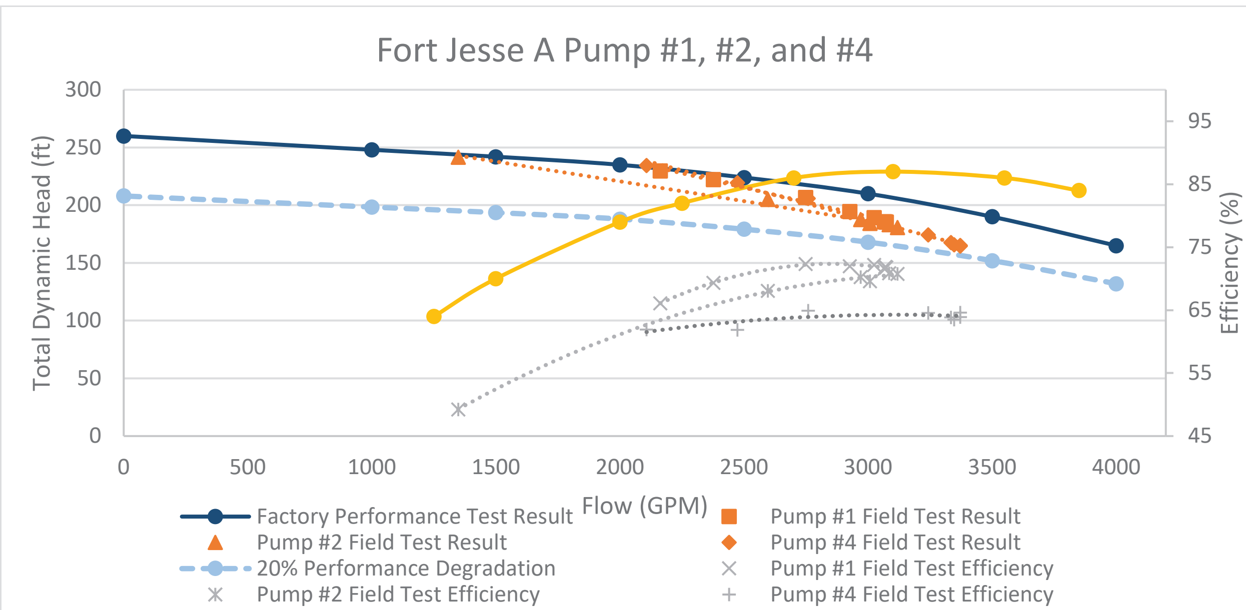


Figure 12: Original and updated performance and efficiency curves for Fort Jesse A Pump Station Pump #1. Complete results of the factory performance tests are shown in Figure H2-11.

Fort Jesse B Pump Station

Figure 13 shows the results of the performance tests conducted at the Fort Jesse B Pump Station on February 15, 2018. All three pumps at Fort Jesse B were tested. Pumps #1, #2, and #3 have the same factory performance curve so their results are presented together in Figure 13. Each of the pumps has experienced significant degradation in performance when compared to the factory performance curve and follow a similar trend of reduced TDH as flow increases. For example, the TDH is approximately 5% to 10% lower than it was in the factory performance test at flow rates between 300 gpm and 2,000 gpm. As the flow rate increases to 4,000 gpm, there is almost a 20% drop in TDH from the factory performance test.

The pumps also have decreased in efficiency since when compared to the factory performance test. The difference in efficiency between the field testing and factory testing is lesser in the lower flow rate tested but increases to 8% to 25% in magnitude at the high-end of tested flow rates. Polynomial regression of the updated efficiency results estimates the optimal flow rate for Pumps #1, #2, and #3 to be 4,400 gpm, 4,200 gpm, and 4,200 gpm respectively.

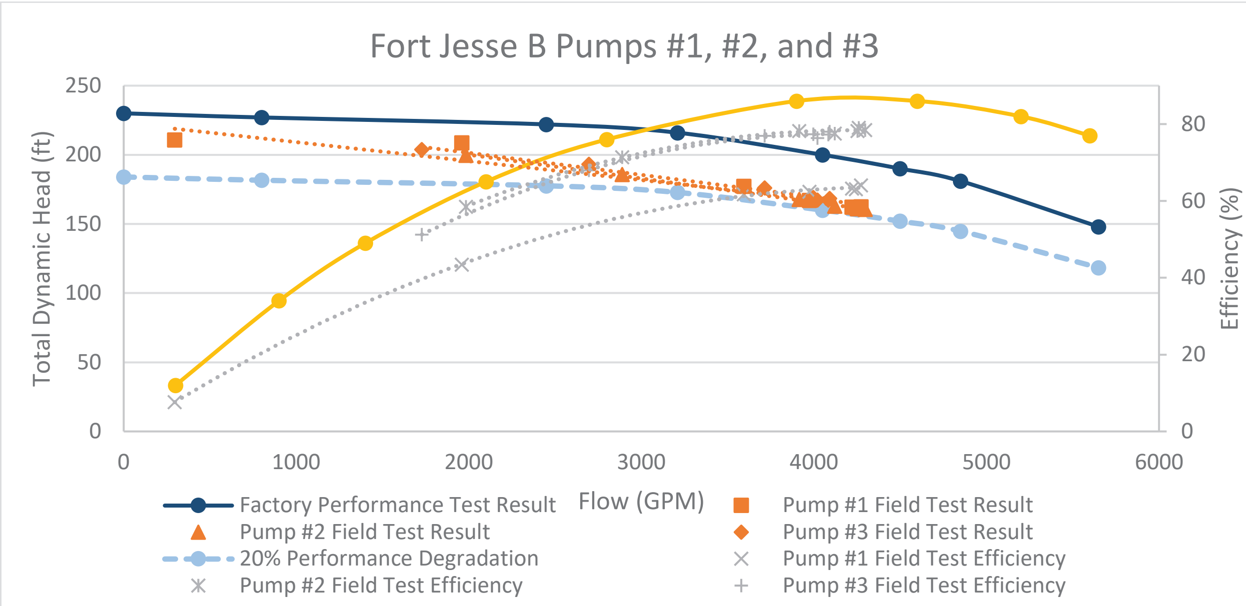


Figure 13: Original and updated performance and efficiency curves for Fort Jesse B Pump Station Pump #1. Complete results of the factory performance tests are shown in Figure H2-12.

Enterprise Zone Pump Station

Figure 14 shows the results of the performance testing conducted at the Enterprise Zone Pump Station on February 13, 2018. While all three pumps were tested, only Pump #1 and #3 data are presented as there were difficulties measuring the flow rate of Pump #2. Pumps #1 and #3 have the same factory performance curve so their results are presented together in Figure 14. Both Pumps #1 and #3 have experienced very little degradation in performance as their TDH is within 5% of the original factory test. However, due to clustering of data at the higher flow rates tested, there are essentially only two data points. Closing the discharge control valve had very little impact on the flow rate when it was between 100% to 16% open. A significantly different flow rate was not measured until the discharge control valve was only 5% open. Ideally, closing the discharge control valve would have resulted in a larger spread of tested flow rates to get a more complete picture of the pump's performance capabilities.

Efficiencies of Pumps #1 and #3 have not changed since the pumps were first installed. Due to clustering of data, polynomial regression cannot be effectively used to estimate the optimal flow rate in terms of efficiency. From looking at the test results, the efficiency for Pumps #1 and #3 appears to be greatest at around 3,100 gpm and 3,000 gpm respectively.

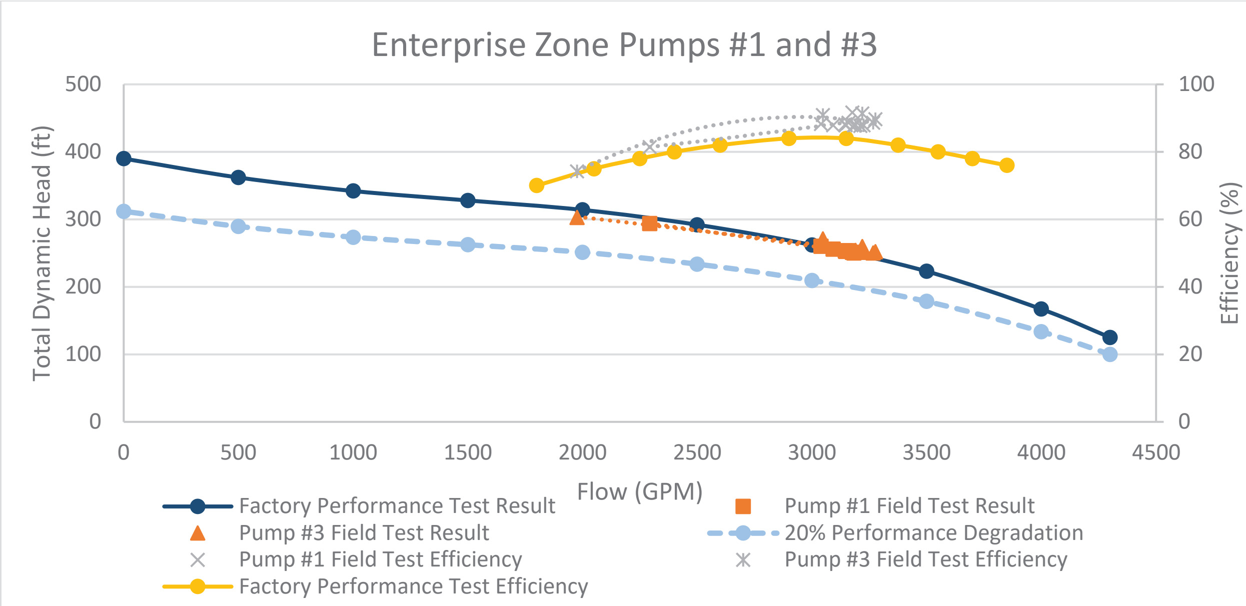


Figure 14: Original and updated performance and efficiency curves for Enterprise Zone Pump Station Pump #1. Complete results of the factory performance tests are shown in Figure H2-13.

Conclusions

The 2018 performance tests provided an update on the condition of the low service, high service, and booster pumps that were tested from the water treatment plant and distribution system at the following locations: Lake Bloomington Low Lift Pumps, Evergreen Lake Low Lift Pumps, Water Treatment Plant High Service Pumps, Division Street Pump Station, Fort Jesse A Pump Station, Fort Jesse B Pump Station, and Enterprise Zone Pump Station. The majority of the pumps are in fair condition and have experienced a decline in performance of 10% or less since they were first installed. The City should consider monitoring the pumps whose performance have degraded by 20% or more since installation. The pumps that have experienced a performance decline at or approaching 20% are as follows:

- Evergreen Lake Low Service Pumps #2 and #3
- WTP High Service Pumps #1 and #2
- Fort Jesse B Pumps #1, #2, and #3

While pump efficiency could not be calculated for all pumps, the efficiency results available show a general decline from the factory testing results. The three pumps tested in the Fort Jesse A Pump Station have experienced the largest decline in efficiency of all pumps tested. Operating the pumps at their maximum efficiency should be incorporated to reduce energy usage. CDM Smith recommends investigation and maintenance on the Fort Jesse A and B pumps to evaluate and address the loss of efficiency for those pumps.

Appendix H1

M.E. SIMPSON Co., Inc.

April 3, 2018

Mr. Amrou Atassi
Project Engineer
CDM Smith, Inc.
125 South Wacker Drive, Suite 600
Chicago, IL 60606

RE: SUMMARY OF PUMP CURVE ANALYSIS AND TESTING IN BLOOMINGTON, IL

Dear Mr. Atassi,

M.E. Simpson Company, Inc. is pleased to submit the following summary report of the Pump Curve Analysis and Testing conducted for the City of Bloomington on behalf of CDM from February 6th through February 15th, 2018. The purpose of this testing was to assess the operational conditions of high and low lift pumps at various production facilities located throughout The City of Bloomington's water distribution system.

M.E. Simpson field crews conducted the testing over the course of eight working days. There were numerous operational set-backs and delays due to emergent malfunctions at some of the pump facilities. In order to help CDM reduce the cost of the project, M.E. Simpson has invoiced CDM for only seven working days.

Twenty-seven pumps located at eight production facilities were inspected prior to the testing and an inspection report was previously submitted so that improvements could be made to facilitate the testing. Twenty of the pumps were tested, while seven of them could not be tested due to various reasons which are detailed in this summary document.

Detailed reports for each pump tested, which were previously submitted to CDM, have been included in this document.

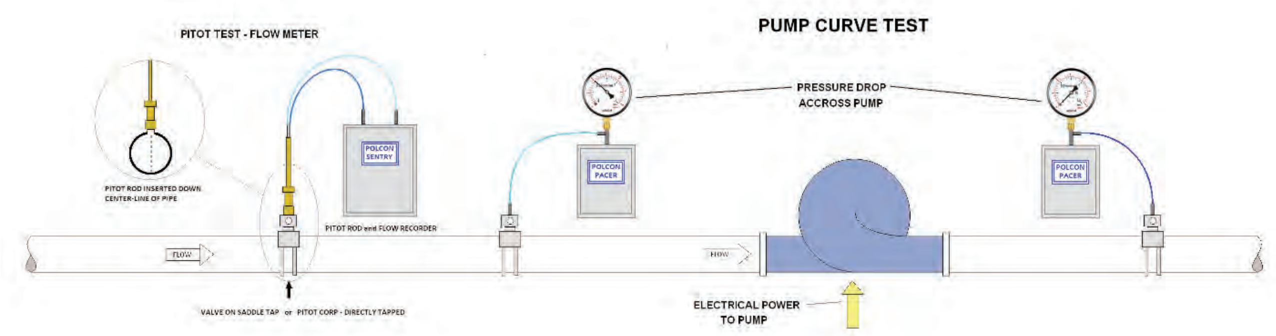
We thank you for allowing us the opportunity to provide you with our Pump Curve Testing Services and look forward to working with you again in the future. Feel free to contact us with any questions or concerns.

Best regards,

Aaron M. Horbovetz, PE, PMP
Engineering Services Manager
aaronh@mesimpson.com

TESTING METHODOLOGY

The testing methodology for all of the pumps was very similar with minor variations based on the layout and functionality of each pump facility. Below is a general description of how the testing was conducted. Variations are described in the summaries which follow.



Control valves on the discharge sides of each pump were throttled by utility personnel in order to generate test points over the flow and pressure range of each pump.

A third-party electrician was brought in to measure each pumps power consumption during the testing. The purpose of collecting this data was so that CDM could assess the wire-to-water efficiencies of each pump. In some cases' it was not possible for the electricians to measure this data. When available, this data was recorded by M.E. Simpson Company personnel for record keeping purposes, though M.E. Simpson Company was not tasked with performing the wire-to-water efficiency calculations.

SCADA flow data was requested from The City of Bloomington as a comparative supplement to the local meter readings and measured Pitot flows. However, this data is not available, per utility personnel, and cannot be utilized.

Bloomington Lake WTP – High Lift Pumps

- 25515 Waterside Way, Hudson, IL 61748

Initially there were issues with the automatic valves for Pumps 1 & 3 but these issues were resolved and tests were conducted on all of the pumps.

The flow for each test was measured from a Pitot tap located downstream of the effluent meter located in the basement of the water treatment plant.

The suction lift was measured directly from a wet-well access hatch located in the pump room. Discharge pressures were measured from pressure taps located downstream of each pump.

Bloomington Lake WTP – Low Lift Pumps

- 25515 Waterside Way, Hudson, IL 61748

Pump 2 was out of service at the time of the testing. It had been removed for repairs.

There was no suction tap available for Pump 3. The suction pressure for this test was measured from the suction tap for Pump 1. At the time of the test, the lake elevation was 714.4 feet and the elevation of the centerline of Pump 3 is 702 feet. As the flow was throttled, Pump 3 began to cavitate, prompting utility personnel to end the test at 40% closure. Discharge pressures were measured from taps located downstream of each pump.

The flow for each test was measured from a Pitot tap located in a vault at the water treatment plant. A valve had to be throttled in order to create enough back pressure for the Pitot rod to function properly.

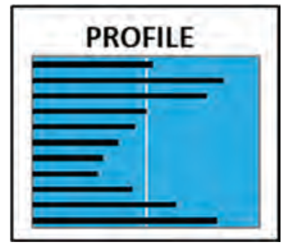
Division Street Pump Station

- 603 W Division Street – Bloomington, IL 61701

There were issues on the first day of testing, Tuesday February 6th, 2018. The pumps were shutting down sporadically due to an electrical issue. Also, there was a main break in front of the pump station. Because of these factors, field crews were dispatched to Fort Jesse A. However, the magnitude of the problems at Division Street required that all available utility personnel be dispatched to assist, and the testing at Fort Jesse A was postponed until the following day. Field crews returned to the Division Street Pump Station on February 12th and completed the testing.

Pump 4 was not tested per utility personnel. The soft-start was not functioning properly and it was determined that applying 2,400 volts directly to the motor could possibly damage the pumps.

The isolation valve on the West effluent line was leaking. This leakage allowed flow, travelling through the pumps, to escape the plant without being measured by either the Pitot rod or the East meter. The utility suspects that there is a valve, downstream of the East meter, which is broken in a partially closed position. This partial blockage may be affecting the meters accuracy.



The velocity profile at the Pitot tap site indicates that the measured Pitot flows are not reliable. This type of hydraulic flow pattern may also be disrupting the performance of the East meter, which is located just downstream of the Pitot test tap site.

Suction pressure was measured from a tap on the common manifold for all of the pumps. Discharge pressure was measured from taps downstream of each pump.

Enterprise Pump Station

- 603 W Division Street – Bloomington, IL 61701

All three pumps at this station were tested, but the test results for Pump 2 are unusable. This is due to the size of the pump relative to the effluent pipe size and corresponding flow velocities. Both the pump station meter and the Pitot flow measurements were unusable due to the ultra-low velocity during testing. For each of the five valve positions, the flow rate indicated by the meter never changed and remained at approximately 1,100 gpm. The velocity at the Pitot rod was well below the range of the equipment and no useful flow measurements were recorded.

The flow for each test was measured using a Pitot tap in a vault located outside of the pump station.

The suction lift was measured directly from a wet-well access hatch located in the pump room. Discharge pressures were measured from pressure taps located downstream of each pump.

Evergreen Lake - Low Lift Pumps

- 12676 E 2500 North Road – Hudson, IL 61748

All three pumps were tested. Flow measurements were taken from a Pitot tap located in a vault approximately six miles away at Bloomington Lake WTP. A valve had to be throttled in order to create enough back pressure to facilitate the Pitot flow measurements.

The suction lift was measured directly from a lake-level access hatch located inside the pump room. Discharge pressures were measured from pressure taps located downstream of each pump.

The meter readout was located six miles away at the Bloomington Lake WTP. SCADA flow data for these tests was not available per utility personnel.

Fort Jesse A Pump Station

- 1519 Fort Jesse Road – Normal, IL 61761

Field crews attempted to perform the testing on February 6th but were forced to halt due to the aforementioned issues at Division Street which required the assistance of all available utility personnel. The testing was completed the following day, February 7th.

Pump 3 could not be tested due to a damaged flex coupling which had been “cut into” by mounting bolts; there were no thrust bolts to hold the coupling in place, which could have resulted in catastrophic failure during the testing process.

Suction pressure was measured from a tap on the common manifold for all of the pumps. Discharge pressure was measured from taps downstream of each pump.

The flow for each test was measured from a Pitot tap located on the influent suction line inside the pump station. The effluent meter read erratically during the testing and may be malfunctioning.

Fort Jesse B Pump Station

- 1519 Fort Jesse Road – Normal, IL 61761

All of the pumps at this station were tested. Initially there was no flow at the Pitot test site. This was due to pump station valving issues, which were corrected, allowing the tests to be completed.

The flow for each test was measured using a Pitot tap located in a vault outside of the pump station.

Suction and discharge pressures were measured from taps located up and down stream of each pump.

The effluent meter was reading erratically during the testing and is known to be unreliable and inaccurate per utility personnel.

South Main Booster Station

- 1615 S Main Street – Bloomington, IL 61701

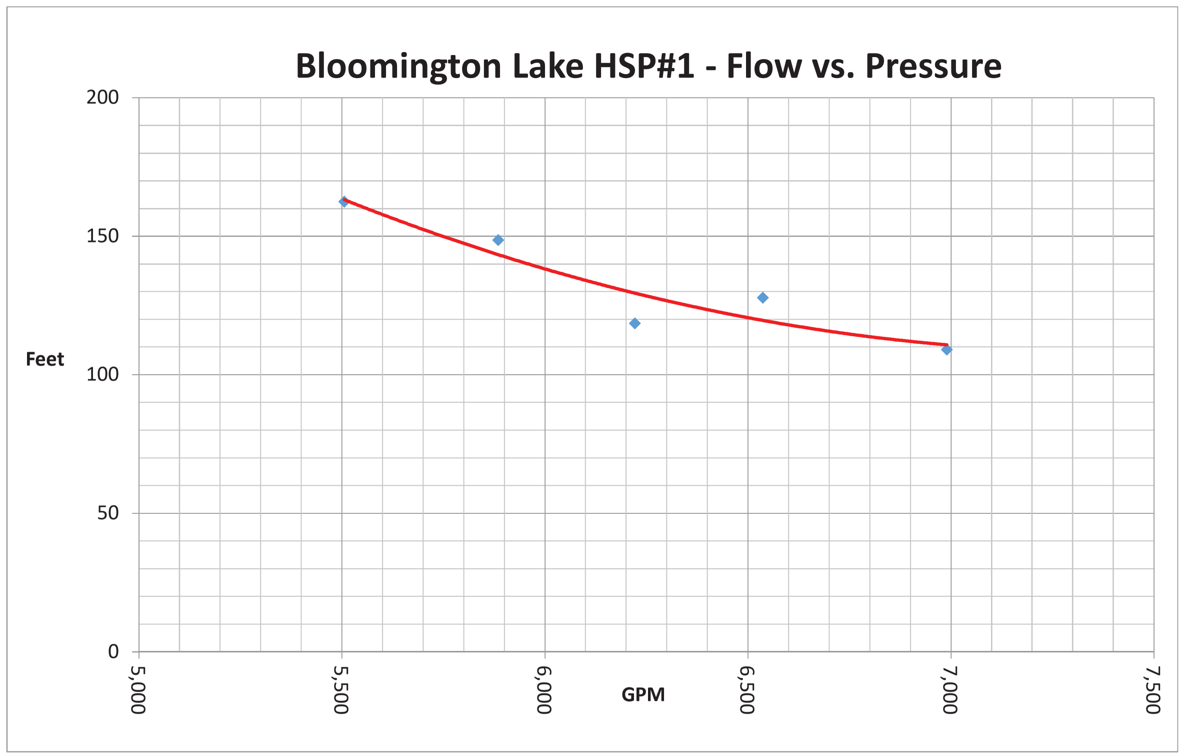
No pumps were tested at this station; Pump 1 has a faulty bearing, Pump 2 has no taps for pressure measurements, and Pump 3 was out of service.

3406 Enterprise Ave., Valparaiso, IN 46383 | Ph: (800) 255-1521 | Fax: (888) 531-2444 | www.mesimpson.com | salesinfo@mesimpson.com

Bloomington Lake - High Service Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/8/18	11:01:00 AM	11:03:00 AM	100%	6,990		6,708	6.83		44.86	-1.375	**102.25**		
2	2/8/18	11:12:00 AM	11:14:00 AM	85%	6,221		6,287	6.75		49.00	-1.375	**111.82**		
3	2/8/18	11:16:30 AM	11:18:30 AM	67%	6,537		6,437	6.79		53.00	-1.375	**121.06**		
4	2/8/18	11:20:30 AM	11:22:30 AM	50%	5,885		5,868	6.75		62.00	-1.375	**141.85**		
5	2/8/18	11:25:00 AM	11:27:00 AM	45%	5,506		5,520	6.75		68.00	-1.375	**155.71**		
6														
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
6,990	109.08		96.0%
6,221	118.57		101.1%
6,537	127.85		98.5%
5,885	148.60		99.7%
5,506	162.46		100.3%



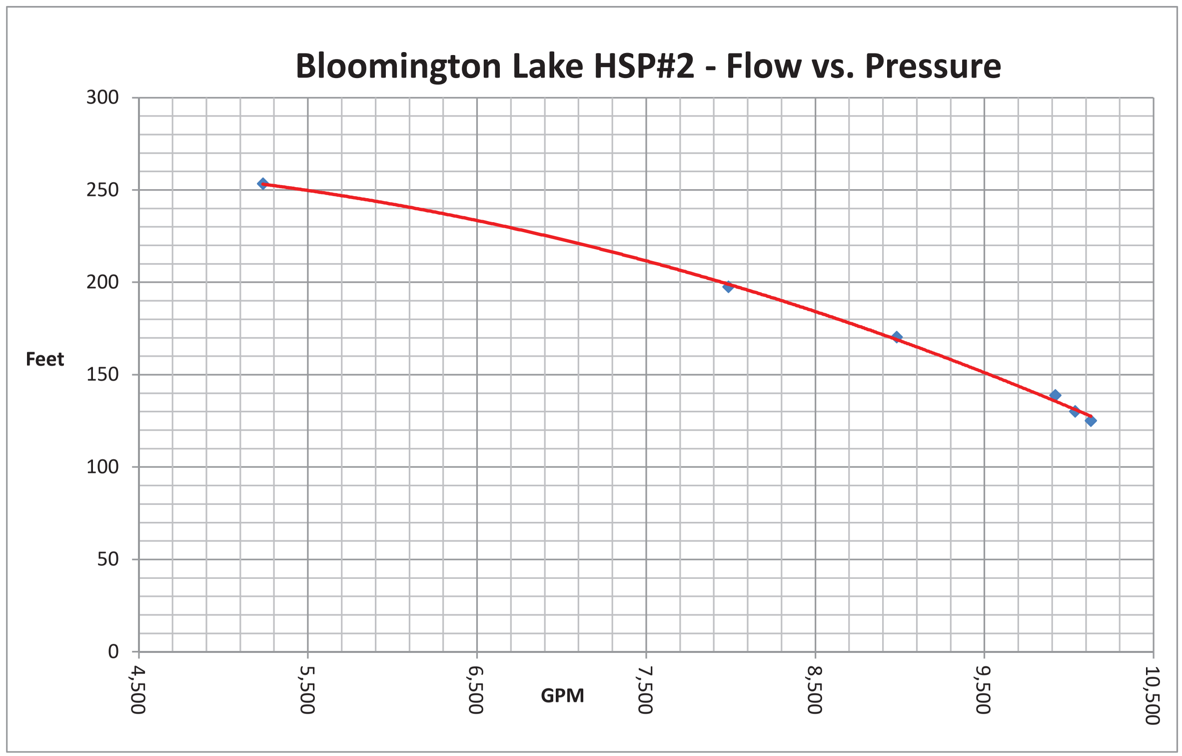
COMMENTS:

M.E. SIMPSON Co., Inc.

Bloomington Lake - High Service Pump #2

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/8/18	11:52:00 AM	11:54:00 AM	100%	10,130		9,354	6.83		51.85	-1.375	**118.39**	458.0	468.9
2	2/8/18	11:58:00 AM	12:00:00 PM	85%	10,037		9,291	6.88		53.98	-1.375	**123.32**	458.0	468.9
3	2/8/18	12:01:30 PM	12:03:30 PM	67%	9,919		9,166	6.92		57.74	-1.375	**132.00**	458.0	476.0
4	2/8/18	12:05:30 PM	12:07:30 PM	50%	8,980		8,305	6.92		71.35	-1.375	**163.45**	458.0	496.3
5	2/8/18	12:10:00 PM	12:12:00 PM	45%	7,986		7,465	6.92		83.16	-1.375	**190.73**	458.0	503.7
6	2/8/18	12:16:00 PM	12:18:00 PM	38%	5,233		4,930	6.83		107.33	-1.375	**246.57**	458.0	496.0
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
10,130	125.22	214,756	92.3%
10,037	130.19	214,756	92.6%
9,919	138.92	218,008	92.4%
8,980	170.37	227,305	92.5%
7,986	197.65	230,695	93.5%
5,233	253.40	227,168	94.2%

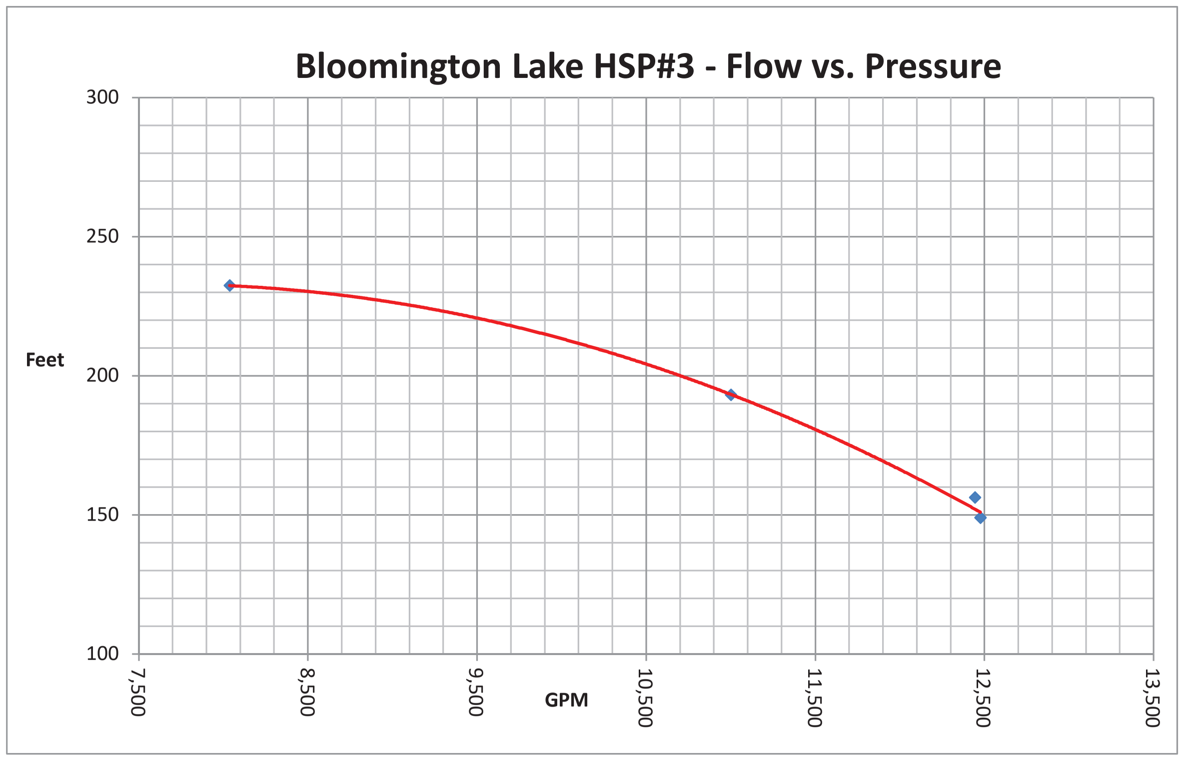


COMMENTS:

Bloomington Lake - High Service Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/8/18	12:33:00 PM	12:35:00 PM	100%	12,476		11,590	7.17		61.98	-1.375	**141.79**	2493.0	105.0
2	2/8/18	12:27:00 PM	12:29:00 PM	85%	12,476		11,542	7.17		61.98	-1.375	**141.80**	2493.0	105.0
3	2/8/18	12:41:30 PM	12:43:30 PM	67%	12,445		11,292	7.42		65.00	-1.375	**148.78**	2493.0	106.0
4	2/8/18	12:45:30 PM	12:47:30 PM	50%	11,002		9,861	7.42		81.00	-1.375	**185.74**	2493.0	109.0
5	2/8/18	12:49:30 PM	12:51:30 PM	40%	8,036		7,361	7.42		98.00	-1.375	**225.01**	2493.0	101.0
6														
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
12,476	148.96	261,765	92.9%
12,476	148.97	261,765	92.5%
12,445	156.20	264,258	90.7%
11,002	193.16	271,737	89.6%
8,036	232.43	251,793	91.6%



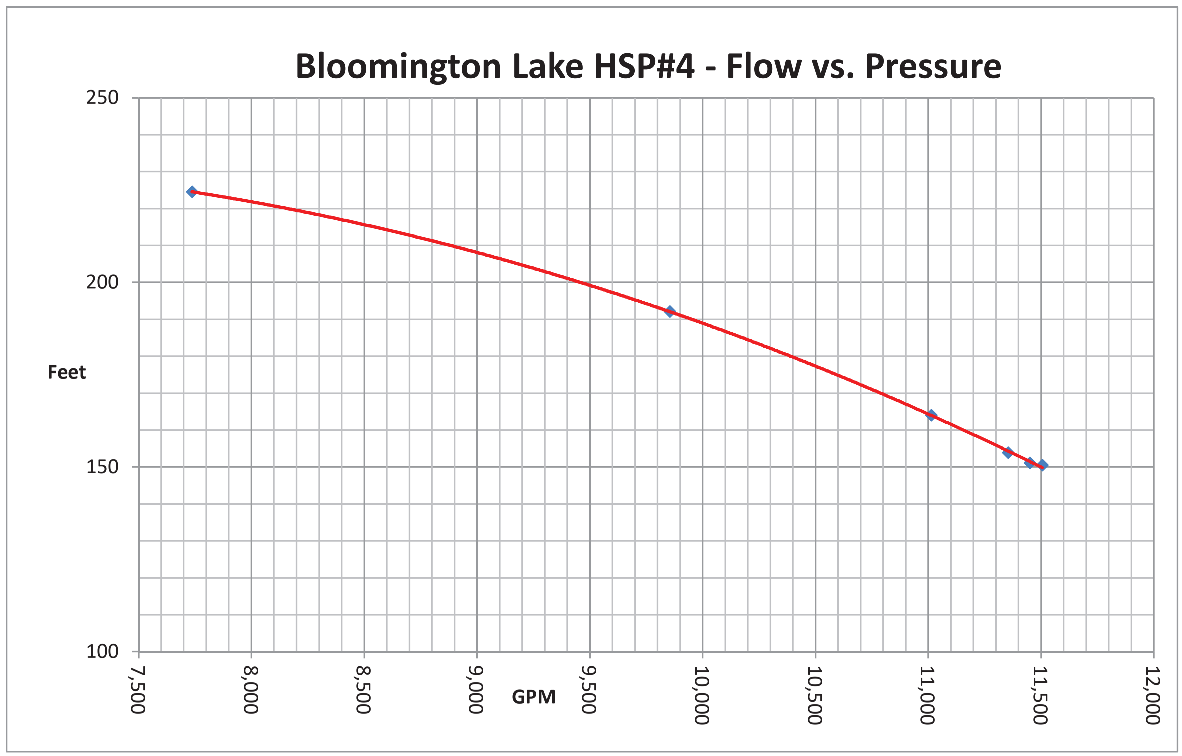
COMMENTS:

M.E. SIMPSON Co., Inc.

Bloomington Lake - High Service Pump #4

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/8/18	1:08:00 PM	1:10:00 PM	100%	12,701		11,506	7.83		62.33	-1.317	**142.67**	2487.0	104.7
2	2/8/18	1:13:30 PM	1:15:30 PM	85%	12,626		11,451	7.83		62.62	-1.317	**143.33**	2487.0	105.0
3	2/8/18	1:18:00 PM	1:20:00 PM	67%	12,520		11,354	7.92		63.78	-1.317	**146.01**	2487.0	105.0
4	2/8/18	1:22:00 PM	1:24:00 PM	50%	12,056		11,013	8.00		68.14	-1.317	**156.08**	2487.0	106.0
5	2/8/18	1:26:30 PM	1:28:30 PM	40%	10,902		9,854	8.00		80.30	-1.317	**184.17**	2487.0	108.0
6	2/8/18	1:30:30 PM	1:32:30 PM	35%	8,579		7,736	7.92		94.36	-1.317	**216.65**	2493.0	100.0
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
11,506	150.50	260,389	90.6%
11,451	151.16	261,135	90.7%
11,354	153.93	261,135	90.7%
11,013	164.08	263,622	91.3%
9,854	192.17	268,596	90.4%
7,736	224.57	249,300	90.2%



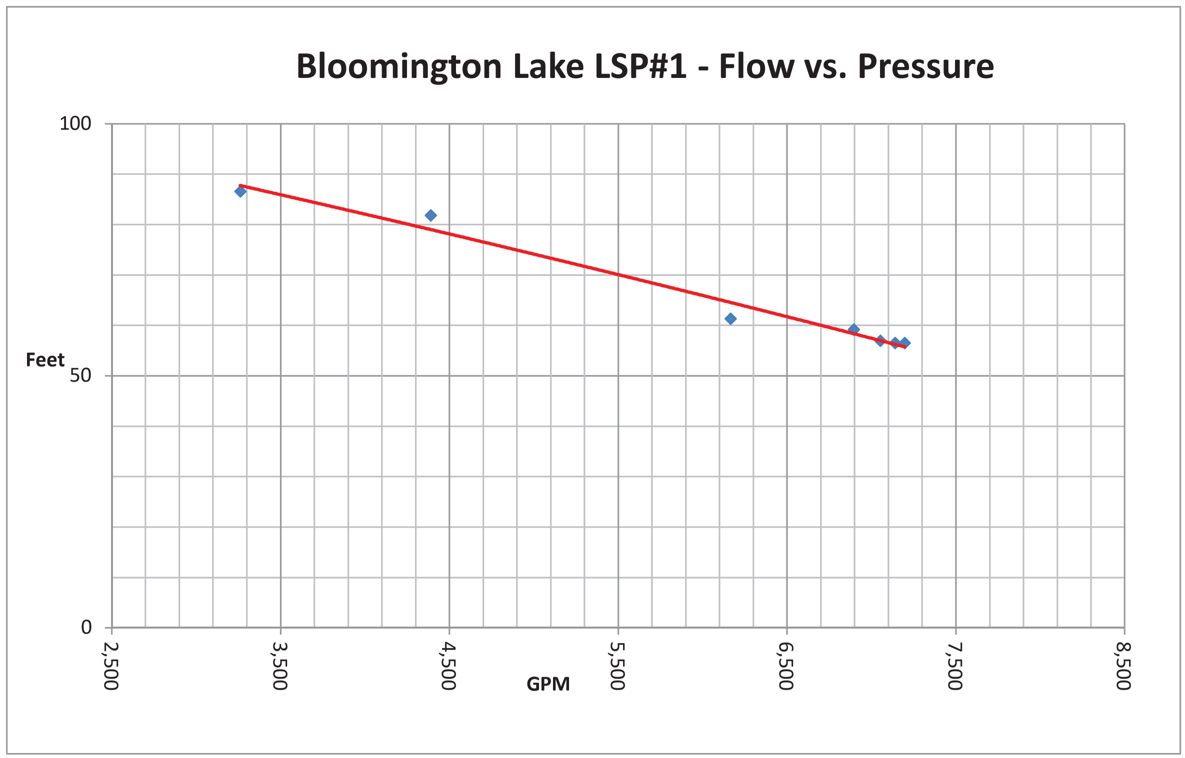
COMMENTS:

M.E. SIMPSON Co., Inc.

Bloomington Lake - Low Service Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/9/18	10:17:00 AM	10:19:00 AM	100%	7,139				1.54	27.27	-2.910	**56.51**		
2	2/9/18	10:21:00 AM	10:23:00 AM	88%	7,197				1.55	27.28	-2.910	**56.53**		
3	2/9/18	10:25:30 AM	10:27:30 AM	75%	7,052				1.62	27.53	-2.910	**56.94**		
4	2/9/18	10:29:30 AM	10:31:30 AM	63%	6,894				1.78	28.65	-2.910	**59.17**		
5	2/9/18	10:33:30 AM	10:35:30 AM	50%	6,166				2.12	29.93	-2.910	**61.33**		
6	2/9/18	10:37:30 AM	10:39:30 AM	38%	4,389				2.91	39.61	-2.910	**81.86**		
7	2/9/18	10:42:00 AM	10:44:00 AM	30%	3,260				3.40	42.14	-2.910	**86.57**		
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
7,139	56.51		
7,197	56.53		
7,052	56.94		
6,894	59.17		
6,166	61.33		
4,389	81.86		
3,260	86.57		



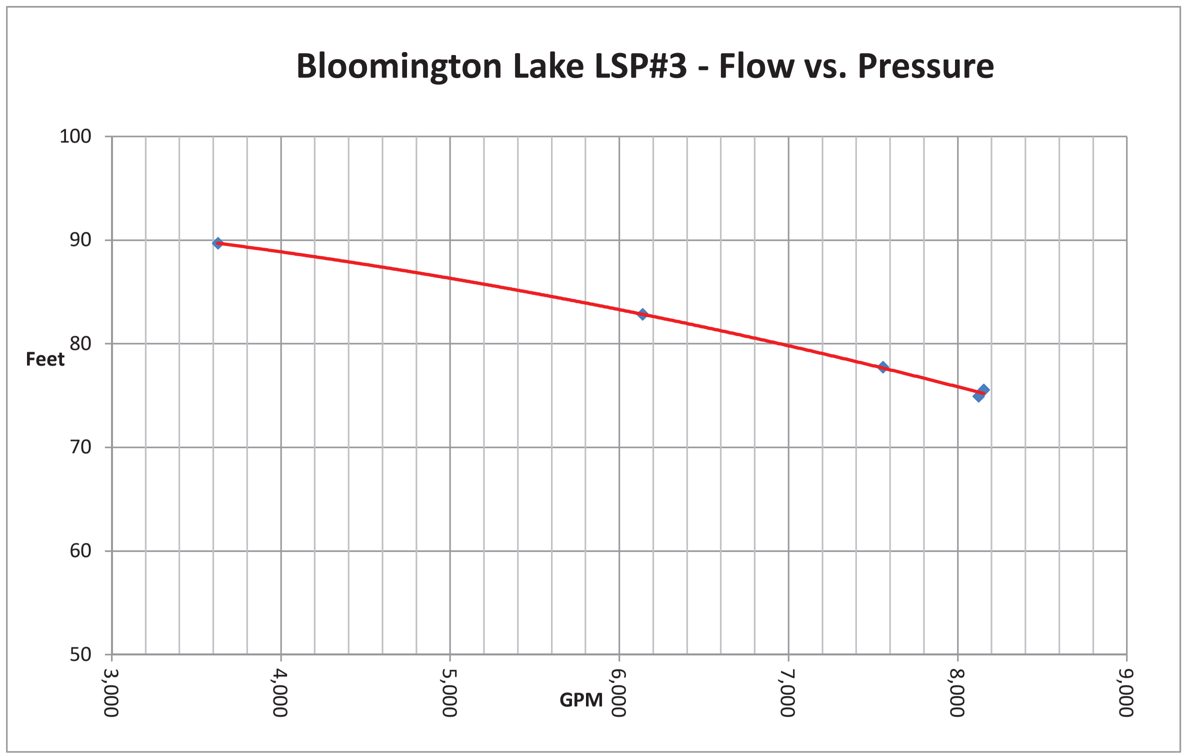
COMMENTS:

M.E. SIMPSON Co., Inc.

Bloomington Lake - Low Service Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/9/18	9:48:00 AM	9:50:00 AM	100%	8,123				3.49	37.12	-2.750	**74.94**	423.0	262.0
2	2/9/18	9:53:00 AM	9:55:00 AM	85%	8,154				3.51	37.41	-2.750	**75.57**	423.0	259.0
3	2/9/18	9:57:30 AM	9:59:30 AM	67%	7,557				3.55	38.40	-2.750	**77.75**	424.0	251.0
4	2/9/18	10:01:30 AM	10:03:30 AM	50%	6,137				3.67	40.72	-2.750	**82.84**	429.0	232.0
5	2/9/18	10:05:30 AM	10:07:30 AM	40%	3,626				3.81	43.84	-2.750	**89.72**	435.0	209.0
6														
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
8,123	74.94	110,826	
8,154	75.57	109,557	
7,557	77.75	106,424	
6,137	82.84	99,528	
3,626	89.72	90,915	



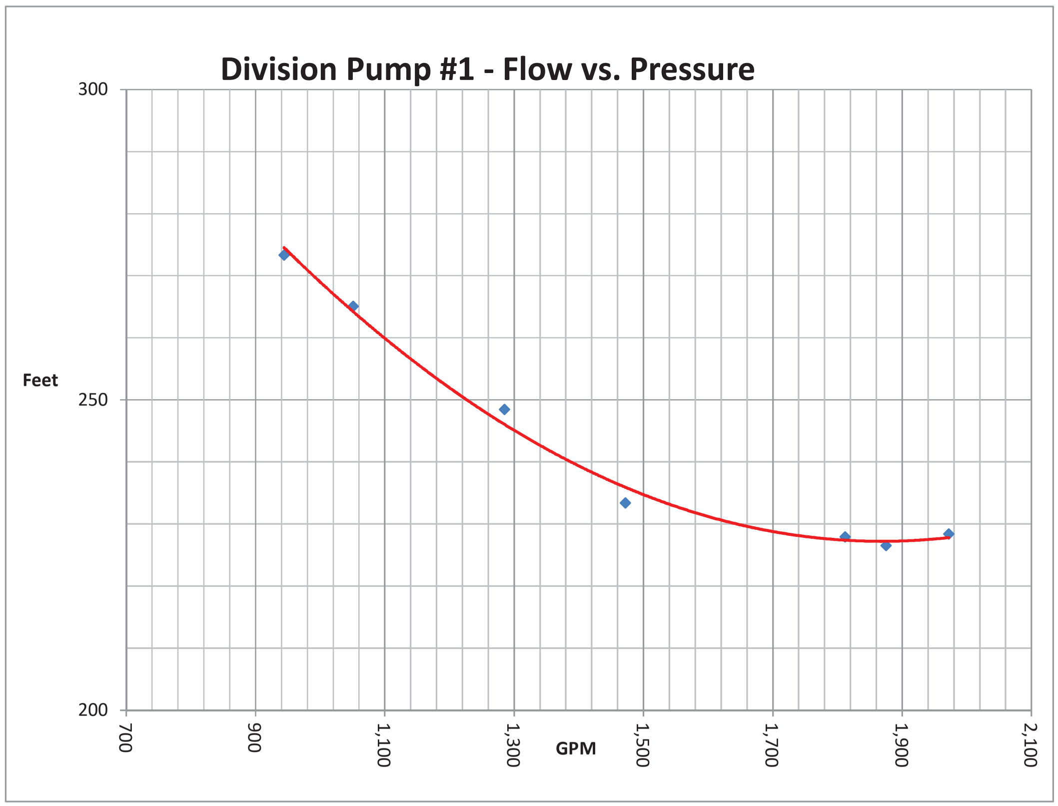
COMMENTS:

M.E. SIMPSON Co., Inc.

Division - Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/12/18	1:22:30 PM	1:24:30 PM	100%	1,737		1,812		1.44	101.39	-3.000	**227.90**		
2	2/12/18	1:26:30 PM	1:28:30 PM	84%	1,711		1,875		1.68	101.04	-3.000	**226.52**		
3	2/12/18	1:30:00 PM	1:32:00 PM	68%	1,057		1,972		1.96	102.12	-3.000	**228.36**		
4	2/12/18	1:33:30 PM	1:35:30 PM	52%	932		1,472		2.13	104.47	-3.000	**233.42**		
5	2/12/18	1:37:00 PM	1:39:00 PM	36%	747		1,285		1.45	110.30	-3.000	**248.44**		
6	2/12/18	1:40:30 PM	1:42:30 PM	20%	262		1,051		3.04	119.10	-3.000	**265.09**		
7	2/12/18	1:43:30 PM	1:45:30 PM	4%	153		944		3.31	122.94	-3.000	**273.35**		
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
1,812	227.90		104.3%
1,875	226.52		109.6%
1,972	228.36		186.5%
1,472	233.42		158.0%
1,285	248.44		172.0%
1,051	265.09		401.5%
944	273.35		618.6%



COMMENTS:

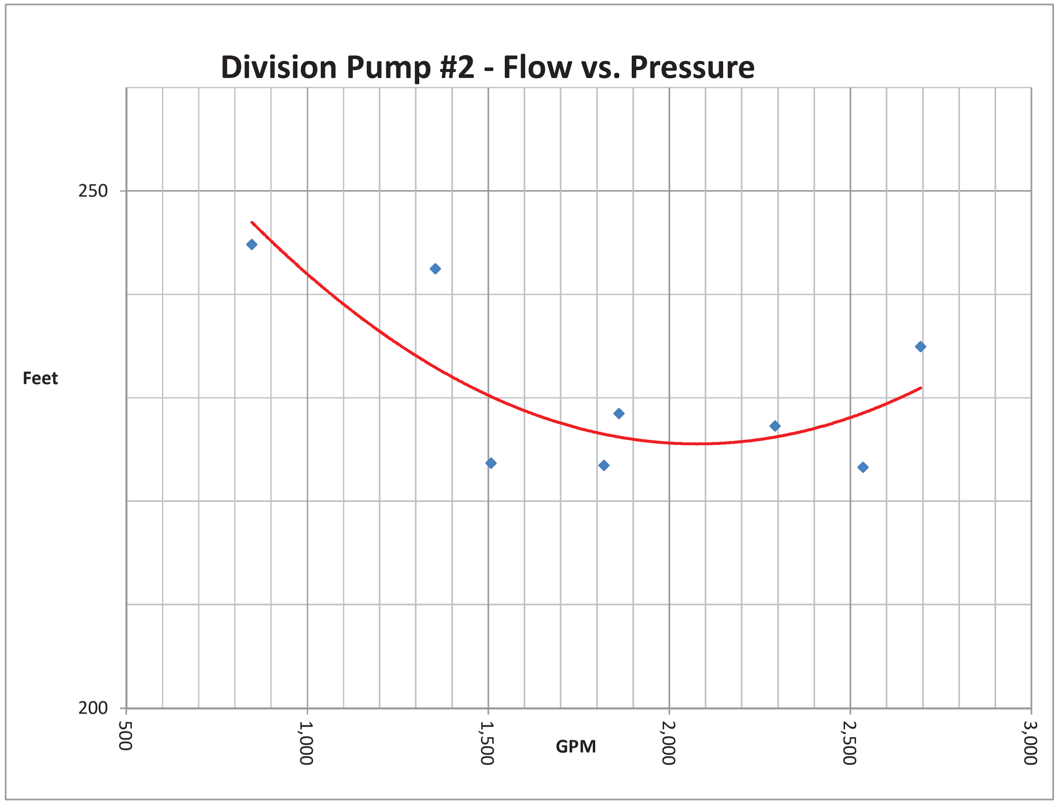
The Pitot test tap is not reliable. The velocity profile was "inverted" and the flow data is not usable. Local meter readings were used for this pump curve. The accuracy of the local meter is not known and it may be malfunctioning.

M.E. SIMPSON Co., Inc.

Division - Pump #2

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/12/18	2:02:30 PM	2:04:30 PM	100%	1,004		2,535		2.60	100.56	-3.000	**223.27**		
2	2/12/18	2:06:30 PM	2:08:30 PM	86%	1,309		1,507		2.72	100.85	-3.000	**223.68**		
3	2/12/18	2:10:00 PM	2:12:00 PM	72%	1,641		1,819		2.71	100.76	-3.000	**223.48**		
4	2/12/18	2:13:30 PM	2:15:30 PM	58%	1,303		2,292		1.81	101.50	-3.000	**227.27**		
5	2/12/18	2:17:00 PM	2:19:00 PM	46%	754		1,861		2.83	103.04	-3.000	**228.48**		
6	2/12/18	2:20:30 PM	2:22:30 PM	32%	679		2,694		3.02	106.03	-3.000	**234.95**		
7	2/12/18	2:24:00 PM	2:26:00 PM	18%	99		1,354		1.85	108.11	-3.000	**242.46**		
8	2/12/18	2:27:30 PM	2:29:30 PM	4%	5		847		3.29	110.57	-3.000	**244.82**		
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
2,535	223.27		252.5%
1,507	223.68		115.1%
1,819	223.48		110.8%
2,292	227.27		175.8%
1,861	228.48		246.8%
2,694	234.95		396.7%
1,354	242.46		1368.4%
847	244.82		n/a



COMMENTS:

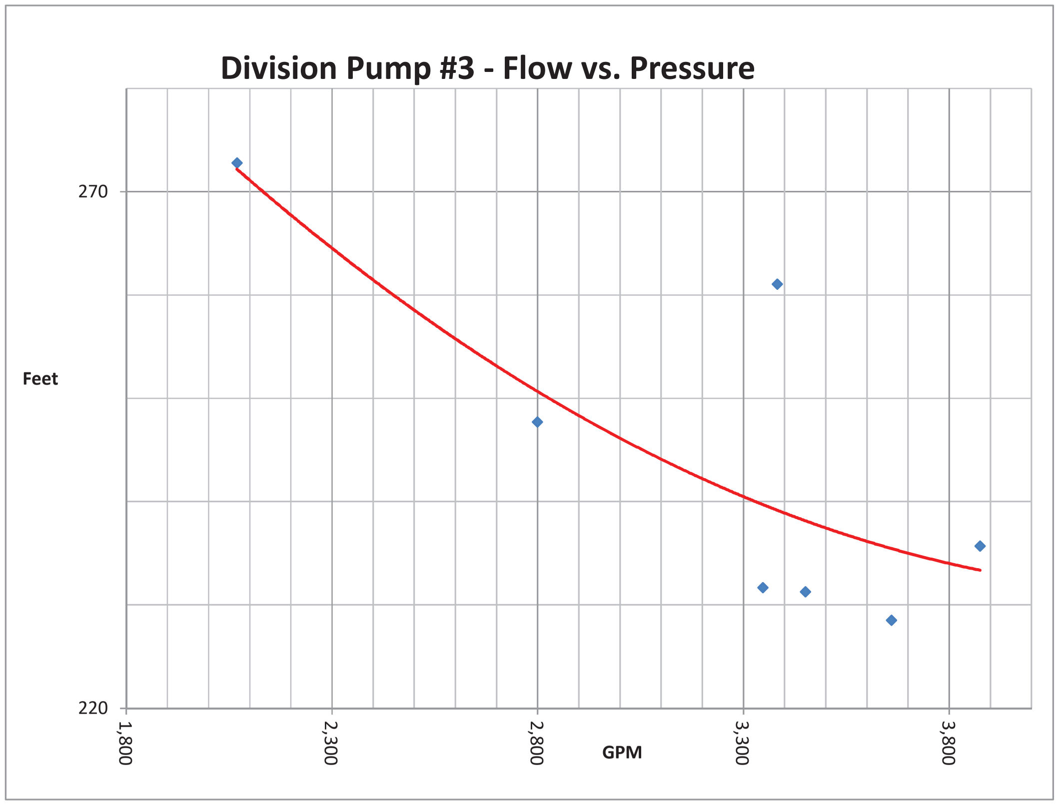
The Pitot test tap is not reliable. The velocity profile was "inverted" and the flow data is not usable. Local meter readings were used for this pump curve. The accuracy of the local meter is not known and it may be malfunctioning.

M.E. SIMPSON Co., Inc.

Division - Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/12/18	12:25:00 PM	12:27:00 PM	100%	2,664		3,660		2.50	102.72	-3.000	**228.51**		
2	2/12/18	12:29:00 PM	12:31:00 PM	84%	2,711		3,347		1.40	103.00	-3.000	**231.69**		
3	2/12/18	12:32:30 PM	12:34:30 PM	68%	2,896		3,451		2.42	103.83	-3.000	**231.26**		
4	2/12/18	12:36:00 PM	12:38:00 PM	52%	2,720		3,875		2.63	105.97	-3.000	**235.71**		
5	2/12/18	12:39:30 PM	12:41:30 PM	36%	1,978		2,799		2.92	111.44	-3.000	**247.70**		
6	2/12/18	12:43:00 PM	12:45:00 PM	20%	1,112		3,382		1.77	116.09	-3.000	**261.07**		
7	2/12/18	12:46:30 PM	12:48:30 PM	4%	113		2,069		3.38	122.76	-3.000	**272.78**		
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,660	228.51		137.4%
3,347	231.69		123.4%
3,451	231.26		119.2%
3,875	235.71		142.5%
2,799	247.70		141.5%
3,382	261.07		304.2%
2,069	272.78		1824.9%



COMMENTS:

The Pitot test tap is not reliable. The velocity profile was "inverted" and the flow data is not usable. Local meter readings were used for this pump curve. The accuracy of the local meter is not known and it may be malfunctioning.

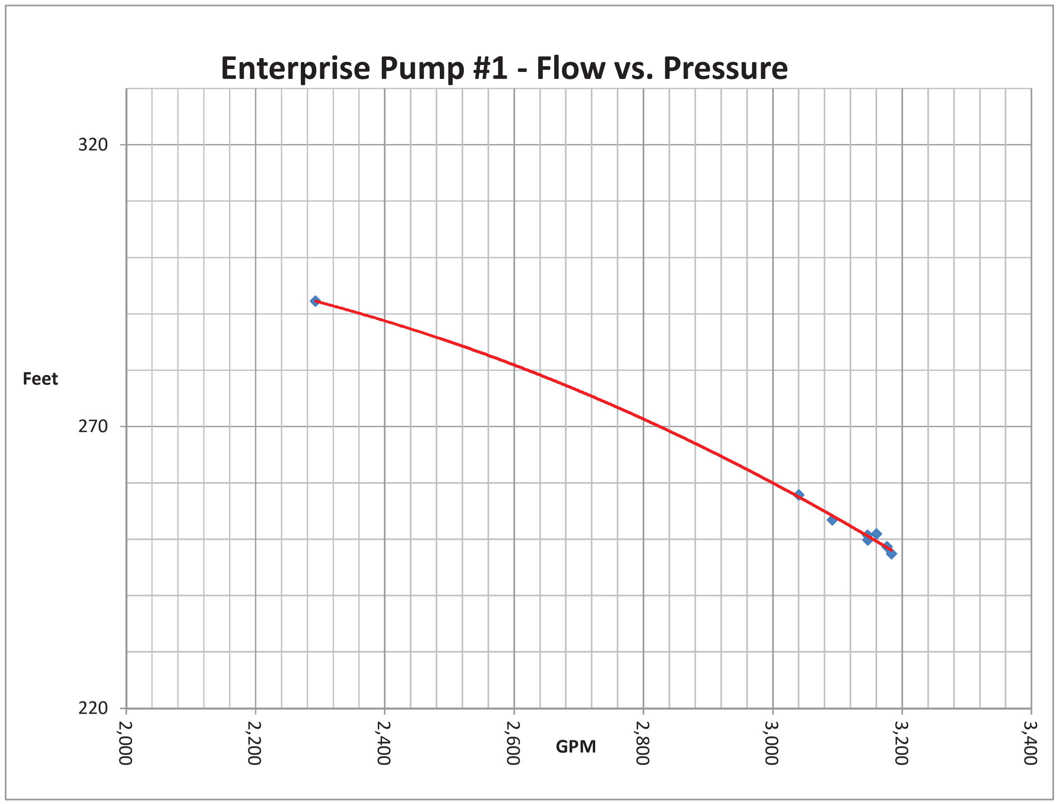
M.E. SIMPSON Co., Inc.

Enterprise - Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/13/18	1:24:30 PM	1:26:30 PM	100%	3,176		2,972	9.30		103.63	0.000	**239.39**	456.0	251.2
2	2/13/18	1:28:00 PM	1:30:00 PM	86%	3,160		2,944	12.00		103.45	0.000	**238.97**	456.0	260.7
3	2/13/18	1:31:30 PM	1:33:30 PM	72%	3,183		3,000	6.70		104.22	0.000	**240.75**	456.0	261.4
4	2/13/18	1:35:00 PM	1:37:00 PM	58%	3,147		3,000	9.50		104.06	0.000	**240.38**	456.0	260.7
5	2/13/18	1:38:30 PM	1:40:30 PM	44%	3,092		2,916	11.90		104.57	0.000	**241.55**	456.0	259.7
6	2/13/18	1:42:00 PM	1:44:00 PM	30%	3,146		2,916	7.00		105.51	0.000	**243.74**	457.0	260.3
7	2/13/18	1:45:30 PM	1:47:30 PM	16%	3,040		2,895	8.80		107.83	0.000	**249.09**	456.0	258.7
8	2/13/18	1:49:00 PM	1:51:00 PM	5%	2,293		2,326	11.50		121.54	0.000	**280.76**	457.0	238.0
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,176	248.69	114,547	93.6%
3,160	250.97	118,879	93.2%
3,183	247.45	119,198	94.2%
3,147	249.88	118,879	95.3%
3,092	253.45	118,423	94.3%
3,146	250.74	118,957	92.7%
3,040	257.89	117,967	95.2%
2,293	292.26	108,766	101.5%

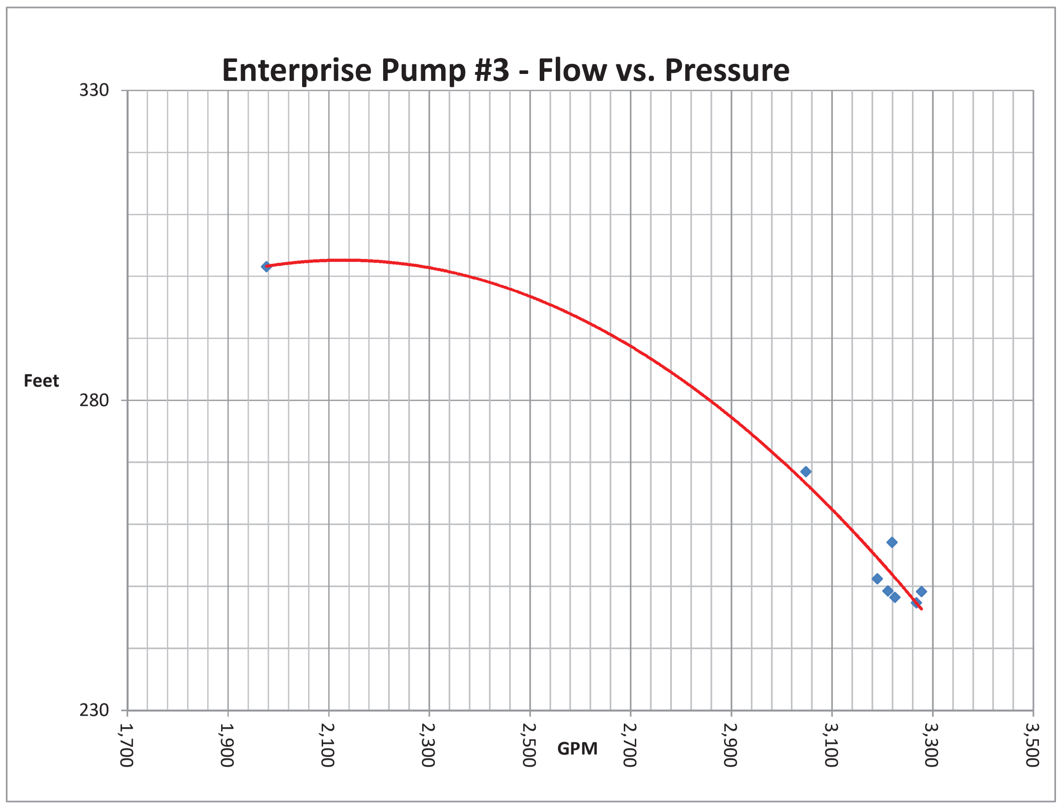
COMMENTS:



Enterprise - Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/13/18	11:47:30 AM	11:49:30 AM	100%	3,211		3,118	9.58		103.76	0.000	**239.70**	452.0	268.4
2	2/13/18	11:51:00 AM	11:53:00 AM	86%	3,225		3,118	7.42		104.25	0.000	**240.81**	451.0	268.5
3	2/13/18	11:54:30 AM	11:56:30 AM	72%	3,190		3,083	10.66		104.15	0.000	**240.58**	452.0	267.9
4	2/13/18	11:58:30 AM	12:00:30 PM	58%	3,277		3,083	8.92		104.00	0.000	**240.25**	452.0	267.9
5	2/13/18	12:02:00 PM	12:04:00 PM	44%	3,267		3,125	7.81		103.71	0.000	**239.56**	452.0	268.4
6	2/13/18	12:05:30 PM	12:07:30 PM	30%	3,219		3,020	11.40		106.37	0.000	**245.71**	452.0	266.5
7	2/13/18	12:09:00 PM	12:11:00 PM	16%	3,048		2,888	10.25		111.79	0.000	**258.24**	453.0	263.7
8	2/13/18	12:12:30 PM	12:14:30 PM	5%	1,976		2,118	6.81		127.61	0.000	**294.78**	455.0	232.9
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,211	249.28	121,317	97.1%
3,225	248.23	121,094	96.7%
3,190	251.24	121,091	96.6%
3,277	249.17	121,091	94.1%
3,267	247.37	121,317	95.6%
3,219	257.11	120,458	93.8%
3,048	268.49	119,456	94.7%
1,976	301.59	105,970	107.2%



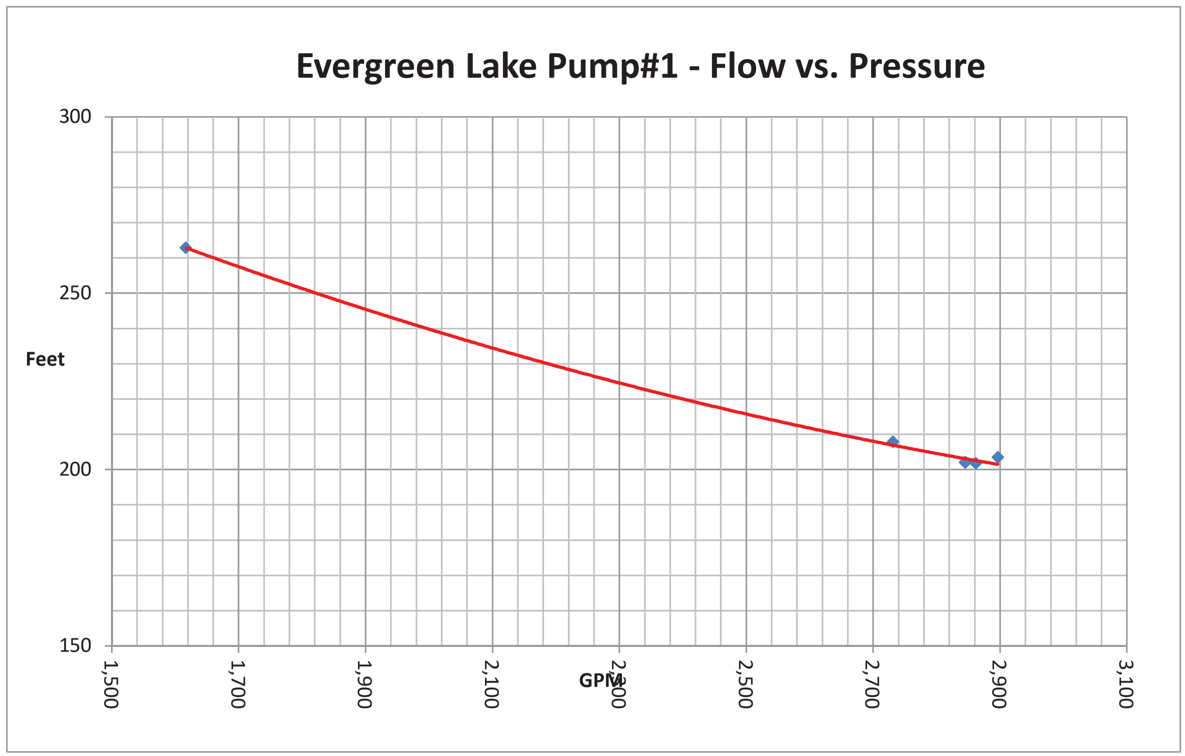
COMMENTS:

M.E. SIMPSON Co., Inc.

Evergreen Lake - Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/14/18	11:16:00 AM	11:18:00 AM	100%	2,845			13.20		82.17	-0.920	**188.90**		
2	2/14/18	11:26:00 AM	11:28:00 AM	87%	2,862			13.20		82.06	-0.920	**188.64**		
3	2/14/18	11:36:00 AM	11:38:00 AM	64%	2,845			13.20		82.18	-0.920	**188.91**		
4	2/14/18	11:46:00 AM	11:48:00 AM	50%	2,896			13.20		82.79	-0.920	**190.32**		
5	2/14/18	11:54:00 AM	11:56:00 AM	37%	2,731			13.20		84.67	-0.920	**194.67**		
6	2/14/18	12:04:00 PM	12:06:00 PM	14%	1,616			13.20		108.49	-0.920	**249.68**		
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
2,845	**202.10**		
2,862	**201.84**		
2,845	**202.11**		
2,896	**203.52**		
2,731	**207.87**		
1,616	**262.88**		



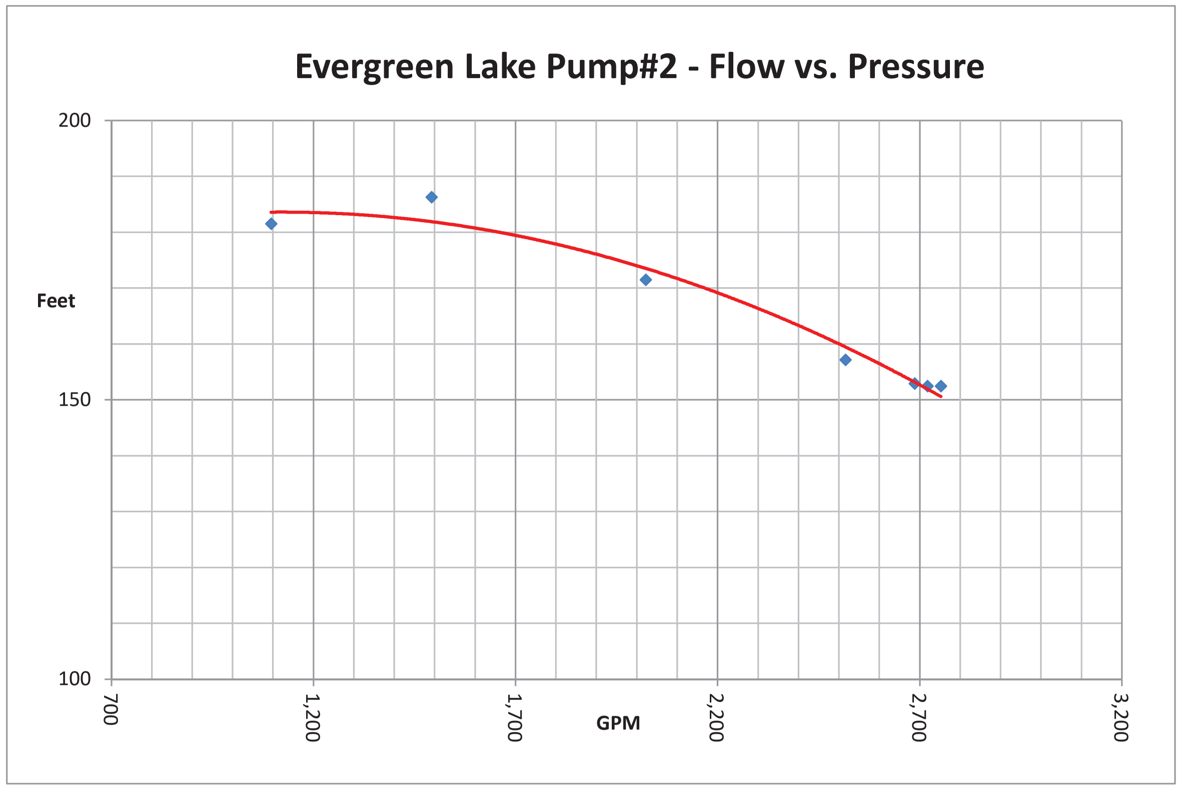
COMMENTS:

M.E. SIMPSON Co., Inc.

Evergreen Lake - Pump #2

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/14/18	9:30:00 AM	9:32:00 AM	100%	2,752			13.20		60.70	-0.920	**139.29**		
2	2/14/18	9:42:00 AM	9:44:00 AM	87%	2,719			13.20		60.70	-0.920	**139.30**		
3	2/14/18	9:52:00 AM	9:54:00 AM	64%	2,688			13.20		60.88	-0.920	**139.72**		
4	2/14/18	10:02:00 AM	10:04:00 AM	50%	2,516			13.20		62.72	-0.920	**143.96**		
5	2/14/18	10:12:00 AM	10:14:00 AM	37%	2,022			13.20		68.93	-0.920	**158.30**		
6	2/14/18	10:20:00 AM	10:22:00 AM	20%	1,492			13.20		75.33	-0.920	**173.08**		
7	2/14/18	10:30:00 AM	10:32:00 AM	14%	1,095			13.20		73.28	-0.920	**168.36**		
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
2,752	**152.49**		
2,719	**152.50**		
2,688	**152.92**		
2,516	**157.16**		
2,022	**171.50**		
1,492	**186.28**		
1,095	**181.56**		



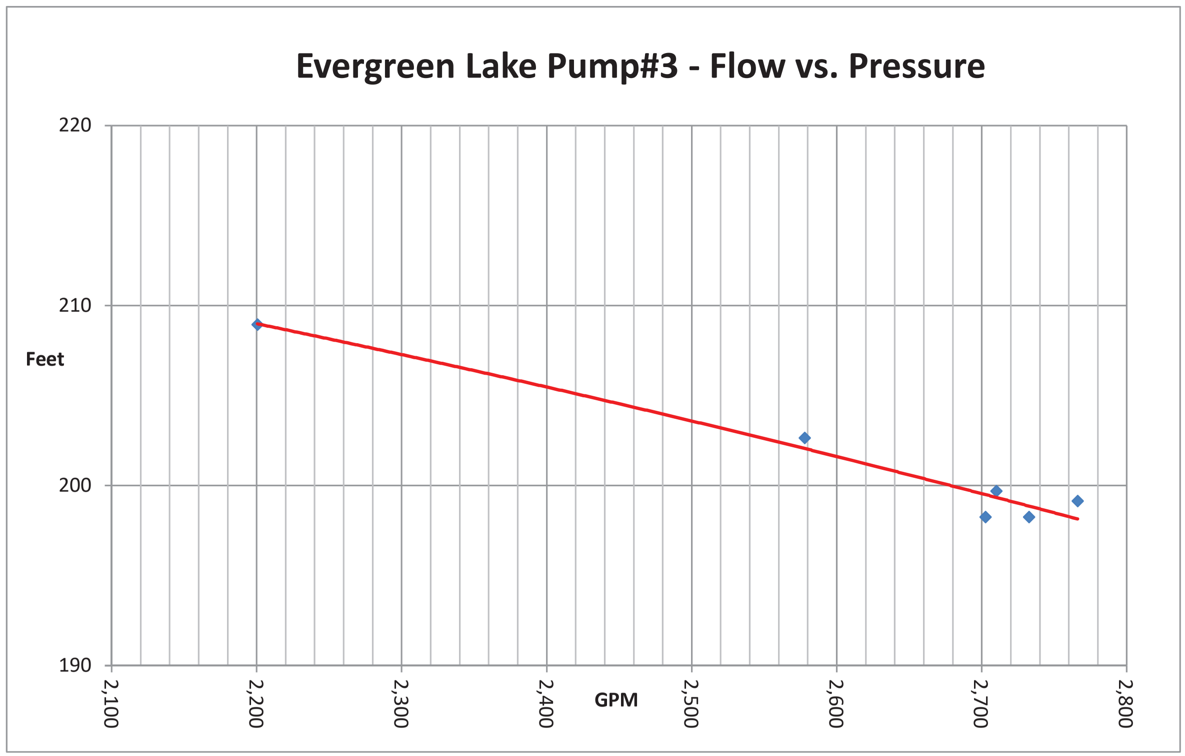
COMMENTS:

M.E. SIMPSON Co., Inc.

Evergreen Lake - Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/14/18	12:36:00 PM	12:38:00 PM	100%	2,733			13.20		80.51	-0.920	**185.06**		
2	2/14/18	12:43:00 PM	12:45:00 PM	87%	2,766			13.20		80.90	-0.920	**185.95**		
3	2/14/18	12:52:00 PM	12:54:00 PM	64%	2,702			13.20		80.51	-0.920	**185.06**		
4	2/14/18	1:00:00 PM	1:02:00 PM	50%	2,710			13.20		81.13	-0.920	**186.50**		
5	2/14/18	1:08:00 PM	1:10:00 PM	37%	2,578			13.20		82.41	-0.920	**189.45**		
6	2/14/18	1:16:00 PM	1:18:00 PM	20%	2,201			13.20		85.14	-0.920	**195.74**		
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
2,733	198.26		
2,766	199.15		
2,702	198.26		
2,710	199.70		
2,578	202.65		
2,201	208.94		



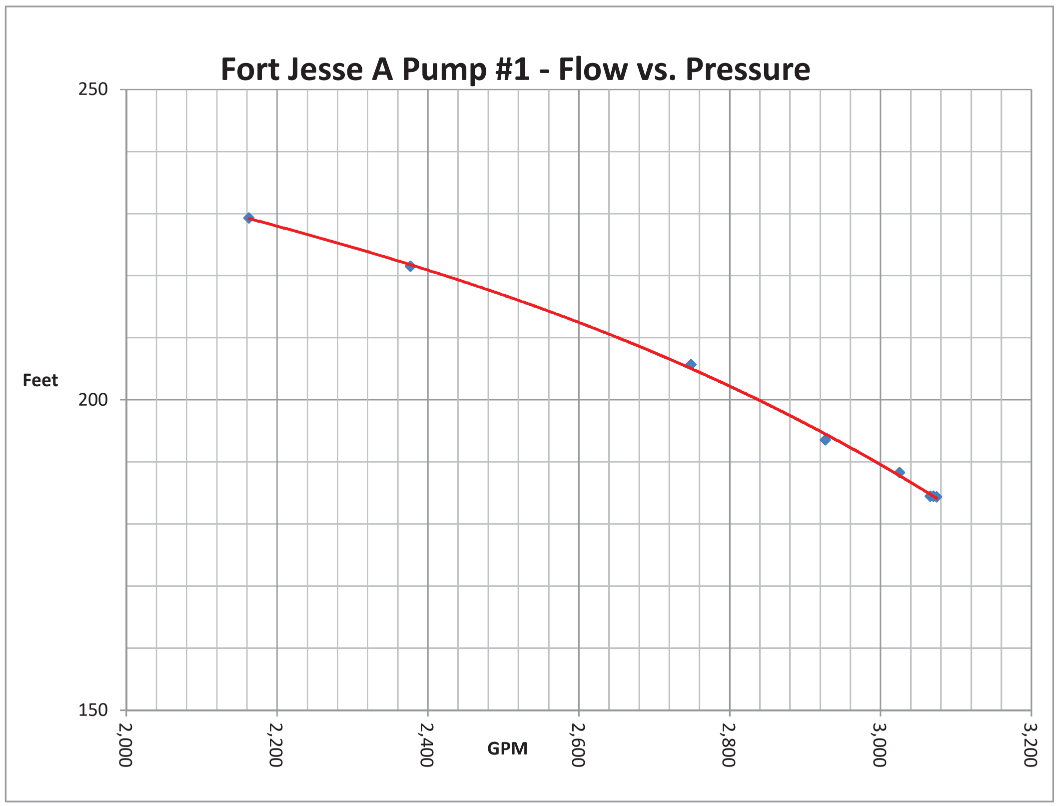
COMMENTS:

M.E. SIMPSON Co., Inc.

Fort Jesse A - Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/7/18	11:52:00 AM	11:54:00 AM	100%	3,074				9.42	88.40	1.917	**184.36**	480.0	217.6
2	2/7/18	11:55:30 AM	11:57:30 AM	84%	3,066				9.37	88.40	1.917	**184.48**	480.0	217.8
3	2/7/18	11:59:30 AM	12:01:30 PM	68%	3,070				9.35	88.39	1.917	**184.49**	480.3	217.1
4	2/7/18	12:03:00 PM	12:05:00 PM	53%	3,025				9.29	89.97	1.917	**188.28**	480.9	217.0
5	2/7/18	12:07:30 PM	12:09:30 PM	37%	2,927				9.28	92.24	1.917	**193.57**	481.0	216.2
6	2/7/18	12:11:00 PM	12:13:00 PM	26%	2,748				9.29	97.50	1.917	**205.69**	481.4	214.3
7	2/7/18	12:15:30 PM	12:17:30 PM	21%	2,377				9.36	104.42	1.917	**221.53**	481.3	208.0
8	2/7/18	12:19:00 PM	12:21:00 PM	18%	2,163				9.31	107.74	1.917	**229.28**	481.9	205.2
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,074	184.36	104,448	
3,066	184.48	104,544	
3,070	184.49	104,273	
3,025	188.28	104,355	
2,927	193.57	103,992	
2,748	205.69	103,164	
2,377	221.53	100,110	
2,163	229.28	98,886	



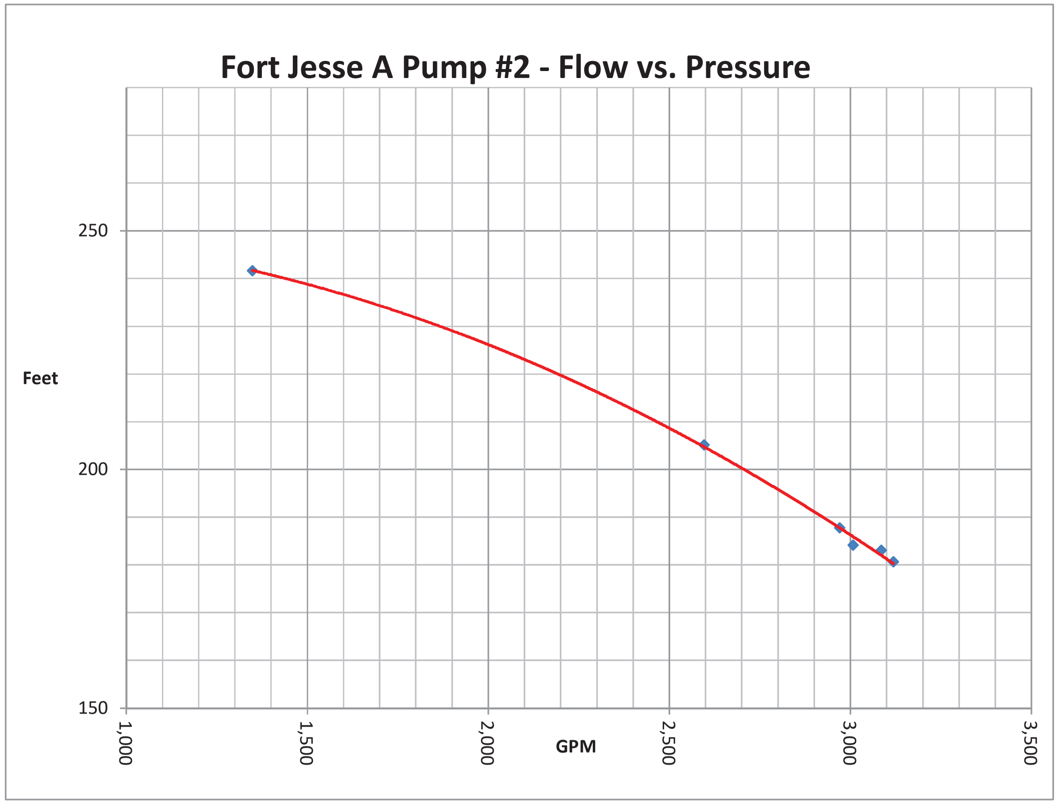
COMMENTS:

Fort Jesse A - Pump #2

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/7/18	10:47:00 AM	10:49:00 AM	100%	3,119				10.35	87.73	1.917	**180.64**	480.7	217.7
2	2/7/18	10:51:00 AM	10:53:00 AM	83%	3,007				10.28	89.18	1.917	**184.18**	480.7	217.6
3	2/7/18	10:54:30 AM	10:56:30 AM	67%	3,085				10.23	88.65	1.917	**183.07**	480.9	217.9
4	2/7/18	10:58:00 AM	11:00:00 AM	50%	2,970				10.19	90.65	1.917	**187.77**	480.8	217.1
5	2/7/18	11:02:00 AM	11:04:00 AM	33%	2,596				10.16	98.13	1.917	**205.14**	482.1	213.3
6	2/7/18	11:07:30 AM	11:09:30 AM	22%	1,348				10.14	113.93	1.917	**241.67**	482.0	180.4
7														
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,119	180.64	104,648	
3,007	184.18	104,600	
3,085	183.07	104,788	
2,970	187.77	104,382	
2,596	205.14	102,832	
1,348	241.67	86,953	

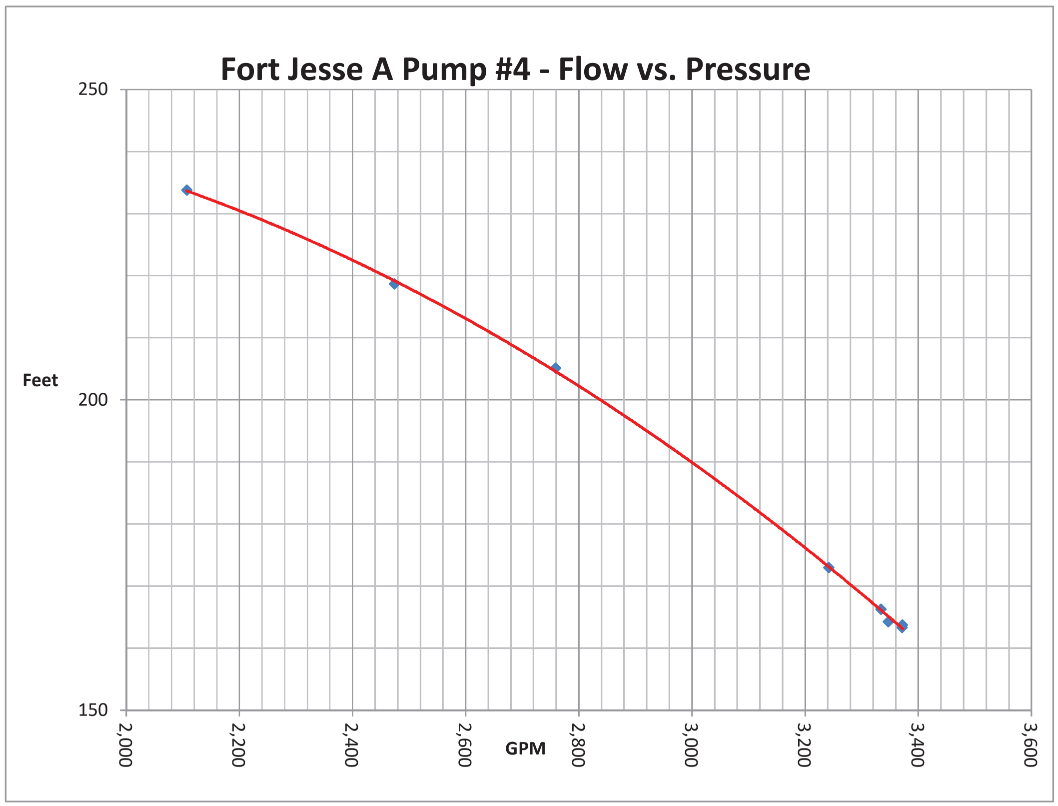
COMMENTS:



Fort Jesse A - Pump #4

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/7/18	9:18:00 AM	9:20:00 AM	100%	3,371				10.92	80.79	1.917	**163.31**	480.0	235.0
2	2/7/18	9:21:00 AM	9:23:00 AM	84%	3,372				10.90	80.95	1.917	**163.72**	480.0	239.0
3	2/7/18	9:25:00 AM	9:27:00 AM	68%	3,347				10.86	81.13	1.917	**164.24**	480.0	239.0
4	2/7/18	9:28:30 AM	9:30:30 AM	53%	3,334				10.84	81.98	1.917	**166.27**	480.7	239.3
5	2/7/18	9:33:00 AM	9:35:00 AM	37%	3,242				10.83	84.89	1.917	**172.99**	480.0	239.7
6	2/7/18	9:39:30 AM	9:41:30 AM	21%	2,759				10.81	98.76	1.917	**205.09**	480.0	233.0
7	2/7/18	9:47:30 AM	9:49:30 AM	18%	2,474				10.79	104.61	1.917	**218.66**	480.0	224.0
8	2/7/18	9:54:30 AM	9:56:30 AM	16%	2,107				10.76	111.15	1.917	**233.82**	481.0	217.9
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
3,371	163.31	112,800	
3,372	163.72	114,720	
3,347	164.24	114,720	
3,334	166.27	115,032	
3,242	172.99	115,056	
2,759	205.09	111,840	
2,474	218.66	107,520	
2,107	233.82	104,810	



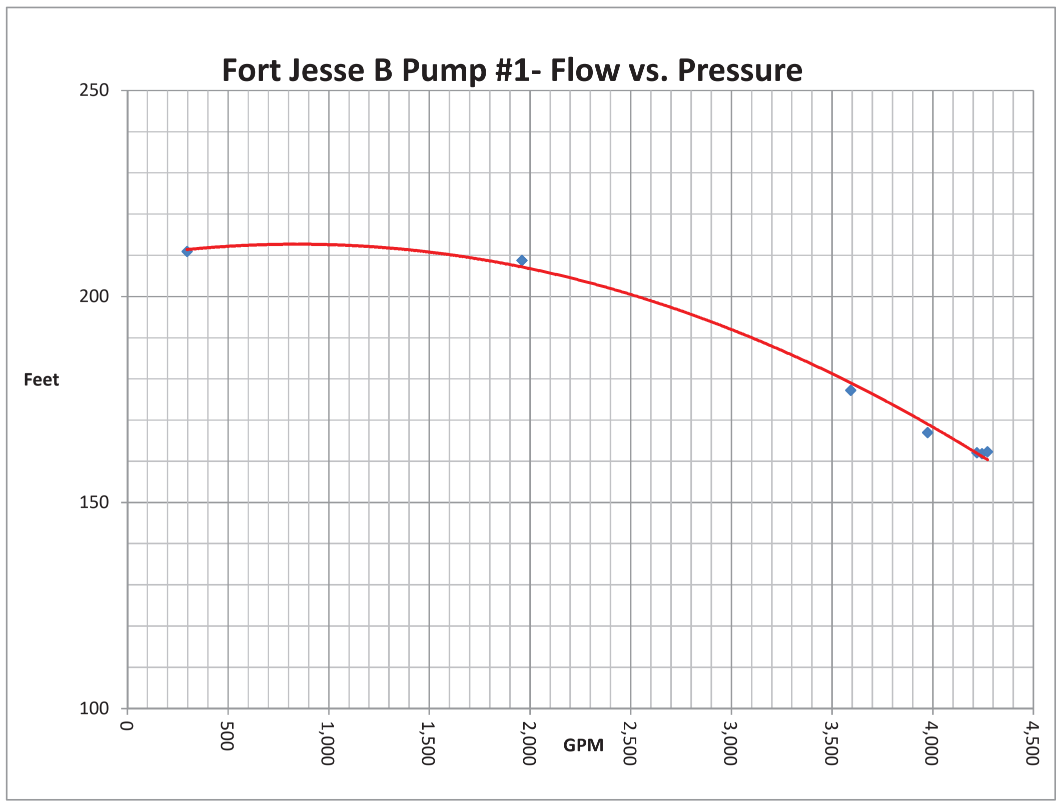
COMMENTS:

M.E. Simpson Co., Inc.

Fort Jesse B - Pump #1

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/15/18	12:01:00 PM	12:03:00 PM	100%	4,244				4.21	75.14	-2.000	**161.85**	485.3	320.0
2	2/15/18	12:04:30 PM	12:06:30 PM	87%	4,272				4.25	75.40	-2.000	**162.34**	485.7	317.7
3	2/15/18	12:08:00 PM	12:10:00 PM	64%	4,220				4.23	75.27	-2.000	**162.11**	485.7	317.7
4	2/15/18	12:12:00 PM	12:14:00 PM	50%	3,974				4.43	77.59	-2.000	**166.98**	485.7	312.3
5	2/15/18	12:16:00 PM	12:18:00 PM	37%	3,593				4.88	82.47	-2.000	**177.24**	485.3	303.0
6	2/15/18	12:21:00 PM	12:23:00 PM	14%	1,960				5.92	97.15	-2.000	**208.75**	485.3	276.3
7	2/15/18	12:25:00 PM	12:27:00 PM	5%	296				6.42	98.59	-2.000	**210.90**	486.3	239.3
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
4,244	161.85	155,296	
4,272	162.34	154,307	
4,220	162.11	154,307	
3,974	166.98	151,684	
3,593	177.24	147,046	
1,960	208.75	134,088	
296	210.90	116,372	



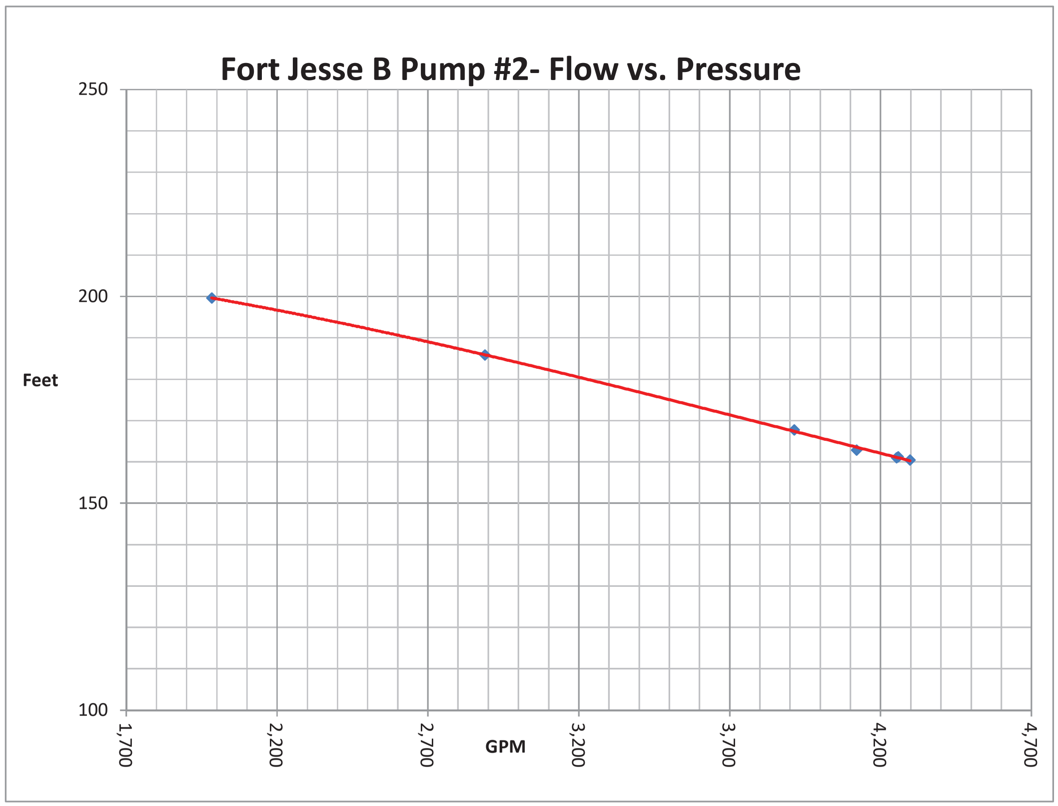
COMMENTS:

M.E. SIMPSON Co., Inc.

Fort Jesse B - Pump #2

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/15/18	12:42:00 PM	1:44:00 PM	100%	4,297				4.45	74.77	-2.000	**160.44**	482.0	260.0
2	2/15/18	12:46:00 PM	12:48:00 PM	87%	4,253				4.46	75.02	-2.000	**160.99**	482.3	258.7
3	2/15/18	12:50:00 PM	12:52:00 PM	64%	4,259				4.48	75.15	-2.000	**161.24**	482.3	256.7
4	2/15/18	12:54:00 PM	12:56:00 PM	50%	4,121				4.58	75.94	-2.000	**162.84**	483.0	255.3
5	2/15/18	12:58:00 PM	1:00:00 PM	37%	3,914				4.83	78.32	-2.000	**167.77**	482.7	248.0
6	2/15/18	1:02:30 PM	1:04:30 PM	14%	2,889				5.65	86.95	-2.000	**185.81**	484.3	221.3
7	2/15/18	1:06:00 PM	1:08:00 PM	5%	1,983				6.18	93.46	-2.000	**199.64**	485.0	198.7
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
4,297	160.44	125,320	
4,253	160.99	124,771	
4,259	161.24	123,806	
4,121	162.84	123,310	
3,914	167.77	119,710	
2,889	185.81	107,176	
1,983	199.64	96,370	



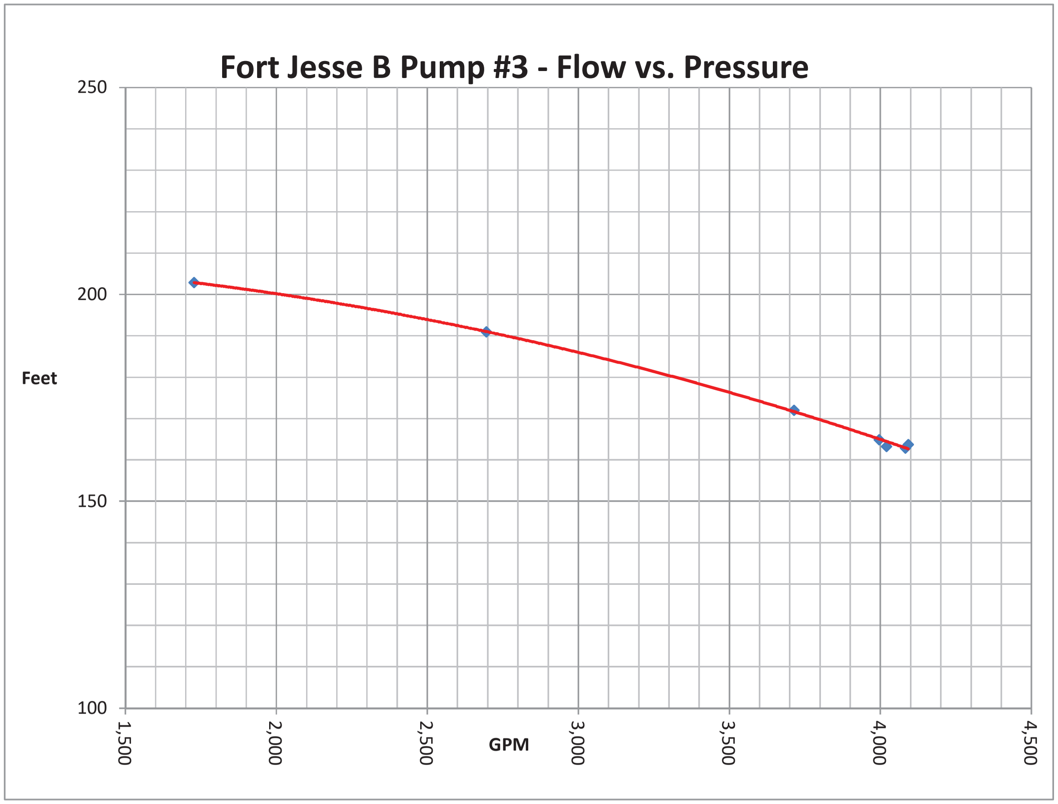
COMMENTS:

M.E. SIMPSON Co., Inc.

Fort Jesse B - Pump #3

	Date	Start Time	End Time	Valve %	Pitot Q (gpm)	Additional Q (gpm)	Meter Q (gpm)	Suction Lift (ft)	Suction Press (psi)	Discharge Press (psi)	Gage Elev. from C/L (ft)	Discharge Press (ft)	Voltage (V)	Amperage (A)
1	2/15/18	11:22:00 AM	11:24:00 AM	100%	4,083				4.12	75.50	-2.000	**162.89**	482.3	260.7
2	2/15/18	11:28:00 AM	11:30:00 AM	87%	4,021				4.13	75.66	-2.000	**163.25**	482.3	260.0
3	2/15/18	11:31:30 AM	11:33:30 AM	64%	4,092				4.21	75.95	-2.000	**163.71**	483.3	260.0
4	2/15/18	11:35:30 AM	11:37:30 AM	50%	3,996				4.24	76.49	-2.000	**164.89**	483.0	257.7
5	2/15/18	11:39:00 AM	11:41:00 AM	37%	3,714				4.52	79.85	-2.000	**172.00**	482.0	251.0
6	2/15/18	11:43:00 AM	11:45:00 AM	14%	2,695				5.24	88.79	-2.000	**190.99**	483.7	225.3
7	2/15/18	11:47:00 AM	11:49:00 AM	5%	1,728				5.79	94.47	-2.000	**202.85**	484.0	202.0
8														
9														
10														

TOTAL Q (gpm)	Δ Pressure (ft)	Power (W)	Meter Acc %
4,083	162.89	125,736	
4,021	163.25	125,398	
4,092	163.71	125,658	
3,996	164.89	124,469	
3,714	172.00	120,982	
2,695	190.99	108,978	
1,728	202.85	97,768	



COMMENTS:

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Appendix H2: Original Factory Performance Testing Results

Figure B-1: Factory performance testing results for Lake Bloomington Low Service Pump #1 (16" Impeller)

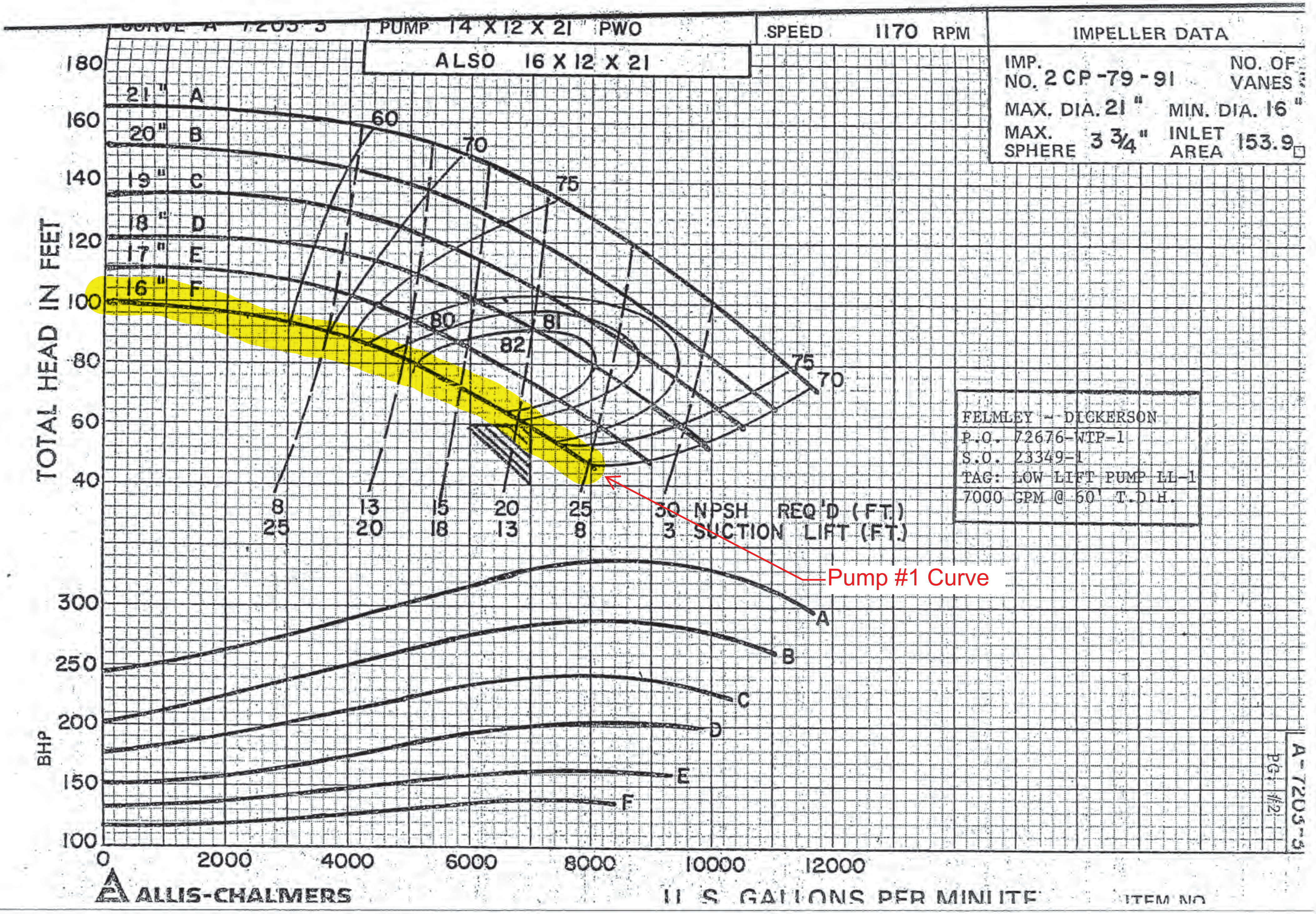
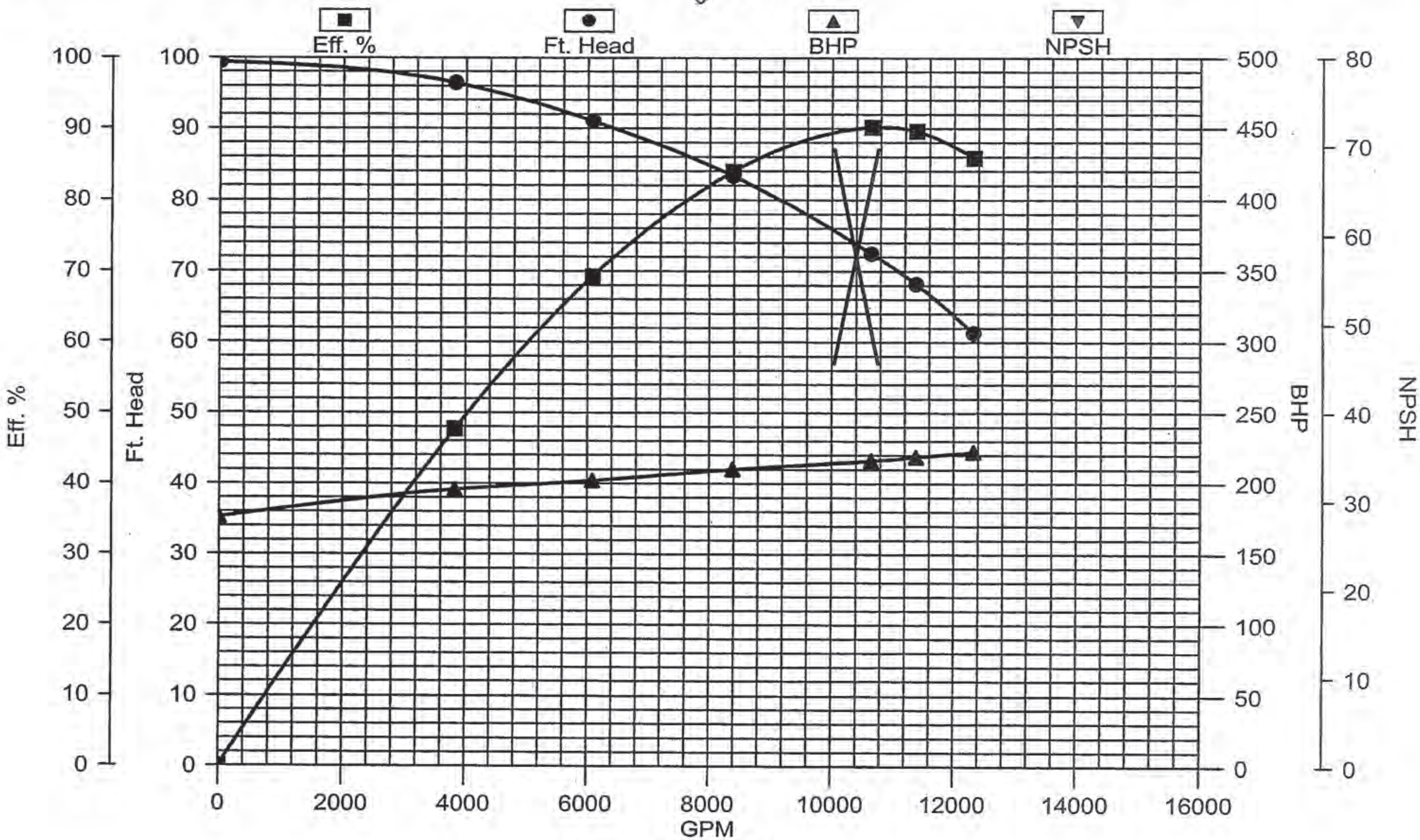


Figure B-2: Factory performance testing results for Lake Bloomington Low Service Pump #3

Serial No: SC-C033573
Pump Type:20X18 MAD
Imp Pattern:C-4823
Imp Dia:23.813
Vane Tips:.500
No. Stages:1
Certified By:____MSA__________

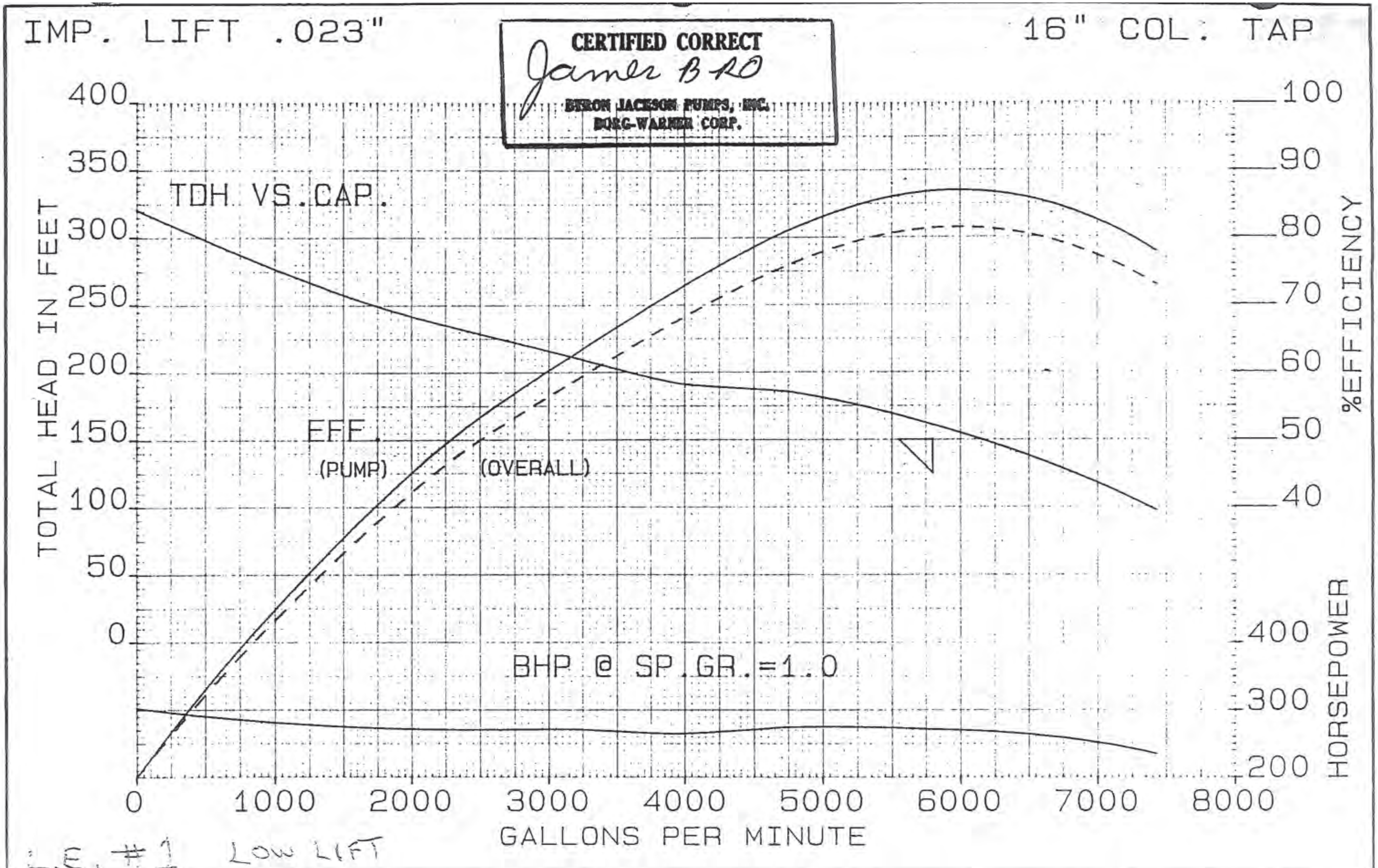
Sold To: GEORGE GILDNER
Test Driver:G.E.
HP:250
Eff%:0.941
Test RPM:710
Test Type:Performance Test
Approved By:_[signature]______

Job: 110004
GPM:10400
Ft. Head:72
Rated RPM:715
Test Num:1
Date:Jul-15-2002
Witnessed By:______________



LB - LL #3

Figure B-3: Factory performance testing results for Lake Evergreen Low Service Pump #1



PUMP SIZE AND TYPE 3 STG.	RPM	IMP. NUMBER	VANES	EYE DIA.	EYE AREA	MAX. DIA.	TEST DIA.	UNDERFILE	STGS.
20HQO	1180	329562	5				12.188	STD. #2.5	3

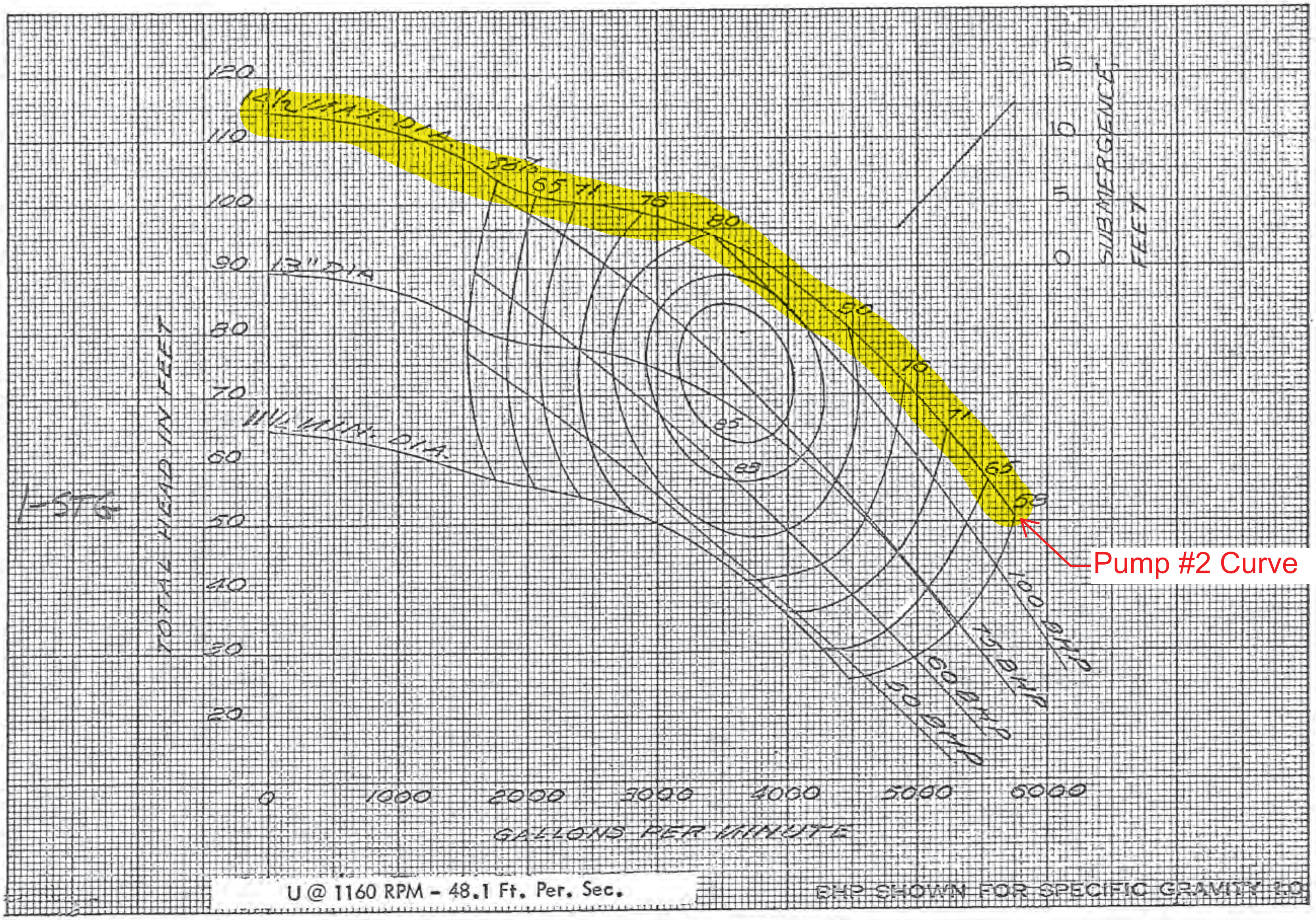
ITEM NO.	DATA BY	DATE			
	RW SB	17 MAR 87			
FACTORY NO.	DRAWN BY	CUSTOMER'S ORDER NO.	POLISHED: IMP. BOWL	MOTOR H.P. 700	PEAK EFF.
861-C-0035	CTW		MATERIAL: IMP VE BOWL	INT. DRIVE	PEAK EFF.

T-20HQO-78

Figure B-4: Factory performance testing results for Lake Evergreen Low Service Pump #2

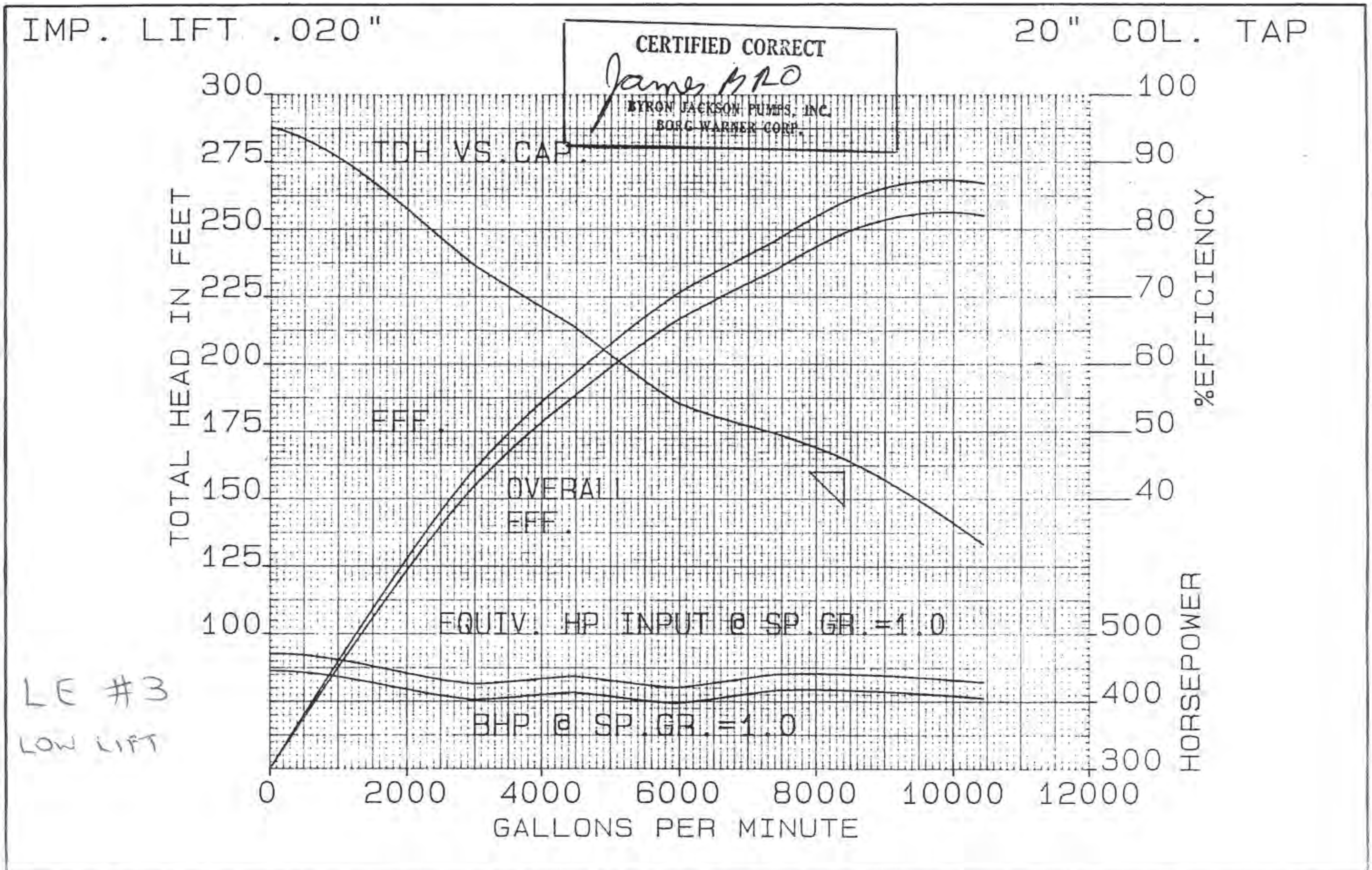
Byron Jackson
ENGINEERED PUMPS

SUPERSEDES ALL PREVIOUS ISSUES



PUMP SIZE AND TYPE	RPM	EYE AREA = 60.0 SQ. IN.	DRAWN BY	DATE	BYRON JACKSON RATING
20 KXH Vertical Circulating	1160		D. C.	2-16-49	KX-1549
			SUPERSEDES KX-12	DATE 8-8-47	

Figure B-5: Factory performance testing results for Lake Evergreen Low Service Pump #3



PUMP SIZE AND TYPE	2 STG.	RPM	IMP. NUMBER	VANES	EYE DIA.	EYE AREA	MAX. DIA.	TEST DIA.	UNDERFILE	STGS.
23HQO		1180	329627	5				14-5/8"	STD. #2.5	2

ITEM NO.	DATA BY	DATE
	RW SB	4 FEB 87

FACTORY NO.	DRAWN BY	CUSTOMER'S ORDER NO.	POLISHED: IMP.	BOWL	MOTOR H.P.	PEAK EFF.	
861-C-0034	CTW		MATERIAL: IMP VE	BOWL JW	700 / INT. DRIVE	PEAK EFF.	T-23HQO-51

Figure B-6: Factory performance testing results for WTP High Service Pump #1

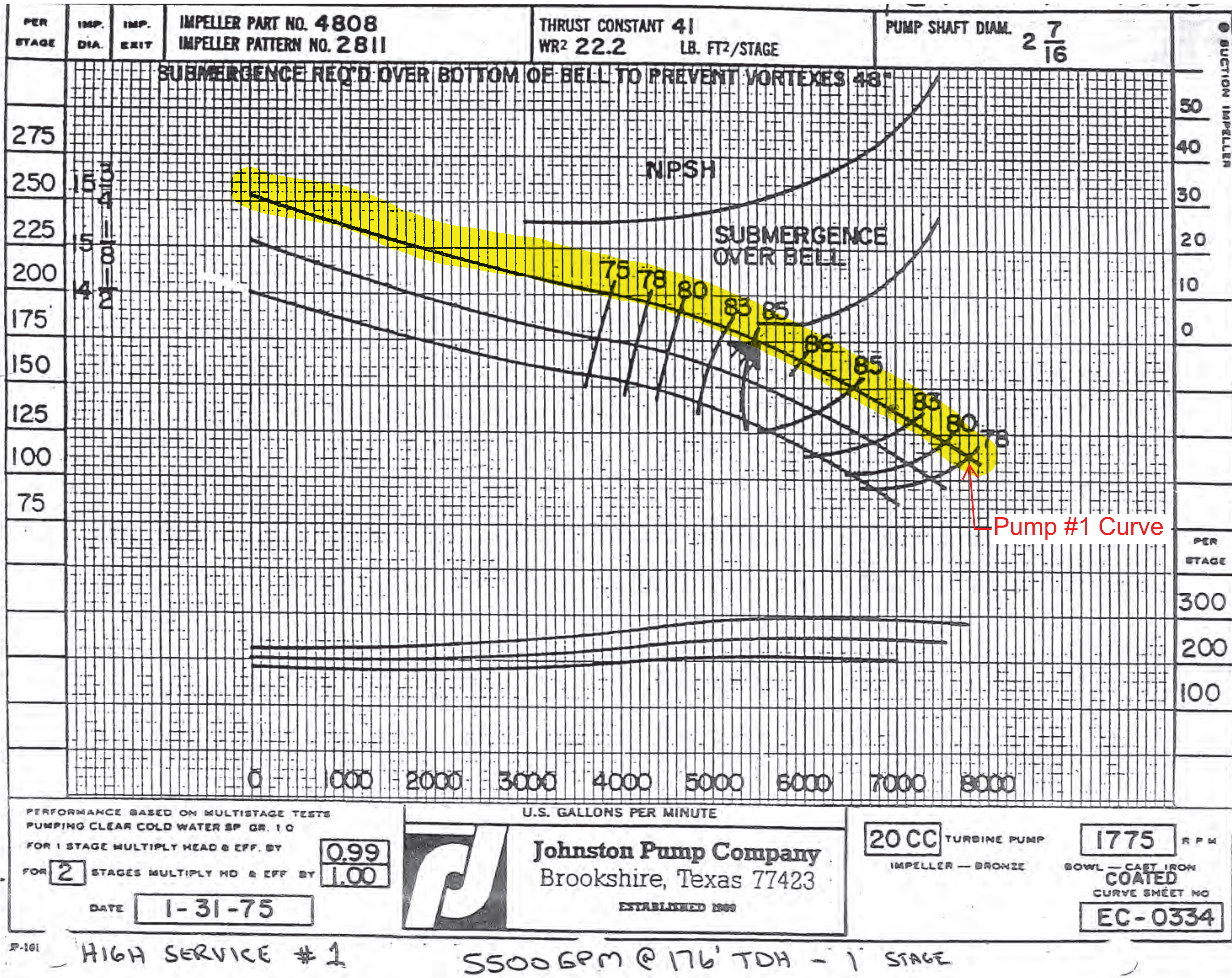


Figure B-7: Factory performance testing results for WTP High Service Pump #2

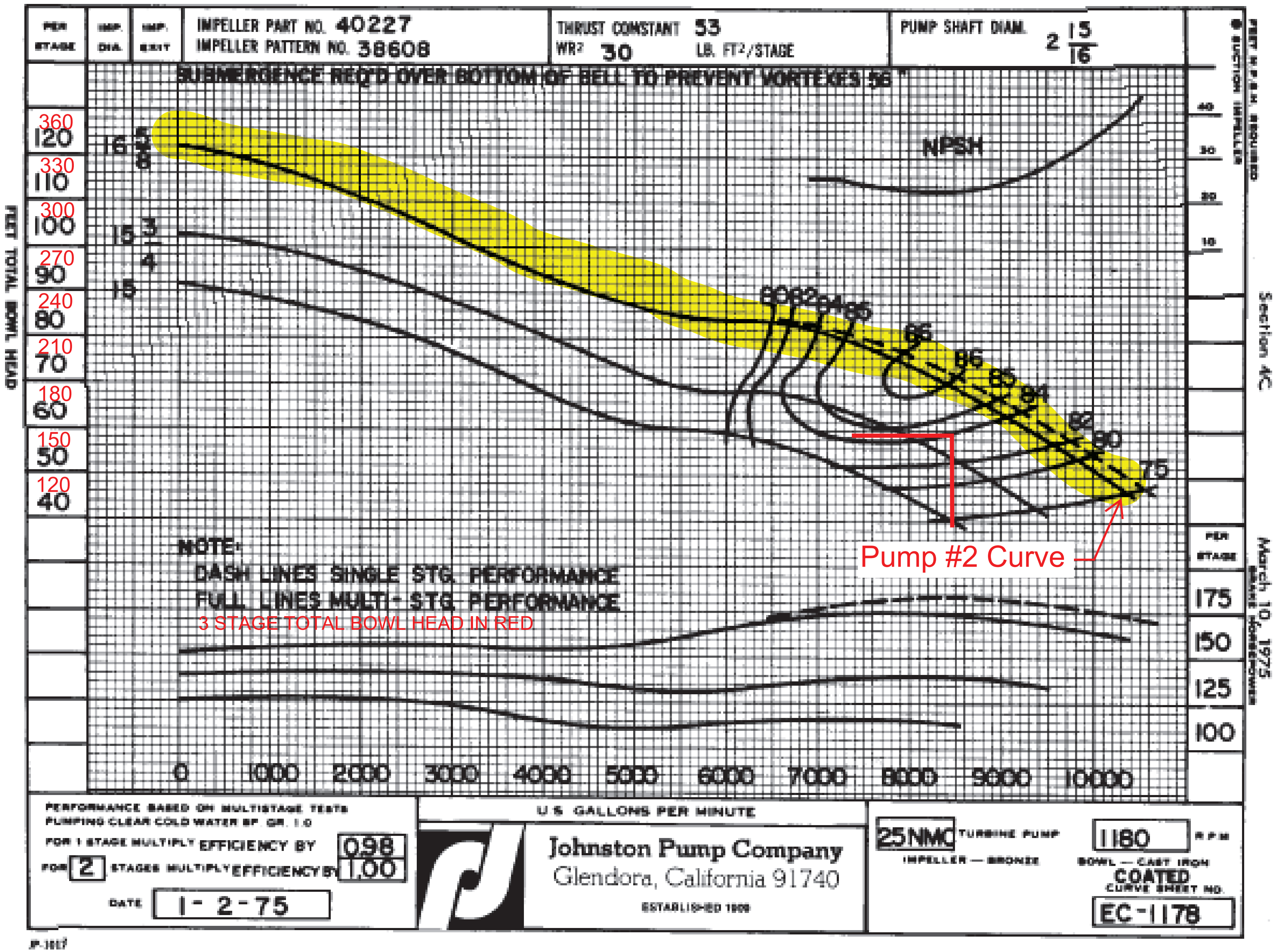


Figure B-8: Factory performance testing results for WTP High Service Pumps #3 and #4

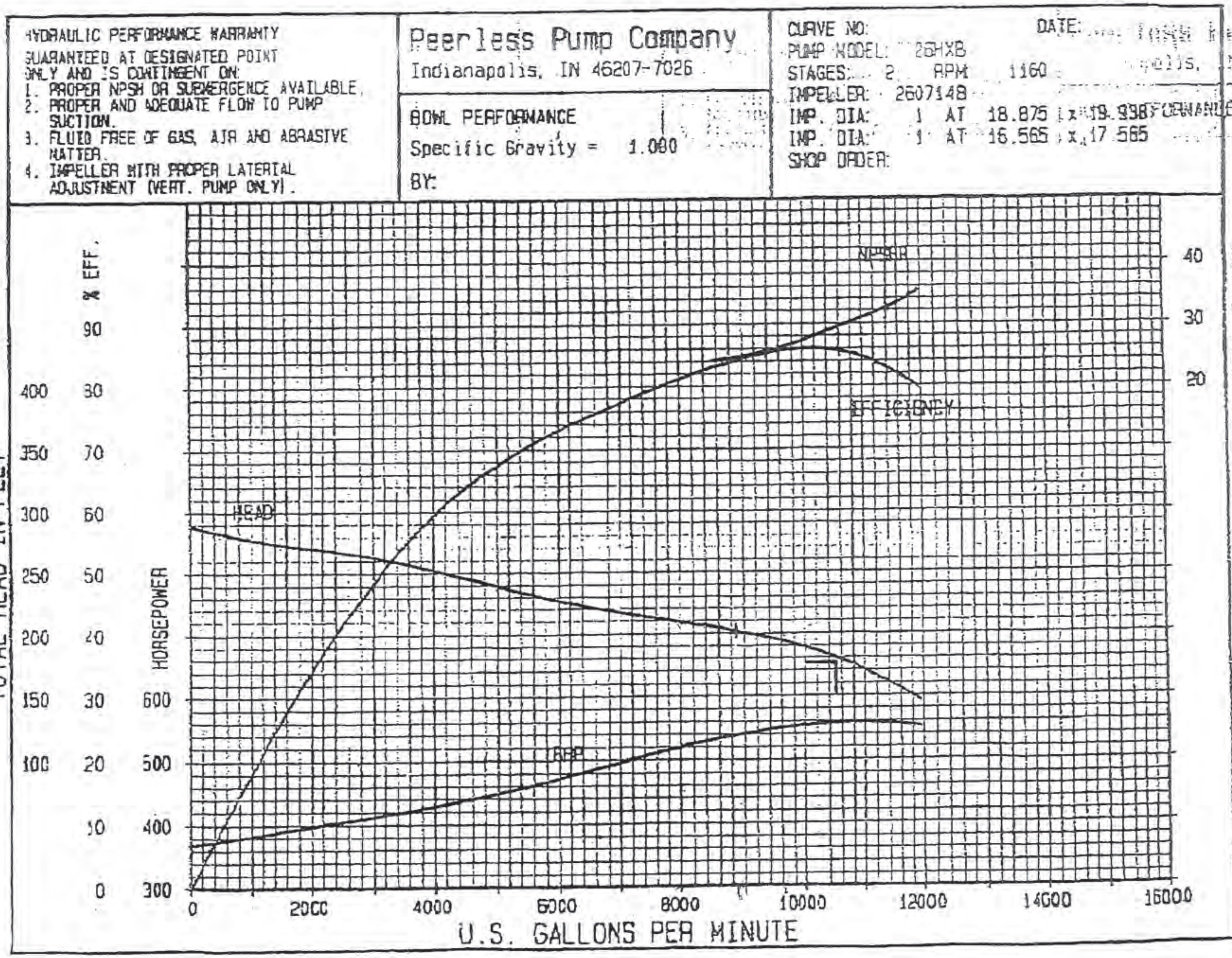


Figure B-9: Factory performance testing results for Division Street Pump Station Pumps #1 and #2

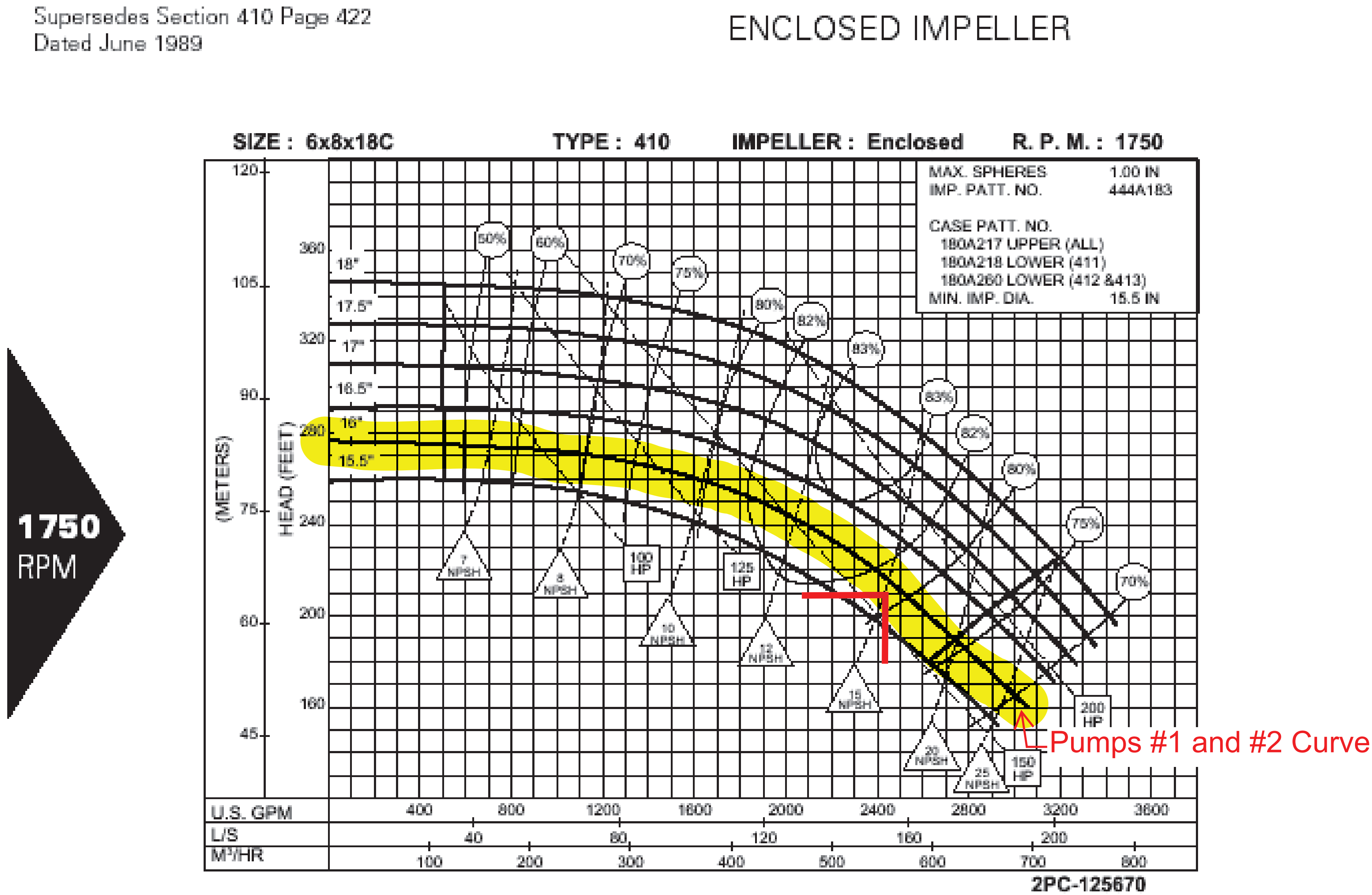


Figure B-10: Factory performance testing results for Division Street Pump Station Pump #3

SERIES 410

ENCLOSED IMPELLER

Date **January 2001**

Supersedes Section 410 Page 429
Dated October 1990

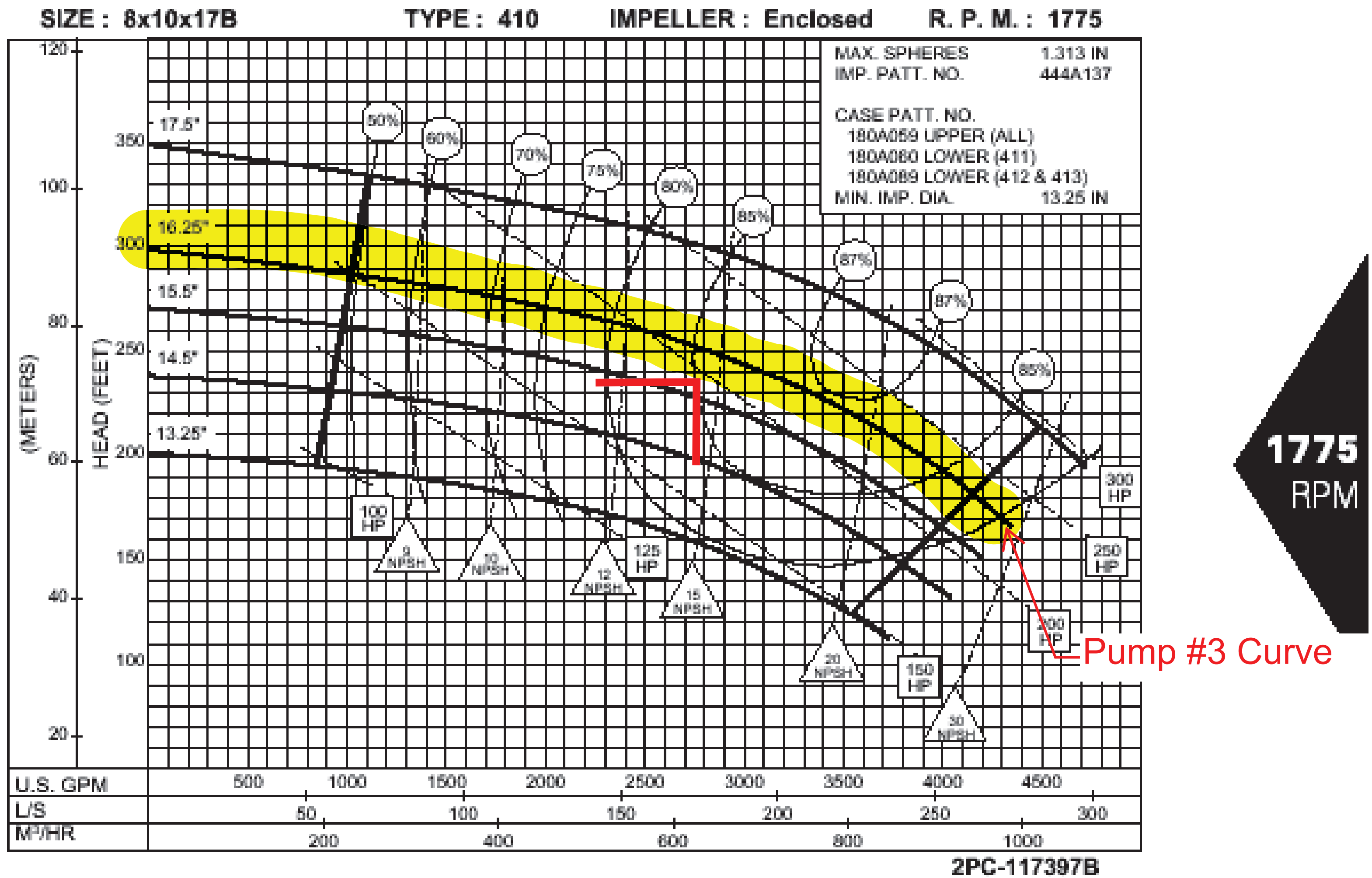


Figure B-11: Factory performance testing results for Fort Jesse A Pump Station Pumps #1, #2, and #4

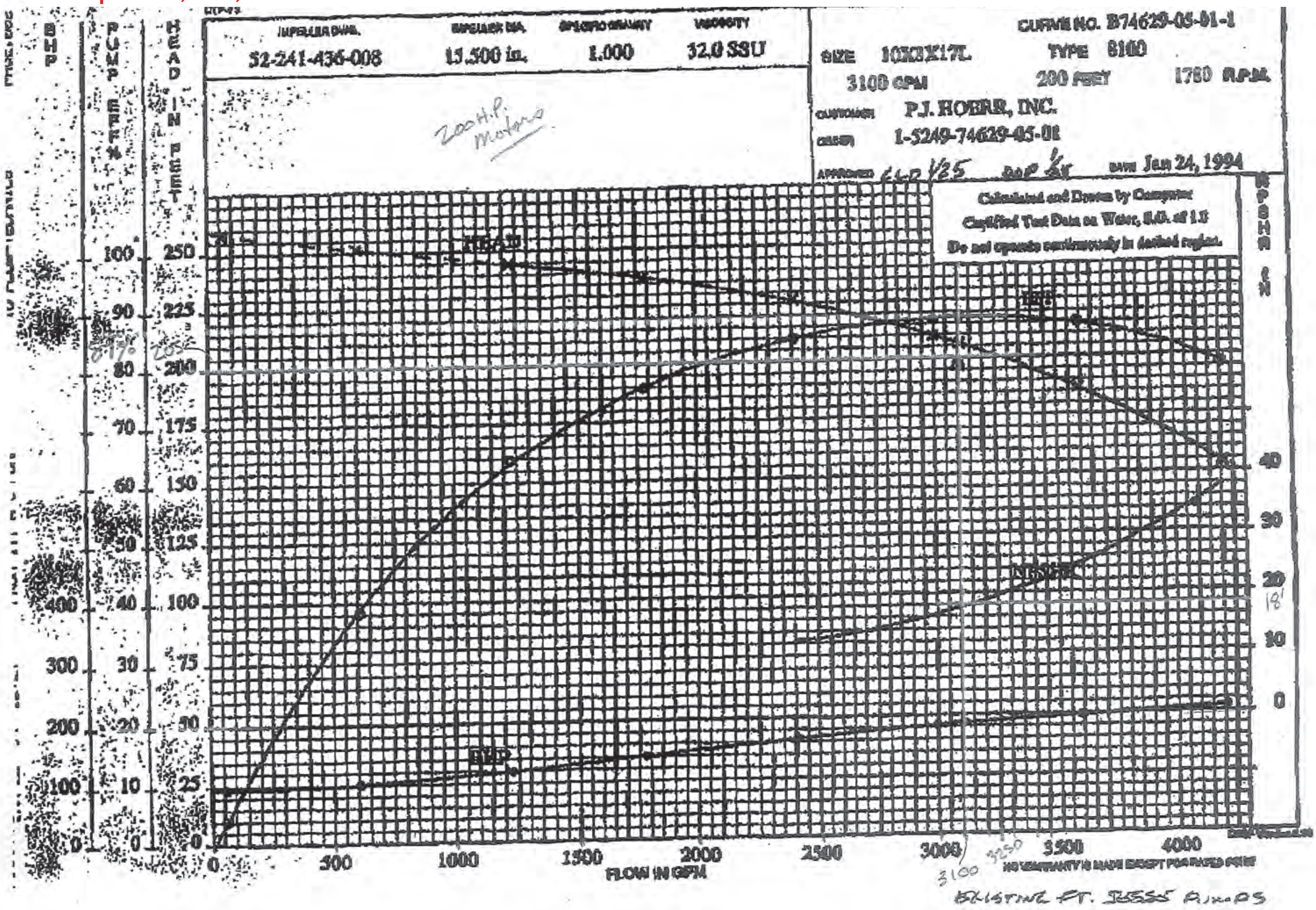
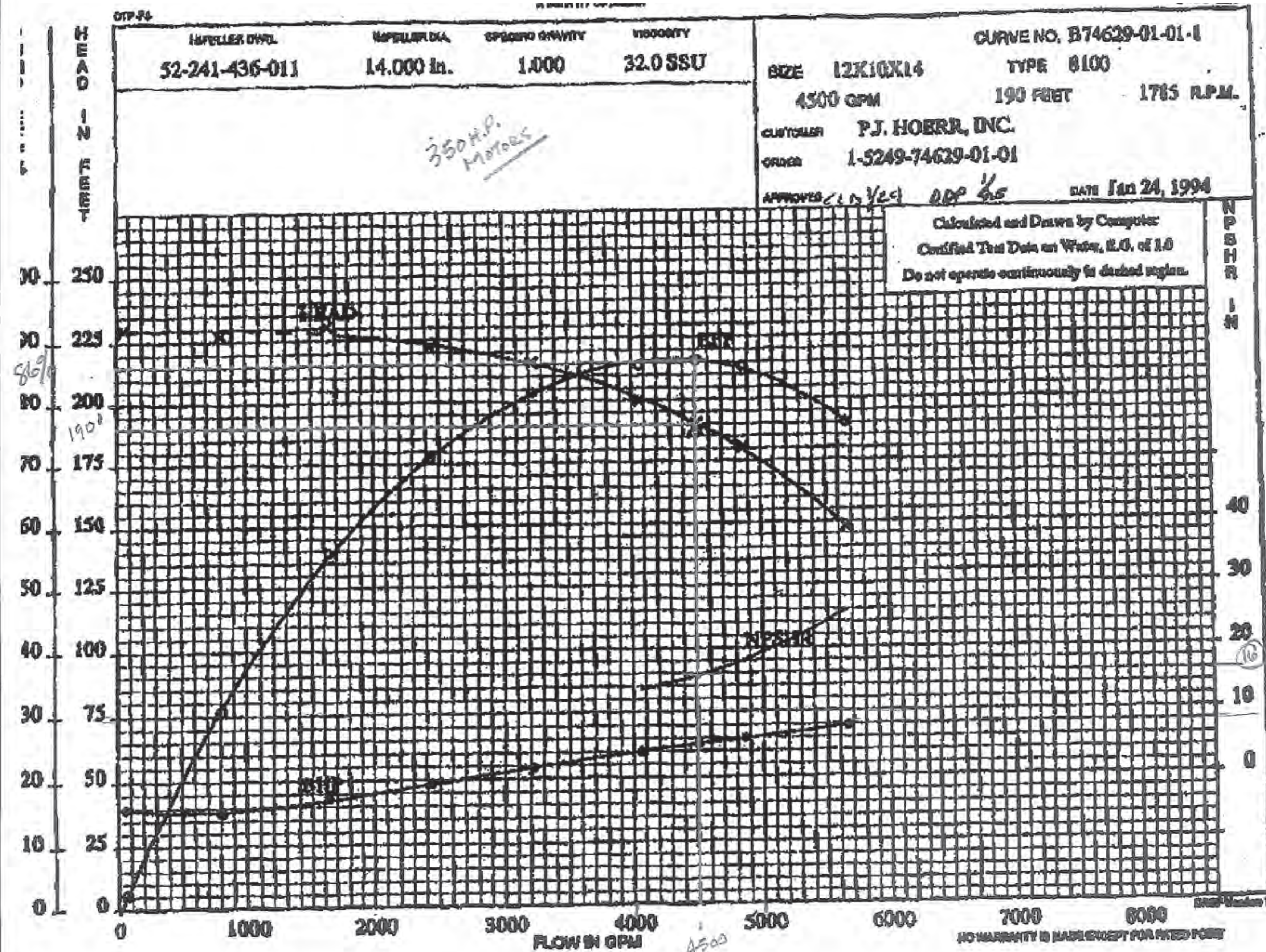


Figure B-12: Factory performance testing results for Fort Jesse B Pump Station Pumps #1, #2, and #3



New Ft. Jesse Pumps

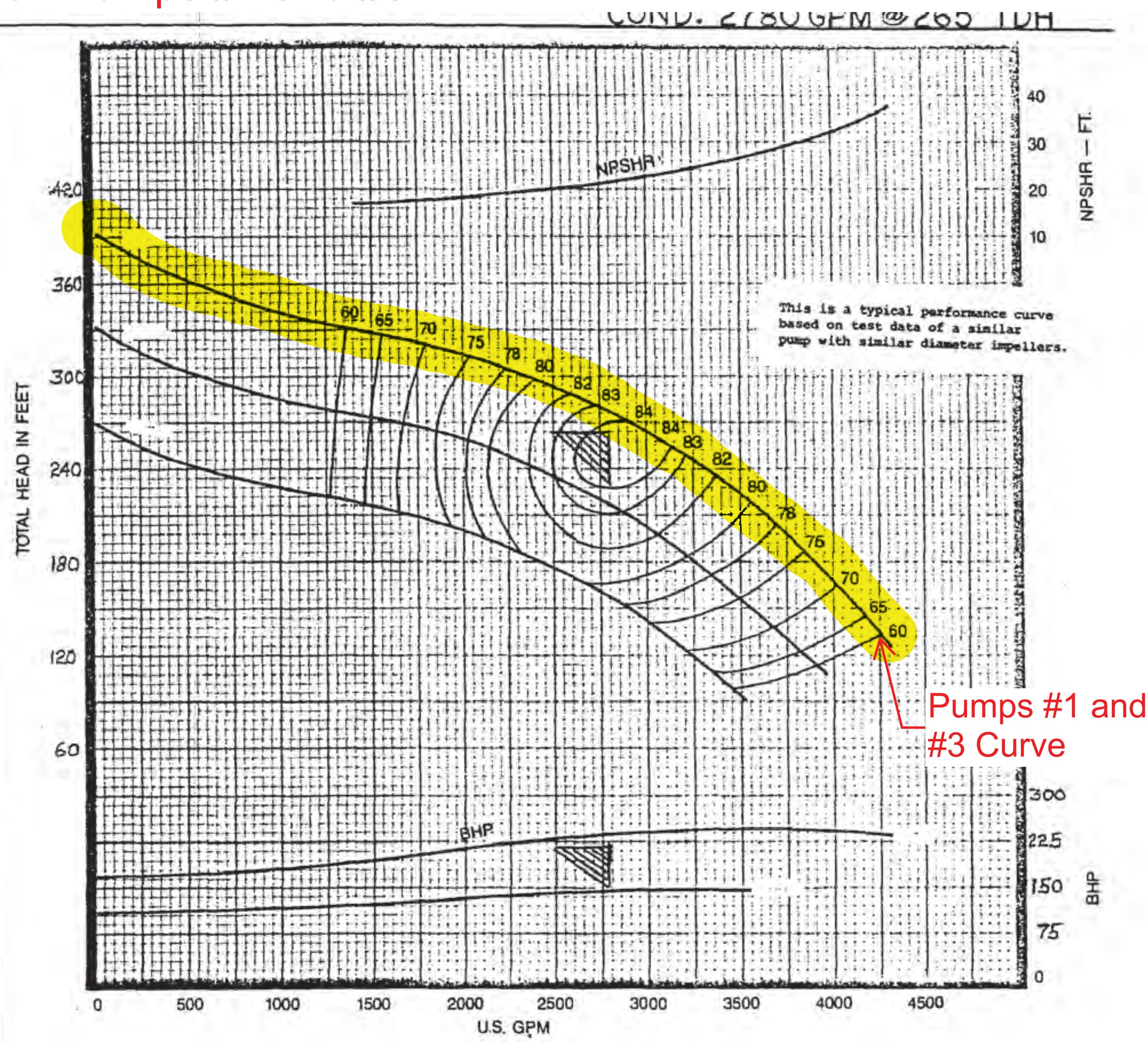
Figure B-13: Factory performance testing results for Enterprise Zone Pump Station Pumps #1 and #3

15H 7000

1770 RPM

ENCLOSED IMPELLER T7FKA99B

MULTI-STAGE



EFFICIENCY CORRECTIONS(1)

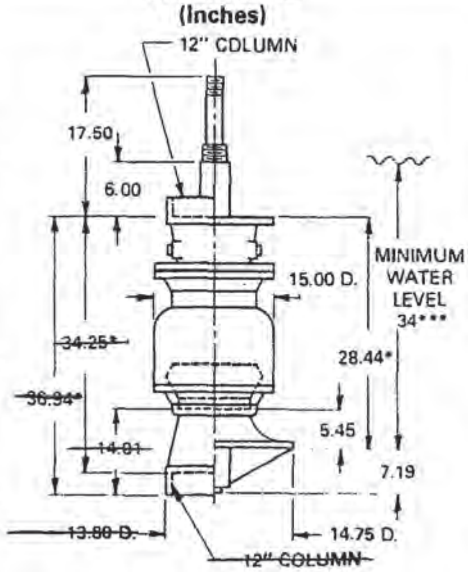
NUMBER OF STAGES	EFFICIENCY CHANGE
1	NA
2	NO CHANGE
3	NO CHANGE
4	NO CHANGE
5	NO CHANGE
6 OR MORE	NO CHANGE

BOWL MATERIAL	EFFICIENCY CHANGE
CAST IRON	-2.0 POINTS
ENAMELED C.I.	NO CHANGE

IMPELLER MATERIAL	EFFICIENCY CHANGE
CAST IRON	-1.0 POINTS
BRONZE	NO CHANGE
ENAMELED C.I.	NO CHANGE

(1) Refer to "Application and Reference Data" for head correction.

DIMENSIONS (Inches)



*Add 14.50 for each additional stage

TECHNICAL DATA

DATA	VALUE
MAXIMUM OPERATING SPEED	2100 RPM
MAXIMUM NUMBER OF STAGES	7**
PUMP SHAFT DIAMETER	1 15/16 IN.
IMPELLER EYE AREA	37.80 SQ. IN.
MAXIMUM SPHERE SIZE	1.31 IN.
K_t (THRUST FACTOR)	14.47 LBS./FT.
K_a (ROTOR WT. PER STAGE)	53.40 LBS.
BOWL WT. (FIRST STAGE)	469 LBS.
BOWL WT. (EACH ADD'L. STAGE)	200 LBS.
ALLOWABLE SHAFT STRETCH	.86 IN.**
WK^2 (FIRST STAGE)	4.91 LBS.-FT.^{2}
WK^2 (EACH ADD'L. STAGE)	4.69 LBS.-FT.^{2}
BOWL RING CLEARANCE	.014/.018 IN.

** These are nominal values. Refer to "Application and Reference Data" for information further limiting or extending these values.

*** This value is the minimum submergence required to prevent vortexing only. This value may need to be increased to provide adequate NPSHA.

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