CHAPTER 4

WATER REQUIREMENTS

Projections of customer demands serve as the basis for water and sewer system capital improvements planning. Several standard methods were used in this study to project water supply needs based on estimates of population and community growth. This chapter summarizes the methodology used and the results of these projections.

4.1 WATER CONSUMPTION HISTORY

An analysis was made of past water consumption characteristics by reviewing annual pumpage and water sales records for the period from 1988 to 2005. Average and maximum day water consumption during this period, together with the amount of water sold in each customer category, have been analyzed. Projections of future water requirements are based on the results of this analysis coupled with estimates of population and community growth discussed in Chapter 3.

A summary of historical customer water usage and Sister Bay Water Utility pumpage is provided in Table 4-1. Over the 18-year period of data summarized in the table, water usage varied from a low of 44 million gallons per year (MGY) in 1988 to a high of 74 MGY in 2005. Water usage over the 2001-2004 period was relatively stable, averaging 65 MGY with little variation. Water use increased 17 percent in 2005 over 2004 levels.

Average day water utility pumpage over the past 5 years has varied between 192,000 gallons per day (gpd) and 243,000 gpd, averaging 217,000 gpd. Sister Bay Water Utility sales and pumpage trends are graphically illustrated in Figure 4-1.

A recent historical summary of Utility customers served is provided in Table 4-2. Residential customers presently account for 79 percent to the Utility's customers, and 38 percent of total water sales. Commercial water use in 2005 accounted for approximately 45 percent of total sales. Sister Bay presently has no industrial water customers. Public water uses, which also include water sales to LGSD No. 1, account for approximately 17 percent of total demand.

4.1.1 LGSD No. 1 Water Usage

A summary of historical LGSD No. 1 customer water usage is provided in Table 4-3. Over the 9-year period of data summarized in the table, water usage varied from a low of 7 MGY in 2000 to a high of 9.9 MGY in 2005. Water usage by Sanitary District customers has averaged 8.03 MGY over the past five years. Average daily water consumption in 2005 was approximately 22,000 gpd.

A recent historical summary of Utility customers served is also provided in Table 4-3. Residential customers presently account for 81 percent to the District's customers, and 56 percent of the total demand. Commercial water use in 2005 accounted for approximately 44 percent of total sales. LGSD No. 1 does not have any industrial or public authority water customers.

TABLE 4-1

WATER CONSUMPTION HISTORY

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Year	Annual Water Sales (MGY) Resi-dential	Com-mercial	Indust-rial	Public*	System Uses	Total Usage (MGY)	Total Pumpage (MGY)	% Pumpage Metered
1988	13.471	25.044	0.000	5.438	---	43.953	73.070	60.2%
1989	15.290	25.236	0.000	6.090	---	46.615	52.277	89.2%
1990	15.517	23.588	0.000	5.876	---	44.981	51.538	87.3%
1991	17.929	25.520	0.000	6.431	---	49.879	54.872	90.9%
1992	17.330	24.778	0.000	6.391	---	48.500	62.343	77.8%
1993	17.649	26.527	0.000	7.605	---	51.781	66.984	77.3%
1994	19.888	29.570	0.000	8.537	---	57.996	71.106	81.6%
1995	19.514	32.460	0.000	9.170	---	61.144	78.726	77.7%
1996	19.586	30.065	0.000	8.630	---	58.281	75.491	77.2%
1997	21.109	32.461	0.000	9.122	0.904	63.596	68.630	92.7%
1998	24.392	**36.721**	0.000	9.994	1.264	72.371	87.293	82.9%
1999	22.778	34.257	0.000	8.228	1.982	67.245	83.516	80.5%
2000	21.017	28.877	0.000	7.870	1.042	58.806	85.448	68.8%
2001	23.745	31.862	0.000	8.182	1.792	65.581	73.906	88.7%
2002	22.529	32.258	0.000	8.502	1.802	65.091	70.207	**92.7%**
2003	24.454	32.109	0.000	8.767	0.587	65.917	79.459	83.0%
2004	21.910	30.849	0.000	9.239	1.217	63.215	83.764	75.5%
2005	**26.856**	32.259	0.000	**12.163**	**2.761**	**74.039**	**88.653**	83.5%

Maximum Value =

* Public sales include water sales to LGSD No. 1

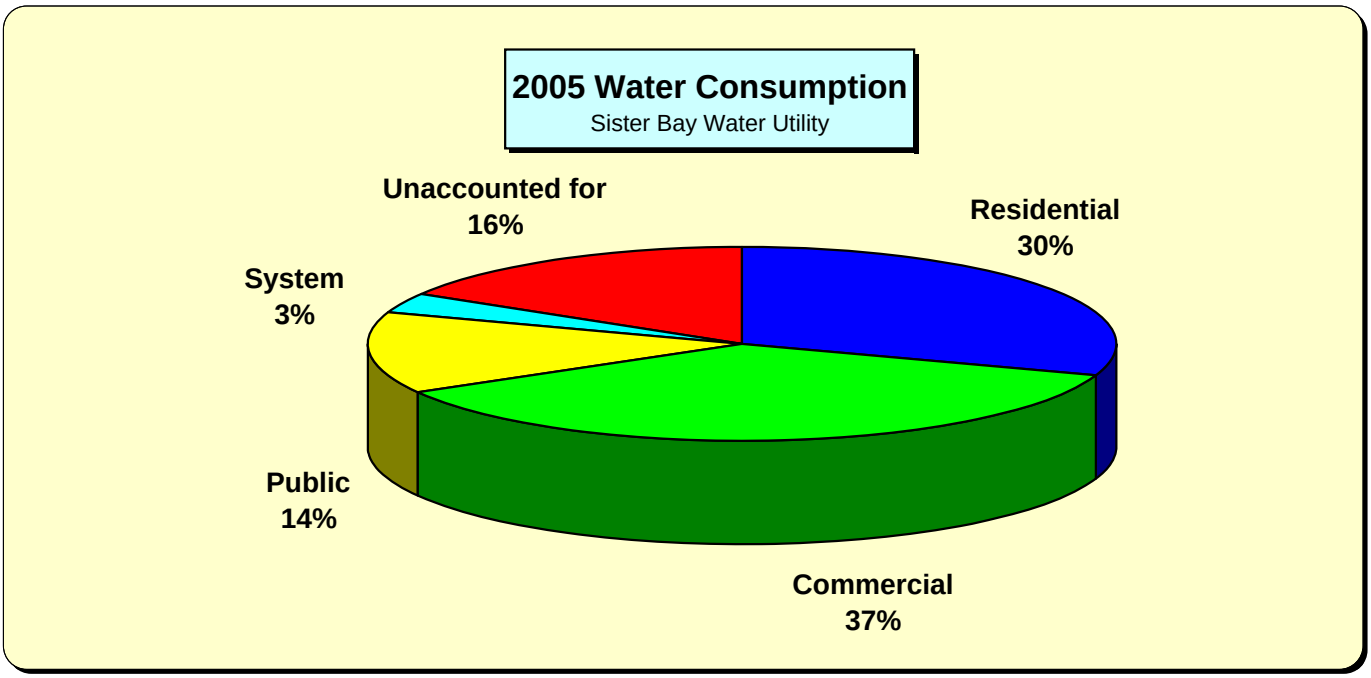

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TABLE 4-2

HISTORICAL CUSTOMER SUMMARY

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Year	Number of Customers			
	Residential	Commercial	Public Authority	**Total**
1997	606	166	9	**781**
1998	632	173	9	**814**
1999	655	174	12	**841**
2000	688	175	12	**875**
2001	696	175	12	**883**
2002	703	177	13	**893**
2003	707	179	13	**899**
2004	738	**180**	13	**931**
2005	**750**	**180**	**15**	**945**

Maximum Value =

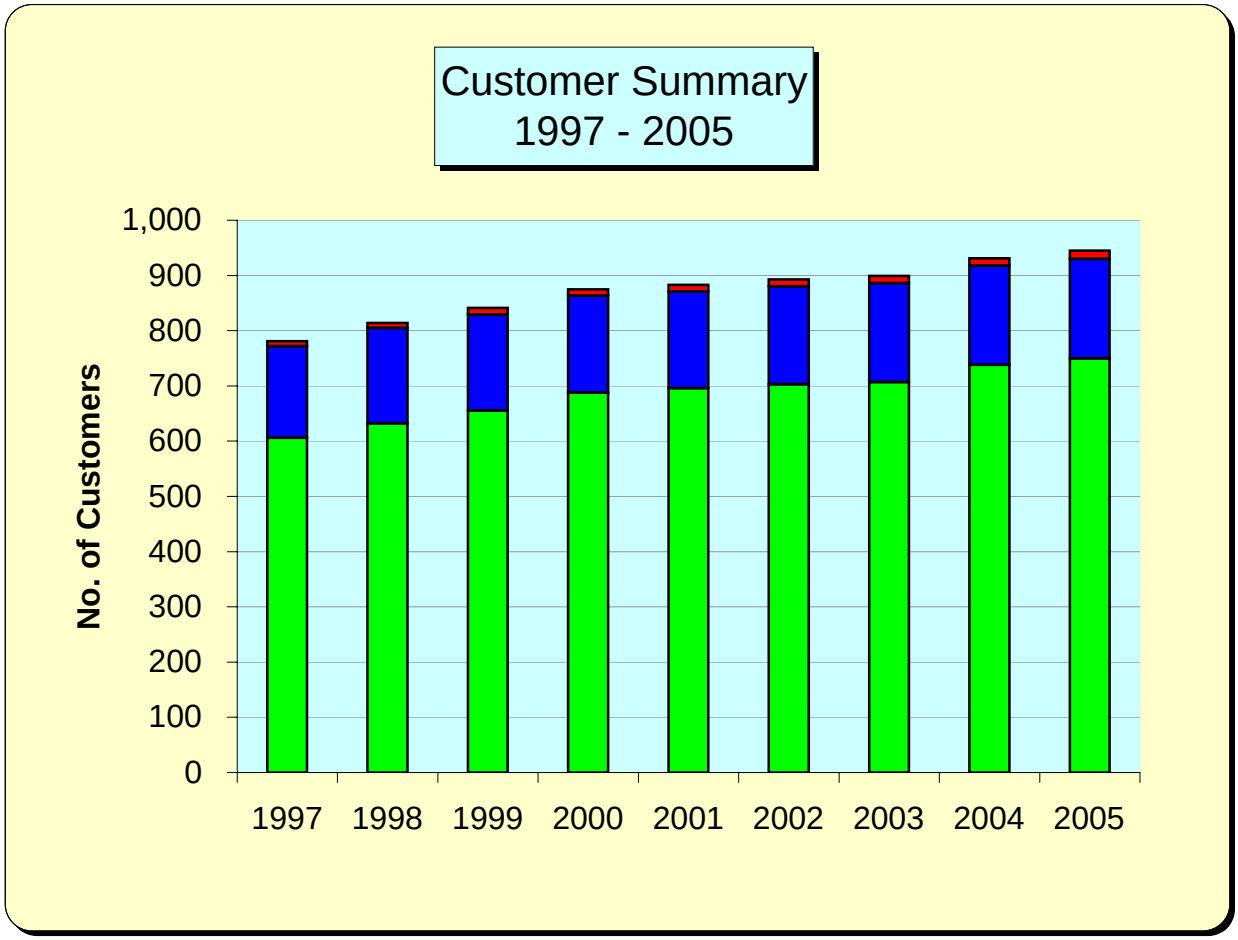

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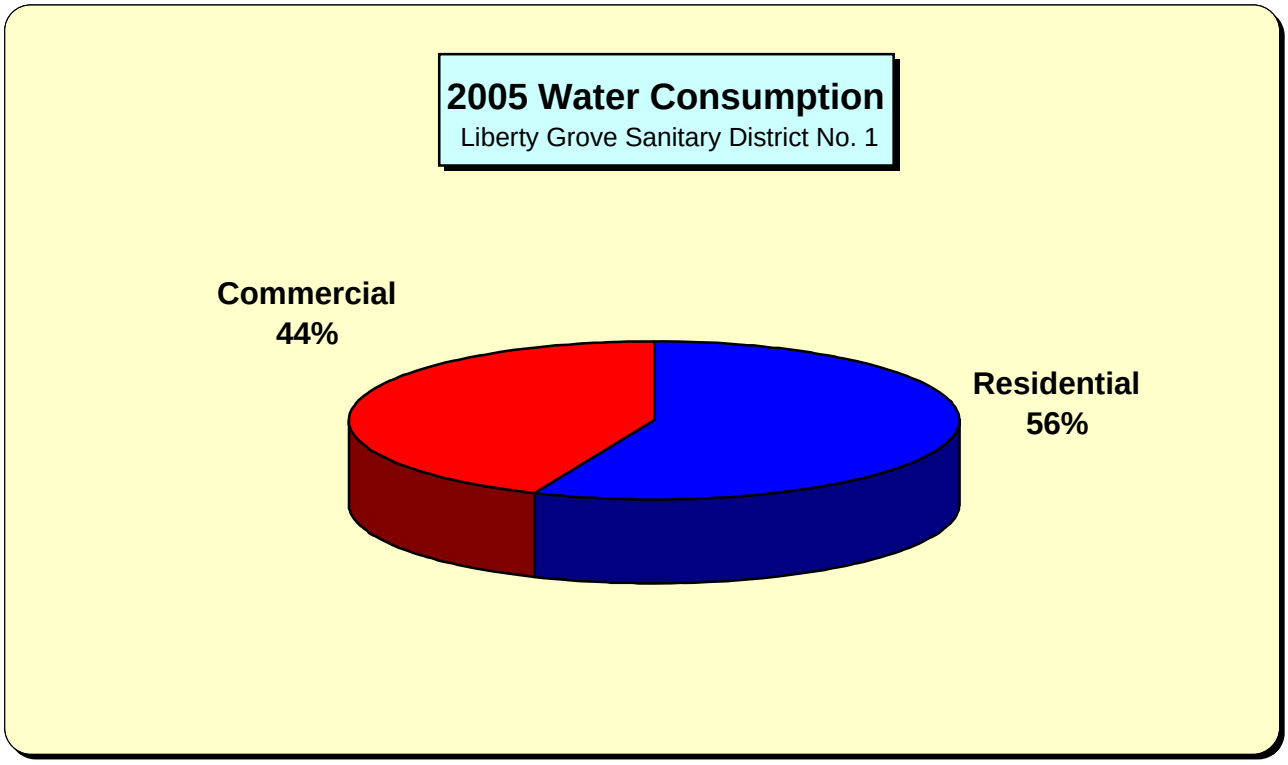
TABLE 4-3

WATER CONSUMPTION HISTORY

LIBERTY GROVE SANITARY DISTRICT NO. 1
TOWN OF LIBERTY GROVE, WISCONSIN

Year	Customers		Water Sales (MGY)		System Uses	Total Usage (MGY)
	Resi-dential	Com-mercial	Resi-dential	Com-mercial		
1997	88	23	3.377	4.246	0.066	7.689
1998	89	23	3.560	**4.968**	0.086	8.614
1999	91	23	3.444	3.807	0.064	7.315
2000	94	23	3.461	3.450	0.123	7.034
2001	96	25	3.987	3.323	0.056	7.366
2002	95	25	3.656	3.686	0.036	7.378
2003	100	25	4.111	3.425	0.049	7.585
2004	109	**26**	4.091	3.794	0.043	7.928
2005	**113**	**26**	**5.496**	4.250	**0.139**	**9.885**

Maximum Value =



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4.2 PER CAPITA WATER USAGE

Residential, commercial, and public water usage can be correlated to a community's population. An analysis of per capita water consumption for the Village of Sister Bay for each of these customer classifications was made from the available sales records and is summarized in Table 4-4. Figure 4-2 illustrates the results of this analysis. As indicated in this figure, per capita sales to residential, commercial, and public customers have followed certain trends over the previous 18 years.

The apparent trend in per capita residential water usage illustrated in Figure 4-2 is consistent with observed results for other Wisconsin municipal water utilities. Although per capita residential water usage in the U.S. had consistently increased until the early 1970s, water usage statistics indicate that the increasing rate of per capita consumption has leveled off. This may be due in part to residential customers becoming more aware of water costs, and water conservation measures becoming more common.

The Utility's residential per capita consumption has remained relatively constant over the previous 5 years, averaging 70 gallons per capita per day (gpcd). To project future water needs, average daily water usage for residential customers in the Sister Bay Water Utility planning area was projected to be 70 gpcd throughout the 20-year planning period.

Over the previous 5 years, per capita commercial sales have been relatively constant, varying between 89 and 97 gpcd. For this study, it was projected that future per capita commercial consumption will average approximately 93 gpcd. Since 2001, per capita public sales have averaged 4.0 gpcd. For this study, it was projected that future per capita public consumption will continue to average approximately 4 gpcd.

4.3 LARGE WATER USERS

Water consumption can vary widely on an annual basis depending on the types of large customers served, and the annual level of commercial activity. Fluctuations in water consumption for a particular large customer can be attributed to several factors including:

1. Changes in operating schedules or capacity
2. Changes in large water using processes
3. Changes in the number of persons employed
4. Seasonal variation in irrigation requirements
5. Seasonal changes in business activity
6. Implementation of conservation measures

Table 4-5 summarizes annual water sales to the major Utility water customers over the 2001-2005 period. A review of recent water sales records indicates that the top nine Sister Bay high volume water users consumed 52 percent of the total 2005 commercial water sales. Consequently, any significant changes in water consumption characteristics by these high volume users could have a very large impact on total Utility water requirements.

4.4 UNACCOUNTED-FOR WATER

There is generally a close relationship between the total gallons of water pumped, and the gallons of water metered and sold to water utility customers. Total metered water sales are always less than the amount of pumpage due to several factors, including:

TABLE 4-4

HISTORICAL PER CAPITA USAGE

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Year	Estimated Population	GALLONS PER CAPITA PER DAY				
		Residential	Commercial	Public*	Total Metered	Total Pumpage
1988	653	56.4	104.8	22.8	183.9	305.7
1989	664	63.1	104.1	25.1	192.3	215.7
1990	675	63.0	95.7	23.9	182.6	209.2
1991	696	70.6	100.5	25.3	196.3	216.0
1992	717	66.0	94.4	24.4	184.8	237.6
1993	738	65.5	98.5	28.2	192.2	248.7
1994	759	71.8	106.7	30.8	209.3	256.7
1995	780	68.5	114.0	32.2	214.8	276.5
1996	801	66.8	102.6	29.5	198.9	257.5
1997	822	70.4	108.2	4.8	183.3	228.7
1998	843	79.3	119.3	4.5	203.1	283.7
1999	864	72.2	108.6	2.9	183.8	264.8
2000	886	65.0	89.3	2.6	156.9	264.2
2001	902	72.1	96.8	2.5	171.4	224.5
2002	918	67.2	96.3	3.4	166.9	209.5
2003	934	71.7	94.2	3.5	169.4	233.1
2004	950	63.0	88.7	3.8	155.5	240.9
2005	967	76.1	91.4	6.8	174.3	251.2

* Includes water sales to LGSD No. 1 (1988-1996)

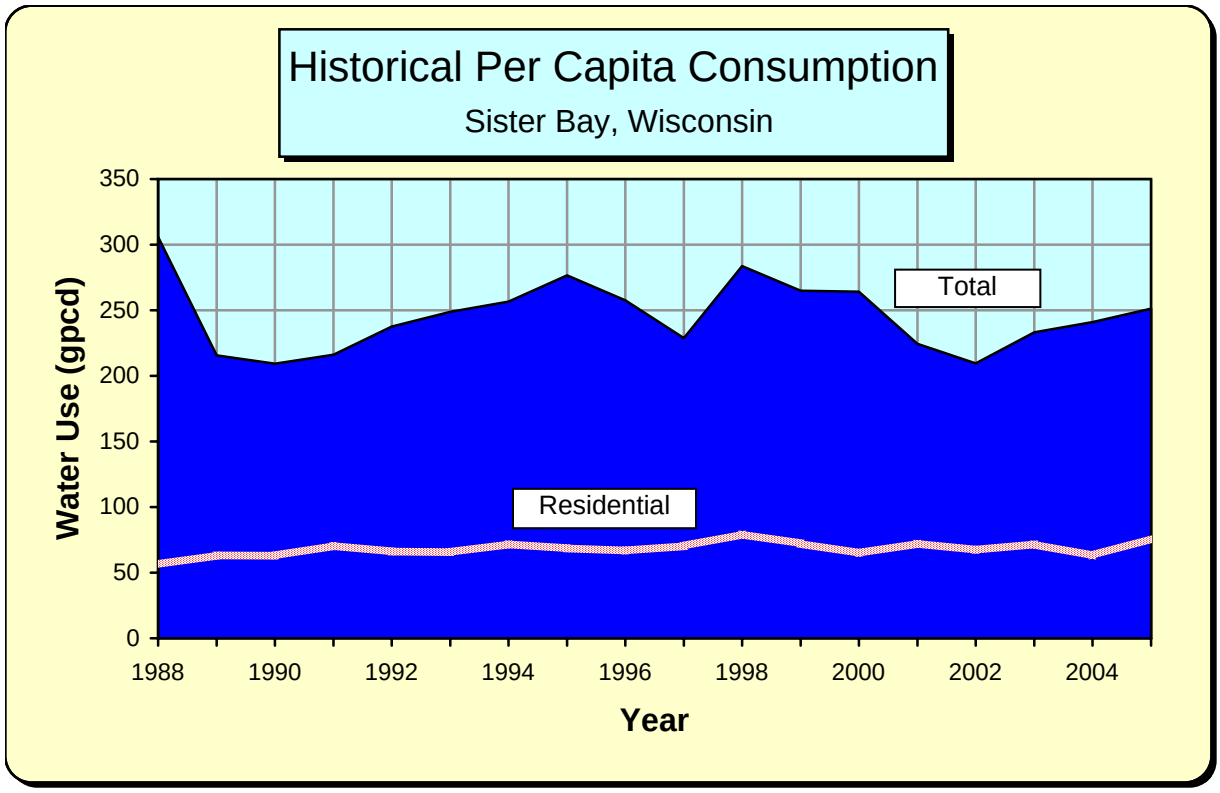

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TABLE 4-5

SUMMARY OF LARGEST UTILITY CUSTOMERS

SISTER BAY WATER UTILITY

VILLAGE OF SISTER BAY, WISCONSIN

		LARGE CUSTOMER CONSUMPTION (MGY)				
2005 Rank	**LARGEST CUSTOMERS**	**2005**	**2004**	**2003**	**2002**	**2001**
1	Scandia Village	4.64	4.59	3.37	4.92	4.73
2	Pheasant Park Owners Association	2.84	2.24	2.40	2.46	1.86
3	Scandanavian Lodge	1.70	1.85	1.82	1.97	1.73
4	Birchwood Lodge	1.47	1.49	2.13	2.19	0.37
5	Al Johnson's Restaurant	1.41	1.29	1.31	1.26	1.56
6	DuNord Properties (LGSD)	1.05	1.07	1.20	1.22	1.29
7	Church-Hill Inn	1.02	1.04	1.06	1.03	1.07
8	Helms Four Seasons Resort	0.87	1.02	1.00	0.97	0.99
9	Final Rinse Laundromat	0.87	0.83	0.87	0.97	0.96
10	Sister Bay Bowl	0.80	0.95	0.70	1.18	0.65
	Total	**16.67**	**16.36**	**15.87**	**18.16**	**15.21**

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1. Unmetered water usage for maintenance purposes such as hydrant flushing and water main repairs
2. Unmetered water usage for fire fighting
3. Inaccuracies in water metering devices
4. Unaccounted-for public water usage
5. Leakage within the distribution system

The difference between total pumpage and total water sales is termed "unaccounted-for" water. The amount of unaccounted-for water is an indication of the condition of the water system and is usually expressed as a percentage. When a distribution system is very old or poorly maintained, the percentage of unaccounted-for water often increases dramatically.

Table 4-1 provided a historical summary of the percentage of total pumpage metered over the past 18 years. The percentage of total Sister Bay pumpage metered has been reported to be as low as 60 percent and as high as 93 percent since 1988. This high degree of fluctuation is often common for small public water utilities, and can be influenced by the factors summarized above. For example, the percentage of total pumpage metered would be expected to decrease in years when unusual problems with leakage or meter stoppage occurred, or when unusually high water demands for fire protection occurred. As a general rule, for small water systems the percentage of total pumpage metered should be maintained above 85 percent, which would correspond to unaccounted-for water amounting to less than 15 percent.

Over the previous 10 years, the Utility has averaged approximately 17 percent unaccounted-for water. For this study, it was assumed that the percentage of total pumpage metered in future years will be maintained at a minimum value of 15 percent.

4.5 VARIATIONS IN CUSTOMER DEMANDS AND PUMPAGE

Seasonal fluctuations in water usage are important factors in the design and sizing of water supply and storage facilities. The seasonal nature of water consumption in the Village of Sister Bay can be demonstrated by an analysis of monthly pumpage variations. The Utility's monthly pumpage variations in 2005 are presented in Table 4-6. In 2005, the maximum monthly pumpage occurred in July, while the minimum monthly pumpage occurred in March.

Maximum daily water demands usually occur during the summer months on hot days when additional water is used for watering lawns, gardening, bathing, and other recreation. The maximum day demand is defined as the amount of water pumped during a single day of the year with the highest water usage, and is often expressed as a ratio of the annual average day pumpage. The maximum day pumpage is of particular importance to water system planning, because water supply facilities are sized to meet this demand.

Table 4-7 presents the average and maximum day pumpage for each year from 1988 to 2005. The maximum day pumpage usually occurs during June, July, or August. The minimum day pumpage typically occurs during winter or early spring. Over the last 18 years, the maximum day pumpage ratio (ratio of maximum to average day pumpage) has varied from a low of approximately 1.98 in 1993 to a high of 3.21 in 2005.

To gain a better understanding of expected fluctuations in customer demands for the Village of Sister Bay; a statistical analysis was performed of historical maximum day pumpage ratios. Table 4-8

TABLE 4-6

SEASONAL PUMPAGE VARIATIONS

SISTER BAY WATER UTILITY

VILLAGE OF SISTER BAY, WISCONSIN

Month	2005 Monthly Pumpage (MG)	Percentage of Total Pumpage	Percentage of Average Pumpage
January	5.185	5.8%	70.2%
February	4.826	5.4%	65.3%
March	3.914	4.4%	53.0%
April	4.686	5.3%	63.4%
May	6.149	6.9%	83.2%
June	10.775	12.2%	145.8%
July	16.659	18.8%	225.5%
August	12.270	13.8%	166.1%
September	7.823	8.8%	105.9%
October	7.440	8.4%	100.7%
November	4.475	5.0%	60.6%
December	4.451	5.0%	60.2%
Total	**88.653**	**100.0%**	

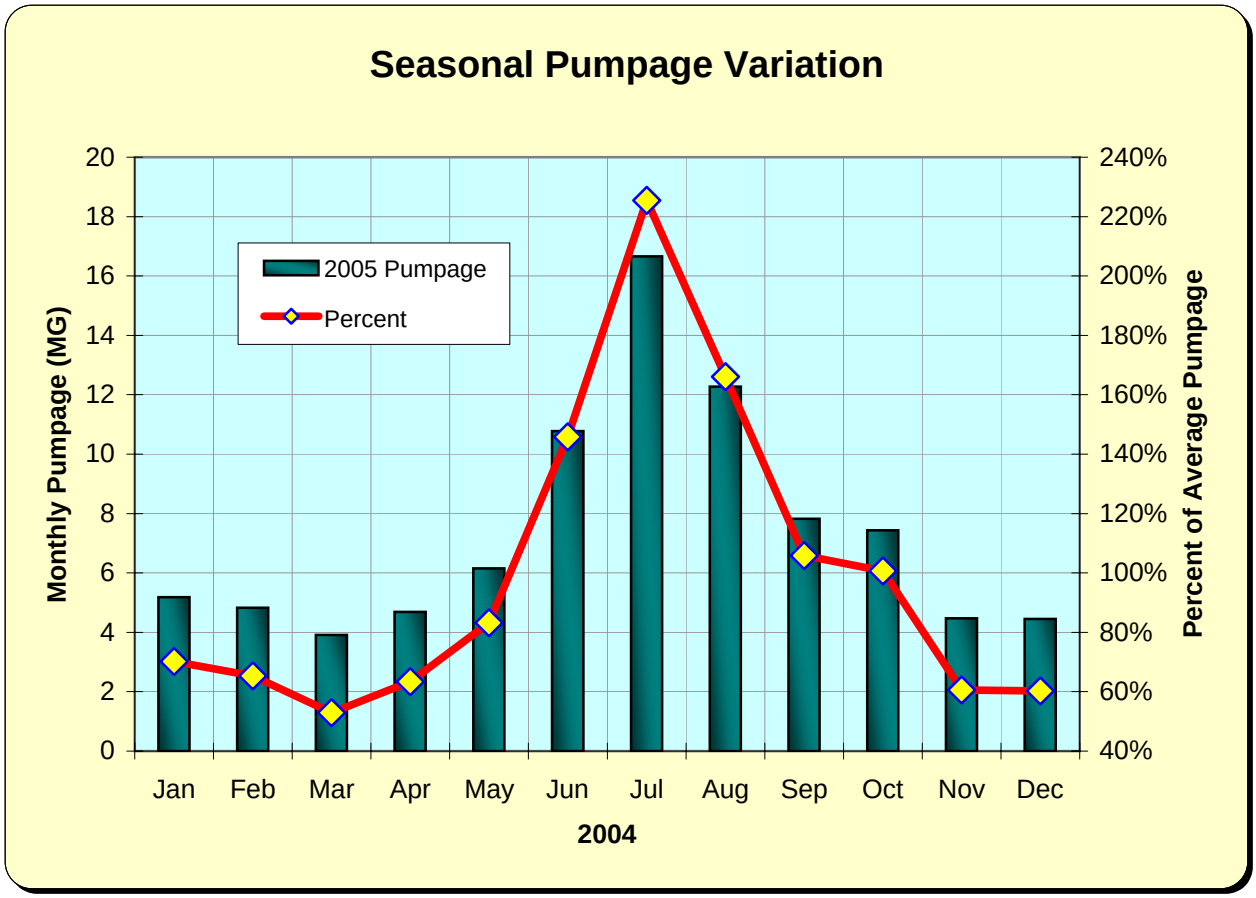

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TABLE 4-7

DAILY PUMPAGE VARIATIONS

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Year	Avg. Day Pumpage (MGD)	Max. Day Pumpage (MGD)	Ratio of Max. to Avg. Day	Year	Avg. Day Pumpage (MGD)	Max. Day Pumpage (MGD)	Ratio of Max. to Avg. Day
1988	0.200	0.471	2.36	1997	0.188	0.516	2.74
1989	0.143	0.402	2.81	1998	0.239	0.698	2.92
1990	0.141	0.358	2.54	1999	0.229	0.498	2.18
1991	0.150	0.397	2.64	2000	0.234	0.467	1.99
1992	0.170	0.482	2.83	2001	0.202	0.614	3.03
1993	0.184	0.363	1.98	2002	0.192	0.524	2.72
1994	0.194	0.466	2.40	2003	0.218	0.595	2.73
1995	0.216	0.560	2.60	2004	0.229	0.590	2.58
1996	0.206	0.466	2.26	2005	**0.243**	**0.779**	**3.21**

Maximum Value =

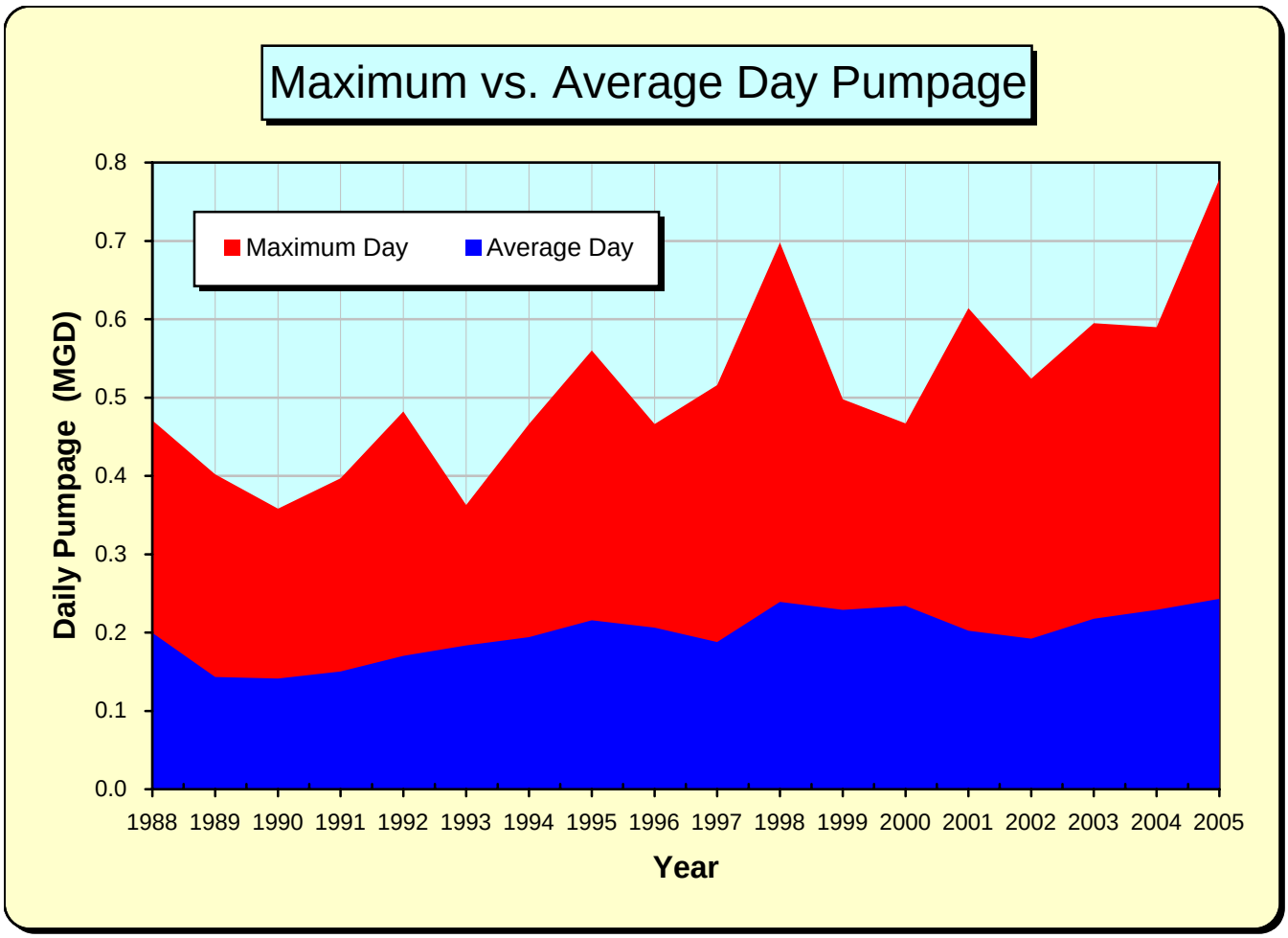

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TABLE 4-8

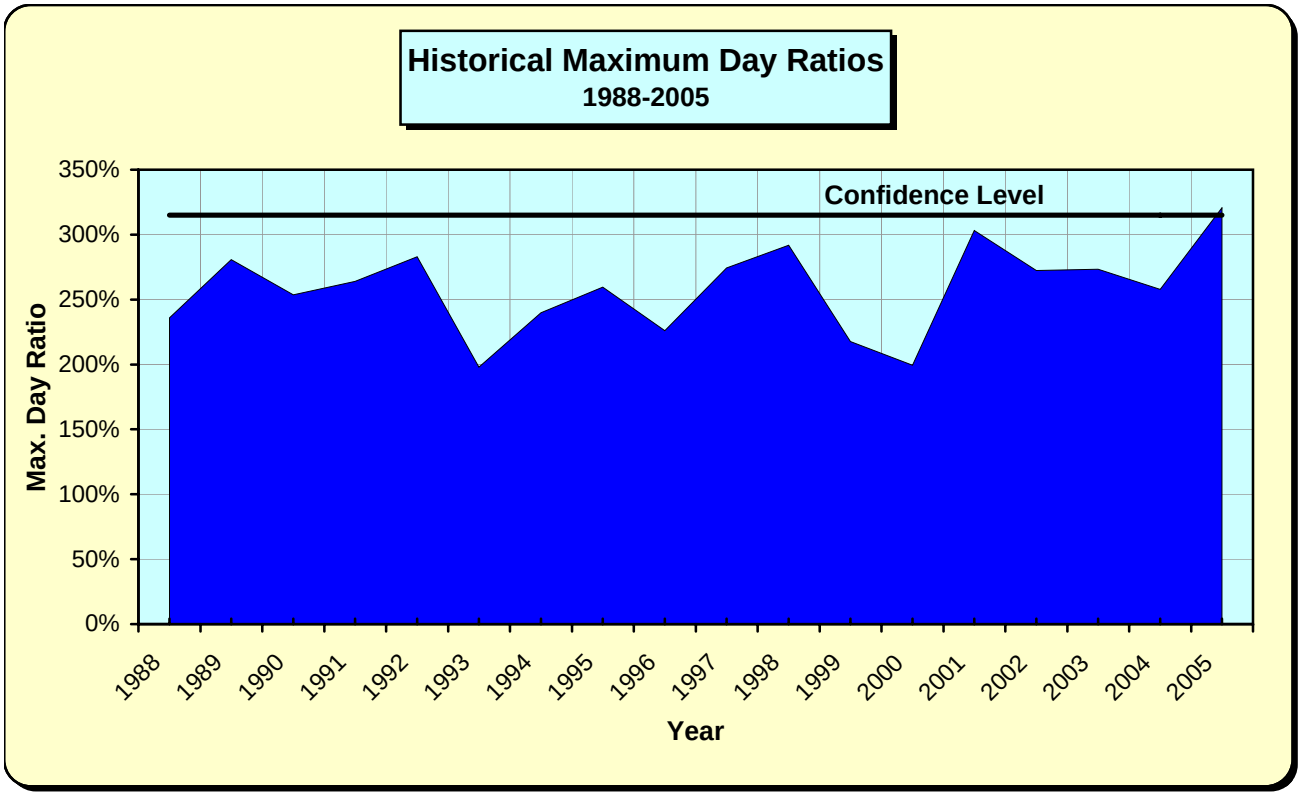
STATISTICAL ANALYSIS:
RATIO OF AVERAGE TO MAXIMUM DAY DEMAND

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

	2001 to 2005	1988 to 2005
Number of years of Data	5	18
Maximum Ratio - Max. to Avg. Day Pumpage	3.21	3.21
Minimum Ratio - Max. to Avg. Day Pumpage	2.58	1.98
Average Ratio Max. to Avg. Day Pumpage	2.86	2.58
Standard Deviation	23%	33%

Confidence Level (%)	Ratio of Max. to Avg. Day Pumpage	Ratio of Max. to Avg. Day Pumpage
80%	3.05	2.86
85%	3.09	2.93
90%	3.15	3.01
95%	3.23	3.12
98%	3.33	3.26
99%	3.39	3.35

Note The "Confidence Level" represents the probability (%) that in any given year, the actual ratio of maximum to average day pumpage will be less than or equal to the ratio indicated in the table. The ratios in the table were determined based on a statistical analysis of historical ratios over each period of analysis, assuming a normal distribution.



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summarizes the results of this analysis. Two periods of analysis were examined; the entire period of 1988 to 2005, and the latest 5-year period from 2001 to 2005.

For the years 1988 to 2005, the average maximum day demand ratio was 2.58, with a standard deviation of 33 percent. In comparison, over the period of 2001 to 2005, the average ratio was 2.86, with a standard deviation of 23 percent. For this study, it was projected that future demand variations will resemble the variations observed over the most recent 5-year period.

Table 4-8 also includes a statistical analysis of expected maximum day pumpage ratios for various normal distribution confidence levels. For example, based on the analysis of the data from 2001 to 2005, there is an 80 percent chance in any given year that the actual maximum day pumpage ratio will be less than or equal to 3.05. Conversely, there is a 20 percent chance the actual ratio will exceed 3.05.

To evaluate future water supply and storage needs, a maximum day pumpage ratio of 3.15 was used for this study. This ratio provides a confidence level of 90 percent based on maximum day pumpage ratios over the past 5 years.

4.6 HOURLY DEMAND FLUCTUATIONS

The hour-to-hour variation of customer demands is also an important characteristic used to evaluate water supply and storage requirements. As with maximum day demands, peak hour demand is often expressed as a ratio of average day demand for the year. The peak hour demand is simply the hour of maximum demand that occurs on the maximum day.

The peak hourly rate for Sister Bay was estimated to be approximately 200 percent of the maximum day rate. This estimate is based on hourly demand fluctuations measured in the Sister Bay water system during field testing. The estimated diurnal water demand curve for the Sister Bay water system as determined for the September 27, 2005, field testing date is summarized in Table 4-9. As indicated in the graph in Table 4-9, Sister Bay water consumption typically peaks at three different times during the day: mid-morning, noon hour and early evening.

This diurnal demand curve is common for small, largely residential communities with little or no large industrial water consumption. This analysis would indicate a peak hour demand to average day pumpage ratio of approximately 6.3.

4.7 WATER CONSUMPTION AND PUMPAGE PROJECTIONS

Future sales and pumpage projections are based on assumptions of water demand, coupled with estimates of future population and community growth. A detailed summary of the individual components of projected water sales and pumpage requirements is provided in Table 4-10. Figure 4-3 illustrates the historical annual water sales along with the future projections.

4.7.1 Residential Sales

Residential sales were projected based on current trends and assumptions regarding future population served and per capita water consumption. By the year 2025, it is estimated that the residential consumption rate will be approximately 70 gpcd, resulting in total residential sales of approximately 36 MGY. The projected 2025 residential consumption will be about 36 percent of total annual sales.

TABLE 4-9

ESTIMATED TIME-OF-DAY DEMAND CURVE

Sister Bay Water Utility
Village of Sister Bay, Wisconsin

Time Period	September 27 2005 Time of Day	System Demand Estimate (MGD)	Percent of Average Demand
1	Midnight - 1 am	0.108	37%
2	1 am - 2 am	0.133	46%
3	2 am - 3 am	0.153	53%
4	3 am - 4 am	0.119	41%
5	4 am - 5 am	0.080	28%
6	5 am - 6 am	0.134	46%
7	6 am - 7 am	0.351	122%
8	7 am - 8 am	0.479	166%
9	8 am - 9 am	0.480	167%
10	9 am - 10 am	0.439	152%
11	10 am - 11 am	0.310	108%
12	11 am - Noon	0.334	116%
13	Noon - 1 pm	0.494	172%
14	1 pm - 2 pm	0.548	190%
15	2 pm - 3 pm	0.455	158%
16	3 pm - 4 pm	0.332	115%
17	4 pm - 5 pm	0.304	105%
18	5 pm - 6 pm	0.326	113%
19	6 pm - 7 pm	0.398	138%
20	7 pm - 8 pm	0.416	144%
21	8 pm - 9 pm	0.288	100%
22	9 pm - 10 pm	0.174	61%
23	10 pm - 11 pm	0.086	30%
24	11 pm - Midnight	0.074	26%
TOTAL DEMAND		**0.288**	

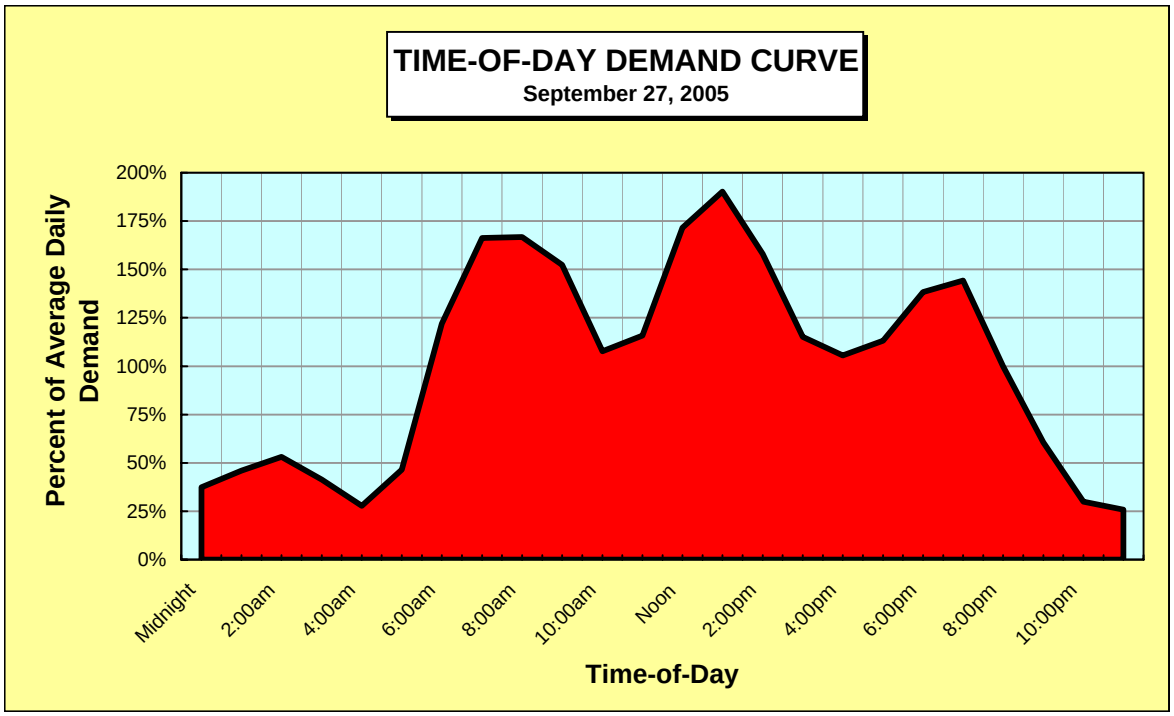

TABLE 4-10

WATER SALES & PUMPAGE PROJECTIONS

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

Customer Classification	Actual 2005	Projected 2015	Projected 2025
Population Served	967	1,163	1,407
Residential Sales			
Per Capita Sales (gpcd)	76.1	70	70
Annual Sales (MGY)	26.86	29.70	35.90
Public Sales			
Per Capita Sales (gpcd)	6.8	4	4
Annual Sales (MGY)	2.42	1.70	2.10
Commercial Sales			
Per Capita Sales (gpcd)	91.4	93	93
Annual Sales (MGY)	32.26	39.00	48.00
LGSD No. 1 Sales			
Annual Sales (MGY)	9.89	9.50	11.40
System Uses			
Annual Usage (MGY)	2.76	3.30	4.00
TOTAL METERED SALES (MGY)	74.18	**83.20**	**101.40**
Unaccounted-For Water (MGY)	14.48	14.70	17.90
TOTAL PUMPAGE (MGY)	*88.65*	***97.90***	***119.30***

Notes

1. Projections assume no significant changes in consumption patterns of largest Utility customers.
2. Projections assume similar proportional increases in water usage by LGSD No. 1 into the future.
3. Unaccounted-for water was projected at 15% of total pumpage for future years.

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4.7.2 Public Sales

Future per capita sales to public customers were projected to be approximately 4 gpcd throughout the planning period. By the year 2025, it is estimated that public sales will be approximately 2.1 MGY, or about 2 percent of total annual sales.

4.7.3 Commercial Sales

Future per capita consumption by commercial customers was projected to be approximately 93 gpcd over the planning period. Total annual sales to commercial customers are projected to reach 48 MGY by 2025, or approximately 48 percent of total annual sales.

4.7.4 LGSD No. 1 Sales

Water use by LGSD No. 1 was projected to increase in proportion to the increase in water sales to existing residential and commercial customers of the Sister Bay Water Utility. By the year 2025, it is estimated that water consumption by LGSD No. 1 will be approximately 13.7 MGY, or about 14 percent of total annual sales.

4.8 SUMMARY OF TOTAL DEMANDS AND PUMPAGE REQUIREMENTS

The total annual metered sales projections previously summarized in Table 4-10 were based on a summation of sales projections for each major customer classification. An allowance was also made for unmetered miscellaneous water usage and losses (unaccounted-for water) to arrive at total pumpage projections.

Table 4-11 summarizes projections of future water needs. Future annual sales are projected to increase from 74 MGY to 104 MGY in 2025. Total annual pumpage should increase to approximately 122 MGY by the year 2025.

Estimates of daily demand fluctuations have also been made based on projections of future annual sales. By the year 2025, average day pumpage is projected to increase to 0.334 mgd, and maximum day pumpage is projected to increase to 1.05 mgd. Future projections of maximum day pumpage are based on a ratio of maximum day to average day of 315 percent.

Peak hour demand was projected in a similar fashion. Peak hour demand was projected by assuming a ratio of peak hour demand to maximum day pumpage of 200 percent. Peak hour demand is projected to increase to a rate of approximately 1,460 gpm by the year 2025.

4.9 WATER NEEDS FOR FIRE PROTECTION

In addition to the water supply requirements for residential, public, commercial, and LGSD customers, water system planning for fire protection needs is an important consideration. In most instances, water main sizes are designed specifically to supply needed fire flow requirements.

Guidelines for determining fire flow requirements are developed based on recommendations offered by the Insurance Services Office (ISO), which is responsible for evaluating and classifying municipalities for fire insurance rating purposes. When a community evaluation is conducted by ISO, the water system is evaluated for its capacity to provide needed fire flow at a specific location and will depend on land use

TABLE 4-11

FUTURE PUMPAGE PROJECTIONS

SISTER BAY WATER UTILITY
VILLAGE OF SISTER BAY, WISCONSIN

	Actual 2005	Projected 2015	Projected 2025
Total Annual Sales (MGY)	74.2	85.1	103.7
Total Annual Pumpage (MGY)	88.7	100.0	122.0
Average Day Pumpage (mgd)	0.243	0.274	0.334
Design Maximum Day Pumpage (mgd)	0.765	0.860	1.050
Design Peak Hour Demand (gpm)	1,060	1,190	1,460

Notes

1. Year 2005, 2015 and 2025 design maximum day pumpage projections were estimated using a ratio of maximum to average day pumpage of 315 percent.
2. Year 2005, 2015 and 2025 design peak hour demand projections were estimated using a ratio of peak hour demand to maximum day pumpage of 200 percent.

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characteristics and the types of properties to be protected. In high value districts, fire flow requirements of up to 3,500 gpm can be expected. However, based on consultations with the Sister Bay/Liberty Grove Fire Department, it was agreed that the maximum fire flow requirement of 2,000 gpm for three hours would be used for establishing water supply and storage requirements.

Therefore, for the purposes this study, the basic fire flow requirement for all high density residential and commercial developments was assumed to be 2,000 gpm for 3 hours, and 1,000 gpm for 1 hour for all medium and low density residential developments. Based on current development trends currently expected within the planning area, these basic fire flow requirements are not expected to change over the planning period.