Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

67th Avenue Stormdrain
Bell Road to ACDC
Design Calculations
Memorandum

67TH AVE STORMDRAIN - BELL RD TO ACDC DESIGN CALCULATIONS MEMORANDUM

A118.823

Greiner

67th Avenue Stormdrain
Bell Road to ACDC
Design Calculations
Memorandum

FLOOD CONTROL DISTRICT
RECEIVED
JAN 16 '89

	CH ENG		P & PM
	DEP		HYDRO
	ADMIN		LMGT
	FINANCE		FILE
	C & O		
	ENGR		

REMARKS

Prepared for:

Flood Control District of Maricopa County
3335 W. Durango
Phoenix, Arizona 85009

Prepared by:

Greiner, Inc.
7310 N. 16th Street - Suite 160
Phoenix, Arizona 85020
(602) 275-5400

January 1989

Contract FCD 88-21
Greiner Job No. E111124

Introduction

This memorandum provides the supporting calculations for the design of the 67th Avenue stormdrain. Included in this presentation are the on-site hydrology and catch basin design, hydraulic analysis of the stormdrain network D-load calculations for mainline pipe and laterals and supporting calculations for the design of the junction structure located at Greenway Road and 67th Avenue. The results summarized herein should provide the basis of design for all future catch basins and major lateral connections.

Hydrology

The results of the approved "Off-site Hydrology Report," dated September 1988, were used for sizing the stormdrain mainline and the laterals located along Bell Road, Paradise Land and Greenway Road. These results were also used for sizing the proposed and future catch basins to be located along the east project right-of-way.

The Rational Method (Q = CIA) was otherwise utilized where:

C = 0.82 (paving and desert landscaping)
I = 3.85 in/hr (10-year storm)
A = area in acres

The 67th Avenue right-of-way was assumed to be developed to its full width of 130 feet.

The results of the on-site hydrologic calculations are provided in the attached "Pavement Drainage" worksheets.

Catch Basin Design

Street flow hydraulic analysis and catch basin sizing and location calculations were performed in accordance with HEC No. 12, "Drainage of Highway Pavements." The following criteria were used:

- Pavement "n" value of 0.016
- Allowable pavement spread limited to gutter and one travel lane (12.5 feet).
- Street cross slope is 0.2%
- Street longitudinal slope is 0.002 ft/ft
- City of Phoenix type "M" catch basins are used (requested by City of Glendale)

Catch basin design calculations are found attached on the "Storm Sewer System Design Inlet Calculation" sheets.

Stormdrain Hydraulic Analysis

Hydraulic grade line elevations for the proposed stormdrain system were calculated using the "Storm" computer program developed by the Los Angeles County Road Department.

The program calculates the following:

- o Normal depth of flow
- o Critical depth of flow
- o Flow type (partial, full, seal)
- o Friction slope
- o Flow velocities
- o Hydraulic grade line elevations
- o Calculated depth of flow
- o Location and characteristics of hydraulic jump

Friction losses are computed from the Manning equation. Minor losses are derived from the velocity head,

$$K \frac{V^2}{2g}$$

Minor loss coefficients used are as follows:

Type	K
Curve	0.08
Manhole	0.05
Exit	1.0
Entrance	0.10
Tee (thru)	0.3
Junction (Greenway)	0.54
Junction (Paradise Lane)	0.55
Junction (Kings Avenue)	0.49
Junction (Phelps Road)	0.39

The program computes internally sharp bend losses such as at 90° or 45° pipe bends. Total junction losses are calculated by applying the pressure plus momentum equation.

Hydraulic analysis criteria input to the storm program are as follows:

- o For precast concrete pipe, n = 0.012
- o The 10-year WSEL in the ACDC was set as downstream controlling HGL
- o Tailwater elevation limits of, 1 foot below pavement at catch basins and 5 feet below pavement for mainline pipe were set.

The hydraulic analysis was performed for the fully developed stormdrain system including the laterals along Bell Road, Paradise Lane and Greenway Road. Minor catch basins were not incorporated. However, the results of the storm program were checked to ensure that the calculated mainline HGL is sufficiently below the pavement (i.e. 5 feet or greater) to allow for future connections to junctions.

The printout of the Storm program analysis is attached.

Pipe Design Strength Analysis

Minimum pipe strength requirements were calculated for the various pipe sizes and depths specified in the plans. Required minimum D-loads to produce a 0.01 inch crack were calculated using standard procedures described in the literature and then rounded to the nearest 50 lbs/L.F./ft (I.D.) The procedure followed and a summary of the results is attached.

Structural Calculations

Calculations were performed for the structural design of the junction structure located at 67th Avenue and Greenway Road. Grade 60 steel is specified. These calculations are also attached.

2:67STORM

PAVEMENT DRAINAGE WORKSHEET

LOCATION DATA
Highway 67th Avenue
Location Glendale Az
Project No. E111124

DESIGN DATA
Frequency 10 years

RUNOFF CALCULATIONS West Pavement

From Station	To Station	L ft.	W ft.	D.A. acr.	C	I in/hr	Q cfs	INLET Type	COMMENTS
68+00	63+50	450	65	0.67	0.82	3.85	2.12	M-1, L=10'	Future C.B.
63+50	59+50	400	65	0.60			1.88	M-1, L=10'	"
59+50	55+50	400	65	0.60			1.88	M-1, L=10'	"
55+50	51+50	400	65	0.60			1.88	M-1, L=10'	"
51+50	47+00	450	65	0.67			2.12	M-1, L=17'	"
46+50	42+00	450	65	0.67			2.12	M-1, L=~~17~~ 10'	"
42+00	38+50	350	65	0.52			1.65	M-1, L=10'	"
38+50	33+65	485	65	0.72			2.28	M-1, L=10'	"
33+65	28+35	530	65	0.79		same value?	2.50	M-1, L=10'	"
28+35	25+20	315	65	2.27			2.27	M-1, L=10'	Future C.B. includes some offsite area
25+20	22+75	245	65	0.81	0.82	3.85	2.56	M-1, L=10'	Future CB includes some offsite area

Computed by: M. C. Checked by: G. S. Date: 1-89

PAVEMENT DRAINAGE WORKSHEET

LOCATION DATA
Highway 67th Avenue
Location Glendale Az
Project No. E111124

DESIGN DATA
Frequency 10 years

RUNOFF CALCULATIONS

From Station	To Station	L ft.	W ft.	D.A. acr.	C	I in/hr	Q cfs	INLET Type	COMMENTS
22+75	20+85	190	65	0.28	0.82	3.85	0.90	M-1, L=10'	For this Project Construct M-1, L=17'
20+00	15+50	450	65	0.67	0.82	3.85	2.12	M-1, L=6'	Future C.B.
15+50	12+40	310	65	0.46	0.82	3.85	1.45	M-1, L=6'	Future C.B. Project Limit
				East	Pavement				
68+00	63+50	450	65	0.67	0.82	3.85	2.12	M-1, L=10'	Future C.B.
Phelps	Road	—	—	—	—	—	11	2(M-1) L=17'	To be Constructed Q_{10} From SWMM
63+50	58+79	471	65	0.70	0.82	3.85	2.2	M-1, L=10'	To be Constructed
58+79	56+00	279	65	0.60	0.82	3.85	1.9	M-1, L=10'	Future C.B.
Kings	Avenue	—	—	—	—	—	32	2(M-2) L=10'	To be Constructed Q_{10} From SWMM
56+00	52+60	340	65	0.51	0.82	3.85	1.6	M-1, L=17'	To be Constructed
52+60	49+60	300	65	0.45	0.82	3.85	1.41	M-1, L=6'	Future C.B.

Computed by: M. C. Checked by: G. S. Date: 1-89

PAVEMENT DRAINAGE WORKSHEET

LOCATION DATA
Highway 67th Avenue
Location Glendale Az
Project No. E111124

DESIGN DATA
Frequency 10 years

RUNOFF CALCULATIONS East Pavement

From Station	To Station	L ft.	W ft.	D.A. acr.	C	I in/hr	Q cfs	INLET Type	COMMENTS
49+60	46+80	280	65	0.42	0.82	3.85	1.32	M-1, L=10'	Future CB temp. headwall @ 46+65
46+80	43+80	300	—	—	—	—	2.6	M-1, L=10	Future CB Q_{10} prorated from Summ
43+80	41+30	250	—	—	—	—	2.2	M-1, L=10'	Future CB Q_{10} Prorated from Summ
41+30	38+80	250	—	—	—	—	2.2	M-1, L=10'	Future CB Q_{10} Prorated from Summ
38+80	36+30	250	—	—	—	—	2.2	M-1, L=10'	Future CB Q_{10} Prorated from Summ
36+30	33+65	265	—	—	—	—	2.3	M-1, L=10'	Future CB Q_{10} Prorated from Summ
33+65	32+60	105		Nancy	Road		8	M-1, L=17'	Construct temp "N" Area Drain Q_{10} from Summ
32+60	29+90	270		Carol Ann	Way		4	M-1, L=17'	Construct temp. "N" Area Drain Q_{10} from Summ
29+90	27+30	260		Mary	Jane	Lane	4	M-1, L=17'	Construct temp. "N" Area Drain Q_{10} from Summ
27+30	24+00	330	65	0.49	0.82	3.85	1.55	M-1, L=6'	Future C.B.
24+00	20+70	330	65	0.49	0.82	3.85	1.55	M-1, L=10'/6	Future C.B. @ Greenway Rd.

Computed by: M. C. Checked by: G.S. Date: 1-89

PAVEMENT DRAINAGE WORKSHEET

LOCATION DATA
Highway 67th Avenue
Location Glendale Az
Project No. E111124

DESIGN DATA
Frequency 10 years

RUNOFF CALCULATIONS East Pavement

From Station	To Station	L ft.	W ft.	D.A. acr.	C	I in/hr	Q cfs	INLET Type	COMMENTS
20+00	15+50	450	65	0.67	0.82	3.85	2.12	M-1, L=6	Future C.B.
15+50	12+40	310	65	0.46	0.82	3.85	1.45	M-1, L=6	Future C.B. Location adjusted to M.H.

Computed by: M. C. Checked by: G.S. Date: 1-89

STORM SEWER SYSTEM DESIGN INLET CALCULATION SHEET

LOCATION DATA:
HIGHWAY 67th Avenue
LOCATION Glendale, Az
PROJECT NO. E111124

DESIGN DATA
FREQUENCY 10 YEARS
T_{ALL} 12.5
n 0.016

INLET CALCULATIONS West Pavement

INLET NO	INLET STATION	DA NO	INLET TYPE	Q cfs	Q_c cfs	Q_T cfs	S_o %	GUTTER S_x	GUTTER z/n	PAVEMENT S_x	PAVEMENT z/n	D ft.	T ft.	a in.	INLET LENGTH ACT.	INLET LENGTH CORR.	Q_i/Q	Q_i cfs	Q_c cfs
1	63+50 Lt		M-1, L=10'	2.1		2.1	.2	2%	3125	2%	3125		<12.5		13	9.8	0.93	1.97	0.15
2	59+50 Lt		M-1, L=10'	1.9	0.15	2.1							"		13	9.8	0.93	1.89	0.14
3	55+50 Lt		M-1, L=10'	1.9	0.14	2.1							"		13	9.8	0.93	1.88	0.14
4	51+50 Lt		M-1, L=10'	1.9	0.14	2.1							"		13	9.8	0.93	1.88	0.14
5	47+00 Lt		M-1, L=17'	2.1	0.14	2.3		Paradise Lane					"		17	12.8	1.0	2.3	ϕ
6	42+00 Lt		M-1, L=10'	2.1		2.1							"		13	9.8	0.93	1.97	0.15
7	38+50 Lt		M-1, L=10'	1.7	0.15	1.8							"		13	9.8	0.96	1.7	0.1
8	33+65 Lt		M-1, L=10'	2.3	0.1	2.4							12.5		13	9.8	0.91	2.17	0.21
9	28+35 Lt		M-1, L=10'	2.5	0.21	2.7							13		13	9.8	0.89	2.41	0.3
10	25+20 Lt		M-1, L=10'	2.3	0.3	2.6							12.5		13	9.8	0.90	2.31	0.26
11	22+75 Lt		M-1, L=10'	2.6	0.26	2.8							13.7		13	9.8	0.88	2.49	0.33
12	20+85 Lt		M-1, L=10'	0.9	0.33	1.23		Greenway	Road				12.5		13	9.8	1.0	1.23	ϕ
13	15+50 Lt		M-1, L=6'	2.1		2.1							"		9	6.8	0.75	1.59	0.53
14	12+40 Lt		M-1, L=6'	1.5		2.0							"		9	6.8	0.77	1.52	0.46

COMPUTED BY: M.C. CHECKED BY: G.S. DATE: 1-89

STORM SEWER SYSTEM DESIGN INLET CALCULATION SHEET

LOCATION DATA:
HIGHWAY 67th Avenue
LOCATION Glendale, Az
PROJECT NO. E111124

DESIGN DATA
FREQUENCY 10 YEARS
T_{ALL} 12.5
n 0.016

INLET CALCULATIONS East Pavement

INLET NO	INLET STATION	DA NO	INLET TYPE	Q cfs	Q_c cfs	Q_T cfs	S_o %	GUTTER S_x	GUTTER z/n	PAVEMENT S_x	PAVEMENT z/n	D ft.	T ft.	a in.	INLET LENGTH ACT.	INLET LENGTH CORR.	Q_i/Q	Q_i cfs	Q_c cfs
15	63+50RT		M-1, L=10'	2.1		2.1	.2	2%	3125	2%	3125		42.5		13	9.8	0.93	1.97	0.15
16	59+06RT		M-1, L=17'	5.5		5.5			Phelps Road				"		20	15	0.95	5.23	0.26
17	59+42RT		M-1, L=17'	5.5		5.5			Phelps Road				"		20	15	0.95	5.23	0.26
18	58+79RT		M-1, L=10'	2.2	0.63	2.9							"		13	9.8	0.88	2.53	0.35
19	56+00RT		M-1, L=10'	1.9	0.35	2.2							"		13	9.8	0.93	2.06	0.14
20	52+91RT		M-2, L=10'	16		16			Kings Avenue				"		23	17.3	0.82	13.1	2.9
21	53+35RT		M-2, L=10'	16		16			Kings Avenue				"		23	17.3	0.82	13.1	2.9
22	52+60RT		M-1, L=17'	1.6	6	7.6							"		20	15	0.92	7.0	0.6
23	49+60RT		M-1, L=6'	1.4	0.6	2.0							"		9	6.8	0.76	1.54	0.49
24	46+80RT		M-1, L=10'	1.3	0.5	1.8							"		13	9.8	0.96	1.69	0.07
25	43+80RT		M-1, L=10'	2.6		2.6							"		13	9.8	0.90	2.33	0.27
26	41+30RT		M-1, L=10'	2.17	0.27	2.44							"		13	9.8	0.91	2.22	0.22
27	38+80RT		M-1, L=10'	2.17	0.22	2.39							"		13	9.8	0.91	2.18	0.21
28	36+30RT		M-1, L=10'	2.17	0.21	2.38							"		13	9.8	0.92	2.19	0.20
29	33+65RT		M-1, L=10'	2.30	0.2	2.50							"		13	9.8	0.91	2.26	0.24

COMPUTED BY: M.C. CHECKED BY: G.S. DATE: 1-89

STORM SEWER SYSTEM DESIGN INLET CALCULATION SHEET

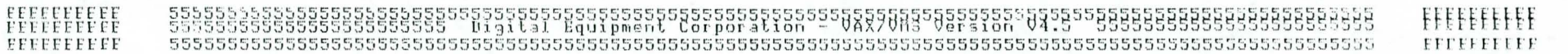
LOCATION DATA:
HIGHWAY 67th Avenue
LOCATION Glendale Az
PROJECT NO. E111124

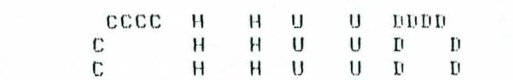
DESIGN DATA
FREQUENCY 10 YEARS
T_{ALL} 12.5
n 0.016

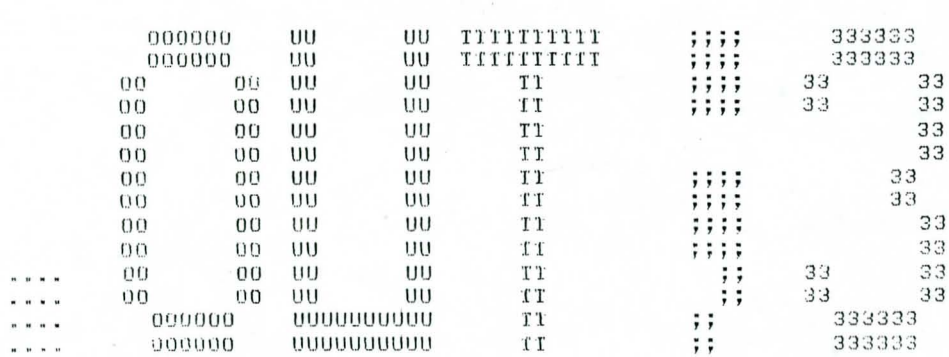
INLET CALCULATIONS

INLET NO	INLET STATION	DA NO	INLET TYPE	Q cfs	Q_c cfs	Q_T cfs	S_o %	GUTTER S_x	GUTTER z/n	PAVEMENT S_x	PAVEMENT z/n	D ft.	T ft.	a in.	INLET LENGTH ACT.	INLET LENGTH CORR.	Q_i/Q	Q_i cfs	Q_c cfs
30	32+60 RT		M-1, L=17'	8	0.24	8.24	.2	2%	3125	2%	3125		42.5		20	15	0.88	7.26	0.98
31	29+90 Rt		M-1, L=10'	4	0.98	4.98							"		13	9.8	0.77	3.81	1.17
32	27+30 RT		M-1, L=17'	4	1.17	5.17							"		20	15	0.96	4.97	0.20
33	24+00 Rt		M-1, L=6'	1.55	0.2	1.75							"		9	6.8	0.79	1.39	0.36
34	20+70 Rt		M-1, L=10'	1.55	0.36	1.91			Greenway			Road			13	9.8	0.95	1.82	0.09
35	15+50 Rt		M-1, L=6'	2.12		2.12							"		9	6.8	0.75	1.59	0.53
36	12+40 Rt		M-1, L=6'	1.45	0.53	1.98							"		9	6.8	0.77	1.52	0.46

COMPUTED BY: M.C. CHECKED BY: G.S. DATE: 1-89

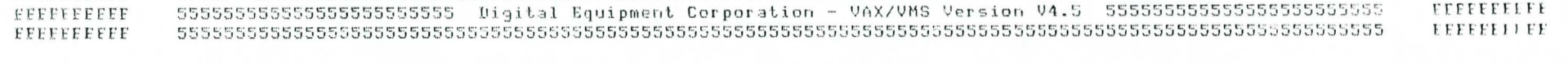






File _DUA1:[USERS.E111124.ENGR]FSD.OUT;3 (98,71,0), last revised on 28-NOV-1988 15:46, is a 33 block sequential file owned by UIC [PHXGREIN,CHUD]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 132 bytes.

Job FSD (854) queued to SYS$PRINT on 28-NOV-1988 15:46 by user CHUD, UIC [PHXGREIN,CHUD], under account ENGR at priority 100, started on printer _OPA0: on 28-NOV-1988 15:46 from queue SYS$PRINT.



PROJECT : 67TH AVENUE STORMDRAIN BELL <ROAD TO ACDC>
DESIGNER : MUSTAFA CHUDNOFF
FINAL SD DESIGN, OUTFALL IS SHORT RADIUS BEND TO ACDC

INPUT FILE : FSD.DAT

DATE : 28-NOV-88
TIME : 15:04:10

COMMENTS : 1) THIS ANALYSIS IS FOR FUTURE FULL SYSTEM CONDITIONS PER THE APPROVE HYDROLOGY REPORT
2) THIS ANALYSIS DOES NOT INCORPORATE TEMPORARY INLETS AND CATCH BASINS
3) CATCH BASINS ALONG KINGS AVENUE AND PHELPS ROAD HAVE BEEN INCORPORATED
4) TAILWATER LIMIT (TW) FOR THE MAINLINE WAS SET AT 5 FT. BELOW PAVEMENT AND
1 FT. BELOW PAVEMENT FOR CATCH BASINS

<<<<<THIS OUTPUT HAS BEEN EDITED MANUALLY FOR CLARITY>>>>>

INPUT

CD	L2	MAX Q	ADJ Q	LENGTH	FL 1	FL 2	CTL/TW	D	W	S	KJ	KE	KM	LC	L1	L3	L4	A1	A3	A4	J	N
8	1						1198.35	<10-YR WSEL IN ACDC>														
	ACDC TO GREENWAY ROAD																					
2	2	390.0	390.0	1125.00	1191.05	1193.50	1215.00	84.	0.	3	0.54	0.00	1.18	1	3	12	0	0.	90.	0.	0.00	0.012
	GREENWAY ROAD TO STA. 26+55																					
2	3	170.0	170.0	644.00	1201.00	1203.49	1217.00	60.	0.	3	0.00	0.00	0.05	0	4	0	0	0.	90.	0.	0.00	0.012
	STA. 25+65 TO STA. 32+50																					
2	4	170.0	170.0	595.00	1203.49	1205.71	1220.00	60.	0.	3	0.00	0.00	0.05	0	5	0	0	0.	0.	0.	0.00	0.012
	STA. 32+50 TO STA. 39+75																					
2	5	178.0	178.0	725.00	1205.71	1208.47	1222.00	60.	0.	3	0.00	0.00	0.05	0	6	0	0	0.	0.	0.	0.00	0.012
	STA 39+75 TO PARADISE LANE																					
2	6	178.0	178.0	660.00	1208.47	1210.97	1224.00	60.	0.	3	0.55	0.00	0.10	0	7	16	0	0.	90.	0.	0.00	0.012
	PARADISE LANE TO STA 53+20																					
2	7	69.0	69.0	685.00	1210.97	1213.00	1225.00	42.	0.	3	0.49	0.00	0.30	0	8	19	0	0.	90.	0.	0.00	0.012
	STA 53+20 TO STA. 59+70																					
2	8	41.0	41.0	650.00	1213.50	1214.97	1225.00	36.	0.	3	0.35	0.00	0.30	0	9	22	0	0.	90.	0.	0.00	0.012
	STA. 59+70 TO BELL ROAD <<END THIS PROJECT>>																					
2	9	34.0	34.0	790.00	1214.97	1216.75	1228.00	36.	0.	3	0.00	0.00	0.30	0	10	0	0	45.	0.	0.	0.00	0.012
	ALONG BELL RD. <<FUTURE PROJECT>>																					
2	10	35.0	35.0	2570.00	1216.75	1231.90	1237.00	36.	0.	3	0.00	0.00	0.30	0	11	0	0	45.	0.	0.	0.00	0.012
	ALONG BELL RD. <<FUTURE PROJECT>>																					
2	11	24.0	24.0	1320.00	1232.40	1237.68	1243.00	30.	0.	1	0.00	0.00	0.30	0	0	0	0	0.	0.	0.	0.00	0.012
	ALONG BELL RD. <<FUTURE PROJECT>>																					
2	12	220.0	220.0	1000.00	1200.50	1203.50	1216.00	66.	0.	3	0.00	0.00	0.30	3	13	0	0	0.	0.	0.	0.00	0.012
	ALONG GREENWAY ROAD																					
2	13	212.0	212.0	160.00	1203.50	1204.22	1217.00	66.	0.	3	0.00	0.00	0.30	0	14	0	0	0.	0.	0.	0.00	0.012
	ALONG GREENWAY ROAD																					
2	14	138.0	138.0	1320.00	1204.72	1210.00	1220.00	60.	0.	3	0.00	0.00	0.30	0	15	0	0	0.	0.	0.	0.00	0.012
	ALONG GREENWAY ROAD																					
2	15	45.0	45.0	1320.00	1214.00	1220.28	1223.00	36.	0.	1	0.00	0.00	0.30	0	0	0	0	0.	0.	0.	0.00	0.012
	ALONG GREENWAY ROAD																					
2	16	109.0	109.0	900.00	1210.97	1216.70	1225.00	54.	0.	3	0.00	0.00	0.30	7	17	0	0	0.	0.	0.	0.00	0.012
	ALONG PARADISE LANE																					
2	17	84.0	84.0	1620.00	1217.20	1222.06	1229.00	48.	0.	3	0.00	0.00	0.30	0	18	0	0	0.	0.	0.	0.00	0.012
	ALONG PARADISE LANE																					
2	18	27.0	27.0	1320.00	1223.56	1227.52	1230.00	36.	0.	1	0.00	0.00	0.30	0	0	0	0	0.	0.	0.	0.00	0.012
	ALONG KINGS AVENUE																					
2	19	26.0	26.0	72.00	1220.00	1220.50	0.00	24.	0.	3	0.00	0.00	0.30	8	20	21	0	90.	90.	0.	0.00	0.012
	ALONG KINGS AVENUE																					
2	20	13.0	13.0	28.00	1220.50	1226.18	1228.00	24.	0.	1	0.00	0.00	0.40	0	0	0	0	0.	0.	0.	0.00	0.012

	ALONG KINGS AVENUE																					
2	21	13.0	13.0	15.00	1220.50	1222.64	1228.00	24.	0.	1	0.00	0.00	0.40	19	0	0	0	0.	0.	0.	0.00	0.012
	ALONG PHELPS ROAD																					
2	22	10.0	10.0	62.00	1215.50	1216.00	0.00	18.	0.	3	0.00	0.00	0.30	9	23	24	0	90.	45.	0.	0.00	0.012
	ALONG PHELPS ROAD																					
2	23	5.0	5.0	18.00	1216.17	1226.83	1229.50	18.	0.	1	0.00	0.00	0.40	0	0	0	0	0.	0.	0.	0.00	0.012
	ALONG PHELPS ROAD																					
2	24	5.0	5.0	18.00	1216.25	1223.81	1229.50	18.	0.	1	0.00	0.00	0.40	22	0	0	0	0.	0.	0.	0.00	0.012

OUTPUT

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	EL 1 (FT)	EL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
1	HYDRAULIC GRADE LINE CONTROL = 1198.35 <<AT ACDC>>																	
2	390.0	84	0	7.00	5.20	FULL	0.00318	10.1	10.1	1191.05	1193.50	1198.35	1203.80	7.30	10.30	0.00	0.00	
3	170.0	60	0	3.97	3.74	FULL	0.00363	8.7	8.7	1201.00	1203.49	1206.45	1208.79	5.45	5.30	0.00	0.00	
4	170.0	60	0	4.04	3.74	FULL	0.00363	8.7	8.7	1203.49	1205.71	1208.79	1210.95	5.30	5.24	0.00	0.00	
5	178.0	60	0	5.00	3.82	FULL	0.00398	9.1	9.1	1205.71	1208.47	1210.73	1213.62	5.02	5.15	0.00	0.00	
6	178.0	60	0	5.00	3.82	FULL	0.00398	9.1	9.1	1208.47	1210.97	1213.62	1216.25	5.15	5.28	0.00	0.00	
7	69.0	42	0	3.50	2.60	FULL	0.00401	7.2	7.2	1210.97	1213.00	1218.63	1221.37	7.66	8.37	0.00	0.00	
8	41.0	36	0	3.00	2.08	FULL	0.00322	5.8	5.8	1213.50	1214.97	1222.33	1224.42	8.83	9.45	0.00	0.00	
9	34.0	36	0	2.44	1.89	FULL	0.00221	4.8	4.8	1214.97	1216.75	1224.75	1226.50	9.78	9.75	0.00	0.00	
10	35.0	36	0	1.73	1.92	SEAL	0.00235	5.0	7.3	1216.75	1231.90	1226.68	1233.82	9.93	1.92	0.00	0.00	HYD JUMP
	X = 1952.57 X(N) = 2300.64 X(J) = 2117.61 E(J) = 12.15 D(BJ) = 1.73 D(AJ) = 2.12																	
11	24.0	30	0	1.78	1.66	SEAL	0.00292	4.9	6.4	1232.40	1237.68	1234.94	1239.46	2.54	1.78	1240.10	1243.00	
	X = 33.59 X(N) = 516.53																	
3	HYDRAULIC GRADE LINE CONTROL = 1205.13 BEGIN GREENWAY ROAD SYSTEM																	
12	220.0	66	0	5.50	4.15	PART	0.00366	10.3	9.6	1200.50	1203.50	1205.13	1208.61	4.63	5.11	0.00	0.00	
13	212.0	66	0	4.17	4.07	PART	0.00340	9.0	9.2	1203.50	1204.22	1208.88	1209.34	5.38	5.12	0.00	0.00	
14	138.0	60	0	3.30	3.36	SEAL	0.00239	7.0	9.6	1204.72	1210.00	1210.77	1213.45	6.05	3.45	0.00	0.00	HJ @ UJT
	X = 652.31 X(N) = 1253.25																	
15	45.0	36	0	2.23	2.18	PART	0.00388	7.1	8.0	1214.00	1220.28	1216.54	1222.51	2.54	2.23	1223.50	1223.00	
	X = 0.00 X(N) = 181.10																	

OUTPUT

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SF-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	EL 1 (FT)	EL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS
7	HYDRAULIC GRADE LINE CONTROL = 1217.44											BEGIN PARADISE LANE SYSTEM						
16	109.0	54	0	2.62	3.07	SEAL	0.00262	6.9	9.5	1210.97	1216.70	1217.44	1219.77	6.47	3.07	0.00	0.00	HYD JUMP
	X = 524.60 X(N) = 0.00 X(J) = 693.02 E(J) = 48.98 D(BJ) = 2.66 D(AJ) = 3.53																	
17	84.0	48	0	3.23	2.78	PART	0.00291	6.9	7.7	1217.20	1222.06	1220.95	1225.31	3.75	3.25	0.00	0.00	HJ @ UJT
18	27.0	36	0	1.82	1.67	SEAL	0.00140	3.8	6.0	1223.56	1227.52	1227.18	1229.34	3.62	1.82	1229.90	1230.00	
	X = 387.26 X(N) = 1220.07																	
8	HYDRAULIC GRADE LINE CONTROL = 1221.85											BEGIN KINGS AVENUE SYSTEM						
19	26.0	24	0	2.00	1.78	SEAL	0.01125	8.6	8.3	1220.00	1220.50	1221.85	1222.72	1.85	2.22	0.00	0.00	
	X = 21.41 X(N) = 0.00																	
20	13.0	24	0	0.46	1.29	SEAL	0.00281	4.1	6.1	1220.50	1226.18	1224.85	1227.47	4.35	1.29	1228.04	1228.00	HYD JUMP
	X = 8.30 X(N) = 0.00 X(J) = 8.30 E(J) = 6.97 D(BJ) = 0.59 D(AJ) = 2.67																	
18	HYDRAULIC GRADE LINE CONTROL = 1225.60																	
21	13.0	24	0	0.51	1.29	FULL	0.00281	4.1	4.1	1220.50	1222.64	1225.60	1225.74	5.10	3.10	1226.01	1228.00	
9	HYDRAULIC GRADE LINE CONTROL = 1224.59											BEGIN PHELPS ROAD SYSTEM						
22	10.0	18	0	1.20	1.22	FULL	0.00772	5.7	5.7	1215.50	1216.00	1224.59	1225.21	9.09	9.21	0.00	0.00	
23	5.0	18	0	0.24	0.86	SEAL	0.00193	2.8	4.8	1216.17	1226.83	1226.03	1227.69	9.86	0.86	1228.04	1229.50	HYD JUMP
	X = 13.76 X(N) = 0.00 X(J) = 13.76 E(J) = 2.19 D(BJ) = 0.39 D(AJ) = 1.73																	
21	HYDRAULIC GRADE LINE CONTROL = 1225.17																	
24	5.0	18	0	0.26	0.86	SEAL	0.00193	2.8	2.9	1216.25	1223.81	1225.17	1225.19	8.92	1.38	1225.32	1229.50	
	X = 17.74 X(N) = 0.00																	

PROJECT : 67TH AVENUE STORMDRAIN BELL <ROAD TO ACDC>
DESIGNER : MUSTAFA CHUDNOFF

INPUT FILE : FSD.DAT

DATE : 28-NOV-88
TIME : 15:04:10

OUTPUT

LINE NO	Q (CFS)	D (IN)	W (IN)	DN (FT)	DC (FT)	FLOW TYPE	SE-FULL (FT/FT)	V 1 (FPS)	V 2 (FPS)	EL 1 (FT)	EL 2 (FT)	HG 1 CALC	HG 2 CALC	D 1 (FT)	D 2 (FT)	TW CALC	TW CK	REMARKS

V 1, EL 1, D 1 AND HG 1 REFER TO DOWNSTREAM END
V 2, EL 2, D 2 AND HG 2 REFER TO UPSTREAM END
X - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HG INTERSECTS SOFFIT IN SEAL CONDITION
X(N) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE WATER SURFACE REACHES NORMAL DEPTH BY EITHER DRAWDOWN OR BACKWATER
X(J) - DISTANCE IN FEET FROM DOWNSTREAM END TO POINT WHERE HYDRAULIC JUMP OCCURS IN LINE
F(J) - THE COMPUTED FORCE AT THE HYDRAULIC JUMP
D(BJ) - DEPTH OF WATER BEFORE THE HYDRAULIC JUMP (UPSTREAM SIDE)
D(AJ) - DEPTH OF WATER AFTER THE HYDRAULIC JUMP (DOWNSTREAM SIDE)
SEAL INDICATES FLOW CHANGES FROM PART TO FULL OR FROM FULL TO PART
HYD JUMP INDICATES THAT FLOW CHANGES FROM SUPERCRITICAL TO SUBCRITICAL THROUGH A HYDRAULIC JUMP
HJ @ UJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE UPSTREAM END OF THE LINE
HJ @ DJT INDICATES THAT HYDRAULIC JUMP OCCURS AT THE JUNCTION AT THE DOWNSTREAM END OF THE LINE

Greiner

Greiner, Inc.

Tucson 602 887-1800
Phoenix 602 275-5400

Job E111124 67th Avenue
Description D-Load Calculations

Calculated by M.C. Date 11-22 Sheet No. 1
Checked by RB Date 11-28 of 2

Design D-Load is Calculated in a two step procedure:

For deep trench conditions Live load is neglected and only trench fill load is calculated.

$W_d = C_d \cdot W \cdot B_d^2$ where: W_d: fill load

C_d: Coefficient

W: unit wt. of fill

B_d: trench width

$W = 120$ lbs/c.f.

C_d is determined from published tables where a K_u of 0.150 is used due to fine materials in fill.

After calculation the trench fill load, W_d, Safety factors are applied to Calculate D-Load as

$$D_{0.01} = \frac{W_d \times F_s}{D_{Lf} \times ID}$$ where: F_s: Safety Factor

D_{Lf}: trench factor

ID: Pipe diameter

an F_s of 1.0 is use (RCP)

D_{Lf} 1.5 (trench conditions)

Final result is rounded to nearest 50 lbs/ft/ID

Greiner

Greiner, Inc.
Tucson 602 887-1800
Phoenix 602 275-5400

Job E 111124 67th Ave
Description D-Load Calculations
Calculated by M.C. Date 11-22 Sheet No. 2
Checked by RB Date 11-28 of 2

Pipe Size	Fill Ht. (ft)	B_d (ft)	H/B_d	C_d	W_d *	Calculated D-load **	Design D-load
18"	13	3.5	3.7	2.235	3285	1460	1450
	13.5		3.9	2.299	3379	1501	1500
	14		4.0	2.329	3424	1522	1500
	14.5		4.1	2.359	3468	1541	1550
24"	8	4.5	1.8	1.391	3388	1129	1150
	14		3.1	2.018	4904	1635	1650
36"	12.5	6	2.1	1.558	6731	1496	1500
	13		2.2	1.610	6955	1546	1550
	14		2.3	1.661	7176	1595	1600
42"	13	6.5	2.0	1.504	7625	1452	1450
	14		2.2	1.610	8163	1555	1550
54"	13.5	8.5	1.6	1.271	11,020	1633	1650
60"	13	9	1.4	1.143	11,110	1481	1500
66"	14	10	1.4	1.143	13,716	1663	1650
84"	18.5	12.5	1.5	1.208	22,650	2157	2150

Greiner

Job 67TH AVE STORM DRAIN Computed By RLE Date 12-13-88

Description REINFORCING Checked By GB Date 1-89

TOP & BOTTOM SLAB Sheet 1 of 3

TOP SLAB REINF

HEIGHT OF SOIL ABOVE SLAB = EL. 1219.66 - EL. 1207.0 = 12.77'

UNIFORM LOAD ON SLAB

UNIF D.L OF SOIL ABOVE SLAB = $12.77' \times 0.12^{KCF} = 1.53^{KSF}$

" " " CONCRETE = $1.25' \times 0.15^{KCF} = 0.19^{KSF}$

" LL = 2' EARTH SURCHARGE = $2' \times 0.12 = .24^{KSF}$

1.96^{KSF}

DETERMINE TRANSVERSE (SHORT) REINF FOR FIXED END SLAB

FOR FIXED END SLAB $M^- = \frac{wl^2}{12} = \frac{1.96(7)^2}{12} = 8.0^{K-1}/L.F.$

$A_s = \frac{M}{ad} = \frac{8.0}{1.76 \times 12.69"} = 0.36^{D"}/LF$

BOTTOM BARS = $\frac{1}{2}$ TOP = $0.18^{D"}/LF$

WIDTH OF TOP SLAB = 10' LESS 4' FOR MANHOLE

REQ'D REINF IN TOP LAYER = $0.36^{D"/LF} \times \frac{10'}{6'} = 0.60^{D"}/LF$

FOR NEG (TOP LAYER) TRANS REINF USE #5@6"

$A_s = 0.62^{D"}/LF$

FOR POS (LOWER LAYER) TRANS REINF → USE #5@12"

USE SAME PATTERN FOR LONGIT REINF.

" " " " BOTTOM REINF EXCEPT 3" CLR

Greiner

Job 67TH AVE STORM DRAIN Computed By RLE Date 12-5-88
Description CHECK REINFORCING Checked By GNS Date 1-89
Sheet 2 of 3

ASSUMPTIONS & CONDITIONS

WALL REINFORCING

CHECK LONG WALL (10' SPAN)

SVC LOAD DESIGN USED
STEEL $f_s = 24^{KSI}$
WT OF SOIL $= 120^{PCF}$
EQUIV FLUID PRESS $= 35^{PSF} = \gamma$

HEIGHT OF SOIL = 1219.66 − 1193.5 = 26.16 FT + 2' LIVE LOAD*

PRESSURE @ BOTTOM OF WALL: $P = \gamma h = 0.035(28.16') = 0.99^{KSF}$

ASSUME BEAM W/ 1.0' WIDE SECTION AT BOTTOM OF WALL WITH UNIF LOAD OF 0.99 KSF AND FIXED ENDS.

$$M^- = \frac{wl^2}{12} = \frac{0.99 \times (10')^2}{12} = 8.25^{K\text{-}1}$$ ** @ THE ENDS

A_s REQ'D $= \frac{M}{a\,d}$ $\quad d = 15" - 3" - \frac{\#5}{2} = 11.69"$

A_s REQ'D $= \frac{8.25}{1.76 \times 11.69} = 0.40^{\square"}/LF$ USE #5 @ 9"

$\therefore$ OK $\quad A_s$ PROV'D $= 0.41^{\square"}$

$$M_+ = \frac{wl^2}{24} = \frac{0.99 \times 10^2}{24} = 4.13^{K\text{-}1}$$

A_s REQ'D $= \frac{4.13}{1.76 \times 11.69} = 0.20^{\square"}$ USE #5 @ 18"

$A_s = 0.206^{\square"}$

REFERENCES
* AASHTO 3.20.3
** AISC STEEL MANUAL, Pg 2-119, DIAGRAM 15

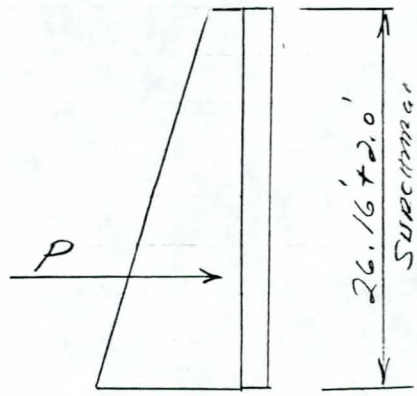
Greiner

Greiner, Inc.

Tucson 602 887-1800
Phoenix 602 275-5400

Job 67TH AVE STORM DRAIN
Description SHEAR CHECK - SIDE & TOP SLAB
Calculated by RLE Date 12-14-88 Sheet No. 3
Checked by GS Date 1-89 of 3

CHECK SHEAR FOR 15" WALL



TOTAL FORCE P ON 1' SECTION OF WALL

$$P = \frac{1}{2}\gamma h^2 = \frac{1}{2}(0.035)(28.16)^2$$ ← SHT #1

$$P = 13.89^{KLF}$$

$\frac{2}{3}P$ IS ACTING @ BOTTOM OF WALL

$$13.89^{K} \times \frac{2}{3} = 9.25^{KLF}$$

$$\text{ACTUAL } v = \frac{9.25^{K}}{15" \times 12"} = 51.4^{PSI}$$

VERY CONSERV. SIDEWALLS WILL TAKE LOAD ALSO

$$\text{ALLOWABLE } v = 0.95\sqrt{f'_c} \rightarrow .95\sqrt{3000} = 52^{PSI} \therefore \text{OK}$$

CHECK SHEAR @ TOP SLAB

UNIF LOAD INCLUDING LL SURCHARGE = 1.96^{KSF} ON TOP SLAB

$$1.96^{KSF} \times 7' \text{ SPAN} \times \frac{1}{2} = 6.86^{KLF} \text{ EACH SIDE}$$ (SIDEWALLS WILL ALSO BE TAKING LOAD)

OK BY INSPECTION

$6.86^{KLF} < 9.25^{KLF}$ ON VERTICAL WALLS