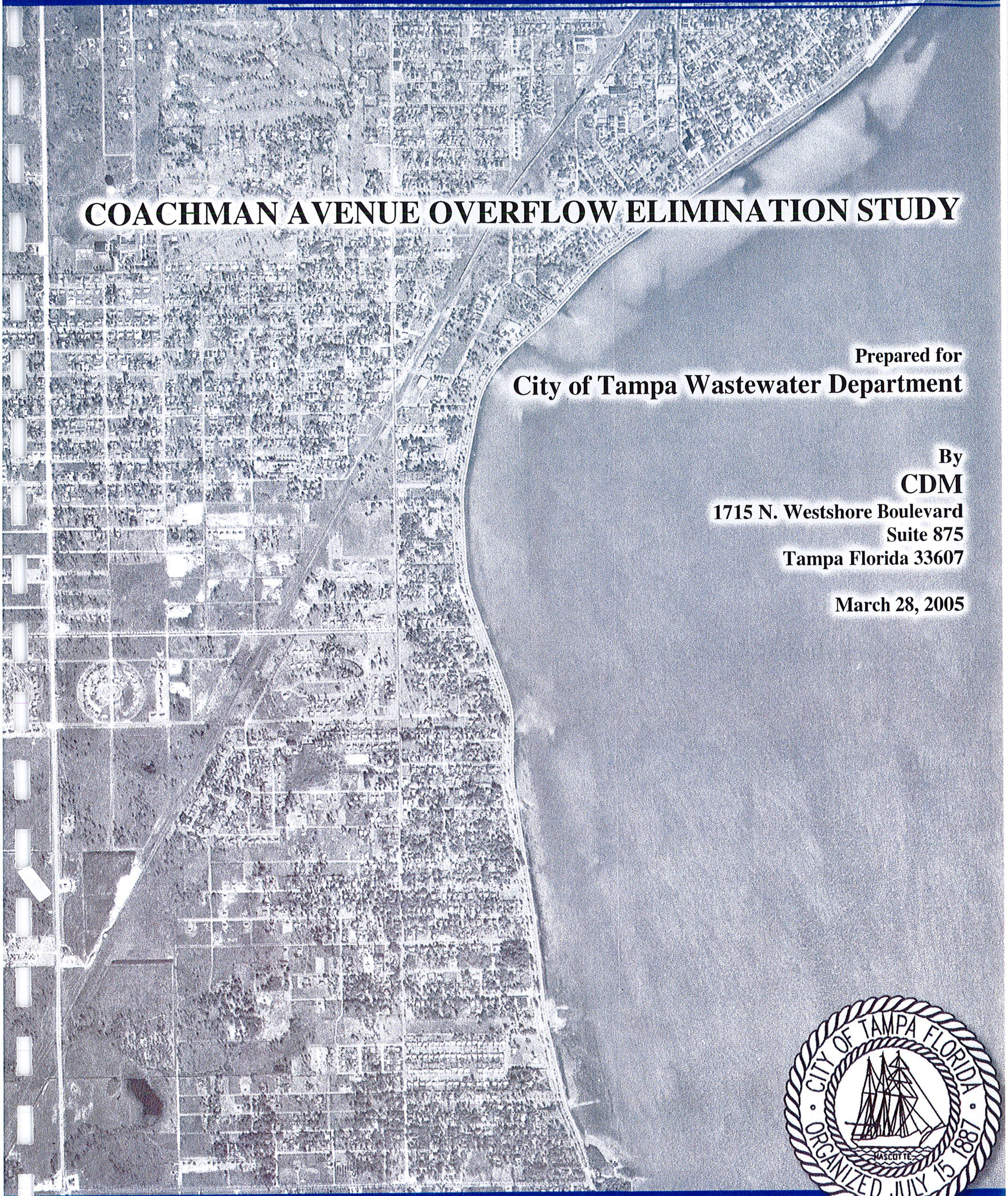
CDM

COACHMAN AVENUE OVERFLOW ELIMINATION STUDY



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Executive Summary Coachman Avenue Overflow Elimination Study

Background

During the hurricanes of August and September 2004, the sanitary sewer overflowed at two manholes on Coachman and Alline Avenues as well as the Bayshore Pump Station located in south Tampa. This area has historically experienced stormwater runoff problems, particularly during summer rain events. The manhole on Coachman Avenue that overflowed appears to be at the lowest street elevation on Coachman Avenue and is also centered in between two stormwater inlets.

To help resolve the sanitary overflow problem, the City of Tampa Sewer Department contracted with CDM to complete a study called "The Coachman Avenue Overflow Elimination Study." The study objectives are to determine existing collection system capacity in the area of the overflows and to evaluate the City's proposed improvement alternatives.

CDM developed a hydraulic model for the main sanitary trunklines of Bayshore Boulevard and Coachman Avenue as well as other major collectors to evaluate the improvement alternatives. After confirming that the model simulates existing conditions well, several improvement alternative scenarios were evaluated.

Improvement Alternatives

From three main improvement alternatives, a total of fifteen (15) model scenarios were developed to analyze various flows for each alternative. The alternatives that worked consist of:

- Alternative 1 - Upgrade Bayshore Pump Station with Interconnection to the San Carlos Force Main (includes new higher-capacity pumps, 1100 linear feet of 20-inch force main with a tie-in to a 48-inch force main, and a new generator); and

- Alternative 3 – Divert the Coachman Avenue Pump Station flows (which includes Clark Street Pump Station flows) to the Manhattan Avenue Interceptor (includes Coachman pump upgrades and 3900 linear feet of 10-inch force main.)

Alternative 2, Divert Clark Street Pump Station Flows, did not eliminate sanitary overflows since its flows are relatively low compared to the Coachman Avenue and Bayshore Pump Stations.

The rain events of early September 2004 (i.e. hurricane conditions) were used in the model simulations since they resulted in more rain than the August hurricane (total of 7.35 inches of rain with a peak of 2.69 inches in one hour). The model verified that sanitary sewer overflows would occur at the Coachman Avenue and Alline Avenue manholes when the Bayshore Pump Station was limited to a pumping rate of 2000 gpm. The Bayshore Pump Station is designed to operate at approximately 4800 gpm; however, City operators manually adjust the pumping rate as needed to prevent surcharging of the downstream collection system.

Conclusions

Based on CDM's study, the major conclusions are summarized below:

- The existing Bayshore Pump Station pumping at 4000 gpm (assumes a force main tie-in to San Carlos force main) will improve conditions; however, the Bayshore Boulevard trunkline will still be close to surcharging, providing little factor of safety.

- Alternative 1 - Upgrading the Bayshore Pump Station to 6000 gpm (assumes a force main tie-in to San Carlos force main) with no diversion of flows from Coachman Avenue Pump Station will relieve system overflows.

- Alternative 3 – Diverting the Coachman Avenue Pump Station flows (including Clark Street pump station flows) improves system capacity; however, many manholes still surcharge, providing no factor of safety.

Based on this analysis, increasing the pumping capacity of the Bayshore Pump Station to 6000 gpm alone (without diverting the Coachman Avenue Pump Station flows) will result in significantly improved hydraulic conditions and will likely prevent future sanitary overflows. The peak rains (of September 2004) that led to the sanitary overflows have a 4% chance of occurring again, based on review of the last 50 years of historical rainfall (2 times in 50 years).

To increase the confidence that this improvement alternative will prevent future overflows, an even more "rare" storm with a 1% chance of occurrence (100-year storm with a peak intensity of 4.5 inches of rain in one hour) was simulated with CDM's model. The results show that the sanitary system will still not overflow, assuming conditions similar to those modeled (i.e. ground water infiltration and seepage based on current conditions).

Therefore, CDM recommends upgrading the Bayshore Pump Station to 6000 gpm and constructing a new force main tie-in to the San Carlos force main. This alternative is the least costly alternative at about $800,000, is the least disruptive to the public, and can be accomplished relatively quickly. The other alternatives evaluated such as diversion of the Coachman Avenue trunkline and installing a neighborhood pump station were much more costly (up to $2 million) and much more disruptive to the public. CDM also recommends that the City continue with its planned sanitary sewer evaluation study (SSES) to further define inflow and infiltration locations and to identify other possible improvements that could be implemented, such as corking manholes and unclogging pipes, both of which are relatively inexpensive.

Section 1
Introduction

1.1 Purpose

During the hurricanes of 2004, sanitary sewer overflows occurred at two sanitary manholes on Coachman and Alline Avenues as well as at the Bayshore Pump Station located on Bayshore Boulevard in South Tampa. The City of Tampa Wastewater Department contracted CDM to conduct a study that evaluates hydraulic capacity and possible alternatives to relieve future overflows from this collection system. Although this study is entitled, the Coachman Avenue Overflow Elimination Study, it includes evaluation of the hydraulic capacity of Bayshore Boulevard Interceptor system, in addition to the neighborhood collection systems on Coachman and Alline Avenues.

The objectives of the Coachman Avenue Overflow Elimination Study are to determine existing collection system capacity and to evaluate whether the City's proposed improvement alternatives will relieve the system overflows. **Figure 1-1** presents the overall project study area. The study area covers approximately 2.65 square miles and includes the gravity sanitary sewer and force main systems flowing to the Bayshore Pump Station.

One important factor in this study is that the Bayshore Pump Station operation is limited to a pumping rate equal to half its design capacity. According to the City, this is due to the downstream interceptor overflows when sanitary flows greater than 2000 gpm are sent to the receiving sanitary collection system. It is also important to note that the two manholes located on Coachman and Alline Avenue that experienced sanitary overflows are located in very low-lying areas within this South Tampa neighborhood. These areas are also subject to frequent flooding due to stormwater runoff along these streets.

1.2 Scope

The City identified three main alternatives for possible elimination of sanitary overflows in this area. The first alternative is to manifold the Bayshore Pump Station force main directly to the San Carlos force main on Barcelona Street. This alternative would also include upgrading the pumps to allow for the increased head conditions encountered by connection to this pressurized force main. This interconnect would divert flow from the interceptor located downstream of the Bayshore Pump Station since this interceptor has a limited hydraulic capacity during heavy rains.

The second alternative is to divert the wastewater flow from the Clark Street Pump Station to the Manhattan Avenue Interceptor. The third alternative is to divert wastewater flow from the Coachman Avenue Pump Station, which includes the Clark Street Pump Station flows. This would essentially reduce the amount of wastewater in the Coachman Avenue trunkline and the Bayshore Boulevard trunkline. Our scope of work is to specifically evaluate these improvement alternatives to see if they will

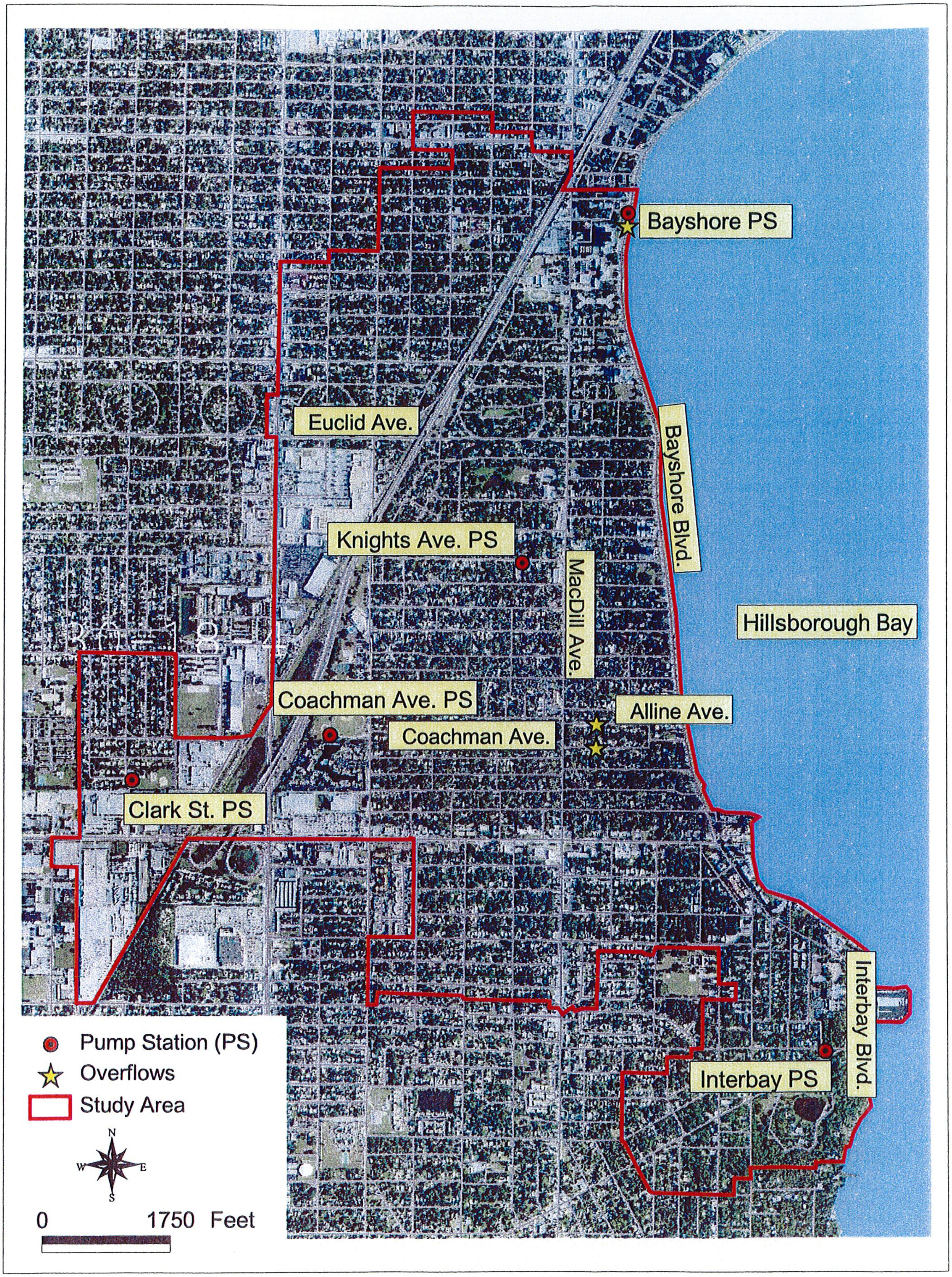

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Figure 1-1. Overall Study Area
Coachman Avenue Overflow Elimination Study

relieve the sanitary sewer overflows at the Bayshore Pump Station, and the Coachman Avenue and Alline Avenue manholes. CDM's scope of work does not include identification of the cause of any inflow and infiltration into the system. Nor does this study include any flow monitoring. Further, this study does not include modeling of the Bayshore Pump Station discharge force main or downstream gravity sewer system. CDM's scope is to specifically evaluate whether either or both of City identified alternatives will relieve the overflows.

An XPSWMM model was used in conducting the hydraulic analysis of the existing collection system within the study area. The City provided CDM with input data for this evaluation, including existing maps and as-built construction drawings of the sewer collection system, water use records, available pump station flow records, and pump run times, and data available from the SCADA system for the Krause and San Carlos Pump Stations, which included wastewater flows and rainfall data at San Carlos Pump Station for the period of April to November 2004. The City also provided CDM with the Flow Monitoring Study of the City of Tampa, Florida Krause Street Pumping Station Basin (ADS, 1999) for information related to previously measured groundwater infiltration and surface stormwater inflow in the general area. These data in part were useful in support of CDM's hydraulic model. This is discussed later in the model development section.

The following sections of this report present each task involved in this study. Section 2 describes the wastewater flow calculations performed while Section 3 describes the hydraulic model developed for the study. Section 4 discusses the various improvement alternatives considered and Section 5 presents conclusions drawn from this study and CDM's recommendations.

Section 2
Wastewater Flows

This section describes the methodology for establishing the wastewater flows that were input into the hydraulic model. CDM obtained a county-wide Geographic Information System (GIS) parcel database from the Hillsborough County Property Appraiser's office. Using this parcel database and City atlas sheets of the south Tampa sanitary collection systems, subbasin collection systems within the study area were identified. These collection system basin boundaries are shown in **Figure 2-1**. Existing water use records for the parcel addresses with the subbasin areas were obtained from the City Water Department. Using the water use records along with available wastewater flow data, representative wastewater flows for each collection system subbasin were established.

2.1 Water Use Records

The City provided monthly water use records from April 2004 to November 2004 for the parcels identified within the study area. The data consisted of domestic water use records and irrigation water use records for those parcels that had separate irrigation meters. The total domestic water usage for the study area was calculated at an average daily water usage of 1.56 million gallons per day (MGD). Since only the domestic portion of the water use data was used, it was assumed that 100% of domestic water use contributes to wastewater generation. This is a conservative assumption since some losses would actually be expected. This wastewater flow generation was considered to be reasonable since the model calibration closely matched observed overflow conditions. Model calibration is discussed in Section 3.0. The estimated wastewater flows for each collection system subbasin are presented in **Table 2-1**.

2.2 Dry and Wet Weather Flow Calculations

Since CDM's scope of work did not include flow monitoring, we reviewed available information from the ADS report, The Flow Monitoring Study of the City of Tampa, Florida Krause Street Pumping Station Basin, dated November 1999. The ADS report had measured wastewater flows for the Krause Intercepting system, which includes the Bayshore Intercepting system, which is our study area. The ADS study had two flow monitors installed in the Bayshore intercepting system, one near the Bayshore Pump Station labeled as KRA03 and one near the intersection of Bayshore Boulevard and West Harbor View Avenue labeled as KRA04, as shown in **Figure 2-2**. The figure also depicts the collection system subbasins that contribute wastewater flow to each monitoring station in the ADS study.

The ADS study reported an average base sanitary wastewater flow of 0.405 mgd at KRA03 and 0.372 mgd at KRA04. Using the ratio of water use for each subbasin to total water use, the total ADS wastewater flows were proportionally distributed into the collection system subbasins. **Table 2-2** presents the base wastewater flow, the

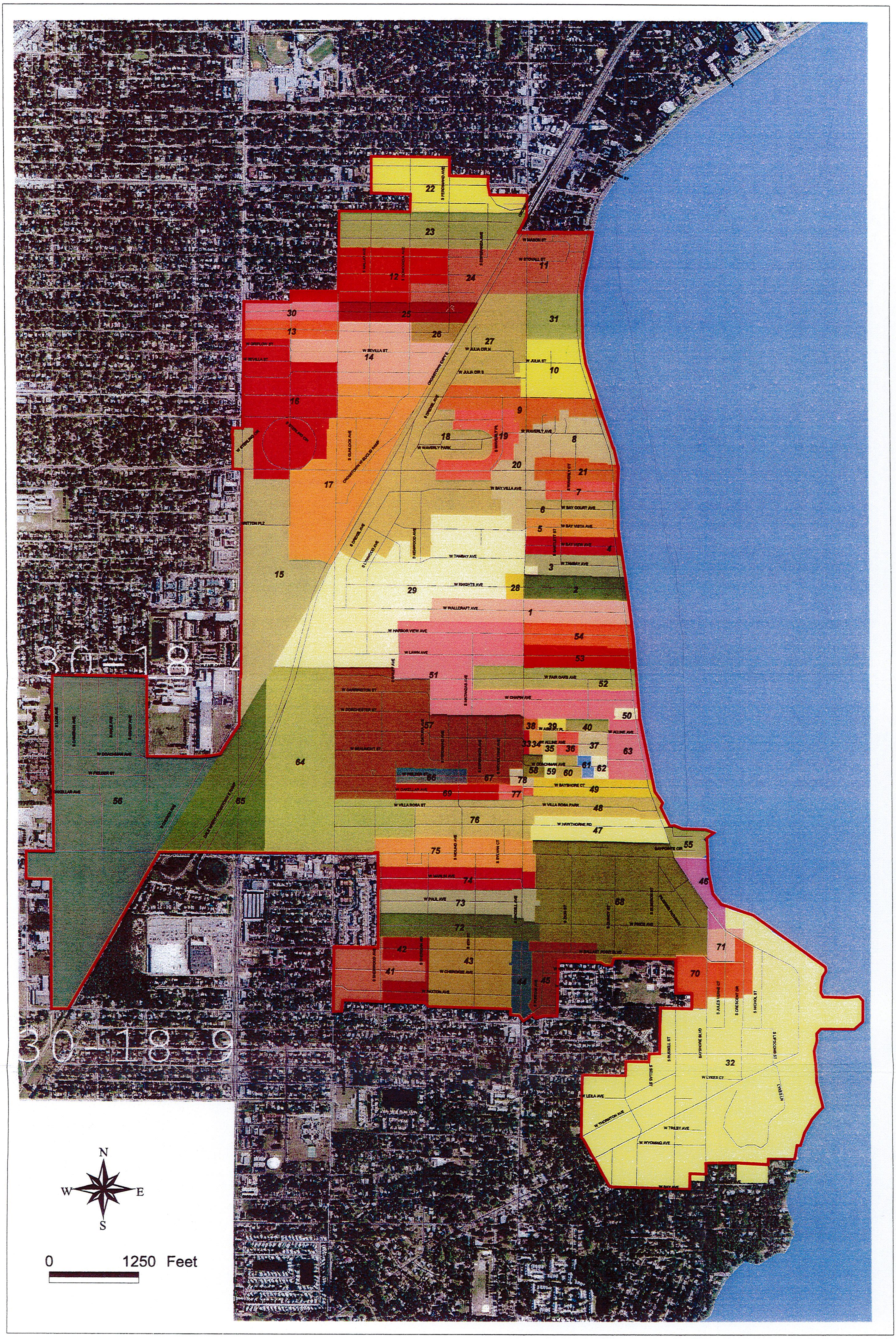

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Figure 2-1. Collection System Basins within Study Area
Coachman Avenue Overflow Elimination Study

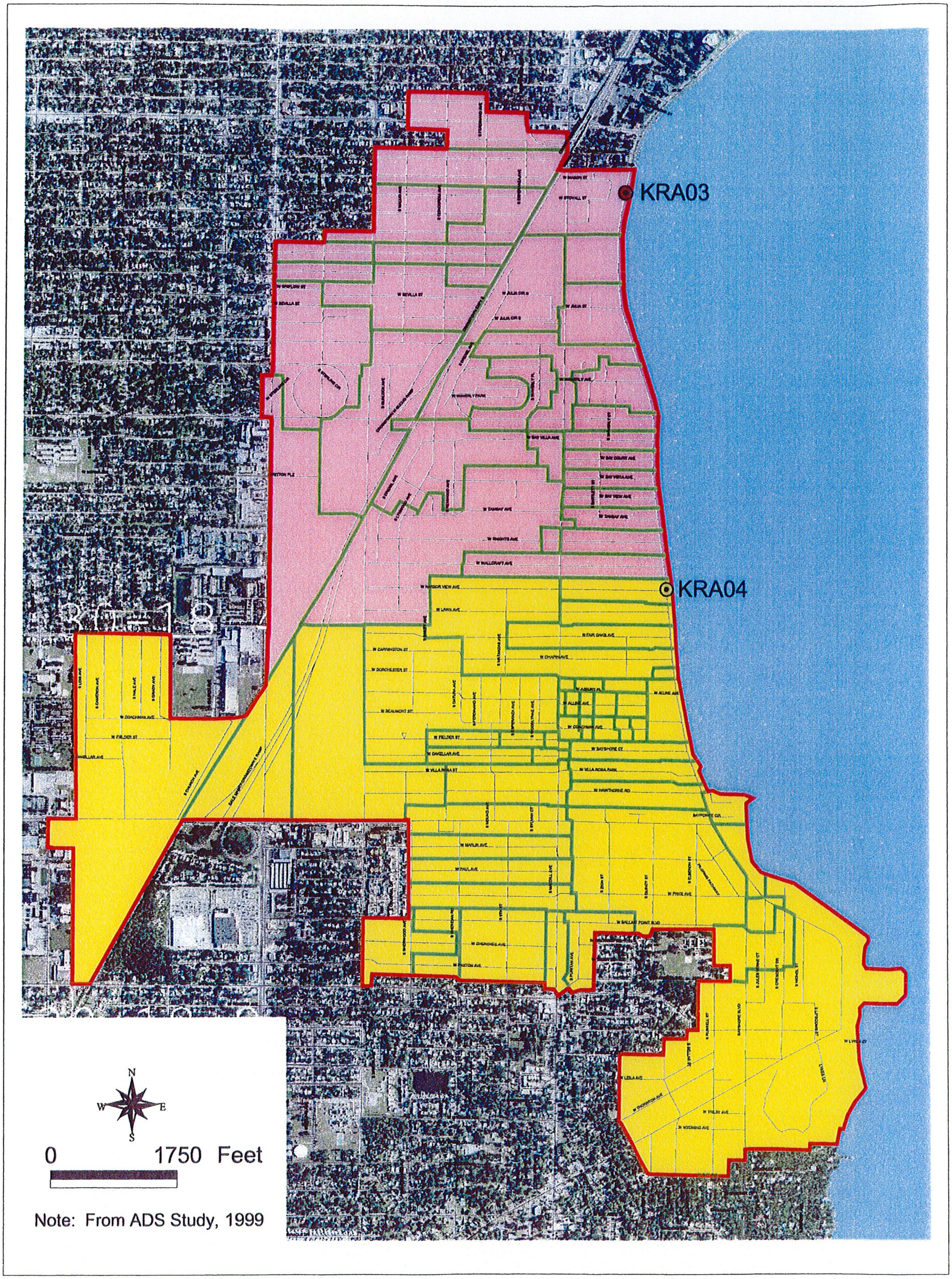

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Figure 2-2. KRA03 and KRA04 Monitoring Stations and Collection Systems
Coachman Avenue Overflow Elimination Study

Table 2-1. Wastewater Flows Calculated from Water Use Records
Coachman Avenue Overflow Elimination Study

Collection System Basin ID	Collection System Basin Name	Calculated Wastewater Flows (MGD)
1	bay34	0.030
2	bay36	0.014
3	bay38	0.023
4	bay40	0.015
5	bay42	0.009
6	bay44	0.009
7	bay46	0.007
8	bay52	0.014
9	bay54	0.010
10	bay56	0.032
11	bay60	0.061
12	concord10	0.027
13	corona10	0.026
14	corona12	0.023
15	euclid10	0.039
16	euclid12	0.031
17	euclid14	0.020
18	euclid16	0.038
19	euclid18	0.013
20	euclid20	0.011
21	euclid22	0.006
22	ferdina10	0.021
23	ferdina12	0.036
24	ferdina14	0.015
25	ferdina16	0.010
26	ferdina18	0.004
27	julia10	0.017
28	knights10	0.004
29	knightsps10	0.090
30	leona10	0.026
31	miramar10	0.020
32	interps10	0.131
33	alline10	0.000
34	alline12	0.001
35	alline14	0.001
36	alline16	0.002
37	alline18	0.002
38	asbury10	0.000
39	asbury12	0.001
40	asbury14	0.003
41	balla10	0.011
42	balla12	0.006
43	balla14	0.019
44	balla16	0.009
45	balla18	0.010

Table 2-1. Wastewater Flows Calculated from Water Use Records
Coachman Avenue Overflow Elimination Study

Collection System Basin ID	Collection System Basin Name	Calculated Wastewater Flows (MGD)
46	bay10	0.008
47	bay16	0.018
48	bay18	0.015
49	bay20	0.016
50	bay24	0.000
51	bay26	0.078
52	bay28	0.019
53	bay30	0.012
54	bay32	0.010
55	baypo10	0.009
56	clarkps10	0.061
57	coach12	0.070
58	coach16	0.003
59	coach18	0.001
60	coach20	0.003
61	coach22	0.001
62	coach24	0.001
63	coach26	0.003
64	coachps10	0.063
65	cross10	0.045
66	field12	0.006
67	field14	0.005
68	gandy10	0.057
69	oakel10	0.011
70	sjules10	0.032
71	sjules12	0.009
72	smcdill10	0.011
73	smcdill12	0.010
74	smcdill14	0.011
75	smcdill16	0.051
76	smcdill18	0.024
77	smcdill20	0.003
78	smcdill22	0.003
	Total	1.564

NOTE: Based on Water Use Records from April 2004 to November 2004.

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Table 2-2. Dry Weather Flow Ratios Used in Wastewater Flow Calculations Coachman Avenue Overflow Elimination Study

Collection System Basin ID	Collection System Basin Name	AREA (acres)	ADS BASIN	RATIO1	BASE WASTEWATER FLOW (MGD)	RATIO2	INFILTRATION (MGD)
1	bay34	21.368	KRA03	0.043	0.017	0.030	0.008
2	bay36	11.394	KRA03	0.020	0.008	0.016	0.004
3	bay38	8.969	KRA03	0.033	0.013	0.012	0.003
4	bay40	8.118	KRA03	0.022	0.009	0.011	0.003
5	bay42	7.835	KRA03	0.013	0.005	0.011	0.003
6	bay44	7.822	KRA03	0.013	0.005	0.011	0.003
7	bay46	6.852	KRA03	0.010	0.004	0.009	0.003
8	bay52	13.782	KRA03	0.021	0.008	0.019	0.005
9	bay54	17.31	KRA03	0.014	0.006	0.024	0.007
10	bay56	17.814	KRA03	0.045	0.018	0.025	0.007
11	bay60	24.45	KRA03	0.087	0.035	0.034	0.009
12	concord10	26.207	KRA03	0.039	0.016	0.036	0.010
13	corona10	8.23	KRA03	0.036	0.015	0.011	0.003
14	corona12	32.659	KRA03	0.033	0.013	0.045	0.012
15	euclid10	56.527	KRA03	0.055	0.022	0.078	0.022
16	euclid12	47.944	KRA03	0.044	0.018	0.066	0.018
17	euclid14	79.288	KRA03	0.028	0.011	0.110	0.030
18	euclid16	57.938	KRA03	0.055	0.022	0.080	0.022
19	euclid18	14.584	KRA03	0.019	0.008	0.020	0.006
20	euclid20	15.945	KRA03	0.015	0.006	0.022	0.006
21	euclid22	8.312	KRA03	0.008	0.003	0.011	0.003
22	ferdina10	25.538	KRA03	0.030	0.012	0.035	0.010
23	ferdina12	29.363	KRA03	0.052	0.021	0.041	0.011
24	ferdina14	14.595	KRA03	0.021	0.008	0.020	0.006
25	ferdina16	12.541	KRA03	0.014	0.006	0.017	0.005
26	ferdina18	4.664	KRA03	0.006	0.002	0.006	0.002
27	julia10	29.598	KRA03	0.024	0.010	0.041	0.011
28	knights10	2.111	KRA03	0.006	0.002	0.003	0.001
29	knightsps10	91.907	KRA03	0.129	0.052	0.127	0.035
30	leona10	8.283	KRA03	0.037	0.015	0.011	0.003
31	miramar10	11.914	KRA03	0.029	0.012	0.016	0.005
32	interps10	191.402	KRA04	0.152	0.057	0.192	0.112
33	alline10	0.715	KRA04	0.000	0.000	0.001	0.000
34	alline12	1.505	KRA04	0.001	0.000	0.002	0.001
35	alline14	1.563	KRA04	0.001	0.000	0.002	0.001
36	alline16	2.458	KRA04	0.002	0.001	0.002	0.001
37	alline18	3.094	KRA04	0.002	0.001	0.003	0.002
38	asbury10	0.805	KRA04	0.000	0.000	0.001	0.000
39	asbury12	1.522	KRA04	0.001	0.000	0.002	0.001
40	asbury14	2.559	KRA04	0.003	0.001	0.003	0.001
41	balla10	17.159	KRA04	0.012	0.005	0.017	0.010
42	balla12	9.649	KRA04	0.007	0.002	0.010	0.006
43	balla14	26.392	KRA04	0.022	0.008	0.027	0.015
44	balla16	6.983	KRA04	0.010	0.004	0.007	0.004
45	balla18	12.785	KRA04	0.011	0.004	0.013	0.007
46	bay10	6.478	KRA04	0.009	0.003	0.007	0.004
47	bay16	15.353	KRA04	0.020	0.008	0.015	0.009
48	bay18	12.292	KRA04	0.018	0.007	0.012	0.007
49	bay20	10.204	KRA04	0.019	0.007	0.010	0.006
50	bay24	1.239	KRA04	0.001	0.000	0.001	0.001
51	bay26	57.867	KRA04	0.090	0.034	0.058	0.034
52	bay28	17.189	KRA04	0.021	0.008	0.017	0.010

Table 2-2. Dry Weather Flow Ratios Used in Wastewater Flow Calculations
Coachman Avenue Overflow Elimination Study

Collection System Basin ID	Collection System Basin Name	AREA (acres)	ADS BASIN	RATIO1	BASE WASTEWATER FLOW (MGD)	RATIO2	INFILTRATION (MGD)
53	bay30	11.214	KRA04	0.013	0.005	0.011	0.007
54	bay32	11.248	KRA04	0.012	0.004	0.011	0.007
55	baypo10	5.064	KRA04	0.011	0.004	0.005	0.003
56	clarkps10	141.893	KRA04	0.070	0.026	0.143	0.083
57	coach12	74.288	KRA04	0.081	0.030	0.075	0.043
58	coach16	2.201	KRA04	0.003	0.001	0.002	0.001
59	coach18	1.313	KRA04	0.001	0.000	0.001	0.001
60	coach20	2.467	KRA04	0.003	0.001	0.002	0.001
61	coach22	1.445	KRA04	0.001	0.000	0.001	0.001
62	coach24	1.561	KRA04	0.001	0.001	0.002	0.001
63	coach26	10.606	KRA04	0.003	0.001	0.011	0.006
64	coachps10	76.131	KRA04	0.073	0.027	0.077	0.044
65	cross10	42.134	KRA04	0.053	0.020	0.042	0.025
66	field12	5.194	KRA04	0.007	0.003	0.005	0.003
67	field14	3.08	KRA04	0.006	0.002	0.003	0.002
68	gandy10	80.533	KRA04	0.066	0.025	0.081	0.047
69	oakel10	7.461	KRA04	0.012	0.005	0.007	0.004
70	sjules10	15.875	KRA04	0.037	0.014	0.016	0.009
71	sjules12	4.615	KRA04	0.010	0.004	0.005	0.003
72	smcdill10	17.266	KRA04	0.012	0.005	0.017	0.010
73	smcdill12	17.875	KRA04	0.011	0.004	0.018	0.010
74	smcdill14	16.178	KRA04	0.013	0.005	0.016	0.009
75	smcdill16	21.075	KRA04	0.059	0.022	0.021	0.012
76	smcdill18	21.395	KRA04	0.028	0.010	0.022	0.012
77	smcdill20	2.162	KRA04	0.004	0.001	0.002	0.001
78	smcdill22	1.455	KRA04	0.004	0.001	0.001	0.001
			TOTAL	-	0.777	-	0.857

NOTE:
1. Based on ADS Flow Study 1999
2. Ratio 1 - collection basin's calculated wastewater flow divided by the total wastewater flow of the appropriate ADS Basin
3. Ratio 2 - collection basin area divided by the total area of the appropriate ADS Basin

contributing area for each collection system subbasin, and the ADS monitored flow allocated within each collection system subbasin.

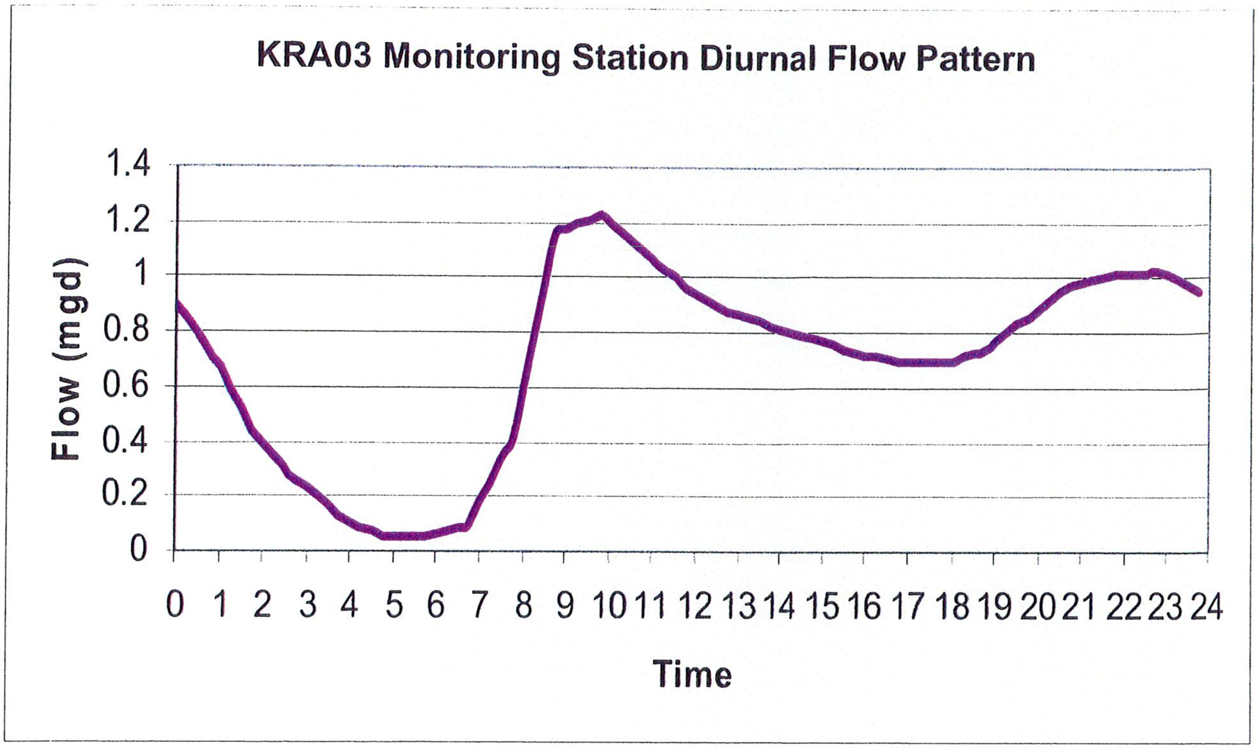
The ADS report estimated base groundwater infiltration for the areas associated with each flow monitor station. The ADS study reported an average base groundwater flow of 0.276 mgd at KRA03 (68% of the base sanitary wastewater flow) and 0.581 mgd (or 156% of the base sanitary wastewater flow) for KRA04. This indicates significant infiltration under dry weather conditions. The base groundwater flow for each collection system subbasin was estimated by proportionally distributing the total reported base groundwater flow to the collection system subbasins based on subbasin area. The groundwater flow for each collection system subbasin is also shown in **Table 2-2**.

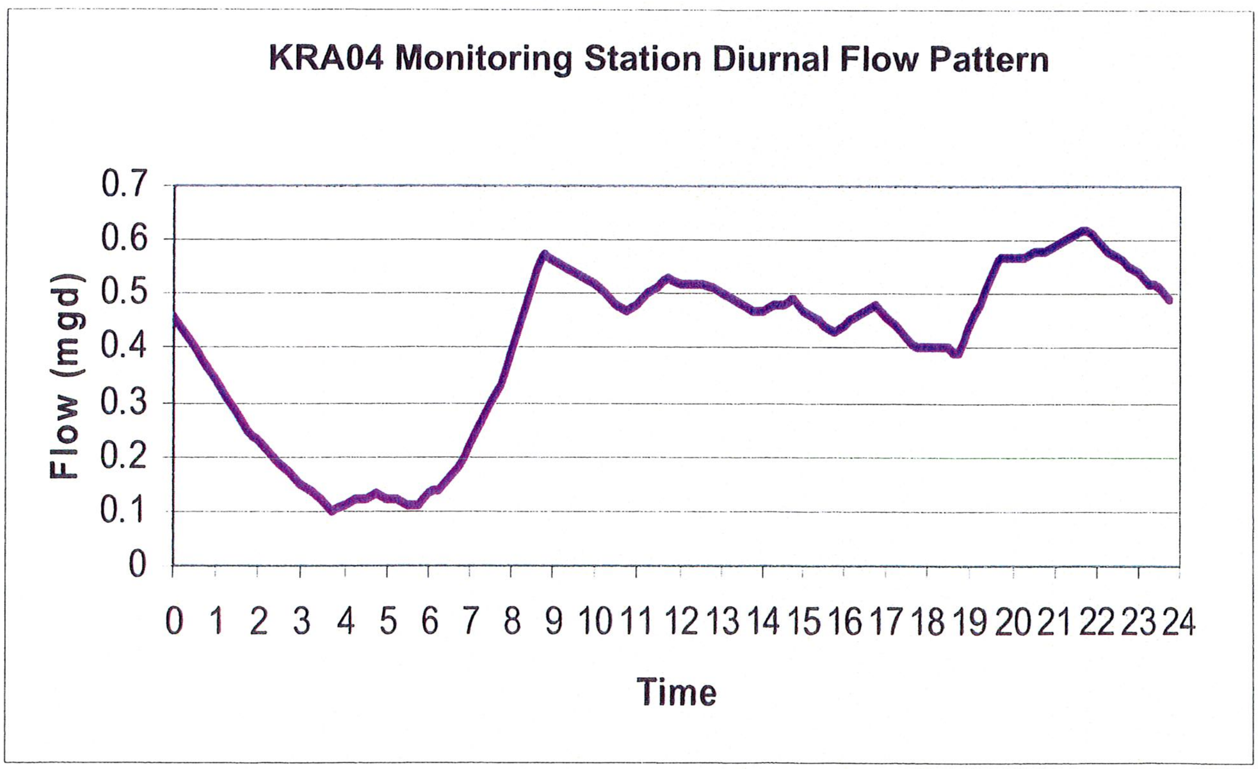
Diurnal patterns for the KRA03 and KRA04 subbasins were developed using the reported measured flow data from the ADS study. The diurnal patterns established are presented in **Figure 2-3**.

To estimate the wet weather flows for the study area, rainfall data from the San Carlos Pump Station SCADA system was used. Specifically rainfall from August through September 2004 was evaluated since four recorded hurricanes occurred during this period. The total rainfall from August 1 to August 31 equaled 12.75 inches. The highest intensity rainfall during this period was 1.6 inches/hour. From September 4th thru September 8th, the total reported rainfall was 7.35 inches, with the highest intensity of 2.69 inches per hour occurring on September 6 from 2 to 3 PM as presented in **Figure 2-4**. This September rainfall was chosen as the basis to establish wet weather flows for the model simulation since it had most intense hourly rainfall for the entire study period of the April 2004 to November 2004. This rainfall event could be compared to a typical return storm of a 3 to 5 year -1 hour design storm, based on the input provided by the City of Tampa Stormwater Department.

CDM programs such as RDIIVIEW and BASINFL2 programs were then used to develop wet weather hydrographs for the storm events. These are discussed further in the model section of this report. Generally, the BASINFL2 program is used to generate the hydrographs for the collection system subbasins, while the RDIIVIEW program is used to help breakdown the hydrograph into dry weather and wet weather components. The BASINFL2 program sums the base wastewater flow and groundwater flow and then applies the diurnal shape to only the base wastewater flow portion of the hydrograph. Wet weather flow is then added to the dry weather flow to get a total flow in for the collection system subbasins. **Figure 2-5** presents the wet weather inflow hydrograph calculated using the BASINFL2 program for the loading point at model node "Field10."

The calculated wet weather wastewater flows from September 4th thru September 8th, 2004 ranged from 1.57 to 7.30 mgd with the average daily flow at 3.45 mgd. These wet weather flows were used in the model analyses discussed in Section 3.

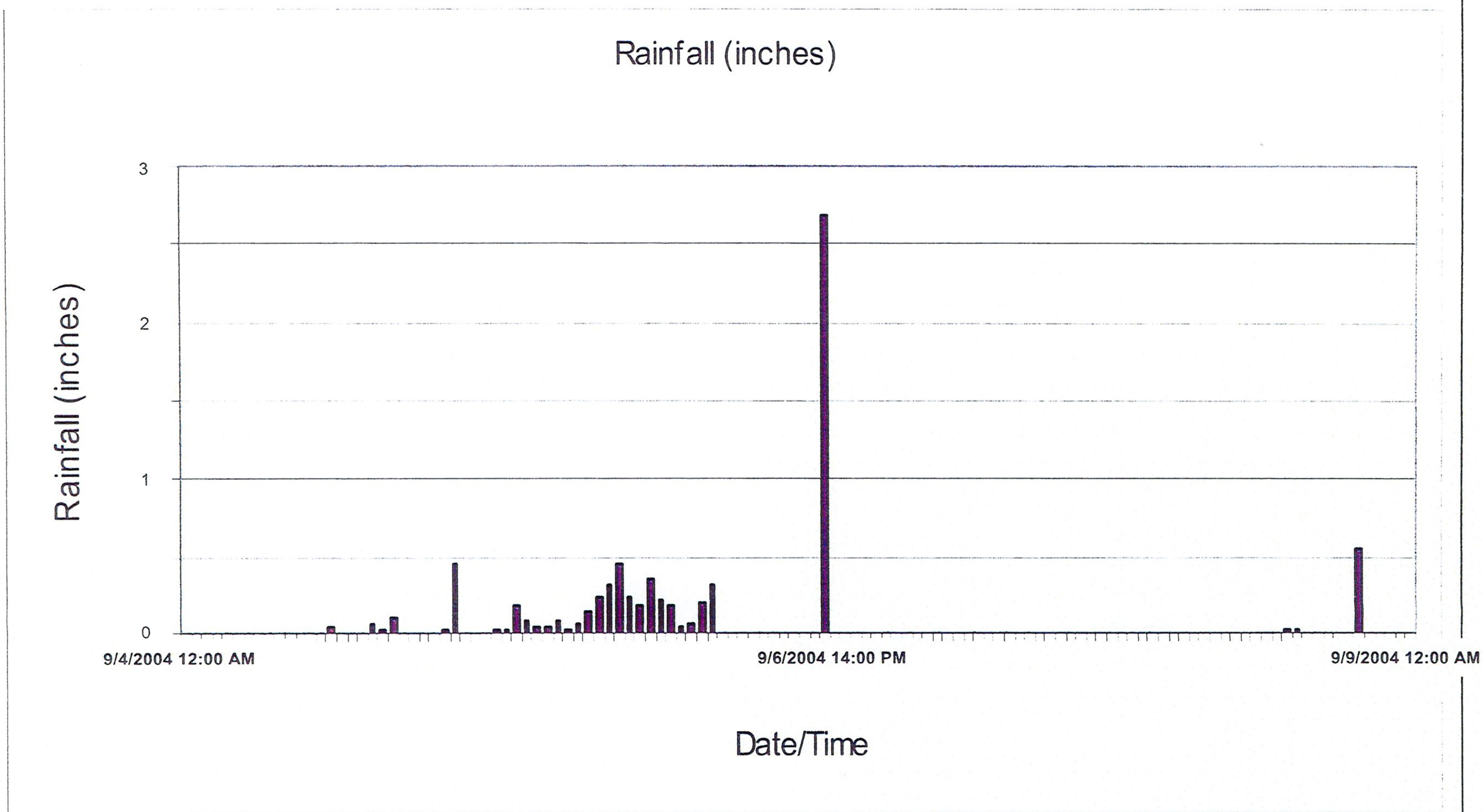




Note: From ADS Study 1999

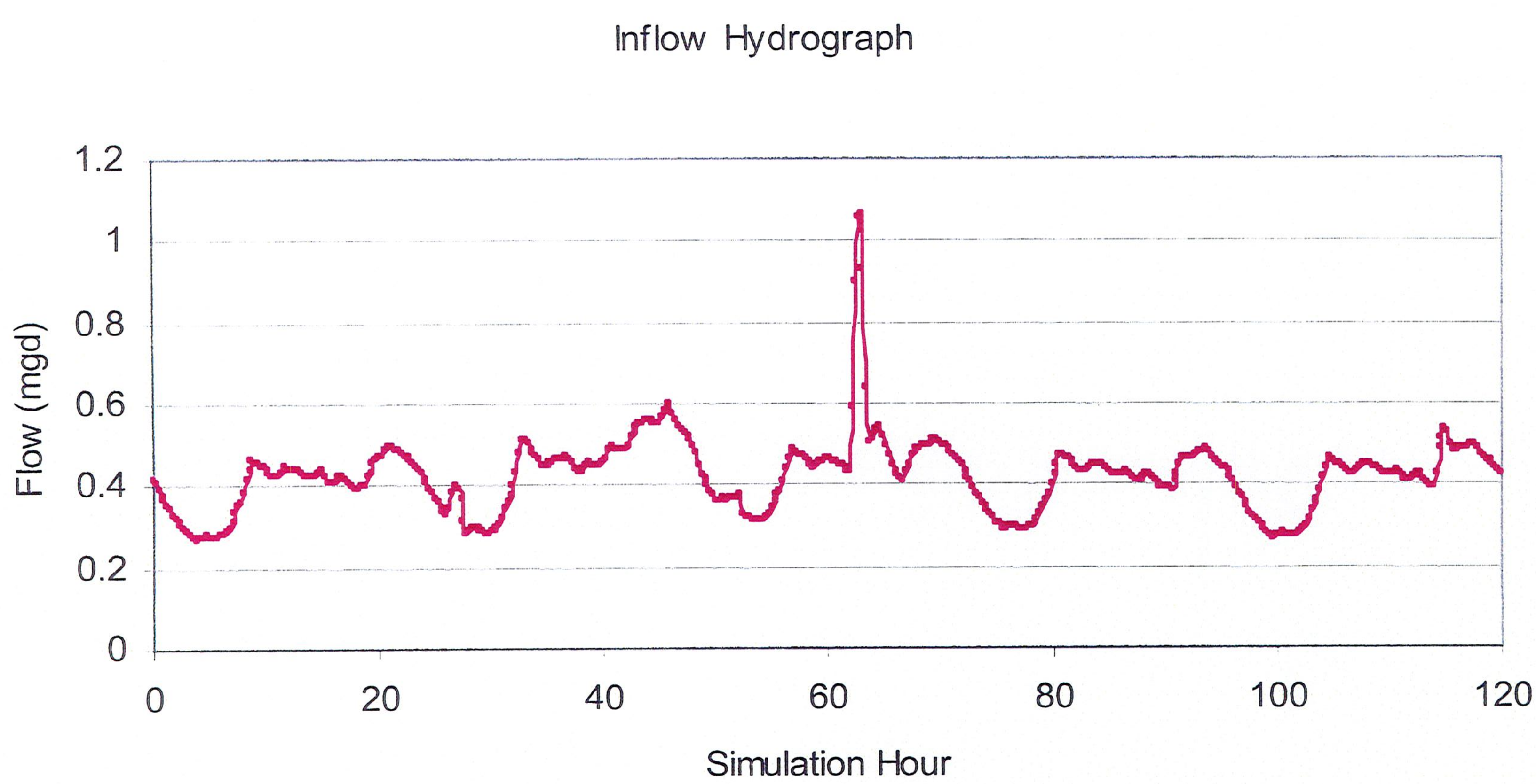
Figure 2-3. Diurnal Flow Patterns for KRA03 and KRA04
Coachman Avenue Overflow Elimination Study

CDM



Source: City of Tampa

Figure 2-4. September 4th -8th 2004 Rainfall at San Carlos Pump Station
Coachman Avenue Overflow Elimination Study



Generated From: CDM Model

CDM

Figure 2-5. Inflow Hydrograph at Field10
Coachman Avenue Overflow Elimination Study

Section 3
Hydraulic Model

The XPSWWM model program, which is accepted by EPA and SWFWMD, was chosen to develop the hydraulic model for the study area since the City is familiar with this modeling software. The City Wastewater Department has used XPSWWM for other hydraulic models.

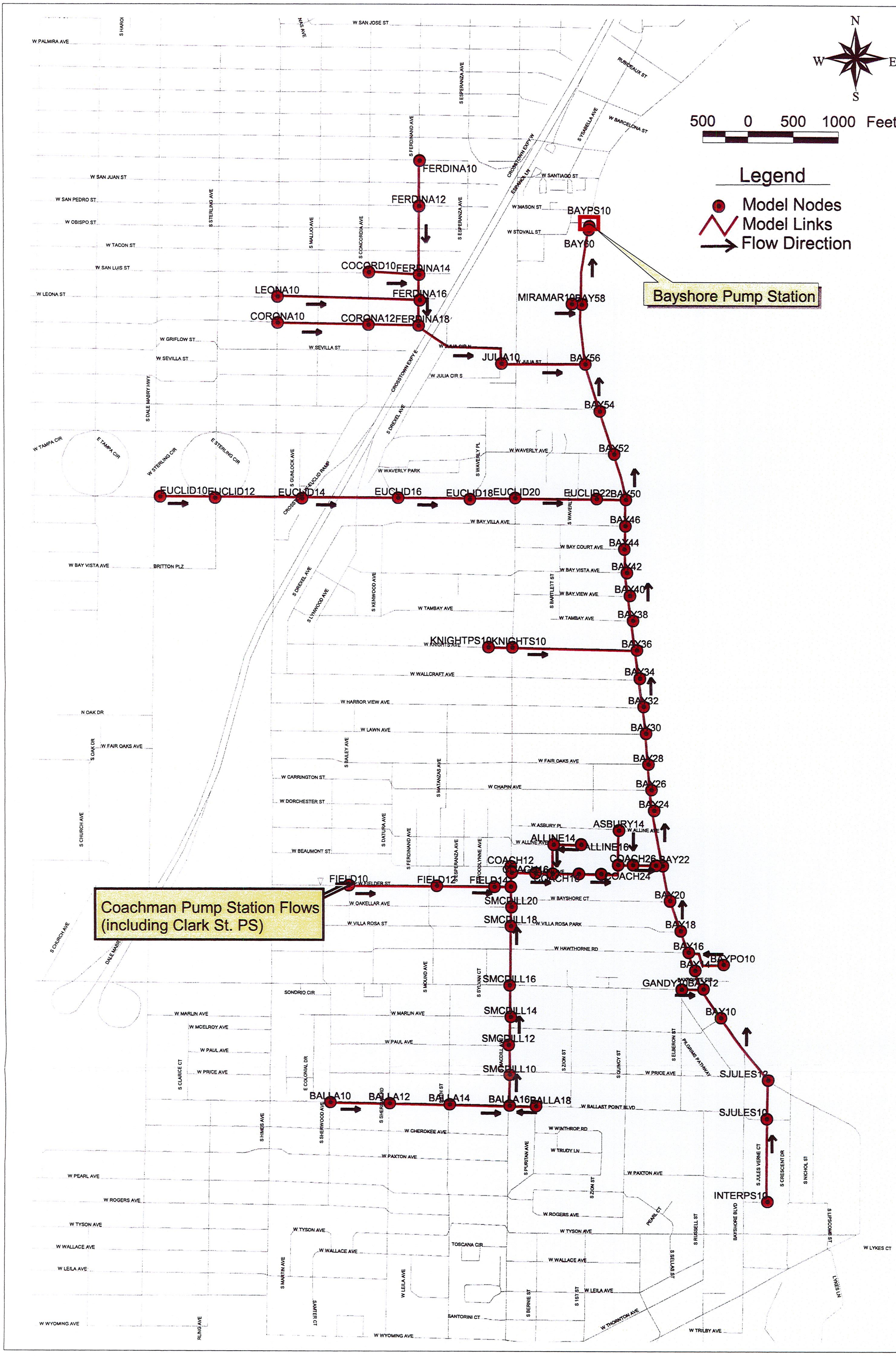
3.1 Model Development

As mentioned previously, various GIS data coverages including streets, parcels, and aerial photographs as well as the City's as-builts of the collection system were used in developing the hydraulic model. Not all of the manholes/pipes in the study area were included in the model. For this analysis, it was not necessary to simulate the entire collection system. Therefore, the collection system branches were truncated to one or two manholes just off of the main Bayshore Boulevard trunkline or in some cases the branch flows were applied directly to the receiving manhole in the Bayshore interceptor. Only the gravity sanitary collection system leading to the Bayshore Pump Station was modeled. Individual pump station flows for Interbay, Knights Avenue, Clark Street, and Coachman Avenue Pump Station were input into the model at the appropriate manhole (or model junction). These pump stations were not explicitly modeled as pump stations, but their flows were included in the model.

More of the sanitary collection system was modeled for the pipeline branches along Coachman and Alline Avenues, where the overflows were reported. **Figure 3-1** presents the model schematic. The model junctions are generally manholes where the collection system sub-basins flows were applied. There are 78 model junctions and 65 flow input or load points included in the hydraulic model. **Table A-1** (Appendix A) presents the input data used in creating the model with upstream downstream junctions and detailed pipe/link information. Bayshore Pump Station was modeled as a pump station using the wet well depth and volume information determined from the as-built drawings provided by the City Wastewater Department. The overflow pipe from the manhole leading to the Bayshore Pump Station was also included in the model at the pump station. Overflows at the Bayshore Pump Station are limited to the overflow pipe.

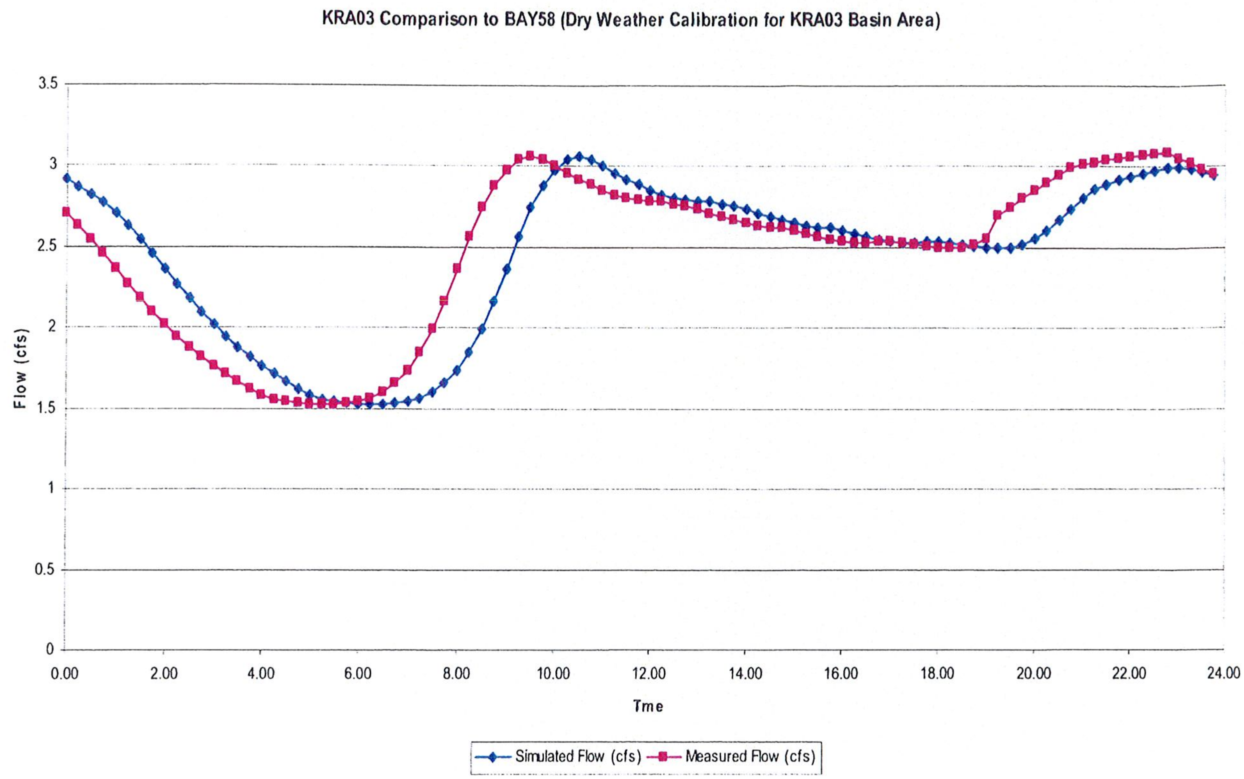
3.2 Model Calibration/Verification

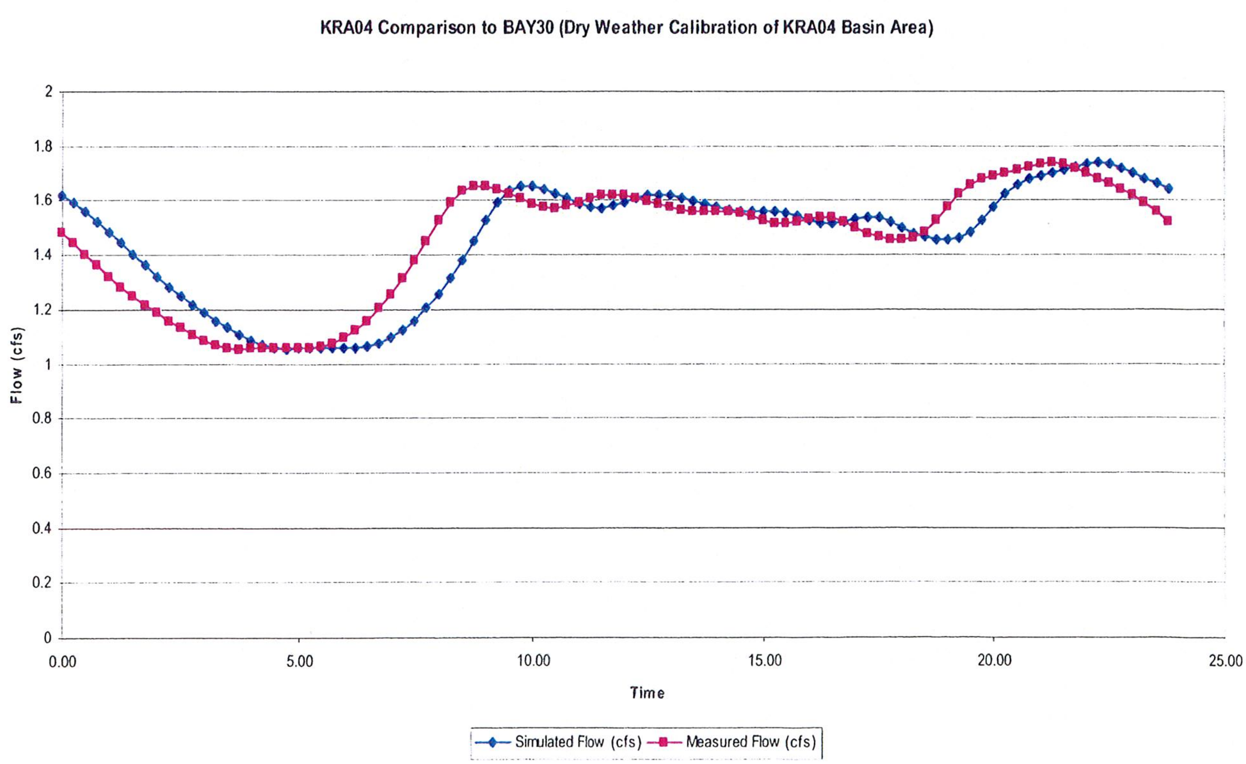
Data provided by the Wastewater Department indicates that the wastewater flows to the Bayshore pump station were calculated to be approximately 6.1 mgd; however, continuous flow meter records are not available for that pump station for the study period from April to November 2004. Since actual wastewater flows from this pump station was not available, the calibration of the hydraulic model was conducted using the measured flow data from 1999 ADS study (for flow monitoring stations KRA03 and KRA04) for both dry simulation and wet weather simulations. **Figure 3-2** presents the dry weather calibration results for these two flow monitoring stations.



CDM

Figure 3-1. Model Schematic
Coachman Avenue Overflow Elimination Study





Note: Measured Flow from ADS Study 1999
Simulated Flow From CDM Model

CDM

Figure 3-2. Dry Weather Calibration
Coachman Avenue Overflow Elimination Study

The simulated dry weather flow from our model matches fairly well as compared to the ADF flow data.

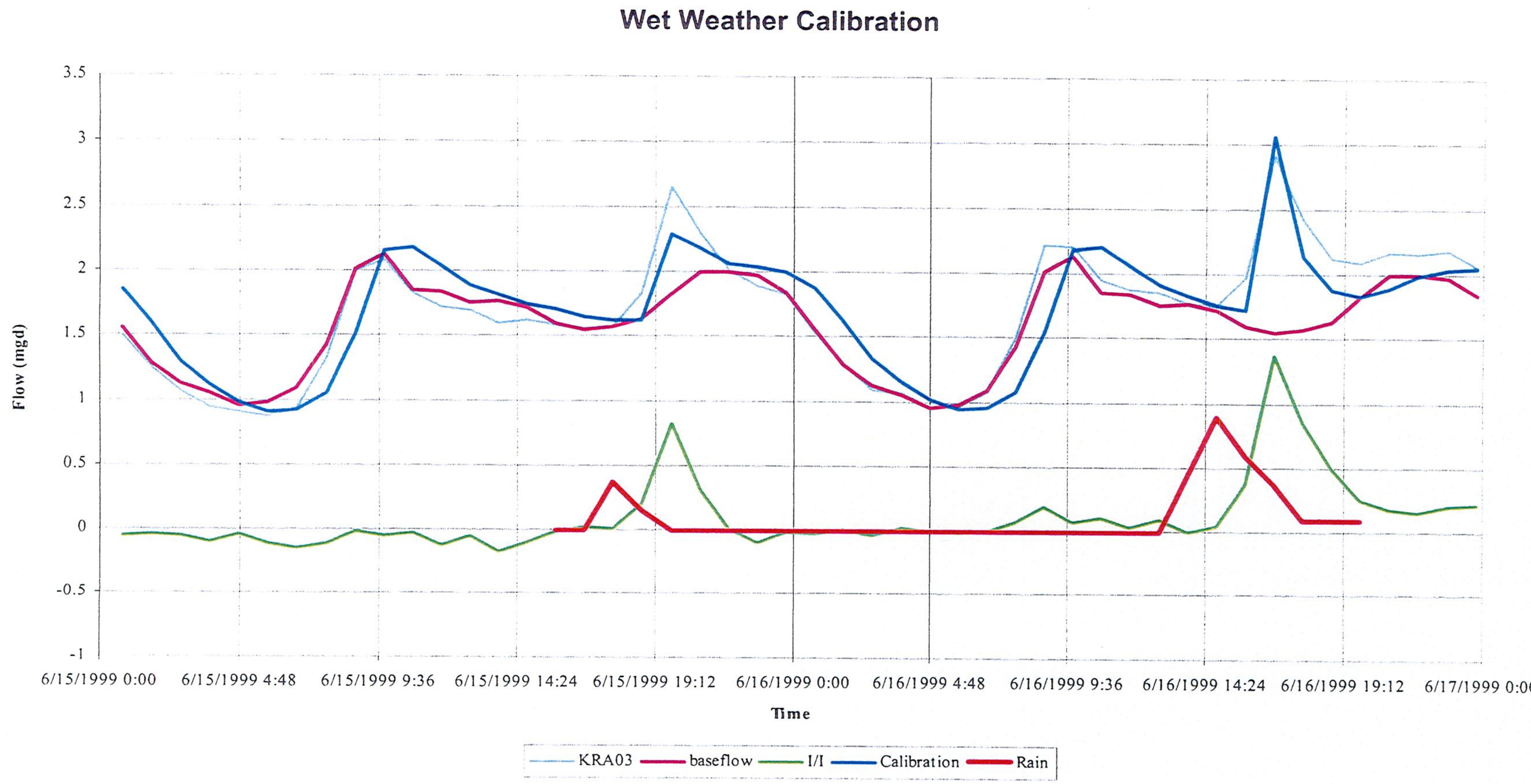
For the wet weather calibration and verification of the model accuracy, the June 15th thru 16th, 1999 storm was used since this storm event had definitive and significant peaks that could be determined without interference from other factors, such as back to back rainfall events. The ADS recorded flow and rainfall data were used for the calibration of the wet weather flow model.

Figure 3-3 presents the wet weather flow calibration results for this study using the June 15th thru 16th, 1999 storm event. The simulated flow matches the measured flow data fairly well. The inflow parameters that produced this calibration were then used to generate wet weather flow for the period from September 4th thru September 8th, 2004. This time period was chosen since it had most intense rainfall during the April to November 2004 study period time frame. In addition, the groundwater infiltration from the dry weather calibration was increased by 50% to account for the wet conditions as calculated in the ADS report.

The BASINFL2 program was then used to generate the inflow hydrographs at the model load points. The BASINFL2 program generated the hydrographs in a format that can be directly imported into XPSWMM. XP SWMM simulations were then performed to evaluate how well the model demonstrated the reported overflows in the study area.

The model predicted overflows at Coachman Avenue and Alline Avenue manholes and the Bayshore Pump Station under the existing conditions scenario. These simulated results generally corresponded with observed conditions and reported overflows in the study area. At this point, the model was considered to be reasonably calibrated to continue with the alternative analyses.

Using this existing conditions model, several improvement alternative scenarios were then simulated to identify an alternative that would relieve the Coachman Avenue, Alline Avenue, and the Bayshore Pump Station overflows. Section 4 describes the alternatives evaluated.



Note: Measured Flow from ADS Study 1999 For KRA03 Monitoring Station

(June 15-16, 1999 Storm Event)

CDM

Figure 3-3. Wet Weather Calibration
Coachman Avenue Overflow Elimination Study

Section 4
Improvement Alternatives

4.1 Description of Alternatives

The City of Tampa Wastewater Department identified three main alternatives to relieve future sanitary overflows in this area. These alternatives are listed below.

- Alternative 1 - Upgrading Bayshore Pump Station and manifold the force main directly to the San Carlos Force Main at Barcelona Street (includes new higher-capacity pumps, 1100 linear feet of 20-inch force main with a tie-in to a 48-inch force main);
- Alternative 2 – Diversion of Clark Street Pump Station Flows to the Manhattan Avenue Interceptor(includes pump upgrade and 2200 linear feet of 12-inch force main;
- Alternative 3 – Diversion of Coachman Avenue Pump Station Flows to the Manhattan Avenue Interceptor (includes Clark Street Pump Station Flows); requires upgrades to Coachman pumps and 3900 linear feet of 10-inch force main.

Since the Bayshore pump station has a design capacity of approximately 4800 gpm, the 2000 gpm and 4000 gpm pumping scenarios were considered as "existing conditions". However, as mentioned previously, due to downstream gravity sanitary system hydraulic constraints, the Bayshore Pump Stations flows have been manually limited to 2000 gpm. Consequently, to operate the Bayshore pumping station at flows greater than 2000 gpm, changes to the downstream collection system would be required to improve its hydraulic capacity.

From these three main alternatives, a total of fifteen (15) model scenarios were developed to analyze various flow scenarios (in 2000 gpm increments) for each of these alternatives. Although the existing Bayshore Pump Station is designed to pump up to 4800 gpm, increasing the pumping rate to 6000, 8000, and 10,000 gpm was modeled to represent pump station upgrades.

A detailed description of each model scenario is provided below.

<u>Existing Condition at 2000 gpm</u> - This is the existing system as is, with Bayshore Pump Station pumping at a rate of 2000 gpm. The existing system consists of the Clark Street Pump Station flows discharging into the gravity sanitary sewer flowing to Coachman Avenue Pump Station, the Coachman Avenue Pump Station then pumps the combined flows into the Fielder St. manhole, which flows by gravity into the Coachman Avenue sanitary sewer system, and then into the Bayshore Boulevard trunk system, ultimately flowing into to the Bayshore Pump Station; Bayshore Pump Station pumping at 2000 gpm to existing gravity interceptor.

<u>Existing Condition at 4000 gpm</u> – This is the same scenario as above, except with the Bayshore Pump Station pumping at 4000 gpm (would require manifold force main to San Carlos force main).

<u>Alternative 1 - Upgrade Bayshore Pump Station to 6000 gpm</u> – This scenario consists of the Bayshore Pump Station pumping at a 6000 gpm pumping rate, and assumes a manifold force main directly to the San Carlos force main.

<u>Alternative 1A - Upgrade Bayshore Pump Station to 8000 gpm</u> – This scenario consists of upgrading the Bayshore Pump Station to a 8000 gpm pumping rate, and assumes a manifold force main directly to the San Carlos force main.

<u>Alternative 1B - Upgrade Bayshore Pump Station to 10000 gpm</u> – This scenario consists of upgrading the Bayshore Pump Station to a 10000 gpm pumping rate, and assumes a manifold force main directly to the San Carlos force main.

<u>Alternative 2 – Diversion of Clark Street Pump Station Flows with Bayshore Pumping at 2000 gpm -</u>This scenario consists of diverting Clark Street Pump Station flows (100-375 gpm) to the Manhattan Avenue gravity interceptor, thus removing the Clark Street Pump Station flows from the Coachman Avenue/Bayshore Interceptor system. Bayshore Pump Station operation is simulated at 2000 gpm.

<u>Alternative 2A – Diversion of Clark Street Pump Station Flows with Bayshore Pumping at 4000 gpm -</u>This scenario consists of diverting Clark Street Pump Station flows (100-375 gpm) to the Manhattan Avenue gravity interceptor, thus removing the Clark Street Pump Station flows from the Coachman Avenue/Bayshore Interceptor system. Bayshore Pump Station operation is simulated at 4000 gpm.

<u>Alternative 2B – Diversion of Clark Street Pump Station Flows with Bayshore Pumping at 6000 gpm -</u>This scenario consists of diverting Clark Street Pump Station flows (100-375 gpm) to the Manhattan Avenue gravity interceptor, thus removing the Clark Street Pump Station flows from the Coachman Avenue/Bayshore Interceptor system. Bayshore Pump Station operation is simulated at 6000 gpm.

<u>Alternative 2C – Diversion of Clark Street Pump Station Flows with Bayshore Pumping at 8000 gpm -</u>This scenario consists of diverting Clark Street Pump Station flows (100-375 gpm) to the Manhattan Avenue gravity interceptor, thus removing the Clark Street Pump Station flows from the Coachman Avenue/Bayshore Interceptor system. Bayshore Pump Station operation is simulated at 8000 gpm.

<u>Alternative 2D – Diversion of Clark Street Pump Station Flows with Bayshore Pumping at 10000 gpm -</u>This scenario consists of diverting Clark Street Pump Station flows (100-375 gpm) to the Manhattan Avenue gravity interceptor, thus removing the Clark Street Pump Station flows from the Coachman Avenue/Bayshore Interceptor system. Bayshore Pump Station operation is simulated at 10000 gpm.

Alternative 3 – Diversion of Coachman Avenue Pump Station Flows, with Bayshore Pumping at 2000 gpm -This scenario consists of diverting the Coachman Avenue Pump Station flows, (200-700 gpm) , which includes the Clark Street Pump Station flows. Bayshore Pump Station operation is simulated at 2000 gpm.

Alternative 3A – Diversion of Coachman Avenue Pump Station Pump Station Flows with Bayshore Pumping at 4000 gpm -This scenario consists of diverting the Coachman Avenue Pump Station flows, (200-700 gpm) , which includes the Clark Street Pump Station flows. Bayshore Pump Station operation is simulated at 4000 gpm.

Alternative 3B – Diversion of Clark Street and Coachman Avenue Pump Station Pump Station Flows with Bayshore Pumping at 6000 gpm -This scenario consists of diverting the Coachman Avenue Pump Station flows, (200-700 gpm) , which includes the Clark Street Pump Station flows. Bayshore Pump Station operation is simulated at 6000 gpm.

Alternative 3C – Diversion of Clark Street and Coachman Avenue Pump Station Pump Station Flows with Bayshore Pumping at 8000 gpm -This scenario consists of diverting the Coachman Avenue Pump Station flows, (200-700 gpm) , which includes the Clark Street Pump Station flows. Bayshore Pump Station operation is simulated at 8000 gpm.

Alternative 3D – Diversion of Clark Street and Coachman Avenue Pump Station Pump Station Flows with Bayshore Pumping at 10000 gpm -This scenario consists of diverting the Coachman Avenue Pump Station flows, (200-700 gpm) , which includes the Clark Street Pump Station flows. Bayshore Pump Station operation is simulated at 10000 gpm.

4.2 Model Results

A summary of the model results is presented in **Table 4-1**. The model results show that overflows occur at the Coachman Avenue and Alline St. manholes and at the Bayshore Pump Station under the existing conditions scenario with Bayshore Pump Station limited to 2000 gpm under wet weather conditions. Basically, this means that the Bayshore Avenue pump station cannot keep up with the incoming flows during wet weather when limited to a pumping rate of 2000 gpm. This scenario also shows significant surcharging in 48 manholes in the modeled sewer collection system. **Figure 4-1** presents a schematic drawing of the overflowing and surcharging manholes under the 2000 gpm existing condition scenario. These modeling results align closely with observed conditions during wet weather events.

The existing conditions scenario at 4000 gpm shows no manholes overflowing under the simulated wet weather conditions, but 1 manhole is surcharging. **Figure 4-2** illustrates the manhole conditions under the 4000 gpm existing conditions scenario. The surcharging manhole is the Fielder Street manhole, which receives flow from the Coachman Pump Station (including Clark Street Pump Station flows). A closer look

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Figure 4-1. Existing Condition - 2000 gpm
Coachman Avenue Overflow Elimination Study

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Figure 4-2. Existing Condition - 4000 gpm
Coachman Avenue Overflow Elimination Study

at the hydraulic profile of the Fielder Street collection system shows slight surcharging, but there is more than 3 feet of freeboard to the manhole rim. The Bayshore trunkline is at nearly 87% full capacity, but is not surcharging under this 4000 gpm scenario.

Table 4-1
Model Results
Coachman Avenue Overflow Elimination Study

Scenario	No. of Surcharging Nodes	No. of Flooding Nodes	Estimated Flooding Volume (cu.ft.)
Existing Conditions at 2000 gpm	48	3	86,873
Existing Conditions at 4000 gpm	1	-	-
Alternative 1 - Upgrade Bayshore PS to 6000 gpm	1	-	-
Alternative 1A - Upgrade Bayshore PS to 8000 gpm	1	-	-
Alternative 1B - Upgrade Bayshore PS to 10000 gpm	1	-	-
Alternative 2 – Diversion of Clark Street PS; Bayshore PS at 2000 gpm	42	1	28,130
Alternative 2A – Diversion of Clark Street PS; Bayshore PS at 4000 gpm	0	-	-
Alternative 2BA – Diversion of Clark Street PS; Bayshore PS at 6000 gpm	0	-	-
Alternative 2C – Diversion of Clark Street PS; Bayshore PS at 8000 gpm	0	-	-
Alternative 2D – Diversion of Clark Street PS; Bayshore PS at 10000 gpm	0	-	-
Alternative 3 – Diversion of Coachman Av PS, Bayshore PS at 2000 gpm	17	-	-
Alternative 3A – Diversion of Coachman Av PS, Bayshore PS at 4000 gpm	0	-	-
Alternative 3B – Diversion of Coachman Av PS, Bayshore PS at 6000 gpm	0	-	-
Alternative 3C– Diversion of Coachman Av PS, Bayshore PS at 8000 gpm	0	-	-
Alternative 3D– Diversion of Coachman Av PS, Bayshore PS at 10000 gpm	0	-	-

Note: PS – Pump Station

The results of the Alternative 1A and 1B scenarios show that surcharging occurs at one manhole (the Fielder Street manhole) under the simulated flow rates. Taking a closer look at the hydraulic profile (from the model) at Fielder Street reveals surcharging just above the crown of the pipe (with more than 3 feet of freeboard in the manhole before overflowing). The City might want to consider actual flow monitoring at the Fielder Street manhole during the future Sanitary Sewers System Evaluation Study (SSES) of this area. This would help determine the extent of surcharging.

Figure 4-3 illustrates the manhole conditions for the Alternative 1, 1A and 1B scenarios, upgrading the Bayshore Pump Station to 6000, 8000, and 10,000 gpm pumping rates. There are no surcharging manholes and no overflows, according to the model results.

For the Alternative 2 scenarios, diverting the Clark Street Pump Station flows to the Manhattan Street interceptor (with Bayshore Pump Station pumping at 2000 gpm) still results in overflows at the Bayshore Pump Station. The model results also show that the Alline and Coachman Avenue manholes are surcharging along with more than 40 other manholes in the collection system. The results also indicate that no surcharging or overflows occur at the 4000, 6000, 8000, and 10,000 pumping rates. **Figure 4-4** illustrates the manhole conditions for Alternative 2 (diversion of Clark Street Pump Station, with Bayshore pumping at 2000 gpm). No surcharging or overflows occur at the 4000, 6000, 8000, and 10,000 pumping rates, which are Alternatives 2A, 2B, 2C and 2D.

The model results for the Alternative 3 scenarios (diversion of both the Coachman Avenue Pump Station flows, including Clark Street Pump Station flows), indicate that surcharging occurs in 17 manholes under the 2000 gpm pumping scenario, which is shown in **Figure 4-5**. However, no overflows occur under the 2000 gpm simulated condition. The results for the 4000, 6000, 8000, and 10,000 pumping rates, show that no surcharging or overflows occur in the system at these flow rates under the simulated wet weather conditions.

Figure 4-6 shows a graphical illustration of the maximum hydraulic profile of the Coachman Avenue and Bayshore Boulevard collection systems under the 2000 gpm existing conditions scenario. You can see surcharging in most of the manholes, and overflows at the Coachman Avenue manhole and the Bayshore Pump Station overflow pipe. This profile also clearly shows that the Coachman Avenue manhole is at the lowest grade elevation in the collection system.

4.3 Improvement Project Costs

Based on the conceptual model scenarios, definitive improvement projects and costs were developed by the City. These improvement projects are described below:

- Upgrade the Bayshore Pump Station - includes new higher-capacity pumps, 1100 linear feet of 20-inch force main, manifold to a 48-inch force main, and new generator.
- Construct a new force main from the Coachman PS to the Manhattan Avenue Interceptor – includes 3900 LF of 10-inch force main; upgrading Coachman pumps.
- Construct a new gravity sanitary sewer from Coachman PS to the Manhattan Avenue interceptor consisting of standard 8, 10 and 12-inch gravity collection system.
- Construct a new force main from the Coachman PS to Clark St. gravity system; pump flows to Manhattan Avenue Interceptor - includes 2800 LF of 10-inch force main, 2200 linear feet of 12-inch force main, upgrade pumps at both stations.
- Construct a new force main from the Coachman PS to the Manhattan interceptor and a new force main from the Clark PS to the Manhattan interceptor (i.e. two separate force mains to Manhattan Interceptor) - includes 3900 LF of 10-inch force main, 2200 LF of 8-inch force main, upgrade pumps at both stations.
- Redirect Coachman Avenue Trunk; includes new neighborhood pump station at Coachman Avenue 18-inch diameter gravity sanitary, 18-inch jack and bore, and a new 4-inch force main (directional drill).

Estimated costs for each improvement alternative as developed by the City Wastewater Department are presented in **Table 4-2**.

Table 4-2
Cost Estimates for Possible Improvement Projects

	Improvement Projects	Cost Estimate
1.	Upgrade Bayshore Pump Station (includes manifold to San Carlos FM)	$800,000
2.	Force main from Coachman PS to Manhattan Interceptor; upgrade Coachman PS	$1,000,000
3.	Gravity Sanitary System from Coachman PS to Manhattan Interceptor	$1,200,000
4.	Force main from Coachman PS to Clark St. gravity system; upgrade Clark St PS; force main from Clark St to Manhattan Interceptor	$1,600,000
5.	Force main from Coachman PS to Manhattan Interceptor; force main from Clark PS to Manhattan Interceptor; upgrade both PS	$1,500,000
6.	Redirect Coachman Avenue Trunk; plus new neighborhood PS	$2,000,000
7.	Upgrade Bayshore Pump Station and Divert Coachman PS to Manhattan *	$1,800,000

Notes: All costs provided by the City Wastewater Department
PS- Pump Station
FM-Force Main
* Assumes force main/pumping option

Project Nos. 2, 3, 4 and 5 above essentially accomplish the Coachman Avenue Pump Station flow diversion. Project No. 6 is another method to divert the Coachman Avenue flows. However, this project was not in itself modeled. Project No. 7 is a combination of Project No. 1 and No. 2, and includes upgrading the Bayshore Pump Station and diversion of flows from the Coachman Pump Station (via a new force main rather than gravity sanitary sewer). These improvement project costs range from $800,000 to $2 million and have various safety factors and impacts to the public during construction.

The conclusions that can be drawn from this study and CDM's recommendations are provided in Section 5.

CDM

Figure 4-3. Alternatives 1, 1A, & 1B - Upgrade Bayshore Pump Station to 6000, 8000, & 10000 gpm
Coachman Avenue Overflow Elimination Study

Figure 4-4. Alternative 2 - Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 2000 gpm
Coachman Avenue Overflow Elimination Study

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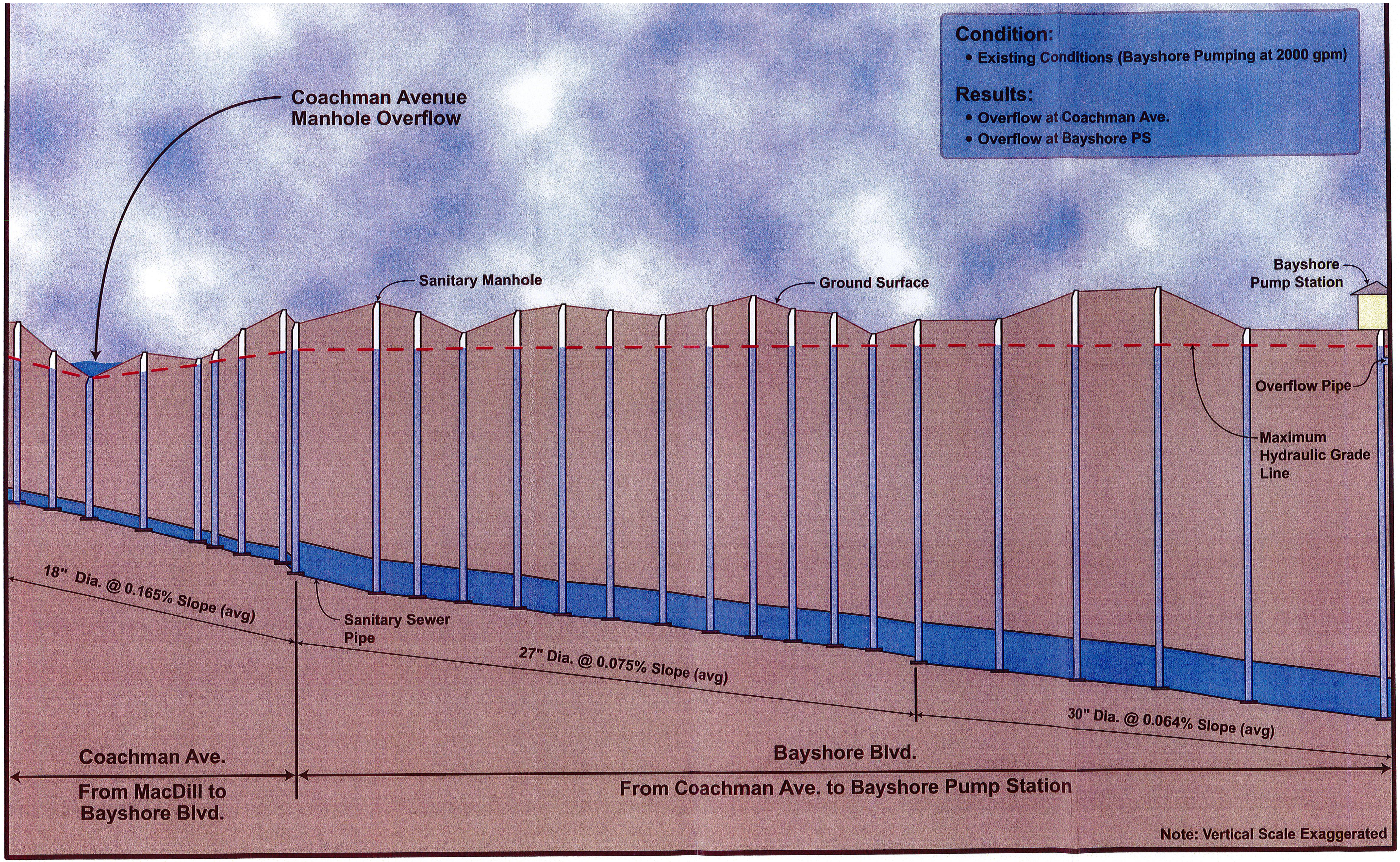
CDM

Figure 4-5. Alternative 3 - Diversion of Clark St. & Coachman Ave. Pump Station Flows with Bayshore Pumping at 2000 gpm
Coachman Avenue Overflow Elimination Study



CDM

Figure 4-6
Hydraulic Profile of Coachman Ave. and Bayshore Blvd.
Scenario: Existing Conditions with Bayshore Pumping at 2000 gpm
Coachman Avenue Overflow Elimination Study

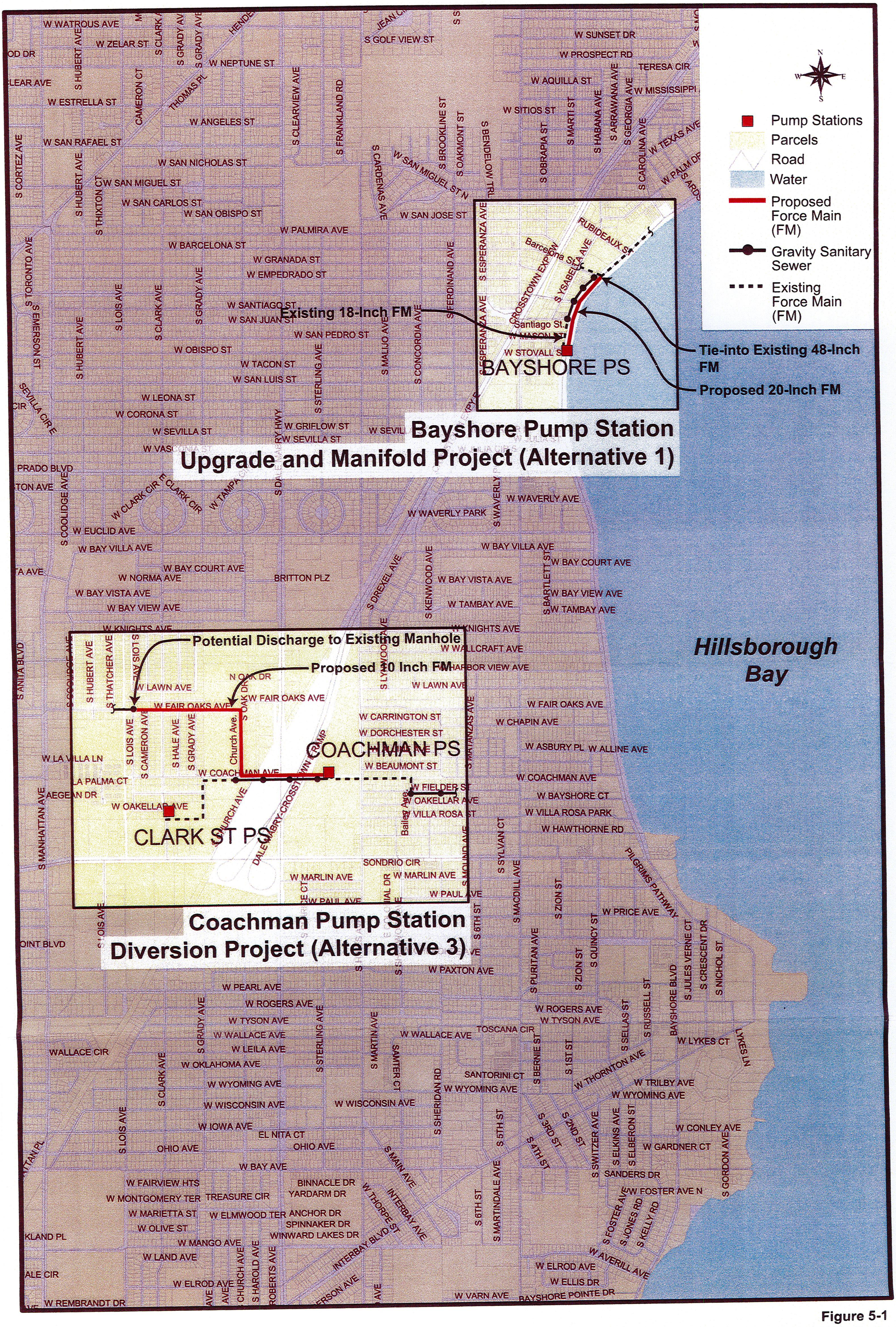


Figure 5-1
Conceptual Layout of Main Improvement Projects
Coachman Avenue Overflow Elimination Study

Section 5
Conclusions and Recommendations

Based on this study, the major conclusions that can be drawn are summarized below:

- The existing Bayshore Pump Station pumping at 4000 gpm (assuming a force main manifold to the San Carlos force main) will improve conditions; however, the Bayshore Boulevard trunkline will still be close to surcharging, providing little factor of safety from overflowing.
- Alternative 1 - Upgrading the Bayshore Pump Station to 6000 gpm (assuming a force main manifold to San Carlos force main) with no diversion of flows from Coachman Avenue Pump Station will relieve system overflows on Coachman and Alline Avenues and at the Bayshore Pump Station.
- Alternative 3 – Diverting the Coachman Avenue Pump Station flows (including Clark Street pump station flows) will improve system capacity; however, many manholes still surcharge at the 2000 gpm pumping rate at the Bayshore Pump Station, providing no factor of safety.

Figure 5-1 presents a conceptual layout of the Alternative 1 and Alternative 3 improvement projects. Given the above conclusions, it is clear that the Bayshore Pump Station should be upgraded to at least 4000 gpm (with a manifold force main to San Carlos). The question is whether to upgrade the pump station to 4000 gpm or 6000 gpm. Further, if the City has to upgrade the pump station and the pump station upgrades alone prevent overflows, then it is unnecessary to divert flows from Coachman Avenue.

Table 5-1 summarizes the hydraulic conditions with the Bayshore Pump Station pumping at 4000 gpm vs. 6000 gpm. Increasing the pumping capacity of the Bayshore Pump Station to 6000 gpm alone (without diverting the Coachman Avenue Pump Station flows) will result in significantly improved hydraulic conditions (particularly in the Bayshore Boulevard trunkline) as compared to pumping at 4000 gpm.

Table 5-1
Summary of Hydraulic Conditions
Bayshore PS at 4000 gpm Versus 6000 gpm
For the Coachman Ave and Bayshore Blvd Trunklines

Collection System	Existing -Bayshore Pump Station at 4000 gpm	Alternative 1- Bayshore Pump Station at 6000 gpm
Coachman Avenue	74% Full	74% Full
Bayshore Avenue	87% Full	46% Full

CDM Transmittal

CDM

1715 North Westshore Blvd., Suite 875
Tampa, FL 33607
813-281-2900
813-288-8787

To: Tim Wire, E.I.

Organization/ Address: City of Tampa, Wastewater Dept.

From: Karen Lowe, E.I.

Date: March 16, 2007

Re: Coachman Avenue Overflow Report

Job #:

Via: *Mail:* *Overnight:* *Courier:*

Enclosed please find:

For your information		**Approved**	
For your review		**Approved as noted**	
For your signature		**Returned to you for correction**	

Message:

Per your request one copy of final Coachman Avenue Overflow Report. If you have any questions please don't hesitate to contact me.

Karen Lowe
Signed

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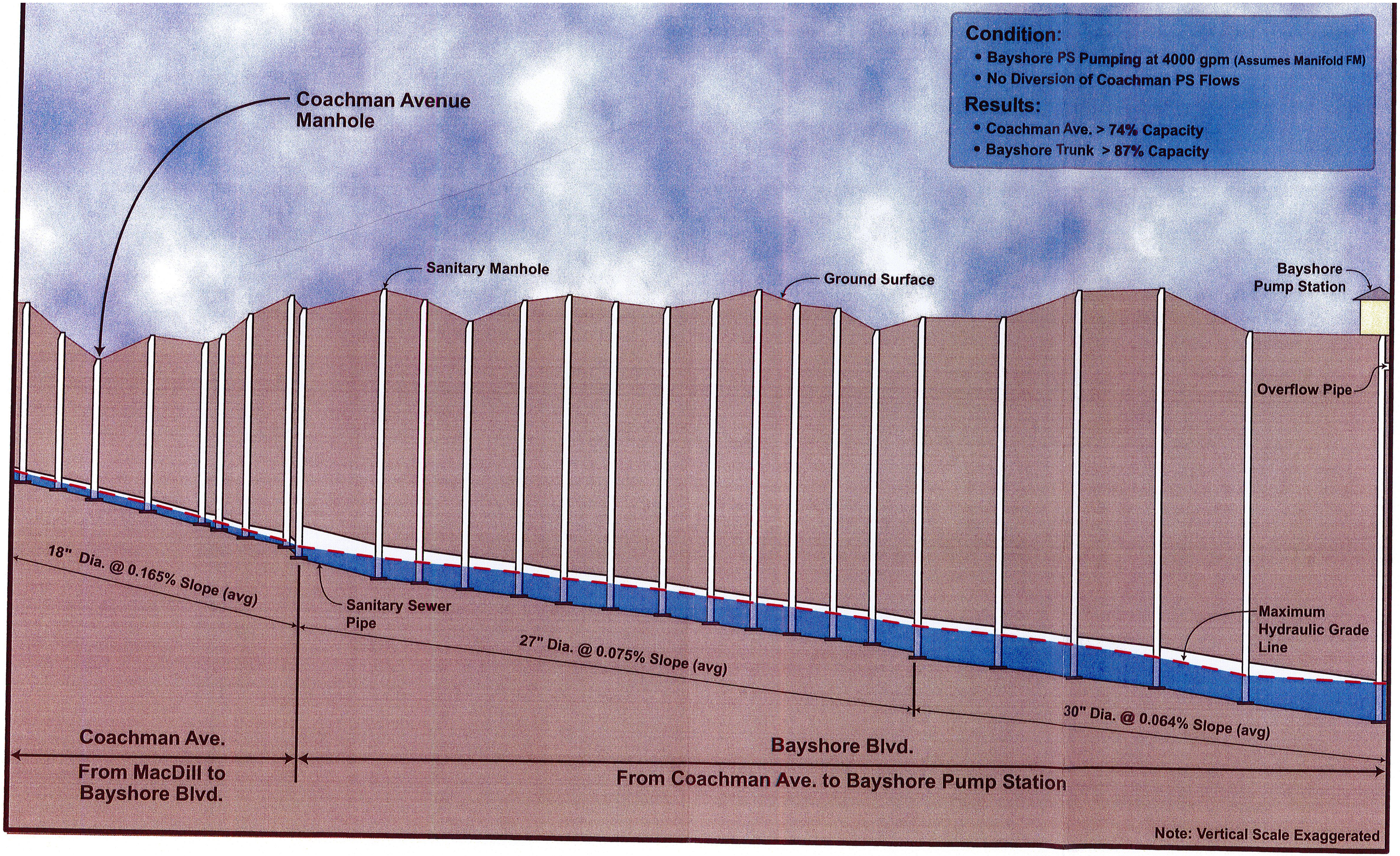
In **Figure 5-2**, which is the hydraulic profile of the Coachman Avenue and Bayshore Boulevard trunklines when the Bayshore Pump Station is pumping at 4000 gpm, you can see that the Coachman trunkline is at roughly 74% capacity while the Bayshore trunkline is at nearly 87% capacity. Upgrading the Bayshore Pump Station to 6000 gpm (as shown in **Figure 5-3**) would further improve the Bayshore trunkline capacity (less than 46% full) based on the simulated wet weather conditions. It should be noted that the peak rains (of September 2004) that were modeled (and used to evaluate these alternatives) have a 4% chance of occurring again, based on review of the last 50 years of historical rainfall (2 times in 50 years). This should provide the City some level of confidence that this alternative will prevent future overflows.

To further increase the confidence that this improvement alternative will prevent future overflows, an even more "rare" storm with a 1% chance of occurrence (100-year storm with a peak intensity of 4.5 inches of rain in one hour) was simulated with CDM's model. The results show that the sanitary system will still not overflow, assuming conditions similar to those modeled (i.e. ground water infiltration and seepage based on current conditions).

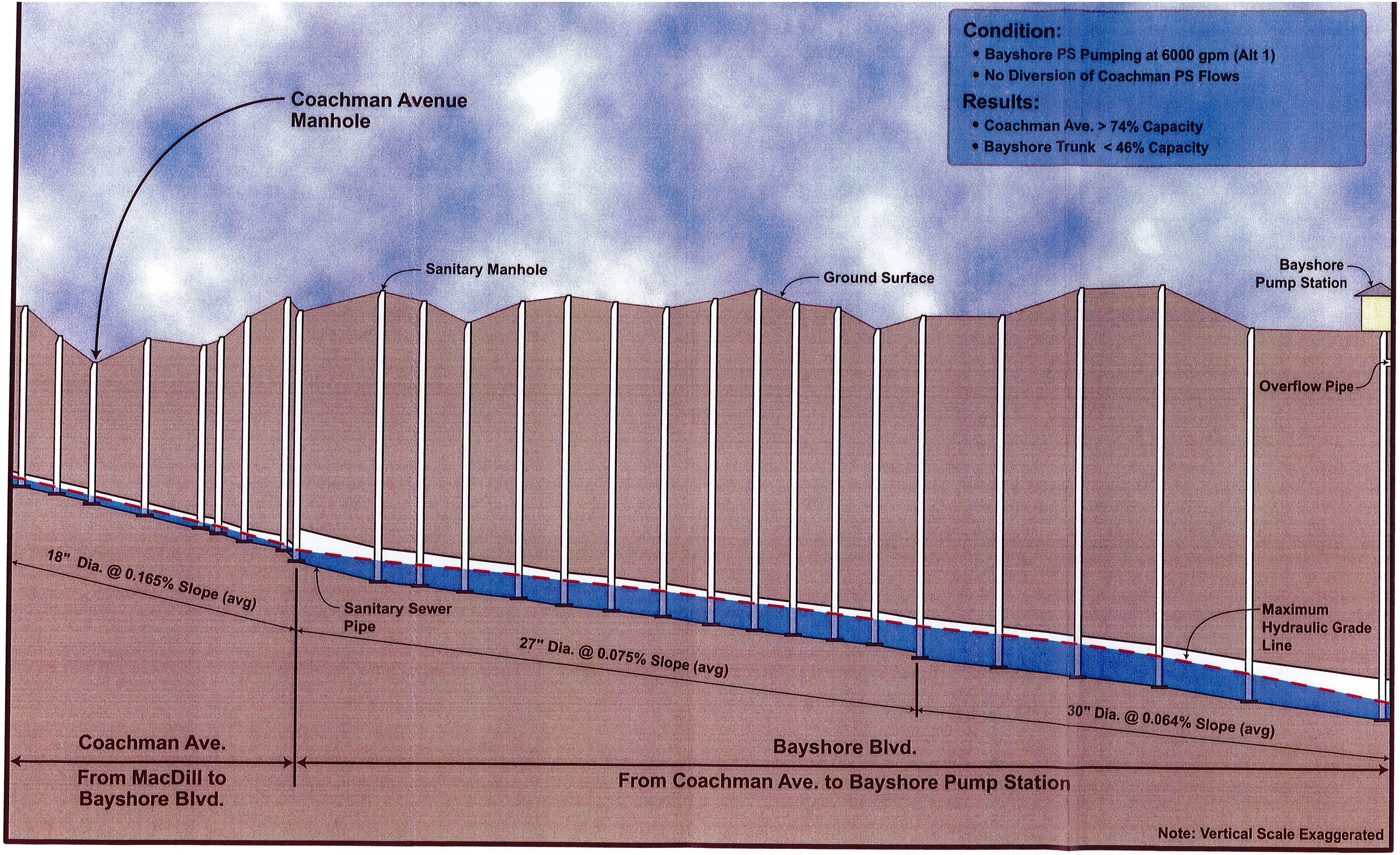
Therefore, CDM recommends upgrading the Bayshore Pump Station to 6000 gpm and constructing the force main manifold to the San Carlos force main. This alternative is the least costly alternative at about $800,000, is the least disruptive to the public, and can be accomplished relatively quickly. The other alternatives evaluated such as diversion of the Coachman Avenue trunkline and installing a neighborhood pump station were much more costly (up to $2 million) and much more disruptive to the public.

CDM also recommends that the City continue with its planned sanitary sewer evaluation study (SSES) to further define inflow and infiltration locations and to identify other possible improvements that could be implemented, such as corking manholes and unclogging pipes, both of which are relatively inexpensive.



CDM

Figure 5-2
Hydraulic Profile of Coachman Ave. and Bayshore Blvd.
Scenario: Bayshore Pump Station at 4000 gpm Only
Coachman Avenue Overflow Elimination Study



CDM

Figure 5-3
Hydraulic Profile of Coachman Ave. and Bayshore Blvd.
Scenario: Upgrade Bayshore Pump Station to 6000 gpm Only
Coachman Avenue Overflow Elimination Study

Appendix A

Supporting Information for Model Development

Appendix A

Table A-1. Model Input Data for Junctions and Links
Coachman Avenue Overflow Elimination Study

LINK_ID	UPSTREAM NODE	DOWNSTREAM NODE	UPSTREAM MANHOLE RIM	DOWNSTREAM MANHOLE RIM	UPSTREAM PIPE INVERT	DOWNSTREAM PIPE INVERT	UPSTREAM STATION	DOWNSTREAM STATION	PIPE LENGTH	DIAMETER
FIELD10	FIELD10	FIELD12	15.7	14.0	11.28	9.59	1739.4	811.9	927.5	12
FIELD12	FIELD12	FIELD14	14.0	11.0	9.59	6.49	811.9	249.9	562.0	12
FIELD14	FIELD14	SMCDILL22	11.0	8.8	5.84	3.37	249.9	0.0	249.9	12
SMCDILL22	SMCDILL22	COACH14	8.8	7.2	-0.87	-1.21	1977.2	1817.3	159.9	18
COACH14	COACH14	COACH16	7.2	5.0	-1.25	-1.48	1817.3	1580.2	237.1	18
COACH16	COACH16	COACH18	5.0	3.2	-1.48	-1.78	1580.2	1345.3	234.9	18
COACH18	COACH18	COACH20	3.5	5.0	-1.81	-2.28	1345.3	990.2	355.1	18
COACH20	COACH20	COACH22	5.0	4.5	-2.28	-2.75	990.2	635.1	355.1	18
COACH22	COACH22	COACH24	4.5	5.0	-2.74	-2.87	635.1	523.7	111.4	18
COACH24	COACH24	COACH26	5.0	6.5	-2.89	-3.17	523.7	351.4	172.3	18
COACH26	COACH26	COACH28	6.5	8.0	-3.17	-3.43	351.4	83.8	267.6	18
COACH28	COACH28	BAY22	8.0	7.0	-3.47	-3.85	83.8	0.0	83.8	18
ALLINE10	ALLINE10	ALLINE12	5.5	4.0	1.59	0.63	405.1	201.3	203.8	8
ALLINE12	ALLINE12	ALLINE14	4.0	3.2	0.63	-0.43	201.3	0.0	201.3	8
ALLINE18	ALLINE18	ALLINE16	6.0	4.5	1.93	0.74	950.8	635.4	315.4	8
ALLINE16	ALLINE16	ALLINE14	4.5	3.2	0.74	-0.43	635.4	320.0	315.4	8
ALLINE14	ALLINE14	COACH18	3.2	3.2	-0.41	-1.38	320.0	0.0	320.0	8
ASBURY10	ASBURY10	ASBURY12	6.3	5.2	2.41	1.16	1466.5	1070.3	396.2	8
ASBURY12	ASBURY12	ASBURY14	5.2	6.7	1.16	-1.13	1070.3	388.5	681.8	8
ASBURY14	ASBURY14	COACH24	6.7	5.0	-1.13	-2.42	388.5	0.0	388.5	8
BALLA10	BALLA10	BALLA12	13.5	13.4	6.29	5.17	6441.2	5778.0	663.2	15
BALLA12	BALLA12	BALLA14	13.4	13.0	5.11	4.20	5778.0	5117.6	660.4	15
BALLA14	BALLA14	BALLA16	13.0	13.2	4.20	3.10	5117.6	4446.7	670.9	15
BALLA16	BALLA16	SMCDILL10	13.2	14.0	3.10	2.49	4446.7	4106.2	340.5	15
BALLA18	BALLA18	BALLA16	13.0	13.2	5.97	5.03	299.8	0.0	299.8	8
SMCDILL10	SMCDILL10	SMCDILL12	14.0	13.0	2.49	2.03	4106.2	3764.6	341.6	15
SMCDILL12	SMCDILL12	SMCDILL14	13.0	13.0	2.03	1.47	3764.6	3440.4	324.2	15
SMCDILL14	SMCDILL14	SMCDILL16	13.0	14.0	1.47	0.96	3440.4	3196.0	244.4	15
SMCDILL16	SMCDILL16	SMCDILL18	14.0	14.0	0.96	-0.15	3196.0	2420.6	775.4	15
SMCDILL18	SMCDILL18	SMCDILL20	14.0	11.5	-0.18	-0.41	2420.6	2298.8	121.8	15
SMCDILL20	SMCDILL20	SMCDILL22	11.5	8.8	-0.41	-0.87	2298.8	1977.2	321.6	15
COACH12	COACH12	COACH14	6.5	7.2	-0.35	-0.57	61.1	0.0	61.1	8
OAKEL10	OAKEL10	SMCDILL20	13.5	11.5	7.86	6.88	288.6	0.0	288.6	8
INTERPS10	INTERPS10	SJULES10	8.2	8.2	2.93	1.03	2641.0	1683.0	958.0	18

Table A-1. Model Input Data for Junctions and Links
Coachman Avenue Overflow Elimination Study

LINK_ID	UPSTREAM NODE	DOWNSTREAM NODE	UPSTREAM MANHOLE RIM	DOWNSTREAM MANHOLE RIM	UPSTREAM PIPE INVERT	DOWNSTREAM PIPE INVERT	UPSTREAM STATION	DOWNSTREAM STATION	PIPE LENGTH	DIAMETER
SJULES10	SJULES10	SJULES12	8.2	7.5	1.03	0.50	1683.0	1254.0	429.0	18
SJULES12	SJULES12	BAY10	7.5	7.5	0.50	-0.68	1254.0	454.0	800.0	18
BAY10	BAY10	BAY12	7.5	7.5	-0.68	-1.31	454.0	0.0	454.0	18
BAY12	BAY12	BAY14	8.0	7.5	-1.46	-1.90	8683.7	8451.8	231.9	21
BAY14	BAY14	BAY16	7.5	7.0	-1.90	-2.11	8451.8	8222.7	229.1	21
BAY16	BAY16	BAY18	7.0	8.0	-2.18	-2.67	8222.7	7927.4	295.3	21
BAY18	BAY18	BAY20	8.0	7.0	-2.69	-3.09	7927.4	7617.2	310.2	21
BAY20	BAY20	BAY22	7.0	7.0	-3.09	-3.95	7617.2	7160.9	456.3	21
BAY22	BAY22	BAY24	7.0	8.5	-3.95	-4.60	7160.9	6630.5	530.4	27
BAY24	BAY24	BAY26	8.5	7.8	-4.60	-4.79	6630.5	6360.4	270.1	27
BAY26	BAY26	BAY28	7.8	6.3	-4.79	-5.02	6360.4	6059.6	300.8	27
BAY28	BAY28	BAY30	6.3	7.8	-5.02	-5.24	6059.6	5713.1	346.5	27
BAY30	BAY30	BAY32	7.8	8.2	-5.24	-5.46	5713.1	5425.8	287.3	27
BAY32	BAY32	BAY34	8.2	7.8	-5.46	-5.64	5425.8	5102.3	323.5	27
BAY34	BAY34	BAY36	7.8	7.4	-5.64	-5.88	5102.3	4766.5	335.8	27
BAY36	BAY36	BAY38	7.4	8.0	-5.88	-6.12	4766.5	4446.5	320.0	27
BAY38	BAY38	BAY40	8.0	8.8	-6.12	-6.32	4446.5	4165.8	280.7	27
BAY40	BAY40	BAY42	8.8	7.8	-6.32	-6.48	4165.8	3904.8	261.0	27
BAY42	BAY42	BAY44	7.8	7.5	-6.48	-6.69	3904.8	3642.0	262.8	27
BAY44	BAY44	BAY46	7.5	6.0	-6.69	-6.84	3642.0	3382.5	259.5	27
BAY46	BAY46	BAY50	6.0	7.0	-6.84	-7.12	3382.5	3082.2	300.3	27
BAY50	BAY50	BAY52	7.0	7.0	-7.33	-7.66	3082.2	2557.2	525.0	30
BAY52	BAY52	BAY54	7.0	9.0	-7.66	-7.97	2557.2	2033.1	524.1	30
BAY54	BAY54	BAY56	9.0	9.2	-7.97	-8.26	2033.1	1495.5	537.6	30
BAY56	BAY56	BAY58	9.2	6.0	-8.27	-8.82	1495.5	893.5	602.0	30
BAY58	BAY58	BAY60	6.2	6.0	-8.82	-9.44	893.5	0.0	893.5	28.3
BAY60	BAY60	BAYPS10	6.0	6.0	-9.44	-9.45	20.0	0.0	20.0	30
BAY_OF	BAY60	BAY_OF	6.0	-	0.18	0.12	56.5	0.0	56.5	24
BAYPO10	BAYPO10	BAY14	6.0	7.5	0.35	-0.34	64.6	0.0	64.6	8
FERDINA10	FERDINA10	FERDINA12	17.0	16.0	10.57	9.05	3914.2	3413.2	501.0	8
FERDINA12	FERDINA12	FERDINA14	16.0	14.0	9.02	5.99	3413.2	2647.3	765.9	8
FERDINA14	FERDINA14	FERDINA16	14.0	16.5	5.93	5.05	2647.3	2368.5	278.8	10
FERDINA16	FERDINA16	FERDINA18	16.5	17.0	5.02	4.15	2368.5	2004.1	364.4	10
FERDINA18	FERDINA18	JULIA10	17.0	15.0	4.14	1.41	2004.1	941.0	1063.1	12
JULIA10	JULIA10	BAY56	15.0	9.2	1.41	-0.61	941.0	0.0	941.0	12
CORONA10	CORONA10	CORONA12	17.0	14.5	9.06	6.06	1574.2	567.0	1007.2	8

Table A-1. Model Input Data for Junctions and Links
Coachman Avenue Overflow Elimination Study

LINK_ID	UPSTREAM NODE	DOWNSTREAM NODE	UPSTREAM MANHOLE RIM	DOWNSTREAM MANHOLE RIM	UPSTREAM PIPE INVERT	DOWNSTREAM PIPE INVERT	UPSTREAM STATION	DOWNSTREAM STATION	PIPE LENGTH	DIAMETER
CORONA12	CORONA12	FERDINA18	14.5	17.0	6.03	4.36	567.0	0.0	567.0	8
LEONA10	LEONA10	FERDINA16	17.0	16.5	9.95	5.24	1573.8	0.0	1573.8	8
COCORD10	COCORD10	FERDINA14	15.0	14.0	7.80	6.02	569.5	0.0	569.5	8
EUCLID10	EUCLID10	EUCLID12	14.0	15.0	8.26	5.85	2225.6	1583.6	642.0	8
EUCLID12	EUCLID12	EUCLID14	15.0	15.0	5.79	3.67	1583.6	651.0	932.6	10
EUCLID14	EUCLID14	EUCLID16	15.0	12.0	3.67	1.30	651.0	-414.4	1065.4	10
EUCLID16	EUCLID16	EUCLID18	12.0	14.0	1.13	-0.71	2588.6	1684.2	904.4	12
EUCLID18	EUCLID18	EUCLID20	14.0	14.0	-0.71	-1.47	1684.2	1246.9	437.3	12
EUCLID20	EUCLID20	EUCLID22	14.0	9.0	-1.47	-3.23	1246.9	309.3	937.6	12
EUCLID22	EUCLID22	BAY50	9.0	7.0	-3.23	-3.70	309.3	0.0	309.3	12
GANDY10	GANDY10	BAY12	9.0	8.0	0.01	-0.77	214.6	0.0	214.6	8
KNIGHTPS10	KNIGHTPS10	KNIGHTS10	16.5	17.0	12.28	11.52	1626.5	1398.7	227.8	8
KNIGHTS10	KNIGHTS10	BAY36	17.0	7.4	11.49	3.11	1398.7	0.0	1398.7	8
MIRAMAR10	MIRAMAR10	BAY58	6.0	6.2	1.60	1.31	63.4	0.0	63.4	8

Table A-2

RTK Parameters for the Study Area
Coachman Avenue Overflow Elimination Study

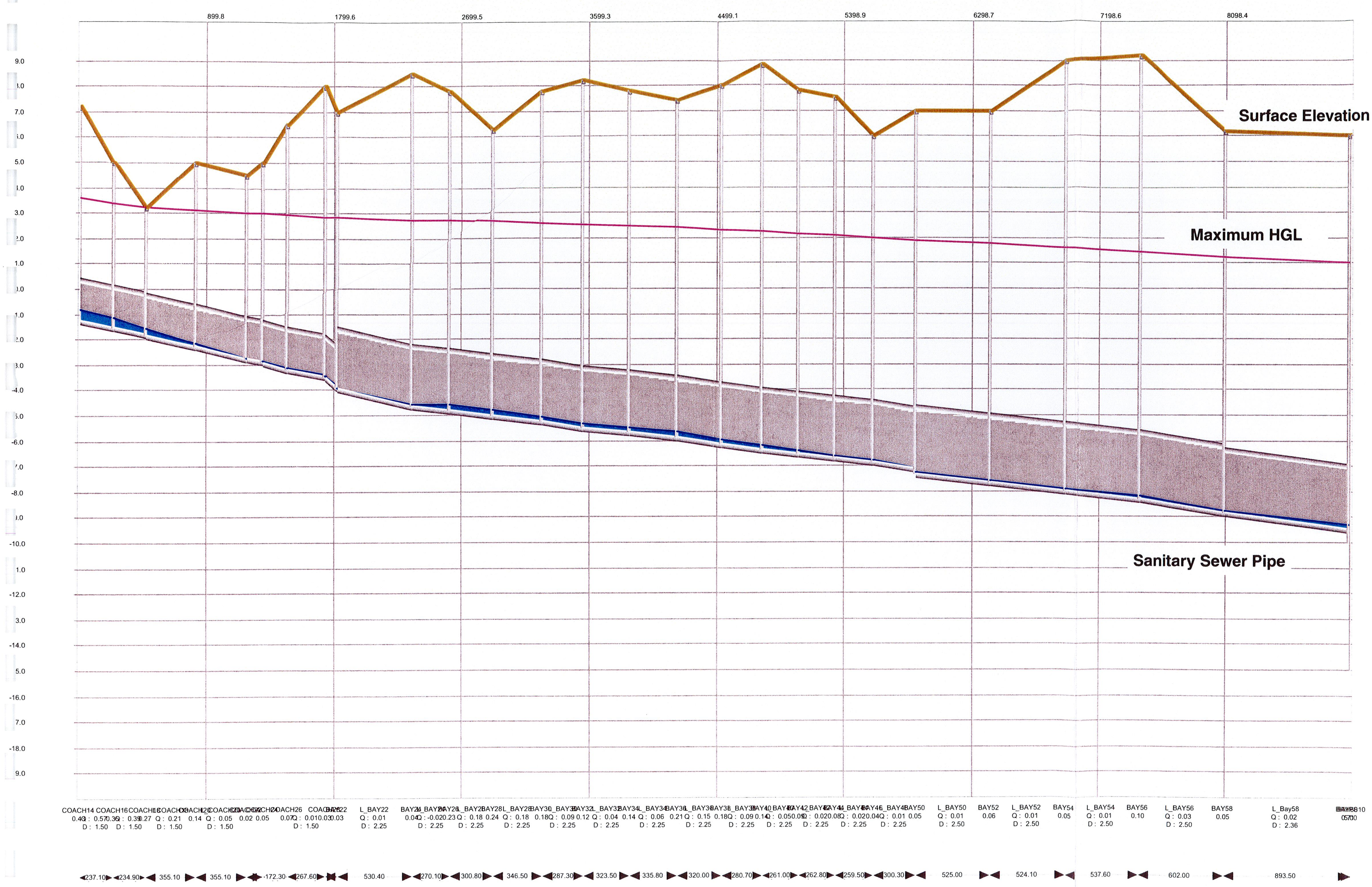
R1	T1	K1	R2	T2	K2	R3	T3	K3
0.00130	0.50	1.00	0.00052	2.00	1.00	0.00078	8.00	2.00

Appendix B

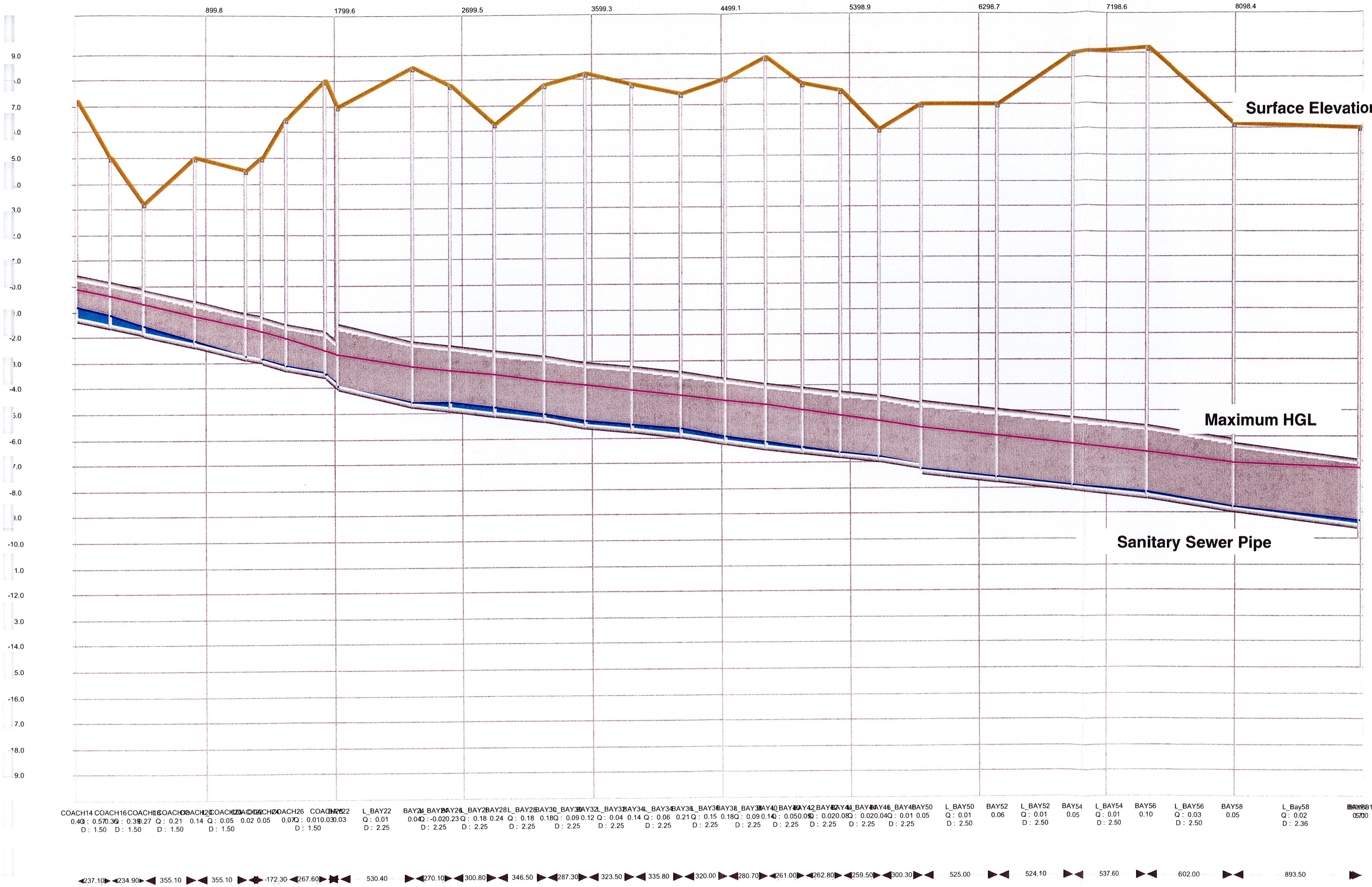
Hydraulic Profiles

- Existing Condition at 2000 gpm
- Existing Condition at 4000 gpm
- Alternative 1 – Upgrade Bayshore Pump Station to 6000 gpm
- Alternative 1A – Upgrade Bayshore Pump Station to 8000 gpm
- Alternative 1B – Upgrade Bayshore Pump Station to 10000 gpm
- Alternative 2 – Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 2000 gpm
- Alternative 2A – Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 4000 gpm
- Alternative 2B – Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 6000 gpm
- Alternative 2C – Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 8000 gpm
- Alternative 2D – Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 10000 gpm
- Alternative 3 – Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 2000 gpm
- Alternative 3A – Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 4000 gpm
- Alternative 3B – Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 6000 gpm
- Alternative 3C – Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 8000 gpm
- Alternative 3D – Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 10000 gpm

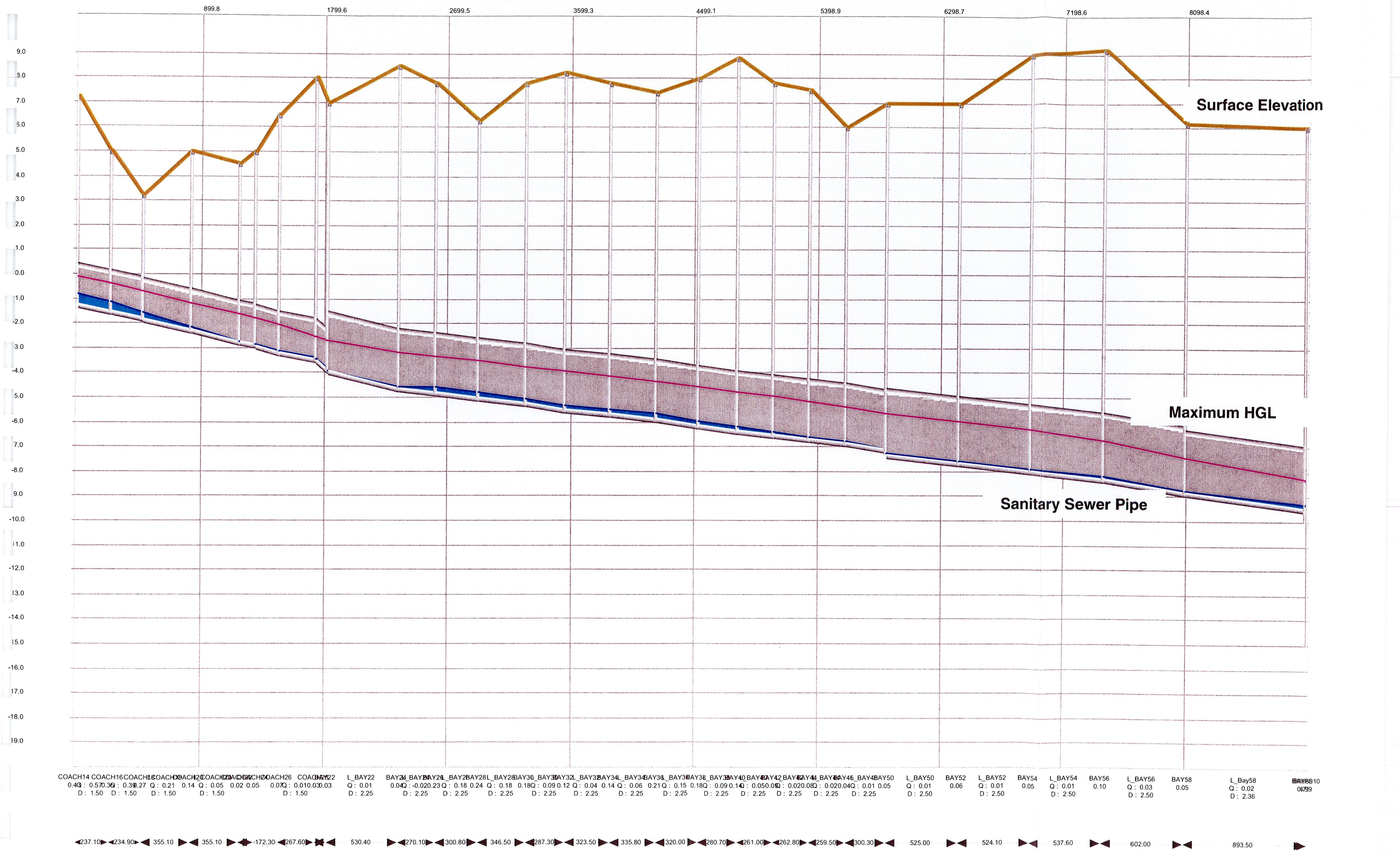
Existing Condition at 2000 gpm



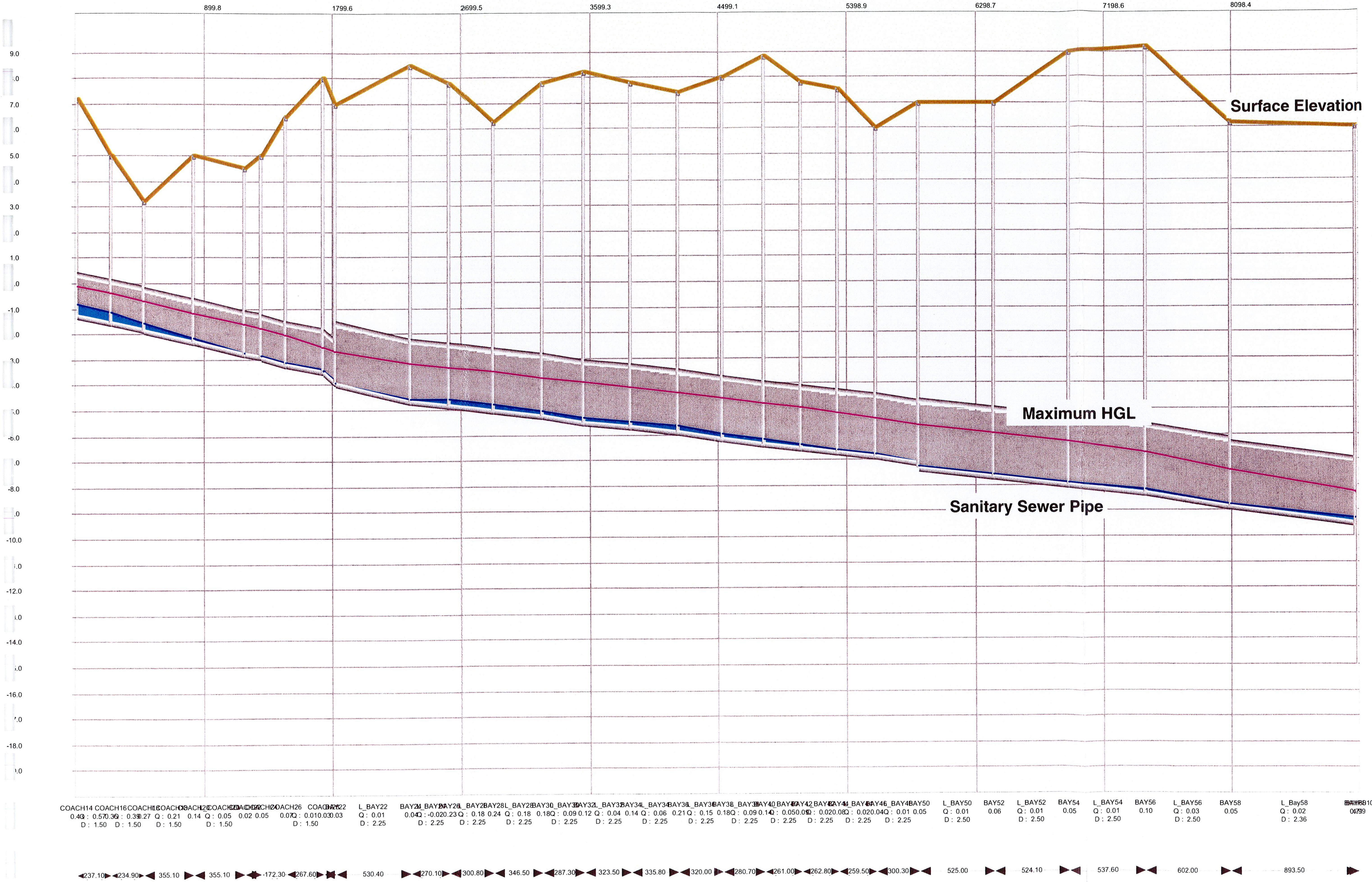
Existing Condition at 4000 gpm



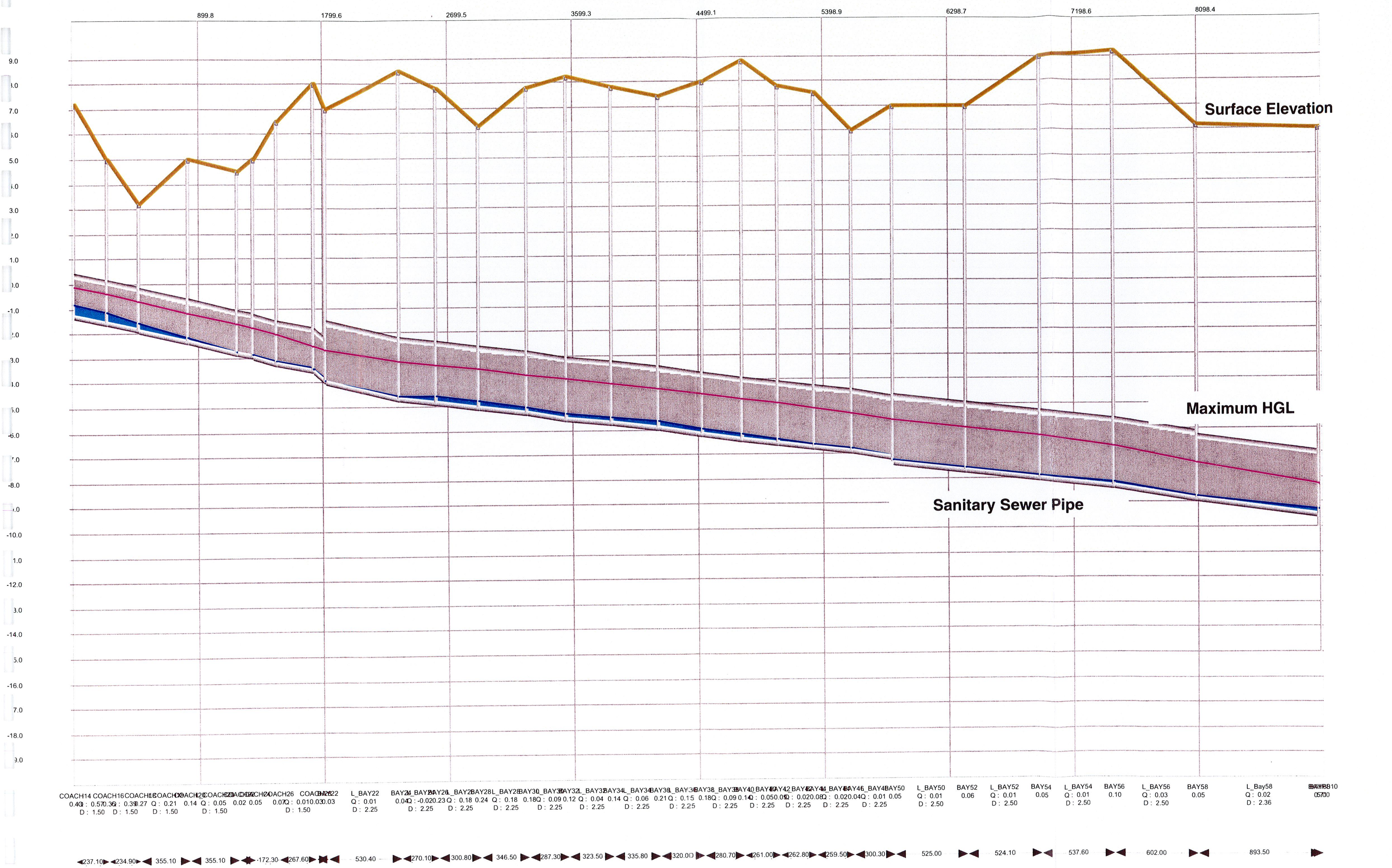
Alternative 1 - Upgrade Bayshore Pump Station to 6000 gpm



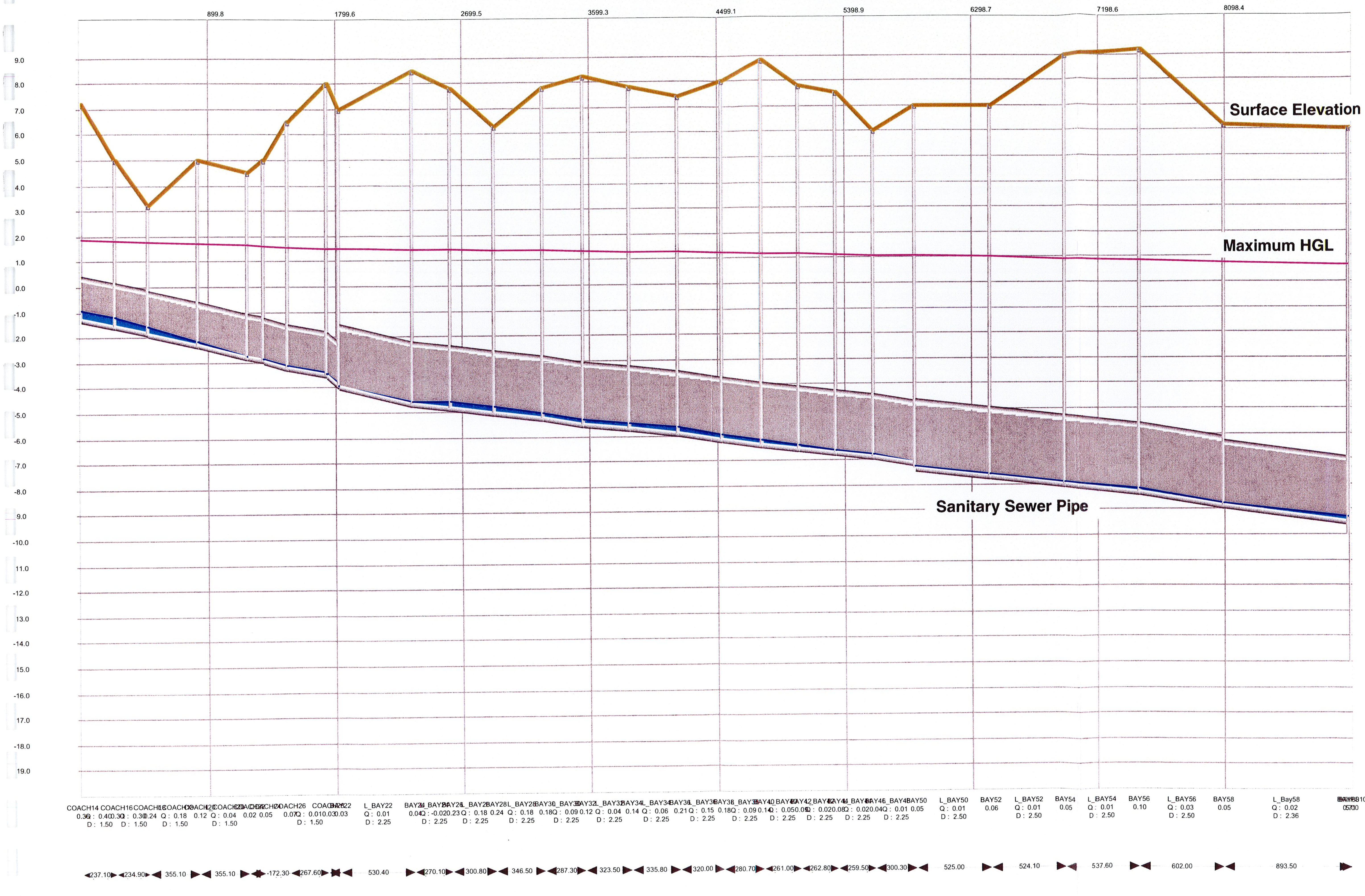
Alternative 1A - Upgrade Bayshore Pump Station to 8000 gpm



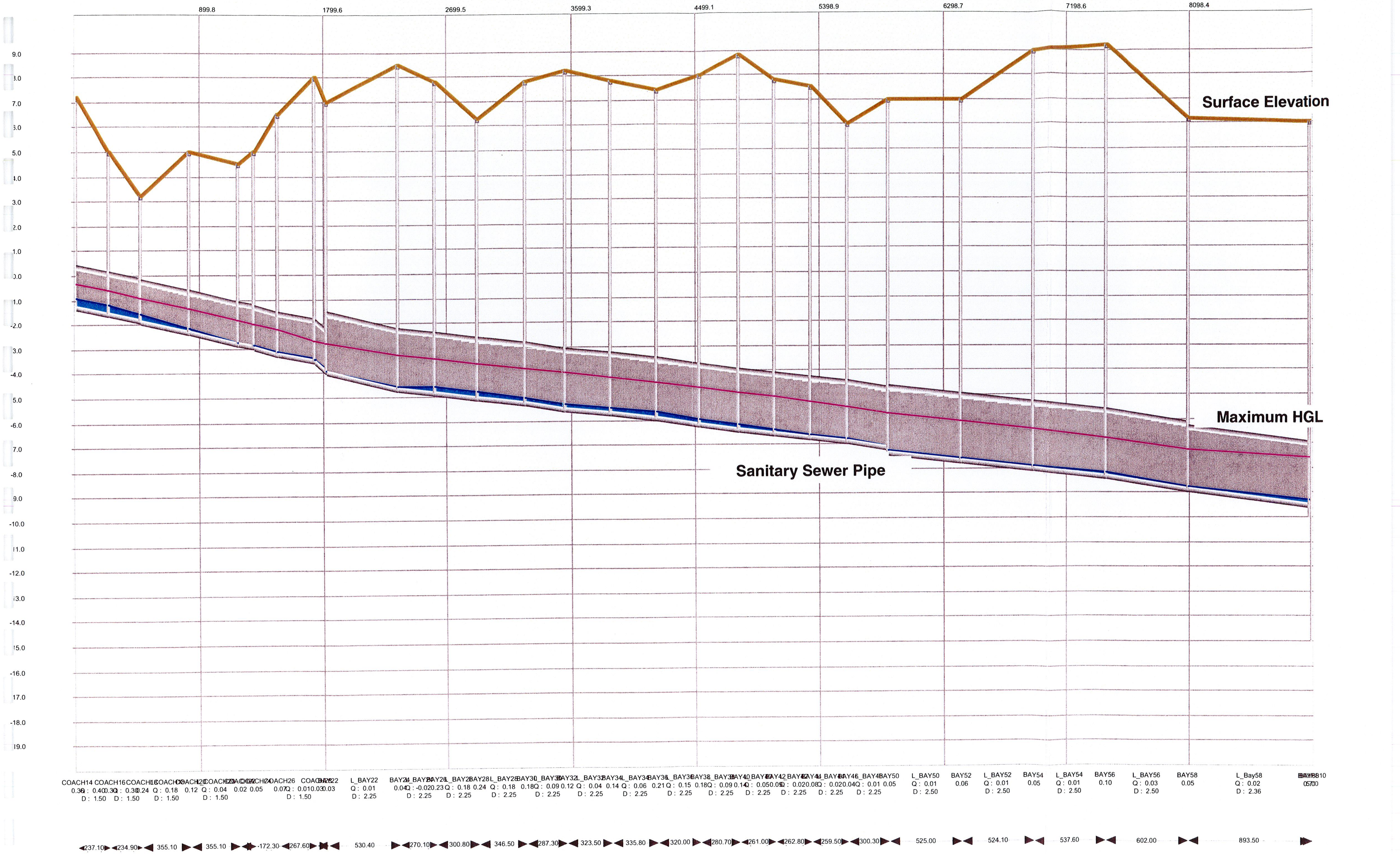
Alternative 1B - Upgrade Bayshore Pump Station to 10000 gpm



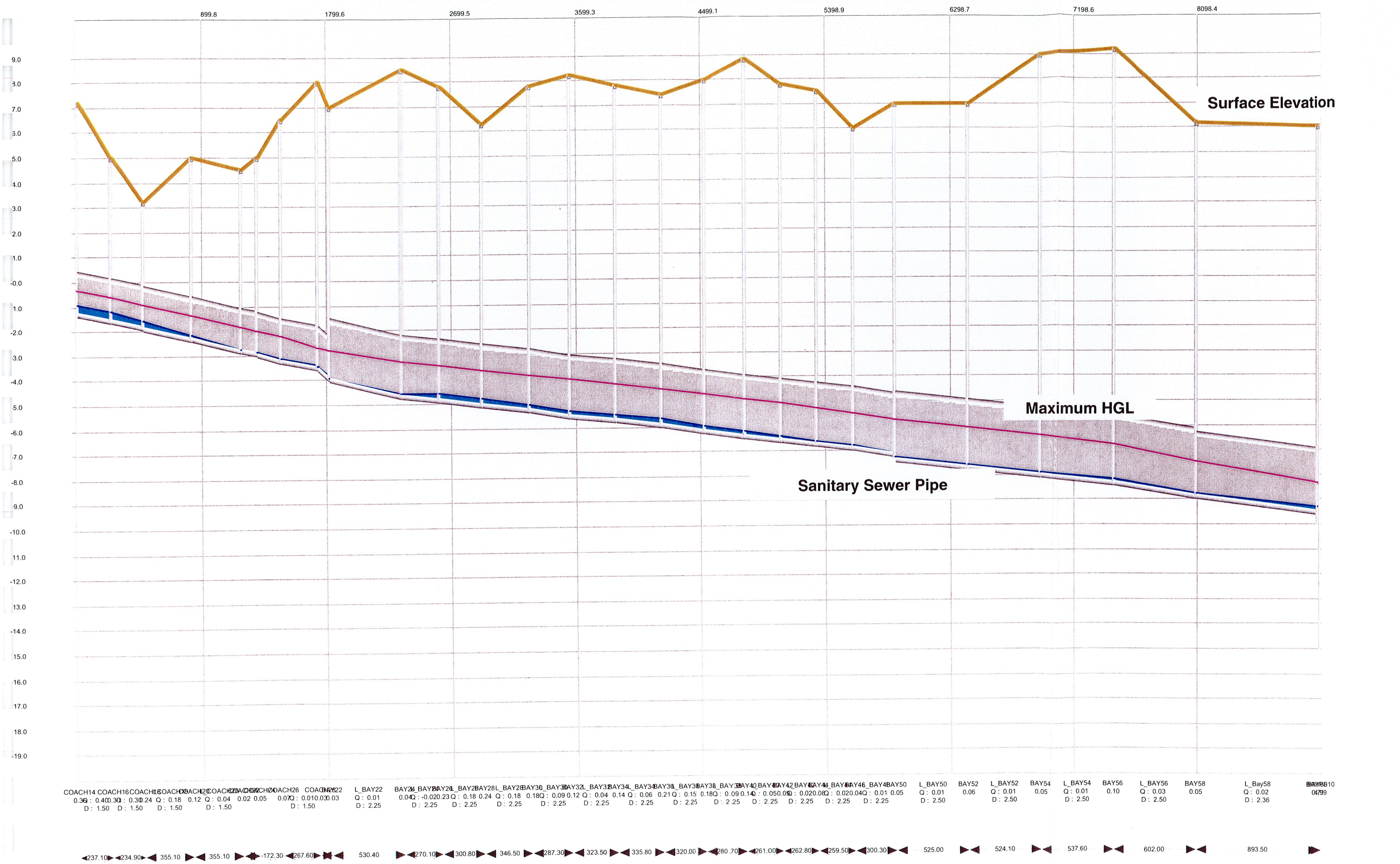
Alternative 2 - Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 2000 gpm



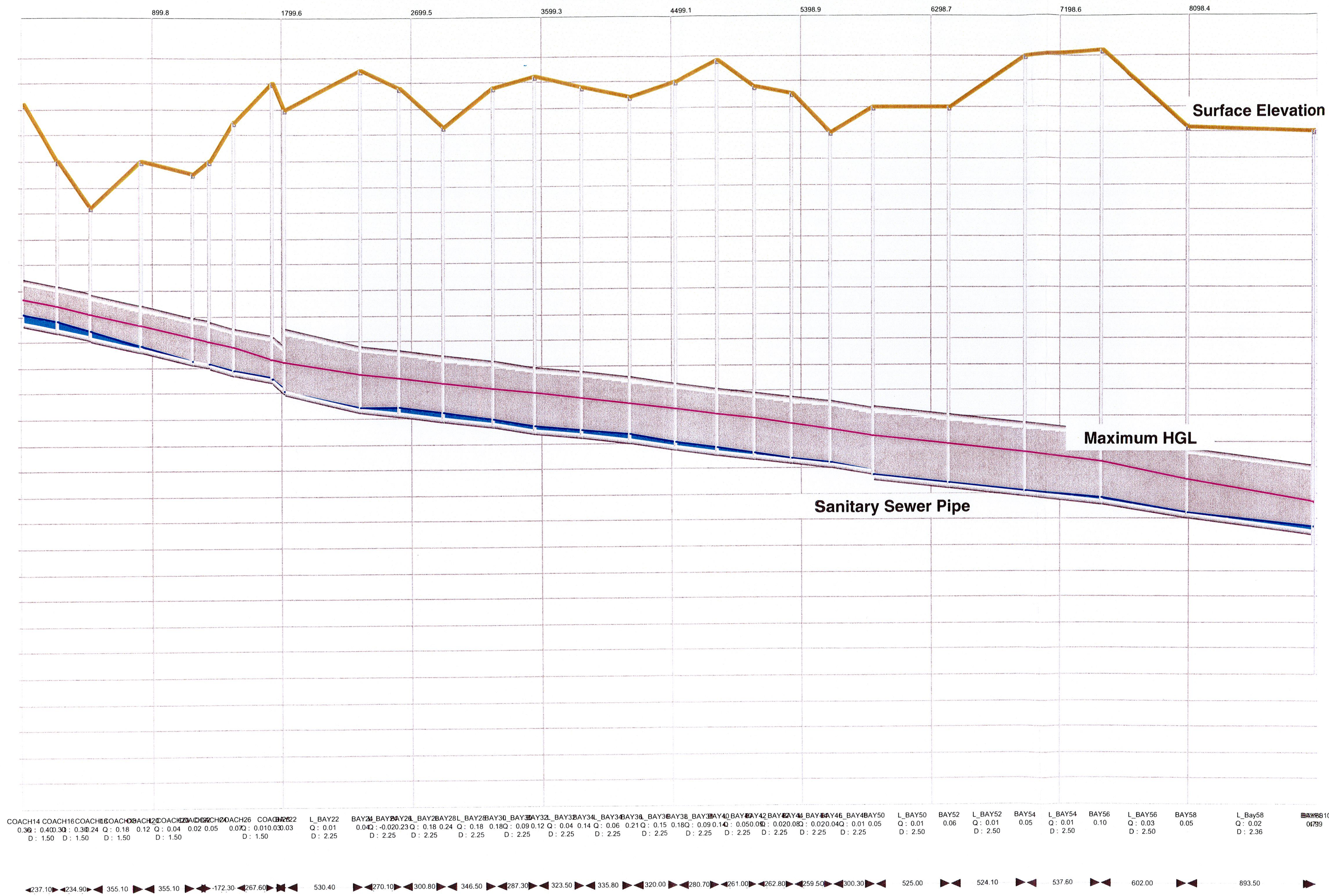
Alternative 2A - Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 4000 gpm



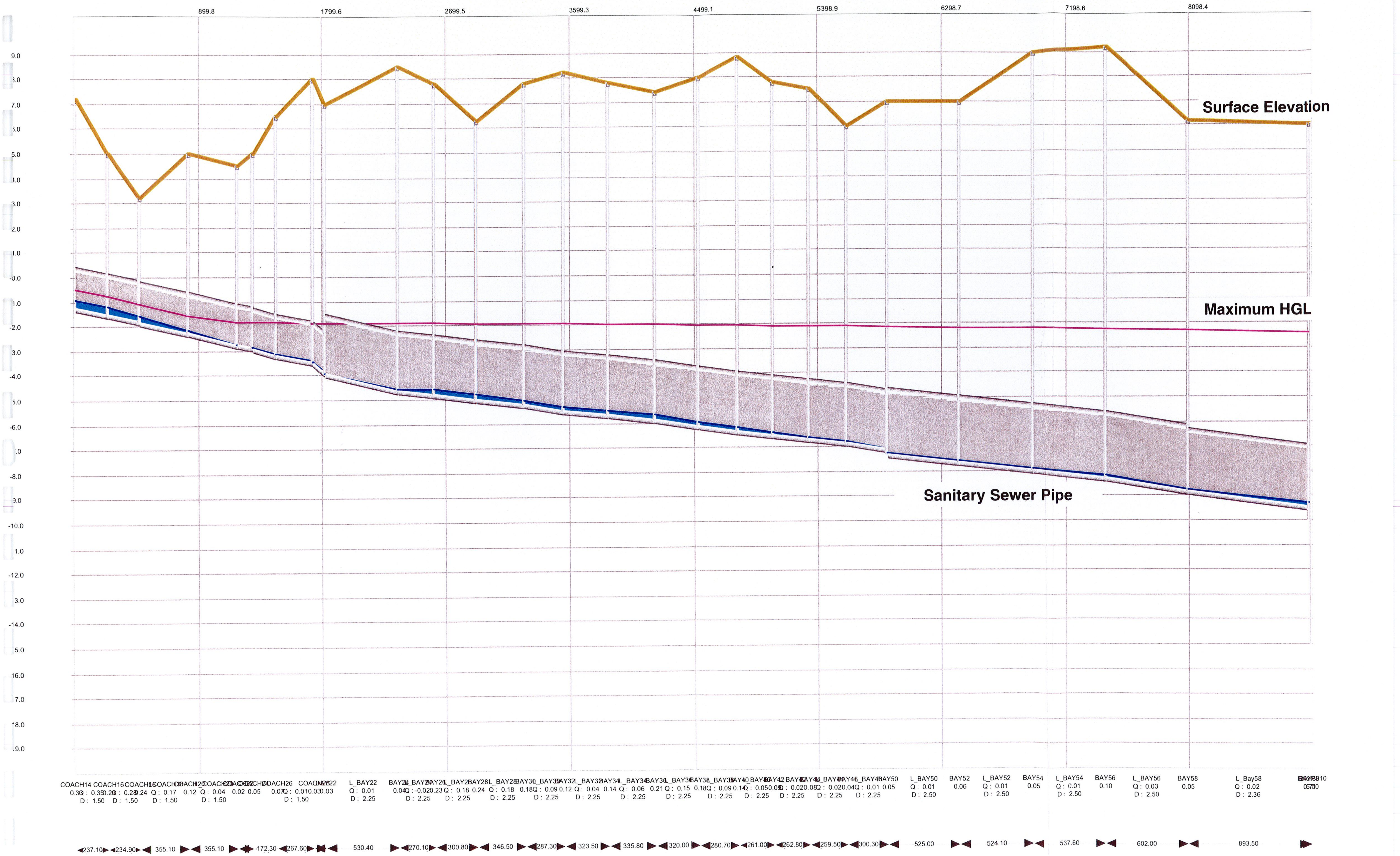
Alternative 2B - Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 6000 gpm



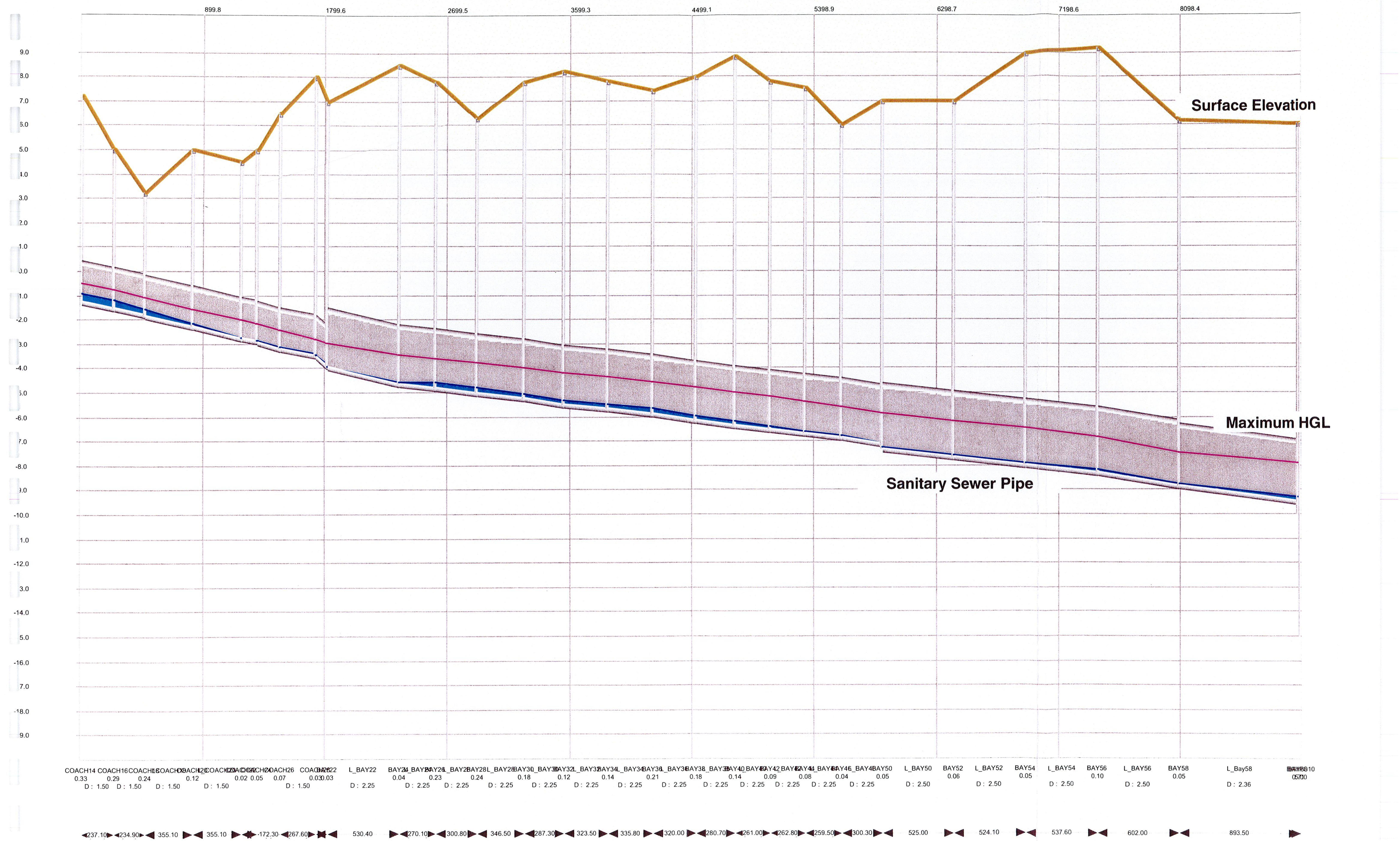
Alternative 2C - Diversion of Clark St. Pump Station Flows with Bayshore Pumping at 8000 gpm



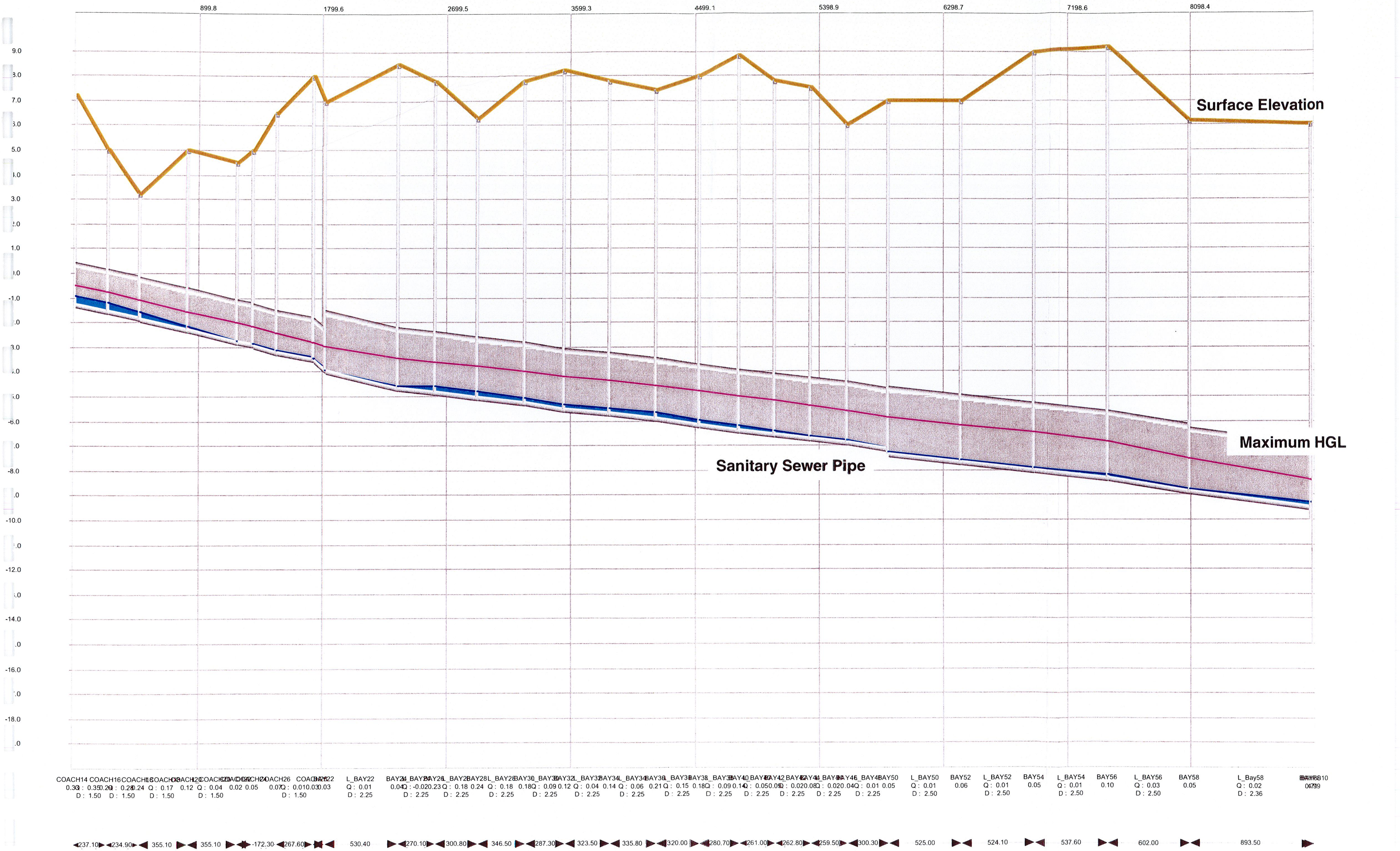
Alternative 3 - Diversion of Clark St. and Coahcman Ave. Pump Station Flows with Bayshore Pumping at 2000 gpm



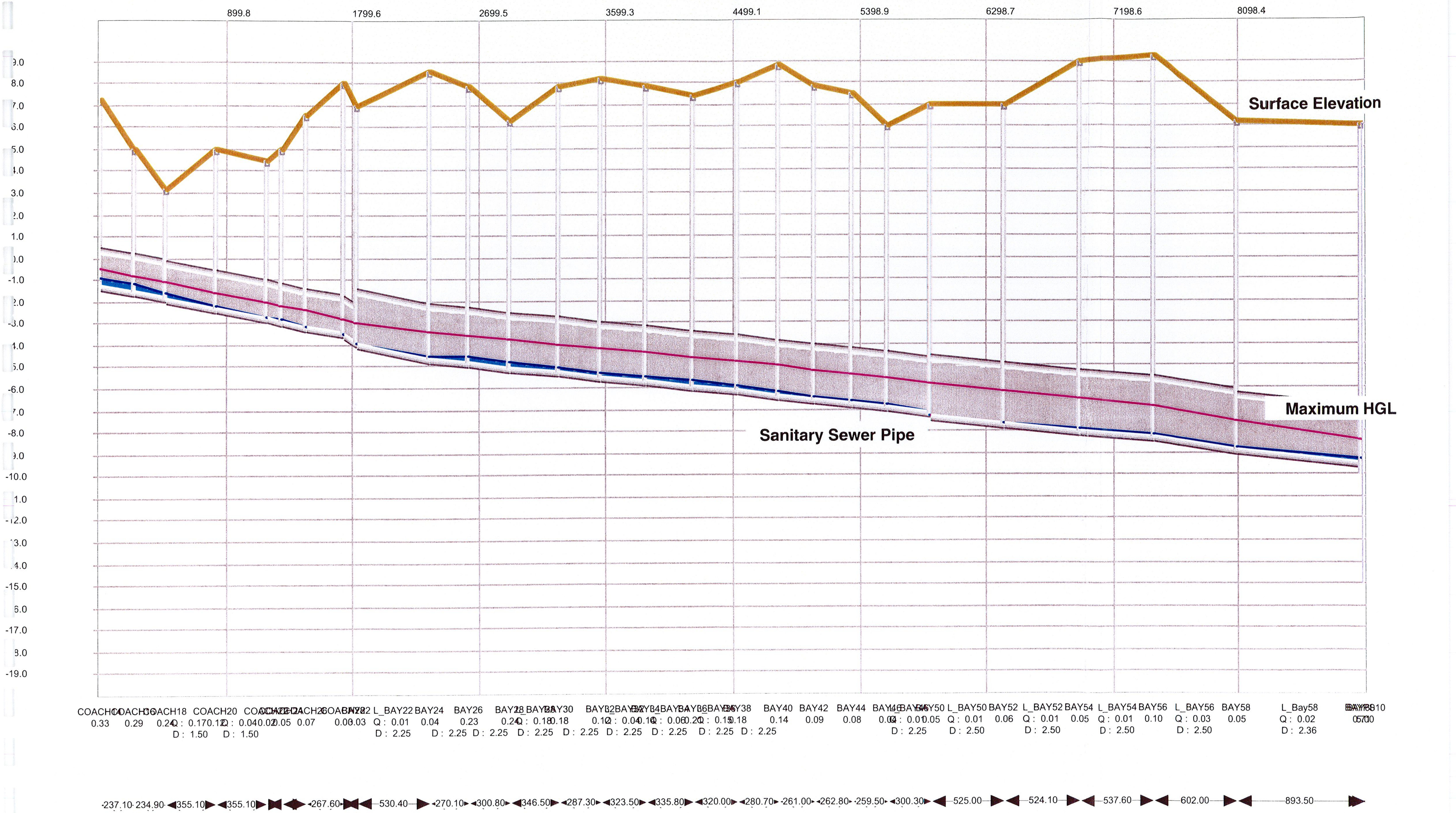
Alternative 3A - Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 4000 gpm



Alternative 3C - Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 8000 gpm



Alternative 3D - Diversion of Clark St. and Coachman Ave. Pump Station Flows with Bayshore Pumping at 10000 gpm



Alternative 3B - Diversion of Clark St. and Coahcman Ave. Pump Station Flows with Bayshore Pumping at 6000 gpm