CHAPTER 7

RECOMMENDED WATER SYSTEM IMPROVEMENTS

This chapter summarizes recommended water system improvements. The following categories of improvements are discussed:

- Water storage improvements
- Water service to outlying areas
- Distribution system improvements
- Distribution system expansion

Based on projected growth planned for the Sister Bay Water Utility service area, the water system will require improvements to accommodate future service needs and address existing system deficiencies.

7.1 WATER STORAGE IMPROVEMENTS

To address the system's existing storage deficiency, the Water Utility currently requires an additional 0.15 MG of water storage volume. Based on projected water demand growth over the planning period and to meet the water storage needs of the planning area, the Utility will require an additional 0.25 MG of water storage volume by the year 2025. The additional recommended water storage volume needed is illustrated in Figure 7-1.

In general, a water utility has three types of storage facilities to choose from when additional water storage is required. Storage facility alternatives include:

- Clearwell Storage
- Ground Storage
- Elevated Storage

Storage located adjacent to the water supply or treatment facilities is generally defined as clearwell storage. Clearwell storage is provided to meet peak demands which exceed water supply and/or treatment production rates and to allow production facilities to operate at a constant rate which results in more uniform and efficient operation.

Ground storage is simply storage located on or beneath the ground. It is generally located within the distribution system network to provide equalization of system pressures and to supply peak or fire flow water demands. For the Sister Bay system, water from ground storage facilities would be required to be pumped into the distribution system.

Sister Bay currently utilizes an elevated tank and a standpipe to provide water system storage. Advantages of elevated storage include an increase in system reliability and reducing the need to construct large size mains to the system extremities. In contrast to ground storage, elevated storage provides increased reliability for fire protection and for emergencies during power outages or other pumping interruptions.

For this study, two types of storage, elevated and ground level, were considered suitable alternatives for addressing the planning area's additional storage needs. Table 7-1 summarizes the primary advantages and disadvantages of these two alternative storage types.

7.1.1 Alternative 1 - Ground Storage and Booster Pump Station

Alternative 1 involves the construction of a new 250,000 ground storage tank and booster pumping station. Ground storage is typically less costly to construct and maintain than elevated storage. However, a ground storage reservoir will require the Utility to construct and operate a booster pumping station. Therefore, operating costs would be higher with this option, because the stored water must be re-pumped into the distribution system.

A primary advantage of implementing a ground reservoir and pump station would be the ability of the booster pumps to overcome the limited hydraulic capacity of existing distribution system, especially in the LGSD No. 1 area. In addition, the ground reservoir approach could be constructed in phases (separate reservoirs) that would provide the Utility with the flexibility to add additional ground storage volume in the future to meet growing planning area needs. Water stored in ground reservoirs is less likely to be subjected to freezing problems compared to elevated storage. Finally, a ground storage tank could be constructed in two segments that would allow one-half of the reservoir to be removed from service for maintenance (or for seasonal operational needs), while the other half continues to function for the system.

7.1.2 Alternative 2 - Water Tower (Elevated Storage) in High Level Zone

Alternative 2 involves construction of a new 250,000 gallon water tower in the northern or central part of the High Level Pressure Zone. The primary advantages of this alternative include added reliability of elevated storage versus ground storage, lower operating costs incurred using elevated storage, and simple control methodologies needed to operate the system. This alternative should not significantly impact existing pump operating procedures of the Utility. To provide the greatest benefit to the identified lower pressure and lower fire flow areas, a new elevated tank should ideally be located close to the northeastern portion of the existing distribution system, serving the High Level Pressure Zone. A second elevated tank serving the HLPZ would work in conjunction with the existing Jungwirth Water Tower to establish pressure for the HLPZ, and provide a reliable supply of water held in storage to meet the additional water storage needs of the Utility. The additional water provided by this storage facility would be available in the Main Pressure Zone through the existing interzone PRV stations.

The primary disadvantages of constructing an additional elevated storage facility in Sister Bay would be higher capital and maintenance costs compared to costs for the same storage in a ground level facility, and concerns regarding potential water stagnation and freezing problems. Operation of a second, larger volume water tower will be problematical for the Utility, as the current average daily demand in the HLPZ is estimated to less than 0.15 mgd, while the total volume of elevated storage operated in the zone would be would be 0.40 MG.

Of even greater concern for operation of two HLPZ elevated tanks would be the current minimum-day HLPZ demand of less than 0.10 mgd, or less than one-quarter of the proposed elevated water storage volume including a third elevated tank. The potential for significant water freezing problems in elevated tanks rises sharply when winter season elevated tank turnover exceeds 2-3 days; it would be over 4 days with the addition of a new 250,000 gallon elevated tank.

TABLE 7-1

GROUND AND ELEVATED STORAGE COMPARISONS

SISTER BAY WATER UTILITY

VILLAGE OF SISTER BAY, WISCONSIN

Advantages of Adding Additional Elevated Storage	Advantages of Adding Ground Storage
• Reliability of emergency supplies • Better water system pressure equalization which helps minimize pressure variations and reduce surging • Can be located based on water system hydraulics to minimize or eliminate need for large diameter system mains • May be possible to take advantage of off-peak electric rates to reduce pumping costs	• Lower initial construction costs (may be offset by cost of booster pumping facilities) • Lower maintenance costs • Less significant visual impact on surrounding properties • Usually less susceptible to freezing problems

Disadvantages of Adding Additional Elevated Storage	Disadvantages of Adding Ground Storage
• Available flow capacity limited by capacity of distribution system mains to transport water from tank to area of need • More susceptible to freezing problems during winter months • Significant visual impact • Higher cleaning and painting costs	• Higher operating costs associated with need to pump stored water into system and inefficiencies in dual pumping systems • Available delivery rates limited by capacity of booster pumping equipment • Pressure variations may occur when booster pumps are operated

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Finally, the limited hydraulic capacity of the northern portion of the Sister Bay distribution system does not lend itself to the easy siting of a new water tower. A tower located in the northern part of the existing service area would provide minimal benefits to the southern portion of the distribution system without significant transmission main improvements. Similarly, a new tower located in the southern part of the existing service area would provide minimal benefits to the northern portion of the distribution system without significant transmission main improvements.

7.1.3 Alternative 3 - Water Tower (Elevated Storage); Combined Pressure Zones

Alternative 3 is similar to Alternative 2, and involves construction of a new 250,000 gallon water tower in the northern or central part of the High Level Pressure Zone to address the existing and future system water storage deficiency. However, in addition to the added elevated storage, Alternative 3 would also eliminate the two pressure zone system operation, by combining both pressure zones into a single zone.

Combining the pressure zones into a single zone would require the following:

- Abandon the existing seven PRV stations located on the boundary between the pressure zones
- Open all closed water main isolation valves located on the existing pressure zone boundary
- Modify Well 1 pump equipment to allow well pump to operate against the additional 90+ feet of head
- Operate the existing Hwy 57 Standpipe as a ground reservoir

The primary advantages of this storage improvement alternative are the same as Alternative 2, (greater reliability, lower operating costs, simple system control operations), but also address the water storage turnover concerns of Alternative 2. The greater demand of the combined zones would significantly reduce turnover concerns. In addition, the weak system hydraulic concerns of the northern distribution system would be eliminated by combining the pressure zones, and significantly increased available fire flows throughout the central and northern system area. Operation and maintenance of the PRV stations would also be eliminated.

The Alternative 3 water tower is still recommended to be located in the northern or central part of the existing water service area (similar to Alternative 2), and would work in conjunction with the existing Jungwirth Water Tower to establish pressure for the entire water distribution system. The standpipe would no longer establish pressure for the system, but would need to be operated as a ground reservoir.

The primary disadvantage of combining the pressure zones into a single zone would be the increased normal operating pressure throughout the Main Zone distribution system area. Pressures would increase between 35 to 40 psi in the existing Main Zone service area. Pressures in the lowest lying areas along the Green Bay shoreline would be increased to between 95 and 105 psi; but still be maintained largely below the DNR Code required maximum pressure of 100 psi. The higher available system pressures would generate significantly higher available fire flows throughout the existing Main Zone service area.

7.1.4 Storage Alternative Evaluation

The three storage improvement alternatives were screened for feasibility. Each alternative plan was evaluated with respect to each other on the basis of functional water utility operational standards. The results of this initial screening are summarized in the table below. For the terminology used in the table, a “marginal” rating indicates that, although the alternative may meet minimum criteria, it is clearly inferior

to the other alternatives, or is of doubtful long-term suitability. An "adequate" rating describes an alternative which more than meets the minimum criteria, but which exhibits either long-term unsuitability, or is not as desirable as other plans. Those alternatives that provide superior performance with the capability of meeting or exceeding all anticipated criteria, including long-term suitability, were rated as "superior".

Functional Standard	Alternative No. 1	Alternative No. 2	Alternative No. 3
System Pressure	Adequate	Superior	Adequate
Fire Flows	Adequate	Adequate	Superior
System Hydraulics	Adequate	Adequate	Superior
Water Storage Turnover	Adequate	Marginal	Adequate
Reliability	Adequate	Superior	Superior
Operational Flexibility	Adequate	Adequate	Superior
Operating Cost	Marginal	Superior	Superior
Maintenance Cost	Superior	Marginal	Marginal
System Control	Marginal	Adequate	Superior

Based on the preliminary screening of the three storage improvement alternatives, Alternative Nos. 1 and 3 are clearly superior to Alternative No. 2. Therefore, further evaluations of Alternatives No. 1 and 3 were performed, and are summarized below.

7.1.4.1 Storage Alternative No. 1 Evaluation

The criteria used to evaluate the location for a recommended ground storage reservoir/booster pump facility for Sister Bay included the following:

- Land availability
- Proximity to large water mains
- Compatibility with distribution system hydraulics
- Proximity to areas with high fire protection needs
- Proximity to future growth areas
- Compatibility of reservoir aesthetics with surrounding land uses
- Impact of future reservoir maintenance activities on surrounding property

Based on a review of potential planning area site alternatives using the above criteria, the recommended location for a new 0.25 MG ground reservoir and associated booster pump station is adjacent to the Sister Bay wastewater treatment facility on Village-owned land. This location is superior to all other potential reservoir site alternatives with respect to the siting criteria.

A new booster pump station associated with a new ground reservoir should be designed with an overall pumping capacity of 2,000 gpm with multiple pumping units (3 minimum). To minimize/eliminate

pressure surging of the system during pump startup, all pump motors should include variable frequency drive units.

Figure 7-2 illustrates computer simulated 2025 water system peak hour pressures throughout the planning area assuming Alternative No. 1 is implemented. As indicated in the figure, the majority of the future service area can be adequately served by the existing HLPZ water system. Only two future service areas cannot be served adequately with a minimum pressure of 35 psi under all normal operating conditions. These areas include higher elevation land south and west of Country Lane in the far southwestern corner of the planning area; and the corridor along STH 42 northeast of LGSD No. 1. A higher pressure plane is needed in these areas to ensure that all customers can be provided with a minimum water pressure of 35 psi under all normal operating conditions as required by Wisconsin Administrative Code, Chapter NR 811.

Figure 7-3 illustrates computer simulated 2025 water system available fire flows throughout the planning area assuming Alternative No. 1 is implemented. Available fire flows were modeled assuming a minimum system residual pressure of 20 psi. Future transmission main extensions were included in the Year 2025 system model. Significant transmission main improvements would be required to serve areas north of LGSD No. 1.

As indicated in Figure 7-3, and very similar to the modeling results illustrated in Figure 7-2, the majority of the future service area can be adequately served by the existing HLPZ water system. Only two future service areas cannot be served adequately with the minimum recommended fire flows under a Year 2025 maximum day demand condition. These areas include higher elevation land south and west of Country Lane in the far southwestern corner of the planning area; and the corridor along STH 42 northeast of LGSD No. 1 and north of Seaquist Road. These areas also cannot be served with adequate pressures.

To adequately serve these areas in the future with the minimum recommended fire flows, a higher pressure plane is needed and adequate booster pumping capacity required.

A preliminary budget estimate for the Alternative No. 1 ground reservoir and booster pump station improvements is $1,075,000. Table 7-2 summarizes a preliminary budget estimate for the Alternative No. 1 water storage improvements.

7.1.4.2 Storage Alternative No. 3 Evaluation

The same criteria used to evaluate the location for a recommended ground storage reservoir were used for siting a new elevated storage tank. Based on a review of potential planning area site alternatives using the storage tank siting criteria, the recommended location for a new 0.25 MG water tower is also adjacent to the Sister Bay wastewater treatment facility on Village-owned land. This location is superior to all other potential water tower site alternatives with respect to the siting criteria.

Figure 7-4 illustrates computer simulated 2025 water system peak hour pressures throughout the planning area assuming Alternative No. 3 is implemented. As indicated in the figure, the majority of the future service area could be adequately served by the combined, single pressure zone water system. There would be only one future service area could not be served adequately with a minimum pressure of 35 psi under all normal operating conditions with Storage Alternative No. 3 implemented. This area includes the higher elevation land south and west of Country Lane in the far southwestern corner of the planning area. The vast majority of the corridor along STH 42 northeast of LGSD No. 1 could be adequately served with Alternative No. 3, with the exception of the small area in the extreme, far northeastern corner

TABLE 7-2

PRELIMINARY BUDGET ESTIMATE
GROUND RESERVOIR & BOOSTER PUMP STATION
SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Description	**Estimated Cost**
Land Acquisition	See Note Below
250,000 gallon Ground Reservoir	$375,000
Booster Pump Station	$425,000
Site Work Allowance	$25,000
Total Estimated Construction Cost	$825,000
Administrative, Engineering, Financing, Legal, & Construction Contingency Costs (30%)	$250,000
Total Estimated Project Cost	**$1,075,000**

Note: Reservoir site property owned by Village.

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of the future service area. Due to the limited area involved, it is not cost effective to provide service to this area, and service is not recommended at this time. Normal system operating pressures between 90 and 100 psi could be expected in low lying areas along the Green Bay shoreline.

Figure 7-5 illustrates computer simulated 2025 water system available fire flows throughout the planning area assuming Alternative No. 3 is implemented. Available fire flows were modeled assuming a minimum system residual pressure of 20 psi. Future transmission main extensions were included in the Year 2025 system model.

As indicated in Figure 7-5, the majority of the existing and future service area would have a significant increase in available fire flows from the distribution system. Only the future service area southwest of Country Lane could not be served adequately with the minimum recommended fire flows under a Year 2025 maximum day demand condition. This area also cannot be served with adequate pressures.

To adequately serve this area in the future with the minimum recommended fire flows, a higher pressure plane is needed and adequate booster pumping capacity required.

A preliminary budget estimate for the Alternative No. 3 elevated water storage tank improvements is $995,000. This estimate includes a very short 12 inch water main that would be required to connect the recommended water tower to the existing water system, and pump modifications for the Well 1 pump. The general location recommended for the new water tower is adjacent to the wastewater treatment plant. Table 7-3 summarizes a preliminary budget estimate for the Alternative No. 3 water storage improvements.

7.1.5 Recommendations

7.1.5.1 Water Storage Approach

Alternative No. 3 is the recommended storage alternative for the Sister Bay water system. Reliability is a primary advantage of elevated storage. Because water in storage is directly connected to the water system, no mechanical devices are required to deliver water from storage to the system when it is needed.

Alternative No. 3 has additional operational and hydraulic advantages over Alternative No. 1. Increased system pressures in low lying areas of the existing Main Zone will approach the DNR Code maximum, but will allow fire flows to be greatly increased in areas where greater fire flows are needed and higher property values exist. The Utility can eliminate the operation of all seven PRV stations, and no significant changes in equipment or operation would be required at Wells 2 and 3. The Utility should consider installing individual PRVs on all customer water services in low elevations areas immediately adjacent to Green Bay. Finally, Alternative No. 3 is estimated to be less costly to implement.

Therefore, it is recommended that a new water tower be constructed to serve the Sister Bay water system to meet the current and future storage needs of the planning area.

7.1.5.2 Water Storage Location

The new tower location adjacent to the wastewater treatment plant is the recommended site of the new elevated water storage tank. However, the comparative analysis described in Section 7.1.4 was performed looking at service levels within the entire Year 2025 planning area, assuming the needed future transmission mains are in place.

TABLE 7-3

PRELIMINARY BUDGET ESTIMATE: ALTERNATIVE NO. 3
ELEVATED WATER STORAGE TANK

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Description	Estimated Cost
250,000 gallon Elevated Tank	$700,000
Site Work Allowance	$25,000
Well 1 Pump Modifications	$40,000
Total Estimated Construction Cost	$765,000
Administrative, Engineering, Financing, Legal, & Construction Contingency Costs (30%)	$230,000
Total Estimated Project Cost	**$995,000**

Note: Tower site property owned by Village.

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Many of the transmission mains in the northern section of the future service area may not be constructed for many years. Therefore, to better understand the probable impacts of a second water tower serving the current water system, additional computer modeling of the existing water system was performed. Two other potential tower sites were also modeled to evaluate any significant differences on existing system pressures and fire flows using the two vs. one pressure zone approach. The anticipated hydraulic impacts to the current system are graphically illustrated in the figures in Appendix E.

As illustrated in the figures in Appendix E, there are no significant differences in anticipated water system pressures between the three different tower locations using either pressure zone approach. However, as illustrated previously in Figure 7-5, anticipated fire flows throughout the entire water system are all considerably higher using the combined pressure zone approach.

A new water tower located near the wastewater treatment plant will provide the following system benefits:

- System pressures and fire flows in the LGSD No. 1 area would be increased.
- Elimination of pressure fluctuations in the LGSD No. 1 service area.
- Higher needed fire flows in high density and commercial development areas would be provided.
- Land acquisition and associated costs are eliminated. Land is available (Village-owned property).
- Site is in close proximity to largest system water mains.
- Site is very compatibility with existing and proposed future distribution system hydraulics.
- Site is near areas with high fire protection needs and near future growth areas.
- Water tower aesthetics are compatible with surrounding land uses (park and wastewater plant buildings).
- There would be minimal impact of future tower maintenance activities on surrounding private property. Park open space adjacent to the wastewater treatment plant is ideal for construction and future maintenance of a water tower.

Therefore, based on these reasons, it is recommended that the Village construct the proposed new water tower on Village-owned park land adjacent to the wastewater treatment plant.

7.1.5.3 Water Storage Volume

Based on the supply and storage analysis performed for this study, the Water Utility needs an additional 250,000 gallons of storage or an additional 1,500 gpm of supply capacity (or a combination of both) to meet the projected system supply and storage needs by the end of the 2025 planning period. Implementing an additional 1,500 gpm of new supply capacity (3 new supply wells) is not a cost effective approach for meeting these projected requirements.

Providing all of the needed storage for the 20-year planning period in the new water tower is not recommended. Implementation of a new 250,000 gallon water tower will create significant operational problems in the winter months, when the overall system demand falls to below 150,000 gallons per day, while the Utility would be operating 400,000 gallons of elevated storage, plus the 100,000 gallons stored in the Standpipe. Tank water freezing problems due to lack of water turnover will be a major concern for

the Utility following the construction of the new water tower, even with taking the Standpipe out of service in the winter months.

A more operationally feasible approach to address long-term storage needs for the planning area and address shorter-term operational concerns would be to construct a smaller, 150,000 gallon water tower. The increasing supply and storage needs of the system should be evaluated immediately after placing the new tower into service, and then regularly evaluated at a minimum of every 3 years.

As noted above, the additional supply/storage needs can be met by implementing a new supply well project or by adding additional ground storage. A suitable site for additional ground storage is adjacent to the Standpipe. This site is already adequately equipped to pump water from the Standpipe into the distribution system. The Utility recently had the Highway 57 Standpipe inspected to determine any maintenance needs and its current structural condition. The inspection report indicated that the 34-year old Standpipe is in excellent condition. With proper regular maintenance, this storage facility should serve the water system throughout the planning period of this study. Therefore, replacing the Standpipe with a larger ground storage facility is probably not cost effective during the planning period. Adding a second ground storage reservoir at the site is one recommended alternative.

A second alternative that could be considered following the completion of the new water tower project is implementing a new water supply well. It is usually not cost-effective to increase a municipal water system's supply capacity when there already exists sufficient capacity to meet current or projected maximum day system demands. Given the Sister Bay Water Utility's very large seasonal water demand variation between summer and winter, implementing additional supply over storage may be more operationally cost effective than constructing and maintaining additional water storage capacity. Potential distribution system water quality concerns from operating excessive storage volumes would not exist; but other operational issues would also have to be addressed in operating a 4th water supply well (wellhead protection planning and zoning issues, potential contamination concerns, additional sampling requirements, routine well and pump maintenance, etc.). Figure 7-6 illustrates the water supply and storage improvements recommended to be implemented during the planning period of this study.

It is recommended that the Utility construct a second 150,000 gallon water tower adjacent to the Village's wastewater treatment plant. Table 7-4 summarizes the budget estimate for the recommended water tower storage and combined pressure zone improvement project.

It is also recommended that the Utility plan for a future 100,000 gallon ground reservoir adjacent to the Standpipe, and begin looking for potential Well 4 sites. The Utility should plan on budgeting $350,000 for a future 100,000 gallon ground reservoir project. To minimize interference effects between the existing wells and a future Well 4, it is recommended that future well sites be planned in the western and/or southwestern areas of the Village of Sister Bay. A possible site for future Well 4 could be on Village-owned property immediately adjacent to the Jungwirth Tower. The Utility should plan on budgeting $800,000 for a future Well 4 project.

7.2 WATER SERVICE TO OUTLYING AREAS

The recommended combined pressure zone distribution system would be adequate to serve areas with ground elevations ranging up to approximately 730 feet USGS. The ground elevations proposed to be served in the outlying planning area range up to over 750 feet USGS. The combined pressure zone could only adequately serve future development within the planning area with topographic elevations less than

TABLE 7-4

PROJECT BUDGET ESTIMATE
ELEVATED WATER STORAGE TANK
SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Description	Estimated Cost
150,000 gallon Elevated Tank	$620,000
Site Work Allowance	$25,000
Well 1 Pump Modifications	$40,000
Total Estimated Construction Cost	$685,000
Administrative, Engineering, Financing, Legal, & Construction Contingency Costs (30%)	$210,000
Total Estimated Project Cost	**$895,000**

Note: Tower site property owned by Village.

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730 feet USGS. For the Sister Bay Water Utility to serve areas with elevations greater than 730 feet USGS, additional hydraulically separate higher level pressure zones will need to be created.

The Sister Bay water system computer model created for this study was expanded to simulate Year 2025 conditions, including transmission main extensions and 2025 water demand equivalent to full development of the planning area. Full development was assumed to occur using one level greater development density as indicated on the Study Area Land Use Map previously illustrated in Figure 2-1.

7.2.1 Future System Pressures

Figure 7-4 illustrated computer simulated 2025 water system peak hour pressures throughout the planning area. As indicated in the figure, the majority of the future service area can be adequately served by the combined pressure zone water system. Only one major future service areas could not be served adequately with a minimum pressure of 35 psi under all normal operating conditions. This area includes higher elevation land south and west of Country Lane in the far southwestern corner of the planning area. A higher pressure plane is needed in this area to ensure that all customers can be provided with a minimum water pressure of 35 psi under all normal operating conditions as required by Wisconsin Administrative Code, Chapter NR 811.

7.2.2 Future System Fire Flows

Figure 7-5 illustrated computer simulated 2025 water system available fire flows throughout the planning area. Available fire flows were modeled assuming a minimum system residual pressure of 20 psi. Future transmission main extensions were included in the Year 2025 system model. Significant transmission main improvements were assumed to serve LGSD No. 1 and the northern planning area.

As indicated in Figure 7-5, and very similar to the modeling results illustrated in Figure 7-4, the majority of the future service area can be adequately served by the recommended combined pressure zone water system. The same future service area that cannot be adequately served with pressure cannot be adequately served with the minimum recommended fire flows under a Year 2025 maximum day demand condition.

To adequately serve these areas in the future with the minimum recommended fire flows, a higher pressure plane is needed and adequate booster pumping capacity required.

7.2.3 Outlying Future Service Area Recommendations

For the outlying future service area that cannot be adequately served by the recommended combined pressure zone system, it is recommended that this area be served by a small, higher level pressure zone, supplied by a booster pump station. Because of the relatively small size of these needed pressure zone, it is recommended the zone's pressure plane be established by continuously operating variable speed booster pumps, with fire flows provided by a large capacity booster pump(s). Construction of storage facilities to serve this pressure zone is not recommended.

Service to the small area along STH 42 and north of Seaquist Road is not cost effective or recommended at this time.

Figure 7-7 illustrates a schematic of the Sister Bay water system Year 2025 that includes the recommended facilities to meet the needs of the planning area over the 20 year planning period.

7.3 DISTRIBUTION SYSTEM IMPROVEMENTS

Distribution system improvements have been recommended to strengthen the existing system, enhance supply reliability, loop water mains, and improve flow capacity and fire protection to various parts of the existing Village area.

There are several areas where the Sister Bay distribution system cannot supply the higher needed fire flows and where distribution system improvements that loop existing dead end water mains are recommended. Figure 7-8 illustrates recommended improvements to the existing water distribution system. The estimated costs of the water main segments are summarized in Table 7-5.

The existing PRV station on west STH 42 is not operational, and negates the operational benefits of the PRV station in the north Meadow Lane area. As pressures in the far western portion of the existing Village service area are not substandard (similar to the exiting Main Zone areas under a combined pressure zone system), it is recommended that the Village abandon the STH 42 PRV station, and decommission the Meadow Lane PRV station.

7.4 DISTRIBUTION SYSTEM EXPANSION

As the water system begins to expand to serve the Sister Bay future service planning area, it will be necessary to further extend the water transmission main system to adequately accommodate these new service areas.

Figure 7-8 illustrates recommended improvements to serve the future service planning service area. All major transmission mains identified in Figure 7-8 have been sized to meet projected future water system demands, and support system supply sources and storage facilities to serve outlying area land uses. Mains were sized to provide at least 2,000 gpm of flow capacity in commercial and high density residential areas and 1,000 gpm in medium and low density residential development areas at a residual pressure of 20 psi.

The mains shown in Figure 7-8 are only the recommended transmission mains. Smaller local service mains have not been shown. The transmission mains shown follow known or presumed locations for major streets or roads in the future service planning area, and have been located on a conceptual basis to run parallel to recommended trunk sanitary sewers (where feasible). Adjustments in the actual location of these mains can be expected at the time the mains or sanitary sewers are required, or as local needs dictate.

Water mains to serve developing residential land should be sized at a minimum of 8 inches in diameter. These mains should provide a minimum of 1,000 gpm at a 20 psi residual pressure in single-family areas. Fire flows of 2,000 gpm should be used as the criterion for all high density residential and commercial developments. All water mains to serve new developments should be looped; the Village should not allow dead end mains to be constructed.

The recommended improvement plan illustrated in Figure 7-8 to serve the future service area has been developed as a tool to guide the Village of Sister Bay in the siting and sizing of future system improvements. While the plan may represent the current planned expansion of the Sister Bay water system, future changes in land use, water demands, or customer characteristics could substantially alter the implementation of the plan. For this reason, it is recommended that the plan be periodically reviewed

TABLE 7-5

RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS
2006-2010
SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Distribution Improvement	**General Location**	**Diameter** (inches)	**Approximate Length** (feet)	**Budget Cost Estimate**
Segment A	Sunny Court	8	400	$ 64,000
Segment B	N. Highland Road	8	250	$ 40,000
Segment C	Sister Bluff Drive	8	550	$ 88,000
Segment D	Country Walk Lane	8	200	$ 32,000
Segment E	STH 57 (near Smith Drive)	8	150	$ 24,000
Segment F	East of Smith Drive (north)	8	450	$ 72,000
Segment G	East of Smith Drive (south)	8	350	$ 56,000
Segment H	Little Sister Rd Loop	8	2,400	$ 384,000
TOTAL			**4,750**	**$ 760,000**

Notes

1. Recommended improvement locations shown in Figure 7-8.
2. Extensive rock excavation assumed.

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and updated using Village planning information to reflect the most current projections of Sister Bay area growth and development.

The improvement plan is a guidance document that details existing conditions and recommendations for the future. The plan is based on future conditions as perceived in 2006. As time progresses, additional information will become available and events will shape the development of the Sister Bay area. The plan must be dynamic in response; it should be studied and used but also adjusted to conform to the changes and knowledge that will come with time. Updates should be made on a regular basis. Due to the rapid rate of growth and development expected it the planning area, it is recommended that the water system master plan should be reviewed and updated (as necessary) every five years.

7.5 RECOMMENDED WATER SYSTEM CAPITAL IMPROVEMENTS

7.5.1 Estimated Cost of Water Main Improvements to Address Existing Deficiencies

The improvements to address existing deficiencies are shown in Figure 7-8. These improvements address dead end water mains in low available fire flow areas. The estimated costs to address existing deficiencies were presented in Table 7-5. These are preliminary budget estimates only, and actual costs should be determined through the competitive bidding process. The costs include anticipated contingencies and indirect project costs.

7.5.2 Estimated Cost of Supply and Transmission Main Facilities to Serve Future Growth

Preliminary cost estimates for the proposed supply and transmission main facility improvements to serve expansion areas in 2006 dollars are presented in Table 7-6. These estimates include allowances for surface restoration, construction contingencies, and indirect project costs such as engineering, finance, legal and administrative.

The linear foot costs used for the estimates may vary depending on the year the improvements are constructed. The unit costs used are based on recent projects, and make assumptions for extensive rock excavation and dewatering during construction. Actual costs may vary significantly depending upon actual conditions within the different improvement areas.

Due to the exact location of the transmission mains being unknown at this time, costs are considered preliminary. Extraordinary costs such as subsurface crossings, removal and replacement of other existing utilities, easement costs, etc., are not included in the preliminary estimates.

Table 7-6 lists the costs for the transmission mains that are needed to provide water service within the study planning area. As this study's recommendations are conceptual in nature, detailed feasibility reports and cost estimates should be prepared prior to the design and construction of any improvements.

7.5.3 Schedule of Improvements

The timing of future transmission main improvements will be influenced by a number of parameters. Items such as the location of development pressure in specific areas, aging facilities and/or facilities which are undersized, availability of funds, etc., all play a role in the timing of future transmission main sewer improvements.

TABLE 7-6

RECOMMENDED DISTRIBUTION SYSTEM EXPANSION
2007-2025
SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Distribution System Expansion Segment *(as shown in Figure 7-8)*	**General Village Location**	**Diameter** (inches)	**Approximate Length** (feet)	**With Sanitary Sewer** (feet)	**Without Sanitary Sewer** (feet)	**Budget Cost Estimate**
Pipe Segment W100	Southwest	12	1,600	1,600	0	$ 198,400
Pipe Segment W101	Southwest	8	1,600	800	800	$ 239,200
Pipe Segment W102	Southwest	12	1,700	1,700	0	$ 210,800
Pipe Segment W103	Southwest	12	4,200	3,200	1,000	$ 585,800
Pipe Segment W104	South	12	3,600	3,600	0	$ 446,400
Pipe Segment W105	South	8	1,900	1,900	0	$ 222,300
Pipe Segment W106	South	12	2,200	1,000	1,200	$ 350,800
Pipe Segment W107	South	12	3,200	3,200	0	$ 396,800
Pipe Segment W108	Southeast	12	5,400	3,725	1,675	$ 778,500
Pipe Segment W109*	Southeast	12	1,300	0	1,300	$ 245,700
Pipe Segment W110	Southeast	12	1,000	1,000	0	$ 124,000
Pipe Segment W111	East	12	2,500	2,500	0	$ 310,000
Pipe Segment W112	East	12	1,310	1,310	0	$ 162,400
Pipe Segment W113	East	12	2,600	1,300	1,300	$ 406,900
Pipe Segment W114	East	12	1,300	900	400	$ 187,200
Pipe Segment W115	East	12	925	925	0	$ 114,700
Pipe Segment W116	East	12	1,000	1,000	0	$ 124,000
Pipe Segment W117	East	12	1,600	1,100	500	$ 230,900
Pipe Segment W118	East	12	3,600	1,700	1,900	$ 569,900
Pipe Segment W119	East	12	3,000	2,800	200	$ 385,000
Pipe Segment W120*	East	12	4,800	0	4,800	$ 907,200
Pipe Segment W121	Northeast	12	950	200	750	$ 166,600
Pipe Segment W122	Northeast	12	3,800	2,700	1,100	$ 542,700
Pipe Segment W123	North	12	1,450	1,200	250	$ 196,100
Pipe Segment W124	North	12	2,000	1,400	600	$ 287,000
Pipe Segment W125	Northeast	12	3,800	3,700	100	$ 477,700
Pipe Segment W126	North	12	2,760	2,560	200	$ 355,200
Pipe Segment W127	Northeast	12	2,600	1,490	1,110	$ 394,600
Pipe Segment W128	North	12	1,300	1,300	0	$ 161,200
Pipe Segment W129	North	12	5,300	5,030	270	$ 674,800
Pipe Segment W130	North	8	3,190	2,815	375	$ 397,600
Pipe Segment HL100	New HLPZ	12	1,800	500	1,300	$ 307,700
Pipe Segment HL101	New HLPZ	12	3,400	1,400	2,000	$ 551,600
Pipe Segment HL102	New HLPZ	12	2,200	1,425	775	$ 323,200
TOTAL			**84,885**	**60,980**	**23,905**	**$ 12,033,000**

Note: Extensive rock excavation assumed.
*Water main not installed in a common trench with sanitary sewer

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Because of the factors involved, it is difficult to accurately predict the timing of future improvements, especially those which may occur far into the future. However, some areas of the Village are more likely to experience rapid development than others.

Based on input from Village staff, a recommended Capital Improvement Plan (CIP) for water system improvements has been developed. The CIP is broken down into short-term and long-term improvements. Short term improvements generally include improvements that are needed to address existing deficiencies. Short term improvements can also include improvements to accommodate future development in areas where development is relatively cost effective, such as areas that do not need to be served by a new high level pressure zone. Long term improvements typically include providing service to future expansion areas that are located farther from the existing system and are more expensive to construct. The CIP for short term improvements and long term improvements is presented in Table 7-7.

7.5.4 Financing of Water System Improvements

Expanding the existing water system to accommodate future development can include construction of transmission mains, and implementing new pressure zone booster stations in areas where adequate service cannot be provided by the recommended combined pressure zone system.

It is anticipated that these improvements will either be financed by a developer, assessed to benefiting properties, paid for by the Utility, or a combination thereof. Typically, construction of future transmission main improvements will be constructed and paid for in conjunction with a development project. In some communities, the costs of transmission main extensions are the sole responsibility of the developer. In other communities, the developer has the option of allowing the transmission improvements to be constructed by the Utility with all associated costs being assessed back to the benefiting properties.

Construction of future booster stations and implementation of new pressure zones can also be treated in a similar way to transmission main extensions. If the pressure zone and booster pump station are necessary only to serve new development, the entire cost of these facilities can be passed back to the identified new development. If development is staged, it may be possible to stage the improvements to track with the development. When staging improvements is not possible, over-sizing costs can be recovered through special assessments, transmission area charges, or other means. As a last resort, over-sizing costs may need to be carried by the Utility until future development occurs within the larger service area, at which time the costs can be recovered from the development through one of the methods described above.

7.5.5 Short-Term System Improvement Impacts on Utility Revenue Requirements

Table 7-8 summarizes the results of a preliminary analysis of the probable impact on Water Utility revenue requirements (rates) of implementing the recommended short-term capital improvements. The effect of the short-term improvements with respect to each revenue requirement category has been estimated.

Table 7-9 summarizes projected increases in the Water Utility's cost of service with the implementation of the proposed short-term improvements. It is projected that the improvements will cause the Utility's revenue requirements to increase by $206,100 to approximately $578,500. This represents a 143 percent increase from the Utility's 2005 operating revenues. The actual impact on water rates would need to be determined based on the Utility's revenues in the year the improvements were constructed. Water sales are projected to increase approximately 2 percent per year during the planning period.

TABLE 7-7

WATER SYSTEM CAPITAL IMPROVEMENT PLAN
SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

SHORT TERM IMPROVEMENTS

Type of Improvement	System Location	Recommended Improvement	Planning Level Costs
Water Storage	Village Wastewater Treatment Plant	Construct New Water Tower	$840,000
Distribution System	South Central	Eliminate Dead End Water Mains in Low Fire Flow Areas	$760,000
Combine Pressure Zones	All	Modify Well 1 Pump to operate in Combine Zone System	$55,000
		Total	**$1,655,000**

LONG TERM IMPROVEMENTS

Type of Improvement	System Location	Recommended Improvement	Planning Level Costs
Water Supply or Storage	West Village area (supply) or adjacent to Standpipe (storage)	Construct water supply Well 4 or a new 100,000 gallon ground reservoir	$800,000
Distribution System Expansion	Planning Area	Construct Transmission Main Improvements to Support Growth and Development within Planning Area	$12,033,000
Implement New Southwest High Level Pressure Zone	Southwest	Construct Booster Pumping Station to Serve New Pressure Zone	$450,000
		Total	**$13,283,000**

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TABLE 7-8

CAPITAL IMPROVEMENTS IMPACT ON UTILITY REVENUE REQUIREMENTS

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

		Estimated Increase in Utility Revenue Requirements				
Recommended Water System Capital Improvement	**Budget Cost Estimate**	Operation & Maintenance Expenses	Depreciation Expense	Tax Equivalent	Return on Rate Base*	**Total**
New Water Tower	$895,000	$22,400	$17,900	$7,000	$76,000	**$123,300**
Water Main Improvements	$760,000	$3,800	$8,000	$6,000	$65,000	**$82,800**
Total	**$1,655,000**	**$26,200**	**$25,900**	**$13,000**	**$141,000**	**$206,100**

* 8.5% return on rate base assumed

TABLE 7-9

PRELIMINARY COST OF SERVICE ANALYSIS

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

2005 Utility Revenue Requirements:

	Operation & Maintenance Expenses	$197,919	
	Depreciation Expense	$51,586	
	Tax Equivalent	$28,358	
	Authorized Return on Rate Base	$94,498	
	Total		**$372,361**
Plus:	Increased Revenue Requirements due to Proposed Improvements		**$206,100**
Total Projected Revenue Requirements			**$578,461**
2005 Utility Operating Revenue			$238,362
Net Service Cost Increase			$340,099
Net Service Cost Increase as a Percentage of 2005 Utility Revenue			***143%***

7.5.6 Water System Ordinance Review

As part of the analysis of future improvements, a review of the Village's existing water system regulations and ordinances was conducted. The purpose of this review was to identify any changes that could be made to the ordinances that would allow the Village to better implement the water system recommendations contained in this report.

Several documents were reviewed, including the Municipal Code of the Village of Sister Bay, and the Engineering Design Manual.

7.5.6.1 Municipal Code

The Municipal Code contains the essential rules and regulations pertaining to governance of the Village. The water system is discussed primarily in Chapter 54 (Land Division and Platting Code) and Chapter 62 (Utilities).

Chapter 54 of the Municipal Code contains Section 54.106, Water Supply Facilities. This section covers the design, installation and cost recovery aspects of constructing water distribution system facilities in conjunction with development. Section 54.106 addresses these areas quite thoroughly, and only a few suggested additions are recommended:

1. Reference this Comprehensive Utilities Plan and its role in the development review process in Section 54.106. Although this plan is conceptual and schematic in nature, this plan should be an important tool for the Village in the development review process. The plan is intended to be used as a guide, for both developers and the Village, of an efficient and economic way to construct the future distribution system. Concept plans submitted by developers should be consistent with the "spirit" of the plan, whenever possible. This may not be possible in some cases, due to unique conditions and constraints that are not known at this time. However, where it is not possible to follow the concepts identified in the plan, the developer should document why the proposed deviation would be in the best interests of the Village. Similar to the Engineering Design Manual, this plan should be kept on file at the Village Hall, and should be open to inspection by the public during normal office hours.

2. Section 54.105 (k) (3) states that the Village will pay the oversizing costs for water main pipes that need to be oversized to accommodate future development. It is not clear how the Village recovers the cost for this payment. Paying for and carrying this oversizing cost will be one of the major challenges that the Village will face in the future.

Chapter 62 of the Municipal Code is entitled "Utilities", and it provides rules for the Village water and sewer system, abandonment of private wells and cross connection control. Chapter 62 is quite comprehensive and thorough; no changes are needed. Section 62-7 (e) (2) identifies accommodating property owners in routing of water mains, and suggests looping of water mains "whenever possible". The Village should only approve dead-end water mains in very special circumstances – dead end water mains compromise public fire protection and distribution system water quality, and should not be allowed to be constructed unless there is a specific plan to loop the water main in the near-term future.

7.5.6.2 Engineering Design Manual

The Engineering Design Manual contains Chapter 7 that deals with water distribution system issues. The purpose of this chapter is to provide guidance to the designer regarding the Village's requirements for design of water system facilities. Comments on this document are listed below:

1. The required fire flow listed in Section C.5 is less than the flows used in this planning study. It is recommended that the required flows used in the Village be consistent with this report (1,000 gpm in low density residential areas, 2,000 gpm in higher density residential, commercial, industrial or public areas).

2. Required easement widths for water mains are listed in Section C.12 as 25 feet, whereas required easement widths in Village Ordinance Sections 54.105 and 62-7 are listed as 30 feet. The 30 foot dimension is recommended.