SOUTH CROSS BAYOU
WASTEWATER RECLAMATION FACILITY
ONSITE FORCE MAIN IMPROVEMENTS

MARCH 2009

SOUTH CROSS BAYOU WATER RECLAMATION FACILITY

FORCE MAIN BYPASS CONCEPTUAL DESIGN REPORT

PCU #1994 Work Assignment #6

PREPARED FOR:

PINELLAS COUNTY UTILITIES
14 S. FT. HARRISON AVENUE
6TH FLOOR
CLEARWATER, FL 33756

PREPARED BY:

KING ENGINEERING ASSOCIATES, INC.
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I. Introduction

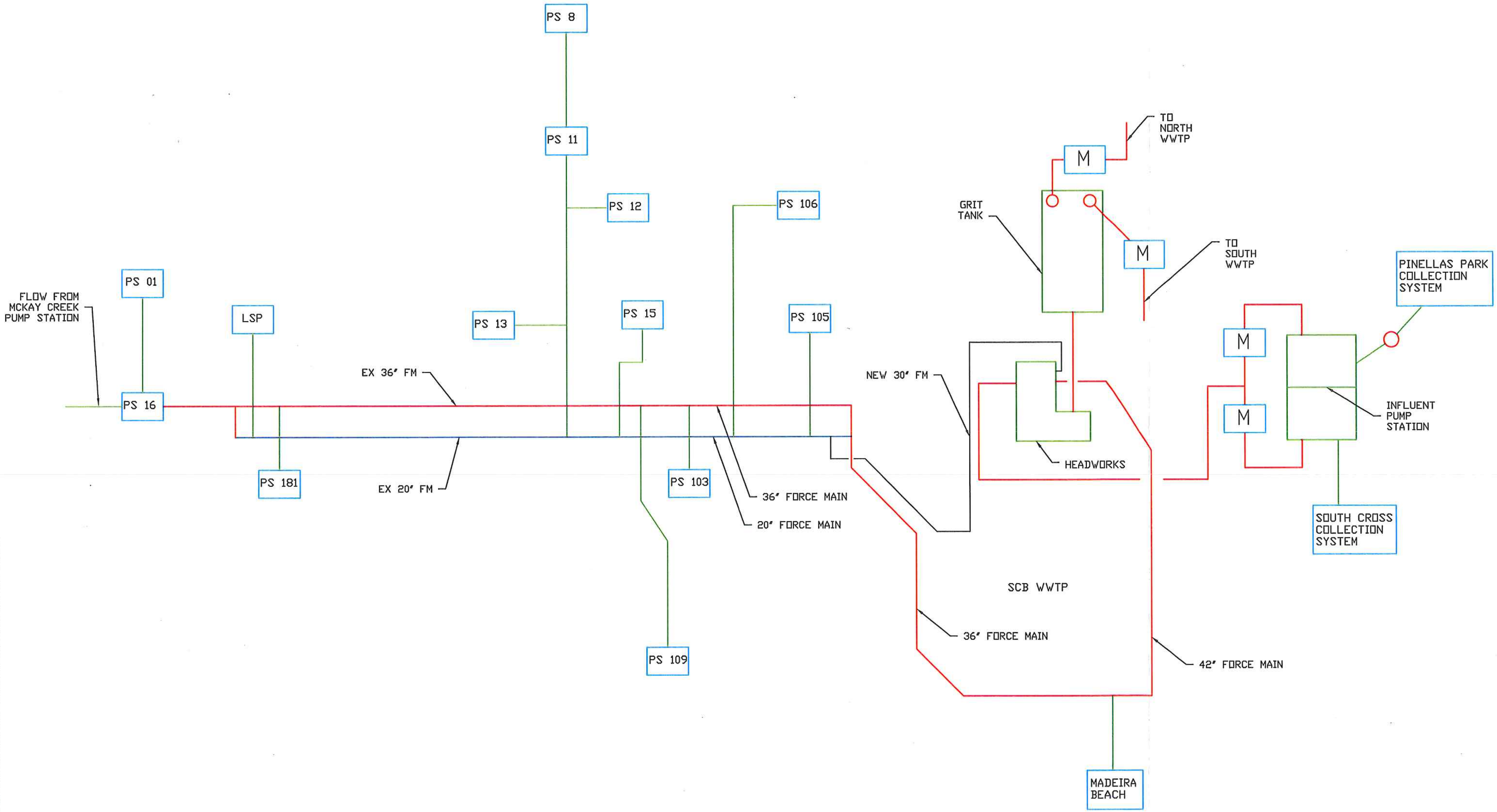
In May of 2007 McKim & Creed submitted a Report to Pinellas County (County) entitled *"Park Boulevard 20-inch Force Main Reactivation Hydraulic Analysis Report"* (Hydraulic Analysis Report) that evaluated reactivation of the 20-inch force main between Pump Station 016 and the South Cross Bayou Water Reclamation Facility (SCBWRF). The purpose of the Hydraulic Analysis Report was to examine the hydraulic constraints of the Boca Ciega pump station and force main system though the use of a hydraulic model.

The Hydraulic Analysis Report concluded that activation of the existing 20-inch force main coupled with the construction of a 30-inch force main at the SCBWRF and a number of pump station upgrades would allow Pump Station 16 to pump at 85% of its design capacity with the remaining manifolded stations pumping at 75% of their design capacities. The Hydraulic Analysis Report also recommends that the County investigate construction of an in-line booster pump station after 2017 to allow the manifolded pump stations to pump at 100% of their design capacity.

In support of this effort, the County tasked King Engineering Associates, Inc. (King) to provide limited confirmation of the hydraulic benefits of the recommendation to construct a 30-inch on-site force main. King was also tasked with evaluating potential methods for construction of the 30-inch on-site force main.

II. Existing Pump Station and Flow Data

Figure 1 is a schematic of the Boca Ciega manifolded pump stations and the other pumped wastewater flows into the SCBWRF. Manifolded stations that directly connect to the 36-inch and 20-inch force mains downstream of Pump Station 016 are 181, 8, 11, 12, 13, 15, 109, 103, 106, 105 and Lake Seminole



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SOUTH CROSS BAYOU
WASTE WATER TREATMENT PLANT

FIGURE 2
SCBWRF MANIFOLDED PUMP STATION
FLOW SCHEMATIC

NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO. 2031-057-000
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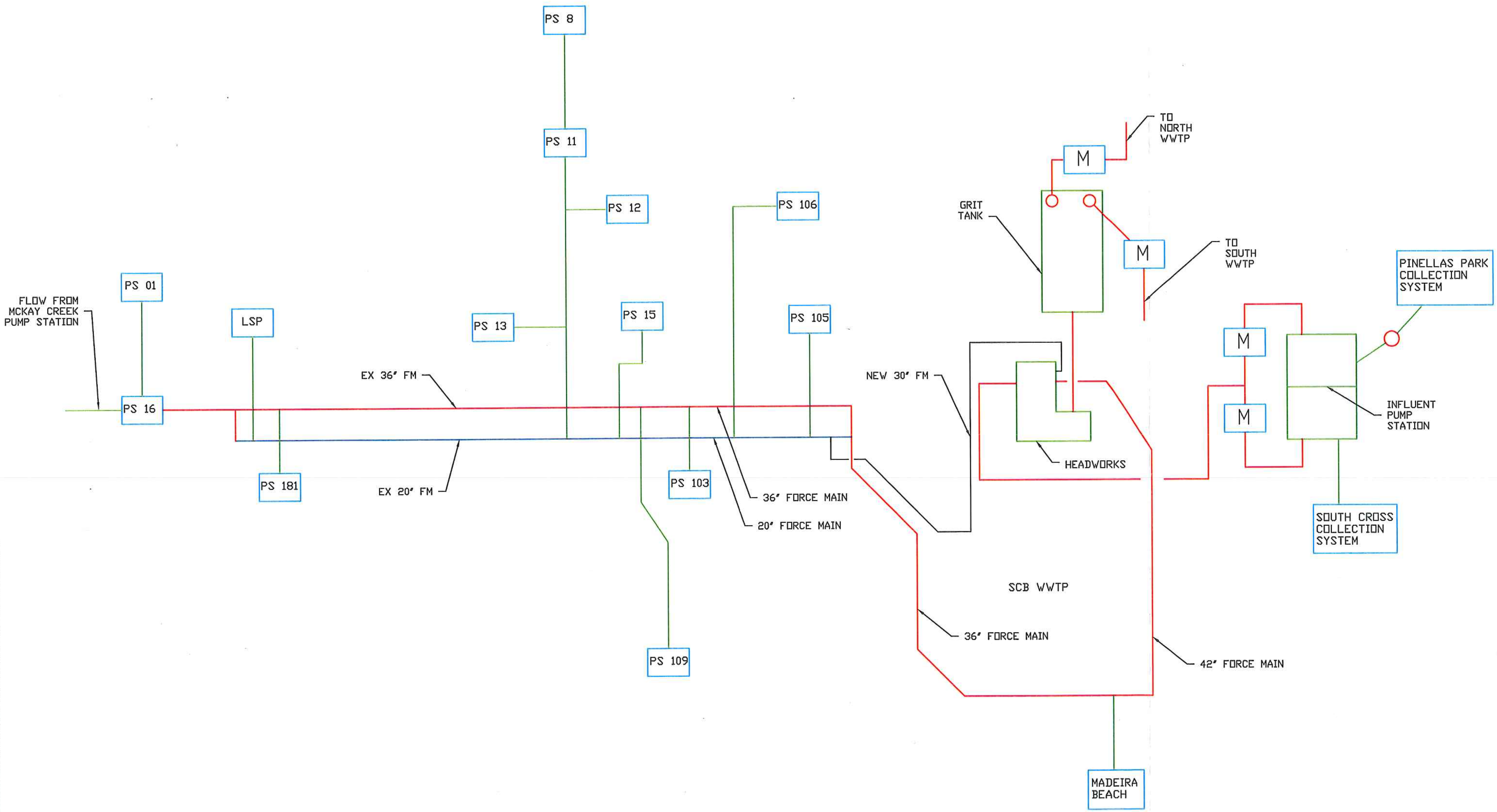

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SOUTH CROSS BAYOU WASTE WATER TREATMENT PLANT

FIGURE 2
SCBWRF MANIFOLDED PUMP STATION FLOW SCHEMATIC

NO.	DATE	DESCRIPTION	APP'D BY
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JOB NO.	2031-057-000
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Park. General pump station information, design flows and wet well depths were provided in Table 2-1 of the Hydraulic Analysis Report (Appendix A).

Paragraph 3.2.4 of the Hydraulic Analysis Report describes the available flow information at the time the study was conducted. Based on available data, it is concluded that the manifolded pump stations appear to be operating at 75% of their design capacity. Projected maximum daily flows for each of the pump stations from 2007 through 2017 were listed in Table 3-1 of the Hydraulic Analysis Report (Appendix A). As shown, in 2007 the actual total maximum daily flow of 22,261 gpm is approximately 76% of the total design flow of the system. Maximum daily flows were predicted to increase a mere 0.5 MGD between 2007 and 2017.

The County provided King with 24-hour flow data for the first two weeks of February and October 2008 for the service areas that discharge to the SCBWRF (Appendix B). By subtracting the flow contributions from the Madeira Beach and Pinellas Park Service Areas from the total flow recorded at the North and South Trains at the plant, the flow contribution from the Boca Ciega Service Area was determined. As shown, flows in February 2008 were greater than those for October 2008, however those flows average only 47% of the pump station design flows. This is likely not indicative of the year-round total flows in the system since, according to the County, the system is subject to inflow and infiltration.

To estimate peak hour flows, hourly flow data provided by the County were used to develop diurnal curves for the Boca Ciega Service Area for February and October 2008 (Figures 2 and 3).

III. Hydraulic Modeling

A. Model Construction

The County provided King with a SewerCAD model of the Boca Ciega

Figure 2
February 2008 Boca Ciega Service Area
Diurnal Curve

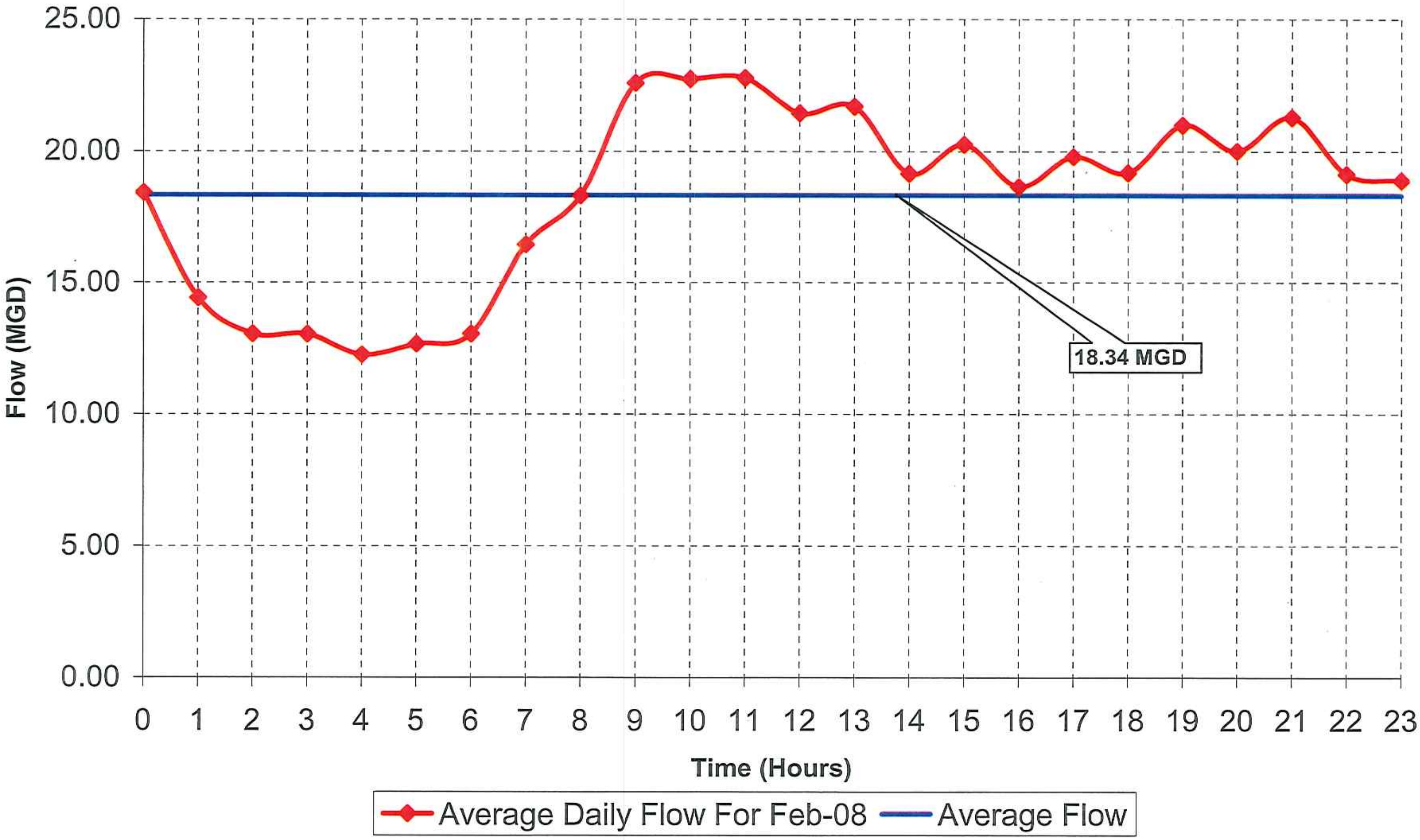
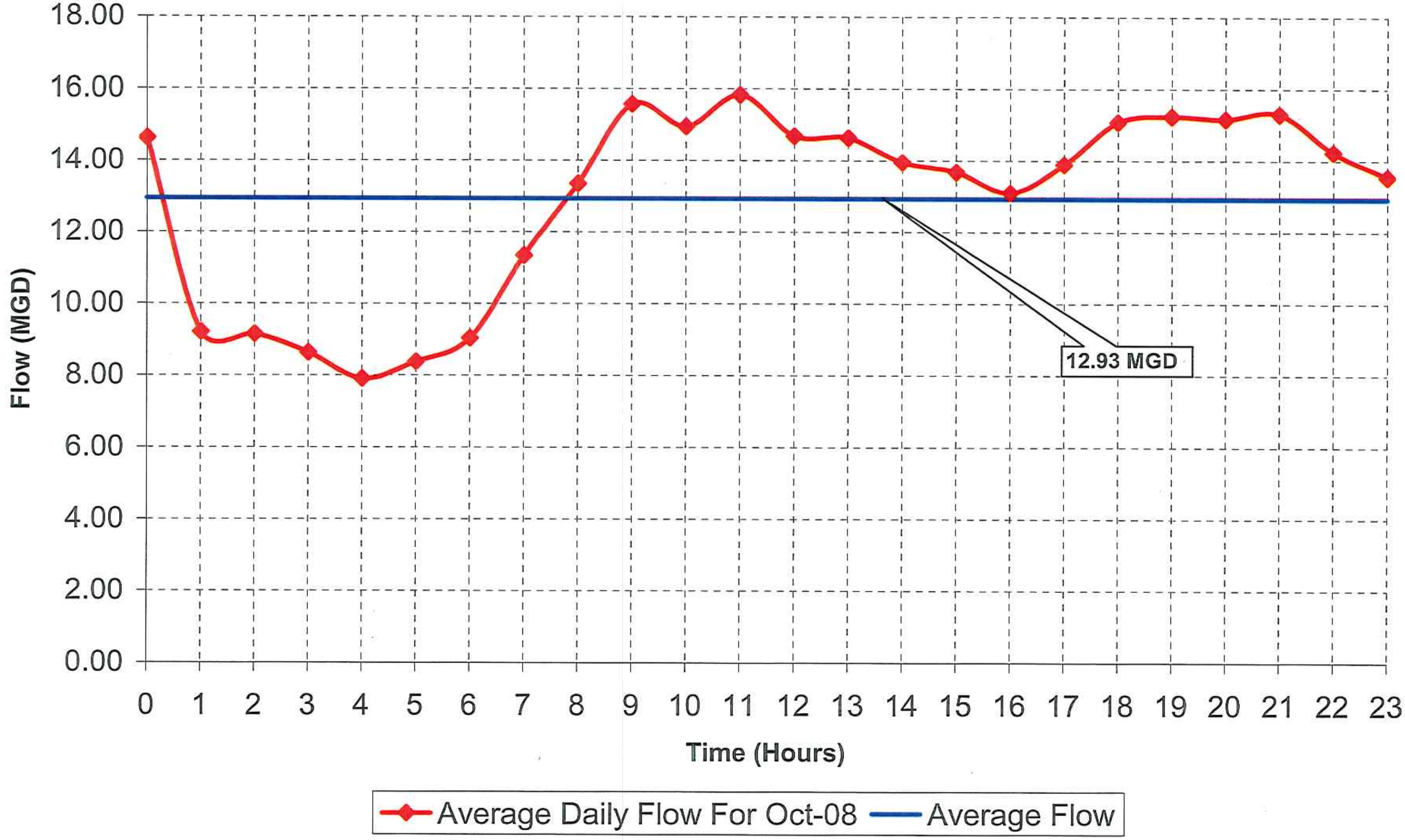


Figure 3
October 2008 Boca Ciega Service Area
Diurnal Curve



force main system which was provided by the consultant that developed the Hydraulic Analysis Report. To confirm the hydraulic benefits associated with the addition of a new on-site force main to serve the Boca Ciega Service Area, data in the hydraulic model provided by the County were used to develop a hydraulic model of the Boca Ciega force main system using H2ONet Analyzer 8. Pump curves, elevations, pipe lengths, sizes and C-factors were all taken from the County model. The new force main was assumed to tie into the 20 and 36-inch force mains at the point where these mains enter the plant site from the west and then follow the open cut/above ground route to the headworks shown in Figure 4. Pump station 001, which currently discharges into pump station 106, was assumed to manifold into the force main system.

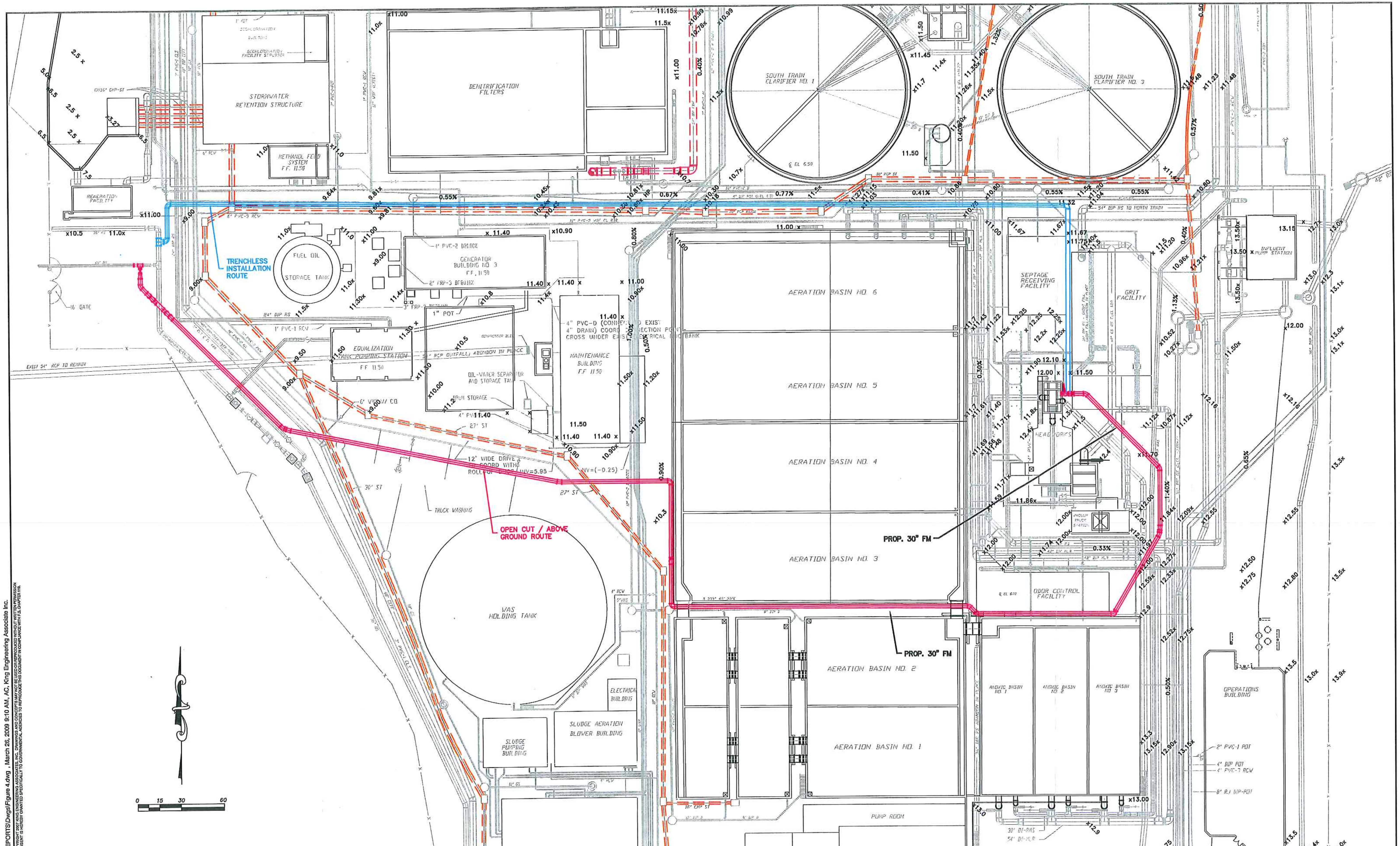
B. Results

1. Existing System

The model was run for the existing system with one pump active in each manifolded pump station (two at PS 106 since it is a triplex station) and the flow at PS 016 forced at 85% of its design flow. Results are outlined in Table 1. As shown, with PS 016 pumping at 85% of its design flow, pump stations 001, 008, 011, 012, 013 and 015 are predicted to be unable to pump at 75% of their design flow, with pump stations 012 and 013 the most severely handicapped at 31% and 56% of their design capacity available respectively.

2. Existing Force Mains with Upgraded Pump Stations

The model was run by forcing 75% of the design flow at each of the pump stations noted to be deficient above to simulate conditions if these stations were upgraded. The additional flow in



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SOUTH CROSS BAYOU
WASTE WATER TREATMENT PLANT

FIGURE 4
OVERALL ROUTES

NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO. 2031-057-000
DATE: OCT. 2008
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TABLE 1
BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

Existing System, Pumps Active, PS 016 Discharging @ 85% Capacity

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% Design Flow
# 001 Currently Discharges to PS 106	300	119	115	40%
# 008	975	699	145	72%
# 011	375	212	136	57%
# 012	450	138	126	31%
# 013	250	139	131	56%
# 015	900	544	131	60%
# 103	180	148	119	82%
# 105	420	422	93	100%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	1428	111	75%
# 109	375	289	127	77%
# 181	1231	1210	143	98%
# 016	21,875	18,594	Forced	85%
Total	**29,241**	**23,942**		
% of Design Total		**82%**		
TDH @ Entrance To SCBWRF	**49.1'**			

Pump station requires upgrade

the system results in higher head conditions, requiring that pump stations 106 and 109 also be upgraded. In total, eight of the eleven manifolded pump stations would need to be upgraded. Results are presented in Table 2.

3. Proposed New Force Main

The model was run based on the existing system scenario plus the proposed parallel 30-inch force main at the plant site. As shown in Table 3, with pump station 016 pumping at 85% of its design capacity, the overall capacity of the manifolded pump stations is predicted to increase 777 gpm, or approximately 1.1 MGD over the existing system scenario. The total dynamic head at the point where the 20 and 36-inch force mains enter the plant decreases by approximately 11 feet. Pump stations 001, 012, 013 and 015 are still predicted to be unable to pump at 75% of their design flows, indicating that upgrades at these stations may still be necessary. If these stations are upgraded to pump at 75% of their design flow under this condition, the increased flow and head in the system will also require that pump station 011 be upgraded. These results are shown in Table 4. These results differs from those of the Hydraulic Analysis Report which concluded that for this scenario, these pump stations plus pump stations 008, 103, 106 and 109 would also need to be upgraded.

4. In-Line Booster Pump Station @ Reduced Capacity

The Hydraulic Analysis Report includes several scenarios in which an in-line booster pump station is constructed in the future, in the vicinity of the Wagon Wheel Flea Market on Park Boulevard, to increase system capacity. For cost comparison reasons, King conducted an analysis to determine the extent of required

TABLE 2
BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

Existing System, Pumps Active, PS 016 Discharging @ 85% Capacity
Pump Stations Upgraded to provide 75% of Design Flow Minimum

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% of design flow
# 001 Currently Discharges to PS 106	300	225	115	75%
# 008	975	731.25	145	75%
# 011	375	281.25	136	75%
# 012	450	337.5	126	75%
# 013	250	187.5	131	75%
# 015	900	675	131	75%
# 103	180	138	120	77%
# 105	420	406	94	97%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	1432.5	111	75%
# 109	375	281.25	127	75%
# 181	1231	1184	146	96%
# 016	21,875	18,594	Forced	85%
Total	**29,241**	**24,473**		
% of Design Total		**84%**		
TDH @ Entrance To SCBWRF			**49.6'**	

Pump station requires upgrade

TABLE 3
BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

Pumps Active, PS 016 Discharging @ 85% Capacity
30-inch Force Main @ SCBWRF

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% of design flow
# 001 Currently Discharges to PS 106	300	181	111	60%
# 008	975	785	141	81%
# 011	375	294	131	78%
# 012	450	139	119	31%
# 013	250	140	124	56%
# 015	900	664	126	74%
# 103	180	179	117	99%
# 105	420	509	86	121%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	1621	105	85%
# 109	375	340	124	91%
# 181	1231	1273	137	103%
# 016	21,875	18,594	Forced	85%
Total	**29,241**	**24,719**		
% of Design Total		**85%**		
TDH @ Entrance To SCBWRF	**38.2'**			

(shaded) Pump station requires upgrade

TABLE 4
BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

Pumps Active, PS 016 Discharging @ 85% Capacity
30-inch Force Main @ SCBWRF, Pump Stations Upgraded to Provide 75% of Design Capacity

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% of design flow
# 001 Currently Discharges to PS 106	300	225	115	75%
# 008	975	731.25	145	75%
# 011	375	281.25	136	75%
# 012	450	337.5	126	75%
# 013	250	187.5	131	75%
# 015	900	675	131	75%
# 103	180	176	117	98%
# 105	420	505	87	120%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	1596	106	84%
# 109	375	334	125	89%
# 181	1231	1263	138	103%
# 016	21,875	18,594	Forced	85%
Total	**29,241**	**24,905**		
% of Design Total		**85%**		
TDH @ Entrance To SCBWRF			**38.3'**	

Pump station requires upgrade

upgrades if an in-line booster pump station is constructed, but an on-site 30" force main is not, assuming that the stations would only need to pump at 75% of their design capacity with pump station 016 pumping at 85% of its design capacity. Results, as presented in Table 5, indicate that for this condition, only pump stations 012 and 013 would need to be upgraded to provide 75% of their design capacity. Under this scenario, the flow from the manifolded pump stations is predicted to increase approximately 2.03 MGD above the existing system.

5. In-Line Booster Pump Station @ 100% Capacity

The Hydraulic Analysis Report recommended that, in addition to the on-site 30" force main, an in-line booster pump station be constructed in the future, in the vicinity of the Wagon Wheel Flea Market on Park Boulevard, to allow all pump stations to operate at 100% of their design capacity. King simulated this scenario in two steps. First, all pumps in the model were turned off and the flow from PS 016 was set to zero. 100% of the pump stations' capacities were then forced into the model at the proposed location of the in-line booster pump station along with 100% of the design flow from PS 105 (downstream of the in-line booster pump station location) to determine the TDH required to drive this flow from this location to the headworks. This TDH represents the required discharge TDH of the in-line booster pump station. With the in-line booster pump station discharge TDH established, a second run was conducted to determine the TDH required at the in-line booster pump station suction to allow the upstream stations to pump at 100% of their design capacity. In this scenario, the model terminated at a theoretical reservoir at the location of the proposed booster pump station. The pumps in each of the

TABLE 5

BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

Existing Force Mains, Pumps Active, PS 016 Discharging @ 85% Capacity
In-Line Booster Pump Station, Pump Stations Upgraded to Provide 75% of Design Capacity

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% of design flow
# 001 Currently Discharges to PS 106	300	230	97	77%
# 008	975	834	132	86%
# 011	375	344	122	92%
# 012	450	338	106	75%
# 013	250	188	109	75%
# 015	900	762	114	85%
# 103	180	203	110	113%
# 105	420	372	115	89%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	1784	83	93%
# 109	375	380	115	101%
# 181	1231	1326	119	108%
# 016	21,875	18,594	Forced	85%
Total	**29,241**	**25,355**		
% of Design Total		**87%**		
TDH @ Entrance To SCBWRF	**51'**			
Inline Booster Pump Design	**25,566 gpm @ 19' TDH**			

Pump station requires upgrade

manifolded stations were activated and 100% of PS 016's design flow (21,875 gpm/31.5 MGD) was forced into the model at PS 016. The elevation of the theoretical reservoir was then progressively dropped, to simulate the in-line booster pump station relieving the system, and the flow from each pump station was monitored. The simulation ended when most of the manifolded stations were pumping at or above 100% of their design capacity. The difference between the in-line booster pump station suction TDH determined by this run, and the required in-line booster pump station discharge TDH determined in the previous run is the theoretical head that the in-line booster pump station would need to add to the system.

Results indicated that the in-line booster pump station would have little effect on pump stations 012 and 013 and that these stations would need to be upgraded to pump at 100% of their design flow rates. Results also indicated that, because it manifolds in downstream of the proposed in-line booster pump station, the increased flows would have a detrimental effect on PS 105 and it would only be capable of pumping 88.1% of its design flow. The above analysis was therefore conducted with 100% of their design flow forced at pump stations 012, 013 and 105. Results, as shown in Table 6, indicate that the design condition for the in-line booster pump station would be approximately 30,194 gpm @ 48 feet TDH, which is similar to the 32,200 gpm at 40 feet TDH calculated in the Hydraulic Analysis Report.

An additional run was conducted assuming that the 30-inch force main at the SCBWRF is not constructed. Since this only serves to increase the head in the system, results are identical to the case above, except that the design condition for the in-line booster

TABLE 6

BOCA CIEGA PUMP STATION/FORCE MAIN SYSTEM MODELING RESULTS

30-inch Force Main at SCBWRF, Pumps Active, PS 016 Discharging @ 100% Capacity
In-Line Booster Pump Station, Pump Stations Upgraded to Provide 100% of Design Capacity

PS No.	Design Flow	Model Results		
	gpm	gpm	TDH	% of design flow
# 001 Currently Discharges to PS 106	300	361	97	120%
# 008	975	981	132	101%
# 011	375	470	122	125%
# 012	450	450	106	100%
# 013	250	250	109	100%
# 015	900	987	114	110%
# 103	180	267	110	148%
# 105	420	420	87	100%
# 106 (Two Pumps Running, 955 gpm Design Flow Each Pump).	1910	2249	83	118%
# 109	375	485	115	129%
# 181	1231	1443	119	117%
# 016	21,875	21,875	Forced	100%
Total	**29,241**	**30,238**		
% of Design Total		**103%**		
TDH @ Entrance To SCBWRF	**40.3'**			
Inline Booster Pump Design	**30,194 gpm @ 48' TDH**			

Pump station requires upgrade

pump station increases to 30,194 gpm @ 65 feet TDH.

It should be noted that at this flow condition, the maximum velocities in the Park Boulevard 20" and 36" force mains are predicted to be 5.6 and 7.9 ft/s respectively. However, it is not likely that all of the pump stations would run simultaneously and this condition is considered a worst case.

C. Summary

A summary of King's modeling results is presented in Table 7.

Table 7

Summary of Modeling Results

Scenario	Flow Goal	Pump Stations Requiring Upgrades
Existing System	PS 016 @ 85% of design flow, remaining stations at 75% of design flow	001, 008, 011, 012, 013, 015, 106, 109
Existing System plus On-Site 30-inch Force Main	PS 016 @ 85% of design flow, remaining stations at 75% of design flow	001, 011, 012, 013, 015
Existing System plus In-Line Booster Pump Station	PS 016 @ 85% of design flow, remaining stations at 75% of design flow	012, 013
Existing System plus On-Site 30-inch Force Main plus In-Line Booster Pump Station	All stations at 100% of design flow	012, 013, 105

IV. Power Savings

Construction of a new on-site force main is predicted to result in reduced system pressures and increased flows. The net effect of the reduced pressures should be a decrease in electrical consumption. To determine the reduction in

upstream system head that would result from construction of the new plant force main, the model was run forcing flows at the proposed new force main tie-in point over a 24-hour period, with and without the new force main, and subject to the diurnal curve developed based on the February 2008 flow data provided by the County (Figure 2). Flows were forced at 85% of the design capacity for pump station 016 plus 75% of the design capacity of the remaining manifolded pump stations.

The analysis was conducted for both a 30-inch and a 36-inch force main in order to evaluate if increasing the force main to a 36-inch would justified. The associated horsepower reduction for the overall system was estimated using the following equation:

$$\mathbf{HP} = \frac{\mathbf{Q \times H}}{\mathbf{3960 \times Eff.}}$$

Where:

- HP = Horsepower
- Q = Flow (gpm)
- H = Head (ft)

Eff. = Pump Station Efficiency (assumed at 40%)

Head reductions and the resulting power savings calculations for the reduced capacity scenario are presented in Table 8. As shown, construction of a new 30-inch force main is calculated to reduce the system head at the proposed tie-in location approximately 9.4 feet during peak hour flows. Increasing the new force main to 36-inches only reduces the head at this location by another 1.7 feet for the same flow condition. Therefore, upsizing the new force main to a 36-inch pipe therefore does not appear warranted.

V. Proposed Force Main

A. Alternatives

TABLE 8

POWER SAVINGS ESTIMATES

85% OF DESIGN FLOW FROM PS-016 & 75% DESIGN FLOW FROM ALL OTHER BOGA CIEGA PUMP STATIONS

		Existing System		30" Force Main		36" Force Main		Reduction in Head (ft)		Power Savings Based on System Head Reduction					
										30" FM			36" FM		
Time	Flow (gpm)	Head (ft)	HP	Head (ft)	HP	Head (ft)	HP	30" FM	36" FM	HP Saved	kW	Dollars	HP Saved	kW	Dollars
00:00 hrs	19,751	42.1	525	36.0	449	34.9	435	6.1	7.2	76	57	$5.13	89	67	$6.03
01:00 hrs	15,454	39.3	383	35.1	342	34.3	335	4.2	4.9	41	31	$2.79	48	36	$3.24
02:00 hrs	13,981	38.2	337	34.7	306	34.1	301	3.5	4.1	31	23	$2.07	36	27	$2.43
03:00 hrs	13,964	38.1	336	34.7	306	34.1	301	3.4	4.0	30	22	$2.07	35	26	$2.43
04:00 hrs	13,139	37.6	312	34.5	286	34.0	282	3.1	3.6	26	19	$1.80	30	23	$2.07
05:00 hrs	13,572	37.9	324	34.6	296	34.0	292	3.3	3.8	28	21	$1.89	33	24	$2.25
06:00 hrs	13,983	38.1	336	34.7	306	34.1	301	3.4	4.0	30	23	$2.07	35	26	$2.43
07:00 hrs	17,629	40.7	454	35.6	396	34.7	386	5.2	6.1	58	43	$3.96	68	51	$4.59
08:00 hrs	19,633	42.5	527	36.1	448	35.0	434	6.4	7.5	79	59	$5.31	93	69	$6.30
09:00 hrs	24,204	46.7	713	37.5	573	35.9	548	9.2	10.8	140	105	$9.45	165	123	$11.16
10:00 hrs	24,369	46.9	722	37.6	578	35.9	553	9.3	11.0	144	107	$9.72	169	126	$11.43
11:00 hrs	24,414	47.1	725	37.6	580	35.9	554	9.4	11.1	146	109	$9.81	171	128	$11.52
12:00 hrs	22,982	45.6	661	37.1	539	35.6	517	8.4	9.9	122	91	$8.28	144	107	$9.72
13:00 hrs	23,247	45.7	671	37.2	546	35.7	524	8.5	10.0	125	94	$8.46	147	110	$9.99
14:00 hrs	20,534	43.2	561	36.4	472	35.2	456	6.9	8.1	89	66	$6.03	105	78	$7.11
15:00 hrs	21,717	44.3	608	36.7	504	35.4	485	7.6	8.9	104	78	$7.02	123	91	$8.28
16:00 hrs	20,001	42.8	540	36.2	457	35.1	443	6.5	7.7	83	62	$5.58	97	72	$6.57
17:00 hrs	21,218	43.9	588	36.6	490	35.3	473	7.3	8.6	98	73	$6.57	115	86	$7.74
18:00 hrs	20,570	43.3	562	36.4	472	35.2	457	6.9	8.1	89	67	$6.03	105	79	$7.11
19:00 hrs	22,498	45.1	640	37.0	525	35.5	505	8.1	9.5	115	86	$7.74	136	101	$9.18
20:00 hrs	21,455	44.1	597	36.6	496	35.3	479	7.4	8.7	101	75	$6.84	118	88	$8.01
21:00 hrs	22,813	45.3	653	37.1	534	35.6	513	8.3	9.7	119	89	$8.01	140	104	$9.45
22:00 hrs	20,509	43.3	560	36.4	471	35.2	455	6.9	8.1	89	66	$6.03	105	78	$7.11
23:00 hrs	20,259	43.0	550	36.3	464	35.1	449	6.7	7.9	86	64	$5.76	101	75	$6.84
										Total Daily Savings		$138			$163
										Total Annual Savings		$50,523			$59,491

King evaluated three alternative methods for constructing the 30-inch on-site force main. The methods included combinations of directional drill/open cut; micro-tunneling/open cut; and above ground/open cut and resulted in the routing alternatives shown in Figure 4.

1. Horizontal Directional Drill and Micro-Tunneling

   Plan and profile views of existing utilities along the proposed alignment for the horizontal directional drill and micro-tunneling alternatives are provided in (Appendix C). The pipe profile information shows that the existing ground surface at the SCBWRF is approximately 10 feet above sea level. Major pipes that cause the depth of these two alternatives to be greater than 15 feet below the surface are a 42-inch storm drain on the west side of the force main and the 54-inch return sludge line on the east side of the plant. The analysis of the directional drill and micro-tunneling alternatives presented in (Appendix D) concludes that site constraints and the existing utilities allow very little space to install a new pipeline using either of these methods. In the case of horizontal directional drill, the existing utilities do not allow sufficient space to prepare entry and exit pits and a reasonable work area. Additionally, the pipe layout and staging for pull-in offer another significant challenge. The geometry of the installation is also such that difficulty is much greater than average. Based on these factors, installation using horizontal directional drill is not recommended. Installing the new force main by micro-tunneling appears to be feasible based on the soil conditions, utility locations, and site constraints. However, as discussed below, this installation method does not appear cost-effective.

2. Above Ground/Open Cut

a. Alignment

The proposed alignment for the above ground/open cut alternative is shown on the conceptual drawings provided in (Appendix E). As shown, the pipeline will tie into the existing 20-inch force main entering the SCBWRF via a tapping sleeve and valve. From there the pipe will go under the existing 36-inch force main and head east along the pathway just north of the truck wash. The pipeline will then come out of the ground and head south along a portion of the west wall of Aeration Tank # 4 and Aeration Tank # 3. Pipeline will then head east along the south wall of Aeration Tank # 3, and re-enter the ground in a grassy area just west of the Administration Building. From there, pipeline will head north under existing roadway, then west to the head works where it will tie into an existing blind flange assembly at the headworks.

b. Pipe Materials

Several materials are available for use for the force main installed by open cut. Those most typically used in the County's system include ductile iron, AWWA C-905 PVC and High Density Polyethylene (HDPE). Because of the wall thickness of HDPE pipe, a 36-inch main would need to be installed to obtain the same inside diameter as ductile iron or PVC. This would then require 36-inch ductile iron fittings and would therefore typically result in a higher cost than PVC or ductile iron.

AWWA C-905 PVC is also a viable material, however the County has typically preferred to avoid its use in larger diameter pipes.

Regardless of the pipe material used in the buried areas, King recommends that the above ground pipe and fittings be flanged ductile iron with a Protecto 401 ceramic epoxy internal lining. This being the case, and given the drawbacks associated with the other pipe materials, lined ductile iron pipe is the recommended material for this application.

c. Construction and Risk Considerations

The County has indicated they would like to avoid open cut construction of existing pavement if possible so as not to disrupt the normal daily operation of the facility. Therefore open cutting behind the curb line will need to be considered during design. Due to the size of the pipe and the resulting depth of the trench, it is likely that any open cutting near pavement will affect the pavement in some fashion. In addition, constructing the force main without crossing some pavement and accessways is not possible. Therefore, the construction documents will need to specifically require that the Contractor perform the work in a manner that minimizes disruption to traffic, such as working at night or on weekends.

There are several potential risks associated with constructing the force main. They include:

- Conflicts with existing pipes/utilities;

- Unforeseen ground conditions/obstacles resulting from the congested nature of the site such as buried electrical/control conduit banks not denoted on the Record Drawings;
- Damaging other buried facilities. This could result from encountering unforeseen facilities and could also result from the losing bedding or support due to the pipe excavation. At a minimum, the pipe trench will be 5 feet deep. At locations where the pipe must be deeper to pass under existing facilities, the conceptual design drawings indicate that the trench could be 16 feet deep. Depending on the congestion in the area, it may prove difficult for the contractor to install sheeting, shoring and other trench stabilizing methods;
- Damaging above ground tankage and pipes, especially in the narrow above ground pipe corridor;

It is likely that more subsurface investigation will be required during design to reduce the risk of encountering unforeseen conditions. The Contract Documents should also require the contractor to pothole and locate all utilities to be crossed by hand prior to excavation.

d. Contractor Considerations

To reduce the risk of damaging existing facilities and disrupting plant operations, the contractor should have extensive, proven experience with working on large pipes in congested treatment plant environments. In construction of the force main is implemented, the County should

consider pre-qualifying a minimum of three contractors for the project and then having those contractors competitively bid the work. This could reduce the risks associated with having an open competitive bid and would help ensure that the Contractor is qualified for such work. The County could also consider an alternative method of construction contract procurement such as Design-Build or Construction Manager at Risk. Using either of these procurement methods could give the County more control over who is chosen to construct the project while also placing a larger proportion of the project risk on the contractor.

VI. Opinions of Probable Construction Cost

A. Costs

Conceptual opinions of probable construction cost for all three force main alternatives are presented in (Appendix F). These opinions of probable construction cost are considered Class 4 estimates as defined by the American Association of Cost Engineers (AACE). The AACE establishes that a cost estimate at this level can be expected to be accurate within -15% and +50% of the nominal value. A summary of the estimate values is as follows:

	Low	Nominal	High
Horizontal Directional Drill/Open Cut	$1,069,640	$1,258,400	$1,887,600
Micro-tunneling/Open Cut	$1,997,840	$2,350,400	$3,525,600
Above Ground/Open cut	$1,151,283	$1,354,450	$2,031,675

As shown, the horizontal directional drill alternative and the above ground alternative are estimated to be similar in cost and, at this level of

estimate, can be considered equal. However, the directional drill approach is not recommended and does not appear feasible. The least costly approach to constructing the force main therefore appears to be the above ground alternative. As discussed above, all of these approaches have significant risks associated with working in the treatment plant environment. These risks are difficult to assess at this time and can be investigated further during the design of the force main. Any difficulty factor applied to these estimates would be an estimate at this time and would apply to all three methods. The values presented above are therefore more valid for comparing the methods than for determining an absolute cost for the work.

B. Alternative Comparison

A cost comparison of the alternatives presented above is provided in Table 9 including the net present value of potential electrical savings associated with lowering the head in the system by constructing an on-site 3-inch force main. Cost estimates for upgrading pump stations and for the in-line booster pump station were taken directly from the Hydraulic Analysis Report.

As shown, and as recommended in the Hydraulic Analysis Report, the least costly option to provide 75% of design capacity at the manifolded pump stations and 85% of design capacity at pump station 016 appears to be to construct the on-site 30-inch force main in conjunction with upgrading pump stations 001, 011, 012, 013 and 015. This is based on recovering electrical costs over a 20 year period. From a capital cost standpoint, all three approaches are very similar in cost.

Similarly, all three options considered to provide 100% capacity are similar in cost once the 20 years of electrical savings are taken into

TABLE 9
SUMMARY OF COST ESTIMATES AND POWER SAVINGS

	75% DESIGN CAPACITY/85% AT PS 016			100% DESIGN CAPACITY		
	Base Condition	New Force Main	In-Line Booster @ 75%	Base Condition	In-Line Booster @ 100%	In-Line Booster @ 100%, No FM
	Existing System, No New Force Main, Upgrade Pump Stations to Provide 75% of Design Capacity. PS 016 @ 85% of Design Capacity	New 30-inch Force Main at SCBWRF. Upgrade Pump Stations to Provide 75% of Design Capacity. PS 016 @ 85% of Design Capacity	No New Force Main, Upgrade Pump Stations to Provide 75% of Design Capacity. PS 016 @ 85% of Design Capacity. Construct In-Line Booster Pump Station.	Existing System, No New Force Main, Upgrade Pump Stations to Provide 100% of Design Capacity. PS 016 @ 100% of Design Capacity.	New 30-inch Force Main, Upgrade Pump Stations to Provide 100% of Design Capacity. PS 016 @ 100% of Design Capacity. Construct In-Line Booster Pump Station.	No new 30-inch Force Main, Upgrade Pump Stations to Provide 100% of Design Capacity. PS 016 @ 100% of Design Capacity. Consruct In-Line Booster Pump Station.
Pump Station Upgrades						
PS 001	$189,496	$189,496	$0	$189,496	$0	$0
PS 008	$515,219	$0	$0	$515,219	$0	$0
PS 011	$556,545	$556,545	$0	$556,545	$0	$0
PS 012	$412,674	$412,674	$412,674	$412,674	$412,674	$412,674
PS 013	$144,895	$144,895	$144,895	$144,895	$144,895	$144,895
PS 015	$369,506	$369,506	$0	$369,506	$0	$0
PS 105	$0	$0	$0	$224,816	$224,816	$224,816
PS 106	$581,934	$0	$0	$581,934	$0	$0
PS 109	$412,674	$0	$0	$412,674	$0	$0
New 30-inch Force Main	$0	$1,354,450	$0	$0	$1,354,450	$0
In-Line Booster Station	$0	$0	$2,396,462	$0	$2,396,462	$2,755,931
Total	**$3,182,943**	**$3,027,566**	**$2,954,031**	**$3,407,759**	**$4,533,297**	**$3,538,316**
20-yr Present Value of Power Savings @ $.09/kW-hr	$0	-$680,151	$0	$0	-$1,093,643	$0
Grand Total	**$3,182,943**	**$2,347,415**	**$2,954,031**	**$3,407,759**	**$3,439,654**	**$3,538,316**
-15%	**$2,705,502**	**$1,995,303**	**$2,510,926**	**$2,896,595**	**$2,923,706**	**$3,007,569**
+50%	**$4,774,415**	**$3,521,123**	**$4,431,047**	**$5,111,639**	**$5,159,481**	**$5,307,474**
Average	**$3,739,958**	**$2,758,213**	**$3,470,986**	**$4,004,117**	**$4,041,593**	**$4,157,522**

account and the estimated cost for the in-line booster pump station is increased by an estimated factor of 15% to take into account the higher horsepower motors and higher rated generator and electrical system that would be required for the option without the 30-inch force main. From a capital cost standpoint, upgrading all of the manifolded pump stations or constructing an in-line booster pump station without the 30-inch force main are estimated to be more cost-effective than constructing both the in-line booster pump station and the 30-inch force main.

Given the preliminary and cursory nature of this analysis, and the similarity between estimated costs,

VII. <u>Recommendations</u>

Hydraulic analyses of the pump station and force main system have produced similar results as those presented in the Hydraulic Analysis Report. Namely:

- Construction of an on-site force main in conjunction with pump station upgrades appears to be the most cost-effective approach to increasing system capacity such that pump station 016 can pump at 85% of its design capacity while the remaining manifolded pump stations pump at 75% of their design capacities;
- An in-line booster pump station with a capacity of approximately 30,194 gpm @ 48 feet TDH, operating in conjunction with a 30-inch force main at the SCBWRF and the pump station upgrades described above, could allow all of the pump stations to pump at 100% of their design capacity simultaneously.

Given the preliminary nature of this analysis and the similarity of estimated costs between alternatives, a conclusive recommendation cannot be made based on cost alone. All of the analyses conducted assume that all of the pump stations will be operating simultaneously either at a reduced capacity or at

100% capacity. Under typical conditions, it is more likely that some stations run more than others and that the number of pump stations operating simultaneously varies throughout the day and quite possibly throughout the year depending on seasonal influences and the influences of infiltration and inflow. Because of this, it is possible that the extent of system upgrades required to meet the goals outlined above may be significantly less than anticipated.

Because of the risks and unknowns associated with constructing the 30-inch force main on site, the magnitude of the associated costs, and the similarity in estimated costs between the potential approaches, it is recommended that additional real-time data be collected to allow a statistical analysis to be conducted regarding station run times. Using these data, the likelihood of pump stations running simultaneously can be more accurately determined and cycle times and storage volumes in each pump station wet well can be evaluated. In addition, a calibrated, dynamic hydraulic model of the system should be developed using flow and pressure data collected in the system. Knowing the likelihood of stations running simultaneously and using the calibrated model, productive and cost-effective system upgrades can be determined.

Appendix A

APPENDIX A

PARK BOULEVARD 20-INCH FORCE MAIN
REACTIVATION HYDRAULIC ANALYSIS REPORT TABLES

forcemain directly to the 16-inch forcemain downstream of PS 106. Information about these pump stations can be found in **Table 2-1** and **Appendix A.**

Table 2-1: General Pump Station Information

PS No.	PUMP INFORMATION						WETWELL INFO[1]							
	QTY	TYPE	MODEL/ IMPELLER	HP	GPM	TDH	Top El	Pumps Off	Lead On	Lag On	High Water	Influent Invert	Bottom	Wet Well Area (sf)
#001	2	Flygt	3152/454	20	300	90	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A
# 008	2	Flygt	3300/466	88	975	132	8.33	-8.97	-9.67	-10.97	-14.47	-7.37	-17.87	113
# 011	2	Flygt	3201/457	47	375	127	8.50	-3.90	-4.90	-5.90	-11.50	-6.9	-13.20	38
# 012	2	Flygt	3201/457	47	450	124	9.02	-0.18	-1.18	-2.28	-6.98	-1.78	-7.56	50
# 013	2	Flygt	3201/457	47	250	135	7.17	-5,63	-6.63	-7.63	-11.53	-7.43	-12.83	44
# 015	2	Flygt	3300/467	60	900	117	8.56	N/A	N/A	N/A	N/A	-7.84	-12.14	50
# 016	1	Flygt	3231/430	250	4,517	126	8.5	N/A	N/A	N/A	N/A	N/A	-16.3	300
#103	2	Flygt	3140/480	15	180	107	10.98	-2.02	-3.02	-3.82	-5.82	-3.62	-7.52	44
#105	2	Flygt	3152/454	20	420	93	8.34	N/A	N/A	N/A	N/A	-3.36	-8.86	62
#106	3	Flygt	3201/457	47	955	95	12.05	N/A	N/A	N/A	N/A	-4.75	-10.80	92
#109	2	Flygt	3201/457	47	375	122	7.07	-3.13	-4.63	-6.13	-9.13	-5.93	-11.13	97
#181	2	Flygt	3300/454	88	1,231	147	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A

1 Pump Station Elevations are referenced in MSL unless otherwise noted

2.3 *Purpose*

The analysis determined how much additional capacity and longevity the 20-inch forcemain could provide the Boca Ciega collection system, what configuration is best for the County, and what impacts this potential change will have on the interconnected pump stations.

future flow rates in the Boca Ciega service area. Ten year projections for the flow rates at each pump station are shown on **Table 3-1.**

Table 3-1: Boca Ciega Service Area Flow Projections.

Pump Station	Planning Zone	Design	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
001	9	300	225	226	226	227	227	227	228	228	228	228	229
008	9	975	731	733	735	736	737	738	739	740	742	742	743
011	9	375	281	282	283	283	284	284	284	285	285	285	286
012	9	450	338	338	339	340	340	341	341	342	342	343	343
013	9	250	188	188	188	189	189	189	190	190	190	190	190
015	9	900	900	902	904	906	908	909	910	911	913	913	914
016	9	21,875	16,406	16,445	16,483	16,521	16,544	16,567	16,590	16,614	16,637	16,650	16,663
103	9	180	135	135	136	136	136	136	137	137	137	137	137
105	10	420	420	422	423	425	426	427	428	429	431	431	432
106	9	1,910	1,433	1,436	1,439	1,443	1,445	1,447	1,449	1,451	1,453	1,454	1,455
109	9	375	281	282	283	283	284	284	284	285	285	285	286
181	9	1,231	923	925	928	930	931	932	934	935	936	937	938
	Total (gpm)	29,241	22,261	22,313	22,366	22,418	22,450	22,482	22,514	22,546	22,578	22,597	22,615
	Total (mgd)	42.11	32.06	32.13	32.21	32.28	32.33	32.37	32.42	32.47	32.51	32.54	32.57

4.0 SCENARIOS CONSIDERED

Initially nine potential configurations were identified. These scenarios were evaluated and modeled on a conceptual level to determine the benefits each of them had on maximizing the capacity of the collection system, minimizing the impacts to the existing station and extending the useful life of the system. The findings of this analysis were entered into a decision matrix that subjectively scored each of the scenarios on several key considerations, as detailed in **Section 4.12** below.

Upon completion of this preliminary matrix a meeting was held with County representatives to discuss the findings and verify the ranking. During this

Appendix B

APPENDIX B

FEBRUARY & OCTOBER 2008
SCBWRF FLOW DATA

Hour	SCBWRF South Train Recorded Flow MGD													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	9.4	8.9	9.4	9.5	8.6	8.5	10.46	9.24	9.90	8.46	8.03	9.13	8.79	8.88
1:00 AM	8.4	8.5	8.3	8.0	7.8	7.7	8.21	8.44	7.12	8.03	7.43	7.30	8.30	8.42
2:00 AM	7.1	7.2	6.5	6.3	6.4	6.9	6.65	7.35	7.32	5.37	6.47	5.58	7.73	6.79
3:00 AM	6.8	6.8	6.4	6.1	6.2	6.4	5.47	6.50	7.24	5.76	5.48	5.89	6.75	6.59
4:00 AM	5.8	6.4	6.4	5.7	5.2	5.0	6.62	5.61	6.53	5.21	4.76	5.58	6.13	6.06
5:00 AM	6.3	5.9	5.9	5.6	5.8	6.0	5.45	6.23	6.55	5.43	5.36	5.22	5.95	5.46
6:00 AM	6.6	5.7	4.8	5.7	6.2	6.9	6.49	6.67	6.51	4.85	5.62	5.50	5.69	7.04
7:00 AM	9.6	6.8	6.1	8.7	9.1	9.8	9.44	9.27	6.99	5.89	9.00	8.87	9.20	9.47
8:00 AM	11.7	8.5	7.9	11.1	11.8	12.1	11.92	11.57	8.40	7.44	11.06	11.04	11.76	12.06
9:00 AM	13.8	12.2	11.6	14.1	14.3	14.4	14.13	14.76	12.48	10.83	13.74	14.06	14.54	14.68
10:00 AM	13.2	13.7	13.4	13.8	13.7	13.8	13.55	14.22	14.73	12.24	14.00	13.66	15.04	13.32
11:00 AM	13.9	16.2	15.9	14.2	13.3	13.7	13.91	13.04	15.46	15.41	13.19	13.34	13.45	14.19
12:00 PM	12.5	14.5	15.5	12.5	11.8	13.0	12.46	12.85	15.39	15.39	12.20	12.39	12.23	12.00
1:00 PM	11.5	15.2	15.1	12.7	11.9	11.5	13.13	13.02	15.54	16.18	12.61	12.59	9.78	12.44
2:00 PM	11.4	13.4	14.1	11.4	10.6	10.7	11.63	11.10	12.71	13.28	10.85	7.88	11.47	10.63
3:00 PM	12.1	13.8	13.6	11.8	11.1	11.2	11.84	11.78	15.12	12.94	11.25	10.90	11.57	10.84
4:00 PM	10.9	12.6	11.8	11.1	10.7	10.6	10.90	11.10	11.48	11.69	10.95	10.11	10.42	9.71
5:00 PM	11.9	12.8	14.2	11.6	11.2	11.3	10.84	11.23	13.13	12.40	10.71	11.42	12.14	11.23
6:00 PM	11.5	12.3	13.0	11.2	10.9	11.3	11.24	11.01	10.88	11.65	11.06	11.63	11.48	11.10
7:00 PM	13.1	13.1	13.4	13.2	12.6	12.8	13.19	12.62	13.08	12.81	12.34	13.75	13.29	13.09
8:00 PM	12.3	11.8	12.2	12.9	12.5	12.1	12.44	11.83	10.95	11.89	12.39	13.53	12.75	11.92
9:00 PM	12.5	12.3	12.8	13.6	13.1	13.4	14.49	12.07	11.85	14.26	12.85	14.46	13.41	14.27
10:00 PM	11.1	10.9	11.0	12.2	12.1	11.8	12.42	10.38	9.81	12.07	12.11	12.44	12.02	11.98
11:00 PM	11.0	10.4	11.3	11.2	11.2	11.3	11.49	10.63	9.82	10.89	10.72	11.24	12.32	11.24

Hour	SCBWRF North Train Recorded Flow MGD													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	13.6	15.5	13.5	13.4	12.5	13.7	15.25	13.08	13.88	16.19	16.19	16.19	16.19	16.19
1:00 AM	12.3	15.5	12.2	11.7	11.6	11.5	13.54	12.26	10.30	16.19	16.19	16.19	16.19	16.19
2:00 AM	11.0	11.1	9.9	9.7	9.7	10.3	11.32	10.64	11.02	16.19	16.19	16.19	16.19	16.19
3:00 AM	10.5	10.5	9.8	9.3	9.4	8.6	10.07	9.29	10.47	16.19	16.19	16.19	16.19	16.19
4:00 AM	8.9	9.8	9.8	8.8	8.1	8.0	9.54	9.37	9.61	16.19	16.19	16.19	16.19	16.19
5:00 AM	9.5	9.0	9.1	8.7	8.9	9.4	8.55	9.96	9.89	16.19	16.19	16.19	16.19	16.19
6:00 AM	10.4	8.8	7.7	8.8	9.5	9.4	9.20	10.14	9.81	16.19	16.19	16.19	16.19	16.19
7:00 AM	13.6	10.2	9.4	12.4	12.8	12.3	12.85	13.20	10.66	16.19	16.19	16.19	16.19	16.19
8:00 AM	15.7	12.3	11.5	14.7	15.2	13.8	13.79	15.83	12.38	16.19	16.19	16.19	16.19	16.19
9:00 AM	17.3	15.8	15.5	17.6	17.8	16.9	15.30	17.34	15.44	16.19	16.19	16.19	16.19	16.19
10:00 AM	17.6	17.3	17.1	17.5	17.4	18.5	17.58	17.83	17.90	16.19	16.19	16.19	16.19	16.19
11:00 AM	17.3	19.4	19.2	17.6	16.9	17.7	17.09	17.19	19.44	16.19	16.19	16.19	16.19	16.19
12:00 PM	17.1	18.6	18.6	16.2	15.9	16.2	17.38	17.38	18.33	16.19	16.19	16.19	16.19	16.19
1:00 PM	16.4	18.6	19.3	16.7	16.0	15.6	16.82	16.46	19.25	16.19	16.19	16.19	16.19	16.19
2:00 PM	15.9	17.2	17.6	15.5	14.9	14.9	15.14	15.03	16.65	16.19	16.19	16.19	16.19	16.19
3:00 PM	16.2	17.4	18.1	15.9	15.1	15.7	16.21	15.30	18.03	16.19	16.19	16.19	16.19	16.19
4:00 PM	14.6	16.4	16.8	15.0	15.0	16.3	14.36	14.88	15.65	16.19	16.19	16.19	16.19	16.19
5:00 PM	15.3	16.3	17.4	15.2	15.6	13.4	15.13	15.46	16.52	16.19	16.19	16.19	16.19	16.19
6:00 PM	15.6	15.9	16.4	15.1	15.8	14.2	15.10	14.84	15.33	16.19	16.19	16.19	16.19	16.19
7:00 PM	15.9	16.7	16.8	16.6	15.9	15.2	15.46	14.89	16.27	16.19	16.19	16.19	16.19	16.19
8:00 PM	15.5	15.7	15.6	16.2	18.0	15.2	15.90	15.49	15.49	16.19	16.19	16.19	16.19	16.19
9:00 PM	16.3	15.9	16.2	16.8	17.4	15.7	16.94	15.01	15.10	16.19	16.19	16.19	16.19	16.19
10:00 PM	15.9	15.0	14.9	15.7	16.6	16.8	15.56	14.40	16.19	16.19	16.19	16.19	16.19	16.19
11:00 PM	15.1	14.4	15.3	15.2	15.2	16.9	15.26	14.61	16.19	16.19	16.19	16.19	16.19	16.19

Hour	Pinellas Park Recorded Flow MGD													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	5.14	4.74	4.64	4.88	4.80	4.83	4.71	4.97	4.69	4.53	4.71	4.71	4.70	4.91
1:00 AM	4.44	4.25	4.19	4.40	4.12	4.16	4.34	4.18	4.26	3.91	4.12	3.87	4.12	4.07
2:00 AM	3.75	3.70	3.64	3.78	3.52	3.54	3.60	3.47	3.63	3.68	3.71	3.55	3.43	2.91
3:00 AM	3.22	3.32	3.25	3.21	3.08	3.02	3.00	3.50	3.17	3.70	2.93	3.09	3.14	2.84
4:00 AM	2.78	3.01	3.01	2.77	2.80	2.74	2.81	2.80	2.97	2.84	2.68	2.75	2.74	2.47
5:00 AM	2.70	2.73	2.71	2.58	2.60	2.64	2.82	2.54	2.56	2.66	2.46	2.48	2.54	2.93
6:00 AM	2.91	2.70	2.58	2.74	2.67	2.68	2.67	2.99	2.58	2.36	2.44	2.46	2.60	2.38
7:00 AM	3.71	2.85	2.79	3.44	3.44	3.49	3.17	3.17	2.78	2.22	3.29	2.99	3.38	3.32
8:00 AM	4.91	3.49	3.15	4.72	4.76	4.74	4.67	4.81	3.26	2.95	4.63	4.49	4.68	4.79
9:00 AM	5.73	4.39	3.99	5.59	5.56	5.56	5.59	5.11	4.12	3.60	5.57	5.35	5.64	5.34
10:00 AM	6.09	5.61	5.31	6.09	5.91	5.84	5.88	5.67	5.32	5.25	5.68	5.66	4.33	5.75
11:00 AM	6.07	6.52	6.37	6.21	5.96	5.86	5.72	5.71	6.33	6.17	5.98	5.67	6.01	5.70
12:00 PM	5.97	6.87	6.87	6.14	5.93	5.68	5.59	5.75	6.61	6.57	5.90	5.68	5.86	5.71
1:00 PM	5.81	6.78	6.98	6.00	5.70	5.46	5.60	5.63	5.96	6.45	5.83	5.60	5.48	5.58
2:00 PM	5.73	6.56	6.78	5.85	5.47	5.37	5.61	5.44	6.13	6.31	5.48	5.41	5.37	5.50
3:00 PM	5.65	6.26	6.48	5.67	5.33	5.42	5.58	5.58	5.87	6.12	5.35	5.60	5.52	5.36
4:00 PM	5.51	6.02	6.27	5.49	5.19	5.30	5.26	5.42	5.84	5.76	5.26	5.41	5.51	5.15
5:00 PM	5.48	5.79	6.11	5.42	5.13	5.22	5.06	5.04	5.47	5.36	5.01	5.12	5.15	4.97
6:00 PM	5.45	5.69	5.98	5.42	5.18	5.19	5.39	5.20	5.56	5.50	4.99	5.31	5.16	5.19
7:00 PM	5.56	5.66	5.91	5.65	5.42	5.46	5.64	5.21	5.46	5.56	5.56	5.81	5.47	5.33
8:00 PM	5.74	5.70	5.83	5.84	5.71	5.70	5.80	5.64	5.34	5.79	5.79	5.92	5.75	5.36
9:00 PM	5.62	5.71	5.84	5.99	5.93	5.93	5.93	5.53	5.25	6.03	5.90	5.88	5.69	5.75
10:00 PM	5.36	5.39	5.59	5.79	5.70	5.79	5.71	5.21	5.12	5.93	5.72	5.74	5.82	5.66
11:00 PM	5.12	4.99	5.15	5.37	5.32	5.44	5.49	4.97	4.74	5.47	5.40	5.37	5.70	5.11

Hour	Maderia Beach Recorded Flow MGD													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	0.000	0.000	0.000	2.520	2.478	0.000	0.000	0.000	0.000	0.000	2.562	0.000	0.000	0.000
1:00 AM	3.444	3.234	2.604	2.058	2.352	2.604	3.570	4.032	4.368	4.368	0.000	3.444	3.738	3.486
2:00 AM	2.184	2.016	2.520	2.520	2.520	2.436	2.520	2.520	2.520	2.520	4.872	2.520	2.520	2.520
3:00 AM	1.722	1.470	2.520	2.478	2.520	2.436	2.520	2.520	0.630	1.932	2.436	2.268	2.520	2.520
4:00 AM	1.512	1.554	2.520	2.562	2.436	2.982	2.520	2.394	4.158	2.016	1.638	1.722	2.562	2.520
5:00 AM	1.638	1.596	2.520	2.520	2.562	1.932	1.974	2.562	2.142	1.932	2.268	2.310	2.520	2.520
6:00 AM	1.134	1.680	2.520	2.478	2.436	2.520	2.268	2.520	0.126	2.520	2.478	1.974	2.520	2.520
7:00 AM	2.310	2.520	2.520	2.520	2.436	2.478	2.478	2.562	2.520	0.000	2.520	2.520	2.520	2.520
8:00 AM	2.520	2.520	2.520	2.562	2.520	2.520	2.520	2.520	5.040	2.520	2.730	2.520	2.520	2.520
9:00 AM	2.646	1.722	2.562	2.520	2.562	2.520	2.688	2.520	0.000	2.520	2.520	2.520	2.520	2.520
10:00 AM	2.520	2.562	2.520	2.478	2.520	2.520	2.562	2.520	2.520	2.562	2.520	2.520	2.520	2.520
11:00 AM	2.520	2.520	3.570	2.562	2.520	2.520	2.562	2.520	5.040	2.520	2.520	2.604	2.520	2.520
12:00 PM	2.520	2.520	3.444	2.478	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520
1:00 PM	2.520	2.562	0.210	2.604	2.520	2.520	2.520	2.520	2.520	2.520	2.562	2.520	2.226	2.520
2:00 PM	2.520	2.520	2.520	2.478	2.562	2.562	2.520	2.520	2.520	2.856	2.562	2.604	2.520	2.520
3:00 PM	2.520	2.520	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.520	2.562	2.520	2.520	2.520
4:00 PM	2.520	2.520	2.520	2.520	2.520	2.562	2.520	2.604	2.520	2.562	2.520	2.520	2.520	2.520
5:00 PM	2.520	2.520	2.520	2.520	2.520	2.562	2.562	2.562	2.520	2.520	2.520	2.520	2.520	3.150
6:00 PM	2.688	2.520	2.520	2.520	2.562	2.520	2.562	2.562	2.520	2.520	2.520	2.520	2.520	2.520
7:00 PM	2.520	2.520	2.520	2.520	2.562	2.688	2.520	2.562	2.520	2.604	2.520	2.520	2.520	2.520
8:00 PM	2.520	2.520	2.520	2.688	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.352
9:00 PM	2.520	2.520	2.520	2.520	2.562	2.520	2.520	2.520	0.000	2.520	2.520	2.520	2.520	2.520
10:00 PM	2.520	2.520	2.520	2.604	2.520	2.562	2.520	2.520	5.040	2.520	2.520	2.520	2.520	2.520
11:00 PM	2.520	2.520	2.520	2.520	2.520	2.520	2.604	2.520	2.520	2.520	2.814	2.520	2.520	2.520

Hour	Pump Station 16 & Other Boca Ciega Manifolded Pump Stations Combined Flow (MGD)													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	17.85	19.59	18.25	15.45	13.91	17.33	21.00	17.34	19.09	20.12	16.95	20.60	20.27	20.16
1:00 AM	12.81	16.42	13.65	13.19	12.87	12.44	13.84	12.49	8.79	15.94	19.50	16.18	16.62	17.05
2:00 AM	12.17	12.59	10.20	9.68	9.99	11.23	11.85	12.01	12.19	15.36	14.07	15.69	17.97	17.55
3:00 AM	12.34	12.54	10.45	9.72	9.99	9.56	10.01	9.77	13.92	16.31	16.31	16.72	17.28	17.41
4:00 AM	10.43	11.64	10.59	9.12	8.12	7.30	10.83	9.79	9.00	16.54	16.63	17.29	17.02	17.26
5:00 AM	11.48	10.59	9.74	9.26	9.54	10.86	9.21	11.09	11.73	17.02	16.82	16.61	17.07	16.20
6:00 AM	12.94	10.14	7.40	9.32	10.59	11.14	10.75	11.30	13.62	16.16	16.89	17.25	16.76	18.33
7:00 AM	17.21	11.61	10.22	15.20	16.04	16.11	16.64	16.74	12.34	19.86	19.38	19.55	19.49	19.82
8:00 AM	19.98	14.82	13.73	18.43	19.72	18.67	18.51	20.07	12.48	18.16	19.89	20.22	20.74	20.93
9:00 AM	22.73	21.88	20.57	23.54	23.96	23.26	21.15	24.47	23.81	20.89	21.84	22.38	22.57	23.01
10:00 AM	22.21	22.76	22.67	22.77	22.60	23.99	22.68	23.86	24.78	20.62	21.99	21.66	24.37	21.24
11:00 AM	22.68	26.60	25.17	23.01	21.70	23.07	22.72	22.00	23.54	22.91	20.87	21.26	21.11	22.16
12:00 PM	21.07	23.76	23.75	20.16	19.28	21.00	21.73	21.96	24.58	22.49	19.96	20.38	20.03	19.95
1:00 PM	19.54	24.49	27.19	20.79	19.72	19.14	21.83	21.32	26.31	23.39	20.40	20.66	18.26	20.53
2:00 PM	19.05	21.47	22.46	18.61	17.47	17.68	18.63	18.17	20.71	20.30	18.99	16.05	19.77	18.80
3:00 PM	20.09	22.49	22.68	19.44	18.37	18.96	19.96	18.98	24.76	20.49	19.52	18.97	19.71	19.15
4:00 PM	17.48	20.45	19.84	18.08	18.01	19.03	17.48	17.95	18.77	19.55	19.35	18.37	18.58	18.22
5:00 PM	19.22	20.86	22.98	18.84	19.14	16.93	18.35	19.09	21.66	20.70	19.36	19.97	20.65	19.29
6:00 PM	18.99	19.98	20.92	18.35	18.88	17.77	18.39	18.09	18.13	19.82	19.74	19.99	19.98	19.58
7:00 PM	20.92	21.67	21.72	21.64	20.53	19.89	20.49	19.74	21.37	20.84	20.44	21.61	21.48	21.44
8:00 PM	19.54	19.19	19.46	20.52	22.26	19.05	20.01	19.16	18.59	19.76	20.27	21.27	20.66	20.39
9:00 PM	20.64	20.01	20.64	21.89	22.03	20.65	22.97	19.03	21.70	21.89	20.62	22.25	21.38	22.19
10:00 PM	19.12	18.05	17.76	19.50	20.43	20.25	19.74	17.05	15.84	19.81	20.05	20.37	19.86	19.98
11:00 PM	18.45	17.34	18.91	18.43	18.56	20.29	18.66	17.74	18.75	19.09	18.70	19.54	20.29	19.80

Hour	Pump Station 16 & Other Boca Ciega Manifolded Pump Stations Combined Flow (MGD)													
	2/1/2008	2/2/2008	2/3/2008	2/4/2008	2/5/2008	2/6/2008	2/7/2008	2/8/2008	2/9/2008	2/10/2008	2/11/2008	2/12/2008	2/13/2008	2/14/2008
12:00 AM	17.85	19.59	18.25	15.45	13.91	17.33	21.00	17.34	19.09	20.12	16.95	20.60	20.27	20.16
1:00 AM	12.81	16.42	13.65	13.19	12.87	12.44	13.84	12.49	8.79	15.94	19.50	16.18	16.62	17.05
2:00 AM	12.17	12.59	10.20	9.68	9.99	11.23	11.85	12.01	12.19	15.36	14.07	15.69	17.97	17.55
3:00 AM	12.34	12.54	10.45	9.72	9.99	9.56	10.01	9.77	13.92	16.31	16.31	16.72	17.28	17.41
4:00 AM	10.43	11.64	10.59	9.12	8.12	7.30	10.83	9.79	9.00	16.54	16.63	17.29	17.02	17.26
5:00 AM	11.48	10.59	9.74	9.26	9.54	10.86	9.21	11.09	11.73	17.02	16.82	16.61	17.07	16.20
6:00 AM	12.94	10.14	7.40	9.32	10.59	11.14	10.75	11.30	13.62	16.16	16.89	17.25	16.76	18.33
7:00 AM	17.21	11.61	10.22	15.20	16.04	16.11	16.64	16.74	12.34	19.86	19.38	19.55	19.49	19.82
8:00 AM	19.98	14.82	13.73	18.43	19.72	18.67	18.51	20.07	12.48	18.16	19.89	20.22	20.74	20.93
9:00 AM	22.73	21.88	20.57	23.54	23.96	23.26	21.15	24.47	23.81	20.89	21.84	22.38	22.57	23.01
10:00 AM	22.21	22.76	22.67	22.77	22.60	23.99	22.68	23.86	24.78	20.62	21.99	21.66	24.37	21.24
11:00 AM	22.68	26.60	25.17	23.01	21.70	23.07	22.72	22.00	23.54	22.91	20.87	21.26	21.11	22.16
12:00 PM	21.07	23.76	23.75	20.16	19.28	21.00	21.73	21.96	24.58	22.49	19.96	20.38	20.03	19.95
1:00 PM	19.54	24.49	27.19	20.79	19.72	19.14	21.83	21.32	26.31	23.39	20.40	20.66	18.26	20.53
2:00 PM	19.05	21.47	22.46	18.61	17.47	17.68	18.63	18.17	20.71	20.30	18.99	16.05	19.77	18.80
3:00 PM	20.09	22.49	22.68	19.44	18.37	18.96	19.96	18.98	24.76	20.49	19.52	18.97	19.71	19.15
4:00 PM	17.48	20.45	19.84	18.08	18.01	19.03	17.48	17.95	18.77	19.55	19.35	18.37	18.58	18.22
5:00 PM	19.22	20.86	22.98	18.84	19.14	16.93	18.35	19.09	21.66	20.70	19.36	19.97	20.65	19.29
6:00 PM	18.99	19.98	20.92	18.35	18.88	17.77	18.39	18.09	18.13	19.82	19.74	19.99	19.98	19.58
7:00 PM	20.92	21.67	21.72	21.64	20.53	19.89	20.49	19.74	21.37	20.84	20.44	21.61	21.48	21.44
8:00 PM	19.54	19.19	19.46	20.52	22.26	19.05	20.01	19.16	18.59	19.76	20.27	21.27	20.66	20.39
9:00 PM	20.64	20.01	20.64	21.89	22.03	20.65	22.97	19.03	21.70	21.89	20.62	22.25	21.38	22.19
10:00 PM	19.12	18.05	17.76	19.50	20.43	20.25	19.74	17.05	15.84	19.81	20.05	20.37	19.86	19.98
11:00 PM	18.45	17.34	18.91	18.43	18.56	20.29	18.66	17.74	18.75	19.09	18.70	19.54	20.29	19.80

Hour	SCBWRF South Train Recorded Flow MGD													
	10/1/2008	10/2/2008	10/3/2008	10/4/2008	10/5/2008	10/6/2008	10/7/2008	10/8/2008	10/9/2008	10/10/2008	10/11/2008	10/12/2008	10/13/2008	10/14/2008
12:00 AM	5.03	5.20	6.00	4.50	4.59	6.86	8.27	6.91	6.46	6.00	5.82	5.71	5.34	5.02
1:00 AM	4.32	4.22	3.92	4.54	4.38	5.46	6.86	6.30	5.68	5.57	5.07	5.06	5.21	4.80
2:00 AM	3.87	3.81	3.90	3.82	3.68	5.14	6.48	4.90	5.21	4.76	4.46	4.88	4.11	3.81
3:00 AM	3.36	3.39	3.26	3.57	3.56	4.73	5.89	4.90	4.74	4.40	4.24	4.56	3.73	4.01
4:00 AM	3.18	3.25	3.14	3.46	2.87	4.75	5.73	4.59	4.77	4.71	3.92	4.21	3.19	3.55
5:00 AM	3.34	3.24	3.51	3.51	3.18	4.77	6.09	4.64	4.35	4.72	4.00	4.02	3.85	3.86
6:00 AM	3.84	3.87	3.61	3.22	3.06	5.22	6.88	5.11	5.20	4.99	3.79	3.95	3.90	3.89
7:00 AM	4.84	5.03	4.74	3.43	2.93	6.59	7.71	6.24	6.21	6.19	4.42	4.24	5.24	5.40
8:00 AM	6.00	5.96	5.68	4.17	3.65	7.50	8.92	7.57	7.42	7.17	5.06	4.36	6.27	6.27
9:00 AM	6.74	6.19	6.85	5.76	5.03	8.50	9.46	8.40	7.73	8.04	6.80	5.95	7.57	7.13
10:00 AM	6.47	6.49	6.30	6.22	5.77	8.19	8.89	8.43	7.63	7.81	7.73	6.79	7.12	6.88
11:00 AM	6.44	6.23	6.49	7.33	6.95	7.97	8.93	8.14	7.58	7.31	7.97	7.89	7.58	7.02
12:00 PM	6.15	6.52	6.06	6.79	6.99	8.42	8.46	7.61	7.00	7.15	7.82	7.55	6.76	6.29
1:00 PM	6.17	6.06	5.86	7.07	6.87	7.67	8.41	7.52	7.22	7.22	7.50	7.23	7.06	6.40
2:00 PM	6.30	5.75	6.05	6.29	6.98	7.54	7.73	7.12	7.46	6.57	7.19	6.95	6.31	6.07
3:00 PM	5.55	5.75	5.29	6.71	6.73	6.97	8.01	7.26	6.86	6.81	6.83	7.10	6.60	6.14
4:00 PM	5.42	5.50	5.33	6.38	6.58	7.16	7.45	7.03	6.65	6.47	6.70	6.43	6.10	5.67
5:00 PM	5.55	5.78	5.51	6.32	6.83	8.02	7.61	7.25	7.20	6.60	6.97	6.33	6.47	5.96
6:00 PM	6.06	5.87	5.74	5.95	8.18	10.39	8.30	7.73	7.55	6.41	7.00	6.54	6.23	5.90
7:00 PM	6.09	6.23	5.46	6.15	9.74	10.20	8.45	7.80	7.23	6.81	6.38	7.59	7.03	6.61
8:00 PM	6.26	6.55	5.40	5.70	9.89	10.88	8.53	8.03	7.82	6.56	6.46	7.01	6.78	6.58
9:00 PM	6.42	6.67	5.66	5.90	9.47	10.64	8.81	8.22	7.87	6.80	6.26	7.17	7.31	7.13
10:00 PM	6.29	6.45	5.91	5.30	8.79	10.43	7.80	7.50	7.32	6.23	5.76	6.39	6.55	6.39
11:00 PM	5.62	6.04	5.29	5.20	7.40	9.40	7.48	7.04	7.09	6.12	5.86	6.68	6.30	6.17

Hour	SCBWRF North Train Recorded Flow MGD													
	10/1/2008	10/2/2008	10/3/2008	10/4/2008	10/5/2008	10/6/2008	10/7/2008	10/8/2008	10/9/2008	10/10/2008	10/11/2008	10/12/2008	10/13/2008	10/14/2008
12:00 AM	12.83	13.16	15.40	11.53	11.75	16.03	18.81	16.41	15.77	14.54	14.30	14.08	13.56	12.90
1:00 AM	11.24	10.97	10.34	11.65	11.34	13.18	16.17	15.12	14.17	13.72	12.74	12.72	13.05	12.43
2:00 AM	10.14	9.93	10.26	9.94	9.53	12.65	15.51	12.13	13.24	11.97	11.29	12.36	10.72	10.15
3:00 AM	8.92	8.91	8.69	9.35	9.28	11.77	14.22	11.92	12.25	11.22	10.91	11.53	9.83	10.54
4:00 AM	8.46	8.58	8.35	9.05	7.55	11.80	13.90	11.34	12.27	11.86	10.21	10.72	8.50	9.44
5:00 AM	8.86	8.46	9.25	9.13	8.33	11.83	14.65	11.69	11.21	12.23	10.34	10.26	10.06	10.10
6:00 AM	10.02	10.06	9.47	8.43	8.03	12.84	16.20	12.70	13.15	12.73	9.81	10.08	10.13	10.07
7:00 AM	12.13	12.35	11.99	8.94	7.71	15.36	17.71	14.87	15.10	14.97	11.31	10.80	13.01	13.62
8:00 AM	14.49	14.29	13.95	10.68	9.46	16.89	19.94	17.15	17.32	16.69	12.80	11.04	15.22	15.34
9:00 AM	15.91	14.63	15.78	13.85	12.46	18.82	20.99	18.87	17.77	18.26	16.11	14.52	17.24	16.88
10:00 AM	15.52	15.46	15.05	14.75	14.03	18.47	19.91	18.97	17.76	17.95	17.67	16.01	16.78	16.40
11:00 AM	15.38	15.18	15.54	16.73	16.10	18.16	20.04	18.49	17.59	17.00	18.07	17.91	17.50	16.55
12:00 PM	15.07	15.65	14.81	15.87	16.43	18.97	19.13	17.70	16.54	16.68	17.90	17.42	16.20	15.33
1:00 PM	14.88	14.81	14.46	16.40	16.14	17.58	19.06	17.45	16.84	16.92	17.34	17.01	16.73	15.50
2:00 PM	15.29	14.25	14.75	15.12	16.44	17.33	17.78	16.68	17.33	15.68	16.82	16.46	15.28	14.63
3:00 PM	13.69	14.06	13.06	15.86	15.99	16.35	18.31	16.99	16.21	16.08	16.22	16.62	15.76	14.88
4:00 PM	13.50	13.36	13.24	15.24	15.68	16.70	17.33	16.50	15.84	15.41	15.90	15.50	14.83	13.90
5:00 PM	13.61	14.03	13.64	15.13	16.08	18.14	17.43	16.88	16.90	15.63	16.47	15.33	15.51	14.65
6:00 PM	14.67	14.27	14.13	14.47	18.63	22.86	18.66	17.70	17.48	15.36	16.40	15.70	15.23	14.52
7:00 PM	14.71	15.01	13.54	14.79	21.70	22.55	18.94	17.90	16.95	16.26	15.48	17.44	16.52	15.83
8:00 PM	15.07	15.64	13.55	13.96	21.76	24.21	19.12	18.33	17.95	15.57	15.53	16.58	16.11	15.80
9:00 PM	15.43	15.87	13.88	14.32	21.23	23.43	19.60	18.70	18.10	16.13	15.07	16.90	16.91	16.74
10:00 PM	15.17	15.52	14.41	13.20	19.74	22.96	17.79	17.48	17.16	15.16	14.26	15.58	15.82	15.42
11:00 PM	14.07	15.24	13.15	13.00	17.24	20.92	17.38	16.66	16.74	14.86	14.34	16.07	15.45	15.04

Hour	Pinellas Park Recorded Flow MGD													
	10/1/2008	10/2/2008	10/3/2008	10/4/2008	10/5/2008	10/6/2008	10/7/2008	10/8/2008	10/9/2008	10/10/2008	10/11/2008	10/12/2008	10/13/2008	10/14/2008
12:00 AM	5.38	5.25	5.94	5.03	4.76	5.80	7.61	6.15	5.82	6.08	5.11	5.16	4.95	4.99
1:00 AM	4.68	4.57	4.35	4.59	4.31	5.60	7.00	5.40	5.04	5.07	4.72	5.26	4.30	4.26
2:00 AM	3.99	3.87	3.84	3.97	3.85	4.30	5.96	4.66	4.31	4.73	4.29	4.12	3.69	3.67
3:00 AM	3.54	3.40	3.32	3.55	3.45	3.95	5.98	4.23	3.87	4.37	3.78	3.86	3.30	3.22
4:00 AM	3.22	3.09	3.00	3.22	3.83	3.78	5.73	4.23	3.59	3.89	3.40	3.44	3.08	3.59
5:00 AM	3.09	2.98	2.88	3.02	4.32	3.57	4.98	3.73	3.51	3.45	3.19	3.85	4.16	4.23
6:00 AM	3.25	3.12	3.10	3.03	4.37	3.81	5.25	3.99	3.79	3.58	3.16	4.08	3.96	4.07
7:00 AM	4.02	3.89	3.74	3.26	4.49	4.52	6.04	4.82	4.99	4.36	3.40	4.03	3.75	3.74
8:00 AM	5.17	5.11	4.98	3.81	3.84	5.58	7.01	5.92	6.29	5.42	3.89	3.53	4.89	4.82
9:00 AM	6.02	5.97	6.04	4.53	3.95	6.36	7.64	6.65	6.61	6.09	5.07	4.10	5.74	5.71
10:00 AM	6.25	6.09	6.03	5.61	4.96	6.67	7.85	6.73	6.55	6.31	5.89	5.20	6.01	6.09
11:00 AM	6.15	6.04	6.01	6.28	5.86	6.68	7.58	6.84	6.27	6.23	6.81	6.20	6.07	6.04
12:00 PM	5.83	5.96	6.05	6.53	6.38	6.62	7.18	6.73	6.38	6.26	7.02	6.65	6.01	6.14
1:00 PM	5.85	5.85	5.88	6.59	6.62	6.57	6.97	6.72	6.30	6.11	6.98	6.73	5.91	5.96
2:00 PM	5.72	5.70	5.69	6.36	6.58	6.41	6.84	6.82	6.25	5.90	6.80	6.66	5.73	5.74
3:00 PM	5.49	5.55	5.69	6.23	6.36	6.27	6.88	6.70	5.95	5.83	6.68	6.39	5.61	5.60
4:00 PM	5.38	5.26	5.63	6.01	6.19	6.04	6.86	6.73	5.97	5.67	6.05	5.97	5.44	5.41
5:00 PM	5.31	5.25	5.54	5.82	5.96	6.23	6.64	6.61	6.20	5.64	6.05	5.70	5.34	5.32
6:00 PM	5.65	5.23	5.44	5.62	5.91	7.92	6.60	6.66	6.01	5.61	5.73	5.69	5.37	5.37
7:00 PM	5.67	5.36	5.44	5.55	6.17	9.31	6.61	6.56	6.13	5.74	5.74	5.81	5.50	5.59
8:00 PM	5.97	5.71	5.58	5.55	6.92	9.98	6.96	6.61	6.23	5.97	5.62	6.02	5.77	5.80
9:00 PM	6.28	5.94	5.64	5.57	7.80	9.63	7.23	6.74	6.55	5.71	5.88	6.22	5.97	6.07
10:00 PM	6.14	5.95	5.57	5.48	7.40	9.11	7.15	6.75	6.36	5.68	5.62	6.37	5.99	6.04
11:00 PM	5.76	5.88	5.29	5.10	6.68	8.36	6.94	6.38	6.21	5.47	5.19	5.85	5.60	5.68

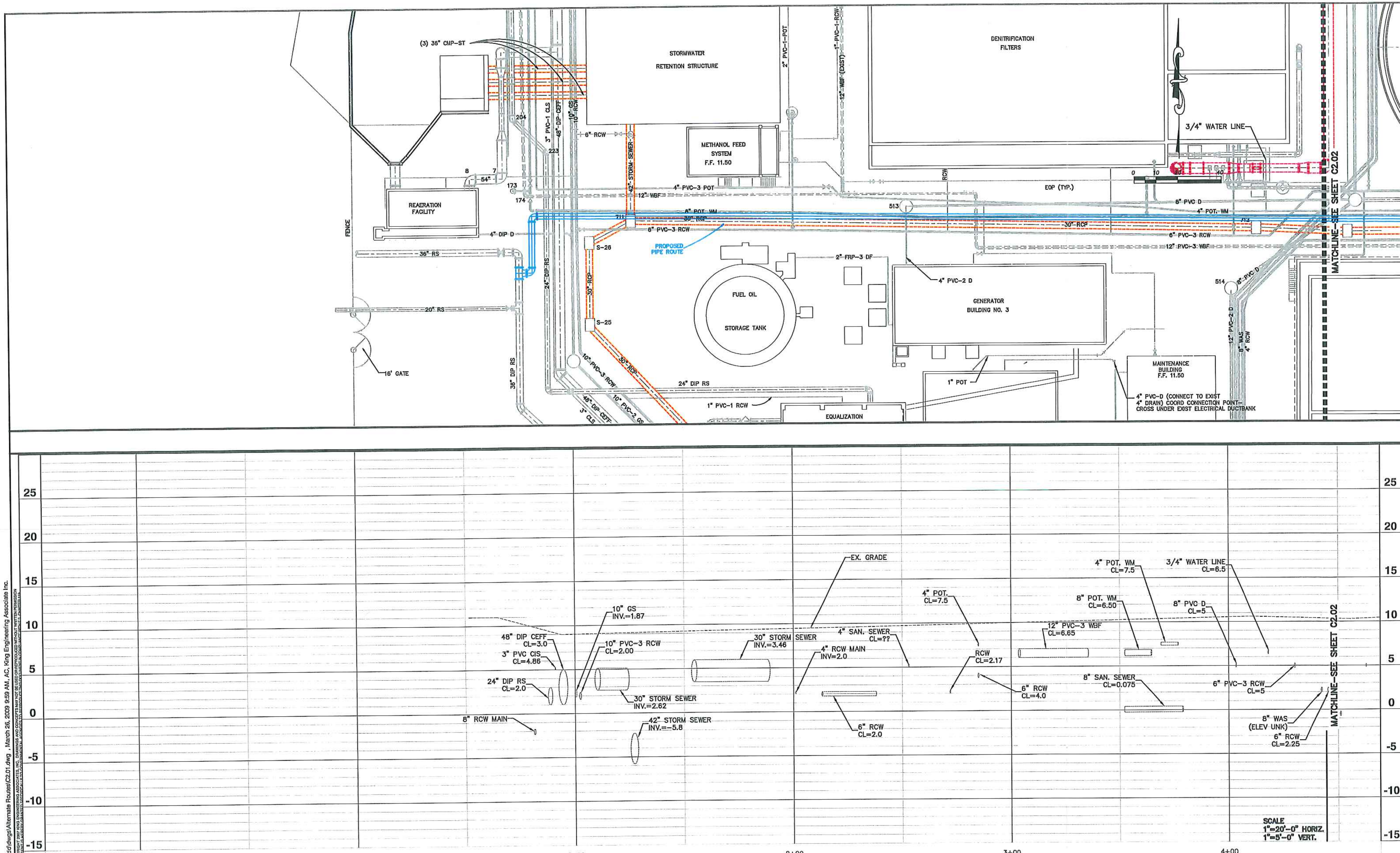
Hour	Maderia Beach Recorded Flow MGD													
	10/1/2008	10/2/2008	10/3/2008	10/4/2008	10/5/2008	10/6/2008	10/7/2008	10/8/2008	10/9/2008	10/10/2008	10/11/2008	10/12/2008	10/13/2008	10/14/2008
12:00 AM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1:00 AM	3.066	3.780	4.116	3.822	3.864	4.956	5.880	4.116	3.108	3.297	3.276	2.646	3.822	2.604
2:00 AM	2.520	2.580	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.625	2.520	2.520	2.520	2.562
3:00 AM	2.520	2.520	2.520	2.520	2.520	0.126	2.520	2.520	2.520	2.604	2.688	2.520	2.520	2.520
4:00 AM	2.520	2.520	2.562	2.520	2.520	2.772	2.520	2.520	2.520	2.520	2.520	2.562	2.520	2.520
5:00 AM	2.520	2.562	2.520	2.520	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.562
6:00 AM	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.562	2.562	2.520	2.520
7:00 AM	2.520	2.520	2.520	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520	2.520
8:00 AM	2.520	0.924	2.184	2.520	2.520	2.520	2.520	2.562	2.520	2.562	3.192	2.520	2.520	2.520
9:00 AM	2.520	3.472	3.066	2.520	2.520	2.604	1.281	0.840	2.520	2.520	2.380	2.520	2.520	2.520
10:00 AM	2.520	3.398	2.520	2.520	2.520	2.562	3.717	4.200	2.520	2.520	3.416	2.520	2.520	2.520
11:00 AM	2.520	2.383	1.785	2.520	2.520	2.520	1.281	2.520	2.604	2.520	2.604	2.562	2.520	2.604
12:00 PM	2.520	2.152	2.856	2.520	2.520	2.562	3.780	2.562	2.520	2.604	3.780	2.520	2.520	2.562
1:00 PM	2.520	2.520	1.434	2.520	2.520	2.520	2.520	2.562	2.520	2.520	3.780	2.520	2.562	2.520
2:00 PM	2.562	2.520	2.787	2.520	2.562	2.604	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.520
3:00 PM	2.520	2.520	3.108	2.562	2.520	2.520	2.562	2.520	2.520	2.520	2.520	2.562	2.520	2.520
4:00 PM	2.520	2.520	2.520	2.562	2.520	2.562	2.520	2.520	2.520	2.520	2.520	2.982	2.562	2.520
5:00 PM	2.520	2.562	2.520	2.520	2.520	2.688	2.520	2.520	2.520	2.709	2.562	2.604	2.520	2.562
6:00 PM	2.520	2.520	2.520	2.520	3.024	2.667	2.520	1.176	2.520	1.995	2.520	2.520	2.520	2.520
7:00 PM	2.520	2.520	2.520	2.268	5.544	5.313	2.520	2.604	2.520	2.520	2.562	2.520	2.520	2.520
8:00 PM	2.520	2.520	2.520	2.520	5.040	5.250	2.604	2.562	2.520	2.520	2.520	2.520	2.520	2.520
9:00 PM	2.520	2.520	2.520	2.688	5.040	5.796	2.520	2.520	2.520	2.520	2.562	2.520	2.520	2.520
10:00 PM	2.520	2.520	2.520	2.562	5.040	5.040	2.520	2.520	2.520	2.562	0.000	2.520	2.520	2.562
11:00 PM	2.520	2.520	2.520	2.520	5.040	5.124	2.520	2.520	2.562	2.520	0.000	2.520	2.520	2.520

Hour	Pump Station 16 & Other Boca Ciega Manifolded Pump Stations Combined Flow (MGD)													
	10/1/2008	10/2/2008	10/3/2008	10/4/2008	10/5/2008	10/6/2008	10/7/2008	10/8/2008	10/9/2008	10/10/2008	10/11/2008	10/12/2008	10/13/2008	10/14/2008
12:00 AM	12.49	13.11	15.46	11.00	11.58	17.09	19.47	17.17	16.41	14.46	15.02	14.63	13.96	12.93
1:00 AM	7.82	6.84	5.79	7.78	7.55	8.08	10.15	11.90	11.70	10.92	9.80	9.87	10.13	10.36
2:00 AM	7.51	7.28	7.81	7.28	6.85	10.96	13.52	9.85	11.62	9.38	8.93	10.60	8.63	7.73
3:00 AM	6.21	6.39	6.11	6.84	6.86	12.43	11.60	10.07	10.59	8.65	8.68	9.72	7.74	8.81
4:00 AM	5.89	6.22	5.93	6.77	4.07	9.99	11.37	9.17	10.93	10.16	8.21	8.93	6.08	6.87
5:00 AM	6.59	6.15	7.36	7.10	4.68	10.47	13.25	10.08	9.53	10.99	8.63	7.90	7.24	7.17
6:00 AM	8.09	8.29	7.46	6.09	4.21	11.73	15.31	11.30	12.04	11.62	7.87	7.39	7.56	7.37
7:00 AM	10.43	10.97	10.47	6.59	3.59	14.90	16.86	13.78	13.80	14.28	9.81	8.48	11.98	12.77
8:00 AM	12.79	14.20	12.46	8.51	6.75	16.30	19.32	16.25	15.93	15.88	10.78	9.34	14.08	14.27
9:00 AM	14.10	11.38	13.53	12.57	11.02	18.35	21.53	19.78	16.37	17.69	15.45	13.85	16.56	15.77
10:00 AM	13.22	12.45	12.80	12.84	12.32	17.43	17.23	16.46	16.33	16.93	16.10	15.08	15.37	14.66
11:00 AM	13.15	12.99	14.23	15.25	14.67	16.93	20.11	17.27	16.30	15.56	16.62	17.03	16.49	14.92
12:00 PM	12.87	14.06	11.97	13.60	14.52	18.21	16.62	16.01	14.64	14.97	14.92	15.80	14.43	12.91
1:00 PM	12.68	12.50	13.00	14.36	13.87	16.16	17.99	15.68	15.24	15.51	14.08	14.99	15.31	13.42
2:00 PM	13.31	11.79	12.32	12.53	14.29	15.85	16.15	14.42	16.02	13.83	14.69	14.23	13.34	12.44
3:00 PM	11.23	11.74	9.55	13.79	13.84	14.54	16.87	15.03	14.59	14.54	13.85	14.78	14.24	12.90
4:00 PM	11.02	11.08	10.42	13.05	13.55	15.26	15.39	14.28	14.00	13.70	14.03	12.98	12.93	11.64
5:00 PM	11.33	12.01	11.10	13.11	14.43	17.25	15.88	15.00	15.37	13.88	14.83	13.36	14.12	12.73
6:00 PM	12.57	12.38	11.91	12.27	17.89	22.67	17.84	17.59	16.50	14.17	15.15	14.04	13.56	12.53
7:00 PM	12.62	13.36	11.04	13.12	19.73	18.13	18.26	16.54	15.54	14.81	13.56	16.69	15.53	14.33
8:00 PM	12.84	13.95	10.85	11.59	19.69	19.86	18.09	17.18	17.01	13.63	13.84	15.05	14.60	14.05
9:00 PM	13.06	14.09	11.38	11.97	17.86	18.65	18.66	17.66	16.90	14.70	12.89	15.33	15.73	15.28
10:00 PM	12.80	13.50	12.22	10.46	16.10	19.24	15.92	15.71	15.59	13.14	14.41	13.08	13.86	13.21
11:00 PM	11.41	12.89	10.63	10.58	12.92	16.84	15.40	14.80	15.06	12.99	15.00	14.38	13.63	13.01

Appendix C

APPENDIX C

MICRO TUNNELING & DIRECTIONAL DRILL
ALTERNATIVE EXISTING UTILITYS PLAN AND PROFILE
DERAWINGS



DESIGNED	HGS
DRAWN	FWP
CHECKED	AMC
Q.C.	

THE SIGNATURE OF THE QUALITY CONTROL OFFICER IN THIS SPACE INDICATES THAT ALL REQUIRED PERMITS HAVE BEEN OBTAINED AND THAT CONSTRUCTION IS AUTHORIZED TO COMMENCE.

King ENGINEERING ASSOCIATES, INC.

4921 Memorial Highway
One Memorial Center, Suite 300
Tampa, Florida 33634
Phone 813 880-8881
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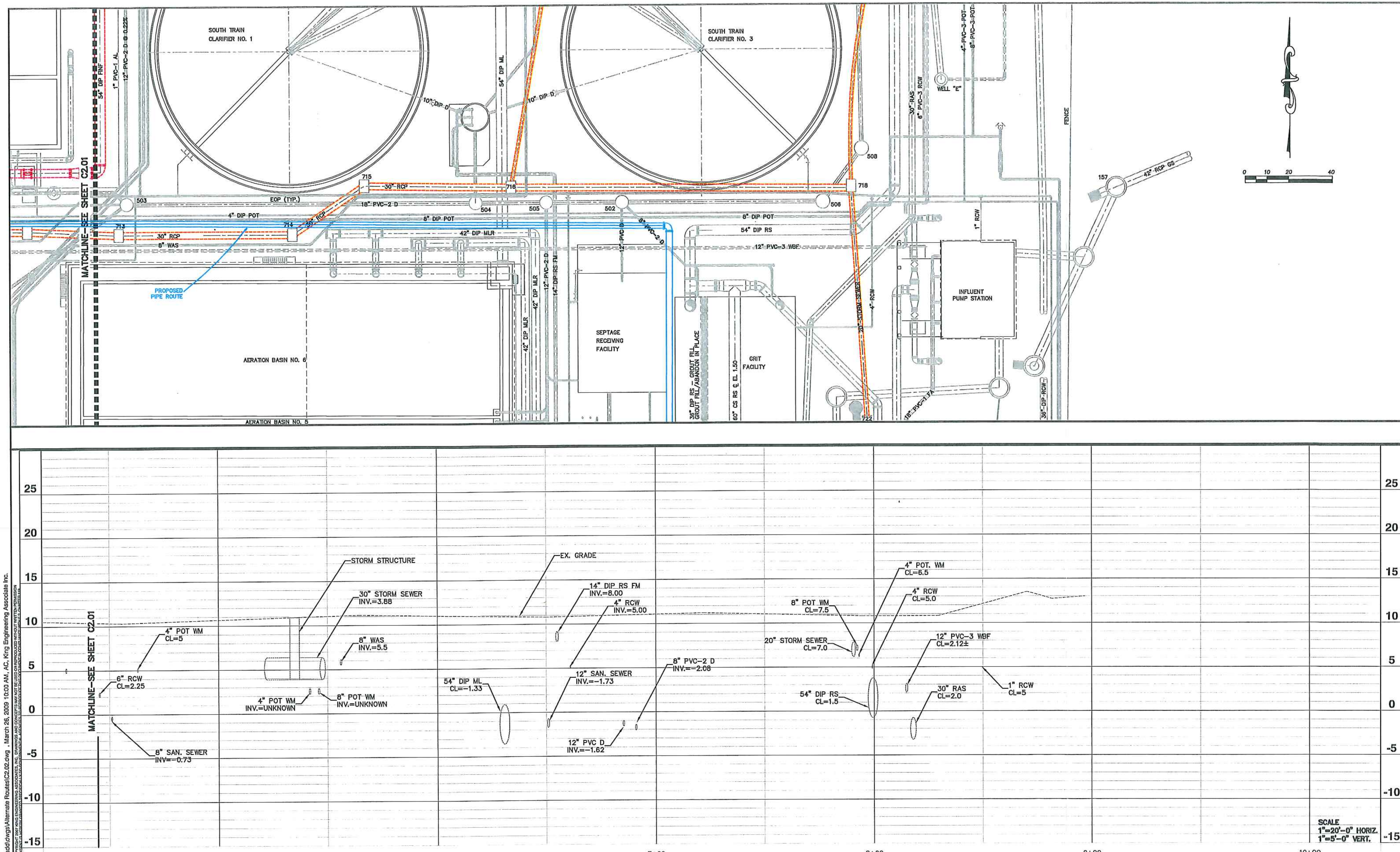
www.kingengineering.com
Engineering License #2610

SOUTH CROSS BAYOU WASTE WATER TREATMENT PLANT

TRENCHLESS INSTALLATION ROUTE EXISTING UTILITIES PLAN AND PROFILE DRAWINGS

NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO.	2031-057-000
DATE	OCT. 2008
SCALE	
SHEET NO.	C2.01



DESIGNED	HGS
DRAWN	FWP
CHECKED	AMC
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NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO. 2031-057-000
DATE: OCT. 2008
SCALE:
SHEET NO. C2.02

O:\ENV_ENG\2031\057\000\cadd\dwgs\Alternate Routes\C2.02.dwg , March 26, 2009 10:00 AM, AC, King Engineering Associate Inc.

Appendix D

APPENDIX D

MICRO TUNNELING & DIRECTIONAL DRILL
ALTERNATIVE CONCEPTUAL REPORT

Evaluation of Trenchless Construction Methods to Install a Parallel 36" Force Main at South Cross Bayou Water Reclamation Facility

January 16, 2009

Prepared for:
King Engineering Assoc., Inc.
4921 Memorial Hwy., Ste. 300
Tampa, Florida 33634

Prepared by:
J.R. Giese Operations, LLC
3560 Cardinal Point Drive, Ste. 201
Jacksonville, Florida 32257

TABLE OF CONTENTS

INTRODUCTION

This report will evaluate two trenchless construction methods, horizontal directional drilling (HDD) and microtunneling, for feasibility for a new 30" inside diameter force main at the South Cross Bayou Water Reclamation Facility. The installation of a new parallel force main will reduce the pressure in the existing force main and provide additional capacity for the pump stations that use this pipeline.

PROJECT SCOPE

The project scope involves evaluating trenchless methods of construction with consideration of existing site conditions, design, pipe materials, construction, contractors, and risk for the installation of a 30" force main. Additionally, an opinion of probable cost will be developed for budgeting purposes.

EXISTING CONDITIONS

The existing conditions at this site include an extremely congested above and below ground work area. There are numerous tanks, roads, and other structures above ground and the property size limits work areas adjacent to the proposed pipe location. Underground utilities are plentiful as is expected at a large water reclamation facility.

UNDERGROUND UTILITIES

As can be expected, there is an extensive network of existing underground utilities at the South Cross Water Reclamation Facility. The utilities range in size up to 54" diameter pipe. There are gravity pipes, pressure pipes, and various conduits. These will have to be avoided by staying beneath them. There are numerous utilities within the first 10' below grade with the deepest around 15' deep in the proposed route. Fortunately, the two construction methods considered here are both compatible with deep installations. Relocating one or more utilities is also a possibility.

GEOTECHNICAL DATA

A geotechnical exploration report prepared by Williams Earth Sciences for Parsons Engineering Science, Inc. in turn for Pinellas County Utilities was made available to us for evaluation of the existing soil conditions at the project site. The report is dated December 15, 2000. The report provides a description of the soils encountered, the blow count, and other information. There are thirteen borings that were drilled to a depth of fifty feet or greater. The borings identified in the report were drilled within a short distance from the project site and will be considered a reasonable approximation of the soil conditions to be expected for this project. The following is an excerpt from the report that describes the subsurface conditions:

4.2 Subsurface Conditions

The soil test borings in the area of the digestors and tanks generally revealed similar soils Initially, most of the borings encountered a pavement structure with variable thicknesses of both the asphalt and base The thickness of the asphalt varied from none to as much as 11 inches while the base ranged in thickness from 2 to 11 inches. In the initial 10 feet, loose to dense fine sands were encountered. Some zones of organically stained and slightly organic sands were encountered by most, but not all of the borings. Boring B-110 encountered a piece of rubble at about 3.5 feet. The nature and extent of such material was not determined. About 10 to 20 feet of very loose to loose fine sands were then revealed. Below these sands, the borings then generally encountered very loose fine sands with varying amounts of shell fragments to about 35 feet below the ground surface. The borings then generally encountered stiff to very hard clay. This material also contained cemented sands and limestone Some of the borings were terminated in this material at about 50 feet. Below 45 feet, some of the borings encountered a zone of hard calcareous sandy limestone and were terminated in this material at about 50 feet. Four borings, B-108, B-110, B-116 and B-117, were carried to greater depths. Borings B-108 and B-110 were scheduled to be drilled to 71 5 feet. These borings generally encountered very dense clayey fine sands with cemented sands from 50 feet to their termination. However, boring B-110 encountered loose fine sand near its termination at 71.5 feet Borings B-116 and B-117 were extended due to a 3 to 5 foot zone of very loose fine sands encountered at about 55 feet. Below this zone, the borings encountered weathered limestone in the form of sandy limestone that also contained phosphate and were terminated in this type of material at 70 2 and 61 5 feet respectively

A loss of circulation of the drilling fluids was experienced in four of the borings When this occurs, there is a concern that there is a potential for sinkhole formation. This situation occurred in four borings, B-101, B-108, B-116 and B-117 However, casing was required only in boring B-108 to re-establish circulation and maintain the integrity of the boring As a result, it does not appear that the potential for sinkhole formation is high at this site.

The standard penetration resistance of the soils in the initial 10 feet generally ranged from 5 to 58 blows per foot (BPF). Most of the values in this zone were in excess of 10 BPF The resistance of the loose sands from 10 to 35 feet ranged from as little as 1 blow for 18 inches of penetration to 11 BPF with the resistances generally 5 BPF or less Within the clays, the resistances ranged from as low as 10 BPF to well in excess of 100 BPF Most of the resistances were in excess of 25 BPF In the sandy limestone, the resistances were generally in excess of 30 BPF However, at 55 feet in borings B-116 and B-117, the standard sampler penetrated 2 to 3 feet under the weight of the rods alone.

Borings B-113 and B-114 were drilled in the proposed visitors center area. These borings generally encountered medium dense fine sand in the initial 10 feet and loose fine sand to the termination of the borings at 21 5 feet. The penetration resistance of the soils in the initial 10 feet ranged from 11 to 17 BPF. Below 10 feet the resistance decreased to 6 to 9 BPF Boring B-115 was drilled in the area of the proposed warehouse This boring initially encountered about 13 feet of medium dense fine sands. Below the near surface soils, loose fine sands were encountered to the termination of the boring at 21.5 feet. The standard penetration of the near surface soils ranged from 9 to 21 BPF, while the resistance of the deeper soils was 5 to 7 BPF

The soils encountered by the auger borings were similar to those found in the soil test borings. Three of the eight borings encountered a pavement structure consisting of 2 inches of asphalt over 4 inches of limerock base while four other borings revealed fine sand with rock fragments. Fine sands of varying colors were then found to the termination of the borings at 8 feet. Three of the borings encountered zones of slightly organic fine sands that were ½ foot to 2 feet thick

These descriptions are intended to be a generalization of the soil conditions. Please refer to the boring logs in the Appendix for a detailed description of all of the soils encountered.

Based on this description and the detailed boring logs contained in the report, it appears that limerock or similar material should be expected as well as various sand, silt, and clay soils. These soils are generally compatible with the construction methods being considered for installation of the new force main.

HORIZONTAL DIRECTIONAL DRILLING

DESIGN PARAMETERS

The design parameters for this project must be carefully chosen to minimize difficulty during construction while meeting acceptable requirements for pressures, loads, and pipe-controlled geometry.

Pressure

Internal, external, and installation pressures must be considered during the design phase. Although a full analysis is beyond the scope of this report, it is prudent to perform a cursory review of these loads. Internal pressure is a function of system characteristics down gradient. Fortunately, the project location is very near the end of the pipeline at an open discharge. The friction head is therefore relatively low. The discharge elevation appears to be at an elevated headworks structure approximately 30 feet above grade. This will increase the internal pressure in the pipe. All carrier pipes considered for this project will have a minimum internal pressure capability of 150 psig. Actual pressures can be calculated during the design phase.

External pressures typically include live, dead, groundwater, vacuum, and surface structures. Due to an expected depth of cover in excess of 25 feet, live loads will have minimal effect on the pipe. The most significant loads to consider are groundwater and soil loading above the pipe. Although a full analysis of external loads should be performed during design, soil arching may mitigate the full effect of the total dead load. Additionally, internal pressure during operation will offset most if not all external loads.

Installation pressures include tensile and bending stresses. Although they are relatively short in duration, they are typically the limiting design criteria for pipes installed by HDD. A brief consideration of HDPE pipe reveals an allowable safe tensile load of 320,000 pounds. A reasonable estimate for the installation force required for the 36" HDPE pipe is 100,000 pounds, well within a safe tolerance. Fusible PVC has stronger material properties than HDPE and also meets the installation load requirements.

Pipe Geometry

Pipe geometry is an important consideration and will be controlled by material properties and corresponding stress limits, underground utility avoidance, and soil conditions. Ideally, the radius of curvature for 36" HDPE should be around 1800 ft. and 30" fPVC should be 2250 ft. Concerning the radius of curvature, it should be noted that the radius length should be maximized. This reduces bending stresses and tensile loads. Also, Underground Solutions should be contacted regarding any HDD installation of large diameter fPVC pipe prior to beginning design.

Underground utilities will have a significant role in determining the entry and exit angles, the depth of installation, and the entry and exit point locations. The goal is to determine a safe separation and avoid any damage to existing infrastructure.

Soil conditions were reviewed and evaluated to determine a suitable depth for drilling, separation from existing utilities, and placement of the finished product pipe. A consistent soil type is desired for drilling to avoid steering difficulty and the need to use multiple drill bits or tools. If rock is encountered, it is preferable to drill into the rock and stay within the formation for the entire length of the line.

<u>PIPE SELECTION</u>

The pipe selected for this application must meet several criteria: 30" inside diameter availability, corrosion resistance, meet internal/external pressure requirements, compatibility with HDD installation, and acceptable to Pinellas County Utilities. Based on these criteria, we believe the viable options are those pipe materials with fusible joints, these include HDPE, fPVC, and steel. The two plastic pipe materials, HDPE and fPVC, offer abundant corrosion resistance from wastewater. However, steel pipe requires a significant investment in corrosion protection due to its reactivity with wastewater and, more importantly, is not a PCU approved pipe material for this application. Due to these reasons, steel pipe will not be considered a viable option for this application.

HDPE pipe has become a very familiar product in the trenchless pipe industry. It is a very resilient product able to withstand significant abuse. HDPE pipe is also very flexible making it a good choice for projects that require creative work site solutions. We have selected 36" IPS DR 13.5 C-906 HDPE pipe to meet the project requirements. Selected characteristics and dimensions include:

Outside Diameter	36.00"
Inside Diameter	30.346"
Pressure Rating	160 psi
Minimum Bending Radius	75 ft.

The primary benefit of HDPE pipe compared to fPVC is its longer service record, especially in the larger diameters.

Fusible polyvinylchloride (fPVC) is a relatively new product based on a familiar pipe material. The ability to fuse the pipe into jointless strings makes it ideal for HDD applications. To meet the project requirements, 30" DR 25 C-905 fPVC has been selected for comparison. Selected characteristics and dimensions include:

Outside Diameter	32.00"
Inside Diameter	29.29"
Pressure Rating	165 psi
Minimum Bending Radius	667 ft.

One of the primary benefits of fPVC is a smaller required pipe diameter compared with HDPE pipe with similar inside diameters, this is due to the stronger material properties and corresponding thinner wall. In this case a 30" fPVC pipe is comparable to a 36" HDPE pipe. Ultimately this translates to an opportunity for cost savings.

From a material standpoint both fPVC and HDPE meet the project requirements.

CONSTRUCTION CONSIDERATIONS

Construction considerations include work areas for fusing pipe, set up area for a drill rig, a pipe string, and installing the pipe. It appears that the best approach for installing the pipe via HDD is to set a drill rig up on the west end of the work area in the grass area near the reaeration facility. The pipe can be staged along the north-south road on the east side of the property. The various support equipment (fluid recyclers, pumps, etc.) can be located as areas allow and can be connected by hoses. To install the pipe, several cranes will be necessary to force the pipe around the 90° turn. This short radius turn will allow only the use of HDPE pipe. The minimum bending radius of fPVC is much too large to allow it to turn this corner safely.

The installation of this pipe beneath a roadway and an extensive network of underground utilities results in a serious concern for maintaining these items without damage during construction. One method to manage this is the installation of steel casing pipes at each end to contain drilling fluid, drill rods, and pipe. Also, and more importantly, the steel casing will largely isolate the drilling operations from the external environment, i.e. existing utilities and roads. Normally, the length of casing installed is only enough to achieve the goals listed above, 20' to 50' on each end in this case. After the pipe is installed the steel casing is cut off below grade and left in place.

The number, size, and location of the existing utilities coupled with the required geometry of this pipe diameter prevent a reasonable opportunity for HDD. The large 36" diameter pipe requires a reamer of approximately 48" diameter. To further add difficulty, a casing pipe diameter of ±54" requires a very sizable window to avoid damage or impact to other utilities.

CONTRACTOR CONSIDERATIONS

The difficulty of this project warrants a thorough consideration of accepting only highly qualified HDD contractors. With little or no margin for error, a contractor with extensive experience with complex projects is a vital requirement for this project. Fortunately, there are several HDD construction firms that can perform work such as this. A thorough and stringent qualification process is highly recommended prior or during the bid process.

RISK CONSIDERATIONS

The primary risks associated with this project are damage to existing structures and utilities and to a lesser degree, the inability to completely install the pipe. Damage to existing structures, utilities, and surface features is more likely to be the major concern on this project since it is a relatively short length. A careful approach and execution can avoid most if not all damage and the installation of casings as previously discussed may also help to mitigate inadvertent damage. The ability to maneuver and guide the fused pipe into the bore hole is also an area of concern requiring careful planning and execution.

MICROTUNNELING

DESIGN PARAMETERS

Similar to HDD installation, microtunneling pipe design parameters also need to meet external and internal pressure requirements, but more importantly is the installation force. There are a number of pipe materials used for microtunneling and all are designed for very high compressive loads due to the installation by jacking. Because pipelines installed by microtunneling are normally constructed in a straight line, there are no geometric constraints as there are in HDD. Consideration of pipe materials and applicability for this project will be considered in the next section.

Pipe Selection

The common pipe materials used in microtunneling include steel, fiberglass, concrete (reinforced concrete cylinder pipe - RCCP), clay, and composite materials such as fiberglass reinforced polymer mortar (FRPM) pressure pipe. Using the criteria identified in the HDD section, a corrosion resistant pressure pipe is needed. This eliminates steel and clay which are normally used for casing or gravity applications. Ductile iron for microtunneling is available only up to a maximum of 16 inch diameter. This leaves RCCP and FRPM for consideration. Both of these pipes are capable of withstanding the installation, internal, and external loads. Through our discussions with microtunneling contractors, HOBAS pipe (FRPM) is the recommended pipe for this application and also meets the design criteria.

Hobas Pipe is also categorized as centrifugally cast glass fiber reinforced plastic (CCGFRP). Their product for microtunneling applications is HOBAS CC-GRP and is characterized by high axial compressive strength. The pipe is also available for pressure applications and is available in 10' lengths which may allow a smaller shaft footprint for the jacking side.

CONSTRUCTION CONSIDERATIONS

There are several considerations that need to be managed to allow a successful project to be undertaken. These include the location of the jacking and receiving shafts and the drive length. The size of the jacking and receiving shafts will depend on the jacking equipment and the pipe length. With smaller pipe lengths (±10 ft) the footprint of the shaft size can be reduced which will be advantageous for this project due to the limited work area.

The drive length at 650 to 775 feet is fairly long, but not unmanageable. Our discussions with contractors indicated mixed results, one said it was manageable (a Florida based contractor familiar with site conditions), one said it was too long and should be divided into two or more segments. The preferred approach is to complete this installation with one segment to accommodate site constraints and minimize shaft construction cost. The key to minimizing jacking forces, which limits overall length, is lubrication. Bentonite slurry is used to lubricate the

surface area in contact with the soil by injecting it around the circumference of the MTBM. The bentonite slurry is similar to that used in HDD.

CONTRACTOR CONSIDERATIONS

Our research into contractors qualified to perform this work resulted in varied results. We are not aware of any contractors currently working in the Tampa Bay area. There is one contractor based in Southeast Florida that would be well suited for this project. Other than that, other contractors are located in the Midwest or western United States. The reasons for the limited number of local or regional contractors appears to be the limited amount of work on a recurring basis. Also, HDD is often a preferable and cost effective solution to most trenchless projects. Market conditions may promote interest in this project and help mitigate the larger mobilization costs for non-local contractors.

RISK CONSIDERATIONS

The risks inherent to this construction method include high jacking forces, unforeseen ground conditions/obstacles, and pipe issues. Jacking forces are managed with a properly developed bentonite lubrication plan based on soil conditions. Additionally, the selection of the cutter head diameter to allow an overcut slightly larger than the pipe outside diameter will also reduce friction forces.

Unforeseen ground conditions are always a risk with trenchless construction methods. If microtunneling is selected it may be advisable to perform additional soil borings along the alignment to further explore the soil conditions. There is minimal risk of a major soil issue as compared to areas where cobble and boulders consisting of extremely hard rock are common.

Concerns regarding the pipe include non-sealing joints which, although remote, could cause a serious problem considering that this is a pressure pipe. Selection of an appropriate pipe joint and proper installation should minimize this risk to acceptable levels.

CONCLUSION AND RECOMMENDATION

Based on the information evaluated and discussed herein, it is apparent that this is a very challenging project. The work site constraints and the existing utilities allow very little space to install a new pipeline. Trenchless methods normally help minimize or eliminate these types of problems. In the case of HDD, the existing utilities do not allow sufficient space to prepare entry and exit pits and a reasonable work area. Additionally, the pipe layout and staging for pull-in offer another significant challenge. The geometry of the installation is also such that difficulty is much greater than average. The combination of these factors leads us to not recommend this installation method.

Installing the new force main by microtunneling appears to be feasible based on the soil conditions, utility locations, and site constraints. Although a fairly long push with shaft location constraints, it appears that there are areas for jacking and receiving shafts. Other advantages of this construction method include more accurate alignment and grade control, higher operating pressure capability, and less construction space requirements.

Appendix A

ESTIMATE OF PROBABLE COST

Pinellas County Utilities

South Cross Bayou Water Reclamation Facility
36" Force Main Evaluation
Option of Probable Construction Cost

HDD INSTALLATION

Item No.	Item Description	Unit	Quantity	Unit Price	Total Cost
1	36" IPS DR13.5 Force Main	LF	600	$130	$78,000
2	Installation of 36" Pipe by HDD	LF	600	$500	$300,000
2	48" Steel Casings	LF	200	$200	$40,000
3	Installation of 48" Steel Casing	LF	200	$250	$50,000
4	Mobilization	LS	1	$75,000	$75,000
6	Connection to Existing 36" FM	LS	1	$150,000	$150,000
7	36" DI FM	LS	1	$75,000	$75,000
8	36" Valve	EA	1	$25,000	$25,000
9	36" DI MJ Fittings	TN	5	$25,000	$125,000
10	Dewatering, Shoring, S&E Control, Etc.	LS	1	$50,000	$50,000
	Subtotal				$968,000
	General Conditions (5%)				$48,400
	Contingency (25%):				$242,000
	Total				**$1,258,400**

Pinellas County Utilities

South Cross Bayou Water Reclamation Facility
36" Force Main Evaluation
Option of Probable Construction Cost

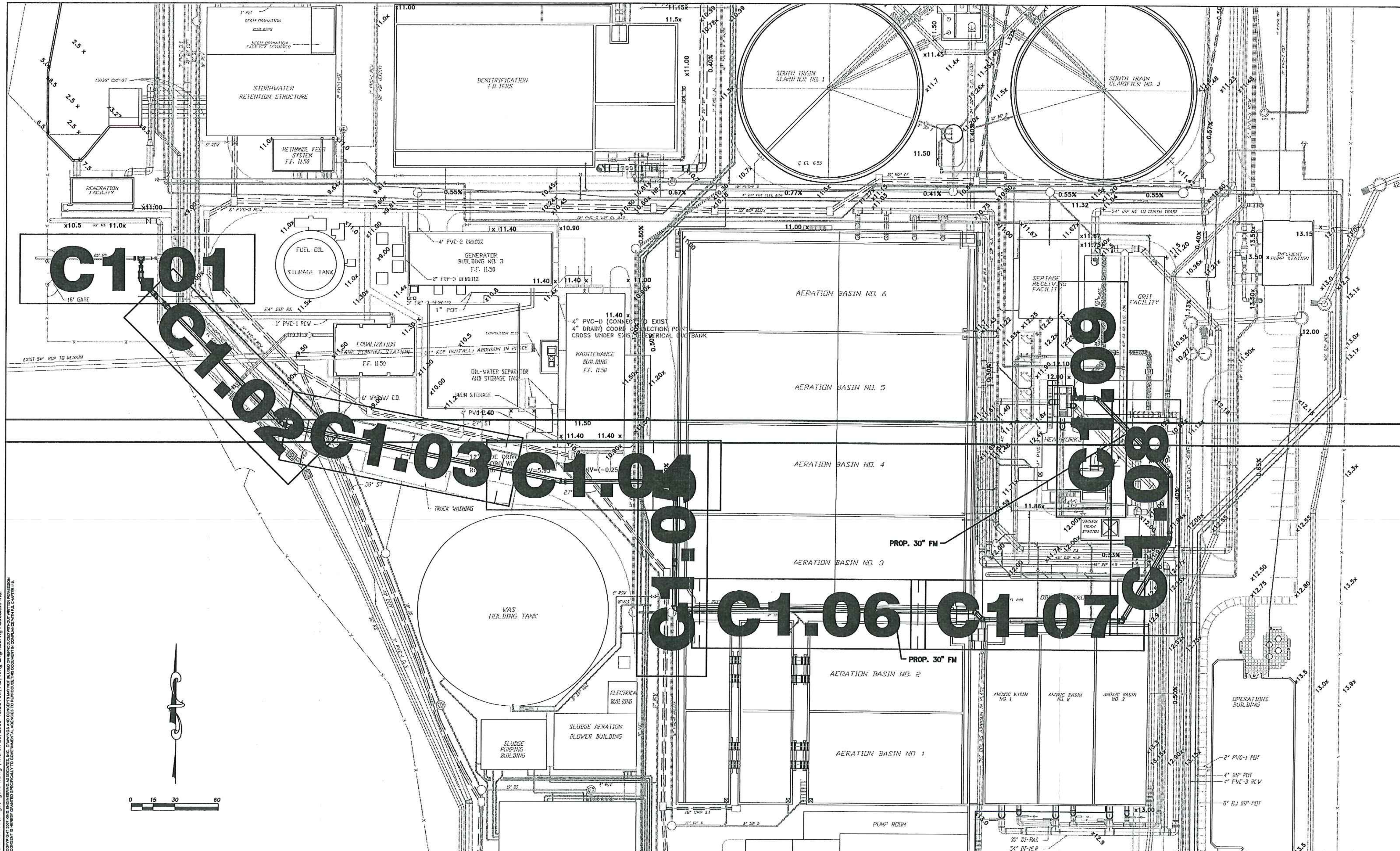
MICROTUNNELING INSTALLATION

Item No.	Item Description	Unit	Quantity	Unit Price	Total Cost
1	36" HOBAS Force Main	LF	780	$300	$234,000
2	Installation of 36" Pipe by MTBM	LF	780	$800	$624,000
2	Jacking & Receiving Shafts	LS	1	$450,000	$450,000
3	Mobilization	LS	1	$75,000	$75,000
4	Connection to Existing 36" FM	LS	1	$150,000	$150,000
6	36" DI FM	LS	1	$75,000	$75,000
7	36" Valve	EA	1	$25,000	$25,000
8	36" DI MJ Fittings	TN	5	$25,000	$125,000
9	Dewatering, Shoring, S&E Control, Etc.	LS	1	$50,000	$50,000
	Subtotal				$1,808,000
	General Conditions (5%)				$90,400
	Contingency (25%):				$452,000
	Total				**$2,350,400**

Appendix E

APPENDIX E

OPEN CUT / ABOVE GROUND ALTERNATIVE
CONCEPTUAL DESIGN PLAN & PROFILE DRAWINGS



DESIGNED	HGS
DRAWN	FWP
CHECKED	AMC
Q.C.	

THE SIGNATURE OF THE QUALITY CONTROL OFFICER IN THIS SPACE INDICATES THAT ALL REQUIRED PERMITS HAVE BEEN OBTAINED AND THAT CONSTRUCTION IS AUTHORIZED TO COMMENCE.

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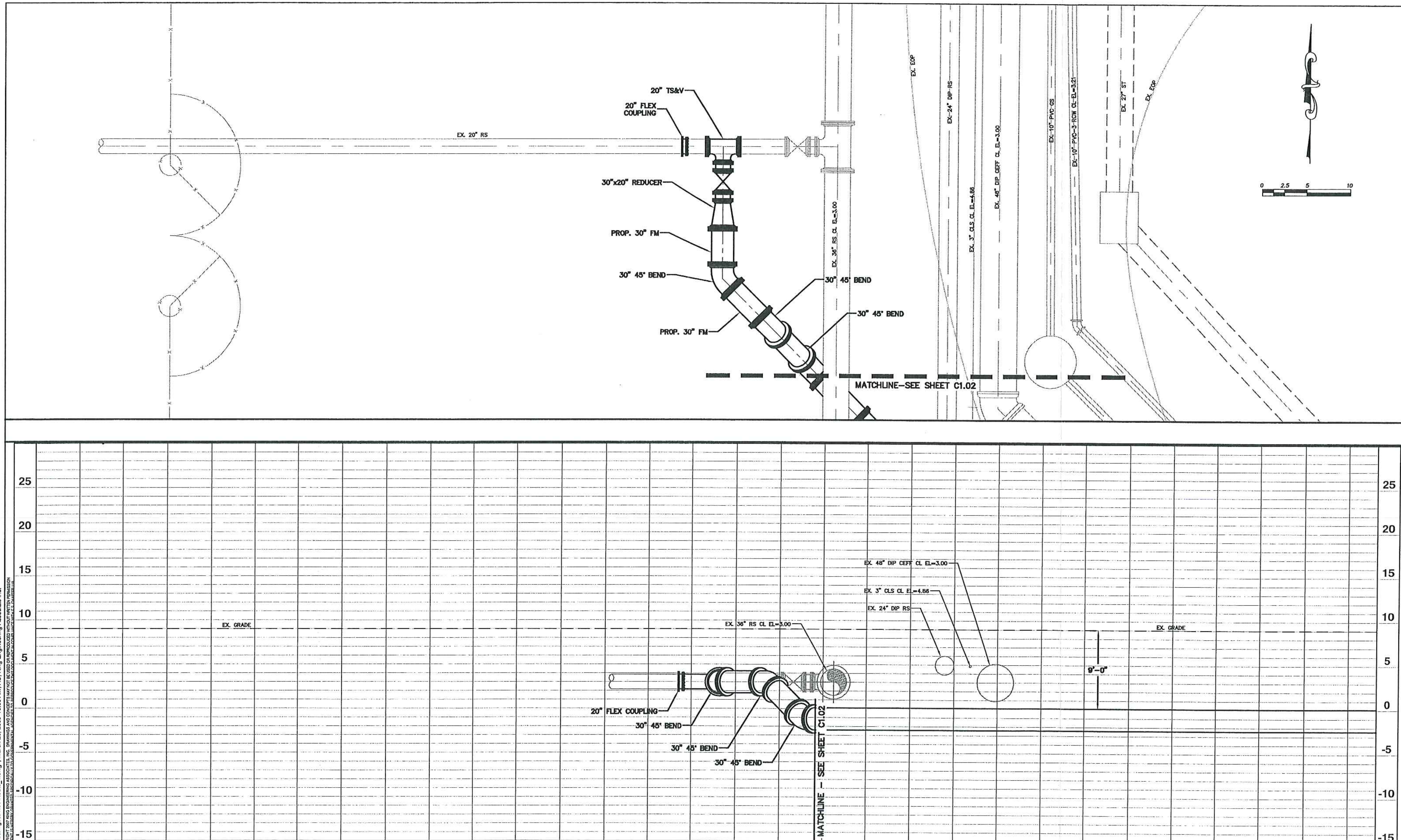
SOUTH CROSS BAYOU
WASTE WATER TREATMENT PLANT

KEY MAP
OPEN CUT / ABOVE GROUND ROUTE

NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO.	2031-057-000
DATE	OCT. 2008
SCALE	
SHEET NO.	C1.00



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WASTE WATER TREATMENT PLANT

PLAN AND PROFILE

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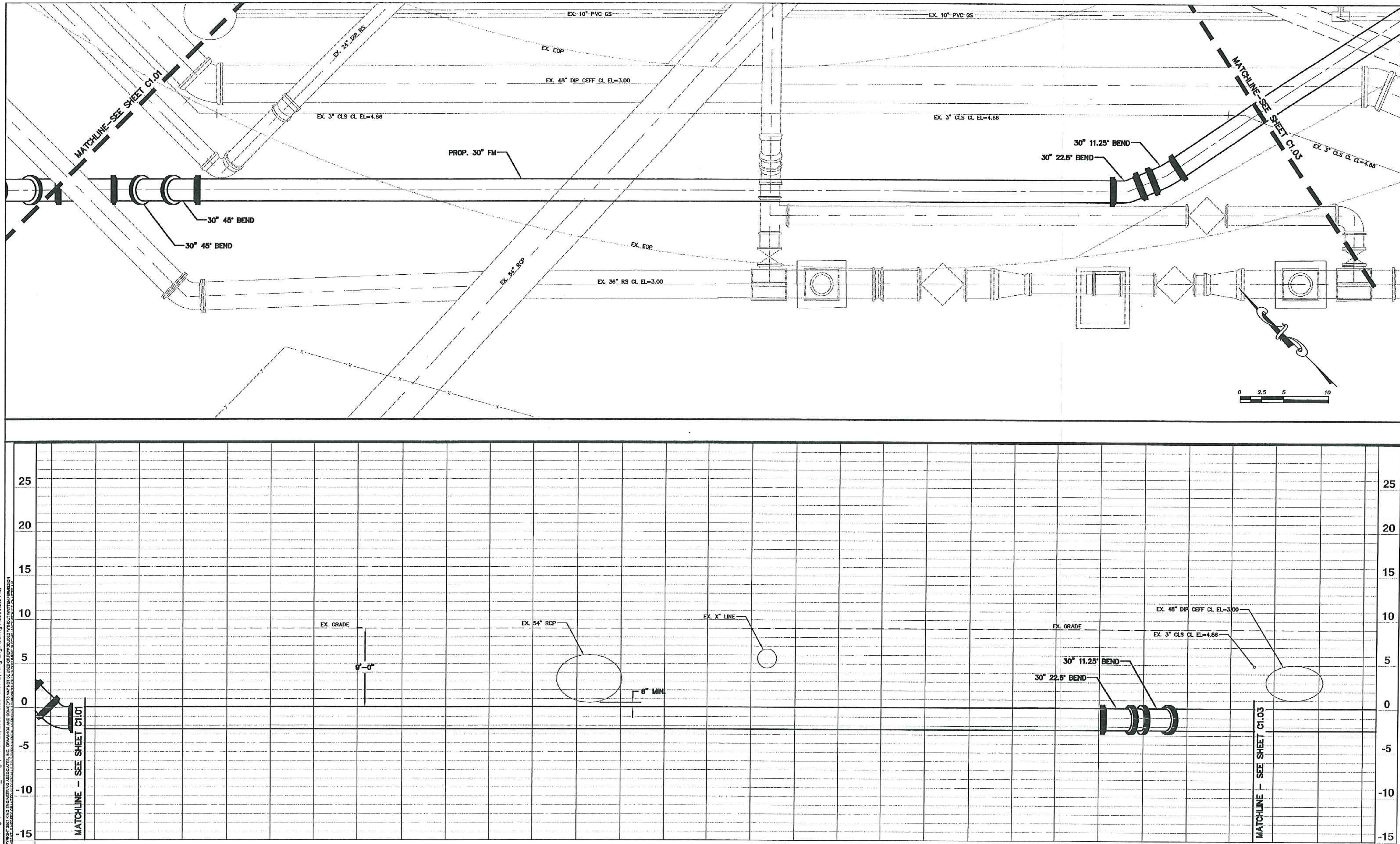

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SOUTH CROSS BAYOU WASTE WATER TREATMENT PLANT

PLAN AND PROFILE

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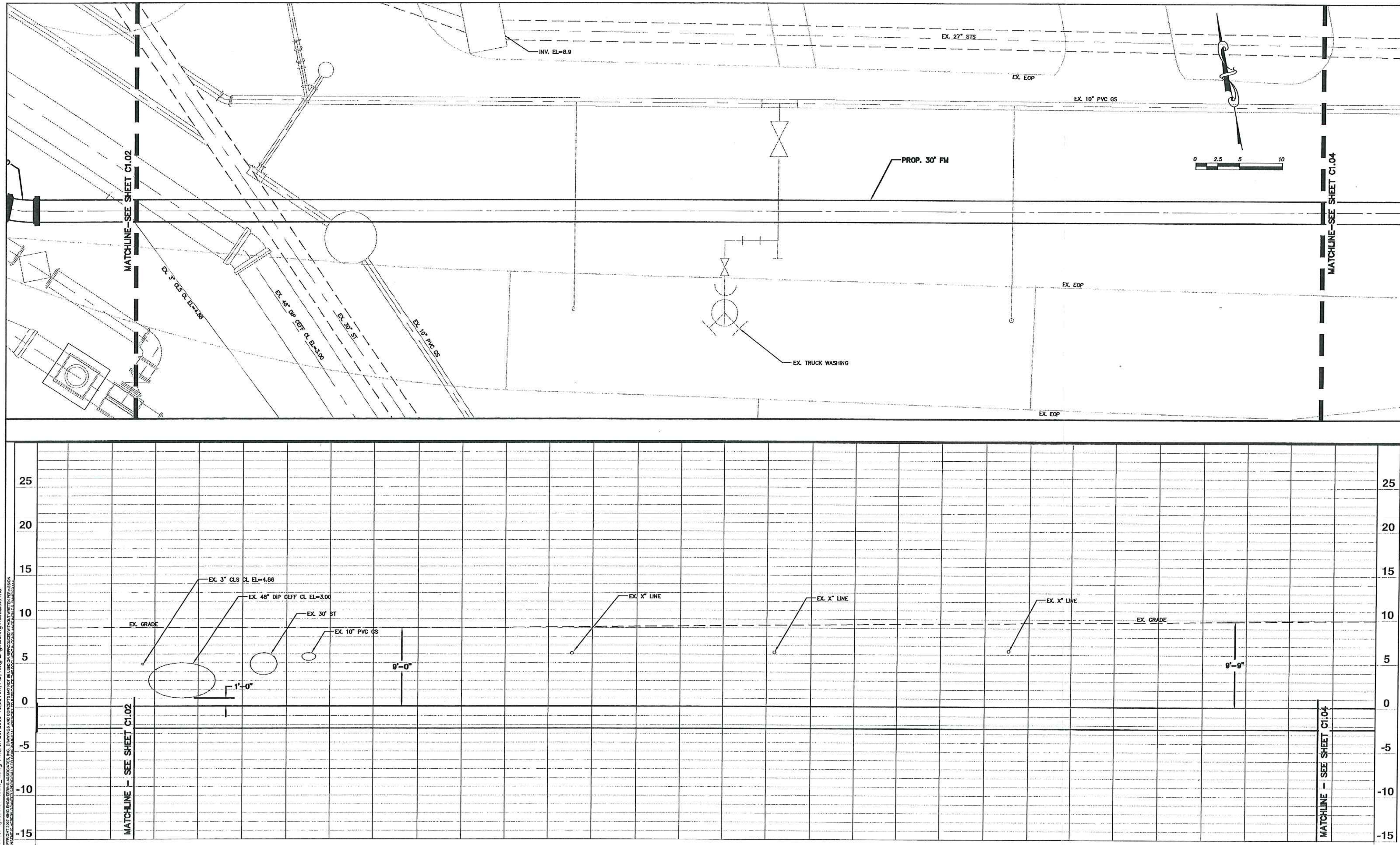

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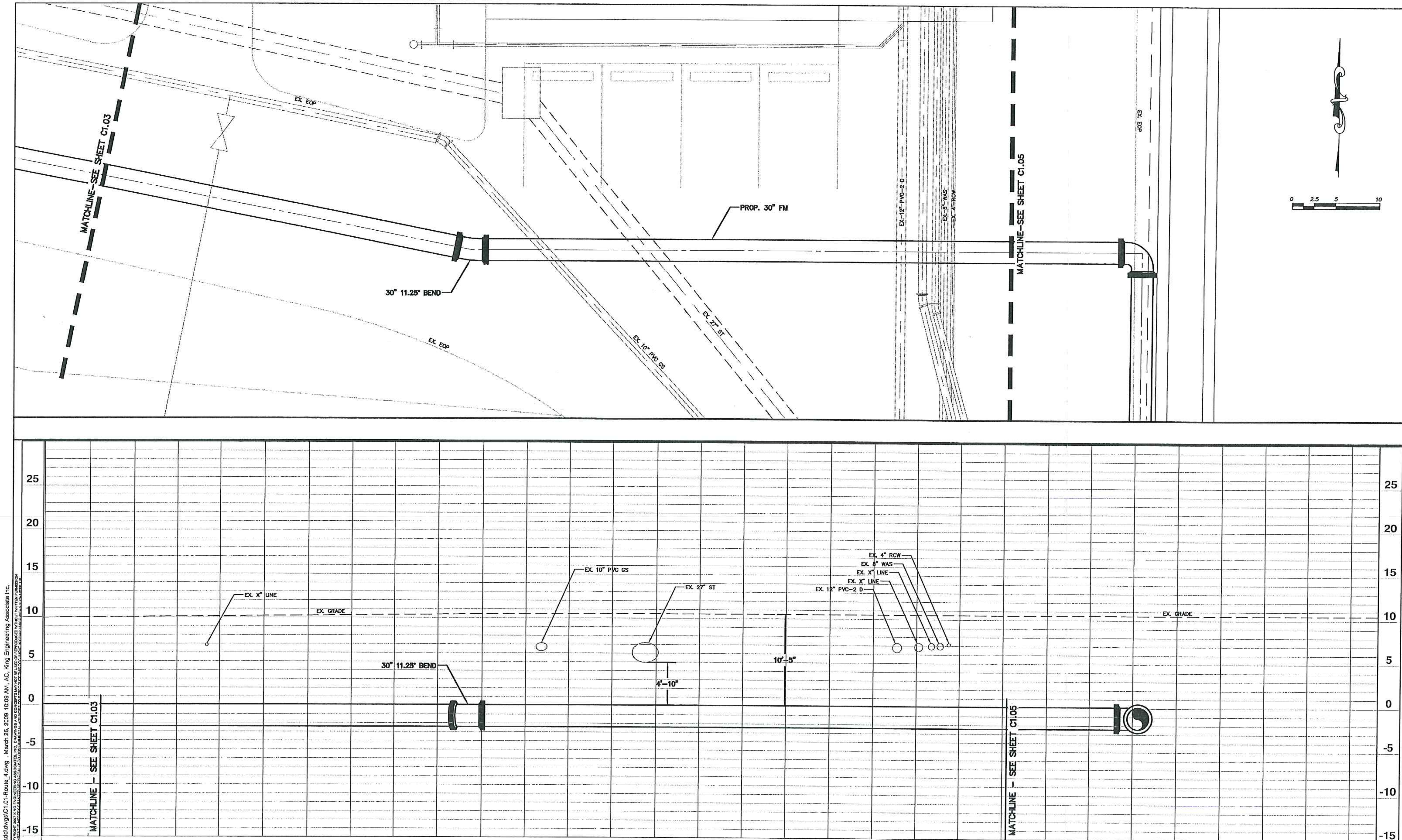

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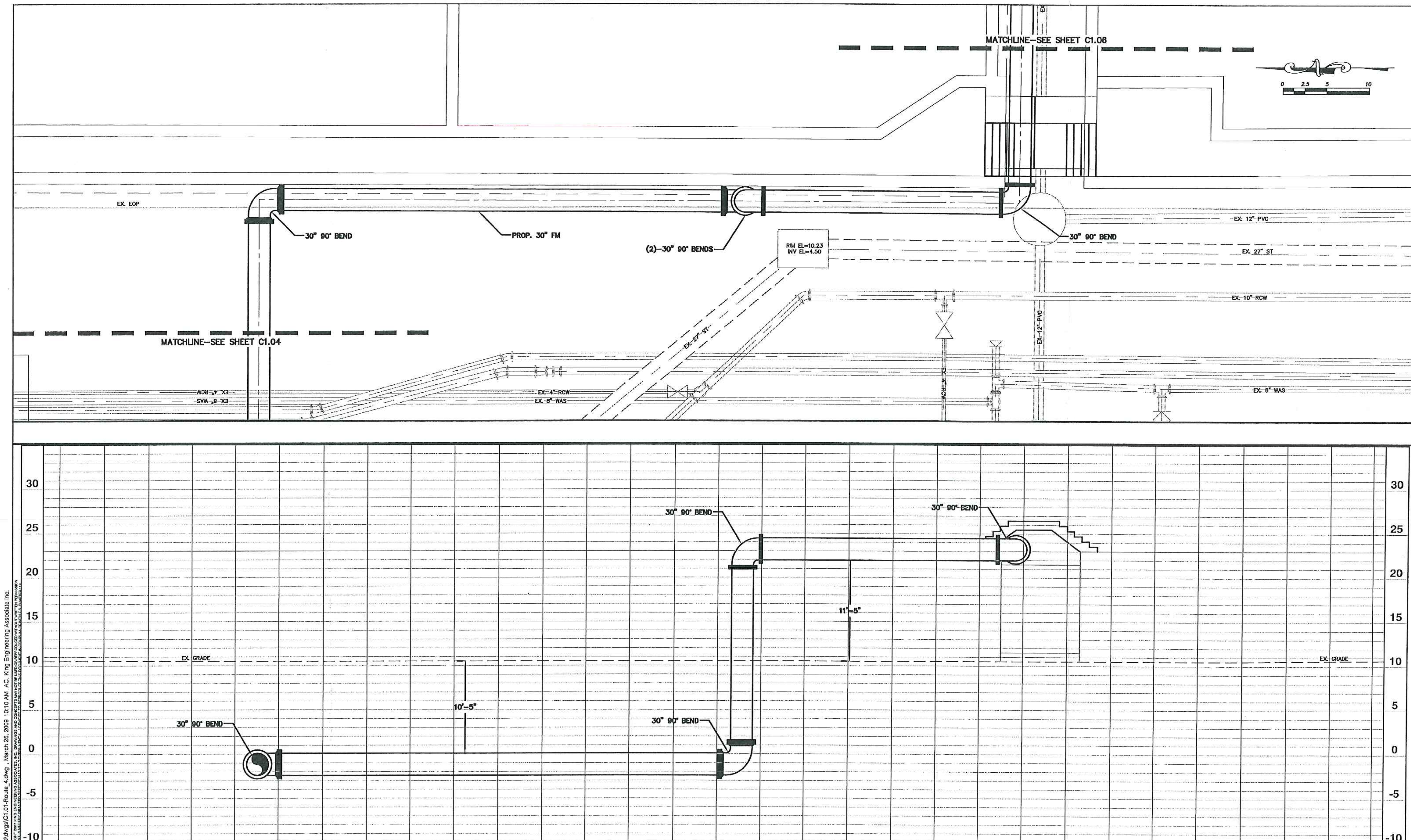

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SOUTH CROSS BAYOU
WASTE WATER TREATMENT PLANT

PLAN AND PROFILE

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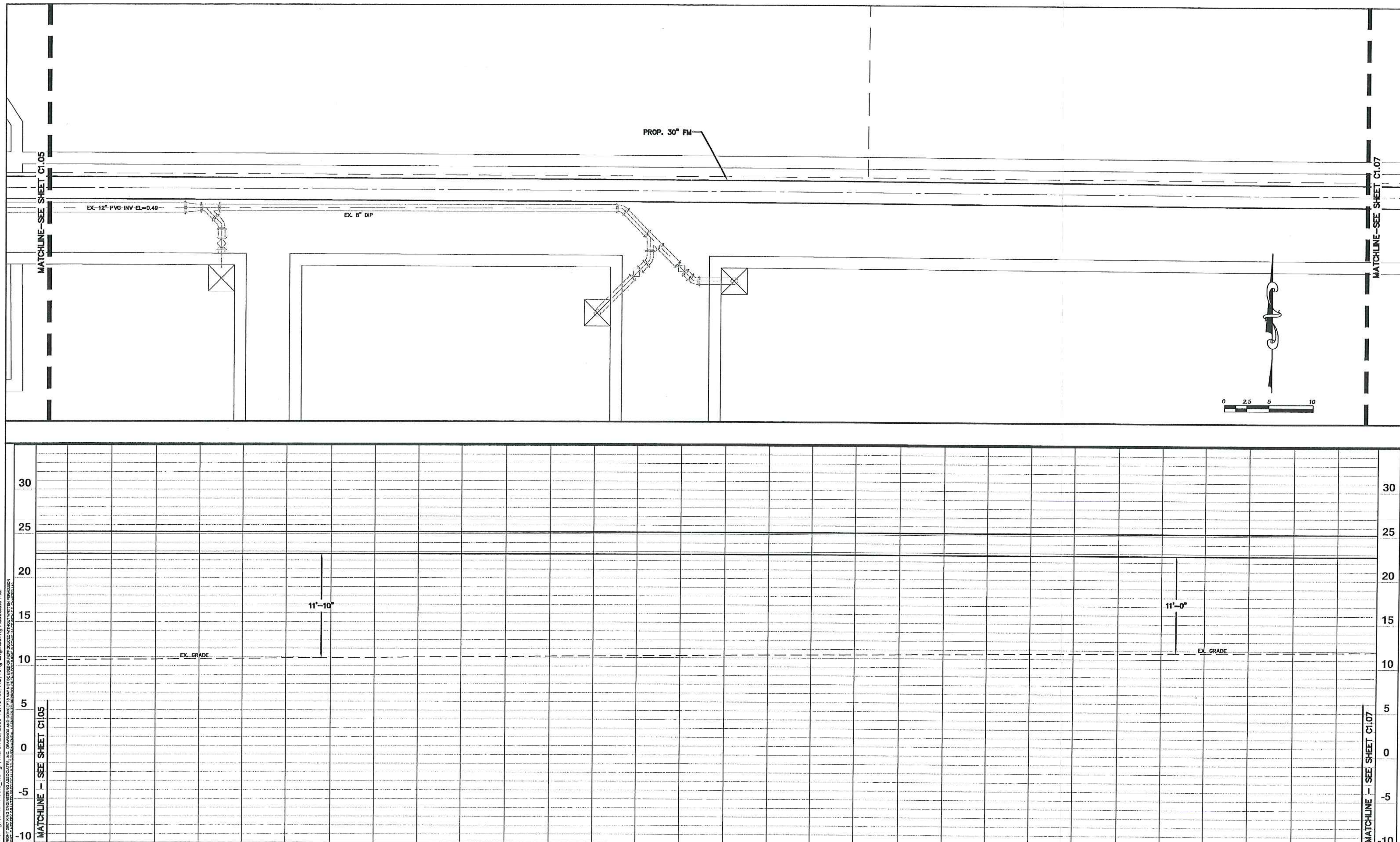

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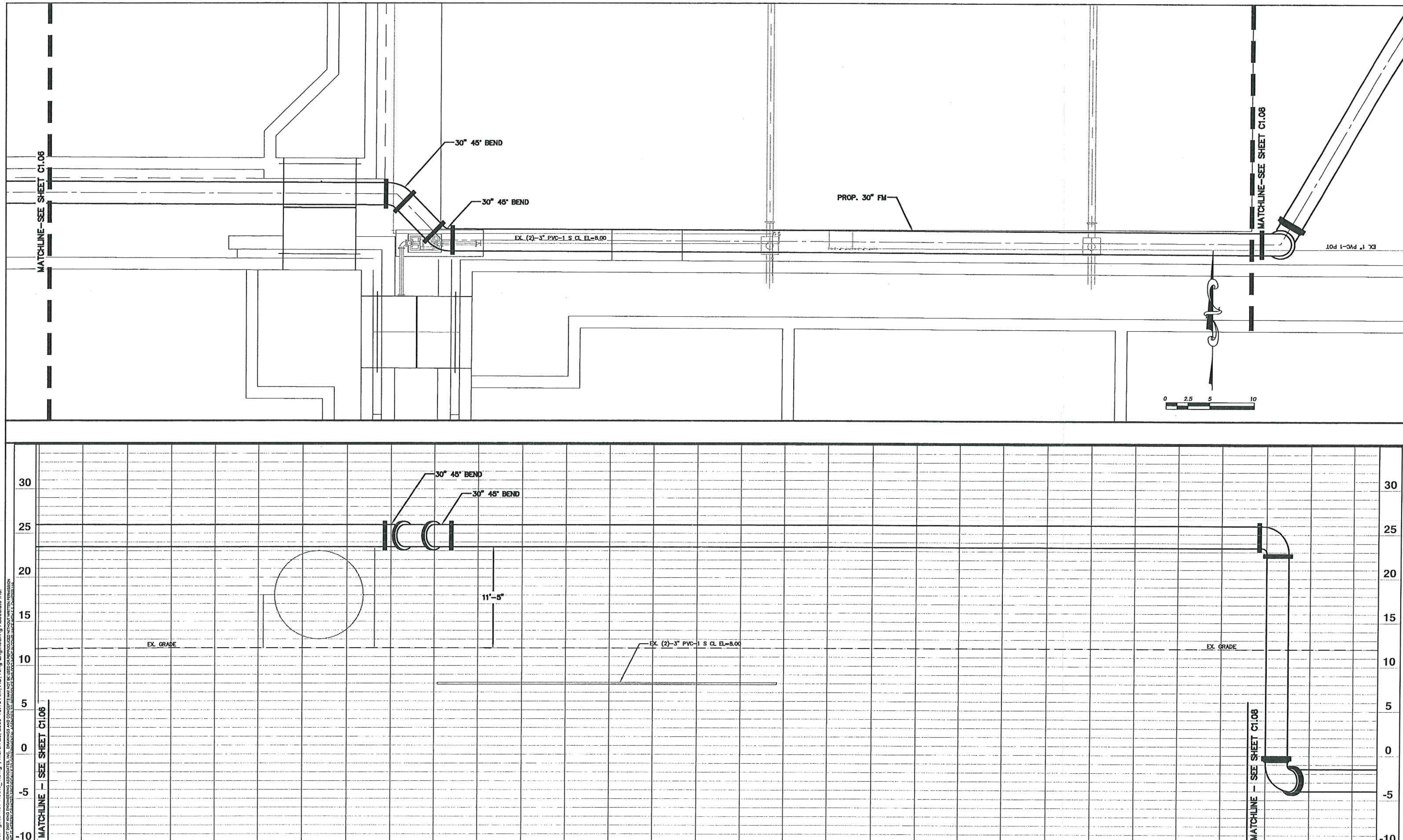

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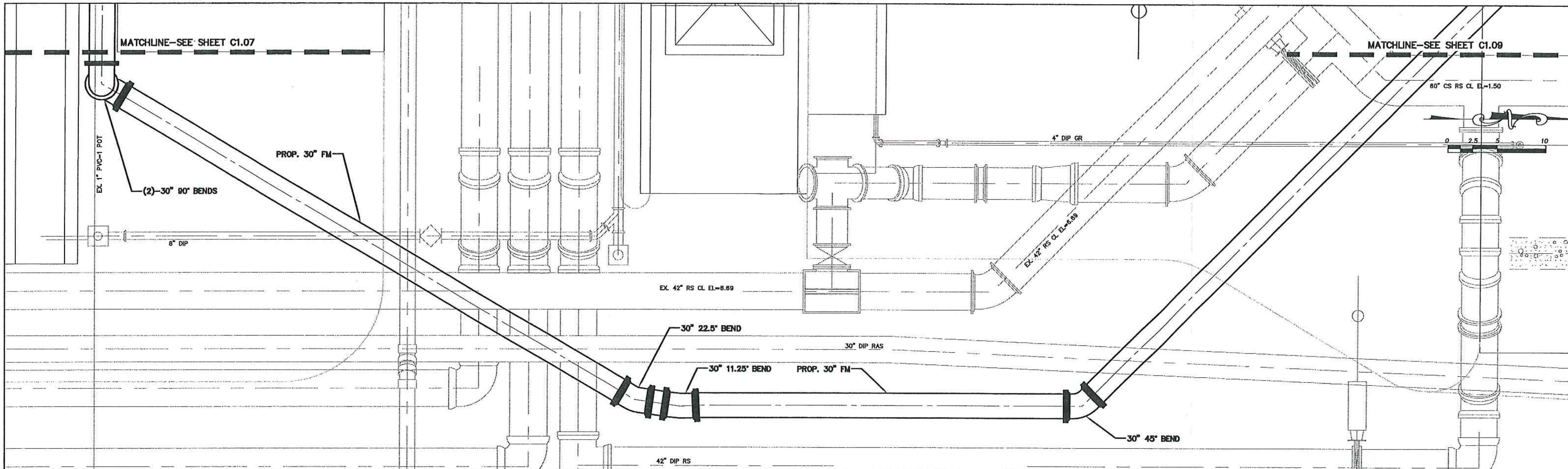

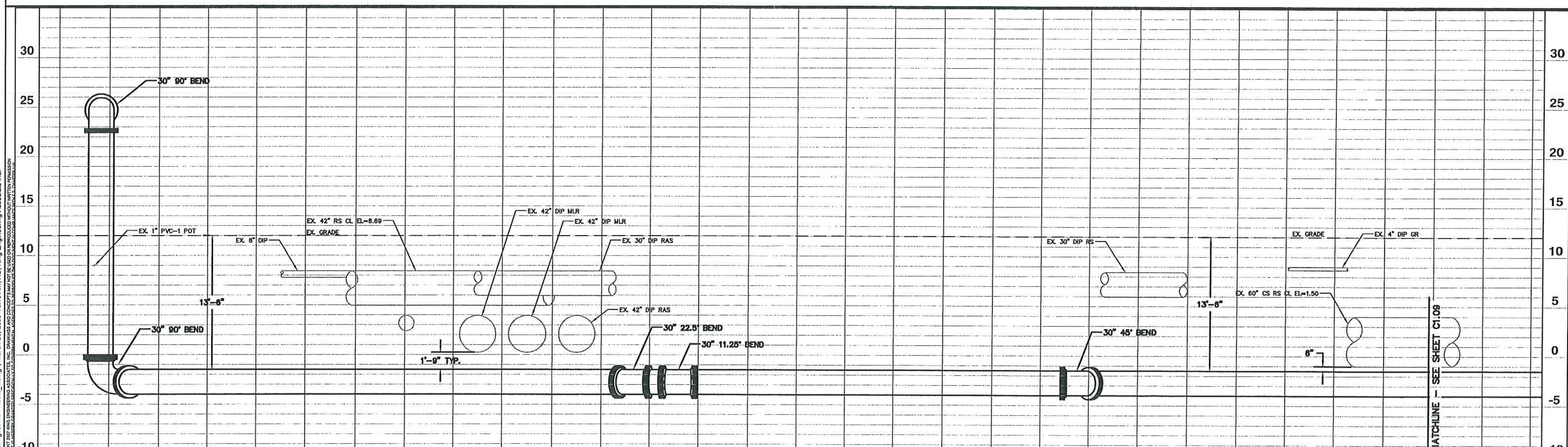

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DESIGNED	HGS
DRAWN	FWP
CHECKED	AMC
Q.C.	

THE SIGNATURE OF THE QUALITY CONTROL OFFICER IN THIS SPACE INDICATES THAT ALL REQUIRED PERMITS HAVE BEEN OBTAINED AND THAT CONSTRUCTION IS AUTHORIZED TO COMMENCE.

King ENGINEERING ASSOCIATES, INC.
4921 Memorial Highway
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Phone 813 880-8881
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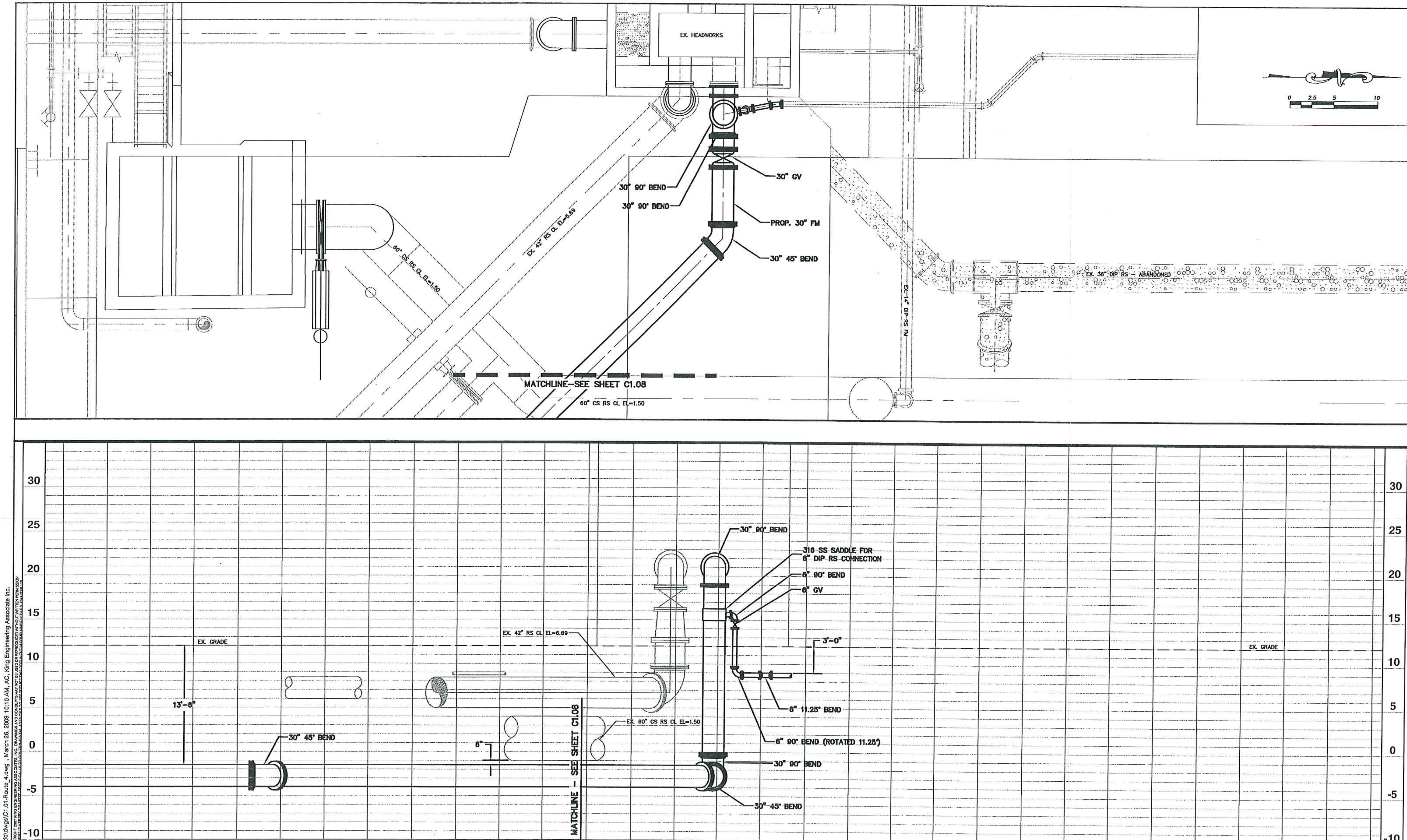
Engineering License #2610

SOUTH CROSS BAYOU
WASTE WATER TREATMENT PLANT

PLAN AND PROFILE

NO.	DATE	DESCRIPTION	APP'D BY
A	10/07/08	SUBMITTAL	

JOB NO. 2031-057-000
DATE: OCT. 2008
SCALE:
SHEET NO. C1.08



DESIGNED	HGS
DRAWN	FWP
CHECKED	AMC
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PLAN AND PROFILE

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A	10/07/08	SUBMITTAL	

JOB NO. 2031-057-000
DATE: OCT. 2008
SCALE:
SHEET NO. C1.09

Appendix F

APPENDIX F

PIPE ALTERNATIVES
PROBABLE COSTS

Pinellas County Utilities

South Cross Bayou Water Reclamation Facility
36" Force Main Evaluation
Option of Probable Construction Cost

HDD INSTALLATION

Item No.	Item Description	Unit	Quantity	Unit Price	Total Cost
1	36" IPS DR13.5 Force Main	LF	600	$130	$78,000
2	Installation of 36" Pipe by HDD	LF	600	$500	$300,000
2	48" Steel Casings	LF	200	$200	$40,000
3	Installation of 48" Steel Casing	LF	200	$250	$50,000
4	Mobilization	LS	1	$75,000	$75,000
6	Connection to Existing 36" FM	LS	1	$150,000	$150,000
7	36" DI FM	LS	1	$75,000	$75,000
8	36" Valve	EA	1	$25,000	$25,000
9	36" DI MJ Fittings	TN	5	$25,000	$125,000
10	Dewatering, Shoring, S&E Control, Etc.	LS	1	$50,000	$50,000
	Subtotal				$968,000
	General Conditions (5%)				$48,400
	Contingency (25%):				$242,000
	Total				**$1,258,400**

Pinellas County Utilities

South Cross Bayou Water Reclamation Facility
36" Force Main Evaluation
Option of Probable Construction Cost

MICROTUNNELING INSTALLATION

Item No.	Item Description	Unit	Quantity	Unit Price	Total Cost
1	36" HOBAS Force Main	LF	780	$300	$234,000
2	Installation of 36" Pipe by MTBM	LF	780	$800	$624,000
2	Jacking & Receiving Shafts	LS	1	$450,000	$450,000
3	Mobilization	LS	1	$75,000	$75,000
4	Connection to Existing 36" FM	LS	1	$150,000	$150,000
6	36" DI FM	LS	1	$75,000	$75,000
7	36" Valve	EA	1	$25,000	$25,000
8	36" DI MJ Fittings	TN	5	$25,000	$125,000
9	Dewatering, Shoring, S&E Control, Etc.	LS	1	$50,000	$50,000
	Subtotal				$1,808,000
	General Conditions (5%)				$90,400
	Contingency (25%):				$452,000
	Total				**$2,350,400**

SCB WRF - PINELLAS COUNTY
FURNISH & INSTALL 30" BYPASS FORCE MAIN

SUMMARY OF COSTS

Div	Description	Total
1.00	General Condtions - Dewatering	$188,000.00
2.00	Site Work/ Excavation	$518,000.00
3.00	Concrete	$0.00
4.00	Masonry	$0.00
5.00	Misc. Metals - Pipe Supports	$147,000.00
6.00	Carpentry	$0.00
7.00	Thermal Protection	$0.00
8.00	Windows and Doors	$0.00
9.00	Painting	$0.00
10.00	Specials	$0.00
11.00	Equipment	$0.00
12.00	Furnishings	$0.00
13.00	Instrumentation	$0.00
14.00	Handling Equipment	$0.00
15.00	Pipe	$199,000.00
15.40	HVAC	$0.00
15.50	Plumbing	$0.00
16.00	Electrical	$0.00
Total		$1,052,000.00

Bonds, builders risk, ocp etc	$7,000.00
Contingencies @ 10%	$105,200.00
Grand Total	$1,164,200.00