Executive Summary

A. Introduction

The purpose of this *Infrastructure Management Plan Report* is to evaluate water distribution system facilities and pipelines, and to develop reinvestment recommendations for the existing system.

The principal elements of this study are summarized below:

- Inspect facilities to help determine of their condition.
- Develop a condition and valuation database of the Utility's facilities and pipelines.
- Develop long-term annual funding levels for distribution system facilities and pipeline reinvestment.
- Develop a 10-year prioritized improvement program for distribution system facilities and pipelines reinvestment
- Develop recommendations for future data collection and analyses.

Costs in this report are presented in 2005 dollars and do not take into account inflation.

B. Existing System

The major facilities which make up the distribution system include 24 operating wells, 31 pumping stations, and 31 storage facilities. Distribution facilities were classified into the following major functional components:

- Unit Well: No two "unit wells" are identical, although the majority of them consist of a deep well with a line shaft turbine pump, an above-grade reinforced concrete reservoir, and one or two booster pumps. The deep well and booster pumps are typically housed in a common masonry structure, which also includes chlorine and fluoride feed equipment.

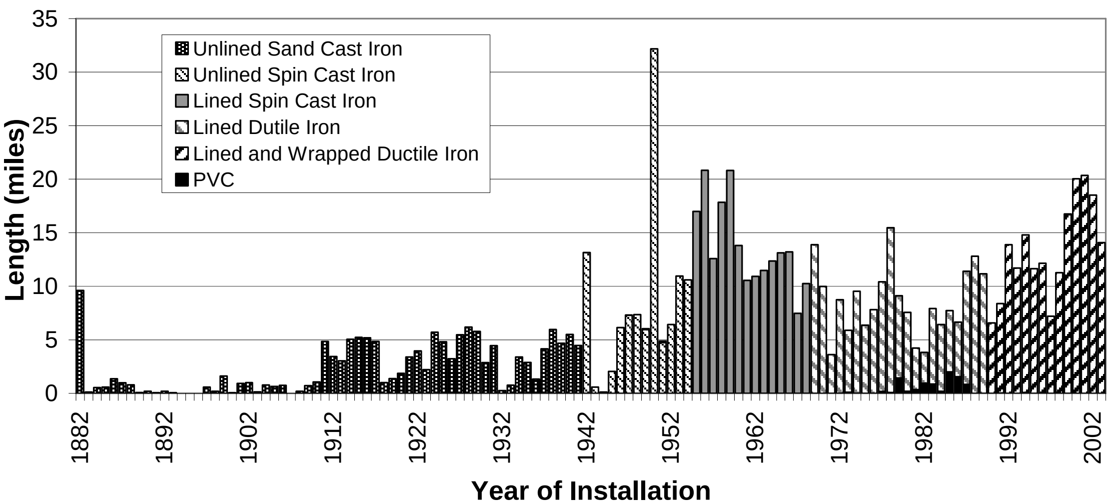
- Independent Deep Well: There are three deep wells which differ from the unit well definition in that they pump directly into distribution storage facilities which provide "floating" storage for the system. Thus water from these wells can enter the distribution system without any further pumping. The independent deep wells are typically housed in structures similar to those housing the unit wells, including the chlorine and fluoride feed equipment.

- Interzone Booster Station: An interzone booster station delivers water from one pressure zone to another. In many cases, interzone booster stations are located on the same site as a distribution storage facility.

- Distribution Storage: Distribution storage facilities consist of ground storage reservoirs, standpipes, and elevated tanks. All distribution system storage facilities "float" directly on the distribution system except for Reservoir 115 (E.L. Nordness Reservoir), which is filled from the distribution system during low demand periods in the evening. It is pumped out during daytime peak demands. It is commonly referred to as a "dump/re-pump" facility, as water is "dumped" it, and then "re-pumped" by booster pumps into the main pressure zone.

The system includes over 820 miles of pipelines, ranging from 1-1/2 to 24 inches in diameter. Figure 1 shows the pipe in the distribution system as of December 31, 2003, by year installed and material type.

Figure 1 - Length of Pipe by Material and Year Installed



C. Facilities Assessment

The facility assessments began with on-site inspections. The inspection confirmed existing equipment inventories and the structural, electrical, and/or mechanical condition of the major components. The facilities are generally aesthetically pleasing, well maintained, and in good functional condition.

The overall condition and current value of each facility was determined based on the condition of its individual components. The condition ratings for the components for the pumping station and storage facilities are listed in Table 1.

Table 1
Condition Rating – Pumping and Storage Facilities

Condition Rating	Definition
1	New condition. Meets or exceeds standard.
2	Well maintained and appears to be in better condition than actual age would indicate. No improvements needed in near future to maintain working order.
3	In working order and shows signs of aging consistent with actual age of component. Improvements needed in near future to maintain working order.
4	Operable, but shows greater than expected signs of aging greater. Has a high maintenance requirement.
5	Needs immediate replacement. Failure is imminent.

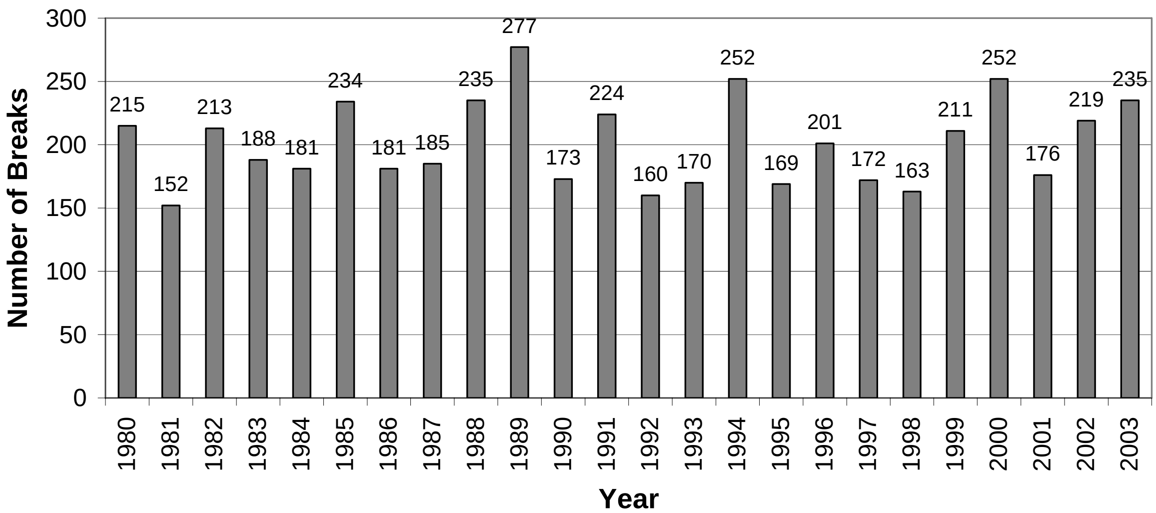
The remaining useful life and current value of each component was based on the assigned rating. The current value of the facility was then determined as the sum of the individual component values. Reinvestment requirements were determined based on replacing the individual components at the end of their useful life.

The facilities assessment identified “high priority improvements” needed to correct deficiencies such as structural and electrical problems. In addition, many of the older well structures do not have adequate chemical feed rooms, and in some older storage facilities the overflow pipes do not meet current Wisconsin Department of Natural Resources (DNR) requirements. Excluding the cost of correcting such DNR code issues, the total cost of high priority improvements was determined to be slightly above $1 million.

D. Pipeline Assessment

The condition of the pipes in the distribution system was evaluated based on main break records. Figure 2 shows the historical main breaks by year for 1980 through 2003.

Figure 2 - Historical Main Breaks



The following observations were made based on analysis of the main breaks:

- The average number of breaks over the 24-year period from 1980 through 2003 was 202 per year.
- About 31% (1,304,000 feet) of all the pipe sections in the distribution system have experienced at least one break. Approximately 40% of these sections have had only one break.
- About 1% of all pipes in the distribution system have experienced seven or more breaks.
- The incidence of breaks has been higher for smaller diameter pipes, regardless of pipe material.
- The break rate of oldest pipe material in the system (thick wall sand cast iron) is not much greater than the break rate of the newest pipe material in the system (lined and wrapped ductile iron).
- The highest break rates were identified for spun cast iron pipe.

- Ductile iron pipe installed in the 1960's has a significantly lower break rate than spun cast iron pipe installed in the same decade.
- PVC pipe has a higher break rate than lined and wrapped ductile iron installed during the same period.
- The break rate for unlined sand cast iron pipe in marshy areas has a higher break rate than for the same pipe not located in marshy areas.

The replacement value of the existing distribution pipelines is about $660 million. When considering deterioration and the associated loss of value, the current value of the distribution system pipelines is about $560 million.

E. Facility and Pipeline Maintenance Recommendations

Based on observations from facility inspections and routine maintenance activities, the following maintenance suggestions are presented for the Utility's consideration.

Table 2
Facility Maintenance Recommendations

Common Problem	Maintenance Suggestion
Moisture penetration and high humidity.	Tuckpoint and caulk building cracks. Check roofs, doors and windows for leaks and replace or repair where needed. Divert runoff from roofs and pavement away from station. Install dehumidification equipment in basements and other areas of high humidity
Chemical storage inside of/or chemical rooms open to pumping station interiors.	Isolate chemical rooms from pumping stations with exterior access only, where possible. Keep all interior chemical room doors closed.
Reservoir vent and overflow screen integrity.	Check on monthly basis. (Ground level reservoir overflows and vents require #24 mesh.)
Paint failure of piping in trenches.	Paint all piping in trenches and insulate piping or ventilate trenches to prevent future corrosion.
Well static and pumping levels.	Obtain data weekly for static and pumping levels. Plot every 4 months to see if downward trend develops.
Well and booster pump output.	Check pump performance at least monthly and plot every 4 months to see if downward trend develops. Install vibration monitoring equipment to help detect bearing or shaft problems.
Hydraulic surges.	Review surge problems in field and add surge control to all booster pumps where spikes are observed during startup or shutdown.
Security monitoring.	Review Vulnerability Assessment recommendations. Consider installation of motion detectors inside pump stations.
Overflow Code Issues	Change overflows to above-grade discharges.
Well Pump Maintenance	Pull well pump, inspect all mechanical components, and videotape the well borehole every 8 to 12 years depending on past pump life and usage.

Table 2 (continued) Facility Maintenance Recommendations	
Booster Pump Maintenance	Check packing on regular basis. Check performance with pump curve. Inspect impeller and shaft every 5 to 10 years depending on use.
Motors	Check for noise and overheating on weekly basis.
Mechanical/specialty valves	Verify operation of all valves every 2 years.
Flow Meters	Verify accuracy every 5 years.
Electronic Level/Pressure Indication	Verify accuracy every 2 years.
Mechanical Level/Pressure Indication	Verify accuracy every 5 years.

Basic pipeline maintenance should be increased by adding the following tasks to the Utility's regular maintenance program:

- Regular system leak detection surveys.
- Flushing program.
- Selected unidirectional flushing program.
- Valve exercising program.
- Hydrant inspection program.

F. Data Collection and Analysis Recommendations

The following additional data collection protocols should be developed to gather detailed information to improve assessment of the distribution system:

- Use the facilities assessment database provided with this report to maintain up to date inventory and condition information.
- Develop a form for recording main break and leak data and the pipe condition data when exposed. Enter the recorded data into a database, and directly correlate to specific pipelines in the electronic inventory.
- Further develop the water quality database to document the locations and results of water quality sampling, and use this information to help focus further inspections and investigations of the interior condition of the pipelines.

Additional analyses should be conducted to improve the evaluation of factors affecting the deterioration of existing pipelines. Pressures within the pipelines should be correlated to historical main breaks. Additional information on soil conditions should be collected and used to assess the risk of corrosion and unusual pipe loading conditions.

A water audit should be conducted in accordance with current American Water Works Association (AWWA) guidelines to identify and develop recommendations for reducing non-revenue water.

The facilities assessment database provided with this report should be replaced with a commercially available computerized maintenance management system (CMMS) to accurately log and track maintenance, repair, and replacement history for facilities, pipelines, valves, and hydrants.

Consideration should be given to replacing existing pipelines using trenchless techniques. Additional evaluations should be conducted into the cost-effectiveness of rehabilitation of existing lines. These techniques have the potential of producing significant savings, which could be used to replace or rehabilitate a larger portion of the distribution system annually.

G. Reinvestment Needs and Recommendations

Future reinvestment needs for facilities were determined based on replacing the individual components of the facilities at the end of their useful service lives. Total reinvestment requirements for the facilities were averaged in 10-year increments starting in year 2006 as summarized in Table 3.

Table 3
Averaged Annual Facility Reinvestments Needs[1,2]

Year	Average Annual Capital Costs
2006 to 2015	$2,580,000 [3]
2015 to 2025	$1,670,000
2025 to 2035	$1,730,000
2035 to 2045	$1,400,000
2045 to 2055	$2,030,000
After 2055	$1,220,000

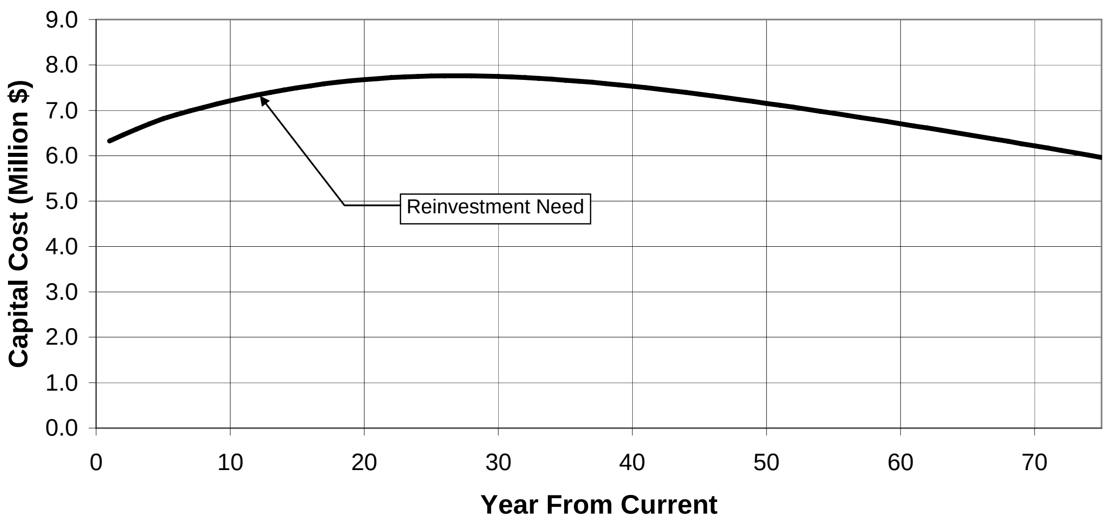
[1] Capital costs represent 2005 dollars and do not include inflation.

[2] Does not include the costs of bringing reservoir overflow pipes or chemical rooms up to DNR requirements. Capital costs of these improvements which would include adding exterior chemical rooms to 13 unit wells and retrofitting overflows to 13 reservoirs would total $2,600,000.

[3] The year 2006 to 2015 requirements include the $1,020,000 in high priority improvements.

As pipelines age they will deteriorate. The deterioration is associated with loss of value. This loss of value should be reinvested in the system in order to maintain it at current levels. The loss of value is identified herein as the annual "reinvestment need" for the distribution system pipelines. The total system reinvestment need for pipelines is shown graphically on Figure 3.

Figure 3 - Pipeline Reinvestment Needs



During the preparation of this report it became apparent that distribution system reinvestment needs far exceed current budgeted levels. Increasing the reinvestment levels to those identified in this report is not feasible either financially or politically. It is understood that when funds spent on rehabilitation and replacement are less than the reinvestment need, the system will continue to deteriorate and more money will be required to restore it in the future. However, delayed reinvestment spending in distribution system infrastructure may not have any immediately noticeable impact on the system's operation.

In September 2005, after reviewing reinvestment needs, annual funding capacity, the potential for rate increases, and the Utility's bonding capacity, the Utility provided information about projected capital spending for reinvestment for the next 15 years. It is the goal of the Utility to regularly increase the annual reinvestment spending to catch up with needs. It will take many years to achieve this goal due to limitations in rate increases and the Utility's bonding capacity.

The Utility has proposed moderate annual budget increases for facilities to build up from

$250,000 per year in 2007 to $2 million per year by 2025. The annual amount budgeted for pipeline replacement is $2.8 million per year in 2005, increasing annually to $9 million per year in 2024. Reinvestment into distribution system infrastructure should be reviewed and updated annually, as additional data is collected and additional definitions are formalized for level of service for the distribution system.

H. Prioritized Improvements

A 10-year implementation plan for facilities was developed based on budgetary numbers provided by the Utility. Based on facility condition and other needs, the following priorities are recommended for facilities:

1. Complete High Priority Facility Improvements.
2. Replace Booster Station 106.
3. Repair Reservoir 106.
4. Rehabilitate Well Boreholes 13, 17, and 24.
5. Repair Pumping Station 12.
6. Repair Reservoir 7.
7. Repaint Elevated Tanks 120, 126, and 315.

Candidate pipe sections for replacement were identified and grouped into two different programs as described below:

- **Set 1 –Candidate Project Pipe Replacement Program**
  Each pipe section that has had two or more breaks is considered an immediate candidate for replacement.
- **Set 2 – Watch List Pipes**
  All pipe sections with only one break were included in the watch list.

Candidate project pipes were prioritized based on seven criteria. Each criterion is weighted based on its relative importance, as presented in Table 4.

Table 4 Pipeline Criteria Scoring				
	Impact Score			
Criteria	1	2	3	Weight
Number of Breaks	2 to 3	3 to 6	7 or more	3
Break Rates	Lowest 1/3	Middle 1/3	Highest 1/3	3
Coordination With Public Works	Default	Roadway Resurfacing, Storm Water or Sanitary Sewer Project	Roadway Reconstruction Project	3
Diameter	8” and smaller	4” and smaller	10” and larger	2
Critical Pipelines	Default	Not-limited Access Federal and State Highways	Limited Access Federal Highways and U.S. Highway 151, single supply lines, and others as directed by City	2
Noteworthy Locations	Default	Colleges and Schools	Hospitals, Stadiums, Airport, State Capital Building, University of Wisconsin Co-generation Plant	1
Soil Type	Default	Marshy	Not used	1

A detailed spreadsheet was provided with the report that identified prioritized improvements for facilities and pipelines. Pipeline projects should continue to be coordinated with City street projects. However as the budget increases, the Utility will undertake projects on its own. Pipeline projects should be evaluated and prioritized annually, and the prioritization spreadsheet should be reviewed and updated routinely to ensure that funds are efficiently and effectively used to maintain the system.