CITY OF HUNTINGTON BEACH SEWER CAPACITY ANALYSIS

Prepared by:
AKM Consulting Engineers

October 2008

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SEWER CAPACITY
ANALYSIS

Submitted to

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ES-1 Introduction

The City of Huntington Beach's Sewer Master Plan was completed in May 2003. The Master Plan conducted a capacity analysis of the collection system and determined that out of approximately 360 miles of sewer reaches, only several reaches were found deficient based on the model results and criteria. The calculated deficiencies are based upon somewhat conservative unit flow factors and peaking relationships. Therefore it is prudent to verify the calculated deficiencies before investing in replacement or relief projects. The objective of this study is to conduct flow monitoring along the reaches that were identified as deficient by the 2003 Sewer Master Plan in order to ascertain whether a deficiency exists, and to provide recommendations for eliminating the verified deficiencies.

ES-2 Criteria

<u>Sewer Design Criteria</u>

The 2003 Master Plan analysis of sewer pipes was based upon the depth to diameter ratio (d/D), resulting from peak dry weather flows. The criteria used for the 2003 Master Plan are as follows:

- Depth to diameter ratio (d/D) less than or equal to 0.5 for pipes 12-inch and smaller in diameter
- d/D less than or equal to 0.67 for 15-inch diameter pipes
- d/D less than or equal to 0.75 for 18-inch diameter and larger pipes

Reaches that do not satisfy the City's d/D criteria are considered deficient and require additional capacity analyses.

The 2003 Master Plan flow depths were calculated utilizing estimated peak dry weather flows. Average dry weather flows, which are calculated based upon the product of the tributary land use areas and unit flow factors, and a peaking relationship were used to estimate the peak dry weather flows.

The depth of flow and design capacity of gravity pipes were calculated based on the Manning formula with a friction factor (Manning's n) of 0.013.

ES-3 Existing System

The 2003 Sewer Master Plan identified nine (9) areas as deficient, which are listed in Table ES1. The locations of the deficient reaches are shown in Appendix A.

Table ES1
2003 Master Plan Identified Deficiencies

Deficiency No.	Location		Hydraulic Model Pipe Numbers	Existing Size	Proposed Size	Length (feet)
1	Hamilton Ave	Brookhurst Street to extension of Archer Circle	1019, 1017, 1016, 1015, 1014, 1013	18"	21"	1,540
2	Edwards Street, Heil Avenue	From Brad Drive to Heil Avenue; From Edwards Street to Oakmont Lane	345, 335, 321, 308 293, 5005	10" 10", 8"	15" 15", 12"	1,692
3	Heil Avenue	From Sabot Lane to Goldenwest Street	296, 295, 294	12"	15"	833
4	Speer Avenue	Jacquelyn Lane to Beach Boulevard	550, 549, 543, 544, 545, 548	10"	15"	1,397
5	Beach Boulevard	From Speer Avenue to Slater Avenue	547, 531	12"	18"	659
6	Beach Boulevard	From South of Talbert Avenue to Ronald Road	5013, 1080, 598, 590	8", 10"	12", 15"	1,086
7	Saybrook Lane	South of Heil Avenue to Morning Star Drive	2586	12"	18	299
8	Mandalay Circle	From Edinger Avenue to Humboldt Drive	202, 206, 211, 213, 216, 219, 221, 222, 232, 237	10"	15"	2,181
9	Edinger Avenue	From Trinidad Lane to Santa Barbara Lane	194, 165, 166, 167, 168, 169, 170, 174	10"	15'	1,967
					Total Length	**11,654**

ES-4 System Analysis

Flow Monitoring Locations

The flow monitoring locations were chosen to analyze the capacity deficient sewers that were identified in the 2003 Sewer Master Plan. Extensive flow monitoring near the Edinger Lift Station was required to analyze the effects the pumped flows have on the existing sewer system.

Initially, eleven (11) sites were selected for flow monitoring. Flow monitors were installed at nine (9) of the eleven (11) sites. Data was collected between 12:00 A.M. June 14, 2007 and 11:45 P.M. June 27, 2007. Two (2) additional flow monitoring sites were selected and monitors were installed between 12:00 A.M. January 16, 2008 and 11:45 P.M. February 5, 2008 to analyze the flows with the improved Edinger Lift Station. The flow monitoring results are summarized in Table ES2.

Table ES2
Flow Monitoring Summary

General Data			2003 Sewer Master Plan Data				Flow Monitoring Data					
Site #	Location		Ave GPM	Peak GPM	Existing Size	Slope	Total Days	Min GPM	ADWF GPM	PDWF GPM	Max Depth	d/D
1	Hamilton Ave	West of John Ln	807	1,533	18	0.001	12.5	137	520	928	9.29	0.52
2	Edwards St	Peggy Cir	**Removed from Flow Monitoring**									
3	Heil Ave	Goldenwest St	186	411	12	0.002	14.0	40	149	256	5.54	0.46
4	Speer Ave	Beach Blvd	263	561	8	0.002	14.0	3	41	140	4.35	0.54
5	Beach Blvd	Slater Avenue	453	914	12	0.002	14.0	100	284	508	9.38	0.78
6	Beach Blvd	Talbert Ave	149	336	10	0.002	14.0	64	234	431	7.67	0.77
7	Saybrook Ln	Heil Ave	0		12	0.002	14.0	46	346	642	7.10	0.59
8	Mandalay Cir	Humboldt Dr	229	494	10	0.002	14.0	29	227	455	8.78	0.88
8*	Mandalay Cir	Humboldt Dr	0	494	10	0.002	21.0	29	228	500	10.00	1.00
9	Edinger Ave	Santa Barbara Ln	**Removed from Flow Monitoring**									
10	Edinger Ave	Trinidad Ln	190	419	10	0.002	14.0	67	157	277	5.18	0.52
11	Santa Barbara Ln	Shorebreak Dr	198	434	10	0.002	14.0	2	205	520	8.67	0.87
12*	Saybrook Ln	Fisher Dr	190	758	12**		21.0	58	247	517	7.01	0.68

* Additional Flow Monitoring performed between January 16, 2008 to February 5, 2008
** At Flow Monitoring Location the height of the inflow pipe was 11" which is used to calculate the d/D

The City's 2003 Sewer Master Plan used the following peaking relationship to develop the peak dry weather flow (Q_{pdw}) from the average dry weather flow (Q_{adw}):

$$Q_{pdw} = 1.93(Q_{adw})^{0.898}$$

This relationship was evaluated with the use of the flow monitoring data, maintaining the exponent 0.898. Flow Monitoring Sites No.'s 4, 7, 8, 11, and 12 were excluded from this analysis because they are downstream of lift stations. The coefficient used in the Master Plan (1.93) is higher than the values calculated from the flow monitoring data, which average approximately 1.60. Therefore, the peak dry weather flow estimates used in the 2003 Master Plan were conservative, which is appropriate for planning level studies.

Capacity Analysis and Recommendations

During the initial field verification at Flow Monitoring Site No. 2, the field crew realized that the Sewer Master Plan Deficiency No. 2 was no longer in existence. The Orange County Sanitation District installed a 30-inch diameter trunk sewer on Heil Avenue, and the City was able to divert its wastewater directly into this facility. This also allowed the City to abandon the sewers on Heil Avenue from Torjian Lane to Oakmont Lane, and on Edwards Street from Heil Avenue to Brad Drive. Deficient Location No. 2 was part of these abandoned pipes and does not require further analysis.

Assuming that the normal maximum flow recordings from the flow monitoring effort represent the peak dry weather flows, the flow monitoring results were analyzed based on the 2003 Sewer Master Plan criteria.

- Sewer Master Plan Deficiency No.'s 1 and 3 meet the existing depth to diameter (d/D) criteria and are not recommended to be replaced for capacity.

- Deficiency No.'s 4 and 9 do not satisfy the City's d/D criteria. However, these deficiencies are minor and do not warrant replacement of the existing pipes for capacity. If the tributary land use is proposed to be changed significantly in the future, resulting in higher wastewater flows, then these reaches should be re-evaluated.

- The flow monitoring measurements at Sewer Master Plan Deficiency No. 5 show a maximum depth to diameter ratio of 0.78. Based on a pipe slope of 0.002 and Manning's n of 0.013, the Master Plan estimated that the ultimate peak dry weather flow would require a minimum pipe diameter of 15 inches to meet the City's depth to diameter design criteria of 0.67. These reaches will require further evaluation by the City.

- At Sewer Master Plan Deficiency No. 6, the flow monitoring shows the four reaches of sewer pipes flowing at a maximum depth to diameter ratio of 0.77. Based on the record slope of 0.002, Manning's n of 0.013 and the ultimate peak dry weather flow, the existing sewers would require a minimum pipe diameter of 15 inches to meet the City's depth to diameter criteria of 0.67. These reaches will require further evaluation by the City.

- Sewer Master Plan Deficiency No. 7 is downstream of the Saybrook Lift Station, which is scheduled to be replaced in the next 3 to 8 years. The flow monitoring shows the reach flowing at a depth to diameter ratio of 0.59, which does not meet the City's criteria. Based on a slope of 0.002, Manning's n of 0.013 and the anticipated Saybrook Lift Station discharge of 826 gpm, a minimum pipe diameter of 15 inches in needed to meet the City's depth to diameter design criteria of 0.67. This reach will require further evaluation by the City when the Saybrook Lift Station is improved.

- The Edinger Lift Station underwent improvements during the recent sewer capacity analysis. Sewer Master Plan Deficiency No. 8 is downstream of this lift station and required additional analysis, which included flow monitoring before and after the pump station improvements were completed as well as pump capacity tests at the Edinger Lift Station. The flow monitoring performed after the Edinger Lift Station was replaced indicated maximum flow rates of 500 gpm. Pump capacity tests conducted in May 2008 estimated similar flows of 510 gpm. Based on this flow rate, the record slope of 0.002, and Manning's n of 0.013, a minimum pipe diameter of 15 inches would be necessary to meet the City's depth to diameter criteria of 0.67 for the ten (10) reaches identified as deficient in the 2003 Sewer Master Plan. During the Edinger Lift Station pump capacity testing, the existing peak inflow into the lift station was measured as 285 gpm. To reduce the depth to diameter ratio in the ten (10) downstream sewers, the City may decrease the pump capacity from 500 gpm to 400 gpm. In doing so, approximately 37% of the ultimate PDWF will remain available for wet weather inflow and infiltration. By reducing the flow to 400 gpm, the downstream sewers are expected to flow at a depth to diameter ratio of approximately 0.744.

- The 2003 Sewer Master Plan identified three (3) "Borderline" deficient reaches just downstream of Deficiency No. 8. During the master planning effort, "Borderline conditions" were the reaches that had calculated d/D values which were close to the deficiency criteria d/D values, but were not determined "Deficient" by engineering judgment. For this current analysis, these reaches were evaluated with the relevant Edinger Lift Station flow monitoring data. While the d/D ratios for these reaches were 0.59, which is deficient according to the master plan standards, it does not warrant replacement of the existing pipes for capacity. If the tributary land us is proposed to be changed significantly in the future, resulting in higher wastewater flows, then these reaches should be reevaluated.

City of Huntington Beach

SEWER SYSTEM CAPACITY ANALYSIS

1-1 Introduction

The City of Huntington Beach's Sewer Master Plan was completed in May 2003. The Master Plan conducted a capacity analysis of the collection system utilizing a computer hydraulic model. Out of approximately 360 miles of sewer reaches, only a few reaches (less than 0.6 percent) were determined to be deficient. The calculated deficiencies are based upon somewhat conservative unit flow factors and peaking relationships. Therefore it is prudent to verify the calculated deficiencies before investing in replacement or relief projects. The objective of this study is to conduct flow monitoring along the reaches that were identified as deficient by the 2003 Sewer Master Plan in order to ascertain whether a deficiency exists, and to provide recommendations for eliminating the verified deficiencies.

1-2 Criteria

The 2003 Sewer Master Plan generated the average dry weather flows by summing the product of tributary land uses and their corresponding unit flow factors. The land use was designated based on the general plan. The flow factors were created using the flow monitoring results as well as previous studies.

The adequacy of a sewage collection system is based upon its ability to convey the peak flows. At any individual point in the system, peak dry weather flow (PDWF) is estimated by converting the total average dry weather flow upstream of the point in question to peak dry weather flow by an empirical peak-to-average relationship.

The peaking relationship used in preparing the 2003 Master Plan was developed based upon the flow monitoring conducted at 12 locations throughout the City.

$$Q_{pdw} = 1.93(Q_{adw})^{0.898}$$

Flowrates are in million gallons per day (mgd).

<u>Sewer Design Criteria</u>

Design criteria are established to ensure that the sewer system can operate effectively under all flow conditions. Each sewer reach must be able to carry peak wet weather flows without surcharging the system. Low flows must be conveyed at a velocity that will prevent solids from settling and blocking the system.

The design and analysis of sewer pipes were based upon the depth to diameter ratio (d/D), resulting from peak dry weather flows. The criteria used for the 2003 Master Plan are as follows:

Depth to diameter ratio (d/D) less than or equal to 0.5 for pipes 12-inch and smaller in diameter

d/D less than or equal to 0.67 for 15-inch diameter pipes

d/D less than or equal to 0.75 for 18-inch diameter and larger pipes

The remaining area above the maximum dry weather flow depth is primarily reserved for the selected design wet weather flows; however, this space also keeps the sewage aerated which reduces the possibility of septic conditions and odors.

The 2003 Master Plan flow depths were calculated based on peak dry weather flows.

The design capacity of gravity pipes is calculated based on the Manning formula:

$Q = 1.486\ A\ R^{2/3}\ S^{1/2} / n$

Q = flow in cubic feet per second

R = hydraulic radius in feet = A / P

A = cross-sectional area of the pipe in square feet

P = wetted perimeter in feet

S = slope of pipe in feet of rise per foot of length

n = Manning's friction factor (n=0.013 was used for vitrified clay pipe in the 2003 Master Plan)

The peak flow velocity should be greater than 2 feet per second to prevent deposition of solids in the pipe.

1-3 Existing System

The City's existing sewer collection system is made up of a network of gravity sewers, consisting of approximately 360 miles of pipe, and twenty-nine (29) sewer lift stations.

The general direction of flow is from north to south and west to east. The majority of the City sewers tie into the Orange County Sanitation District (OCSD) trunk sewers for conveyance to the local treatment plant.

The sewers are primarily constructed of vitrified clay pipe with sizes ranging from 6-inches to 30-inches in diameter. Approximately 85 percent of the pipes are 8-inches in diameter.

The 2003 Sewer Master Plan identified nine (9) areas as deficient, which are listed in Table 1. The locations of the deficient reaches are shown in Appendix A.

Table 1
2003 Master Plan Identified Deficiencies

Deficiency No.	Location		Hydraulic Model Pipe Numbers	Existing Size	Proposed Size	Length (feet)
1	Hamilton Ave	Brookhurst Street to extension of Archer Circle	1019, 1017, 1016, 1015, 1014, 1013	18"	21"	1,540
2	Edwards Street, Heil Avenue	From Brad Drive to Heil Avenue; From Edwards Street to Oakmont Lane	345, 335, 321, 308 293, 5005	10" 10", 8"	15" 15", 12"	1,692
3	Heil Avenue	From Sabot Lane to Goldenwest Street	296, 295, 294	12"	15"	833
4	Speer Avenue	Jacquelyn Lane to Beach Boulevard	550, 549, 543, 544, 545, 548	10"	15"	1,397
5	Beach Boulevard	From Speer Avenue to Slater Avenue	547, 531	12"	18"	659
6	Beach Boulevard	From South of Talbert Avenue to Ronald Road	5013, 1080, 598, 590	8", 10"	12", 15"	1,086
7	Saybrook Lane	South of Heil Avenue to Morning Star Drive	2586	12"	18	299
8	Mandalay Circle	From Edinger Avenue to Humboldt Drive	202, 206, 211, 213, 216, 219, 221, 222, 232, 237	10"	15"	2,181
9	Edinger Avenue	From Trinidad Lane to Santa Barbara Lane	194, 165, 166, 167, 168, 169, 170, 174	10"	15'	1,967
					Total Length	**11,654**

There are four (4) sewer lift stations that are upstream of the identified deficient sewer pipes. Speer Lift Station (LS No. 20) affects Deficient Location No. 4; Saybrook Lift Station (LS No. 22) affects Deficient Location No. 7; Edinger Lift Station (LS No. 25) affects Deficient Location No.'s 8 and 9; and Trinidad Lift Station (LS No. 29) affects Deficient Location No. 9.

Speer Lift Station (LS No. 20) is located at Speer Avenue and Crabb Lane. It has two (2) Wemco 6 x 11 pumps with 9-inch impellers. Each pump has a rated capacity of 400 GPM at 14 foot total dynamic head (TDH). The 2003 Sewer Master Plan estimated the peak dry weather flow at 300 gpm, and did not recommend any capacity improvement at this lift station.

Saybrook Lift Station (LS No. 22) is located on Saybrook Avenue, north of Heil Avenue. It has two (2) Wemco 4 x 11 M pumps with 9.75-inch impellers. Each pump has a rated capacity of 550 GPM at 23 foot TDH. The estimated ultimate peak dry weather flow is 739 gpm. The 2003 Sewer Master Plan recommended that the firm capacity of this pump station be increased to 1,000 gpm to accommodate the peak wet weather flows. Firm capacity is the total pumping capacity at the lift station when the largest pump is not in operation.

The Edinger Lift Station (LS No. 25) is located on Edinger Avenue and Santa Barbara Drive. According to the 2003 Sewer Master Plan, the estimated ultimate peak dry weather flow is 423 gpm. Prior to the recent improvements, the lift station had two (2) Wemco 4 x 11 M pumps with 8-inch impellers. These pumps were rated at 300 GPM capacity and 12 foot TDH. Recent improvements increased the design capacity of the Edinger Lift Station pumps from 300 gpm to 400 gpm each. It currently contains two (2) Wemco 4 x 11 S pumps with 8.5-inch impellers. As shown in Tables 16 and 17, the flow monitoring conducted in January and February 2008 indicated that the flows recorded at Site No.'s 8 and 12 respectively, are notably higher than the improved pump station design capacity. Further testing at the pump station was performed to verify the actual pumping capacity, as detailed in Section 1-4. The downstream sewer facilities were analyzed based upon the actual pump capacities.

Trinidad Lift Station (LS No. 29) is located on Trinidad Lane and Aquarius Drive. It has two (2) Wemco 4x11M pumps with 8-inch impellers. Each pump is rated at 250 gpm and 15 foot TDH. The estimated ultimate peak dry weather flow is 153 gpm. Since the existing firm capacity is greater than the expected peak wet weather flow, the 2003 Sewer Master Plan did not recommend any capacity improvement at this lift station.

1-4 System Analysis

Flow Monitoring Locations

The flow monitoring locations were chosen to analyze the capacity deficient sewers that were identified in the 2003 Sewer Master Plan. Ideally, the flow monitoring locations would have smooth flows with sufficient depth and velocity that could be detected by the flow monitoring equipment. Manholes with multiple inflow pipes or sharp turns are generally avoided because the turbulent flows cannot be accurately measured by the flow monitors.

Extensive flow monitoring near the Edinger Lift Station was required to analyze the effects the pumped flows have on the existing sewer system.

The locations of the flow monitoring sites are described in Table 2, and shown in Appendix B.

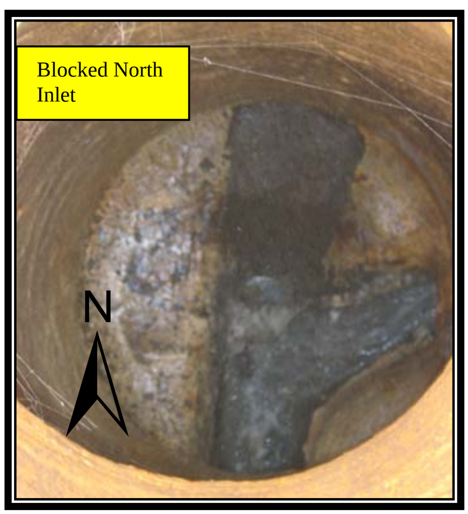
Table 2
Initial Flow Monitoring Locations

Site	Location		Size
1	Hamilton Ave	Between Archer Circle and St. John Lane	18"
2	Removed due to diverted flow		
3	Heil Avenue	East of Goldenwest Street	12"
4	Speer Avenue	West of Beach Boulevard	10"
5	Beach Boulevard	South of Slater Avenue	12"
6	Beach Boulevard	Between Talbert Ave and Ronald Road (line flowing to the north)	10"
7	Saybrook Lane	Morning Star Drive	12"
8*	Mandalay Circle	North of Humboldt Drive	10"
9	Removed due to pump station upgrade		
10	Edinger Avenue	Montego Drive	10"
11	Santa Barbara Lane	South of Shorebreak Drive	10"
12*	Saybrook Lane	Fisher Drive	12"

* Additional flow monitoring performed January 16, 2008 to February 5, 2008

Initially, eleven (11) sites were selected for flow monitoring. Prior to the installation of the flow monitoring equipment, field verifications were made on June 6, 2007 to ensure that the locations would provide useful data. Following the review of Flow Monitoring Site No. 2 at Edwards Street and Brad Drive, the field crew realized that the study sewer no longer exists at the location. The 2003 Sewer Master Plan shows that there are three (3) manholes on Edwards Street, between Brad Drive and Heil Avenue. The field crew could not locate any of these manholes. The inspection of the manhole at the intersection of Edwards Street and Brad Drive shows that the inlet pipe from the north had been blocked off, as shown on Figure 1.

Figure 1
Manhole on Edwards Street and Brad Drive



The Orange County Sanitation District installed a 30" diameter trunk sewer on Heil Avenue. The City was able to divert its wastewater directly into this OCSD facility at the intersection of Heil Avenue and Torjian Lane from the southwest and at the intersection of Heil Avenue and Oakmont Lane from the northeast. In doing so, the City abandoned the sewers on Heil Avenue from Torjian Lane to Oakmont Lane and on Edwards Street from Heil Avenue to Brad Drive. Since the sewers at Deficient Location No. 2 are included in this abandoned pipe set, there will be no need for improvements.

Furthermore, while reviewing the flow monitoring Site No. 9 at Edinger Avenue and Santa Barbara Lane, the field crew became aware that the Edinger Lift Station was undergoing construction. The sewers that are upstream of the Edinger Lift station were inaccessible due to the construction of the improvements. Therefore, flow monitoring at Site No. 9 was not possible.

Following the field verification, nine (9) flow monitoring sites were selected for the capacity analysis study.

The improvements to the Edinger Lift Station were finalized after the initial flow monitoring was completed. Since the new pumps have higher capacities, further flow monitoring was required to accurately evaluate the capacity of the downstream sewer reaches with the new pumps. Flow monitoring was performed between January 16, 2008 and February 5, 2008 at two locations. One flow monitor was installed at Site No. 8, and another was installed at Saybrook Lane and Fisher Drive (Site No.12). The initial and additional flow monitoring data at Site No. 8 will be utilized throughout this report for various purposes; however, the final recommendations are based on the most recent flow monitoring data which reflect the current sewer system.

<u>General Flow Monitoring Results</u>

The initial flow monitors were installed and data was collected between 12:00 A.M. June 14, 2007 and 11:45 P.M. June 27, 2007. Subsequent flow monitoring was performed between 12:00 A.M. January 16, 2008 and 11:45 P.M. February 5, 2008. Flow vs. time graphs are located in Appendix C. The flow monitoring results are summarized in Table 3.

Table 3
Flow Monitoring Summary

General Data			2003 Sewer Master Plan Data				Flow Monitoring Data					
Site #	Location		Ave GPM	Peak GPM	Existing Size	Slope	Total Days	Min GPM	ADWF GPM	PDWF GPM	Max Depth	d/D
1	Hamilton Ave	West of John Ln	807	1,533	18	0.001	12.5	137	520	928	9.29	0.52
2	Edwards St	Peggy Cir	Removed from Flow Monitoring									
3	Heil Ave	Goldenwest St	186	411	12	0.002	14.0	40	149	256	5.54	0.46
4	Speer Ave	Beach Blvd	263	561	8	0.002	14.0	3	41	140	4.35	0.54
5	Beach Blvd	Slater Avenue	453	914	12	0.002	14.0	100	284	508	9.38	0.78
6	Beach Blvd	Talbert Ave	149	336	10	0.002	14.0	64	234	431	7.67	0.77
7	Saybrook Ln	Heil Ave	0		12	0.002	14.0	46	346	642	7.10	0.59
8	Mandalay Cir	Humboldt Dr	229	494	10	0.002	14.0	29	227	455	8.78	0.88
8*	Mandalay Cir	Humboldt Dr	0	494	10	0.002	21.0	29	228	500	10.00	1.00
9	Edinger Ave	Santa Barbara Ln	Removed from Flow Monitoring									
10	Edinger Ave	Trinidad Ln	190	419	10	0.002	14.0	67	157	277	5.18	0.52
11	Santa Barbara Ln	Shorebreak Dr	198	434	10	0.002	14.0	2	205	520	8.67	0.87
12*	Saybrook Ln	Fisher Dr	190	758	12**		21.0	58	247	517	7.01	0.68

* Additional Flow Monitoring performed between January 16, 2008 to February 5, 2008
** At Flow Monitoring Location the height of the inflow pipe was 11" which is used to calculate the d/D

For the most part, the flow monitoring results appear to be reasonable. The sites experienced flow patterns typical of their tributary sewersheds throughout the day, with the low flows occurring in the very early morning hours. High flows for residential areas occur around 8:00 AM during weekdays and 11:00 A.M. during weekends. High flows in commercial areas occur roughly near 12:00 P.M.

The flow monitoring between January 16, 2008 and February 5, 2008 included periods of wet weather. The precipitation data at Station 219, Costa Mesa, was obtained from Orange County Public Works (OC Public Works), Watershed and Coastal Resources Division. Table 4 shows the daily flow monitoring results and precipitation data at Site No 8. and Site No. 12.

Table 4
Precipitation and Flow Monitoring Summary

Day	Date	Precipitation at Station #219, Costa Mesa (in)	Flow Monitoring Site #8 (10" Pipe Diameter)				Flow Monitoring Site #12 (12" Pipe Diameter)			
			Daily Average (GPM)	Daily Max (GPM)	Max Depth (in)	Time of Max Depth	Daily Average (GPM)	Daily Max (GPM)	Max Depth (in)	Time of Max Depth
Wed	1/16/2008		226	499	10	7:25	245	499	6.86	8:35
Thu	1/17/2008		229	512	10	7:25	249	511	6.92	8:20
Fri	1/18/2008		220	508	10	7:30	245	505	7.01	8:40
Sat	1/19/2008		229	499	10	9:05	251	460	6.64	10:20
Sun	1/20/2008		233	508	10	9:10	250	517	6.9	9:35
Mon	1/21/2008		222	508	10	8:30	243	502	6.8	9:50
Tues	1/22/2008	0.11	226	508	10	7:05	246	497	6.83	10:00
Wed	1/23/2008		235	490	10	8:20	264	495	7.06	8:25
Thu	1/24/2008	0.7	237	482	10	7:25	258	537	6.97	13:05
Fri	1/25/2008	0.34	262	517	10	7:15	284	524	7.11	7:20
Sat*	1/26/2008*		238	672	10	8:30	261	772	11	17:55
Sun	1/27/2008	0.31	243	511	10	9:15	281	512	7.27	10:30
Mon	1/28/2008	0.53	244	482	10	7:35	283	513	7.02	9:45
Tues	1/29/2008	0.04	232	490	10	7:45	265	509	7.15	7:50
Wed	1/30/2008		226	474	10	8:20	263	504	6.84	8:30
Thu	1/31/2008		218	465	10	7:25	258	526	6.85	7:20
Fri	2/1/2008		217	521	10	7:40	254	553	7.09	7:45
Sat	2/2/2008		222	508	10	9:55	256	499	6.85	10:25
Sun	2/3/2008	0.21	238	547	10	10:55	276	569	7.52	11:45
Mon	2/4/2008	0.26	227	525	10	11:20	265	510	7.05	8:35
Tues	2/5/2008		225	508	10	7:25	262	504	7	7:30

*Saybrook and Edinger Lift Stations were out of operation due to a power outage

Table 5 summarizes the average and peak flow conditions at these sites. For the purposes of this report, the dry weather conditions will be utilized for the pipe capacity analysis.

Table 5
Dry and Wet Weather Summary

	Disregards Wet Weather				Includes Wet Weather			
Site #	ADWF GPM	PDWF GPM	Max Depth	d/D	Ave GPM	Max GPM	Max Depth	d/D
8	228	500	10.00	1.00	231	546	10.00	1.00
12	247	517	7.01	0.64	260	569	7.52	0.68

As described in the criteria section, the City's 2003 Sewer Master Plan used the following peaking relationship to develop the peak dry weather flow (Qpdw) from the average dry weather flow (Qadw):

$$Q_{pdw} = 1.93(Q_{adw})^{0.898}$$

This relationship was evaluated with the use of the flow monitoring data, maintaining the exponent 0.898. Flow Monitoring Sites No.'s 4, 7, 8, 11, and 12 were excluded from this analysis because they are downstream of lift stations. This review shows that the coefficient used in the Master Plan (1.93) is higher than the values calculated from the flow monitoring data, as shown in Table 6. Therefore, the peak dry weather flows calculated by the Master Plan are estimated conservatively, which is appropriate for planning studies.

Table 6
Peaking Coefficients per Flow Monitoring Data

General Data			Flow Monitoring Data			Calculations	
Site #	Location		Minimum MGD	Average MGD	Maximum MGD	(Qave)^0.898	Coefficient = Qmax/(Qave)^0.898
1	Hamilton Ave	West of John lane	0.197	0.749	1.337	0.77	1.73
2	Edwards St	Peggy Cir	**Not Flow Monitored**				
3	Heil Ave	Goldenwest St	0.058	0.214	0.368	0.25	1.47
4	Speer Ave	Beach Blvd	0.005	0.059	0.202	Excluded*	
5	Beach Blvd	Slater Avenue	0.144	0.409	0.731	0.45	1.63
6	Beach Blvd	Talbert Ave	0.092	0.337	0.62	0.38	1.65
7	Saybrook Lane	Heil Ave	0.066	0.498	0.925	Excluded*	
8	Mandalay Cir	Humboldt Dr	0.042	0.327	0.656	Excluded*	
8**	Mandalay Cir	Humboldt Dr	0.042	0.329	0.720	Excluded*	
9	Edinger Ave	Santa Barbara Ln	**Not Flow Monitored**				
10	Edinger Ave	Trinidad Lane	0.096	0.226	0.399	0.26	1.52
11	Santa Barbara Ln	Shorebreak Dr	0.003	0.295	0.75	Excluded*	
12**	Saybrook Lane	Fisher Drive	0.084	0.356	0.744	Excluded*	
					Average Peaking Coeficient =		**1.60**

* Downstream of Pump Station
** Additional Flow Monitoring

<u>Capacity Analysis and Recommendations</u>

The hydraulic analysis for the 2003 Sewer Master Plan is included in Appendix D. It includes the calculated existing peak dry weather flow and the ultimate peak dry weather flow.

Deficient Location No. 1

This location includes six (6) reaches of 18-inch diameter sewer located on Hamilton Avenue, from Brookhurst Street to Archer Circle with a total length of 1,530 feet. The flow monitor was installed in Pipe 1014, upstream of the manhole between Pipes 1013 and 1014. This location is near the downstream end of the deficient pipe, with nearly the largest tributary area of the six segments. The comparison of the flow monitoring data and the 2003 Sewer Master Plan data is shown in Table 7.

Table 7
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 1

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
1	1013	0.001	18" VCP	370	807	1,533	Full	Full	1,547	Full	Full				
1*	1014	0.001	18" VCP	100	795	1,514	Full	Full	1,527	Full	Full	520	928	9.29	0.52
1	1015	0.001	18" VCP	226	794	1,512	Full	Full	1,524	Full	Full				
1	1016	0.001	18" VCP	200	758	1,451	Full	Full	1,460	Full	Full				
1	1017	0.001	18" VCP	330	757	1,448	14.28	0.79	1,458	14.40	0.80				
1	1019	0.001	18" VCP	304	731	1,403	13.92	0.77	1,411	13.92	0.77				

** Location of Flow Monitor*

With the Master Plan calculated peak dry weather flows, four (4) of the six (6) reaches would flow full, and the depth to diameter ratio would exceed 0.75 in the other two reaches. The Site 1 flow monitor recorded average dry weather flow, peak dry weather flow, and depth values that are much lower than those calculated by the Sewer Master Plan. The Sewer Master Plan average dry weather flow (795 gpm) is larger than the flow monitoring average dry weather flow (520 gpm) by a factor of 1.5. The Sewer Master Plan peak dry weather flow (1,514 gpm) is larger than the flow monitoring peak dry weather flow (907 gpm) by a factor of 1.7. According to the flow monitoring data, this 18" sewer is flowing at a d/D of 0.52, which is considered sufficient. The sewers in this location are not recommended to be replaced for capacity. If the tributary land use is proposed to be changed in the future resulting in higher wastewater flows, these sewers should be re-evaluated.

Deficient Location No. 2

Appendix D of the 2003 Sewer Master Plan shows that the ultimate d/D's for the reaches of sewer on Edwards Street from Heil Avenue to Brad Drive and on Heil Avenue from Oakmont Lane to Edwards Street were calculated from 0.67 to full, which is deficient according to the master plan criteria. When these sewers were reviewed in the field for selecting flow monitoring locations, the field crew concluded that the sewer on Edwards Street was removed because the City sewers upstream have been diverted to the OCSD's trunk sewer on Heil Avenue. The OCSD records show that the City facilities have been diverted to the OCSD trunk sewer on Heil Avenue at Torjian Lane and Heil Avenue at Oakmont Drive. The 2003 Master Plan indicates that none of these pipes are on the City's Sewer GIS.

Deficient Location No. 3

The 2003 Sewer Master Plan identified capacity deficiencies in three (3) reaches of 12-inch diameter pipe located on Heil Avenue between Sabot Lane on the east and Goldenwest Street on the west. With the master plan calculated peak dry weather flows, the d/D's of these three (3) reaches are approximately 0.68, which is deficient per the master plan criteria. The total length of these reaches is approximately 830 feet. The flow direction is from east to west. The flow monitor was installed in Pipe 295, upstream of the manhole between Pipes 294 and 295. It measures nearly the entire flow tributary to the most downstream pipe. The comparison between the flow monitoring data and the 2003 Sewer Master Plan data is shown in Table 8.

Table 8
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 3

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
3	294		12" VCP	335					579	8.16	0.68				
3*	295	0.002	12" VCP	330	186	411	6.60	0.55	579	8.16	0.68	149	256	5.54	0.46
3	296	0.002	12" VCP	165	186	410	6.60	0.55	578	8.16	0.68	.			

** Location of Flow Monitor*

The Pipe 294 data is missing the slope value in the Master Plan. However, this value can be estimated as 0.002, which is representative of the slopes for the nearby pipes. The 2003 Sewer Master Plan estimates a depth to diameter ratio of 0.55 for all three reaches of 12” pipe. According to the 2003 Sewer Master Plan Criteria, these pipes are considered deficient. However the average dry weather flow from the flow monitoring (149 gpm) was lower than the calculated 2003 Sewer Master Plan existing average dry weather flow (186 gpm). Likewise, the peak dry weather flow from the flow monitoring (256 gpm) was far lower than the calculated 2003 Sewer Master Plan existing peak dry weather flow (411 gpm). The flow monitoring data shows that these pipes are flowing at a depth to diameter ratio of about 0.46 with the actual peak dry weather flows. Therefore, these reaches of pipe are currently sufficient per the 2003 Sewer Master Plan criteria, and are not recommended to be replaced for capacity. The 2003 Sewer Master Plan shows the ultimate peak dry weather flow at 579 gpm, an increase of nearly 41 percent. Based upon review of the aerial photographs, the tributary area does not seem to include significant vacant land. However, assuming a similar increase over the existing flows, the peak dry weather flow would be 354 gpm, and the depth to diameter ratio would be approximately 0.5, which is still sufficient. If the tributary land use is proposed to be changed in the future resulting in higher wastewater flows, then these reaches should be re-evaluated.

Deficient Location No. 4

The 2003 Sewer Master Plan identified capacity deficiencies in six (6) reaches of 8-inch diameter sewer on Speer Avenue between Jacquelyn Lane to the west and Beach Boulevard to the east. With the master plan calculated peak dry weather flows, these six (6) reaches will flow full. The total length of these reaches is approximately 1,365 feet. The flow direction is from west to east. These reaches convey the wastewater flow pumped by Speer Lift Station (LS No. 20), which is located at Crabb Lane and Speer Avenue, as well as the wastewater collected from the tributary area to the east of the lift station.

The flow monitor was installed in Pipe 545, upstream of the manhole between Pipes 545 and 548. It measures nearly the entire flow tributary to the most downstream reach of the deficient sewers. The comparison between the flow monitoring data and the 2003 Sewer Master Plan data is shown in Table 9.

Table 9
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 4

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
4	543	0.002	8" VCP	300	239	513	Full	Full	514	Full	Full				
4	544	0.002	8" VCP	300	262	558	Full	Full	561	Full	Full				
4*	545	0.002	8" VCP	300	263	561	Full	Full	565	Full	Full	41	140	4.35	0.54
4	548	0.002	8" VCP	300	205	449	Full	Full	566	Full	Full				
4	549	0.002	8" VCP	15	237	511	Full	Full	512	Full	Full				
4	550	0.002	8" VCP	150	237	511	Full	Full	512	Full	Full				

** Location of Flow Monitor*

The 2003 Sewer Master Plan estimates peak dry weather flows of over 500 gpm near the pump station, and 449 gpm at the most downstream reach. All six reaches of pipe would flow full with the Master Plan estimated flows. However, the average dry weather flow from the flow monitoring (41 gpm) is approximately 25 percent of the Master Plan flows. The peak dry weather flow from the flow monitoring (140 gpm) is also approximately 25 percent of the Master Plan flows and the reported pump capacity of 500 gpm. Available aerial photography shows the lift station tributary area to be industrial. The flow monitoring results are clearly of an industrial land use with weekend flows significantly lower than the weekday flows. The discrepancy between the measured and calculated flows is most likely due to the high industrial unit flow factors used in the Master Plan, and the selected peaking relationship. The discrepancy between the reported pump capacity and measured flows may be due to the attenuation in the gravity pipe system, infrequent pump operation, and short duration of pumping. The tributary area is fully developed, and the ultimate flows are not expected to be greater than the existing flows.

The flow monitoring data shows that these pipes are flowing at a maximum depth to diameter ratio of 0.54. While this is deficient per the City’s criteria, it does not warrant replacement of the existing pipes for capacity. If the tributary land use is proposed to be changed significantly in the future, resulting in higher wastewater flows, then these reaches should be re-evaluated.

Deficient Location No. 5

The 2003 Sewer Master Plan identified capacity deficiencies in two (2) reaches of 12-inch diameter sewer on Beach Boulevard between Speer Avenue to the south and Slater Avenue to the north. With the master plan calculated peak dry weather flows, both reaches will flow full. The total length of these reaches is 657 feet and the flow direction is from south to north. The Deficient Location No. 4 flows, including the Speer Lift Station are tributary to this area.

The flow monitor was installed in Pipe 547, upstream of the manhole between Pipes 531 and 547. It measures nearly the entire flow tributary to the most downstream reach of the deficient sewers. The comparison between the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 10.

Table 10
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 5

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
5	531	0.002	12" VCP	329	453	914	Full	Full	946	Full	Full				
5*	547	0.0032	12" VCP	328	453	912	Full	Full	944	Full	Full	284	508	9.38	0.78

** Location of Flow Monitor*

The 2003 Sewer Master Plan estimates existing peak dry weather flows of about 912 and 914 gpm in the two reaches of pipe. Both of these reaches would flow full with the Master Plan estimated flows. The average dry weather flow from flow monitoring (284 gpm) is approximately 63 percent of the Master Plan estimated existing flow. Likewise, the peak dry weather flow from the flow monitoring (508 gpm) is approximately 56 percent of the Master Plan estimated existing flows. The Master Plan estimates only a 3.9 percent increase in the average dry weather flows and 3.5 percent increase in the peak dry weather flows with the ultimate development of the tributary area. The discrepancy between the estimated and measured flows is most likely due to the high industrial unit flow factors, and the peaking relationship used in the Master Plan.

The 2003 Sewer Master Plan estimated peak dry weather flow exceeds the capacity of the pipe, and both pipes would flow full under these conditions. The flow monitoring data shows a maximum depth to diameter ratio of 0.78. Based upon a pipe slope of 0.002, and Manning's n of 0.013, the Master Plan estimated that the ultimate peak dry weather flow would require a minimum pipe diameter of 15 inches to meet the City's depth to diameter design criteria of 0.67. These reaches will require further evaluation by the City.

Deficient Location No. 6

The 2003 Sewer Master Plan identified deficiencies in two (2) reach of 8-inch and two reaches of 10-inch diameter sewer on Beach Boulevard between south of Talbert Avenue to the south and Ronald Road to the north. With the master plan calculated peak dry weather flows, two (2) of the four (4) reaches flow full and the d/D's exceed 0.66 in the other two (2) reaches. The total length of the four reaches is 1,086 feet. The flow direction is from south to north.

The flow monitor was installed in Pipe 598, upstream of the manhole between Pipes 590 and 598. It measures nearly the entire flow tributary to the most downstream reach of the deficient sewers. The comparison between the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 11.

Table 11
Comparison of Master Plan and Flow Monitoring Data
Deficient Location No. 6

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
6	590		10" VCP	293					360	6.96	0.69				
6*	598	0.002	10" VCP	284	149	336	6.48	0.65	357	6.84	0.68	234	431	7.67	0.77
6	1080	0.002	8" VCP	294	149	336	Full	Full	357	Full	Full				
6	5013	0.002	8" VCP	209	104	244	Full	Full	263	Full	Full				

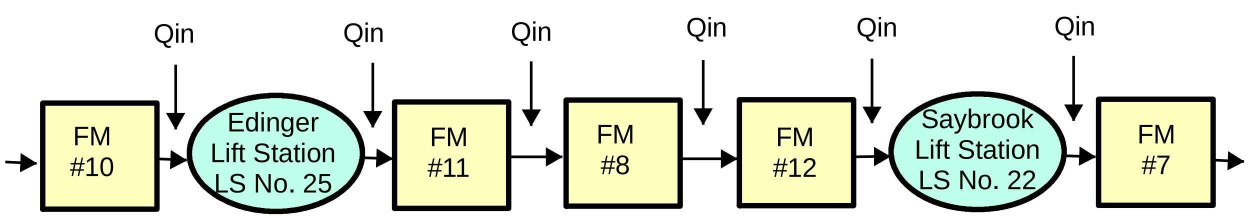
** Location of Flow Monitor*

The Pipe 590 data is missing the slope value in the 2003 Sewer Master Plan. However, this value can be estimated as 0.002, which is representative of the slopes for the nearby pipes. The 2003 Sewer Master Plan estimates existing average and peak dry weather flow of 149 gpm and 336 gpm respectively in Pipe 598. The average dry weather flow from flow monitoring (234) is approximately 57 percent higher than the Master Plan estimated existing average dry weather flow. The peak dry weather flow from flow monitoring (431 gpm) is approximately 28 percent higher than the Master Plan estimated existing peak dry weather flow. The discrepancy between the measured and estimated flows may be due to the presence of some high water users in the tributary area. A detailed study of the water use in the tributary area should be conducted to identify the reason for the difference. The Master Plan estimates only a 7.3 percent increase in the average dry weather flows with the ultimate development of the tributary area. Applying the same increase to the measured flows, the ultimate peak dry weather flow would be 460 gpm.

The flow monitoring shows these pipes flowing at a depth to diameter ratio of 0.77. Based on the slope of 0.002, Manning's n of 0.013 and the ultimate peak dry weather flow of 460 gpm, the four (4) existing sewers would require a minimum pipe diameter of 15 inches to meet the City's depth to diameter design criteria of 0.67. These reaches will require further evaluation by the City.

Site No.'s 7, 8, 10, 11, and 12 - Flow Monitoring Sites No.'s 8, 10, 11, and 12 are tributary to Flow Monitoring Site No. 7. These five flow monitoring sites will be described together for clarity. The flow pattern is shown on Figure 2.

Figure 2
Flow Pattern Schematic for Site No.'s 7, 8. 10, 11 and 12

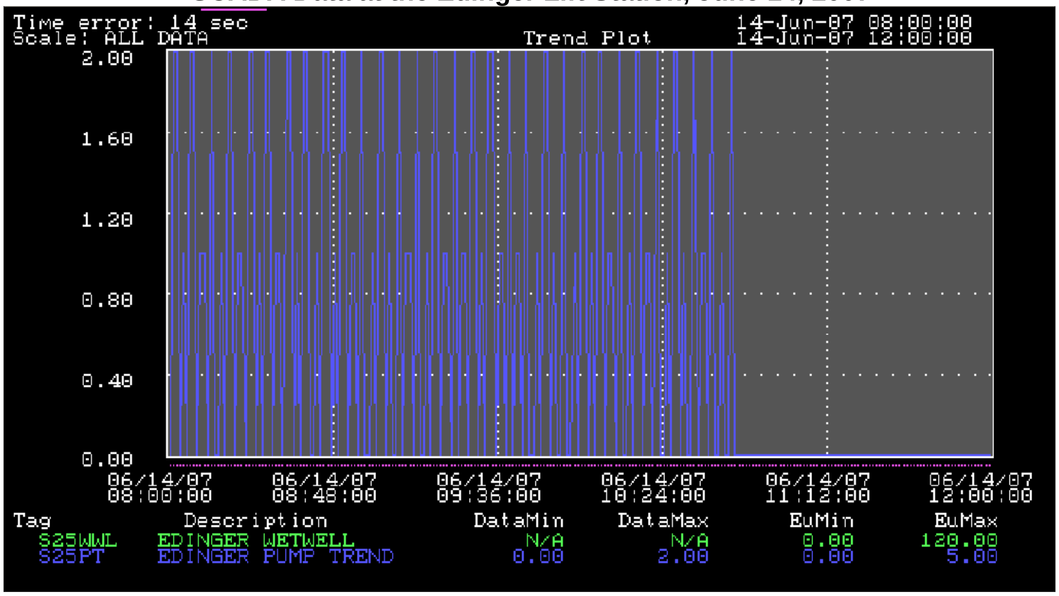


Since the flow monitoring sites are tributary to one another; a variation at one site could affect all of the sites. Prior to the installation of the flow monitors, it was understood that the Edinger Lift Station (Lift Station No. 25) was undergoing replacement. During the period when the flow monitors were initially installed (June 14, 2007 to June 28, 2007), the City ran tests on this lift station. These tests might have altered the initial results at Flow Monitoring Sites No.'s 7, 8, and 11. To analyze the flow monitoring data at these three unique sites, the flow monitoring must be done simultaneously. Therefore, the Site No. 8 flow monitoring data described hereon will refer to the initial flow monitoring that took place in June 2007. The flow monitoring at Site No. 8 performed in January, 2008 will be analyzed later.

The Edinger Lift Station underwent testing at roughly 10:30 AM on July 14, 2007. According to Dudek Engineering, the existing lift station (before capacity improvements) was temporarily shut down to test the capacity of the new pumps. The SCADA data at the Edinger Lift Station, illustrated on Figure 3, shows that the existing pumps were not in operation at 10:30 A.M.

Figure 3

SCADA Data at the Edinger Lift Station, June 14, 2007



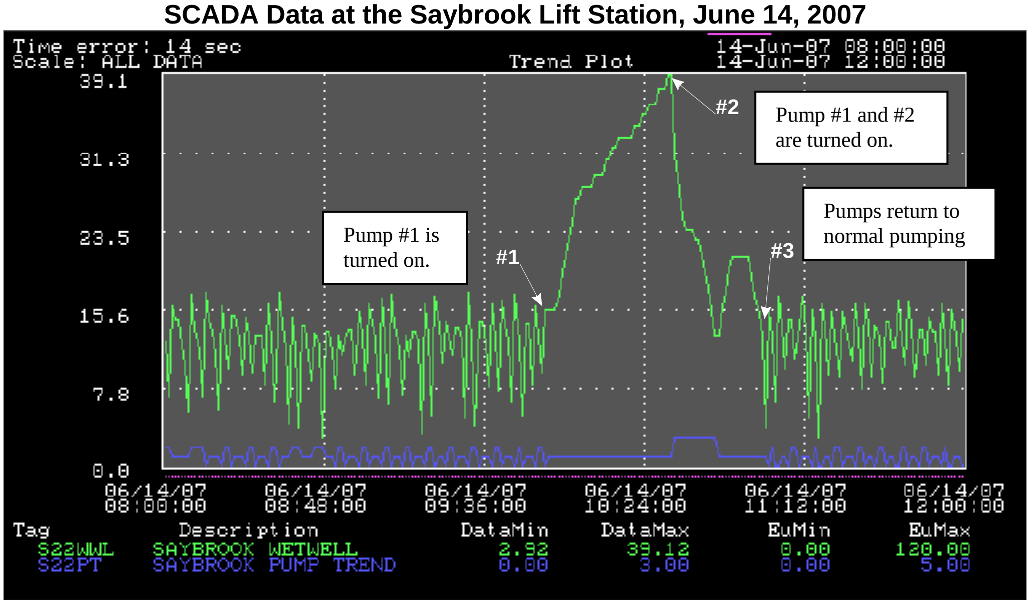
Blue line represent the "Pump Trend"

Value = 1 is when Pump 1 is turned on. Value = 2 is when Pump No. 2 is turned on.

During the testing period, Flow Monitoring Site No.'s 7, 8 and 11 experienced higher flow rates, as can be seen on the flow versus time graphs for these sites in Appendix C. The Saybrook Lift Station also showed abnormal behavior at this time. Beginning at roughly 10:00 am, this station was incapable of pumping the entire inflow. Figure No. 4 shows the rise in the wet well water level during this time period.

Figure No. 4

SCADA Data at the Saybrook Lift Station, June 14, 2007



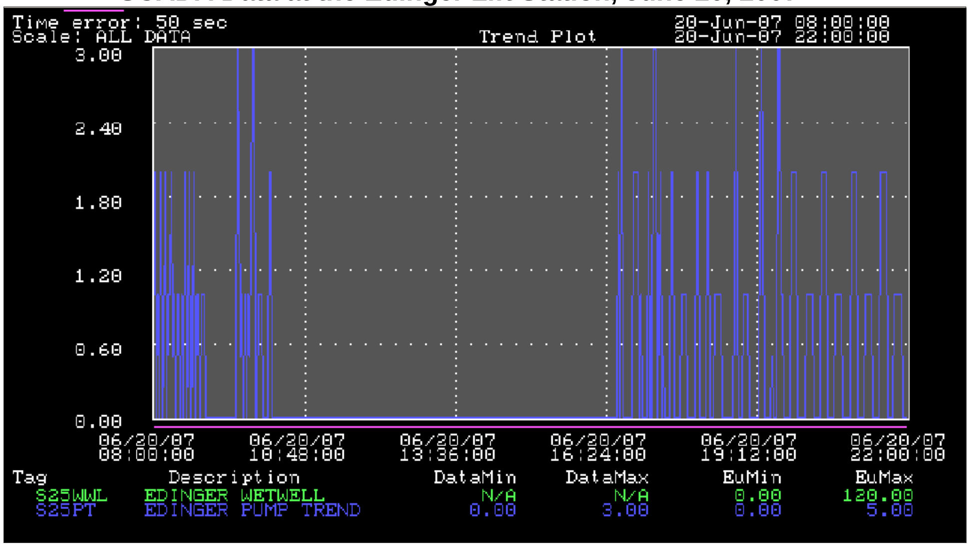
Green line represent water surface elevation in the wet well.

Blue line represent the "Pump Trend"

Value = 1 when Pump No. 1 is turned on. Value =2 when Pump No. 2 is turned on. Value =3 is when both Pumps are on.

The Edinger Lift Station underwent testing at roughly 9:00 AM on June 20, 2007. According to the City, the flow was diverted around the Edinger Lift Station during this period. The flow data does not reflect normal operating conditions.

Figure No. 5
SCADA Data at the Edinger Lift Station, June 20, 2007



The increased flows during the Edinger Lift Station testing must be analyzed in further detail before analyzing the downstream sewer lines. During these two periods, the Site No.'s 7, 8 and 11 flow monitors recorded abnormally high flow rates. These abnormalities can be seen on the flow versus time graphs for these sites in Appendix C. These high flow rates are more representative of the improved pump station conditions, not the conditions during that time period. The additional flow monitoring was performed at Site No. 8 and Site No. 12 following the completion of the improvement to the Edinger Lift Station (LS No. 25) in order to analyze the capacity of the downstream system.

Prior to the improvements, each pump at the Edinger Lift Station had a design capacity of roughly 225 gpm. With both pumps running, the lift station has a capacity of about 450 gpm. The 2003 Sewer Master Plan calculated the existing PDWF at the Edinger Lift Station at 415 gpm. The pumped flow was measured at Site No. 11, which is directly downstream of the existing lift station. Not including the high flow values related to the pump station testing, the peak dry weather flows were measured to be roughly 460 gpm during the initial flow monitoring. These various flows are consistent and are representative of the Edinger Lift station flows before the improvements were completed.

The existing pumps at the Edinger Lift Station were designed for a capacity of 400 gpm. Under normal circumstances, one pump will be in operation. The pumps currently alternate to avoid wear-and-tear on one single pump. However, during extreme wet weather conditions and/or emergencies, both pumps may be required to operate simultaneously when the wet well level exceeds the maximum set level. The results at the downstream Flow Monitoring Sites No. 8 and 11 exhibited flows that are greater than what the pumps were designed for. The maximum daily flows at these flow monitoring sites were frequently greater than 500 gpm, which is higher than what was expected if the Edinger Lift Station were in operation with one pump at a capacity of 400 gpm. During the flow monitoring period, the Edinger Lift Station required both pumps to run simultaneously on only one occasion, which occurred when wastewater accumulated in the wet well during a power outage.

Since the measured flows from the flow monitoring study were considerably higher than the design pump capacity, pump tests were performed to verify the actual capacity of the pumps. The testing was performed when the wastewater flows were expected to be largest. The City crew informed AKM Consulting Engineers that the testing should be performed at approximately 7:00 a.m., which is when the City generally observes peak dry weather flows. The tidal affects on the inflow to the lift station were also taken into consideration. The different tide levels affect the groundwater levels, which contribute to the amount of infiltration into the wastewater system. Since the Edinger Lift Station tributary area is adjacent to the Pacific Ocean, a tide analysis was conducted before performing the pump tests.

The average daily flows from the recent Flow Monitoring Sites No. 8 and 12 were analyzed with the daily tide history during the same period. It was concluded that larger average day flows occurred approximately 5 days after a spring tide, which is when a tide's range is at a maximum. The tide tables showed that the next spring tide occurred on May 5, 2008. The Edinger Lift Station testing was performed on Friday May 9, 2008 between 7:00 and 9:00 a.m. when the wastewater flows were anticipated to be at its highest.

The flow rates determined during the field testing were compared to the readings at the existing flow meter at the Edinger Lift Station, which may be too low. The field testing consisted of measuring the time it takes to fill the wet well, every 0.5-foot increment between wet well levels of 2 feet to 5 feet. The time it takes each pump to lower the depth of wastewater in the wet well, every 0.5-foot increment between wet well levels of 5 feet to 2 feet was also measured.

The wastewater levels in the wet well are constricted because the tributary sewer system will experience backflow conditions once the waste water level reaches an elevation of -8.50 feet amsl.

The average incoming flow rate was calculated as follows:

$$Q_{accumulated} = \frac{\text{(Accumulated Volume)}}{\text{(Accumulated Time)}}$$

Accumulated Volume = (L*W*H)*(7.48 gallons/cubic foot)

L = Length (7.5-feet)

W = Width (10.0-feet)

H = Height (0.5-feet)

Accumulated Time = Time to fill the wet well 3.0 feet (min)

During the testing period, the wet well filled from the 2-foot elevation to 5-foot elevation at a minimum time of 6 minutes and 15 seconds which corresponds to a flow rate of 269.3 gpm. The minimum time it took to raise the wet well level 0.5 feet was measured to be 59 seconds, which corresponds to a flow rate of 285.3 gpm. This value is used as the peak dry weather flow into the Edinger Lift Station.

The rate at which the flow is discharged is calculated in a similar manner; however, the flow into the wet well also needs to be accounted for. The flow rates were measured at every half foot increment to see how the different elevations in the wet well affect the pump discharge rate. The discharge flow rate was calculated as follows:

$$Q_{discharge} = \frac{(\text{Discharge Volume})}{(\text{Discharge Time})} + Q_{accumulated}$$

Discharge Volume = (L*W*H)*(7.48 gallons/cubic foot)

L = Length (7.5-feet)

W = Width (10.0-feet)

H = Height (0.5-foot)

Discharge Time = Time to lower the wet well every 0.5 Feet (min)

$Q_{accumulated}$ = Flow coming in to the wet well while pumps are on

The discharge time was recorded at each 0.5 foot wet well depth increment. The flow reading from the lift station flow meter was also logged at most of the 0.5 foot increments. The results show that the flow meters indicate flow rates lower than those measured by the testing. Tables 12 and 13 show the measured discharge rate as well as the flow meter readings for each pump.

Table 12
Pump No. 1 Discharge Rate Summary

	Test No. 1			Test No. 2		
Level	**Reading on Stop Watch**	**Calculated Flow (gpm)**	**Flow Meter Reading (gpm)**	**Reading on Stop Watch**	**Calculated Flow (gpm)**	**Flow Meter Reading (gpm)**
5	0:1:18	494		0:30:18	476	419
4.5	0:2:18	485	415	0:31:34	474	424
4	0:3:20	477		0:32:51	460	417
3.5	0:4:24	465	403	0:34:13	442	407
3	0:5:31	454	402	0:35:43	438	402
2.5	0:6:41	451	395	0:37:15	425	395
2	0:7:52			0:38:54		390
Maximum		**494.48**	**415.00**		**476.48**	**424.00**
Average		**470.27**	**403.75**		**450.73**	**407.71**
Minimum		**451.01**	**395.00**		**425.03**	**390.00**

Table 13
Pump No. 2 Discharge Rate Summary

	Test No. 1			Test No. 2		
Level	**Reading on Stop Watch**	**Calculated Flow (gpm)**	**Flow Meter Reading (gpm)**	**Reading on Stop Watch**	**Calculated Flow (gpm)**	**Flow Meter Reading (gpm)**
5	0:15:44	493	440	0:45:30	510	440
4.5	0:16:51	486	435	0:46:40	494	430
4	0:18:0	470	415	0:47:55	485	421
3.5	0:19:14	450	415	0:49:13	477	422
3	0:20:35	455	412	0:50:34	458	412
2.5	0:21:54	436	405	0:52:3	463	407
2	0:23:21			0:53:30		397-402
Maximum		**493.39**	**440.00**		**509.74**	**440.00**
Average		**463.15**	**420.33**		**479.69**	**422.00**
Minimum		**435.64**	**405.00**		**458.41**	**407.00**

Pump No. 1 has an average discharge rate of 461 gpm, while Pump No. 2 has a discharge rate of 471 gpm. On average Pumps 1 and 2 are pumping 15% and 18% more flow than the rated 400 gpm. The maximum calculated discharge rate at Pump No. 1 is 494 gpm or 124% of the design flow rate of 400 gpm. The maximum calculated discharge rate at Pump No. 2 is 510 gpm or 128% of the design flow rate of 400 gpm. The pump testing appears to validate the recent flow measurements at Flow Monitoring Site No. 8 and 12. For the purposes of this study, the Edinger Lift Station is rated at the maximum output of 510 gpm.

Deficient Location No. 9

The 2003 Sewer Master Plan identified deficiencies in one (1) reach of 10-inch diameter sewer on Trinidad Lane south of Edinger Avenue; and seven (7) reaches of 10-inch diameter sewer on Edinger Avenue between Trinidad Lane to the west and Santa Barbara Lane to the east. With the master plan calculated peak dry weather flows, the d/D's exceed 0.70 for all eight (8) reaches, which is deficient according to the master plan criteria. The total length of these deficient reaches is 2,171 feet. The flow direction is from south to north and west to east. These deficient sewers are downstream of the Trinidad Lift Station (LS No. 29), which has two pumps with rated capacities of 250 gpm, and upstream of the Edinger Lift Station (LS No. 25).

The flow monitor was installed in Pipe 166 on Edinger Avenue west of Bimini Lane, upstream of the manhole between Pipes 167 and 166. It measures most, but not all, of the flows tributary to the most downstream reach of the deficient sewers. The comparison between the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 14.

Table 14
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 9

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
10	194	0.002	10" VCP	138					382	7.20	0.72				
10	165	0.002	10" VCP	320	169	376	7.08	0.71	382	7.20	0.72				
10*	166	0.002	10" VCP	347	169	376	7.08	0.71	383	7.20	0.72	157	277	5.18	0.52
10	167	0.002	10" VCP	314	169	377	7.08	0.71	383	7.20	0.72				
10	168	0.002	10" VCP	335	184	408	7.68	0.77	415	7.80	0.78				
10	169	0.002	10" VCP	308	186	410	7.68	0.77	418	7.80	0.78				
10	170	0.002	10" VCP	304	190	418	7.80	0.78	427	7.92	0.79				
10	174	0.002	10" VCP	105	190	419	7.80	0.78	428	7.92	0.79				

** Location of Flow Monitor*

The Pipe 194 data is missing the slope value in the Master Plan. However, the value can be estimated as 0.002, which is representative of the slopes for the nearby pipes. The 2003 Sewer Master Plan estimates existing average dry weather flows of about 169 gpm in Pipe 165 to 190 gpm in Pipe 174. The average dry weather flow from flow monitoring (157 gpm) in Pipe 166 is approximately 92 percent of the Master Plan estimated existing average dry weather flow of 169 gpm in Pipe 166. The average dry weather flows estimated in the Master Plan are relatively similar to the average dry weather flows recorded by the flow monitors; however, the relationship between the peak dry weather flows is not as close. The 2003 Sewer Master Plan estimates existing peak dry weather flows of about 376 gpm in Pipe 165 to 419 gpm in Pipe 174. The peak dry weather flow from flow monitoring (277 gpm) in Pipe 166 is approximately 74 percent of the Master Plan estimated existing peak dry weather flow of 376 gpm in Pipe 166. The discrepancy between the measured and estimated flows may be due to the high coefficient used in the Master Plan peaking relationships. The Master Plan estimates only a 1.9 percent increase in the peak dry weather flows with the ultimate development of the tributary area.

The 2003 Sewer Master Plan calculated similar flow values through Pipes 194, 165, 166, and 167. The peak dry weather flows from the Master Plan calculations were exceeding the capacity of these pipes with both the existing and ultimate peak dry weather flows. The Master Plan also calculated the depth to diameter ratios at 0.72. The flow monitoring data shows that these four (4) pipes are flowing at a maximum depth to diameter ratio of 0.52. While this is deficient per the City's criteria, it does not warrant replacement of the existing pipes for capacity. If the tributary land use is proposed to be changed significantly in the future, resulting in higher wastewater flows, then these reaches should be re-evaluated.

According to the 2003 Sewer Master Plan, the four (4) reaches along Edinger Avenue between Bimini Lane to the west and the Edinger Lift station to the east, experience higher flows than the upstream reaches. The average dry weather flows from the lift station are a conservative estimate of the average dry weather flows through these four (4) reaches. The Master Plan calculated the average dry weather flow rates for Pipes 168, 169, 170, and 174 between 184 gpm to 190 gpm. The average dry weather flow from Flow Monitoring Site No. 11 (205 gpm) is approximately 8 percent higher than the Master Plan estimated average dry weather flow at Pipe 174 (190 gpm).

During the pump testing on Friday May 9, 2008, the existing peak dry weather flows were measured to be approximately 285 gpm at the Edinger Lift Station. The Master Plan estimates only a 2.1 percent increase in the average dry weather flows with the ultimate development of the tributary area. Applying the same increase to the measured flows, the ultimate peak dry weather flow would be 291 gpm. Based on a slope of 0.002, Manning's n of 0.013 and the ultimate peak dry weather flow, the four (4) existing 10-inch sewers are flowing at a d/D of 0.59. While this calculated d/D is deficient per the City's criteria, it does not necessarily warrant replacement of the existing pipes for capacity. If the tributary land use is proposed to be changed in the future, resulting in higher wastewater flows, then these reaches should be re-evaluated.

Deficient Location No. 8

The 2003 Sewer Master Plan identified capacity deficiencies in ten (10) reaches of 10-inch diameter sewers located on Santa Barbara Lane and Mandalay Circle between the Edinger Lift Station (LS No. 25) and Humboldt Drive. With the master plan calculated peak dry weather flows, all ten (10) reaches were flowing full. The total length of these reaches is 1,964 feet.

In order to evaluate the effect of Edinger Lift Station (LS No. 25) flows on the downstream sewers, two flow monitors were initially installed on June 14, 2007. Two additional flow monitors were installed once the improvements to the Edinger Lift Stations were finalized.

On June 14, 2007, the first flow monitor was installed in the downstream end of Pipe 202 at the manhole between Pipes 206 and 202 on Santa Barbara Lane and Shorebreak Drive (FM Site No. 11). Pipe 202 is the first pipe downstream of the Edinger Lift Station force main.

The comparison of the initial flow monitoring data and the 2003 Sewer Master Plan results for the area tributary to the flow monitoring site is shown in Table 15.

Table 15
Comparison of Master Plan and Flow Monitoring Data
Deficient Location No. 8 *(Flow Monitoring Site 11)*

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
11*	202	0.002	10" VCP	136	198	434	8.04	0.80	443	Full	Full	205	520	8.67	0.87

** Location of Flow Monitor*

The 2003 Sewer Master Plan estimated the existing and ultimate peak dry weather flows at 434 gpm and 443 gpm, respectively. During pump operations before the improvements were implemented, the flow monitor recorded the peak dry weather flow at 520 gpm, which was significantly higher than both master plan values. During the Edinger Lift Station testing on June 14, 2007, the flow monitor recorded the peak dry weather flow at 900 gpm, which is significantly higher than all values.

The Master Plan also estimated that this pipe would flow at a depth to diameter ratio of 0.80 with the existing peak dry weather flows and full with the ultimate peak dry weather flows. With the normal pump operations during June 2007, the flow monitoring equipment recorded the maximum depth to diameter ratio at about 0.87 which verifies that this 10" diameter sewer does not meet the existing criteria. When the Edinger Lift Station testing was performed, Site No 11 experienced full flow conditions.

The design flow for the Edinger Lift Station is roughly 400 gpm; however, the pumping tests performed on May 9, 2008 show that the actual pumping rate is as high as 510 gpm. The measured pumping rate is capable of conveying both the existing and ultimate peak dry weather flows, and this value (510 gpm) will be used to evaluate the downstream sewer capacities. Based on a slope of 0.002, and a Manning's n of 0.013, the required pipe size would be 15-inch diameter.

Flow monitoring was performed at the downstream end of Pipe 232 at the manhole between Pipes 237 and 232 on Mandalay Circle north of Humboldt Drive (FM Site No. 8). The flow monitoring was performed in June, 2007 to analyze the affect the Edinger Lift Station had on the downstream sewer system. However, the Edinger Lift Station capacity was recently increased, and additional flow monitoring was necessary to analyze the downstream system based on the new pump capacities. A flow monitor was installed at Site No. 8 in January, 2008. The comparison of the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 16. This table shows the flows at Site No. 8 before and after the improvements to the Edinger Lift Station (LS No. 25) were completed. For the purposes of this report, the downstream reaches will be analyzed with the most-recent flow monitoring data because it represents the existing flow conditions.

Table 16
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 8 *(Flow Monitoring Site 8)*

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
8	206	0.002	10" VCP	226	200	438	8.04	0.80	447	Full	Full				
8	211	0.002	10" VCP	204	202	443	Full	Full	452	Full	Full				
8	213	0.002	10" VCP	112	204	447	Full	Full	455	Full	Full				
8	216	0.002	10" VCP	240	205	449	Full	Full	458	Full	Full				
8	219	0.002	10" VCP	240	208	453	Full	Full	464	Full	Full				
8	221	0.002	10" VCP	108	208	453	Full	Full	463	Full	Full				
8	222	0.002	10" VCP	213	223	483	Full	Full	496	Full	Full				
8* (June 2007)	232	0.002	10" VCP	239	226	490	Full	Full	504	Full	Full	227	455	8.78	0.88
8* (January 2008)		0.002	10" VCP	239	226	490	Full	Full	504	Full	Full	228	500	Full	Full
8	237	0.002	10" VCP	246	229	494	Full	Full	509	Full	Full				

** Location of Flow Monitor*

The 2003 Sewer Master Plan existing and ultimate peak dry weather flows exceed the capacities of the nine (9) reaches of sewers listed above. The existing peak dry weather flows varied from 438 gpm to 494 gpm, with the ultimate peak dry weather flows approximately 3 percent higher. With the upgraded Edinger Lift Station in operation, Flow Monitoring Site No. 8 recorded the peak dry weather flow as 500 gpm, which is similar to the Master Plan values. The Peak Dry weather flow (500 gpm) at flow monitoring Site No. 8 is less than the measured discharge at the Edinger Lift Station, due to the attenuation of the flows in the upstream gravity system.

For the most part, the flow monitoring data at Site No. 8 consistently displays typical flow patterns during the three (3) weeks that the flow monitor collected data. However, on January 26, 2008, there was a power outage which shutdown both the Edinger Lift Station (#25) and the Saybrook Lift Station (#22). The power outage lasted between 5:45 P.M. to 7:10 P.M. As shown in Appendix C, Site 8 displays an abnormally high flow rate at 7:30. Once the power at the pump station was restored, the two (2) pumps were both automatically turned on to discharge the wastewater that accumulated in the wet well. This flow rate (656 cfs) at 7:30 illustrates the scenario when both pumps are running.

During normal operations, the flow monitor recorded full or near full levels between 7:00 A.M. and 10:30 A.M, which coincides with normal peak wastewater production periods. Although it does not appear that two (2) pumps are running simultaneously during this time, the pumps are required to operate more frequently since the wet well fills at a faster rate during the peak period. The detailed flow monitoring results show the daily depths rise to full or near full levels at Site No. 8 for 1 to 4 hour periods. Based on the slope of 0.002, Manning's n of 0.013 and the flow monitoring maximum flow of 500 gpm, a minimum pipe diameter of 15 inches would be necessary to meet the City's depth to diameter design criteria of 0.67 for the nine (9) study reaches. The 15-inch pipe would also have the capacity to convey the measured flow rate of 656 cfs during the case when both pumps were in operation.

The maximum inflow into the Edinger Lift Station was measured to be approximately 285 gpm and the pumps are discharging roughly 500 gpm. To reduce the depth to diameter ratio in the ten (10) downstream sewers, the City may decrease the pump capacity from 500 gpm to 400 gpm. In doing so, approximately 37% of the ultimate PDWF will remain available for wet weather inflow and infiltration. By reducing the flow to 400 gpm, the downstream sewers are expected to flow at a depth to diameter ratio of approximately 0.744. While this is deficient according to the City's standards, the sewers will no longer experience full flow conditions.

To evaluate the effects of the improvements to the Edinger Lift Station (LS No. 25), an additional flow monitor was installed between Site No. 8 and the Saybrook Lift Station (LS No. 22). The flow monitor was installed in Pipe 256, upstream of the manhole between Pipes 256 and 261. It measures nearly the entire flow tributary to the Saybrook Lift Station. The comparison between the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 17.

Table 17
Comparison of Master Plan Results and Flow Monitoring Data
Deficient Location No. 8 *(Flow Monitoring Site 12)*

					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing Depth	Existing d/D	Ultimate ADWF GMP	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
12	239		12" VCP	302				300	632	7.80	0.65				
12	256		12" VCP	513				347	719	7.20	0.60				
12*	261		12" VCP	246				368	758	6.60	0.55	247	517	7.01	0.58

** Location of Flow Monitor*

Like Site No. 8, the flow monitoring results at Site No. 12 are fairly typical, however, the site experienced high and low flows when the power outage left the Saybrook Lift Station (LS No. 22) and Edinger Lift Stations (LS No. 25) inoperable. As Shown in Appendix C, Site No. 12 experienced back water conditions at about 6:00 P.M. where the flow level reached the top of the pipe and the flow rate is zero. Site 12 is just upstream of the Saybrook Lift Station; therefore, the flow accumulated in the pipe once the wet well had reached its maximum capacity. During the power outage, Site No. 8 did not experience these backwater conditions because it is further upstream. Once the power at the lift station was restored, the two (2) pumps were automatically turned on to discharge the wastewater that accumulated in the wet well during the power outage. This flow rate (771 cfs) at 7:30 illustrates the scenario when both pumps are running.

The 2003 Sewer Master Plan considered Pipes 239, 256, and 261 to be "Borderline conditions", with ultimate average dry weather flows between 300 gpm and 368 gpm. During the master planning effort, "Borderline conditions" were the reaches that had calculated d/D values which were close the deficiency criteria d/D values, but were not determined "Deficient" by engineering judgment.

During normal dry weather conditions the flow monitoring shows that the average and peak dry weather flows are 247 gpm and 517 gpm respectively. The Sewer Master Plan peak dry weather flow (758 gpm) is larger than the flow monitoring peak dry weather flow (517 gpm) by a factor of 1.47. According to the flow monitoring data, this 12" sewer is flowing at a d/D of 0.58. While this is deficient per the City's criteria, it does not warrant replacement of the existing pipes for capacity. If the tributary land use is proposed to be changed significantly in the future, resulting in higher wastewater flows, then these reaches should be re-evaluated.

Deficient Location No. 7

The 2003 Sewer Master Plan identified a capacity deficiency in one (1) reach of 8-inch diameter sewer on Saybrook Lane between Heil Avenue to the north and Morning Star Drive on the south. With the master plan calculated peak dry weather flow, this reach is flowing full. The total length is 290 feet, and the flow direction is from north to south. This reach conveys the wastewater flow pumped by Saybrook Lift Station (LS No. 22), located on Saybrook Lane north of Heil Avenue.

The flow monitor was installed in the downstream end of Pipe 2586, upstream of the manhole between Pipes 312 and 2586 at the intersection of Saybrook Lane and Morning Star Drive. It measures the entire flow tributary to the deficient sewer. The comparison between the flow monitoring data and the 2003 Sewer Master Plan results is shown in Table 18.

Table 18
Comparison of Master Plan and Flow Monitoring Data
Deficient Location No. 7

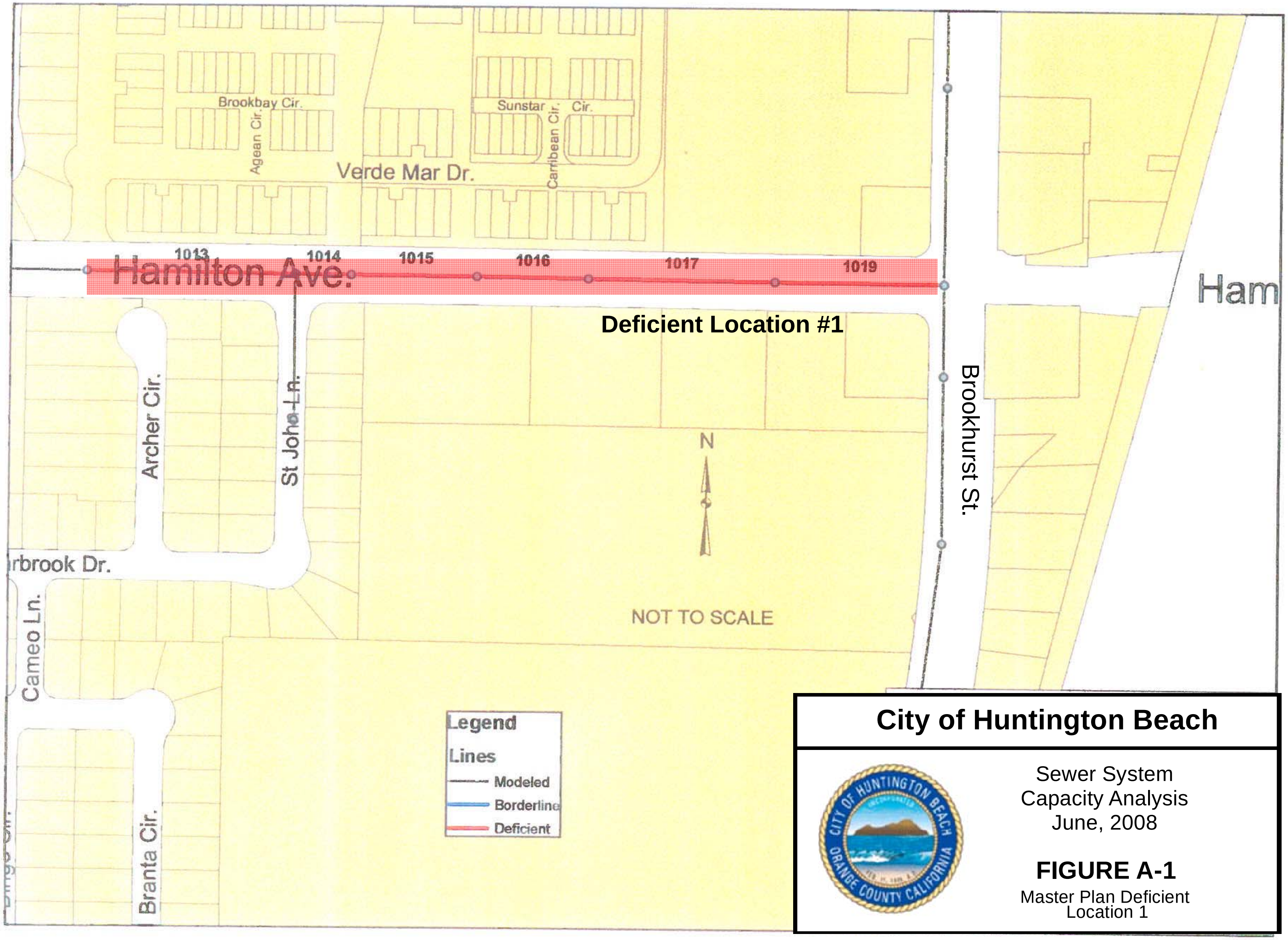
					Master Plan Data Data							Flow Monitoring Data			
Flow Monitoring Site	Pipe ID	Report Slope	Size Material	Model Length	Existing ADWF GPM	Existing PDWF GPM	Existing Depth	Existing d/D	Ultimate PDWF GPM	Ultimate Depth	Ultimate d/D	ADWF (GPM)	PDWF (GPM)	Depth	d/D
7*	2586	0.002	12" VCP	299	311	652	9.00	0.75	760	Full	Full	346	642	7.10	0.59

** Location of Flow Monitor*

Based upon information contained in Appendix D of the 2003 Sewer Master Plan, the existing peak dry weather flow is 652 gpm, and the ultimate peak dry weather flow is 760 gpm. The Master Plan calculated a depth to diameter ratio of 0.75 in this 12-inch pipe with the existing peak dry weather flows. The flow monitoring equipment recorded a peak dry weather flow of 642 gpm, which is nearly the firm capacity of the Saybrook Lift Station. The flow monitors recorded the maximum depth to diameter ratio at 0.59 which verifies that this 12" diameter sewer does not meet the City's existing criteria.

The City anticipates that the Saybrook Lift Station will be replaced within the next 3 and 8 years. To reduce the length of time that the pumps are running, it is anticipated that the City will double the firm capacity of the pumps. Each pump's existing design capacity is 413 gpm. The City recommends that the future design capacity of the downstream sewers will be 826 gpm. A minimum pipe diameter of 15 inches is needed to meet the City's depth to diameter design criteria of 0.67. These reaches will require additional evaluation by the City.

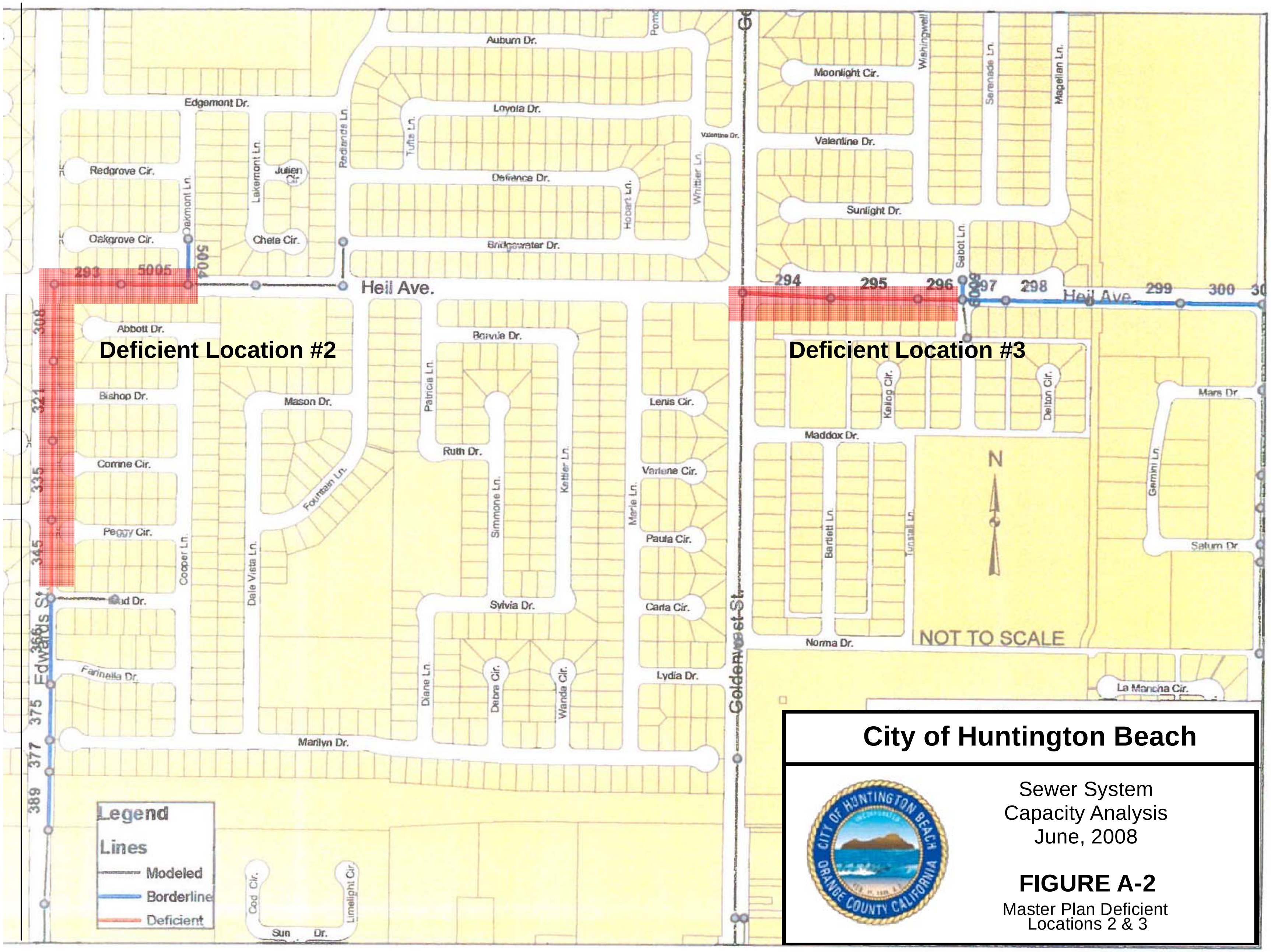
The system downstream of this reach should also be evaluated for this planned increase in the flows.



City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

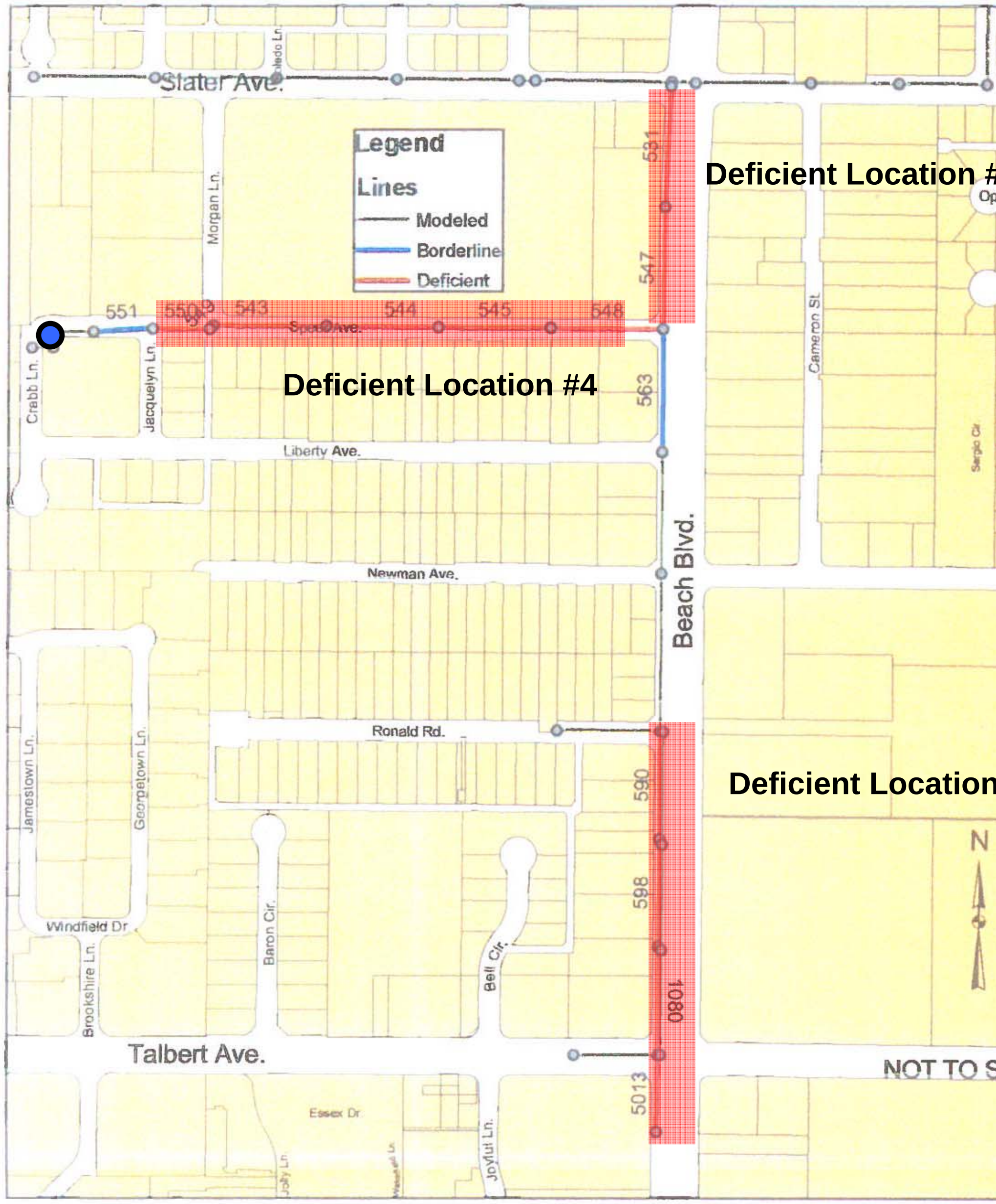
FIGURE A-1
Master Plan Deficient
Location 1



City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE A-2
Master Plan Deficient
Locations 2 & 3

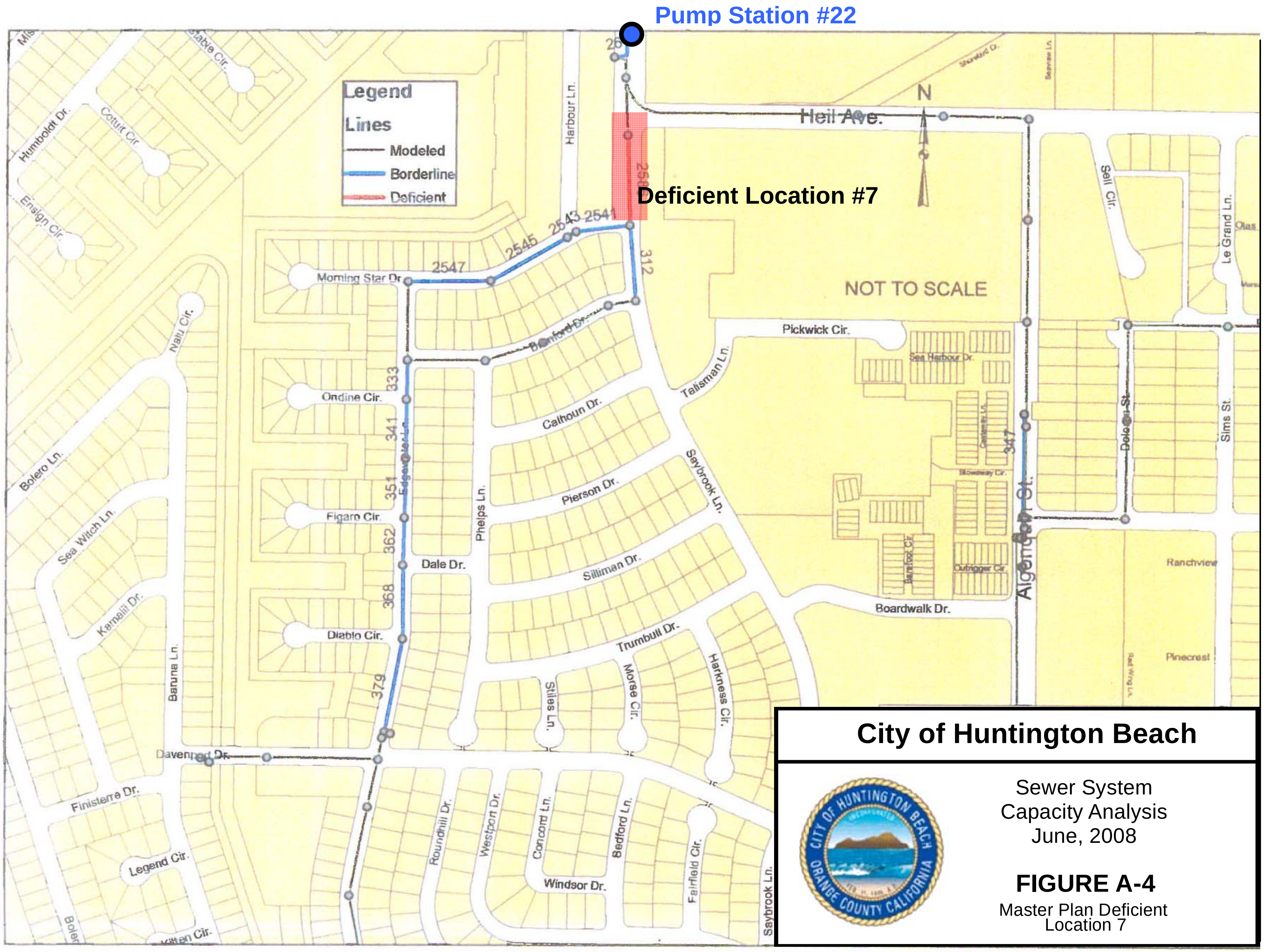


City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE A-3

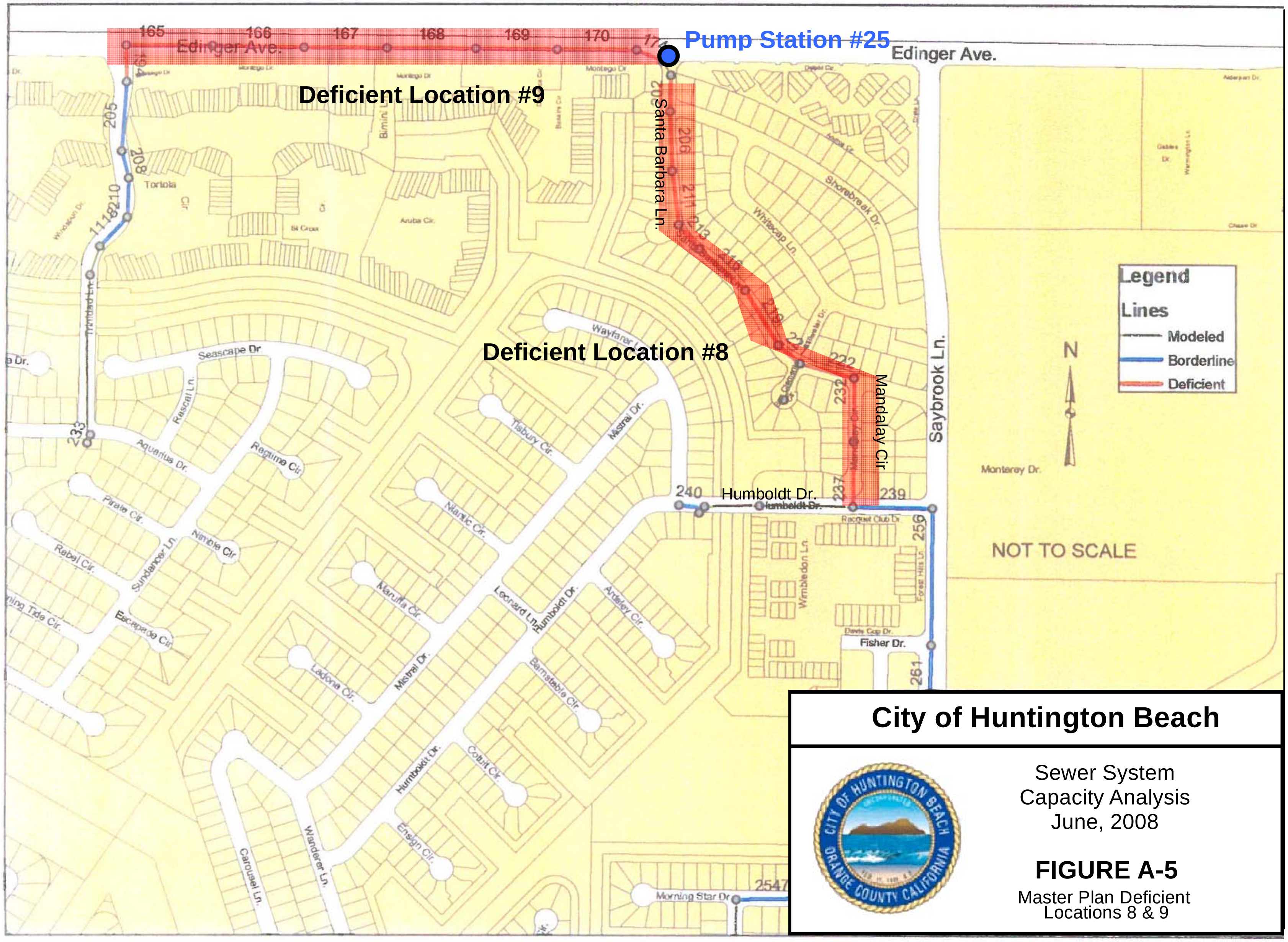
Master Plan Deficient
Locations 4, 5, & 6



City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE A-4
Master Plan Deficient Location 7

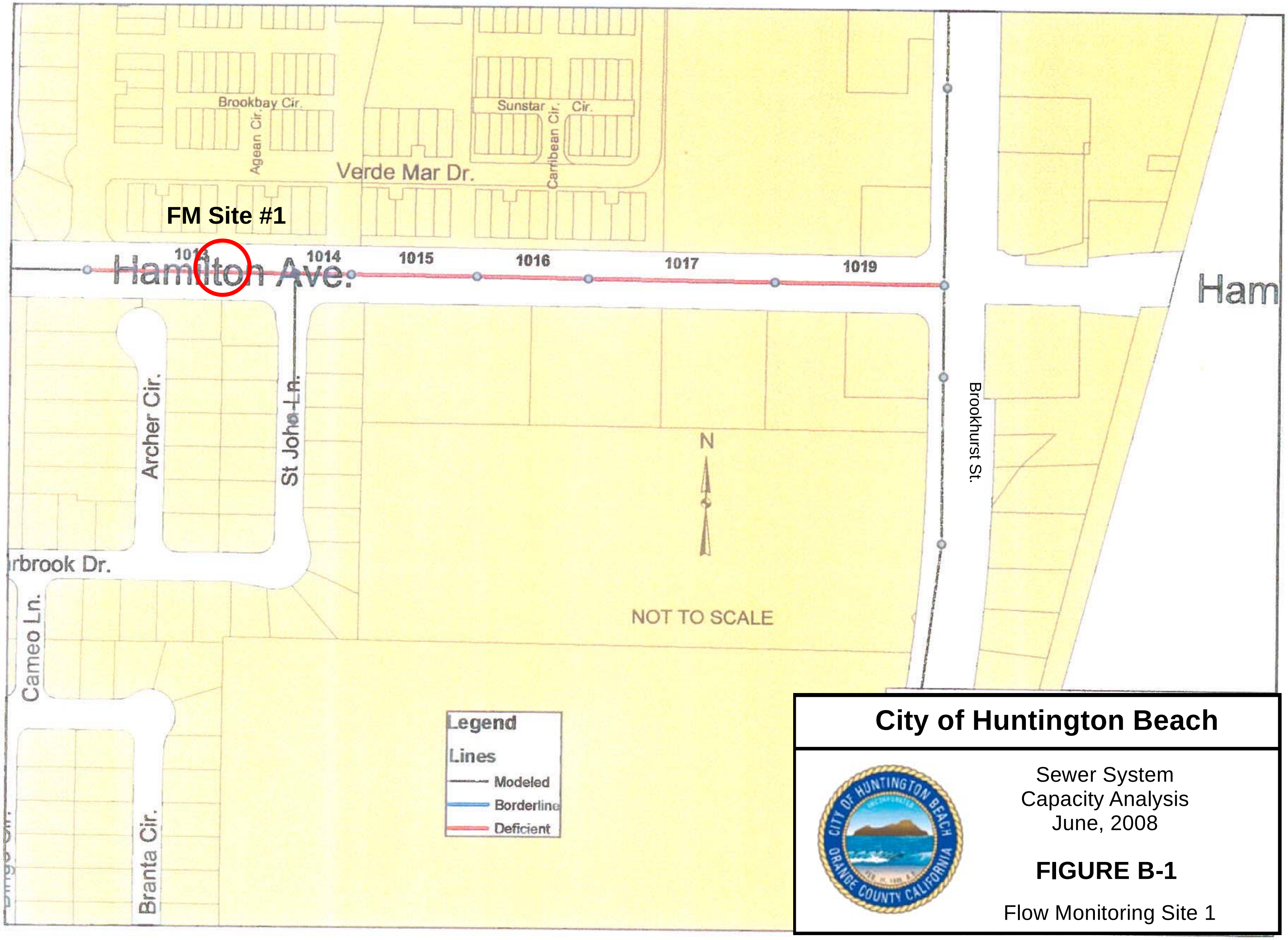


City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE A-5

Master Plan Deficient Locations 8 & 9

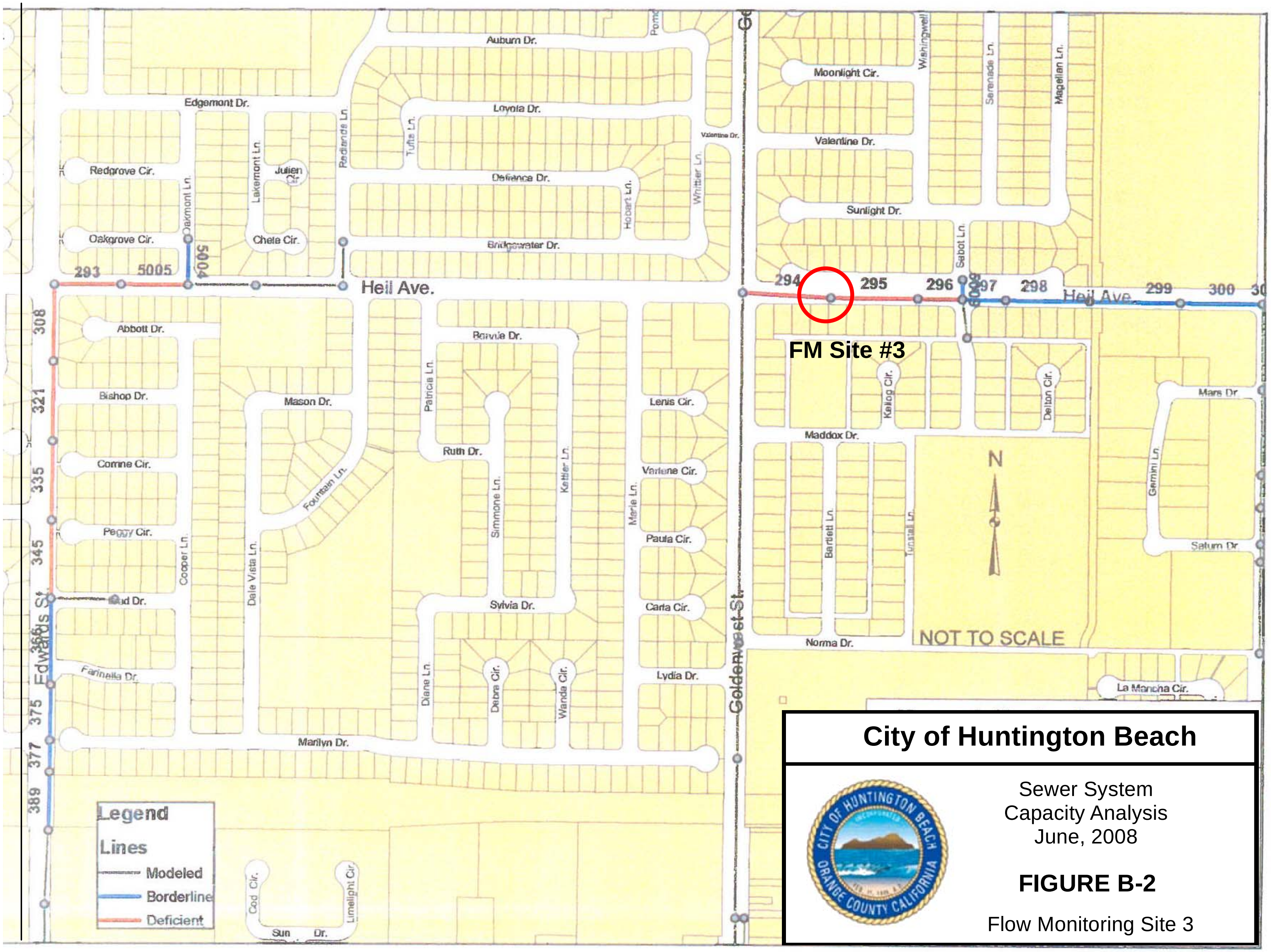


City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE B-1

Flow Monitoring Site 1

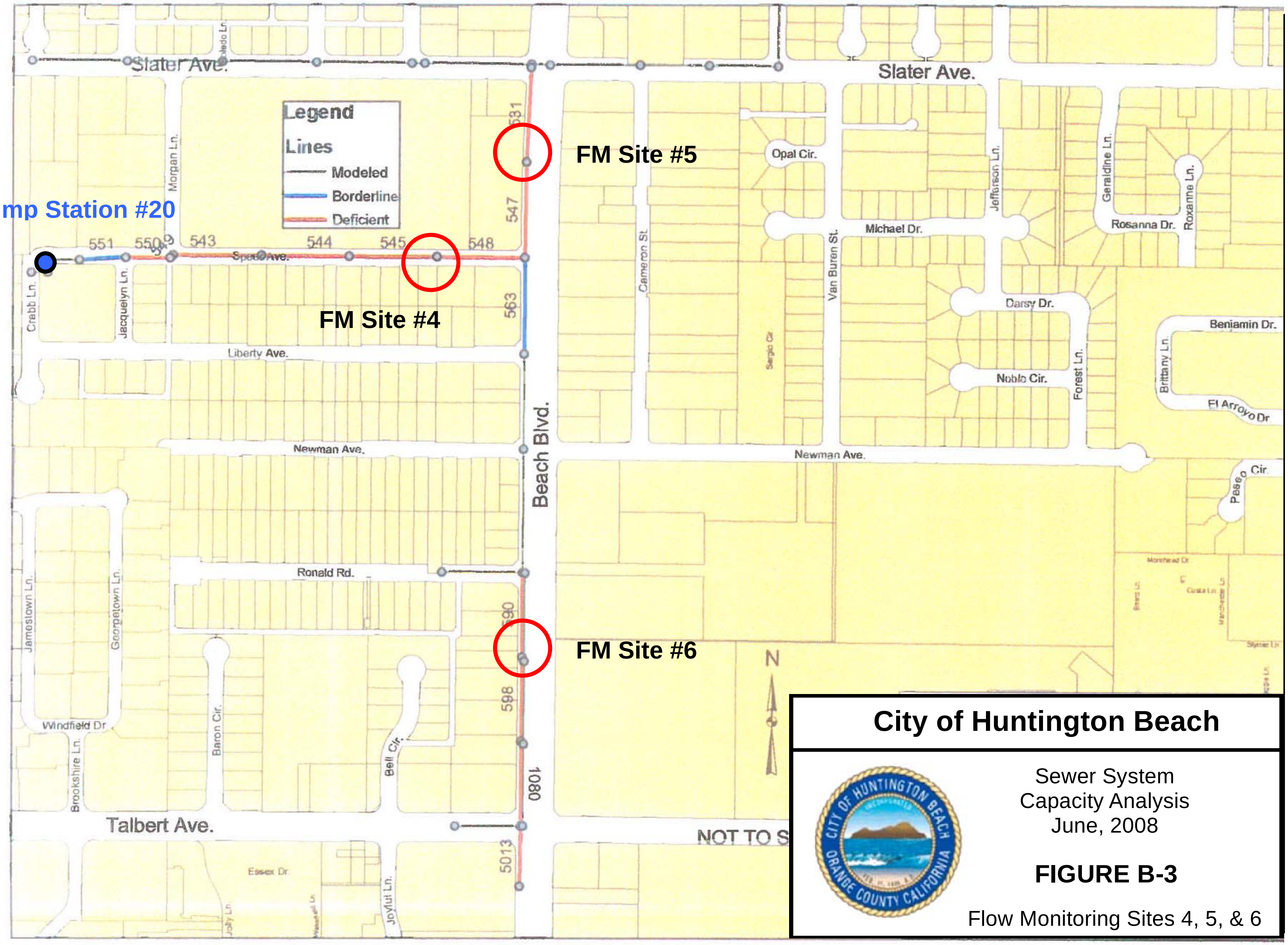


City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE B-2

Flow Monitoring Site 3



City of Huntington Beach

Sewer System
Capacity Analysis
June, 2008

FIGURE B-3

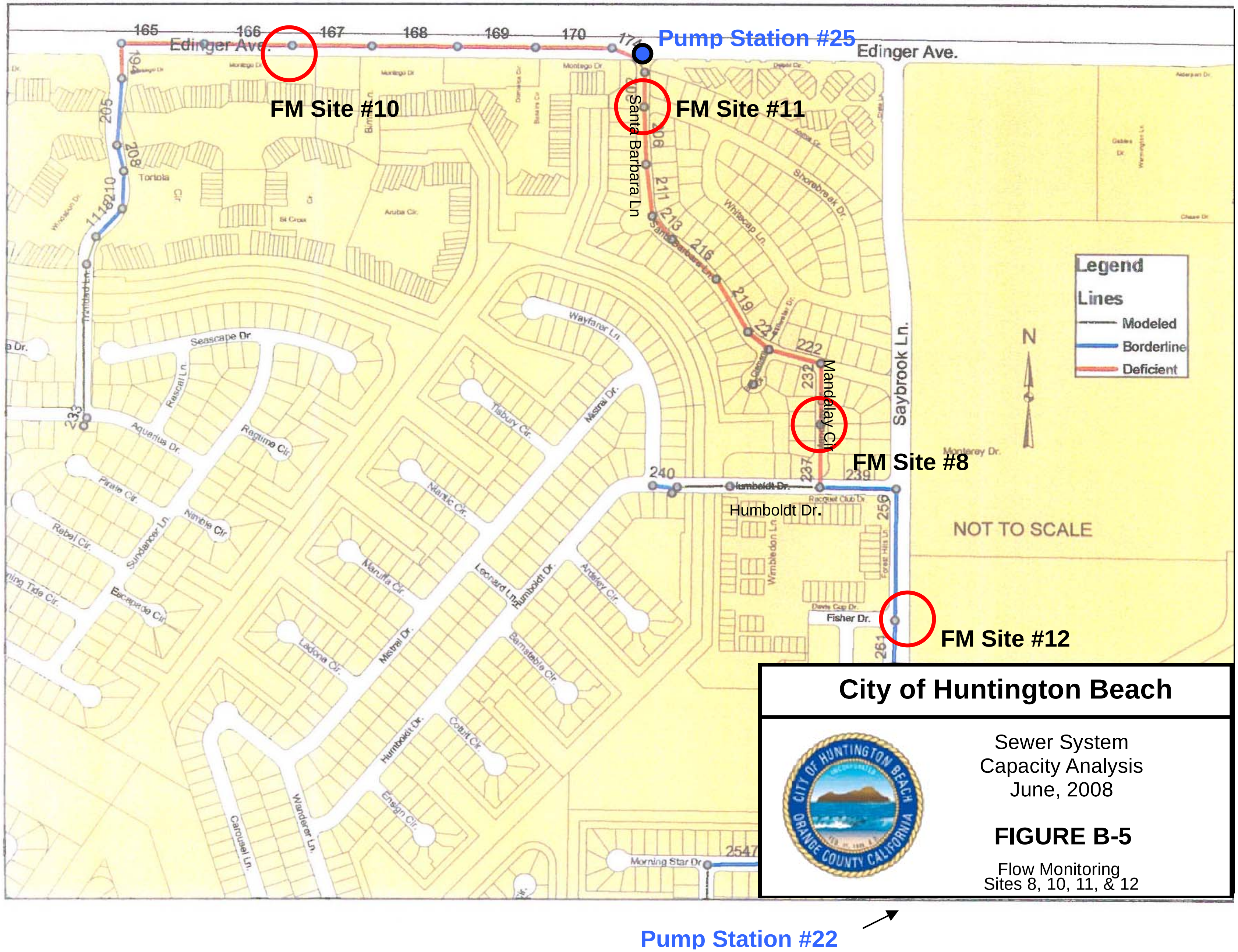
Flow Monitoring Sites 4, 5, & 6

City of Huntington Beach

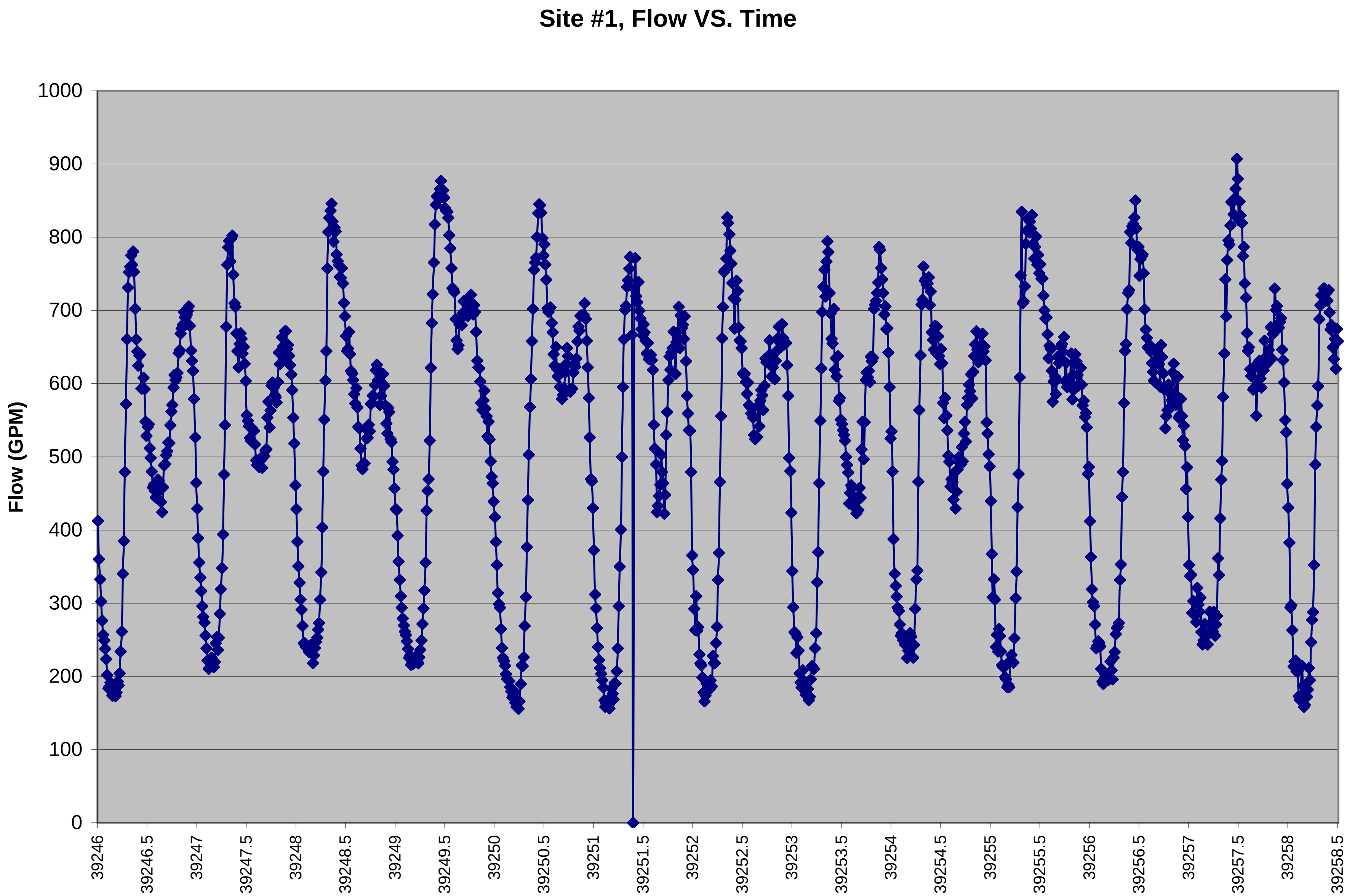
Sewer System
Capacity Analysis
June, 2008

FIGURE B-4

Flow Monitoring Site 7



Pump Station #25
Edinger Ave.
165
166
167
168
169
170
FM Site #10
FM Site #11
Santa Barbara Ln
FM Site #8
Mandalay Cir
FM Site #12
Humboldt Dr.
Saybrook Ln.
Legend
Lines
Modeled
Borderline
Deficient
N
NOT TO SCALE
Pump Station #22
City of Huntington Beach
Sewer System
Capacity Analysis
June, 2008
FIGURE B-5
Flow Monitoring
Sites 8, 10, 11, & 12


Site #1, Flow VS. Time
Flow (GPM)
1000
900
800
700
600
500
400
300
200
100
0
39246
39246.5
39247
39247.5
39248
39248.5
39249
39249.5
39250
39250.5
39251
39251.5
39252
39252.5
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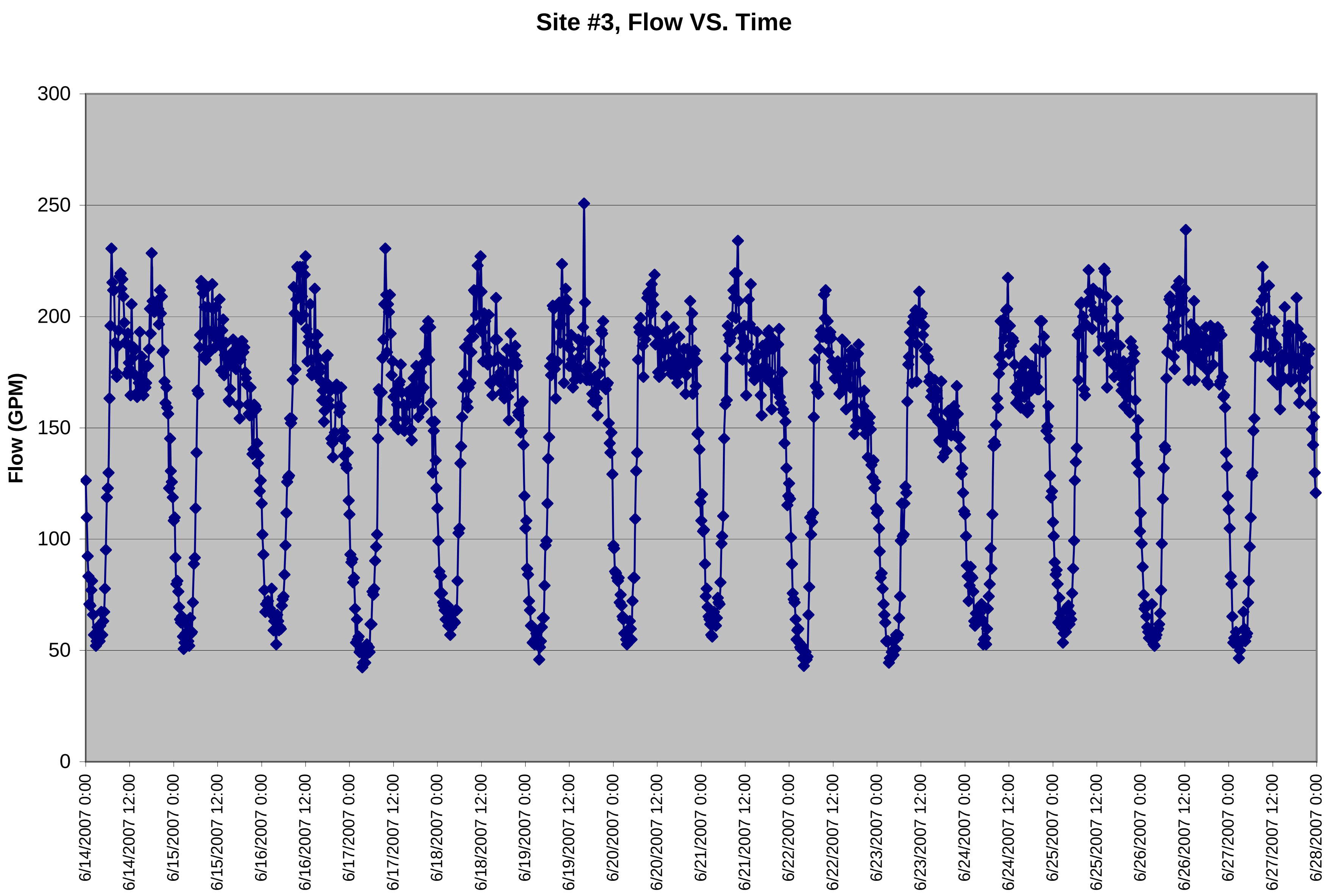
39257.5
39258
39258.5


Site #3, Flow VS. Time
Flow (GPM)
300
250
200
150
100
50
0
6/14/2007 0:00
6/14/2007 12:00
6/15/2007 0:00
6/15/2007 12:00
6/16/2007 0:00
6/16/2007 12:00
6/17/2007 0:00
6/17/2007 12:00
6/18/2007 0:00
6/18/2007 12:00
6/19/2007 0:00
6/19/2007 12:00
6/20/2007 0:00
6/20/2007 12:00
6/21/2007 0:00
6/21/2007 12:00
6/22/2007 0:00
6/22/2007 12:00
6/23/2007 0:00
6/23/2007 12:00
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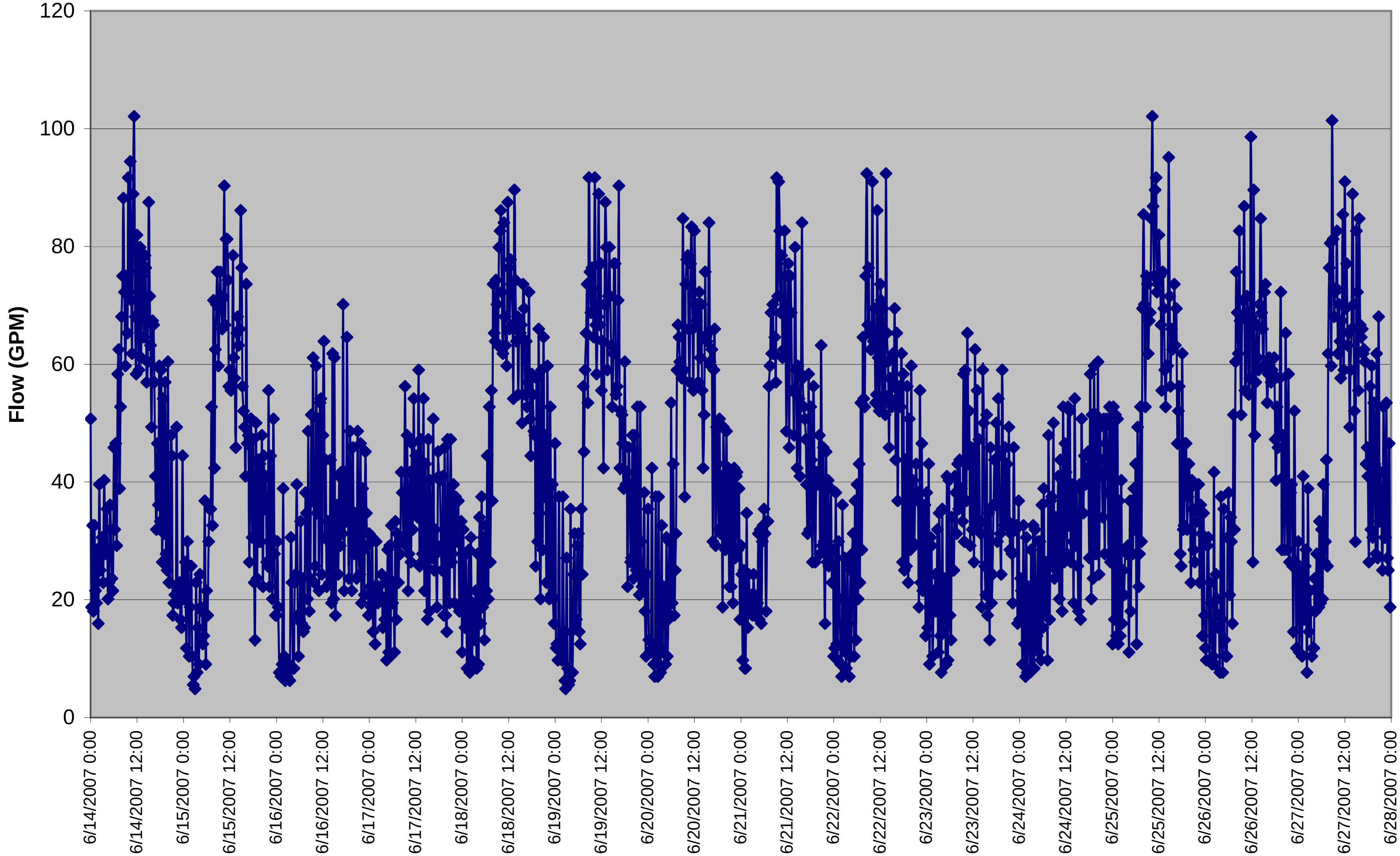
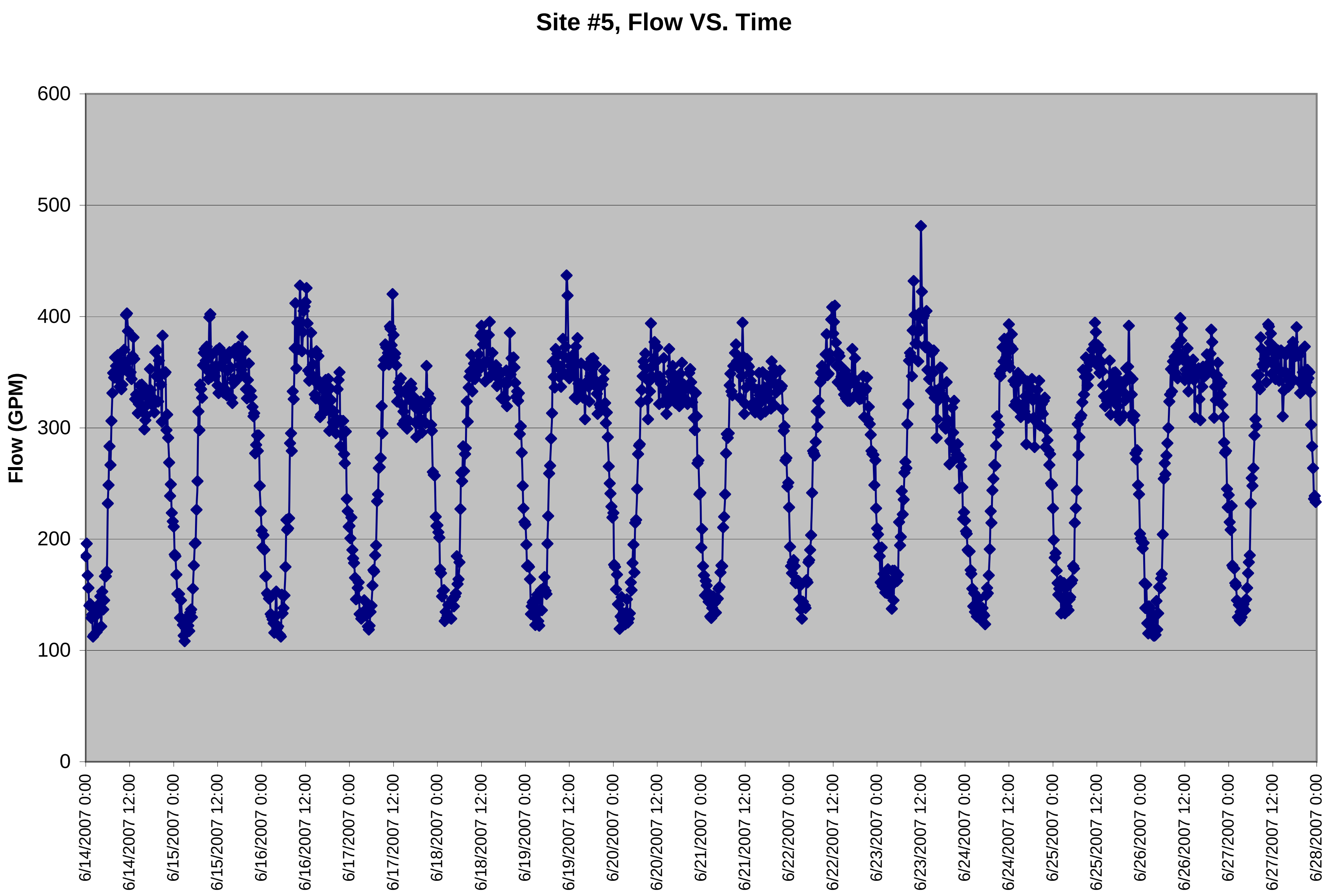
6/24/2007 12:00
6/25/2007 0:00
6/25/2007 12:00
6/26/2007 0:00
6/26/2007 12:00
6/27/2007 0:00
6/27/2007 12:00
6/28/2007 0:00

Site #4, Flow VS. Time





Site #5, Flow VS. Time
Flow (GPM)
600
500
400
300
200
100
0
6/14/2007 0:00
6/14/2007 12:00
6/15/2007 0:00
6/15/2007 12:00
6/16/2007 0:00
6/16/2007 12:00
6/17/2007 0:00
6/17/2007 12:00
6/18/2007 0:00
6/18/2007 12:00
6/19/2007 0:00
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6/24/2007 12:00
6/25/2007 0:00
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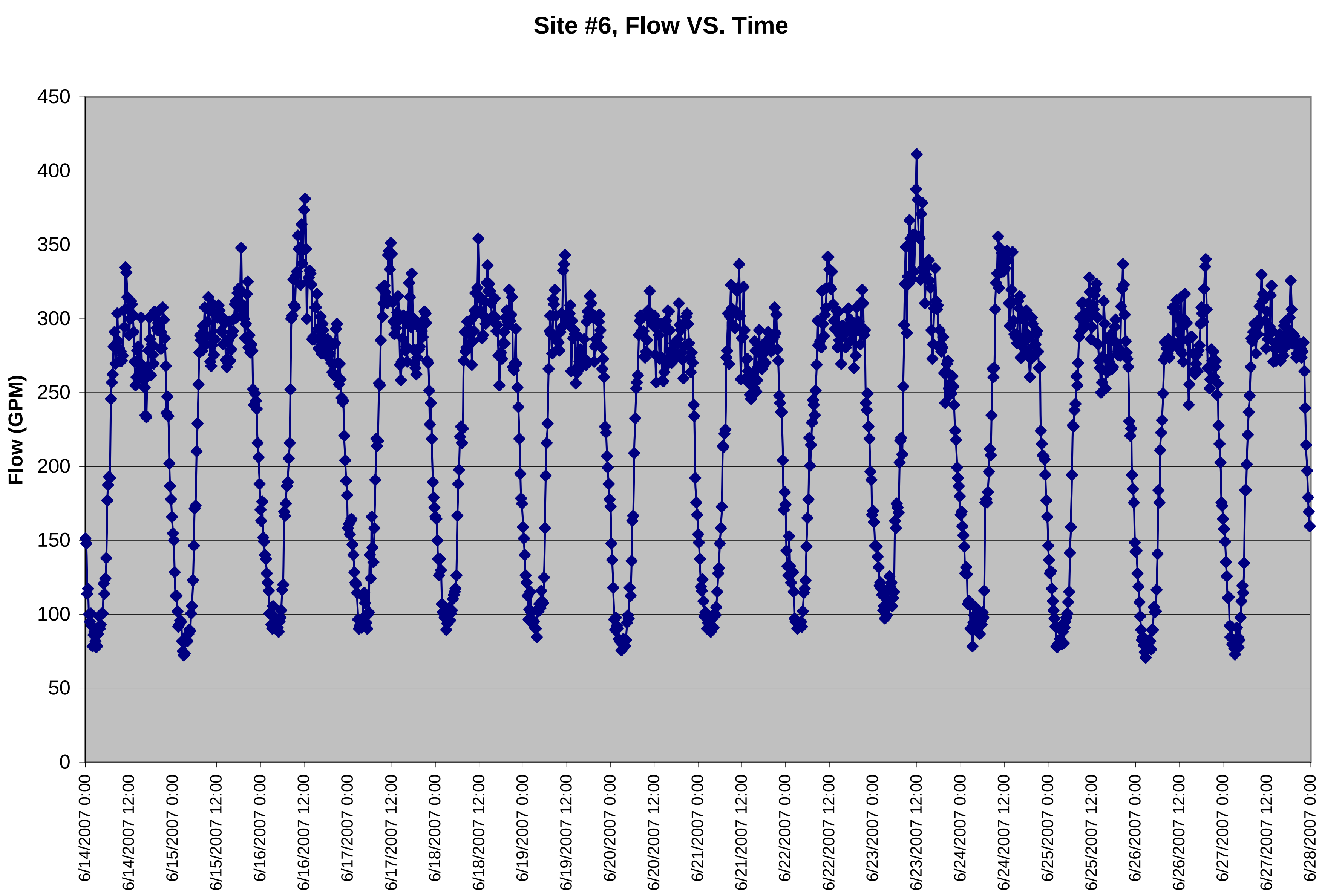
6/28/2007 0:00


Site #6, Flow VS. Time
Flow (GPM)
0
50
100
150
200
250
300
350
400
450
6/14/2007 0:00
6/14/2007 12:00
6/15/2007 0:00
6/15/2007 12:00
6/16/2007 0:00
6/16/2007 12:00
6/17/2007 0:00
6/17/2007 12:00
6/18/2007 0:00
6/18/2007 12:00
6/19/2007 0:00
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6/24/2007 12:00
6/25/2007 0:00
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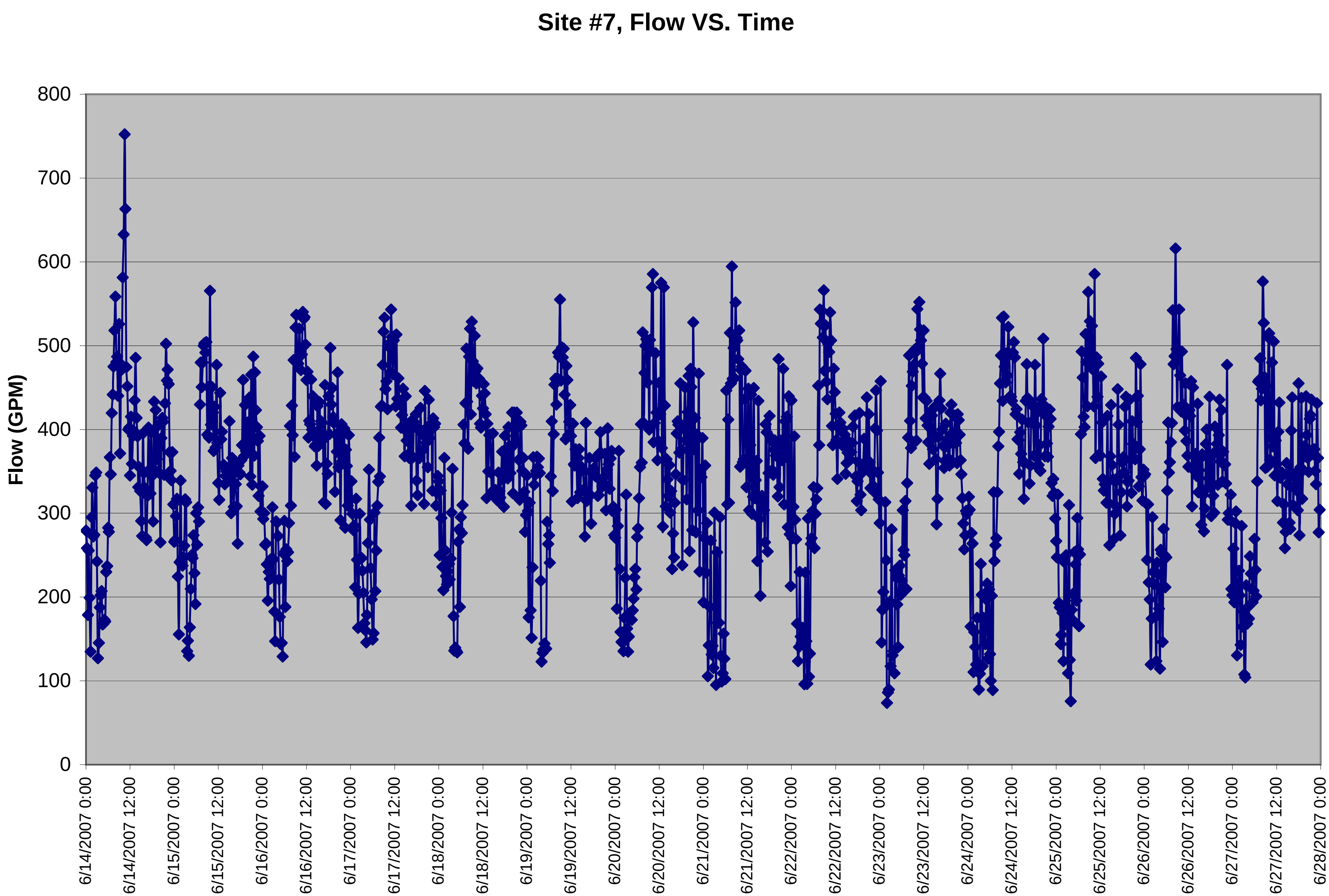
6/28/2007 0:00



Site #7, Flow VS. Time
Flow (GPM)
800
700
600
500
400
300
200
100
0
6/14/2007 0:00
6/14/2007 12:00
6/15/2007 0:00
6/15/2007 12:00
6/16/2007 0:00
6/16/2007 12:00
6/17/2007 0:00
6/17/2007 12:00
6/18/2007 0:00
6/18/2007 12:00
6/19/2007 0:00
6/19/2007 12:00
6/20/2007 0:00
6/20/2007 12:00
6/21/2007 0:00
6/21/2007 12:00
6/22/2007 0:00
6/22/2007 12:00
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6/23/2007 12:00
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6/24/2007 12:00
6/25/2007 0:00
6/25/2007 12:00
6/26/2007 0:00
6/26/2007 12:00
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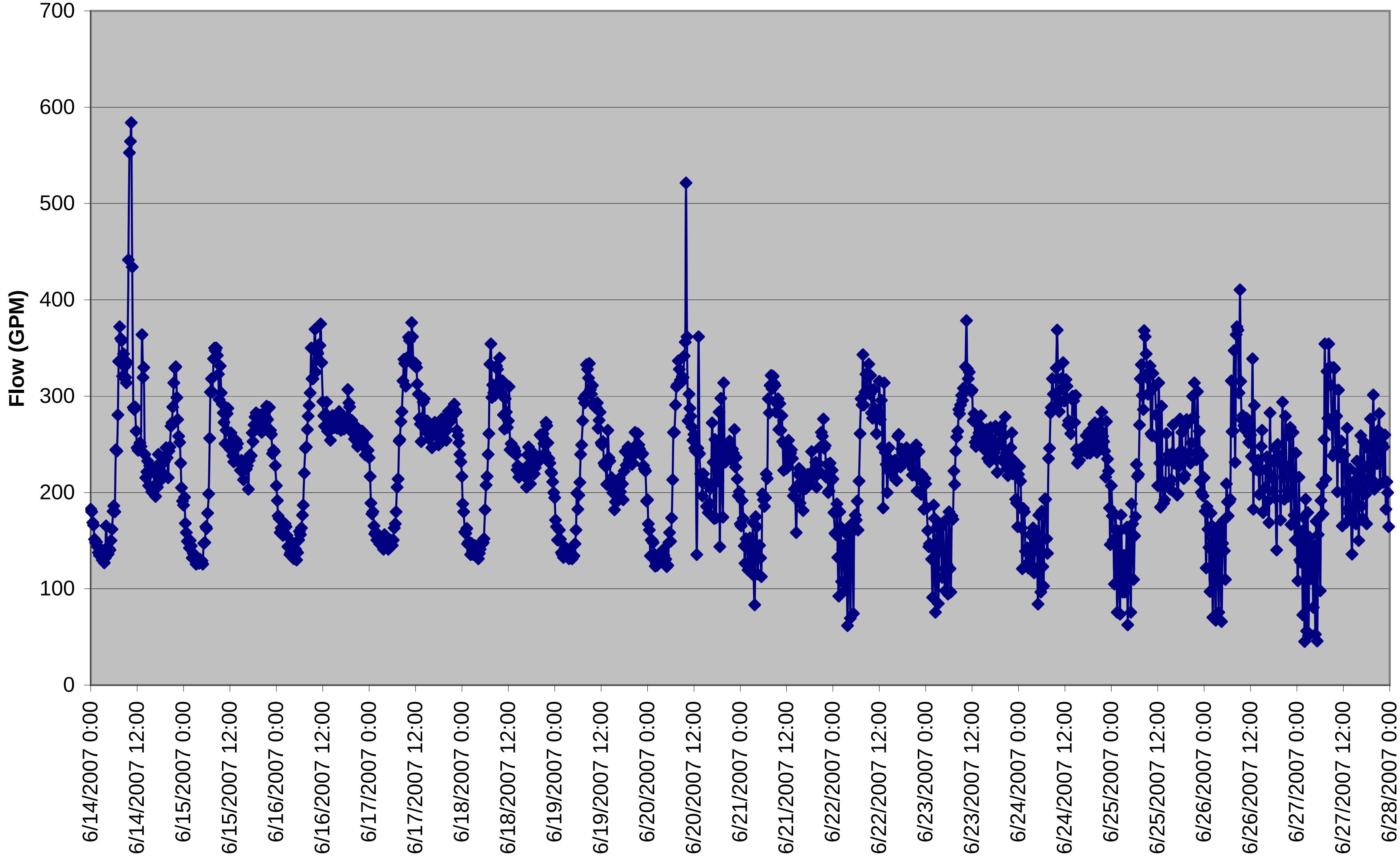
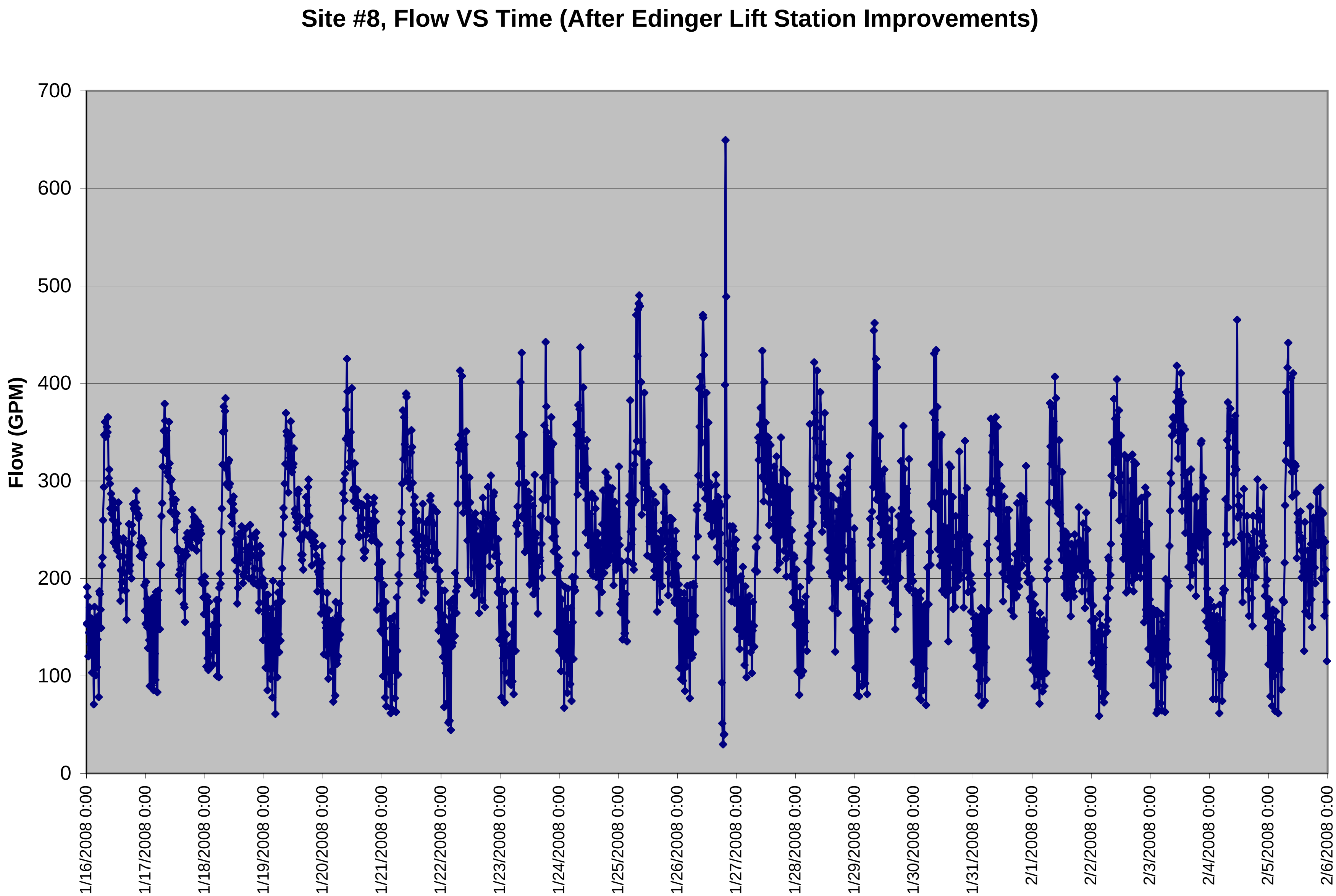
6/27/2007 12:00
6/28/2007 0:00

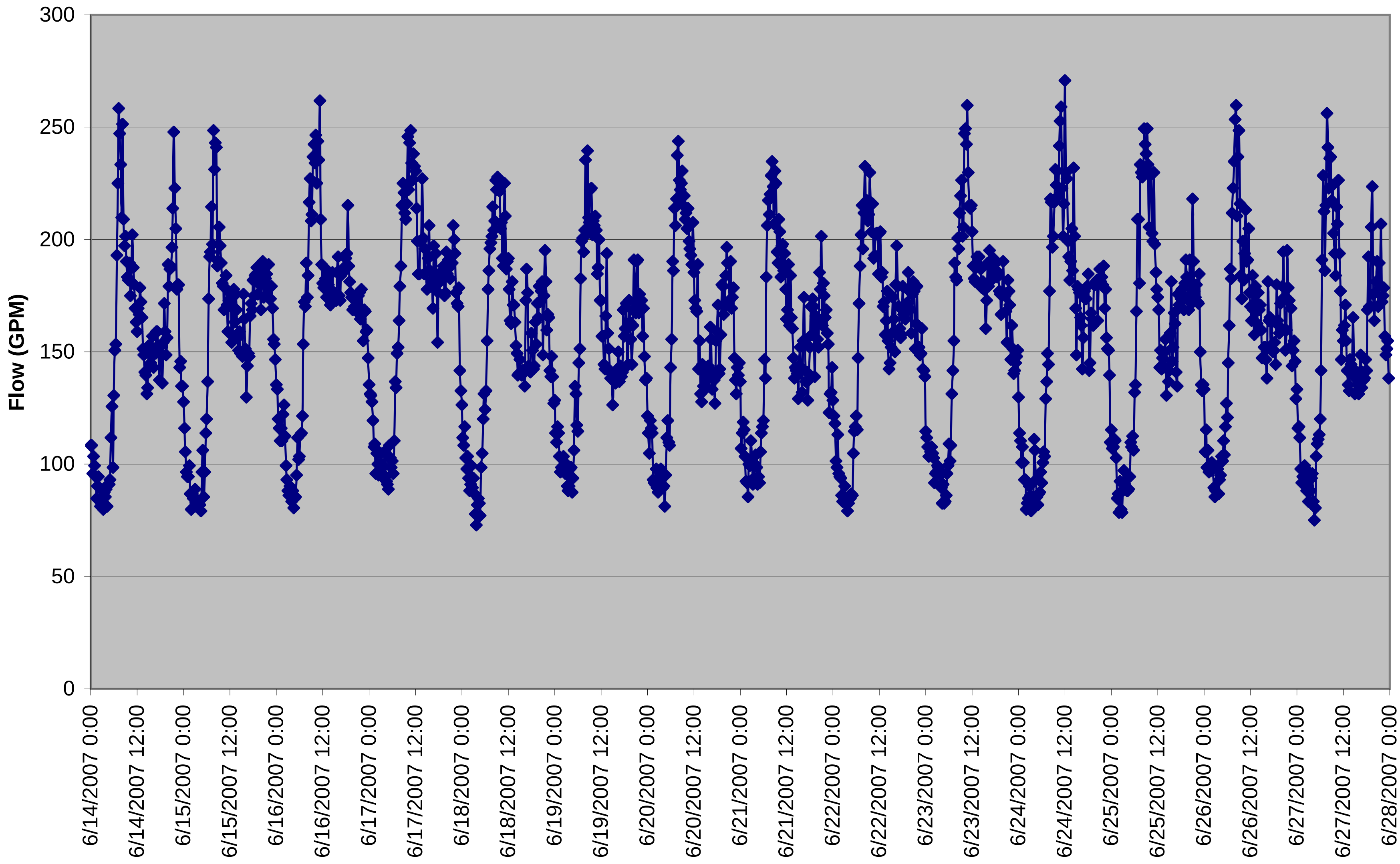
Site #8, Flow VS. Time (Before Edinger Lift Station Improvements)

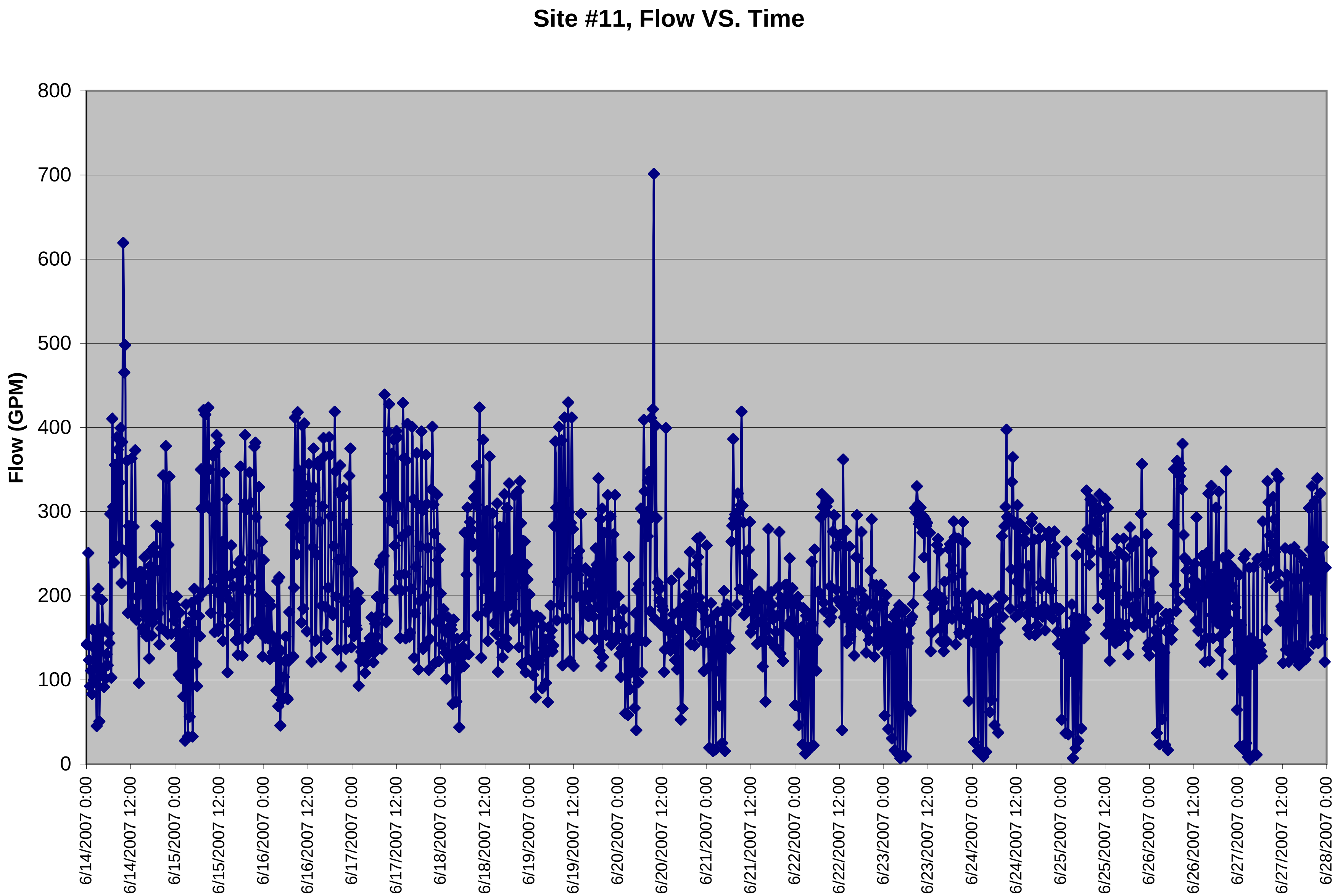




Site #8, Flow VS Time (After Edinger Lift Station Improvements)
Flow (GPM)
0
100
200
300
400
500
600
700
1/16/2008 0:00
1/17/2008 0:00
1/18/2008 0:00
1/19/2008 0:00
1/20/2008 0:00
1/21/2008 0:00
1/22/2008 0:00
1/23/2008 0:00
1/24/2008 0:00
1/25/2008 0:00
1/26/2008 0:00
1/27/2008 0:00
1/28/2008 0:00
1/29/2008 0:00
1/30/2008 0:00
1/31/2008 0:00
2/1/2008 0:00
2/2/2008 0:00
2/3/2008 0:00
2/4/2008 0:00
2/5/2008 0:00
2/6/2008 0:00

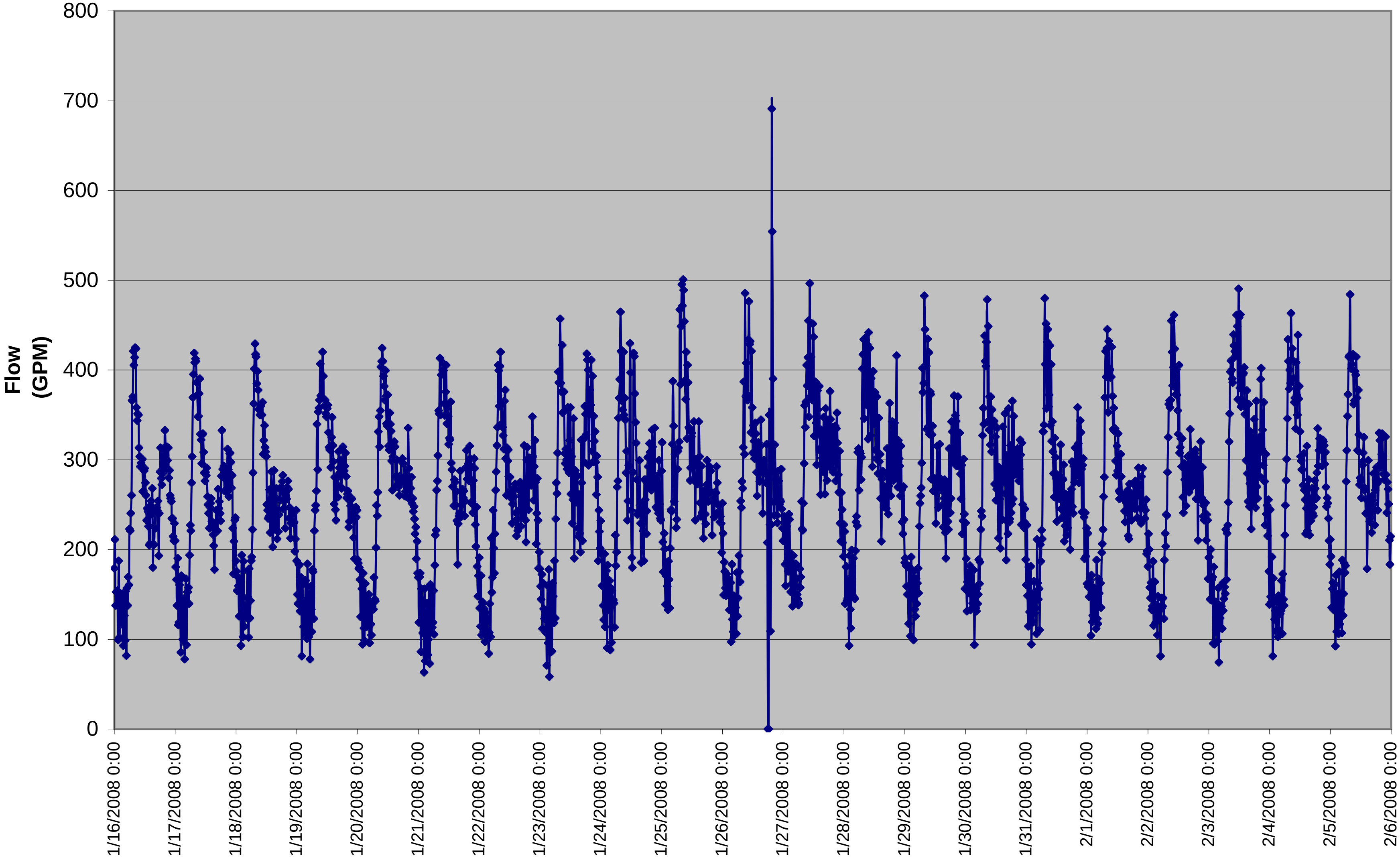
Site #10, Flow VS. Time





Site #11, Flow VS. Time
Flow (GPM)
0
100
200
300
400
500
600
700
800
6/14/2007 0:00
6/14/2007 12:00
6/15/2007 0:00
6/15/2007 12:00
6/16/2007 0:00
6/16/2007 12:00
6/17/2007 0:00
6/17/2007 12:00
6/18/2007 0:00
6/18/2007 12:00
6/19/2007 0:00
6/19/2007 12:00
6/20/2007 0:00
6/20/2007 12:00
6/21/2007 0:00
6/21/2007 12:00
6/22/2007 0:00
6/22/2007 12:00
6/23/2007 0:00
6/23/2007 12:00
6/24/2007 0:00
6/24/2007 12:00
6/25/2007 0:00
6/25/2007 12:00
6/26/2007 0:00
6/26/2007 12:00
6/27/2007 0:00
6/27/2007 12:00
6/28/2007 0:00

Site #12, Flow VS Time (After Edinger Lift Station Improvements)



Appendix D
2003 Master Plan Capacity Analysis

ID #	SLOPE	Size, Material	Elevation GRN UP	Elevation GRN DN	Model Length	Peak Exist. CFS	INVERT Down	INVERT UP	PEAK Ult. CFS
1013	0.001	18" vcp	8.1	7.53	370	3.416	-2.17	-1.8	3.447
1014	0.001	18" vcp	7.3	8.1	100	3.373	-1.6	-1.5	3.402
1015	0.001	18" vcp	8.03	7.3	225.97	3.368	-1.3	-1.07	3.396
1016	0.001	18" vcp	9.33	8.03	200	3.232	-0.87	-0.67	3.253
1017	0.001	18" vcp	9.86	9.33	330	3.226	-4.7	-0.14	3.249
1019	0.001	18" vcp	10.17	9.86	303.7	3.127	0.06	0.37	3.143
531	0.002	12" vcp	25.02	28.16	329.13	2.036	12.66	14.12	2.107
547	0.0032	12" vcp	27	25.02	328	2.033	14.12	15.17	2.104
2586	0.002	8" vcp	not in model						
294	0.002	12" vcp	not in model						
295	0.002	12" vcp	12.76	12.4	330	0.915	1.7	2.36	1.291
296	0.002	12" vcp	11.49	12.76	165	0.914	2.56	2.89	1.288
165	0.002	10" vcp	10.16	9.8	320	0.838	-0.73	-0.9	0.852
166	0.002	10" vcp	9.8	9.67	347.01	0.838	-1.63	-0.93	0.853
167	0.002	10" vcp	9.67	8.77	313.55	0.84	-2.46	-1.83	0.853
168	0.002	10" vcp	8.77	10.47	335	0.908	-3.33	-2.66	0.925
169	0.002	10" vcp	10.47	10.85	307.53	0.914	-4.15	-3.53	0.931
170	0.002	10" vcp	10.85	9.54	304	0.932	-4.96	-4.35	0.951
174	0.002	10" vcp	9.54	12.15	105	0.934	-5.37	-5.16	0.953
194	0.002	10" vcp	not found						
202	0.002	10" vcp	12.15	11.08	135.51	0.968	3.4	3.75	0.988
206	0.002	10" vcp	11.08	10.9	225.97	0.975	2.83	3.4	0.996
211	0.002	10" vcp	10.9	10.4	203.73	0.986	2.33	2.83	1.006
213	0.002	10" vcp	10.4	10	112	0.995	2.05	2.33	1.014
216	0.002	10" vcp	10	9.4	240	1	1.45	2.05	1.021
219	0.002	10" vcp	9.4	8.7	240	1.01	0.85	1.45	1.033
221	0.002	10" vcp	8.7	9.02	108	1.01	0.58	0.85	1.031
222	0.002	10" vcp	9.02	11.39	212.6	1.077	0.5	0.58	1.106
232	0.002	10" vcp	10.72	10.72	239	1.091	-0.64	-0.5	1.122
237	0.002	10" vcp	10.72	9.71	246.26	1.101	-1.25	-0.64	1.133
293	ot on GIS								
308	ot on GIS								
321	ot on GIS								
335	ot on GIS								
345	ot on GIS								
543	0.002	8" vcp	29.91	29.8	300	1.144	20.6	21.8	1.146
544	0.002	8" vcp	29.94	29.7	300	1.244	19.4	20.6	1.251
545	0.002	8" vcp	29.8	29.62	300	1.25	18.2	19.4	1.258
548	0.002	8" vcp	29.62	27	300	1	17	18.2	1.26
549	0.002	8"vcp	29.83	29.9	15	1.138	21.8	21.86	1.14
550	0.002	8" vcp	27.44	29.83	150	1.138	22	22.6	1.14
598	0.002	10" vcp	45.17	43.4	283.62	0.003	30.8	31.37	0.003
974	not found								
980	not found								
3002	not found								
1080	0.002	8" vcp	39.62	42.33	294.02	0.748	29.03	29.62	0.796
5005	ot on GIS								
5013	0.002	8" vcp	39	39.62	208.64	0.544	34.5	34.9	0.585