SECTION 7

HYDRAULIC MODEL AND COLLECTION SYSTEM CAPACITY ANALYSIS

7-1 GENERAL

To perform a detailed evaluation of the capacity of the sewer collection system, it is convenient to create a mathematical model that is capable of simulating the operating characteristics of the system. The simulations for this study were performed on a Microsoft Windows based computer utilizing software designed for the analysis of sewer systems. The software selected for this study is InfoSewer. It is an ArcGIS-based computer program with the ability to perform steady state analyses of the flows in the sewer system. InfoSewer offers direct ArcGIS integration allowing GIS analysis and hydraulic modeling to exist in a single environment. The program also manages and maintains the database that stores the sewer analysis input and output results. Manning's Equation is used for depth of flow calculations in the gravity sewer pipes.

7-2 GEOMETRIC MODEL

As a part of this Master Plan project, the City's Wastewater GIS was developed. As-built plans were georeferenced and the wastewater facilities were then digitized. Data was collected from the as-built plans and input into the GIS. The developed Wastewater GIS served as the basis of the system geometric model. Data utilized included upstream and downstream manhole invert elevations, pipe sizes and pipe lengths. Design pipe slopes were calculated from the invert elevations and reach lengths.

Inverts for approximately 4.8 percent of the system (99 reaches out of 2,078) were not found through a search of the City's available construction plans. Invert elevations for these reaches were obtained through field surveying. Detailed survey information is provided in Appendix 2.

The hydraulic model includes the entire sewer system that is owned and operated by the City, from the uppermost reaches of the system to its confluence with a Los Angeles County Sanitation District (LACSD) trunk sewer or until the flow exits the City into an adjacent agency facility. Excluded from the model are laterals, private sewers, and any areas within the City that are provided sewer service by other agencies. The pipe information utilized in the model, including size, material, length, and upstream/downstream manhole elevations is listed in Appendix 3.

7-3 LAND USE

The parcel layer, which provides the City's 2003 General Plan land use information, was used as the land use base map. The land uses within the City boundaries are shown on Figure 3-4. Since the City's service area is mostly developed, the hydraulic analyses were conducted assuming fully developed and occupied tributary areas.

7-4 SPLIT MANHOLES AND FLOW PATTERNS

The existing system consists of 16 split manholes (more than one pipe exiting the manhole). Most of the split manholes occur at high points in the system, where the manhole is typically dry. In general, the flows at the split manholes were divided by calculations based on invert elevations, downstream pipes sizes, and downstream slopes at the split manhole.

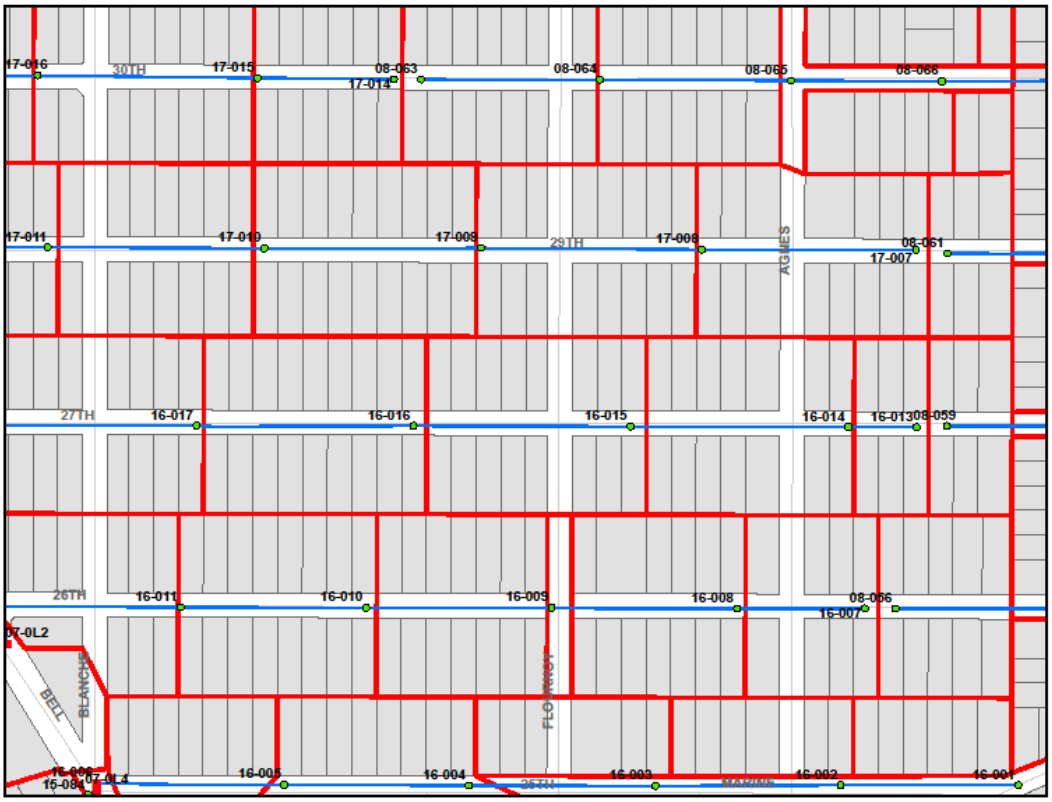
Table 7-1
Flow Split Locations

No.	Manhole ID	Location	Flow Directions from Split Manhole	Comments
1	06-009	Cedar Ave & 16th St	East-West	High Point
2	06-011	Sepulveda Blvd & 17th St	North-South	High Point
3	06-040	Meadows Ave & 12th St	North-South	High Point
4	06-168	Dianthus St & 11th St	East-West	High Point
5	06-193	Pacific Ave & 23rd St	North-South	High Point
6	06-203	Poinsettia Ave & 18th St	North-South	High Point
7	06-225	Pine Ave & 19th St	North-South	High Point
8	06-230	Elm Ave & Marine Ave	North-South	High Point
9	06-245	Palm Ave & 23rd St	North-South	High Point
10	06-277	Sepulveda Blvd & 30th St	North-South	High Point
11	06-287	Elm Ave & 30th St	North-South	High Point
12	10-148	Ingleside Dr & 1st St	South- Southeast	-
13	11-001	19 th St & Ardmore Ave	East-West	High Point
14	16-021	Bell Ave & 27th St	North-Northwest	-
15	17-027	36th Pl & Blanche Rd	East-West	High Point
16	20-059	Manhattan Ave & 24th St	North-West	-

7-5 TRIBUTARY AREAS

Polygons were created around individual sewer manholes to define the tributary area to each manhole. Most manholes have a tributary area assigned to it unless there are multiple manholes in the same area. Approximately 1,530 polygons were created for the existing and ultimate system analysis. A sample area, displaying the tributary area polygons is shown on Figure 7-1.

Figure 7-1
Tributary Area Polygons



7-6 MODEL LOADS

For each tributary area, the existing land uses (discussed in Subsection 3-5) and the developed unit flow factors (see Table 4-2) were utilized to apply the average loads to the hydraulic model.

Peak dry weather flows are calculated in the model by a user defined relationship. The peaking formula used in the City's sewer model is as follows:

$$PDWF\ (cfs) = 2.35 \times ADWF(cfs)^{0.92}$$

7-7 PUMPED FLOWS

There are two separate analysis methods that can be used on the City's sewer collection system to evaluate the effect of pumped flows downstream of the existing 8 pump stations. A description of each of the analysis methods is as follows:

Method 1: The average tributary flow to each pump station was transferred to the manholes located at the discharge end of the respective forcemains. The total average flow was peaked and the downstream sewer depth to diameter ratios were evaluated based on the calculated peak dry weather flows or

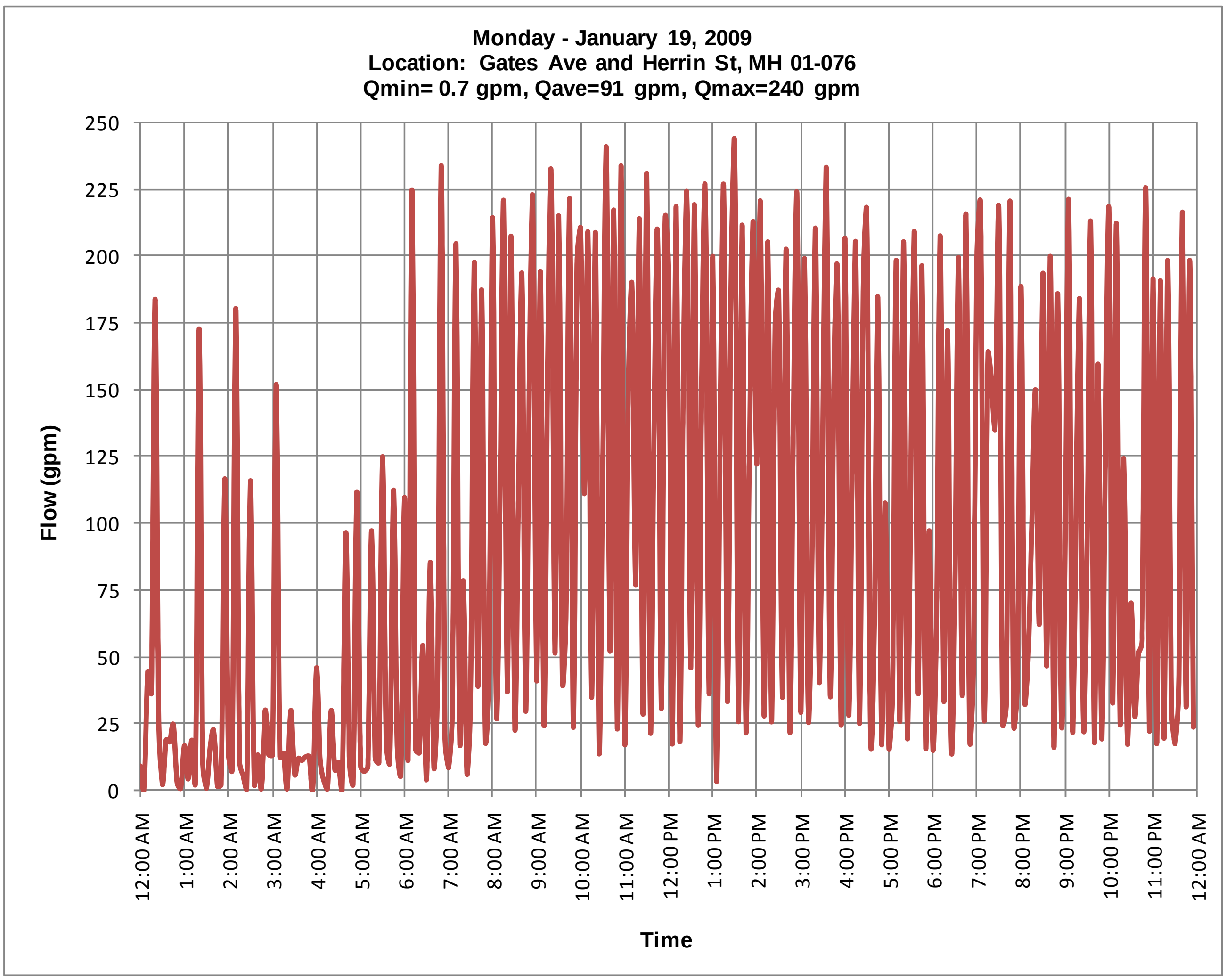
$$Qpdw = (2.35 \times Qadw^{0.92})\ (\text{in mgd})$$

Method 2: The pump capacity of each pump station was transferred to the manholes located at the discharge end of the respective forcemains. The pump capacities were not peaked, but added to the peak dry weather flow at each manhole located downstream of the pump station. The downstream sewer depth to diameter ratios were evaluated based on the calculated peak dry weather flows plus the pump capacities (Qpump) or

$$Qpdw = (2.35 \times Qadwf^{0.92}) + Qpump \text{ (in mgd)}$$

Flow monitoring results have shown that pump discharge becomes more and more attenuated the further downstream in the system the monitor is placed. Often times, only the first few reaches located immediately downstream of the discharge point will experience a rush of flow that reflects the pump capacity as displayed on Figure 7-2. In this study, the pump capacity was only considered in the first few reaches downstream of the pump discharge locations. For the pipes located a far distance from the pump discharge point, the calculated peak dry weather flow based on land use and unit flow factors was utilized for analysis (Method 1).

Figure 7-2
Flow Monitoring of 8" Sewer with Influence from Voorhees Pump Station



7-8 HYDRAULIC ANALYSIS RESULTS

At the completion of a modeling run, output data is created for viewing on the screen or for printing. Output data for pipes include flow rate, velocity, full pipe capacity, ratio of flow depth to diameter, and required size of replacement or relief pipes to satisfy the established criterion. Appendix 4 of this Wastewater Master Plan contains the results of hydraulic analyses of the sewer collection system.

The depth to diameter ratio exceeded the established criteria of 0.64 at the following locations:

1. Bell Avenue at 25th Street (Pipe ID 15084-070L4)
   10” diameter sewer with peak d/D>1.00
   No pump station influence

   As-built plans show a slope of 0.00 and a length of 10 feet. The downstream manhole 070L4 is a LACSD manhole. It is recommended that the slope of this sewer be verified.

2. Pacific Avenue north of 27th Street (Pipe ID 08077-08082)
   8” diameter sewer with peak d/D=0.66 with no pump station influence
   8” diameter sewer with peak d/D>1.00 with pump station influence from Palm Avenue PS (see Table 7-2 and description below)

A few reaches downstream of the Poinsettia Avenue Pump Station, Palm Avenue Pump Station, and Bell Avenue Pump Station discharge locations resulted in d/D ratios greater than 0.64 when the pump capacities were implemented (Method 2). These locations are listed in Table 7-2 and shown on Figure 7-3. It is recommended that flow monitoring be conducted in these areas to verify the d/D ratios prior to implementing any replacement projects.

Table 7-2
Pipes with Model Calculated Capacity Deficiencies Downstream of Pump Discharge Points

Pipe ID	U/S MH ID	D/S MH ID	Dia (in)	Length (ft)	Slope	ADWF (mgd)	Pumped Flow (mgd)	PDWF (mgd)	PDWF Vel (ft/s)	PDWF d/D	PDWF Depth (ft)	Full Flow (mgd)	Comments
06173-06174	06-173	06-174	8	192	0.0040	0.0019	0.7363	0.7437	3.30	1.00	0.67	0.4959	D/S of Poinsettia PS
06174-06175	06-174	06-175	8	254	0.0040	0.0028	0.7363	0.7469	3.31	1.00	0.67	0.4962	D/S of Poinsettia PS
06175-06176	06-175	06-176	8	190	0.0136	0.0033	0.7363	0.7485	4.51	0.69	0.46	0.9125	D/S of Poinsettia PS
08037-08052	08-037	08-052	8	262	0.0040	0.0446	0.4085	0.5430	2.41	1.00	0.67	0.4957	D/S of Palm PS
08052-08055	08-052	08-055	8	281	0.0040	0.0583	0.4085	0.5805	2.57	1.00	0.67	0.4944	D/S of Palm PS
08055-08077	08-055	08-077	8	350	0.0040	0.0637	0.4085	0.5951	2.64	1.00	0.67	0.4953	D/S of Palm PS
08077-08082	08-077	08-082	8	110	0.0040	0.0858	0.4085	0.6538	2.90	1.00	0.67	0.4951	D/S of Palm PS
16019-16022	16-019	16-022	8	68	0.0099	0.0131	0.5728	0.6164	3.84	0.67	0.45	0.7809	D/S of Bell PS
16022-070L3	16-022	07-0L3	10	18	0.0028	0.0135	0.5728	0.6176	2.38	0.69	0.58	0.7504	D/S of Bell PS
			Total	1,725									

City of El Segundo
City of Hawthorne
City of Redondo Beach
City of Hermosa Beach
Pacific Ocean
Bell Ave PS
Palm Ave PS
Pacific Ave PS
LACSD PS
Civic Center PS
Poinsetta Ave PS
Meadows Ave PS
Pier PS
Voorhees Ave PS
Legend
Sewer Manholes
Manhattan Beach Sewage Pump Station
LACSD Sewage Pump Station
Manhattan Beach Forcemain
Manhattan Beach Sewer
LACSD Trunk Sewer
City Boundary
Model Calculated Capacity Deficiency Locations
N
0 600 1,200 2,400
Feet
1" = 1,200'
CITY OF MANHATTAN BEACH
WASTEWATER MASTER PLAN
PROJECT NO: 1640901.10
DATE: September 2009
Model Calculated
Capacity Deficiency Locations
Figure 7-3