Northern/Orangewood
Storm Drain Project
Contract FCD 94-12, Phase II
Glendale Avenue Storm Drain
Sub-Phase "B"
Design Documentation Summary
for
Final Plan Submittal

WOOD/PATEL

Northern/Orangewood
Storm Drain Project
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Glendale Avenue Storm Drain
Sub-Phase "B"
Design Documentation Summary
for
Final Plan Submittal

Prepared by:

Property of
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Registered Professional Engineer (Civil) CERTIFICATE NO. 32845 R. SCOTT RASMUSSEN Date Signed 11-16-98 ARIZONA, U.S.A.

Registered Professional Engineer (Civil) CERTIFICATE NO. 10512 ASHOK C. PATEL Date Signed 11/16/98 ARIZONA, U.S.A.

November 16, 1998
WP #94153.04

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

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November 16, 1998

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

Attn: Mr. R.W. Shobe, P.E.

Re: **Northern/Orangewood Storm Drain Project**
Contract FCD 94-12 Phase II
Glendale Avenue Storm Drains, Sub-Phase "B"
WP #94153.04

Dear Mr.Shobe:

We are pleased to submit this data package in conjunction with the Final submittal for the referenced project. The package includes:

- Original Mylars - Signed and Sealed - 1 set (under separate cover)
- Drainage Report - 12 sets (under separate cover)
- Construction Drawing Diskettes - 1 set (under separate cover)
- Construction General Conditions and Special Provisions - 1 set (under separate cover)
- Structural Design Calculations - 6 sets (under separate cover)
- Construction Cost Estimate - 2 sets (under separate cover)
- Correspondence - 1 set (under separate cover)
- 90% Comments and Responses - 1 set (under separate cover)
- Information requested by Richard Harris - 1 set (under separate cover)

The 90% review comments are incorporated into this submittal. The 90% review comments and responses are included under separate cover. This submittal incorporates the removal of the conflict structure at 97th Avenue (RID) and coordinates the removal of the conflict structure at 91st Avenue via the separate plan package prepared by Wood/Patel for SRP construction. Please note that SRP indicated that a decision on whether they will allow the structure east of 95th Avenue to be eliminated is being reviewed. This decision has not been made yet, but will be based in part on their ability to accept RID flows at 91st Avenue and on FCDMC's willingness to accept tailwater flows into the storm drain at this location.

Wood/Patel is available for a final review meeting, if deemed necessary. You may want to inform the appropriate agencies (e.g., City of Glendale, ADOT, etc.) About the review response deadlines as well as the meeting.

Please feel free to call if you have any questions.

Sincerely,

WOOD, PATEL & ASSOCIATES, INC.

Ashok C. Patel, P.E., R.L.S.
Principal

ACP/ztj
REPORT 94153.04FINAL GLENDALE AVENUE-NOV16

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Registered Professional Engineer (Civil) CERTIFICATE NO. 32845 R. SCOTT RASMUSSEN Date Signed 11-16-98 ARIZONA, U.S.A.

Registered Professional Engineer (Civil) CERTIFICATE NO. 10512 ASHOK C. PATEL Date Signed 11/16/98 ARIZONA, U.S.A.

This Summary has been compiled to document significant matters relating to the design of the Final plan for the Flood Control District of Maricopa County (District) Contract FCD 94-12 Phase II, Glendale Avenue Storm Drain, Sub-Phase "B".

- **Hydrology/Hydraulics Development:**

  Runoff used for the design of the storm drains is based on the 10-year, 6-hour storm event as developed and previously approved in the Northern/Orangewood Storm Drain Project Concept/Routing Study by Wood, Patel & Associates, Inc., dated March 14, 1996. This hydrology model has been recently updated for storage basin routing, basin bypass flows and storage volume requirements. The output HEC-1 files, is included in Appendix I. In addition to the 10-year , 6-hour offsite flows developed along mile and half mile streets in the HEC-1 model, the rational method was used to quantify local runoff which contributes to the quarter mile and eighth mile street catch basins. These rational and HEC-1 based flows were combined where appropriate to determine the total flow for inlet design. For instance, there may be flow by at mile street catch basins which will be bypassed to ⅛ mile catch basins. This bypass is added to the rational flow for local catch basins and used for inlet design.

  Storm drain hydraulic grade lines were computed using the StormCAD Version 1.5 software program. An output file of the hydraulic data is included in this document (See Appendix I). Catch basin inlet and connector pipe hydraulic calculations have been included (See Appendix II).

  The proposed storm drain will outfall into the Agua Fria Freeway Outfall Channel (AFFOC). BRW is currently designing this channel as part of De Leuw Cather's 95% Plans for this reach of Agua Fria Freeway-(Camelback to Northern) for the Arizona Department of Transportation (ADOT). A stub-out from the channel outfall will be included in the ADOT channel plans for this storm drain project. A portion of the materials required to construct the storm drain to the stub out will be purchased with this project, stockpiled onsite and constructed as part of the ADOT project. A drywell will be used to drain the nuisance flow entering the storm drain until final completion of AFFOC in approximately June 2000.

- **Utilities:**

  Utilities shown on the Final plan are derived from utility maps obtained from the utility companies, field surveys locating any visible surface facilities/appurtenances and potholing information.

  Final plans are being distributed to the affected utilities for their review. The following is a list of utilities that will be supplied with plans:

AT&T	US West
MCI	Cox Cable
Southwest Gas	SRVWUA
SRP Electric	City of Glendale (Water and Sewer)
APS Electric	

  The results of potholing utilities have been previously supplied to the FCDMC.

- **Right-of-Way:**

  The proposed storm drain alignment for this phase lies within the existing Northern Avenue right-of-way. It is not anticipated that additional right-of-way will be required for this phase.

- **Survey:**

  The survey performed by Wood/Patel was based upon information provided by the City of Glendale. The survey also tied into several ADOT control points provided by DMJM for the Agua Fria Freeway to verify datums. By comparing the project datum (City of Glendale) with the ADOT datum near 99th Avenue and Glendale Avenue, it was found that the City of Glendale datum is an average of 0.033' below ADOT's datum.

- **Soils:**

  Ricker-Atkinson-McBee & Associates, Inc., Geotechnical Subconsultant for this project, completed a soils investigation for this phase in January 1998 (R.A.M. Project No. G10522, Report No. 2). Soil boring logs are included in the Final Plans and copies of the report were submitted as part of the 30% bid package.

- **Partnering:**

  Due to the many agencies and consultants involved in the Northern/Orangewood Storm Drain Project, the Firm Corporate Advisors was retained to help coordinate partnering workshops among the parties. The first partnering workshop was held on May 11, 1998, at the offices of the District.

- **Schedule:**

  The original design schedule for the Sub-Phase "B" storm drain in Glendale Avenue called for submittal of the Final plans on November 26, 1998. However, per the District's request, this submittal has been slightly expedited.

  Wood/Patel is available for a final review meeting if deemed necessary by the FCDMC

- **Final Plan:**

  The Final plan has been developed per the standards as set forth in the scope of work, input from the City of Glendale, and on standard Flood Control District of Maricopa County sheets provided to us by the District.

- **Traffic Control**

During the construction of this section of storm drain, 2-way traffic will be carried on the north side of Glendale Avenue in a single traffic lane in each direction.

Two-way traffic will be created by placing vertical panels or tubular markers on the existing lane line. Westbound traffic will be carried in the northernmost lane while eastbound traffic will be carried across one of the median openings and maintained in the lane adjacent to the median island. The contractor will be limited to shifting eastbound traffic onto the north half of the roadway only in those areas where storm drain construction is occurring on the south side of the roadway. The length of the traffic control zone where 2-way traffic is carried on the north half of the roadway will be limited to a maximum length of 1/4 mile.

While working in the 91st Avenue intersection, the contractor shall maintain eastbound and westbound traffic on the north half of Glendale Avenue. Left turns will be prohibited. North-south traffic on 91st Avenue will also have to be restricted to a single lane in each direction and left turns will need to be prohibited. A uniformed, off-duty police officer will be required to manually operate the traffic signal while construction activities are occurring in the intersection.

The same types of traffic control will be utilized at the Glendale Avenue and 83rd Avenue intersection. Two-way traffic will be maintained on the north side of Glendale and the east side of 83rd Avenue. A uniformed, off-duty police officer will be required to manually operate the traffic signal. Left turns will need to be prohibited on all approaches to the intersection. The contractor will be required to minimize the amount of time that he will be working in the intersection. The contractor will not be allowed to work in both the 91st Avenue and 83rd Avenue intersections at the same time.

Access to the properties along the south side of Glendale will need to be maintained by the contractor, providing this access through the work areas. Where access is being maintained, No Left Turn signing will be required. Upon completion of the major storm drain system, it will be necessary for the contractor to shift 2-way traffic to the south half of Glendale Avenue in those areas where storm drain laterals are being provided across the westbound lanes.

- **Cost Estimate:**

The Engineers estimate for construction costs for the project based on Final Plans is included under separate cover.

APPENDIX I

STORM DRAIN HYDRAULIC ANALYSIS

- Hydraulic Summary Glendale Avenue Storm Drain
- HEC-1 & Storm CAD

NORTHERN/ORANGEWOOD STORM DRAIN PROJECT

Glendale Avenue Storm Drain
Phase II, Sub-Phase B
Flood Control District of Maricopa County

11/10/98

Hydraulic Summary Table: West Basin to Agua Fria Channel

Contract FCD 94-12
PHASE II
Sub-phase "B"

Note: *Based on Storm CAD file: w:\94153-NorthernOrangewood\Phase II b\hydraulics\Wb100p.stm*

W/P # 94153.04

U/S Node	D/S Node	Pipe	Discharge (cfs)	Length (ft)	Slope (ft/ft)	Pipe Size	Manning's n Value	Velocity (fps)	U/S Invert El (ft)	D/S Invert El (ft)	U/S NG Elev (ft)	D/S NG Elev (ft)	U/S Cover (ft)	D/S Cover (ft)	U/S HGL (ft)	D/S HGL (ft)	U/S EGL (ft)	D/S EGL (ft)	HGL to NG (ft)	EGL to NG (ft)
I-70	J-59	P-176	57	380	0.004237	42 inch	0.013	5.9	1,113.00	1,111.39	1,129.30	1,128.50	12.8	13.61	1,127.00	1,125.78	1,127.54	1,126.32	2.30	1.76
J-59	J-58	P-179	57	380	0.004263	42 inch	0.013	5.9	1,111.39	1,109.77	1,128.50	1,127.50	13.61	14.23	1,125.75	1,124.53	1,126.30	1,125.08	2.75	2.20
J-58	J-15	P-180	57	380	0.004237	42 inch	0.013	5.9	1,109.77	1,108.16	1,127.50	1,126.40	14.23	14.74	1,124.51	1,123.29	1,125.05	1,123.83	2.99	2.45
J-15	J-14c	P-6b5	57	143.59	0.00188	42 inch	0.013	5.9	1,108.16	1,107.89	1,126.40	1,126.50	14.74	15.11	1,122.99	1,122.52	1,123.53	1,123.07	3.41	2.87
J-14c	J-14b	P-6b4	57	335	0.001851	42 inch	0.013	5.9	1,107.89	1,107.27	1,126.50	1,125.17	15.11	14.4	1,122.39	1,121.31	1,122.93	1,121.86	4.11	3.57
J-14b	J-14a	P-6b3	57	200.49	0.001845	48 inch	0.013	4.5	1,107.27	1,106.90	1,125.17	1,124.91	13.9	14.01	1,121.23	1,120.92	1,121.55	1,121.24	3.94	3.62
J-14a	J-56	P-6b2	57	374.78	0.001868	48 inch	0.013	4.5	1,106.90	1,106.20	1,124.91	1,124.63	14.01	14.43	1,120.84	1,120.25	1,121.16	1,120.57	4.07	3.75
J-56	J-14	P-6b1	57	375	0.001867	48 inch	0.013	4.5	1,106.20	1,105.50	1,124.63	1,124.00	14.43	14.5	1,120.23	1,119.64	1,120.55	1,119.96	4.40	4.08
J-14	J-13d	P-6a5	82	492.72	0.001908	48 inch	0.013	6.5	1,105.50	1,104.56	1,124.00	1,123.20	14.5	14.64	1,119.21	1,117.60	1,119.87	1,118.27	4.79	4.13
J-13d	J-13c	P-6a4	82	492.5	0.001909	48 inch	0.013	6.5	1,104.56	1,103.62	1,123.20	1,122.12	14.64	14.5	1,117.60	1,116.00	1,118.27	1,116.66	5.60	4.93
J-13c	J-13b	P-6a3	82	122.95	0.00122	54 inch	0.013	5.2	1,103.62	1,103.47	1,122.12	1,121.83	14	13.86	1,115.98	1,115.76	1,116.39	1,116.18	6.14	5.73
J-13b	J-13a	P-6a2	82	141.07	0.002552	54 inch	0.013	5.2	1,103.47	1,103.11	1,121.83	1,121.46	13.86	13.85	1,115.74	1,115.50	1,116.16	1,115.91	6.09	5.67
J-13a	J-13	P-6a1	82	116.47	0.002061	60 inch	0.013	4.2	1,103.11	1,102.87	1,121.46	1,121.10	13.35	13.23	1,115.49	1,115.37	1,115.76	1,115.64	5.97	5.70
J-13	J-12c	P-5b4	95	178.81	0.002013	60 inch	0.013	4.8	1,102.87	1,102.51	1,121.10	1,120.55	13.23	13.04	1,115.28	1,115.04	1,115.64	1,115.40	5.82	5.46
J-12c	J-12b	P-5b3	95	110	0.002	60 inch	0.013	4.8	1,102.51	1,102.29	1,120.55	1,120.18	13.04	12.89	1,115.02	1,114.88	1,115.39	1,115.24	5.53	5.16
J-12b	J-12a	P-5b2	95	485.28	0.002122	48 inch	0.013	7.6	1,102.29	1,101.26	1,120.18	1,118.53	13.89	13.27	1,114.83	1,112.71	1,115.72	1,113.60	5.35	4.46
J-12a	J-12	P-5b1	95	485.50	0.002142	48 inch	0.013	7.6	1,101.26	1,100.22	1,118.53	1,116.90	13.27	12.68	1,112.66	1,110.54	1,113.55	1,111.43	5.87	4.98
J-12	J-11a	P-5a2	124	662.50	0.002083	60 inch	0.013	6.3	1,100.22	1,098.84	1,116.90	1,115.25	11.68	11.41	1,110.20	1,108.70	1,110.82	1,109.32	6.70	6.08
J-11a	J-11	P-5a1	124	662.50	0.002098	66 inch	0.013	5.2	1,098.84	1,097.45	1,115.25	1,113.60	10.91	10.65	1,108.68	1,107.77	1,109.10	1,108.20	6.57	6.15
J-11	J-10B	P-4b	158	1,324.22	0.001895	66 inch	0.013	6.7	1,097.45	1,094.94	1,113.60	1,111.50	10.65	11.06	1,107.40	1,104.46	1,108.08	1,105.15	6.20	5.52
J-10B	J-10	P-4a	158	1322	0.001899	66 inch	0.013	6.7	1,094.94	1,092.43	1,111.50	1,106.00	11.06	8.07	1,104.43	1,101.50	1,105.12	1,102.19	7.07	6.38
J-10	J-9	P-44b	215	1,298.50	0.003573	72 inch	0.013	7.6	1,092.33	1,087.69	1,106.00	1,103.00	7.67	9.31	1,099.84	1,096.49	1,100.74	1,097.39	6.16	5.26
J-9	J-8	P-44a	216	1346	0.003484	72 inch	0.013	7.6	1,087.69	1,083.00	1,103.00	1,095.00	9.31	6	1,096.27	1,092.76	1,097.17	1,093.67	6.73	5.83
I-53	J-8	P-43e	169	162.8	0.003378	84 inch	0.013	4.4	1,083.45	1,082.90	1,095.20	1,095.00	4.75	5.1	1,092.88	1,092.76	1,093.18	1,093.06	2.32	2.02
J-8	J-7	P-43d	385	1,335.00	0.003363	84 inch	0.013	10	1,082.90	1,078.41	1,095.00	1,092.40	5.1	6.99	1,090.26	1,085.41	1,091.82	1,086.97	4.74	3.18
J-7	J-6a	P-43c2	387	644	0.003385	84 inch	0.013	10.2	1,078.41	1,076.23	1,092.40	1,091.00	6.99	7.77	1,085.00	1,082.99	1,086.65	1,084.59	7.40	5.75
J-6a	J-6	P43c1	387	684	0.003377	90 inch	0.013	9	1,076.23	1,073.92	1,091.00	1,089.60	7.27	8.18	1,082.92	1,081.48	1,084.26	1,082.67	8.08	6.74
J-6	J-5	P-43b	392	1327	0.003384	90 inch	0.013	8.9	1,073.92	1,069.43	1,089.60	1,084.00	8.18	7.07	1,081.16	1,077.78	1,082.41	1,079.00	8.44	7.19
J-5	J-4a	P-43a2	394	668	0.003383	90 inch	0.013	8.9	1,069.43	1,067.17	1,084.00	1,080.76	7.07	6.09	1,077.47	1,075.71	1,078.70	1,076.95	6.53	5.30
J-4a	J-4	P-43a1	394	651.63	0.003376	90 inch	0.013	8.9	1,067.17	1,064.97	1,080.76	1,077.60	6.09	5.13	1,075.65	1,073.93	1,076.88	1,075.17	5.11	3.88
J-4	CS-3a	P-42b3	453	48.37	0.003515	90 inch	0.013	10.3	1,064.97	1,064.80	1,077.60	1,077.52	5.13	5.22	1,072.87	1,072.70	1,074.50	1,074.34	4.73	3.10
CS-3a	J-3a	P-42b1	453	620	0.003371	90 inch	0.013	11.5	1,064.80	1,062.71	1,077.52	1,076.30	5.22	6.09	1,071.05	1,068.94	1,073.11	1,071.01	6.47	4.41
J-3a	J-3	P-42b1a	453	661.00	0.003389	96 inch	0.013	10.2	1,062.71	1,060.47	1,076.30	1,075.00	5.59	6.53	1,068.85	1,067.71	1,070.71	1,069.10	7.45	5.59
J-3	CS-2a	P-42a2	454	1264	0.003378	96 inch	0.013	9.5	1,060.47	1,056.20	1,075.00	1,068.31	6.53	4.11	1,067.33	1,064.63	1,068.85	1,065.90	7.67	6.15
CS-2a	J-2	P-42a1	454	59	0.00339	96 inch	0.013	9.4	1,056.20	1,056.00	1,068.31	1,068.00	4.11	4	1,063.53	1,063.42	1,064.90	1,064.78	4.78	3.41
J-2	J-60	P-41e	485	1105.7	0.002406	102 inch	0.013	10.2	1,056.00	1,053.34	1,068.00	1,065.62	3.5	3.78	1,062.49	1,060.10	1,064.18	1,061.66	5.51	3.82
J-60	J-1a	P-41d	485	204.3	0.002398	102 inch	0.013	10.1	1,053.34	1,052.85	1,065.62	1,065.62	3.78	4.27	1,060.02	1,059.61	1,061.62	1,061.17	5.60	4.00
J-1a	J-1	P-41c	486	88.25	0.00238	102 inch	0.013	10.1	1,052.85	1,052.64	1,065.62	1,066.00	4.27	4.86	1,059.53	1,059.34	1,061.13	1,060.94	6.09	4.49
J-1	ADOT Stub	P-41b	486	139.4	0.004591	102 inch	0.013	10.2	1,052.64	1,052.00	1,066.00	1,066.00	4.86	5.5	1,058.99	1,058.97	1,060.76	1,060.45	7.01	5.24
ADOT Stub	Outlet	P-41a	486	12.76	0.004702	102 inch	0.013	12.7	1,052.00	1,051.94	1,066.00	1,066.00	5.5	5.56	1,057.53	1,057.29	1,059.93	1,059.88	8.47	6.07

Concrete Lined Corrugated Metal Pipe
Main Line & Lateral
Glendale Avenue Storm Drain, Sub Phase "B"
Contract FCD 94-12 Phase II

Glendale Avenue

Pipe Number	Upstream Station	Offset from C/L	Upstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Downstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Pipe Length (ft)	Pipe Dia. (in)	Pipe Wall Thickness (in)	(Gage)	Corrugation Size (in)
Main Line													
	11+08.33		ADOT Stubo	1065.70	1052.00	Outlet	1065.50	1051.94	12.76	102	0.109	12	3 x 1
	12+37.76		J-1	1065.60	1052.64	ADOT Stubou	1065.70	1052.00	139.40	102	0.109	12	3 x 1
	13+26.00		MH1	1065.62	1052.85	J-1	1065.60	1052.64	88.25	102	0.109	12	3 x 1
	26+36.00		MH2	1067.63	1056.00	MH1	1065.62	1052.85	1310.00	102	0.109	12	3 x 1
	26+96.17		CS-2a	1067.88	1056.20	MH2	1067.63	1056.00	55.67	96	0.109	12	3 x 1
	39+59.00		MH3	1074.84	1060.47	CS-2a	1067.88	1056.20	1258.33	96	0.109	12	3 x 1
	46+20.00		MH4A	1076.40	1062.71	MH3	1074.84	1060.47	661.00	96	0.109	12	3 x 1
	52+44.22		MH4	1078.10	1064.80	MH4A	1076.40	1062.71	612.62	90	0.109	12	3 x 1
	52+88.37		MH4B	1078.25	1064.97	MH4	1078.10	1064.80	32.55	90	0.109	12	3 x 1
	59+40.00		MH5	1079.70	1067.17	MH4B	1078.25	1064.97	651.63	90	0.109	12	3 x 1
	66+08.00		MH6	1083.94	1069.43	MH5	1079.70	1067.17	668.00	90	0.109	12	3 x 1
	79+35.00		MH7	1089.62	1073.92	MH6	1083.94	1069.43	1327.00	90	0.109	12	3 x 1
	86+19.00		Redr	1090.60	1076.23	MH7	1089.62	1073.92	678.00	90	0.109	12	3 x 1
	92+63.00		MH8	1091.92	1078.41	Redr	1090.60	1076.23	638.00	84	0.079	14	3 x 1
	105+98.20		MH9	1095.30	1082.90	MH8	1091.92	1078.41	1335.20	84	0.079	14	3 x 1
	107+61.00		I-53	1095.20	1083.45	MH9	1095.30	1082.90	162.80	84	0.079	14	3 x 1
	11+64.00		J-9	1095.90	1083.65	MH9	1095.30	1082.90	192.00	72	0.079	14	3 x 1
Laterals													
	13+25.45		Pipe Coll	1065.80	1057.50	Pipe Collar	1065.00	1057.50	20.00	36	0.079	14	2-2/3 x 1/2
	26+36.00		Plug	1067.90	1061.05	MH2	1067.70	1059.24	79.60	36	0.079	14	2-2/3 x 1/2
	52+88.37		MH10	1078.02	1068.69	MH4B	1078.25	1067.50	238.60	42	0.079	14	2-2/3 x 1/2
	12+09.63		CB33	1077.51	1072.26	MH10	1078.02	1068.69	36.80	30	0.079	14	2-2/3 x 1/2
	12+09.63		CB34	1077.47	1069.50	MH10	1078.02	1068.69	28.90	30	0.079	14	2-2/3 x 1/2

RGRCP
Main Line
Glendale Avenue Storm Drain, Sub Phase "B"
Contract FCD 94-12 Phase II

Glendale Avenue

Pipe Number	Upstream Station	Offset from C/L	Upstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Depth (ft)	Structure Depth (ft)	Downstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Depth (ft)	Pipe Length (ft)	Total Fall	Pipe Slope	Pipe Dia. (in)	Pipe Wall Thickness	Pipe O.D. (ft)	Depth of Cover (ft)	Fill Height Range No.	Fill Height Range (ft)	RGRCP Pipe Class
			0						*	*						*					*
	11+08.33		ADOT Stubo	1065.70	1052.00	4.41	13.70	Outlet	1065.50	1051.94	4.27	12.76	0.06	0.00470	102	9.5	10.08	4.41	2	3 - 5	II
	12+37.76		J-1	1065.60	1052.64	3.67	12.96	ADOT Stubou	1065.70	1052.00	4.41	139.40	0.64	0.00459	102	9.5	10.08	4.41	2	3 - 5	II
	13+26.00		MH1	1065.62	1052.85	3.48	12.77	J-1	1065.60	1052.64	3.67	88.25	0.21	0.00238	102	9.5	10.08	3.67	2	3 - 5	II
	26+36.00		MH2	1067.63	1056.00	2.34	11.63	MH1	1065.62	1052.85	3.48	1310.00	3.15	0.00240	102	9.5	10.08	3.48	2	3 - 5	II
	26+96.17		CS-2a	1067.88	1056.20	2.93	11.68	MH2	1067.63	1056.00	2.88	55.67	0.20	0.00359	96	9	9.50	2.93	1	1 - 3	II
	39+59.00		MH3	1074.84	1060.47	5.62	14.37	CS-2a	1067.88	1056.20	2.93	1258.33	4.27	0.00339	96	9	9.50	5.62	3	5 - 8	II
	46+20.00		MH4A	1076.40	1062.71	4.94	13.69	MH3	1074.84	1060.47	5.62	661.00	2.24	0.00339	96	9	9.50	5.62	3	5 - 8	II
	52+44.22		MH4	1078.10	1064.80	5.09	13.30	MH4A	1076.40	1062.71	5.48	612.62	2.09	0.00341	90	8.5	8.92	5.48	3	5 - 8	II
	52+88.37		MH4B	1078.25	1064.97	5.07	13.28	MH4	1078.10	1064.80	5.09	32.55	0.17	0.00522	90	8.5	8.92	5.09	3	5 - 8	II
	59+40.00		MH5	1079.70	1067.17	4.32	12.53	MH4B	1078.25	1064.97	5.07	651.63	2.20	0.00338	90	8.5	8.92	5.07	3	5 - 8	II
	66+08.00		MH6	1083.94	1069.43	6.30	14.51	MH5	1079.70	1067.17	4.32	668.00	2.26	0.00338	90	8.5	8.92	6.30	3	5 - 8	II
	79+35.00		MH7	1089.62	1073.92	7.49	15.70	MH6	1083.94	1069.43	6.30	1327.00	4.49	0.00338	90	8.5	8.92	7.49	3	5 - 8	II
	86+19.00		Redr	1090.60	1076.23	6.16	14.37	MH7	1089.62	1073.92	7.49	678.00	2.31	0.00341	90	8.5	8.92	7.49	3	5 - 8	II
	92+63.00		MH8	1091.92	1078.41	5.84	13.51	Redr	1090.60	1076.23	6.70	638.00	2.18	0.00342	84	8	8.33	6.70	3	5 - 8	II
	105+98.20		MH9	1095.30	1082.90	4.73	12.40	MH8	1091.92	1078.41	5.84	1335.20	4.49	0.00336	84	8	8.33	5.84	3	5 - 8	II
	107+61.00		I-53	1095.20	1083.45	4.08	11.75	MH9	1095.30	1082.90	4.73	162.80	0.55	0.00338	84	8	8.33	4.73	2	3 - 5	II
	11+64.00		J-9	1095.90	1083.65	5.67	12.25	MH9	1095.30	1082.90	5.82	192.00	0.75	0.00391	72	7	7.17	5.82	3	5 - 8	II

RGRCP
Laterals
Glendale Avenue Storm Drain, Sub Phase "B"
Contract FCD 94-12 Phase II

Glendale Avenue

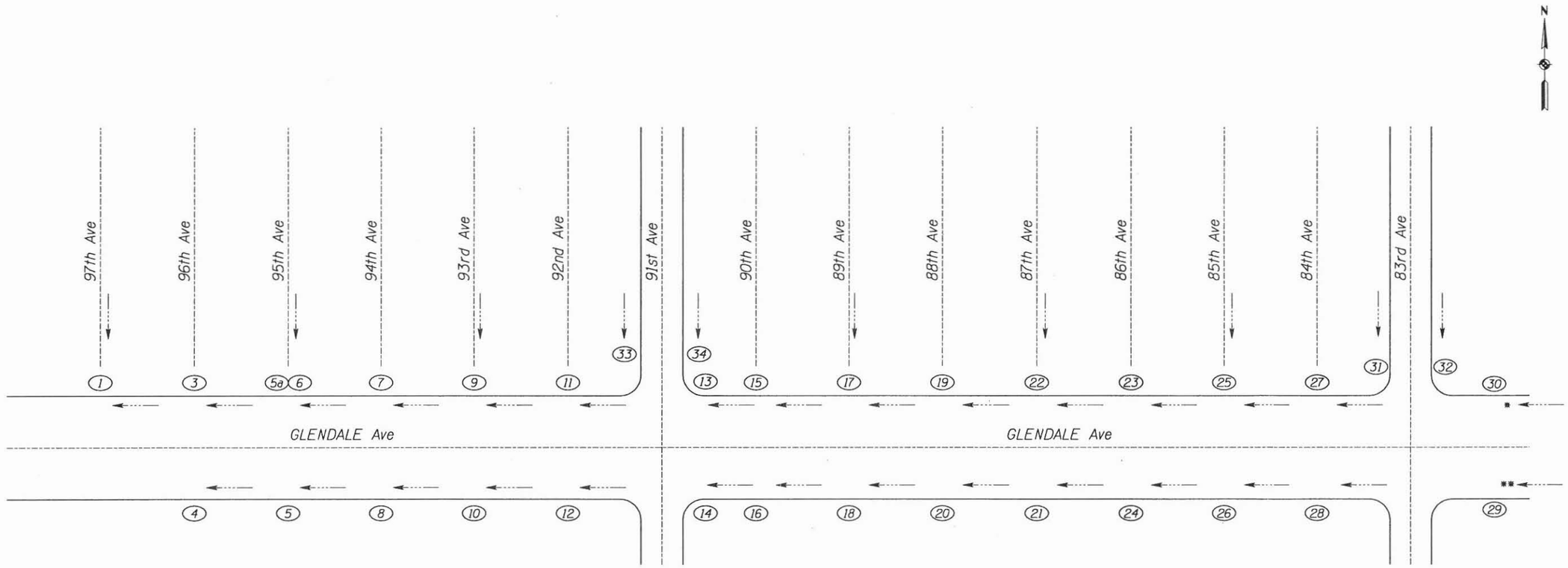
Pipe Number	Upstream Station	Offset from C/L	Upstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Depth (ft)	Structure Depth (ft)	Downstream Structure	Grate/Rim Elev (ft)	Invert Elev (ft)	Depth (ft)	Pipe Length (ft)	Total Fall	Pipe Slope	Pipe Dia. (in)	Pipe Wall Thickness	Pipe O.D. (ft)	Depth of Cover (ft)	Fill Height Range No.	Fill Height Range (ft)	RGRCP Pipe Class
			0						*	*						*					*
	13+25.45		Pipe Coll	1065.80	1057.50	4.97	8.30	Pipe Collar	1065.00	1057.50	4.17	20.00	0.00	0.00000	36	4	3.67	4.97	2	3 - 5	II
	15+29.79		CB1	1065.57	1059.25	4.75	6.32	MH2	1065.62	1057.08	6.97	76.80	2.17	0.02826	15	3.875	1.90	6.97	3	5 - 8	III
	19+66.00		CB4	1066.36	1062.22	6.34	7.91	3ML	1067.70	1059.79	6.34	6.50	2.43	0.37385	15	3.875	1.90	6.34	3	5 - 8	III
	19+78.00		CB3	1066.25	1061.65	2.89	4.60	4ML	1066.25	1058.21	6.33	75.60	3.44	0.04550	18	2.5	1.92	6.33	3	5 - 8	III
	26+24.00		CB5	1067.50	1063.52	2.41	3.98	5ML	1067.70	1061.00	5.13	8.20	2.52	0.30732	15	3.875	1.90	5.13	3	5 - 8	III
	26+06.00		CB5a	1067.66	1062.02	3.93	5.64	5aML	1067.80	1061.78	4.31	29.40	0.24	0.00816	18	2.5	1.92	4.31	2	3 - 5	II
	26+81.00		CB6	1067.66	1061.67	3.74	5.99	6ML	1067.80	1061.55	4.00	43.90	0.12	0.00273	24	3	2.50	4.00	2	3 - 5	II
	26+36.00		Plug	1067.90	1061.05	3.52	6.85	MH2	1067.70	1059.24	5.13	79.60	1.81	0.02274	36	4	3.67	5.13	3	5 - 8	II
	32+86.50		CB8	1070.30	1066.16	2.57	4.14	8ML	1070.20	1063.09	5.54	8.80	3.07	0.34886	15	3.875	1.90	5.54	3	5 - 8	III
	32+98.50		CB7	1070.27	1066.13	2.57	4.14	7ML	1070.50	1061.77	7.16	74.20	4.36	0.05876	15	3.875	1.90	7.16	3	5 - 8	III
	39+47.00		CB10	1074.74	1070.60	2.57	4.14	9ML	1074.80	1065.92	7.31	9.90	4.68	0.47273	15	3.875	1.90	7.31	3	5 - 8	III
	39+59.00		CB9	1074.52	1068.88	3.93	5.64	MH3	1074.84	1063.76	9.37	74.50	5.12	0.06872	18	2.5	1.92	9.37	4	8 - 11	III
	46+08.00		CB12	1076.22	1072.08	2.57	4.14	11ML	1076.25	1067.53	7.15	13.00	4.55	0.35000	15	3.875	1.90	7.15	3	5 - 8	III
	46+20.00		CB11	1076.07	1071.13	2.69	4.94	MH4A	1076.40	1065.77	8.38	70.60	5.36	0.07592	24	3	2.50	8.38	4	8 - 11	III
	52+88.37		MH10	1078.02	1068.69	5.45	9.33	MH4B	1078.25	1067.50	6.88	238.60	1.19	0.00499	42	4.5	4.25	6.88	3	5 - 8	II
	53+95.00		CB13	1077.88	1074.88	1.43	3.00	13ML	1078.20	1068.58	8.05	70.80	6.30	0.08898	15	3.875	1.90	8.05	4	8 - 11	IV
	54+07.00		CB14	1077.88	1074.88	1.43	3.00	12ML	1078.00	1069.94	6.49	13.60	4.94	0.36324	15	3.875	1.90	6.49	3	5 - 8	III
	59+28.00		CB16	1078.86	1075.86	1.43	3.00	14ML	1079.50	1071.53	6.40	13.40	4.33	0.32313	15	3.875	1.90	6.40	3	5 - 8	III
	59+40.00		CB15	1079.35	1075.21	2.57	4.14	MH5	1079.70	1070.36	7.77	70.60	4.85	0.06870	15	3.875	1.90	7.77	3	5 - 8	III
	65+96.00		CB18	1082.91	1077.41	3.93	5.50	15ML	1083.00	1073.58	7.85	14.00	3.83	0.27357	15	3.875	1.90	7.85	3	5 - 8	III
	66+08.00		CB17	1083.53	1078.89	2.93	4.64	MH6	1083.94	1072.62	9.61	69.50	6.27	0.09022	18	2.5	1.92	9.61	4	8 - 11	III
	71+70.00		CB19	1086.62	1082.48	2.57	4.14	16ML	1087.20	1074.68	10.95	69.90	7.80	0.11159	15	3.875	1.90	10.95	4	8 - 11	IV
	71+82.00		CB20	1086.59	1082.09	2.93	4.50	17ML	1087.00	1076.09	9.34	15.00	6.00	0.40000	15	3.875	1.90	9.34	4	8 - 11	IV
	79+35.00		Plug	1090.00	1081.35	6.40	8.65	MH7	1089.62	1077.18	10.19	75.10	4.17	0.05553	24	3	2.50	10.19	4	8 - 11	III
	79+46.22		CB22	1089.45	1084.31	3.43	5.14	19L	1089.80	1081.59	6.50	11.20	2.72	0.24286	18	2.5	1.92	6.50	3	5 - 8	III
	79+47.00		CB21	1089.21	1084.71	2.93	4.50	18ML	1089.50	1078.70	9.23	14.90	6.01	0.40336	15	3.875	1.90	9.23	4	8 - 11	IV
	85+87.00		CB24	1090.17	1084.67	3.93	5.50	20ML	1090.50	1080.43	8.50	14.10	4.24	0.30071	15	3.875	1.90	8.50	4	8 - 11	IV
	85+99.00		CB23	1090.35	1086.21	2.57	4.14	21ML	1090.50	1079.49	9.44	69.60	6.72	0.09655	15	3.875	1.90	9.44	4	8 - 11	IV
	92+51.00		CB26	1091.20	1085.20	4.43	6.00	22ML	1091.80	1082.06	8.17	13.90	3.14	0.22590	15	3.875	1.90	8.17	4	8 - 11	IV
	92+63.00		CB25	1091.48	1087.34	2.57	4.14	MH8	1091.92	1081.41	8.94	70.00	5.93	0.08471	15	3.875	1.90	8.94	4	8 - 11	IV
	99+05.00		CB28	1092.97	1085.97	5.43	7.00	24ML	1093.00	1083.97	7.46	13.60	2.00	0.14706	15	3.875	1.90	7.46	3	5 - 8	III
	99+26.50		CB27	1093.00	1088.87	2.56	4.13	23ML	1093.00	1083.61	7.82	70.00	5.26	0.07514	15	3.875	1.90	7.82	3	5 - 8	III
	107+44.00		CB29	1095.14	1088.14	5.29	7.00	25ML	1095.50	1086.58	7.21	12.50	1.56	0.12480	18	2.5	1.92	7.21	3	5 - 8	III
	107+56.00		CB30	1095.17	1091.17	1.75	4.00	26ML	1095.50	1085.96	7.29	71.50	5.21	0.07287	24	3	2.50	7.29	3	5 - 8	II
	11+16.17		CB31	1095.27	1090.77	2.93	4.50	27ML	1095.50	1086.13	7.80	36.40	4.64	0.12747	15	3.875	1.90	7.80	3	5 - 8	III
	11+50.23		CB32	1095.60	1092.60	1.43	3.00	28ML	1095.80	1086.19	8.04	29.10	6.41	0.22027	15	3.875	1.90	8.04	4	8 - 11	IV
	12+09.63		CB33	1077.51	1072.26	2.46	5.25	MH10	1078.02	1068.69	6.54	36.80	3.57	0.09701	30	3.5	3.08	6.54	3	5 - 8	II
	12+09.63		CB34	1077.47	1069.50	5.18	7.97	MH10	1078.02	1068.69	6.54	28.90	0.81	0.02803	30	3.5	3.08	6.54	3	5 - 8	II

APPENDIX II

CATCH BASIN INLET HYDRAULICS

- Rational Method Calculations
- Catch Basin Hydraulics
- Catch Basin Connector Pipe Hydraulics

•RATIONAL METHOD CALCULATIONS



CB#	FLOW HEC-1	FLOW RATIONAL	FLOWBY RECEIVED	FLOW BYPASS	FLOW CAPTURED
1	7	2	0	0	9
3	0	2	11.5	0	13.5
4	0	2	0	0	2
5	0	2	0	0	2
5a	0	0	22.3	11.5	10.8
6	41	3	0	22.3	21.7
7	0	2	0	0	2
8	0	3	0	0	3
9	6	2	0	0	8
10	0	2	0	0	2
11	0	2	10.5	0	12.5
12	0	2	0	0	2
13	0	2	0	0.1	1.9
14	0	2	0.80	0.18	2.62
15	0	3	0	0	3
16	0	3	0.73	0.80	2.93
17	7	2	0	0	9
18	0	2	0.90	0.73	2.17

CB#	FLOW HEC-1	FLOW RATIONAL	FLOWBY RECEIVED	FLOW BYPASS	FLOW CAPTURED
19	0	3	0	0	3
20	0	3	0.52	0.90	2.62
21	0	2	0.51	0.52	1.99
22	8	2	0	0	10
23	0	3	0	0	3
24	0	2	0.28	0.51	1.77
25	4	2	0	0	6
26	0	2	0.25	0.28	1.97
27	0	2	0.7	0	2.7
28	0	2	0	0.25	1.75
29	*	*	*	*	9.6
30	*	*	*	*	10.5
31	0	2	0	0.4	1.6
32	0	2	0.3	0.3	2
33	28	0	0	4.6	23.4
34	32	0	0	5.8	26.2

NOTE: All Flows Shown In Cubic Feet Per Second

KEY NOTES

(1) CATCH BASIN ID NUMBER

FLOW DIRECTION

* CAPACITY WITH FLOW AT TOP OF CURB=10.5 cfs
CAPACITY WITH NO FLOWBY=4.7 CFS

** CAPACITY WITH FLOW AT TOP OF CURB=9.6 cfs
CAPACITY WITH NO FLOWBY=4.7 CFS

2.5 0 2.5 5
Scale In Feet

Two working days before you dig
263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

NO.	REVISION	BY	DATE
1			
2			
3			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

GLENDALE AVE STORM DRAIN
SUB-PHASE "B"
CONTRACT FCD - PHASE II

	BY	DATE
DESIGNED	J. TAILLON	11/98
DRAWN	A. LINN	11/98
CHECKED	A. PATEL	11/98

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

CATCH BASIN FLOW SCHEMATIC

SHEET 20 OF 39

PCN 4500332

V:\980105\cpdt13.dgn 11/10/98

v:/980105/60sub/flowsch.dgn Nov. 13, 1998 08:12:55

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Glendale Avenue Storm Drain

PROJECT No. 94153.04 SHEET No. _____ OF _____

CALCULATED BY RSR DATE _____ CHECKED BY _____ DATE _____

Catch Basin 5a

Catch Basin 5a was located to recieve by pass flow from Catch Basin 6. There are no rational method calculations for Catch Basin 5a.

Catch Basins 29+30

Catch Basins 29+30 were sized with a 17' wing opening. These catch basins were not designed to intercept all the flow coming down Glendale Ave. In order to recieve the total flow the storm drain will have to be extended east. Catch Basin connector pipes for 29+30 were sized with the flow at the top of curb. The capacity of these inlets with no flowby was also calculated for future design considerations. There are no rational method calculations for Catch Basins 29+30.

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 11-11-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB 1 Sta 15+29.79 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.82	acres
Watercourse Length	503.0	feet
Top Elevation	1066.8	feet
Bottom Elevation	1065.3	feet
Slope	.00304	feet/feet
Roughness Coefficient (Kb)	.04054	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	2	4	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	11.4	10.1	9.6	8.6	8.2	7.8
i (in/hr)	2.8	3.9	4.4	5.8	6.7	7.7

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-3 STa 19+78 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.76	acres
Watercourse Length	659.0	feet
Top Elevation	1067.9	feet
Bottom Elevation	1066.1	feet
Slope	.00266	feet/feet
Roughness Coefficient (Kb)	.04073	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	14.2	12.5	11.9	10.7	10.1	9.6
i (in/hr)	2.5	3.5	4.0	5.4	6.2	7.1

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-4 STA 19+66 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83	acres
Watercourse Length	713.0	feet
Top Elevation	1067.9	feet
Bottom Elevation	1065.4	feet
Slope	.00360	feet/feet
Roughness Coefficient (Kb)	.04050	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.2	11.7	11.1	9.9	9.4	8.9
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-5 STA 26+24 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	717.5	feet
Top Elevation	1070.8	feet
Bottom Elevation	1066.6	feet
Slope	.00591	feet/feet
Roughness Coefficient (Kb)	.04049	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	2	4	5	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	11.0	9.8	9.3	8.3	7.9	7.5
i (in/hr)	2.8	3.9	4.4	5.9	6.8	7.8

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-6 STA 25+82 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.90	acres
Watercourse Length	771.5	feet
Top Elevation	1070.8	feet
Bottom Elevation	1067.2	feet
Slope	.00472	feet/feet
Roughness Coefficient (Kb)	.04027	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	12.5	11.0	10.5	9.4	8.9	8.5
i (in/hr)	2.7	3.7	4.2	5.7	6.5	7.5

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-7 STA 32+98.5 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83	acres
Watercourse Length	715.5	feet
Top Elevation	1076.6	feet
Bottom Elevation	1074.0	feet
Slope	.00363	feet/feet
Roughness Coefficient (Kb)	.04051	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.2	11.7	11.1	9.9	9.4	8.9
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-8 STA 32+86.5 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83	acres
Watercourse Length	715.5	feet
Top Elevation	1074.9	feet
Bottom Elevation	1069.9	feet
Slope	.00711	feet/feet
Roughness Coefficient (Kb)	.04049	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	10.3	9.1	8.7	7.8	7.4	7.0
i (in/hr)	2.9	4.0	4.6	6.1	7.0	8.0

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB-9 Sta 39+59 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83	acres
Watercourse Length	716.0	feet
Top Elevation	1076.6	feet
Bottom Elevation	1074.0	feet
Slope	.00369	feet/feet
Roughness Coefficient (Kb)	.04049	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.2	11.6	11.1	9.9	9.4	8.9
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB - 10 STA 39+47 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83 acres
Watercourse Length	716.0 feet
Top Elevation	1076.6 feet
Bottom Elevation	1074.1 feet
Slope	.00360 feet/feet
Roughness Coefficient (Kb)	.04049
10-Year, 6-Hour Rainfall	2.07 inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.3	11.7	11.2	10.0	9.5	9.0
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB 11 STa 96+20 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.83	acres
Watercourse Length	715.0	feet
Top Elevation	1077.9	feet
Bottom Elevation	1075.6	feet
Slope	.00323	feet/feet
Roughness Coefficient (Kb)	.04050	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.8	12.2	11.6	10.4	9.8	9.3
i (in/hr)	2.6	3.5	4.0	5.4	6.2	7.2

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-16-1998

LOCATION DATA

Location: Glendale Ave

Project Name: Northern Orange Subarea id: CB -12 STA 46+08 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.85	acres
Watercourse Length	727.0	feet
Top Elevation	1077.9	feet
Bottom Elevation	1076.0	feet
Slope	.00257	feet/feet
Roughness Coefficient (Kb)	.04045	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	15.2	13.4	12.7	11.4	10.8	10.2
i (in/hr)	2.4	3.4	3.9	5.2	6.0	6.9

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen

Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB 13 53+95 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.69	acres
Watercourse Length	598.0	feet
Top Elevation	1080.0	feet
Bottom Elevation	1077.8	feet
Slope	.00371	feet/feet
Roughness Coefficient (Kb)	.04102	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	4
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	11.9	10.5	10.0	8.9	8.5	8.0
i (in/hr)	2.7	3.8	4.3	5.8	6.6	7.6

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-24-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-14 STa 54+07 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.66	acres
Watercourse Length	576.0	feet
Top Elevation	1080.0	feet
Bottom Elevation	1077.8	feet
Slope	.00375	feet/feet
Roughness Coefficient (Kb)	.04114	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	4
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	11.6	10.2	9.7	8.7	8.3	7.9
i (in/hr)	2.8	3.8	4.4	5.8	6.7	7.7

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB15 - 59+40 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	723.0	feet
Top Elevation	1084.0	feet
Bottom Elevation	1079.4	feet
Slope	.00639	feet/feet
Roughness Coefficient (Kb)	.04046	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	10.8	9.5	9.1	8.1	7.7	7.3
i (in/hr)	2.9	4.0	4.5	6.0	6.8	7.9

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-16 STA 59+28 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	723.0	feet
Top Elevation	1084.0	feet
Bottom Elevation	1079.1	feet
Slope	.00678	feet/feet
Roughness Coefficient (Kb)	.04047	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	10.5	9.3	8.9	8.0	7.6	7.2
i (in/hr)	2.9	4.0	4.5	6.0	6.9	7.9

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB 17 - 6610827

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.71	acres
Watercourse Length	617.0	feet
Top Elevation	1087.6	feet
Bottom Elevation	1083.0	feet
Slope	.00746	feet/feet
Roughness Coefficient (Kb)	.04093	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	9.3	8.2	7.8	7.1	6.7	6.4
i (in/hr)	3.0	4.2	4.8	6.3	7.2	8.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-18 STA 65+96 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.74	acres
Watercourse Length	641.0	feet
Top Elevation	1087.3	feet
Bottom Elevation	1083.1	feet
Slope	.00655	feet/feet
Roughness Coefficient (Kb)	.04082	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	10.0	8.8	8.4	7.6	7.2	6.8
i (in/hr)	2.9	4.1	4.7	6.1	7.0	8.1

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-19 - 71+20 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	1.02	acres
Watercourse Length	865.0	feet
Top Elevation	1090.3	feet
Bottom Elevation	1086.2	feet
Slope	.00483	feet/feet
Roughness Coefficient (Kb)	.03994	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.2	11.7	11.1	9.9	9.4	8.9
i (in/hr)	2.6	3.6	4.1	5.5	6.3	7.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-20 STA 71+82 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.97	acres
Watercourse Length	820.0	feet
Top Elevation	1089.6	feet
Bottom Elevation	1086.8	feet
Slope	.00341	feet/feet
Roughness Coefficient (Kb)	.04008	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	14.6	12.9	12.3	11.0	10.4	9.8
i (in/hr)	2.5	3.5	3.9	5.3	6.1	7.0

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-21 STA 79+47 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.81	acres
Watercourse Length	695.0	feet
Top Elevation	1090.9	feet
Bottom Elevation	1089.1	feet
Slope	.00259	feet/feet
Roughness Coefficient (Kb)	.04057	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	14.8	13.0	12.4	11.1	10.5	9.9
i (in/hr)	2.5	3.4	3.9	5.3	6.1	7.0

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-22-79+88.5 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.78	acres
Watercourse Length	674.0	feet
Top Elevation	1090.9	feet
Bottom Elevation	1089.4	feet
Slope	.00220	feet/feet
Roughness Coefficient (Kb)	.04067	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	15.5	13.6	13.0	11.6	11.0	10.4
i (in/hr)	2.4	3.4	3.9	5.2	5.9	6.9

Flood Control District of Maricopa County
Hydrologic Design Manual· Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-23 - 851997T

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84 acres
Watercourse Length	609.0 feet
Top Elevation	1092.0 feet
Bottom Elevation	1089.2 feet
Slope	.00460 feet/feet
Roughness Coefficient (Kb)	.04047
10-Year, 6-Hour Rainfall	2.07 inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	2	2	3	4	5	6
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	11.0	9.7	9.2	8.3	7.9	7.5
i (in/hr)	2.8	3.9	4.5	5.9	6.8	7.8

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-24 STA 85+87 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	719.0	feet
Top Elevation	1091.0	feet
Bottom Elevation	1090.1	feet
Slope	.00125	feet/feet
Roughness Coefficient (Kb)	.04047	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	4
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	19.9	17.5	16.5	14.9	14.0	13.3
i (in/hr)	2.1	3.0	3.5	4.6	5.4	6.2

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-25 STA 92+63 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.77	acres
Watercourse Length	609.0	feet
Top Elevation	1093.5	feet
Bottom Elevation	1091.5	feet
Slope	.00328	feet/feet
Roughness Coefficient (Kb)	.04071	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	12.5	11.0	10.5	9.4	8.9	8.5
i (in/hr)	2.7	3.7	4.2	5.7	6.5	7.5

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-26 Sta 92+51 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	719.0	feet
Top Elevation	1093.6	feet
Bottom Elevation	1091.3	feet
Slope	.00320	feet/feet
Roughness Coefficient (Kb)	.04047	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	13.9	12.3	11.7	10.4	9.9	9.4
i (in/hr)	2.5	3.5	4.0	5.4	6.2	7.2

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-27 Sta 99+26.5 LT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.84	acres
Watercourse Length	718.0	feet
Top Elevation	1095.2	feet
Bottom Elevation	1093.0	feet
Slope	.00306	feet/feet
Roughness Coefficient (Kb)	.04047	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	14.1	12.5	11.9	10.6	10.1	9.5
i (in/hr)	2.5	3.5	4.0	5.4	6.2	7.1

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 06-03-1998

LOCATION DATA

Location: Glendale Ave.

Project Name: Northern Orange Subarea id: CB-28 STa 99+14.5 RT

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.86	acres
Watercourse Length	734.0	feet
Top Elevation	1095.2	feet
Bottom Elevation	1093.0	feet
Slope	.00300	feet/feet
Roughness Coefficient (Kb)	.04040	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	14.4	12.7	12.1	10.8	10.3	9.7
i (in/hr)	2.5	3.5	4.0	5.3	6.1	7.1

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 08-27-1998

LOCATION DATA

Location: 83rd Ave

Project Name: Northern Orange Subarea id: CB-31

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.48	acres
Watercourse Length	567.2	feet
Top Elevation	1099.2	feet
Bottom Elevation	1095.4	feet
Slope	.00661	feet/feet
Roughness Coefficient (Kb)	.04199	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	1	2	2	3	3
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	9.4	8.3	7.9	7.1	6.8	6.4
i (in/hr)	3.0	4.2	4.8	6.2	7.2	8.3

Flood Control District of Maricopa County
Hydrologic Design Manual Rational Method

Computed by: Scott Rasmussen Date: 08-27-1998

LOCATION DATA

Location: 83rd Ave

Project Name: Northern Orange Subarea id: CB-32

Drainage Area Cover: AC

DESIGN DATA

Drainage Area	0.64	acres
Watercourse Length	527.0	feet
Top Elevation	1099.2	feet
Bottom Elevation	1095.6	feet
Slope	.00674	feet/feet
Roughness Coefficient (Kb)	.04121	
10-Year, 6-Hour Rainfall	2.07	inches

Hydrological Summary Table

Parameter	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Q (cfs)	1	2	2	3	4	5
C	0.670	0.670	0.670	0.737	0.804	0.838
Tc (min)	8.8	7.8	7.4	6.7	6.4	6.0
i (in/hr)	3.1	4.3	4.9	6.4	7.3	8.4

•CATCH BASIN HYDRAULICS

COP Type M Det P-1569

Weir/Orifice Flow Capacities of Single Grate Inlet

Weir EQ. $Q_i = C_w P d^{1.5}$ **Orifice EQ.** $Q_i = C_o A(2gd)^{0.5}$

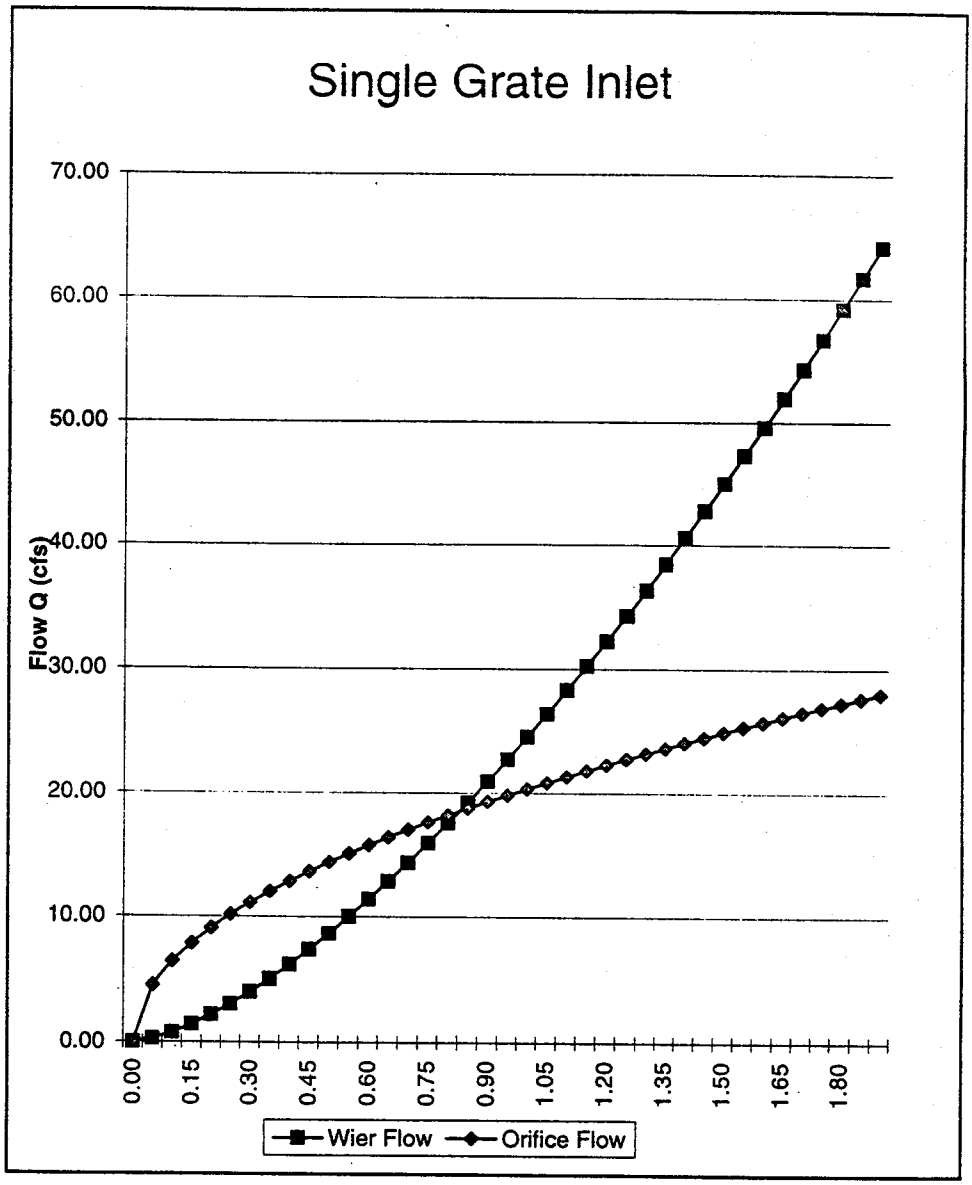
Where: $C_w = 3.0$ **and** $C_o = 0.67$

Single Grate

P =	8.17	ft
A =	3.78	ft^2

Grate Opening

Depth (ft)	Weir Qi (cfs)	Orifice Qi (cfs)
0.00	0.00	0.00
0.05	0.27	4.54
0.10	0.78	6.43
0.15	1.42	7.87
0.20	2.19	9.09
0.25	3.06	10.16
0.30	4.03	11.13
0.35	5.08	12.02
0.40	6.20	12.85
0.45	7.40	13.63
0.50	8.67	14.37
0.55	10.00	15.07
0.60	11.39	15.74
0.65	12.84	16.39
0.70	14.35	17.00
0.75	15.92	17.60
0.80	17.54	18.18
0.85	19.21	18.74
0.90	20.93	19.28
0.95	22.69	19.81
1.00	24.51	20.32
1.05	26.37	20.83
1.10	28.28	21.32
1.15	30.23	21.80
1.20	32.22	22.26
1.25	34.25	22.72
1.30	36.33	23.17
1.35	38.45	23.61
1.40	40.60	24.05
1.45	42.80	24.47
1.50	45.03	24.89
1.55	47.30	25.30
1.60	49.60	25.71
1.65	51.95	26.11
1.70	54.33	26.50
1.75	56.74	26.89
1.80	59.19	27.27
1.85	61.67	27.64
1.90	64.19	28.01



Maximum Depth = 1.14 ft. Maximum Inlet capacity = 0.5*21.7 = 10.85 cfs

Weir/Orifice Flow Capacities of Double Grate Inlet

Weir EQ. $Q_i = C_w P d^{1.5}$ **Orifice EQ.** $Q_i = C_o A (2gd)^{0.5}$

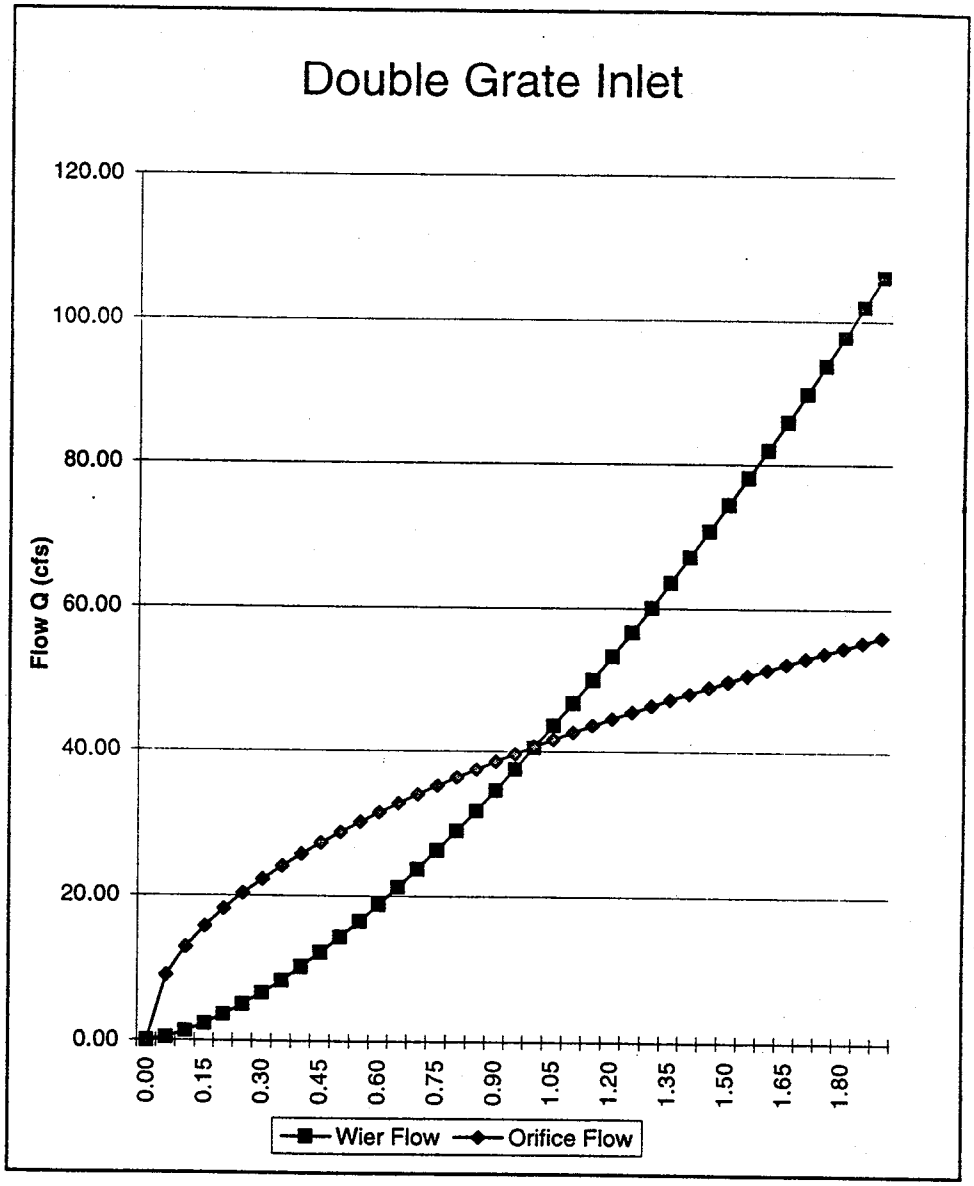
Where: $C_w = 3.0$ **and** $C_o = 0.67$

Double Grate

P =	13.50	ft
A =	7.56	ft^2

Grate Opening

Depth (ft)	Weir Qi (cfs)	Orifice Qi (cfs)
0.00	0.00	0.00
0.05	0.45	9.09
0.10	1.28	12.85
0.15	2.35	15.74
0.20	3.62	18.18
0.25	5.06	20.32
0.30	6.65	22.26
0.35	8.39	24.05
0.40	10.25	25.71
0.45	12.23	27.27
0.50	14.32	28.74
0.55	16.52	30.15
0.60	18.82	31.49
0.65	21.22	32.77
0.70	23.72	34.01
0.75	26.31	35.20
0.80	28.98	36.36
0.85	31.74	37.48
0.90	34.58	38.56
0.95	37.50	39.62
1.00	40.50	40.65
1.05	43.58	41.65
1.10	46.72	42.63
1.15	49.95	43.59
1.20	53.24	44.53
1.25	56.60	45.45
1.30	60.03	46.35
1.35	63.53	47.23
1.40	67.09	48.10
1.45	70.71	48.95
1.50	74.40	49.78
1.55	78.15	50.61
1.60	81.97	51.42
1.65	85.84	52.21
1.70	89.77	53.00
1.75	93.76	53.77
1.80	97.81	54.54
1.85	101.91	55.29
1.90	106.07	56.03



Maximum Depth = 1.14 ft. Maximum Inlet capacity = 0.5*43.4 = 21.7 cfs

•CATCH BASIN HYDRAULICS

COP Type N Det P-1570

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 53+95

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 13

$Q_b = 0$

$Q = 2.0$ cfs

$S = .0019$ ft/ft

$S_x = .020$ ft/ft

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.02) = .139$

$S'_w = .139/1.42 = .098$

$S_e = .020 + .098(.313) = .051$

$L_T = .6(2)^{.42}(.0019)^{.3}(1/(.016)(.051))^{.6} = 8.7$

Reduction Factor = .8 so $L_T/.8 = 10.9$

For 9' Opening

$E = 1-(1-9/10.9)^{1.8} = 95.7\%$

$Q_{cap} = 2(.957) = 1.91$ cfs

$Q_b = 2-1.91 = .09$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-06-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 13 Sta 53+95
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JGT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.190
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.020
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.020
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.000
SPREAD-Ft.--T	=	12.505
Average Velocity-V-fps	=	1.248
FLOW in Gutter-CFS--Q	=	0.626
% Flow in Gutter-CFS	=	31.303
Velocity of Flow in Gutter-fps	=	1.677
Depth at Curb Line-Inches--d	=	3.649

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O STa 54+07

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB - 14

$Q_b = .80$

$Q = 2.0$ cfs

$S = .0015$ 1/1

$S_x = .026$ 1/1

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.026) = .130$

$S'_w = .130/1.42 = .092$

$S_e = .026 + (.092)(.296) = .053$

$L_T = .6(2.79)^{.42}(.0015)^{.3}(1/(.016)(.053))^{.6} = 9.1$

Reduction Factor = .8 so $L_T/.8 = 11.4$

For 9' Opening

$E = 1-(1-9/11.4)^{1.8} = 93.9$

$Q_{cap} = .939(2.79) = 2.62$ cfs

$Q_b = 2.80 - 2.62 = .18$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-12-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - LB-14 Sta 54+07
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JGT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.150
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.026
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.026
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.800
SPREAD-Ft.--T	=	12.684
Average Velocity-V-fps	=	1.318
FLOW in Gutter-CFS--Q	=	0.828
% Flow in Gutter-CFS	=	29.565
Velocity of Flow in Gutter-fps	=	1.745
Depth at Curb Line-Inches--d	=	4.503

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 59+28

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 16

$Q_b = .73$ cfs

$Q = 3.0$ cfs

$S = .0071$ ft/ft

$S_x = .016$ ft/ft

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.016) = .144$

$S_v' = .144/1.42 = .101$

$S_e = .016 + .101(.289) = .045$

$L_T = .6(3.68)^{.42}(.0071)^{.3}(1/(.016)(.045))^{.6} = 18.1$

Reduction Factor = .8 so $L_T/.8 = 22.6$

For 13' Opening

$E = 1 - (1 - 13/22.6)^{1.8} = 78.6$

$Q_{cap} = .786(3.73) = 2.93$

$Q_b = 3.73 - 2.93 = .80$

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-12-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB-16 59+28
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JCT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.710
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.016
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.016
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	3.730
SPREAD-Ft.--T	=	14.161
Average Velocity-V-fps	=	2.265
FLOW in Gutter-CFS--Q	=	1.077
% Flow in Gutter-CFS	=	28.878
Velocity of Flow in Gutter-fps	=	3.096
Depth at Curb Line-Inches--d	=	3.435

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 65+96

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JIM DATE 9/98

CB 18

$Q_b = .90$ cfs

$Q = 2.0$ cfs

$S = .0061$ ft/ft

$S_x = .021$ ft/ft

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.021) = .137$

$S_w' = .137/1.42 = .096$

$S_e = .021 + .096(.346) = .054$

$L_T = .6(2.61)^{.42}(.0061)^{.3}(1/.016)(.054)^{.6} = 13.4$

Reduction Factor = .8 so $L_T/.8 = 16.8$

For 9' Opening

$E = 1 - (1 - 9/16.8)^{1.8} = 74.9\%$

$Q_{cap} = .749(2.90) = 2.17$

$Q_b = 2.9 - 2.17 = .73$

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-12-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 18 Sta 65+96
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - VST
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.610
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.021
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.021
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.900
SPREAD-Ft.--T	=	11.170
Average Velocity-V-fps	=	2.153
FLOW in Gutter-CFS--Q	=	1.004
% Flow in Gutter-CFS	=	34.636
Velocity of Flow in Gutter-fps	=	2.876
Depth at Curb Line-Inches--d	=	3.445

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O STa 71+82

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB-20

$Q_b = .52$ cfs

$Q = 3.0$ cfs

$S = .0038$ ft/ft

$S_x = .024$ ft/ft

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.024) = .133$

$S'_w = .133/1.42 = .094$

$S_e = .024 + .094(.312) = .053$

$L_T = .6(3.46)^{.42}(.0038)^{.3}(1/.016 \times .053))^{.6} = 13.2$

Reduction Factor = .8 so $L_T/.8 = 16.5$

For 9' Opening

$E = 1-(1-9/16.5)^{1.8} = 75.8\%$

$Q_{cap} = .758(3.46) = 2.62$ cfs

$Q_b = 3.52 - 2.62 = .9$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-12-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB20 STa 71+82
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - YGT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.380
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.024
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.024
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	3.520
SPREAD-Ft.--T	=	12.166
Average Velocity-V-fps	=	1.944
FLOW in Gutter-CFS--Q	=	1.097
% Flow in Gutter-CFS	=	31.156
Velocity of Flow in Gutter-fps	=	2.582
Depth at Curb Line-Inches--d	=	4.083

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 79+47

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 21

$Q_b = .51$ cfs

$Q = 2.0$ cfs

$S = .0014$ %

$S_x = .024$ %

$n = .016$

$R_f = .8$

$a = .167 - .024(1.42) = .133$

$S_w' = .133/1.42 = .094$

$S_e = .024 + .094(.293) = .052$

$L_T = .6(2.23)^{.42}(.0014)^{.3}(1/(.016)(.052))^{.6} = 8.2$

Reduction Factor = .8 so $L_T/.8 = 10.3$

For 6' Opening

$E = 1-(1-6/10.3)^{1.8} = 79.2\%$

$Q_{cap} = 2.51(.792) = 1.99$ cfs

$Q_b = 2.51 - 1.99 = .52$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-12-1998

PROJECT NAME- N10 TRACS NO.-
HIGHWAY NAME- DESIGNER - RSR
LOCATION - CB-21 STa 79+47 CHECKER - JGT PAGE
Ver 3.40: December 1995

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.140
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.024
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.024
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.510
SPREAD-Ft.--T	=	12.948
Average Velocity-V-fps	=	1.227
FLOW in Gutter-CFS--Q	=	0.736
% Flow in Gutter-CFS	=	29.338
Velocity of Flow in Gutter-fps	=	1.632
Depth at Curb Line-Inches--d	=	4.308

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O STa 85+87

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 24

$Q_b = .28$ cfs

$Q = 2$ cfs

$S = .0009$ ft

$S_x = .016$

$n = .016$

$R_f = .8$

$a = .167 - .016(1.42) = .144$

$S'_w = .144 / 1.42 = .101$

$S_e = .016 + .101(.233) = .040$

$L_T = .6(2.28)^{.42}(.0009)^{.3}(1/(.016)(.040))^{.6} = 8.5$

Reduction Factor: .8 so $L_T/.8 = 10.6$

For 6' Opening

$E = 1 - (1 - 6/10.6)^{1.8} = 77.7\%$

$Q_{cap} = 2.28(.777) = 1.77$ cfs

$Q_b = 2.28 - 1.77 = .51$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-06-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 24 Sta 85+87
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JGT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.090
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.016
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.016
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.280
SPREAD-Ft.--T	=	17.471
Average Velocity-V-fps	=	0.918
FLOW in Gutter-CFS--Q	=	0.531
% Flow in Gutter-CFS	=	23.268
Velocity of Flow in Gutter-fps	=	1.254
Depth at Curb Line-Inches--d	=	4.070

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O STA 92+51

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 26

$Q_d = .25$ cfs

$Q = 2.0$ cfs

$S = .0024$ '/'

$S_x = .017$ '/'

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.017) = .143$

$S'_w = .143/1.42 = .101$

$S_e = .017 + .101(.292) = .046$

$L_T = .6(2.25)^{.42}(.0024)^{.3}(1/(.016)(.046))^{.6} = 10.5$

Reduction Factor = .8 so $L_T/.8 = 13.1$

For 9' opening

$E = 1-(1-9/13.1)^{1.8} = 87.6\%$

$Q_{cap} = .876(2.25) = 1.97$

$Q_b = 2.25 - 1.97 = .28$

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-06-1998

PROJECT NAME- N/O Sta 92+51 TRACS NO.-
HIGHWAY NAME- DESIGNER - RSR
LOCATION - CB 26 CHECKER - KET PAGE
Ver 3.40: December 1995

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.240
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.017
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.017
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.250
SPREAD-Ft.--T	=	13.836
Average Velocity-V-fps	=	1.349
FLOW in Gutter-CFS--Q	=	0.657
% Flow in Gutter-CFS	=	29.205
Velocity of Flow in Gutter-fps	=	1.835
Depth at Curb Line-Inches--d	=	3.521

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 99+05

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 28

$Q_b = 0$

$Q = 2.0$ cfs

$S = .0031$ '/'

$S_x = .016$ '/'

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.016) = .144$

$S'_w = .144 / 1.42 = .101$

$S_e = .016 + .101(.314) = .048$

$L_T = .6(2)^{.42}(.0031)^{.3}(1/.016(.048))^{.6} = 10.5$

Reduction Factor = .8 so $L_T/.8 = 13.1$

For 9' Opening

$E = 1 - (1 - 9/13.1)^{1.8} = 87.6\%$

$Q_{cap} = .876(2) = 1.75'$

$Q_b = 2 - 1.75 = .25'$

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-05-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION -CB28 STa 99+05
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - [illegible]
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.310
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.016
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.016
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.000
SPREAD-Ft.--T	=	13.043
Average Velocity-V-fps	=	1.425
FLOW in Gutter-CFS--Q	=	0.628
% Flow in Gutter-CFS	=	31.392
Velocity of Flow in Gutter-fps	=	1.947
Depth at Curb Line-Inches--d	=	3.220

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 107+56

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 29

$Q_b = 0$

$Q = 11.8$ → Based on Flow at Top of Curb, Depth = 6 in

$S = .0029\ ^1/_1$

$S_x = 0.0190\ ^1/_1$

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.019) = .140$

$S_w' = .140/1.42 = .099$

$S_e = .019 + .099(.166) = .035$

$$L_T = .6(11.8)^{.42}(.0029)^{.3}\left(\frac{1}{(.016)(.035)}\right)^{.6}$$

$L_T = 26.2$

Reduction Factor = .8 so $L_T/.8 = 32.8$

For 20' Opening

$E = 1-(1-20/32.8)^{1.8} = 81.6\%$

$Q_{cap} = .816(11.8) = 9.6$ cfs

Inlet Capacity with no Flowby For Future Design

$S_e = .019 + .099(.239) = .043$

$$L_T = .6(4.7)^{.42}(.0029)^{.3}\left(\frac{1}{(.016)(.043)}\right)^{.6} = 15.73$$

$\frac{15.73}{.8} = 19.7 < 20$ so 100% captured $Q = 4.7$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

09-16-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB29 Sta 107+56
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JJT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.290
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.019
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.019
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.056
Gutter Depression-Inches--	=	0.954
Manning's 'N	=	0.016
Flow-CFS--Q	=	11.805 ← Capacity Top of Curb
SPREAD-Ft.--T	=	23.551
Average Velocity-V-fps	=	2.225
FLOW in Gutter-CFS--Q	=	1.961
% Flow in Gutter-CFS	=	16.610
Velocity of Flow in Gutter-fps	=	3.000
Depth at Curb Line-Inches--d	=	6.000

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-13-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 29 Sta 107+56
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JGT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.290
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.019
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.019
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	4.700 ← capacity No Flowby
SPREAD-Ft.--T	=	16.561
Average Velocity-V-fps	=	1.777
FLOW in Gutter-CFS--Q	=	1.122
% Flow in Gutter-CFS	=	23.863
Velocity of Flow in Gutter-fps	=	2.402
Depth at Curb Line-Inches--d	=	4.440

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 107+44

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 30

$Q_b = 0$

$Q = 13.4$ cfs → Based on flow at Top of Curb, Depth = 6in

$S = .0034'/'$

$S_x = 0.0180'/'$

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.018) = .141$

$S'_w = .141/1.42 = .099$

$S_e = .018 + .099(.159) = .034$

$L_T = .6(13.4)^{.42}(.0029)^{.3}\left(\frac{1}{(.016)(.034)}\right)^{.6}$

$L_T = 28.1$

Reduction Factor = .8 so $L_T/.8 = 35.1$

For 20' Opening

$E = 1-(1-20/35.1)^{1.8} = 78.1\%$

$Q_{cap} = .781(13.4) = 10.5$ cfs

Inlet Capacity with no Flowby For Future Design

$S_e = .018 + .099(.240) = .042$

$L_T = .6(4.7)^{.42}(.0029)^{.3}\left(\frac{1}{.016(.042)}\right)^{.6} = 15.95$

$\frac{15.95}{.8} = 19.9$ $19.9 < 20$ so 100% captured $Q = 4.7$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

09-16-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB30 Sta 107+44
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - [illegible]
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.340
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.018
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.018
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.056
Gutter Depression-Inches--	=	0.954
Manning's 'N	=	0.016
Flow-CFS--Q	=	13.375 ← Capacity, Top of Curb
SPREAD-Ft.--T	=	24.780
Average Velocity-V-fps	=	2.403
FLOW in Gutter-CFS--Q	=	2.123
% Flow in Gutter-CFS	=	15.874
Velocity of Flow in Gutter-fps	=	3.249
Depth at Curb Line-Inches--d	=	6.000

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

11-13-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 30 Sta 107+44
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - CST
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.340
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.018
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.018
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	4.700 ← Capacity No Flow by
SPREAD-Ft.--T	=	16.611
Average Velocity-V-fps	=	1.862
FLOW in Gutter-CFS--Q	=	1.128
% Flow in Gutter-CFS	=	24.008
Velocity of Flow in Gutter-fps	=	2.526
Depth at Curb Line-Inches--d	=	4.270

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O STA 11+16.17 83rd Ave

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB-31

$Q_b = 0$

$Q = 2$ cfs

$S = .0054$ '/FT

$S_x = .0158$ '/FT

$n = .016$

$R_F = .8$

$a = .167 - 1.42(.0158) = .145$

$S'_w = .145/1.42 = .102$

$S_e = .0158 + .102(.349) = .051$

$L_T = .6(2)^{.42}(.0054)^{.3}\left(\frac{1}{(.016)}\frac{}{.051}\right)^{.6} = 11.9$

Reduction Factor = .8 so $L_T/.8 = 14.9$

For 9' Opening

$E = 1-(1-9/14.9)^{1.8} = 81.1\%$

$Q_{cap} = 2(.811) = 1.62$ cfs

$Q_b = 2 - 1.62 = .38$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-28-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB-31 Sta 11+16.17 83' Rvc
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JCT
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.540
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.016
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.016
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.000
SPREAD-Ft.--T	=	11.770
Average Velocity-V-fps	=	1.759
FLOW in Gutter-CFS--Q	=	0.698
% Flow in Gutter-CFS	=	34.890
Velocity of Flow in Gutter-fps	=	2.400
Depth at Curb Line-Inches--d	=	2.951

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 11+50.23 83rd Ave

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 32

$Q_b = .32$ cfs

$Q = 2$ cfs

$S = .0061$ '/FT

$S_x = .0100$ '/FT

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.01) = .153$

$S'_w = .153/1.42 = .108$

$S_e = .010 + .108(.280) = .040$

$L_T = .6(2.32)^{.42}(.0061)^{.3}(.016)(.040)^{.6} = 15.3$

Reduction Factor = .8 so $L_T/.8 = 19.1$

For 13' Opening

$E = 1-(1-13/19.1)^{1.8} = 87.2\%$

$Q_{cap} = 2.32(.872) = 2.02$ cfs

$Q_b = 2.32 - 2.02 = .30$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-27-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB-32 STA 1450.23 83rd Ave
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER -
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.610
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.010
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.010
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	2.320
SPREAD-Ft.--T	=	16.202
Average Velocity-V-fps	=	1.705
FLOW in Gutter-CFS--Q	=	0.650
% Flow in Gutter-CFS	=	28.019
Velocity of Flow in Gutter-fps	=	2.422
Depth at Curb Line-Inches--d	=	2.762

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O Sta 12+09.63 91st Ave

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY TPM DATE 9/98

CB 33

$Q_b = 0$

$Q = 28$ cfs

$S = .0033$ %

$S_x = .015$ %

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.015) = .146$

$S'_w = .146/1.42 = .103$

$S_e = .015 + .103(.108) = .026$

$L_T = .6(28)^{.42}(.0033)^{.3}(1/.016(.026))^{.6} = 46.8$

Reduction Factor: .8 so $L_T/.8 = 58.5$

for 37' Opening

$E = 1-(1-37/58.5)^{1.8} = 83.5$

$Q_{cap} = .835(28) = 23.4$

$Q_b = 28 - 23.4 = 4.6$

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-06-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 33 Sta 12+09.63 91st Ave
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - VST
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.330
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.015
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.015
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	28.000
SPREAD-Ft.--T	=	36.925
Average Velocity-V-fps	=	2.727
FLOW in Gutter-CFS--Q	=	3.019
% Flow in Gutter-CFS	=	10.783
Velocity of Flow in Gutter-fps	=	3.706
Depth at Curb Line-Inches--d	=	7.379

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT N/O 58a 12+09.63 91st Ave

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY RSR DATE 9/98 CHECKED BY JPM DATE 9/98

CB 34

$Q_b = 0$ cfs

$Q = 32$ cfs

$S = .0033'/_1$

$S_x = .016$

$n = .016$

$R_f = .8$

$a = .167 - 1.42(.016) = .144$

$S'_w = .144/1.42 = .101$

$S_e = .016 + .101(.106) = .027$

$L_T = .6(32)^{.42}(.0033)^{.3}(1/.016(.027))^{.6} = 48.4$

Reduction Factor = .8 so $L_T/.8 = 60.5$

For 37' Opening

$E = 1-(1-37/60.5)^{1.8} = 81.8\%$

$Q_{cap} = .818(32) = 26.2$ cfs

$Q_b = 32 - 26.2 = 5.8$ cfs

ARIZONA DEPARTMENT OF TRANSPORTATION
DRAINAGE DESIGN SECTION

08-06-1998

PROJECT NAME- N/O
HIGHWAY NAME-
LOCATION - CB 34 Sta 12+09.63 91st Ave
Ver 3.40: December 1995

TRACS NO.-
DESIGNER - RSR
CHECKER - JBS
PAGE

GUTTER FLOW HYDRAULICS
GUTTER DESCRIPTION

Roadway Grade-% Per cent--G	=	0.330
Roadway Cross-Slope-Ft./Ft.--Sx	=	0.016
Shoulder Width-Ft.--	=	10.000
Shoulder Slope-Ft./Ft.--Ss	=	0.016
Gutter Width-Ft.--W	=	1.420
Gutter Slope-Ft./Ft.--Sw	=	0.058
Gutter Depression-Inches--	=	0.988
Manning's 'N	=	0.016
Flow-CFS--Q	=	32.000
SPREAD-Ft.--T	=	37.300
Average Velocity-V-fps	=	2.864
FLOW in Gutter-CFS--Q	=	3.391
% Flow in Gutter-CFS	=	10.598
Velocity of Flow in Gutter-fps	=	3.882
Depth at Curb Line-Inches--d	=	7.877

•CATCH BASIN CONNECTOR PIPE HYDRAULICS

Catch Basin Connector Pipe Hydraulics

NORTHERN/ORANGEWOOD STORM DRAIN PROJECT
Glendale Avenue Storm Drain - Agua Fria Freeway to 83rd Avenue
Phase II, Sub-Phase B
Flood Control District of Maricopa County
Final Plans

11/16/98
Contract FCD 94-12
W/P # 94153.04

CB #	Lateral / Connector Pipe No.	Q (cfs)	Pipe Dia. (in)	Inlet Invert (ft)	Slope (ft/ft)	Top of Curb (ft)	Gutter / Grate / Ground (ft)	D/S HGL Elev. (ft)	D/S Invert based on Slope (ft)	Submerged Pipe Loss*	Normal / Critical Depth (ft)	Horizontal Length of Pipe (ft)	Tail Water (ft)	Inlet Control HW (ft)	Outlet Control HW (ft)	Inlet Control HW Elev (ft)	Oulet Control HW Elev (ft)	Controlling HW	Difference (gutter/grate-HW elev) (ft)
1	L1	9	15	1059.25	0.0283	N/A	1064.43	1060.10	1057.08	0.00	1.25	76.73	3.02	2.98	3.58	1062.23	1062.83	Outlet Control	1.60
3	L3	10.5	18	1061.65	0.0399	N/A	1065.15	1061.04	1058.64	0.00	1.25	75.36	2.40	2.41	0.96	1064.06	1062.61	Inlet Control	1.09
4	L4	2	15	1062.22	0.4559	N/A	1065.22	1061.01	1059.79	0.00	0.56	5.33	1.22	0.67	-1.14	1062.89	Not Valid	Inlet Control	2.33
5	L5	2	15	1063.52	0.3466	N/A	1066.52	1062.45	1061.00	0.00	0.56	7.27	1.45	0.73	-1	1064.25	Not Valid	Inlet Control	2.27
5a	L5a	10.8	18	1062.02	0.0082	N/A	1066.52	1064.06	1061.78	0.00	1.50	29.30	2.28	2.51	3.23	1064.53	1065.25	Outlet Control	1.27
6	L6	21.7	24	1061.67	0.0027	N/A	1066.52	1064.07	1061.55	0.00	2.00	43.88	2.52	3.24	3.82	1064.91	1065.49	Outlet Control	1.03
N/A	C5	32.5	36	1061.05	0.0030	N/A	1068.09	1063.41	1060.81	0.00	2.23	79.47	2.60	2.84	3.04	1063.89	1064.09	Outlet Control	4.00
7	L7	2	15	1066.13	0.0592	N/A	1069.13	1065.90	1061.77	0.15	0.56	73.60	4.28	0.80	0.05	1066.93	1066.18	Inlet Control	2.20
8	L8	3	15	1066.16	0.3997	N/A	1069.16	1065.88	1063.09	0.00	0.70	7.68	2.79	0.94	-0.12	1067.10	Not Valid	Inlet Control	2.06
9	L9	8	18	1068.88	0.0695	N/A	1073.38	1067.69	1063.76	0.93	1.10	73.64	4.86	1.86	0.64	1070.74	1069.52	Inlet Control	2.64
10	L10	2	15	1070.60	0.5947	N/A	1073.60	1067.29	1065.92	0.00	0.56	7.87	1.37	0.58	-3.24	1071.18	Not Valid	Inlet Control	2.42
11	L11	12.5	24	1071.13	0.0769	N/A	1074.93	1068.93	1065.77	0.46	1.27	69.69	3.62	1.97	-1.16	1073.10	Not Valid	Inlet Control	1.83
12	L12	2	15	1072.08	0.3922	N/A	1075.08	1068.82	1067.53	0.00	0.56	11.60	1.29	0.71	-3.19	1072.79	Not Valid	Inlet Control	2.29
13	L13	1.9	15	1074.88	0.0902	1078.38	1077.88	1074.21	1068.58	0.13	0.55	69.85	5.76	0.78	-0.42	1075.66	Not Valid	Inlet Control	2.22
14	L14	2.6	15	1074.88	0.4093	1078.38	1077.88	1074.24	1069.94	0.00	0.65	12.07	4.30	0.84	-0.52	1075.72	Not Valid	Inlet Control	2.16
15	L15	3	15	1075.21	0.0694	N/A	1078.21	1075.70	1070.36	0.33	0.70	69.87	5.67	1.04	1.11	1076.25	1076.32	Outlet Control	1.89
16	L16	2.9	15	1075.86	0.3552	1079.36	1078.86	1075.62	1071.53	0.00	0.68	12.19	4.09	0.94	-0.09	1076.80	Not Valid	Inlet Control	2.06
17	L17	9	18	1078.89	0.0910	N/A	1082.39	1077.78	1072.62	1.10	1.16	68.87	6.26	2.03	1.1	1080.92	1079.99	Inlet Control	1.47
18	L18	2.2	15	1077.41	0.2931	1083.41	1082.91	1077.44	1073.58	0.00	0.59	13.07	3.86	0.80	0.12	1078.21	1077.53	Inlet Control	4.70
19	L19	3	15	1082.48	0.1133	N/A	1085.48	1079.21	1074.68	0.32	0.70	68.85	4.85	1.03	-2.66	1083.51	Not Valid	Inlet Control	1.97
20	L20	2.6	15	1082.09	0.4580	1087.09	1086.59	1079.24	1076.09	0.00	0.65	13.09	3.15	0.82	-2.72	1082.91	Not Valid	Inlet Control	3.68
21	L21	1.8	15	1084.71	0.4630	1089.71	1089.21	1081.50	1078.70	0.00	1.06	12.98	2.80	0.62	-3.15	1085.33	Not Valid	Inlet Control	3.88
22	L22	10	18	1084.31	0.2618	N/A	1088.31	1083.04	1081.59	0.00	1.06	10.39	1.45	2.23	-0.43	1086.54	Not Valid	Inlet Control	1.77
N/A	C19	10	24	1081.35	0.0409	N/A	1090.00	1081.47	1078.29	0.00	1.13	74.88	3.18	1.69	0.5	1083.04	1081.85	Inlet Control	6.96
23	L23	3	15	1086.21	0.0976	N/A	1089.21	1082.87	1079.49	0.32	0.70	68.86	3.70	1.03	-2.73	1087.24	Not Valid	Inlet Control	1.97
24	L24	1.8	15	1084.67	0.3267	1090.67	1090.17	1082.85	1080.43	0.00	0.53	12.98	2.42	0.69	-1.76	1085.36	Not Valid	Inlet Control	4.81
25	L25	6	15	1087.34	0.0856	N/A	1090.34	1085.40	1081.41	1.30	0.99	69.24	5.29	1.78	0.51	1089.12	1087.85	Inlet Control	1.22
26	L26	2	15	1085.20	0.2373	1091.70	1091.20	1084.96	1082.06	0.00	0.56	13.23	2.90	0.77	-0.17	1085.97	Not Valid	Inlet Control	5.23
27	L27	2.7	15	1088.87	0.0760	N/A	1091.87	1087.81	1083.61	0.26	0.66	69.24	4.46	0.96	-0.57	1089.83	Not Valid	Inlet Control	2.04
28	L28	1.8	15	1085.97	0.1517	1093.47	1092.97	1087.74	1083.97	0.00	0.53	13.18	3.77	0.74	1.83	1086.71	1087.80	Outlet Control	5.17
29	L29	9.6	18	1088.14	0.1283	1095.64	1095.14	1092.87	1086.58	0.00	1.20	12.16	6.08	2.17	5.31	1090.31	1093.45	Outlet Control	1.69
30	L30	10.5	24	1091.17	0.0739	1095.67	1095.17	1092.88	1085.96	0.33	1.16	70.49	7.24	1.74	2.44	1092.91	1093.61	Outlet Control	1.56
31	L31	1.6	15	1090.77	0.1293	1095.77	1095.27	1093.14	1086.13	0.00	0.50	35.89	7.01	0.70	2.43	1091.47	1093.20	Outlet Control	2.07
32	L32	2	15	1092.60	0.2300	1096.10	1095.60	1093.22	1086.19	0.06	0.57	27.87	7.09	0.78	0.77	1093.38	1093.37	Inlet Control	2.22
33	L33	23.4	30	1072.26	0.0975	1078.01	1077.51	1075.12	1068.69	0.00	1.65	36.60	6.43	2.58	3.51	1074.84	1075.77	Outlet Control	1.74
34	L34	26.2	30	1069.50	0.0281	1077.97	1077.47	1075.12	1068.69	0.00	1.74	28.80	6.43	2.82	6.4	1072.32	1075.90	Outlet Control	1.57
N/A	C26	49.6	42	1068.69	0.0050	N/A	1077.47	1073.93	1067.50	0.00	2.20	238.60	6.43	3.40	6.43	1072.09	1075.12	Outlet Control	2.35

* Submerged Pipe Loss was calculated using the following equation: 10.14(n^2)(L)(Q^2)/D^5.33
Where: n=.013, L=Pipe Length(ft), Q=Flow(cfs), D=Pipe Diameter(ft)

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 9, 1998
Pipe 5
Sta 26+24 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	7.3
Culvert Slope (feet per foot)	0.3466

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	1.45	0.73	-1.00	0.20	0.56	0.20	16.37

==========

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Trunk HGL = 1062.45
Lat Invert = 1061.00
T_W = 1.45
AHW = 1065.52
DHW = 1064.25

Procedure for Calculating The HGL For Straight Catch Basin Connector Pipes From The Mainline Storm Drain to the Catch Basin

---

1. Using the hydraulic calculations for the Mainline Storm Drain, calculate the HGL at Catch basin connector point..

2. Based on top of curb elevation at catch basin, calculate invert of connector pipe and gutter at catch basin.

3. Calculate slope of pipe, pipe diameter and pipe length.

4. Calculate the tailwater based on the HGL-connector pipe outlet invert.

5. Using Dodson pipe program, calculate the headwater required for the pipe to convey this flow.

6. Determine "Control Type" (inlet or outlet)
   Inlet=invert elevation at CB plus inlet HW
   Outlet=invert elevation at connector pipe outlet plus outlet HW
   "Control Type" the larger number of the two.

7. Compare largest number to gutter elevation the minimum difference = 1'.

8. Adjust pipe size, slope and invert as required.

Procedure for Calculating The HGL For Catch Basin Connector Pipes which have a Shallow Slope to Clear Existing Utilities and then Drop into Mainline Storm Drain

---

1. Follow the previous 8 steps for calculating the HGL for straight catch basin connector pipes.

2. The shallow pipe slope is hypothetically extended to the mainline and the invert calculated at that point. This elevation is then subtracted from the mainline HGL to determine the tailwater.

Procedure for Calculating The HGL For Catch Basin Connector Pipes That Dip Under Existing Utilities And Then Connect To The Mainline At The Shallow Slope

---

1. Follow the previous 8 steps for calculating the HGL for straight catch basin connector pipes.

2. The slope used in the calculation was a hypothetical line connecting the invert of the catch basin and the invert at the trunkline.

3. Add the headloss from the submerged pipe to the tailwater. This headloss was added in order to balance the use of a steeper slope in calculation than same sections of the proposed pipe.

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 1
Sta 15+29.79 LT

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	76.7
Culvert Slope (feet per foot)	0.0283

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.0	3.02	2.98	3.58	0.87	1.16	1.25	7.33

==========

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Trunk HGL = 1060.10

Lat Invert = 1057.08

T_W = 3.02

AHW = 1063.43

DHW = 1062.83

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT Glendale Avenue Storm Drain

PROJECT NO. 94153.04 SHEET NO. _____ OF _____

CALCULATED BY JGT DATE _____ CHECKED BY KW DATE 11/11/96

DRYWELL @ Sta. 15+29.79 RIGHT

Based on the proposed pavement design for the Glendale Avenue / Agua Fria Freeway interchange, a sump will be created at this location. ADOT will be constructing a pavement taper along the South Side of Glendale Avenue. The City of Glendale has requested that a drywell be installed near the end of the storm drain within their Right of Way to dewater the storm drain prior to the outfall construction.

We have located a drywell at this sump location to collect local runoff & dewater the storm drain. The drywell has limited ability to dispose of inflow which will be coming from the storm drain & the grate. Therefore, the drywell is not designed for a particular capacity at the grate but will capture some pavement drainage runoff & will allow some runoff to continue to flow to the south as it does today.

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 9, 1998
Pipe 3
Sta 19+78 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	75.4
Culvert Slope (feet per foot)	0.0399

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
10.5	2.40	2.41	0.96	1.13	1.25	1.13	7.39

==========

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Trunk HGL = 1061.04

OUT Invert = 1058.64

T_w = 2.4

AHW = 1064.15

DHW = 1064.06

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 9, 1998
Pipe 4
Sta 19+66 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.25
FHWA Chart Number (1,2 or 3).....	1
Scale Number on Chart (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.0130
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	5.3
Culvert Slope (feet per foot).....	0.4559

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	1.22	0.67	-1.14	0.18	0.56	0.18	18.05

==========

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Trunk HGL = 1061.01

Lat. Invert = 1059.79

T_W = 1.22

AHW = 1063.20

DHW = 1062.89

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 5a
Sta 26+06 to 26+36

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	29.3
Culvert Slope (feet per foot)	0.0082

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
10.8	2.28	2.51	3.23	1.50	1.26	1.50	6.14

==========

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Connecting Pipe HGL = 1064.06

Lat. Invert = 1061.78

T_w = 2.28

AHW = 1065.52

DHW = 1065.25

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 6
Sta 26+36 to 26+81

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.00
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	29.3
Culvert Slope (feet per foot)	0.0027

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
21.7	2.52	3.24	3.82	2.00	1.67	2.00	6.91

==========

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Connector Pipe HGL = 1064.07
Lat. Invert = 1061.55
T_w = 2.52
AHW = 1065.52
DHW = 1065.49

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Connector Pipe 5
Sta 26+36 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	3.00
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	79.4
Culvert Slope (feet per foot)	0.0030

==========

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
Design	32.5	2.60	2.84	3.04	2.23	1.85	2.60	4.99
Ultimate	44.0	2.60	3.61	3.61	3.00	2.16	2.60	6.76

==========

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Trunk HGL = 1063.41

Out Invert = 1060.81

T_w = 2.6

AHW = 1065.52

DHW = 1064.09

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 7
Sta 32+98.5 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	73.6
Culvert Slope (feet per foot)	0.0592

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	4.28	0.80	0.05	0.30	0.56	0.30	8.79

==========

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HGL Trunk = 1065.90

Leg. Invert = 1061.77

Sub Pipe Loss = .15

T_W = 4.13 + .15 = 4.28

AHW = 1068.13

DHW = 1066.93

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 8
Sta 32+86.5 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	7.7
Culvert Slope (feet per foot)	0.3997

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.0	2.79	0.94	-0.12	0.23	0.70	0.23	19.43

==========

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HGL Trunk = 1065.88
Lat. Invert = 1063.09
T_W = 2.79
AHW = 1068.13
DHW = 1067.10

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 9
Sta 39+59 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	73.6
Culvert Slope (feet per foot)	0.0695

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
8.0	4.86	1.86	0.64	0.55	1.10	0.55	13.57

==========

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HGL Trunk = 1067.69

Lat invert = 1063.76

Sub. Pipe Loss = .93

T_w = 3.93 + .93 = 4.86

AHW = 1072.38

DHW = 1070.74

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 10
Sta 39+47 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	7.9
Culvert Slope (feet per foot)	0.5947

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	1.37	0.58	-3.24	0.17	0.56	0.17	19.42

==========

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Trunk HGL = 1067.29
Lat. Invert = 1065.92
T_W = 1.37
AHW = 1072.60
DHW = 1071.18

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 11
Sta 46+20 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.00
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	69.7
Culvert Slope (feet per foot)	0.0769

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
12.5	3.62	1.97	-1.16	0.60	1.27	0.60	15.64

==========

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Q = 10.5 + 2 = 12.5

Trunk HGL = 1068.93

Lat Invert = 1065.77

Sub Loss = .46

Tw = 3.16 + .46 = 3.62

AHW = 1073.93

DHW = 1073.10

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 12
Sta 46+08 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	11.6
Culvert Slope (feet per foot)	0.3922

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	1.29	0.71	-3.19	0.19	0.56	0.19	17.13

==========

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Trunk HGL = 1068.82

Lat Invert = 1067.53

T_w = 1.29

AHW = 1074.08

DHW = 1072.79

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 13
Sta 53+95 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	69.8
Culvert Slope (feet per foot)	0.0902

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.9	5.76	0.78	-0.42	0.26	0.55	0.26	10.06

==========

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Trunk HGL = 1074.21
Lat. Invert = 1068.58
Sub. Loss = .13
T_W = .13 + 5.63 = 5.76
AHW = 1077.38
DHW = 1075.66

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 14
Sta 54+07 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	12.1
Culvert Slope (feet per foot)	0.4093

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.6	4.30	0.84	-0.52	0.21	0.65	0.21	18.80

==========

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Trunk HGL = 1079.29

Lat Invert = 1069.94

T_w = 4.3

AHW = 1077.38

DHW = 1075.72

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 15
Sta 59+40 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	69.9
Culvert Slope (feet per foot)	0.0694

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.0	5.67	1.04	1.11	0.36	0.70	1.25	2.44

==========

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Trunk HGL = 1075.70
Lat Invert = 1070.36
Sub. Loss = .33
T_W = .33 + 5.34 = 5.67
AHW = 1077.21
DHW = 1076.32

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 16
Sta 59+28 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	12.2
Culvert Slope (feet per foot)	0.3552

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.9	4.09	0.94	-0.09	0.23	0.68	0.23	18.46

==========

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Trunk HGL = 1075.62

Lat. Invert = 1071.53

T_W = 4.09

AHW = 1078.36

DHW = 1076.80

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 17
Sta 66+08 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	68.9
Culvert Slope (feet per foot)	0.0910

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.0	6.26	2.03	1.10	0.55	1.16	0.55	15.45

==========

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Trunk HGL = 1077.78

Lat Invert = 1072.62

Sub Loss = 1.10

T_w = 1.10 + 5.16 = 6.26

AHW = 1081.39

DHW = 1080.92

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 18
Sta 65+96 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.1
Culvert Slope (feet per foot)	0.2931

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.2	3.86	0.80	0.12	0.21	0.59	0.21	15.91

==========

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Trunk HGL = 1077.44

Lat. Invert = 1073.58

T_w = 3.86

AHW = 1081.91

DHW = 1078.21

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 19
Sta 71+70 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	68.8
Culvert Slope (feet per foot)	0.1133

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.0	4.85	1.03	-2.66	0.31	0.70	0.31	12.47

==========

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Trunk HGL = 1079.21

Lat. Invert = 1074.68

Sob. Loss = .32

T_W = 4.53 + .32 = 4.85

AHW = 1084.48

DHW = 1083.51

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 20
Sta 71+82 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.1
Culvert Slope (feet per foot)	0.4580

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.6	3.15	0.82	-2.72	0.21	0.65	0.21	19.54

==========

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Trunk HGL = 1079.24
Lat Invert = 1076.09
T_w = 3.15
AHW = 1085.59
DHW = 1082.91

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 21
Sta 79+47 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.0
Culvert Slope (feet per foot)	0.4630

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.8	2.80	0.62	-3.15	0.17	0.53	0.17	17.58

==========

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Trunk HGL = 1081.50

Lat Invert = 1078.70

T_w = 2.8

AHW = 1088.21

DHW = 1085.33

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 22
Sta 79+35 to 79+46.22

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	10.4
Culvert Slope (feet per foot)	0.2618

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
10.0	1.45	2.23	-0.43	0.44	1.27	0.44	23.27

==========

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Connector HGL = 1083.04

Est. Invert = 1081.59

T_w = 1.45

AHW = 1087.31

DHW = 1086.54

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Connector Pipe 19
Sta 79+35 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.00
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	74.9
Culvert Slope (feet per foot)	0.0409

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
10.0	3.18	1.69	0.50	0.64	1.13	0.64	11.66

==========

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Trunk HGL = 1081.47

Lat. Invert = 1078.29

T_W = 3.18

AHW = 1087.31

DHW = 1083.04

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 23
Sta 85+99 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	68.9
Culvert Slope (feet per foot)	0.0976

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.0	3.70	1.03	-2.73	0.33	0.70	0.33	11.79

==========

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Trunk HGL = 1082.87

Lat Invert = 1079.49

Sub Loss = .32

T_w = 3.38 + .32 = 3.70

AHW = 1088.21

DHW = 1087.24

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 24
Sta 85+87 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.0
Culvert Slope (feet per foot)	0.3267

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.8	2.42	0.69	-1.76	0.19	0.53	0.19	15.55

==========

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Trunk HGL = 1082.85
Lat Invert = 1080.43
T_W = 2.42
AHW = 1089.17
DHW = 1085.36

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 25
Sta 92+63 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	69.2
Culvert Slope (feet per foot)	0.0856

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
6.0	5.29	1.78	0.51	0.48	0.99	0.48	13.66

==========

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Trunk HGL = 1085.40
Lat Invert = 1081.41
Sub Loss = 1.30
T_W = 3.99 + 1.3 = 5.29
AHW = 1089.34
DHW = 1089.12

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 26
Sta 92+51 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.2
Culvert Slope (feet per foot)	0.2373

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	2.90	0.77	-0.17	0.21	0.56	0.21	14.41

==========

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Trunk HGL = 1084.96

Lat Invert = 1082.06

T_W = 2.90

AHW = 1090.2

DHW = 1085.97

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 27
Sta 99+26.5 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	69.2
Culvert Slope (feet per foot)	0.0760

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.7	4.46	0.96	-0.57	0.33	0.66	0.33	10.48

==========

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Trunk HGL = 1087.81
Lat Invert = 1083.61
Sub Loss = .26
T_w = 4.2 + .26 = 4.46
AHW = 1090.87
DHW = 1089.83

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 10, 1998
Pipe 28
Sta 99+05 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	13.2
Culvert Slope (feet per foot)	0.1517

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.8	3.77	0.74	1.83	0.23	0.53	1.25	1.47

==========

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Trunk HGL = 1087.74

Lat Invert = 1083.97

T_W = 3.77

AHW = 1091.97

DHW = 1087.80

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 29
Sta 107+44 Rt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	12.2
Culvert Slope (feet per foot)	0.1283

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.6	6.08	2.17	5.31	0.52	1.20	1.50	5.43

==========

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Trunk HGL = 1092.87

Lat Invert = 1085.95

T_W = 6.08

AHW = 1094.14

DHW = 1093.45

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 30
Sta 107+56 Lt

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.00
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	70.5
Culvert Slope (feet per foot)	0.0739

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
10.5	7.24	1.74	2.44	0.56	1.16	2.00	3.34

==========

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Trunk HGL = 1092.88

Lat Invert = 1085.96

Sub Loss = .32

T_w = 6.92 + .32 = 7.24

AHW = 1094.17

DHW = 1093.61

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 31
Sta 11+16.17 Lt
83rd Ave

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	35.9
Culvert Slope (feet per foot)	0.1293

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.6	7.01	0.70	2.43	0.22	0.50	1.25	1.32

==========

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Trunk HGL = 1093.14
Lat Invert: 1086.13
T_W = 7.01
AHW = 1094.27
DHW = 1093.20

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 32
Sta 11+50.23 Rt
83rd Ave

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	1.25
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	27.9
Culvert Slope (feet per foot)	0.2300

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2.0	7.09	0.78	0.77	0.22	0.57	0.22	14.24

==========

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Trunk HGL = 1093.22

Lat Invert = 1086.19

Sub Loss = .06

T_w = 7.03 + .06 = 7.09

AHW = 1094.60

DHW = 1093.38

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 33
Sta 12+09.63 Lt
91st Ave

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	36.6
Culvert Slope (feet per foot)	0.0975

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
23.4	6.43	2.58	3.51	0.72	1.65	2.50	4.77

==========

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Connection HGL = 1075.12

Lat. Invert = 1068.69

T_W = 6.43

AHW = 1076.47

DHW = 1075.77

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Pipe 34
Sta 12+09.63 Rt
91st Ave

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	2.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	28.8
Culvert Slope (feet per foot)	0.0281

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
26.2	6.43	2.82	6.40	1.07	1.74	2.50	5.34

==========

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Connector HGL = 1075.12

Lat. Invert = 1068.69

T_W = 6.43

AHW = 1076.47

DHW = 1075.90

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

November 11, 1998
Connector Pipe 26
Sta 9+71 to 12+09.63
91st Ave

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet)	3.50
FHWA Chart Number (1,2 or 3)	1
Scale Number on Chart (Type of Culvert Entrance)	1
Manning's Roughness Coefficient (n-value)	0.0130
Entrance Loss Coefficient of Culvert Opening	0.50
Culvert Length (feet)	238.6
Culvert Slope (feet per foot)	0.0050

==========

PROGRAM RESULTS:

	Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
Design =>	49.6	6.43	3.40	6.43	2.15	2.20	3.50	5.16
Ultimate =>	60.0	6.43	3.91	6.99	2.46	2.43	3.50	6.24

==========

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Trunk HGL = 1073.93
Left Invert = 1067.50
T_w = 6.43
AHW = 1076.47
DHW = 1075.12

WOOD/PATEL

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS

PROJECT _____

PROJECT NO. _____ SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____ CHECKED BY _____ DATE _____

Catch Basins 33+34

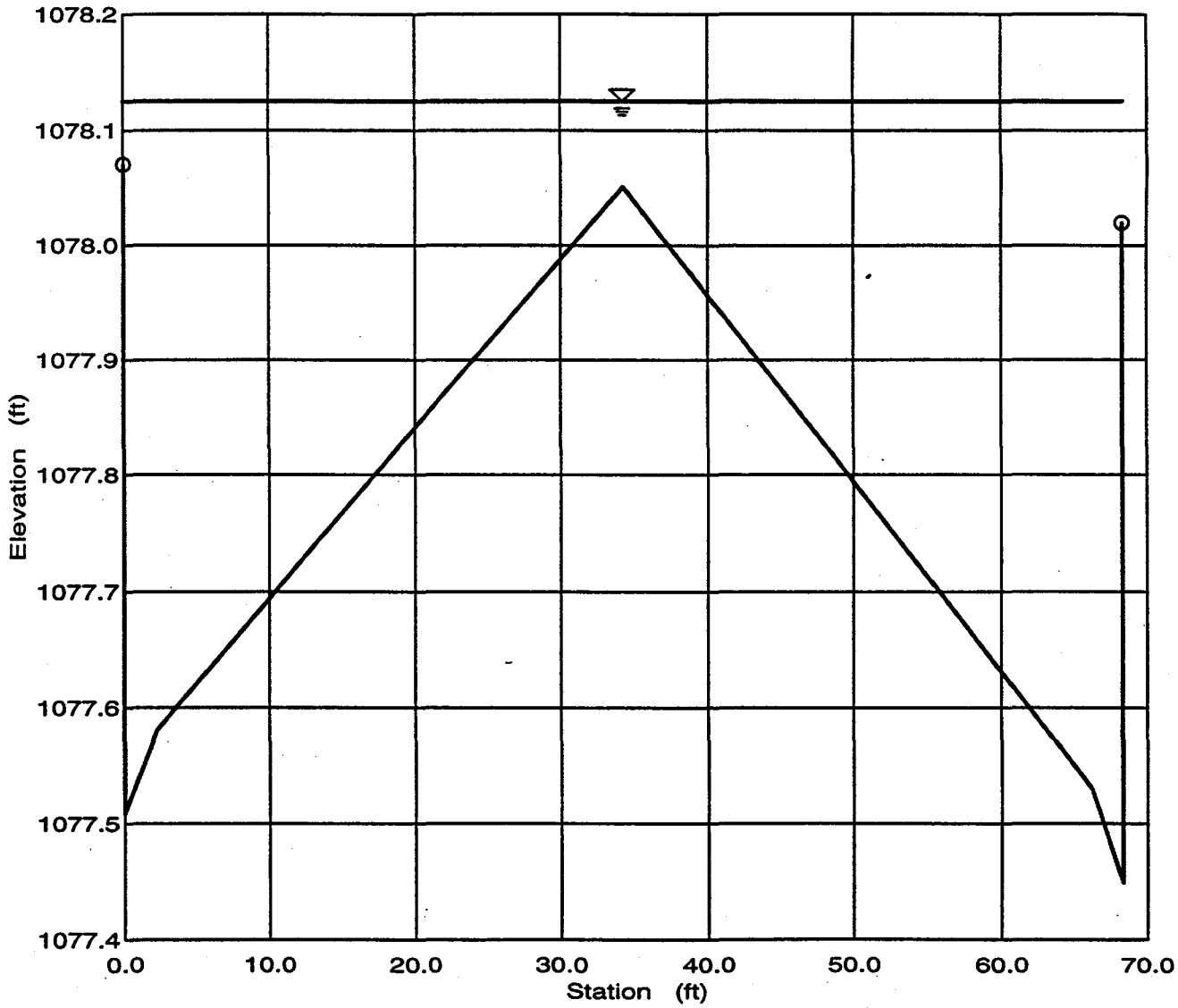
The following Manning Calculations were used in order to determine the flows approaching catch Basins 33+34. First a mannings was computed to determine the water surface. Since the water surface was above the crown of the roadway a seperate mannings calculation was preformed using the previous water surface in order to determine the flow approaching each catch Basin.

Sta 52+88.37
Connecter Pipe

91st Ave
Cross Section for Irregular Channel

Project Description	
Project File	w:\94153--1\phaseii\spread~1\no.fm2
Worksheet	91st avenue
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.016	
Channel Slope	0.003300	ft/ft
Water Surface Elevation	1078.13	ft
Discharge	60.00	ft^3/s



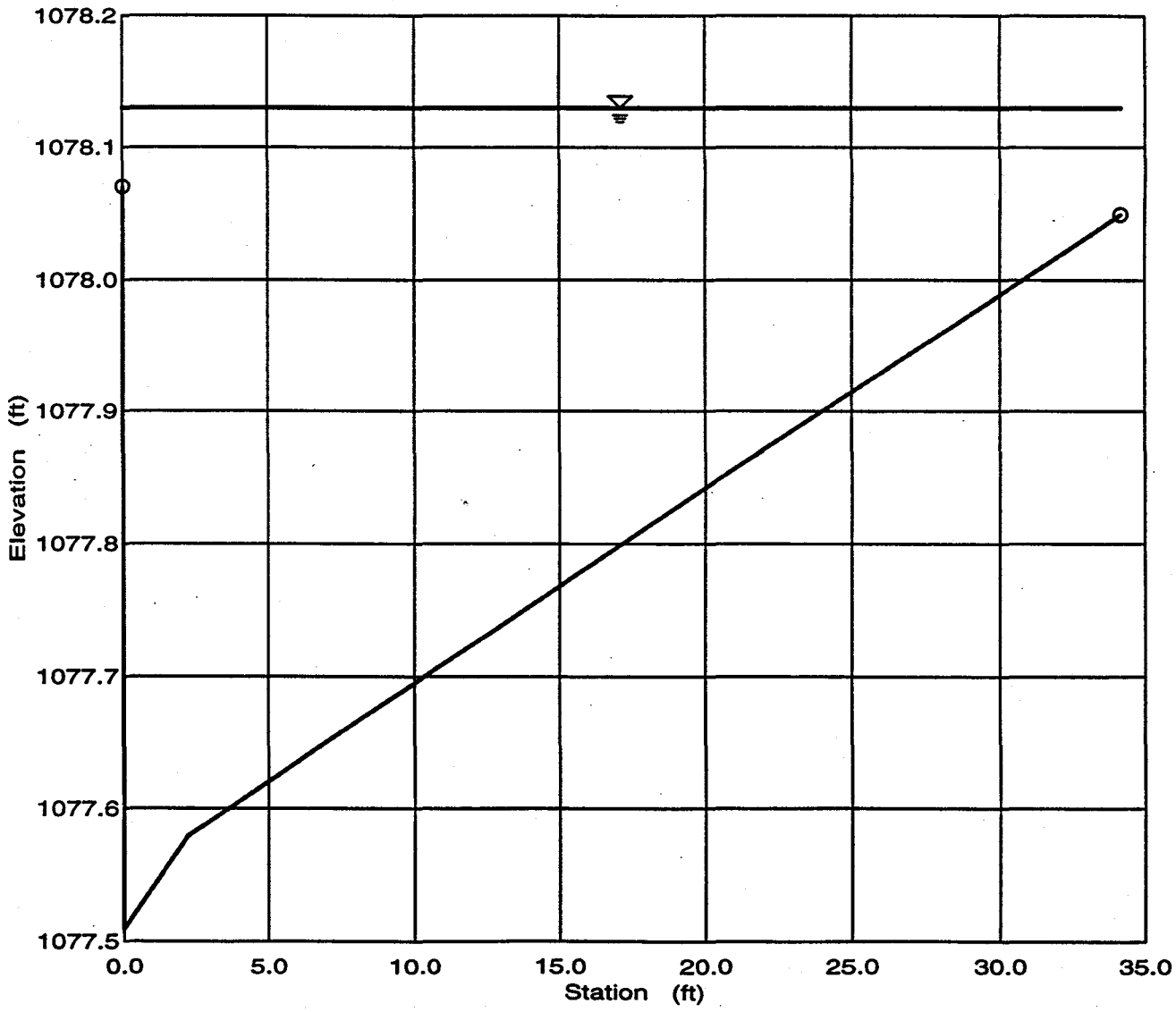
CB 33 STA 12+09.63 LT

91st West Side
Cross Section for Irregular Channel

Project Description	
Project File	w:\94153--1\phaseii\spread~1\no.fm2
Worksheet	91stWest
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Wtd. Mannings Coefficient	0.016	
Channel Slope	0.003300	ft/ft
Water Surface Elevation	1078.13	ft
Discharge	28.70	ft³/s

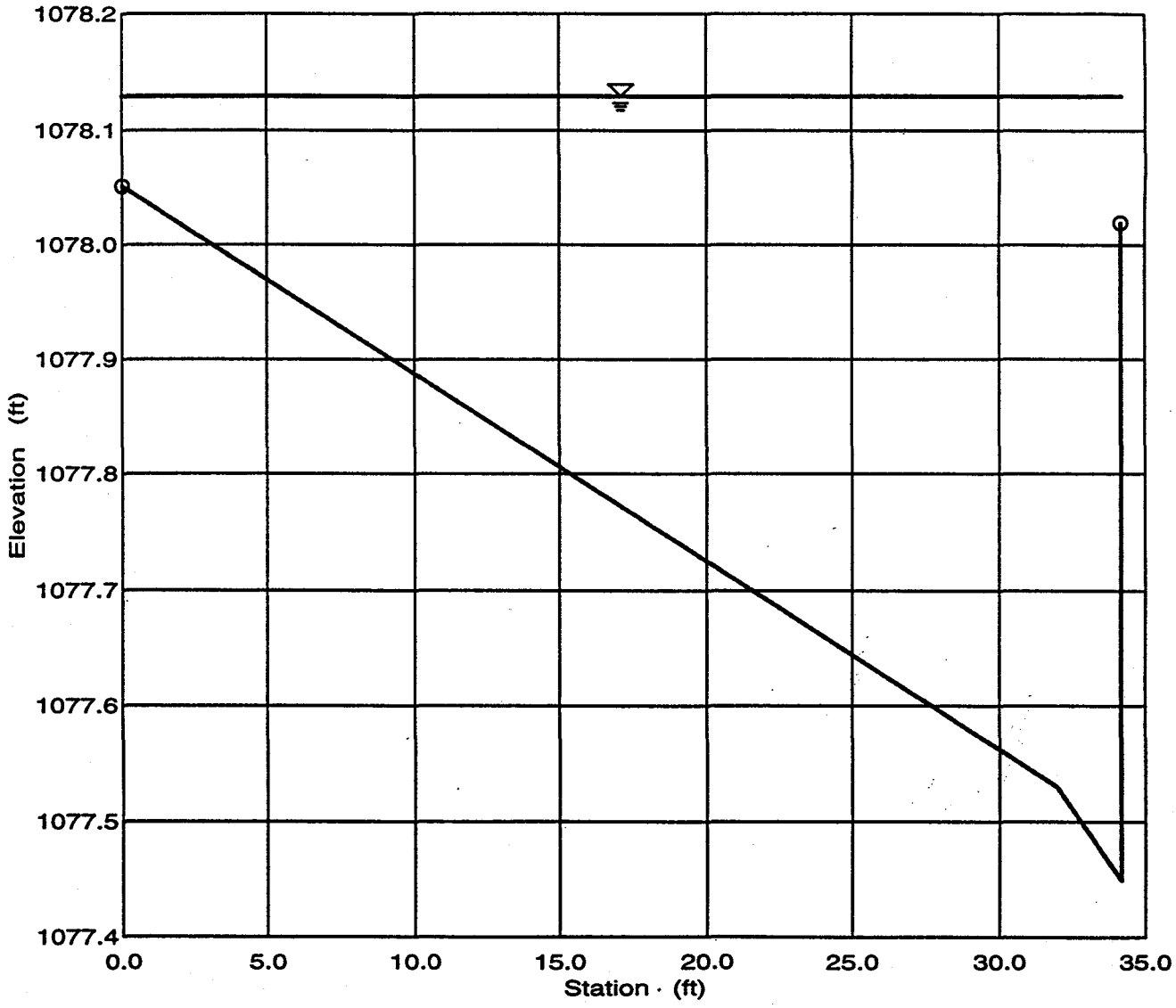
USE 28 CFS ∴ 28+32 = 60 CFS



CB 34 STA 12+09.63 RT

91st Ave East Side
Cross Section for Irregular Channel

Project Description	
Project File	w:\94153-~1\phaseii\spread~1\no.fm2
Worksheet	91stEast
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Wtd. Mannings Coefficient	0.016	
Channel Slope	0.003300	ft/ft
Water Surface Elevation	1078.13	ft
Discharge	32.65	ft³/s

USE 32 cfs ∴ 28+32 = 60 cfs