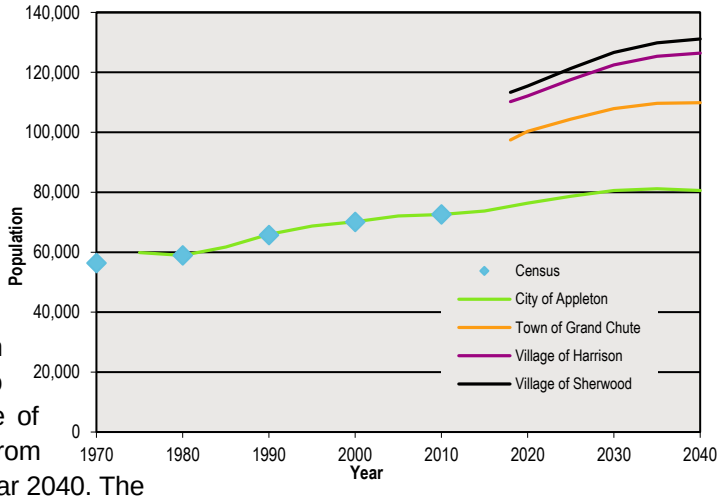
Executive Summary

The City of Appleton is a community of nearly 75,000 persons located in East Central Wisconsin. The Utility provides water service to residences and businesses within the City of Appleton and wholesale water supply to Town of Grand Chute, Village of Sherwood and Harrison Utilities.

The City of Appleton water system consists of a surface water treatment plant (WTP), 4 elevated storage tanks, 1 standpipe, 1 reservoir, 2 booster pumping stations, 2 valve stations and approximately 379 miles of transmission and distribution water mains. The water system is separated into three pressure zones to meet the service needs of the customers.

Population and Future Service Area

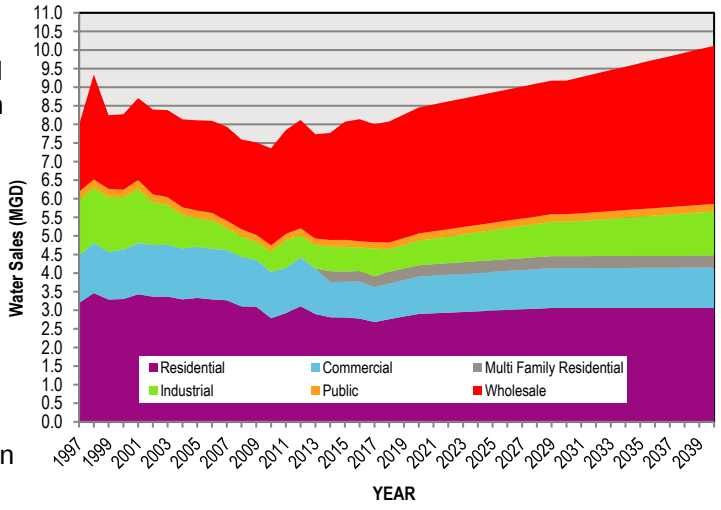
The 2018 City of Appleton population, according to the Wisconsin Department of Administration (DOA), was approximately 74,700. For this study, it was assumed the City of Appleton population served by the Utility by the year 2040 will be 80,605.



It is projected that the Town of Grand Chute will increase in population from approximately 22,700 to approximately 29,300 by the year 2040. The Village of Harrison is projected to increase in population from approximately 12,800 to approximately 16,600 by the year 2040. The Village of Sherwood is projected to increase in population from approximately 3,100 to approximately 4,700 by the year 2040. The potential wholesale customer Town of Clayton currently has a population of approximately 4,200 and is projected to increase to approximately 5,700 by the year 2040.

Water Requirements

Based on an analysis of land development and population growth in the City of Appleton and within current and potential wholesale customers, the projected 2040 maximum day water demand is estimated to be approximately 17.7 million gallons per day (MGD). This represents an increase in water requirements of nearly 16 percent from the current average day water requirement of approximately 14.9 MGD.



Water System Evaluation

The major findings from the water system evaluation are summarized in Table ES-1.

Capital Improvement Plan

The schematic of the recommended future water distribution system is illustrated in Figure ES-1. **Error! Reference source not found.** summarizes the proposed Capital Improvement Plan for the Appleton water system, which is illustrated in Figure ES-2.

TABLE ES-1: SUMMARY OF WATER SYSTEM EVALUATION

Water System Pressures

Pressure Zone	Pressure Range		Average Pressure		Notes
	Average Day	Peak Hour	Average Day	Peak Hour	
Main Pressure Zone	~ 30 to 90 psi (day) ~ 35 to 95 psi (night)	~ 30 to 86 psi	~54 psi (day) ~59 psi (night)	~53 psi	~ 35 psi near Lake Park Road and Midway Road ~ 30-35 psi near Northland Avenue and Richmond Street (near pressure zone boundary) ~ 30-35 psi on 16-inch supply line to Lindbergh Standpipe (has customer services) ~10 psi on Ballard Road to North Reservoir (~50 psi at last customer service) ~ 65-90 psi near the Fox River
Ridgeway Pressure Zone	~ 40 to 70 psi	~ <40 to 68 psi	~55 psi	~50 psi	
North Pressure Zone	~ <35 to 90 psi	~ <35 to 86 psi	~65 psi	~60 psi	~90 psi on Apple Creek Road

Available Fire Flows

Pressure Zone	Percent of Hydrants Providing Required Fire Flow	Notes
Main Pressure Zone	95 percent	Small diameter/older main including some 4-inch mains, dead ends.
Ridgeway Pressure Zone	94 percent	Dead ends at pressure zone boundary, small diameter/older mains.
North Pressure Zone	99 percent	

Hydraulic Capacity (Headloss/Velocity)

- No water mains have higher than recommended velocities or headlosses.

Guidelines
- AWWA Manual M32 recommends that all pipe velocities should be less than 4 to 6 feet per second (fps) during normal operation.
- AWWA Manual M32 recommends headlosses in pipes less than 16-inches in diameter should be less than 5 to 7 feet per 1,000 feet of pipe during normal operating conditions. The recommended headloss limit for larger pipes in AWWA Manual M32 is 2 to 3 feet per 1,000 feet of pipe during normal operating conditions.

Water Age (Water Quality)

- Water age in Main Pressure Zone ranges typically from 1-5 days, with water age greater than 5 days at extremities/dead ends.
- Water age in North Pressure Zone and Ridgeway Pressure zone typically 5 to 8 days, with greater than 8 days at extremities/dead ends.
- Chlorine levels measured indicate that chlorine residuals are maintained within the system

Supply

- Adequate reliable supply (22 MGD hydraulic capacity of high lift pumps) to meet existing (14.9 MGD) and projected (17.7 MGD) maximum day demands.
- Adequate reliable capacity to supply the Ridgeway Pressures Zone and the North Pressure Zone under existing and projected 2040 demand conditions.

Storage

- The Main Pressure Zone had adequate total available effective storage to meet existing and projection demand conditions; however, has a deficiency in operational storage that is projected to grow to approximately 0.43 MG by 2040. The deficiency in operational storage can be offset with excess reliable supply capacity.
- The Ridgeway Pressure Zone has a storage deficiency of approximately 0.68 MG; however, it can be offset with excess reliable pumping capacity and the ability to transfer water from the North Pressure Zone via 47 Valve Station.
- The North Pressure Zone has a storage deficiency which is projected to grow to approximately 0.38 MG based on projected 2040 projections. The deficiency can be offset with excess pumping capacity under existing conditions; however, is projected to be slightly deficient (approximately 50,000 gallons) by 2040 with the additional demands and the increase in fire storage requirement (assuming industrial development).

System Reliability

- The raw water lake intake and transmission from the Raw Water Pump Station to the WTP have no redundancy to ensure a reliable supply of water to the WTP.
- Appleton can maintain water supply provided with auxiliary sources of power in the event of a power emergency or interruption. Appleton has standby power on site at the WTP and the North Booster Station, and a transfer switch at the Lindbergh Booster Station for a portable generator.

Water Loss Evaluation – Performance Indicators

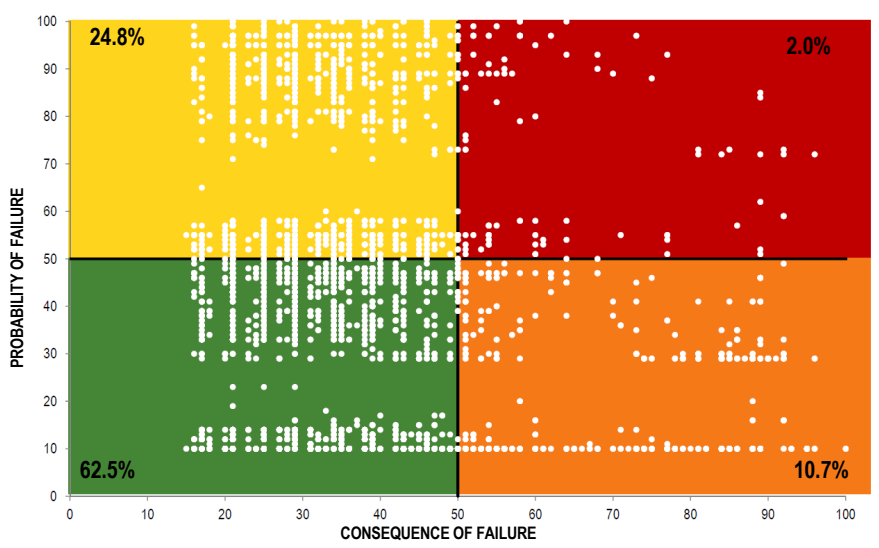
Real Losses: 301 MG/year, 29 gallons per service connection per day
Infrastructure Leakage Index (ILI): 1.9
Financial:
- Non-revenue water as percent by volume of water supplied: 17.9% (has ranged from 13.7 percent to 17.9 percent in the past 5 years)
- Non-revenue water as percent of cost of operating system: 1.2%

Leak/Break Frequency

- Average number of leaks/breaks per 100 miles per year
  22 leaks/breaks per 100 miles per year (10 years)
  25 leaks/breaks per 100 miles per year (5 years)
- Optimized distribution system failure frequency identified in WRF Water Loss Report: ~15 failures per 100 miles per year
- Aggregate North American failure frequencies identified in WRF Water Loss Report: ~25 failures per 100 miles per year.

Water Main Reinvestment Level (KANEW Analysis)

- The City's water distribution system is an "average aged" water system; approximately 30 percent of the water mains are over 50 years old and approximately 10 percent of the water mains are over 70 years old.
- Based on the long and short life expectancies in the KANEW analysis, the total recommended replacement lengths in the first 10 years of replacement are approximately 80 miles (21 percent) and 104 miles (28 percent), respectively.
- Based on the long and short life expectancies in the KANEW analysis, the total replacement lengths over the 20 year period of replacement are approximately 103 miles (27 percent) and 128 miles (34 percent), respectively.



P:\60578987\900_CAD_GIS\920-GIS\FIGURES\REPORT_FIGURES\FIGURE ES-1_RECOMMENDED WATER DISTRIBUTION SYSTEM SCHEMATIC.VSD

TOWNHALL TOWER
1.0 MG
990 FT

0.75 MG
990 FT
MISTY TOWER

TOWN OF GRAND CHUTE

EXPANDED NORTH PRESSURE ZONE
NORTH PRESSURE ZONE

NORTH TOWER
1,000.0 FT
0.5 MG
962.5 FT
860 FT

NORTH BOOSTER STATION
1,400 GPM
1,400 GPM

NORTH RESERVOIR**
3.1 MG
914.3 FT
867 FT

16-INCH

47 PRV STATION
TYPICAL FLOW: 550 GPM
4-INCH
12-INCH
500 GPM
SETTING: 68 PSI

NORTH PRESSURE ZONE

RETURN FLOW PRV

RIDGEWAY TOWER
951.0 FT
0.3 MG
918.5 FT
846 FT

RIDGEWAY PRESSURE ZONE

LITTLE CHUTE EMERGENCY CONNECTION

16-INCH

LINDBERGH STANDPIPE*
914.3 FT
66 FEET
2.0 MG
836 FT

RIDGEWAY PRESSURE ZONE

LINDBERGH BOOSTER STATION
1,400 GPM
1,100 GPM
BYPASS

ONEIDA BOOSTER STATION
1,600 GPM
1,600 GPM

GLENDALE TOWER
74 FT
914.3 FT
1.0 MG
892.3 FT
879.3 FT
784 FT

REEVE PRV STATION
12-INCH
1500 GPM
TYPICAL FLOW: 450 GPM
W. WINNEBAGO STREET

COLLEGE BOOSTER STATION
700 GPM
700 GPM

LILAS BOOSTER STATION
700 GPM
700 GPM

MAIN PRESSURE ZONE

COLLEGE AVE.
LAWE ST.
TELULAH AVE.
12" CIP 1958
12" DIP 2008
20" DIP/PVC/HDPE/PVC
ONEIDA ST.
MEMORIAL DR.
12" CIP 1965
6" CIP
12" PVC
12" PVC
12" PVC
24" DIP UNWRAPPED 1985
W. RIVER
12" HDPE
CROSSING IS CURRENTLY OUT OF SERVICE

MAIN PRESSURE ZONE

DEMOLISH
MATTHIAS TOWER
65 FT
914.3 FT
1.0 MG
884.3 FT
874.3 FT
52 FT
781 FT
400 GPM
RECIRCULATION PUMP

NEW SOUTH CONTROL STATION
3x1,500 GPM
POTENTIAL NEW TOWER
960 FT
0.2 MG
0.5 MG
POTENTIAL NEW PUMP STATION
FILL VALVE

HWY 441

POTENTIAL NEW SOUTH PRESSURE ZONE
16-INCH

POTENTIAL CONNECTION TO THE TOWN OF CLAYTON

HARRISON METER 1 (400 MIDWAY)
36-INCH TO 42-INCH
42-INCH TO 36-INCH
HARRISON METER 2 (W6409 MIDWAY)
16-INCH
500 GPM
3 METERS
VILLAGE OF SHERWOOD

HARRISON UTILITIES (FORMERLY WAVERLY SANITARY DISTRICT)

TARGET DISCHARGE PRESSURE:
64.0 PSIG / HGL: 926 FT: 2130 – 0630
57 PSIG / HGL: 908 FT: 0630 – 2130

RAW WATER PUMP STATION
8.6 MGD
8.6 MGD
10.2 MGD
10.2 MGD
6.8 MGD
42-INCH RAW WATER INTAKE

MODIFICATIONS TO INTAKE & PUMP STATION

HIGH LIFT PUMP STATION
6.0 MGD, VFD
6.0 MGD, VFD
6.0 MGD, VFD
6.0 MGD, VFD
6.0 MGD, VFD
6.0 MGD, VFD

NEW RAW WATER TRANSMISSION MAIN
~1.4 MILES 42-INCH
WTP
1.65 MG
3.65 MG
CONCRETE CLEARWELLS

LAKE WINNEBAGO

NOTES:
* TANK CONTAINS A MIXER.
**TANK CONTAINS TWO MIXERS.

AECOM

FIGURE ES-1
RECOMMENDED WATER DISTRIBUTION SYSTEM SCHEMATIC
APPLETON, WISCONSIN
SEPTEMBER 2019 **60578987**

TABLE ES-2: CAPITAL IMPROVEMENT PLAN

Short-Term Improvements (5 Years)	Estimated Cost	Long-Term Improvements (10-20 Years)	Estimated Cost
42-inch Raw Water Main to WTP for Reliability (approximately 7,500 feet)[1]	$7,500,000	Transmission Mains for Development (approximately 12.3 miles)	$4,400,000
Raw Water Intake Main at Raw Water Pump Station[1]	$9,000,000	Water Main Replacement- Year 11: ~3.8 miles[3]	$2,700,000
		Water Main Replacement- Year 12: ~3.8 miles[3]	$2,700,000
Improvements & Modifications to Existing Lake Pump Station & Existing Lake Intake System[1]	$3,600,000	Water Main Replacement- Year 13: ~3.8 miles[3]	$2,700,000
		Water Main Replacement- Year 14: ~3.8 miles[3]	$2,700,000
Water Main Replacement to Address Fire Deficiencies (~ 7 miles, ~1.4 miles annually)[2]	$5,500,000	Water Main Replacement- Year 15: ~3.8 miles[3]	$2,700,000
		Water Main Replacement- Year 16: ~3.8 miles[3]	$2,700,000
Water Main Replacement - Year 1: ~6.6 miles[3]	$4,600,000	Water Main Replacement- Year 17: ~3.8 miles[3]	$2,700,000
Water Main Replacement - Year 2: ~6.6 miles[3]	$4,600,000	Water Main Replacement- Year 18: ~3.8 miles[3]	$2,700,000
Water Main Replacement - Year 3: ~6.6 miles[3]	$4,600,000	Water Main Replacement - Year 19: ~3.8 miles[3]	$2,700,000
Water Main Replacement - Year 4: ~6.6 miles[3]	$4,600,000	Water Main Replacement -Year 20: ~3.8 miles[3]	$2,700,000
Water Main Replacement - Year 5: 6.6 miles[3]	$4,600,000	Demolish Matthias Tower	$180,000
Subtotal	**$47,900,000**	**Subtotal**	**$31,580,000**
Engineering and Contingencies[4]	$19,160,000	Engineering and Contingencies[4]	$12,632,000
Total	**$67,060,000**	**Total**	**$44,212,000**

Mid-Term Improvements (5-10 Years)	Estimated Cost	Grand Total	$160,006,000
Transmission Mains for Development (approximately 12.3 miles)	$4,400,000		
Water Main Replacement - Year 6: ~8.0 miles[3]	$5,500,000		
Water Main Replacement - Year 7: ~ 8.0 miles[3]	$5,500,000		
Water Main Replacement - Year 8: ~8.0 miles[3]	$5,500,000		
Water Main Replacement - Year 9: ~8.0 miles[3]	$5,500,000		
Water Main Replacement - Year 10: ~8.0 miles[3]	$5,500,000		
Potential New South Pressure Zone:			
New 0.5 MG Spheroid Tower in Potential South Pressure Zone	$1,200,000		
New Flow Control Valve from Potential South Pressure Zone to Main Pressure Zone	$210,000		
South Pump Station including VFD, 0.2 MG Underground Reservoir, backup generator, SCADA	$1,500,000		
Subtotal	**$34,810,000**		
Engineering and Contingencies[4]	$13,924,000		
Total	**$48,734,000**		

Footnotes:

1 Estimated cost from Appleton Public Works Department, November 2018.

2 Replacement cost provided by Appleton Department of Public Works at $130 per foot for 8-inch water main, and $150 per foot for 12-inch water main replacement.

3 Replacement rates based on KANEW analysis with first 5 years lowered to include recommended water main replacements for fire flow deficiencies. Replacement cost provided by Appleton Department of Public Works at $130 per foot for 8-inch water main

4 Assumed 15 percent for engineering and 25 percent for contingencies.

Notes:

- Estimates do not include land purchase, if necessary.
- The Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions, etc. may affect the accuracy of this estimate. AECOM is not responsible for any variance from this estimate or actual prices and conditions obtained.
- This estimate is an AACE Class 4 Order of Magnitude cost estimate.
- Estimates are 2019 dollars unless otherwise noted.

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LEGEND

WATER SYSTEM FACILITIES
- FUTURE PUMP STATION
- FUTURE GROUND RESERVOIR
- FUTURE ELEVATED STORAGE TANK
- FUTURE CONTROL VALVE STATION
- NORMALLY CLOSED VALVE

RECOMMENDED FOR RELIABILITY
- 42-INCH RAW WATER MAIN

RECOMMENDED WATER MAIN IMPROVEMENT
- 8-INCH
- 12-INCH

RECOMMENDED WATER MAIN EXPANSION
- 8-INCH
- 12-INCH
- 16-INCH

PLANNED WATER MAIN EXPANSION
- 8-INCH

WATER MAIN DIAMETER
- 4-INCH AND LESS
- 6-INCH
- 8-INCH
- 10-INCH
- 12-INCH
- 16-INCH
- 18-INCH
- 20-INCH
- 24-INCH
- 30-INCH
- 36-INCH
- 42-INCH

PRESSURE ZONE
- MAIN
- NORTH
- RIDGEWAY
- POTENTIAL NEW SOUTH
- FUTURE NORTH

BASE MAPPING
- ROADS
- WATER
- PARKS

NORTH TOWER
NORTH RESERVOIR
NORTH BOOSTER STATION

47 PRV STATION

RIDGEWAY TOWER

ONEIDA BOOSTER STATION
(GRAND CHUTE)

LINDBERGH BOOSTER STATION
AND STANDPIPE

GLENDALE TOWER

TOWN OF GRAND CHUTE

REEVE PRV STATION

COLLEGE BOOSTER STATION
(GRAND CHUTE)

LILAS BOOSTER STATION
(GRAND CHUTE)

EMERGENCY
CONNECTION
TO LITTLE CHUTE

POTENTIAL CONNECTION
TO TOWN OF CLAYTON

DEMOLISH
MATTHIAS TOWER

HARRISON
METER 1

HARRISON
METER 2

SUPPLY TO
THE VILLAGE
OF SHERWOOD
(~ 2.0 MILES EAST)

WATER TREATMENT PLANT
(RAW WATER INTAKE ~ 1.4 MILES SOUTH)

0 3,700 7,400
FEET

AECOM

FIGURE ES-2
RECOMMENDED WATER SYSTEM MASTER PLAN
APPLETON, WISCONSIN
SEPTEMBER 2019 **60578987**

Additional Recommendations

Additional recommendations include:

- The City currently alternates discharge pressure at the water treatment plant (WTP) between day and night to facilitate turnover of water storage within the Main Pressure Zone. Areas of the water distribution system currently experience pressures below 35 psi when the WTP is set to the lower discharge pressure. As older mains are continued to be replaced, the City should consider raising the WTP pressure discharge set points by approximately 5 psi to raise pressure in these areas of lower pressure to above 35 psi.
- AECOM recommends that a unidirectional flushing (UDF) plan for a small pilot area in a location with colored water complaints be designed and performed as a preventative water quality and distribution system maintenance practice. The water quality metrics before and after within the pilot area should be quantified and a determination made on whether a system wide UDF plan be implemented. A UDF program may require signs, public notice, and additional equipment purchases by the City. A pilot UDF plan for the area defined on Figure 10-13 would cost approximately $12,000 to $15,000.
- The City should update the water system hydraulic model on an annual basis.
- The City should plan on updating the master plan every 5 to 10 years or after significant changes that are not outlined in this document are made to the water distribution system.
- The City should continue to perform tank maintenance as scheduled.
- The City should complete the water audit annually.
- The City should consider having a leak detection survey performed.

The Town of Clayton has expressed an interest in obtaining water from the City of Appleton for future water supply. If the Town of Clayton requests water supply from the City, the City should extend the 12-inch water main on Prospect Avenue and provide the necessary infrastructure (meter and SCADA) for service.