CHAPTER 9

SANITARY SEWER SYSTEM EVALUATION

An important component of the Comprehensive Utilities Plan was the evaluation of the existing sanitary sewer collection system and performing a deficiency analysis. This chapter summarizes the findings from this evaluation.

9.1 SANITARY SEWER SYSTEM COMPUTER MODEL

A hydraulic computer model of the existing collection system was developed to assist with the evaluation of the existing Sister Bay sanitary sewer system. The goal of the evaluation was to determine if any current deficiencies exist in the system, not including the impact of additional growth.

9.1.1 Model Setup

The modeling software selected for this project utilized the spreadsheet capabilities of Microsoft Excel. The inventory information which had been collected and stored in DataView software was transferred into the hydraulic model and populated. Populating the Sister Bay sewer model with inventory data involved computing the pipe slope between manholes by reviewing invert and length data from DataView. Using the computed pipe slopes and pipe sizes obtained from Utility records, the flow capacity of each pipe was estimated. Estimates of existing individual sewer pipe capacities were developed to compare with estimated existing flows to determine if any deficiencies existed.

9.1.2 Model Loading

The process of loading the hydraulic model with existing flows involved several steps. First, estimated sewer flows were allocated to each manhole. This was done by reviewing aerial photography and zoning maps to estimate the size and type of existing land use tributary to each manhole. In residential areas, the number of existing units was counted. In non-residential areas, the service areas were measured in acres.

Next, average sewer flows tributary to each manhole were estimated using the unit and area flow generation rates shown in Table 9-1. Cumulative average flows at each point in the system were developed by adding the flows upstream of each manhole.

Finally, a peak flow factor was applied to the cumulative average flows at each manhole. The resulting estimated cumulative peak flow at each point in the system theoretically represented the maximum flow that the piping system would experience under current development levels. The peak flow factor was based on the peaking ratios observed at the WWTP and also on the typical peaking relationships which are sited in literature (NR 110 and Recommended Standards for Wastewater Facilities, 2004 Edition).

9.1.3 Model Calibration

Calibration of the existing model was performed by reviewing Sister Bay WWTP flow records. The concept of calibration involves matching the model flows with measured flows so that the model is a reasonably accurate simulation of peak flow conditions. A number of assumptions were built into the model. These assumptions affected the magnitude of the peak flow predicted by the model. These assumptions and the associated peak flows predicted by the model were adjusted through the use of a

TABLE 9-1

UNIT AND AREA FLOW GENERATION RATES FOR EXISTING CONDITIONS

SISTER BAY SANITARY SEWER SYSTEM

VILLAGE OF SISTER BAY, WISCONSIN

		Current Zoning Densities		Parameters Used in Existing Model			
Land Use Type	**Zoning Catagories**	**Lot Size**	**Dwelling Units per Lot**	**Maximum Density in Units/Acre**	**Assumed Density in People/Unit**	**Assumed Flow Rate in Gallons per Capita per Day (GPCD)**	**Existing Flow Rate in Gallons per Acre per Day (GAD)**
Residential	(CS-1) Countryside	10 acre	1	0.10	3.00	110	33
	(R-1) Single-Family Residence	20,000 sq. ft.	1	2.18	2.50	100	545
	(R-2) Multiple-Family Residence	20,000 sq. ft.	6/acre	6.00	2.25	90	1,215
	(R-3) Large Lot Residence	5 acre	1	0.20	3.00	110	66
	(R-4) Small Lot Residence	4,500 sq. ft.	1	9.68	2.00	85	1,646
Non-Residential	(B-1) General Business	20,000/25,000 sq. ft.		2.18			1,200
	(B-2) Downtown Business Transition	4,500 sq. ft.		9.68			1,646
	(B-3) Downtown Business	4,500 sq. ft.		9.68			1,500
	(I-1) Institutional						1,500
	(P-1) Park/Recreation						60
	Liberty Grove Industrial	60,000 sq. ft.		0.73			1,500
	Liberty Grove Natural Area	15 acre	1	0.07			10

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calibration factor that was applied to the flows. In this case, complete lift station pumping records and flow metering data was not available for the system. Therefore, the WWTP flow data was used as a calibration point for the existing Sister Bay model.

In reviewing the historical flow records at the WWTP, it was observed that the peak flow in a year with normal rainfall typically ranges from 300,000 to 350,000 gallons per day (gpd), and occurs in June or July. However, there have been isolated cases where flows have spiked significantly. For example, the largest event recorded in recent years was a snow melt/rainfall event which occurred in late March and early April 2004. The largest daily flow during that event was on March 29, 2004, where a volume of approximately 900,000 gallons was received at the plant. This flow volume nearly reached the plant's total treatment capacity of 945,000 gpd.

Since the maximum flow event of 900,000 gpd at the WWTP occurred quite recently (March 2004), it is a good estimate of the potential peak that could occur today. Accordingly, the computer model was calibrated to this peak event, which simulates a maximum peak flow condition with existing development.

In addition to the WWTP calibration point, a second field measurement was used to check model calibration. On May 12, 2006, a flow monitor was inserted into the 10 inch pipe between MH 17 and MH 15. A capacity test was conducted by manually starting the four upstream lift stations such that the surge in flow from each of the stations reached the flow monitor at approximately the same time. The model was modified to simulate the same conditions, and the measured flow at the monitor was compared to the flow predicted from the computer model. The resulting close comparison between the measured flow and modeled flow at this location provided further support that the assumptions used in the model were reasonable.

9.2 CAPACITY ANALYSIS

9.2.1 Pipe Capacity

After the existing model was calibrated to match existing peak flows at the WWTP and the flows measured by the flow monitor, a comparison was made between the estimated flows in each pipe and the estimated pipe capacity. The result was expressed as percent utilized. For example, a pipe having a utilization of 75 percent meant that the estimated existing flow was 75 percent of the pipe capacity, and there was 25 percent of the pipe capacity remaining for future development. Pipes with a utilization of 100 percent or more indicated a deficiency in the form of a capacity restriction.

Pipes with a capacity restriction could theoretically be flowing under surcharged conditions during peak flow periods, and could cause sewer backups and overflows. This may or may not correspond to reported backups or surcharging observations. Many times, peak flows occur during unusual hours when observations cannot be made (i.e., during or immediately after rainstorms, during early morning hours, etc.). In addition, depending on the pipe depth and number of service connections, some pipes can be periodically surcharged without causing backups or any visible sign of the surcharge. Thus, some surcharges may take place without any indication.

After final calibration, all pipes in the system were estimated to be under 100 percent utilized. The segment showing the highest utilization was the 10 inch diameter pipe from MH 15 to MH 13 on Mill Road, just west of Bay Shore Drive. This segment was estimated to be between 80 and 90 percent utilized under existing conditions. In addition, pipe segments on both sides of this segment were estimated to be between 70 and 80 percent utilized.

Table 9-2 and Figure 9-1 show the peak flow level of existing sewer pipes under current conditions in percent of maximum capacity. Table 9-2 lists the pipe segments in four categories. The categories include:

- Pipes at 25 – 50 percent of capacity
- Pipes at 50 – 75 percent of capacity
- Pipes at 75 – 100 percent of capacity
- Pipes over 100 percent of capacity

All other sewer pipe segments not listed in Table 9-2 were estimated to be below 25 percent of capacity.

9.2.2 Lift Station and Force Main Capacity

Lift stations and force mains were also checked for capacity restrictions under existing conditions. The estimated peak flow coming to each station was checked against the pumping capacity which had been recorded during the test pumping activities. The peak flows were also checked against the force main capacities. In each case, the estimated peak flows were less than the lift station and force main capacities. This indicates that the existing lift station and force main systems appear to be adequately sized for peak flows under current conditions.

TABLE 9-2

CAPACITY LEVEL OF PIPES UNDER EXISTING CONDITIONS

SISTER BAY SANITARY SEWER SYSTEM

VILLAGE OF SISTER BAY, WISCONSIN

SANITARY SEWER PIPE CAPACITY			
Pipes at 25% to 50% of Capacity	Pipes at 50% to 75% of Capacity	Pipes at 75% to 100% of Capacity	Pipes over 100% of Capacity
MH301 - MH303	MH021 - MH019	MH015 - MH013	NONE
MH251 - MH059	MH019 - MH017		
MH055 - MH581	MH017 - MH015		
MH047 - MH045	MH013 - MH011		
MH045 - MH043	MH011 - MH009		
MH043 - MH041	MH009 - MH007		
MH085 - MH083	MH007 - MH005		
MH079 - MH077	MH005 - MH003		
MH077 - MH075	MH003 - MH001		
MH073A - MH073	MH001 - MH000		
MH073 - MH025			
MH159 - MH001			
MH033 - MH031			
MH031 - MH029			
MH025 - MH023			
MH002 - MH000			

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