MASTER DRAINAGE STUDY
FOR
ARIZONA TRADITIONS

American Engineering Company

Clouse Engineering, Inc.
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MASTER DRAINAGE STUDY
FOR
ARIZONA TRADITIONS

January 12, 1996

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO.
20952
DARRELL D.
SMITH
Date Signed 1-17-96
ARIZONA, U.S.A.

CLOUSE ENGINEERING, INC.
JOB NO. 931007

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INTRODUCTION

ARIZONA TRADITIONS is a proposed master planned community encompassing approximately 530 acres located in portions of Sections 34 and 35, T. 4 N., R. 2 W., G. & S. R. B. & M., Maricopa County, Arizona.

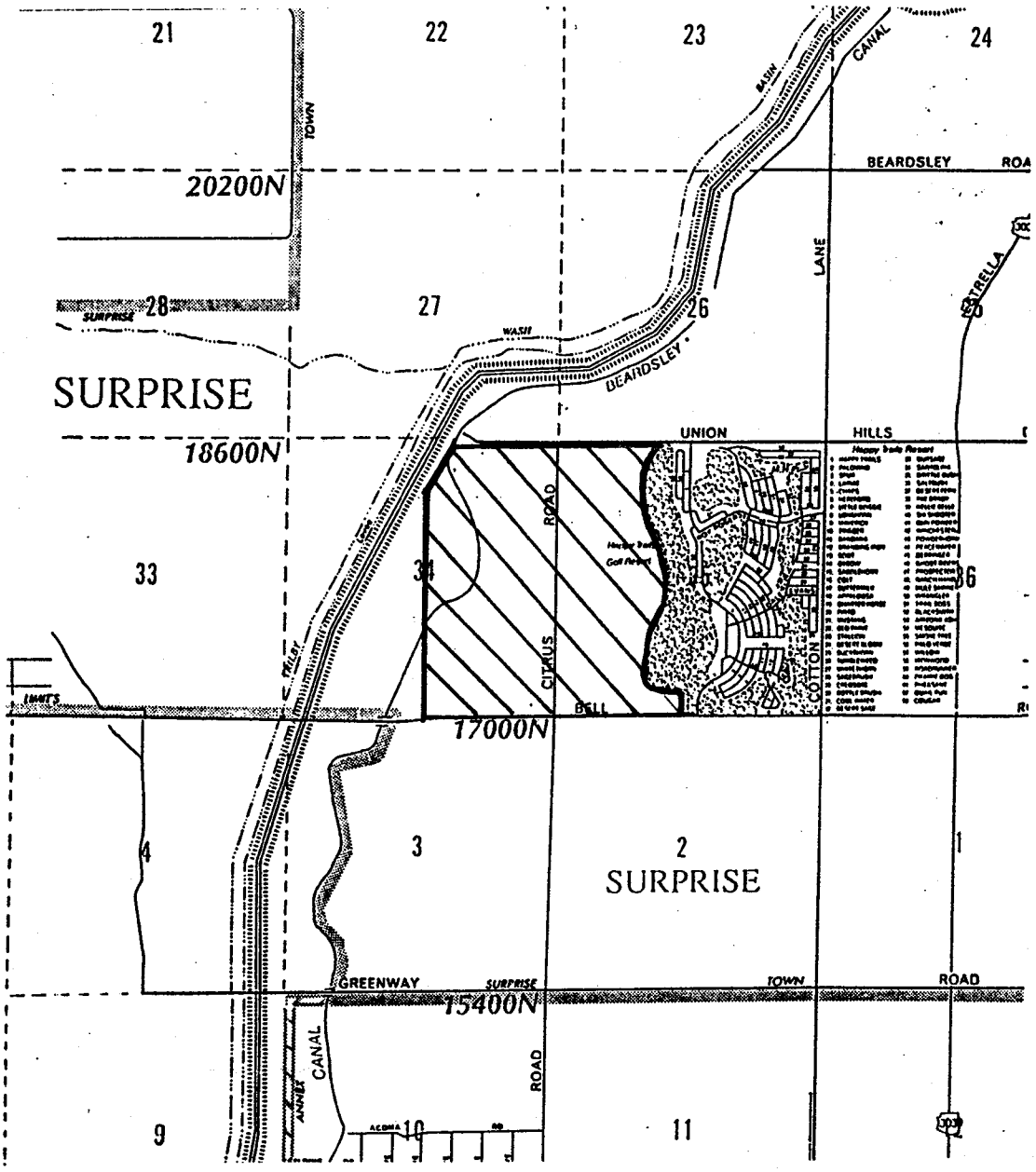
The proposed development is located within the City of Surprise, Arizona. The site is bordered by the Union Hills alignment on the north, Bell Road on the south, the existing Happy Trails development on the east, and the Beardsley Canal on the west. A small portion of the community lies west of the canal, between the McMicken Dam and the canal. Refer to pages 2 and 3 for the vicinity and site location maps, respectively.

Proposed land uses within ARIZONA TRADITIONS include: single family subdivisions, an eighteen hole golf course and clubhouse encompassing 110 acres, a lake encompassing approximately 2 acres, and open spaces throughout the site encompassing approximately 12 acres.

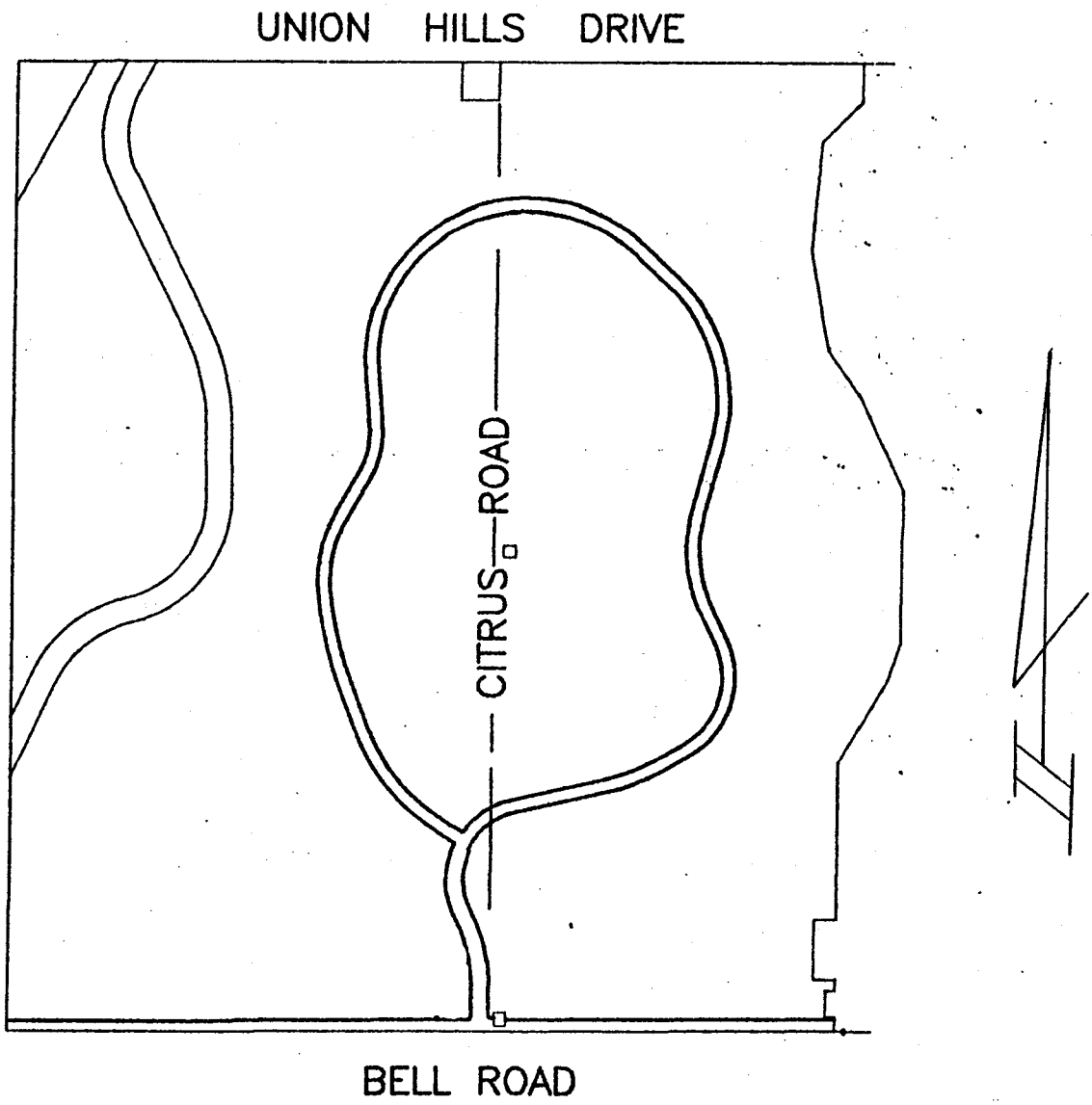
The natural drainage pattern of the site is to the southeast at an average slope of 0.6 percent.

The subject property does not lie within a flood hazard area and is indicated to lie within Flood Zone X as indicated on the F.I.R.M. for the City of Surprise, Map Numbers 04013C1140-F and 04013C1145-E, with effective dates of December 3, 1993 and September 4, 1991, respectively. Refer to page 4 for the F.I.R.M. exhibit.

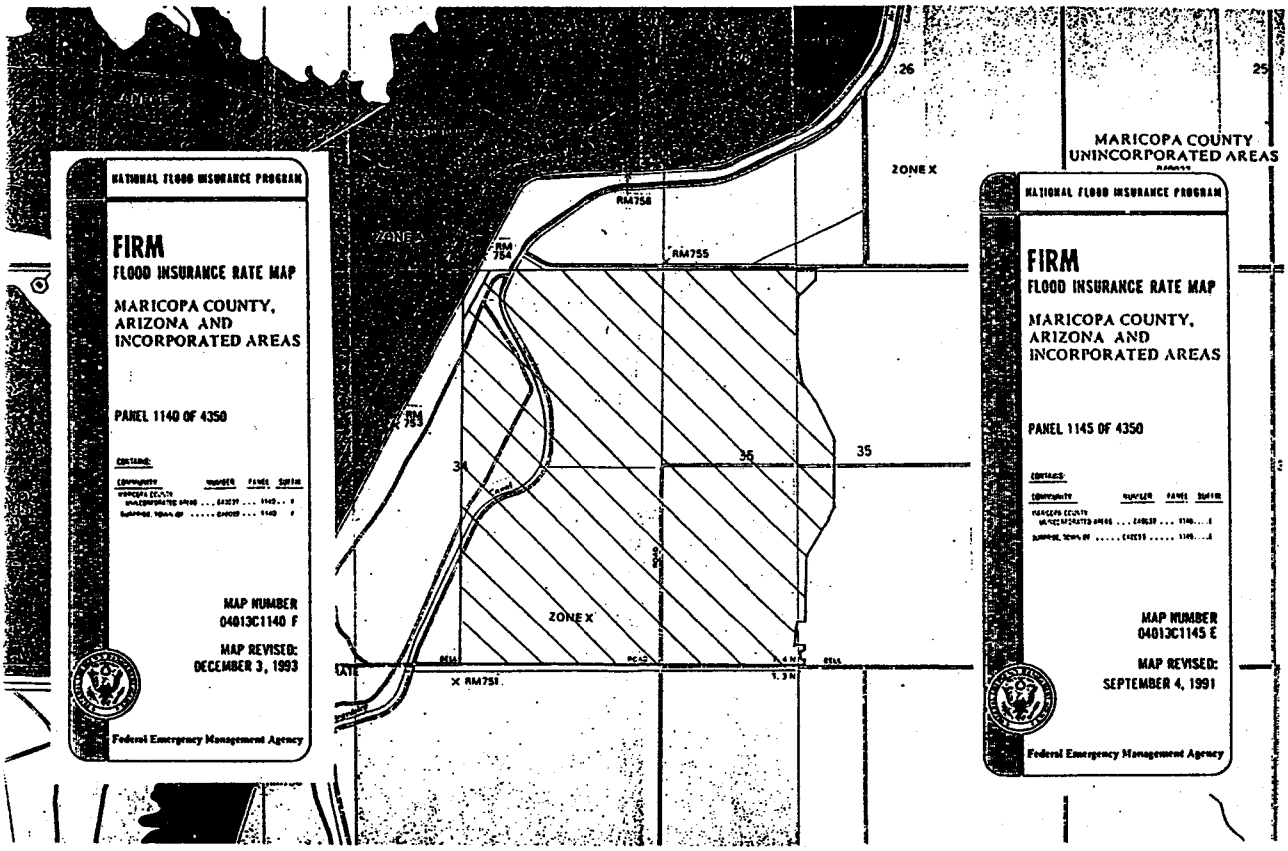
VICINITY MAP



SITE MAP



FIRM MAP


NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS
PANEL 1140 OF 4350
MAP NUMBER 04013C1140 F
MAP REVISED: DECEMBER 3, 1993
Federal Emergency Management Agency
ZONE X
RM756
RM755
RM754
RM753
RM751
26
25
35
34
MARICOPA COUNTY UNINCORPORATED AREAS
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS
PANEL 1145 OF 4350
MAP NUMBER 04013C1145 E
MAP REVISED: SEPTEMBER 4, 1991
Federal Emergency Management Agency

DRAINAGE CONCEPTS

The purpose of this Master Drainage Study is to identify the current drainage patterns associated with the site and provide in detail the required design for both offsite and onsite drainage. The design concept for the site has been set forth in the master drainage report prepared by Greiner, Inc. entitled: "The Villages at Surprise Master Drainage Report", dated December 30, 1994, with a revision date of June 8, 1995. The aforementioned report was prepared for zoning purposes and was approved by the City of Surprise in May of 1995. The subject development is designated as "Village I" in that report.

The City of Surprise has adopted the Drainage Design Manual for Maricopa County as its design manual. Accordingly, all design parameters and calculations within this report will conform to the Maricopa County Manual.

EXISTING DRAINAGE CONDITIONS AND OFFSITE DRAINAGE:

Runoff generated by areas south and east of the McMicken Dam drain to the site's north and west property lines, respectively. These areas are designated as Areas "A" and "B" on the Offsite Drainage Map located in APPENDIX A. Currently runoff from Area "A" drains to several depressed areas along the north property line. Runoff exceeding the capacity of the depressed areas combines with runoff generated by the subject site and continues to flow southeasterly across the subject site. Two detention basins exist along the east property line of the subject development. Runoff exceeding the capacity of the detention basins overflows into the Happy Trails development located directly east of the subject site.

With the development of the site, offsite runoff generated by Area "A" will be intercepted by a drainage channel along the north property line. The channel will continue along the east property line to convey flows to the south. To remain consistent with the historic drainage pattern, a portion of this offsite runoff will be diverted into the Happy Trails development. The remainder of the offsite flows will be conveyed beneath Bell Road and will continue to the south.

The Greiner report indicates that a flow of 236 cfs is to be diverted into Happy Trails. This flow was dictated by the Area Drainage Master Study (ADMS) prepared by WLB for the Flood Control District of Maricopa County. The developer of the subject property has consulted with the owners of the Happy Trails development to come up with an acceptable plan for introducing these offsite flows into the Happy Trails Golf Course. This plan is reflected in the offsite drainage design presented in this report.

Offsite runoff generated by Area "B" currently combines with runoff generated by the portion of the site west of the Beardsley Canal and continues to the southeast. The combined runoff ponds behind the Beardsley Canal. The ultimate outfall for this area is the west bank of the canal.

With the development of the subject portion of the site, a retention basin will be constructed at the southwest corner of this area, adjacent to west property line. Offsite runoff generated by Area "B" will be intercepted by a drainage channel along the west property line. The channel will discharge to the retention basin. Should runoff exceed the capacity of the basin, the runoff will spill over the bank of the Beardsley Canal and continue south within the canal.

The offsite drainage areas and corresponding flows have been delineated and computed in the Greiner report. This information will be extracted directly from that report. The nomenclature for these areas will remain consistent with the Greiner report.

ONSITE DRAINAGE:

The general concept for onsite drainage is to collect and convey parcel runoff within streets, storm drain, and drainage channels to retention/detention basins within the golf course. In areas where the golf course is not accessible, basins will be graded within the open space areas.

The 100-year, 2-hour rainfall will be used to determine the retention requirement for the site. The 100-year, 6-hour rainfall will be used for all other drainage purposes. Weirs will

be set on the retention/detention basins so that the retention requirement for the corresponding drainage area is met, but flows in excess of the 100-year, 2-hour storm will be allowed to continue downstream. All basins will be drained by bleed lines within 36 hours. A standpipe and headgate will be located at the downstream end of each drainage area to regulate the bleed lines.

Specifically, the site is divided into four major drainage basins, labelled as AREAS 1 through 4 on the enclosed Master Drainage Map. The following discussion summarizes the drainage details associated with each area.

AREA 1:

AREA 1 consists of the area which lies west of the Beardsley Canal. Runoff generated by this area will be conveyed by streets and storm drain to two retention basins. The basins will be sized to contain the 100 year, 2 hour storm event. Runoff exceeding the capacity of Basin 1B1 will overflow to the street and continue to Basin 1B2. Runoff exceeding the capacity of Basin 1B2 will overflow to the Beardsley Canal and continue south within the canal.

AREA 2:

AREA 2 consists of the portion of the golf course located within the loop road (Holes 1-5, and 10-15) and the area which drains to this portion of the golf course. Runoff generated by this area will be conveyed by streets, storm drain, and drainage swales to the golf course. This area of the golf course will provide the 100 year, 2 hour required retention volume for AREA 2. Overflow from AREA 2 will discharge to AREA 4 via a box culvert located beneath the loop road.

AREA 3:

AREA 3 consists of Holes 6, 7, and 8 of the golf course and the portion of the site which drains to this portion of the course. This area of the course will provide the 100 year, 2 hour required retention volume for AREA 3. Runoff generated by this area will be conveyed by

streets and drainage swales to the course. Overflow from this portion of the golf course will be conveyed by storm drain to the drainage channel adjacent to Bell Road.

AREA 4:

AREA 4 consists of the clubhouse, Holes 16, 17, and 18 of the golf course, and the portion of the site which ultimately drains to this portion of the course. The retention requirement for this area is provided in a combination of basins located along the east property line and a basin located within Holes 16, 17, and 18. The portion of AREA 4 west of Citrus Road will drain to a drainage channel paralleling Bell Road. The channel discharges to the basin located within Holes 16, 17, and 18. The area east of the loop road and west of Happy Trails will drain to a series of basins located along the east property line. Runoff exceeding the capacity of an upstream basin will be conveyed by streets to the next downstream basin. The furthest downstream basin will overflow to Holes 16, 17, and 18. Overflow from this basin will spill to the offsite drainage channel adjacent to the east property line. The combined offsite and onsite flows will be conveyed beneath Bell Road and will continue to the south.

The drainage patterns and outfalls for the various drainage areas outlined in this report are based on preliminary land plans for the site. Preliminary grades have been established for the entire development based on these land plans and are reflected in the calculations contained in the report. In conjunction with development plans for each individual parcel, a drainage report and a grading and drainage plan shall be submitted to the City of Surprise for approval. Actual grades, drainage patterns, and drainage facilities required within each parcel will be determined with the individual development plans. However, the drainage patterns and grades shall remain in substantial conformance to the Master Drainage Plan.

A hydrologic model has been developed to analyze the ability of the golf course and basins to retain/detain onsite runoff. The model is also utilized in sizing the outlet structures to which the golf course and basins drain.

This report also includes a preliminary design for the catch basins and storm drain which will be required to remove runoff from the loop road. This design is based on preliminary grades which have been established for the loop road. This preliminary design should be re-evaluated when the actual design of the loop road is completed.

The design of streets within the development shall be based on flows calculated using the Rational Method. Runoff coefficients shall be obtained from Table 3.2 in the Maricopa County Hydrology Manual. Rainfall intensities shall be taken from Figure 3.2 in the manual. Streets shall be designed to maintain the 10 year flow beneath the top of curb elevation, and the 100 year flow shall not exceed a depth of 0.67 inches above the centerline.

All finished floors shall be designed to be a minimum of one foot above the adjacent high water surface elevation or ultimate outfall elevation for the respective drainage area.

HYDROLOGY

OFFSITE:

As mentioned previously, the results of the offsite hydrology will be extracted directly from the Greiner report. The following table summarizes the peak offsite flows at the points of concentration indicated on Offsite Drainage Map located in APPENDIX A. These flows are also indicated on the enclosed Master Drainage Map.

DRAINAGE AREA NAME	Q_{100} (cfs)
111A	19
111B	17
111C	87
111D	64
111E	93
111F	176
104A	120
104B	189
C3-OF1	394

ONSITE:

In order to remain consistent with the Greiner report, the 100 year, 6 hour post-development onsite runoff is analyzed using the U.S. Army Corps of Engineers' HEC-1 Computer Program. The Clark Unit Hydrograph is used for runoff routing, the Green and Ampt Infiltration Equation is used to estimate rainfall losses, and Kinematic Wave Routing is used for channel routing. The enclosed Master Drainage Map outlines the boundaries of the drainage system and the sub-basins within the system.

The Maricopa County Unit Hydrograph Procedure-1 (MCUHP1) Program is used to prepare the input file for the HEC-1 program. The following table summarizes the data required as input to MCUHP1, and the source of the data if applicable. Figure and table numbers correspond to information contained in the Maricopa County Hydrology Manual. Values

extracted from the tables correspond to the proposed land use for each sub-basin. Copies of the tables and figures, as well as summary tables for the information associated with individual sub-basins are contained in APPENDIX A. A copy of the soils map for the site is also included.

INPUT TO MCUHP1

DRAINAGE AREA INPUT

- Drainage Basin Area = 0.83 square miles
- 100-year, 6-hour point rainfall = 3.29 inches (from Figure 2.7)

INDIVIDUAL SUB-BASIN INPUT

- Basin Area
- Flow Path Length
- Slope
- k_b = watershed resistance coefficient (Table 5.1- Type A)
- IA = surface retention loss (Table 4.1)
- DTHETA = volumetric soil moisture deficit (Table 4.2 - Normal Condition)
- PSIF = wetting front capillary suction (Table 4.2)
- XKSAT = hydraulic conductivity (Table 4.2)
- RTIMP = % effective impervious area (Table 4.2a)

Calculation of stage verses storage verses discharge tables for the retention/detention basins are contained in APPENDIX A. Details concerning the outlet structures to which the basins discharge are contained in the HYDRAULICS section of this report.

As previously mentioned, offsite runoff from the north will be intercepted and conveyed to a channel paralleling the east property line. To incorporate this flow into the HEC-1 model, the hydrograph at Point C3-OF1 is extracted from the Greiner report and input directly into the subject model. The Divert function is used at locations where this offsite runoff is to enter the Happy Trails Development.

The output for the HEC-1 model is contained in APPENDIX A. The tables on the following pages summarize the results of the model. Reference should be made to the Master Drainage Map for the location and identification of the facilities and structures listed.

PEAK FLOW SUMMARY TABLE FOR ARIZONA TRADITIONS

STATION	PEAK FLOW (cfs)	STATION	PEAK FLOW (cfs)	STATION	PEAK FLOW (cfs)
1A1	102	2G4	83	4R1	2
1B1	0	CP12	226	CP27	221
1A2	73	2A9	42	4R3	16
CP1	73	2R3	13	4A9	30
1B2	0	CP13	54	CP28	262
2A1	30	2G5	35	CP29	262
2B1	12	CP14	87	4A4	70
2A2	69	2A10	34	4B1	20
2A3	52	CP15	118	4A5	32
CP2	118	CP16	341	CP30	34
2R1	6	2B5	41	4B2	15
2A4	52	CP17	41	4A6	67
CP3	176	3A1	41	CP31	67
2G1	80	CP18	40	4B3	8
CP4	256	3A2	37	4A7	84
2B2	0	CP19	73	CP32	84
2G2	16	3A3	35	4B4	48
2B3	0	CP20	108	4A8	53
2G3	21	3A4	58	CP33	59
2R2	6	3G1	46	4G2	96
CP5	26	CP21	200	CP34	145
2B4	0	3B1	0	CP35	406
CP6	0	4A1	77	4B5	62
2A5	38	CP22	77	C3OF1	394
CP7	38	CP23	76	DIV1	30
2A6	32	4A2	45	CP36	364
CP8	68	CP24	121	DIV2	76
CP9	68	CP25	119	CP37	288
2A7	38	4A3	71	DIV3	126
CP10	104	4G1	20	CP38	162
2A8	46	4R2	9	CP39	162
CP11	150	CP26	219		

STRUCTURE/DISCHARGE SUMMARY
FOR
ARIZONA TRADITIONS

BASIN	NORMAL WATER SURFACE OR BOTTOM	HIGH WATER SURFACE	RISE (FT)	PEAK DISCHARGE (CFS)	OUTLET STRUCTURE
1B1	1327.9	1330.7	2.8	0	N/A
1B2	1326.5	1328.8	2.3	0	N/A
2B1	1323.0	1326.7	3.7	12	5' WEIR AT 1326.0
2B2	1312.0	1317.6	5.6	0	N/A
2B3	1316.0	1318.1	2.1	0	N/A
2B4	1312.0	1316.0	4.0	0	N/A
2B5	1306.0	1311.3	5.3	41	TRIANGULAR WEIR AT 1311.0
3B1	1316.0	1319.1	3.1	0	N/A
4B1	1311.0	1314.5	3.5	20	12' WEIR AT 1314.0
4B2	1306.8	1310.3	3.5	15	10' WEIR AT 1309.8
4B3	1303.8	1307.6	3.8	8	3' WEIR AT 1306.8
4B4	1301.5	1305.5	4.0	48	10' WEIR AT 1304.5
4B5	1300.0	1306.0	6.0	63	55' WEIR AT 1305.5

LOOP ROAD DESIGN:

The 10 and 100 year peak flows for the drainage design of the loop road are calculated using the Rational Method.

$$Q = c\,i\,A$$

where:

Q = peak runoff (cfs)

c = respective runoff coefficient

i = rainfall intensity (in/hr)

A = tributary area (acres)

A runoff coefficient of **0.95** will be used for the right-of-way area. This value was obtained from Table 3.2 in the Maricopa County Hydrology Manual. Rainfall intensities are taken from the I-D-F curves contained in Figure 3.2. Copies of these items are contained in APPENDIX A.

The following table summarizes the peak flows at each point of concentration indicated on the Drainage Map. Street travel time is calculated by dividing the travel length by the average velocity of flow. The velocity is calculated using Manning's Equation and the pertinent street geometry and slope.

LOOP ROAD PEAK FLOWS

POINT OF CONC.	AREA (ac)	TIME OF CONC. (min)	C_{10}	C_{100}	i_{10} (in/hr)	i_{100} (in/hr)	Q_{10} (cfs)	Q_{100} (cfs)
2R1	2.4	13.9	0.95	0.95	3.9	6.1	8.9	13.9
2R2	3.2	17.1	0.95	0.95	3.5	5.5	10.6	16.7
2R3	9.1	26.0	0.95	0.95	2.8	4.4	24.2	38.0
4R1	3.3	9.1	0.95	0.95	4.6	7.2	14.4	22.6
4R3	0.8	3.9	0.95	0.95	5.9	9.0	4.5	6.8

HYDRAULICS

WEIRS:

Rectangular shaped weirs have been used to regulate the discharges from the basins. The locations and sizes of the weirs are indicated on the Structure/Discharge Summary Table on Page 14. Detailed weir flow calculations are contained in APPENDIX B.

ROADWAY CULVERTS:

Culvert crossings required within the project are indicated on the enclosed Master Drainage Map. All culverts are sized to convey the peak 100-year, 6-hour flows beneath the roadway. In order to ensure that AREA 2 outfalls directly to AREA 4, the culvert crossing at CP17 has been designed to convey a peak flow of 255 cfs beneath the loop road. This is the estimated flow generated by AREA 2 should back to back 100-year, 6-hour storms occur. Culverts have been sized using the methods outlined in the Federal Highway Department's HEC-5 Circular. Individual sizing calculations and the appropriate charts from the HEC-5 Circular are provided in APPENDIX B. The following table summarizes the culverts required at the respective points of concentration.

LOCATION	Q_{100} (cfs)	CULVERT SIZE
CP2	118	(3) 30 inch pipes
CP8	68	(3) 24 inch pipes
CP10	104	(4) 30 inch pipes
CP17	255	8 x 3 box culvert
CP19	73	(2) 30 inch pipes
CP22	77	(3) 24 inch pipes
CP26	219	(5) 38 x 24 elliptical pipes
CP39	161	(3) 36 inch pipes

STREETS:

Streets within the parcels shall be designed to carry the 10 year event at or below the top of curb elevation. Catch basins and storm drain will be used to convey flows exceeding a 6 inch top of curb elevation. The 100 year event shall not exceed a depth of 0.67 feet above the centerline.

GOLF CART PATH CROSSINGS:

In several locations within the golf course, the cart path crosses a designated drainage way. In some locations the path has been dipped and (2) 18 inch corrugated metal pipes have been placed at the flowline of the drainage way to allow low flows to continue through. Triangular shaped weirs are used to simulate the dipping of the cart path. Box culverts are used in locations where the cart path crosses immediately downstream of a concentrated discharge draining directly from a developed area. This design is used to allow runoff to reach the course without backing up into the adjacent development. Detailed weir flow and culvert calculations associated with the golf cart crossings are contained in APPENDIX B. It should be noted that the minimal elevation differences between water surfaces causes the weirs to operate in a submerged condition, and the pipes to operate in an outlet control condition. These conditions have been factored in to the crossing designs.

CHANNELS:

Channels on the interior of the development are designed using the 100 year, 6 hour peak flows and analyzed using Manning's Equation and the appropriate channel geometry and slope. Summary sheets for Manning's Equation are contained in APPENDIX B. It should be noted that the ultimate design for channels located on the interior of the site will be prepared with improvement plans for the parcels that are affected by the channels.

Channels on the perimeter of the site are designed using the 100-year, 6-hour peak flows and are analyzed using the U.S. Army Corps of Engineers' HEC-2 Water Surface Profiles Program. Channel locations and designations are indicated on the Master Drainage Map. The east bank of the East Drainage Channel will be dipped in three locations to allow runoff to enter the Happy Trails golf course. Weirs located at Points CP36, CP37, and CP38 will discharge 30, 76, and 126 cfs, respectively to Happy Trails. The Split Flow Option in the HEC-2 Program is used to model the side flow weirs. The Input/Output for each of the HEC-2 Models is contained in APPENDIX B. Channel stationing is indicated on the Master Drainage Map.

The tables on the following pages summarize the various channel designs within the project.

CHANNEL DESIGN SUMMARY TABLE

LOCATION	SHAPE	LINING	MANNING'S "N"	CHANNEL SLOPE (ft/ft)	WIDTH (ft)	SIDE SLOPES	BOTTOM WIDTH (ft)	$Q_{CAPACITY}$ (cfs)	Q_{DESIGN} (cfs)
CP2 to CP3	vee	grass	0.025	0.0020	30	3 to 1	0	267	118
2A5 to CP8	vee	grass	0.025	0.0035	24	3 to 1	0	259	68
CP8 to CP10	vee	grass	0.025	0.0035	24	3 to 1	0	259	104
3A1 to CP19	vee	grass	0.025	0.0020	24	3 to 1	0	195	73
4B4 to 4B5	trapezoid	grass	0.025	0.0022	35	3 to 1	10	65	59
North Prop. Line									
Sta. 100 to 1565	trapezoid	loose rock	0.030	0.0017	50	3 to 1 Max	22	436	394
Sta. 1565 to 2925	trapezoid	loose rock	0.030	0.0025	40	3 to 1 Max	22	397	224
Sta. 2925 to 4125	trapezoid	loose rock	0.030	0.0030	30	3 to 1 Max	12	274	104
East Prop. Line									
Sta. 195 to 1940	trapezoid	loose rock	0.030	0.0019	38	3 to 1 Max	8	505	162
Sta. 1940 to 2310	trapezoid	loose rock	0.030	0.0019	38	3 to 1 Max	8	505	288
Sta. 2310 to 2770	trapezoid	loose rock	0.030	0.0030	38	3 to 1 Max	8	389	288
Sta. 2770 to 3610	trapezoid	loose rock	0.030	0.0030	38	3 to 1 Max	12	397	364
Sta. 3610 to 3810	trapezoid	loose rock	0.030	0.0052	38	3 to 1 Max	12	523	364
Sta. 3810 to 5615	trapezoid	loose rock	0.030	0.0052	38	3 to 1 Max	12	644	394

CHANNEL DESIGN SUMMARY TABLE (con't.)

LOCATION	SHAPE	LINING	MANNING'S "N"	CHANNEL SLOPE (ft/ft)	WIDTH (ft)	SIDE SLOPES	BOTTOM WIDTH (ft)	$Q_{CAPACITY}$ (cfs)	Q_{DESIGN} (cfs)
South Prop. Line									
Sta. 100 to 580	trapezoid	loose rock	0.030	0.0060	34	3 to 1 Max	10	470	219
Sta. 580 to 1350	trapezoid	loose rock	0.030	0.0060	34	3 to 1 Max	10	413	121
Sta. 1350 to 2500	trapezoid	loose rock	0.030	0.0060	32	3 to 1 Max	8	413	77
West Prop. Line									
Sta. 100 to 400	vee	loose rock	0.030	0.0025	24	3 to 1	0	85*	176
Sta. 400 to 700	vee	loose rock	0.030	0.0025	24	3 to 1	0	85*	93
Sta. 700 to 900	vee	loose rock	0.030	0.0037	24	3 to 1	0	221	93
Sta. 900 to 1400	vee	loose rock	0.030	0.0011	24	3 to 1	0	120	93
Sta. 1400 to 1900	vee	loose rock	0.030	0.0017	24	3 to 1	0	70	34

*See HEC-2 plots for these sections.

LOOP ROAD DESIGN:

The depths of flow within the street at locations 2R2 and 4R1 are calculated using Manning's Equation with n = 0.015 and the pertinent street geometry and slope. The loop road section is 33 feet in width to the face of curbs with a 0.41 foot crown and vertical (6 inch) curb. The depths at the remaining locations are dictated by the ponding depth at the catch basin inlet opening. The following table summarizes the depth of flow at each point of concentration indicated on the Master Drainage Map. Depths are measured in feet from the gutter.

DEPTHS ON THE LOOP ROAD

POINT OF CONC.	Q_{10} (cfs)	Q_{100} (cfs)	TYPE OF CURB	SLOPE (ft/ft)	D_{10} (ft)	D_{100} (ft)
2R1	8.9	13.9	6"	SUMP	0.38	0.50
2R2	10.6	16.7	6"	.0050	0.32	0.38
2R3	24.2	38.0	6"	SUMP	0.44	0.60
4R1	14.4	22.6	6"	.0060	0.35	0.41
4R3	4.5	6.8	6"	SUMP	0.34	0.45

Inlet opening sizes are determined using the methods outlined in the Federal Highway Departments HEC-12 Circular, March 1984. Reduction factors are applied to the theoretical capacities based on Table 3.2 in the Maricopa County Hydraulics Manual. Inlet sizing calculations and a copy of Table 3.2 are contained in APPENDIX B.

Hydraulic grade line calculations for the storm drain lines are also contained in APPENDIX B. Reference should be made to the Master Drainage Map for location and indication of each identification letter or number listed.

RETENTION

The required retention volume for the subject property is calculated using the following formula:

$$V_r = \frac{P}{12} A\,C$$

Where:

V_r = required retention volume (ac-ft)

P = 100 yr, 2 hr rainfall depth

A = contributing area (ac)

C = runoff coefficient

According to Figure 2.1 in the Maricopa County Hydrology Manual, the 100-year, 2-hour rainfall depth is 2.78 inches. Runoff coefficients are obtained from Table 3.2 in the manual. Copy of these figures are contained in APPENDIX C. The following table summarizes the coefficients used for the various land uses within the site.

LAND USE	"C"
Single Family Development	0.69
Golf Course	0.31
Club House	0.81
Roadway	0.95

Each drainage area acts as a separate system in regard to retention requirements. The following discussion summarizes the retention characteristics of each area.

<u>AREA 1:</u>

The retention requirements of AREA 1 is provided in Basins 1B1 and 1B2, respectively.

AREA 2:

The retention requirement of AREA 2 is provided in Basins 2B1 through 2B5. Basin 2B1 is located in Area 2A1. Basins 2B2 through 2B5 are located within Holes 1 through 5 and 10 through 15 of the golf course. Basin 2B1 does not provide the entire retention requirement for area 2A1. Accordingly, a weir will be set on the basin to allow runoff in excess of a three foot depth to continue to the golf course, where the remainder of the retention requirement is provided.

AREA 3:

The retention requirement of AREA 3 is provided in Basin 3B1. Basin 3B1 is located within Holes 6, 7, and 8 of the golf course.

AREA 4:

The retention requirement of AREA 4 is provided in basins 4B1 through 4B5. Basins 4B1 through 4B4 are located within areas 4A4 through 4A7, respectively. Basin 4B5 is located within Holes 16, 17, and 18 of the golf course. Basins 4B1 through 4B4 do not provide the entire retention requirement for the areas which drain to them. Accordingly, weirs will be set on the basins to allow runoff in excess of a three foot depth to continue downstream to the golf course, where the remainder of the retention requirement is provided.

The tables on the following pages summarize the retention required and provided for each area. Reference should be made to the Stage/Storage/Discharge Tables for the retention volume provided calculations.

RETENTION REQUIRED FOR DRAINAGE AREA 1

SUB-BASIN	LAND USE	AREA (ac)	C	V_r (ac-ft)
1A1	SF	30.46	0.69	4.87
1A2	SF	22.33	0.69	3.57
TOTAL		**52.79**		**8.44**

SF = SINGLE FAMILY

RETENTION PROVIDED FOR DRAINAGE AREA 1

BASIN	BOTTOM "TOE" AREA (ac)	TOP "HIGH WATER" AREA (ac)	AVERAGE AREA (ac)	AVERAGE DEPTH (ft)	VOLUME PROVIDED (ac-ft)
1B1	1.77	2.43	2.10	3.00	6.30
1B2	1.72	2.28	2.00	3.00	6.00
				Total V_p Area 1	**12.30**

RETENTION REQUIRED FOR DRAINAGE AREA 2

SUB-BASIN	LAND USE	AREA (ac)	C	V_r (ac-ft)
2A1	SF	10.00	0.69	1.60
2A2	SF	22.52	0.69	3.60
2A3	SF	13.74	0.69	2.20
2A4	SF	16.07	0.69	2.57
2A5	SF	10.93	0.69	1.75
2A6	SF	8.04	0.69	1.29
2A7	SF	10.19	0.69	1.63
2A8	SF	14.39	0.69	2.30
2A9	SF	11.96	0.69	1.91
2A10	SF	6.72	0.69	1.07
2G1	GC	24.40	0.31	1.75
2G2	GC	3.55	0.31	0.25
2G3	GC	4.77	0.31	0.34
2G4	GC	37.71	0.31	2.71
2G5	GC	8.41	0.31	0.60
2R1	ROAD	2.40	0.95	0.53
2R2	ROAD	3.20	0.95	0.70
2R3	ROAD	7.40	0.95	1.63
TOTAL		**216.40**		**28.43**

SF = SINGLE FAMILY GC = GOLF COURSE

RETENTION PROVIDED FOR DRAINAGE AREA 2

BASIN	WEIR ELEVATION (ft)	V_p (ac-ft)
2B1	1326.0	1.02
2B2	1318.0	17.15
2B3	1320.0	1.92
2B4	1316.0	1.64
2B5	1311.0	15.75
	Total V_P Area 2	**37.48**

RETENTION REQUIRED FOR DRAINAGE AREA 3

SUB-BASIN	LAND USE	AREA (ac)	C	V_r (ac-ft)
3A1	SF	9.90	0.69	1.49
3A2	SF	8.22	0.69	1.24
3A3	SF	8.37	0.69	1.34
3A4	SF	14.30	0.69	2.15
3G1	GC	19.84	0.31	1.42
TOTAL		**60.63**		**7.64**

SF = SINGLE FAMILY CG = GOLF COURSE

RETENTION PROVIDED FOR DRAINAGE AREA 3

BASIN	WEIR ELEVATION (ft)	V_p (ac-ft)
3B1	1320.0	15.58
	Total V_p Area 4	**15.58**

RETENTION REQUIRED FOR DRAINAGE AREA 4

SUB-BASIN	LAND USE	AREA (ac)	C	V_r (ac-ft)
4A1	SF	23.00	0.69	3.68
4A2	SF	13.36	0.69	2.14
4A3	SF	22.33	0.69	3.57
4A4	SF	19.44	0.69	3.11
4A5	SF	9.35	0.69	1.49
4A6	SF	19.44	0.69	3.11
4A7	SF	25.98	0.69	4.15
4A8	SF	12.24	0.69	1.96
4A9	SF	6.36	0.69	1.19
4G1	GC	7.76	0.31	0.56
4G2	GC	25.89	0.31	1.86
4R1	ROAD	3.30	0.95	0.73
4R2	ROAD	6.90	0.95	1.52
4R3	ROAD	0.80	0.95	0.18
TOTAL		**196.15**		**29.23**

SF = SINGLE FAMILY GC = GOLF COURSE

RETENTION PROVIDED FOR DRAINAGE AREA 4

BASIN	WEIR ELEVATION (ft)	V_p (ac-ft)
4B1	1314.0	2.22
4B2	1309.8	1.68
4B3	1306.8	2.76
4B4	1304.5	3.03
4B5	1305.5	22.39
	Total V_p Area 4	**32.08**

It is proposed that drywells be used to drain the basins within AREA 1. Basins within AREAS 2, 3, and 4 will be drained by bleed lines which will follow the same drainage pattern as the HEC-1 routing. Should the grades in AREA 4 permit, Basins 4B1 through 4B4 could bleed to the East Drainage Channel.. Should this be the case, an 8 inch line would be sufficient to drain Basin 4B4. Bleed lines for basins within the parcels will be sized to drain the basins within 36 hours. Bleed lines within the golf course will be sized to drain the course within 24 hours. Subsequent bleed lines are sized to drain the entire upstream volume required. Standpipes and headgates will be installed to regulate the bleed lines. The table on the following page summarizes the estimated bleed line sizes required to drain the site.

BLEED LINE SIZING

Basin	V_R (ac-ft)	V_R (ft^3)	Time to Drain Basin (hrs)	Required Drain Rate (cfs)	Available Head (ft)	Estimated Pipe Size (in)	Pipe Capacity (cfs)
2B1	1.02	44,431	36	0.3	3.0	8	3.0
2B2	13.89	605,048	24	7.0	5.0	12	8.5
2B3	0.25	10,890	24	0.1	1.0	8	1.5
2B4	1.04	45,302	24	0.5	3.0	8	3.0
2B5	28.43	1,238,411	24	14.3	5.0	18	18.0
3B1	7.64	332,798	24	3.9	2.5	12	5.5
4B1	2.22	96,703	36	0.7	3.0	8	3.0
4B2	3.90	169,884	36	1.3	3.0	8	3.0
4B3	6.66	290,110	36	2.2	3.0	8	3.0
4B4	9.69	422,096	36	3.3	3.0	12	6.0
4B5	65.61	2,857,972	24	33.2	5.5	30	48.0

TIMING AND RESPONSIBILITY

The following is a synopsis of the drainage infrastructure necessary to the development of each drainage area as indicated on the Master Drainage Map.

AREA 1:

Prior to the development of AREA 1, the West Drainage Channel shall be constructed to prevent offsite flows from entering the development.

AREA 2:

The drainage channel adjacent to the loop road to which Areas 2A5, 2A6, and 2A7 drain shall be constructed prior to the development of these areas. The culvert crossings in the loop road at CP2 and CP10 shall be constructed prior to the development of the parcels which drain to them. The culvert crossing at CP17 shall be constructed to provide the outfall for AREA 2. The portion of the golf course to which this area drains shall be graded prior to parcel development.

AREA 3:

Prior to the development of AREA 3, the drainage channel to which Areas 3A1 and 3A2 drain and the culvert crossing at CP19 shall be constructed. The portion of the golf course to which this area drains shall be graded prior to parcel development.

AREA 4:

Prior to the development of Area 4A1, 4A2 and 4A3 the South Drainage Channel and the culvert crossing at CP26 shall be constructed. The portion of the golf course to which this area drains shall be graded prior to parcel development.

Prior to the development of AREAS 2, 3, and 4 the North Drainage Channel, the East Drainage Channel, and the culvert crossing beneath Bell Road shall be constructed to intercept offsite flows from the north and route the flows to the appropriate outfalls.

In the event that construction phasing does not coincide with the above outlined schedule, temporary drainage measures should be put in place. The temporary facilities shall be designed so as to not significantly alter the drainage patterns or outfalls set forth in the Master Drainage Study.

REFERENCES

Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, - Volume 1, Hydrology, June 1992.

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Greiner, Inc., THE VILLAGES AT SURPRISE Master Drainage Report, Executive Summary, December 30, 1995, revised June 8, 1995.

U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 12, Drainage of Highway Pavements, March, 1984.

U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts", April, 1964.

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United States Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Version 4.0, September, 1990.

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U.S. Department of Agriculture, Soil Conservation Service, Engineering Handbook: Section 5 - Hydraulics, August, 1956.

Stage/Storage/Discharge Calculations

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 1B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1327.9	1.77				
		1.88	1.0	1.88	
1328.9	1.99				1.88
		2.10	1.0	2.10	
1329.9	2.21				3.98
		2.32	1.0	2.32	
1330.9	2.43				6.30

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 1B1:

- No discharge for 100-year, 6-hour storm.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1327.9	0.0	0.00
1328.9	0.0	1.88
1329.9	0.0	3.98
1330.9	0.0	6.30

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 1B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1326.5	1.58				
		1.72	1.0	1.72	
1327.5	1.86				1.72
		2.00	1.0	2.00	
1328.5	2.14				3.72
		2.28	1.0	2.28	
1329.5	2.42				6.00

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 1B2:

- No discharge for 100-year, 6-hour storm.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1326.5	0.0	0.00
1327.5	0.0	1.72
1328.5	0.0	3.72
1329.5	0.0	6.00

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1323.0	0.31				
		0.32	1.0	0.32	
1324.0	0.33				0.32
		0.34	1.0	0.34	
1325.0	0.35				0.66
		0.36	1.0	0.36	
1326.0	0.37				1.02
		0.38	1.0	0.38	
1327.0	0.39				1.40

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B1:

Discharge through 5 foot rectangular weir at elevation 1326.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1323.0	0.0	0.00
1324.0	0.0	0.32
1325.0	0.0	0.66
1326.0	0.0	1.02
1327.0	16.0	1.40

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1312.0	0.33				
		0.45	1.0	0.45	
1313.0	0.56				0.45
		1.18	1.0	1.18	
1314.0	1.80				1.63
		2.33	1.0	2.33	
1315.0	2.86				3.96
		3.39	1.0	3.39	
1316.0	3.92				7.35
		4.41	1.0	4.41	
1317.0	4.90				11.76
		5.39	1.0	5.39	
1318.0	5.88				17.15

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B2:

- No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1312.0	0.0	0.00
1313.0	0.0	0.45
1314.0	0.0	1.63
1315.0	0.0	3.96
1316.0	0.0	7.35
1317.0	0.0	11.76
1318.0	0.0	17.15

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B3:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1316.0	0.12				
		0.21	1.0	0.21	
1317.0	0.30				0.21
		0.39	1.0	0.39	
1318.0	0.48				0.60
		0.57	1.0	0.57	
1319.0	0.66				1.17
		0.75	1.0	0.75	
1320.0	0.84				1.92

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B3:

- No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1316.0	0.0	0.00
1317.0	0.0	0.21
1318.0	0.0	0.60
1319.0	0.0	1.17
1320.0	0.0	1.92

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B4:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1312.0	0.18				
		0.25	1.0	0.25	
1313.0	0.32				0.25
		0.36	1.0	0.36	
1314.0	0.40				0.61
		0.48	1.0	0.48	
1315.0	0.56				1.09
		0.60	1.0	0.60	
1316.0	0.64				1.69

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B4:

No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1312.0	0.0	0.00
1313.0	0.0	0.25
1314.0	0.0	0.61
1315.0	0.0	1.08
1316.0	0.0	1.69

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B5:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1306.0	1.02				
		1.42	1.0	1.42	
1307.0	1.82				1.42
		2.21	1.0	2.21	
1308.0	2.60				3.63
		3.02	1.0	3.02	
1309.0	3.44				6.65
		3.87	1.0	3.87	
1310.0	4.30				10.52
		5.23	1.0	5.23	
1311.0	6.16				15.75
		7.08	1.0	7.08	
1312.0	8.00				22.83

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B5:

Discharge through triangular weir at elevation 1311.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1306.0	0.0	0.00
1307.0	0.0	1.42
1308.0	0.0	3.63
1309.0	0.0	6.65
1310.0	0.0	10.52
1311.0	0.0	15.75
1312.0	140.0	22.83

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 3B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1316.0	1.94				
		2.42	1.0	2.42	
1317.0	2.90				2.42
		3.38	1.0	3.38	
1318.0	3.86				5.80
		4.38	1.0	4.38	
1319.0	4.89				10.18
		5.41	1.0	5.41	
1320.0	5.92				15.58

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 3B1:

No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1316.0	0.0	0.00
1317.0	0.0	2.42
1318.0	0.0	5.80
1319.0	0.0	10.18
1320.0	0.0	15.58

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1311.0	0.65				
		0.68	1.0	0.68	
1312.0	0.71				0.68
		0.74	1.0	0.74	
1313.0	0.77				1.42
		0.80	1.0	0.80	
1314.0	0.83				2.22
		0.86	1.0	0.86	
1315.0	0.89				3.08

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B1:

Discharge through 12 foot rectangular weir at elevation 1314.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1311.0	0.0	0.00
1312.0	0.0	0.68
1313.0	0.0	1.42
1314.0	0.0	2.22
1315.0	38.4	3.08

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1306.8	0.47				
		0.50	1.0	0.50	
1307.8	0.53				0.50
		0.56	1.0	0.56	
1308.8	0.59				1.06
		0.62	1.0	0.62	
1309.8	0.65				1.68
		0.68	1.0	0.68	
1310.8	0.71				2.36

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B2:

Discharge through 10 foot rectangular weir at elevation 1309.8.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1306.8	0.0	0.00
1307.8	0.0	0.50
1308.8	0.0	1.06
1309.8	0.0	1.68
1310.8	32.0	2.36

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B3:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1303.8	0.74				
		0.80	1.0	0.80	
1304.8	0.86				0.80
		0.92	1.0	0.92	
1305.8	0.98				1.72
		1.04	1.0	1.04	
1306.8	1.10				2.76
		1.16	1.0	1.16	
1307.8	1.22				3.92

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B3:

Discharge through 3 foot rectangular weir at elevation 1306.8.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1303.8	0.0	0.00
1304.8	0.0	0.80
1305.8	0.0	1.72
1306.8	0.0	2.76
1307.8	9.6	3.92

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B4:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1301.5	0.80				
		0.87	1.0	0.87	
1302.5	0.94				0.87
		1.01	1.0	1.01	
1303.5	1.08				1.88
		1.15	1.0	1.15	
1304.5	1.22				3.03
		1.29	1.0	1.29	
1305.5	1.36				4.32

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B4:

Discharge through 10 foot rectangular weir at elevation 1304.5.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1301.5	0.0	0.00
1302.5	0.0	0.87
1303.5	0.0	1.88
1304.5	0.0	3.03
1305.5	32.0	4.32

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B5:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1300.0	1.58				
		1.78	1.0	1.78	
1301.0	1.98				1.78
		2.46	1.0	2.46	
1302.0	2.94				4.24
		3.63	1.0	3.63	
1303.0	4.32				7.87
		5.01	1.0	5.01	
1304.0	5.70				12.88
		6.13	1.0	6.13	
1305.0	6.56				19.01
		6.77	1.0	6.77	
1305.5	6.99				22.39
		7.21	1.0	7.21	
1306.0	7.42				26.00

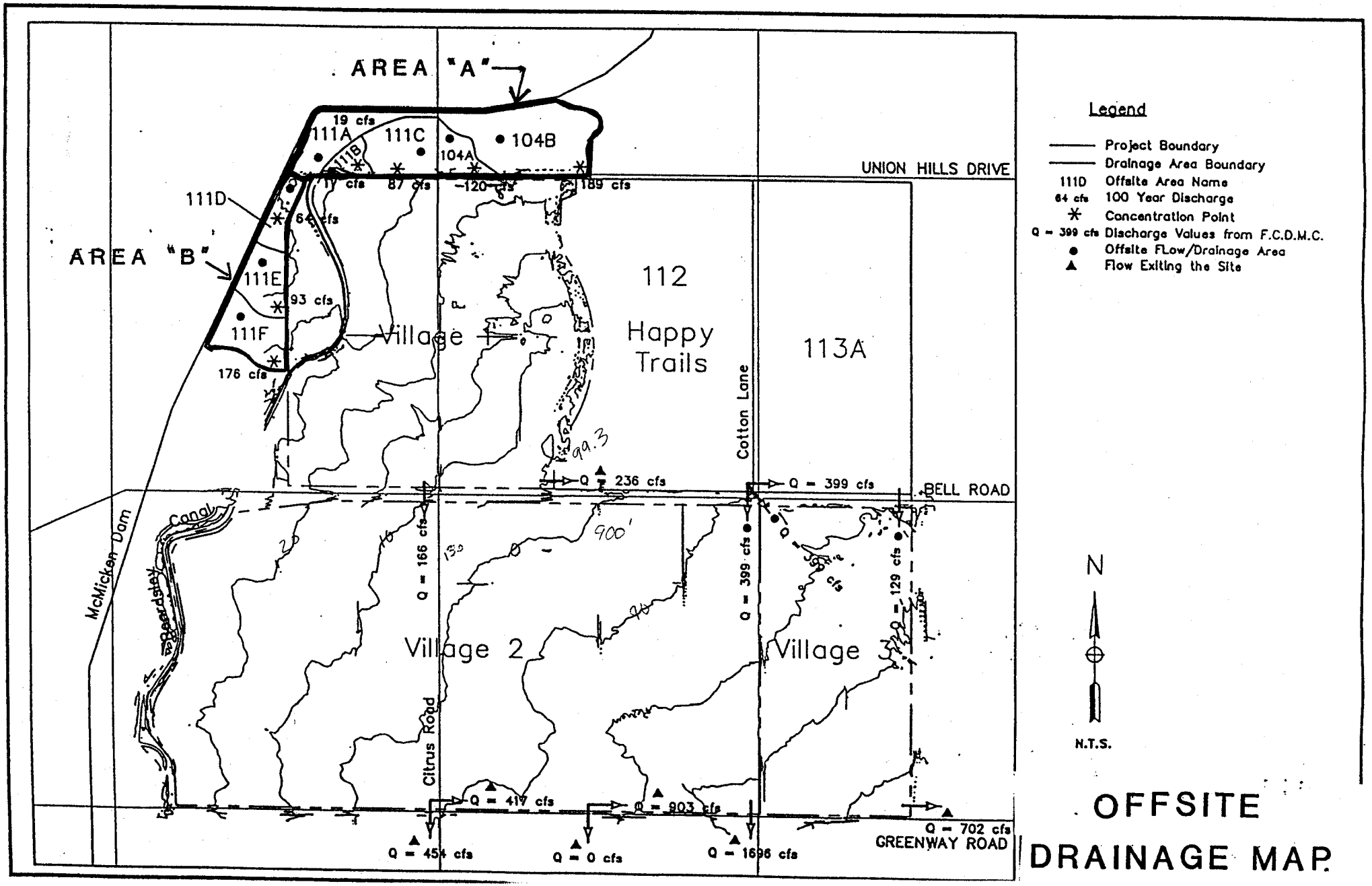
STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B5:

Discharge through 55 foot rectangular weir at elevation 1305.5.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1300.0	0.0	0.00
1301.0	0.0	1.78
1302.0	0.0	4.24
1303.0	0.0	7.87
1304.0	0.0	12.88
1305.0	0.0	19.01
1305.5	0.0	22.39
1306.0	63.0	26.00

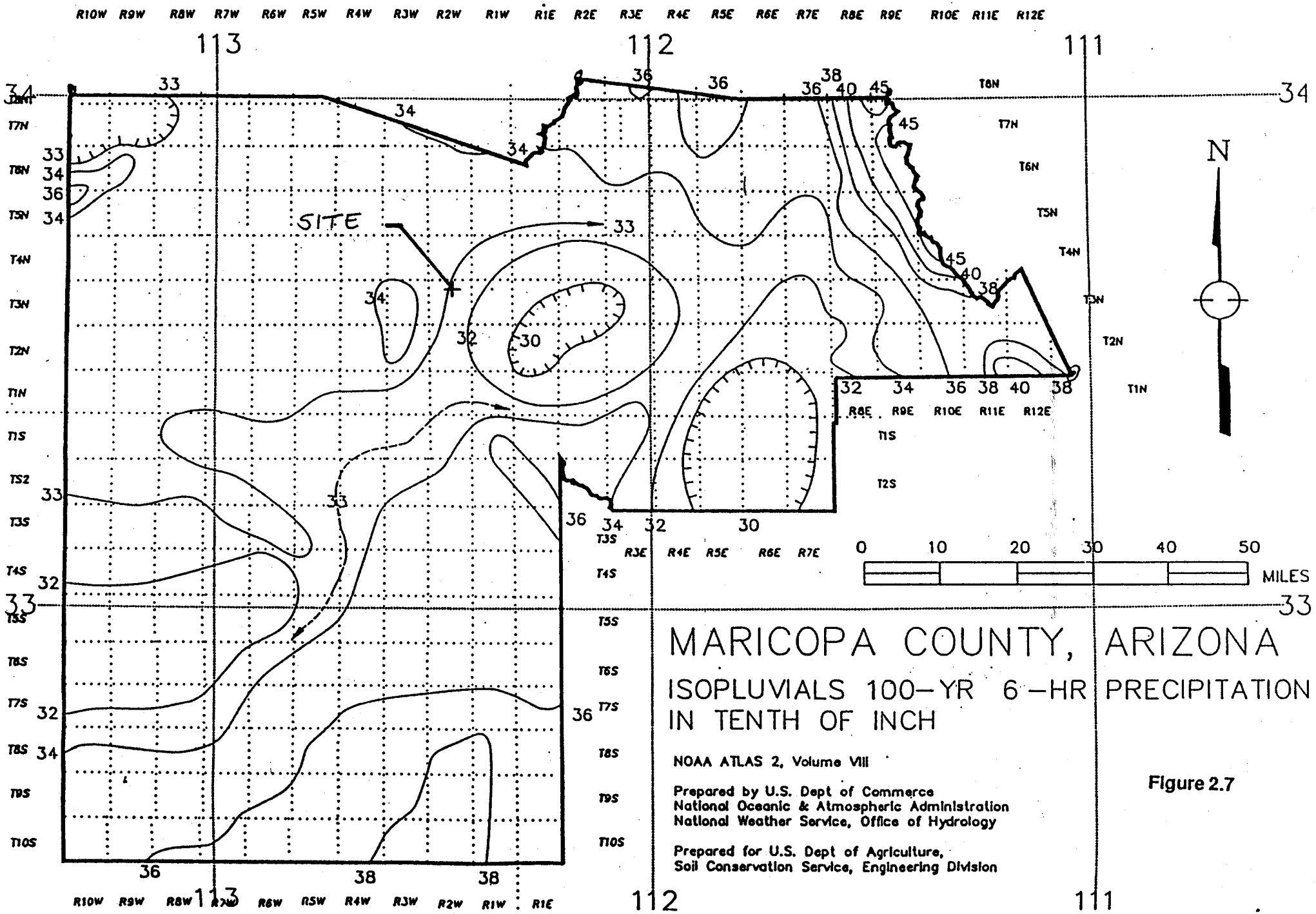
APPENDIX A

HYDROLOGIC CALCULATIONS



OFFSITE DRAINAGE MAP

Figures/Tables from Maricopa County Manual



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 100-YR 6-HR PRECIPITATION IN TENTH OF INCH

NOAA ATLAS 2, Volume VIII

Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.7

Table 4.1
Surface Retention Loss for Various Land Surfaces in Maricopa County

Land-use and/or Surface Cover (1)	Surface Retention Loss IA, Inches (2)
Natural	
Desert and rangeland, flat slope	0.35
Hillslopes, Sonoran Desert	0.15
Mountain, with vegetated surface	0.25
Developed (Residential and Commercial)	
Lawn and turf	0.20
Desert landscape	0.10
Pavement	0.05
Agricultural	
Tilled fields and irrigated pasture	0.50

Table 4.2
Green and Ampt Loss Rate Parameter Values for Bare Ground

Soil Texture Classification (1)	XKSAT Inches/hour (2)	PSIF Inches (3)	DTHETA[1]		
			Dry (4)	Normal (5)	Saturated (6)
loamy sand & sand	1.2	2.4	0.35	0.30	0
sandy loam	0.40	4.3	0.35	0.25	0
loam	0.25	3.5	0.35	0.25	0
silty loam	0.15	6.6	0.40	0.25	0
silt	0.10	7.5	0.35	0.15	0
sandy clay loam	0.06	8.6	0.25	0.15	0
clay loam	0.04	8.2	0.25	0.15	0
silty clay loam	0.04	10.8	0.30	0.15	0
sandy clay	0.02	9.4	0.20	0.10	0
silty clay	0.02	11.5	0.20	0.10	0
clay	0.01	12.4	0.15	0.05	0

[1] Selection of DTHETA:
Dry = Nonirrigated lands, such as desert and rangeland;
Normal = Irrigated lawn, turf, and permanent pasture;
Saturated = Irrigated agricultural land.

Tables extracted from *Drainage Design Manual for Maricopa County, Volume 1: Hydrology*, June 1992, revised 1995.

Table 5.1
Equation for Estimating K_b in the Tc Equation

$K_b = m \log A + b$ Where A is drainage area, in acres				
Type	Description	Typical Applications	Equation Parameters	
			m	b
A	Minimal roughness: Relatively smooth and/or well graded and uniform land surfaces. Surface runoff is sheet flow.	Commercial/ industrial areas Residential area Parks and golf courses	–0.00625	0.04
B	Moderately low roughness: Land surfaces have irregularly spaced roughness elements that protrude from the surface but the overall character of the surface is relatively uniform. Surface runoff is predominately sheet flow around the roughness elements.	Agricultural fields Pastures Desert rangelands Undeveloped urban lands	–0.01375	0.08
C	Moderately high roughness: Land surfaces that have significant large- to medium-sized roughness elements and/or poorly graded land surfaces that cause the flow to be diverted around the roughness elements. Surface runoff is sheet flow for short distances draining into meandering drainage paths.	Hillslopes Brushy alluvial fans Hilly rangeland Disturbed land, mining, etc. Forests with underbrush	–0.025	0.15
D	Maximum roughness: Rough land surfaces with torturous flow paths. Surface runoff is concentrated in numerous short flow paths that are often oblique to the main flow direction.	Mountains Some wetlands	–0.030	0.20

Table extracted from *Drainage Design Manual for Maricopa County, Volume 1: Hydrology*, June 1992, revised 1995.

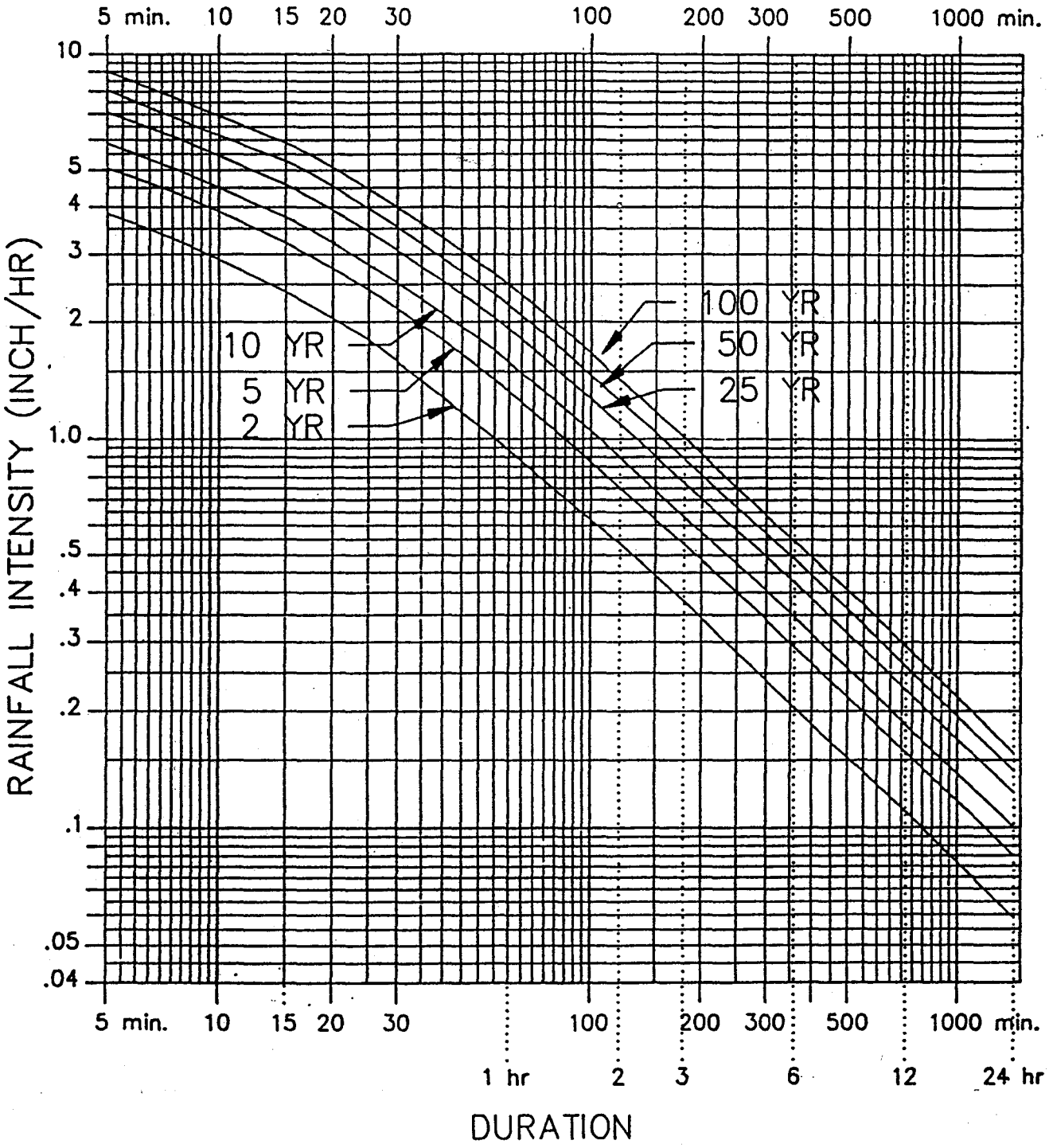


Figure 3.2
Rainfall Intensity-Duration-Frequency Relation
(Phoenix Metro Area)

INPUT PARAMETERS FOR MCUHP1

BASIN I.D.	BASIN AREA (acres)	BASIN AREA (sq. mi.)	FLOW PATH LENGTH (mi.)	Kb	SLOPE (ft/mi.)	SOIL TEXTURE CLASS	IA	DTHETA	PSIF	XKSAT	RTIMP
3A1	9.90	0.016	0.19	0.034	18.5	Clay Loam	0.25	0.15	8.20	0.040	30
3A2	8.22	0.013	0.15	0.034	26.7	Clay Loam	0.25	0.15	8.20	0.040	30
3A3	8.37	0.013	0.13	0.034	15.1	Loam	0.25	0.25	3.50	0.250	30
3A4	14.30	0.022	0.17	0.033	21.1	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
3G1	19.84	0.031	0.31	0.032	6.4	Loam/Sandy Loam	0.05	0.25	3.90	0.325	5
4A1	23.00	0.036	0.35	0.031	21.7	Loam	0.25	0.25	3.50	0.250	30
4A2	13.36	0.021	0.28	0.033	24.3	Loam	0.25	0.25	3.50	0.250	30
4A3	22.33	0.035	0.39	0.032	24.4	Loam	0.25	0.25	3.50	0.250	30
4A4	19.44	0.030	0.27	0.032	31.0	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
4A5	9.35	0.015	0.21	0.034	21.6	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
4A6	19.44	0.030	0.24	0.032	15.6	Loam/Gravelly Loam	0.25	0.25	3.90	0.325	30
4A7	25.98	0.041	0.41	0.031	13.5	Clay/Clay Loam	0.25	0.10	10.30	0.025	30
4A8	12.24	0.019	0.20	0.033	32.3	Clay Loam	0.25	0.15	8.20	0.040	30
4A9	6.36	0.010	0.11	0.035	27.3	Loam/Clay Loam	0.25	0.20	5.85	0.145	50
4G1	7.76	0.012	0.34	0.034	35.2	Loam	0.15	0.25	3.50	0.250	5
4G2	25.89	0.040	0.32	0.031	18.6	Clay Loam	0.15	0.15	8.20	0.040	5
4R1	0.80	0.001	0.07	0.041	14.2	Loam	0.05	0.25	3.50	0.250	80
4R2	3.30	0.005	0.23	0.037	21.7	Loam	0.05	0.25	3.50	0.250	80
4R3	6.90	0.011	0.83	0.035	200.0	Clay Loam	0.05	0.15	8.20	0.040	80

A = Single Family Development G = Golf Course R = Roadway

Stage/Storage/Discharge Calculations

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 1B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1327.9	1.77				
		1.88	1.0	1.88	
1328.9	1.99				1.88
		2.10	1.0	2.10	
1329.9	2.21				3.98
		2.32	1.0	2.32	
1330.9	2.43				6.30

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 1B1:

- No discharge for 100-year, 6-hour storm.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1327.9	0.0	0.00
1328.9	0.0	1.88
1329.9	0.0	3.98
1330.9	0.0	6.30

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 1B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1326.5	1.58				
		1.72	1.0	1.72	
1327.5	1.86				1.72
		2.00	1.0	2.00	
1328.5	2.14				3.72
		2.28	1.0	2.28	
1329.5	2.42				6.00

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 1B2:

- No discharge for 100-year, 6-hour storm.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1326.5	0.0	0.00
1327.5	0.0	1.72
1328.5	0.0	3.72
1329.5	0.0	6.00

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1323.0	0.31				
		0.32	1.0	0.32	
1324.0	0.33				0.32
		0.34	1.0	0.34	
1325.0	0.35				0.66
		0.36	1.0	0.36	
1326.0	0.37				1.02
		0.38	1.0	0.38	
1327.0	0.39				1.40

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B1:

Discharge through 5 foot rectangular weir at elevation 1326.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1323.0	0.0	0.00
1324.0	0.0	0.32
1325.0	0.0	0.66
1326.0	0.0	1.02
1327.0	16.0	1.40

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1312.0	0.33				
		0.45	1.0	0.45	
1313.0	0.56				0.45
		1.18	1.0	1.18	
1314.0	1.80				1.63
		2.33	1.0	2.33	
1315.0	2.86				3.96
		3.39	1.0	3.39	
1316.0	3.92				7.35
		4.41	1.0	4.41	
1317.0	4.90				11.76
		5.39	1.0	5.39	
1318.0	5.88				17.15

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B2:

- No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1312.0	0.0	0.00
1313.0	0.0	0.45
1314.0	0.0	1.63
1315.0	0.0	3.96
1316.0	0.0	7.35
1317.0	0.0	11.76
1318.0	0.0	17.15

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B3:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1316.0	0.12				
		0.21	1.0	0.21	
1317.0	0.30				0.21
		0.39	1.0	0.39	
1318.0	0.48				0.60
		0.57	1.0	0.57	
1319.0	0.66				1.17
		0.75	1.0	0.75	
1320.0	0.84				1.92

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B3:

- No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1316.0	0.0	0.00
1317.0	0.0	0.21
1318.0	0.0	0.60
1319.0	0.0	1.17
1320.0	0.0	1.92

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B4:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1312.0	0.18				
		0.25	1.0	0.25	
1313.0	0.32				0.25
		0.36	1.0	0.36	
1314.0	0.40				0.61
		0.48	1.0	0.48	
1315.0	0.56				1.09
		0.60	1.0	0.60	
1316.0	0.64				1.69

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B4:

No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1312.0	0.0	0.00
1313.0	0.0	0.25
1314.0	0.0	0.61
1315.0	0.0	1.08
1316.0	0.0	1.69

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 2B5:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1306.0	1.02				
		1.42	1.0	1.42	
1307.0	1.82				1.42
		2.21	1.0	2.21	
1308.0	2.60				3.63
		3.02	1.0	3.02	
1309.0	3.44				6.65
		3.87	1.0	3.87	
1310.0	4.30				10.52
		5.23	1.0	5.23	
1311.0	6.16				15.75
		7.08	1.0	7.08	
1312.0	8.00				22.83

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 2B5:

Discharge through triangular weir at elevation 1311.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1306.0	0.0	0.00
1307.0	0.0	1.42
1308.0	0.0	3.63
1309.0	0.0	6.65
1310.0	0.0	10.52
1311.0	0.0	15.75
1312.0	140.0	22.83

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 3B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1316.0	1.94				
		2.42	1.0	2.42	
1317.0	2.90				2.42
		3.38	1.0	3.38	
1318.0	3.86				5.80
		4.38	1.0	4.38	
1319.0	4.89				10.18
		5.41	1.0	5.41	
1320.0	5.92				15.58

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 3B1:

No discharge for 100-year, 6-hour storm event.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1316.0	0.0	0.00
1317.0	0.0	2.42
1318.0	0.0	5.80
1319.0	0.0	10.18
1320.0	0.0	15.58

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B1:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1311.0	0.65				
		0.68	1.0	0.68	
1312.0	0.71				0.68
		0.74	1.0	0.74	
1313.0	0.77				1.42
		0.80	1.0	0.80	
1314.0	0.83				2.22
		0.86	1.0	0.86	
1315.0	0.89				3.08

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B1:

Discharge through 12 foot rectangular weir at elevation 1314.0.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1311.0	0.0	0.00
1312.0	0.0	0.68
1313.0	0.0	1.42
1314.0	0.0	2.22
1315.0	38.4	3.08

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B2:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1306.8	0.47				
		0.50	1.0	0.50	
1307.8	0.53				0.50
		0.56	1.0	0.56	
1308.8	0.59				1.06
		0.62	1.0	0.62	
1309.8	0.65				1.68
		0.68	1.0	0.68	
1310.8	0.71				2.36

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B2:

Discharge through 10 foot rectangular weir at elevation 1309.8.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1306.8	0.0	0.00
1307.8	0.0	0.50
1308.8	0.0	1.06
1309.8	0.0	1.68
1310.8	32.0	2.36

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B3:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1303.8	0.74				
		0.80	1.0	0.80	
1304.8	0.86				0.80
		0.92	1.0	0.92	
1305.8	0.98				1.72
		1.04	1.0	1.04	
1306.8	1.10				2.76
		1.16	1.0	1.16	
1307.8	1.22				3.92

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B3:

Discharge through 3 foot rectangular weir at elevation 1306.8.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1303.8	0.0	0.00
1304.8	0.0	0.80
1305.8	0.0	1.72
1306.8	0.0	2.76
1307.8	9.6	3.92

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B4:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1301.5	0.80				
		0.87	1.0	0.87	
1302.5	0.94				0.87
		1.01	1.0	1.01	
1303.5	1.08				1.88
		1.15	1.0	1.15	
1304.5	1.22				3.03
		1.29	1.0	1.29	
1305.5	1.36				4.32

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B4:

Discharge through 10 foot rectangular weir at elevation 1304.5.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1301.5	0.0	0.00
1302.5	0.0	0.87
1303.5	0.0	1.88
1304.5	0.0	3.03
1305.5	32.0	4.32

JOB NAME: **ARIZONA TRADITIONS** JOB NO: **931007**

STORAGE CALCULATIONS FOR BASIN 4B5:

ELEVATION (ft)	AREA (ac)	AVERAGE AREA (ac)	DEPTH (ft)	VOLUME (ac-ft)	TOTAL VOLUME (ac-ft)
1300.0	1.58				
		1.78	1.0	1.78	
1301.0	1.98				1.78
		2.46	1.0	2.46	
1302.0	2.94				4.24
		3.63	1.0	3.63	
1303.0	4.32				7.87
		5.01	1.0	5.01	
1304.0	5.70				12.88
		6.13	1.0	6.13	
1305.0	6.56				19.01
		6.77	1.0	6.77	
1305.5	6.99				22.39
		7.21	1.0	7.21	
1306.0	7.42				26.00

STAGE/STORAGE/DISCHARGE TABLE FOR BASIN 4B5:

Discharge through 55 foot rectangular weir at elevation 1305.5.

STAGE	DISCHARGE (cfs)	STORAGE (ac-ft)
1300.0	0.0	0.00
1301.0	0.0	1.78
1302.0	0.0	4.24
1303.0	0.0	7.87
1304.0	0.0	12.88
1305.0	0.0	19.01
1305.5	0.0	22.39
1306.0	63.0	26.00

INPUT PARAMETERS FOR MCUHP1

BASIN I.D.	BASIN AREA (acres)	BASIN AREA (sq. mi.)	FLOW PATH LENGTH (mi.)	Kb	SLOPE (ft/mi.)	SOIL TEXTURE CLASS	IA	DTHETA	PSIF	XKSAT	RTIMP
1A1	30.46	0.048	0.34	0.031	10.9	Loam/Clay Loam	0.25	0.20	5.85	0.145	30
1A2	22.33	0.035	0.31	0.032	11.3	Loam/Clay Loam	0.25	0.20	5.85	0.145	30
2A1	10.00	0.016	0.25	0.034	10.8	Loam	0.25	0.25	3.50	0.250	30
2A2	22.52	0.035	0.34	0.032	20.9	Sandy Loam	0.25	0.25	4.30	0.400	30
2A3	13.74	0.021	0.21	0.033	23.8	Loam	0.25	0.25	3.50	0.250	30
2A4	16.07	0.025	0.28	0.032	14.0	Loam	0.25	0.25	3.50	0.250	30
2A5	10.93	0.017	0.21	0.034	19.2	Loam	0.25	0.25	3.50	0.250	30
2A6	8.04	0.013	0.16	0.034	21.7	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
2A7	10.19	0.016	0.18	0.034	19.5	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
2A8	14.39	0.022	0.24	0.033	21.1	Sandy Loam	0.25	0.25	4.30	0.400	30
2A9	11.96	0.019	0.22	0.033	11.5	Laom/Clay Loam	0.25	0.20	5.85	0.145	30
2A10	6.72	0.011	0.09	0.035	11.6	Clay Loam	0.25	0.15	8.20	0.040	30
2G1	24.40	0.033	0.39	0.032	36.0	Laom/Clay Loam	0.15	0.20	5.85	0.145	5
2G2	3.55	0.006	0.09	0.037	94.0	Clay Loam	0.15	0.15	8.20	0.040	5
2G3	4.77	0.008	0.13	0.037	62.0	Clay Loam	0.15	0.15	8.20	0.040	5
2G4	37.71	0.059	0.55	0.030	10.9	Clay Loam/Sandy Loam	0.15	0.20	6.25	0.220	5
2G5	8.41	0.013	0.14	0.034	14.1	Clay Loam	0.15	0.15	8.20	0.040	5
2R1	2.40	0.004	0.23	0.038	8.7	Loam	0.05	0.25	3.50	0.250	80
2R2	3.20	0.005	0.36	0.037	22.2	Loam	0.05	0.25	3.50	0.250	8
2R3	7.40	0.012	0.61	0.035	23.0	Loam/Sandy Loam	0.05	0.25	3.90	0.325	80

A = Single Family Development G = Golf Course R = Roadway

INPUT PARAMETERS FOR MCUHP1

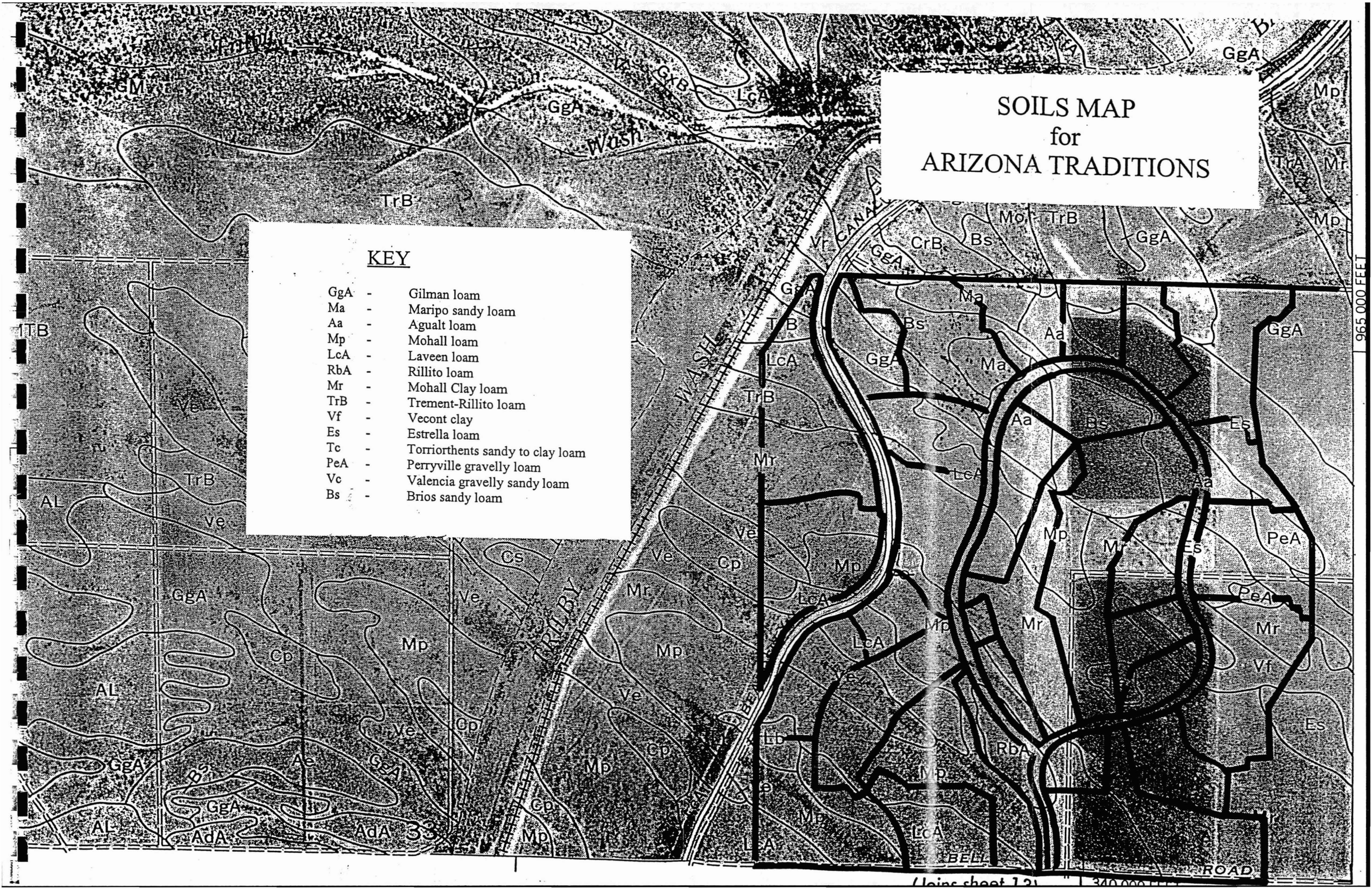
BASIN I.D.	BASIN AREA (acres)	BASIN AREA (sq. mi.)	FLOW PATH LENGTH (mi.)	Kb	SLOPE (ft/mi.)	SOIL TEXTURE CLASS	IA	DTHETA	PSIF	XKSAT	RTIMP
3A1	9.90	0.016	0.19	0.034	18.5	Clay Loam	0.25	0.15	8.20	0.040	30
3A2	8.22	0.013	0.15	0.034	26.7	Clay Loam	0.25	0.15	8.20	0.040	30
3A3	8.37	0.013	0.13	0.034	15.1	Loam	0.25	0.25	3.50	0.250	30
3A4	14.30	0.022	0.17	0.033	21.1	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
3G1	19.84	0.031	0.31	0.032	6.4	Loam/Sandy Loam	0.05	0.25	3.90	0.325	5
4A1	23.00	0.036	0.35	0.031	21.7	Loam	0.25	0.25	3.50	0.250	30
4A2	13.36	0.021	0.28	0.033	24.3	Loam	0.25	0.25	3.50	0.250	30
4A3	22.33	0.035	0.39	0.032	24.4	Loam	0.25	0.25	3.50	0.250	30
4A4	19.44	0.030	0.27	0.032	31.0	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
4A5	9.35	0.015	0.21	0.034	21.6	Loam/Sandy Loam	0.25	0.25	3.90	0.325	30
4A6	19.44	0.030	0.24	0.032	15.6	Loam/Gravelly Loam	0.25	0.25	3.90	0.325	30
4A7	25.98	0.041	0.41	0.031	13.5	Clay/Clay Loam	0.25	0.10	10.30	0.025	30
4A8	12.24	0.019	0.20	0.033	32.3	Clay Loam	0.25	0.15	8.20	0.040	30
4A9	6.36	0.010	0.11	0.035	27.3	Loam/Clay Loam	0.25	0.20	5.85	0.145	50
4G1	7.76	0.012	0.34	0.034	35.2	Loam	0.15	0.25	3.50	0.250	5
4G2	25.89	0.040	0.32	0.031	18.6	Clay Loam	0.15	0.15	8.20	0.040	5
4R1	0.80	0.001	0.07	0.041	14.2	Loam	0.05	0.25	3.50	0.250	80
4R2	3.30	0.005	0.23	0.037	21.7	Loam	0.05	0.25	3.50	0.250	80
4R3	6.90	0.011	0.83	0.035	200.0	Clay Loam	0.05	0.15	8.20	0.040	80

A = Single Family Development G = Golf Course R = Roadway

SOILS MAP for ARIZONA TRADITIONS

KEY

GgA	-	Gilman loam
Ma	-	Maripo sandy loam
Aa	-	Agualt loam
Mp	-	Mohall loam
LcA	-	Laveen loam
RbA	-	Rillito loam
Mr	-	Mohall Clay loam
TrB	-	Trement-Rillito loam
Vf	-	Vecont clay
Es	-	Estrella loam
Tc	-	Torriorthents sandy to clay loam
PeA	-	Perryville gravelly loam
Vc	-	Valencia gravelly sandy loam
Bs	-	Brios sandy loam



HEC-1
Input/Output

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990              *
*           VERSION 4.0                *
*                                      *
* RUN DATE  01/15/1996  TIME  15:23:44 *
*                                      *
****************************************
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```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   ARIZONA TRADITIONS, DECEMBER 1995
  2           ID
  3           IT       5                     300
  4           IO       5

  5           KK   1A1
  6           KM   SUB-BASIN 1A1
  7           KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
  8           KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
  9           KM     L =  .34  Kb = .031  Adj. Slope =   10.9
 10           BA    .048
 11           IN      15
 12           KM   RAINFALL DEPTH OF 3.29 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 13           PB   3.256
 14           KM   THE FOLLOWING PC RECORD USED A 6-HOUR STORM WITH A PATTERN No. OF 1.27
 15           PC    .000    .008    .016    .025    .033    .041    .050    .058    .066    .075
 16           PC    .087    .099    .119    .145    .226    .397    .796    .891    .923    .947
 17           PC    .959    .970    .981    .990   1.000
 18           LG    .250    .200   5.850    .145  30.000
 19           UC    .292    .224
 20           UA       0       5      16      30      65      77      84      90      94      97
 21           UA     100
```

```
 22          KK   1B1
 23          KM   ROUTE RUNOFF FROM 1A1 THROUGH 1B1
 24          RS       1    ELEV  1327.9
 25          SV       0    1.88    3.98    6.30
 26          SQ       0       0       0       0
 27          SE  1327.9  1328.9  1329.9  1330.9

 28          KK   1A2
 29          KM   SUB-BASIN 1A2
 30          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 31          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 32          KM     L =  .31  Kb = .032  Adj. Slope =   11.3
 33          BA    .035
 34          LG    .250    .200   5.850    .145  30.000
 35          UC    .279    .238
 36          UA       0       5      16      30      65      77      84      90      94      97
 37          UA     100

 38          KK   CP1
 39          KM   COMBINE 1B1 AND 1A2
 40          HC       2

 41          KK   1B2
 42          KM   ROUTE CP1 THROUGH 1B2
 43          RS       1    ELEV  1326.5
 44          SV       0    1.72    3.72    6.00
 45          SQ       0       0       0       0
 46          SE  1326.5  1327.5  1328.5  1329.5
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 47          KK   2A1
 48          KM   SUB-BASIN 2A1
 49          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 50          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 51          KM     L =  .25  Kb = .034  Adj. Slope =   10.8
 52          BA    .016
 53          LG    .250    .250   3.500    .250  30.000
 54          UC    .262    .292
 55          UA       0       5      16      30      65      77      84      90      94      97
 56          UA     100

 57          KK   2B1
 58          KM   ROUTE RUNOFF FROM 2A1 THROUGH 2B1
 59          RS       1    ELEV  1323.0
 60          SV       0    0.32    0.66    1.02    1.40
 61          SQ       0       0       0       0    16.0
 62          SE  1323.0  1324.0  1325.0  1326.0  1327.0

 63          KK   2A2
 64          KM   SUB-BASIN 2A2
 65          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 66          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 67          KM     L =  .34  Kb = .032  Adj. Slope =   20.9
 68          BA    .035
 69          LG    .250    .250   4.300    .400  30.000
 70          UC    .242    .218
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 71          UA      0      5     16     30     65     77     84     90     94     97
 72          UA    100

 73          KK   2A3
 74          KM   SUB-BASIN 2A3
 75          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 76          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 77          KM     L =  .21  Kb = .033  Adj. Slope =   23.8
 78          BA    .021
 79          LG    .250    .250   3.500    .250  30.000
 80          UC    .183    .146
 81          UA      0      5     16     30     65     77     84     90     94     97
 82          UA    100

 83          KK   CP2
 84          KM   COMBINE 2B1, 2A2, AND 2A3
 85          HC      3

 86          KK   2R1
 87          KM   SUB-BASIN 2R1
 88          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 89          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 90          KM     L =  .23  Kb = .038  Adj. Slope =    8.7
 91          BA    .004
 92          LG    .050    .250   3.500    .250  80.000
 93          UC    .279    .645
 94          UA      0      5     16     30     65     77     84     90     94     97
 95          UA    100
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 96          KK   2A4
 97          KM   SUB-BASIN 2A4
 98          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 99          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
100          KM     L =  .28  Kb = .032  Adj. Slope =   14.0
101          BA    .025
102          LG    .250    .250   3.500    .250  30.000
103          UC    .246    .231
104          UA      0      5     16     30     65     77     84     90     94     97
105          UA    100

106          KK   CP3
107          KM   COMBINE CP2, 2R1 AND 2A4
108          HC      3

109          KK   2G1
110          KM   SUB-BASIN 2G1
111          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
112          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
113          KM     L =  .39  Kb = .032  Adj. Slope =   36.0
114          BA    .038
115          LG    .150    .200   5.850    .145   5.000
116          UC    .217    .223
117          UA      0      5     16     30     65     77     84     90     94     97
118          UA    100

119          KK   CP4
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 120          KM   COMBINE CP3 AND 2G1
 121          HC       2

 122          KK   2B2
 123          KM   ROUTE CP4 THROUGH 2B2
 124          RS       1    ELEV  1312.0
 125          SV       0    0.45    1.63    3.96    7.35   11.76   17.15
 126          SQ       0       0       0       0       0       0       0
 127          SE  1312.0  1313.0  1314.0  1315.0  1316.0  1317.0  1318.0

 128          KK   2G2
 129          KM   SUB-BASIN 2G2
 130          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 131          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 132          KM     L =  .09  Kb = .037  Adj. Slope =   94.0
 133          BA    .005
 134          LG    .150    .150   8.200    .040   5.000
 135          UC    .083    .063
 136          UA       0       5      16      30      65      77      84      90      94      97
 137          UA     100

 138          KK   2B3
 139          KM   ROUTE 2G2 THROUGH BASIN 2B3
 140          RS       1    ELEV  1316.0
 141          SV       0    0.21    0.60    1.17    1.92
 142          SQ       0       0       0       0       0
 143          SE  1316.0  1317.0  1318.0  1319.0  1320.0
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 144          KK   2G3
 145          KM   SUB-BASIN 2G3
 146          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 147          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 148          KM     L =  .13  Kb = .037  Adj. Slope =   62.0
 149          BA    .007
 150          LG    .150    .150   8.200    .040   5.000
 151          UC    .112    .104
 152          UA       0       5      16      30      65      77      84      90      94      97
 153          UA     100

 154          KK   2R2
 155          KM   SUB-BASIN 2R2
 156          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 157          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 158          KM     L =  .36  Kb = .037  Adj. Slope =   22.2
 159          BA    .005
 160          LG    .050    .250   3.500    .250  80.000
 161          UC    .254    .732
 162          UA       0       5      16      30      65      77      84      90      94      97
 163          UA     100

 164          KK   CP5
 165          KM   COMBINE 2G3 AND 2R2
 166          HC       2

 167          KK   2B4
 168          KM   ROUTE CP6 THROUGH BASIN 2B4
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169          RS       1    ELEV  1312.0
170          SV       0    0.25    0.61    1.09    1.69
171          SQ       0       0       0       0       0
172          SE  1312.0  1313.0  1314.0  1315.0  1316.0

173          KK   CP6
174          KM   COMBINE 2B2, 2B3, AND 2B4
175          HC       3

176          KK   2A5
177          KM   SUB-BASIN 2A5
178          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
179          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
180          KM     L =  .21  Kb = .034  Adj. Slope =   19.2
181          BA    .017
182          LG    .250    .250   3.500    .250  30.000
183          UC    .200    .181
184          UA       0       5      16      30      65      77      84      90      94      97
185          UA     100

186          KK   CP7
187          KM   ROUTE 2A5 TO CP7
188          RK     450    .004    .030                       0       3
                                    HEC-1 INPUT                                          PAGE  5

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


189          KK   2A6
190          KM   SUB-BASIN 2A6
191          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
192          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
193          KM     L =  .16  Kb = .034  Adj. Slope =   21.7
194          BA    .013
195          LG    .250    .250   3.900    .325  30.000
196          UC    .167    .139
197          UA       0       5      16      30      65      77      84      90      94      97
198          UA     100

199          KK   CP8
200          KM   COMBINE CP7 AND 2A6
201          HC       2

202          KK   CP9
203          KM   ROUTE CP8 TO CP9
204          RK     700    .004    .030                       0       3

205          KK   2A7
206          KM   SUB-BASIN 2A7
207          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
208          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
209          KM     L =  .18  Kb = .034  Adj. Slope =   19.5
210          BA    .016
211          LG    .250    .250   3.900    .325  30.000
212          UC    .183    .151
213          UA       0       5      16      30      65      77      84      90      94      97
214          UA     100

215          KK   CP10
216          KM   COMBINE 2A7 AND CP9
```

```
217          HC       2

218          KK   2A8
219          KM   SUB-BASIN 2A8
220          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
221          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
222          KM     L =  .24  Kb = .033  Adj. Slope =   21.1
223          BA    .022
224          LG    .250    .250   4.300    .400  30.000
225          UC    .208    .182
226          UA       0       5      16      30      65      77      84      90      94      97
227          UA     100

228          KK   CP11
229          KM   COMBINE 2A8 AND CP10
230          HC       2
                                        HEC-1 INPUT                                          PAGE  6

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.......10


231          KK   2G4
232          KM   SUB-BASIN 2G4
233          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
234          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
235          KM     L =  .55  Kb = .030  Adj. Slope =   10.9
236          BA    .059
237          LG    .150    .200   6.250    .220   5.000
238          UC    .404    .421
239          UA       0       5      16      30      65      77      84      90      94      97
240          UA     100

241          KK   CP12
242          KM   COMBINE 2G4 AND CP11
243          HC       2

244          KK   2A9
245          KM   SUB-BASIN 2A9
246          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
247          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
248          KM     L =  .22  Kb = .033  Adj. Slope =   11.5
249          BA    .019
250          LG    .250    .200   5.850    .145  30.000
251          UC    .233    .210
252          UA       0       5      16      30      65      77      84      90      94      97
253          UA     100

254          KK   2R3
255          KM   SUB-BASIN 2R3
256          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
257          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
258          KM     L =  .61  Kb = .035  Adj. Slope =   23.0
259          BA    .012
260          LG    .050    .250   3.900    .325  80.000
261          UC    .338    .928
262          UA       0       5      16      30      65      77      84      90      94      97
263          UA     100

264          KK   CP13
265          KM   COMBINE 2R3 AND 2A9
```

```
266          HC       2

267          KK   2G5
268          KM   SUB-BASIN 2G5
269          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
270          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
271          KM     L =  .14  Kb = .034  Adj. Slope =   14.1
272          BA    .013
273          LG    .150    .150   8.200    .040   5.000
274          UC    .175    .132
275          UA       0       5      16      30      65      77      84      90      94      97
276          UA     100
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.......10

277          KK   CP14
278          KM   COMBINE CP13 AND 2G4
279          HC       2

280          KK   2A10
281          KM   SUB-BASIN 2A10
282          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
283          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
284          KM     L =  .09  Kb = .035  Adj. Slope =   11.6
285          BA    .011
286          LG    .250    .150   8.200    .040  30.000
287          UC    .150    .086
288          UA       0       5      16      30      65      77      84      90      94      97
289          UA     100

290          KK   CP15
291          KM   COMBINE 2A10 AND CP14
292          HC       2

293          KK   CP16
294          KM   COMBINE CP12 AND CP15
295          HC       2

296          KK   2B5
297          KM   ROUTE CP16 THROUGH BASIN 2B5
298          RS       1    ELEV  1306.0
299          SV       0    1.42    3.63    6.65   10.52   15.75   22.83
300          SQ       0       0       0       0       0       0   140.0
301          SE  1306.0  1307.0  1308.0  1309.0  1310.0  1311.0  1312.0

302          KK   CP17
303          KM   COMBINE CP7 AND 2B4
304          HC       2

305          KK   3A1
306          KM   SUB-BASIN 3A1
307          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
308          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
309          KM     L =  .19  Kb = .034  Adj. Slope =   18.5
310          BA    .016
311          LG    .250    .150   8.200    .040  30.000
312          UC    .188    .161
313          UA       0       5      16      30      65      77      84      90      94      97
```

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 314          UA     100

 315          KK   CP18
 316          KM   ROUTE 3A1 TO CP18
 317          RK     900    .002    .030                      0       3
                                   HEC-1 INPUT                                                    PAGE  8

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 318          KK   3A2
 319          KM   SUB-BASIN 3A2
 320          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 321          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 322          KM     L =  .15  Kb = .034  Adj. Slope =   26.7
 323          BA    .013
 324          LG    .250    .150   8.200    .040  30.000
 325          UC    .150    .117
 326          UA       0       5      16      30      65      77      84      90      94      97
 327          UA     100

 328          KK   CP19
 329          KM   COMBINE CP18 AND 3A2
 330          HC       2

 331          KK   3A3
 332          KM   SUB-BASIN 3A3
 333          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 334          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 335          KM     L =  .13  Kb = .034  Adj. Slope =   15.1
 336          BA    .013
 337          LG    .250    .250   3.500    .250  30.000
 338          UC    .167    .118
 339          UA       0       5      16      30      65      77      84      90      94      97
 340          UA     100

 341          KK   CP20
 342          KM   COMBINE CP19 AND 3A3
 343          HC       2

 344          KK   3A4
 345          KM   SUB-BASIN 3A4
 346          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 347          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 348          KM     L =  .17  Kb = .033  Adj. Slope =   21.1
 349          BA    .022
 350          LG    .250    .250   3.900    .325  30.000
 351          UC    .171    .111
 352          UA       0       5      16      30      65      77      84      90      94      97
 353          UA     100

 354          KK   3G1
 355          KM   SUB-BASIN 3G1
 356          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 357          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 358          KM     L =  .31  Kb = .032  Adj. Slope =    6.4
 359          BA    .031
 360          LG    .250    .250   3.900    .325   5.000
 361          UC    .367    .345
 362          UA       0       5      16      30      65      77      84      90      94      97
```

```
 363          UA     100
1                                    HEC-1 INPUT                                                    PAGE  9

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 364          KK   CP21
 365          KM   COMBINE CP20, 3A4, AND 3G1
 366          HC       3

 367          KK   3B1
 368          KM   ROUTE CP21 THROUGH BASIN 3B1
 369          RS       1    ELEV  1316.0
 370          SV       0    2.42    5.80   10.18   15.58
 371          SQ       0       0       0       0       0
 372          SE  1316.0  1317.0  1318.0  1319.0  1320.0

 373          KK   4A1
 374          KM   SUB-BASIN 4A1
 375          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 376          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 377          KM     L =  .35  Kb = .031  Adj. Slope =   21.7
 378          BA    .036
 379          LG    .250    .250   3.500    .250  30.000
 380          UC    .233    .211
 381          UA       0       5      16      30      65      77      84      90      94      97
 382          UA     100

 383          KK   CP22
 384          KM   COMBINE 3B1 AND 4A1
 385          HC       2

 386          KK   CP23
 387          KM   ROUTE CP22 TO CP23
 388          RK     700    .006    .030            TRAP       8       3

 389          KK   4A2
 390          KM   SUB-BASIN 4A2
 391          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
 392          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
 393          KM     L =  .28  Kb = .033  Adj. Slope =   24.3
 394          BA    .021
 395          LG    .250    .250   3.500    .250  30.000
 396          UC    .208    .212
 397          UA       0       5      16      30      65      77      84      90      94      97
 398          UA     100

 399          KK   CP24
 400          KM   COMBINE CP23 AND 4A2
 401          HC       2

 402          KK   CP25
 403          KM   ROUTE CP24 TO CP25
 404          RK     500    .006    .030            TRAP      10       3
1                                    HEC-1 INPUT                                                    PAGE 10

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 405          KK   4A3
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406          KM   SUB-BASIN 4A3
407          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
408          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
409          KM     L =  .39  Kb = .032  Adj. Slope =   24.4
410          BA    .035
411          LG    .250    .250   3.500    .250  30.000
412          UC    .242    .243
413          UA       0       5      16      30      65      77      84      90      94      97
414          UA     100

415          KK   4G1
416          KM   SUB-BASIN 4G1
417          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
418          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
419          KM     L =  .34  Kb = .034  Adj. Slope =   35.2
420          BA    .012
421          LG    .150    .250   3.500    .250   5.000
422          UC    .213    .348
423          UA       0       5      16      30      65      77      84      90      94      97
424          UA     100

425          KK   4R2
426          KM   SUB-BASIN 4R2
427          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
428          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
429          KM     L =  .23  Kb = .037  Adj. Slope =   21.7
430          BA    .005
431          LG    .050    .250   3.500    .250  80.000
432          UC    .204    .401
433          UA       0       5      16      30      65      77      84      90      94      97
434          UA     100

435          KK   CP26
436          KM   COMBINE CP25, 4A3, 4G1, AND 4R2
437          HC       4

438          KK   4R1
439          KM   SUB-BASIN 4R1
440          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
441          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
442          KM     L =  .07  Kb = .041  Adj. Slope =   14.2
443          BA    .001
444          LG    .050    .250   3.500    .250  80.000
445          UC    .138    .250
446          UA       0       5      16      30      65      77      84      90      94      97
447          UA     100

448          KK   CP27
449          KM   COMBINE CP26 AND 4R1
450          HC       2
```



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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

451          KK   4R3
452          KM   SUB-BASIN 4R3
453          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
454          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
455          KM     L =  .83  Kb = .035  Adj. Slope =  200.0
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456          BA    .011
457          LG    .050    .150   8.200    .040  80.000
458          UC    .188    .650
459          UA       0       5      16      30      65      77      84      90      94      97
460          UA     100

461          KK   4A9
462          KM   SUB-BASIN 4A9
463          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
464          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
465          KM     L =  .11  Kb = .035  Adj. Slope =   27.3
466          BA    .010
467          LG    .250    .200   5.850    .145  50.000
468          UC    .129    .090
469          UA       0       5      16      30      65      77      84      90      94      97
470          UA     100

471          KK   CP28
472          KM   COMBINE 4R1, 4A9, AND CP27
473          HC       3

474          KK   CP29
475          KM   COMBINE CP28 AND CP17
476          HC       2

477          KK   4A4
478          KM   SUB-BASIN 4A4
479          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
480          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
481          KM     L =  .27  Kb = .032  Adj. Slope =   31.0
482          BA    .030
483          LG    .250    .250   3.900    .325  30.000
484          UC    .192    .153
485          UA       0       5      16      30      65      77      84      90      94      97
486          UA     100

487          KK   4B1
488          KM   ROUTE 4A4 THROUGH BASIN 4B1
489          RS       1    ELEV  1311.0
490          SV       0    0.68    1.42    2.22    3.08
491          SQ       0       0       0       0    38.4
492          SE  1311.0  1312.0  1313.0  1314.0  1315.0

493          KK   4A5
494          KM   SUB-BASIN 4A5
495          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
496          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
497          KM     L =  .21  Kb = .034  Adj. Slope =   21.6
498          BA    .015
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

499          LG    .250    .250   3.900    .325  30.000
500          UC    .192    .186
501          UA       0       5      16      30      65      77      84      90      94      97
502          UA     100

503          KK   CP30
504          KM   COMBINE 4A5 AND 4B1
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505          HC       2

506          KK   4B2
507          KM   ROUTE CP28 THROUGH BASIN 4B2
508          RS       1    ELEV  1306.8
509          SV       0    0.50    1.06    1.68    2.36
510          SQ       0       0       0       0    32.0
511          SE  1306.8  1307.8  1308.8  1309.8  1310.8

512          KK   4A6
513          KM   SUB-BASIN 4A6
514          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
515          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
516          KM     L =  .24  Kb = .032  Adj. Slope =   15.6
517          BA    .030
518          LG    .250    .250   3.900    .325  30.000
519          UC    .221    .163
520          UA       0       5      16      30      65      77      84      90      94      97
521          UA     100

522          KK   CP31
523          KM   COMBINE 4B2 AND 4A6
524          HC       2

525          KK   4B3
526          KM   ROUTE CP29 THROUGH BASIN 4B3
527          RS       1    ELEV  1303.8
528          SV       0    0.80    1.72    2.76    3.92
529          SQ       0       0       0       0     9.6
530          SE  1303.8  1304.8  1305.8  1306.8  1307.8

531          KK   4A7
532          KM   SUB-BASIN 4A7
533          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
534          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
535          KM     L =  .41  Kb = .031  Adj. Slope =   13.5
536          BA    .041
537          LG    .250    .100  10.300    .025  30.000
538          UC    .296    .290
539          UA       0       5      16      30      65      77      84      90      94      97
540          UA     100

541          KK   CP32
542          KM   COMBINE 4A7 AND 4B3
543          HC       2
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

544          KK   4B4
545          KM   ROUTE CP30 THROUGH BASIN 4B4
546          RS       1    ELEV  1302.0
547          SV       0    0.87    1.88    3.03    4.32
548          SQ       0       0       0       0      96
549          SE  1302.0  1303.0  1304.0  1305.0  1306.0

550          KK   4A8
551          KM   SUB-BASIN 4A8
552          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
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553          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
554          KM     L =  .20  Kb = .033  Adj. Slope =   32.3
555          BA    .019
556          LG    .250    .150   8.200    .040  30.000
557          UC    .158    .126
558          UA       0       5      16      30      65      77      84      90      94      97
559          UA     100

560          KK   CP33
561          KM   COMBINE 4A8 AND 4B4
562          HC       2

563          KK   4G2
564          KM   SUB-BASIN 4G2
565          KM   6-HOUR RAINFALL, PATTERN NO. 1.27 WAS USED TO FIND TC & R FOR THIS BASIN
566          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .990
567          KM     L =  .32  Kb = .031  Adj. Slope =   18.6
568          BA    .040
569          LG    .150    .150   8.200    .040   5.000
570          UC    .233    .185
571          UA       0       5      16      30      65      77      84      90      94      97
572          UA     100

573          KK   CP34
574          KM   COMBINE CP33 AND 4G2
575          HC       2

576          KK   CP35
577          KM   COMBINE CP34 AND CP29
578          HC       2

579          KK   4B5
580          KM   ROUTE CP35 THROUGH BASIN 4B5
581          RS       1    ELEV  1300.0
582          SV       0    1.78    4.24    7.87   12.88   19.01   22.39   26.00
583          SQ       0       0       0       0       0       0       0    63.0
584          SE  1300.0  1301.0  1302.0  1303.0  1304.0  1305.0  1305.5  1306.0

585          KK   C3OF1
586          KM   INPUT HYDROGRAPH FROM OFFSITE 104B USING
587          KM   QI CARDS WITH A TIME INCREMENT OF 15 MINUTES. Q100 = 394 CFS
588          KM   AT TIME TO PEAK OF 4-HOURS, 15-MINUTES
589          KM
590          IN      15
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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

591          QI       0       0       0       0       0       0       0       0       0       0
592          QI       0       0       0       0      10     181     394     177      65      24
593          QI       9       3       1       0

594          KK   CP36
595          KM   DIVERT 30 CFS INTO HAPPY TRAILS
596          DT   DIV1
597          DI       0     394
598          DQ       0      30

599          KK   CP37
600          KM   DIVERT 71 CFS INTO HAPPY TRAILS
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601          DT   DIV2
602          DI       0     364
603          DQ       0      76

604          KK   CP38
605          KM   DIVERT 123 CFS INTO HAPPY TRAILS
606          DT   DIV3
607          DI       0     288
608          DQ       0     126

609          KK   CP39
610          KM   COMBINE 4B5 AND CP38
611          HC       2
612          ZZ
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1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*          SEPTEMBER 1990              *
*           VERSION 4.0                *
*                                      *
*  RUN DATE  01/15/1996  TIME  15:23:44 *
*                                      *
****************************************
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```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
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ARIZONA TRADITIONS, DECEMBER 1995

```
 4 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT           HYDROGRAPH TIME DATA
                      NMIN          5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1   0  STARTING DATE
                     ITIME       0000  STARTING TIME
                        NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      2   0  ENDING DATE
                    NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

       *** FDKRUT WARNING TIME STEP CALCULATION FAILED TO CONVERGE. STABILITY PROBLEMS MAY RESULT
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*** FDKRUT WARNING TIME STEP CALCULATION FAILED TO CONVERGE. STABILITY PROBLEMS MAY RESULT

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1A1	102.	4.08	12.	3.	3.	.05		
ROUTED TO	1B1	0.	.08	0.	0.	0.	.05	1330.74	7.17
HYDROGRAPH AT	1A2	73.	4.08	9.	2.	2.	.04		
2 COMBINED AT									

+		CP1	73.	4.08	9.	2.	2.	.08		
	ROUTED TO									
+		1B2	0.	.08	0.	0.	0.	.08		
+									1328.77	7.08
	HYDROGRAPH AT									
+		2A1	30.	4.08	4.	1.	1.	.02		
	ROUTED TO									
+		2B1	12.	4.50	2.	0.	0.	.02		
+									1326.74	4.50
	HYDROGRAPH AT									
+		2A2	69.	4.08	7.	2.	2.	.04		
	HYDROGRAPH AT									
+		2A3	52.	4.00	5.	1.	1.	.02		
	3 COMBINED AT									
+		CP2	118.	4.08	14.	4.	3.	.07		
	HYDROGRAPH AT									
		2R1	6.	4.17	1.	0.	0.	.00		
	HYDROGRAPH AT									
		2A4	52.	4.08	6.	1.	1.	.03		
	3 COMBINED AT									
		CP3	176.	4.08	21.	5.	5.	.10		
	HYDROGRAPH AT									
		2G1	80.	4.08	8.	2.	2.	.04		
	2 COMBINED AT									
		CP4	256.	4.08	30.	7.	7.	.14		
	ROUTED TO									
+		2B2	0.	.08	0.	0.	0.	.14		
									1317.56	8.08
	HYDROGRAPH AT									
		2G2	16.	4.00	1.	0.	0.	.00		
	ROUTED TO									
+		2B3	0.	.08	0.	0.	0.	.00		
									1318.10	6.25
	HYDROGRAPH AT									
		2G3	21.	4.00	2.	0.	0.	.01		
	HYDROGRAPH AT									
		2R2	6.	4.17	2.	0.	0.	.00		
	2 COMBINED AT									
		CP5	26.	4.00	3.	1.	1.	.01		
	ROUTED TO									
		2B4	0.	.08	0.	0.	0.	.01		
									1316.03	9.33

3 COMBINED AT							
	CP6	0.	.08	0.	0.	0.	.16
HYDROGRAPH AT							
	2A5	38.	4.08	4.	1.	1.	.02
ROUTED TO							
	CP7	38.	4.08	4.	1.	1.	.02
HYDROGRAPH AT							
+	2A6	32.	4.00	3.	1.	1.	.01
2 COMBINED AT							
+	CP8	68.	4.00	7.	2.	2.	.03
ROUTED TO							
+	CP9	68.	4.08	7.	2.	2.	.03
HYDROGRAPH AT							
+	2A7	38.	4.00	4.	1.	1.	.02
2 COMBINED AT							
	CP10	104.	4.08	11.	3.	3.	.05
HYDROGRAPH AT							
	2A8	46.	4.08	5.	1.	1.	.02
2 COMBINED AT							
	CP11	150.	4.08	15.	4.	4.	.07
HYDROGRAPH AT							
	2G4	83.	4.17	12.	3.	3.	.06
2 COMBINED AT							
+	CP12	226.	4.08	27.	7.	6.	.13
HYDROGRAPH AT							
+	2A9	42.	4.08	5.	1.	1.	.02
HYDROGRAPH AT							
+	2R3	13.	4.25	4.	1.	1.	.01
2 COMBINED AT							
+	CP13	54.	4.08	8.	2.	2.	.03
HYDROGRAPH AT							
+	2G5	35.	4.00	3.	1.	1.	.01
2 COMBINED AT							
	CP14	87.	4.08	12.	3.	3.	.04
HYDROGRAPH AT							
	2A10	34.	4.00	3.	1.	1.	.01
2 COMBINED AT							
	CP15	118.	4.00	15.	4.	4.	.05
2 COMBINED AT							
	CP16	341.	4.08	42.	11.	10.	.18

ROUTED TO									
	2B5	41.	4.92	10.	3.	2.	.18		
+								1311.29	4.92
2 COMBINED AT									
	CP17	41.	4.92	10.	3.	2.	.34		
HYDROGRAPH AT									
	3A1	41.	4.00	4.	1.	1.	.02		
ROUTED TO									
	CP18	40.	4.08	4.	1.	1.	.02		
HYDROGRAPH AT									
	3A2	37.	4.00	4.	1.	1.	.01		
2 COMBINED AT									
+	CP19	73.	4.08	8.	2.	2.	.03		
HYDROGRAPH AT									
+	3A3	35.	4.00	3.	1.	1.	.01		
2 COMBINED AT									
+	CP20	108.	4.00	11.	3.	3.	.04		
HYDROGRAPH AT									
+	3A4	58.	4.00	5.	1.	1.	.02		
HYDROGRAPH AT									
	3G1	46.	4.17	6.	1.	1.	.03		
3 COMBINED AT									
	CP21	200.	4.00	22.	5.	5.	.09		
ROUTED TO									
	3B1	0.	.08	0.	0.	0.	.09		
+								1319.12	7.33
HYDROGRAPH AT									
	4A1	77.	4.08	9.	2.	2.	.04		
2 COMBINED AT									
	CP22	77.	4.08	9.	2.	2.	.13		
ROUTED TO									
	CP23	76.	4.08	9.	2.	2.	.13		
HYDROGRAPH AT									
	4A2	45.	4.08	5.	1.	1.	.02		
2 COMBINED AT									
	CP24	121.	4.08	13.	3.	3.	.15		
ROUTED TO									
+	CP25	119.	4.08	14.	3.	3.	.15		
HYDROGRAPH AT									
+	4A3	71.	4.08	8.	2.	2.	.04		

	HYDROGRAPH AT								
+		4G1	20.	4.08	2.	1.	1.	.01	
	HYDROGRAPH AT								
+		4R2	9.	4.08	2.	0.	0.	.00	
	4 COMBINED AT								
+		CP26	219.	4.08	26.	6.	6.	.20	
	HYDROGRAPH AT								
+		4R1	2.	4.00	0.	0.	0.	.00	
	2 COMBINED AT								
+		CP27	221.	4.08	26.	7.	6.	.20	
	HYDROGRAPH AT								
		4R3	16.	4.08	4.	1.	1.	.01	
	HYDROGRAPH AT								
		4A9	30.	4.00	3.	1.	1.	.01	
	3 COMBINED AT								
		CP28	262.	4.08	32.	8.	8.	.23	
	2 COMBINED AT								
		CP29	262.	4.08	42.	11.	10.	.56	
	HYDROGRAPH AT								
+		4A4	70.	4.00	7.	2.	2.	.03	
	ROUTED TO								
+		4B1	20.	4.42	2.	1.	1.	.03	
									1314.51 4.42
	HYDROGRAPH AT								
		4A5	32.	4.08	3.	1.	1.	.01	
	2 COMBINED AT								
+		CP30	34.	4.25	6.	1.	1.	.04	
	ROUTED TO								
+		4B2	15.	4.67	2.	1.	1.	.04	
									1310.28 4.67
	HYDROGRAPH AT								
		4A6	67.	4.08	7.	2.	2.	.03	
	2 COMBINED AT								
+		CP31	67.	4.08	9.	2.	2.	.07	
	ROUTED TO								
+		4B3	8.	5.25	3.	1.	1.	.07	
									1307.61 5.25
	HYDROGRAPH AT								
		4A7	84.	4.08	12.	3.	3.	.04	
	2 COMBINED AT								
+		CP32	84.	4.08	15.	4.	4.	.12	

	ROUTED TO									
+		4B4	48.	4.50	9.	2.	2.	.12		
									1305.50	4.50
	HYDROGRAPH AT									
		4A8	53.	4.00	5.	1.	1.	.02		
	2 COMBINED AT									
		CP33	59.	4.42	14.	4.	4.	.13		
	HYDROGRAPH AT									
+		4G2	96.	4.08	11.	3.	3.	.04		
	2 COMBINED AT									
+		CP34	145.	4.00	25.	6.	6.	.17		
	2 COMBINED AT									
+		CP35	406.	4.08	66.	17.	16.	.74		
	ROUTED TO									
+		4B5	63.	5.33	23.	6.	6.	.74		
+									1306.00	5.33
	HYDROGRAPH AT									
+		C3OF1	394.	4.00	37.	10.	9.	.04		
	DIVERSION TO									
+		DIV1	30.	4.00	3.	1.	1.	.04		
	HYDROGRAPH AT									
		CP36	364.	4.00	34.	9.	9.	.04		
	DIVERSION TO									
		DIV2	76.	4.00	7.	2.	2.	.04		
	HYDROGRAPH AT									
		CP37	288.	4.00	27.	7.	7.	.04		
	DIVERSION TO									
		DIV3	126.	4.00	12.	3.	3.	.04		
	HYDROGRAPH AT									
		CP38	162.	4.00	15.	4.	4.	.04		
	2 COMBINED AT									
+		CP39	162.	4.00	38.	10.	9.	.78		

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
CP7	MANE	.66	38.04	245.29	2.21	5.00	38.04	245.00	2.21

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1999E+01 EXCESS= .0000E+00 OUTFLOW= .2001E+01 BASIN STORAGE= .8032E-09 PERCENT ERROR= -.1

CP9	MANE	.97	67.84	242.73	2.16	5.00	67.70	245.00	2.16

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3455E+01 EXCESS= .0000E+00 OUTFLOW= .3457E+01 BASIN STORAGE= .9532E-08 PERCENT ERROR= -.1

CP18	MANE	1.68	40.67	243.53	2.62	5.00	40.35	245.00	2.62

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2233E+01 EXCESS= .0000E+00 OUTFLOW= .2238E+01 BASIN STORAGE= .3119E-07 PERCENT ERROR= -.2

CP23	MANE	.77	76.94	246.66	.61	5.00	75.77	245.00	.61

CONTINUITY SUMMARY (AC-FT) - INFLOW= .4232E+01 EXCESS= .0000E+00 OUTFLOW= .4236E+01 BASIN STORAGE= .4712E-07 PERCENT ERROR= -.1

CP25	MANE	.53	120.15	245.89	.83	5.00	118.73	245.00	.83

CONTINUITY SUMMARY (AC-FT) - INFLOW= .6708E+01 EXCESS= .0000E+00 OUTFLOW= .6711E+01 BASIN STORAGE= .1582E-06 PERCENT ERROR= .0

*** NORMAL END OF HEC-1 ***

APPENDIX B

HYDRAULIC CALCULATIONS

Weir Design

RECTANGULAR WEIR FLOW SUMMARY TABLE

The following table summarizes the stage verses discharge values for rectangular weirs with the designated widths. The following equation was used to determine the discharge values:

$$Q = k\sqrt{2g}\,LH^{3/2}$$

Where:

Q = discharge (cfs)
k = 0.40
g = 32.2 ft/s^2
L = width of weir (ft)
H = depth of flow over weir (ft)

H (ft)	4' WEIR	5' WEIR	12' WEIR	15' WEIR	18' WEIR	20' WEIR	24' WEIR	30' WIER	36' WEIR	38' WEIR	40' WEIR	80' WEIR	100 ' WEIR	120' WEIR
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	4.5	5.7	13.6	17.0	20.4	22.6	27.2	33.9	40.7	43.0	45.3	90.6	113.2	135.8
1.0	12.8	16.0	38.4	48.0	57.6	64.0	76.8	96.0	115.2	121.6	128.0	256.0	320.0	384.0
1.5	23.5	29.4	70.5	88.2	105.8	117.6	141.1	176.4	211.6	223.4	235.2	470.4	588.0	705.5
2.0	36.2	45.3	108.6	135.8	162.9	181.0	217.2	271.5	325.8	343.9	362.0	724.0	905.0	1086.1
2.5	50.6	63.2	151.8	189.7	227.7	253.0	303.6	379.5	455.4	480.7	506.0	1012.0	1265.0	1517.9
3.0	66.5	83.1	199.5	249.4	299.3	332.6	399.1	498.8	598.6	631.9	665.1	1330.2	1663.0	1995.3
3.5	83.8	104.8	251.4	314.3	377.2	419.1	502.9	628.6	754.3	796.2	838.1	1676.2	2095.3	2514.4
4.0	102.4	128.0	307.2	384.0	460.8	512.0	614.4	768.0	921.6	972.8	1024.0	2048.0	2560.0	3072.0
4.5	122.2	152.7	366.6	458.2	549.8	610.9	733.1	916.4	1099.7	1160.8	1221.9	2443.8	3054.7	3665.6
5.0	143.1	178.9	429.3	536.7	644.0	715.5	858.7	1073.3	1288.0	1359.5	1431.1	2762.2	3527.8	4293.3
5.5	165.1	206.4	495.3	619.1	743.0	825.5	990.6	1238.3	1485.9	1568.5	1651.0	3302.0	4127.6	4953.1
6.0	188.1	235.2	564.4	705.5	846.5	940.6	1128.7	1410.9	1693.1	1787.1	1881.2	3762.4	4703.0	5643.6

65'
0
104
312.9

Culvert Design

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

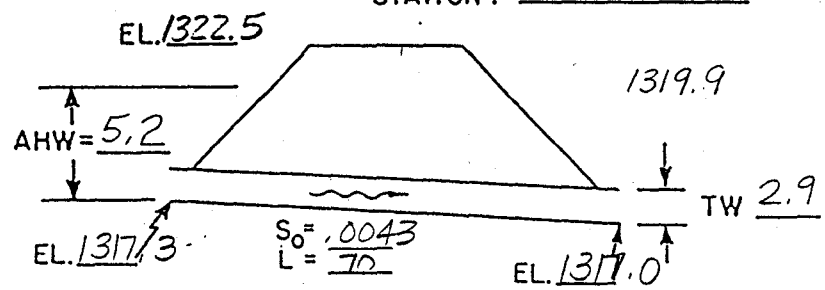
Q_1 = 118 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 2



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
3 30"Ø	39.3	30"	1.75	4.4	0.5	2	2.2	2.35	2.9	2.9	0.3	4.6	4.6			

SUMMARY & RECOMMENDATIONS:

USE 3 30"Ø PIPES

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

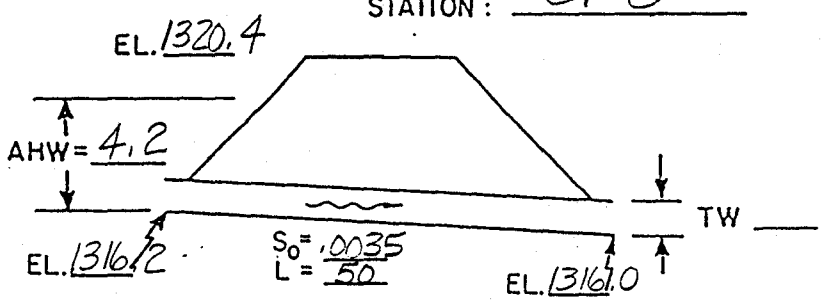
Q_1 = 68 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP8



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 24"Ø	22.7	24"	1.7	3.4												

SUMMARY & RECOMMENDATIONS:

USE 3 24"Ø PIPES

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

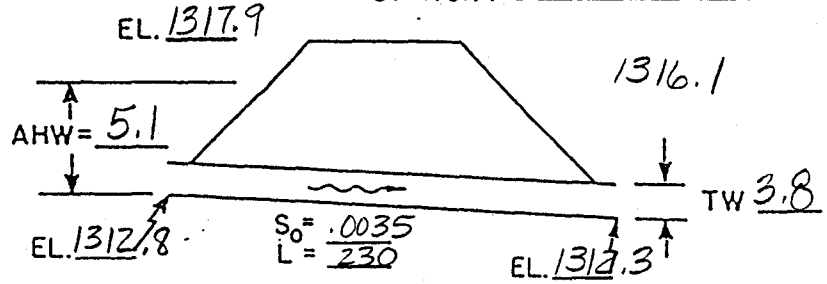
Q_1 = 104 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 10



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW=H+h_o-LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 30" Ø	34.7	30"	1.5	3.75	0.5	2.7	2.0	2.25	3.7	3.7	0.5	5.9	5.9			
4 30" Ø	26.0	30"	1.15	2.9	0.5	1.45	1.7	2.1	3.8	3.8	0.5	4.75	4.75			

SUMMARY & RECOMMENDATIONS:

USE 4 30" Ø PIPES

Figure 7

PROJECT: AZ TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

Estimated Q for occurrence of back to back storms:

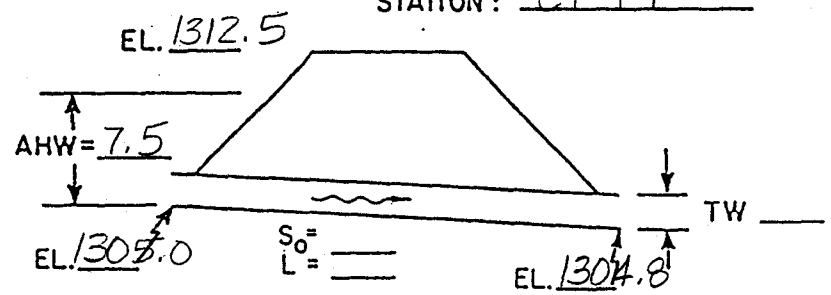
Q_1 = 255 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 17



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
8' x 3'	255		2.2	6.6												

SUMMARY & RECOMMENDATIONS:

USE 8' X 3' BOX

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

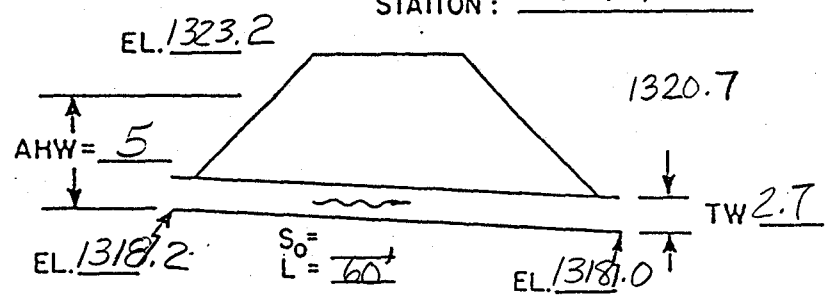
Q_1 = 73 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP19



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2 30"Ø	36.5	30"	1.6	4.0	0.5	1.7	2.1	2.3	2.7	2.7	0.2	4.2	4.2			

SUMMARY & RECOMMENDATIONS:

USE 2 30"Ø PIPES

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

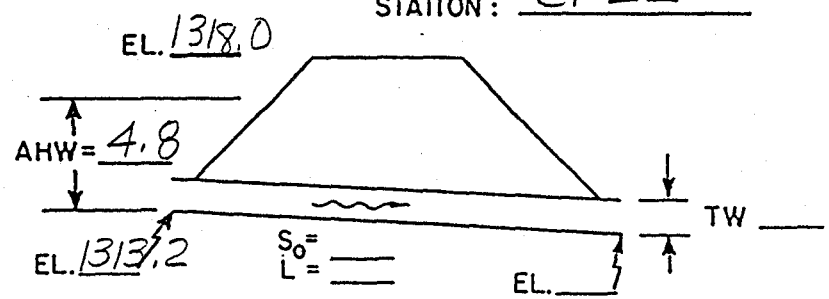
Q_1 = 77 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP22



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
3 24"Ø	25.7	24"	2	4												

SUMMARY & RECOMMENDATIONS:

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

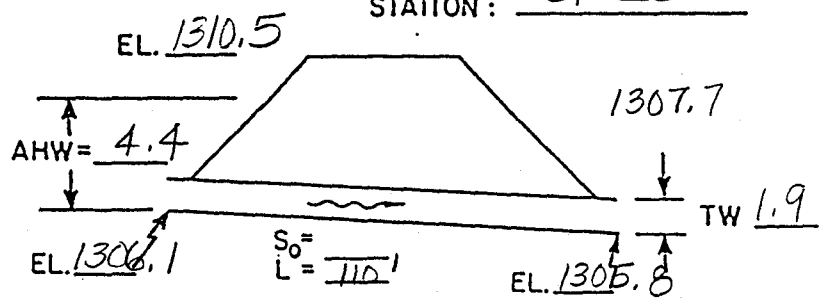
Q_1 = 219 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 26



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
5 38X24	43.8	24"	2.1	4.2	0.5	2.6	1.8	1.9	1.9	1.9	0.3	4.2	4.2			

SUMMARY & RECOMMENDATIONS:

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

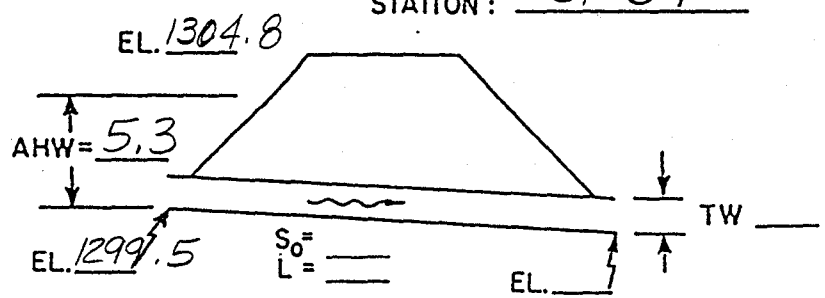
Q_1 = 161 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP39



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

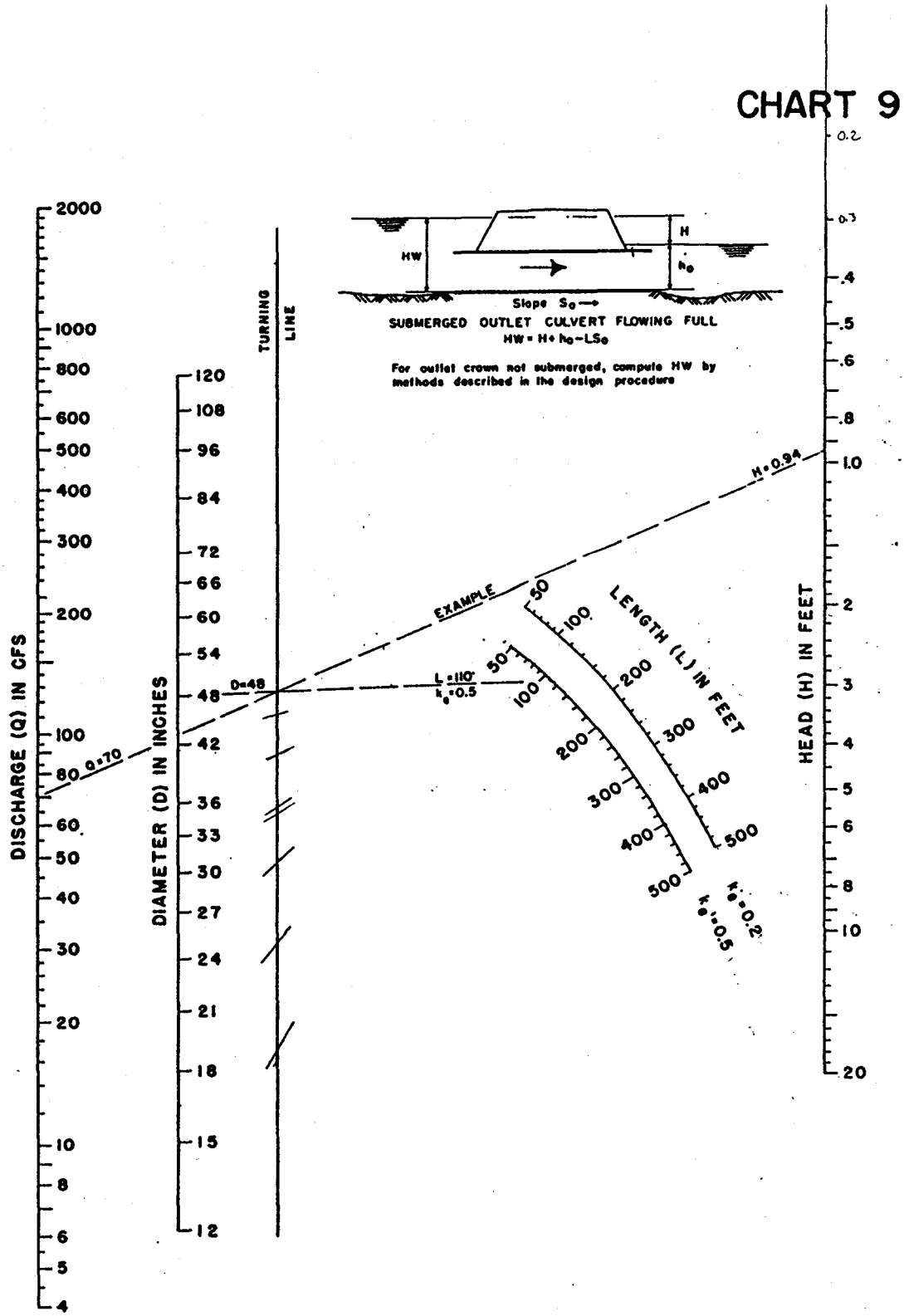
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
4 36"Ø	40.5	36"	1.12	3.36												
3 36"Ø	54.0	36"	1.45	4.35												

SUMMARY & RECOMMENDATIONS:

USE 3 36"Ø PIPES

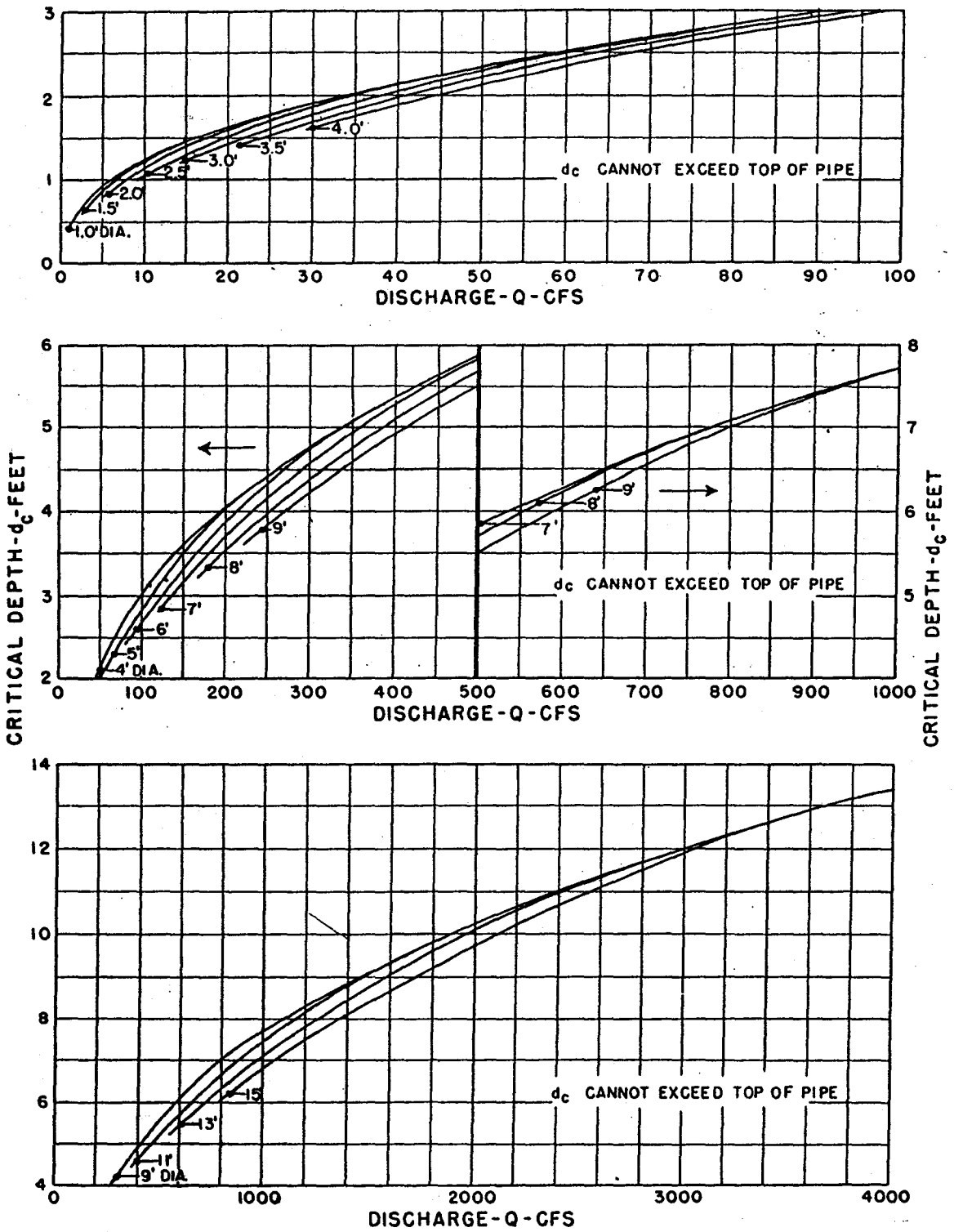
Figure 7

CHART 9



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

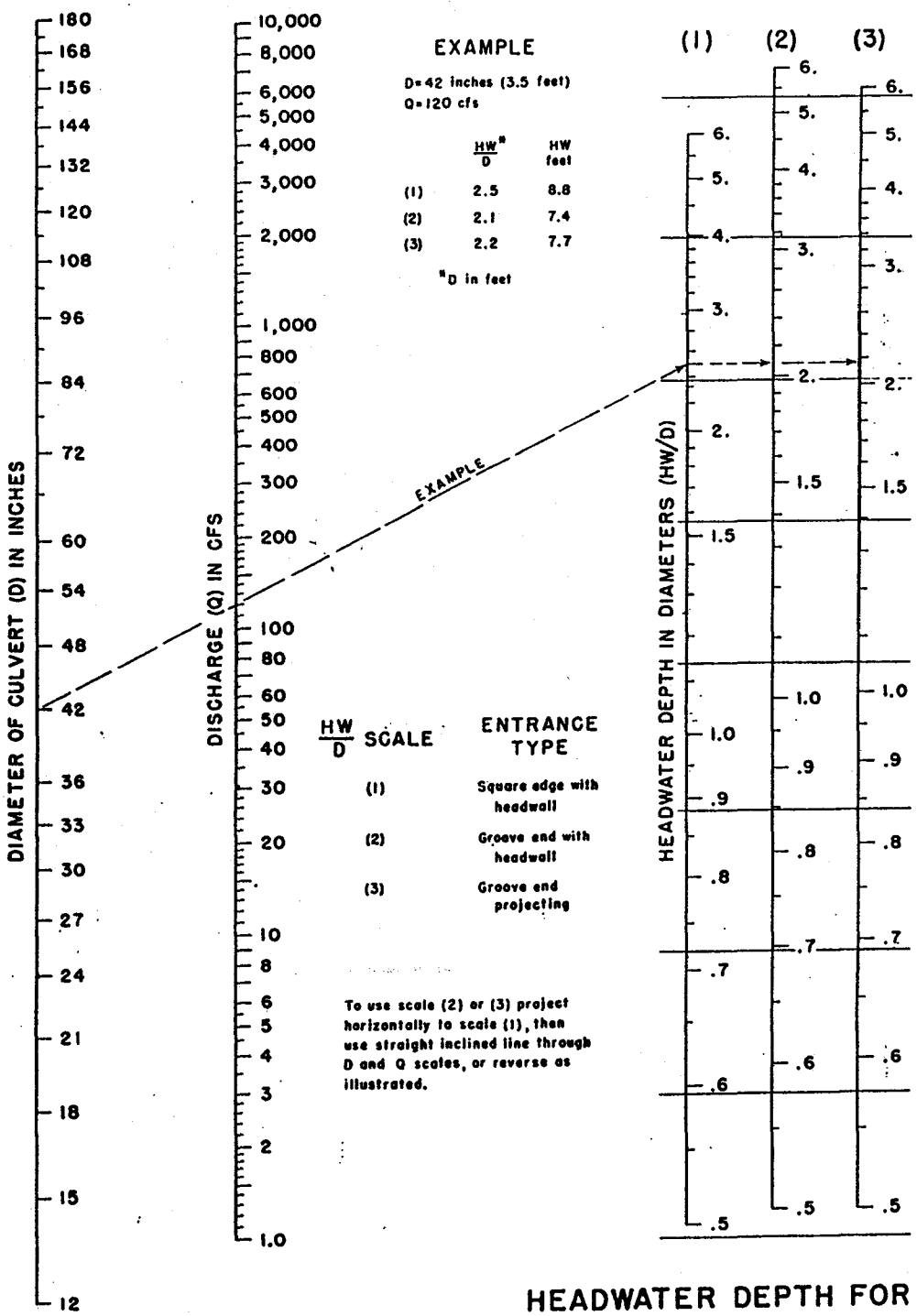


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

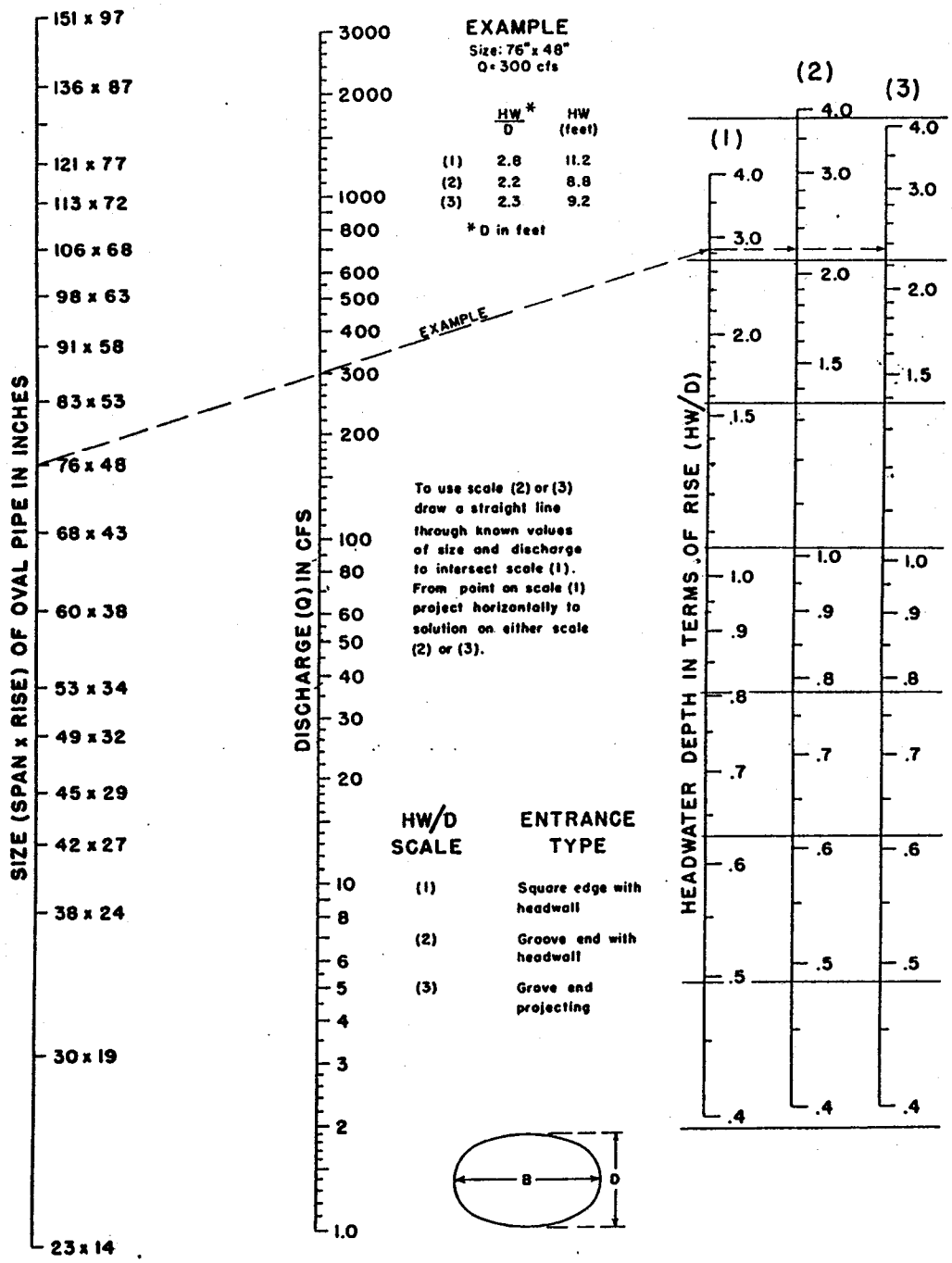
CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

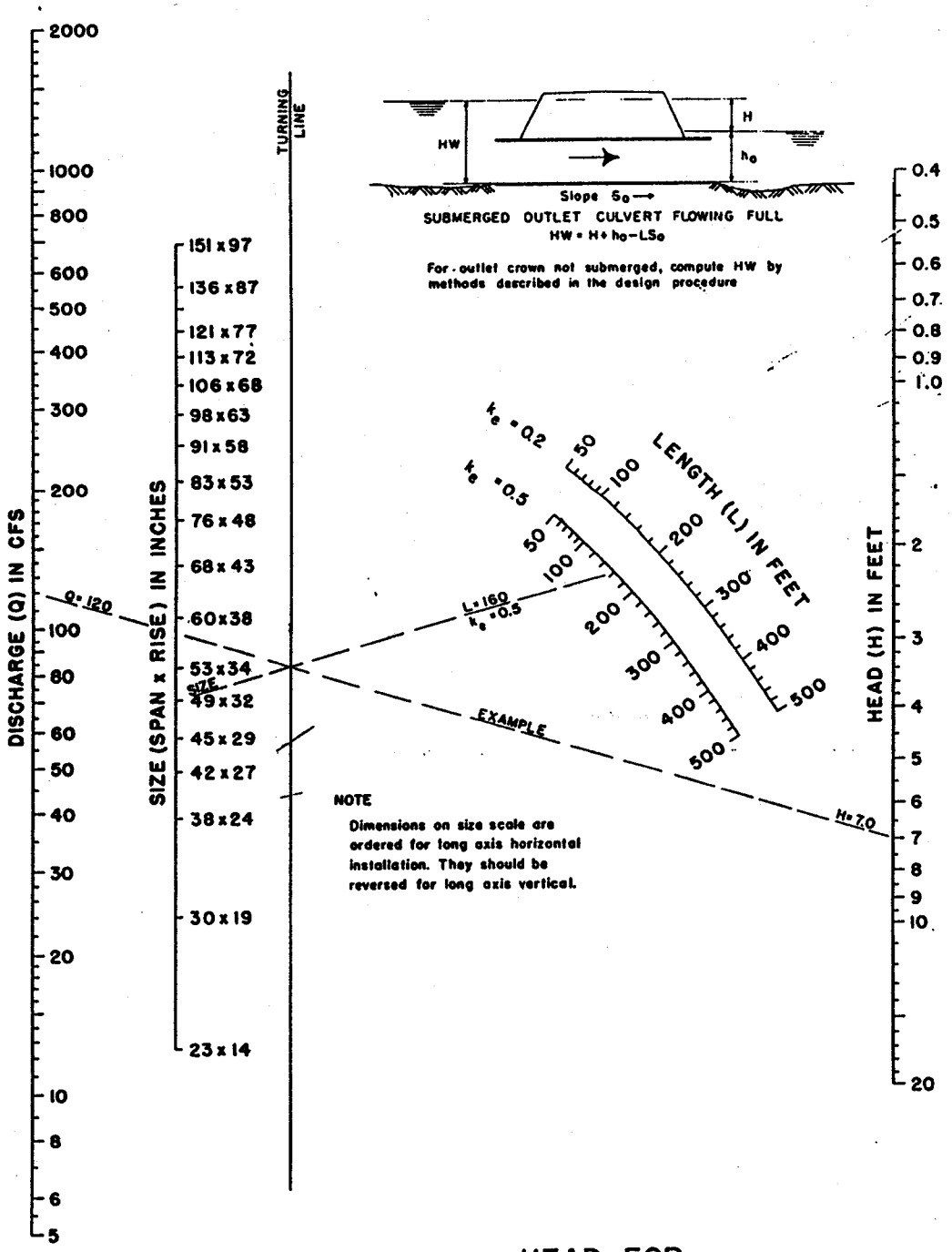
BUREAU OF PUBLIC ROADS JAN. 1963

CHART 3



HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

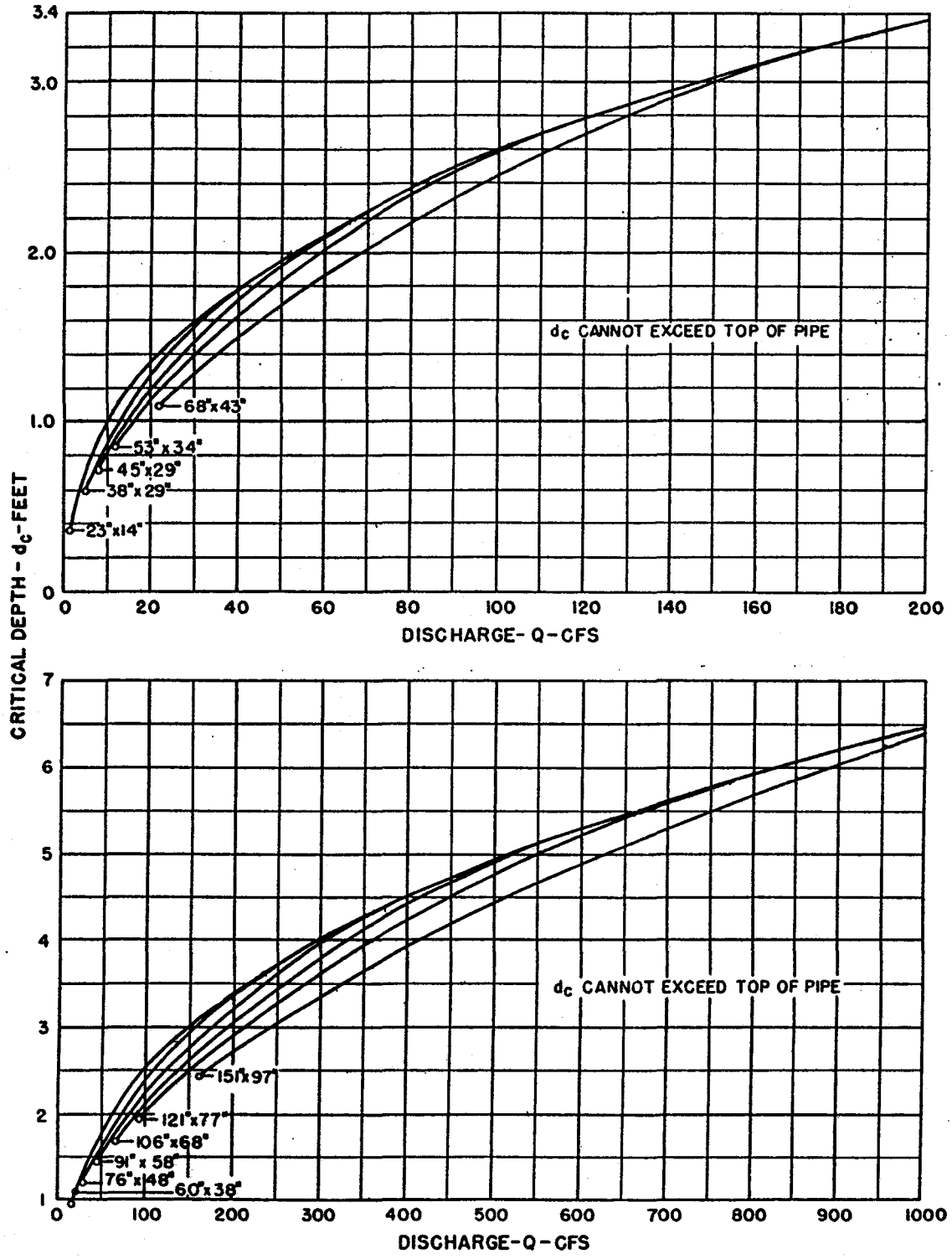


HEAD FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL OR VERTICAL FLOWING FULL

n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 17

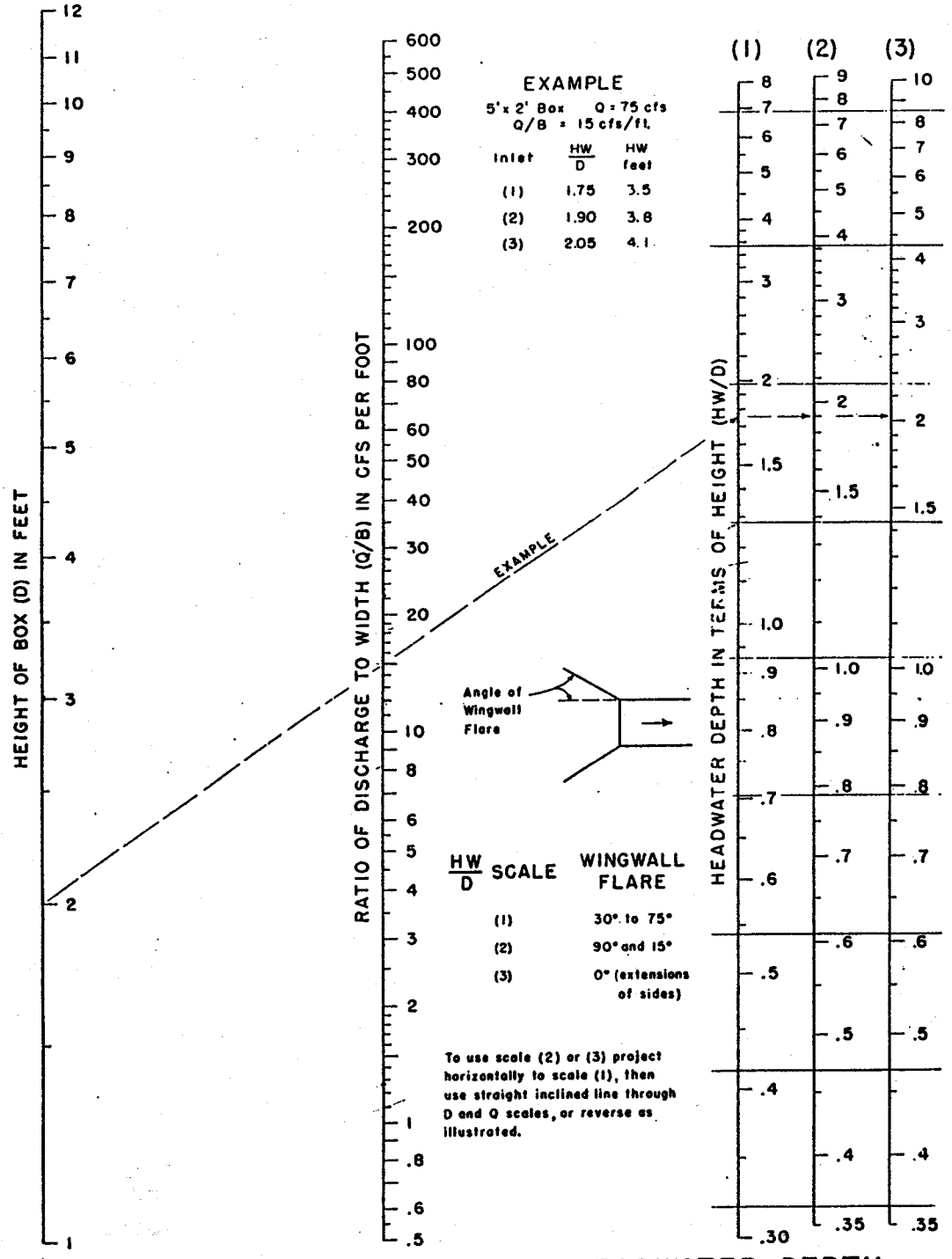


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
OVAL CONCRETE PIPE
LONG AXIS HORIZONTAL

CHART I



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

26

Golf Cart Crossing Design

JOB NAME: ARIZONA TRADITIONS

JOB NO. 931007

TRIANGULAR WEIR FLOW SUMMARY TABLE

The following table summarizes the weir flow over the golf cart path crossings. The following equation was used to determine the discharge values:

Q = (8/15) K (2g)^(1/2) tan (THETA/2) H Where:

Q = discharge (cfs)
K = flow coefficient = 0.57
g = 32.2 ft/s^2
THETA = angle of weir opening
H = head (ft)

Due to the small difference in water surface elevations, the majority of the weirs operate under submerged flow. Reduction factors are applied to the theoretical discharges based on Section 7 in the U.S. Department of Agriculture Soil Conservation Service Engineering Handbook - Section 5: Hydraulics.

Location	Total Q (cfs)	Pipes	Qpipe (cfs)	Pipe Invert (ft)	Qweir (cfs)	% Reduction	Adjusted (cfs)	Weir Elevation (ft)	THETA (deg)	THETA (rad)	H (ft)	Water Surface El. (ft)	Width of Weir (ft)	Head Water Depth (ft)	h/H
PT 3A	216	(2) 18"	16	1313.4	200	15	235	1316.5	168	2.93	2.53	1319.03	50.51	5.63	0.44
PT 11A	150	(2) 12"	6	1311.6	144	20	180	1314	178	3.11	1.11	1315.11	22.13	3.51	0.55
PT 11B	169	(2) 18"	12	1309.0	157	40	262	1312	168	2.93	2.64	1314.64	52.70	5.64	0.69
PT 11C	188	(2) 18"	12	1308.1	176	45	320	1311	168	2.93	2.86	1313.86	57.12	5.76	0.71
PT 11D	207	(2) 18"	12	1307.1	195	50	390	1310	168	2.93	3.09	1313.09	61.82	5.99	0.73
CP12	226	(2) 18"	14	1305.8	212	50	424	1309	168	2.93	3.20	1312.20	63.92	6.40	0.72
CP14	87	(2) 18"	6	1307.1	81	5	85	1310	168	2.93	1.68	1311.68	33.65	4.58	0.25
CP20	108	(2) 18"	18	1316.0	90	0	90	1319	168	2.93	1.72	1320.72	34.39	4.72	0.06
PT20A	81	(2) 18"	13	1315.1	68	10	76	1318.4	168	2.93	1.60	1320.00	32.06	4.90	0.44

7. Weir Flow

7.5 Submerged Flow. When the water surface elevation just downstream from a weir is higher than the crest elevation, it is described as submerged. It is not feasible to include here selected formulas from the considerable number that have been developed for submerged discharge. The following general results have been shown by investigations of submerged weirs. Let H represent the upstream head on a weir, and h, the downstream head.

The discharges of sharp-crested weirs are subject to greater reductions at lower degrees of submergence than is the case with other types. When the ratio h/H reaches 0.3 to 0.4, the discharge may be reduced by 5 to 10 percent; and for h/H ratios of 0.6 to 0.7, reductions of 20 to 40 percent may be expected.

Broad-crested and ogee weir discharges do not show appreciable reductions until the ratio h/H reaches 2/3. For higher degrees of submergence the discharge is rapidly reduced; and for h/H values of 0.75 to 0.85, reductions of 10 to 30 percent should be recognized.

More complete information on the operation of drop spillways under submerged conditions is given in the drop spillway section.

Extracted from U.S. Department of Agriculture Soil Conservation Service Engineering Handbook - Section 5: Hydraulics.

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1316.5

$\frac{h}{H} = \frac{1.1}{2.5} = 0.44$

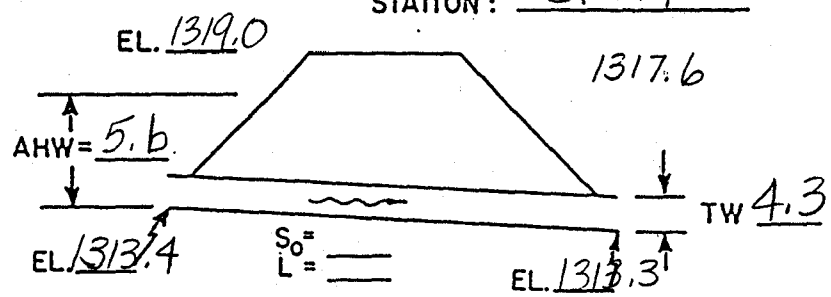
Q_1 = 216 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP3A



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18" Ø	8	18"	1.2	1.8	0.5	1.4	1.5	1.5	4.3	4.3	0.1	5.6	5.6			
C.M. Pipe																

SUMMARY & RECOMMENDATIONS:

2 18" Ø PIPES = 16 cfs

216 cfs − 16 cfs = 200 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1314.0

$\frac{h}{H} = \frac{0.6}{1.1} = .55$

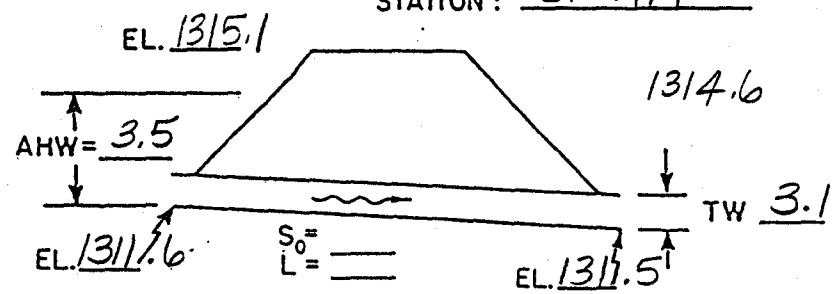
Q_1 = 150 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 11A



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 12"Ø PIPES	3	12"	1.2	1.2	0.5	0.5	1.5	1.5	3.1	3.1	0.1	3.4	3.4			
CM PIPE																

SUMMARY & RECOMMENDATIONS: 2 12"Ø PIPES = 6 cfs weir 1314

150 cfs − 6 cfs = 144 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1312.0

$\frac{h}{H} = \frac{1.8}{2.6} = 0.69$

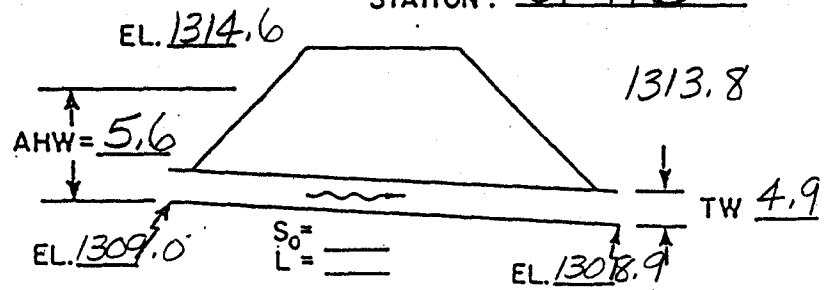
Q_1 = 169 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 11B



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18" Ø	6	18"	1.35	2.0	0.5	0.8	1.5	1.5	4.9	4.9	0.1	5.6	5.6			

SUMMARY & RECOMMENDATIONS:

2 18" Ø PIPES = 12 cfs

169 cfs − 12 cfs = 157 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1311.0

$\frac{h}{H} = \frac{2.0}{2.8} = 0.71$

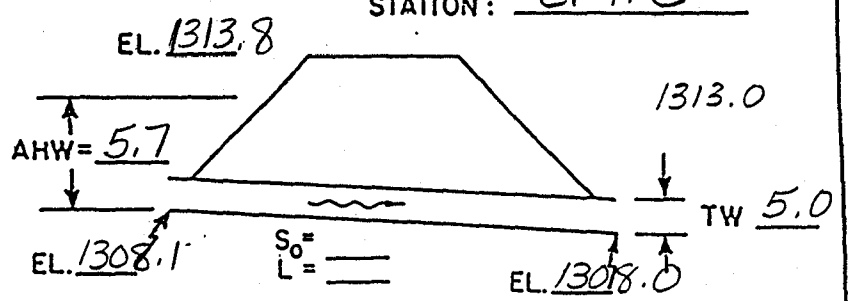
Q_1 = 188 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP11C



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18" Ø	6	18"	1.0	1.5	0.5	0.8	1.5	1.5	5.0	5.0	0.1	5.7	5.7			
CM. PIPE																

SUMMARY & RECOMMENDATIONS:

2 18" Ø PIPES = 12 cfs

188 cfs − 12 cfs = 176 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1310.0

$\frac{h}{H} = \frac{2.2}{3.0} = 0.73$

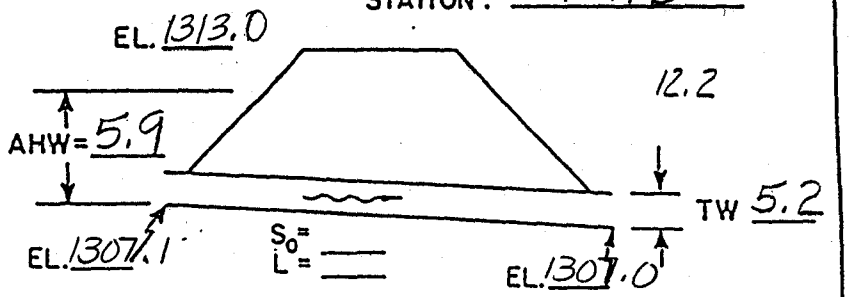
Q_1 = 207 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 11D



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18"Ø	6	18"	1.0	1.5	0.5	0.8	1.5	1.5	5.2	5.2	0.1	5.9	5.9			
C.M. PIPE																

SUMMARY & RECOMMENDATIONS:

2 18" Ø PIPES = 12 cfs

207 cfs - 12 cfs = 195 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1309.0

$\frac{h}{H} = \frac{2.3}{3.2} = 0.72$

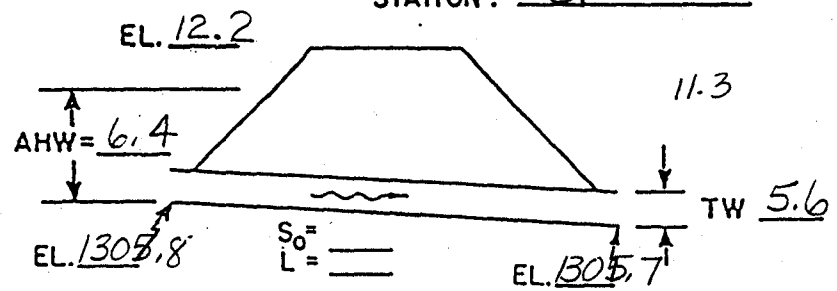
Q_1 = 226 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 12



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18"Ø	7	18"	1.2	1.8	0.5	0.9	1.5	1.5	5.6	5.6	0.1	6.4	6.4			
C.M. Pipe																

SUMMARY & RECOMMENDATIONS:

2 18"Ø PIPES = 14 cfs
226 cfs − 14 cfs = 212 cfs over weir

weir 1309

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1310.0

$\frac{h}{H} = \frac{0.4}{1.7} = 0.24$

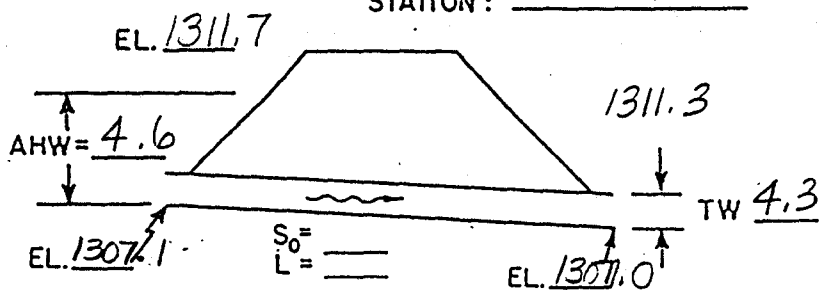
Q_1 = 87 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 14



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2 18" Ø	3	18"	1.2	1.8	0.5	0.4	1.3	1.4	4.3	4.3	0.1	4.6	4.6			
C.M. Pipes																

SUMMARY & RECOMMENDATIONS:

2 18" Ø PIPES = 6 cfs

87 cfs − 6 cfs = 81 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1319.0

$\frac{h}{H} = \frac{.1}{1.7} - 0.06$

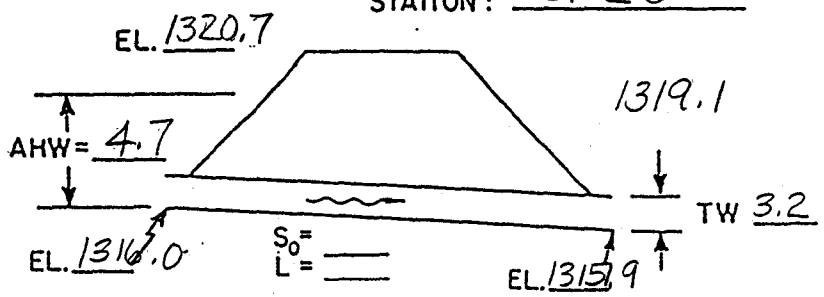
Q_1 = 108 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP20



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL HW=H + h_o − LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
2 18"Ø	9.	18"	1.3	2.0	0.5	1.6	1.3	1.4	3.2	3.2	0.1	4.7	4.7			
C.M. Pipe																

SUMMARY & RECOMMENDATIONS: 2 18"Ø PIPES = 18 cfs.

108 cfs − 18 cfs = 90 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

WEIR ELEVATION = 1318.4

$\frac{h}{H} = \frac{0.7}{1.6} = 0.44$

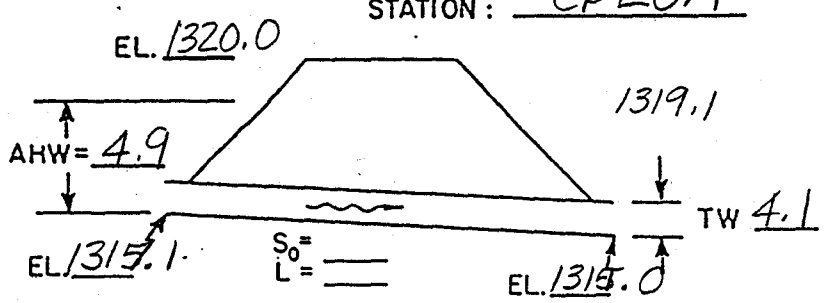
Q_1 = 81 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP20A



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2 18" Ø	6.5	18"	1.0	1.5	0.5	0.9	1.2	1.35	4.1	4.1	0.1	4.9	4.9			
C.M. Pipe																

SUMMARY & RECOMMENDATIONS: 2 18" Ø PIPES = 13 cfs
81 cfs − 13 cfs = 68 cfs over weir

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

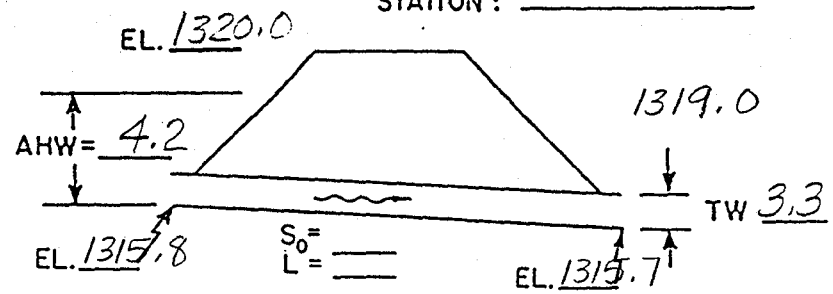
Q_1 = 176 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 3



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
10X3 BOX	176		1.1	3.3	0.5	0.85	2.2	2.6	3.3	3.3	0.1	4.05	4.05			

SUMMARY & RECOMMENDATIONS:

USE 10' X 3' BOX

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

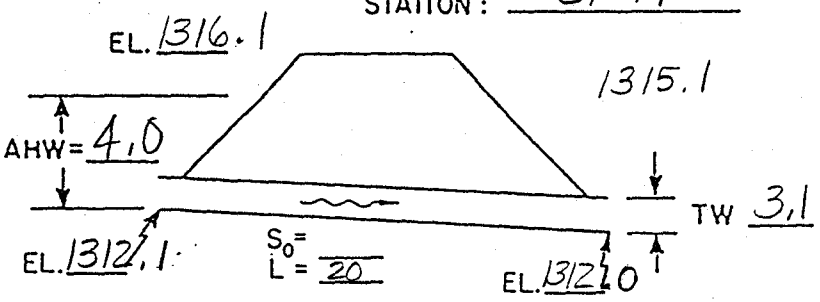
Q_1 = 150 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 11



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
4 36"ϕ	37.5	36	1.05	3.15	0.5	0.75	2.0	2.5	3.1	3.1	0.1	3.75	3.75			
8 X 3 BOX	150	3'	1.2	3.6	0.5	1.0	2.2	2.6	3.1	3.1	0.1	4.0	4.0			

SUMMARY & RECOMMENDATIONS:

USE 8' X 3' BOX

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHAPIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

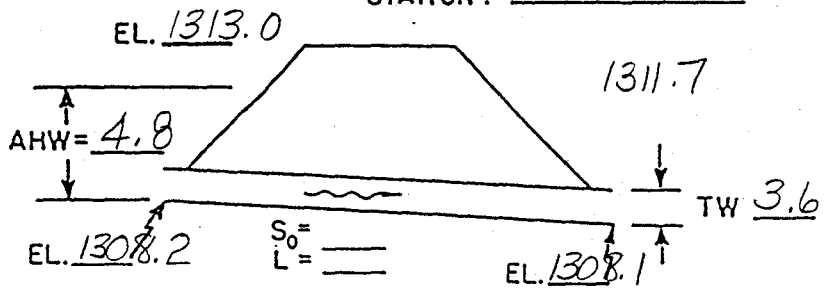
Q_1 = 54 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 13



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL HW=H + h_o − LS_o								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
~~2 30" Ø~~	~~27.5~~	~~30"~~	~~1.2~~	~~3.0~~	~~0.5~~	~~0.9~~	~~1.7~~	~~2.1~~	~~4.1~~	~~4.1~~	~~0.1~~	~~4.7~~	~~4.7~~			
6X3 BOX	54	3	0.7	2.1	0.5	0.3	1.4	2.2	3.6	3.6	0.1	3.8	3.8			

SUMMARY & RECOMMENDATIONS:

USE 6'X3' BOX

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. [illegible]

DATE: 12/05

HYDROLOGIC AND CHANNEL INFORMATION

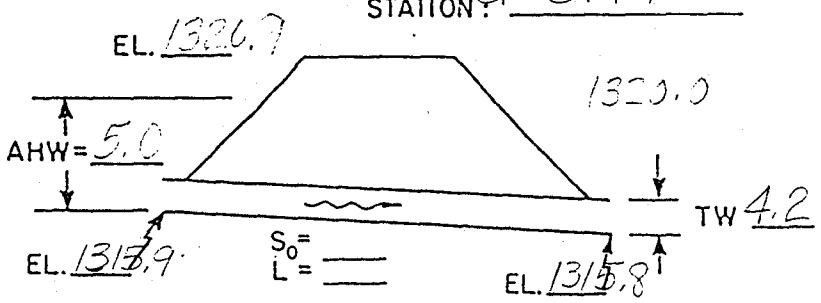
Q_1 = 58 c.f.s. — TW_1 = _____

Q_2 = _____ — TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP 3A4



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
2 30" Ø	29	30"	1.25	3.1	0.5	0.9	1.8	2.15	4.2	4.2	0.1	5.2	5.0			
6X3 BOX	58	3'	0.75	2.3	0.5	0.3	1.5	2.3	4.2	4.2	0.1	4.4	4.4			

SUMMARY & RECOMMENDATIONS:

USE 6' X 3' BOX

Figure 7

PROJECT: ARIZONA TRADITIONS

DESIGNER: J. CHADIN

DATE: 12/95

HYDROLOGIC AND CHANNEL INFORMATION

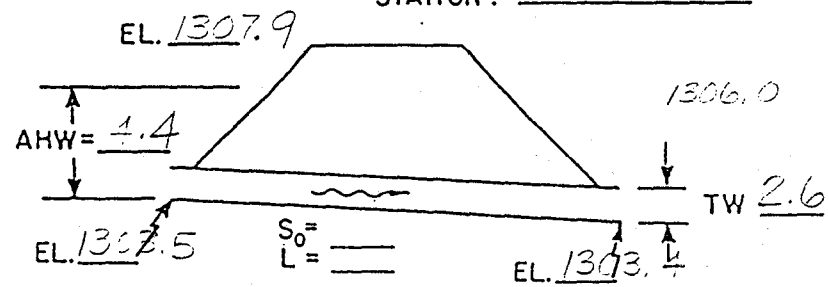
Q_1 = 221 cfs TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: CP27



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

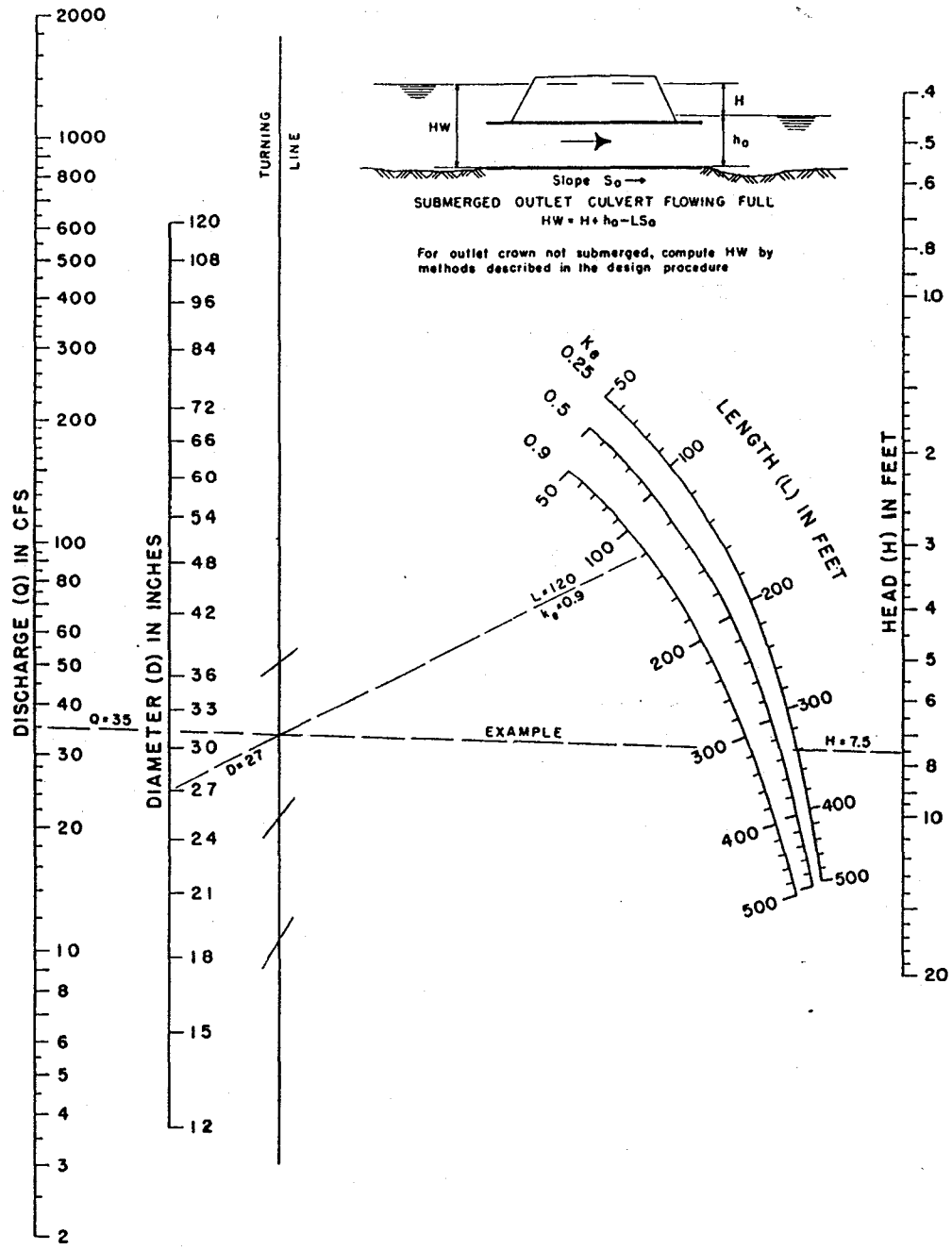
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
10' X 3' BX	221	3'	1.4	4.2	0.5	1.3	1.4	2.7	2.6	2.7	0.1	3.9	4.2			

SUMMARY & RECOMMENDATIONS:

USE 10' X 3' BOX

Figure 7

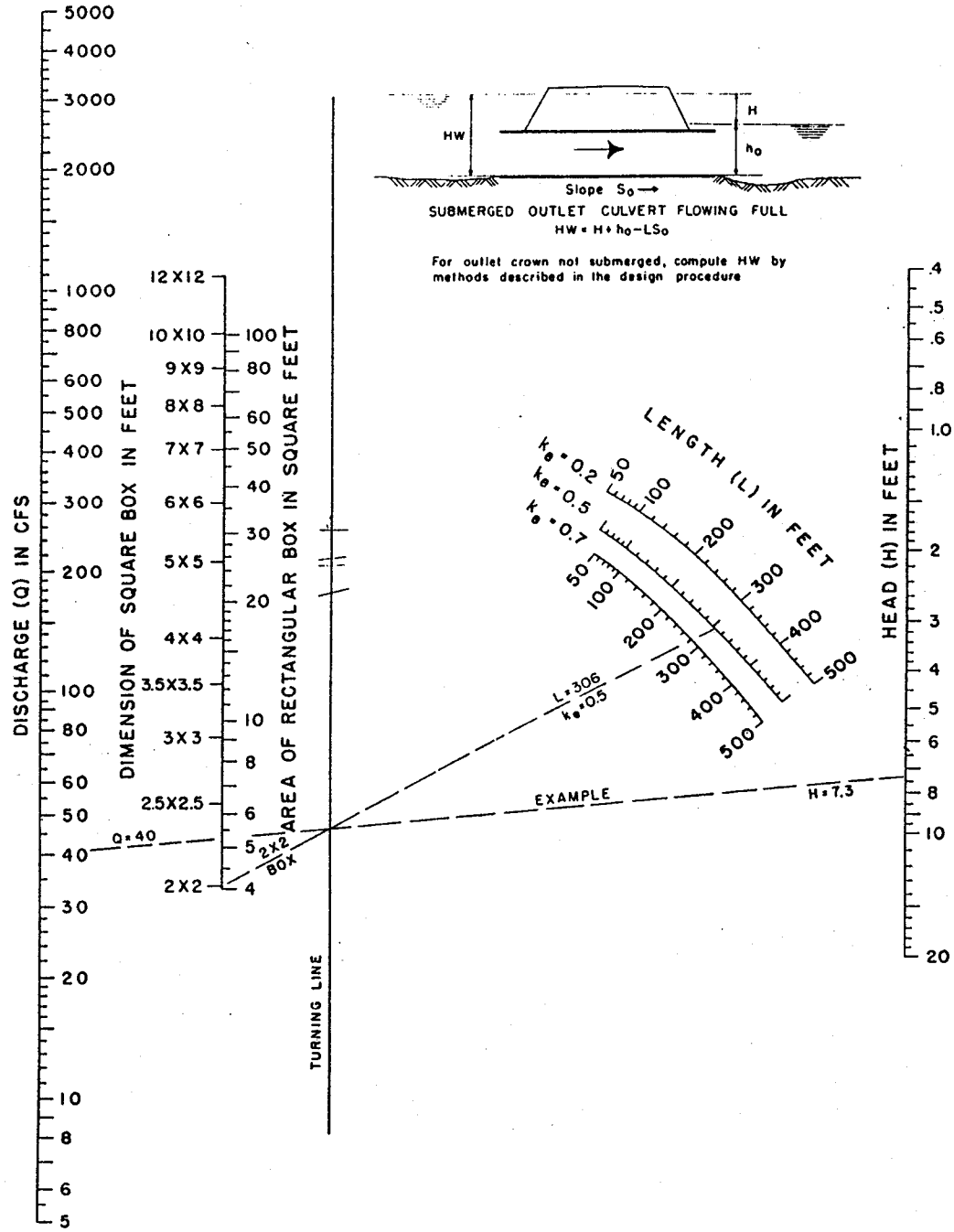
CHART 11



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

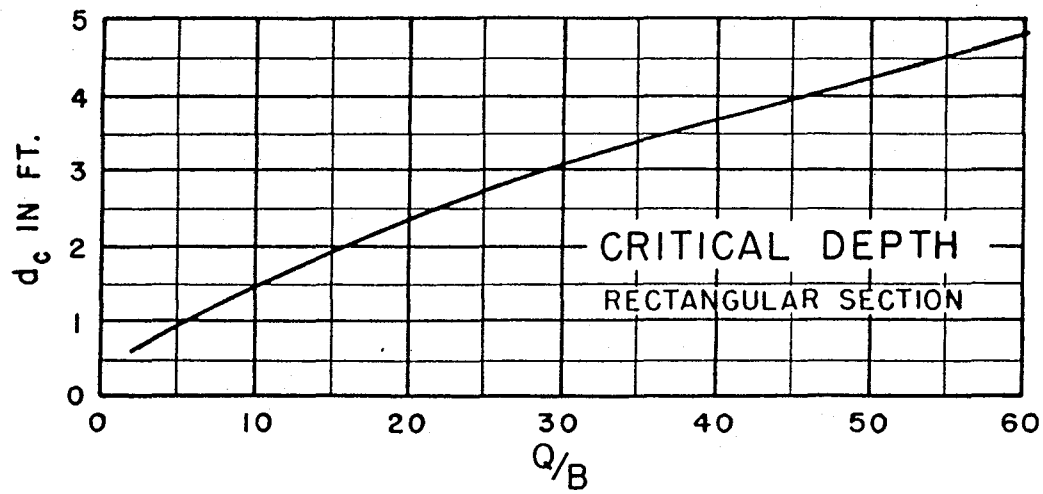
CHART 8

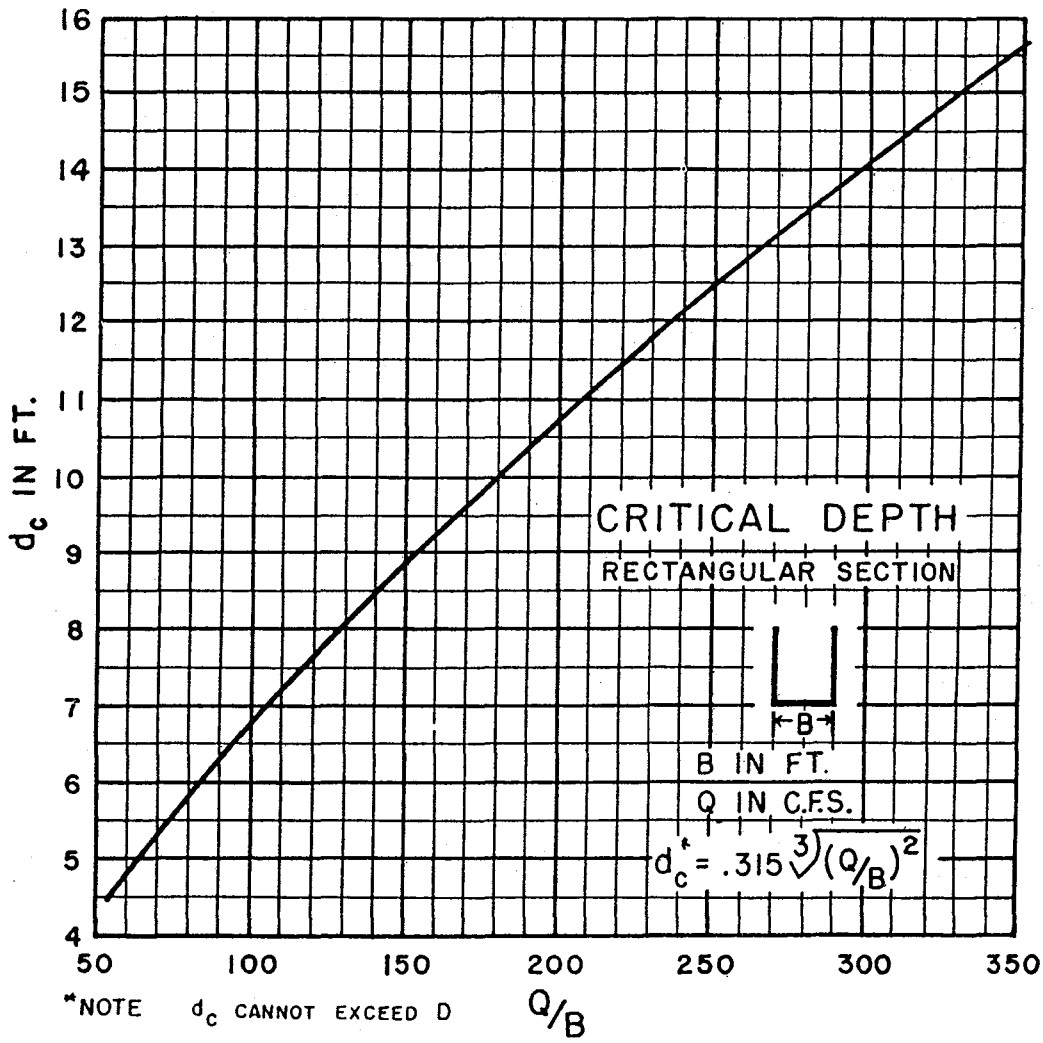


HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 15





*NOTE d_c CANNOT EXCEED D

BUREAU OF PUBLIC ROADS JAN. 1963

Channel Design

CP2 to CP3
(Q CAPACITY)

2 - TRAPEZOID

3 - TRIANGLE

4 - STREET

0 - EXIT

INPUT SECTION NUMBER? 3

SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 0

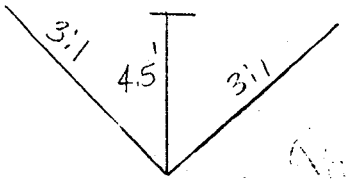
ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .002

DEPTH .....d= ? 4.5

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3



Capacity = 267cf

Grass lined

SELECTED SECTION IS A TRIANGLE 01-12-1996

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	267.717 cfs	0
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.002 ft/ft	.002
DEPTH.....D=	4.5 ft	4.5
VELOCITY.....V=	4.406864 fps	
AREA.....A=	60.75 sf	
WETTED PERIM..WP=	28.4605 ft	
HYDR. RADIUS...R=	2.134537 ft	
TOP WIDTH.....T=	27 ft	
FROUDE NUMBER...=	0	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

CP2 to CP3

(Q DESIGN)

WETTED PERIM..WP= 28.4605 ft

HYDR. RADIUS...R= 2.134537 ft

TOP WIDTH.....T= 27 ft

FROUDE NUMBER...= 0

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 118

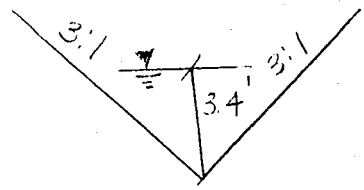
ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .002

DEPTH .....d= ? 4.5

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3



$Q_{design} = 118$ cf

d = 3.4 ft

Grass lined

SELECTED SECTION IS A TRIANGLE 01-12-1996

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	124.704 cfs	118
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.002 ft/ft	.002
DEPTH.....D=	3.378508 ft	4.5
VELOCITY.....V=	3.640665 fps	
AREA.....A=	34.25308 sf	
WETTED PERIM..WP=	21.37072 ft	
HYDR. RADIUS...R=	1.602804 ft	
TOP WIDTH.....T=	20.27405 ft	
FROUDE NUMBER...=	0	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

2A5 to CP10
(Q CAPACITY)

2 - TRAPEZOID

3 - TRIANGLE

1 - STREET

0 - EXIT

INPUT SECTION NUMBER? 3

SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 0

ROUGHNESS COEFF..n= ? .025

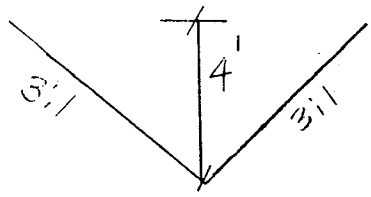
SLOPE.....s= ? .0035

DEPTH .....d= ? 4

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3

Qcapacity = 257 cfs



Grass lined

SELECTED SECTION IS A TRIANGLE 12-12-1995

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	258.6951 cfs	0
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.0035 ft/ft	.0035
DEPTH.....D=	4 ft	4
VELOCITY.....V=	5.389481 fps	
AREA.....A=	48 sf	
WETTED PERIM..WP=	25.29822 ft	
HYDR. RADIUS...R=	1.897367 ft	
TOP WIDTH.....T=	24 ft	
FROUDE NUMBER...=	0	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

CP10
(Q_{DESIGN})

WETTED PERIM..WP= 17.6108 ft

HYDR. RADIUS...R= 1.32081 ft

TOP WIDTH.....T= 16.70707 ft

FROUDE NUMBER...= 0

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 104

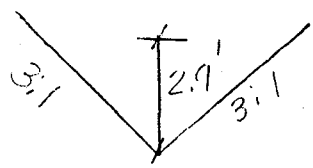
ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .0035

DEPTH .....d= ? 4

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3



Grass lined

Q_{design} = 104 cfs
d = 2.9 ft.

SELECTED SECTION IS A TRIANGLE 12-12-1995

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	106.7377 cfs	104
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.0035 ft/ft	.0035
DEPTH.....D=	2.869512 ft	4
VELOCITY.....V=	4.319459 fps	
AREA.....A=	24.7109 sf	
WETTED PERIM..WP=	18.15155 ft	
HYDR. RADIUS...R=	1.361366 ft	
TOP WIDTH.....T=	17.22007 ft	
FROUDE NUMBER...=	0	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

3A1 to CP19
(Q CAPACITY)

2 - TRAPEZOID

3 - TRIANGLE

1 - STREET

0 - EXIT

INPUT SECTION NUMBER? 3

SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 0

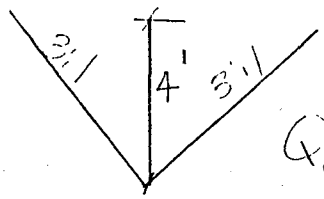
ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .002

DEPTH .....d= ? 4

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3



Q capacity = 195 cf

Grass lined

SELECTED SECTION IS A TRIANGLE 12-12-1995

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	195.5551 cfs	0
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.002 ft/ft	.002
DEPTH.....D=	4 ft	4
VELOCITY.....V=	4.074065 fps	
AREA.....A=	48 sf	
WETTED PERIM..WP=	25.29822 ft	
HYDR. RADIUS...R=	1.897367 ft	
TOP WIDTH.....T=	24 ft	
FROUDE NUMBER...=	0	

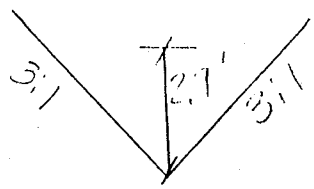
TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

CP 19

(Q_{DESIGN})

```
WETTED PERIM..WP=  25.29822 ft
HYDR. RADIUS...R=  1.897367 ft
TOP WIDTH......T=  24 ft
FROUDE NUMBER...=  0
TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?
SELECTED SECTION IS A TRIANGLE -- INPUT THE FOLLOWING

FLOWRATE.........Q= (Q=0 MUST INPUT d)? 73
ROUGHNESS COEFF..n= ? .025
SLOPE............s= ? .002
DEPTH ............d= ? 4
BTM LEFTSIDE SLOPE RUN ..Z1= ? 3
BTM RIGHTSIDE SLOPE RUN .Z2= ? 3
```



Q_{design} = 73 cfs

d = 2.9 ft.

```
SELECTED SECTION IS A TRIANGLE                    12-12-1995

_____________THE CALCULATED VALUES_________VALUES ENTERED_________
FLOWRATE.......Q=   74.43436 cfs              73
ROUGHNESS COEF.n=  .025                       .025
SLOPE..........S=  .002 ft/ft                 .002
DEPTH..........D=   2.784012 ft                   4
VELOCITY.......V=   3.20003 fps
AREA...........A=   23.26052 sf
WETTED PERIM..WP=  17.6108 ft
HYDR. RADIUS...R=  1.32081 ft
TOP WIDTH......T=  16.70707 ft
FROUDE NUMBER...=  0
TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?
```

4DT 10 [illegible]

(Q design)

SELECTED SECTION IS A TRAPEZOID -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 59

ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .0022

BOTTOM DEPTH ....db= ? 3.5

TOP DEPTH.....dt= ? 0

BOTTOM WIDTH.....bb= ? 10

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

BTM RIGHTSIDE SLOPE RUN .Z2= ? 3

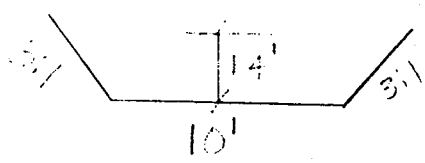
TOP LEFTSIDE SLOPE RUN . Z3= ? 0

TOP RIGHTSIDE SLOPE RUN .Z4= ? 0

DEPTH..(D=0 FOR ITERATION)..D= ?

Q design = 59 cfs

d = 1.4 ft



Grass lined

SELECTED SECTION IS A TRAPEZOID 01-12-1996

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	58.94213 cfs	59
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.0022 ft/ft	.0022
DEPTH.....D=	1.42 ft	0
VELOCITY.....V=	2.910838 fps	
AREA.....A=	20.2492 sf	
WETTED PERIM..WP=	18.98087 ft	
HYDR. RADIUS...R=	1.066822 ft	
TOP WIDTH.....T=	18.52 ft	
FROUDE NUMBER...=	.4304729	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

4B4 to 4B5
(Q capacity)

SELECTED SECTION IS A TRAPEZOID -- INPUT THE FOLLOWING

FLOWRATE.....Q= (Q=0 MUST INPUT d)? 0

ROUGHNESS COEFF..n= ? .025

SLOPE.....s= ? .0022

BOTTOM DEPTH ....db= ? 1.5

TOP DEPTH.....dt= ? 0

BOTTOM WIDTH.....bb= ? 10

BTM LEFTSIDE SLOPE RUN ..Z1= ? 3

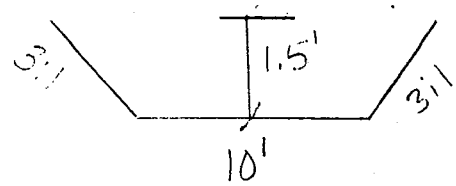
BTM RIGHTSIDE SLOPE RUN .Z2= ? 3

TOP LEFTSIDE SLOPE RUN . Z3= ? 0

TOP RIGHTSIDE SLOPE RUN .Z4= ? 0

DEPTH..(D=0 FOR ITERATION)..D= ? 1.5

Q capacity = 65 cfs



Smooth lined

SELECTED SECTION IS A TRAPEZOID 01-12-1996

	THE CALCULATED VALUES	VALUES ENTERED
FLOWRATE.....Q=	65.24712 cfs	0
ROUGHNESS COEF.n=	.025	.025
SLOPE.....S=	.0022 ft/ft	.0022
DEPTH.....D=	1.5 ft	1.5
VELOCITY.....V=	2.999868 fps	
AREA.....A=	21.75 sf	
WETTED PERIM..WP=	19.48683 ft	
HYDR. RADIUS...R=	1.116138 ft	
TOP WIDTH.....T=	19 ft	
FROUDE NUMBER...=	.4304729	

TO CONTINUE ENTER 0 FOR NEW SECTION ENTER 1 OR EXIT ENTER 2?

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
                                         *
*  Version   4.6.0;  February 1991       *
*                                        *
   RUN DATE    08DEC95    TIME   08:50:49 *
*****************************************
```

```
****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

Offsite Drainage Channel - North Property Line

THIS RUN EXECUTED 08DEC95 08:50:49

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************
```

T1 ARIZONA TRADITIONS JOB NO 931007
2 OFFSITE DRAINAGE CHANNEL NORTH PROPERTY LINE
3 NORTH CHANL ANLYS 100YR

NORTH PROPERTY LINE IS SET AS THE CONTROL LINE WITH A STATION OF 100

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0	0	0	0	1320.95	0

T	1	394.0						
NC	0.030	0.030	0.030					
1	100	4	50	100				
GR	1323.0	50	1318.0	66	1318.0	88	1322.0	100
T	1	224.0						
X1	1565	4	50	100	1465	1465	1465	
GR	1325.0	50	1320.5	66	1320.5	88	1324.0	100
QT	1	104.0						
1	2925	4	60	100	1360	1360	1360	
GR	1327.0	60	1323.9	69	1323.9	91	1327.0	100
1	4125	4	70	100	1200	1200	1200	
GR	1330.5	70	1327.5	79	1327.5	91	1330.5	100

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

PROF 1

SECNO 100.000

100.000	2.95	1320.95	.00	1320.95	1321.24	.29	.00	.00	1323.00
394.0	.0	394.0	.0	.0	91.9	.0	.0	.0	1322.00
.00	.00	4.29	.00	.000	.030	.000	.000	1318.00	56.56
.002574	0.	0.	0.	0	0	0	.00	40.29	96.85

SECNO 1565.000

1565.000	2.93	1323.43	.00	.00	1323.52	.09	2.28	.00	1325.00
224.0	.0	224.0	.0	.0	94.6	.0	3.1	1.4	1324.00
.17	.00	2.37	.00	.000	.030	.000	.000	1320.50	55.57
.000807	1465.	1465.	1465.	3	0	0	.00	42.48	98.06

SECNO 2925.000

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .17

2925.000	1.12	1325.02	.00	.00	1325.23	.21	1.71	.00	1327.00
104.0	.0	104.0	.0	.0	28.2	.0	5.1	2.5	1327.00
.27	.00	3.69	.00	.000	.030	.000	.000	1323.90	65.76
.005727	1360.	1360.	1360.	3	0	0	.00	28.48	94.24

SECNO 4125.000

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.52

4125.000	1.90	1329.40	.00	.00	1329.55	.15	4.32	.00	1330.50
104.0	.0	104.0	.0	.0	33.7	.0	5.9	3.2	1330.50
.38	.00	3.09	.00	.000	.030	.000	.000	1327.50	73.29
.002473	1200.	1200.	1200.	4	0	0	.00	23.42	96.71

THIS RUN EXECUTED 08DEC95 08:50:50

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

NORTH CHANL ANLYS 100YR

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
100.000	.00	.00	.00	1318.00	394.00	1320.95	.00	1321.24	25.74	4.29	91.88	77.66
1565.000	1465.00	.00	.00	1320.50	224.00	1323.43	.00	1323.52	8.07	2.37	94.57	78.84
2925.000	1360.00	.00	.00	1323.90	104.00	1325.02	.00	1325.23	57.27	3.69	28.18	13.74
4125.000	1200.00	.00	.00	1327.50	104.00	1329.40	.00	1329.55	24.73	3.09	33.70	20.91

NORTH CHANL ANLYS 100YR

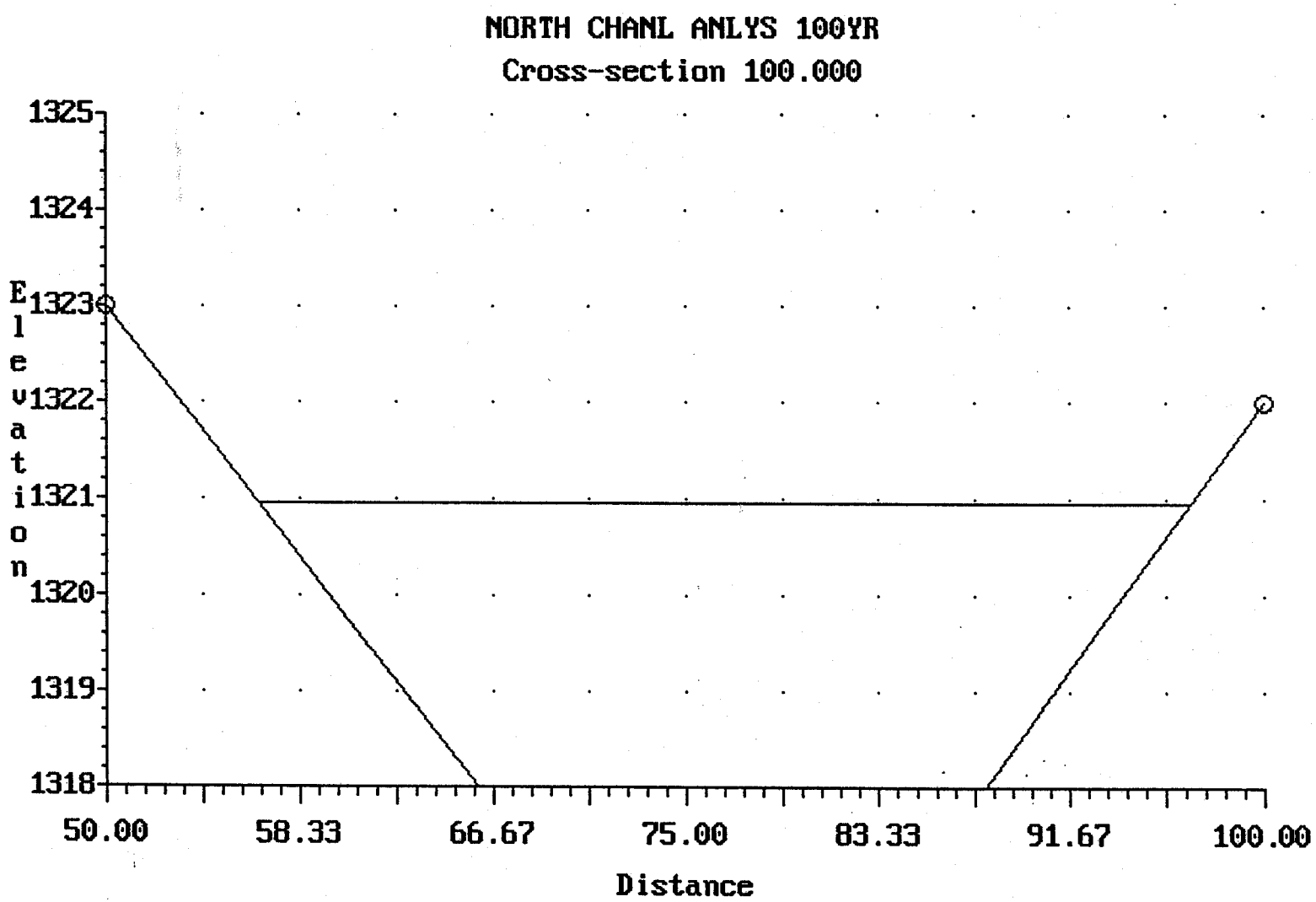
UMMARY PRINTOUT TABLE 150

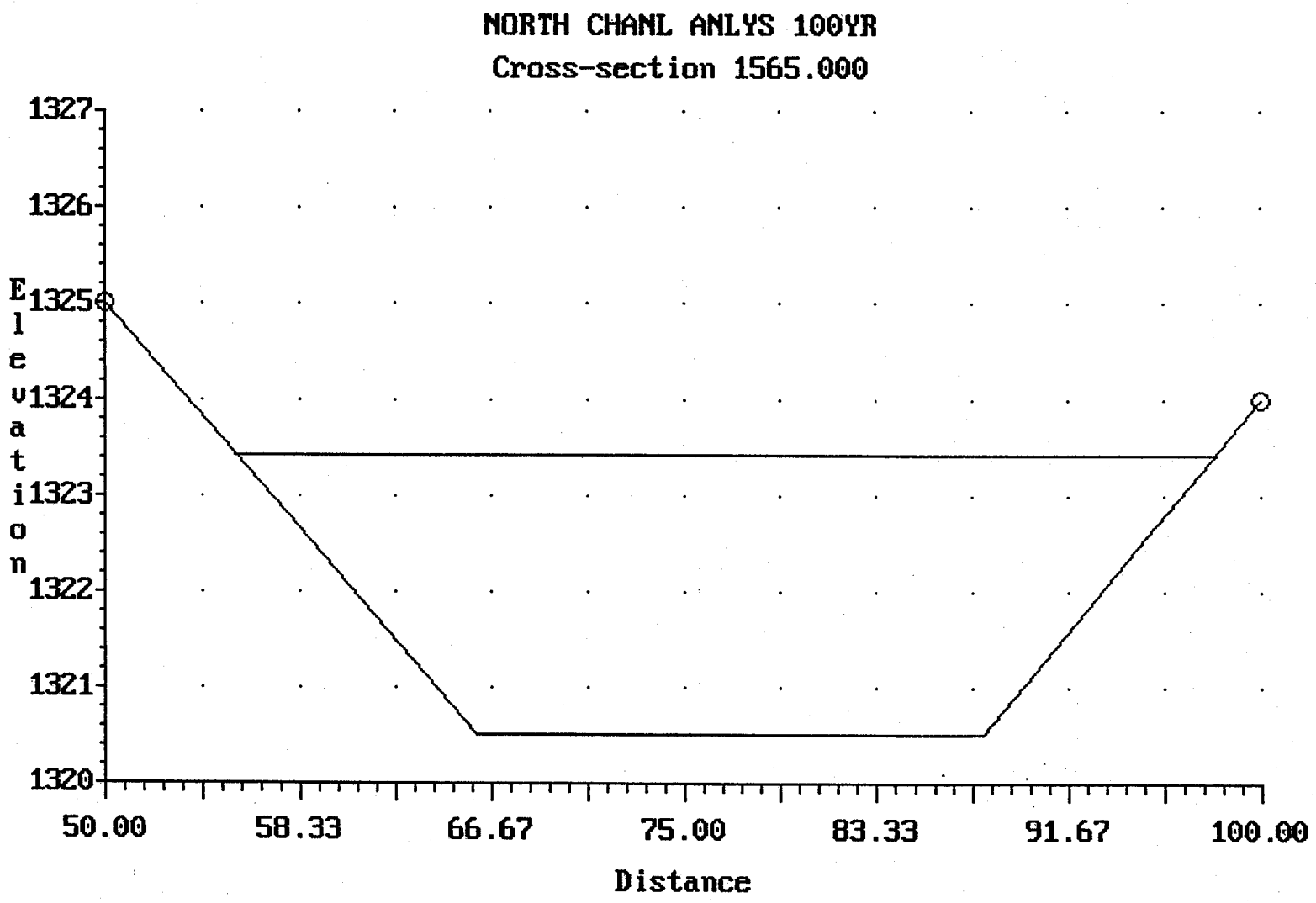
	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	100.000	394.00	1320.95	.00	.00	.00	40.29	.00
	1565.000	224.00	1323.43	.00	2.48	.00	42.48	1465.00
	2925.000	104.00	1325.02	.00	1.58	.00	28.48	1360.00
*	4125.000	104.00	1329.40	.00	4.39	.00	23.42	1200.00

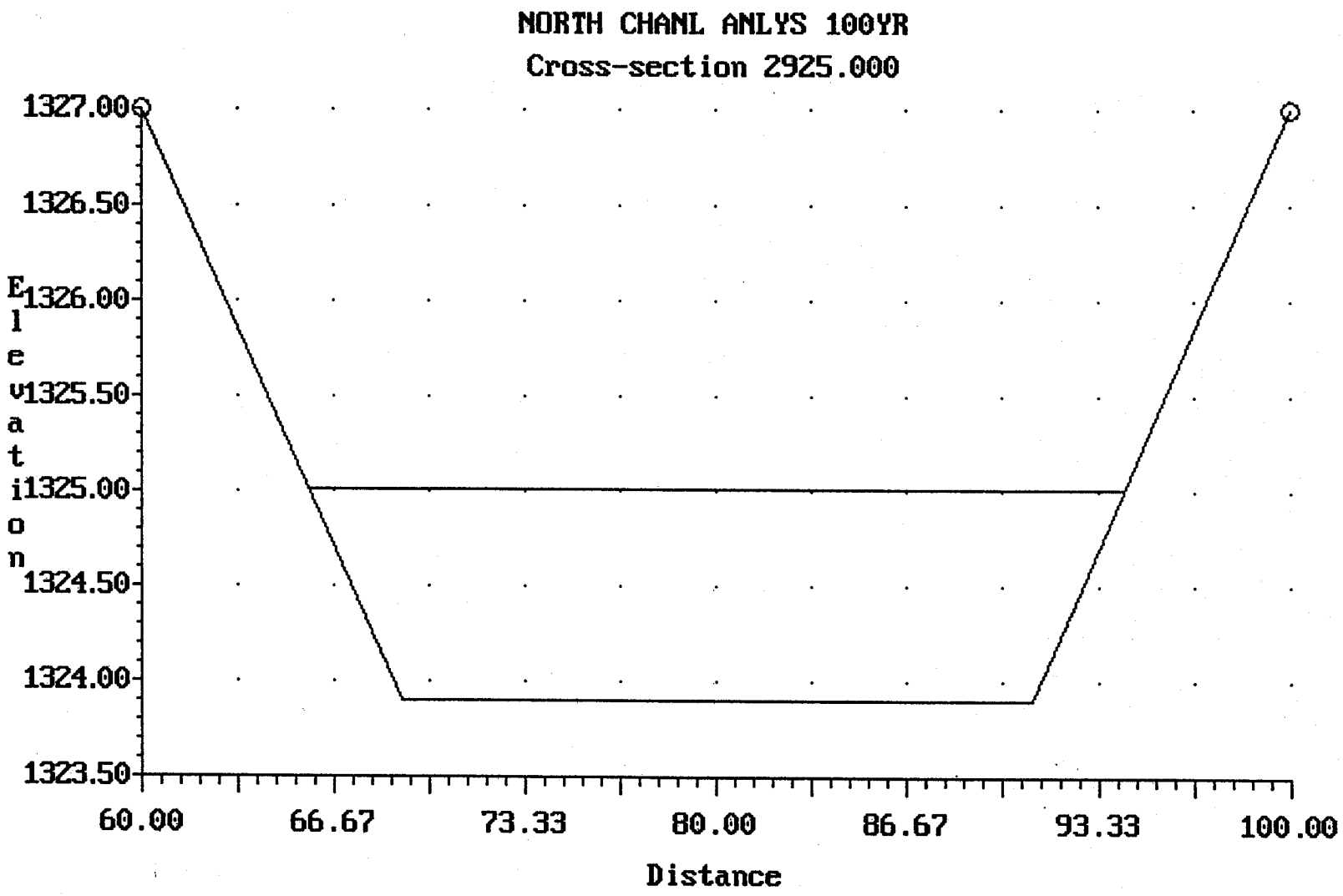
SUMMARY OF ERRORS AND SPECIAL NOTES

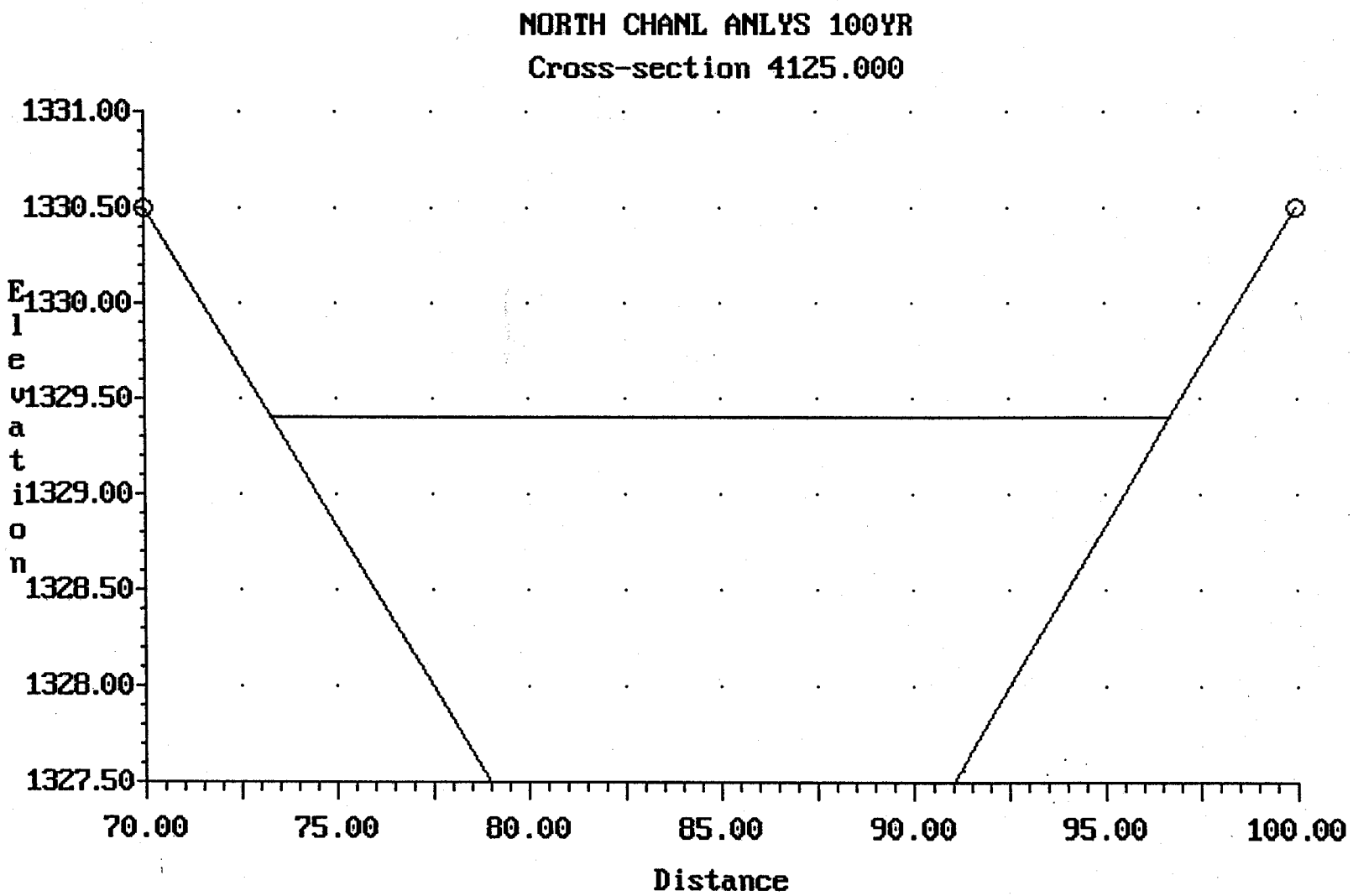
ARNING SECNO= 2925.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

ARNING SECNO= 4125.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE


NORTH CHANL ANLYS 100YR
Cross-section 100.000
1325
1324
1323
1322
1321
1320
1319
1318
Elevation
50.00
58.33
66.67
75.00
83.33
91.67
100.00
Distance


NORTH CHANL ANLYS 100YR
Cross-section 1565.000
1327
1326
1325
1324
1323
1322
1321
1320
Elevation
50.00
58.33
66.67
75.00
83.33
91.67
100.00
Distance


NORTH CHANL ANLYS 100YR
Cross-section 2925.000
1327.00
1326.50
1326.00
1325.50
1325.00
1324.50
1324.00
1323.50
Elevation
60.00
66.67
73.33
80.00
86.67
93.33
100.00
Distance


NORTH CHANL ANLYS 100YR
Cross-section 4125.000
1331.00
1330.50
1330.00
1329.50
1329.00
1328.50
1328.00
1327.50
Elevation
70.00
75.00
80.00
85.00
90.00
95.00
100.00
Distance

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
*                                        *
*  Version   4.6.0;  February 1991       *
*                                        *
*  RUN DATE    07DEC95    TIME   16:06:32 *
*****************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
*************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

Offsite Drainage Channel - East Property Line

THIS RUN EXECUTED 15JAN96 11:33:06

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************



 PLIT FLOW BEING PERFORMED


 F SPLIT FLOW ANALYSIS



 W LEFT BANK BETWEEN SECTION 1940 AND 2030
WS     2    1940    2030      -1     3.4
 C    25  1305.0      65  1305.0


TW LEFT BANK BETWEEN SECTION 2770 AND 2855
 S     2    2770    2855      -1     3.4
..C    10  1307.9      75  1307.9


 W LEFT BANK BETWEEN SECTION 3810 AND 3895
WS     2    3810    3895      -1     3.4
"C    10  1311.5      75  1311.5
```

1 ARIZONA TRADITIONS JOB NO 931007
2 OFFSITE DRAINAGE CHANNEL EAST PROPERTY LINE
T3 EAST CHANL ANLYSIS (100YR)

EAST PROPERTY LINE IS SET AS THE CONTROL LINE WITH A STATION OF 100

HEADWATER DEPTH AT BELL ROAD CULVERT IS INPUT AS STARTING WATER SURFACE

1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0	0	0	0	1304.4	0

QT	1	394.0						
"C	0.030	0.030	0.030					
K1	195	4	130	168				
GR	1305.0	130	1299.6	145	1299.6	153	1305.0	168
K1	2310	4	130	168	2115	2115	2115	
R	1307.8	130	1303.6	145	1303.6	153	1308.6	168
'1	2790	4	130	168	480	480	480	
R	1308.5	130	1305.0	143	1305.0	155	1308.5	168
1	3610	4	130	168	820	820	820	
R	1311.0	130	1307.5	143	1307.5	155	1311.0	168
1	5615	4	130	168	2005	2005	2005	
GR	1322.0	130	1318.0	143	1318.0	155	1322.0	168

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

PROF 1

SECNO 195.000

195.000	4.80	1304.40	.00	1304.40	1304.44	.04	.00	.00	1305.00
162.0	.0	162.0	.0	.0	102.4	.0	.0	.0	1305.00
.00	.00	1.58	.00	.000	.030	.000	.000	1299.60	131.67
.000256	0.	0.	0.	0	0	0	.00	34.67	166.33

SECNO 2310.000

301 HV CHANGED MORE THAN HVINS

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .30

2310.000	2.63	1306.23	.00	.00	1306.90	.67	2.46	.00	1307.80
287.7	.0	287.7	.0	.0	43.8	.0	3.5	1.5	1308.60
.09	.00	6.57	.00	.000	.030	.000	.000	1303.60	135.61
.008829	2115.	2115.	2115.	4	0	0	.00	25.28	160.89

SECNO 2790.000

.02 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.21

2790.000	3.35	1308.35	.00	.00	1308.54	.19	1.64	.00	1308.50
287.7	.0	287.7	.0	.0	81.8	.0	4.2	1.8	1308.50
.13	.00	3.52	.00	.000	.030	.000	.000	1305.00	130.57
.001800	480.	480.	480.	3	0	0	.00	36.86	167.43

SECNO 3610.000

3610.000	2.98	1310.48	.00	.00	1310.91	.44	2.37	.00	1311.00
364.1	.0	364.1	.0	.0	68.6	.0	5.7	2.5	1311.00
.17	.00	5.31	.00	.000	.030	.000	.000	1307.50	131.95
.004659	820.	820.	820.	2	0	0	.00	34.11	166.05

SECNO 5615.000

5615.000	2.97	1320.97	.00	.00	1321.55	.58	10.64	.00	1322.00
394.0	.0	394.0	.0	.0	64.5	.0	8.7	4.0	1322.00
.26	.00	6.11	.00	.000	.030	.000	.000	1318.00	133.33
.006028	2005.	2005.	2005.	0	0	0	.00	31.35	164.67

TW LEFT BANK BETWEEN SECTION 1940 AND 2030

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
125.67	125.62	.04	125.67	125.62	.04	11	1305.909	1305.987	1940.000	2030.000

TW LEFT BANK BETWEEN SECTION 2770 AND 2855

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
76.42	76.15	.35	202.09	201.78	.15	11	1308.260	1308.517	2770.000	2855.000

TW LEFT BANK BETWEEN SECTION 3810 AND 3895

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
29.90	29.81	.30	231.99	231.59	.17	11	1311.524	1311.968	3810.000	3895.000

PROFILE FOR STREAM AST CHANL ANLYSIS (100YR

LOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

```
LEVATION  1300.    1305.    1310.    1315.    1320.    1325.    1330.    1335.    1340.    1345.
  SECNO   CUMDIS

 195.00     0.  I        EL       .        .        .        .        .        .        .        .
            200.  CI     EL       .        .        .        .        .        .        .        .
            400.  C I    WEL      .        .        .        .        .        .        .        .
            600.  C I    .ELR     .        .        .        .        .        .        .        .
            800.  C  I   .WELR    .        .        .        .        .        .        .        .
           1000.  C   I  .WELR    .        .        .        .        .        .        .        .
           1200.  C    I  . E LR  .        .        .        .        .        .        .        .
           1400.  C    I  . WE LR .        .        .        .        .        .        .        .
           1600.  C     I . WE LR .        .        .        .        .        .        .        .
           1800.  C      I .  WE LR .      .        .        .        .        .        .        .
           2000.  C       I .  WE L R .    .        .        .        .        .        .        .
 2310.00   2200.  C       I .  W EL R .    .        .        .        .        .        .        .
           2400.  C        I.    WELR .   .        .        .        .        .        .        .
 2790.00   2600.  C         .I      E .   .        .        .        .        .        .        .
           2800.  C         . I      E.  .        .        .        .        .        .        .
           3000.  C         .  I      E  .        .        .        .        .        .        .
           3200.  C         .   I     .E .        .        .        .        .        .        .
           3400.  C         .     I   . WE .       .        .        .        .        .        .
 3610.00   3600.  C         .     I   . WE .       .        .        .        .        .        .
           3800.  C         .       I . .  WE .    .        .        .        .        .        .
           4000.  C         .         I     WE .   .        .        .        .        .        .
           4200.  C         .         . I     WE.  .        .        .        .        .        .
           4400.  C         .         .  I     WEL .        .        .        .        .        .
           4600.  C         .         .    I  . WEL .       .        .        .        .        .
           4800.  C         .         .      I . .  WEL .   .        .        .        .        .
           5000.  C         .         .        I     WEL .  .        .        .        .        .
           5200.  C         .         .        . I     WE   .        .        .        .        .
           5400.  C         .         .        .   I    .WEL .        .        .        .        .
 5615.00   5600.  C         .         .        .     I  .  WEL .      .        .        .        .
```

THIS RUN EXECUTED 15JAN96 11:33:07

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

AST CHANL ANLYSIS (100YR

UMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	195.000	.00	.00	.00	1299.60	162.01	1304.40	.00	1304.44	2.56	1.58	102.40	101.19
	2310.000	2115.00	.00	.00	1303.60	287.68	1306.23	.00	1306.90	88.29	6.57	43.76	30.62
*	2790.000	480.00	.00	.00	1305.00	287.68	1308.35	.00	1308.54	18.00	3.52	81.77	67.81
	3610.000	820.00	.00	.00	1307.50	364.10	1310.48	.00	1310.91	46.59	5.31	68.61	53.34
	5615.000	2005.00	.00	.00	1318.00	394.00	1320.97	.00	1321.55	60.28	6.11	64.52	50.75

AST CHANL ANLYSIS (100YR

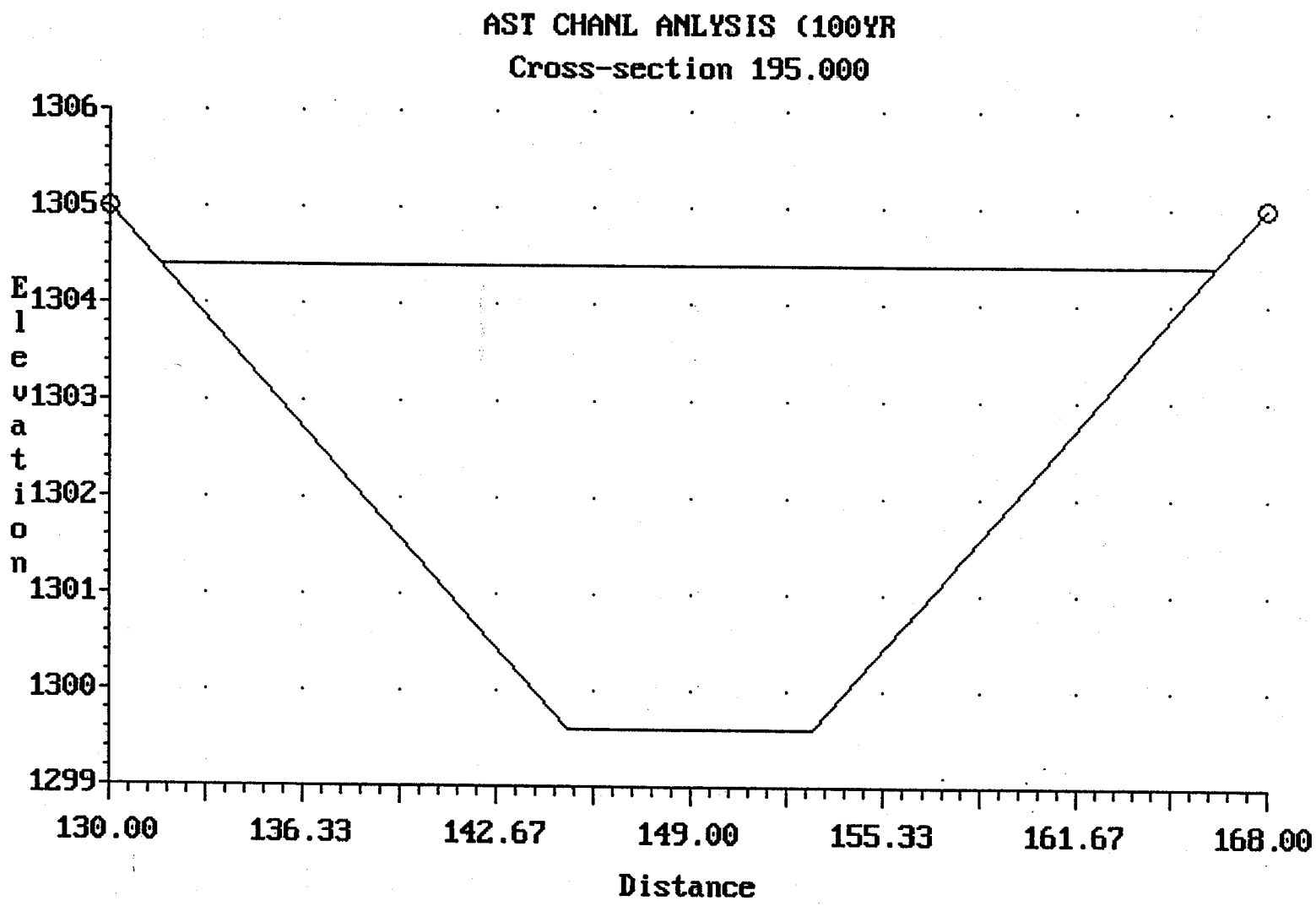
UMMARY PRINTOUT TABLE 150

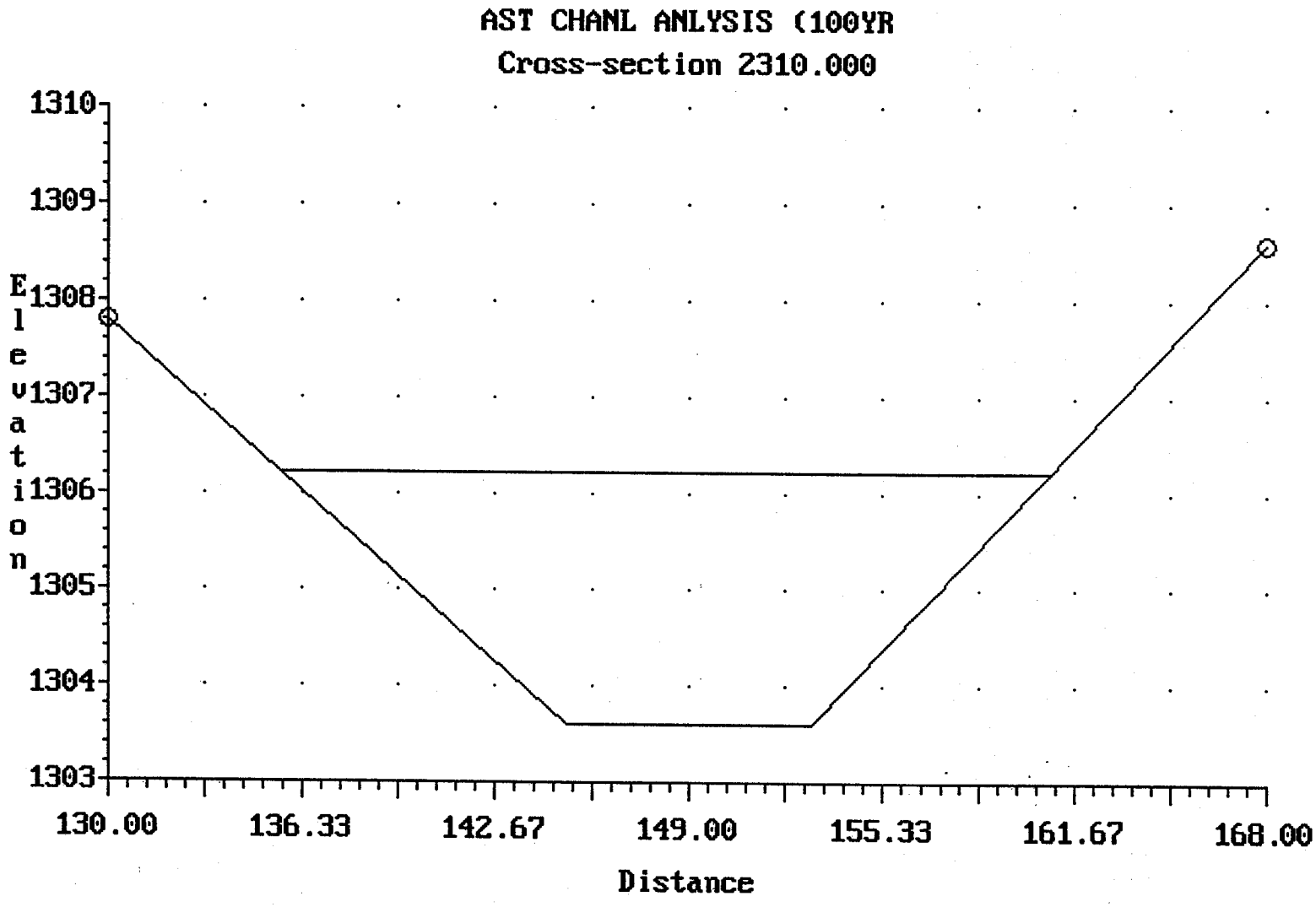
SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
195.000	162.01	1304.40	.00	.00	.00	34.67	.00
2310.000	287.68	1306.23	.00	1.83	.00	25.28	2115.00
2790.000	287.68	1308.35	.00	2.12	.00	36.86	480.00
3610.000	364.10	1310.48	.00	2.13	.00	34.11	820.00
5615.000	394.00	1320.97	.00	10.49	.00	31.35	2005.00

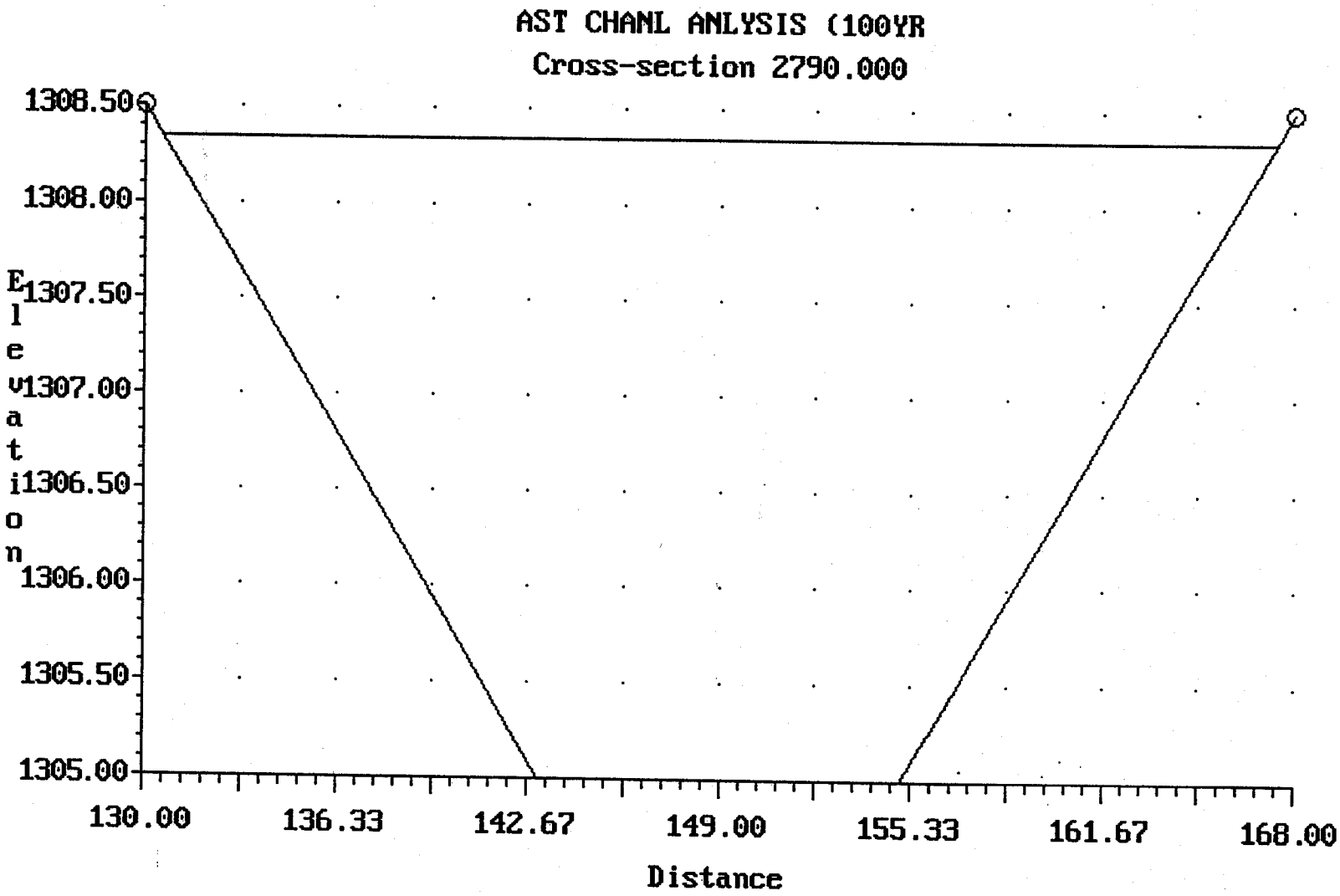
SUMMARY OF ERRORS AND SPECIAL NOTES

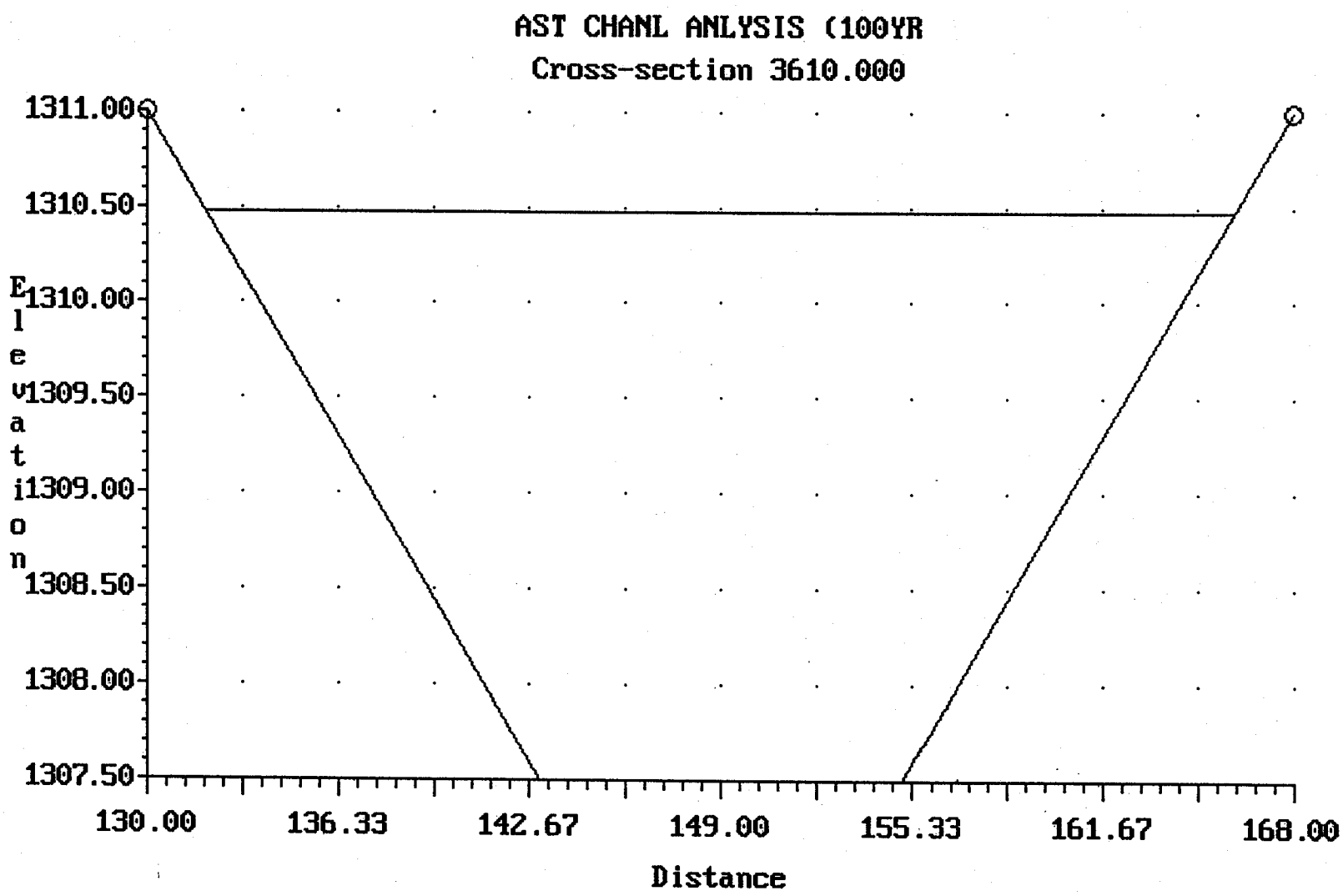
ARNING SECNO= 2310.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

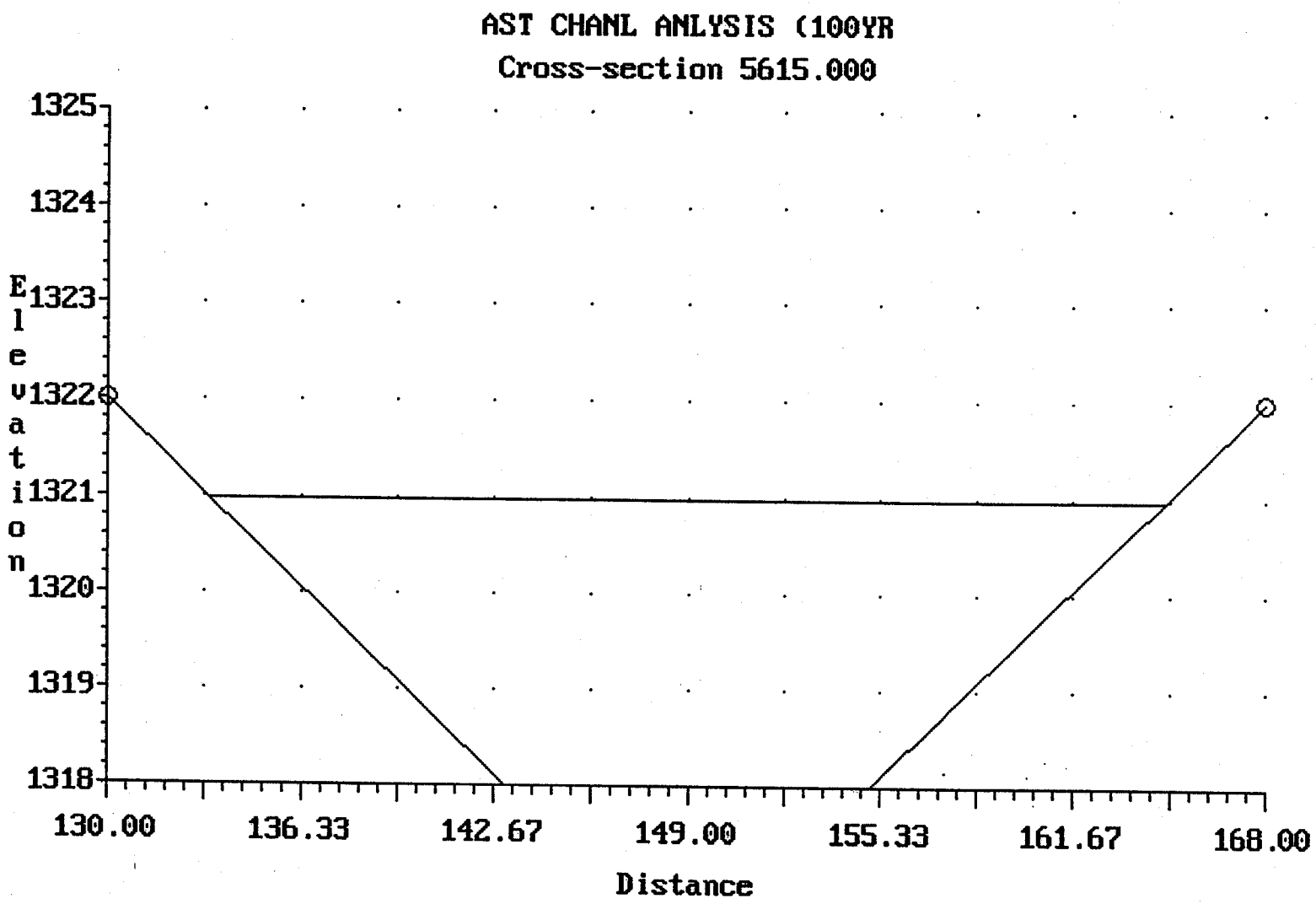
WARNING SECNO= 2790.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE


AST CHANL ANLYSIS (100YR
Cross-section 195.000
1306
1305
1304
1303
1302
1301
1300
1299
Elevation
130.00
136.33
142.67
149.00
155.33
161.67
168.00
Distance


AST CHANL ANLYSIS (100YR
Cross-section 2310.000
1310
1309
1308
1307
1306
1305
1304
1303
Elevation
130.00
136.33
142.67
149.00
155.33
161.67
168.00
Distance


AST CHANL ANLYSIS (100YR
Cross-section 2790.000
1308.50
1308.00
1307.50
1307.00
1306.50
1306.00
1305.50
1305.00
Elevation
130.00
136.33
142.67
149.00
155.33
161.67
168.00
Distance


AST CHANL ANLYSIS (100YR
Cross-section 3610.000
1311.00
1310.50
1310.00
1309.50
1309.00
1308.50
1308.00
1307.50
Elevation
130.00
136.33
142.67
149.00
155.33
161.67
168.00
Distance


AST CHANL ANLYSIS (100YR
Cross-section 5615.000
1325
1324
1323
1322
1321
1320
1319
1318
Elevation
130.00
136.33
142.67
149.00
155.33
161.67
168.00
Distance

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
                                         *
   Version   4.6.0;  February 1991       *
*                                        *
   RUN DATE    13DEC95    TIME   11:43:36 *
*****************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
*************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

Onsite Drainage Channel - South Property Line

THIS RUN EXECUTED 13DEC95 11:43:36

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************
```

T1 ARIZONA TRADITIONS JOB NO 931007
T2 ONSITE DRAINAGE CHANNEL SOUTH PROPERTY LINE
T3 SOUTH CHANL ANLYS 100YR

SOUTH PROPERTY LINE IS SET AS THE CONTROL LINE WITH A STATION OF 100

WATER SURFACE ELEVATIONS AT STA 100 AND STA 1800 CORRESPOND TO
HEADWATER DEPTH AT ADJACENT CULVERT

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0	0	0	0	1310.30	0

T	1	219.0						
NC	0.030	0.030	0.030					
1	100	4	66	100				
GR	1311.0	66	1306.1	78	1306.1	88	1311.0	100
T	1	121.0						
X1	580	4	66	100	480	480	480	
R	1312.5	66	1309.0	78	1309.0	88	1312.4	100
X1	1250	4	66	100	670	670	670	
R	1315.9	66	1313.0	78	1313.0	88	1316.5	100
T	1	77.0						
1	1350	4	68	100	100	100	100	
X5	1	1317.2						
R	1317.9	68	1313.2	80	1313.2	88	1317.5	100

.1	2500	4	68	100	1150	1150	1150	
:R	1323.6	68	1320.3	80	1320.3	88	1323.3	100

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

*SECNO 100.000

100.000	4.20	1310.30	.00	1310.30	1310.40	.10	.00	.00	1311.00
219.0	.0	219.0	.0	.0	85.2	.0	.0	.0	1311.00
.00	.00	2.57	.00	.000	.030	.000	.000	1306.10	67.71
.000736	0.	0.	0.	0	0	0	.00	30.57	98.29

*SECNO 580.000

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .19

580.000	1.69	1310.69	.00	.00	1311.01	.31	.60	.00	1312.50
121.0	.0	121.0	.0	.0	26.9	.0	.6	.3	1312.40
.03	.00	4.50	.00	.000	.030	.000	.000	1309.00	72.19
.006399	480.	480.	480.	2	0	0	.00	21.78	93.98

*SECNO 1250.000

1250.000	1.73	1314.73	1314.38	.00	1315.01	.28	4.00	.00	1315.90
121.0	.0	121.0	.0	.0	28.7	.0	1.0	.6	1316.50
.07	.00	4.22	.00	.000	.030	.000	.000	1313.00	70.83
.005586	670.	670.	670.	17	15	0	.00	23.11	93.94

*SECNO 1350.000

WATER EL=X5 CARD= 1317.200

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 4.13

1350.000	4.00	1317.20	.00	.00	1317.22	.02	.06	.00	1317.90
77.0	.0	77.0	.0	.0	74.8	.0	1.2	.7	1317.50
.10	.00	1.03	.00	.000	.030	.000	.000	1313.20	69.79
.000133	100.	100.	100.	0	0	0	.00	29.38	99.16

SECNO 2500.000

685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

720 CRITICAL DEPTH ASSUMED

2500.000	1.17	1321.47	1321.47	.00	1321.90	.43	.51	.00	1323.60
77.0	.0	77.0	.0	.0	14.6	.0	2.3	1.3	1323.30
.16	.00	5.27	.00	.000	.030	.000	.000	1320.30	75.74
.014130	1150.	1150.	1150.	20	14	0	.00	16.94	92.69

PROFILE FOR STREAM SOUTH CHANL ANLYS 100YR

LOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

```
LEVATION  1306.     1308.     1310.     1312.     1314.     1316.     1318.     1320.     1322.     1324.
  SECNO   CUMDIS

 100.00      0.  I         .         .WE  L    .         .         .         .         .         .         .         .
             50.  C I      .         .WE  L    .         .         .         .         .         .         .         .
            100.  C  I     .         .WE   L   .         .         .         .         .         .         .         .
            150.  C    I   .         . E    L  .         .         .         .         .         .         .         .
            200.  C     I  .         . WE   RL .         .         .         .         .         .         .         .
            250.  C       I .         . WE    L .         .         .         .         .         .         .         .
            300.  C        I.         . WE     L.         .         .         .         .         .         .         .
            350.  C         .I        . W E     L         .         .         .         .         .         .         .
            400.  C         . I       .  WE     RL        .         .         .         .         .         .         .
            450.  C         .   I     .  WE     .RL       .         .         .         .         .         .         .
 580.00     500.  C         .    I    .  W E    . L       .         .         .         .         .         .         .
            550.  C         .     I   .   W E   .  L      .         .         .         .         .         .         .
            600.  C         .      I  .     W E .   ML    .         .         .         .         .         .         .
            650.  C         .        I.      W E.    ML   .         .         .         .         .         .         .
            700.  C         .         I        W.E     LR .         .         .         .         .         .         .
            750.  C         .         . I       W E     LR.         .         .         .         .         .         .
            800.  C         .         .  I      . W E    MLR        .         .         .         .         .         .
            850.  C         .         .    I    .   WE    .LR       .         .         .         .         .         .
            900.  C         .         .     I   .    WE   . L R     .         .         .         .         .         .
            950.  C         .         .       I .      WE .  L R    .         .         .         .         .         .
           1000.  C         .         .        I.       WE.    L R .         .         .         .         .         .
           1050.  C         .         .         .I        WE    L R .         .         .         .         .         .
           1100.  C         .         .         . I       .WE    L  R         .         .         .         .         .
1250.00    1150.  .         .         .         .    I    .C W E   L. R       .         .         .         .         .
           1200.  C         .         .         .    I    .         WE  MLR    .         .         .         .         .
1350.00    1250.  C         .         .         .    I    .          .    WER L.         .         .         .         .
           1300.  C         .         .         .      I  .          .     WER L         .         .         .         .
           1350.  C         .         .         .        I.          .      WE RL        .         .         .         .
           1400.  C         .         .         .         I          .       WE.R L      .         .         .         .
           1450.  C         .         .         .         . I        .        WE R L     .         .         .         .
           1500.  C         .         .         .         .  I       .         WE R L    .         .         .         .
           1550.  C         .         .         .         .    I     .         .WE  RL   .         .         .         .
           1600.  C         .         .         .         .     I    .         . WE  R L .         .         .         .
           1650.  C         .         .         .         .       I .          .  WE  R L.         .         .         .
           1700.  C         .         .         .         .        I.          .   WE  R L         .         .         .
           1750.  C         .         .         .         .         .I         .    WE   RL        .         .         .
           1800.  C         .         .         .         .         . I        .     WE  .R L      .         .         .
           1850.  C         .         .         .         .         .   I      .      WE . R L     .         .         .
           1900.  C         .         .         .         .         .     I    .       WE.  R L    .         .         .
           1950.  C         .         .         .         .         .      I   .       W E   RL    .         .         .
           2000.  C         .         .         .         .         .        I.        W.E   R L .         .         .
           2050.  C         .         .         .         .         .         I         W E   R L.         .         .
           2100.  C         .         .         .         .         .         . I       .W E   R L         .         .
           2150.  C         .         .         .         .         .         .  I      . W E    RL        .         .
           2200.  C         .         .         .         .         .         .   I    . W E   .R L       .         .
           2250.  C         .         .         .         .         .         .    I   .  W E  . R L      .         .
           2300.  C         .         .         .         .         .         .     I .   W E  .  R L     .         .
           2350.  C         .         .         .         .         .         .      I.    W E .   RL     .         .
```

2500.00 2400. . . . . .I W E. R L . .

THIS RUN EXECUTED 13DEC95 11:43:36

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

SOUTH CHANL ANLYS 100YR

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
100.000	.00	.00	.00	1306.10	219.00	1310.30	.00	1310.40	7.36	2.57	85.20	80.71
580.000	480.00	.00	.00	1309.00	121.00	1310.69	.00	1311.01	63.99	4.50	26.91	15.13
1250.000	670.00	.00	.00	1313.00	121.00	1314.73	1314.38	1315.01	55.86	4.22	28.67	16.19
1350.000	100.00	.00	.00	1313.20	77.00	1317.20	.00	1317.22	1.33	1.03	74.75	66.83
2500.000	1150.00	.00	.00	1320.30	77.00	1321.47	1321.47	1321.90	141.30	5.27	14.61	6.48

SOUTH CHANL ANLYS 100YR

UMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	100.000	219.00	1310.30	.00	.00	.00	30.57	.00
	580.000	121.00	1310.69	.00	.39	.00	21.78	480.00
	1250.000	121.00	1314.73	.00	4.04	.00	23.11	670.00
*	1350.000	77.00	1317.20	.00	2.47	.00	29.38	100.00
	2500.000	77.00	1321.47	.00	4.27	.00	16.94	1150.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
 ARNING SECNO=    580.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

NOTE    SECNO=   1350.000  PROFILE=  1  WSEL BASED ON X5 CARD
 ARNING SECNO=   1350.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=   2500.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
 AUTION SECNO=   2500.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
 AUTION SECNO=   2500.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
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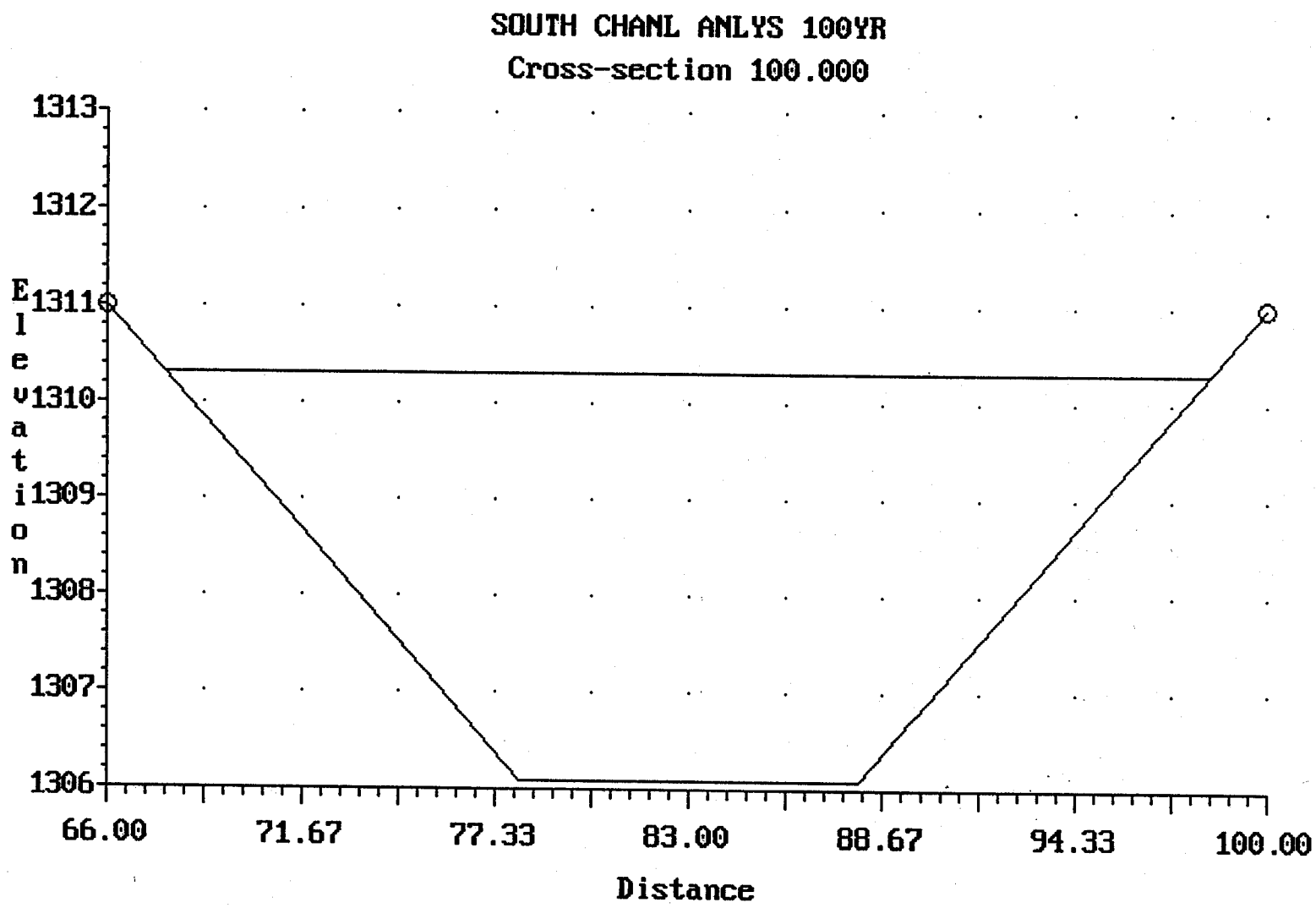
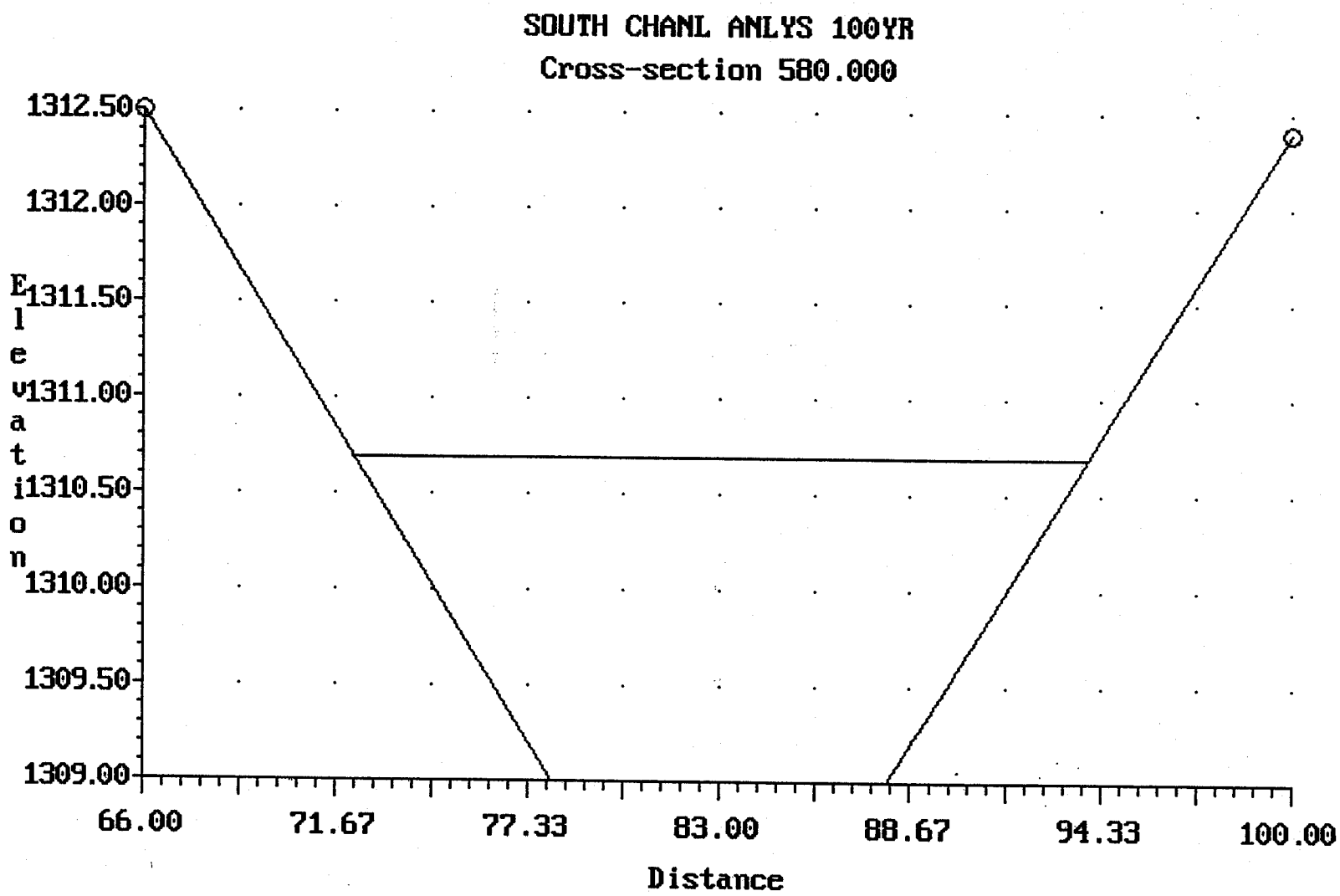
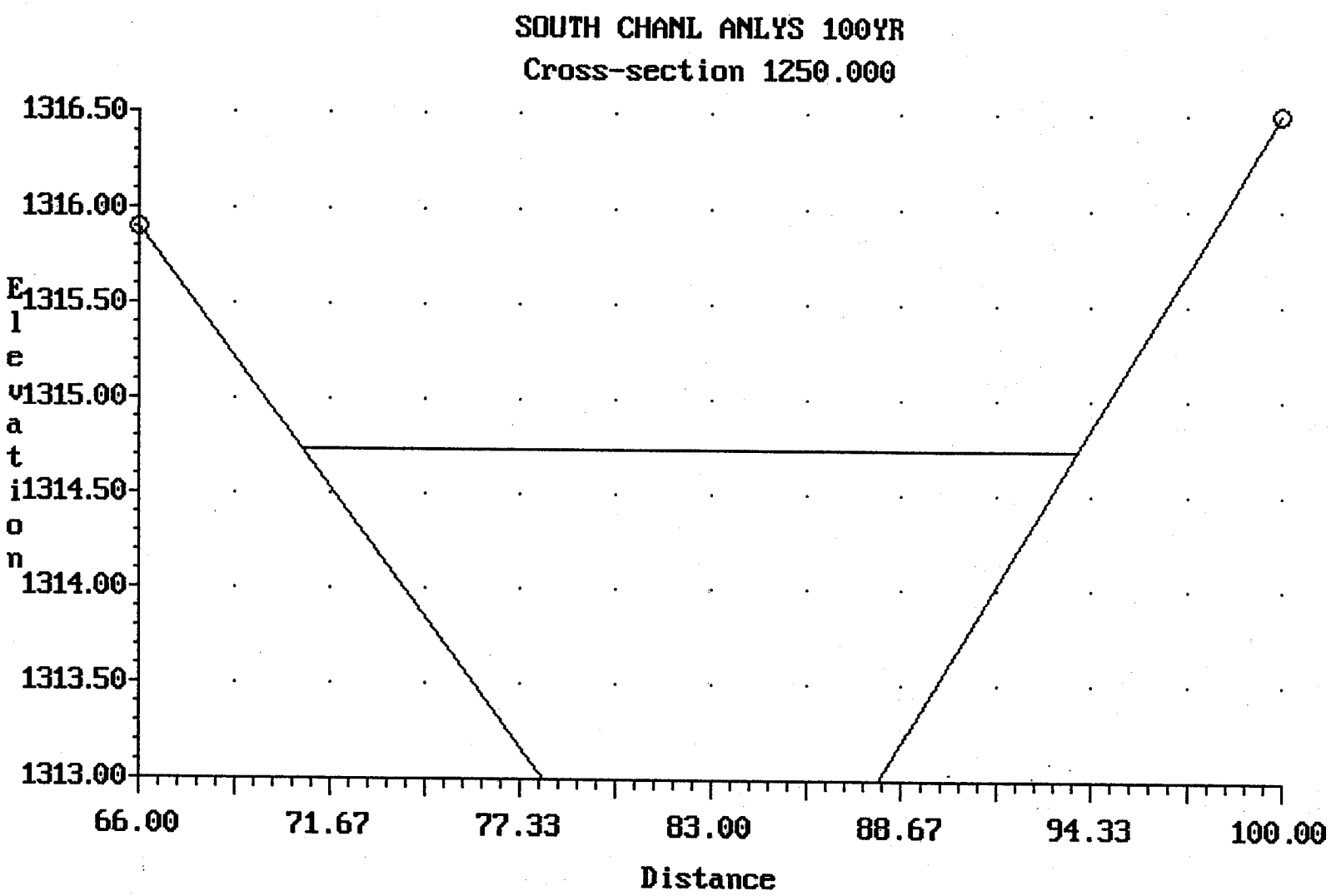

SOUTH CHANL ANLYS 100YR
Cross-section 100.000
1313
1312
1311
1310
1309
1308
1307
1306
Elevation
66.00
71.67
77.33
83.00
88.67
94.33
100.00
Distance


SOUTH CHANL ANLYS 100YR
Cross-section 580.000
1312.50
1312.00
1311.50
1311.00
1310.50
1310.00
1309.50
1309.00
Elevation
66.00
71.67
77.33
83.00
88.67
94.33
100.00
Distance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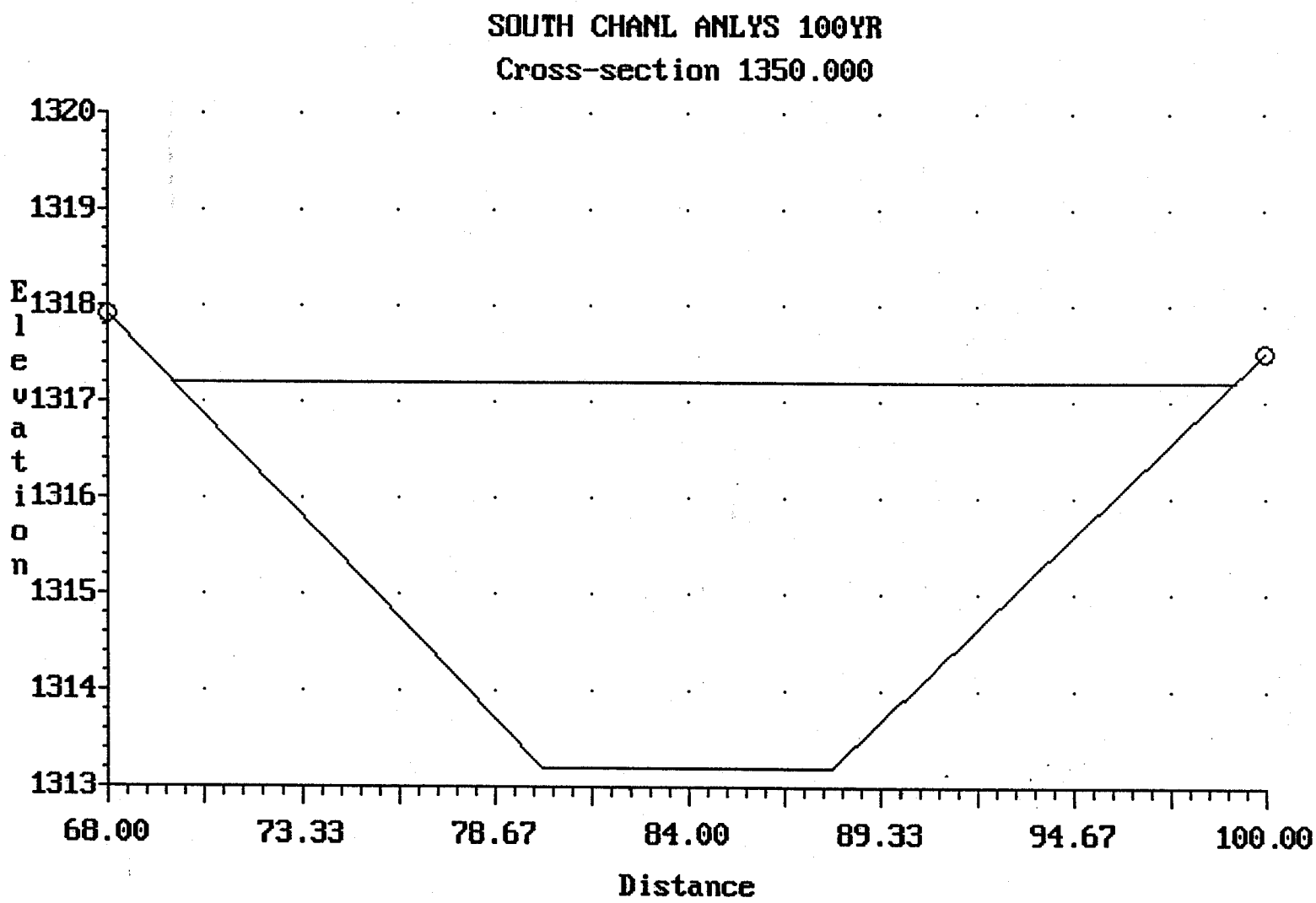
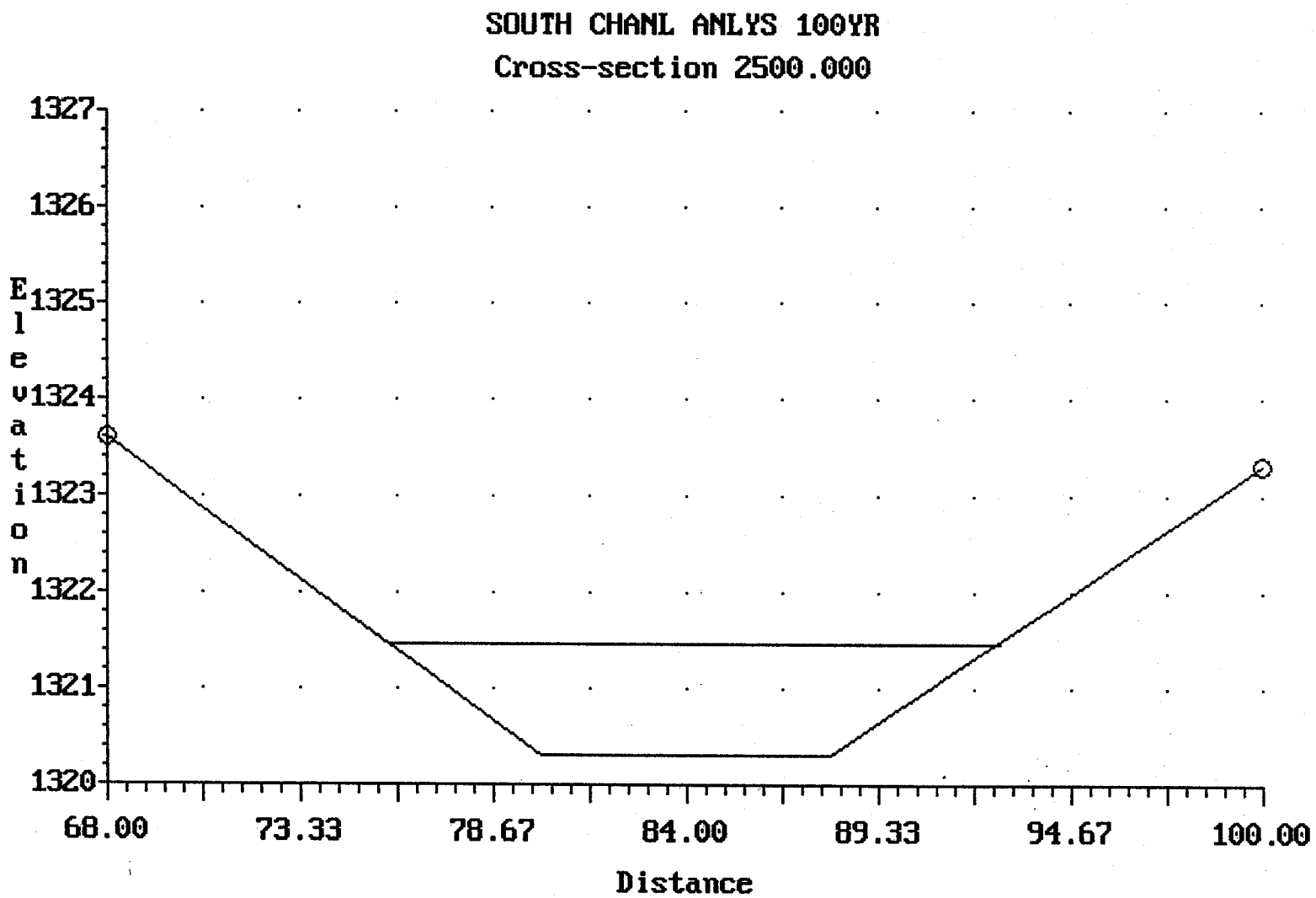
Cross-section 1250.000
1316.50
1316.00
1315.50
1315.00
1314.50
1314.00
1313.50
1313.00
Elevation
66.00
71.67
77.33
83.00
88.67
94.33
100.00
Distance


SOUTH CHANL ANLYS 100YR
Cross-section 1350.000
Elevation
1320
1319
1318
1317
1316
1315
1314
1313
68.00
73.33
78.67
84.00
89.33
94.67
100.00
Distance


SOUTH CHANL ANLYS 100YR
Cross-section 2500.000
Elevation
1327
1326
1325
1324
1323
1322
1321
1320
68.00
73.33
78.67
84.00
89.33
94.67
100.00
Distance

```
*****************************************
*  HEC-2 WATER SURFACE PROFILES          *
                                         *
   Version   4.6.0;  February 1991       *
*                                        *
   RUN DATE    13DEC95    TIME   14:05:05 *
*****************************************
```

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*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
*************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX              XXXXXXX
```

Offsite Drainage Channel - West Property Line

THIS RUN EXECUTED 13DEC95 14:05:05

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************************************
HEC-2 WATER SURFACE PROFILES

Version   4.6.0;  February 1991
************************************
```

T1 ARIZONA TRADITIONS JOB NO 931007
T2 OFFSITE DRAINAGE CHANNEL WEST PROPERTY LINE
T3 WEST CHANL ANLYS 100YR

WEST PROPERTY LINE IS SET AS THE CONTROL LINE WITH A STATION OF 100

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	-1	0	0	0	1333.0	0

T	1	176.0								
NC	0.030	0.030	0.030							
1	100	4	76	94						
GR	1333.9	76	1329.9	88	1332.0	94	1333.0	260		
T	1	93.0								
X1	400	5	76	94	300	300	300			
GR	1333.7	76	1330.65	88	1332.2	94	1333.0	260	1334.0	380
X1	700	3	76	100	300	300	300			
R	1335.4	76	1331.40	88	1335.2	100				
1	900	3	76	100	200	200	200			
R	1336.1	76	1332.13	88	1336.2	100				
T	1	34.0								
X1	1400	3	76	100	500	500	500			
GR	1336.1	76	1332.67	88	1336.8	100				

1	1900	3	76	100	400	400	400
R	1336.5	76	1333.5	88	1337.5	100	

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

*SECNO 100.000

720 CRITICAL DEPTH ASSUMED

100.000	2.79	1332.69	1332.69	1333.00	1332.92	.23	.00	.00	1333.90
176.0	.0	105.0	71.0	.0	22.1	39.1	.0	.0	1332.00
.00	.00	4.76	1.82	.000	.030	.030	.000	1329.90	79.64
.005600	0.	0.	0.	0	8	0	.00	128.28	207.92

SECNO 400.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.38

400.000	2.60	1333.25	.00	.00	1333.26	.01	.34	.00	1333.70
93.0	.0	25.5	67.5	.0	24.3	111.8	.7	1.2	1332.20
.11	.00	1.05	.60	.000	.030	.030	.000	1330.65	77.77
.000276	300.	300.	300.	5	0	0	.00	212.31	290.07

SECNO 700.000

3301 HV CHANGED MORE THAN HVINS

685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

700.000	2.23	1333.63	1333.63	.00	1334.20	.57	.25	.00	1335.40
93.0	.0	93.0	.0	.0	15.3	.0	1.2	2.0	1335.20
.13	.00	6.08	.00	.000	.030	.000	.000	1331.40	81.31
.013945	300.	300.	300.	20	15	0	.00	13.72	95.04

*SECNO 900.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.16

900.000	3.01	1335.14	.00	.00	1335.32	.18	1.12	.00	1336.10
93.0	.0	93.0	.0	.0	27.0	.0	1.3	2.0	1336.20
.14	.00	3.44	.00	.000	.030	.000	.000	1332.13	78.90
.003000	200.	200.	200.	4	0	0	.00	17.97	96.87

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 1400.000

1400.000	3.19	1335.86	.00	.00	1335.87	.02	.55	.00	1336.10
34.0	.0	34.0	.0	.0	32.6	.0	1.6	2.2	1336.80
.28	.00	1.04	.00	.000	.030	.000	.000	1332.67	76.84
.000254	500.	500.	500.	4	0	0	.00	20.42	97.27

*SECNO 1900.000

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .57

1900.000	2.50	1336.00	.00	.00	1336.04	.04	.16	.00	1336.50
34.0	.0	34.0	.0	.0	21.9	.0	1.9	2.4	1337.50
.35	.00	1.56	.00	.000	.030	.000	.000	1333.50	78.00
.000773	400.	400.	400.	2	0	0	.00	17.49	95.50

PROFILE FOR STREAM WEST CHANL ANLYS 100YR

LOTTED POINTS (BY PRIORITY) E-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

```
LEVATION  1330.    1331.    1332.    1333.    1334.    1335.    1336.    1337.    1338.    1339.
  SECNO   CUMDIS

 100.00     0.  I        .        .R      W EM       L        .        .        .        .        .        .
             50. CI       .        .R      W.EM       L        .        .        .        .        .        .
            100. C  I     .        . R      WE M     L.        .        .        .        .        .        .
            150. C   I    .        . R      .WE M    L.        .        .        .        .        .        .
            200. C    I   .        . R      . E   M  L.        .        .        .        .        .        .
            250. C     I  .        .  R     .  E   ML .        .        .        .        .        .        .
 400.00     300. C      I .        .  R     .  WE   L .        .        .        .        .        .        .
            350. C       I.        .      R .   WE    ML       .        .        .        .        .        .
            400. C        I        .        .  R W E  .  ML    .        .        .        .        .        .
            450. C        .I       .        .   W  E .    ML   .        .        .        .        .        .
            500. C        .  I     .        .    W   E  R    ML.        .        .        .        .        .
            550. C        .   I    .        .     W  .E      R M L      .        .        .        .        .
 700.00     600. .        .    I   .        .     W  .  E      .  R L   .        .        .        .        .
            650. C        .      I .        .        .W    E   .    R L .        .        .        .        .
            700. C        .        I.       .        .    W   E.      ML .        .        .        .        .
            750. C        .         I       .        .       W.E       L        .        .        .        .
 900.00     800. C        .         . I     .        .        . W E    . LR      .        .        .        .
            850. C        .         .  I    .        .        .  W E   . L R     .        .        .        .
            900. C        .         .  I    .        .        .   WE   . L R     .        .        .        .
            950. C        .         .   I   .        .        .    WE  . L  R    .        .        .        .
           1000. C        .         .   I   .        .        .    WE  . L  R    .        .        .        .
           1050. C        .         .    I  .        .        .     WE . L   R   .        .        .        .
           1100. C        .         .     I .        .        .      E . L    R  .        .        .        .
           1150. C        .         .     I .        .        .      WE . L   R  .        .        .        .
           1200. C        .         .      I .       .        .       WE. L    R .        .        .        .
           1250. C        .         .      I .       .        .        E. L    R .        .        .        .
 1400.00   1300. C        .         .       I .      .        .        E L     R.        .        .        .
           1350. C        .         .        I.      .        .        E L      R        .        .        .
           1400. C        .         .         I      .        .        E  L     .R       .        .        .
           1450. C        .         .         .I     .        .        E  L     . R      .        .        .
           1500. C        .         .         . I    .        .        WE  L    .  R     .        .        .
           1550. C        .         .         .  I   .        .        WE  L    .  R     .        .        .
           1600. C        .         .         .   I  .        .        .E   L   .   R    .        .        .
           1650. C        .         .         .    I .        .        .E   L   .    R   .        .        .
 1900.00   1700. C        .         .         .     I .       .        .E    L  .     R  .        .        .
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THIS RUN EXECUTED 13DEC95 14:05:06

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HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

WEST CHANL ANLYS 100YR

UMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	100.000	.00	.00	.00	1329.90	176.00	1332.69	1332.69	1332.92	56.00	4.76	61.15	23.52
	400.000	300.00	.00	.00	1330.65	93.00	1333.25	.00	1333.26	2.76	1.05	136.03	56.02
*	700.000	300.00	.00	.00	1331.40	93.00	1333.63	1333.63	1334.20	139.45	6.08	15.29	7.88
	900.000	200.00	.00	.00	1332.13	93.00	1335.14	.00	1335.32	30.00	3.44	27.05	16.98
	1400.000	500.00	.00	.00	1332.67	34.00	1335.86	.00	1335.87	2.54	1.04	32.57	21.34
*	1900.000	400.00	.00	.00	1333.50	34.00	1336.00	.00	1336.04	7.73	1.56	21.85	12.23

WEST CHANL ANLYS 100YR

UMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
* 100.000	176.00	1332.69	.00	.00	-.31	128.28	.00
400.000	93.00	1333.25	.00	.56	.00	212.31	300.00
700.000	93.00	1333.63	.00	.38	.00	13.72	300.00
* 900.000	93.00	1335.14	.00	1.51	.00	17.97	200.00
1400.000	34.00	1335.86	.00	.72	.00	20.42	500.00
* 1900.000	34.00	1336.00	.00	.14	.00	17.49	400.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
 AUTION SECNO=    100.000  PROFILE=  1  CRITICAL DEPTH ASSUMED

WARNING SECNO=    400.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

 AUTION SECNO=    700.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    700.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
 AUTION SECNO=    700.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=    900.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

 ARNING SECNO=   1900.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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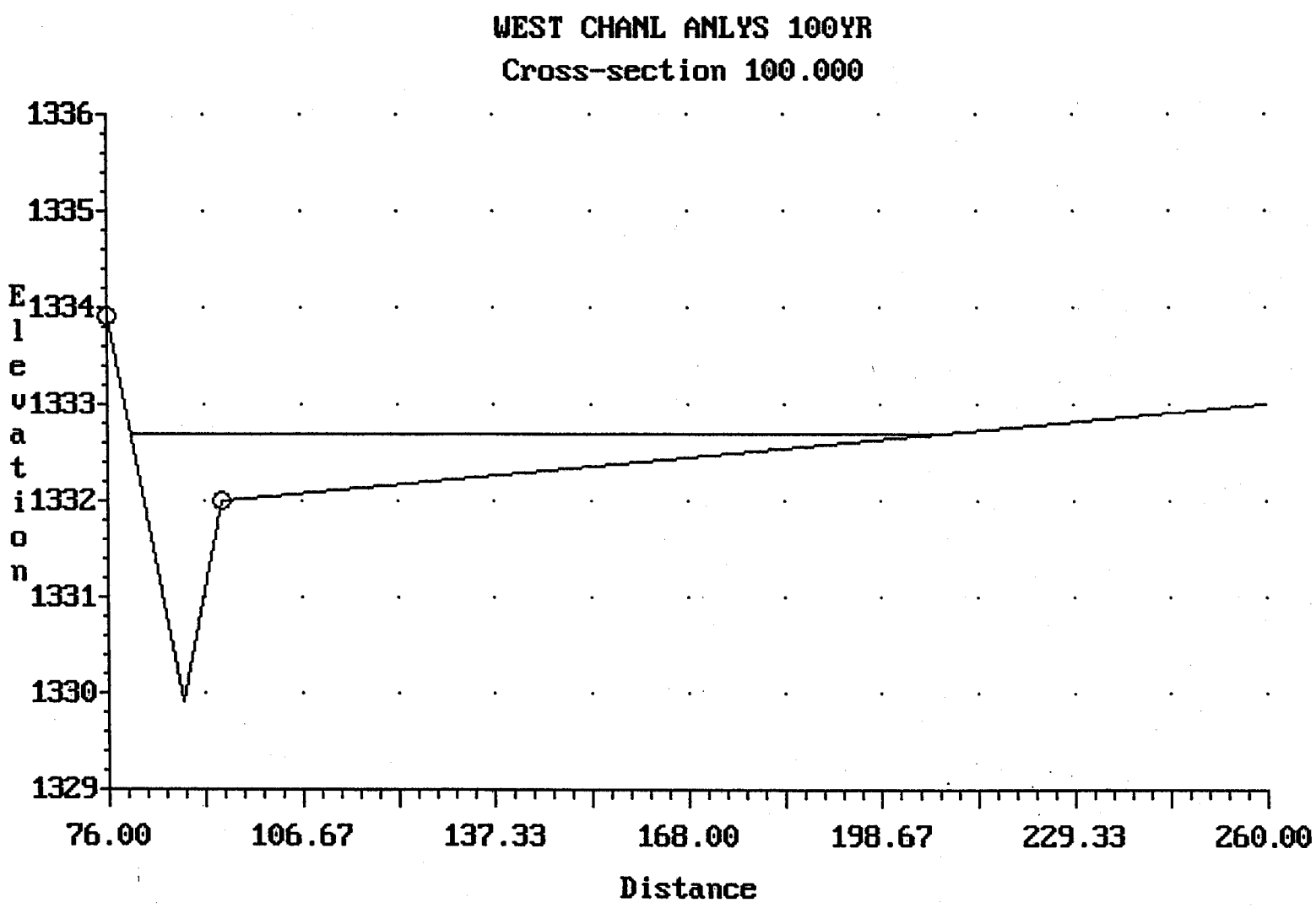
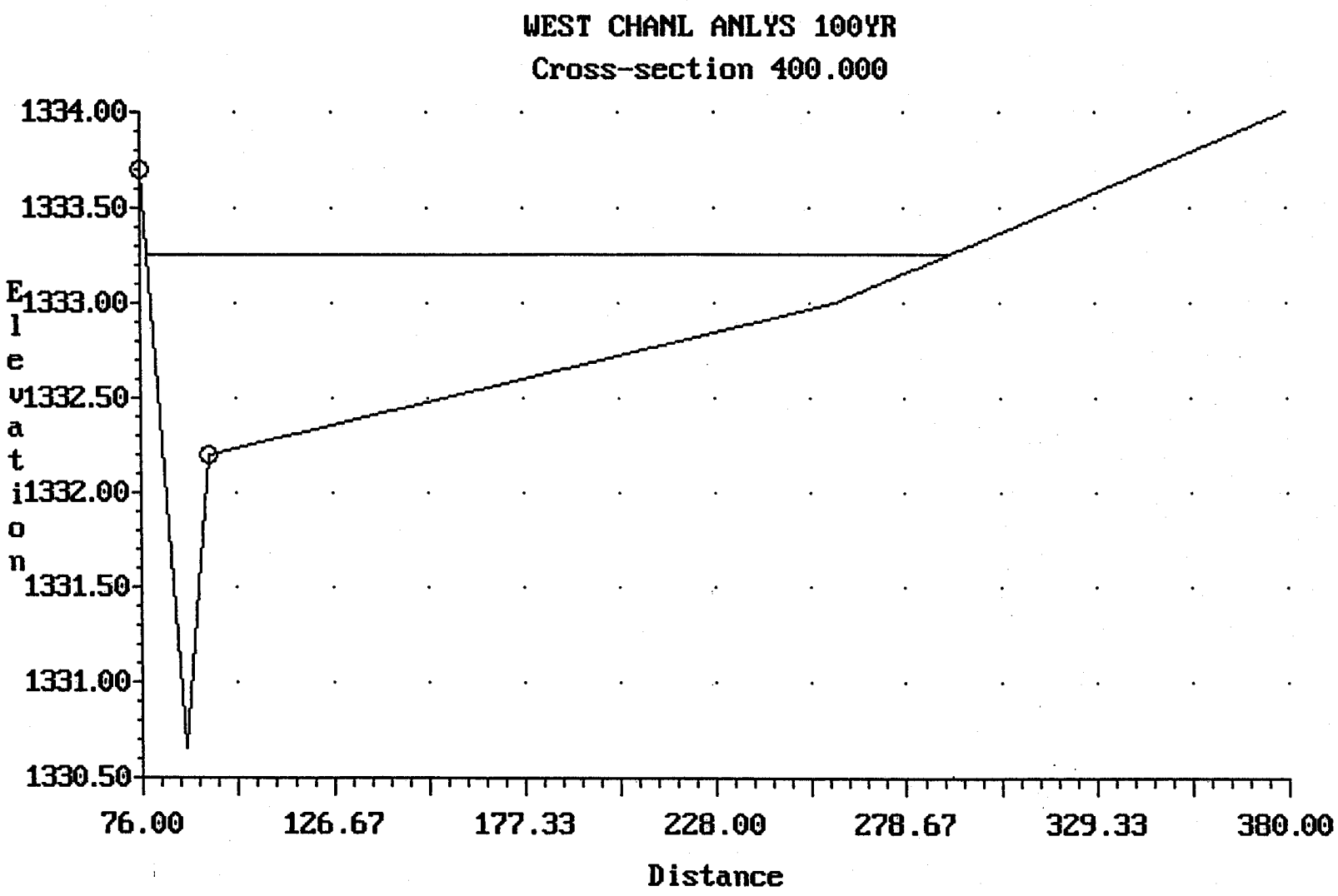
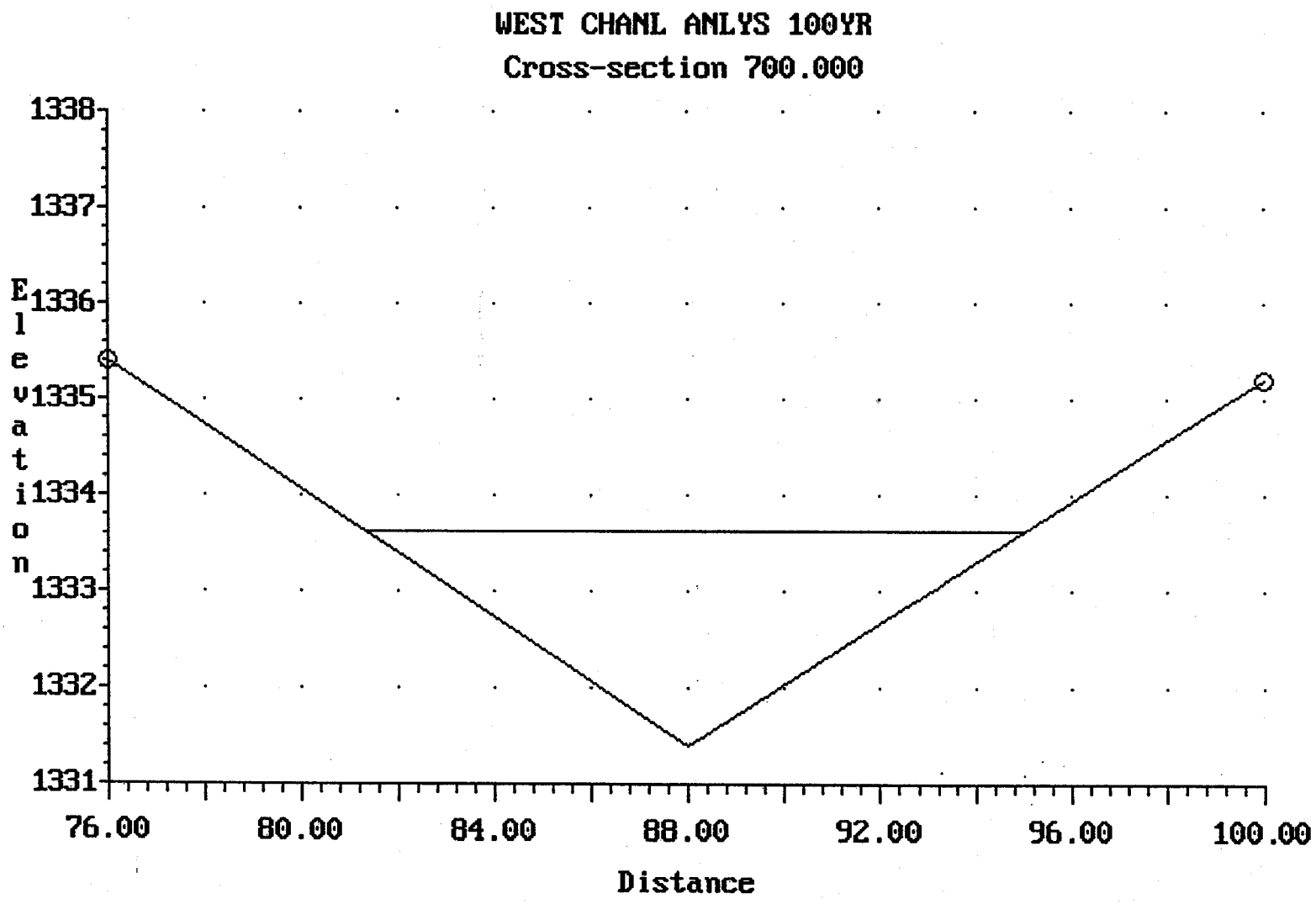
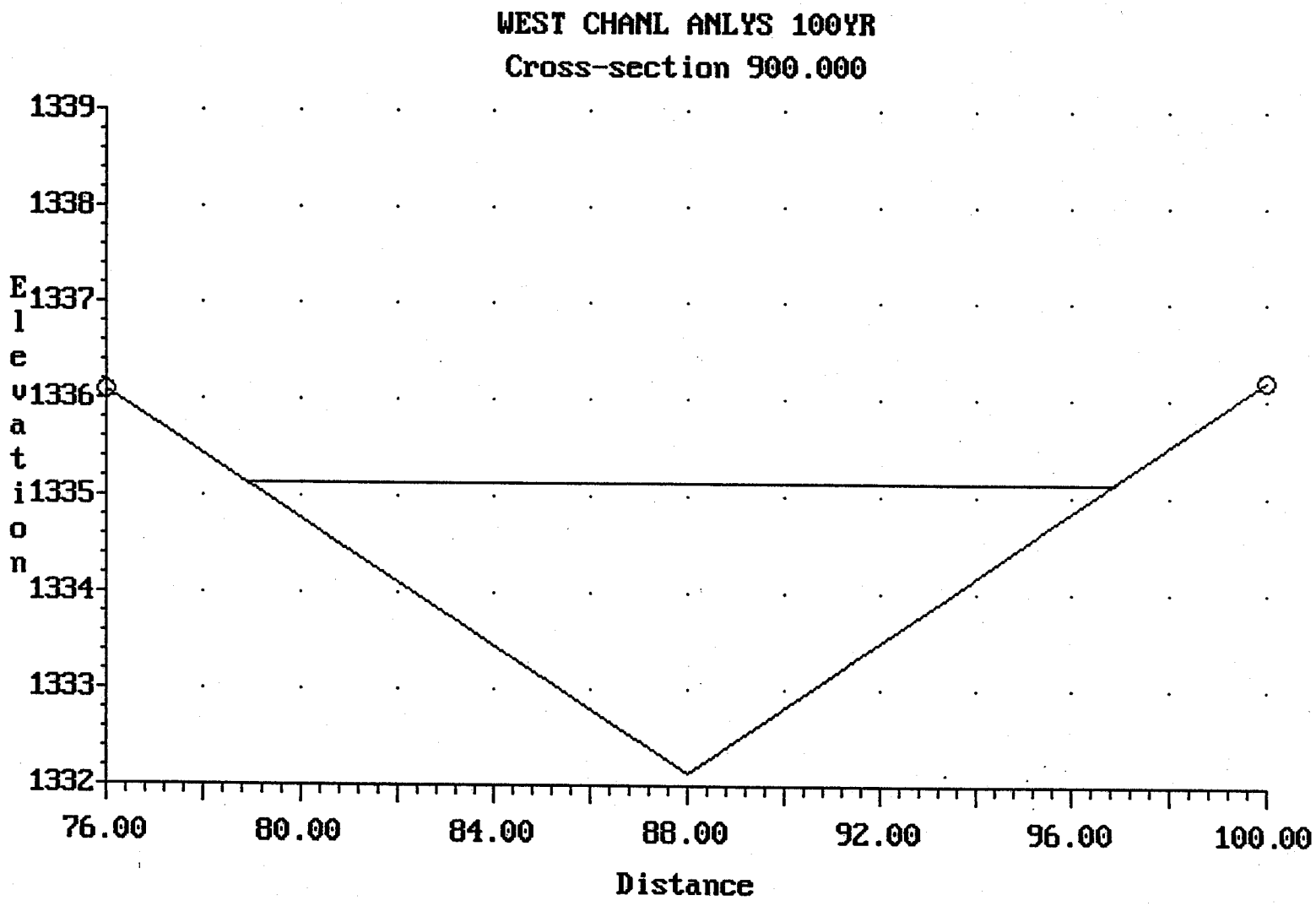
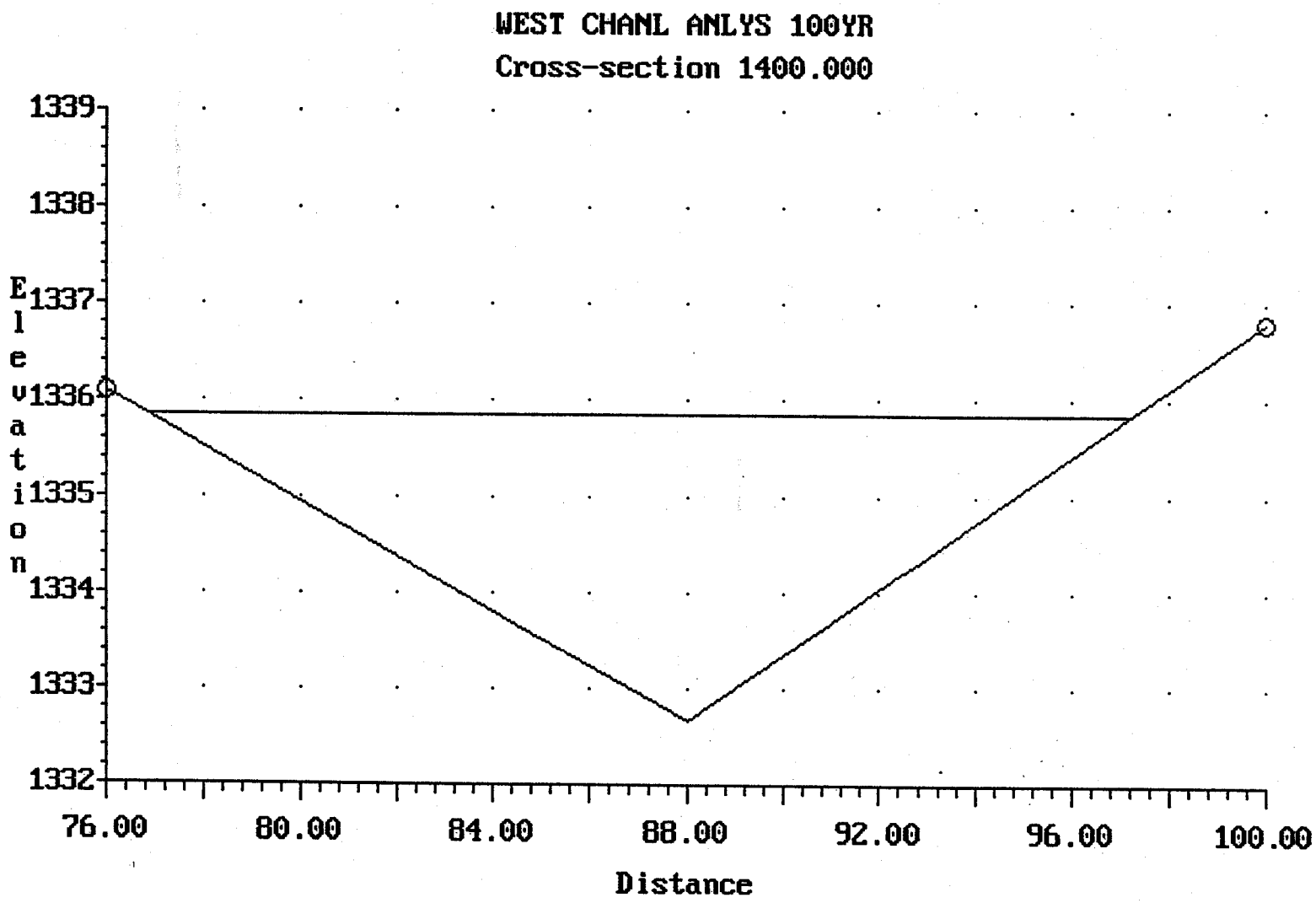
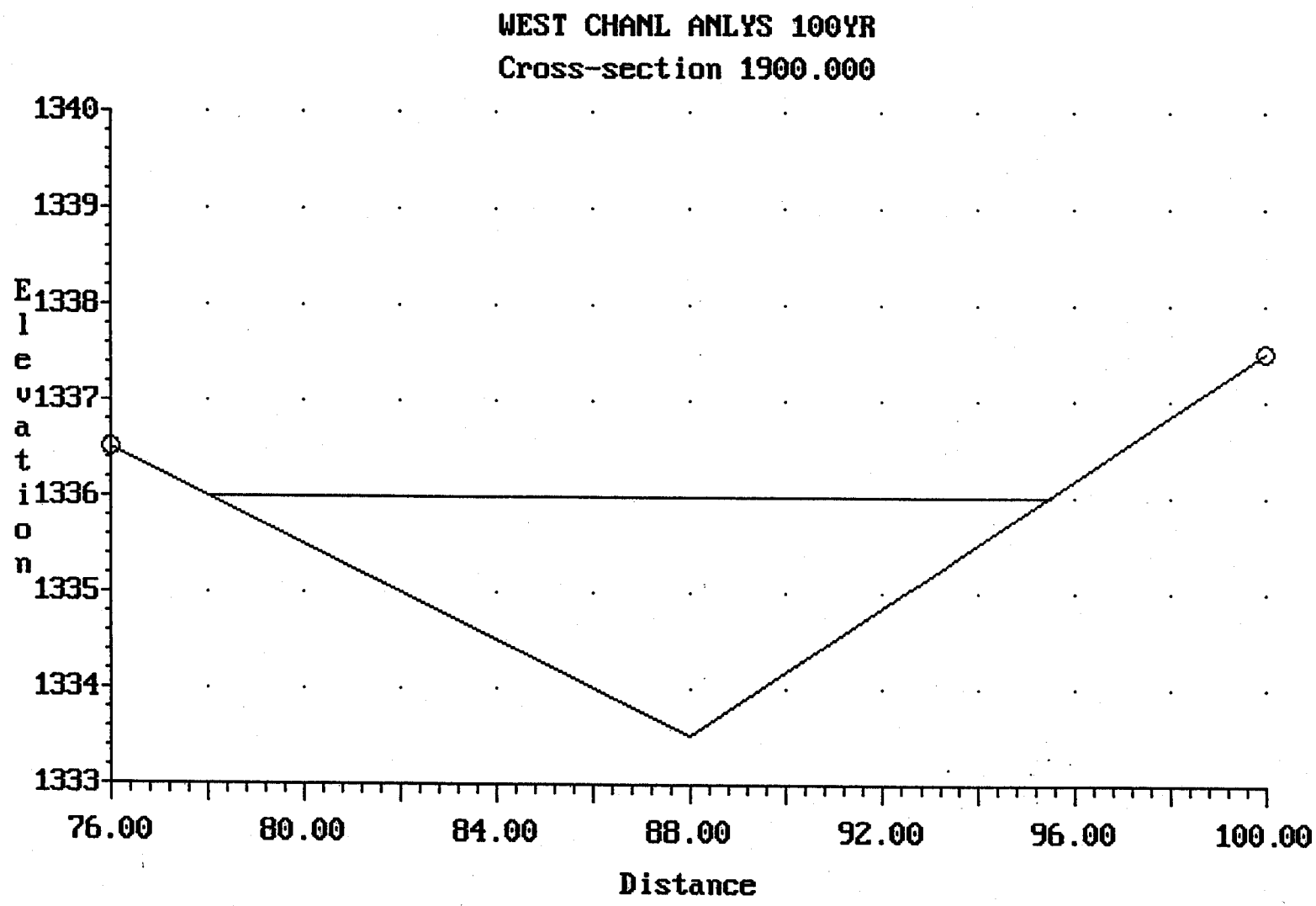

WEST CHANL ANLYS 100YR
Cross-section 100.000
1336
1335
1334
1333
1332
1331
1330
1329
Elevation
76.00
106.67
137.33
168.00
198.67
229.33
260.00
Distance


WEST CHANL ANLYS 100YR
Cross-section 400.000
1334.00
1333.50
1333.00
1332.50
1332.00
1331.50
1331.00
1330.50
Elevation
76.00
126.67
177.33
228.00
278.67
329.33
380.00
Distance


WEST CHANL ANLYS 100YR
Cross-section 700.000
Elevation
1338
1337
1336
1335
1334
1333
1332
1331
76.00
80.00
84.00
88.00
92.00
96.00
100.00
Distance


WEST CHANL ANLYS 100YR
Cross-section 900.000
Elevation
1339
1338
1337
1336
1335
1334
1333
1332
76.00
80.00
84.00
88.00
92.00
96.00
100.00
Distance


WEST CHANL ANLYS 100YR
Cross-section 1400.000
Elevation
1339
1338
1337
1336
1335
1334
1333
1332
76.00
80.00
84.00
88.00
92.00
96.00
100.00
Distance


WEST CHANL ANLYS 100YR
Cross-section 1900.000
1340
1339
1338
1337
1336
1335
1334
1333
Elevation
76.00
80.00
84.00
88.00
92.00
96.00
100.00
Distance

Loop Road Design

JOB NAME: ARIZONA TRADITIONS JOB NO. 931007

INLET SIZING - SUMP LOCATION

Inlet openings are determined using the methods outlined in the Federal Highway Departments HEC-12 Circular, March 1984.
The following equations are used to determine the interception capacity of depressed curb-opening inlets.

Curb Opening Equation

$$Qi = Cw(L + 1.8W)d^{1.5}$$

Where:
Qi = interception capacity of depressed curb-opening inlet (cfs)
Cw = 2.3
L = length of curb opening (ft)
W = lateral width of depression (ft)
d = depth at curb measured from the normal cross slope (ft)

A reduction factor is applied to the theoretical capacity according to Table 3.2 of the Drainage Design Manual for Maricopa County.

Point	Catch Basin Opening Length (ft)	Standard Detail	d10 (ft)	d100 (ft)	Q10 Theoretical (cfs)	Q100 Theoretical (cfs)	Reduction Factor (x .8)	Q10 Actual (cfs)	Q100 Actual (cfs)	Design Q10 (cfs)	Design Q100 (cfs)
2R1-N	8.0	MAG 532	0.38	0.50	5.8	8.7	0.8	4.6	7.0	4.5	7.0
2R1-S	8.0	MAG 532	0.38	0.50	5.8	8.7	0.8	4.6	7.0	4.5	7.0
2R3-E	20.0	C.O.P. P-1569, M-1, L=17'	0.44	0.60	15.2	24.3	0.8	12.2	19.4	12.1	19.0
2R3-W	20.0	C.O.P. P-1569, M-1, L=17'	0.44	0.60	15.2	24.3	0.8	12.2	19.4	12.1	19.0
4R3-N	3.5	MAG 530	0.34	0.45	2.8	4.3	0.8	2.3	3.4	2.3	3.4
4R3-S	3.5	MAG 530	0.34	0.45	2.8	4.3	0.8	2.3	3.4	2.3	3.4

JOB NAME: ARIZONA TRADITIONS JOB NO. 931007

FLOW-BY CATCH BASIN/SCUPPER CALCULATIONS

Flow-by catch basin/scupper selections are determined using the methods outlined in the Federal Highway Departments HEC-12 Circular, Marc
The following equations are used to determine the interception capacity of depressed curb opening inlets and grated inlets on grade.

Curb Opening Length Equation

$$LT = KQ^{0.42}S^{0.3}(1/nSe)^{0.6}$$

Where:
LT = curb opening length (ft)
K = 0.6
Q = gutter flow (cfs)
S = longitudinal slope
n = Manning's roughness coefficient
Se = composite cross slope

Se Calculations

$Se = Sx + Sw'Eo$

where:

$Sw = a/12W + Sx$
Eo = determined from Chart 4 using W/T and Sw/Sx
$T = d/Sx$

Sx = cross slope of pavement
Sw = cross slope of gutter measured from cross slope of pavement
a = gutter depression (in)
W = width of depressed gutter
Eo = ratio of frontal flow to total gutter flow
T = spread width (ft)
d = depth of flow at gutter (ft)

Efficiency Calculations

$E = 1 - (1 - L/LT)^{1.8}$

E = efficiency of curb opening inlet shorter than required length

Reduction factors are applied to the theoretical capacities according to Table 3.2 of the Drainage Design Manual for Maricopa County.

INPUT DATA

n = 0.015 a 2.00 (in)

Sx = 0.02 (ft/ft) Sw/Sx = 6.56

W = 1.50 (ft)

Point	Q10 (cfs)	d10 (ft)	S (ft/ft)	W/T	Eo	LT (ft)	Clogging Factor LT X 1.25 (ft)	Catch Basin Curb Opening Length (ft)	Standard Detail	Qin (cfs)	Qby (cfs)
2R2-N	5.30	0.32	0.0050	0.094	0.38	16.2	20.3	23.0	C.O.P. P-1569, M-2, L=10	5.3	0.0
2R2-S	5.30	0.32	0.0050	0.094	0.38	16.2	20.3	23.0	C.O.P. P-1569, M-2, L=10	5.3	0.0
4R1-W	7.20	0.35	0.0060	0.086	0.34	20.4	25.5	23.0	C.O.P. P-1569, M-2, L=10	7.1	0.1
R41-E	7.20	0.35	0.0060	0.086	0.34	20.4	25.5	23.0	C.O.P. P-1569, M-2, L=10	7.1	0.1

Point	Q100 (cfs)	d100 (ft)	S (ft/ft)	W/T	Eo	LT (ft)	Clogging Factor LT X 1.25 (ft)	Catch Basin Curb Opening Length (ft)	Standard Detail	Qin (cfs)	Qby (cfs)
2R2-N	8.40	0.38	0.0050	0.079	0.32	21.1	26.3	23.0	C.O.P. P-1569, M-2, L=10	8.2	0.2
2R2-S	8.40	0.38	0.0050	0.079	0.32	21.1	26.3	23.0	C.O.P. P-1569, M-2, L=10	8.2	0.2
4R1-W	11.30	0.41	0.0060	0.073	0.30	25.8	32.3	23.0	C.O.P. P-1569, M-2, L=10	10.1	1.2
R41-E	11.30	0.41	0.0060	0.073	0.30	25.8	32.3	23.0	C.O.P. P-1569, M-2, L=10	10.1	1.2

Table 3.2
Reduction Factors to Apply to Catch Basins

Condition	Inlet Type	Reduction Factor
Sump	Curb Opening	0.80
Sump	Grated	0.50
Sump	Combination	0.65
Continuous Grade	Curb Opening	0.80
Continuous Grade	Longitudinal Bar Grate	0.75
	Longitudinal Bar Grate with recessed transverse bars	0.60
Continuous Grade	Combination(1)	Apply factors separately to grate and curb opening
Shallow Sheet Flow(2)	Slotted Drains	0.80

(1) See Section 3.3.4.3, Combination Catch Basins.

(2) Slotted drains are most effective for shallow sheet flow conditions. With greater depths and flows, a different type of inlet should be used.

The allowable capacity of a catch basin should be determined by applying the applicable factor from Table 3.2 to the theoretical capacity calculated in accordance with the appropriate design charts.

The percentage of theoretical capacity allowed may be even lower when the catch basin is likely to intercept large amounts of sediment or debris. For instance, the first catch basin to a pipe network draining a high debris-yielding area may actually accept only 20 percent of the theoretical capacity allowed because of clogging. Sediment traps should not be designed into the catch basin. A sediment trap formed by lowering the floor of the catch basin below the elevation of the outlet pipe is unnecessary and undesirable since there is too much turbulence for effective trapping at design flow rates, and cleaning is costly. Catch basins should be self-scouring, even under low-flow conditions.

3.3.4 Design Procedures

Figures 3.9 to 3.19 (pages 3-24 to 3-34) are capacity curves for standard catch basins. When designing a *nonstandard* catch basin, use the equations and procdures outlined herein. The approval of the governing municipality should be obtained before designing a nonstandard catch basin. The procedures and equations in this section are adapted from the Federal Highway Administration Hydraulic Engineering Circular No. 12 (HEC-12), *Drainage of Highway Pavements* (FHWA, 1984). Refer to Section 3.1 for definitions of coefficients used in the following equations.

3.3.4.1 Curb Opening Catch Basins

On-Grade: The length of curb opening catch basin required for total interception of gutter flow on a pavement section with a straight cross slope is expressed as:

$$L_T = 0.6Q^{0.42} S^{0.3} \left(\frac{1}{nS_x}\right)^{0.6} \tag{3.3}$$

STORM DRAIN HYDRAULIC GRADE LINE CHART

Project: ARIZONA TRADITIONS

FROM	TO	OUTLET WS (feet)	PIPE DIAM (in)	Q (cfs)	MNG'S "n"	PIPE LNGTH (feet)	FRCTN SLOPE (ft/ft)	FRCTN LOSS (feet)	FLOW VEL. (fps)	V^2/2g (feet)	INLET LOSS (feet)	OUTLET LOSS (feet)	PIPE COLLAR BEND ANGLE (dgrs)	BEND LOSS (feet)	SUM OF HD LOSS (feet)	TOTAL HD LOSS (feet)	INLET WS (feet)	RIM ELEV (feet)
Storm Drain Line 1 Calculations (10 Year Event)																		
CB 2R1-N	CB 2R1-S	1318.31	18	4.50	0.013	70	0.0018	0.13	2.55	0.10	0.03	0.04	0	0	0.06	0.19	1318.50	1322.00
CB 2R1-S	OUTLET	1318.00	18	8.90	0.013	10	0.0072	0.07	5.03	0.39	0.10	0.14	0	0	0.24	0.31	1318.31	1322.00
Storm Drain Line 2 Calculations (100 Year Event)																		
CB 2R2-S	CB 2R2-N	1314.58	18	8.40	0.013	70	0.0064	0.45	4.75	0.35	0.09	0.12	0	0	0.21	0.66	1315.24	1316.20
CB 2R2-N	OUTLET	1313.50	18	16.70	0.013	10	0.0253	0.25	9.45	1.39	0.35	0.48	0	0	0.83	1.08	1314.58	1316.20
Storm Drain Line 3 Calculations (10 Year Event)																		
CB 2R3-E	CB 2R3-W	1310.67	24	12.10	0.013	70	0.0029	0.20	3.85	0.23	0.06	0.08	0	0	0.14	0.34	1311.00	1312.50
CB 2R3-W	OUTLET	1310.00	24	24.20	0.013	10	0.0114	0.11	7.70	0.92	0.23	0.32	0	0	0.55	0.67	1310.67	1312.50
Storm Drain Line 4 Calculations (100 Year Event)																		
CB 4R1-W	CB 4R1-E	1309.56	18	11.30	0.013	72	0.0116	0.83	6.39	0.63	0.16	0.22	0	0	0.38	1.21	1310.78	1310.50
CB 4R1-E	OUTLET	1307.30	18	22.60	0.013	16	0.0463	0.74	12.78	2.54	0.63	0.89	0	0	1.52	2.26	1309.56	1310.50
Storm Drain Line 5 Calculations (10 Year Event)																		
CB 4R3-N	CB 4R3-S	1307.42	15	2.30	0.013	70	0.0013	0.09	1.87	0.05	0.01	0.02	0	0	0.03	0.12	1307.55	1314.70
CB 4R3-S	OUTLET	1307.25	15	4.50	0.013	10	0.0049	0.05	3.67	0.21	0.05	0.07	0	0	0.13	0.17	1307.42	1314.70

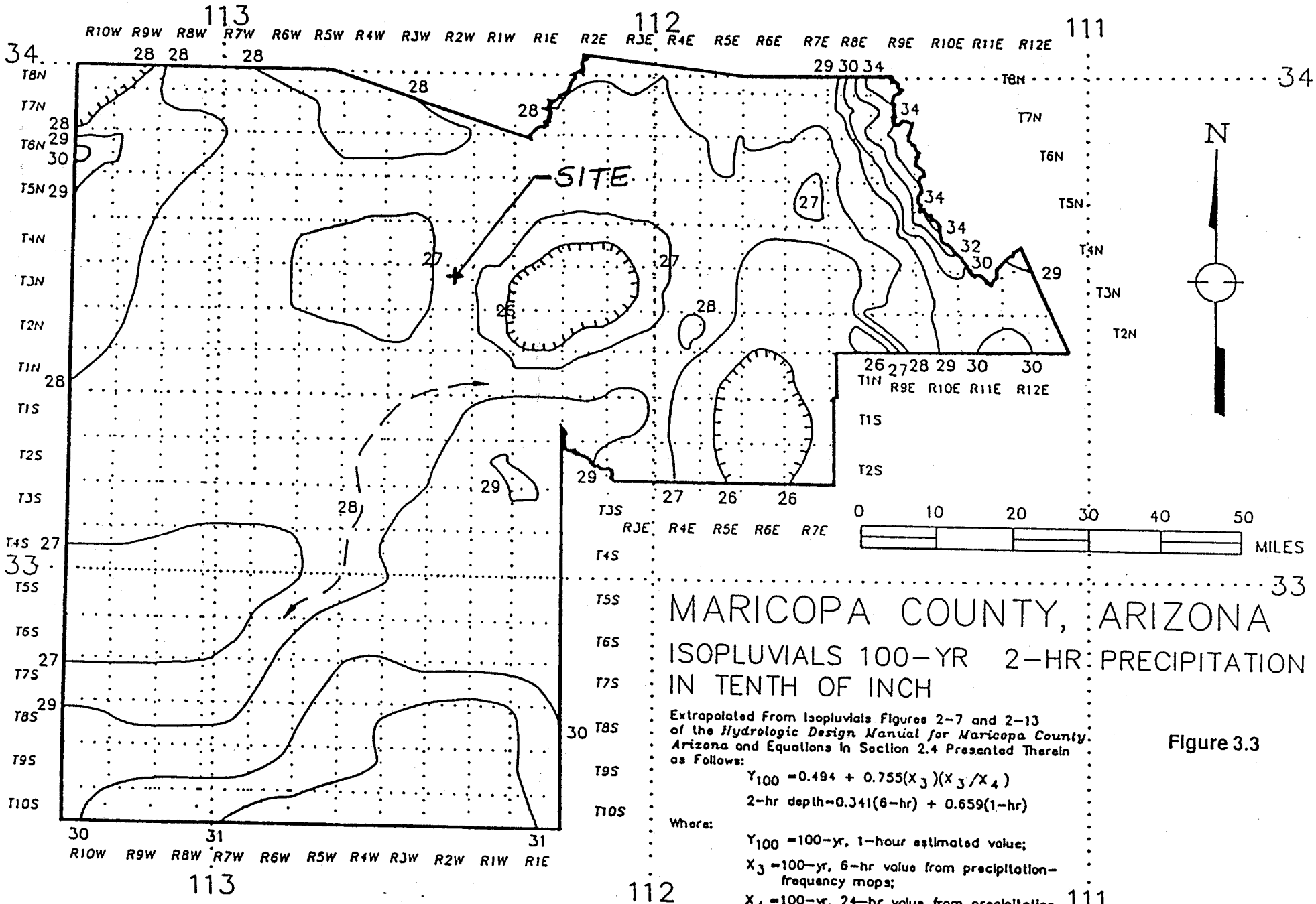
Inlet loss = 0.25 v^2\2g Outlet loss = 0.35 v^2/2g
Sum of head loss = inlet + outlet + bend losses
Total head loss = sum + friction loss

*NOTE: Starting WS at OUTLET is the crown height of the pipe.
Pipe Collar Bend loss = K v^2/2g

90 degrees > K = 0.70	60 degrees > K = 0.55	30 degrees > K = 0.28
80 degrees > K = 0.66	50 degrees > K = 0.47	20 degrees > K = 0.16
70 degrees > K = 0.61	40 degrees > K = 0.38	15 degrees > K = 0.10

APPENDIX C

RETENTION CALCULATIONS



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 100-YR 2-HR PRECIPITATION IN TENTH OF INCH

Extrapolated From Isopluvials Figures 2-7 and 2-13 of the *Hydrologic Design Manual for Maricopa County, Arizona* and Equations in Section 2.4 Presented Therein as Follows:

$$Y_{100} = 0.494 + 0.755(X_3)(X_3/X_4)$$

$$\text{2-hr depth} = 0.341(\text{6-hr}) + 0.659(\text{1-hr})$$

Where:

Y_{100} = 100-yr, 1-hour estimated value;

X_3 = 100-yr, 6-hr value from precipitation-frequency maps;

X_4 = 100-yr, 24-hr value from precipitation-frequency maps;

6-hr = Isopluvial values from figure 2.7;

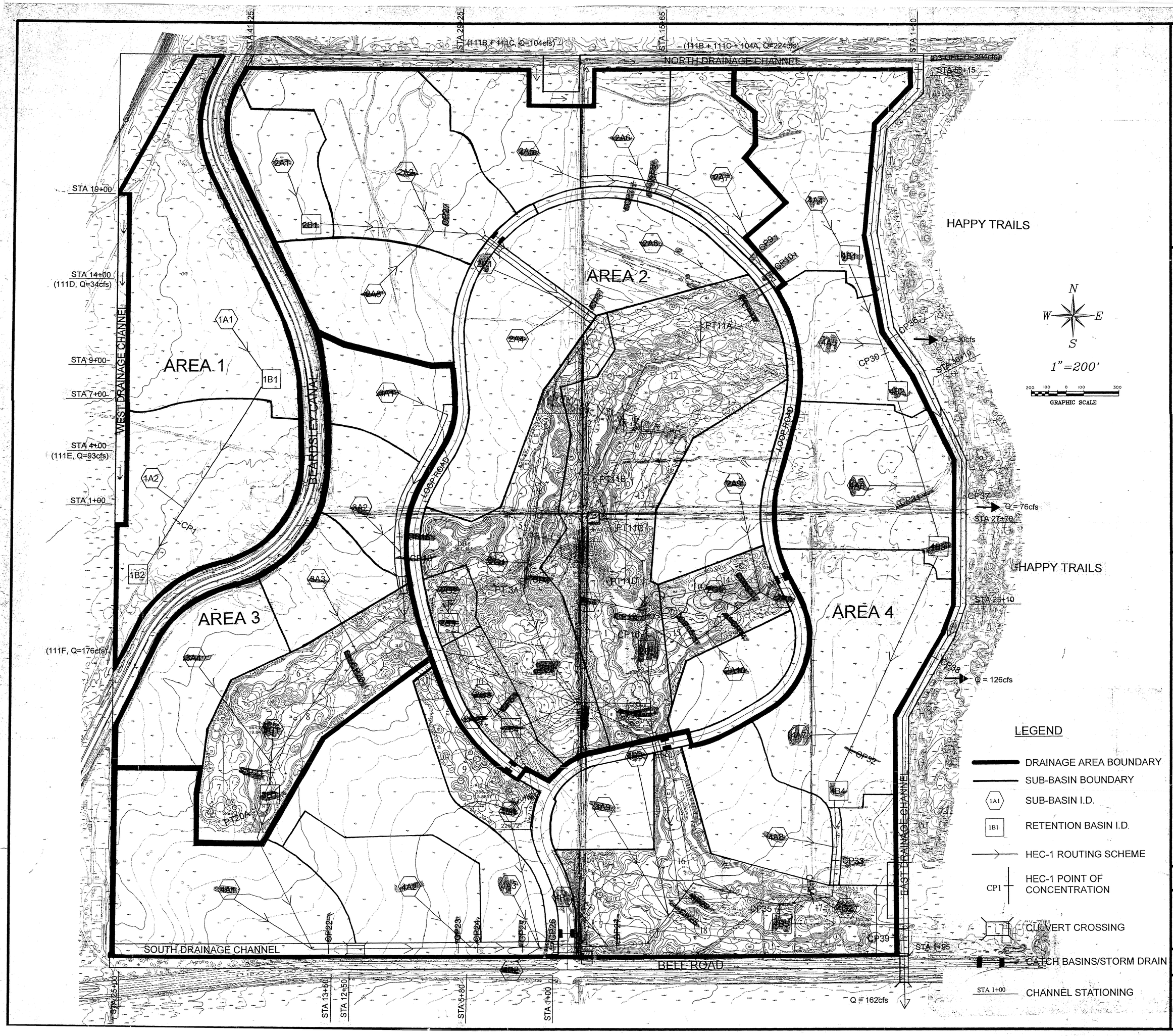
1-hr = Y_{100} value as computed above

Figure 3.3

Table 3.2
C Coefficients for Use with the Rational Method

Land Use	Return Period			
	2-10 Year	25 Year	50 Year	100 Year
Streets and Roads				
Paved Roads	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Gravel Roadways & Shoulders	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Industrial Areas				
Heavy	0.70 – 0.80	0.77 – 0.88	0.84 – 0.95	0.88 – 0.95
Light	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Business Areas				
Downtown	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Neighborhood	0.55 – 0.65	0.61 – 0.72	0.66 – 0.78	0.69 – 0.81
Residential Areas				
Lawns – Flat	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
– Steep	0.25 – 0.40	0.28 – 0.44	0.30 – 0.48	0.31 – 0.50
Suburban	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Single Family	0.45 – 0.55	0.50 – 0.61	0.54 – 0.66	0.56 – 0.69
Multi-Unit	0.50 – 0.60	0.55 – 0.66	0.60 – 0.72	0.63 – 0.75
Apartments	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Parks/Cemetaries	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
Playgrounds	0.40 – 0.50	0.44 – 0.55	0.48 – 0.60	0.50 – 0.63
Agricultural Areas	0.10 – 0.20	0.11 – 0.22	0.12 – 0.24	0.13 – 0.25
Bare Ground	0.20 – 0.30	0.22 – 0.33	0.24 – 0.36	0.25 – 0.38
Undeveloped Desert	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Mountain Terrain (Slopes > 10%)	0.60 – 0.80	0.66 – 0.88	0.72 – 0.95	0.75 – 0.95

Note: Values of C for 25, 50 and 100 Year were derived using frequency adjustment factors of 1.10, 1.20, and 1.25, respectively, with an upper limit of 0.95 for C for the 2-10 Year values.



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MASTER DRAINAGE MAP
FOR
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SURPRISE ARIZONA

Job No. 931007

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Date

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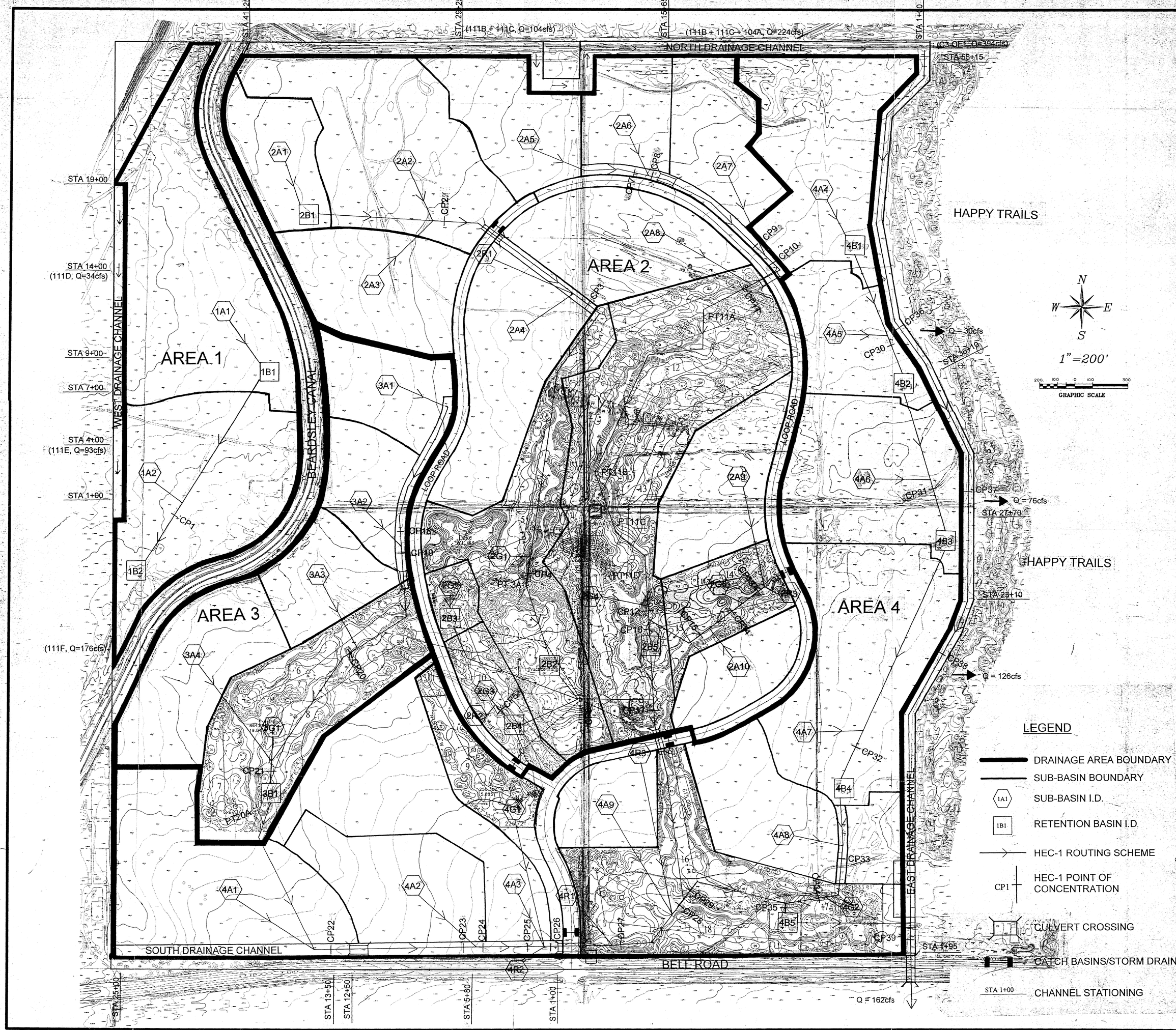

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