DRAINAGE LETTER REPORT
FOR
ALAMEDA BOULEVARD SAN PEDRO TO WYOMING PROJECT
CITY PROJECT NO. 7663.91

January 2012

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I. INTRODUCTION AND SITE LOCATION

Part of the Alameda Boulevard Widening Project from I-25 to Wyoming includes the installation of a storm drain that will tie into a proposed 72" storm drain in San Pedro Drive on the west and tie into an existing 36" storm drain in Alameda Boulevard just east of Louisiana Boulevard. The storm drain system will also extend south in Louisiana Boulevard to Signal Avenue and then east to an existing 36" storm drain in Signal Avenue. The construction of the proposed storm drain is sized to accept the runoff from the ultimate Alameda street section and the adjacent properties and will eliminate the need for three existing retention ponds in the project area.

The Alameda storm drain discharges to the recently constructed or soon to be constructed storm drain included as part of the San Pedro Storm Drain Project. There is also an existing parallel storm drain system in San Pedro ranging from 48" to 54" diameter. The eventual outfall for both San Pedro Storm Drains are either 5-36" RCP culverts under I-25 north of Eagle Rock or the 8-36" RCP culverts under I-25 north of Alameda Place. The peak runoff for the developed condition is determined by following the basins and hydrology in the North Albuquerque Acres Master Drainage Plan (NAAMDP), by Resource Technology Inc. dated October 1998 and revising the basins based on subsequent drainage reports in the drainage area.

II. METHODOLOGY

A hydrologic analysis was not performed for this report. The hydrology given in the NAADMP was used to determine the peak flows that drain to the San Pedro Storm Drain. The hydrologic analyses in the NAAMDP was based on Section 22 of the City of Albuquerque Development Process Manual (DPM), entitled "Drainage, Flood Control, and Erosion Control," January, 1993.

The hydraulic analyses of the proposed storm drain system was also based on Section 22 of the DPM for determining pressure flow conditions and head losses at manholes. Microsoft Excel spreadsheet software was used to calculate the hydraulic grade line in storm drains under pressure and for determining head losses at manholes. Graphs given in Section 22 of the DPM were used to determine storm inlet capacities.

Pipe sizes, invert and rim elevations, and system geometry were taken from the record drawings provided by the COA as well as survey data taken for the project by the design team.

III. DRAINAGE ANALYSIS

A. HYDROLOGY

The scope of work identified reviewing the drainage basins in the NAADMP and revising those basins based on subsequent drainage reports that affect the basins that drain to Alameda within the project area. The NAADMP and San Pedro Storm Drain Project DAR identified basins 117.32 and 117.4 draining to Alameda Boulevard. For the developed condition, these basins have Land Treatment Type D percentages ranging from 50% to 60%.

Basins 117.32 and 117.4 were further divided based on previous drainage reports in the project area or on the proposed storm inlet locations along Alameda Boulevard. Basin 117.32 was divided into 9 sub-basins and Basin 117.4 was divided into 4 sub-basins (refer to Exhibit I). For each of the revised basins it was assumed that the Land Treatment D percentage would be the same for the similar basins in the NAADMP. Therefore, the revised basin area was multiplied by the unit peak flow (CFS/ACRE) to determine the peak flow from that basin. To be conservative, the peak flows from each basin were added instead of routed. Exhibit I shows the revised drainage basins and peak flows for each basin and at critical analysis points. Table 1 shows the peak flows for the revised drainage basins.

Table 1 Revised Drainage Basin Peak Flows

Basins	Area (acres)	Type D Land Treatment (%)	CFS/Acre	100yr Peak Flow (CFS)
117.321	0.54	50	3.82	2.06
117.322	2.44	50	3.82	9.32
117.323	2.68	50	3.82	10.24
117.324	1.37	50	3.82	5.23
117.325	1.25	50	3.82	4.77
117.326	5.96	50	3.82	22.77
117.327	4.80	50	3.82	18.34
117.328	5.34	50	3.82	20.40
117.329	6.74	50	3.82	25.75
117.41	17.75	60	4.02	71.36
117.42	14.29	60	4.02	57.45
117.43	0.85	60	4.02	3.42
117.44	0.43	60	4.02	1.33

B. STORM DRAIN HYDRAULICS

1. INTRODUCTION

The proposed storm drain system was modeled using record drawings and topographic and planimetric survey data obtained in the field. The design survey was produced in the NAVD 88 vertical datum. Two systems were modeled to determine the hydraulic grade line (HGL) of the proposed systems. The proposed storm drain system data were input to the models and flows were input at various points in the system represented by locations future flow interception points.

2. STORM INLET CAPACITIES

Storm inlet capacities were determined for the proposed storm drain to be constructed in Alameda and Louisiana. Graphs given in Section 22 of the DPM were used to determine storm inlet capacities. First, the depth of flow in the ultimate street section was determined using Plate 22.3 D-4. The proposed street slope and one-half of the street flows are inputs to the graph to obtain the depth of flow. Then the depth of flow and street slope are input to Plate 22.3 D-6 for

double grate inlets to determine the inlet capacity. It is assumed that each double grate will be 50% clogged and therefore the inlet capacity is reduced by half. Table 2 gives the inlet capacities for the proposed storm drain system.

Table 2 Storm Inlet Capacities

Inlet Station	Contributing Basins	½ Street Flow (CFS)	Street Slope (%)	Flow Depth (FT)	Inlet Capacity (CFS)	Number of Inlets	Bypass Flow (CFS)
29+00	117.325 & 117.321	3.42	2.83	0.29	1.85	2	0.00
24+50	117.326	11.39	3.11	0.41	3.40	3	1.19
20+00	117.327	10.36	2.40	0.40	3.30	3	0.46
15+50	117.328	10.66	2.61	0.40	3.35	3	0.61
11+00	117.329	13.49	3.00	0.44	4.80	3	0.00

3. STORM DRAIN HYDRAULICS

The hydraulic grade line analysis for the proposed storm drain was completed using an Excel spreadsheet that was developed using the methodology given in Section 22.3 of the DPM. The analysis showed that the downstream portion of the proposed Alameda Storm Drain System just east of San Pedro Drive is under pressure flow. The pressure flow unseals between the manholes at station 11+00 and station 15+50 and continues in gravity flow conditions.

The remainder of the storm drain system flows in gravity flow conditions. Therefore, between manholes the hydraulic grade line equals the normal depth of the storm drain. Table 3 gives the normal depths for each pipe segment under gravity flow conditions.

Table 3 Storm Drain Normal Depth

Segment Stations	Pipe Dia. (IN)	Pipe Slope (%)	Peak Flow (CFS)	Velocity (FPS)	Normal Depth (FT)
Alameda					
15+50 to 20+00	48	2.89	205.0	21.77	2.81
20+00 to 24+50	48	2.61	185.2	20.51	2.70
24+50 to 27+10	42	2.85	165.1	20.12	2.78
27+10 to 29+00	42	2.83	159.8	20.01	2.71
29+00 to 29+80	42	2.94	153.0	20.25	2.56
29+80 to 31+45	42	2.94	142.8	20.04	2.43
31+45 to 33+50	42	2.18	133.5	17.47	2.59
33+50 to 36+67	42	2.10	133.5	17.18	2.63
36+67 to 38+04	36	6.43	71.4	22.91	1.36
38+04 to 40+77	36	2.54	63.2	15.68	1.67
Louisiana					
11+10 to 12+74	36	0.80	60.9	9.61	2.52
7+54 to 11+10	36	0.65	57.5	8.53	2.72
12+74 to 13+59	24	1.42	1.33	4.45	0.30
Signal	36	1.88	57.5	13.67	1.73

The head losses through the manholes equals the heal loss due to bend losses, junction losses, and manhole losses. Table 4 shows the total head losses at each of the manholes.

Table 4 Manhole Head Losses

Station	Bend Loss (FT)	Junction Loss (FT)	Manhole Loss (FT)	Total Losses (FT)
Alameda				
20+00	0.00	1.60	0.33	1.93
24+50	0.00	1.27	0.31	1.58
27+10	0.00	0.38	0.31	0.69
29+00	0.00	0.32	0.32	0.64
29+80	0.00	0.73	0.31	1.04
31+45	0.00	1.68	0.24	1.92
33+50	0.00	0.00	0.23	0.23
36+67	0.00	2.51	0.41	2.92
38+04	0.00	2.56	0.21	2.77
Louisiana				
7+05	0.00	0.00	0.15	0.15
7+55	0.58	0.00	0.15	0.73
11+10	0.00	0.41	0.06	0.47

APPENDIX A
HYDRAULIC CALCULATIONS

STREET CAPACITY

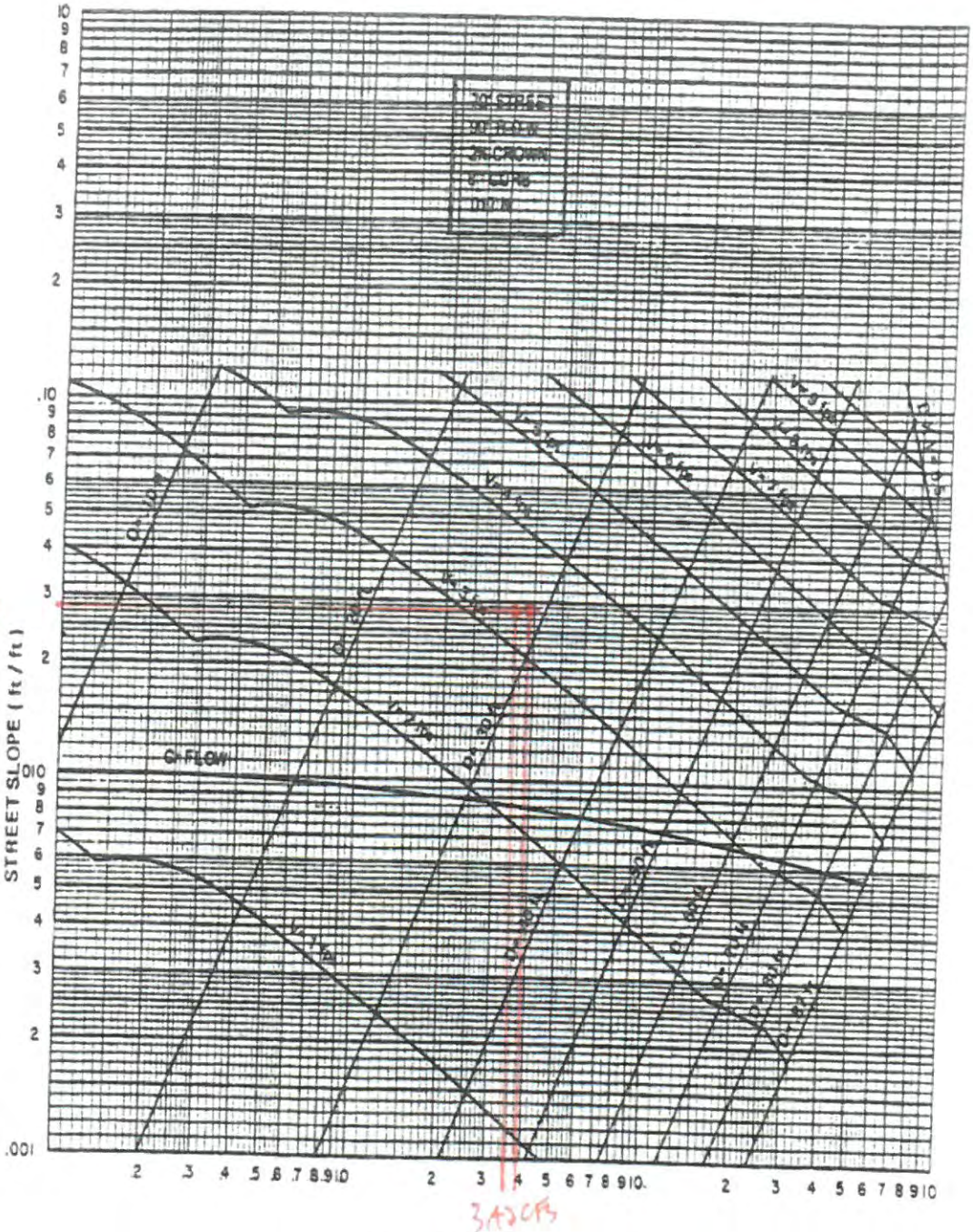


PLATE 22.3 D-4

BASIN 117.32S

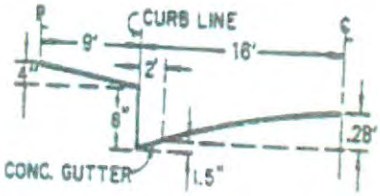
$\frac{1}{2}Q = 2.39\,CFS + (\frac{1}{2}Q_{Basin\,117.32})\,1.03 = 3.42\,CFS$

$S = 2.83\%$

Depth = 0.72'

GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"

GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

3.7CFS Assume 50% Clogging

1.85 CFS per inlet

3.92 ÷ 1.85 = 1.84

use 2 inlets

All flow is Captured

PLATE 22.3 D-6

BASIN 117.325

STREET CAPACITY

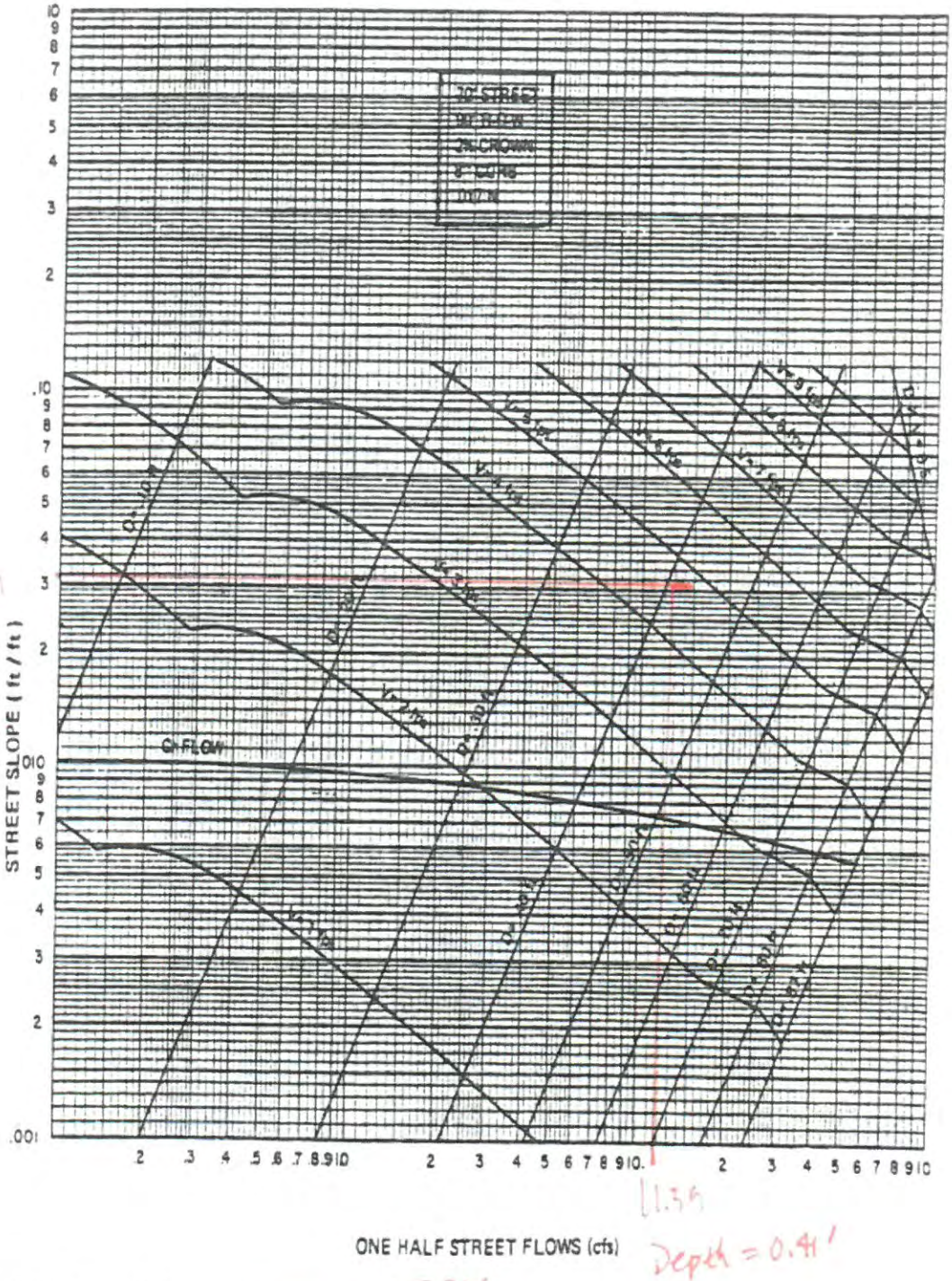
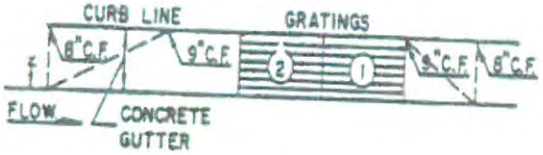
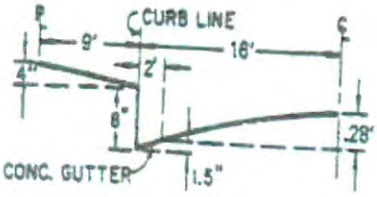


PLATE 22.3 D-4

GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

6.8 CFS
Assume 50% Clogging
3.4 CFS per inlet
11.39 CFS ÷ 3.4 = 3.35
use 3 inlets
bypass 1.19 CFS

BASIN 17.326

PLATE 22.3 D-6

STREET CAPACITY

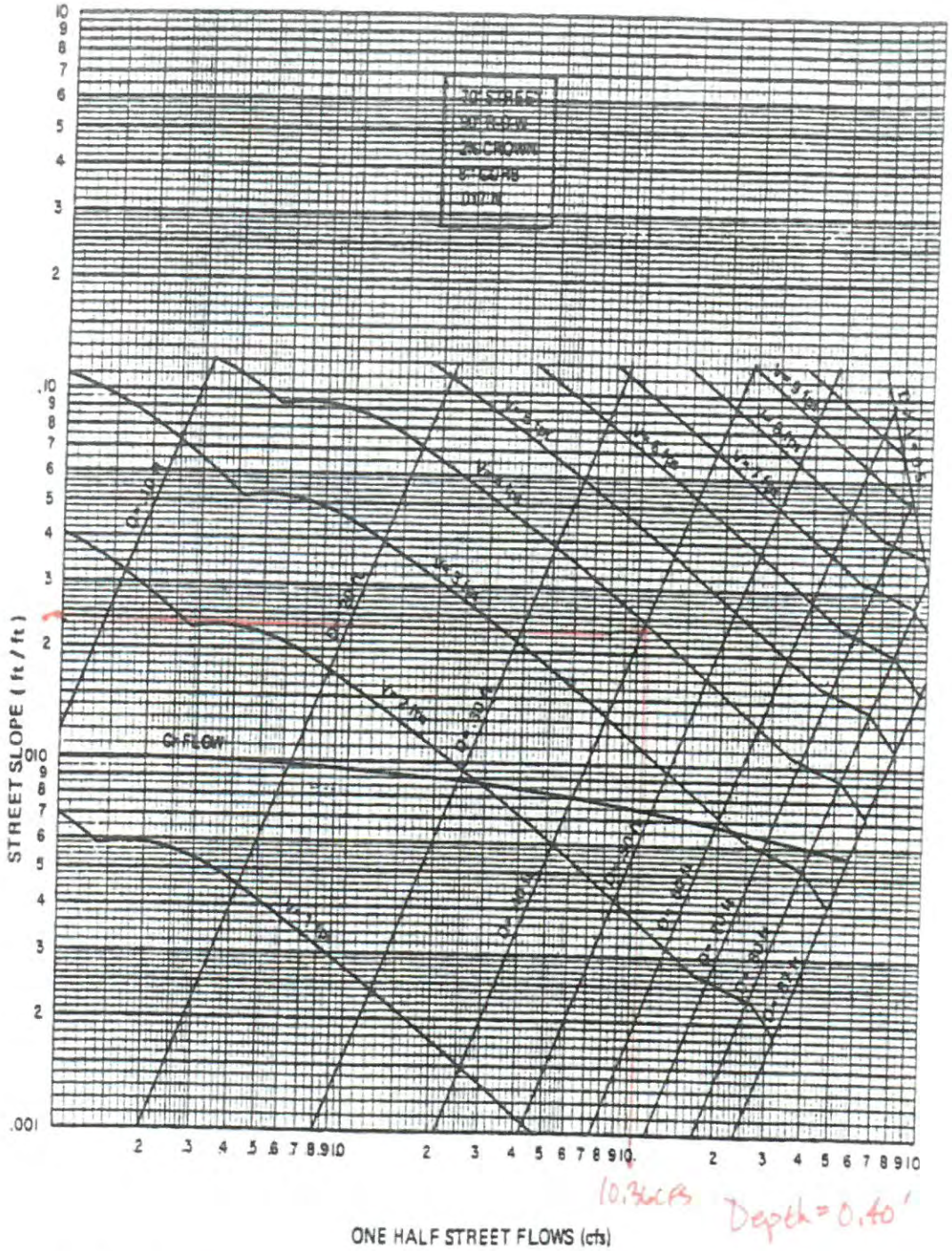
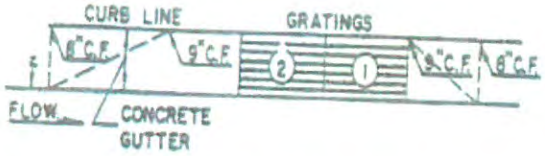


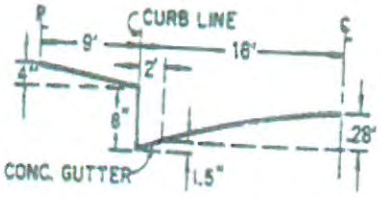
PLATE 22.3 D-4

BASIN 117.327 bypass from 117326
½ Q = 9.17 CFS + 1.19 CFS = 10.36 CFS
S = 2.40%

GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

6.6 CFS per inlet
Assume 50% Clogging
3.3 CFS per inlet
10.36 CFS ÷ 3.3 = 3.13
use 3 inlets
bypass Q = 0.46 CFS

PLATE 22.3 D-6

by Basin 112.327

STREET CAPACITY

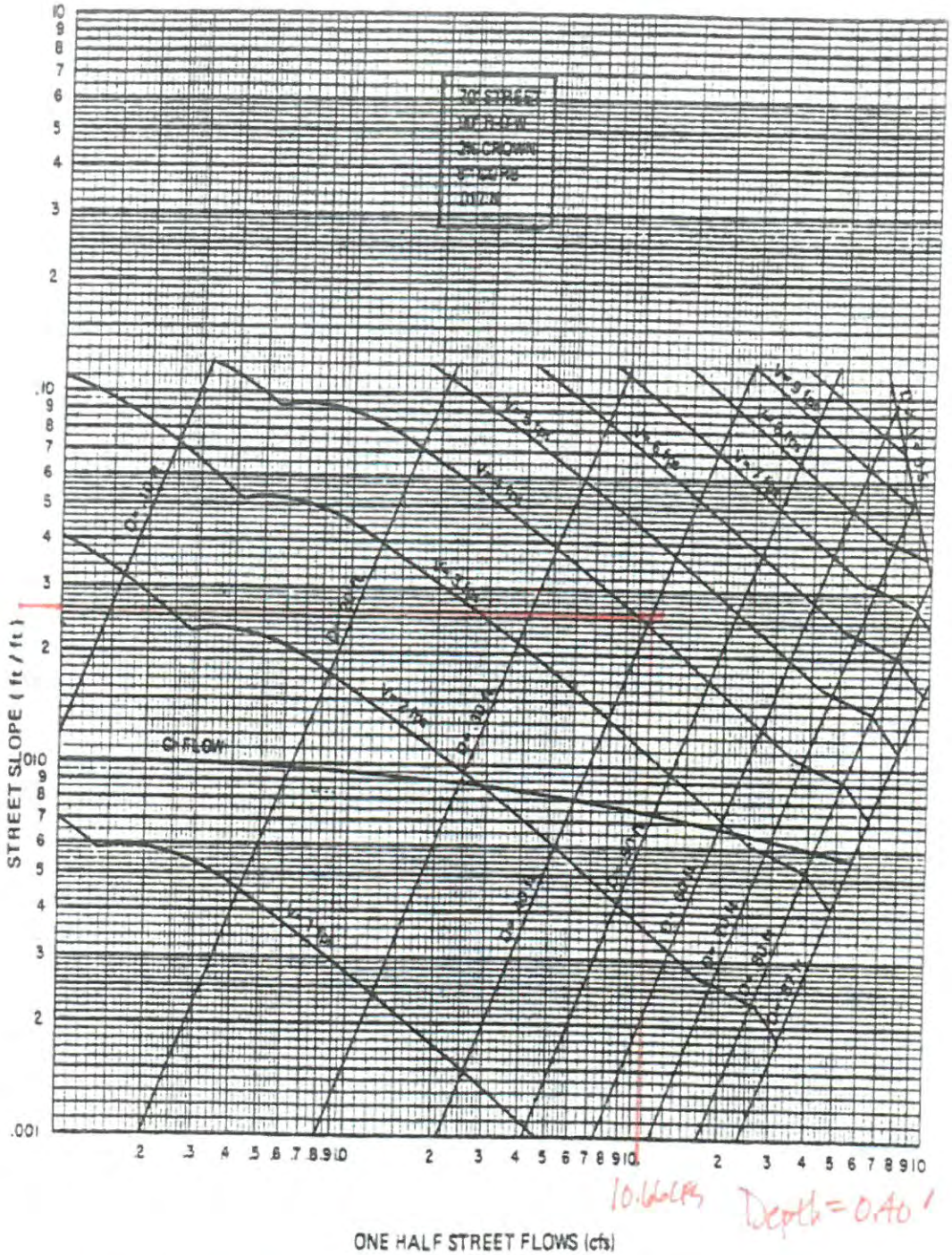


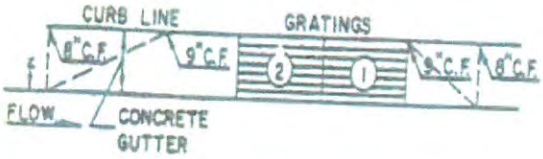
PLATE 22.3 D-4

BASIN 117.328 bypass Q from 117.327

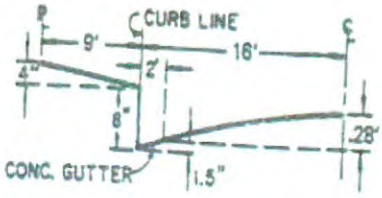
bQ = 10.20 CFS + 0.46 CFS = 10.66 CFS

S = 2.61%

GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

6.70 CFS
Assume 50% Clogging
3.35 CFS per inlet
10 CFS ÷ 3.35 = 3.18
Use 3 inlets
Bypass Q = 0.6 CFS

0.4'

BASIN 117.32B

PLATE 22.3 D-6

STREET CAPACITY

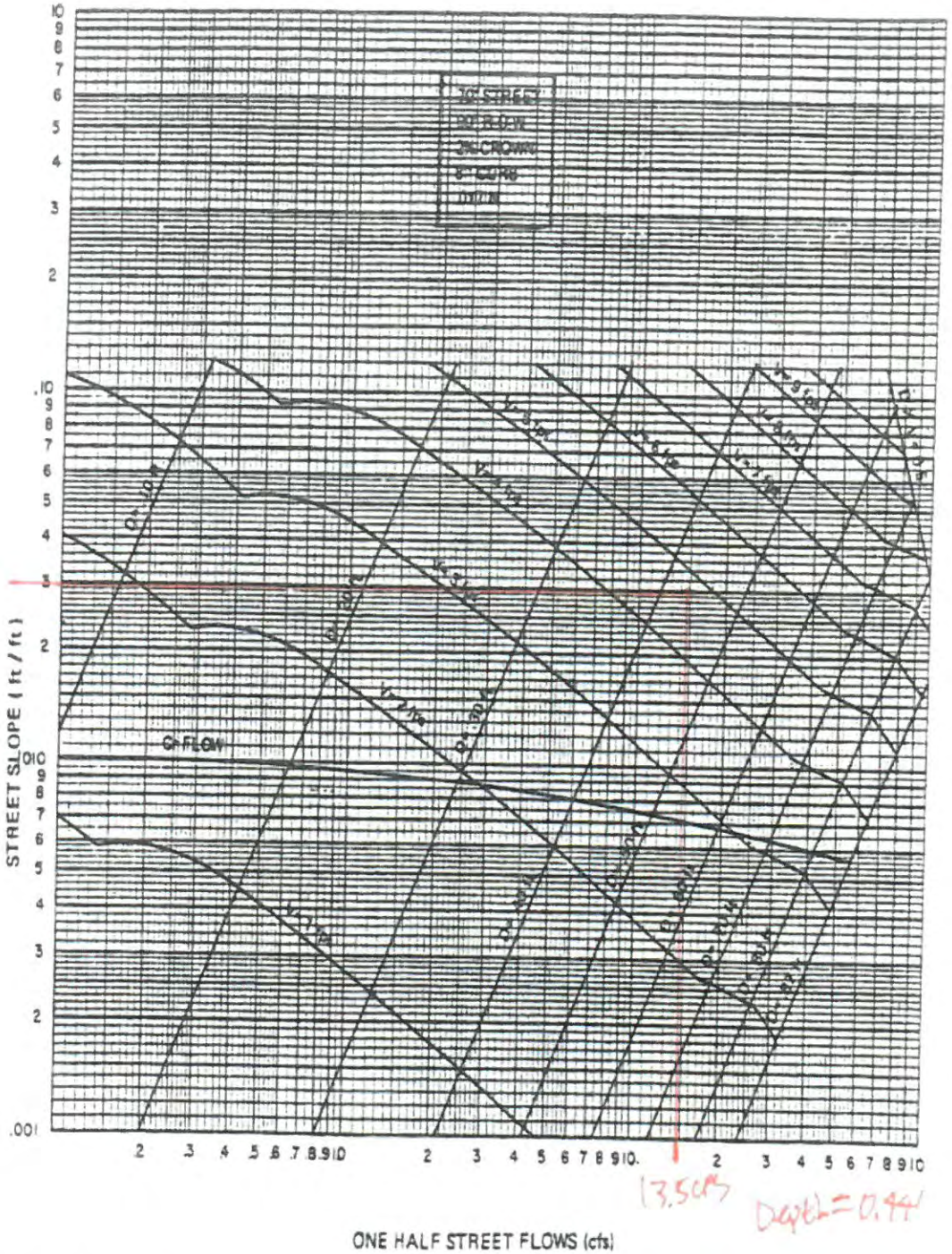


PLATE 22.3 D-4

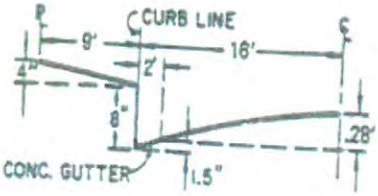
BASIN 117.329 bypass Q 117.328

1/2 Q = 12.88CFS + 0.61 CFS = 13.49CFS

S = 3.0 %

GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"

GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

96 CFS
ASSUME 50% CLOGGING
4.8 CFS per inlet
13.4 CFS ÷ 4.8 CFS = 2.8
Use 3 inlets
NO BYPASS FLOWS

PLATE 22.3 D-6

BASIN 117.3P

SUMMARY OF HYDRAULIC CALCULATIONS
CLOSED CONDUIT

BY: DBT
DATE: 1/10/12
SHEET: 1 of 1

PROJECT: ALAMEDA FROM SAN PEDRO TO EAST OF LOUISIANA AND LOUISIANA FROM SIGNAL TO ALAMEDA

100 year

1	2	3	4	5	6	7	8	9	10		11	12	13	14		15	16	17	18	19	20	21	22	23
											JUNCTION		LOSSES											
STATION	STRUCT	D	Q	A	V	K	Sf	L	DELTA	Q	D	ANGLE	hf	hb	Aavg	hj	hmh	ht	hmisc	SUM	E.G.	hv	H.G.	GROUND ELEV.
																							5228.70	
10+23.88	WYE													0.00					0.00	0.00	5231.26	2.56	5228.70	5230.00
		60	252	19.64	12.83	2606	0.0094	19					0.18							0.18	5231.44	2.56	5228.88	
10+44.56	BEND								45					0.36	19.64	0.00	0.13	0.00		0.49	5231.92	2.56	5229.37	5230.00
		60	252	19.64	12.83	2606	0.0094	56					0.52							0.52	5232.45	2.56	5229.89	
11+00	MH									27	24	80		0.00	17.77	0.02	0.00	0.00		0.02	5232.47	3.11	5229.36	5231.50
		54	225	15.90	14.15	1967.6	0.0131	450					5.88							5.88	5238.35	3.11	5235.24	
15+50	MH													0.00	15.90	0.00	0.16	0.00		0.16	5238.51	3.11	5235.40	5244.00
		54	225	15.90	14.15	1967.6	0.0131	0					0.00							0.00	5238.51	3.11	5235.40	

REMARKS: BETWEEN STATION 11+00 AND 15+50 HGL BECOMES NON-PRESSURE Manning's n: 0.013
AND CONTINUES UNDER GRAVITY FLOW CONDITIONS

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	4.00	48	Station 15+50 to Station 20+00				
Slope	0.0289	ft/ft					
Manning's N	0.013						
Percent full	70%						
Depth	2.81	ft					
theta	3.97						
Area	9.42	sf					
Wetted Perimeter	7.94	ft					
Surface Width	3.661	ft					
Q	**205.02**	cfs					
V	**21.77**	fps					
Depth	theta	A		T	Q	V	
0.20	0.90	0.23	1.80	1.74	**1.17**	**4.99**	
0.40	1.29	0.65	2.57	2.40	**5.10**	**7.80**	
0.60	1.59	1.18	3.18	2.86	**11.87**	**10.04**	
0.80	1.85	1.79	3.71	3.20	**21.38**	**11.95**	
1.00	2.09	2.46	4.19	3.46	**33.45**	**13.62**	
1.20	2.32	3.17	4.64	3.67	**47.82**	**15.08**	
1.40	2.53	3.92	5.06	3.82	**64.21**	**16.38**	
1.60	2.74	4.69	5.48	3.92	**82.29**	**17.53**	
1.80	2.94	5.48	5.88	3.98	**101.71**	**18.55**	
2.00	3.14	6.28	6.28	4.00	**122.10**	**19.43**	
2.20	3.34	7.08	6.68	3.98	**143.03**	**20.20**	
2.40	3.54	7.87	7.09	3.92	**164.06**	**20.84**	
2.60	3.75	8.65	7.50	3.82	**184.71**	**21.36**	
2.80	3.96	9.40	7.93	3.67	**204.45**	**21.76**	
3.00	4.19	10.11	8.38	3.46	**222.67**	**22.03**	
3.20	4.43	10.78	8.86	3.20	**238.69**	**22.15**	
3.40	4.69	11.38	9.38	2.86	**251.63**	**22.10**	
3.60	5.00	11.91	9.99	2.40	**260.26**	**21.85**	
3.80	5.38	12.33	10.76	1.74	**262.39**	**21.28**	
4.00	6.28	12.57	12.57	0.00	**244.19**	**19.43**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	4.00	48	Station 20+00 to Station 24+50				
Slope	0.0261	ft/ft					
Manning's N	0.013						
Percent full	68%						
Depth	2.70	ft					
theta	3.86						
Area	9.03	sf					
Wetted Perimeter	7.72	ft					
Surface Width	3.746	ft					
Q	**185.21**	cfs					
V	**20.51**	fps					
Depth	theta	A		T	Q	V	
0.20	0.90	0.23	1.80	1.74	**1.11**	**4.74**	
0.40	1.29	0.65	2.57	2.40	**4.84**	**7.41**	
0.60	1.59	1.18	3.18	2.86	**11.28**	**9.54**	
0.80	1.85	1.79	3.71	3.20	**20.32**	**11.36**	
1.00	2.09	2.46	4.19	3.46	**31.79**	**12.94**	
1.20	2.32	3.17	4.64	3.67	**45.45**	**14.33**	
1.40	2.53	3.92	5.06	3.82	**61.02**	**15.57**	
1.60	2.74	4.69	5.48	3.92	**78.20**	**16.66**	
1.80	2.94	5.48	5.88	3.98	**96.66**	**17.62**	
2.00	3.14	6.28	6.28	4.00	**116.03**	**18.47**	
2.20	3.34	7.08	6.68	3.98	**135.92**	**19.19**	
2.40	3.54	7.87	7.09	3.92	**155.91**	**19.80**	
2.60	3.75	8.65	7.50	3.82	**175.53**	**20.30**	
2.80	3.96	9.40	7.93	3.67	**194.29**	**20.68**	
3.00	4.19	10.11	8.38	3.46	**211.61**	**20.93**	
3.20	4.43	10.78	8.86	3.20	**226.83**	**21.05**	
3.40	4.69	11.38	9.38	2.86	**239.13**	**21.00**	
3.60	5.00	11.91	9.99	2.40	**247.33**	**20.76**	
3.80	5.38	12.33	10.76	1.74	**249.35**	**20.22**	
4.00	6.28	12.57	12.57	0.00	**232.06**	**18.47**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 24+50 to Station 27+10				
Slope	0.0285	ft/ft					
Manning's N	0.013						
Percent full	80%						
Depth	2.78	ft					
theta	4.41						
Area	8.21	sf					
Wetted Perimeter	7.71	ft					
Surface Width	2.823	ft					
Q	**165.10**	cfs					
V	**20.12**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.82**	**4.54**	
0.35	1.29	0.50	2.25	2.10	**3.55**	**7.08**	
0.53	1.59	0.90	2.78	2.50	**8.26**	**9.12**	
0.70	1.85	1.37	3.25	2.80	**14.87**	**10.86**	
0.88	2.09	1.88	3.67	3.03	**23.27**	**12.37**	
1.05	2.32	2.43	4.06	3.21	**33.26**	**13.70**	
1.23	2.53	3.00	4.43	3.34	**44.66**	**14.88**	
1.40	2.74	3.59	4.79	3.43	**57.24**	**15.93**	
1.58	2.94	4.20	5.15	3.48	**70.75**	**16.85**	
1.75	3.14	4.81	5.50	3.50	**84.92**	**17.65**	
1.93	3.34	5.42	5.85	3.48	**99.48**	**18.35**	
2.10	3.54	6.03	6.20	3.43	**114.11**	**18.93**	
2.28	3.75	6.62	6.56	3.34	**128.48**	**19.41**	
2.45	3.96	7.19	6.94	3.21	**142.20**	**19.77**	
2.63	4.19	7.74	7.33	3.03	**154.88**	**20.01**	
2.80	4.43	8.25	7.75	2.80	**166.02**	**20.12**	
2.98	4.69	8.72	8.21	2.50	**175.02**	**20.08**	
3.15	5.00	9.12	8.74	2.10	**181.02**	**19.85**	
3.33	5.38	9.44	9.42	1.53	**182.51**	**19.33**	
3.50	6.28	9.62	11.00	0.00	**169.85**	**17.65**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 27+10 to Station 29+00				
Slope	0.0283	ft/ft					
Manning's N	0.013						
Percent full	77%						
Depth	2.71	ft					
theta	4.30						
Area	7.99	sf					
Wetted Perimeter	7.52	ft					
Surface Width	2.930	ft					
Q	**159.80**	cfs					
V	**20.01**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.81**	**4.52**	
0.35	1.29	0.50	2.25	2.10	**3.53**	**7.06**	
0.53	1.59	0.90	2.78	2.50	**8.23**	**9.09**	
0.70	1.85	1.37	3.25	2.80	**14.82**	**10.82**	
0.88	2.09	1.88	3.67	3.03	**23.18**	**12.33**	
1.05	2.32	2.43	4.06	3.21	**33.14**	**13.65**	
1.23	2.53	3.00	4.43	3.34	**44.50**	**14.83**	
1.40	2.74	3.59	4.79	3.43	**57.04**	**15.87**	
1.58	2.94	4.20	5.15	3.48	**70.50**	**16.79**	
1.75	3.14	4.81	5.50	3.50	**84.63**	**17.59**	
1.93	3.34	5.42	5.85	3.48	**99.13**	**18.28**	
2.10	3.54	6.03	6.20	3.43	**113.71**	**18.87**	
2.28	3.75	6.62	6.56	3.34	**128.02**	**19.34**	
2.45	3.96	7.19	6.94	3.21	**141.70**	**19.70**	
2.63	4.19	7.74	7.33	3.03	**154.34**	**19.94**	
2.80	4.43	8.25	7.75	2.80	**165.44**	**20.05**	
2.98	4.69	8.72	8.21	2.50	**174.40**	**20.01**	
3.15	5.00	9.12	8.74	2.10	**180.39**	**19.78**	
3.33	5.38	9.44	9.42	1.53	**181.86**	**19.26**	
3.50	6.28	9.62	11.00	0.00	**169.25**	**17.59**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 29+00 to Station 29+80				
Slope	0.0294	ft/ft					
Manning's N	0.013						
Percent full	73%						
Depth	2.56	ft					
theta	4.11						
Area	7.55	sf					
Wetted Perimeter	7.19	ft					
Surface Width	3.098	ft					
Q	**153.00**	cfs					
V	**20.25**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.83**	**4.61**	
0.35	1.29	0.50	2.25	2.10	**3.60**	**7.19**	
0.53	1.59	0.90	2.78	2.50	**8.39**	**9.27**	
0.70	1.85	1.37	3.25	2.80	**15.11**	**11.03**	
0.88	2.09	1.88	3.67	3.03	**23.63**	**12.56**	
1.05	2.32	2.43	4.06	3.21	**33.78**	**13.92**	
1.23	2.53	3.00	4.43	3.34	**45.36**	**15.11**	
1.40	2.74	3.59	4.79	3.43	**58.13**	**16.18**	
1.58	2.94	4.20	5.15	3.48	**71.86**	**17.11**	
1.75	3.14	4.81	5.50	3.50	**86.25**	**17.93**	
1.93	3.34	5.42	5.85	3.48	**101.04**	**18.64**	
2.10	3.54	6.03	6.20	3.43	**115.90**	**19.23**	
2.28	3.75	6.62	6.56	3.34	**130.49**	**19.71**	
2.45	3.96	7.19	6.94	3.21	**144.43**	**20.08**	
2.63	4.19	7.74	7.33	3.03	**157.31**	**20.32**	
2.80	4.43	8.25	7.75	2.80	**168.62**	**20.44**	
2.98	4.69	8.72	8.21	2.50	**177.76**	**20.39**	
3.15	5.00	9.12	8.74	2.10	**183.86**	**20.16**	
3.33	5.38	9.44	9.42	1.53	**185.36**	**19.63**	
3.50	6.28	9.62	11.00	0.00	**172.51**	**17.93**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 29+80 to Station 31+45				
Slope	0.0294	ft/ft					
Manning's N	0.013						
Percent full	69%						
Depth	2.43	ft					
theta	3.94						
Area	7.13	sf					
Wetted Perimeter	6.89	ft					
Surface Width	3.226	ft					
Q	**142.81**	cfs					
V	**20.04**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.83**	**4.61**	
0.35	1.29	0.50	2.25	2.10	**3.60**	**7.19**	
0.53	1.59	0.90	2.78	2.50	**8.39**	**9.27**	
0.70	1.85	1.37	3.25	2.80	**15.11**	**11.03**	
0.88	2.09	1.88	3.67	3.03	**23.63**	**12.56**	
1.05	2.32	2.43	4.06	3.21	**33.78**	**13.92**	
1.23	2.53	3.00	4.43	3.34	**45.36**	**15.11**	
1.40	2.74	3.59	4.79	3.43	**58.13**	**16.18**	
1.58	2.94	4.20	5.15	3.48	**71.86**	**17.11**	
1.75	3.14	4.81	5.50	3.50	**86.25**	**17.93**	
1.93	3.34	5.42	5.85	3.48	**101.04**	**18.64**	
2.10	3.54	6.03	6.20	3.43	**115.90**	**19.23**	
2.28	3.75	6.62	6.56	3.34	**130.49**	**19.71**	
2.45	3.96	7.19	6.94	3.21	**144.43**	**20.08**	
2.63	4.19	7.74	7.33	3.03	**157.31**	**20.32**	
2.80	4.43	8.25	7.75	2.80	**168.62**	**20.44**	
2.98	4.69	8.72	8.21	2.50	**177.76**	**20.39**	
3.15	5.00	9.12	8.74	2.10	**183.86**	**20.16**	
3.33	5.38	9.44	9.42	1.53	**185.36**	**19.63**	
3.50	6.28	9.62	11.00	0.00	**172.51**	**17.93**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 31+45 to Station 33+50				
Slope	0.0218	ft/ft					
Manning's N	0.013						
Percent full	74%						
Depth	2.59	ft					
theta	4.15						
Area	7.64	sf					
Wetted Perimeter	7.26	ft					
Surface Width	3.067	ft					
Q	**133.51**	cfs					
V	**17.47**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.71**	**3.97**	
0.35	1.29	0.50	2.25	2.10	**3.10**	**6.19**	
0.53	1.59	0.90	2.78	2.50	**7.22**	**7.98**	
0.70	1.85	1.37	3.25	2.80	**13.01**	**9.50**	
0.88	2.09	1.88	3.67	3.03	**20.35**	**10.82**	
1.05	2.32	2.43	4.06	3.21	**29.09**	**11.98**	
1.23	2.53	3.00	4.43	3.34	**39.06**	**13.02**	
1.40	2.74	3.59	4.79	3.43	**50.06**	**13.93**	
1.58	2.94	4.20	5.15	3.48	**61.87**	**14.74**	
1.75	3.14	4.81	5.50	3.50	**74.27**	**15.44**	
1.93	3.34	5.42	5.85	3.48	**87.01**	**16.05**	
2.10	3.54	6.03	6.20	3.43	**99.80**	**16.56**	
2.28	3.75	6.62	6.56	3.34	**112.36**	**16.97**	
2.45	3.96	7.19	6.94	3.21	**124.37**	**17.29**	
2.63	4.19	7.74	7.33	3.03	**135.46**	**17.50**	
2.80	4.43	8.25	7.75	2.80	**145.20**	**17.60**	
2.98	4.69	8.72	8.21	2.50	**153.07**	**17.56**	
3.15	5.00	9.12	8.74	2.10	**158.32**	**17.36**	
3.33	5.38	9.44	9.42	1.53	**159.62**	**16.91**	
3.50	6.28	9.62	11.00	0.00	**148.55**	**15.44**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.50	42	Station 33+50 to Station 36+67				
Slope	0.0210	ft/ft					
Manning's N	0.013						
Percent full	75%						
Depth	2.63	ft					
theta	4.20						
Area	7.77	sf					
Wetted Perimeter	7.35	ft					
Surface Width	3.020	ft					
Q	**133.50**	cfs					
V	**17.18**	fps					
Depth	theta	A		T	Q	V	
0.18	0.90	0.18	1.58	1.53	**0.70**	**3.89**	
0.35	1.29	0.50	2.25	2.10	**3.04**	**6.08**	
0.53	1.59	0.90	2.78	2.50	**7.09**	**7.83**	
0.70	1.85	1.37	3.25	2.80	**12.77**	**9.32**	
0.88	2.09	1.88	3.67	3.03	**19.97**	**10.62**	
1.05	2.32	2.43	4.06	3.21	**28.55**	**11.76**	
1.23	2.53	3.00	4.43	3.34	**38.34**	**12.77**	
1.40	2.74	3.59	4.79	3.43	**49.13**	**13.67**	
1.58	2.94	4.20	5.15	3.48	**60.73**	**14.46**	
1.75	3.14	4.81	5.50	3.50	**72.90**	**15.15**	
1.93	3.34	5.42	5.85	3.48	**85.40**	**15.75**	
2.10	3.54	6.03	6.20	3.43	**97.95**	**16.25**	
2.28	3.75	6.62	6.56	3.34	**110.28**	**16.66**	
2.45	3.96	7.19	6.94	3.21	**122.07**	**16.97**	
2.63	4.19	7.74	7.33	3.03	**132.95**	**17.18**	
2.80	4.43	8.25	7.75	2.80	**142.51**	**17.27**	
2.98	4.69	8.72	8.21	2.50	**150.24**	**17.24**	
3.15	5.00	9.12	8.74	2.10	**155.39**	**17.04**	
3.33	5.38	9.44	9.42	1.53	**156.66**	**16.59**	
3.50	6.28	9.62	11.00	0.00	**145.80**	**15.15**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.00	36	Station 36+67 to Station 38+04				
Slope	0.0643	ft/ft					
Manning's N	0.013						
Percent full	45%						
Depth	1.36	ft					
theta	2.95						
Area	3.12	sf					
Wetted Perimeter	4.43	ft					
Surface Width	2.987	ft					
Q	**71.39**	cfs					
V	**22.91**	fps					
Depth	theta	A		T	Q	V	
0.15	0.90	0.13	1.35	1.31	**0.81**	**6.15**	
0.30	1.29	0.37	1.93	1.80	**3.53**	**9.60**	
0.45	1.59	0.66	2.39	2.14	**8.22**	**12.37**	
0.60	1.85	1.01	2.78	2.40	**14.81**	**14.72**	
0.75	2.09	1.38	3.14	2.60	**23.17**	**16.76**	
0.90	2.32	1.78	3.48	2.75	**33.12**	**18.57**	
1.05	2.53	2.20	3.80	2.86	**44.47**	**20.17**	
1.20	2.74	2.64	4.11	2.94	**56.99**	**21.59**	
1.35	2.94	3.09	4.41	2.98	**70.45**	**22.84**	
1.50	3.14	3.53	4.71	3.00	**84.57**	**23.93**	
1.65	3.34	3.98	5.01	2.98	**99.06**	**24.87**	
1.80	3.54	4.43	5.32	2.94	**113.63**	**25.66**	
1.95	3.75	4.86	5.63	2.86	**127.93**	**26.30**	
2.10	3.96	5.29	5.95	2.75	**141.60**	**26.79**	
2.25	4.19	5.69	6.28	2.60	**154.23**	**27.12**	
2.40	4.43	6.06	6.64	2.40	**165.32**	**27.27**	
2.55	4.69	6.40	7.04	2.14	**174.28**	**27.22**	
2.70	5.00	6.70	7.49	1.80	**180.26**	**26.90**	
2.85	5.38	6.94	8.07	1.31	**181.73**	**26.20**	
3.00	6.28	7.07	9.42	0.00	**169.13**	**23.93**	Full

Circular Pipe Flow			Alameda Boulevard				
Diameter (ft..in)	3.00	36	Station 38+10 to Station 40+77				
Slope	0.0254	ft/ft					
Manning's N	0.013						
Percent full	56%						
Depth	1.67	ft					
theta	3.36						
Area	4.03	sf					
Wetted Perimeter	5.04	ft					
Surface Width	2.982	ft					
Q	**63.18**	cfs					
V	**15.68**	fps					
Depth	theta	A		T	Q	V	
0.15	0.90	0.13	1.35	1.31	**0.51**	**3.86**	
0.30	1.29	0.37	1.93	1.80	**2.22**	**6.03**	
0.45	1.59	0.66	2.39	2.14	**5.17**	**7.77**	
0.60	1.85	1.01	2.78	2.40	**9.31**	**9.25**	
0.75	2.09	1.38	3.14	2.60	**14.56**	**10.54**	
0.90	2.32	1.78	3.48	2.75	**20.82**	**11.67**	
1.05	2.53	2.20	3.80	2.86	**27.95**	**12.68**	
1.20	2.74	2.64	4.11	2.94	**35.82**	**13.57**	
1.35	2.94	3.09	4.41	2.98	**44.28**	**14.35**	
1.50	3.14	3.53	4.71	3.00	**53.15**	**15.04**	
1.65	3.34	3.98	5.01	2.98	**62.26**	**15.63**	
1.80	3.54	4.43	5.32	2.94	**71.42**	**16.13**	
1.95	3.75	4.86	5.63	2.86	**80.41**	**16.53**	
2.10	3.96	5.29	5.95	2.75	**89.00**	**16.84**	
2.25	4.19	5.69	6.28	2.60	**96.93**	**17.05**	
2.40	4.43	6.06	6.64	2.40	**103.90**	**17.14**	
2.55	4.69	6.40	7.04	2.14	**109.54**	**17.11**	
2.70	5.00	6.70	7.49	1.80	**113.29**	**16.91**	
2.85	5.38	6.94	8.07	1.31	**114.22**	**16.47**	
3.00	6.28	7.07	9.42	0.00	**106.30**	**15.04**	Full

Circular Pipe Flow			Louisiana Boulevard				
Diameter (ft..in)	3.00	36	Station 11+10 to Station 12+74				
Slope	0.0080	ft/ft					
Manning's N	0.013						
Percent full	84%						
Depth	2.52	ft					
theta	4.64						
Area	6.34	sf					
Wetted Perimeter	6.95	ft					
Surface Width	2.201	ft					
Q	**60.90**	cfs					
V	**9.61**	fps					
Depth	theta	A		T	Q	V	
0.15	0.90	0.13	1.35	1.31	**0.29**	**2.17**	
0.30	1.29	0.37	1.93	1.80	**1.25**	**3.39**	
0.45	1.59	0.66	2.39	2.14	**2.90**	**4.36**	
0.60	1.85	1.01	2.78	2.40	**5.22**	**5.19**	
0.75	2.09	1.38	3.14	2.60	**8.17**	**5.91**	
0.90	2.32	1.78	3.48	2.75	**11.68**	**6.55**	
1.05	2.53	2.20	3.80	2.86	**15.69**	**7.11**	
1.20	2.74	2.64	4.11	2.94	**20.10**	**7.61**	
1.35	2.94	3.09	4.41	2.98	**24.85**	**8.05**	
1.50	3.14	3.53	4.71	3.00	**29.83**	**8.44**	
1.65	3.34	3.98	5.01	2.98	**34.94**	**8.77**	
1.80	3.54	4.43	5.32	2.94	**40.08**	**9.05**	
1.95	3.75	4.86	5.63	2.86	**45.12**	**9.28**	
2.10	3.96	5.29	5.95	2.75	**49.95**	**9.45**	
2.25	4.19	5.69	6.28	2.60	**54.40**	**9.57**	
2.40	4.43	6.06	6.64	2.40	**58.31**	**9.62**	
2.55	4.69	6.40	7.04	2.14	**61.47**	**9.60**	
2.70	5.00	6.70	7.49	1.80	**63.58**	**9.49**	
2.85	5.38	6.94	8.07	1.31	**64.10**	**9.24**	
3.00	6.28	7.07	9.42	0.00	**59.66**	**8.44**	Full

Circular Pipe Flow			Louisiana Boulevard				
Diameter (ft..in)	3.00	36	Station 7+54 to Station 11+10				
Slope	0.0065	ft/ft					
Manning's N	0.013						
Percent full	91%						
Depth	2.72	ft					
theta	5.05						
Area	6.74	sf					
Wetted Perimeter	7.58	ft					
Surface Width	1.734	ft					
Q	**57.50**	cfs					
V	**8.53**	fps					
Depth	theta	A		T	Q	V	
0.15	0.90	0.13	1.35	1.31	**0.26**	**1.95**	
0.30	1.29	0.37	1.93	1.80	**1.12**	**3.05**	
0.45	1.59	0.66	2.39	2.14	**2.61**	**3.93**	
0.60	1.85	1.01	2.78	2.40	**4.71**	**4.68**	
0.75	2.09	1.38	3.14	2.60	**7.37**	**5.33**	
0.90	2.32	1.78	3.48	2.75	**10.53**	**5.90**	
1.05	2.53	2.20	3.80	2.86	**14.14**	**6.41**	
1.20	2.74	2.64	4.11	2.94	**18.12**	**6.86**	
1.35	2.94	3.09	4.41	2.98	**22.40**	**7.26**	
1.50	3.14	3.53	4.71	3.00	**26.89**	**7.61**	
1.65	3.34	3.98	5.01	2.98	**31.50**	**7.91**	
1.80	3.54	4.43	5.32	2.94	**36.13**	**8.16**	
1.95	3.75	4.86	5.63	2.86	**40.68**	**8.36**	
2.10	3.96	5.29	5.95	2.75	**45.02**	**8.52**	
2.25	4.19	5.69	6.28	2.60	**49.04**	**8.62**	
2.40	4.43	6.06	6.64	2.40	**52.56**	**8.67**	
2.55	4.69	6.40	7.04	2.14	**55.41**	**8.65**	
2.70	5.00	6.70	7.49	1.80	**57.31**	**8.55**	
2.85	5.38	6.94	8.07	1.31	**57.78**	**8.33**	
3.00	6.28	7.07	9.42	0.00	**53.77**	**7.61**	Full

Circular Pipe Flow			Louisiana Boulevard				
Diameter (ft..in)	3.00	36	Station 7+54 to Station 11+10				
Slope	0.0188	ft/ft					
Manning's N	0.013						
Percent full	58%						
Depth	1.73	ft					
theta	3.44						
Area	4.21	sf					
Wetted Perimeter	5.16	ft					
Surface Width	2.966	ft					
Q	**57.51**	cfs					
V	**13.67**	fps					
Depth	theta	A		T	Q	V	
0.15	0.90	0.13	1.35	1.31	**0.44**	**3.32**	
0.30	1.29	0.37	1.93	1.80	**1.91**	**5.19**	
0.45	1.59	0.66	2.39	2.14	**4.45**	**6.69**	
0.60	1.85	1.01	2.78	2.40	**8.01**	**7.96**	
0.75	2.09	1.38	3.14	2.60	**12.53**	**9.07**	
0.90	2.32	1.78	3.48	2.75	**17.91**	**10.04**	
1.05	2.53	2.20	3.80	2.86	**24.05**	**10.91**	
1.20	2.74	2.64	4.11	2.94	**30.82**	**11.67**	
1.35	2.94	3.09	4.41	2.98	**38.09**	**12.35**	
1.50	3.14	3.53	4.71	3.00	**45.73**	**12.94**	
1.65	3.34	3.98	5.01	2.98	**53.56**	**13.45**	
1.80	3.54	4.43	5.32	2.94	**61.44**	**13.87**	
1.95	3.75	4.86	5.63	2.86	**69.18**	**14.22**	
2.10	3.96	5.29	5.95	2.75	**76.57**	**14.49**	
2.25	4.19	5.69	6.28	2.60	**83.39**	**14.66**	
2.40	4.43	6.06	6.64	2.40	**89.39**	**14.75**	
2.55	4.69	6.40	7.04	2.14	**94.24**	**14.72**	
2.70	5.00	6.70	7.49	1.80	**97.47**	**14.55**	
2.85	5.38	6.94	8.07	1.31	**98.27**	**14.17**	
3.00	6.28	7.07	9.42	0.00	**91.45**	**12.94**	Full

Circular Pipe Flow			Louisiana Boulevard				
Diameter (ft..in)	2.00	24	Station 12+74 to Station 13+59				
Slope	0.0142	ft/ft					
Manning's N	0.013						
Percent full	15%						
Depth	0.30	ft					
theta	1.60						
Area	0.30	sf					
Wetted Perimeter	1.60	ft					
Surface Width	1.432	ft					
Q	**1.33**	cfs					
V	**4.45**	fps					
Depth	theta	A		T	Q	V	
0.10	0.90	0.06	0.90	0.87	**0.13**	**2.20**	
0.20	1.29	0.16	1.29	1.20	**0.56**	**3.44**	
0.30	1.59	0.30	1.59	1.43	**1.31**	**4.43**	
0.40	1.85	0.45	1.85	1.60	**2.36**	**5.28**	
0.50	2.09	0.61	2.09	1.73	**3.69**	**6.01**	
0.60	2.32	0.79	2.32	1.83	**5.28**	**6.66**	
0.70	2.53	0.98	2.53	1.91	**7.09**	**7.23**	
0.80	2.74	1.17	2.74	1.96	**9.08**	**7.74**	
0.90	2.94	1.37	2.94	1.99	**11.23**	**8.19**	
1.00	3.14	1.57	3.14	2.00	**13.48**	**8.58**	
1.10	3.34	1.77	3.34	1.99	**15.79**	**8.92**	
1.20	3.54	1.97	3.54	1.96	**18.11**	**9.20**	
1.30	3.75	2.16	3.75	1.91	**20.39**	**9.43**	
1.40	3.96	2.35	3.96	1.83	**22.57**	**9.61**	
1.50	4.19	2.53	4.19	1.73	**24.58**	**9.73**	
1.60	4.43	2.69	4.43	1.60	**26.35**	**9.78**	
1.70	4.69	2.85	4.69	1.43	**27.78**	**9.76**	
1.80	5.00	2.98	5.00	1.20	**28.73**	**9.65**	
1.90	5.38	3.08	5.38	0.87	**28.97**	**9.40**	
2.00	6.28	3.14	6.28	0.00	**26.96**	**8.58**	Full

SUMMARY OF HYDRAULIC CALCULATIONS

CLOSED CONDUIT - HEAD LOSS AT MANHOLES

BY:

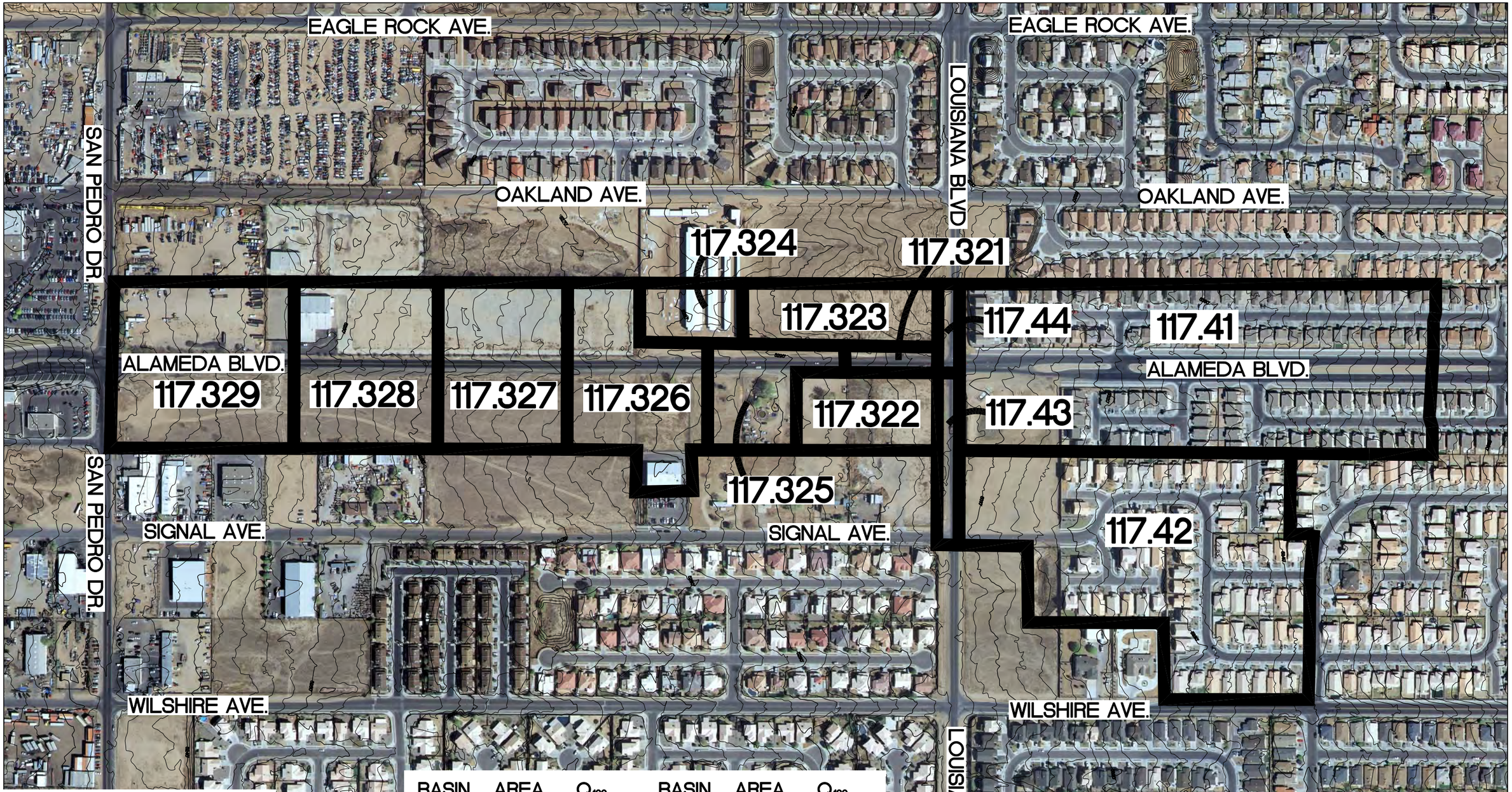
DATE:

SHEET: 1 of 1

PROJECT: ALAMEDA FROM SAN PEDRO TO EAST OF LOUISIANA AND LOUISIANA FROM SIGNAL TO ALAMEDA

100 year

1	2	3	4	5	6	7	8	9	10		11	12	13	14		15	16	17	18	19	21	23
											JUNCTION		LOSSES									
STATION	STRUCT	D	Q	A	V	K	Sf	L	DELTA	Q	D	ANGLE	hf	hb	Aavg	hj	hmh	ht	hmisc	SUM	hv	GROUND ELEV
15+50	MH																		0.00	0.00	7.36	5244.00
		48	205	12.57	21.77	1437.2	0.0203	450												0.00	7.36	
20+00	MH									20	24	80			12.57	1.60	0.33	0.00		1.92	6.53	5257.00
		48	185	12.57	20.51	1437.2	0.0166	450												0.00	6.53	
24+50	MH									20	24	80			11.09	1.27	0.31	0.00		1.58	6.29	5269.00
		42	165	9.62	20.12	1006.6	0.0269	260												0.00	6.29	
27+10	MH									5	24	80			9.62	0.38	0.31	0.00		0.69	6.22	5277.00
		42	160	9.62	20.01	1006.6	0.0253	190												0.00	6.22	
29+00	MH									7	24	80			9.62	0.32	0.32	0.00		0.64	6.37	5282.00
		42	153	9.62	20.25	1006.6	0.0231	80												0.00	6.37	
29+80	MH									10	24	80			9.62	0.73	0.31	0.00		1.04	6.24	5284.00
		42	143	9.62	20.04	1006.6	0.0202	165												0.00	6.24	
31+45	MH									9	24	80			9.62	1.68	0.24	0.00		1.92	4.74	5290.00
		42	134	9.62	17.47	1006.6	0.0177	205												0.00	4.74	
33+50	MH									0					9.62	0.00	0.23	0.00		0.23	4.58	5298.00
		42	134	9.62	17.18	1006.6	0.0177	318												0.00	4.58	
36+67	MH									63	36	90			8.34	2.51	0.41	0.00		2.92	8.15	5307.00
		36	71	7.07	22.91	667.28	0.0113	137												0.00	8.15	
38+04	MH									8	24	90			7.07	2.56	0.21	0.00		2.77	4.27	5311.00
		36	63	7.07	16.58	667.28	0.0089	267												0.00	4.27	
																						5307.00
12+75	MH													0.00					0.00	0.00	1.43	
		36	60.9	7.07	9.61	667.28	0.0083	164												0.00	1.43	
11+10	MH									3.4	24	80		0.00	7.07	0.41	0.06	0.00		0.47	1.13	5306.00
		36	57.5	7.07	8.53	667.28	0.0074	355												0.00	1.13	
7+55	MH								90	0				0.58	7.07	0.00	0.15	0.00		0.73	2.90	5309.00
		36	57.5	7.07	13.67	667.28	0.0074	50												0.00	2.90	
7+05	MH									4.5				0.00	7.07	0.00	0.15	0.00		0.15	2.90	5310.00
		36	53	7.07	13.67	667.28	0.0063	0												0.00	2.90	
0+00	MH									53				0.00	3.53	0.00	0.00	-0.58		-0.58	0.00	
REMARKS:											Manning's n: 0.013											



BASIN	AREA	Q_{100}	BASIN	AREA	Q_{100}
117.321	0.54 AC	2.06 CFS	117.328	5.34 AC	20.40 CFS
117.322	2.44 AC	9.32 CFS	117.329	6.74 AC	25.75 CFS
117.323	2.68 AC	10.24 CFS	117.41	17.75 AC	71.36 CFS
117.324	1.37 AC	5.23 CFS	117.42	14.29 AC	57.45 CFS
117.325	1.25 AC	4.77 CFS	117.43	0.85 AC	3.42 CFS
117.326	5.96 AC	22.77CFS	117.44	0.43 AC	1.33 CFS
117.327	4.80 AC	18.34 CFS			

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N

SCALE: 1"=300'

ALAMEDA BLVD. PROJECT

C.O.A. PROJECT # 7663.91

BASIN EXHIBIT

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