Drainage Study for the Curley School Detention Basin, Ajo

Prepared For:
Pima County

Submitted to:
Pima County

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1.0 INTRODUCTION

1a. Site Location and Project Description

This drainage report has been prepared for the proposed Curley School Detention Basin located in Ajo, Arizona. The site is located in Township 12 South, Range 6 West, Section 22 in Ajo, Arizona. See Figure 1 for Location Map.

Ajo experienced a severe flood on July 29, 2003 from 7:45 p.m to 9:00 p.m, producing a significant amount of rainfall and flooding, primarily along the Gibson Arroyo and tributaries located South of Gibson Arroyo.

The Pima County Regional Flood Control District (PCRFCD) quickly responded to the flood and provided immediate assistance in the form of maintenance of the streets, bridges, and portions of the Gibson Arroyo. PCRFCD staff members also documented the extent of damage to homes and infrastructure and interviewed the residents. Tetra Tech, Inc. was asked to provide an Emergency Evaluation Report on the flooding and prepare a preliminary hydrologic and hydraulic analysis. Tetra Tech submitted the results of that analysis in August 2004.

One of the Gibson Arroyo tributaries studied by Tetra Tech flows south from Camelback Mountain, through an unnamed natural wash that conveys flow to two culverts just upstream of Curley School. Part of the flow enters the culverts and is conveyed into an existing channel upstream of Curley School. The remainder of the flow breaks out onto the Curley School property. The contributing area for these flows is designated as Watershed D in Tetra Tech's report. See Figure 2 for Watershed Map.

DMJM Harris was hired by PCRFCD to verify the discharge reported by Tetra Tech and to evaluate alternatives to detain future floods and regulate the discharge at a site upstream of Curley School. The site is 4 acres of undeveloped land, consisting of a ball field and a section of the unnamed natural wash previously mentioned.

Figure 1. Location Map

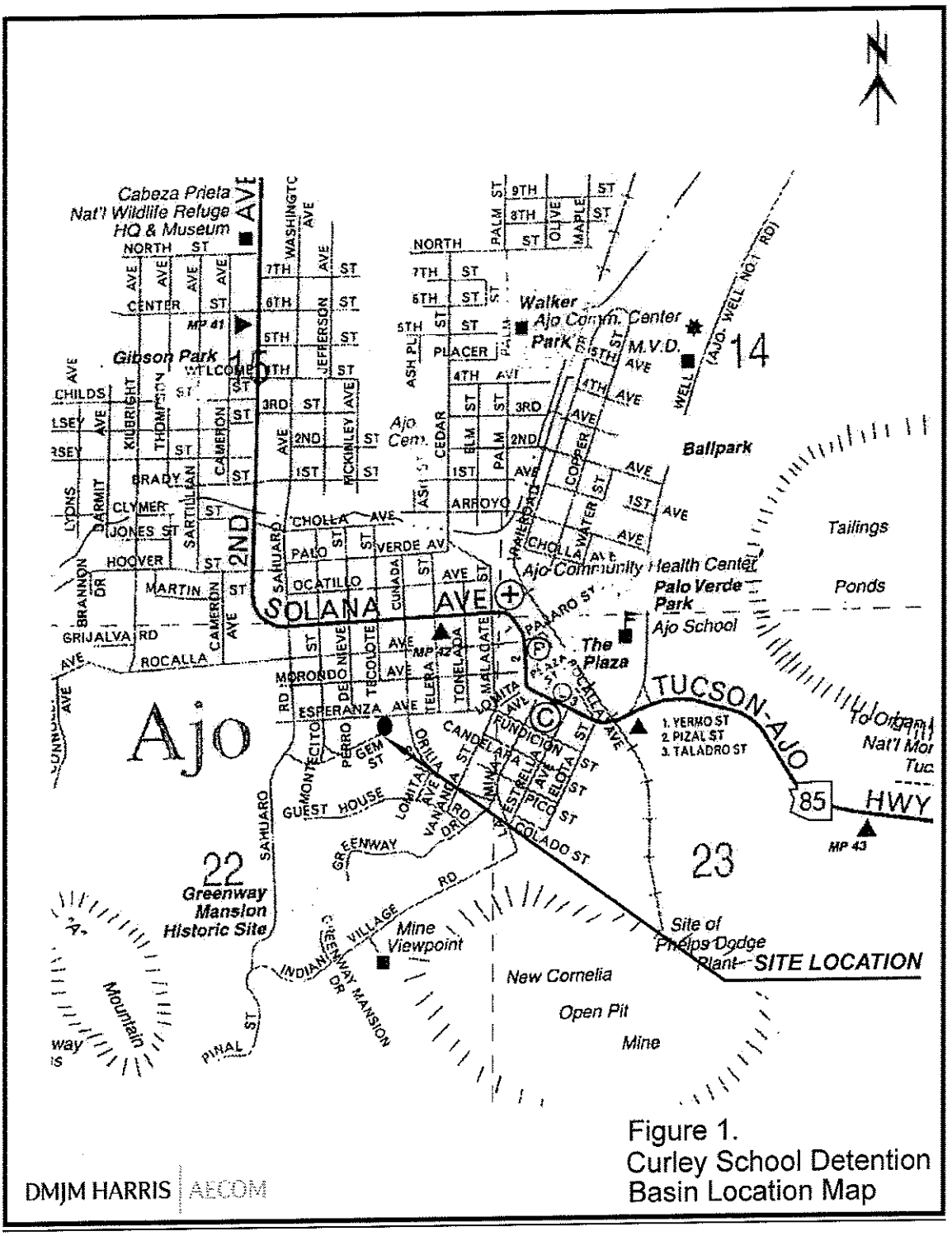
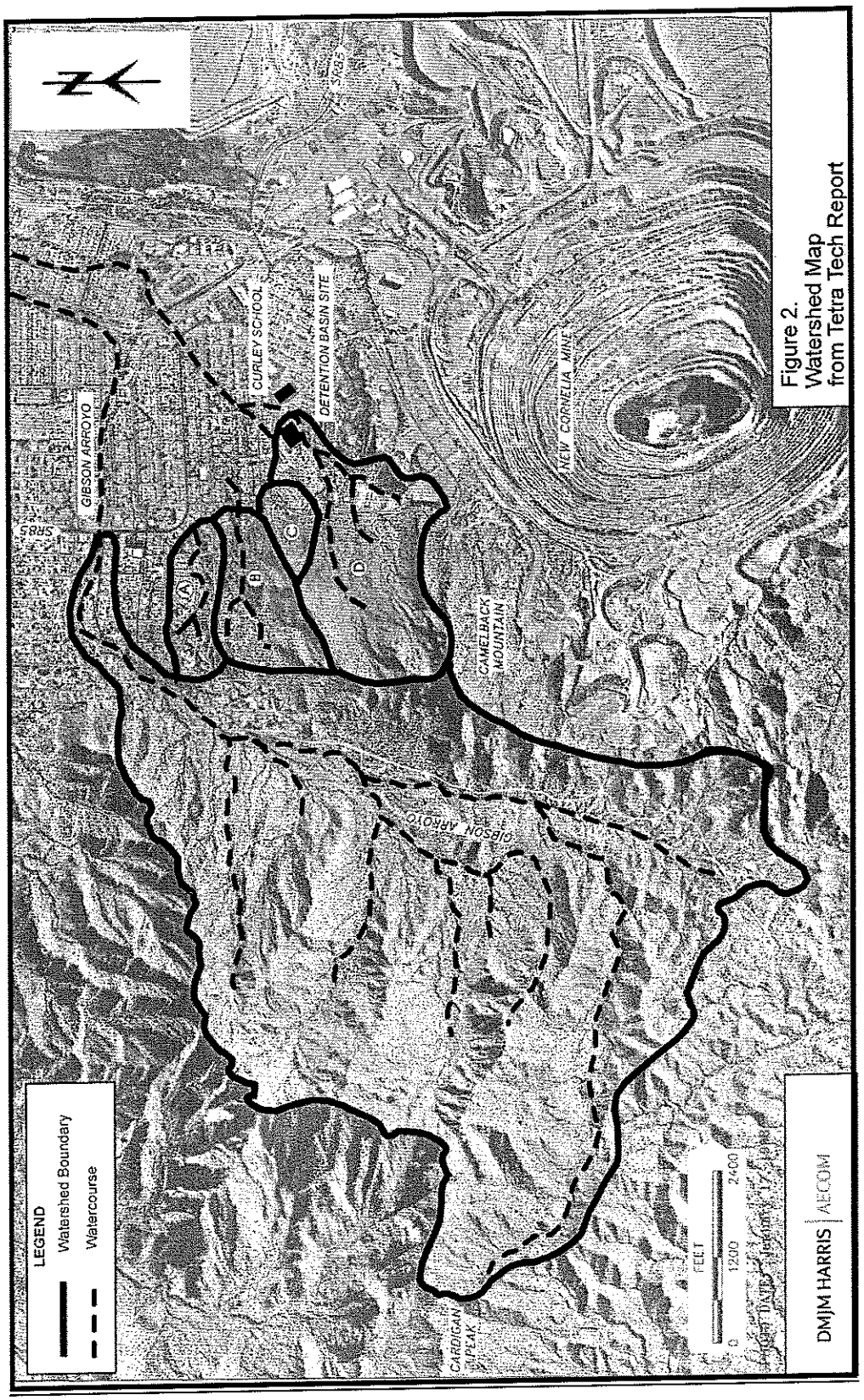


Figure 2. Site Map



2.0 OBJECTIVE

The purpose of this report is to fulfill Pima County's drainage requirements and:

1. Verify the 100 year flow impacting the site.
2. Develop alternatives to reduce the flow downstream of the site.
3. Determine the pre- and post-development flows for each alternative.
4. Recommend a detention solution that meets PCRFCD drainage requirements for a 100 year storm event.

3.0 HYDROLOGY

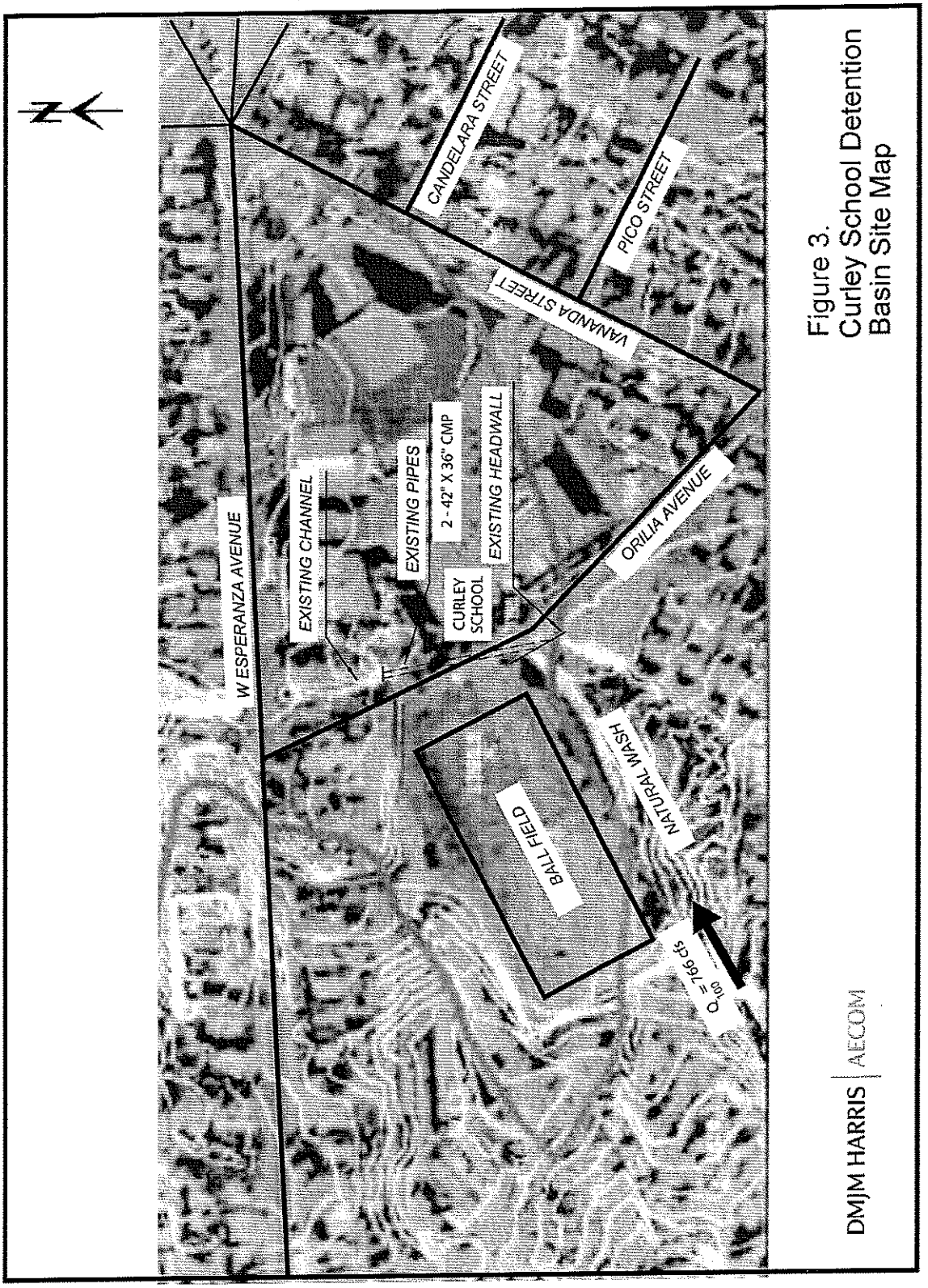
3a. Existing Conditions

The watershed being studied is 124 acres in size and is bounded by the Gibson Arroyo Watershed on the west and urban development on the east. The downstream reaches of the watershed are partly urban and partly undeveloped land covered by natural vegetation. The upstream reaches of the watershed lie within Camelback Mountain and are covered by natural vegetation. Soil mapping for the area shows the site to consist of 100% D soils. The aerial photograph provided in Tetra Tech report provides some details of the surface drainage water course. This particular area is referred as "Watershed D" in the Tetra Tech report.

DMJM Harris used quadrangle maps available through QuadUsa to identify the 20 foot contours and resultant length of the water course for the watershed. Aerial mapping provided by Tetra Tech was used to identify one foot contours. It was determined that Watershed D consists of a relatively steep topography with a relatively well defined watercourse.

Watershed D is 124 acres in size and has a discharge of 766 cfs. The discharge is conveyed by a natural wash to a headwall and culverts at the eastern boundary of the site. See Figure 3 for the Site Map. Two existing horizontally elliptical 42" x 36" culverts convey the flows to an existing channel located downstream and northeast of the site. The remaining 666 cfs currently breaks across the Curley School property.

Figure 3. Existing Site Map



4.0 METHODOLOGY

The "Hydrology Manual for Engineering Design and Flood Plain Management within Pima County, Arizona" was used to determine the 100-year discharge for Watershed D.

Culvert Master Software was used to determine the discharge and water surface elevation for different culvert sizes. Reservoir routing was performed to determine the outflow from the detention area for 100-year flow. Hydrographs were generated from the PCRFCD/City of Tucson, Stormwater Detention/Retention Manual curvilinear dimensionless hydrograph using the peak flows and times of concentration from the Pima County Hydrologic Data Sheets. The Modified Puls method was used to perform the reservoir routing.

5.0 FUTURE CONDITIONS

The following three alternatives were analyzed. The 100-year design storm was used in analyzing these Alternatives.

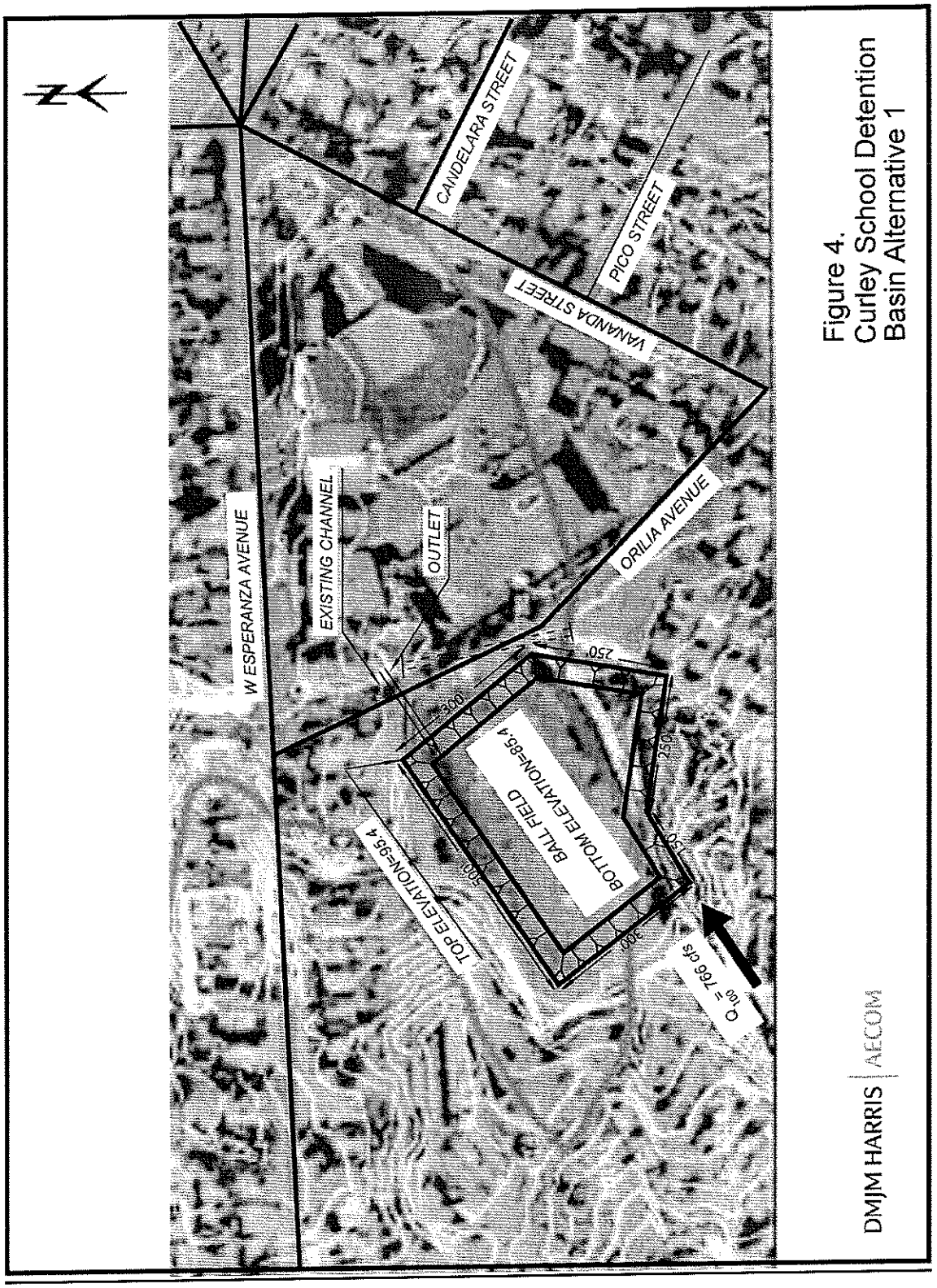
5a. Alternative 1

For Alternative 1, the ball field and channel are combined into one detention basin. Both the ball field and the natural wash would be excavated. The total amount of flow entering directly into the proposed basin would be 766 cfs. Outlet culverts would convey flows directly into the existing downstream channel. See Figure 4 for a display of Alternative 1.

Detention Basin Parameters:

Bottom Elevation	: 85.4
Top of Detention Basin	: 95.4
Volume to top(acre-ft)	: 34.7
Side Slopes	: 4:1

Figure 4. Alternative 1



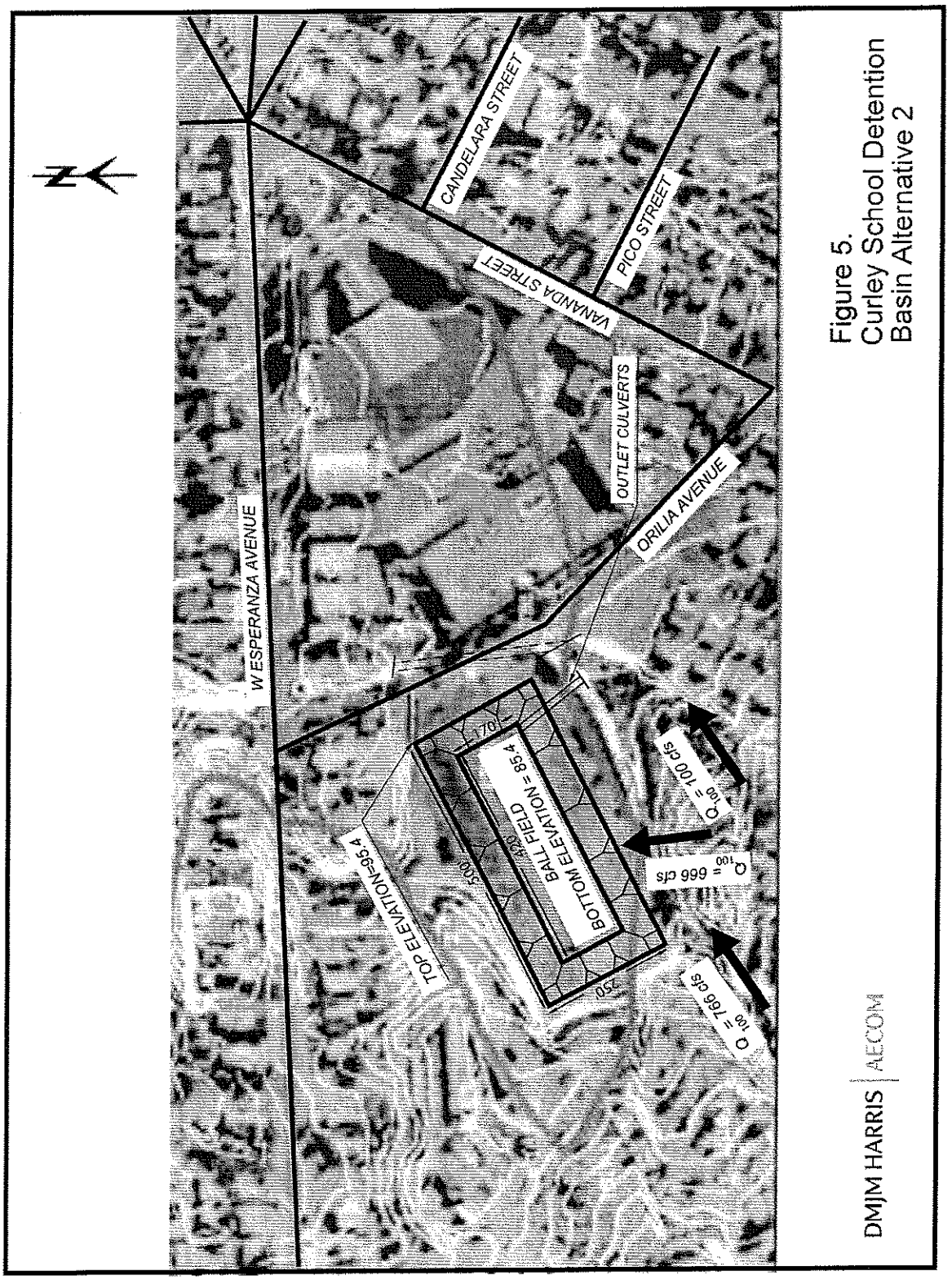
5b. Alternative 2

For Alternative 2, only the ball field is excavated and used as a detention basin. The detention basin discharge flows into the existing natural wash. It was assumed that approximately 100 cfs would continue to be conveyed through the natural wash to the existing culverts and into the existing downstream channel. Flows in excess of 100 cfs would enter the detention basin. The existing culverts would be left in place and new culverts would be placed between the detention basin and natural channel. See Figure 5 for a display of Alternative 2.

Detention Basin Parameters:

Bottom Elevation	: 85.4
Top of Detention Basin	: 95.4
Volume to top (acre-ft)	: 22.3
Side Slopes	: 4:1

Figure 5. Alternative 2



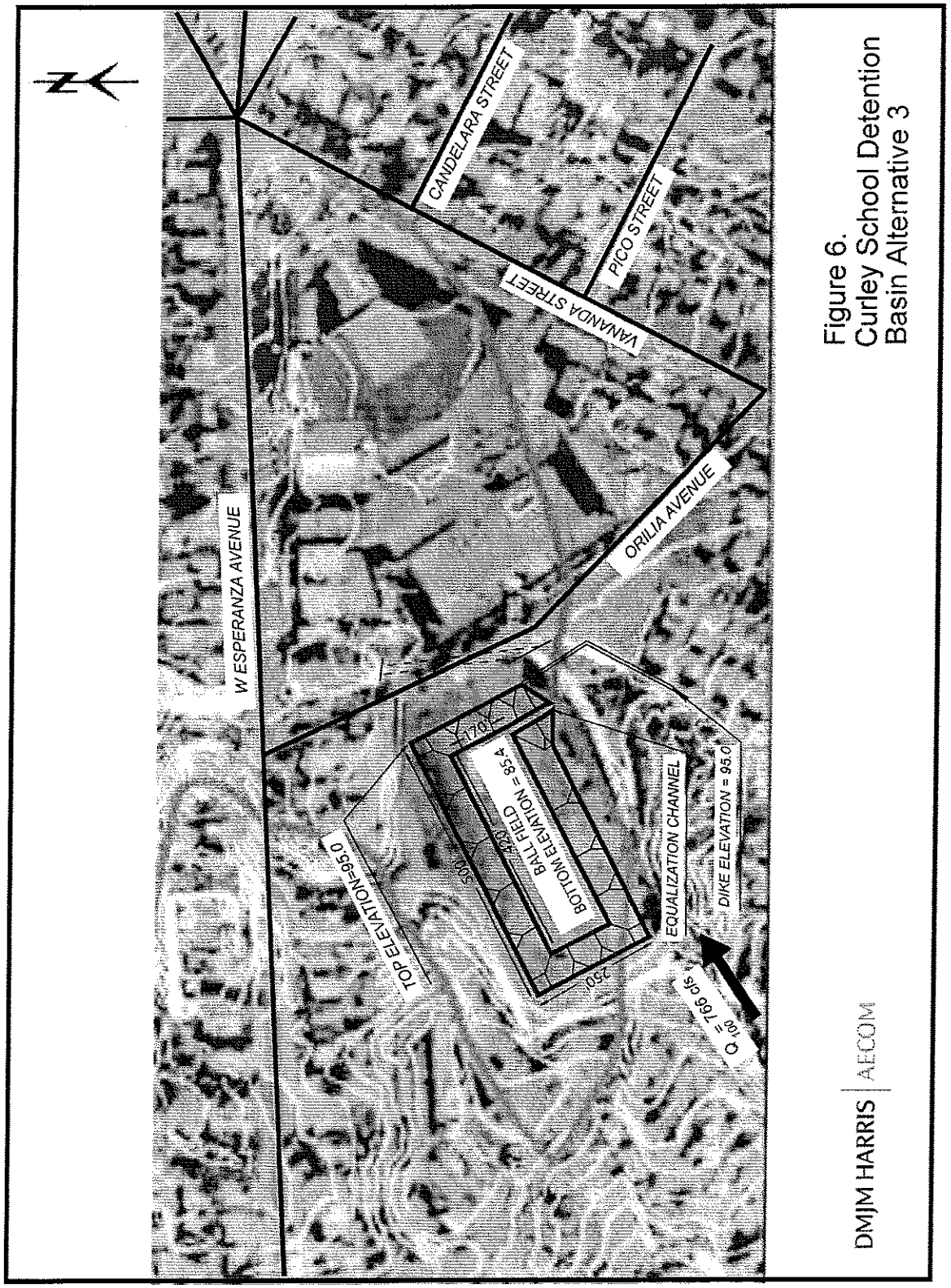
5c. Alternative 3

This alternative combines an excavated detention basin at the ball field with a smaller natural basin in the channel. This would be accomplished by constructing a dike around the existing headwall in order to prevent breakouts. The ball field would be completely excavated. The natural wash would not be graded. A small area in between the detention basin and the natural channel would be excavated as an "equalization channel". The flow would be conveyed into the natural wash and as the water surface elevation rises, runoff would back up into the ball field. A variety of outlet culverts were analyzed. New culverts would be constructed to convey the flow into the existing downstream channel. See Figure 6 for a display of Alternative 3.

Detention Basin Parameters:

Bottom Elevation (ft)	: 85.4
Top of Detention Basin (ft)	: 95.0
Top of Dike Elevation (ft)	: 90.0
Volume to top(acre-ft)	: 25.58
Side Slopes	: 4:1

Figure 6. Alternative 3



6.0 RESULTS

The appendices consist of the following materials.

Appendix A consists of hydrologic calculations, excerpts from "Hydrology Manual for Engineering Design and Flood Plain Management within Pima County, Arizona" and the rainfall calculations.

Appendix B consists of the results of the analysis for Alternative 1. The appendix consists of detention basin calculations, flood routing output files and culvert hydraulics output files.

Appendix C consists of the results of the analysis for Alternative 2. The appendix consists of detention basin calculations, flood routing output files and culvert hydraulics output files.

Appendix D consists of the results of the analysis for Alternative 3. The appendix consists of detention basin calculations, flood routing output files and culvert hydraulics output files.

Appendix E consists of culvert hydraulics output files for existing conditions.

6a. Alternative 1

A variety of outlet culverts were analyzed. The results of this analysis are detailed in Appendix B. Utilizing 1-30" culvert will result in a maximum discharge of 50.90 cfs and a maximum water surface elevation of 91.33. This elevation is four ft below the top of the detention basin. The storage at this water surface elevation is 18.83 acre-ft. The downstream discharge of 50.90 cfs is less than what is being conveyed now. This alternative would eliminate all breakouts. Table 1 shows the results for Summary of Alternative Outlet Analysis.

Table 1

	Outlet Culvert(s)			
	1 - 30"	**2 - 24"**	**2 - 30"**	**2 - 36"**
Max. WSE	91.33	91.2	90.91	90.69
Max. Outflow (cfs)	50.90	60.60	96.50	128.60
Max. Volume (acre-ft)	18.83	18.34	17.33	16.54

6b. Alternative 2

A variety of outlet culverts were analyzed. The results of this analysis are detailed in Appendix C. Utilizing 2-24" culverts will result in a maximum discharge of 54.50 cfs and a maximum water surface elevation of 93.22. This elevation is two ft below the top of the

detention basin. The storage at this water surface elevation is 16.37 acre-ft. This will continue to convey the 100 cfs to the downstream channel. It will reduce the breakout at the inlet headwall from 667 cfs to 54.50 cfs. Table 2 shows the results for Summary of Alternative Outlet Analysis.

Table 2

	Outlet Culvert(s)			
	2 - 24"	2 - 30"	2 - 36"	2 - 42"
Max. WSE	93.22	92.9	92.58	92.25
Max. Outflow (cfs)	54.50	85.80	121.80	159.80
Max. Volume (acre-ft)	16.37	15.56	14.75	13.95

6c. Alternative 3

A variety of outlet culverts were analyzed. The results of this analysis are detailed in Appendix D. Utilizing 2-24" culvert will result in a maximum discharge of 67.50 cfs and a maximum water surface elevation of 92.93. This elevation is two ft below the top of the detention basin. The storage at this water surface elevation is 17.86 acre-ft. The downstream discharge of 67.50 cfs is less than what is being conveyed now. This alternative would eliminate all breakouts. Table 3 shows the results for Summary of Alternative Outlet Analysis.

Table 3

	Outlet Culvert(s)					
	1 - 30"	2 - 24"	2 - 30"	2 - 36"	2 - 42"	2 - 48"
Max. WSE	93.67	92.93	92.51	92.16	91.84	91.54
Max. Outflow (cfs)	58.70	67.50	113.30	154.80	195.70	235.00
Max. Volume (acre-ft)	18.35	17.86	16.52	15.38	14.38	13.50

7.0 RECOMMENDATIONS

It is recommended that Alternative 3 be selected. It will reduce the flows in the downstream channel and eliminate breakout flows onto the Curley School property. There will also be minimum impacts to the natural wash. Pima County will be responsible for ownership and operation, as well as scheduled and unscheduled maintenance of the site. A 404 permit may be required for this project based on the alternative selected and its associated impacts. If this alternative is selected by Pima County, it is also recommended that a design concept report be prepared for this alternative.

REFERENCES

Emergency Evaluation Study Report on the July 29, 2003, Flooding in Ajo, Arizona, August 2004, Tetra Tech, Inc.

Hydrology Manual for Engineering Design and Flood Plain Management within Pima County, AZ, September 1979

Pima County Department of Transportation and Flood Control District/City of Tucson, Stormwater Detention/Retention Manual, July 1987 and revisions.

USGS QuadMap, Ajo South

Appendix A

Hydrologic Calculations

Excerpts from

Hydrology Manual for Engineering Design and Flood Plain Management within PIMA County, AZ

Watershed Type	Mean Slope (S_c)	n_b(Min.)	n_b(Norm.)	n_b(Max.)
III. Valley	Generally less than .01 ft./ft.	.027	.030 - .040	.050

Typically, the drainage area has compartively uniform, gentle slopes and surface characteristics such that, in many cases, well-defined channelization does not occur. Ground cover consists of growths of grass and small shrubs, cacti, or similar vegetation. No drainage improvements exist in the area.

3. Developed Areas

Watershed Type	Density	n_b(Min.)	n_b(Norm.)	n_b(Max.)
IV. Suburban-Foothills	Less than 1 house per acre	.029	.034	.038
Suburban-Valley	Less than 1 house per acre	.027	.029 - .038	.047
Suburban-Foothills	1 to 2 houses/acre	.028	.032	.036
Suburban-Valley	1 to 2 houses/acre	.026	.028 - .036	.045

Typically, the drainage area has fairly uniform, gentle slopes with some watercourses either improved or along paved streets.

Watershed Type	Density	n_b(Min.)	n_b(Norm.)	n_b(Max.)
V. Light to Moderate Urbanization (Includes light industrial)	3 to 5 houses per acre (detached)	.020	.022	.025

Typically, the drainage area has fairly uniform, gentle slopes with most watercourses either improved or along paved streets.

Watershed Type	Density	n_b(Min.)	n_b(Norm.)	n_b(Max.)
VIa. Highly Urbanized	Multiple Dwellings Moderate Industrial and Light Commercial	.018	.020	.022

Typically, the drainage area is similar to a lightly to moderately urbanized basin, except that appreciable areas are developed to the extent that a large percentage of the watershed is impervious and essentially all watercourses are either improved or along paved streets and/or surfaces.

Watershed Type	Density	n_b(Min.)	n_b(Norm.)	n_b(Max.)
VIb Highly Urbanized	Heavy Commercial and Industrial	.015	.018	.020

LEGEND

HYPERTHERMIC (VERY HOT) ARID SOILS:

1. Gilman-Antho-Valencia association: Deep soils on floodplains and alluvial fans. Hydrologic soil group(s) = 100% B.

2. Mohall-Laveen-Coolidge association: Deep soils on the valley plains and old terraces. Hydrologic soil group(s) = 100% B.

3. Gunsight-Rillito-Harqua association: Deep, gravelly, calcareous soils on the upper slopes. Hydrologic soil group(s) = 88% B and 12% C.

4. Rock Outcrop-Lomitas, Cherioni association: Rock outcrop and very shallow and shallow soils on low hills and mountains. Hydrologic soil group(s) = 100% D.

THERMIC (HOT) ARID AND SEMI-ARID SOILS:

5. Grabe-Gila-Pima association: Deep soils of the floodplains. Hydrologic soil group(s) = 100% B.

6. Anthony - Sonoita association: Deep, arid soils on the alluvial fans and valley slopes. Hydrologic soil group(s) = 100% B.

7. Continental-Sonoita-Tubac association: Deep, arid soils on uplands. Hydrologic soil group(s) = 36% B and 64% C.

8. Mohave-Tres Hermanos-Anway association: Deep, arid soils on the valley plans. Hydrologic soil group(s) = 100% B.

9. Pinaleno-Nickel-Palos Verdes association: Deep, arid, gravelly soils on deeply dissected uplands. Hydrologic soil group(s) = 100% B.

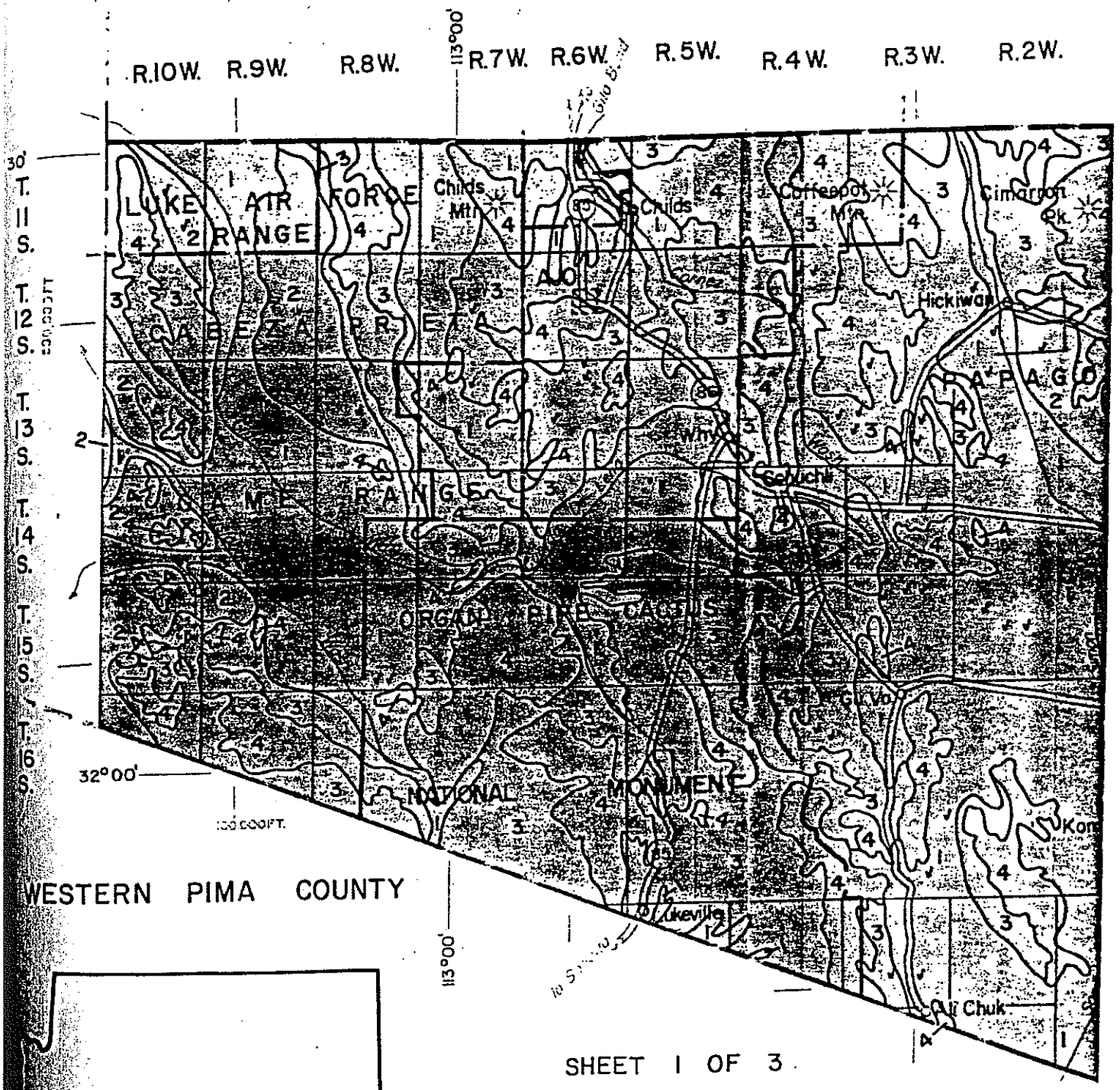
10. Rillino-Latene-Cave association: Deep to very shallow, arid calcareous soils on uplands. Hydrologic soil group(s) = 80% B and 20% D.

11. White House-Bernadino-Caralampi association: Deep, semiarid soils on uplands. Hydrologic soil group(s) = 27% B and 73% C.

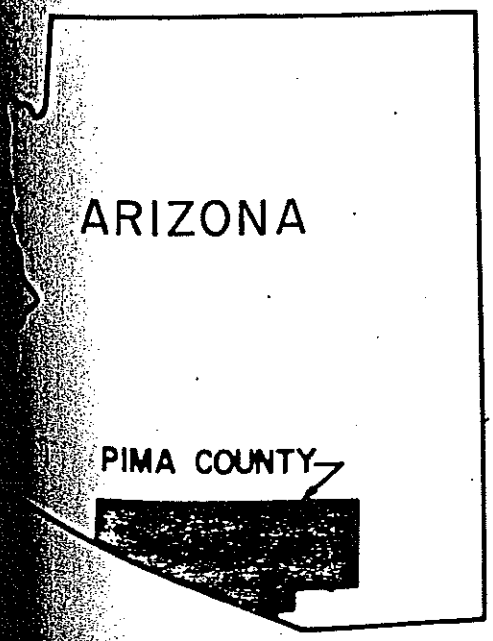
12. Caralampi-Hathaway association: Deep, semiarid gravelly soils on deeply dissected uplands. Hydrologic soil group(s) = 100% B. 10

13. Rock Outcrop-Lampshire-Cellar association: Rock outcrop and very shallow and shallow semiarid soils of the mountains and foothills. Hydrologic soil group(s) = 100% D. 90

14. Rock Outcrop-Barkerville-Faraway association: Rock outcrop and very shallow and shallow subhumid soils of the mountains. Hydrologic soil group(s) = 40% C and 60% D.



SHEET 1 OF 3



LOCATION MAP

GENERAL SOIL MAP

PIMA COUNTY

ARIZONA

SOURCE: U.S. Department of Agriculture Soil Conservation Service

FEBRUARY 1974

10 0 10 20 MILES

SCALE 1:500,000

HYDROLOGIC COVER DENSITY

Hydrologic cover density is defined as the percent of the ground surface covered by the crown canopy of live plants and litter.

The Soil Conservation Service determines vegetation cover density by field surveys of carefully selected locations within the drainage area. However, where runoff from numerous small drainage areas is to be determined, an approximation of the vegetative cover based on visual observation will be adequate.

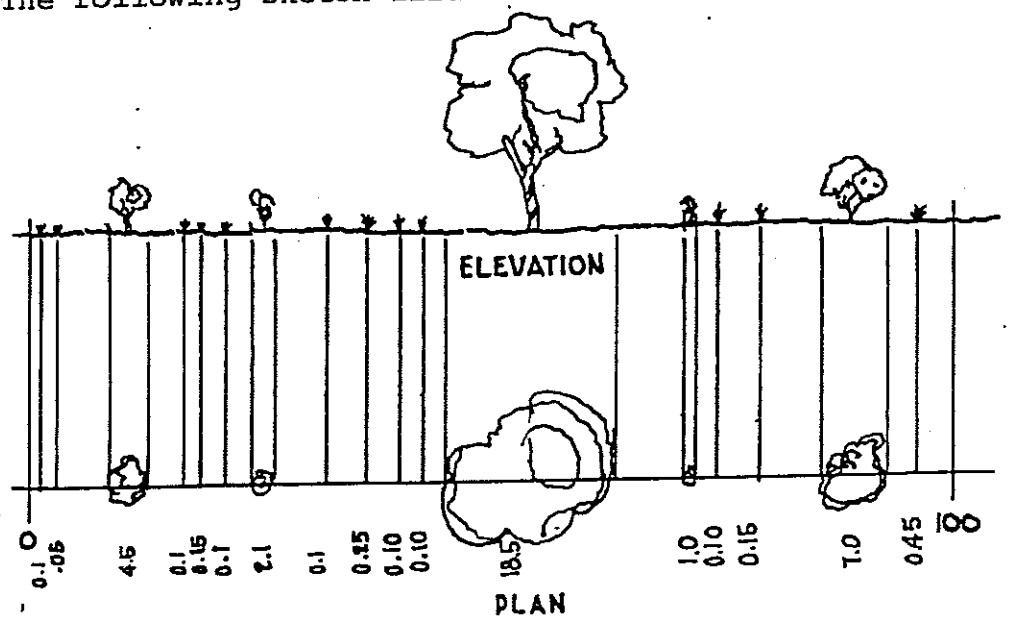
Three broad ranges of vegetative cover density have been established:

Poor	0 - 20% Vegetative cover
Fair	20% - 40% Vegetative cover
Good	40% + Vegetative cover

When possible, vegetative cover densities should be determined by field investigation conducted in the following manner:

1. An area representing the typical vegetative cover density for the drainage area is selected.
2. A 100 foot chain is stretched out between two posts, approximately 3 feet above ground level.
3. The intercepts of the vegetative cover along the 100 foot length are noted.
4. The total distance covered by vegetation and litter along the 100 foot length are summed up and represent the percent of vegetative cover for the selected area.
5. Several determinations may have to be made to compute the average percent of cover for the drainage area.

The following sketch illustrates the field procedure:

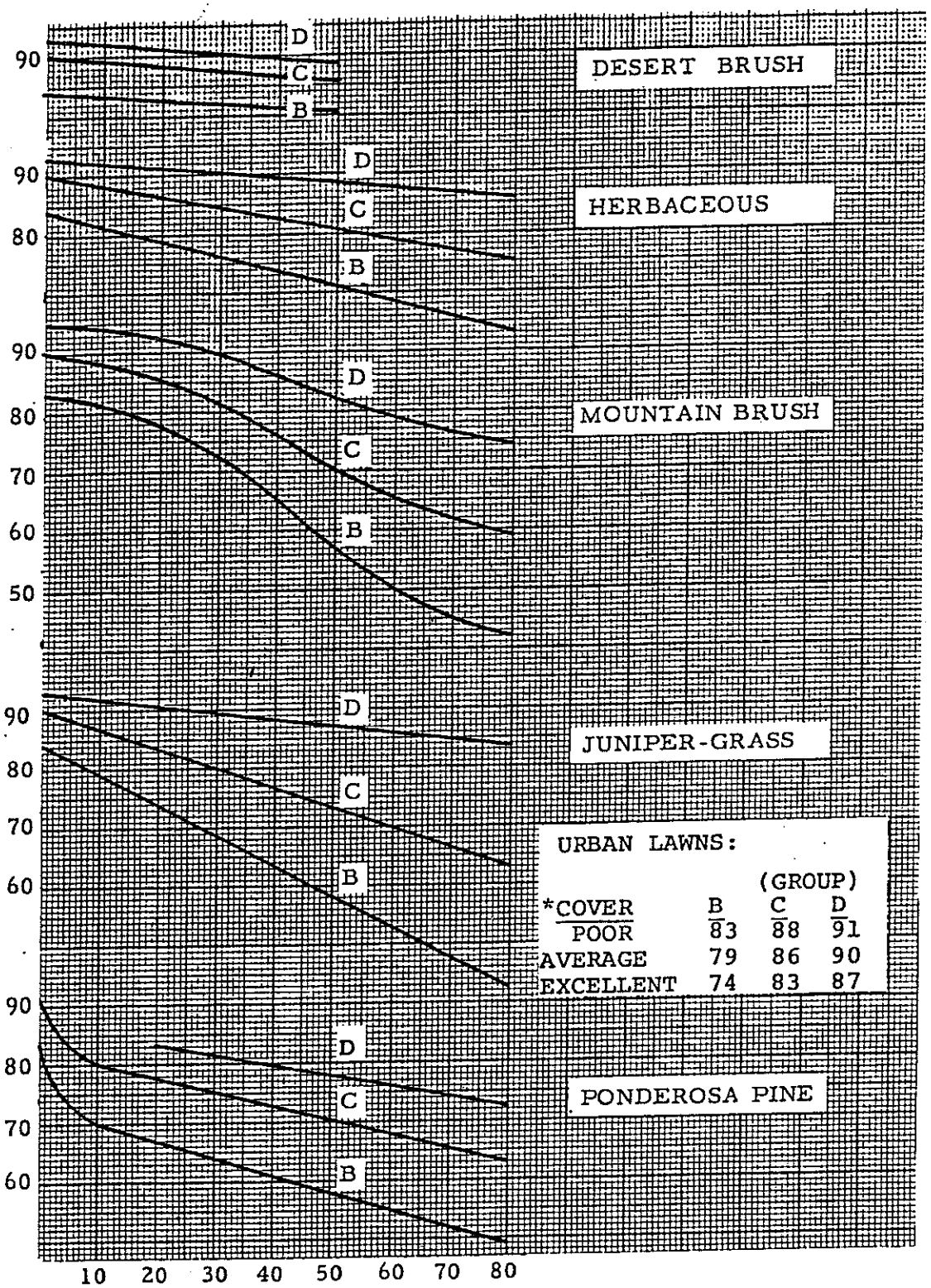


ESTIMATION OF IMPERVIOUS COVER

The values presented in the following table are intended to serve as a general guide; and, as such, cover a wide range of values. However, as a general rule, the values indicated as being "average" for the type of development anticipated should be utilized. Adjustments to these "average" values should be made on the basis of proposed subdivision plats and/or area plans, neighborhood plans, and existing development, etc., which would affect the degree of imperviousness of the watershed(s) under investigation.

* Type of Development Anticipated in Watershed	Percent of Impervious Cover Minimum	Average	Maximum
Suburban:			
(a) Less than 1 house/acre	5%	10%	20%
(b) 1 house/acre	15%	20%	25%
(c) 2 houses/acre	25%	30%	35%
Light to Moderate Urbanization:			
(a) 3 houses/acre	30%	35%	40%
(b) 4 houses/acre (detached)	35%	40%	45%
(c) 5 houses/acre (detached)	45%	50%	55%
Highly Urbanized:			
(a) Multiplied Dwellings (4 units/acre, or more)	50%	65%	90%
(b) Light Industrial & Commercial	50%	65%-75%	80%
(c) Heavy Industrial & Commercial	80%	85%-95%	100%

*It is assumed, in all cases, that paved streets are adjacent to at least one side of a developed lot.



URBAN LAWNS:

*COVER	(GROUP) B	C	D
POOR	83	88	91
AVERAGE	79	86	90
EXCELLENT	74	83	87

*Where
Poor = Less than 1/3.
Average = 1/3 to 2/3.
Excellent = more than 2/3.

HYDROLOGIC SOIL - COVER COMPLEXES
AND ASSOCIATED CURVE NUMBERS

Source : Soil Conservation Service
(Except Urban Lawns)

CHART FOR ADJUSTED CURVE NUMBERS (CN*'s)

CN	R_1	R_2
95	98.67	80.08
94	98.33	78.76
93	98.00	77.44
92	97.50	76.12
91	97.00	75.24
90	96.50	73.92
89	96.00	72.60
88	95.50	71.72
87	95.00	70.40
86	94.50	69.52
85	94.00	68.20
84	93.50	66.88
83	93.00	66.00
82	92.50	65.12
81	92.00	63.80
80	91.50	62.92
79	91.00	62.04
78	90.00	60.72
77	89.50	59.84
76	89.00	58.96
75	88.50	58.08
74	88.00	56.76
73	87.00	55.88
72	86.50	55.00
71	86.00	54.12
70	85.00	53.24
69	84.50	52.36
68	84.00	51.04
67	83.00	50.16
66	82.50	49.28
65	82.00	48.40
64	81.00	47.52
63	80.00	46.64
62	79.00	45.76
61	78.50	44.88
60	78.00	44.00

$$CN^* = \frac{R_1(P_1 - .88) + R_2}{P_1}$$

Where

P_1 = 1 hour rainfall depth.

(Use areal depth, if applicable).

Notes: (1) P_1 must always be greater than .88 inches.

(2) For impervious areas, CN* = 99 (constant).

RUNOFF TO RAINFALL RATIO(S) - (C), AND RUNOFF SUPPLY RATE (q)

The equation used within this Manual for the determination of runoff to rainfall ratios (C's) is a modification of the U.S. Department of Agriculture Soil Conservation Service's "Rainfall-Runoff Relation". For a detailed derivation of this relationship, the designer should refer to the following source:

> The Soil Conservation Service National Engineering Handbook, Section 4 - Hydrology, Chapter 10: Estimation of Direct Runoff From Storm Rainfall.

The equation is:

$$C = \frac{(P_1 - .2S)^2}{P_1(P_1 + .8S)} \quad \text{(dimensionless).}$$

Where

P_1 = one (1) hour rainfall depth.

$S = \frac{1000}{CN^*} - 10$ = potential abstraction.

(CN* - adjusted curve number)

Several important facts must be kept in mind when using this equation:

(1) The adjusted curve number (CN*) is equal to a constant (never varies) for impervious areas. This constant is equal to 99.

(2) Separate runoff to rainfall ratios (C's) must be determined for each type of hydrologic group (pervious and/or impervious) within a particular watershed under investigation. That is, a weighted runoff to rainfall ratio (C) cannot be determined by first weighting the adjusted curve numbers (CN*'s) before solving the aforementioned equation (such an approach would lead to a gross underestimation of peak rates of discharge from more frequent events such as the two (2) year storm).

Once the runoff to rainfall ratio or ratios (C's) have been determined, the runoff supply rate (q) becomes:

$$q = C_w i \quad \text{(inches/hour).}$$

FACTORS (F's) FOR DETERMINING RAINFALL INTENSITIES(i's) WHEN DURATIONS ARE LESS THAN ONE (1) HOUR

T (minutes)	F	T (minutes)	F
5	3.48	33	1.48
6	3.32	34	1.46
7	3.15	35	1.43
8	2.99	36	1.41
9	2.84	37	1.38
10	2.70	38	1.36
11	2.61	39	1.34
12	2.52	40	1.31
13	2.44	41	1.29
14	2.37	42	1.27
15	2.28	43	1.25
16	2.22	44	1.23
17	2.16	45	1.22
18	2.10	46	1.20
19	2.04	47	1.18
20	1.99	48	1.17
21	1.93	49	1.15
22	1.89	50	1.13
23	1.84	51	1.12
24	1.80	52	1.10
25	1.75	53	1.09
26	1.71	54	1.08
27	1.68	55	1.06
28	1.64	56	1.05
29	1.61	57	1.04
30	1.58	58	1.02
31	1.54	59	1.01
32	1.51	60	1.00

Where

$$i = FP_1.$$

i = rainfall intensity during time T.
F = multiplication factor.
P_1 = 1-hour rainfall depth.
(Use areal depth , if applicable).

Rainfall Calculations

RAINFALL DATA SHEET

Return Period (Years)	Precipitation Values (inches)			
	6 Hour Duration		24 Hour Duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2	1.4	1.4 X_1	1.64	1.64 X_2
5	1.93	1.96	2.32	2.36
10	2.36	2.36	2.84	2.84
25	2.91	2.88	3.55	3.50
50	3.33	3.33	4.10	4.08
100	3.83	3.83 X_3	4.63	4.63 X_4

$$Y_2 = -0.011 + 0.942 (X_1^2/X_2)$$

$$Y_{100} = 0.494 + 0.755 (X_3^2/X_4)$$

Hour Rainfall:

$$Y_2 = -0.011 + 0.942 \left(\frac{1.4^2}{1.64}\right) = 1.12 \text{ in}$$

$$Y_{100} = 0.494 + 0.755 \left(\frac{3.83^2}{4.63}\right) = 2.89 \text{ in}$$

or 100 Years:

2 hour = 0.341 (6 hour) + 0.659 (1 hour)

3 hour = 0.569 (6 hour) + 0.431 (1 hour)

2 hour = 0.341 (3.83) + 0.659 (2.89) = 3.21 in

3 hour = 0.569 (3.83) + 0.431 (2.89) = 3.42 in

100 Year

$P_1 = 2.89$

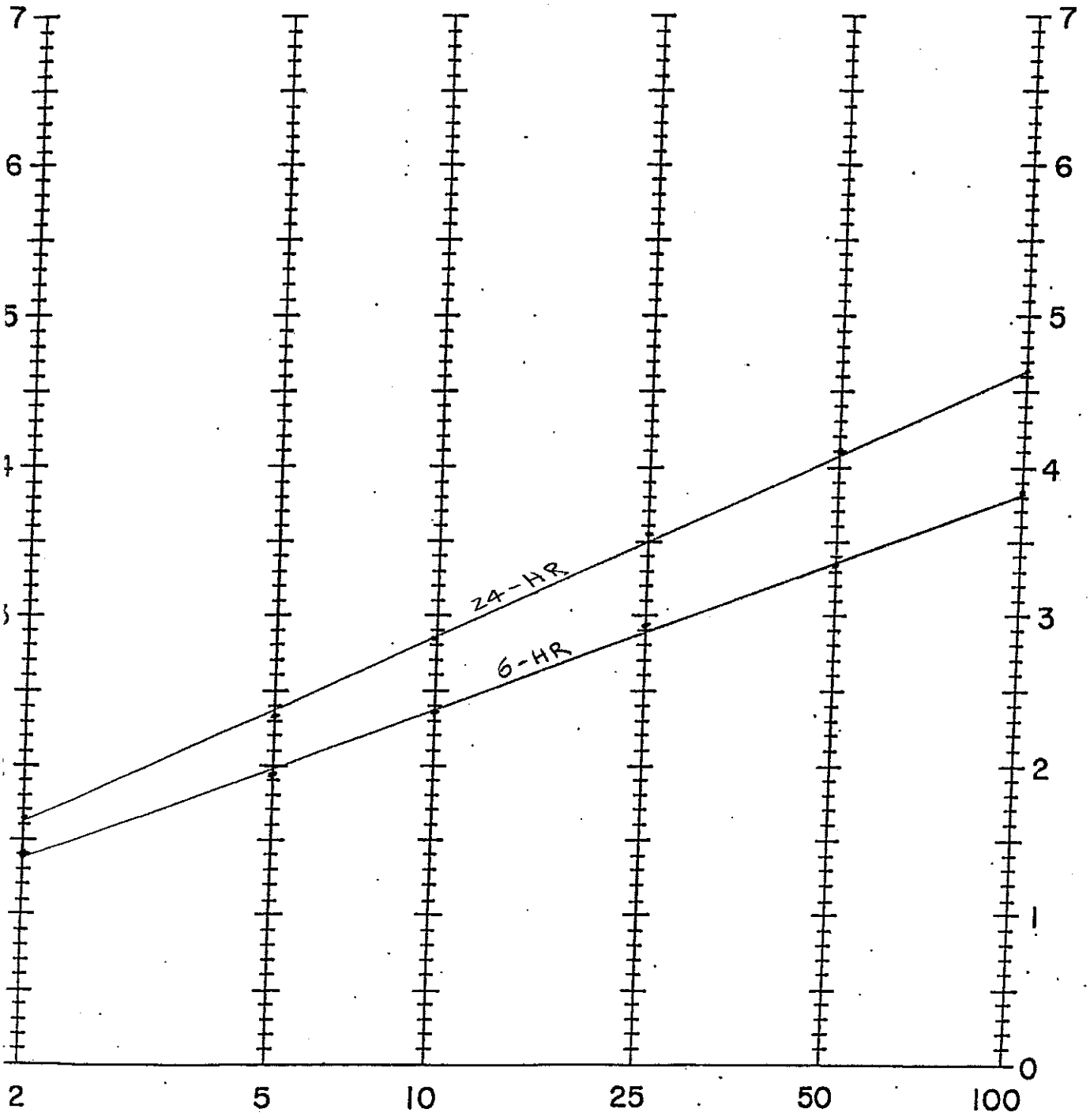
$P_2 = 3.21$

$P_3 = 3.42$

$P_6 = 3.83$

$P_{24} = 4.63$

Latitude _____ Longitude _____



Return Period in Years, Partial - Duration Series

Precipitation Depth Versus Return Period For Partial - Duration Series

Runoff Calculations

Curley School Detention Basin, Ajo

Watershed D

	Incremental Change in Length (ft)	Change in Height (ft)	$l = (L^3/H)^{1/2}$
L_1	773	470	991.3347085
L_2	936	100	2863.609359
L_3	2795	110	14088.87694
L_c	**4504**		**17943.82101**

Length of water course **Lc = 4504'** L_{ca} **= 2692'**

Mean Slope $S_c = (Lc/l)^2$

$S_c = (4504 / 17943.82101)^2$ ft/ft = **0.063004** ft/ft

From USGS maps the following information is detrmined for the Watershed.
All Page numbers refer to " Hydrology Manual for Engineering Design and and Flood Plain Management within PIMA COUNTY, Arizona".

Location: Range - R 6 W & T S 12 Section 22 Page 99
Soil classification: **Type 4** Page 99
Hydrologic soil group = 100% D Page 95

BASIN FACTOR (n_b)
Area: Developed
Watershed Type: Suburban-Foothills
Density: Less than 1 house per acre
Basin Factor (n_b) = 0.042 Page 74
Desert Brush
Cover density (pervious areas) : 20% (Fair) Page 101
Impervious Cover: 10% (Suburban) Page 103

Curve Number CN = 91 Page 107

$$CN^* = \frac{R_1(P_1 - 0.88) + R_2}{P_1}$$

$P_1 = 2.89$ (Calculated 100 Year 1 Hour Rainfall)
$R_1 = 97.00$ $R_2 = 75.24$ Page 108
Modified Curve Number CN

$$\mathbf{CN^*} = \frac{97.00\,(2.89 - 0.88) + 75.24}{2.89} = \mathbf{93.50}$$

RUNOFF TO RAINFALL RATIO (C)

$$C = \frac{(P_1 - .2S)^2}{P_1(P_1 + .8S)}$$ Page 109

$S = \frac{1000}{CN^*} - 10$ (Potential abstraction) Page 109

CN* for **impervious** areas is always = **99** (Constant)

$S_1 = \frac{1000}{93.5} - 10$

$S_1 = 0.70$

$S_2 = \frac{1000}{99} - 10$

$S_2 = 0.10$

$C_A = \frac{(2.89 - .2 * 0.7)^2}{2.89\,(2.89 + .8 * 0.7)}$

$C_A = 0.76$

$C_I = \frac{(2.89 - .2 * 0.1)^2}{2.89\,(2.89 + .8 * 0.1)}$

$C_I = 0.96$

$C_W = \frac{C_A A_A + C_I A_I}{A_T}$ Page 110

$C_A = 0.76$ $A_A = 0.9$ $C_I = 0.96$ $A_I = 0.1$

$A_T = A_A + A_T = 1.0$

$C_W = \frac{0.76 * 0.9 + 0.96 * 0.1}{1.0}$

$C_W = 0.78$

$q = C_W \cdot i$ Page 109

$q = .78\ i$ (inches/hour)

Area **A = 123.94** **Acres** (5398657 sft)

We Calculated

$P_1 = 2.89$ $P_3 = 3.42$

$P_2 = 3.21$ $P_6 = 3.83$

$T_C = \frac{n_b\ (L_C \cdot L_{ca})^{0.3}\ q^{-0.4}}{50\qquad S_C^{.4}}$ hours

$T_C = \frac{0.042\ (4504 * 2692)^{0.3}\ 0.78^{-0.4}\ i^{-0.4}}{50\qquad (0.063)^{.4}}$ hours Page 5

$T_C = 0.3737\ i^{-0.4}$ hours

(or)

$T_C = 22.422\ i^{-0.4}$ **minutes**

T_C	F	$i = F * P_1$	**$Tc = 22.422\ i^{-0.4}$ (min)**
5	3.48	10.06	8.91
6	3.32	9.59	9.08
7	3.15	9.10	9.27
8	2.99	8.64	9.46
9	2.84	8.21	9.66
9.5	2.77	8.01	9.76
9.75	2.74	7.90	9.81
9.88	**2.72**	**7.86**	**9.83**
9.94	2.71	7.83	9.84
10	2.70	7.80	9.86
11	2.61	7.54	9.99
12	2.52	7.28	10.13

Page 115

Therefore assume **Tc = 9.88 minutes**

i= 7.86

$q = C_W * i$

$q = .78\ i$ (inches/hour)

q = 6.13 **inches/hour**

Peak Discharge (Q_P)

$Q_P^{100} = 1.008\ q\ A$ cfs

Q_P^{100} = 765.93 **cfs**

Page 6

Appendix B

Alternative 1
Detention Basin Calculations

Curley School Detention Basin, Ajo

Alternative 1

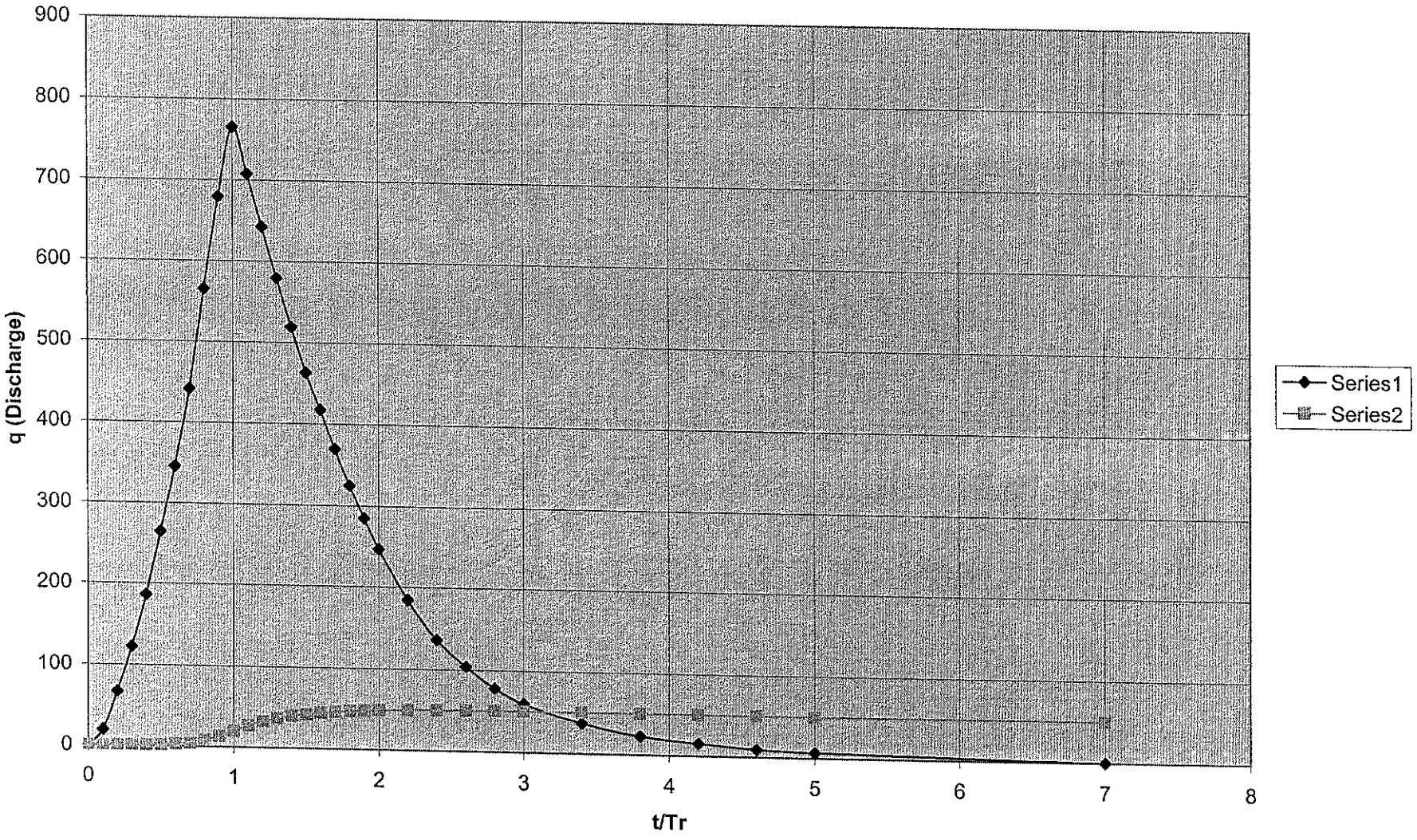
Summary of Inflow & Outflow Hydrographs for Various Outlet Configurations

Tc = 9.88 min Qp= 765.93 cfs
Tr = 17.4 min

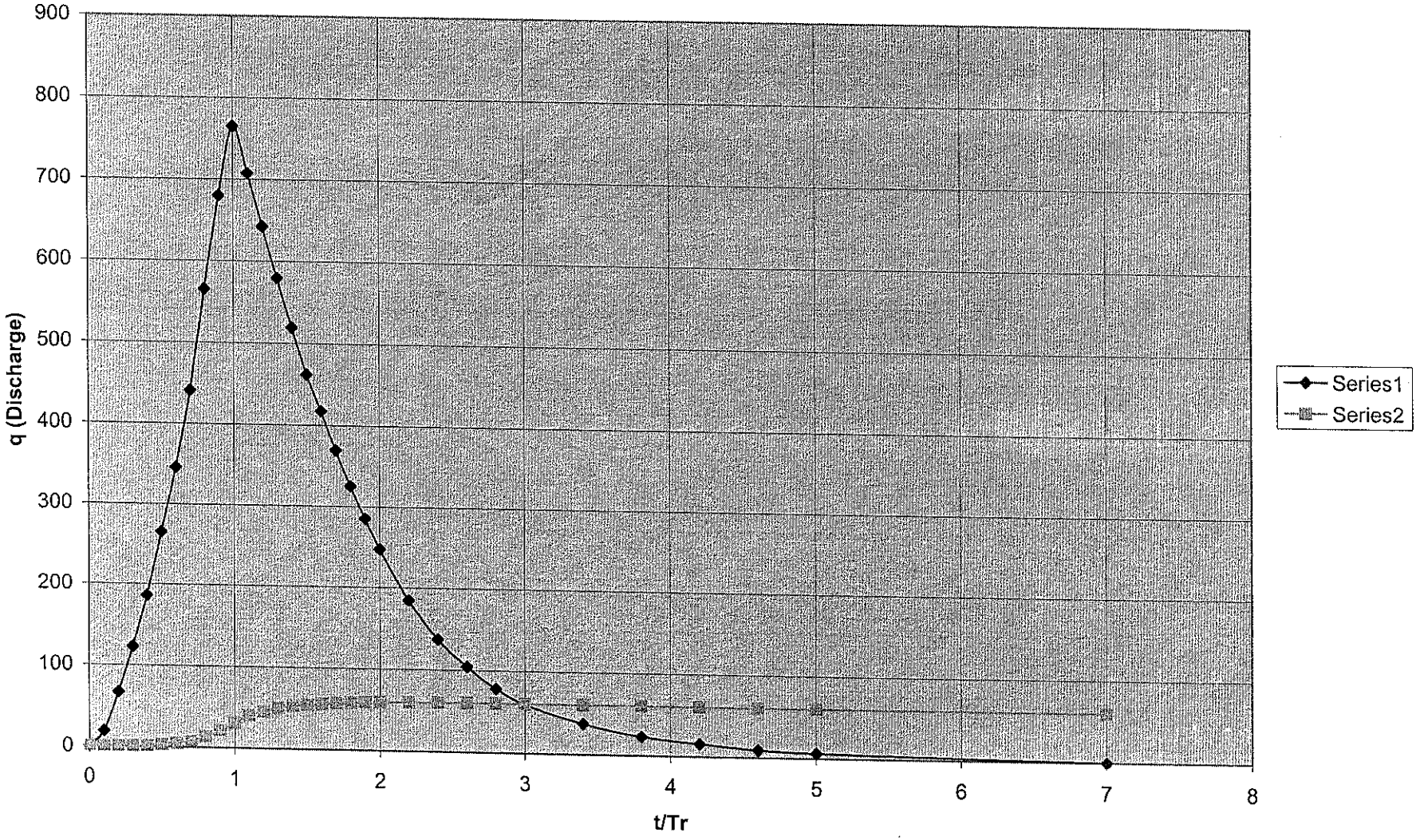
			1 Pipe	2 Pipe		
t/Tr	q/Qp	q	30" Pipe	24" Pipe	30" Pipe	36" Pipe
0	0	0	0	0	0	0
0.1	0.025	19.148	0	0.1	0.1	0.1
0.2	0.087	66.636	0.2	0.3	0.3	0.4
0.3	0.160	122.549	0.5	0.8	1	1.1
0.4	0.243	186.121	1	1.7	2	2.2
0.5	0.346	265.012	1.7	3	3.5	3.9
0.6	0.451	345.434	2.8	4.8	5.5	6.1
0.7	0.576	441.176	4.2	7.2	8.3	9.3
0.8	0.738	565.256	8.3	13.8	16.3	18.4
0.9	0.887	679.380	13.2	21.8	26	29.6
1.0	1.000	765.930	20.1	31.2	39.4	45.9
1.1	0.924	707.719	27.2	40.7	53.3	62.8
1.2	0.839	642.615	32.3	45.7	63.2	78.4
1.3	0.756	579.043	36.9	50.2	71.8	92.1
1.4	0.678	519.301	39.8	52.9	78	102.2
1.5	0.604	462.622	42.2	54.6	82.3	108.7
1.6	0.545	417.432	44.2	56.1	85.9	114.3
1.7	0.482	369.178	45.9	57.4	89.1	119
1.8	0.424	324.754	47.1	58.2	91.5	122.8
1.9	0.372	284.926	48.2	59	93.3	125.2
2	0.323	247.395	49.1	59.6	94.7	127
2.2	0.241	184.589	49.9	60	95.8	128.1
2.4	0.179	137.101	50.3	60.3	96.3	128.6
2.6	0.136	104.166	50.6	60.5	96.5	128.5
2.8	0.102	78.125	50.8	60.6	96.5	128
3	0.078	59.743	50.9	60.6	96.2	127.2
3.4	0.049	37.531	50.9	60.6	95.8	126.2
3.8	0.030	22.978	50.8	60.5	95.3	125
4.2	0.020	15.319	50.6	60.3	94.6	123.7
4.6	0.012	9.191	50.5	60.2	93.9	122
5	0.008	6.127	50.3	60.1	93.2	120
7	0.000	0.000	50.1	59.9	92.5	118.1

Note: Precipitation data obtained from Stormwater Detention/Retention Manual.

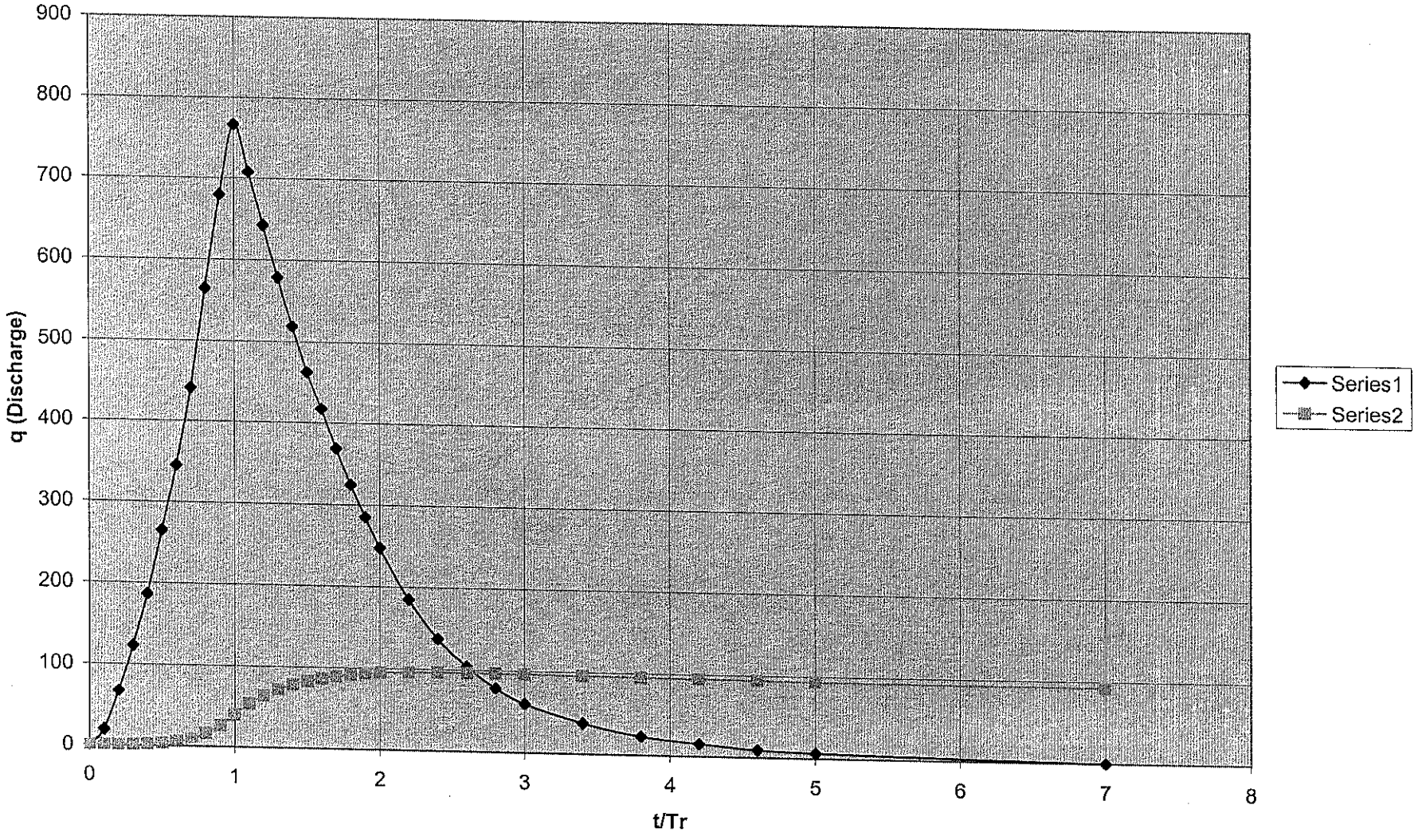
Hydrograph 1 - 30" Pipe



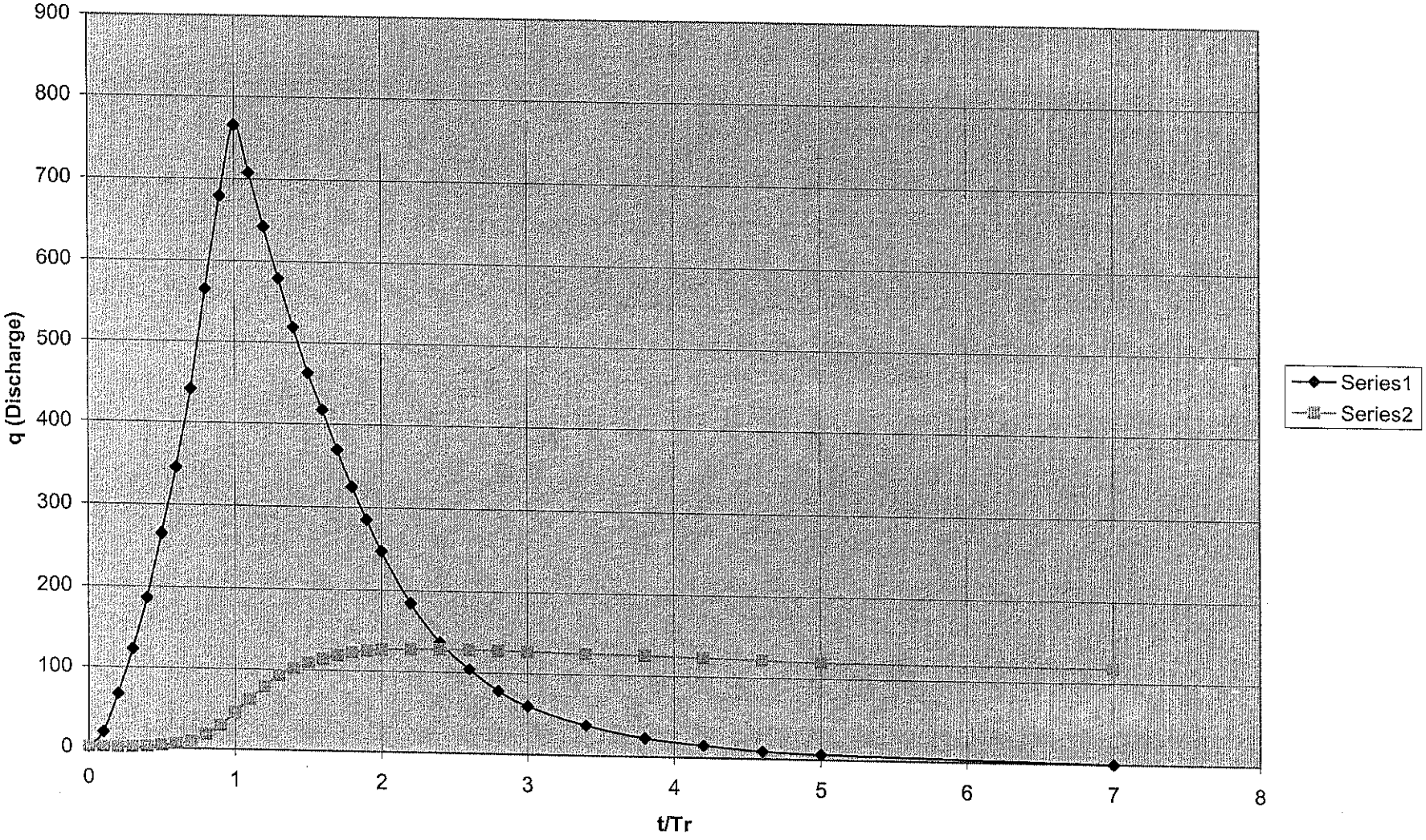
Hydrograph 2 - 24" Pipe



Hydrograph 2 - 30" Pipe



Hydrograph 2 - 36" Pipe



Curley School Detention Basin, Ajo

Alternative 1

Stage, Storage Calculations

4:1 Side slope

Head Water (ft)	Stage (ft)	Area (sf)	Area (acres)	Volume (cf)	Total Vol (cf)	Total Vol (acre-ft)
0	85.4	120360.88	2.76	0	0	0
1	86.4	126161.26	2.90	123261.1	123261.07	2.83
2	87.4	132087.91	3.03	129124.6	252385.66	5.79
3	88.4	138140.85	3.17	135114.4	387500.04	8.90
4	89.4	144320.05	3.31	141230.5	528730.49	12.14
5	90.4	150625.54	3.46	147472.8	676203.28	15.52
6	91.4	157057.29	3.61	153841.4	830044.70	19.06
7	92.4	163615.33	3.76	160336.3	990381.01	22.74
8	93.4	170299.64	3.91	166957.5	1157338.49	26.57
9	94.4	177110.23	4.07	173704.9	1331043.43	30.56
10	95.4	184047.09	4.23	180578.7	1511622.09	34.70

Stage, Storage - Discharge Calculations for Various Outlet Configurations

Stage (ft)	Storage (cf)	Storage (acre-ft)	Discharge (cfs)			
			1 - 30"	2 - 24"	2 - 30"	2 - 36"
85.4	0	0	0	0	0	0
86.4	123261	2.83	3.93	6.85	7.87	8.78
87.4	252386	5.79	13.96	23.26	27.92	31.93
88.4	387500	8.90	27.00	40.81	54.00	64.08
89.4	528730	12.14	37.71	51.55	75.42	99.22
90.4	676203	15.52	45.03	57.17	90.06	123.13
91.4	830045	19.06	51.31	61.47	102.63	142.06
92.4	990381	22.74	56.49	65.49	112.99	158.75
93.4	1157338	26.57	59.76	69.28	119.53	173.85
94.4	1331043	30.56	62.86	72.87	125.72	187.74
95.4	1511622	34.70	65.81	76.30	131.63	200.67

Flood Routing Output Files

Alternative 1

FLOOD ROUTING
ALTERNATIVE-1
1 - 30" DIAMETER CULVERT

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
3.93	2.83
13.96	5.79
27	8.899999
37.71	12.14
45.03	15.52
51.31	19.06
56.49	22.74
59.76	26.57
62.86	30.56
65.81	34.7

DISCHARGE-Cfs	S/T+Q/2
0	0
3.93	1183.437
13.96	2424.197
27	3729.084
37.71	5087.079
45.03	6501.826
51.31	7982.85
56.49	9521.771
59.76	11122.36
62.86	12789.66
65.81	14519.51

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	0
5.796666E-02	66.6	.2
8.694999E-02	122.5	.5
.1159333	186.1	1
.1449167	265	1.7
.1739	345.4	2.8
.2028833	441.2	4.2

.2318666	565.3	8.3
.26085	679.4	13.2
.2898333	765.9	20.1
.3188166	707.7	27.2
.3477999	642.6	32.3
.3767833	579	36.9
.4057666	519.3	39.8
.4347499	462.6	42.2
.4637333	417.4	44.2
.4927166	369.2	45.9
.5216999	324.8	47.1
.5506833	284.9	48.2
.5796666	247.4	49.1
.60865	184.6	49.9
.6376333	137.1	50.3
.6666167	104.2	50.6
.6956001	78.1	50.8
.7245834	59.7	50.9
.7535668	37.5	50.9
.7825501	23	50.8
.8115335	15.3	50.6
.8405168	9.2	50.5
.8695002	6.1	50.3
.8984835	0	50.1

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-1
2 - 24" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
6.85	2.83
23.26	5.79
40.81	8.899999
51.55	12.14
57.17	15.52
61.47	19.06
65.49	22.74
69.28	26.57
72.87	30.56
76.3	34.7

DISCHARGE-Cfs	S/T+Q/2
0	0
6.85	1184.897
23.26	2428.847
40.81	3735.989
51.55	5093.999
57.17	6507.896
61.47	7987.93
65.49	9526.271
69.28	11127.12
72.87	12794.67
76.3	14524.75

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.3
8.694999E-02	122.5	.8
.1159333	186.1	1.7
.1449167	265	3
.1739	345.4	4.8
.2028833	441.2	7.2
.2318666	565.3	13.8

.26085	679.4	21.8
.2898333	765.9	31.2
.3188166	707.7	40.7
.3477999	642.6	45.7
.3767833	579	50.2
.4057666	519.3	52.9
.4347499	462.6	54.6
.4637333	417.4	56.1
.4927166	369.2	57.4
.5216999	324.8	58.2
.5506833	284.9	59
.5796666	247.4	59.6
.60865	184.6	60
.6376333	137.1	60.3
.6666167	104.2	60.5
.6956001	78.1	60.6
.7245834	59.7	60.6
.7535668	37.5	60.6
.7825501	23	60.5
.8115335	15.3	60.3
.8405168	9.2	60.2
.8695002	6.1	60.1
.8984835	0	59.9

VOLUME STORED=

FLOOD ROUTING
ALTERNATIVE-1
2 - 30" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
7.87	2.83
27.92	5.79
54	8.899999
75.42	12.14
90.06	15.52
102.63	19.06
112.99	22.74
119.53	26.57
125.72	30.56
131.63	34.7

DISCHARGE-Cfs	S/T+Q/2
0	0
7.87	1185.407
27.92	2431.177
54	3742.584
75.42	5105.934
90.06	6524.341
102.63	8008.51
112.99	9550.021
119.53	11152.24
125.72	12821.09
131.63	14552.42

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.3
8.694999E-02	122.5	1
.1159333	186.1	2
.1449167	265	3.5
.1739	345.4	5.5
.2028833	441.2	8.3

.2318666	565.3	16.3
.26085	679.4	26
.2898333	765.9	39.4
.3188166	707.7	53.3
.3477999	642.6	63.2
.3767833	579	71.8
.4057666	519.3	78
.4347499	462.6	82.3
.4637333	417.4	85.9
.4927166	369.2	89.1
.5216999	324.8	91.5
.5506833	284.9	93.3
.5796666	247.4	94.7
.60865	184.6	95.8
.6376333	137.1	96.3
.6666167	104.2	96.5
.6956001	78.1	96.5
.7245834	59.7	96.2
.7535668	37.5	95.8
.7825501	23	95.3
.8115335	15.3	94.6
.8405168	9.2	93.9
.8695002	6.1	93.2
.8984835	0	92.5

VOLUME STORED=

FLOOD ROUTING
ALTERNATIVE-1
2 - 36" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
8.78	2.83
31.93	5.79
64.08	8.899999
99.22	12.14
123.13	15.52
142.06	19.06
158.75	22.74
173.85	26.57
187.74	30.56
200.67	34.7

DISCHARGE-Cfs	S/T+Q/2
0	0
8.78	1185.862
31.93	2433.182
64.08	3747.624
99.22	5117.834
123.13	6540.876
142.06	8028.225
158.75	9572.901
173.85	11179.4
187.74	12852.1
200.67	14586.94

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.4
8.694999E-02	122.5	1.1
.1159333	186.1	2.2
.1449167	265	3.9
.1739	345.4	6.1
.2028833	441.2	9.3

.2318666	565.3	18.4
.26085	679.4	29.6
.2898333	765.9	45.9
.3188166	707.7	62.8
.3477999	642.6	78.4
.3767833	579	92.1
.4057666	519.3	102.2
.4347499	462.6	108.7
.4637333	417.4	114.3
.4927166	369.2	119
.5216999	324.8	122.8
.5506833	284.9	125.2
.5796666	247.4	127
.60865	184.6	128.1
.6376333	137.1	128.6
.6666167	104.2	128.5
.6956001	78.1	128
.7245834	59.7	127.2
.7535668	37.5	126.2
.7825501	23	125
.8115335	15.3	123.7
.8405168	9.2	122
.8695002	6.1	120
.8984835	0	118.1

VOLUME STORED=

Culvert Hydraulics

Alternative 1

Culvert Calculator Report
Alt-1 - 30 inch 1 Pipe

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	4.00
Computed Headwater Elev	95.40 ft	Discharge	65.81 cfs
Inlet Control HW Elev.	94.21 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.42 ft
Velocity Downstream	13.41 ft/s	Critical Slope	0.022662 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.79 ft
Ke	0.50	Entrance Loss	1.40 ft

Inlet Control Properties			
Inlet Control HW Elev.	94.21 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	4.9 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Entranco
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Rating Table Report
Alt-1 - 30 inch 1 Pipe

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	3.93
87.40	13.96
88.40	27.00
89.40	37.71
90.40	45.03
91.40	51.31
92.40	56.49
93.40	59.76
94.40	62.86
95.40	65.81

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Culvert Calculator Report
Alt-1 - 24 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	5.00
Computed Headwater Elev	95.40 ft	Discharge	76.30 cfs
Inlet Control HW Elev.	92.59 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.94 ft
Velocity Downstream	12.14 ft/s	Critical Slope	0.025079 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.29 ft
Ke	0.50	Entrance Loss	1.15 ft

Inlet Control Properties			
Inlet Control HW Elev.	92.59 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	6.3 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Entranco
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Rating Table Report
Alt-1 - 24 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	6.85
87.40	23.26
88.40	40.81
89.40	51.55
90.40	57.17
91.40	61.47
92.40	65.49
93.40	69.28
94.40	72.87
95.40	76.30

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Culvert Calculator Report
Alt-1 - 30 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	4.00
Computed Headwater Elev	95.40 ft	Discharge	131.63 cfs
Inlet Control HW Elev.	94.21 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.42 ft
Velocity Downstream	13.41 ft/s	Critical Slope	0.022663 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.79 ft
Ke	0.50	Entrance Loss	1.40 ft

Inlet Control Properties			
Inlet Control HW Elev.	94.21 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	9.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-1 - 30 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	7.87
87.40	27.92
88.40	54.00
89.40	75.42
90.40	90.06
91.40	102.63
92.40	112.99
93.40	119.53
94.40	125.72
95.40	131.63

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Culvert Calculator Report
Alt-1 - 36 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	3.33
Computed Headwater Elev	95.40 ft	Discharge	200.67 cfs
Inlet Control HW Elev.	95.40 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.03 ft	Control Type	Inlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.90 ft
Velocity Downstream	14.19 ft/s	Critical Slope	0.019820 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.03 ft	Upstream Velocity Head	3.13 ft
Ke	0.50	Entrance Loss	1.57 ft

Inlet Control Properties			
Inlet Control HW Elev.	95.40 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	14.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-1 - 36 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	8.78
87.40	31.93
88.40	64.08
89.40	99.22
90.40	123.13
91.40	142.06
92.40	158.75
93.40	173.85
94.40	187.74
95.40	200.67

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Appendix C

Alternative 2
Detention Basin Calculations

Curley School Detention Basin, Ajo

Alternative 2

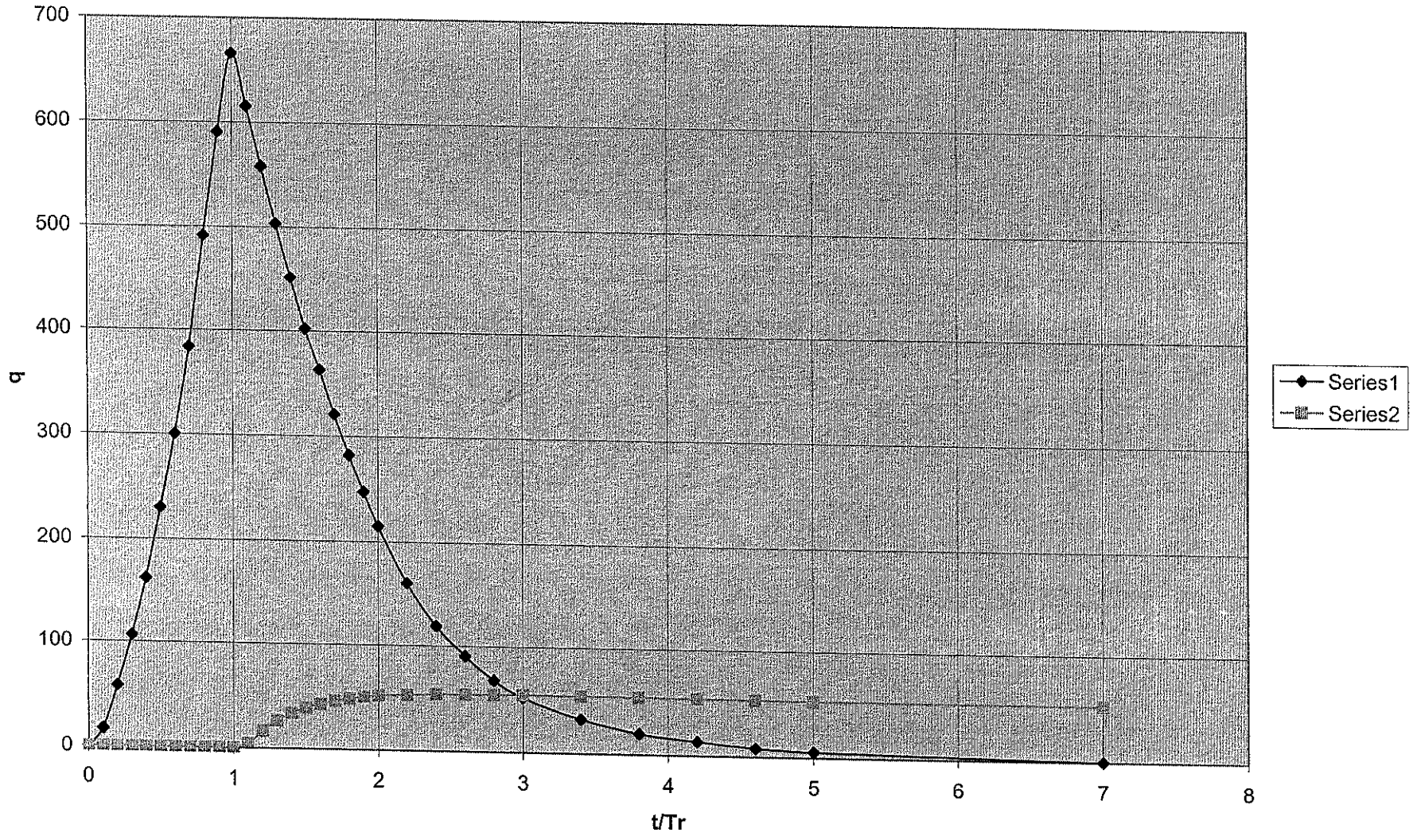
Summary of Inflow & Outflow Hydrographs for Various Outlet Configurations

Tc = 9.88 min Qp= 665.93 cfs
Tr = 17.4 min

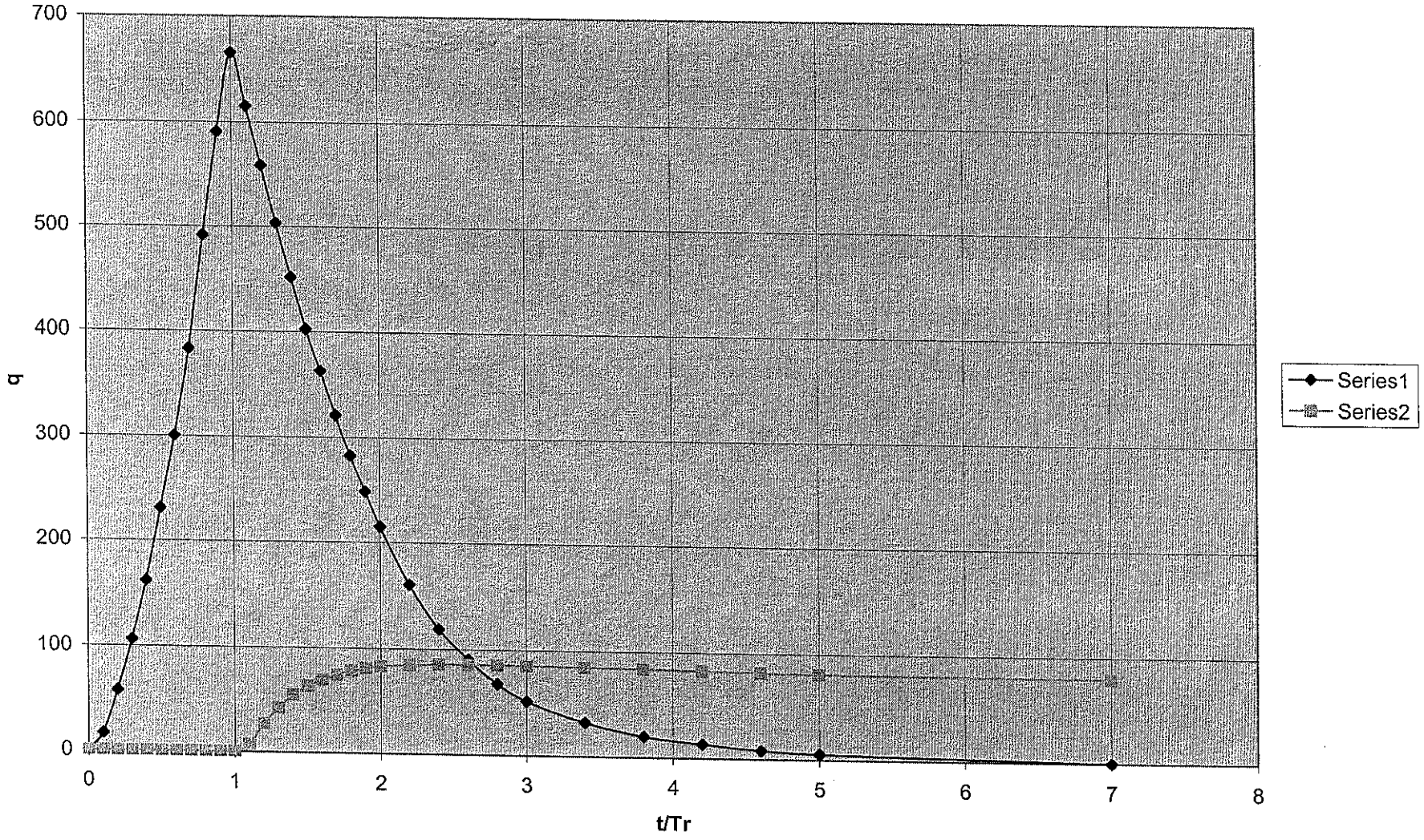
			2 Pipe			
t/Tr	q/Qp	q	24" Pipe	30" Pipe	36" Pipe	42" Pipe
0	0	0	0	0	0	0
0.1	0.025	16.648	0	0	0	0
0.2	0.087	57.936	0	0	0	0
0.3	0.160	106.549	0	0	0	0
0.4	0.243	161.821	0	0	0	0
0.5	0.346	230.412	0	0	0	0
0.6	0.451	300.334	0	0	0	0
0.7	0.576	383.576	0	0	0	0
0.8	0.738	491.456	0	0	0	0
0.9	0.887	590.680	0	0	0	0
1.0	1.000	665.930	0	0	0	0
1.1	0.924	615.319	4.3	7	10.5	14.5
1.2	0.839	558.715	16.6	27.4	40.6	56.1
1.3	0.756	503.443	26.1	42.7	63	86.6
1.4	0.678	451.501	34	55.3	80.9	110
1.5	0.604	402.222	39.1	63.8	93.7	128.1
1.6	0.545	362.932	42.8	69.6	101.6	137.8
1.7	0.482	320.978	46.1	74.5	108.1	145.6
1.8	0.424	282.354	48.5	78.6	113.4	151.5
1.9	0.372	247.726	50.4	81.2	117.6	155.8
2	0.323	215.095	51.9	83.3	120	158.7
2.2	0.241	160.489	53	84.8	121.4	159.8
2.4	0.179	119.201	53.8	85.6	121.8	159.1
2.6	0.136	90.566	54.2	85.8	121.5	157
2.8	0.102	67.925	54.4	85.8	120.6	154
3	0.078	51.943	54.5	85.4	119.3	150.4
3.4	0.049	32.631	54.4	84.8	117.6	146.3
3.8	0.030	19.978	54.1	84	115.1	141.7
4.2	0.020	13.319	53.8	83	112.5	137
4.6	0.012	7.991	53.5	82	109.7	132.2
5	0.008	5.327	53.1	81	106.9	127.4
7	0.000	0.000	52.6	79.9	104	120.5

Note: Precipitation data obtained from Stormwater Detention/Retention Manual.

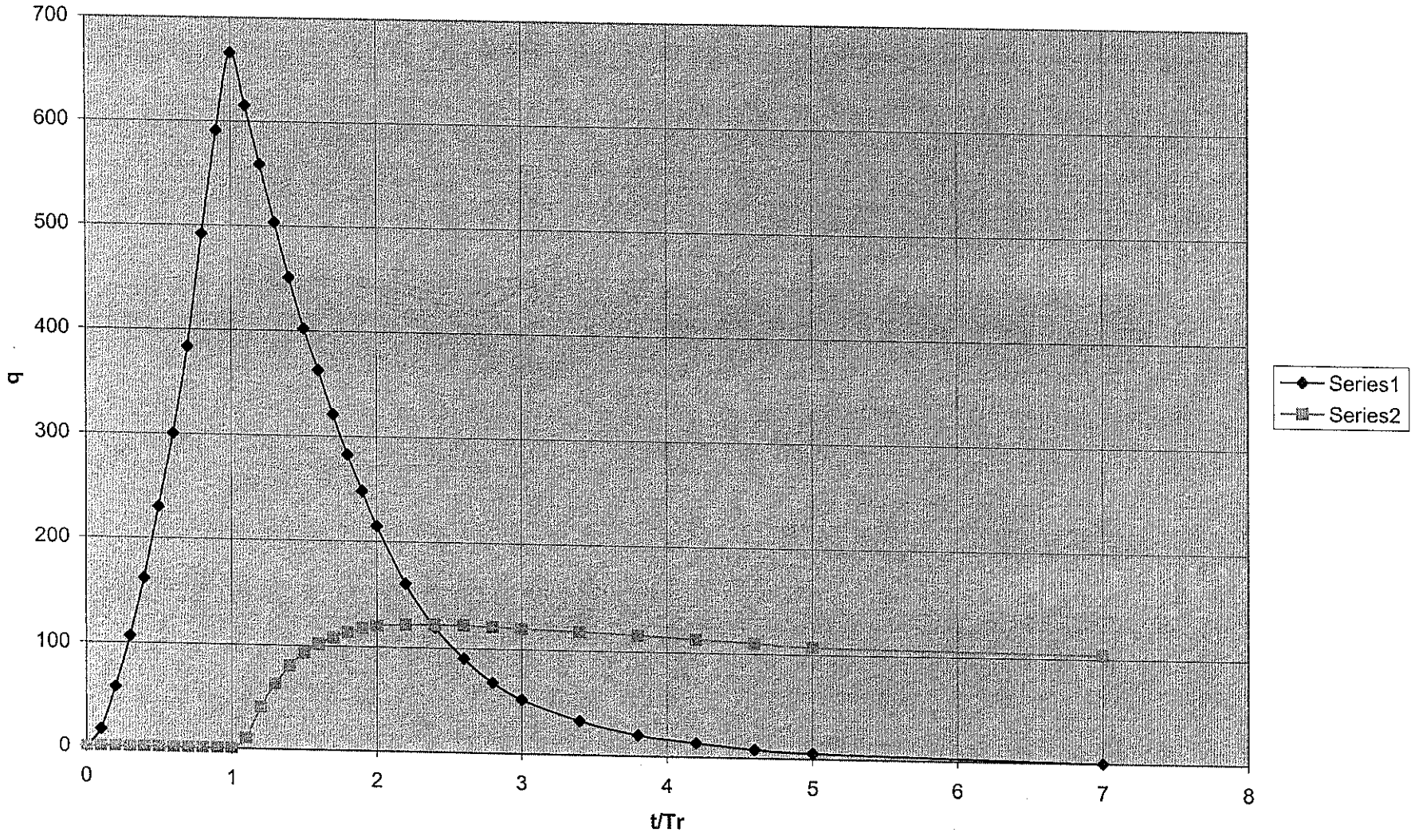
Hydrograph 2 - 24" Pipe



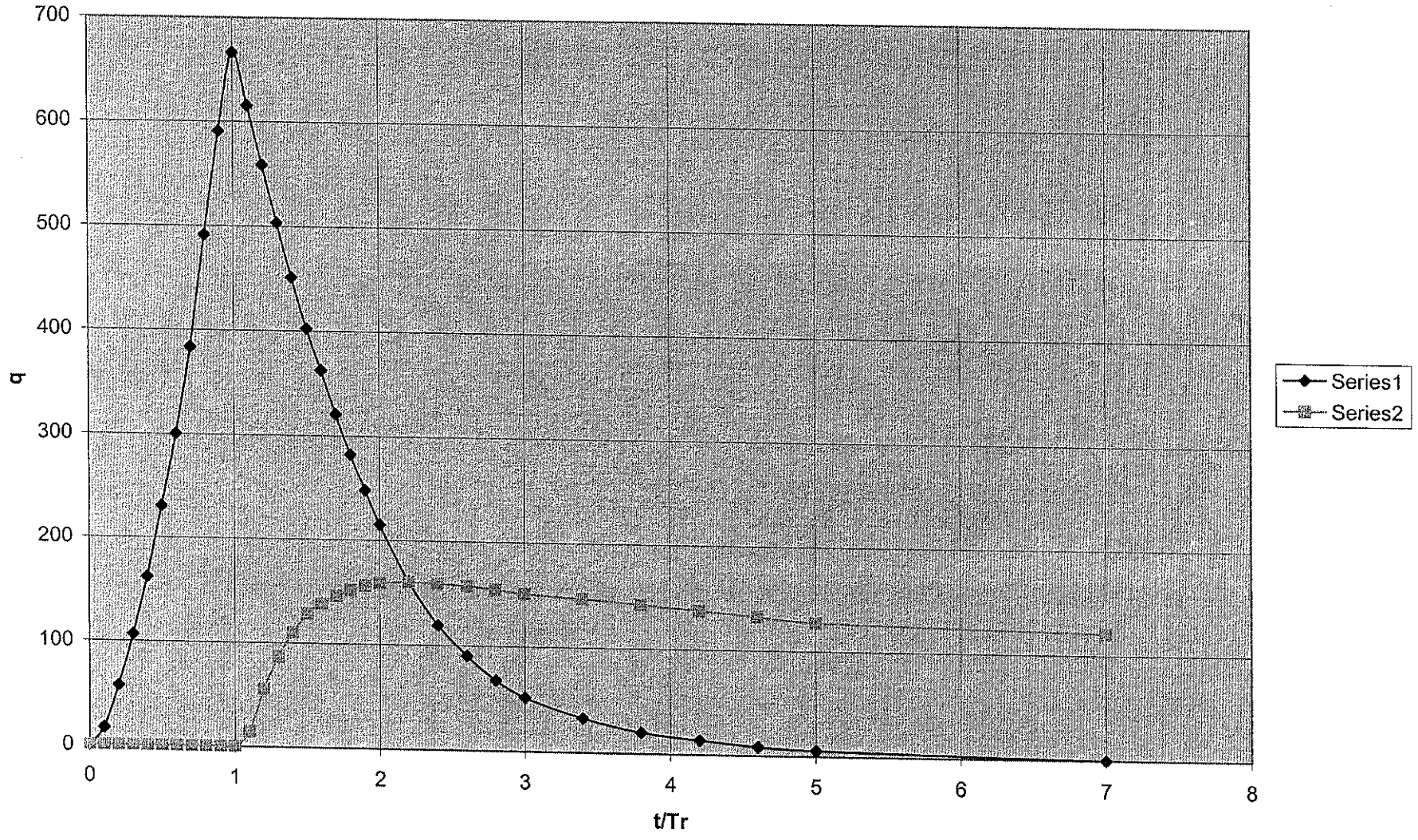
Hydrograph 2 - 30" Pipe



Hydrograph 2 - 36" Pipe



Hydrograph 2 - 42" Pipe



Curley School Detention Basin, Ajo

Alternative 2

Stage, Storage Calculations

Area Control Parameters:

Length = 420 ft Width = 170 ft

4:1 Side slope

Head Water (ft)	Stage (ft)	Length (ft)	Width (ft)	Area (sf)	Volume (cf)	Total Vol (cf)	Total Vol (acre-ft)
0	85.4	420	170	71400	0	0	0
1	86.4	428	178	76184	73792	73792	1.69
2	87.4	436	186	81096	78640	152432	3.50
3	88.4	444	194	86136	83616	236048	5.42
4	89.4	452	202	91304	88720	324768	7.46
5	90.4	460	210	96600	93952	418720	9.61
6	91.4	468	218	102024	99312	518032	11.89
7	92.4	476	226	107576	104800	622832	14.30
8	93.4	484	234	113256	110416	733248	16.83
9	94.4	492	242	119064	116160	849408	19.50
10	95.4	500	250	125000	122032	971440	22.30

* Basin size based on the bottom dimensions of 420' x 170'

Stage, Storage - Discharge Calculations for Various Outlet Configurations

Stage (ft)	Storage (cf)	Storage (acre-ft)	Discharge (cfs)			
			24"	30"	36"	42"
85.4	0	0.00	0	0	0	0
86.4	73792	1.69	0	0	0	0
87.4	152432	3.50	0	0	0	0
88.4	236048	5.42	0	0	0	0
89.4	324768	7.46	0	0	0	0
90.4	418720	9.61	19.25	32.01	48.11	67.55
91.4	518032	11.89	36.02	59.88	90.00	126.38
92.4	622832	14.30	47.16	78.40	117.84	165.47
93.4	733248	16.83	56.13	93.31	140.26	196.94
94.4	849408	19.50	63.86	106.15	159.55	224.04
95.4	971440	22.30	70.74	117.60	176.76	248.20

Flood Routing Output Files

Alternative 2

FLOOD ROUTING
ALTERNATIVE-2
2 - 24" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
0	1.69
0	3.5
0	5.42
0	7.46
19.25	9.609999
36.02	11.89
47.16	14.3
56.13	16.83
63.86	19.5
70.74	22.3

DISCHARGE-Cfs	S/T+Q/2
0	0
0	705.138
0	1460.345
0	2261.449
0	3112.621
19.25	4019.315
36.02	4979.011
47.16	5990.132
56.13	7050.238
63.86	8168.138
70.74	9339.852

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
.029	16.6	0
.058	57.9	0
.087	106.5	0
.116	161.8	0
.145	230.4	0
.174	300.3	0
.203	383.6	0

.232	491.5	0
.261	590.7	0
.29	665.9	0
.319	615.3	4.3
.3479999	558.7	16.6
.3769999	503.4	26.1
.4059999	451.5	34
.4349999	402.2	39.1
.4639999	362.9	42.8
.4929999	321	46.1
.5219999	282.4	48.5
.5509998	247.7	50.4
.5799998	215.1	51.9
.6089998	160.5	53
.6379998	119.2	53.8
.6669998	90.6	54.2
.6959998	67.9	54.4
.7249998	51.9	54.5
.7539997	32.6	54.4
.7829997	20	54.1
.8119997	13.3	53.8
.8409997	8	53.5
.8699996	5.3	53.1
.8989996	0	52.6

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-2
2 - 30" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
0	1.69
0	3.5
0	5.42
0	7.46
32.01	9.609999
59.88	11.89
78.4	14.3
93.31	16.83
106.15	19.5
117.6	22.3

DISCHARGE-Cfs	S/T+Q/2
0	0
0	705.138
0	1460.345
0	2261.449
0	3112.621
32.01	4025.695
59.88	4990.941
78.4	6005.752
93.31	7068.828
106.15	8189.283
117.6	9363.282

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
.029	16.6	0
.058	57.9	0
.087	106.5	0
.116	161.8	0
.145	230.4	0
.174	300.3	0
.203	383.6	0

.232	491.5	0
.261	590.7	0
.29	665.9	0
.319	615.3	7
.3479999	558.7	27.4
.3769999	503.4	42.7
.4059999	451.5	55.3
.4349999	402.2	63.8
.4639999	362.9	69.6
.4929999	321	74.5
.5219999	282.4	78.6
.5509998	247.7	81.2
.5799998	215.1	83.3
.6089998	160.5	84.8
.6379998	119.2	85.6
.6669998	90.6	85.8
.6959998	67.9	85.8
.7249998	51.9	85.4
.7539997	32.6	84.8
.7829997	20	84
.8119997	13.3	83
.8409997	8	82
.8699996	5.3	81
.8989996	0	79.9

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-2
2 - 36" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
0	1.69
0	3.5
0	5.42
0	7.46
48.11	9.609999
90	11.89
117.84	14.3
140.26	16.83
159.55	19.5
176.76	22.3

DISCHARGE-Cfs	S/T+Q/2
0	0
0	705.138
0	1460.345
0	2261.449
0	3112.621
48.11	4033.745
90	5006.001
117.84	6025.472
140.26	7092.303
159.55	8215.983
176.76	9392.862

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
.029	16.6	0
.058	57.9	0
.087	106.5	0
.116	161.8	0
.145	230.4	0
.174	300.3	0
.203	383.6	0

.232	491.5	0
.261	590.7	0
.29	665.9	0
.319	615.3	10.5
.3479999	558.7	40.6
.3769999	503.4	63
.4059999	451.5	80.9
.4349999	402.2	93.7
.4639999	362.9	101.6
.4929999	321	108.1
.5219999	282.4	113.4
.5509998	247.7	117.6
.5799998	215.1	120
.6089998	160.5	121.4
.6379998	119.2	121.8
.6669998	90.6	121.5
.6959998	67.9	120.6
.7249998	51.9	119.3
.7539997	32.6	117.6
.7829997	20	115.1
.8119997	13.3	112.5
.8409997	8	109.7
.8699996	5.3	106.9
.8989996	0	104

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-2
2 - 42" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
0	1.69
0	3.5
0	5.42
0	7.46
67.55	9.609999
126.38	11.89
165.47	14.3
196.94	16.83
224.04	19.5
248.2	22.3

DISCHARGE-Cfs	S/T+Q/2
0	0
0	705.138
0	1460.345
0	2261.449
0	3112.621
67.55	4043.465
126.38	5024.191
165.47	6049.287
196.94	7120.643
224.04	8248.228
248.2	9428.582

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
.029	16.6	0
.058	57.9	0
.087	106.5	0
.116	161.8	0
.145	230.4	0
.174	300.3	0
.203	383.6	0

.232	491.5	0
.261	590.7	0
.29	665.9	0
.319	615.3	14.5
.3479999	558.7	56.1
.3769999	503.4	86.6
.4059999	451.5	110
.4349999	402.2	128.1
.4639999	362.9	137.8
.4929999	321	145.6
.5219999	282.4	151.5
.5509998	247.7	155.8
.5799998	215.1	158.7
.6089998	160.5	159.8
.6379998	119.2	159.1
.6669998	90.6	157
.6959998	67.9	154
.7249998	51.9	150.4
.7539997	32.6	146.3
.7829997	20	141.7
.8119997	13.3	137
.8409997	8	132.2
.8699996	5.3	127.4
.8989996	0	120.5

VOLUME STORED=

□

Culvert Hydraulics

Alternative 2

Culvert Calculator Report
Alt - 2 - 24 inch - 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	4.90
Computed Headwater Elev	95.40 ft	Discharge	70.74 cfs
Inlet Control HW Elev.	91.98 ft	Tailwater Elevation	90.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.60 ft	Downstream Invert	85.40 ft
Length	100.00 ft	Constructed Slope	0.002000 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.60 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.92 ft
Velocity Downstream	11.26 ft/s	Critical Slope	0.021331 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	1.97 ft
Ke	0.50	Entrance Loss	0.99 ft

Inlet Control Properties			
Inlet Control HW Elev.	91.98 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	6.3 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt - 2 - 24 inch - 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	0.00
87.40	0.00
88.40	0.00
89.40	0.00
90.40	19.25
91.40	36.02
92.40	47.16
93.40	56.13
94.40	63.86
95.40	70.74

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Culvert Calculator Report
Alt - 2 - 30 inch - 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	3.92
Computed Headwater Elev	95.40 ft	Discharge	117.60 cfs
Inlet Control HW Elev.	92.98 ft	Tailwater Elevation	90.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.60 ft	Downstream Invert	85.40 ft
Length	100.00 ft	Constructed Slope	0.002000 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.60 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.39 ft
Velocity Downstream	11.98 ft/s	Critical Slope	0.017834 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.23 ft
Ke	0.50	Entrance Loss	1.11 ft

Inlet Control Properties			
Inlet Control HW Elev.	92.98 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	9.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt - 2 - 30 inch - 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	0.00
87.40	0.00
88.40	0.00
89.40	0.00
90.40	32.01
91.40	59.88
92.40	78.40
93.40	93.31
94.40	106.15
95.40	117.60

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Culvert Calculator Report
Alt - 2 - 36 inch - 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	3.27
Computed Headwater Eleva	95.40 ft	Discharge	176.76 cfs
Inlet Control HW Elev.	93.83 ft	Tailwater Elevation	90.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.60 ft	Downstream Invert	85.40 ft
Length	100.00 ft	Constructed Slope	0.002000 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.60 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.84 ft
Velocity Downstream	12.50 ft/s	Critical Slope	0.015187 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.43 ft
Ke	0.50	Entrance Loss	1.21 ft

Inlet Control Properties			
Inlet Control HW Elev.	93.83 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	14.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt - 2 - 36 inch - 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	0.00
87.40	0.00
88.40	0.00
89.40	0.00
90.40	48.11
91.40	90.00
92.40	117.84
93.40	140.26
94.40	159.55
95.40	176.76

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Culvert Calculator Report
Alt - 2 - 42 inch - 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	2.80
Computed Headwater Elev	95.40 ft	Discharge	248.20 cfs
Inlet Control HW Elev.	94.56 ft	Tailwater Elevation	90.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.60 ft	Downstream Invert	85.40 ft
Length	100.00 ft	Constructed Slope	0.002000 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.60 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	3.28 ft
Velocity Downstream	12.90 ft/s	Critical Slope	0.013151 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.50 ft
Section Size	42 inch	Rise	3.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.59 ft
Ke	0.50	Entrance Loss	1.29 ft

Inlet Control Properties			
Inlet Control HW Elev.	94.56 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	19.2 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt - 2 - 42 inch - 2 Pipes

Range Data:				
	Minimum	Maximum	Increment	
Allowable HW E	85.40	95.40	1.00	ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	0.00
87.40	0.00
88.40	0.00
89.40	0.00
90.40	67.55
91.40	126.38
92.40	165.47
93.40	196.94
94.40	224.04
95.40	248.20

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Appendix D

Alternative 3
Detention Basin Calculations

Curley School Detention Basin, Ajo

Alternative 3

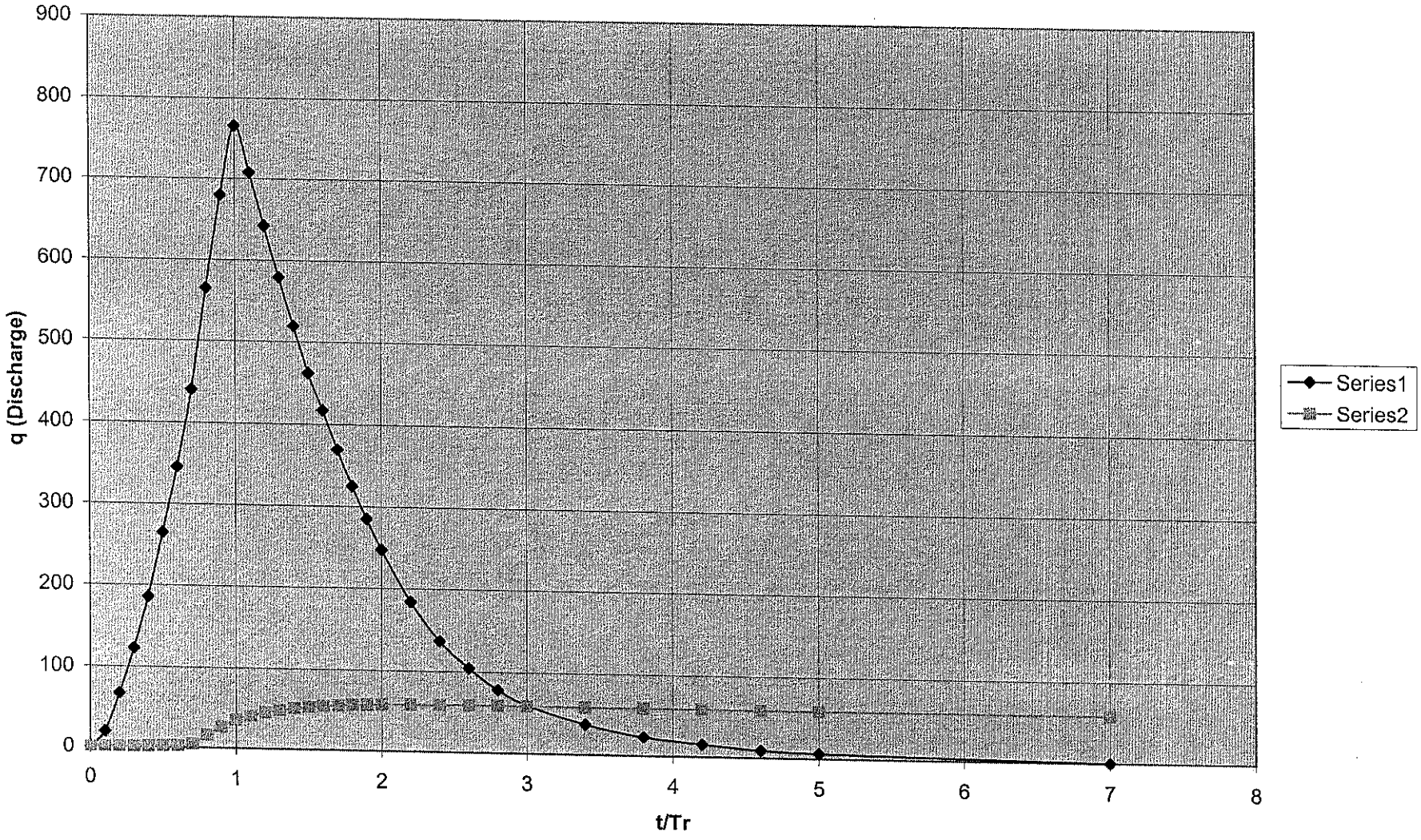
Summary of Inflow & Outflow Hydrographs for Various Outlet Configurations

Tc = 9.88 min Qp= 765.93 cfs
Tr = 17.4 min

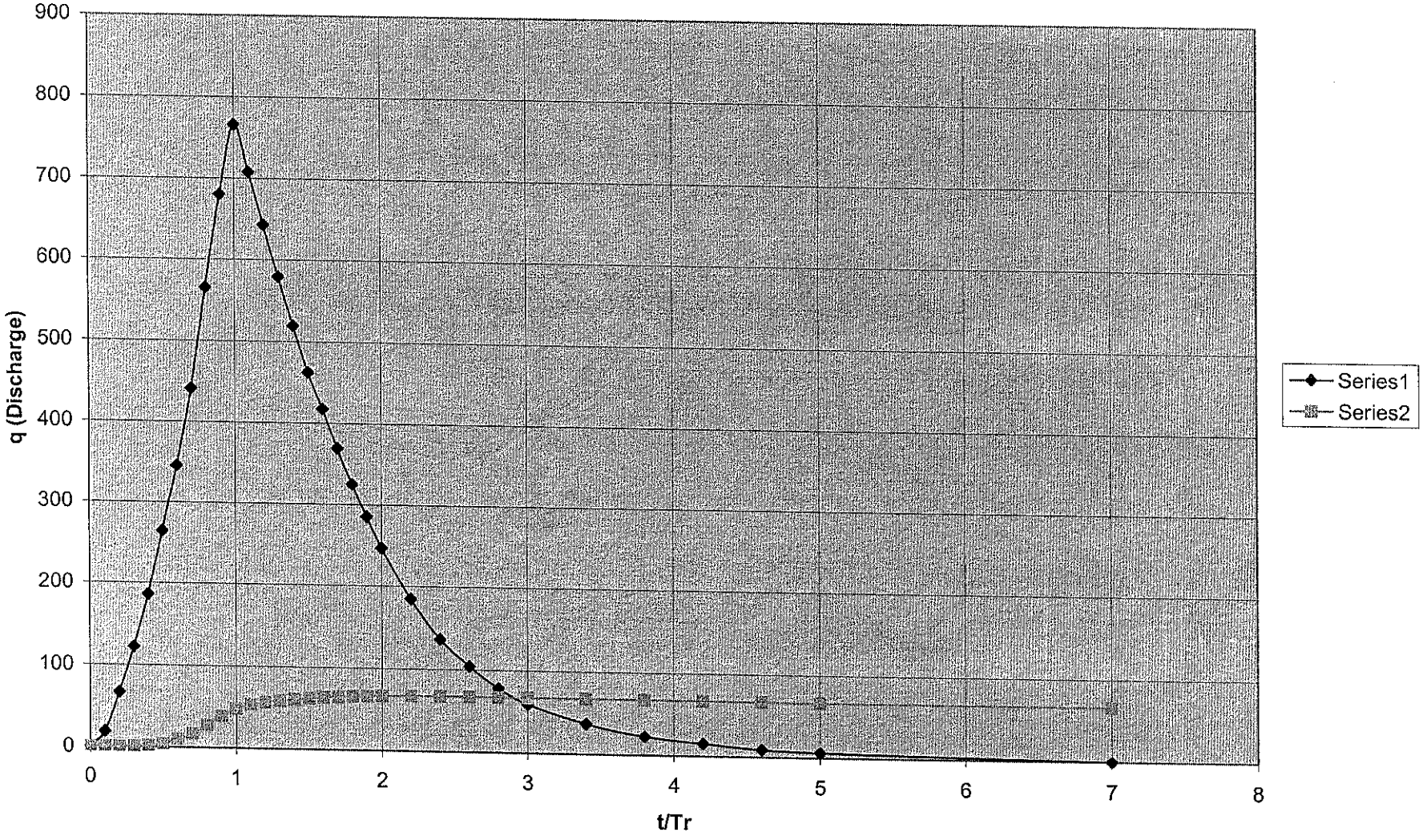
			1 Pipe	2 Pipe				
t/Tr	q/Qp	q	30" Pipe	24" Pipe	30" Pipe	36" Pipe	42" Pipe	48" Pipe
0	0	0	0	0	0	0	0	0
0.1	0.025	19.148	0	0.1	0.1	0.1	0.1	0.1
0.2	0.087	66.636	0.2	0.3	0.4	0.4	0.4	0.5
0.3	0.160	122.549	0.5	0.9	1	1.1	1.2	1.3
0.4	0.243	186.121	1.1	1.9	2.1	2.3	2.5	2.7
0.5	0.346	265.012	1.8	4.5	5.2	5.8	6.3	6.8
0.6	0.451	345.434	2.5	9.9	11.6	13	14.3	15.4
0.7	0.576	441.176	4.8	17.1	20.1	22.7	24.9	26.9
0.8	0.738	565.256	16.1	28.4	34.7	40	44.6	48.7
0.9	0.887	679.380	26.7	39.3	51.7	61.5	69.5	76.5
1.0	1.000	765.930	35.5	48.3	69.6	86.1	99	109.9
1.1	0.924	707.719	41	53.6	80.1	104.9	126.5	142.4
1.2	0.839	642.615	45.1	56.9	88.2	118.9	147.7	169.3
1.3	0.756	579.043	48.5	59.1	94.4	127.7	160.8	189.7
1.4	0.678	519.301	50.9	60.9	99.4	135.1	171.8	206.3
1.5	0.604	462.622	53	62.3	103.1	140.1	179.1	218.3
1.6	0.545	417.432	54.8	63.6	106.2	144.4	184.3	224.4
1.7	0.482	369.178	55.7	64.6	109	147.9	188.5	229
1.8	0.424	324.754	56.5	65.4	110.5	150.7	191.6	232.2
1.9	0.372	284.926	57.2	66.1	111.6	152.8	193.9	234.1
2	0.323	247.395	57.8	66.6	112.4	154.1	195.3	235
2.2	0.241	184.589	58.2	67.1	113	154.8	195.7	234.5
2.4	0.179	137.101	58.5	67.3	113.2	154.8	195	232.5
2.6	0.136	104.166	58.6	67.5	113.3	154.5	193.6	229.4
2.8	0.102	78.125	58.7	67.5	113.2	153.7	191.5	225.7
3	0.078	59.743	58.7	67.5	112.9	152.8	189.1	221.4
3.4	0.049	37.531	58.7	67.5	112.6	151.4	186.3	216.7
3.8	0.030	22.978	58.6	67.4	112.1	149.7	183.1	208.1
4.2	0.020	15.319	58.6	67.2	111.6	147.8	179.9	199.4
4.6	0.012	9.191	58.5	67.1	111	145.9	176.5	190.7
5	0.008	6.127	58.3	66.9	110.5	144	172.4	182.3
7	0.000	0.000	58.2	66.7	109.9	142	167.6	174

Note: Precipitation data obtained from Stormwater Detention/Retention Manual.

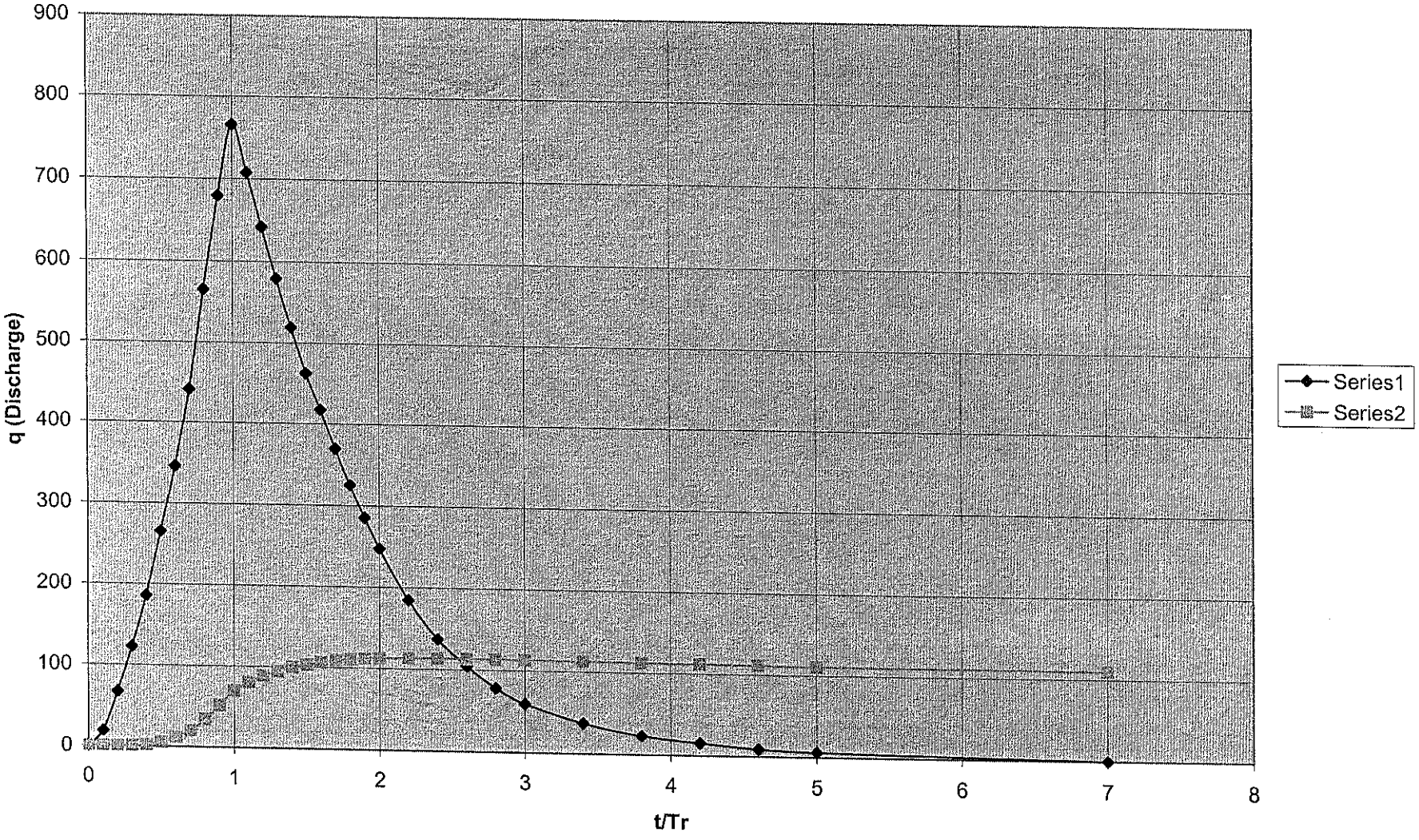
Hydrograph 1 - 30" Pipe



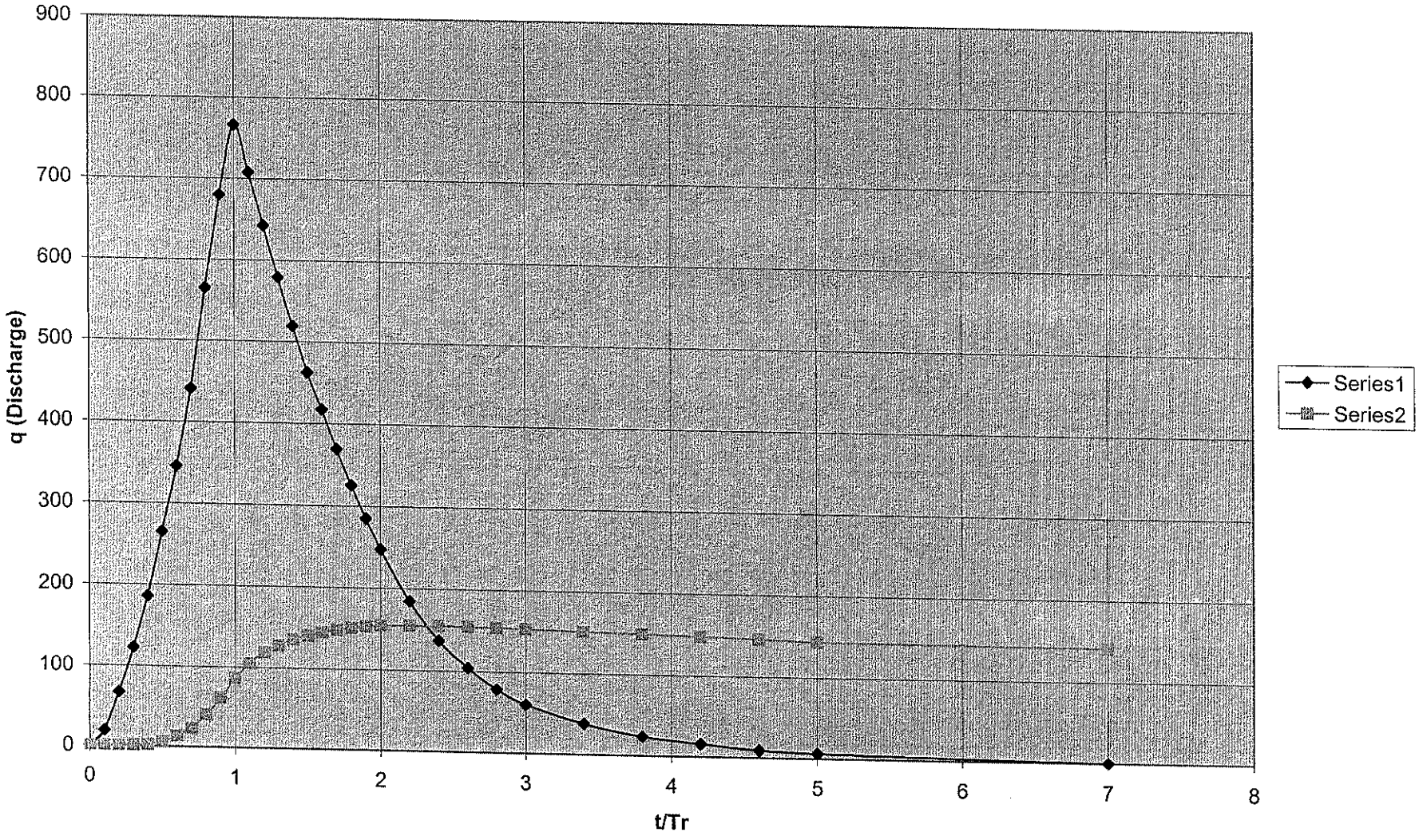
Hydrograph 2 - 24" Pipe



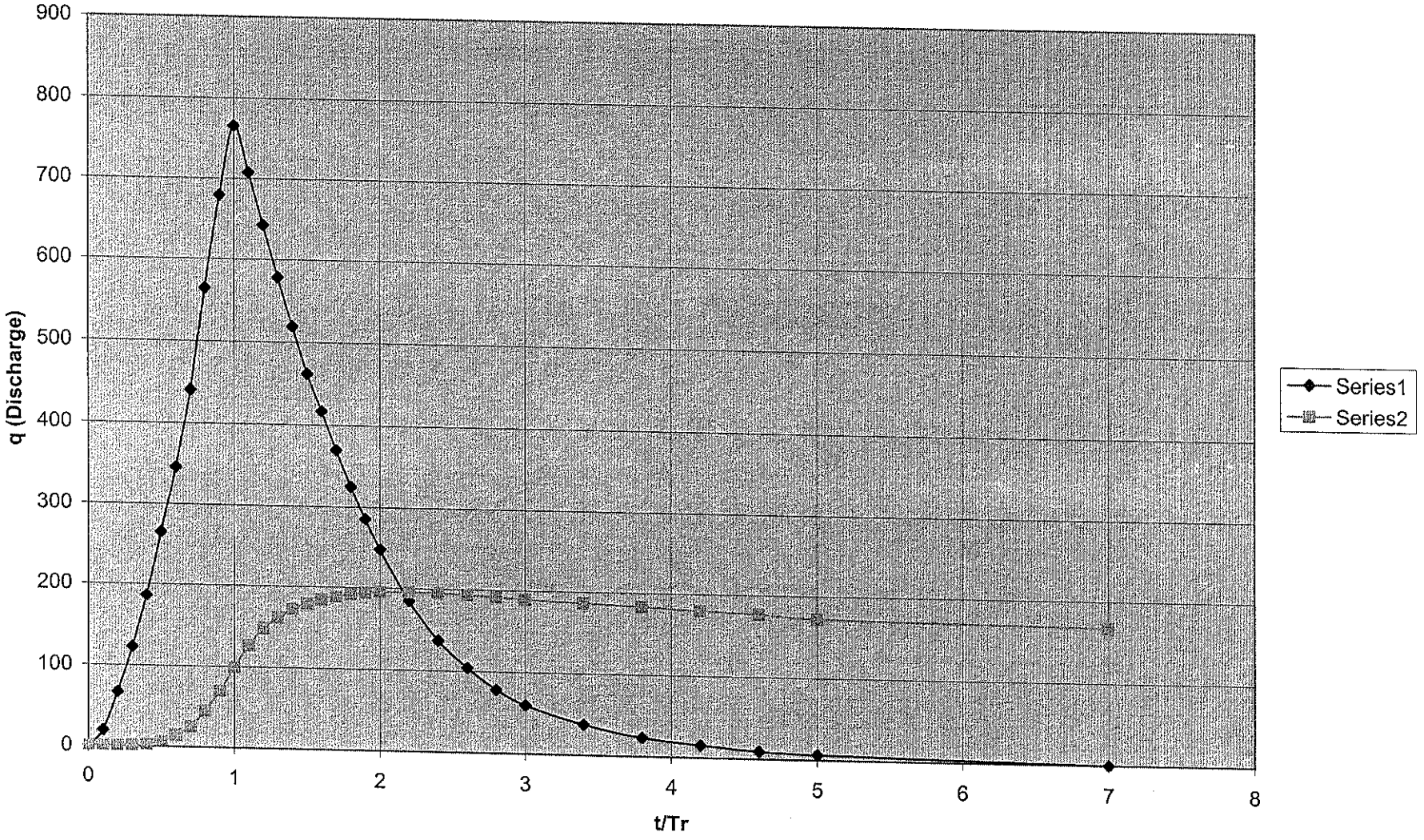
Hydrograph 2 - 30" Pipe



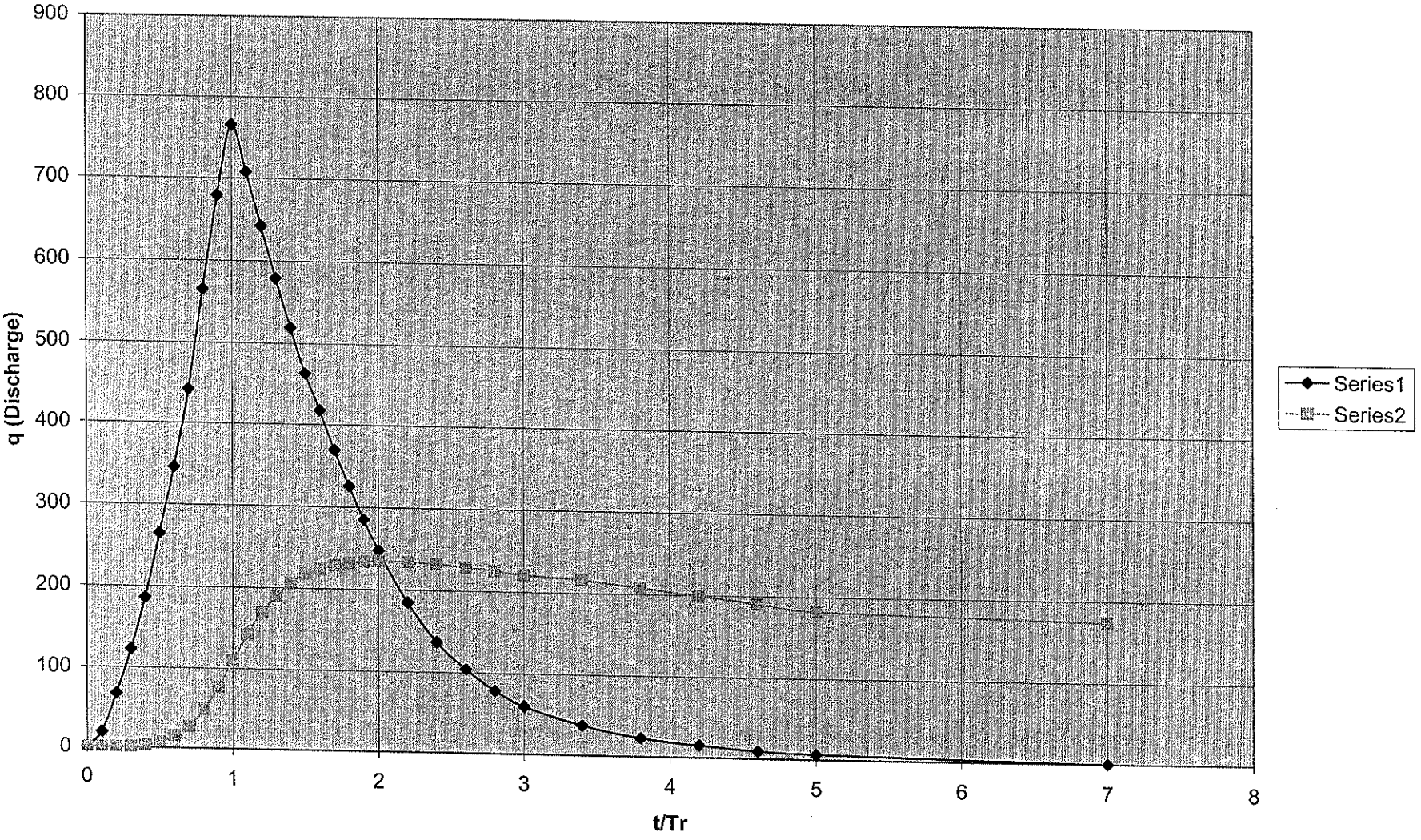
Hydrograph 2 - 36" Pipe



Hydrograph 2 - 42" Pipe



Hydrograph 2 - 48" Pipe



Curley School Detention Basin, Ajo

Alternative 3

Stage, Storage Calculations

4:1 Side slope

Head Water (ft)	Stage (ft)	Area (acre)	Volume (cf)	Cum Vol (cf)	Storage (acre-ft)
0	85.4	1.639	0	0	0
0.6	86.0	1.705	43697	43697	1.003
1	86.4	1.749	30090	73787	1.694
1.6	87.0	1.817	46595	120382	2.764
2	87.4	1.862	32049	152431	3.499
2.6	88.0	2.040	50974	203405	4.670
3	88.4	2.138	36392	239797	5.505
3.6	89.0	2.284	57771	297567	6.831
4	89.4	2.383	40658	338225	7.765
4.6	90.0	2.532	64222	402447	9.239
5	90.4	2.643	45079	447526	10.274
5.6	91.0	2.809	71233	518760	11.909
6	91.4	2.921	49917	568676	13.055
6.6	92.0	3.089	78528	647205	14.858
7	92.4	3.215	54917	702121	16.118
7.6	93.0	3.404	86485	788607	18.104
8	93.4	3.532	60420	849026	19.491
8.6	94.0	3.723	94792	943818	21.667
9	94.4	3.875	66186	1010004	23.187
9.6	95.0	4.102	104224	1114228	25.579
10	95.4	4.119	71624	1185852	27.223

Stage, Storage - Discharge Calculations for Various Outlet Configurations

Stage (ft)	Storage (acre-ft)	Discharge (cfs)					
		1 - 30"	2 - 24"	2 - 30"	2 - 36"	2 - 42"	2 - 48"
85	0.000	0	0	0	0	0	0
86	1.003	1.48	2.60	2.95	3.27	3.55	3.82
87	2.764	3.40	15.98	18.81	21.27	23.47	25.48
88	4.670	21.64	34.74	43.27	50.52	56.89	62.63
89	6.831	34.35	47.55	68.70	85.19	98.59	110.53
90	9.239	42.25	55.35	84.51	114.68	142.94	163.98
91	11.909	48.90	59.79	97.79	134.81	174.92	216.69
92	14.858	54.74	63.91	109.48	152.30	199.75	250.65
93	18.104	58.48	67.79	116.95	167.98	221.82	280.53
94	21.667	61.64	71.46	123.28	182.31	241.88	307.52
95	25.579	64.65	74.95	129.30	195.60	260.40	332.32

Curley School Detention Basin, Ajo

Alternative 3
Storage Calculations

Contour	Planimeter Area (in^2)	Area (sft)	Area (acres)	Area of Basin (acre)	Total Area (acre)	Storage (acre - ft)
88	1.9	4750	0.109	1.931	2.040	0
89		10280	0.236	2.048	2.284	2.162
90	6.324	15810	0.363	2.169	2.532	2.408
91		22505	0.517	2.292	2.809	2.670
92	11.68	29200	0.670	2.418	3.089	2.949
93		37307.5	0.856	2.547	3.404	3.246
94	18.166	45415	1.043	2.680	3.723	3.563
95	21.46	53650	1.232	2.870	4.102	3.912

* Analysis includes planimeter area from the contours combined with area from ball field.

Head Water (ft)	Stage (ft)	Length (ft)	Width (ft)	Area (sft)	Area (acre)
0	85.4	420	170	71400.0	1.639
1	86.4	428	178	76184.0	1.749
2	87.4	436	186	81096.0	1.862
2.6	88.0	440.8	190.8	84104.6	1.931
3	88.4	444	194	86136.0	1.977
3.6	89.0	448.8	198.8	89221.4	2.048
4	89.4	452	202	91304.0	2.096
4.6	90.0	456.8	206.8	94466.2	2.169
5	90.4	460	210	96600.0	2.218
5.6	91.0	464.8	214.8	99839.0	2.292
6	91.4	468	218	102024.0	2.342
6.6	92.0	472.8	222.8	105339.8	2.418
7	92.4	476	226	107576.0	2.470
7.6	93.0	480.8	230.8	110968.6	2.547
8	93.4	484	234	113256.0	2.600
8.6	94.0	488.8	238.8	116725.4	2.680
9	94.4	492	242	119064.0	2.733
9.6	95.0	496.8	246.8	122610.2	2.815
10	95.4	500	250	125000.0	2.870

Flood Routing Output Files

Alternative 3

FLOOD ROUTING
ALTERNATIVE-3
1 - 30" DIAMETER CULVERT

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
1.48	1.003
3.4	2.764
21.64	4.67
34.35	6.831
42.25	9.239001
48.9	11.909
54.74	14.858
58.48	18.104
61.64	21.667
64.65	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
1.48	419.4738
3.4	1155.618
21.64	1960.458
34.35	2868.99
42.25	3878.236
48.9	4996.236
54.74	6230.308
58.48	7587.323
61.64	9076.389
64.65	10711.08

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	0
5.796666E-02	66.6	.2
8.694999E-02	122.5	.5
.1159333	186.1	1.1
.1449167	265	1.8
.1739	345.4	2.5
.2028833	441.2	4.8

.2318666	565.3	16.1
.26085	679.4	26.7
.2898333	765.9	35.5
.3188166	707.7	41
.3477999	642.6	45.1
.3767833	579	48.5
.4057666	519.3	50.9
.4347499	462.6	53
.4637333	417.4	54.8
.4927166	369.2	55.7
.5216999	324.8	56.5
.5506833	284.9	57.2
.5796666	247.4	57.8
.60865	184.6	58.2
.6376333	137.1	58.5
.6666167	104.2	58.6
.6956001	78.1	58.7
.7245834	59.7	58.7
.7535668	37.5	58.7
.7825501	23	58.6
.8115335	15.3	58.6
.8405168	9.2	58.5
.8695002	6.1	58.3
.8984835	0	58.2

VOLUME STORED=

FLOOD ROUTING
ALTERNATIVE-3
2 - 24" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
2.6	1.003
15.98	2.764
34.74	4.67
47.55	6.831
55.35	9.239001
59.79	11.909
63.91	14.858
67.79	18.104
71.46	21.667
74.95	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
2.6	420.0338
15.98	1161.909
34.74	1967.008
47.55	2875.59
55.35	3884.786
59.79	5001.681
63.91	6234.893
67.79	7591.978
71.46	9081.3
74.95	10716.23

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.3
8.694999E-02	122.5	.9
.1159333	186.1	1.9
.1449167	265	4.5
.1739	345.4	9.899999
.2028833	441.2	17.1

.2318666	565.3	28.4
.26085	679.4	39.3
.2898333	765.9	48.3
.3188166	707.7	53.6
.3477999	642.6	56.9
.3767833	579	59.1
.4057666	519.3	60.9
.4347499	462.6	62.3
.4637333	417.4	63.6
.4927166	369.2	64.6
.5216999	324.8	65.4
.5506833	284.9	66.1
.5796666	247.4	66.6
.60865	184.6	67.1
.6376333	137.1	67.3
.6666167	104.2	67.5
.6956001	78.1	67.5
.7245834	59.7	67.5
.7535668	37.5	67.5
.7825501	23	67.4
.8115335	15.3	67.2
.8405168	9.2	67.1
.8695002	6.1	66.9
.8984835	0	66.7

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-3
2 - 30" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
2.95	1.003
18.81	2.764
43.27	4.67
68.7	6.831
84.51	9.239001
97.79	11.909
109.48	14.858
116.95	18.104
123.28	21.667
129.3	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
2.95	420.2089
18.81	1163.324
43.27	1971.273
68.7	2886.165
84.51	3899.366
97.79	5020.681
109.48	6257.678
116.95	7616.558
123.28	9107.209
129.3	10743.41

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.4
8.694999E-02	122.5	1
.1159333	186.1	2.1
.1449167	265	5.2
.1739	345.4	11.6
.2028833	441.2	20.1

.2318666	565.3	34.7
.26085	679.4	51.7
.2898333	765.9	69.6
.3188166	707.7	80.1
.3477999	642.6	88.2
.3767833	579	94.4
.4057666	519.3	99.4
.4347499	462.6	103.1
.4637333	417.4	106.2
.4927166	369.2	109
.5216999	324.8	110.5
.5506833	284.9	111.6
.5796666	247.4	112.4
.60865	184.6	113
.6376333	137.1	113.2
.6666167	104.2	113.3
.6956001	78.1	113.2
.7245834	59.7	112.9
.7535668	37.5	112.6
.7825501	23	112.1
.8115335	15.3	111.6
.8405168	9.2	111
.8695002	6.1	110.5
.8984835	0	109.9

VOLUME STORED=

FLOOD ROUTING
ALTERNATIVE-3
2 - 36" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
3.27	1.003
21.27	2.764
50.52	4.67
85.19	6.831
114.68	9.239001
134.81	11.909
152.3	14.858
167.98	18.104
182.31	21.667
195.6	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
3.27	420.3689
21.27	1164.554
50.52	1974.898
85.19	2894.41
114.68	3914.451
134.81	5039.191
152.3	6279.088
167.98	7642.073
182.31	9136.724
195.6	10776.56

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.4
8.694999E-02	122.5	1.1
.1159333	186.1	2.3
.1449167	265	5.8
.1739	345.4	13
.2028833	441.2	22.7

.2318666	565.3	40
.26085	679.4	61.5
.2898333	765.9	86.1
.3188166	707.7	104.9
.3477999	642.6	118.9
.3767833	579	127.7
.4057666	519.3	135.1
.4347499	462.6	140.1
.4637333	417.4	144.4
.4927166	369.2	147.9
.5216999	324.8	150.7
.5506833	284.9	152.8
.5796666	247.4	154.1
.60865	184.6	154.8
.6376333	137.1	154.8
.6666167	104.2	154.5
.6956001	78.1	153.7
.7245834	59.7	152.8
.7535668	37.5	151.4
.7825501	23	149.7
.8115335	15.3	147.8
.8405168	9.2	145.9
.8695002	6.1	144
.8984835	0	142

VOLUME STORED=

FLOOD ROUTING
ALTERNATIVE-3
2 - 42" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
3.55	1.003
23.47	2.764
56.89	4.67
98.58999	6.831
142.94	9.239001
174.92	11.909
199.75	14.858
221.82	18.104
241.88	21.667
260.4	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
3.55	420.5088
23.47	1165.654
56.89	1978.083
98.58999	2901.11
142.94	3928.581
174.92	5059.246
199.75	6302.813
221.82	7668.993
241.88	9166.51
260.4	10808.96

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.4
8.694999E-02	122.5	1.2
.1159333	186.1	2.5
.1449167	265	6.3
.1739	345.4	14.3
.2028833	441.2	24.9

.2318666	565.3	44.6
.26085	679.4	69.5
.2898333	765.9	99
.3188166	707.7	126.5
.3477999	642.6	147.7
.3767833	579	160.8
.4057666	519.3	171.8
.4347499	462.6	179.1
.4637333	417.4	184.3
.4927166	369.2	188.5
.5216999	324.8	191.6
.5506833	284.9	193.9
.5796666	247.4	195.3
.60865	184.6	195.7
.6376333	137.1	195
.6666167	104.2	193.6
.6956001	78.1	191.5
.7245834	59.7	189.1
.7535668	37.5	186.3
.7825501	23	183.1
.8115335	15.3	179.9
.8405168	9.2	176.5
.8695002	6.1	172.4
.8984835	0	167.6

VOLUME STORED=

□

FLOOD ROUTING
ALTERNATIVE-3
2 - 48" DIAMETER CULVERTS

FLOOD ROUTING

DISCHARGE-Cfs	STORAGE-AcFt
0	0
3.82	1.003
25.48	2.764
62.63	4.67
110.53	6.831
163.98	9.239001
216.69	11.909
250.65	14.858
280.53	18.104
307.52	21.667
332.32	25.579

DISCHARGE-Cfs	S/T+Q/2
0	0
3.82	420.6439
25.48	1166.659
62.63	1980.953
110.53	2907.08
163.98	3939.101
216.69	5080.131
250.65	6328.263
280.53	7698.348
307.52	9199.329
332.32	10844.92

TIME-Hrs	INFLOW-Cfs	OUTFLOW-Cfs
0	0	0
2.898333E-02	19.1	.1
5.796666E-02	66.6	.5
8.694999E-02	122.5	1.3
.1159333	186.1	2.7
.1449167	265	6.8
.1739	345.4	15.4
.2028833	441.2	26.9

.2318666	565.3	48.7
.26085	679.4	76.5
.2898333	765.9	109.9
.3188166	707.7	142.4
.3477999	642.6	169.3
.3767833	579	189.7
.4057666	519.3	206.3
.4347499	462.6	218.3
.4637333	417.4	224.4
.4927166	369.2	229.0
.5216999	324.8	232.2
.5506833	284.9	234.1
.5796666	247.4	235.0
.60865	184.6	234.5
.6376333	137.1	232.5
.6666167	104.2	229.4
.6956001	78.1	225.7
.7245834	59.7	221.4
.7535668	37.5	216.7
.7825501	23	208.1
.8115335	15.3	199.4
.8405168	9.2	190.7
.8695002	6.1	182.3
.8984835	0	174

VOLUME STORED=

□

Culvert Hydraulics

Alternative 3

Culvert Calculator Report
Alt-3 - 30 inch 1 Pipe

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	4.00
Computed Headwater Elev	95.40 ft	Discharge	65.81 cfs
Inlet Control HW Elev.	94.21 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.42 ft
Velocity Downstream	13.41 ft/s	Critical Slope	0.022662 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.79 ft
Ke	0.50	Entrance Loss	1.40 ft

Inlet Control Properties			
Inlet Control HW Elev.	94.21 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	4.9 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-3 - 30 inch 1 Pipe

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.00	95.00	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	1.48
87.00	9.40
88.00	21.64
89.00	34.35
90.00	42.25
91.00	48.90
92.00	54.74
93.00	58.48
94.00	61.64
95.00	64.65

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Culvert Calculator Report
Alt-3 - 24 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	5.00
Computed Headwater Elev	95.40 ft	Discharge	76.30 cfs
Inlet Control HW Elev.	92.59 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.94 ft
Velocity Downstream	12.14 ft/s	Critical Slope	0.025079 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.29 ft
Ke	0.50	Entrance Loss	1.15 ft

Inlet Control Properties			
Inlet Control HW Elev.	92.59 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	6.3 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-3 - 24 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.00	95.00	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	2.60
87.00	15.98
88.00	34.74
89.00	47.55
90.00	55.35
91.00	59.79
92.00	63.91
93.00	67.79
94.00	71.46
95.00	74.95

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Culvert Calculator Report
Alt-3 - 30 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	4.00
Computed Headwater Elev	95.40 ft	Discharge	131.63 cfs
Inlet Control HW Elev.	94.21 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.40 ft	Control Type	Outlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.42 ft
Velocity Downstream	13.41 ft/s	Critical Slope	0.022663 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.40 ft	Upstream Velocity Head	2.79 ft
Ke	0.50	Entrance Loss	1.40 ft

Inlet Control Properties			
Inlet Control HW Elev.	94.21 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	9.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-3 - 30 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.00	95.00	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	2.95
87.00	18.81
88.00	43.27
89.00	68.70
90.00	84.51
91.00	97.79
92.00	109.48
93.00	116.95
94.00	123.28
95.00	129.30

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Culvert Calculator Report
Alt-3 - 36 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	3.33
Computed Headwater Elev	95.40 ft	Discharge	200.67 cfs
Inlet Control HW Elev.	95.40 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	95.03 ft	Control Type	Inlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.90 ft
Velocity Downstream	14.19 ft/s	Critical Slope	0.019820 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	95.03 ft	Upstream Velocity Head	3.13 ft
Ke	0.50	Entrance Loss	1.57 ft

Inlet Control Properties			
Inlet Control HW Elev.	95.40 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	14.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
Alt-3 - 36 inch 2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.00	95.00	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	3.27
87.00	21.27
88.00	50.52
89.00	85.19
90.00	114.68
91.00	134.81
92.00	152.30
93.00	167.98
94.00	182.31
95.00	195.60

Culvert Calculator Report
Alt-3 - 42 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	2.86
Computed Headwater Elev	95.40 ft	Discharge	267.45 cfs
Inlet Control HW Elev.	95.40 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	93.45 ft	Control Type	Inlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	2.77 ft
Slope Type	N/A	Normal Depth	2.74 ft
Flow Regime	N/A	Critical Depth	3.33 ft
Velocity Downstream	16.36 ft/s	Critical Slope	0.015307 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.50 ft
Section Size	42 inch	Rise	3.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	93.45 ft	Upstream Velocity Head	3.12 ft
Ke	0.50	Entrance Loss	1.50 ft

Inlet Control Properties			
Inlet Control HW Elev.	95.40 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	19.2 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
Alt-3 - 42 inch 2 Pipes

Range Data:				
	Minimum	Maximum	Increment	
Allowable HW E	85.00	95.00	1.00	ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	3.55
87.00	23.47
88.00	56.89
89.00	98.59
90.00	142.94
91.00	174.92
92.00	199.75
93.00	221.82
94.00	241.88
95.00	260.40

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Culvert Calculator Report
Alt-3 - 48 inch 2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	95.40 ft	Headwater Depth/Height	2.50
Computed Headwater Elev	95.40 ft	Discharge	341.74 cfs
Inlet Control HW Elev.	95.40 ft	Tailwater Elevation	84.00 ft
Outlet Control HW Elev.	93.70 ft	Control Type	Inlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	2.91 ft
Slope Type	Steep	Normal Depth	2.85 ft
Flow Regime	N/A	Critical Depth	3.73 ft
Velocity Downstream	17.45 ft/s	Critical Slope	0.012235 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	93.70 ft	Upstream Velocity Head	3.05 ft
Ke	0.50	Entrance Loss	1.52 ft

Inlet Control Properties			
Inlet Control HW Elev.	95.40 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	25.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
Alt-3 - 48 inch 2 Pipes

Range Data:

	Minimum	Maximum	Increment	
Allowable HW E	85.00	95.00	1.00	ft

HW Elev. (ft)	Discharge (cfs)
85.00	0.00
86.00	3.82
87.00	25.48
88.00	62.63
89.00	110.53
90.00	163.98
91.00	216.69
92.00	250.65
93.00	280.53
94.00	307.52
95.00	332.32

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Appendix E

Culvert Hydraulics
Existing Conditions

Culvert Calculator Report
2 Pipes

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	88.81 ft	Headwater Depth/Height	1.42
Computed Headwater Elev	88.81 ft	Discharge	100.30 cfs
Inlet Control HW Elev.	88.81 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	88.77 ft	Control Type	Inlet Control

Grades			
Upstream Invert	85.40 ft	Downstream Invert	80.00 ft
Length	280.00 ft	Constructed Slope	0.019286 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.78 ft
Slope Type	Steep	Normal Depth	1.78 ft
Flow Regime	Supercritical	Critical Depth	1.87 ft
Velocity Downstream	8.41 ft/s	Critical Slope	0.017477 ft/ft

Section			
Section Shape	Horizontal Ellipse	Mannings Coefficient	0.024
Section Material	Concrete	Span	3.79 ft
Section Size	29x45 inch	Rise	2.40 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	88.77 ft	Upstream Velocity Head	1.00 ft
Ke	0.50	Entrance Loss	0.50 ft

Inlet Control Properties			
Inlet Control HW Elev.	88.81 ft	Flow Control	N/A
Inlet Type	Square edge with headwall (horizontal ellipse)	Area Full	14.8 ft²
K	0.01000	HDS 5 Chart	29
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

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Rating Table Report
2 Pipes

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	85.40	95.40	1.00 ft

HW Elev. (ft)	Discharge (cfs)
85.40	0.00
86.40	12.14
87.40	45.35
88.40	85.30
89.40	115.36
90.40	122.46
91.40	129.41
92.40	136.13
93.40	142.58
94.40	148.78
95.40	154.74

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