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STORM DRAINAGE SYSTEM
FOR
MCDOWELL ROAD IMPROVEMENTS
64TH STREET TO INDIAN BEND WASH
SCOTTSDALE, ARIZONA
PART 2 - HYDRAULIC DESIGN REPORT
MARCH, 1986
PROJECT NO. S 5504
CBA FILE NO. 40785-01-32

REGISTERED PROFESSIONAL ENGINEER
CERTIFICATE NO.
Date Signed 6/25/86
ARIZONA, U.S.A.

A027.702

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CBA

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I. INTRODUCTION

The City of Scottsdale has contracted Cella Barr Associates (CBA) to provide engineering services for the design of a storm sewer system and road improvements on McDowell Road from 64th Street to Indian Bend Wash. This report is Part 2 of a two part study documenting the hydrology, conceptual design and hydraulic design computations used to develop the final storm drainage system.

The purpose of this report is to document the hydraulic calculations and procedures used to determine the catch basin and storm drain pipe sizes. Design discharges used have been obtained form "Part 1 - Hydrology and Concept Design Report" and refined in producing the final design, and construction drawings entitled, "McDowell Road - Storm Drain Plans, 64th Street to Indian Bend Wash," dated April 1986. Reference should thus be made to both reports and the final construction drawings.

II. FINAL DRAINAGE DESIGN

The storm drainage collection and conveyance systems for McDowell Road have been designed to handle the 100-year storm as specified in the CBA design contract and the City of Scottsdale drainage manual, Section 3-501 "Design Procedures and Criteria - Section 3-Design of Facilities to Manage Stormwater Runoff." Applicable sections from the manual are reproduced as follows:

Major Collector, Minor Arterial and Major Arterial
(McDowell Road, Scottsdale Road, 68th Street and Miller Road)

a. Street flow width limited to maintain a 12-foot dry lane in both directions during a 100-year storm.
b. Retain 100-year storm runoff within the public right-of-way to a depth not to exceed 8 inches above the gutter line.

Local Residential, Local Collector, Local Industrial, Local Commercial, and Minor Collector
(All other streets)

a. Street flow width shall not exceed 12 feet in 2-year storm.
b. Retain 100-year storm in public right-of-way to exceed 8 inches in depth above gutter line.

The net effect of these criteria is that all runoff resulting from the 100-year storm that contributes to McDowell Road is conveyed east along McDowell Road either within the street cross-section or the storm drain pipe. At major intersections, where crown warping prevents the continuation of a valley gutter, a sag point is created and all stormwater is picked up at this point to a maximum depth of 8 inches.

Utilization of the major storm drainage system, as designed, has been maximized by allowing pressure flow throughout the majority of the system. The hydraulic grade line (HGL) is indicated on the final plan set and the hydraulic computations are summarized in this report.

(i) PIPE SIZING

Hydraulic grade line computations presented in this report are based upon the Bernoulli equation. Friction losses are computed based upon the Manning equation and on assigned pipe roughness factors (Table 1). Minor losses for such things as junction structures manholes, bends, angles and transitions are also factored into the computations. Methods used for the determination of minor losses have been based upon equations detailed in the Los Angeles County Flood Control District-Hydraulic Manual (Appendix I).

The proposed storm drainage system west of Scottsdale Road outlets to an existing 60-inch storm drain within Scottsdale Road (Sta. 74+03). A manhole junction structure has been designed to interconnect the two systems while minimizing head losses. The existing storm drainage system, termed here as the Scottsdale Road Outfall (Appendix II), was analyzed

(Table 2) in order to determine the starting hydraulic grade line for the proposed McDowell Road system. Hydraulic Grade Line (HGL) computations for the west McDowell Road system are presented in Table 3. In the analysis of the Scottsdale Road Outfall, it is assumed that the inflow from the existing downstream catch basins is negligible as a result of the differing times of concentrations for the various drainage areas.

The storm drainage system east of Scottsdale Road outlets directly to the Indian Bend Wash. It is assumed that, due to the vastly differing times of concentrations, Indian Bend Wash will not be flowing to its design capacity, when the storm drain system is functional, and thus will not present an outlet control to the storm drain HGL. The soffit of the outlet pipe thus acts as the starting hydraulic grade line control (Tables 4&5).

A special grate inlet has been designed to intercept most of the drainage contributing to Miller Road at Almeria Road (Appendix III) and convey it south to McDowell Road, through a 48" lateral line, where connection is made through a special junction structure to the proposed McDowell Road storm drain system. The HGL for the McDowell Road system at the junction structure (Sta. 100+34 Table 4) acts as the starting control for the HGL along the Miller Road lateral.

The upstream end of the east storm drain project is at Scottsdale Road. Here a 60 inch storm pipe is designed to be stubbed out for future connection from another Scottsdale Road storm drainage system to the north.

(ii) CATCH BASIN SIZING

Catch basins utilized in the final design are from M.A.G. standard details except where necessary to specify specials or alternate designs. Catch basin sizing is based upon the methods described in Section 3-502 of the City of Scottsdale drainage design manual. Street flooding has been limited to the criteria as defined in Table 7, whenever possible. Flooding to a depth of 8 inches does occur in some sag points.

Drainage areas used in the final design conform in general to those shown in Figure 2: "Part 1 - Hydrology and Concept Design Report." Additional intermediate areas were determined where necessary. The computed inflow from each catch basin was used to refine the major storm drain system capacity and to develop the final HGL presented. Catch basin sizes are summarized in Tables 8-11 and in Appendix III.

(iii) CONNECTOR PIPE SIZING

Catch basin connector pipes have been sized based upon the equation:

$$H = \left(1.5 + \frac{185n2L}{d4/3}\right) \frac{V2}{2g}$$

(See TABLE 1)

The allowable head loss is based upon the final computed hydraulic grade line elevation at the connector pipe location and a depth in the catch basin 0.5 feet below the gutter lip. Computations based upon this equation are summarized in Tables 8-11 and in Appendix IV.

III. SUMMARY

Cella Barr Associates has conducted a hydrologic investigation and prepared concept plans for a storm drainage system extending from the Indian Bend Wash to 64th Street. The results are documented in "Part I - Hydrology & Concept Design Report," and were used to refine and develop the final design and construction drawings, as documented herein "Part II - Hydraulic Design Report."

The completion and construction of Project S 5504 will result in a storm drainage system capable of handling stormwater runoff in a manner consistent with the design objectives and satisfying the City of Scottsdale's drainage design guidelines. The designed system utilizes existing drainage facilities where possible, and provides for future expansion of the system along Scottsdale Road as future needs and budgets arise.

TABLE 1: FACTORS FOR PIPE CONDUITS

Manning's Formula - $Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$ (cfs)

Conveyance - $K = \frac{1.486}{n} AR^{2/3}$

Avg. Friction Slope $Sf = (Q/K)^2$

For catch basin connector pipes:

Total head loss $H = (1.5 + \frac{185n^2L}{d^{4/3}})V^2/2g$ (feet)

$H = (1.5 + XL)V^2/2g$

Where: $X = \frac{185n^2}{d^{4/3}}$

Pipe Diameter (ft.)	(in.)	Area (ft2)	K (n=0.012)	X (n=0.012)
1.00	12	0.785	39	0.0266
1.25	15	1.227	70	0.0198
1.50	18	1.767	114	0.0155
1.75	21	2.405	172	0.0126
2.00	24	3.142	245	0.0106
2.25	27	3.976	336	0.0090
2.50	30	4.909	444	0.0079
2.75	33	5.939	573	0.0069
3.00	36	7.068	722	0.0062
3.50	42	9.621	1090	0.0050
4.00	48	12.566	1556	0.0042
4.50	54	15.904	2131	0.0036
5.00	60	19.635	2821	0.0031
5.50	66	23.758	3638	0.0027

TABLE 2

SCOTTSDALE RD.

HYDRAULIC GRADE LINE CALCULATION SHEET

Sht 1 of 1

PROJECT S5504

LINE Exist. 60"–78" S.D.

CALCULATED BY PWRH

*Conduit unseals when D is less than d

DATE 2/27/86

STA.	ELEV. INV.	D*	ELEV. H.G.L.	SECTION	d	A	Q	V	$\frac{v^2}{2g}$	K	S_f	Av. S_f	L	h_f	h_b	h_j	h_t	ELEV. E.G.L.
			STORM	DRAIN	OUTLET		AT	ROOSEVELT	ST.									
48+41	1188.68	8.70	1197.38	78"	6.50	33.18	219	6.6	0.68	4841								1198.06
46+00	1189.69	8.99	1198.68	"	"	"	"	"	"	"	0.0020	0.0020	241	0.48	0.14	0.68	1.30	1199.36
40+65	1191.49	8.40	1199.89	"	"	"	"	"	"	"	"	"	535	1.07	0.14		1.21	1200.57
38+00	1192.05	8.37	1200.42	"	"	"	"	"	"	"	"	"	265	0.53			0.53	1201.10
32+00	1193.25	8.37	1201.62	"	"	"	"	"	"	"	"	"	600	1.20			1.20	1202.30
26+64	1194.32	8.37	1202.69	"	"	"	"	"	"	"	"	"	536	1.07			1.07	1203.37
24+00	1197.18	6.80	1203.98	72"	6.00	28.27	"	7.75	0.93	4589	0.0023	0.0023	264	0.61		0.93	1.54	1204.91
18+00	1200.72	4.64	1205.36	"	"	"	"	"	"	"	"	"	600	1.38			1.38	1206.29
12+00	1204.23	2.64	1206.87	"	"	"	"	"	"	"	"	"	600	1.38	0.08	0.05	1.51	1207.80
			FLOW	WITHIN	PIPE													
12+84	1211.12	5.00	1216.12	60"	5.0	19.64	"	11.15	1.93	2821								1218.05
1+76	1216.07	6.70	1223.16	"	"	"	"	"	"	"	0.0061	0.0061	1108	6.74		0.3	7.04	1225.09

TABLE 3

McDOWELL RD.

HYDRAULIC GRADE LINE CALCULATION SHEET

Sht 1 of 1

PROJECT S 5504

LINE Scottsdale - 75th Pl.

CALCULATED BY PWRH

*Conduit unseals when D is less than d

DATE 2/27/86

STA.	ELEV. INV.	D*	ELEV. H.G.L.	SECTION	d	A	Q	V	$\frac{V^2}{2g}$	K	S_f	Av. S_f	L	h_f	h_b	h_j	h_t	ELEV. E.G.L.
74+03	1216.07	7.09	1223.16	60"	5.00	19.64	219	11.15	1.93	2821	—							1225.09
72+71	1217.06	8.48	1225.54	54"	4.50	15.90	176	11.07	1.90	2131	0.0068	0.0068	132	0.90		1.45	2.35	1227.44
72+00	1217.46	8.83	1226.29	"	"	"	"	"	"	"	"	"	71	0.48	0.27		0.75	1228.19
71+57	1217.70	9.05	1226.75	"	"	"	167	10.50	1.71	"	0.0061	0.0061	43	0.27			0.27	1228.46
70+00	1218.58	9.29	1227.87	"	"	"	149	9.37	1.36	"	0.0049	0.0049	157	0.77			0.77	1229.23
68+27	1219.55	9.67	1229.22	"	"	"	"	"	"	"	"	"	173	0.85	0.34	0.16	1.35	1230.58
66+50	1221.77	8.95	1230.72	48"	4.00	12.57	"	11.85	2.18	1556	0.0092	0.0092	192	1.77	0.55		2.32	1232.90
64+85	1223.36	9.04	1232.40	"	"	"	141	11.22	1.95	"	0.0082	0.0082	165	1.35		0.10	1.45	1234.35
64+00	1224.03	9.20	1233.23	"	"	"	132	10.59	1.74		0.0072	0.0072	85	0.62			0.62	1234.97
60+79	1226.92	8.63	1235.55	"	"	"	"	"	"	"	"	"	321	2.32			2.32	1237.29
59+58	1228.01	8.78	1236.79	"	"	"	111	8.83	1.21	"	0.0051	0.0051	121	0.61		0.10	0.71	1238.00
58+00	1229.77	7.88	1237.65	42"	3.50	9.62	101	10.48	1.71	1090	0.0086	0.0086	158	1.36			1.36	1239.36
56+50	1230.97	7.97	1238.94	"	"	"	"	"	"	"	"	"	151	1.29			1.29	1240.65
55+40	1231.85	8.27	1240.12	"	"	"	83	8.63	1.16	"	0.0058	0.0058	109	0.63			0.63	1241.28
52+46	1235.89	6.84	1242.73	36"	3.00	7.07	73	10.30	1.65	722	0.0102	0.0102	294	3.00		0.10	3.10	1244.38
52+00	1235.35	8.29	1243.64	"	"	"	58	8.14	1.03	"	0.0065	0.0065	46	0.29			0.29	1244.67
51+20	1236.15	8.00	1244.15	"	"	"	"	"	"	"	"	"	80	0.51			0.51	1245.18
46+90	1243.71	4.47	1248.18	33"	2.75	5.94	"	9.76	1.48	573	0.0102	0.0102	430	4.39		0.09	4.48	1249.66
46+00	1244.89	4.66	1249.55	27"	2.25	3.98	32	8.04	1.00	336	0.0091	0.0091	90	0.82		0.07	0.89	1250.55
43+60	1246.69	5.04	1251.73	"	"	"	"	"	"	"	"	"	240	2.18			2.18	1252.73

TABLE 4

McDOWELL RD.

HYDRAULIC GRADE LINE CALCULATION SHEET

Sht 1 of 2

PROJECT S5504

CALCULATED BY PWRH

LINE Indian Bend Wash - Scottsdale Rd.

*Conduit unseals when D is less than d

DATE 2/27/86

STA.	ELEV. INV.	D*	ELEV. H.G.L.	SECTION	d	A	Q	V	$\frac{v^2}{2g}$	K	S_f	Av. S_f	L	h_f	h_b	h_j	h_t	ELEV. E.G.L.
104+34	1193.14	5.50	1198.64	66"	5.5	23.76	389	16.5	4.23	3638	0.0116	0.0116	94	1.09	[illegible]			[illegible]
103+40	1194.22	6.19	1200.41	"	"	"	"	"	"	"	"	"						
101+75	1195.62	6.71	1202.33		"	"	"	"	"	"	"	0.0108						
100+45	1196.72	7.31	1204.03		"	"	378	15.9	3.93	"	0.0108							
			BEGIN	MILLER	ROAD		JUNCTION		STRUCTURE			—						
100+34	1197.26	9.55	1206.81	"	"	"	270	11.4	2.00	"	—	0.0055						
100+00	1199.41	7.59	1207.00	"	"	"	"	"	"	"	0.0055	"						
99+75	1201.00	6.14	1207.14	"	"	"	"	"	"	"	"	"						
97+20	1203.12	5.51	1208.63	"	"	"	"	"	"	"	"	"						
95+00	1205.00	4.84	1209.84	"	"	"	"	"	"	"	"	"						
93+80	1206.00	4.50	1210.50	"	"	"	"	"	"	"	"							
			BEGIN	PRESSURE		FLOW	AGAIN											
93+80	1206.00	5.50	1211.50	"	"	"	"	"	"	"	"	0.0053						
90+40	1207.66	5.81	1213.47	"	"	"	265	11.2	1.93	"	0.0053	"						
88+50	1208.99	5.49	1214.48	"	"	"	"	"	"	"	"	"						
88+00	1209.25	5.50	1214.75	"	"	"	"	"	"	"	"	"	50	0.27			0.27	1216.41
85+95	1210.27	5.57	1215.84	"	"	"	"	"	"	"	"	"	205	1.09			1.09	1216.68
83+20	1213.03	4.40	1217.43	60"	5.0	19.64	244	12.42	2.40	2821	0.0075	0.0075	275	2.06			2.06	1217.77
82+00	1214.01	4.32	1218.33	"	"	"	"	"	"	"	"	"	120	0.90			0.90	1219.83
79+20	1216.36	4.42	1220.78	"	"	"	"	"	"	"	"	"	287	2.15	0.18	0.12	2.45	1220.73
			BEGIN	PRESSURE		FLOW	AGAIN											1223.18
79+20	1216.36	5.00	1221.36	"	"	"	"	"	"	"	"	"						
76+00	1217.84	6.07	1223.91	"	"	"	220	11.20	1.95	"	0.0061	0.0061	320	1.95	0.15		2.10	1223.76
																		1225.86

Size of pipe for outfall structure

TABLE 5

McDOWELL RD.

HYDRAULIC GRADE LINE CALCULATION SHEET

Sht 2 of 2

PROJECT S 5504

CALCULATED BY PWRH

LINE Indian Bend Wash - Scottsdale Rd.

*Conduit unseals when D is less than d

DATE 2/27/86

STA.	ELEV. INV.	D*	ELEV. H.G.L.	SECTION	d	A	Q	V	$\frac{v^2}{2g}$	K	S_f	Av. S_f	L	h_f	h_b	h_j	h_t	ELEV. E.G.L.
76+00	1217.84	6.07	1223.91	60"	5.0	19.64	220	11.20	1.95	2821	0.0061							1225.86
												0.0061	47	0.29			0.29	
75+53	1218.05	6.15	1224.20	"	"	"	"	"	"	"	"							1226.15
												0.0057	131	0.75			0.75	
74+22	1218.64	6.43	1225.07	"	"	"	213	10.85	1.83	"	0.0057							1226.90
												"	71	0.41	0.26		0.67	
73+51	1218.96	6.78	1225.74	"	"	"	"	"	"	"	"							1227.57
												"	69	0.39			0.39	
72+82	1219.27	6.86	1226.13	"	"	"	"	"	"	"	"							1227.96

TABLE 6

MILLER RD.

HYDRAULIC GRADE LINE CALCULATION SHEET

Sht 1 of 1

PROJECT S5504

LINE McDowell - Almeria

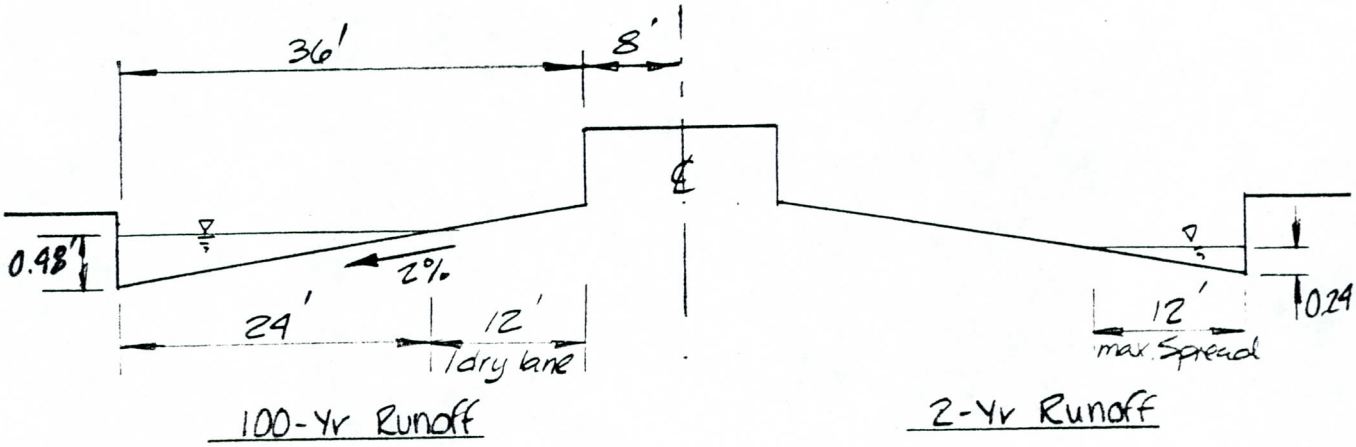
CALCULATED BY PWRH

*Conduit unseals when D is less than d

DATE 2/27/86

STA.	ELEV. INV.	D*	ELEV. H.G.L.	SECTION	d	A	Q	V	$\frac{v^2}{2g}$	K	S_f	Av. S_f	L	h_f	h_b	h_j	h_t	ELEV. E.G.L.
100+34	1197.26	9.55	1206.81	66"	5.50	23.76	270	11.4	2.00	3638	–							1208.81
		BEGIN	MILLER	ROAD	JUNCTION	STRUCTURE.			HGL		OF	LARGER						
			PIPE	SETS	CONTROL													
10+94	1197.72	9.09	1206.81	48"	4.00	12.57	108	8.59	1.15	1556	0.0048	0.0048	44	0.21			0.21	1207.96
10+50	1198.25	8.77	1207.02	"	"	"	"	"	"	"	"	"	94	0.45	0.19		0.64	1208.17
9+56	1199.38	8.28	1207.66	"	"	"	"	"	"	"	"	"	291	1.40			1.40	1208.81
6+64	1202.88	6.18	1209.06	"	"	"	"	"	"	"	"	"	78	0.37	0.23		0.60	1210.21
5+86	1203.82	5.84	1209.66	"	"	"	"	"	"	"	"	"	8	0.03			0.03	1210.81
5+78			1209.69	"	"	"	"	"	"	"	"							1210.84

TABLE 7 - TYPICAL STREET CROSS-SECTION
McDowell Road



STREET SLOPE	ALLOWABLE DISCHARGE (CFS)* 100-YEAR	2-YEAR
0.001	8.3	1.3
0.002	11.8	1.8
0.003	14.5	2.3
0.004	16.6	2.6
0.005	18.6	2.7
0.006	20.5	3.2
0.007	22.1	3.5
0.008	23.6	3.7
0.009	25.0	3.9
0.010	26.3	4.2
0.011	27.6	4.3
0.012	28.3	4.5

* Allowable discharges are based upon a 1/2 street flow capacity with maximum flow spread per the City of Scottsdale drainage criteria (see Section II)

TABLE 8

Sht. 1 of 4

Catch Basin Calculation Sheet

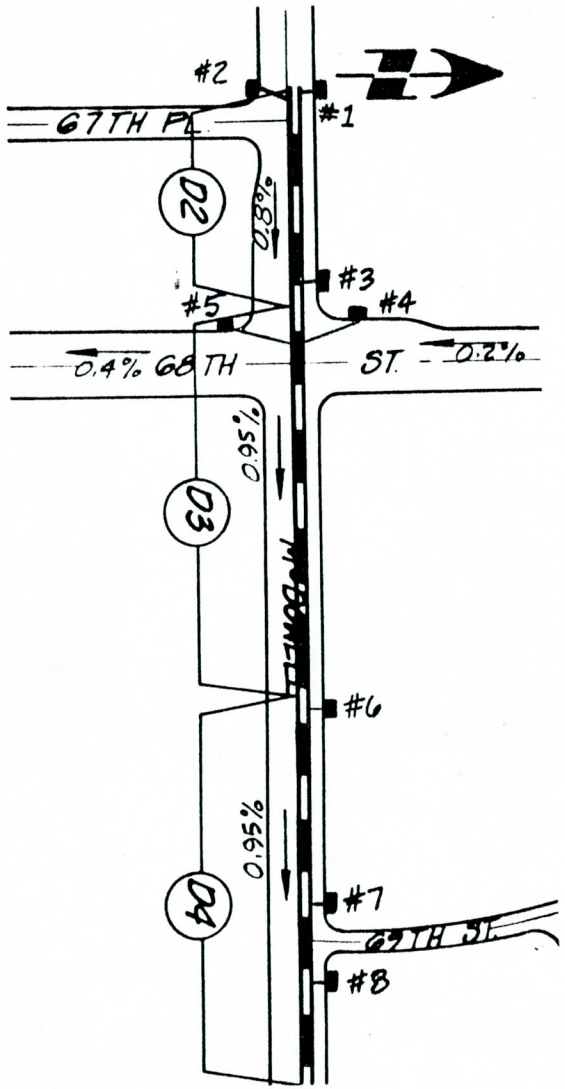
PROJECT S 5504

CALCULATED BY PWRH

DESIGN FREQUENCY 100 YR.

DATE

FLOW DIAGRAM
(Indicate street slopes)



Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	C.B. No.	C.B. Size	Connector Pipe Head	Connector Pipe L	Connector Pipe Dia.	Vel. / H_L
CB #1A	2-A	26	19	N/A	N/A	M.A.G. TYPE 'F'		Σ1&1A 3.7	6	24"	6.05 / 0.89
CB #1	2-A	6	9	27.2	0.3'	C.O.P. P.1568		"	33	24"	8.91 / 2.27
CB #2	3-A	11	4	"	0.4'	EXIST.		4.8	86	15"	3.26 / 0.53
CB #3	2-B	10.5	6	"	0.35'	M.A.G. 533-1	L=10'	3.5	35	15"	4.89 / 0.81
CB #4	2-B & 1/2 68th St.	23.5	23.5	25	0.58'	M.A.G. 533-1	L=10'	4.0	77	24"	9.77 / 3.43
CB #5	3-B	5	2.7		0.3'	M.A.G. 533-1	L=3'	3.8	94	15"	2.2 / 0.25
CB #6	2-C	29.7	15.3	27.2	0.52'	M.A.G. 533-1	L=17'	3.2	29	18"	8.66 / 2.27
CB #7	2-C	23.9	10.1	25.7	0.47	M.A.G. 533-1	L=10'	3.6	26	15"	8.23 / 2.12
CB #8	2-C & 69th St.	37.2	17.9	"	0.56	M.A.G 533-1	L=17'	3.3	26	18"	10.13 / 3.03

TABLE 9

Sht. 2 of 4

Catch Basin Calculation Sheet

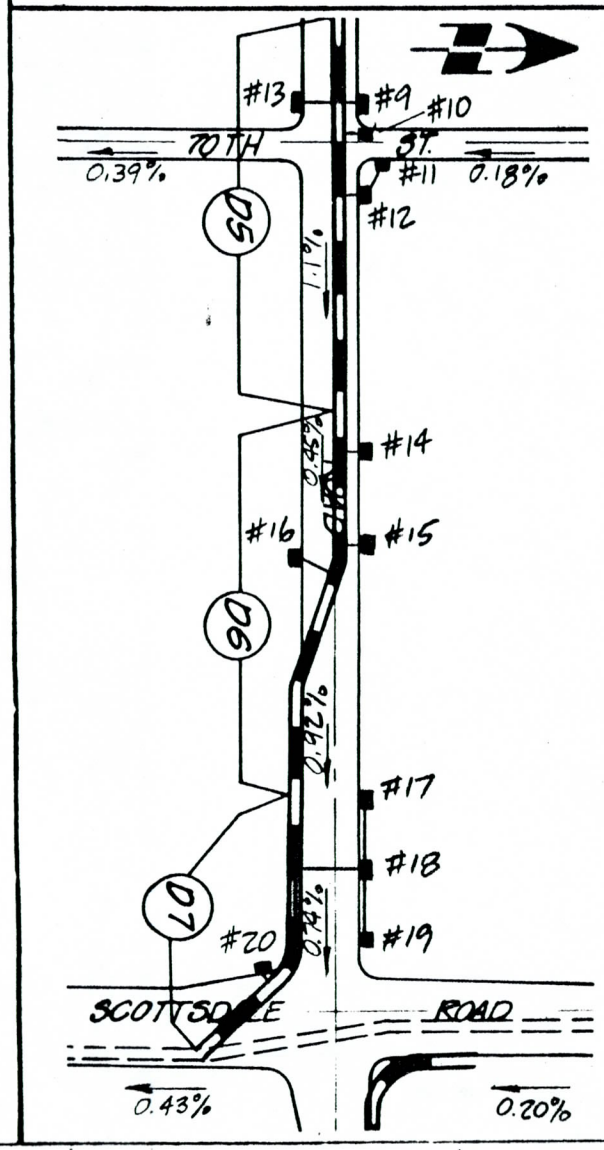
PROJECT S5504

CALCULATED BY PWRH

DESIGN FREQUENCY 100 YR

DATE

FLOW DIAGRAM
(Indicate street slopes)



Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	C.B. No.	C.B. Size	Connector Pipe Head	Connector Pipe L	Connector Pipe Dia.	Vel. / H_L
CB #9	2-D	26.2	10.1	20.5	0.48	M.A.G 533-1	L=10'	3.6	25	15"	8.23 / 2.10
CB #10	2-D & 1/2 70th St.	26	7	"	0.45	EXIST. GRATE	2'x3'	4.2	27	15"	5.70 / 1.03
CB #11	2-D & 70th St.	13	1.6	N.A.	0.40	EXIST. CURB INLET	L=3.5'	Σ11&12 3.7	54	12"	2.04 / 0.19
CB #12	2-D & 70th St.	33.5	12.9	27.6	0.52	M.A.G. 533-1	L=10'	2.9	25	18"	8.21 / 1.98
CB #13	3-C	16	3.3	26.3	0.39	M.A.G. 532	L=8'	3.6	58	15"	2.69 / 0.30
CB #14	2-E	20.6	8.2	17.6	0.46	M.A.G. 533-1	L=6'	2.4	27	15"	6.68 / 1.41
CB #15	2-E	23.8	8.9	"	0.53	M.A.G. 533-1	L=6'	2.4	26	15"	7.25 / 1.64
CB #16	3-D	6.0	2.0	25.5	0.28	M.A.G 532	L=8'	2.6	56	15"	1.63 / 0.11
CB #17	2-E	14.9	2.8	22.5	0.41	EXIST. CURB INLET	L=6.7'	0.3	89	15"	2.28 / 0.26
CB #18	2-E	23.7	10.9	"	0.50	M.A.G. 533-1	L=10'	1.3	103	24"	5.51 / 1.22
CB #19	2-E	12.8	3.6	"	0.35	EXIST CURB INLET	L=10'	0.4	71	15"	2.93 / 0.39
CB #20	3-D	4.0	0.8	17.0	0.18	M.A.G. 531	L=5.5'	1.9	8	15"	0.65 / 0.01

TABLE 10

Sht. 3 of 4

Catch Basin Calculation Sheet

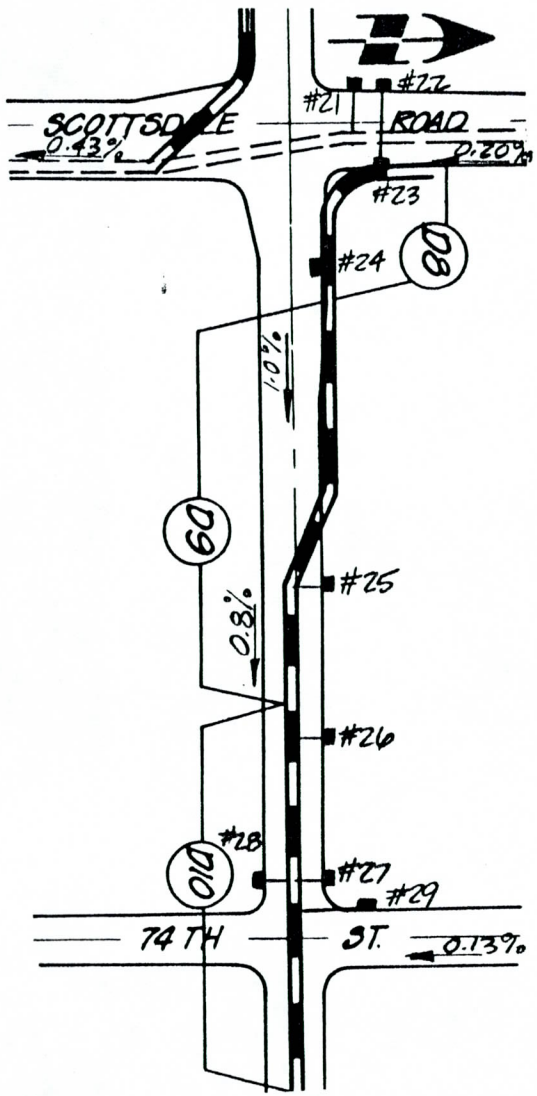
PROJECT S5504

CALCULATED BY PWRH

DESIGN FREQUENCY 100 YR

DATE

FLOW DIAGRAM (Indicate street slopes)



Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	C.B. No.	C.B. Size	Connector Pipe Head	Connector Pipe L	Connector Pipe Dia.	Vel. / H_L
CB #21	2-E + 1-D	9.2	7.2	NA.	0.67	EXIST. CURB INLET	L=6'	2.0	67	15"	5.87 / 1.51
CB #22	1-D	Not Known	23.7	11.8	0.67	M.A.G. 533-1	L=17'	3.0	97	24"	7.54 / 2.23
CB #23	1-E	11.5	6.5	"	0.42	M.A.G 533-1	L=10'	2.1	6	18"	3.68 / 0.33
CB #24	5-A	14.0	10.8	26.3	0.26	C.O.P 1568	L=8'	2.0	5	15"	8.80 / 1.92
CB #25	5-A	39.2	18.7	24.0	0.57	M.A.G 533-1	L=17'	1.7	46	24"	5.95 / 1.09
CB #26	5-A	31.8	13.3	23.6	0.54	M.A.G 533-1	L=10'	1.8	47	18"	7.53 / 1.96
CB #27	5-A	24.9	24.9	"	0.67	M.A.G 533-1	L=10'	1.3	45	27"	6.26 / 1.16
CB #28	6-A	9.0	2.3	"	0.34	M.A.G. 532	L=8'	1.7	35	15"	7.33 / 1.83
CB #29	74th St.	23.3	12.2	N.A.	0.70	M.A.G. 533-1	L=10'	2.0	92	18"	6.90 / 2.16

TABLE II

Sht. 4 of 4

Catch Basin Calculation Sheet

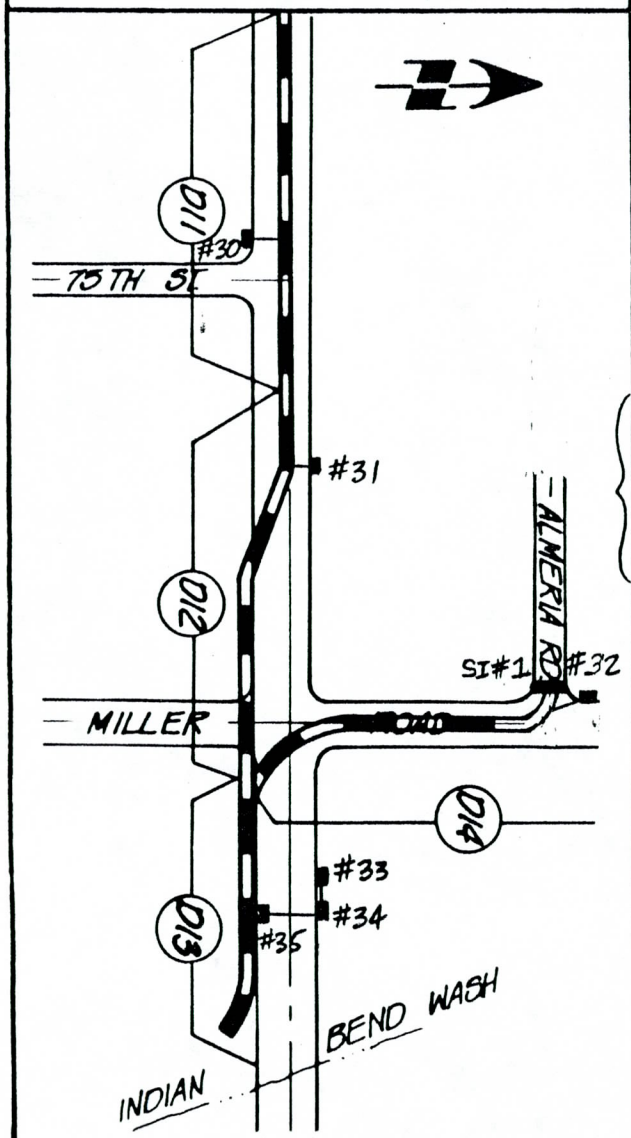
PROJECT S5504

DESIGN FREQUENCY 100 YR

CALCULATED BY PWRH

DATE

FLOW DIAGRAM
(Indicate street slopes)



Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	Nr						Vel. / 4L
CB #30	6-B	3.0	3.0	23.6	0.5	M.A 53						2
CB #31	5-B & 5-C	20.6	13.0	13.2	0.57	M. 5						.78
CB #32	4-C	25.0	17.0	27.0	0.63	1						1
SI #1	4-B	93.0	93.0	N.A.	0.55							0.90
CB #33	5-D MILLER & McDOWELL	27.1	27.1	NA	0.30	INLET						40 / 1.28
CB #34	"	"	"	NA	"	EXIST. GRATE INLET	2 — 2'x3'		"	"		8.63 / 3.21
CB #35	6-D	5	5	NA	0.58	EXIST GRATE INLET	1 — 2'x3'	0.7	11	27"		8.07 / 1.62

... Pipe

Outfall Structure for Indian Bend Wash

BIBLIOGRAPHY

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City of Scottsdale, Arizona Community Development Department; October 3, 1984; Design Procedures and Criteria Section 2 Drainage Report preparation.

City of Scottsdale, Arizona Community Development Department; October 3, 1984; Design Procedures and Criteria Section 3 Design of Facilities to manage stormwater runoff.

Ellis-Murphy, Inc., October 1985, Drainage Report for Scottsdale Road from McDowell Road to Osborn Road.

Los Angeles County Flood Control District; March 1982, Hydraulic Design Manual.

APPENDIX I:
Hydraulic Design Criteria

SECTION B

CRITERIA FOR HYDRAULIC DESIGN:

CLOSED CONDUITS

Section B

CRITERIA FOR HYDRAULIC DESIGN

CLOSED CONDUITS

B-1 General Hydraulic Criteria

Closed conduit sections (pipe, box, or arch sections) shall be designed as flowing full, whenever possible, and may be allowed to flow under pressure except when the following conditions exist:

a. In some areas of high debris potential, there is a possibility of stoppage occurring in drains. In situations where debris may be expected, the District's Hydraulic Division shall be consulted for a determination of the appropriate bulking factor.

b. In certain situations open channel sections upstream of the proposed closed conduit may be adversely affected by back pressure.

If the proposed conduit is to be designed for pressure conditions, the hydraulic grade line shall be positioned sufficiently below the surface of the street to efficiently intercept catch basin flows. However, in those reaches where no surface flow will be intercepted, a hydraulic grade line which encroaches on or is slightly higher than the ground or street surface will be acceptable. Reference is made to subsection B-4.2 for requirements for pressure manholes.

B-2 Water Surface Profile Calculations

B-2.1 Determination of Controlling Water Surface Elevation

A conduit to be designed for pressure conditions may discharge into one of the following:

a. A body of water such as a reservoir or the ocean.

b. A natural watercourse or ravine.

c. An open channel, either improved or unimproved.

d. Another closed conduit.

B-2.1 Determination of Controlling Water Surface Elevation continued.

The controlling water surface elevation at the point of discharge is commonly referred to as the control and, for pressure flow, is generally located at the downstream end of the conduit. If flow becomes unsealed, the control may be at the first gradebreak upstream of the point where unsealing occurs or, under certain conditions, may be farther upstream.

Two general types of controls are possible for a conduit on a mild slope, which is a physical requirement for pressure flow in discharging conduits.

a. Control elevation above the soffit elevation. In such situations the control shall conform to the following criteria:

   (1) In the case of a conduit discharging into a reservoir, the control shall be the reservoir water surface elevation.

   (2) In the case of a conduit discharging into an open channel, the control shall be the design water surface elevation of the channel.

   (3) In the case of a conduit discharging into another conduit, the control shall be the highest hydraulic grade line elevation of the outlet conduit immediately upstream or downstream of the confluence.

   (4) In the case of a conduit discharging into the ocean, the control shall be approved by the District prior to preparation of hydraulic calculations.

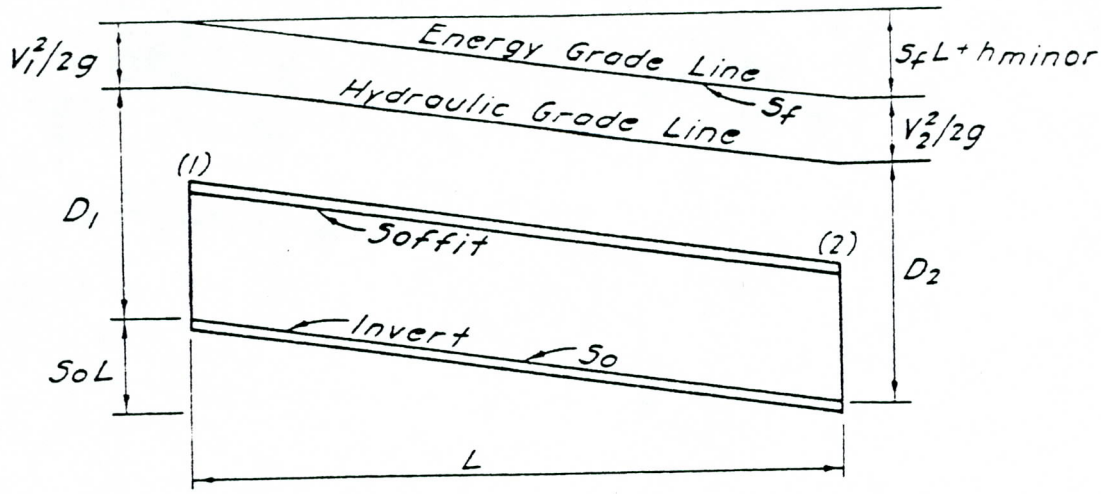
b. Control elevation at or below the soffit elevation. The control shall be the soffit elevation at the point of discharge. This condition may occur in any one of the four situations described on page B-1.

Hydraulic grade line elevations to be used as controls for projects in many cases may be obtained from the District's Design Division. Exceptions to the above policy must be approved by the District.

B-2.2 Instructions for Hydraulic Calculations

Most procedures for calculating hydraulic grade line profiles are based on the Bernoulli equation. This equation can be expressed as follows:

$$\frac{V_1^2}{2g} + D_1 + S_o L = \frac{V_2^2}{2g} + D_2 + S_f L + h_{minor}$$



in which D = Vertical distance from invert to H.G.L.
S_o = Invert slope
L = Horizontal projected length of conduit
S_f = Average friction slope between Sections 1 and 2
V = Average velocity (Q/A)
h_{minor} = Minor head losses

Minor losses have been included in the Bernoulli equation because of their importance in calculating hydraulic grade line profiles and are assumed to be uniformly distributed in the above figure.

B-2.2 Instructions for Hydraulic Calculations continued.

When specific energy (E) is substituted for the quantity $V^2/2g + D$ in the above equation and the result rearranged,

$$L = \frac{E_2 - E_1}{S_o - S_f}$$

The above is a simplification of a more complex equation and is convenient for locating the approximate point where pressure flow may become unsealed.

The format in use at the District for calculating hydraulic grade line profiles is shown on Chart No. B-01. For use in expediting such calculations a computer program is available. (See page B-16.)

B-2.3 Head Losses

B-2.3.1 Friction Loss

Friction losses for closed conduits carrying storm water, including pump station discharge lines, shall be calculated from the Manning equation or a derivation thereof. The Manning equation is commonly expressed as follows:

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

in which Q = Discharge, in c.f.s.
n = Roughness coefficient
A = Area of water normal to flow in ft.^{2}
R = Hydraulic radius
S_f = Friction slope

When rearranged into a more useful form,

$$S_f = \left[\frac{Qn}{1.486 A R^{2/3}}\right]^2 = \left[\frac{Q}{K}\right]^2$$

in which

$$K = \frac{1.486 A R^{2/3}}{n}$$

B-2.3.1 Friction Loss continued.

The loss of head due to friction throughout the length of reach (L) is calculated by:

$$h_f = S_f L = \left[\frac{Q}{K}\right]^2 L$$

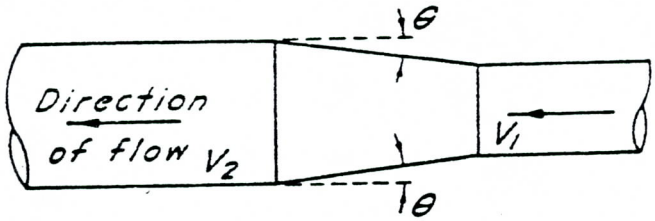
The value of K is dependent upon only two factors: the geometrical shape of the flow cross section as expressed by the quantity $AR^{2/3}$, and the roughness coefficient (n). The values of n shown in Chart No. F-04 & F-05 shall be used.

Values of K corresponding to an n value of .013 for reinforced concrete pipe and equivalent reinforced concrete box sizes are shown on Chart No. F-01.

CHARTS NOT INCLUDED IN REPORT

B-2.3.2 Transition Loss

Transition losses shall be calculated from the equations shown below. These equations are applicable when no change in Q occurs and where the horizontal angle of divergence or convergence (θ) between two sections does not exceed 5°45'.



For velocities which increase in the direction of flow ($V_2 > V_1$),

$$h_f = .1\left[\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right]$$

For velocities which decrease in the direction of flow ($V_2 < V_1$),

$$h_f = .2\left[\frac{V_1^2}{2g} - \frac{V_2^2}{2g}\right]$$

B-2.3.2 Transition Loss continued.

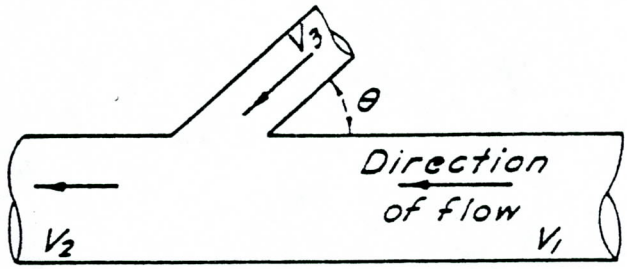
Deviations from the above criteria must be approved by the District. When such situations occur, the angle of divergence or convergence (θ) may be greater than 5°45'. However, when θ is increased beyond 10°, the above equations will give results for h_t that are too small and the values for h_t derived from the preceeding formulas should be increased by multiplying h_t by the following:

For $10° < \theta < 15°$ Multiply h_t by 2
For $15° < \theta < 20°$ Multiply h_t by 3
For $20° < \theta < 25°$ Multiply h_t by 4
For $\theta > 25°$ Multiply h_t by 5

B-2.3.3 Junction Loss

In general, junction losses shall be calculated by equating pressure plus momentum through the confluences under consideration. This can be done by using either the District's P + M method or the City of Los Angeles' Thompson equation, both of which are shown in Section F. Both methods are applicable in all cases for pressure flow and will give the same results.

For the special case of pressure flow with $A_1 = A_2$ and friction neglected,



$$h_j = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} - \frac{2A_3}{A_2} \cdot \frac{V_3^2}{2g} \cdot \cos\theta$$

B-2.3.4 Manhole Loss

Manhole losses shall be calculated from the equation shown below and shall be used only for District Manhole Nos. 1 and 2. Where a change in pipe size and/or change in Q occurs, no additional head loss need be calculated for the manhole. It is considered to be included in the transition and or junction loss.

$$h_{m.h.} = .05 \left[\frac{V^2}{2g}\right]$$

B-2.3.5 Bend Loss

Bend losses shall be calculated from the following equations:

$$h_b = K_b \left[\frac{V^2}{2g}\right]$$

in which

$$K_b = 0.20\sqrt{\frac{\Delta}{90°}}$$

where Δ = Central angle of bend in degrees

K_b may be evaluated graphically from Chart No. B-10 for values of Δ not exceeding 90 degrees.

Bend losses should be included for all closed conduits, those flowing partially full as well as those flowing full.

B-2.3.6 Angle Point Loss

Angle point losses shall be calculated from the following equation:

$$h_{o.pt.} = .0033\,\theta \left[\frac{V^2}{2g}\right]$$

in which θ = Deflection angle in degrees, not to exceed 6° without prior approval from the District.

B-3 Special Cases

B-3.1 Transition From Large to Small Conduit

As a general rule, storm drains shall be designed with sizes increasing in the downstream direction. However, when studies indicate it may be advisable to decrease the size of a downstream section, the conduit may be decreased in size in accordance with the following limitations:

a. For slopes of .0025 (.25 percent) or less, only conduits 75 inches and greater may be decreased. A reduction is limited to a maximum of 6 inches.

b. For slopes of more than .0025, only conduits 33 inches and greater may be decreased. Each reduction is limited to a maximum of 3 inches for pipe 48 inches in diameter or smaller, and to a maximum of 6 inches for pipe larger than 48 inches in diameter. Reductions exceeding the above criteria must have District approval.

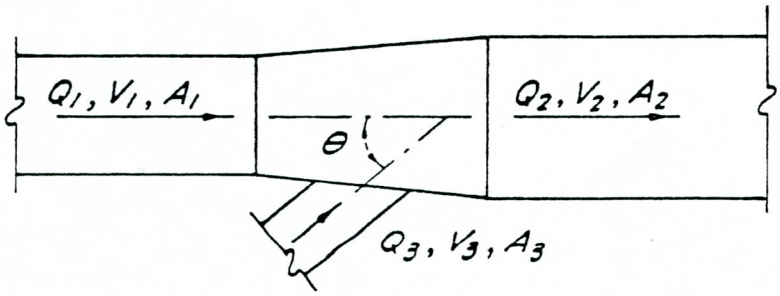
In any case the reduction in size must result in a more economical system.

Where conduits are to be decreased in size due to a change in grade, the criteria for locating the transition shall be as shown on Chart No. B-20. A design that doesn't follow this criteria must have District approval.

The City of Los Angeles

Thompson Equation

The Thompson Equation for junctions is described by the following:



$$\Delta y \cdot A_{avg.} = \frac{Q_2 V_2 - Q_1 V_1 - Q_3 V_3 \cos\theta}{g}$$

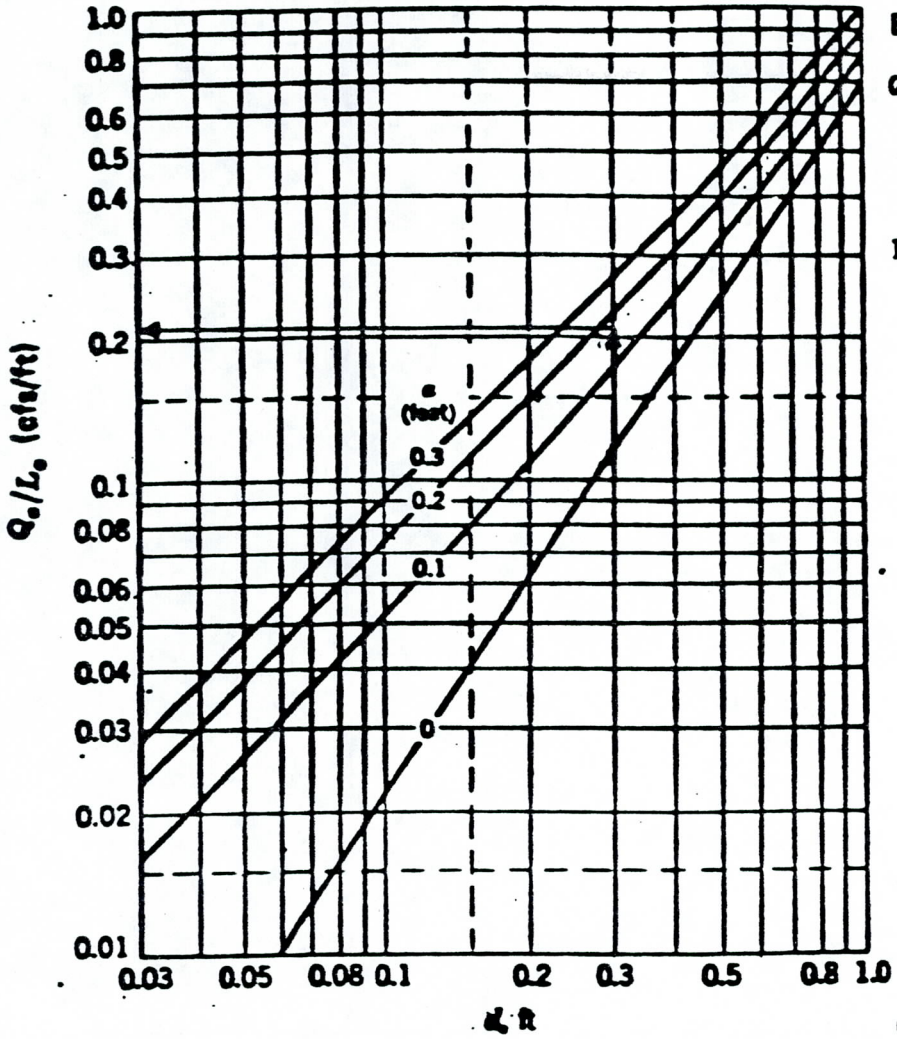
where Δy = Difference in hydraulic gradient for the two end sections, in feet.

A_{avg} = Average area, in feet^2 = $1/6\ (A_1 + 4A_m + A_2)$ or, for practical use, $1/2\ (A_1 + A_2)$

A_m = Mean area of flow, in feet^2.

The above equation is applicable only to prismoidal and circular conduits or channels. The friction force may be considered negligible or can be calculated and taken into account.

For details of the above method, refer to Office Standard No. 115, Hydraulic Analysis of Junctions, 1968 edition, Storm Drain Design Division, Bureau of Engineering, City of Los Angeles.



a

EXAMPLE USING FIGURE 3-46a

Given:

$d = 0.3'$

$a = 0.167'$ (2")

Find:

$\frac{Q_a}{L_a} = 0.21$ cfs/ft.

EXAMPLE USING FIGURE 3-46b

Given:

The above information and

$Q_a = 5.9$ cfs

$L = 10'$

Find: Q

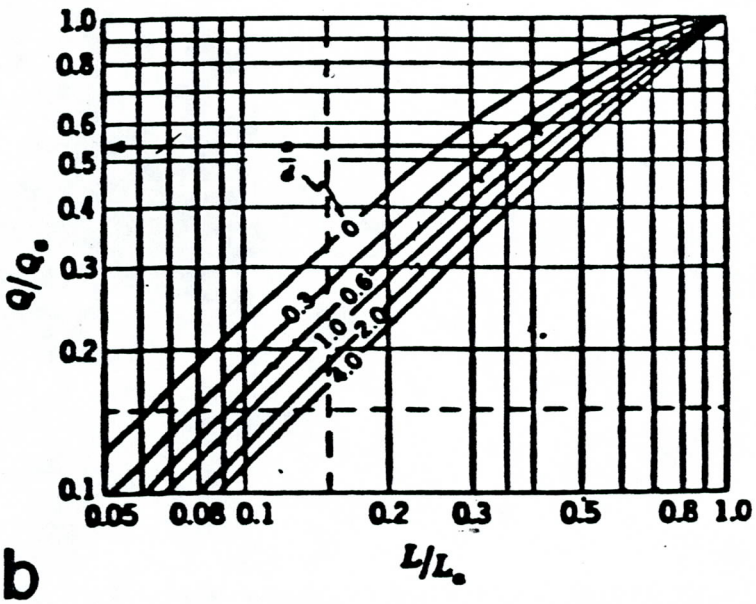
$\frac{a}{d} = \frac{0.167}{0.3} = 0.56$

$L_a = \frac{5.9}{0.21} = 28'$

$\frac{L}{L_a} = \frac{10}{28} = 0.36$

$\frac{Q}{Q_a} = 0.53$

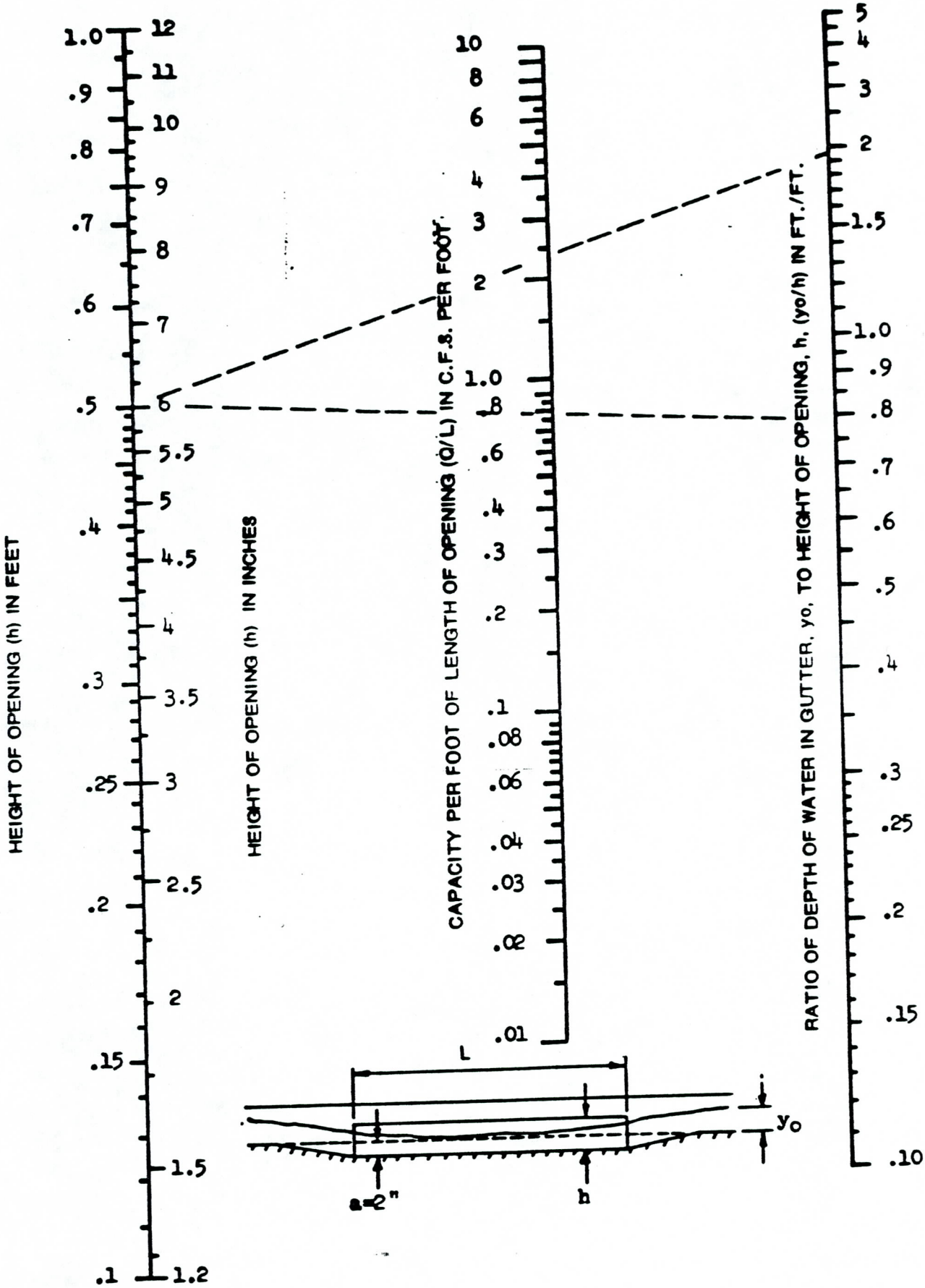
$Q = (0.53)(5.9) = 3.1$ cfs



b

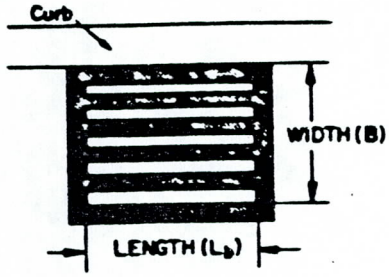
DESIGN CHARTS FOR CURB-OPENING INLETS ON CONTINUOUS GRADES

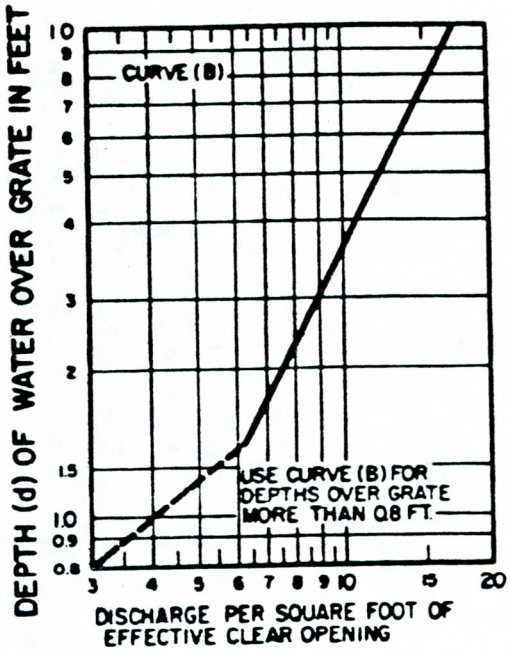
FIGURE 3-46

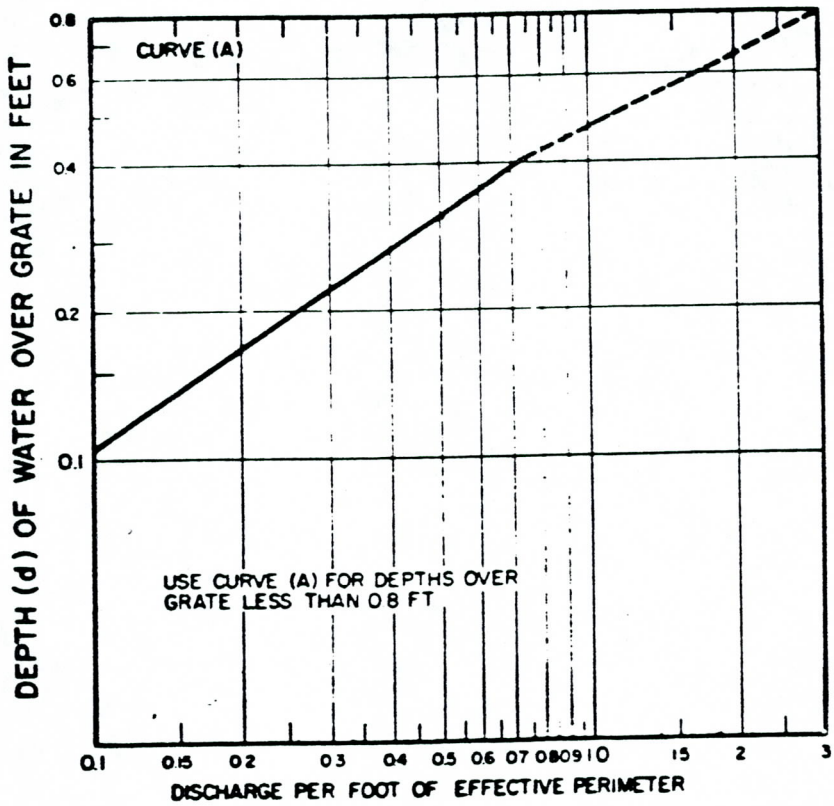


NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"

FIGURE 3-47







BUREAU OF PUBLIC ROADS
REV. AUG. 1968

HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

FIGURE 3-48

APPENDIX II:
Scottsdale Road Outfall Drain

Existing Scottsdale Road S.D.

$Q_{TOTAL} = 176 + 43 = 219$ cfs

Assuming head over bubble-up structure = 2.5'
Depth of pipe = 6.5' ∴ total head = 9'
Discharge through 18" pipe = 25 cfs

Flow through top of structure = 219 - 25 = 194 cfs

Assume discharge along 3 sides each 6.5

Calculate head by weir flow eqn,

$Q = CLH^{3/2}$ where $C = 3.0$ $L = 3 \times 6.5 = 19.5'$

$H = \left(\frac{Q}{CL}\right)^{2/3} \Rightarrow H = \left(\frac{194}{3 \times 19.5}\right)^{2/3} = 2.2$ ft ∴ o.k.

Pipe inv. = 1188.68
H.G.L = 1188.68 + 6.5 + 2.2 = 1197.38

Existing Scottsdale Road S.D.

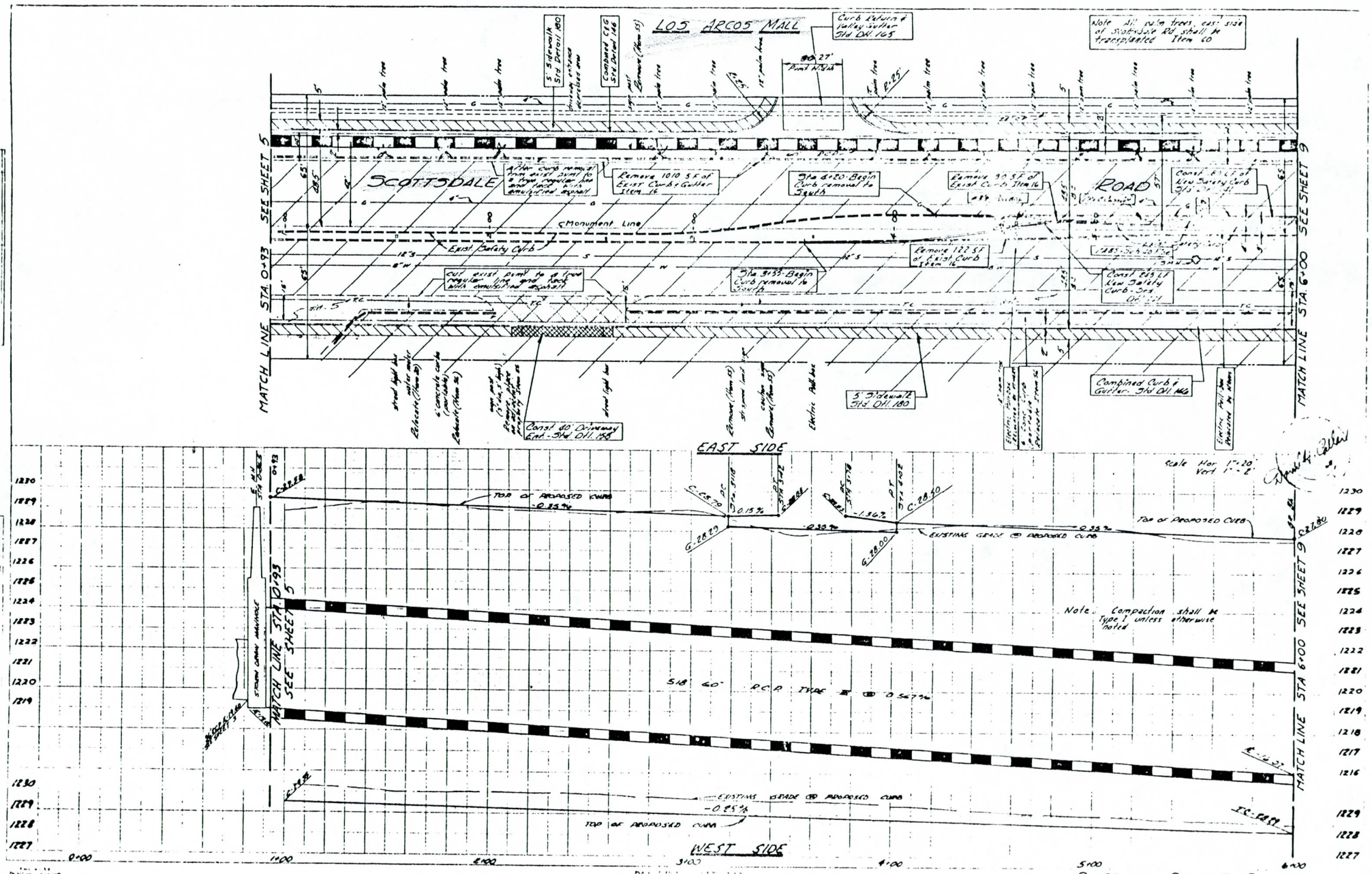
Outlet loss = $1.0 V^2/2g$ = $1.0 \times 0.68 = 0.68$
(Bubble-up)

Bend loss = $0.20 V^2/2g$ = $0.2 \times 0.68 = 0.14$

90° Bend = $1.0 V^2/2g$ = $1.0 \times 0.93 = 0.93$

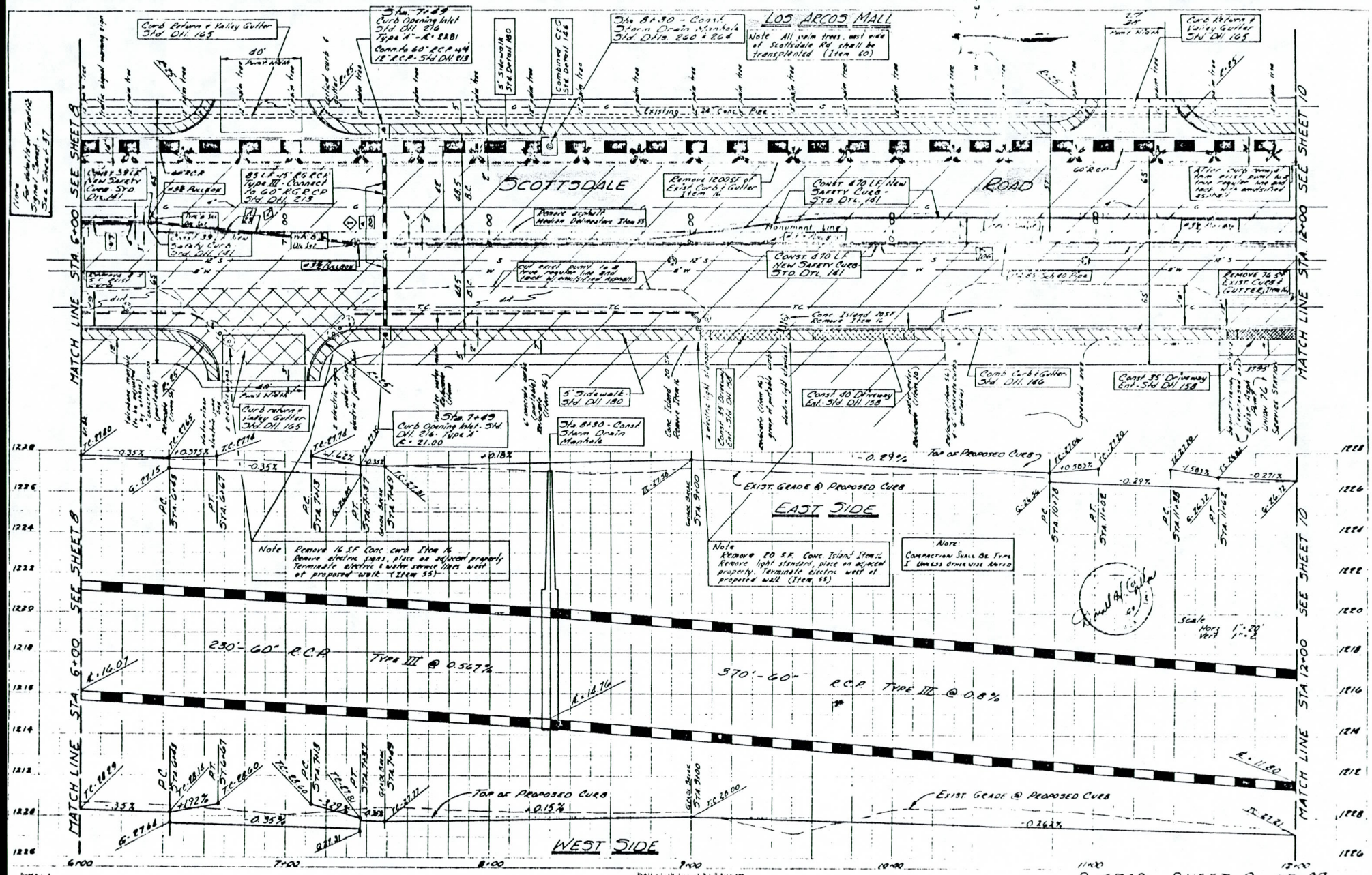
15° Bend = $0.20 \sqrt{15/90} \times \frac{V^2}{2g}$ = $0.08 \times 0.93 = 0.08$

Manhole loss = $0.05 V^2/2g$ = $0.05 \times 0.93 = 0.05$



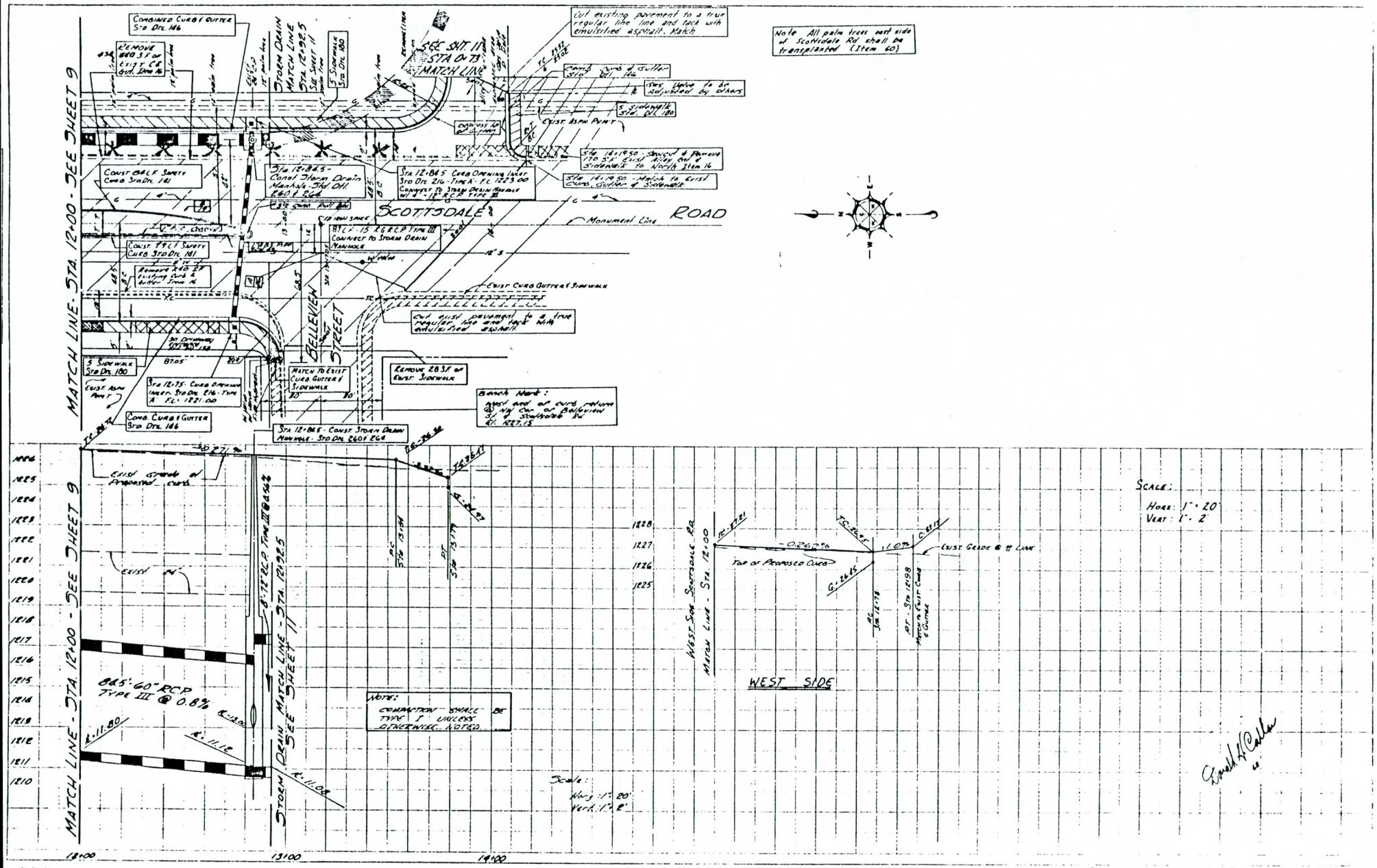
P-6742 SHEET 8 OF 37

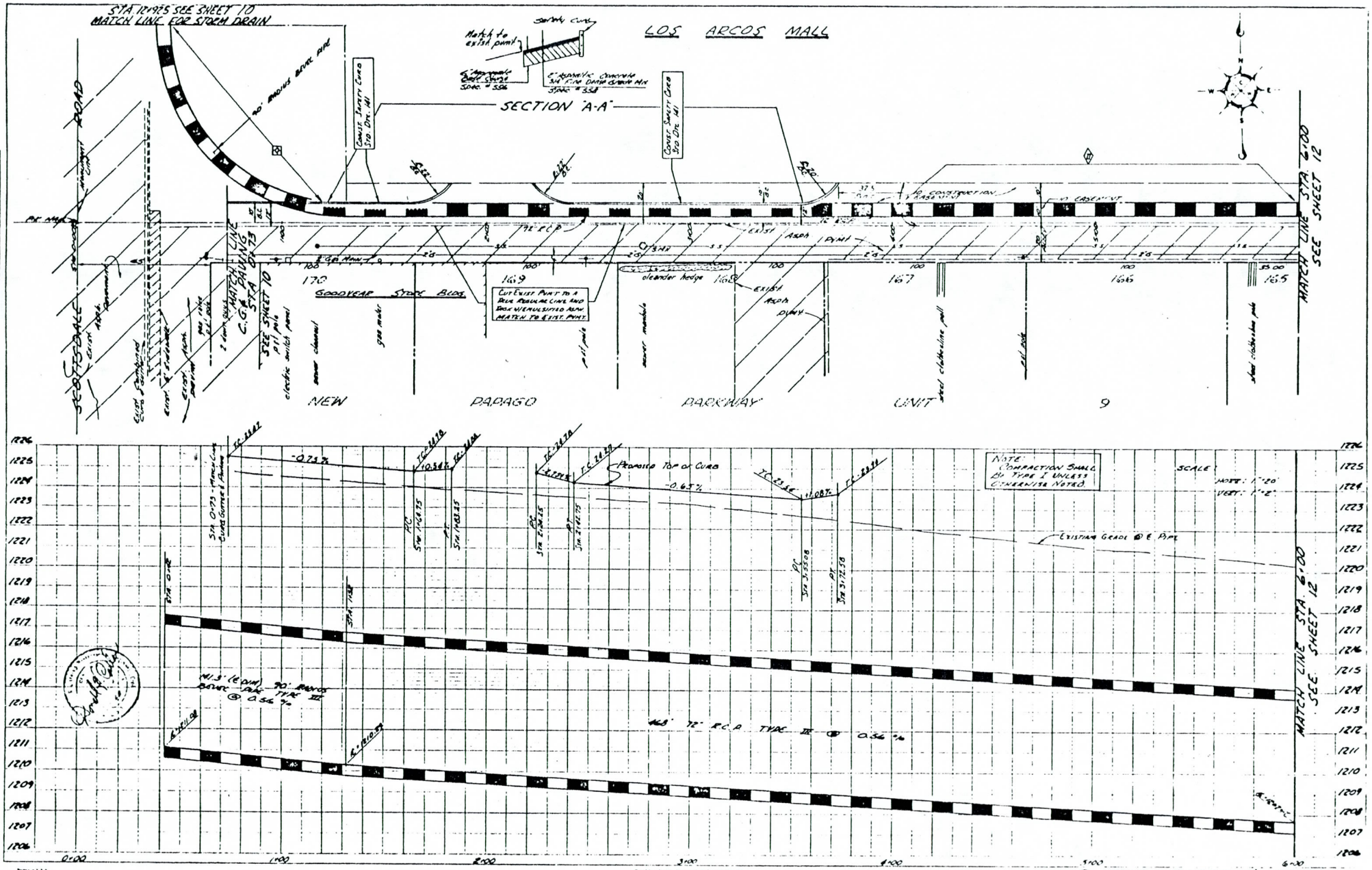
P-36



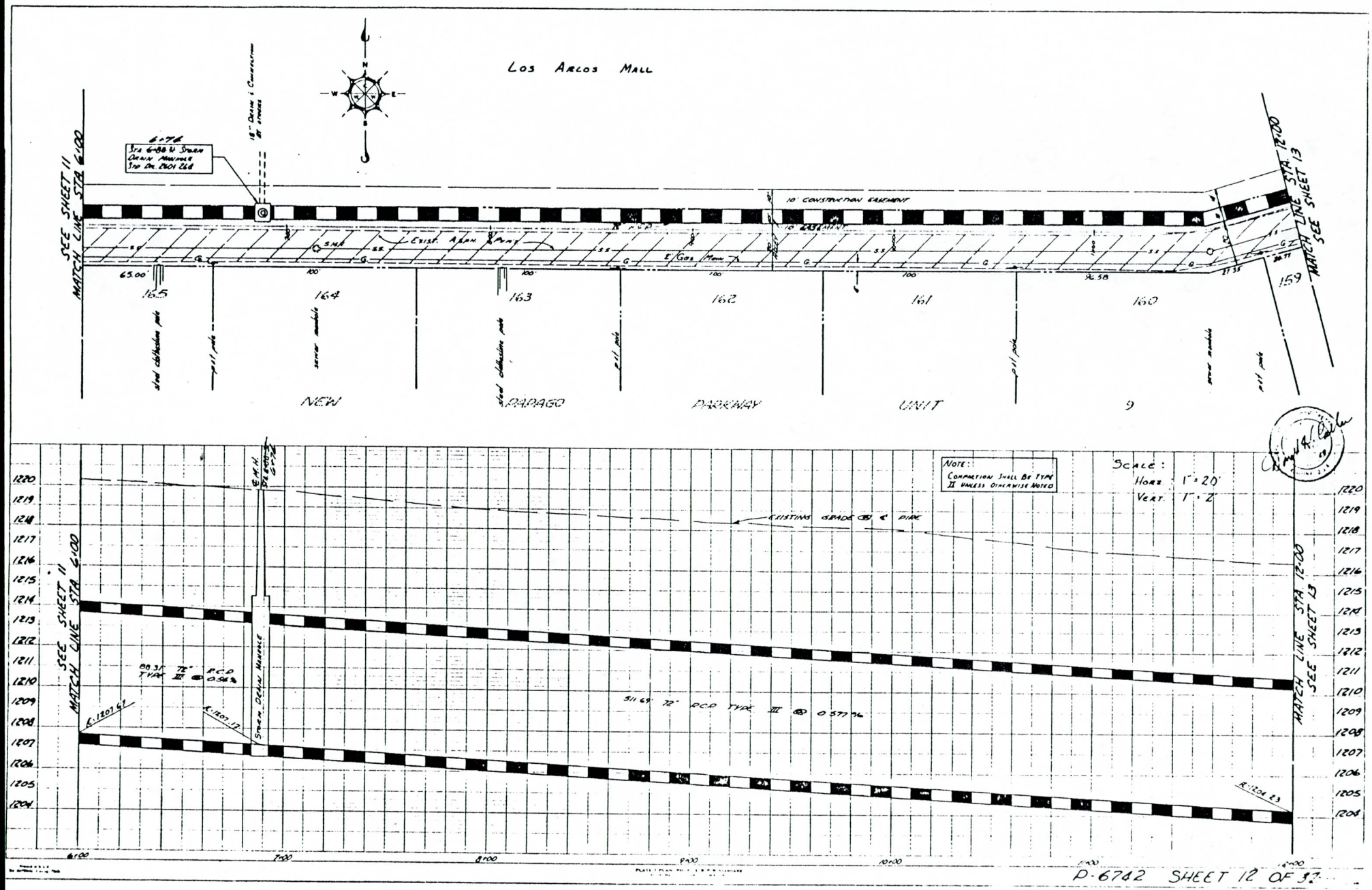
P-6742 SHEET 9 OF 37

P-35


MATCH LINE - STA. 12+00 - SEE SHEET 9
SCOTTSDALE ROAD
BELLEVIEW STREET
SEE SHT. 11 STA 0+73 MATCH LINE
Note All palm trees east side of Scottsdale Rd shall be transplanted (Item 60)
Cut existing pavement to a true regular line line and tack with emulsified asphalt. Match
Combined Curb & Gutter Std Dtl. 146
Remove 880 S.F. of Exist. C&G Gutt. Item 16
Storm Drain Match Line Sta. 12+92.5 See Sheet 11
5' Sidewalk Std Dtl. 180
Const. Bulk Safety Curb Std Dtl. 141
Sta 12+84.5 - Const Storm Drain Manhole - Std. Dtl. E601 & E66
Sta 12+84.5 Curb Opening Inlet Std Dtl. 216 - Type A - F.L. 1223.00 Connect to Storm Drain Manhole w/ 2 - 18" RCP Type III
Sta 14+19.50 - Saw cut & Remove 170 S.F. Exist Alley out & Sidewalk to North Item 16
Sta 14+19.50 - Match to Exist Curb, Gutter & Sidewalk
Exist Asph Pvmt
Monumental Line
Remove 440 S.F. Existing Curb & Gutter Item 16
Exist Curb Gutter & Sidewalk
Cut exist pavement to a true regular line and tack with emulsified asphalt
Remove 28 S.F. of Exist. Sidewalk
Match to Exist Curb Gutter & Sidewalk
Bench Mark: Nail and tag curb return @ N.W. Cor. of Belleview & Scottsdale Rd El. 1227.18
Sta 12+75 - Curb Opening Inlet - Std Dtl. 216 - Type A - F.L. 1221.00
Comb. Curb & Gutter Std Dtl. 146
Sta 12+84.5 - Const. Storm Drain Manhole - Std Dtl. E601 E66
Exist Grade at Proposed Curb
8-18" RCP Type III @ 4.5%
Storm Drain Match Line - Sta. 12+92.5 See Sheet 11
845' 60" RCP Type III @ 0.8%
Note: Compaction shall be Type I unless otherwise noted.
West Side Scottsdale Rd Match Line - Sta. 12+00
Top of Proposed Curb
Exist Grade @ ℄ Line
Match to Exist Curb & Gutter
WEST SIDE
Scale: Horz: 1" = 20' Vert: 1" = 2'
Scale: Horz: 1" = 20' Vert: 1" = 2'
12+00
13+00
14+00


STA. 12+95 SEE SHEET 10
MATCH LINE FOR STORM DRAIN
LOS ARCOS MALL
SECTION "A-A"
GOODYEAR STORE BLDG.
NEW PAPAGO PARKWAY UNIT 9
SCOTTSDALE ROAD
MATCH LINE STA. 6+00 SEE SHEET 12
Promised Top of Curb
Existing Grade @ E. Pipe
Note: Connection Shall be Type I Unless Otherwise Noted.
141.5' (6 Dia.) 90° Radius Bend Pipe Type III @ 0.56 %
146.5' 72" R.C.P. Type III @ 0.56 %
P-6742 SHEET 11 OF 37

P-370



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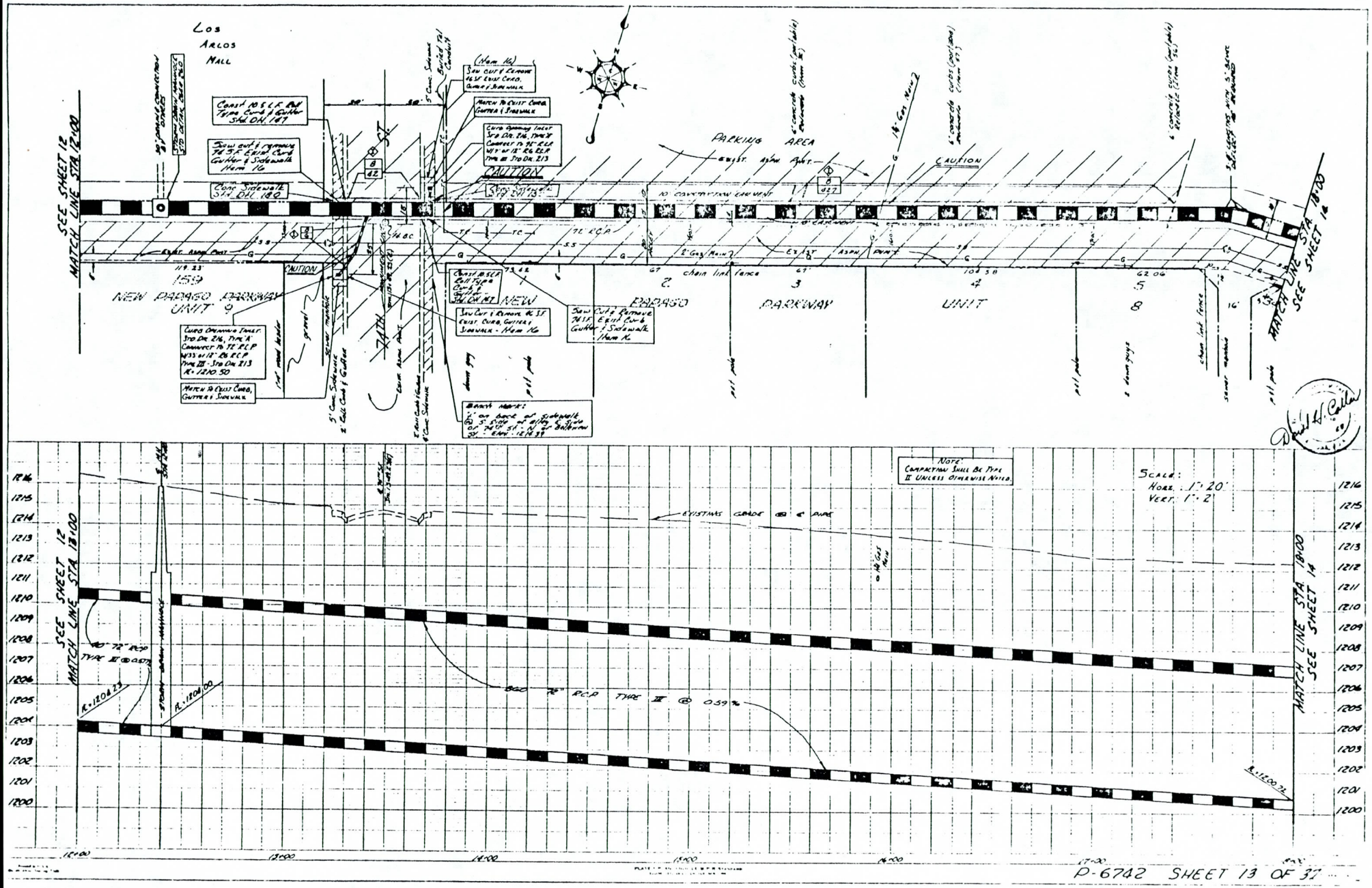
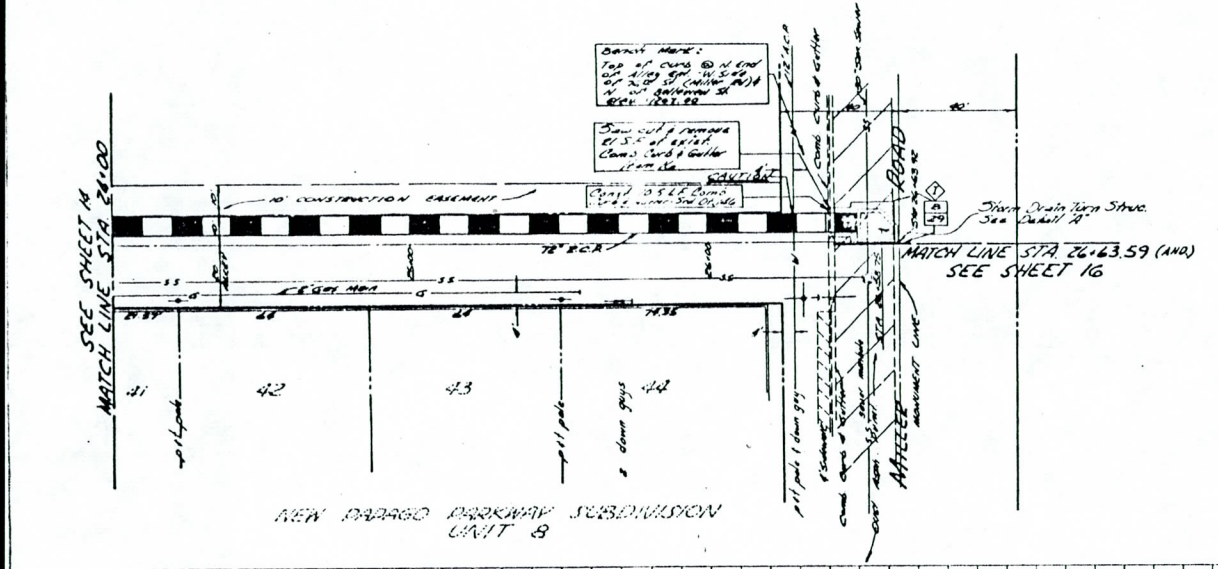
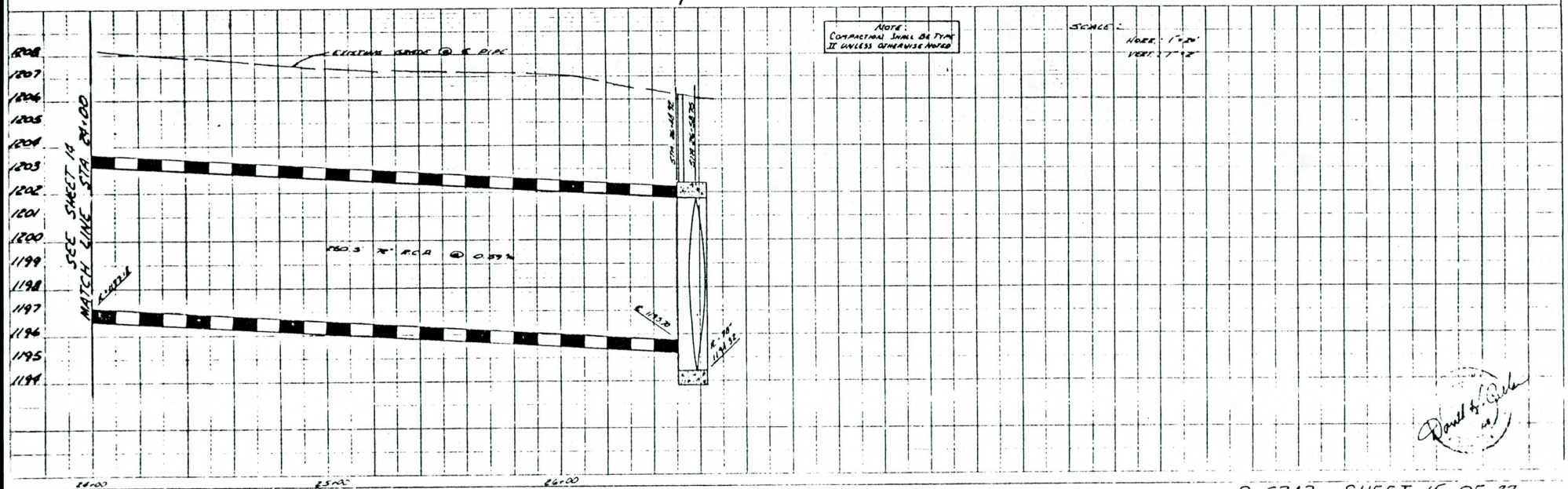
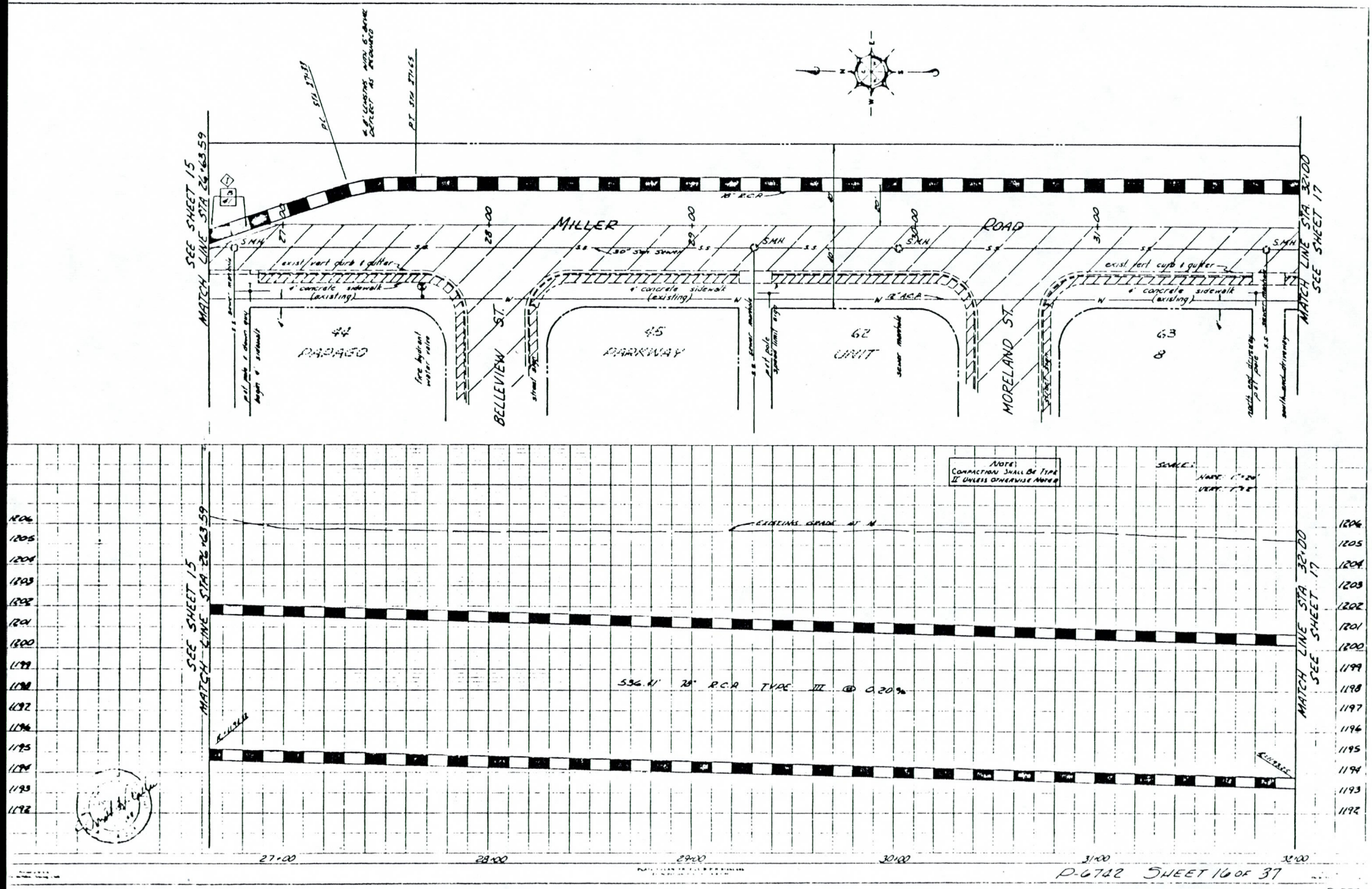
P-371


LOS ARLOS MALL
SEE SHEET 12
MATCH LINE STA 12+00
MATCH LINE STA 18+00
SEE SHEET 14
PARKING AREA
CAUTION
NEW PARKER PARKWAY UNIT 9
PARKER PARKWAY UNIT 8
PATH
Const 10 S.F. Rdwy Type Curb & Gutter Std. DH. 187
Saw cut & remove 74 S.F. Exist Curb Gutter & Sidewalk Item 16
Const Sidewalk Std. DH. 180
Match to Exist Curb, Gutter & Sidewalk
Saw Cut & Remove 74 S.F. Exist Curb Gutter & Sidewalk Item 16
Saw Cut & Remove 74 S.F. Exist Curb Gutter & Sidewalk Item 16
Curb Opening Inlet Std. Dr. 216, Type A Connect to 72" RCP W/33 w/ 12" RG RCP Type III - Std. Dr. 213 R=1210.50
Match to Exist Curb, Gutter & Sidewalk
Curb Opening Inlet Std. Dr. 216, Type A Connect to 72" RCP W/7 w/ 12" RG RCP Type III Std. Dr. 213
Match to Exist Curb Gutter & Sidewalk
Branch Mark:
Existing Grade @ ℄ Pipe
Note: Connection Shall Be Type II Unless Otherwise Noted.
Scale: Horz. 1" = 20' Vert. 1" = 2'
Storm Drain Manhole
840' 72" RCP Type II @ 0.59%
R=1206.29
R=1204.00
R=1200.74
P-6742 SHEET 13 OF 37
P-372

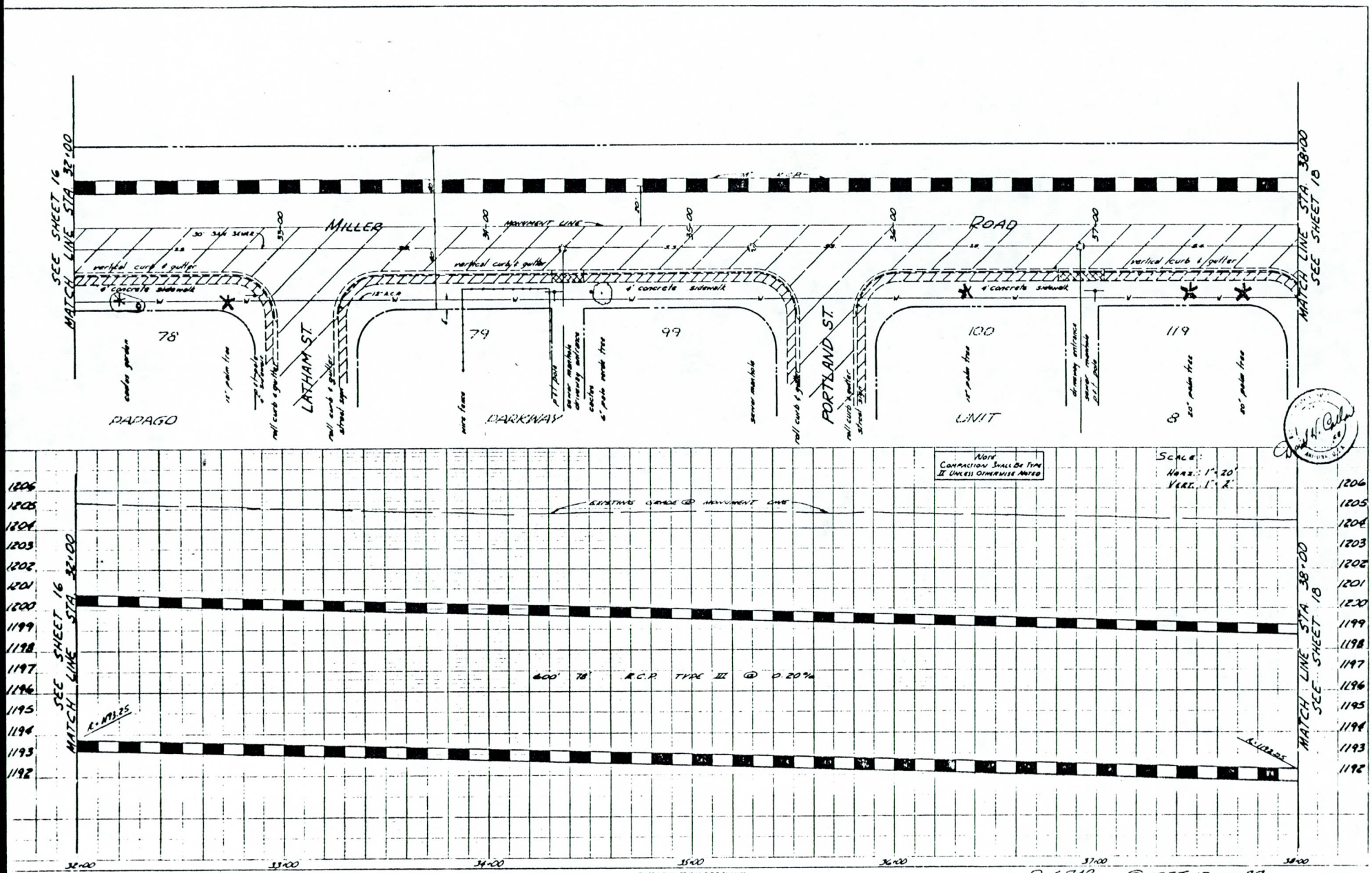

SEE SHEET 14
MATCH LINE STA 24+00
10' CONSTRUCTION EASEMENT
72" RCP
MATCH LINE STA 26+63.59 (AND)
SEE SHEET 16
ROAD
Storm Drain Term Struc.
See Detail "A"
41
42
43
44
NEW DARAGO PARKWAY SUBDIVISION
UNIT 8


NOTE:
COMPACTION SHALL BE TYPE II UNLESS OTHERWISE NOTED
SCALE:
HORZ. 1"=20'
VERT. 1"=2'
SEE SHEET 14
MATCH LINE STA 24+00
1208
1207
1206
1205
1204
1203
1202
1201
1200
1199
1198
1197
1196
1195
1194
260.3' 72" RCP @ 0.59%
24+00
25+00
26+00

P-374

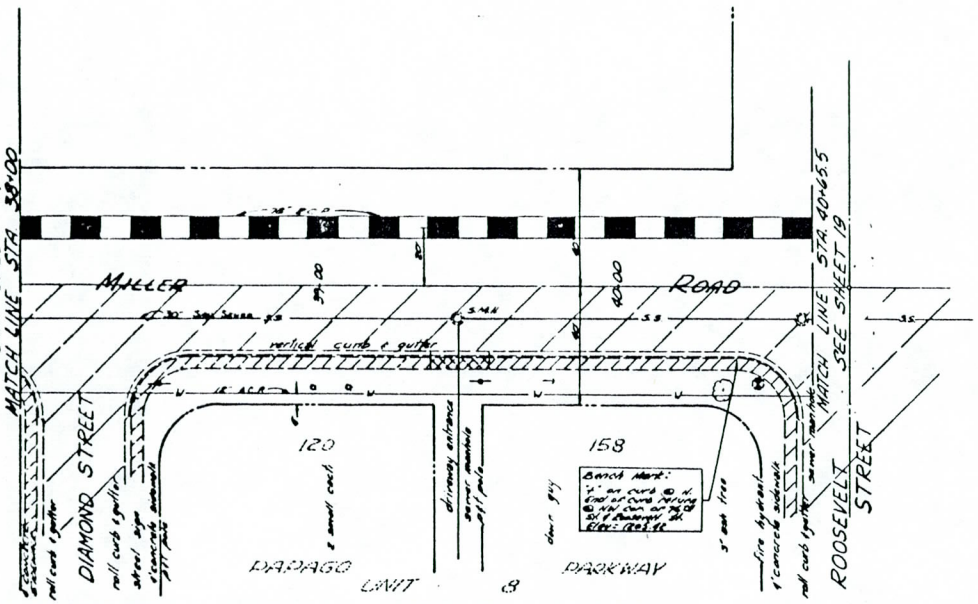

MILLER ROAD
BELLEVIEW ST.
MORELAND ST.
44 PARKED
45 PARKWAY
62 UNIT
63 8
exist. vert. curb & gutter
4' concrete sidewalk (existing)
S.M.H.
28" R.C.P.
30" STM SWMR
MATCH LINE STA 32+00 SEE SHEET 17
SEE SHEET 15 MATCH LINE STA 26+63.59
NOTE: COMPACTION SHALL BE TYPE II UNLESS OTHERWISE NOTED
SCALE: HORIZ. 1"=20' VERT. 1"=2'
EXISTING GRADE AT ℄
536.41' 28" R.C.P. TYPE III @ 0.20%
27+00
28+00
29+00
30+00
31+00
32+00
1206
1205
1204
1203
1202
1201
1200
1199
1198
1197
1196
1195
1194
1193
1192

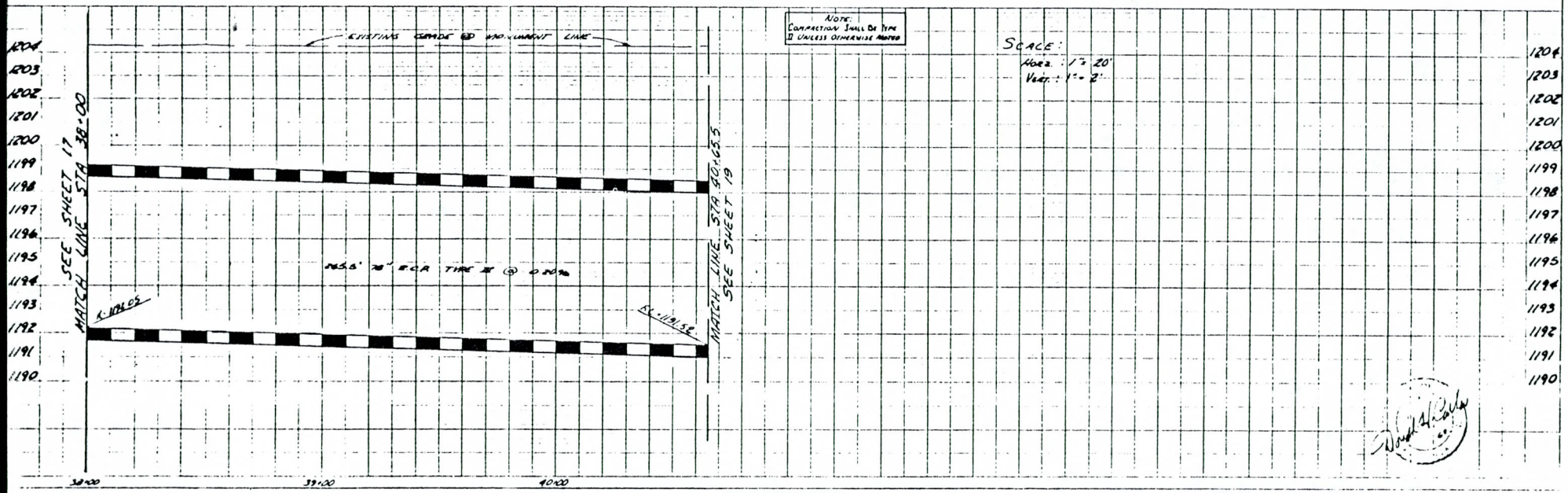
P-375



P-6742 SHEET 17 OF 37

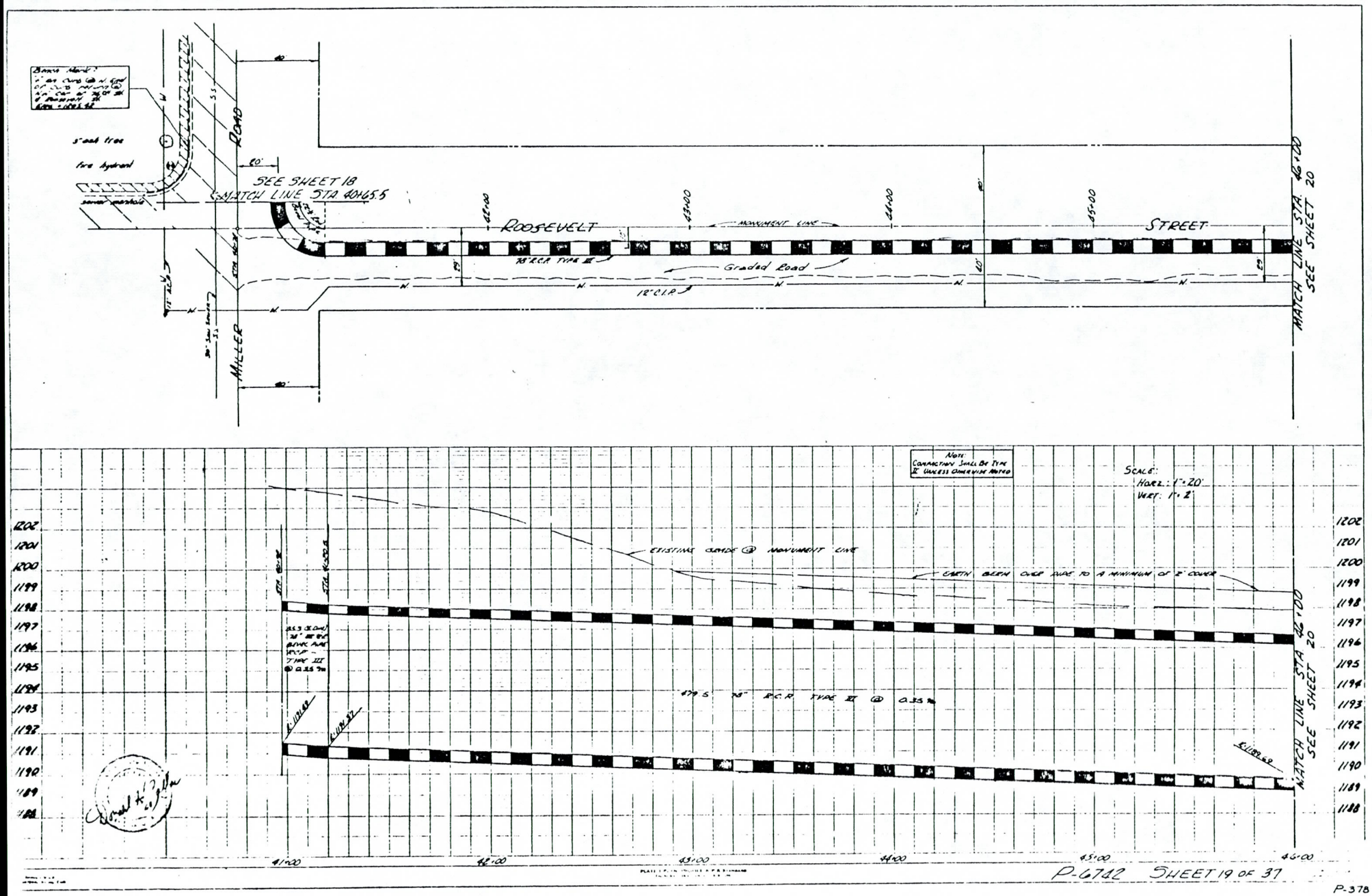
P-316





NOTE:
CONNECTION SHALL BE TYPE II UNLESS OTHERWISE NOTED

SCALE:
HORZ.: 1" = 20'
VERT.: 1" = 2'



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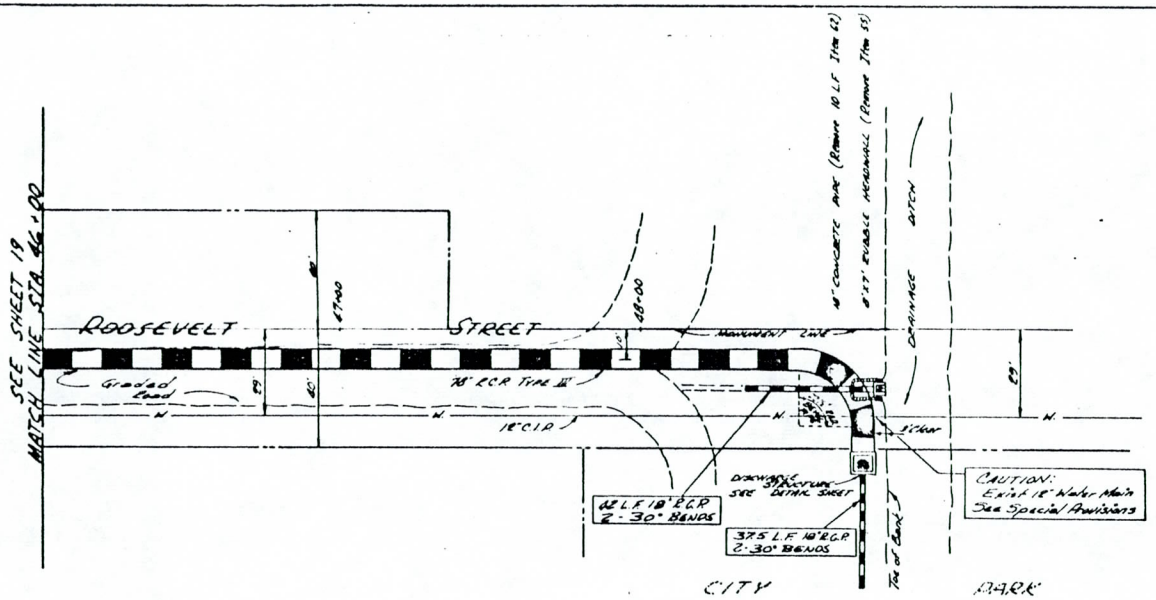
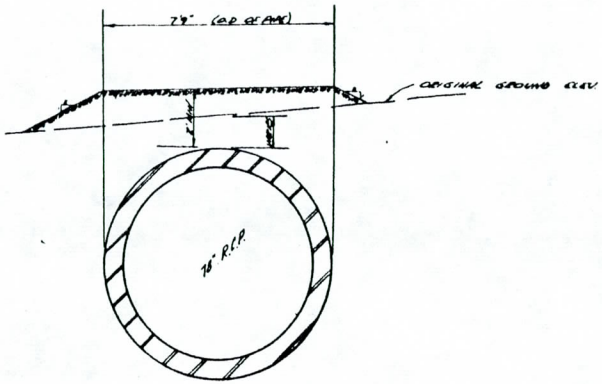
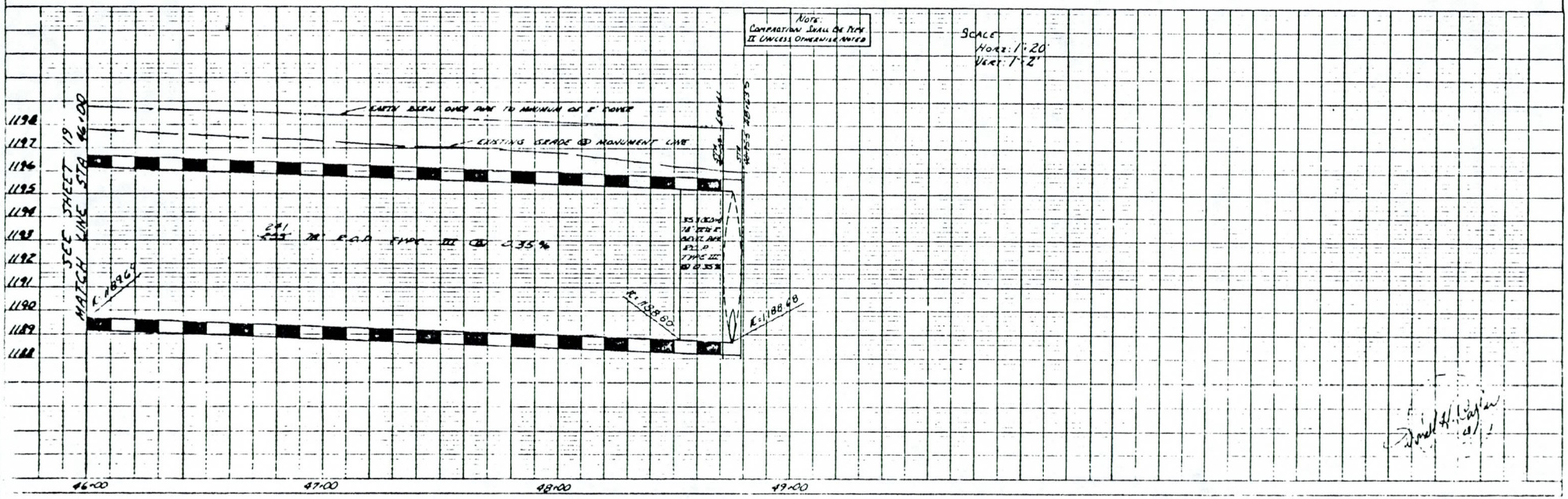
P-378

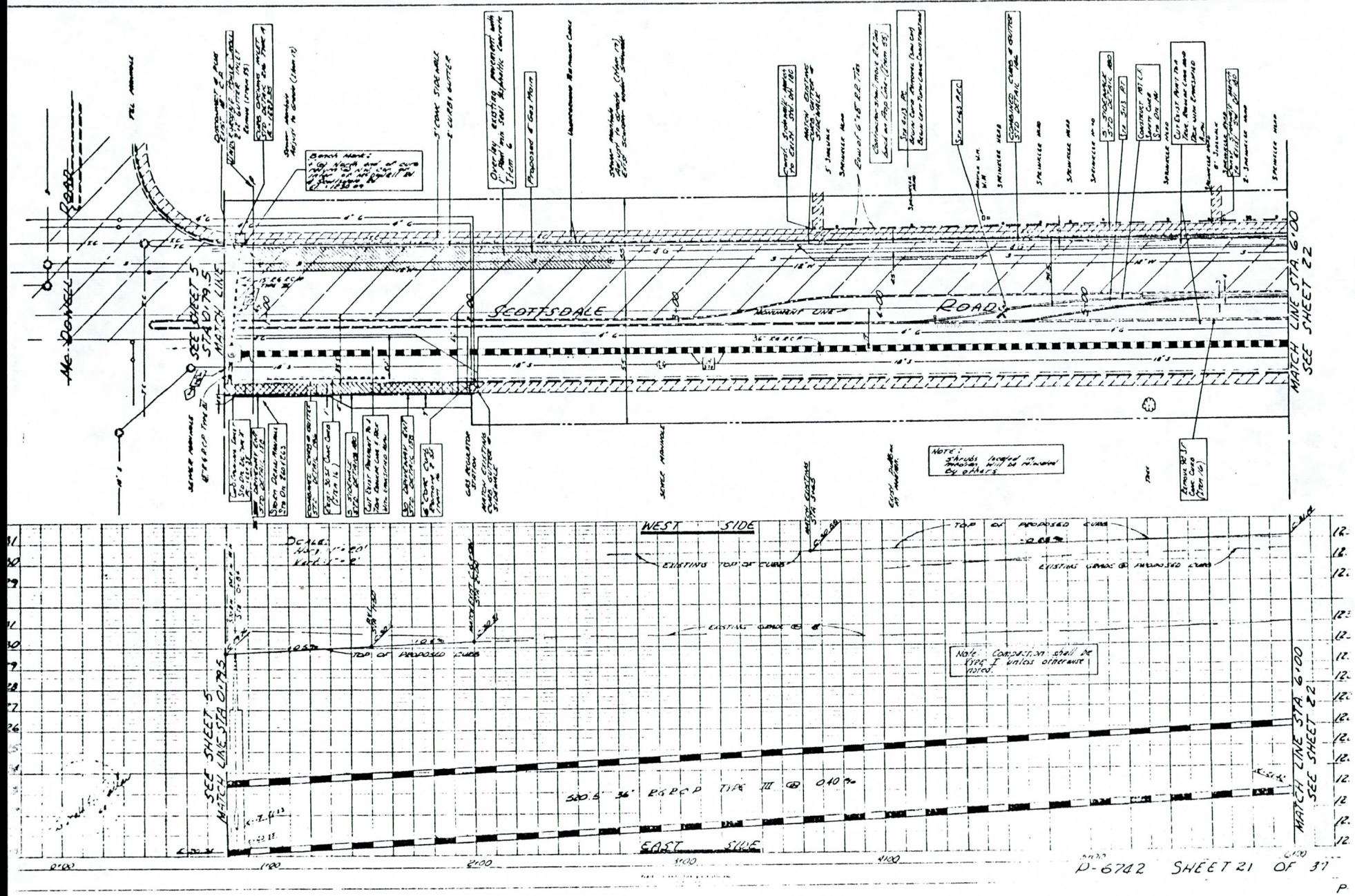


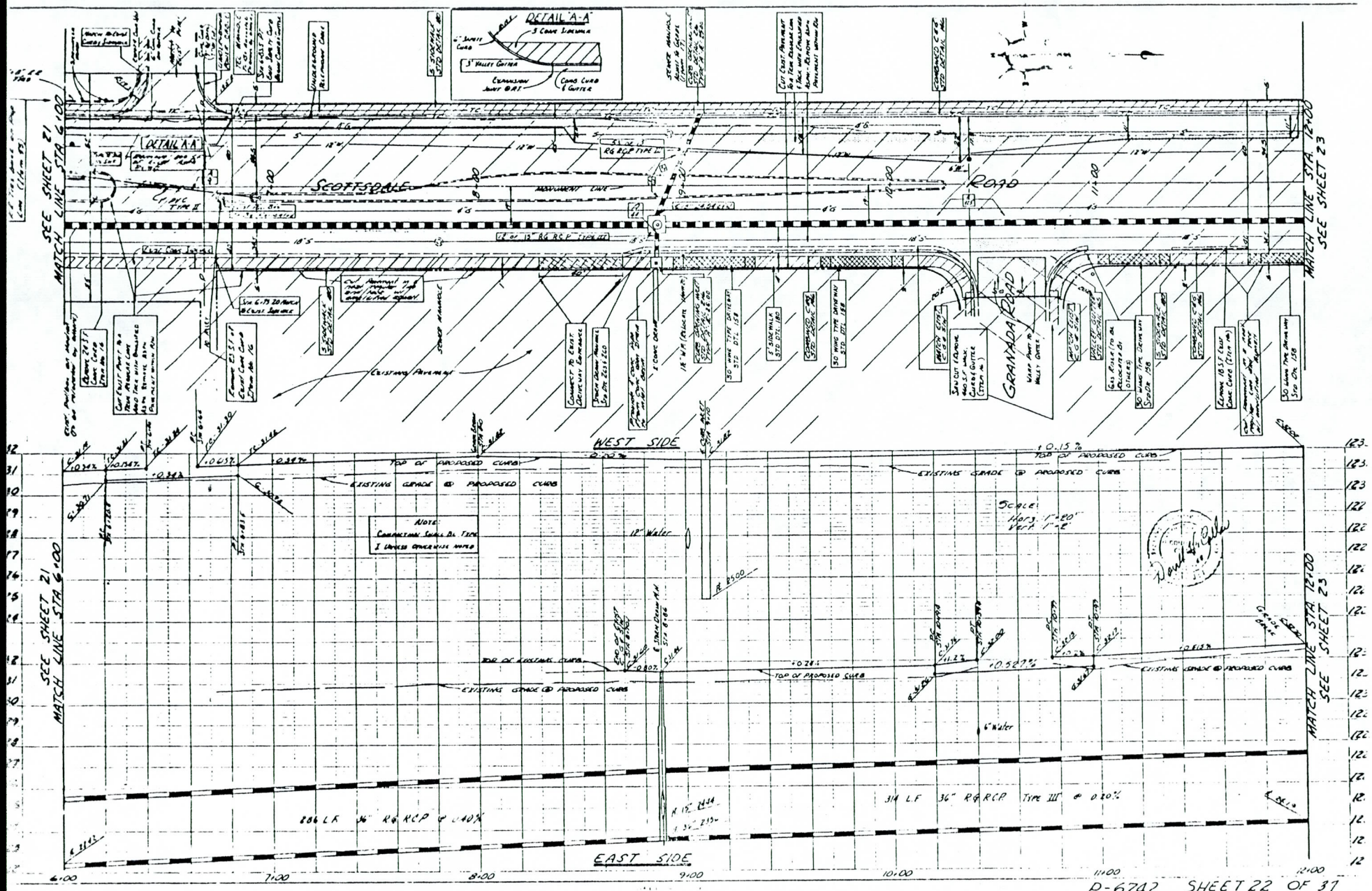


TYPICAL SECTION @ EARTH BERM
SCALE 1"=2' (Cost of Berm to be included in Item 86)

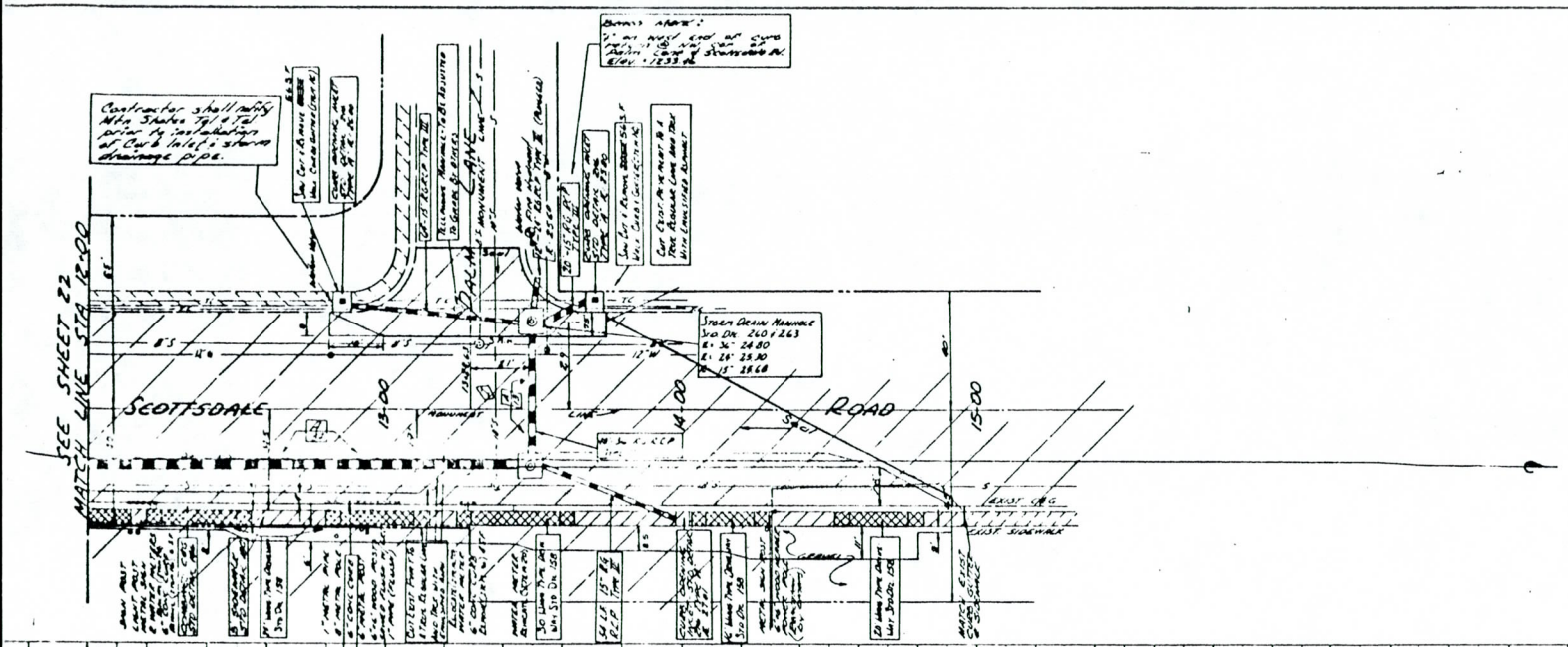


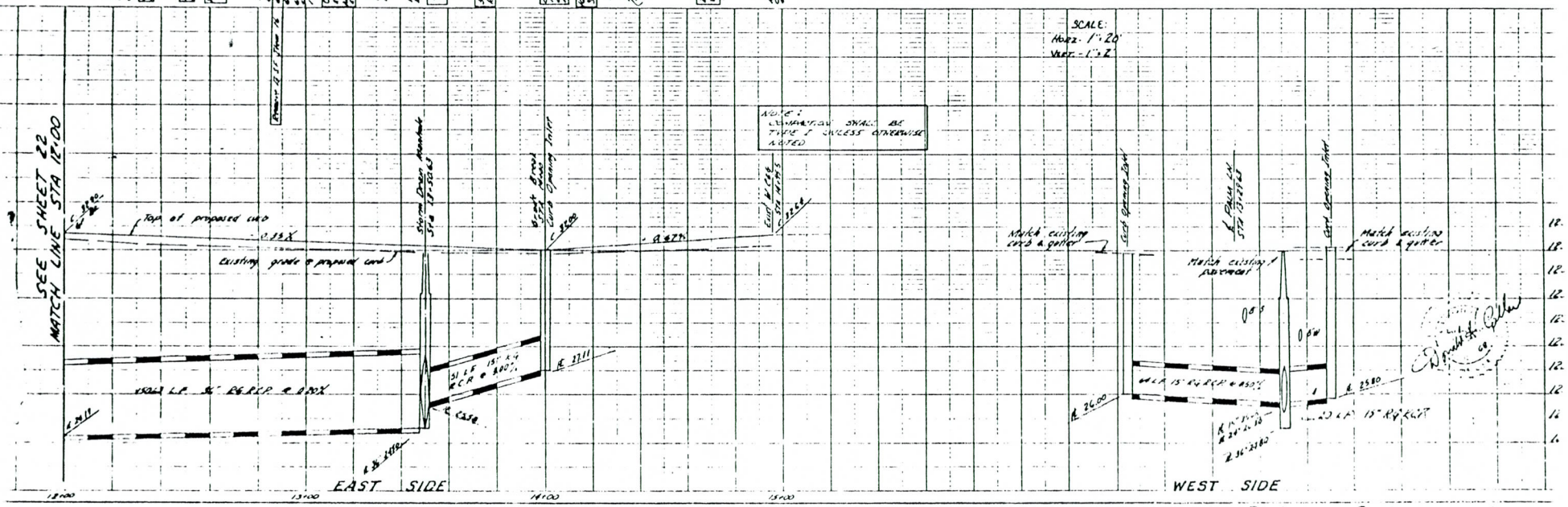
P-6742 SHEET 20 OF 37


McDOWELL
ROAD
SCOTTSDALE
ROAD
SEE SHEET 5
STA 01+79.5
MATCH LINE
MATCH LINE STA 6+00
SEE SHEET 22
NOTE: Shrubs located in median will be removed by others
WEST SIDE
EAST SIDE
EXISTING TOP OF CURB
TOP OF PROPOSED CURB
SEE SHEET 5
MATCH LINE STA 01+79.5
MATCH LINE STA 6+00
SEE SHEET 22

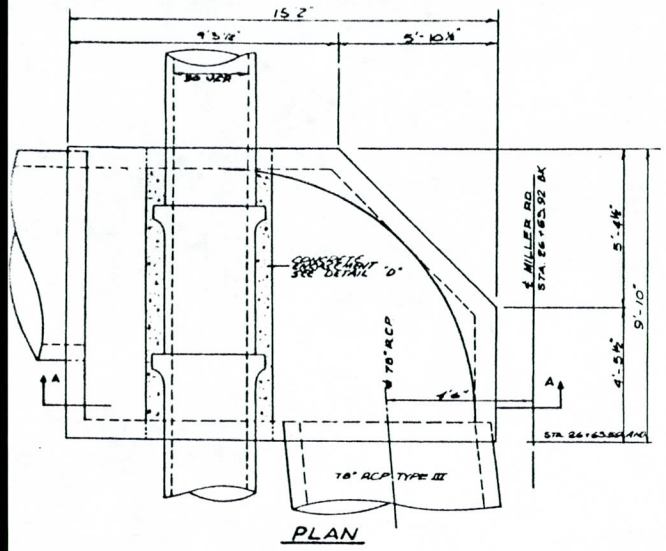


P-6742 SHEET 22 OF 37

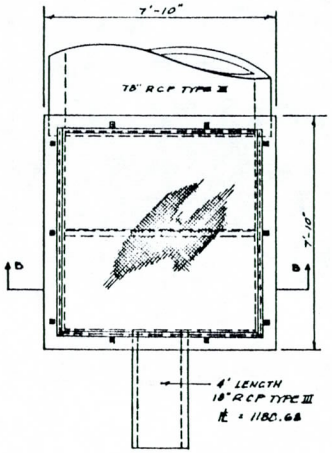




P-6742 SHEET 23 OF 37

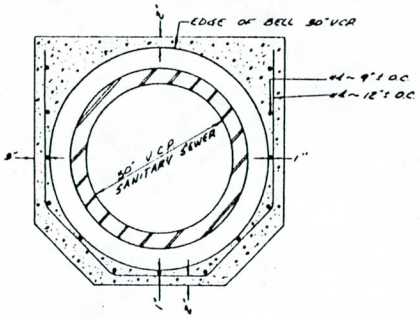


PLAN

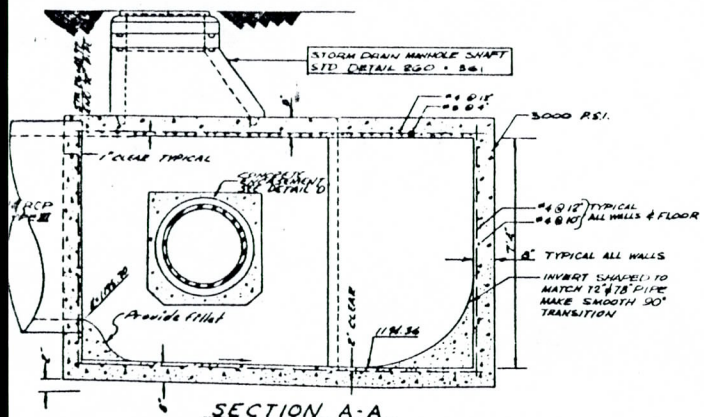


PLAN

STORM DRAIN
TURN STRUCTURE
CONCRETE ENCASEMENT
DETAIL "D"



TYPICAL SECTION
(LOOKING NORTH)
SCALE 1" = 1'

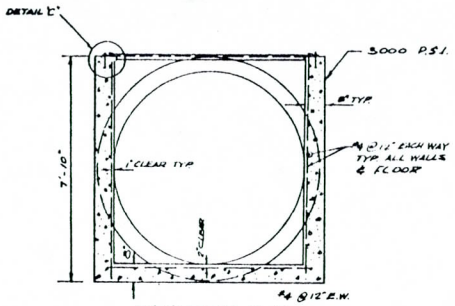


SECTION A-A

STORM DRAIN
TURN STRUCTURE
DETAIL "A"

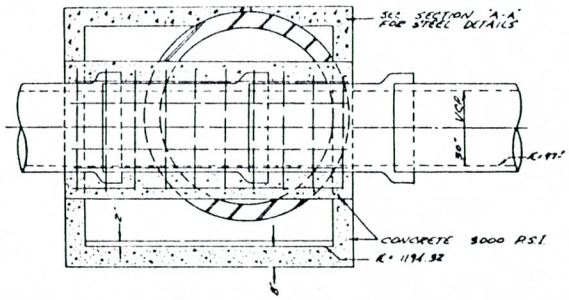
SCALE: 1/2" = 1'-0"

NOTE:
NO EXPOSED METAL SHALL BE PERMITTED UPON COMPLETION OF THE TURN STRUCTURE.

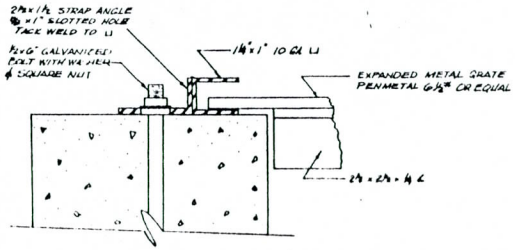


SECTION B-B

STORM DRAIN
DISCHARGE STRUCTURE
DETAIL "B"



TYPICAL SECTION
(LOOKING WEST)
SCALE 1/2" = 1'



DETAIL "C"

APPENDIX III:
Catch Basin Calculations

Catch basin #1 - Double curb opening

Street drainage

$T_c = 13$ $I = 6.6''/hr$

Street area = 900 x 48 = 43200 ft^2 = 0.99 acres

$C = 0.95$ ∴ $Q = 0.95 \times 6.6 \times 0.99 = 6.2$ cfs.

Runoff from Pitre Buick = 32 - 6 = 26 cfs

of which 19 cfs is picked up by grate.

∴ Pick up addt'l 7 cfs.

Road drainage

Flow depth = 0.3' a = 2" L = 8' S = 0.008'/ft

Q_a/L_a = 0.2 cfs/ft Account for clogging L = 8/1.25 = 6.4

$L_a = Q_a/0.2 = 6/0.2 = 30$ ft.

From Fig. 3-46b

$L/L_a = 6.4/30 = 0.21$ $a/d = \frac{0.167}{0.3} = 0.56$

$Q/Q_a = 0.34$

$Q_i = 0.34 \times 6 = 2.0$ cfs Flowby = 4.0 cfs

Ponding drainage

Sump condition Fig.

Height of opening = 0.42' y_o/h = 8'/5" = 1.6

Discharge = 1.5 cfs/ft.

Actual length = 8' 8/1.25 = 6.4' effective length

6.4 x 1.5 = 9.6 cfs ie 7cfs intercepted

Pickup = 26 + 2 = 28 cfs

Catch basin #2

Existi. catch basin Type 'c' with 8' curb opening

Flow passing = 11 cfs

Flow depth = 0.4 ft. (d)

$a = 2'' = 0.167'$ $n = 0.015$ $L = 8'$ $S = 0.008'/ft$

$\frac{Qa}{La} = 0.29$ cfs/ft (Fig 3-46a)

$La = \frac{11}{0.29} = 38$ ft

From Fig. 3-46b

$a/d = 0.167/0.4 = 0.42$

$L/La = 8/38 = 0.21$

$Qi/Qa = 0.34$ $Qi = 0.34 \times 11 = \underline{3.7}$ cfs

55 L.F. 12" Pipe @ $S = 0.006'/ft.$ (CWW)

G = 56.75 (CWW)

$55 \times 0.006 = 0.33'$

Inv. @ C.B = 53.25

Inv. @ M.H = 52.92

Water elev. = 0.5' below gutter = 56.75 - 0.5 = 56.25'

Top of pipe @ outlet to M.H. = 53.92

Head on pipe = 56.25 - 53.92 = 2.33'

$$V = \sqrt{\frac{2.33}{\left(1.5 + \frac{185 \times (0.012)^2 \times 55}{1}\right)} \times 2 \times 32.2} = 7.1 \text{ ft/s}$$

Area $= \frac{\pi \times 1}{4} = 0.79$ ft^2 Discharge = $0.79 \times 7.1 = \underline{5.6}$ cfs ∴ O.K.

Catch basin #3

Contributing flow = 4cfs flowby from #2 and 6.5cfs overland

Total Q = 10.5 cfs

d = 0.35 ft. a = 2"

Qa/La = 0.24 cfs/ft

Combination inlet MAG 533-1 with 10' wing

a/d = 0.167/0.35 = 0.48

La = 10.5/0.24 = 44 ft

L/La = 10/44 = 0.23

Q/Qa = 0.37 Qi = 0.37 x 10.5 = 3.9 cfs

Flowby = 6.6 cfs. to grate

Flow depth = 0.3 ft.

d' = 0.3 - 2/50 = 0.26' Flow passing = 4.5 cfs

Qi (grate) = 6.6 - 4.5 = 2.1 cfs

TOTAL Qi = 3.9 + 2.1 = 6 cfs

Flowby = 4.5 cfs

Catch basin #4

Flow from 68th St. = 19.0 cfs

Flowby from CB #3 = 4.5 cfs

Total Q = 23.5 cfs

For Q = 19.0 cfs depth @ curb = 0.58'

Using a grate in sump condition, dmax = 8" (0.67')

Grate = 2.5' x 3.5' Grate opening = 67%

Perimeter = 2.5 + 2.5 + (3.5 x 0.67) = 7.3'

From Fig. 3-48 Discharge = 2 cfs/ft.

Total capacity = 7.3 x 2 = 14.6 cfs (No clogging factor since combination inlet)

14.6 - 4.5 = 10.1 cfs capacity for flowby from 68th St

19.0 - 10.1 = 8.9 cfs required by wing.

i.e. $\frac{Q}{Q_a} = \frac{8.9}{19.0} = 0.47$

Given $a/d = 0.167/0.58 = 0.29$

From Fig. 3-46 $L/L_a = 0.28$

$Q/L_a = 0.45$ cfs/ft

$L_a = 19.0/0.45 = 42'$

$\Rightarrow L = 0.25 \times L_a = 0.25 \times 42 = 10.5$ ft.

Use Type D catch basin L = 10' at sag point on 68th St.

Catch basin #5

$Q = 5$ cfs

Try type D with $L = 3'$

$S = 0.004$ $d = 0.3'$

$a = 0.167'$

$Q_a/L_a = 0.2$ cfs/ft.

$a/d = 0.167/0.3 = 0.56$

$L_a = 5/0.2 = 25$ ft.

$L/L_a = 3/25 = 0.12$

$Q/Q_a = 0.2$ $Q_i = 1.0$ cfs

Grate $= 2.5' \times 3.5'$

For $Q = 4.0$ cfs $d = 0.28'$

$Q_B = 2.3$ cfs $\Rightarrow Q_i = 1.7$ cfs

Total $Q_i = 2.7$ cfs.

42 381 50 SHEETS 5 SQUARE
42 382 100 SHEETS 5 SQUARE
42 389 200 SHEETS 5 SQUARE
NATIONAL

Catch basin #6

Area 2-C = 7.0 acres Runoff = 30 cfs

Area contributing = 4.0 acres

$\therefore Q = 4/7.0 \times 30 = 17.2$ cfs

$Q_{TOTAL} = 17.2 + 12.5 (1/2\ 68^{th}\ St.) = 29.7$ cfs

Depth $d = 0.52'$ let $a = 0.167'$

$Qa/La = 0.4$ cfs/ft.

$Qa = 29.7$ cfs $La = \frac{29.7}{0.4} = 74.5'$

$a/d = \frac{0.167}{0.52} = 0.32$

Try $L = 17'$ $\Rightarrow L/La = 17/74.5 = 0.23'$

$Q/Qa = 0.4$

$Qi = 11.9$ cfs Flowby = 17.9 cfs

Grate = 2'x3'

$d' = d - 2/50 = 0.44 - 0.04 = 0.40$

$Q_B = 0.56 \times \left(\frac{50}{0.015}\right)(0.4)^{8/3} \times (0.008)^{1/2} = 14.5$ cfs

$Q_i = 17.9 - 14.5 = 3.4$ cfs

$Q_{Ti} = 11.9 + 3.4 = 15.3$ cfs

Catch basin #7

Area 2-C = 7.0 acres Runoff = 30 cfs

Area contributing = 2.2 acres

$\therefore Q = 2.2/7.0 \times 30 = 9.4$ cfs.

Flowby from CB#6 = 14.5 cfs

$Q_{TOTAL} = 14.5 + 9.4 = 23.9$ cfs

$S = 0.0095'/'$ $d = 0.47'$

$Q_a/L_a = 0.34$ cfs/ft

$Q_a = 23.9$ $L_a = \frac{23.9}{0.34} = 69.7'$

$a/d = 0.167/0.47 = 0.36$

Try L = 10' $\Rightarrow L/L_a = 10/69.7 = 0.14$

$Q/Q_a = 0.27 \Rightarrow Q_i = 6.4$ cfs

$Q_B = 17.5$ cfs

Grate

$d' = d - 2/50 = 0.42 - 0.04 = 0.38$

$Q_B = 0.56 \times \frac{50 \times \sqrt{0.0095}}{0.015} \times 0.38^{8/3} = 13.8$ cfs

$Q_i = 17.5 - 13.8 = 3.7$ cfs

Total intercept $Q_{Ti} = 6.4 + 3.7 = 10.1$ cfs

Catch basin #8

Area 2-C = 7.0 acres Runoff = 30 cfs

Area contributing = 0.8 acres

$\therefore Q = 0.8/7.0 \times 30 = 3.4$ cfs

Flowby from CB #7 = 13.8 cfs

Contribution from 69th St. = 20 cfs

$Q_{TOTAL} = 3.4 + 13.8 + 20 = 37.2$ cfs

Slope = 0.0095'/1 $d = 0.56'$

$Q_a/L_a = 0.42$ cfs/ft $L_a = \frac{37.1}{0.4} = 88.3'$

$a/d = 0.167/0.56 = 0.30$

Try $L = 17'$ $\Rightarrow L/L_a = 17/88.3 = 0.19$

$Q/Q_a = 0.36$

$Q_i = 13.5$ cfs $Q_B = 23.7$ cfs

Grate

$$d = \left(\frac{Qn}{0.56\,Z\sqrt{S}}\right)^{3/8} = \left(\frac{23.7 \times 0.015}{0.56 \times 50 \times \sqrt{0.0095}}\right)^{3/8} = 0.47'$$

$$d' = 0.47 - \frac{2}{50} = 0.43'$$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.0095} \times (0.43)^{8/3}}{0.015} = 19.2 \text{ cfs}$$

$Q_i = 23.7 - 19.2 = 4.5$ cfs

$Q_B = 19.2$ cfs

$Q_{Ti} = 4.5 + 13.4 = 17.9$ cfs

Catch basin #9

$Q = 26.2$ cfs Gutter slope = 0.0059

$d = 0.52$ ft $a = 0.167'$

$Q_a/L_a = 0.38$ cfs/ft.

Try C.B Type 'C' $L = 8'$ $8/1.25 = 6.4'$ effective

$a/d = 0.167/0.52 = 0.32$

$L_a = 26.2/0.38 = 68.9'$

$L/L_a = 6.4/68.9 = 0.093$

$\frac{Q}{Q_a} = 0.18$ $Q_i = 4.7$ cfs

$Q_B = 21.5$ cfs

$d = 0.48'$

Try Type 'D' with 10' wing

$L/L_a = 10/68.9 = 0.15$

$Q/Q_a = 0.24$ $Q_i = 6.3$ cfs. $Q_B = 19.9$ cfs.

Grate $2' \times 3'$

$$d = \left(\frac{19.9 \times 0.015}{0.56 \times 50 \times \sqrt{0.0059}} \right)^{3/8} = 0.48'$$

$$d' = 0.48 - \frac{2}{50} = 0.44'$$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.0059} \times (0.44)^{8/3}}{0.015} = 16.1 \text{ cfs}$$

$Q_i = 19.9 - 16.1 = 3.8$ cfs.

$Q_{Ti} = 6.3 + 3.8 = 10.1$ cfs

$Q_B = 26.2 - 10.1 = 16.1$ cfs

Catch basin #10

Flow in 70th St. = 19 cfs

Contribution from Area 2-D = 7 cfs

∴ Total flow in 70th St. = 26 cfs

1/2 street = 13 cfs

Flowby from CB#9 = 16.1 cfs

Total flow at CB#10 = 13 + 16.1 = 29.1 cfs

Grate = 2' x 3' depth = 0.6'

Effective perimeter = 2 + 2 + (3 + 3) x 0.67 = 8

Clogging factor = 2 ∴ P = 8/2 = 4

From Fig. 3-48 Q = 1.75 cfs/ft.

∴ Qi = 4 x 1.75 = 7 cfs

Flowby = 22.1 cfs

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Catch basin #11

1/2 sheet flow = 13 cfs ⇒ d = 0.40'

Qa/La = 0.28 cfs/ft

L = 3.5 ft effective length: 2.8'

a/d = 0.167/0.40 = 0.42

La = 13/0.28 = 46.4'

L/La = 2.8/46.4 = 0.06

Q/Qa = 0.12 = 1.6 cfs

Flowby = 13 - 1.6 = 11.4 cfs

Total flowby from 70th St. = 22.1 + 11.4 = 33.5 cfs

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Catch basin #12

$Q = 33.5$ cfs $\qquad s = \frac{39.36 - 38.72}{59} = 0.011$

$d = 0.52'$

Catch basin Type 'D' $\quad L = 10'$

$a = 0.167'$

$Q_a/L_a = 0.38$ cfs/ft

$a/d = 0.167/0.52 = 0.32$

$L_a = 33.5/0.38 = 88.2$ ft.

$L/L_a = 10/88.2 = 0.11$

$Q/Q_a = 0.2$

$Q_i = 6.7$ cfs

$Q_B = 26.8$ cfs.

Grate inlet 3'x2'

$$d = \left(\frac{26.8 \times 0.015}{0.56 \times 50 \times \sqrt{0.011}} \right)^{3/8} = 0.47$$

$$d' = 0.47 - \frac{2}{50} = 0.43$$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.011} \times (0.43)^{8/3}}{0.015} = 20.6 \text{ cfs}$$

$Q_i = 26.8 - 20.6 = 6.2$ cfs

$Q_{Ti} = 6.2 + 6.7 = 12.9$ cfs

Catch basin #13

$Q = 16.0$ cfs

Use C.B Type 'C' 8' curb opening

$8/1.25 = 6.4$ ft effective width.

Slope $= \frac{1240.65 - 1240.03}{60} = 0.010$

$d = 0.39$ ft

$Qa/La = 0.29$ cfs/ft.

$a/d = 0.167/0.39 = 0.43$

$La = 15.5/0.29 = 53.4$

$L/La = 6.4/53.4 = 0.12$

$Q/Qa = 0.21$

$Qi = 3.3$ cfs.

42 381 50 SHEETS 5 SQUARE
42 382 100 SHEETS 5 SQUARE
42 389 200 SHEETS 5 SQUARE
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Catch basin #14

$Q = 20.6$ cfs $\quad S = 0.0045 \quad d = 0.5$ ft

$a = 0.167'$

$Q_a/L_a = 0.38$ cfs/ft.

Type catch basin type 'C' $\quad L = 8'$

For clogging $L = 8/1.25 = 6.4'$

$a/d = 0.167/0.5 = 0.33$

$L_a = \frac{20.6}{0.38} = 54$ ft $\qquad L/L_a = 6.4/54 = 0.12$

$Q/Q_a = 0.22 \qquad Q_i = 4.5$ cfs

Try catch basin type 'D' $\quad L = 7'$

$L/L_a = 7/54 = 0.13 \qquad Q/Q_a = 0.24 \qquad Q_i = 4.9$ cfs

$Q_B = 20.6 - 4.9 = 15.7$ cfs

$$d = \left(\frac{15.7 \times 0.015}{0.56 \times 50 \times \sqrt{0.0045}}\right)^{3/8} = 0.46'$$

$d' = 0.46 - \frac{2}{50} = 0.42$

$$Q = \frac{0.56 \times 50 \times \sqrt{0.0045} \times (0.42)^{8/3}}{0.015} = 12.4 \text{ cfs}$$

$Q_i = 15.7 - 12.4 = 3.3$ cfs

$Q_{Ti} = 3.3 + 4.9 = 8.2$ cfs

$Q_B = 12.4$ cfs

Catch basin #15

$Q = 12.4 + 11.4 = 23.8$ cfs $s = 0.0045$ $d = 0.53'$

$a = 0.167$ $Q_a/L_a = 0.4$ cfs/ft.

Try catch basin type 'D' $L = 7'$

$a/d = 0.167/0.53 = 0.32$

$Q_a/L_a = 0.41$ cfs/ft.

$L_a = 23.8/0.41 = 58'$

$L/L_a = 7/58 = 0.12$

$Q/Q_a = 0.23$

$Q_i = 5.5$ cfs $Q_B = 18.3$ cfs

Grate intercept 2'x3' efficient

$$d = \left(\frac{18.3 \times 0.015}{0.56 \times 50 \times \sqrt{0.0045}}\right)^{3/8} = 0.49'$$

$d' = 0.49 - 2/50 = 0.45'$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.0045} \times (0.45)^{8/3}}{0.015} = 14.9 \text{ cfs}$$

$Q_i = 18.3 - 14.9 = 3.4$ cfs

$Q_{Ti} = 3.4 + 5.5 = 8.9$ cfs

Catch basin #16

Area of 3-D = 1.8 acres

Q = 10 cfs

Drainage to CB = 1.1 acres ⇒ Q = 1.1/1.8 × 10 = 6 cfs

S = 0.0092 ′/′

d = 0.28′ a = 0.167′

Qa/La = 0.20 cfs/ft.

a/d = 0.167/0.28 = 0.60

La = 6.0/0.2 = 30′

Try Type 'C' L = 8 Leff = 6.4′

L/La = 6.4/30 = 0.21

Q/Qa = 0.33

Qi = 2.0 cfs.

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Catch basin #17

Exist. Catch basin Type 'C' 6.7' curb opening

Gutter slope = $\frac{30.54 - 30.04}{67}$ = 0.0074

Q = 14.9 cfs Effective length = 6.7/1.25 = 5.4'

d = 0.41 ft. a = 0.167

Q_a/L_a = 0.29 cfs/ft

a/d = 0.167/0.41 = 0.41

L_a = 14.9/0.29 = 51.4 ft.

L/L_a = 5.4/51.4 = 0.11

Q/Q_a = 0.19

Q_i = 0.19 × 14.9 = 2.8 cfs

Q_B = 12.1 cfs.

Catch basin #18

Flowby from 17 = 12.1 cfs
Addt'l inflow = 11.6
Total = 23.7 cfs

Gutter slope = $\frac{30.04 - 29.38}{107}$ = 0.0062

d = 0.5 ft

Q_a/L_a = 0.38 cfs/ft. L = 23.7/0.38 = 62.4 ft

Try Type 'D' with 10' wing

L/L_a = 10/62.4 = 0.16

a/d = 0.167/0.5 = 0.33

Q/Q_a = 0.29 ⇒ Q_i = 6.9 cfs

Q_B = 16.8 cfs ⇒ $d = \left(\frac{16.8 \times 0.015}{0.56 \times 50 \times \sqrt{0.0062}}\right)^{3/8}$ = 0.44'

$d' = d - \frac{2}{50}$ = 0.40. ⇒ $Q_B = \frac{0.56 \times 50 \times \sqrt{0.0062} \times (0.4)^{8/3}}{0.015}$ = 12.8 cfs

Q_{IT} = 10.9 cfs

Catch basin #19

Gutter slope = 0.013

Length = 10' Effective length = 8'

Q = 12.8 cfs d = 0.35'

Qa/La = 0.25 cfs/ft

a/d = 0.167/0.35 = 0.48'

La = 12.8/0.25 = 51.2'

L/La = 8/51.2 = 0.16

Q/Qa = 0.28 ⇒ Qi = 3.6 cfs

QB = 9.2 cfs

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Catch basin #20

$Q = 0.7/1.8 \times 10 = 4.0$ cfs

Try Type 'B' catch basin $L = 5.5'$

Effective length $= 4.4'$

$S = 0.43\%$ $d = 0.18'$

$Q_a/L_a = 0.13$ cfs/ft

$a/d = 0.93$

$L_a = 4/0.13 = 31.0$

$L/L_a = 4.4/31 = 0.14$

$Q/Q_a = 0.21$ $Q_i = 0.8$ cfs

NATIONAL 42 381 50 SHEETS 5 SQUARE 42 382 100 SHEETS 5 SQUARE 42 389 200 SHEETS 5 SQUARE

Catch basin #21

Exist. 6' curb inlet

Q from west McDowell = 9.2 cfs

Gutter height = 5"

Allowable depth in sag = 8" (y_o)

y_o/h = 8"/5" = 1.6

6/1.25 = 4.8' eff. length

Capacity of curb = 1.5 cfs/ft

4.8 x 1.5 = 7.2 cfs

9.2 - 7.2 = 2 cfs to CB#22

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Catch basin #22

Allowable depth = 8"

$y_o/h = 8''/5'' = 1.6$

17 ft. wing. effective length = 17/1.25 = 13.6 ft.

Discharge capacity = 1.4 cfs/ft.

Q = 13.6 x 1.4 = 19 cfs.

For grate inlet.

From Fig 3.48 Q = 2 cfs/ft. perim

Grate = 2' x 3' assume 67% open space

effective perimeter = (2+2+3) x 0.67 = 4.7 ft.

$Q_i = 2 \times 4.7 = 9.4$ cfs

To account for clogging $Q_i = 9.4/2 = 4.7$ cfs

$Q_T = 19 + 4.7 = 23.7$ cfs.

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42-389 200 SHEETS 5 SQUARE
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Catch basin #23

Drainage area 1-E = 2.3 acres

Travel distance = 1200 ft

$V = 54\, S^{1/2} = 54 \times \sqrt{0.0037} = 3.3$ ft/s

Travel time = 6 mins north-south.

Total T_c = 16 mins ⇒ $i = 5.9$"/hr

$Q = C i a = 0.85 \times 5.9 \times 2.3 = 11.5$ cfs.

$$d = \left(\frac{11.5 \times 0.015}{0.56 \times 50 \times \sqrt{0.0037}} \right)^{3/8} = 0.42 \text{ ft.}$$

$a = 0.167'$

$Q_a / L_a = 0.3$ cfs/ft

$a/d = 0.167/0.48 = 0.35$

$L_a = 11.5/0.3 = 38$ ft

Try Catch basin Type 'D' $L = 10'$

$L/L_a = 10/38 = 0.26$

$Q/Q_a = 0.42$ $\quad Q_i = 0.42 \times 11.5 = 4.8$ cfs

$Q_3 = 6.7$ cfs.

$$d = \left(\frac{6.7 \times 0.015}{0.56 \times 50 \times \sqrt{0.0037}} \right)^{3/8} = 0.35 \text{ ft.}$$

$d' = d - 3/50 = 0.31$

$$Q_g = \frac{0.56 \times 50 \times \sqrt{0.0037} \times (0.31)^{8/3}}{0.015} = 5 \text{ cfs}$$

$Q_i = 6.7 - 5 = 1.7$ cfs

TOTAL $Q_i = 11.5 - 5 = 6.5$ cfs

Catch basin #24

Use double sided inlet C.O.P. Type 'L' P-1568

length of curb opening = 8'

Flow from area 5-A11 = 9 cfs.

Curb opening in sump.

Gutter depression = 2"

Gutter opening height, h, = 5"

Max. allowable depth = 8"

$y_0/h = 8''/5'' = 1.6$

From Fig. 3-47 capacity = 1.5 cfs/ft.

length for 9 cfs = 9/1.5 = 6 feet.

clogging factor = L = 6×1.25 = 7.5 ft. 8 ft. o.k.

McDonell gutter slope (75+00 - 76+00) = 1.03/100 = 0.0103'/Ft.

Q = 5 cfs L = 8' effective length = 6.4'

$$d = \left(\frac{5 \times 0.015}{0.56 \times 50 \times \sqrt{0.0103}}\right)^{3/8} = 0.26'$$

a = 0.167'

Q_a/L_a = 0.17 cfs/ft

a/d = 0.167/0.26 = 0.64

L_a = 5/0.17 = 29.4 ft.

L/L_a = 6.4/29.4 = 0.22

Q/Q_a = 0.35 Q_i = 1.8 cfs Q_B = 3.2 cfs

Total Q_i = 1.8 + 9 = 10.8 cfs

Catch basin #25

$Q = 36 + 3.2 \text{ cfs} = 39.2 \text{ cfs}$

$$d = \left(\frac{39.2 \times 0.015}{0.56 \times 50 \times \sqrt{0.0085}} \right)^{3/8} = 0.57 \text{ ft.}$$

Try catch basin Type 'D' $L = 17'$

$a = 0.167'$

$Q_a/L_a = 0.43 \text{ cfs/ft}$

$a/d = 0.29$

$L_a = 39.2/0.43 = 91.2'$

$L/L_a = 17/91.2 = 0.19$

$Q/Q_a = 0.35$ $\quad Q_i = 13.7 \text{ cfs}$

$Q_B = 25.5 \text{ cfs}$

$$d = \left(\frac{25.5 \times 0.015}{0.56 \times 50 \times \sqrt{0.0085}} \right)^{3/8} = 0.49'$$

$d' = 0.49 - \frac{2}{50} = 0.45$

$$Q_B = \frac{0.56 \times 50 \times (0.45)^{8/3} \times \sqrt{0.0085}}{0.015} = 20.5 \text{ cfs}$$

$Q_i \text{ (grate)} = 25.5 - 20.5 = 5 \text{ cfs}$

Total $Q_i = 13.7 + 5 = 18.7 \text{ cfs.}$

Catch basin #26

Flowby from #25 = 20.5 cfs

Areas $5\text{-}A_2 + 5A_3 = 14.7 - 9.0 = 5.7$ acres

$5\text{-}A_2 = 2.8$ acres $\Rightarrow 5\text{-}A_3 = 2.9$ acres

Additional Q = 68 - 45 = 23 cfs

Addition from $5\text{-}A_2 = \frac{2.8}{5.7} \times 23 = 11.3$ cfs

" " $5A_3 = 23 - 11.3 = 11.7$ cfs

Total at pt. $5\text{-}A_2 = 11.3 + 20.5 = 31.8$ cfs

Gutter slope = 0.00784'/FT.

$$d = \left(\frac{31.8 \times 0.015}{0.56 \times 50 \times \sqrt{0.00784}} \right)^{3/8} = 0.54'$$

Try CB Type D, L = 10'

$Q_a/L_a = 0.4$ cfs/ft.

$a/d = 0.167/0.54 = 0.31$

$L_a = 31.8/0.4 = 79.5$

$L/L_a = 10/79.5 = 0.13$

$Q/Q_a = 0.25$

$Q_i = 31.8 \times 0.25 = 8.0$ cfs

$Q_3 = 31.8 - 8 = 23.8$ cfs Q.grate

$$d = \left(\frac{23.8 \times 0.015}{0.56 \times 50 \times \sqrt{0.00784}} \right)^{3/8} = 0.48$$

$d' = d - 2/50 = 0.48 - 0.04 = 0.44$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.00784} \times (0.44)^{8/3}}{0.015} = 18.5 \text{ cfs}$$

Q_i grate = 23.8 - 18.5 = 5.3 Total $Q_i = 13.3$

Catch basin #27

Sump section at 74th St. & McDonnell

Try CB Type 'D' L=10'

Gutter slope = 0.00784

Take max. depth = 8" = 0.67'

To account for gutter slope av. depth = 0.6'

Gutter height opening = 5" = 0.42

y_o/h = 0.6/0.42 = 1.43

From Fig 3-47

Capacity = 1.3 cfs/ft.

Total length = 10 ft ⇒ Q = 13 cfs

Grate inlet discharge = 1.7 cfs/ft of perimeter

Grate = 2x3 Perim = 2+2+3 = 7 ft.

Q = 7 x 1.7 = 11.9 cfs

Total Q_i = 13 + 11.9 = 24.9 cfs

Catch basin #28

Q = 9 cfs

$$d = \left(\frac{9 \times 0.015}{0.56 \times 50 \times \sqrt{0.00784}}\right)^{3/8} = 0.34'$$

Try catch basin Type 'C' L = 8'

Effective length = 8/1.25 = 6.4'

a/d = 0.67/0.34 = 0.49 Q_a/L_a = 0.23 cfs/ft

L_a = 9/0.23 = 39 ft.

L/L_a = 6.4/39 = 0.16 Q/Q_a = 0.26

Q_i = 9 x 0.26 = 2.3 cfs.

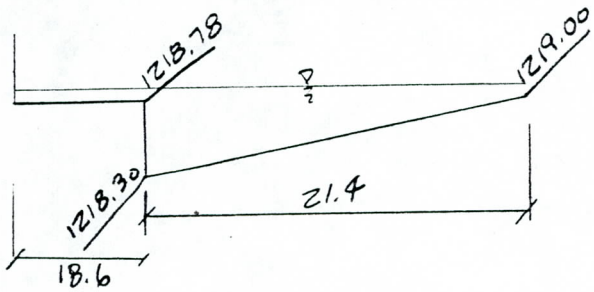
Catch basin #29

Flow to east side of 74th St. $Q = 11.8$ cfs

#26 intercepts 24.9 cfs

Excess flow = $18.5 + 11.7 + 11.8 + 6.2 - 24.9 = 23.3$ cfs

At Sta. 0+89 on 74th St.



Flow depth at gutter = 0.7'

Street slope = 0.14/111 = 0.0013

$$Q = \frac{0.56 \times 30.6 \times \sqrt{0.0013} \times (0.7)^{8/3}}{0.015} = 15.9 \text{ cfs}$$

18.5 + 11.7 + 11.8 = 42 cfs 42 − 24.9 = 17.1 cfs ∴ O.K.

a = 0.167'

$Q_a/L_a = 0.56$ cfs/ft

$a/d = 0.167/0.7 = 0.24$

$L_a = 17.1/0.56 = 30.5$ ft.

Try CB Type D, L = 10'

$L/L_a = 10/30.5 = 0.33$

$Q/Q_a = 0.58$ $Q_i = 9.9$ cfs

$Q_B = 7.2$ cfs $d = \left(\frac{7.2 \times 0.015}{0.56 \times 30.6 \times \sqrt{0.0013}}\right)^{3/8} = 0.52'$

$d' = 0.52 - \frac{2}{30.5} = 0.45'$

$$Q_B = \frac{0.56 \times 30.6 \times \sqrt{0.0013} \times (0.45)^{8/3}}{0.015} = 4.9 \text{ cfs}$$

$Q_{i\,grade} = 7.2 - 4.9 = 2.3$ cfs $Q_{total\ intercept} = 2.3 + 9.9 = 12.2$ cfs

Catch basin #30

Q = 3 cfs Given sag depth = 0.5'

y_o/h = 6"/5" = 1.2

From Fig. 3-47 Q = 1.0 cfs/ft.

Require 3 feet opening

3 x 1.25 (Clogging) = 3.75 feet.

Use catch basin Type 'A' 3.5' curb opening.

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42 382 100 SHEETS 5 SQUARE
42 389 200 SHEETS 5 SQUARE
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Catch Basin #31

$Q = 20.6$ cfs. $s = 0.254\%$

$$d = \left(\frac{20.6 \times 0.015}{0.56 \times 50 \times \sqrt{0.00254}}\right)^{3/8} = 0.57 \text{ ft.}$$

$a = 0.167'$ $Q_a/L_a = 0.42$ cfs/ft.

Try $L = 10'$ $a/d = 0.29$

$L = 20.6/0.42 = 49$ ft.

$L/L_a = 10/49 = 0.20$

$Q/Q_a = 0.36$ $Q_i = 7.4$ cfs

$Q_B = 13.2$ cfs.

$$d = \left(\frac{13.2 \times 0.015}{0.56 \times 50 \times \sqrt{0.00254}}\right)^{3/8} = 0.48'$$

$d' = 0.48 - 2/50 = 0.44'$

$$Q_B = \frac{0.56 \times 50 \times \sqrt{0.00254} \times (0.44)^{8/3}}{0.015} = 10.5 \text{ cfs}$$

$Q_i = 13.2 - 10.5 = 2.7$ cfs

Q_i total $= 7.4 + 2.7 = 10.1$ cfs.

Try $L = 17'$

$L/L_a = 17/49 = 0.35$

$Q/Q_a = 0.53$ $Q_i = 10.9$ cfs $Q_B = 9.7$ cfs

$$d = \left(\frac{9.7 \times 0.015}{0.56 \times 50 \times \sqrt{0.00254}}\right)^{3/8} = 0.43$$

$d' = 0.43 - 2/50 = 0.39$ $Q_B = \dfrac{0.56 \times 50 \times \sqrt{0.00254} \times (0.39)^{8/3}}{0.015} = 7.6$ cfs

Q_i grate $= 9.7 - 7.6 = 2.1$ cfs

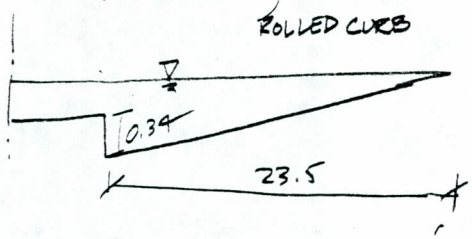
Total $Q_i = 2.1 + 10.9 = 13.0$ cfs $\Rightarrow Q_B = 7.6$ cfs.

Catch basin #32

$Q = 25$ cfs

Sta 4+50	T/C	23.5 ℄	℄	23.5 ℄	T/C
	11.27	10.93	11.46	10.96	11.47

ROLLED CURB



$S = 0.0024'/ft$

$11.46 - 10.93 = 0.53'$

Area $= 0.53 \times \frac{23.5}{2} = 6.2\ ft^2$ $\quad P = 23.5$

$$Q = \frac{1.49 \times 6.2 \times \left(\frac{6.2}{23.5}\right)^{2/3} \times \sqrt{0.0024}}{0.015} = 12.4 \text{ cfs}$$

Assume depth = 0.1' above crown and above s/w

$0.63 - 0.34 = 0.29'$ $\quad$ Area $= 5 \times 0.29 = 1.5\ ft^2$

$0.1 \times 23.5 = 2.35$

$\therefore$ Total area $= 6.2 + 1.5 + 2.35 = 10\ ft^2$

$$Q = \frac{1.49 \times 10 \times \left(\frac{10}{23.5}\right)^{2/3} \times \sqrt{0.0024}}{0.015} = 27 \text{ cfs.} \quad \therefore 25 \text{ o.k.}$$

Flow depth $= 0.63'$

$d = 0.167'$

$Q_a/L_a = 0.48$ cfs/ft.

Try $L = 17'$ $\quad a/d = 0.167/0.63 = 0.27$

$L_a = 25/0.48 = 52$ ft

$L/L_a = 17/52 = 0.33$ $\quad Q/Q_a = 0.58$

$Q_i = 14.5$ cfs. $\quad Q_B = 10.5$ cfs

$$d = \left(\frac{10.5 \times 0.015}{0.56 \times 44 \times \sqrt{0.0024}}\right)^{3/8} = 0.47'$$

Catch basin #32

$d' = 0.47 - 3/44 = 0.42$

$$Q_B = \frac{0.56 \times 44 \times \sqrt{0.0024} \times (0.42)^{8/3}}{0.015} = 8.0 \text{ cfs}$$

$Q_i = 10.5 - 8.0 = 2.5$ cfs

Total $Q_i = 2.5 + 14.5 = 17.0$ cfs

$Q_B = 8.0$ cfs

NATIONAL 42-381 50 SHEETS 5 SQUARE 42-382 100 SHEETS 5 SQUARE 42-389 200 SHEETS 5 SQUARE

Catch basin #33 & #34

Curb opening length = 38'

2-grates 2'x3'

Sump condition

For 2 grates perimeter = 2(3x0.67+2+2) = 12'

Effective perimeter = 6' (due to clogging)

Try d = 0.5'

Curb opening $y_o/h = 0.5/0.41 = 1.22$ Q = 1.1 cfs/ft.

$Q_T = 1.1 \times 38 = 41.8$ cfs.

grate = 1.2 cfs/ft. $Q_T = 1.2 \times 6 = 7.2$ cfs

$Q_{TOTAL} = 49.0$ cfs

Try d = 0.3'

Curb opening $y_o/h = 0.3/0.41 = 0.73$ Q = 0.5 cfs/ft.

$Q_T = 0.5 \times 38 = 19$ cfs

grate = 0.4 cfs/ft $Q_T = 2.4$ cfs

$Q_{TOTAL} = 21.4$ cfs

Try d = 0.4'

Curb opening $y_o/h = 0.4/0.41 = 1.0$ Q = 0.75 cfs/ft

$Q_T = 28.5$ cfs

grate = 0.74 cfs/ft $Q_T = 4.4$ cfs

$Q_{TOTAL} = 32.9$ cfs

$d \approx 0.35'$

Catch basin #35

Grate = 3'x2' Q = 5 cfs

Perimeter = (3x0.67 + 2 + 2) = 6 ft

Effective perimeter = 6/2 = 3 ft.

From Fig. 3-48 for 5/3 = 1.67 cfs/ft.

d = 0.58'

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APPENDIX IV:
Connector Pipe Calculations

Catch basin #1

$Q_{grate} = 19$ cfs

$Q_{curb} = 7$ cfs

$Q_{street} = 2$ cfs $\quad Q_{total} = 28$ cfs

Catch basins in series.

HGL in main line = 51.30

Connector – Grate–Curb

$L = 6$ L.F. $\quad d = 18'' \Rightarrow V = 10.75$ ft/s

$$H = \left(1.5 + \frac{185 n^2 L}{d^{4/3}}\right)\frac{V^2}{2g} = 2.86 \text{ ft.}$$

Try $d = 24'' \Rightarrow V = 6.05$ ft/s

$H_L = 0.89$ ft.

Curb inlet to S.D.

$L = 33$ L.F. $\quad d = 24'' \Rightarrow V = 3.9$ ft/s

$H_L = 2.27$ ft.

HGL = 51.30 at S.D.

HGL CB#A = 51.3 + 2.27 = 53.57

HGL CB#B = 53.57 + 0.89 = 54.46 ∴ O.K.

Catch basin #2

$Q = 4$ cfs

HGL @ M.H = 51.2

Gutter at inlet = 56.49

less 0.5' = 55.99

$H = 55.99 - 51.2 = 4.79'$

$H = \left(1.5 + \frac{185 n^2 L}{d^{4/3}}\right)\frac{V^2}{2g}$ $L = 86'$

Try $d = 15''$ $\Rightarrow$ $H = 3.2\frac{V^2}{2g}$ $\Rightarrow$ $V = 9.8$ ft/s

$Q = 9.8 \times 1.227 = 12$ cfs $\therefore$ O.K.

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Catch basin #3

$Q = 6$ cfs

HGL @ pipe = 49.1

Gutter = 53.11 less 0.5' = 52.61

$H = 52.61 - 49.1 = 3.51'$

Try $d = 15''$ $\Rightarrow$ $H = 2.19\frac{V^2}{2g}$ $\Rightarrow V = 10.15$ ft/s

$\Rightarrow Q = 12.5$ cfs.

Catch basin #4

$Q = 19.5$ cfs

HGL @ pipe = 47.7 $L = 77'$

Gutter = 52.22 less 0.5' = 51.72

$H = 51.7 - 47.7 = 4'$

Try $d = 24''$ $\Rightarrow$ $V = 9.77$'/s $H = 3.43'$

Catch basin #5

Use 15" connector

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Catch basin #6

$Q = 15.3$ cfs

HGL = 42.50 Gutter = 46.22 less 0.5' = 45.72

$H = 3.22$

Try $d = 18''$

$H = 1.95 \frac{V^2}{2g} \Rightarrow V = 10.31$ ft/s $\Rightarrow Q = 18.2$ cfs

Catch basin #7

$Q = 10.1$ cfs

HGL = 39.4 Gutter = 43.48 less 0.5' = 42.98

$H = 3.58$

Try $d = 15''$

$H = 2.76 \frac{V^2}{2g} \Rightarrow V = 9.15$ ft/s $\Rightarrow Q = 11.22$ cfs

Catch basin #8

$Q = 17.9$ cfs

HGL = 38.8 Gutter = 42.63 less 0.5' = 42.13

$H = 3.33$

Try $d = 18''$

$H = 1.90 \frac{V^2}{2g} \Rightarrow V = 10.62$ ft/s $\Rightarrow Q = 18.77$ cfs.

Catch basin #9

$Q = 10.1$ cfs

HGL = 36.00 Gutter = 40.56 less 0.5' = 40.06

$H = 4.06$

Try $d = 15''$

$H = 2.35 \frac{V^2}{2g} \Rightarrow V = 10.55$ ft/s $\Rightarrow Q = 12.94$ cfs.

Catch basin #10, 11 & 12

$Q_{10} = 7$ cfs $Q_{11} = 1.6$ cfs $Q_{12} = 12.9$ cfs

Grate #10 = 1240.47 less 0.5' = 1239.97

$d = 12'' \Rightarrow V = 8.91$ ft/s $\Rightarrow H = 3.29'$

HGL = 35.4

1239.97 - 3.29 = 36.68 36.68 - 35.4 = 1.28

Head loss is too great.

Disconnect CB# 10

For CB #10

HGL = 35.8 39.97 - 35.8 = 4.17

Try $d = 15''$

$H = 2.03 \frac{V^2}{2g} \Rightarrow V = 11.49$ ft/s $\Rightarrow Q = 14.1$ cfs.

Catch basin #11 #12

$Q_{11} = 1.6$ cfs G = 1239.78 less 0.5' = 1239.28

d = 12" L = 54'

$H = 2.94 \frac{V^2}{2g}$ V = 2.04 ft/s ⇒ H = 0.19'

head = 1239.28 − 0.19 = 1239.09

HGL @ sta. 60+79 35.40

39.09 − 35.40 = 3.69

$Q_{12} = 12.9$ cfs Combined Q = 14.5 cfs

Try d = 18"

$H = 1.89 \frac{V^2}{2g}$ ⇒ V = 11.22 ft/s ⇒ Q = 19.8 cfs.

Catch basin #13

Q = 3.3 cfs. Use 15" RCP

G = 40.10 less 0.5' = 39.6

HGL = 36.00 H = 3.60

$H = 2.65 \frac{V^2}{2g}$ ⇒ V = 9.36 ft/s ⇒ Q = 11.5 cfs

Catch basin #14

Q = 8.2 cfs

G = 35.32 less 0.5' = 34.82

HGL = 32.40 H = 2.42'

Try d = 15"

$H = 2.05 \frac{V^2}{2g}$ ⇒ V = 8.75 ft/s ⇒ Q = 10.74

Catch basin #15

$Q = 8.9$ cfs

$G = 33.90$ less $0.5' = 33.40$

$HGL = 31.0$ $H = 2.40$

Try $d = 15''$ $H = 2.01 \frac{V^2}{2g}$ $\Rightarrow V = 8.76$ ft/s $\Rightarrow Q = 10.75$ cfs

Catch basin #16

Use 15" pipe

Catch basin #17

$Q = 2.8$ cfs

Use $d = 15''$ $H = 3.26 \frac{V^2}{2g}$ $V = 2.28$ ft/s

$H = 0.26$ ft

$G = 30.07$ less $0.5' = 29.57$

H @ CB #18 = $29.57 - 0.26 = 29.31$

Catch basin #19

$Q = 3.6$ cfs

Use $d = 15''$ $H = 2.90 \frac{V^2}{2g}$ $V = 2.93$ ft/s

$G = 28.79$ less $0.5' = 28.29'$

$H = 0.39$ Elev. @ CB #19 = $28.29 - 0.39 = 27.90$

Catch basin #18

$Q = 2.8 + 3.6 + 10.9 = 17.3$ cfs

$HGL = 1226.60$ $27.90 - 26.6 = 1.3$ feet.

Try $d = 18''$ $V = 9.79$ ft/s

$H = 3.10 \frac{V^2}{2g} = 4.6$ ft.

Catch basin #18

Try $d = 24''$ $V = 5.5$ ft/s

$H = 2.59 \frac{V^2}{2g} = 1.21$ ft. $\therefore$ O.K.

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Catch basin #23

$Q = 6.5$ cfs

HGL = 1225.1

G = 27.71 less 0.5' = 27.21

H = 27.21 − 25.1 = 2.11

Try d = 15" V = 5.3 ft/s

$H = 1.62 \frac{V^2}{2g} = 0.71$ ∴ O.K.

Catch basin #24

$Q = 10.8$ cfs

HGL = 1223.6

G = 26.09 less 0.5' = 25.59

H = 25.59 − 23.6 = 1.99

Try d = 15" V = 8.8 ft/s

$H = 1.6 \frac{V^2}{2g} \Rightarrow H = 1.92$ ∴ O.K.

Catch basin #25

$Q = 18.7$ cfs

HGL = 20.00 (Flow within pipe)

G = 22.21 less 0.5' = 21.71

H = 1.71 ft.

Try d = 18" ⇒ V = 10.58 ft/s

$H = 2.2 \frac{V^2}{2g} \Rightarrow H = 3.82$

Try d = 21" ⇒ V = 7.78 ft/s $H = 2.08 V^2/2g = 1.96$

Try d = 24" ⇒ V = 5.95 ft/s $H = 1.77 V^2/2g = 0.97$ ∴ O.K.

Catch basin #26

$Q = 13.3$ cfs

HGL = 17.6 (crown of pipe)

G = 19.94 less 0.5' = 19.44

19.44 - 17.6 = 1.84

Try d = 18" V = 7.53'/s

$H = 2.2 V^2/2g \Rightarrow H = 1.94'$ close enough

Catch basin #27

$Q = 24.9$ cfs

HGL = 1216

G = 1217.78 less 0.5' = 1217.28

H = 1.28

Try d = 24" V = 7.92'/s

$H = 1.98 V^2/2g \Rightarrow H = 1.92'$

Try d = 27" V = 6.26'/s

$H = 1.91 \frac{V^2}{2g} \Rightarrow H = 1.16$ ∴ O.K.

Catch basin #28

$Q = 2.3$ cfs

HGL = 1216

G = 1218.16 less 0.5' = 1217.66

H = 1.66' Try d = 15" V = 1.87'/s

$H = 2.17 \frac{V^2}{2g} = 0.12'$ ∴ O.K.

Catch basin #29

Q = 12.2 cfs

HGL = 15.6

G = 18.12 less 0.5' = 17.62

H = 2.02

Try d = 18" ⇒ V = 6.90 '/s

$H = 2.93 V^2/2g$ ⇒ H = 2.16 close enough.

Catch basin #30

Use 15"

Catch basin #31

Q_i = 13 cfs

HGL = 129.3 ft

G = 12.97 less 0.5' = 12.47

H = 12.47 − 9.3 = 3.17

Try d = 18" V = 7.4 '/s

$H = 2.09 V^2/2g$ H = 1.78 ft. ∴ O.K.

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For 68 cfs $d = 0.45'$ $V = 4.5$ ft/s

$$L = \frac{V}{2}(d + d_b)^{1/2} = \frac{4.5}{2}(0.45 + 0.29)^{1/2} = 1.94'$$

Clogging factor of 2x req'd length

$\Rightarrow$ length req'd $= 1.94 \times 2 = 3.88'$

Actual length $= 3.5'$ close enough.

Actual situation will flow under partial sump condition.

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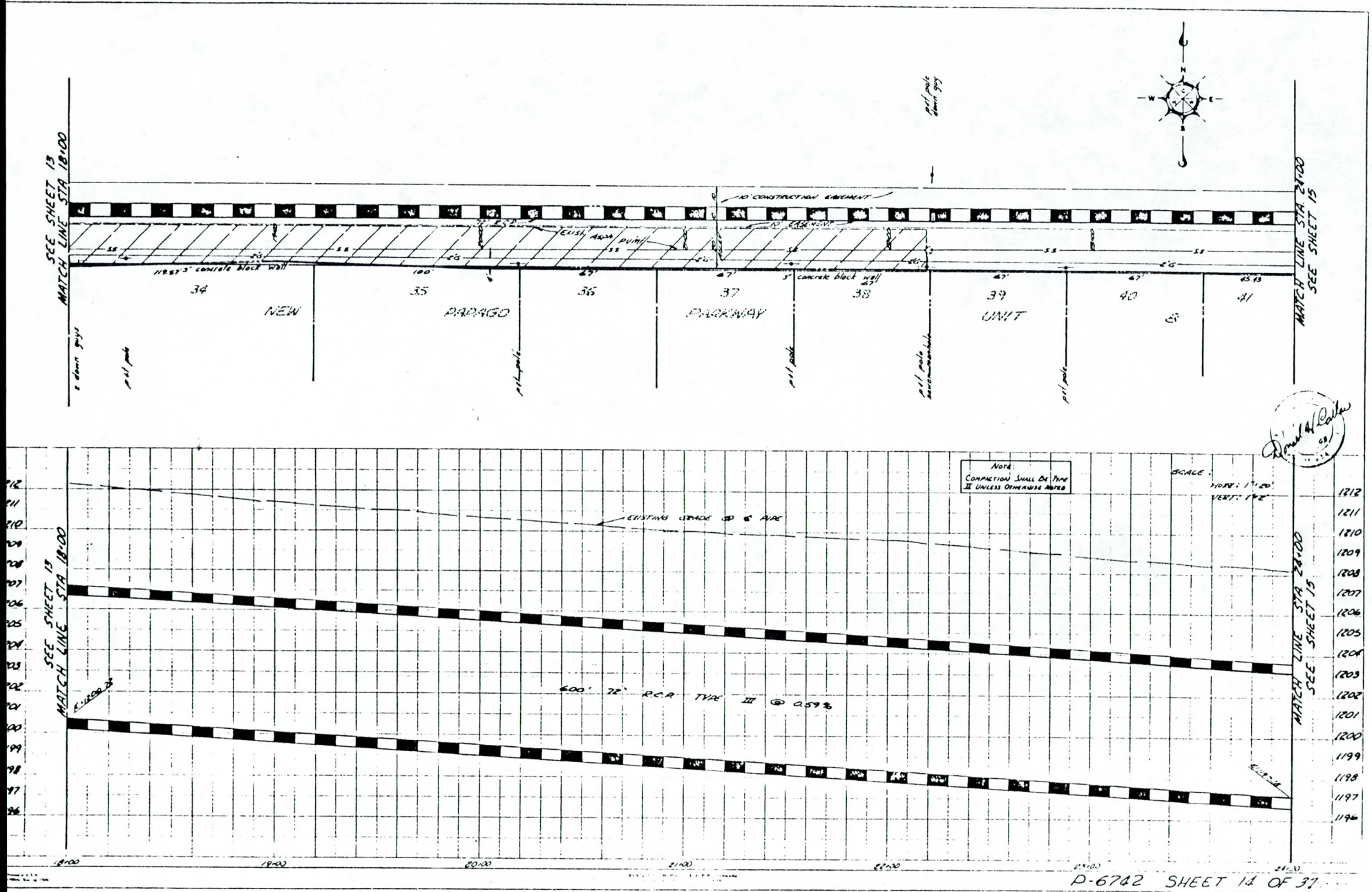
42 382 100 SHEETS 5 SQUARE
42 389 200 SHEETS 5 SQUARE
NATIONAL



P-6742 SHEET 14 OF 37

P-373

5062 North 19th Avenue
Phoenix, Arizona 85015
(602) 242-2999

CELLA BARR
ASSOCIATES

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Project Name: McDowell Road
Storm Sewer
Project No. 40785-01-32
WP Code: BHH-38

Date Prepared: April 28, 1986
Date Revised: July 10, 1986
Engineer: BHH
Owner/Developer: Scottsdale

CONSTRUCTION QUANTITIES

ITEM	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	AMOUNT
Pipe:					
1.	66" Pipe	L.F.	135.00	1,856	250,560.00
2.	60" Pipe	L.F.	120.00	1,327	159,240.00
3.	54" Pipe	L.F.	115.00	569	65,435.00
4.	48" Pipe	L.F.	85.00	1,383	117,555.00
5.	42" Pipe	L.F.	70.00	419	33,520.00
6.	36" Pipe	L.F.	70.00	420	29,400.00
7.	33" Pipe	L.F.	65.00	430	27,950.00
8.	27" Pipe	L.F.	70.00	330	21,450.00
9.	27" R.G.R.C.P.	L.F.	70.00	56	3,920.00
10.	24" R.G.R.C.P.	L.F.	65.00	407	28,490.00
11.	18" R.G.R.C.P.	L.F.	60.00	259	16,835.00
12.	15" R.G.R.C.P.	L.F.	55.00	709	42,540.00
13.	12" R.G.R.C.P.	L.F.		34	1,870.00
Catch Basins:					
14.	C.B. (M.A.G. 530) "A"	EA.	1,500.00	1	1,500.00
15.	C.B. (M.A.G. 531) "B"	EA.	1,500.00	1	1,500.00
16.	C.B. (M.A.G. 532) "C"	EA.	1,650.00	3	4,950.00
17.	C.B. (M.A.G. 533-1)"D" L = 3′	EA.	1,500.00	1	1,500.00
18.	C.B. (M.A.G. 533-1) "D" L = 6′	EA.	1,750.00	2	3,500.00
19.	C.B. (M.A.G. 533-1) "D" L = 10′	EA.	1,950.00	10	19,500.00
20.	C.B. (M.A.G. 533-1) "D" L = 17′	EA.	2,250.00	6	13,500.00
21.	C.B. (M.A.G. 535) "F"	EA.	1,250.00	1	1,250.00
22.	C.B. (C.O.P. P-1568) "L"	EA.	1,650.00	2	3,300.00

ITEM	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	AMOUNT
	Manholes (bases, shafts, covers & connections):				
23.	M.H. (C.O.P. P-1560) & (M.A.G. 420 & 424)	EA.	3,000.00	1	3,000.00
24.	M.H. (M.A.G. 520, 420 & 424)	EA.	2,850.00	6	17,100.00
25.	M.H. (M.A.G. 521, 522 & 524)	EA.	2,600.00	3	7,800.00
26.	M.H. (M.A.G. 521, 420 & 424)	EA.	2,600.00	2	5,200.00
	Pavement (sawcut, removal & replacement):				
27.	Main-Detail "E" Sht. D-20	S.Y.	25.00	4,665	116,625.00
28.	Connectors	S.Y.	25.00	758	18,950.00
29.	Driveway Crossings (Match Existing Pvmt. Sec.	S.Y.	20.00	67	1,340.00
30.	Remove, regrade & replacement	S.Y.	30.00	145	4,350.00
31.	Sidewalk removal & replacement	S.F.	27.00	114	3,080.00
32.	Remove & replace conc. sw, apron, C & G	L.S.	15.00	1	1,500.00
	Miscellaneous:				
33.	66" Pipe Collar (M.A.G. 505)	EA.	500.00	1	500.00
34.	60" Pipe Collar (M.A.G. 505)	EA.	450.00	1	450.00
35.	48" Pipe Collar (M.A.G. 505)	EA.	400.00	1	400.00
36.	24" Pipe Collar (M.A.G. 505)	EA.	350.00	2	700.00
37.	18" Pipe Collar (M.A.G. 505)	EA.	300.00	3	900.00
38.	15" Pipe Collar (M.A.G. 505)	EA.	250.00	7	1,750.00
39.	Manhole junction structure	EA.	7,500.00	2	15,000.00
40.	Junction structure	EA.	1,200.00	2	24,000.00
41.	Pipe replacement & encasement	L.S.	-	1	8,000.00
42.	Pipe realignment	L.S.	-	1	10,500.00
43.	Inlet structure	EA.	-	1	23,000.00

ITEM	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	AMOUNT
44.	Outlet retaining headwall	L.S.	-	1	12,000.00
45.	Grouted riprap	S.Y.	35.00	110	3,850.00
46.	Concrete slab	L.S.	-	1	500.00
47.	Sawcut, remove conc. slab	L.S.	-	1	300.00
48.	Conc. outlet channel	L.S.	-	1	500.00
49.	4" thick crushed aggregate	S.Y.	15.00	7.5	115.00
50.	Gunite slope protection	S.Y.	25.00	40	1,000.00
51.	Remove 60" R.G.R.C.P., backfill & compact	L.S.	-	1	825.00
52.	Remove exist. C.B.	L.S.	-	1	750.00
53.	Traffic Control	L.S.	400/day 6 mo.	Job	52,000.00

TOTAL = $1,163,650.00