

**DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS**

FOR

BRADLEY FAIR 2ND ADDITION

WICHITA, KANSAS

PREPARED BY

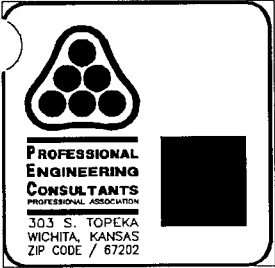
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.

ENGINEERS

WICHITA, KANSAS

DECEMBER 18, 1995

MEMO



TO: M. E. Lindebak, P.E.
455 N. Main, 7th Floor
Wichita, KS 67202

PROJECT NO. 36-95785-3650

PROJECT: Bradley Fair 2nd Addition

COPIES TO:

ATTN: V. R. Huang, P.E.

DATE: 12/18/95

George Laham

FROM: M. W. Berry, P.E.

Ron Spangenberg

REFERENCE: Drainage Plan Computations

PLEASE ADVISE IMMEDIATELY OF ANY MISCONCEPTIONS OR OMISSIONS YOU BELIEVE TO BE CONTAINED HEREIN.

Attached hereto are the drainage computations for the referenced project

The publication Interim Drainage and Storm Sewer policy for Design Criteria and Documentation, City of Wichita, as revised 7/1/87 was used as the guideline for the hydrologic and hydraulic computations. This publication is hereinafter referred to as the Design Manual.

Manual #1, as referenced herein, refers to Design of Urban Highway Drainage - The State of the Art by Reitz & Jens, Inc., April 1980. Manual #2 refers to Drainage of Highway Pavements, Hydraulic Engineering Circular #12 by Tye Engineering, Inc., March 1984.

The analysis made herein is based on the available site data which includes the following:

Contour map at two foot interval and 1"=100' scale for the final plat area

Contour map at two foot interval and 1"=200' scale for the balance of the Wilson Farms tract.

City of Wichita Flood Insurance Study, May 1986

HYDROLOGIC ANALYSIS FOR STORM WATER SEWERS

For storm sewer design, the Rational Method was used for the hydrologic analysis in accordance with the Design Manual. Runoff coefficients were estimated based on tables presented in the Design Manual.

For this development, a uniform assumption of the minimum time of concentration of 15 minutes was deemed appropriate.

Travel time for flow through defined channels, pipes, etc., for these basins was estimated on the basis of Manning's Equation.

M. E. Lindebak, P.E.
Bradley Fair 2nd Addition
12/11/95
Page 2

HYDRAULIC ANALYSIS FOR STORM WATER SEWERS

For each inlet, street flooding and inlet capacity were checked for the minor storm. Conveyance in the street is based on the Modified Manning's Equation, as expressed in Manual #1, Equation (5-1), page 5-9. It has been assumed that T_c for street flow is equal for T_c for pipe flow. This is a simplifying, but conservative, assumption, since pipe flow velocities generally exceed street flow velocities.

For local streets, curb-deep flow is tolerable for the minor storm. For collector streets, a single eight-foot center lane should remain unflooded for the minor storm.

Inlet capacities were determined by the methods described in Manual #2, using Chart #12.

In this analysis, City of Wichita Type 1A inlets and 3/8 inch per foot street cross slopes have been assumed. Minimum walk grade has been assumed to be 0.3 feet above the top of curb, unless otherwise noted. Streets have been assumed to have 6-5/8 inch standard curb, unless otherwise noted.

Storm sewers are designed for the minor storm, with major storm overflows to be routed through easements and rights-of-way to an appropriate outlet.

The minor storm has a recurrence interval of five years. The major storm evaluated has a recurrence interval of one hundred years.

To simplify hydraulic analysis, the following assumptions have been made:

1. The time of concentration is identical for both the major and the minor storms.
2. The street conveyance is computed using only the pavement width. Depths above the curb up to the walk (right-of-way) elevation are used, but the conveyance of the landscaped area behind the curb was neglected. In general, this area has a very small conveyance due to the higher "n" factor.

Hydraulic computations for the pipe system were estimated using Manning's Equation to calculate friction losses for pipes flowing full. Minor losses estimated at a constant 0.5 feet per structure. All pipe area assumed to be reinforced concrete with a Manning's "n" of 0.013. It is desirable to keep the hydraulic grade line at least one foot below the top of curb for the minor storm.

HYDROLOGIC AND HYDRAULIC MODELS FOR DETENTION

Detention basins are analyzed using the US Army Corps of Engineers HEC-1 computer package. Runoff computations within that program were made using the NCRS (formerly SCS) unit hydrograph procedure utilizing the Curve Number method. Stage-discharge relationships for weirs are automatically computed by HEC-1. For culvert control structures, the FHWA HY-8 Culvert computer program is used to develop a stage-discharge curve. Reservoir routing is computed using the Modified Puls method within HEC-1.

Potential detention areas have been identified throughout the site. The effects of urbanization on the basin have been analyzed utilizing the SCS hydrologic method and the HEC-21 computer program. The results of this analysis are summarized in a table I the report.

FEMA REGULATED STREAMS

The Middle Fork of Gypsum Creek has been include in the detailed study of the City of Wichita Flood Insurance Study (FIS). Regulatory floodplain limits, regulatory floodway limits, base flood elevations, and design discharges have been identified in the FIS. For the purposes of this study, the design flows identified in the report are assumed to enter the site at 21st Street and discharge from the site at the Burlington Northern Railroad essentially unchanged. No attempt has been made to evaluate the effects of detention to be provided on this site.

DESIGN AIDS

Charts, nomographs, etc. used in these computation are reprinted in this section

DRAINAGE PLAN MAP

A map at 1"=200' scale is include in the map pocket(s) at the back of the report.

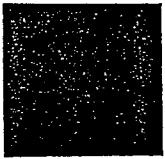
HYDROLOGY DATA SHEET

PAGE OF

PROJECT: BRADLEY FAIR 2ND ADD PROJECT NO. 36.95785.365

ITEM: DATE: 12.17.95

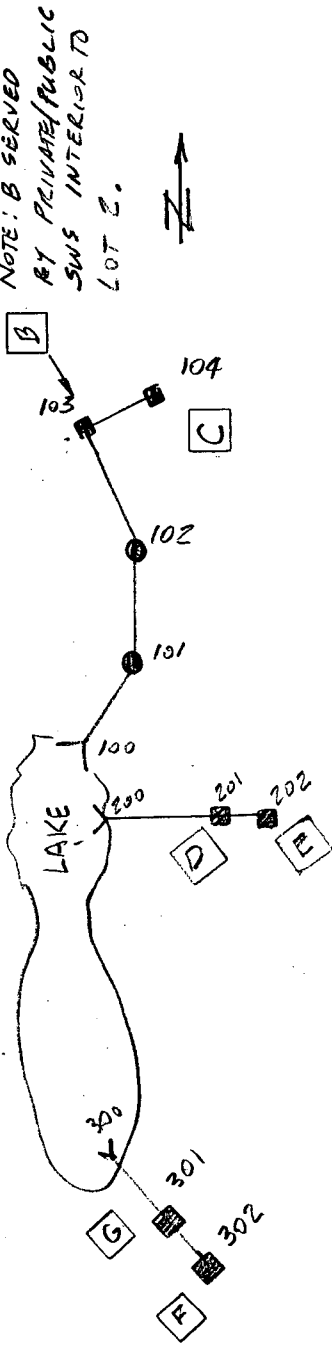
RETURN PERIOD: 5-yr COMPUTATIONS BY: MBS REVISIONS BY:



PROFESSIONAL
ENGINEERING
CONSULTANTS
PROFESSIONAL ASSOCIATION

1440 EAST ENGLISH
WICHITA, KANSAS 67211
(316) 262-2691

SCHEMATIC DIAGRAM:



NOTE: B SERVED BY PRIVATE/PUBLIC SWS INTERIOR TO LOT 2.

NOTE: "G" WILL BE SERVED BY PRIVATE/PUBLIC SWS INSTALLED INTERIOR TO LOTS 1 & 2.

		TRIBUTARY AREA					HYDROLOGY SUMMATION					CONDUIT DATA					
SUB-BASIN	C	AREA (acres)	SLOPE (%)	LENGTH (feet)	T _c (minutes)	I ₀ (in./hr.)	Q ₀ (cfs)	T _c (minutes)	I (in./hr.)	Q (cfs)	Σ Q (cfs)	PIPE (inches)	SLOPE (%)	VELOCITY (ft./sec.)	LENGTH (feet)	T ₁ (minutes)	T _c + T ₁ (minutes)
(11)	(12)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
C	0.69	6			15	4.56	18.9	15		18.9		30"	0.21	3.8	60	0.3	15.3
B	0.69	24			20	4.00	66.2	20	4.00	66.2	82.8	48"	0.33	6.6	525	1.3	21.3
E	0.60	2.5			15	4.56	7.9	15		7.9		24"	0.12	2.5	60	0.4	15.4
D	0.50	0.8			15	4.56	1.8	15	4.56	1.8	9.7	24"	0.18	3.1	75	0.4	15.8
F	0.69	10			15	4.56	31.5	15	$\frac{15}{15.4} \times 7.9 + 1.8 = 9.5$ OR $\frac{451}{556} \times 7.8 + 7.9 = 9.7$			36"	0.22	4.4	75	0.3	15.3
G	0.69	8			15	4.56	25.2	15.3	4.52	25.0	56.5	48"	0.15	4.5	75	0.3	15.6

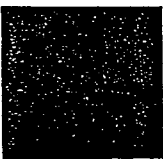
HYDROLOGY DATA SHEET

PAGE OF

PROJECT: BRADLEY FAIR LAND ADDITION PROJECT NO. 36.95785.3650

ITEM: DATE: 12.17.95

RETURN PERIOD: 100 Yr COMPUTATIONS BY: MMS REVISIONS BY:



**PROFESSIONAL
ENGINEERING
CONSULTANTS**
PROFESSIONAL ASSOCIATION

1440 EAST ENGLISH
WICHITA, KANSAS 67211
(316) 262-2691

SCHEMATIC DIAGRAM:

(SEE OTHER SHEET)

SUB-BASIN (1)	TRIBUTARY AREA						HYDROLOGY SUMMATION				CONDUIT DATA						
	C (2)	AREA (acres) (3)	SLOPE (%) (4)	LENGTH (feet) (5)	T_c (minutes) (6)	I_o in./hr. (7)	Q_o (cfs) (8)	T_c (minutes) (9)	I in./hr. (10)	Q (cfs) (11)	ΣQ (cfs) (12)	PIPE (Inches) (13)	SLOPE (%) (14)	VELOCITY (ft./sec.) (15)	LENGTH (feet) (16)	T_t (minutes) (17)	$T_c + T_t$ (minutes) (18)
C	0.8	6			15	7.37	35.4	15			35.4	30"	0.75	7.2!	60		
B	0.8	24			20	6.53	125	20	6.53		156.7	48"	1.19	12.5!	525		
											156.7	54"	0.64	9.9!			
											156.7	60"	0.36	8.0!			
E	0.8	2.5			15	7.37	14.7				14.7	24"	0.42	4.7	60		
D	0.6	0.8			15	7.37	3.5				18.2	24"	0.65	5.8	75		
F	0.8	10			15	7.37	59	15	7.37		59	36"	0.78	8.3	75		
G	0.8	8			15	7.37	47.2	15	7.37		106	48"	0.54	8.4	75		

USE FOR Q100



Date 12.17.95

Page of

Comp by MMS

Project BRADLEY FAIR 2ND ADD 36.95785.3650

NOTE: ASSUME NO MORE THAN 1.25 AC PAVT DISCHARGES DIRECTLY ONTO STREET
 ITEM AT EACH ENTRANCE. BALANCE IS CARRIED TO PUBLIC SWS BY PRIVATE SWS.

z/n = 2000

INLET CAPACITY

NODE No.	HYDROLOGY		APPROACHING FLOW			INLET		ON-GRADE COMP			SUMP COMP.						
	Q ₀ cfs	Q ₀ +Q _b cfs	S ₀ o/o	S _x in/ft	d ft	T ft	TYPE	L	Lt ft	L/Lt	E ft	d _i ft	d ft	T ft	Q _i cfs	Q _b cfs	
104	18.9	—	Assume 3/4 Q from NORTH	3/8	0.5	16	OK	14.2									
NORTH	14.2		0.5	3/8	0.5	16	OK BY INSPECTION										
SOUTH	4.7		0.4	3/8	0.4	10	1A	10'				0.6	0.43	13.8	18.9	0	OK
103	66.2	Assume all except E/W (1.0 Ac)	Assume all except E/W (1.0 Ac)	3/8	0.46	14.7	1A	10'				0.47	0.30	9.6	10	0	OK
NORTH	10		0.5	3/8	0.46	14.7	1A	10'									
SOUTH	Negligible																
202	79	—															
NORTH	4.0		0.43	3/8	0.33	10.6	1A	5'				0.4	0.23	7.4	7.9	0	OK
SOUTH	3.9		0.46	3/8	0.32	10.5	1A	5'									
201	6.8	OK BY INSPECTION (SEE DOC)	OK BY INSPECTION (SEE DOC)									0.17	—	—	10	0	OK
For 302 + 301, assume 3 drives @ 1.25 EA + R/W (1.5 Ac)								5.25 AC	5.25/10 x 31.5 = 16.5 cfs			5.25/8 x 31.5 = 16.5 cfs					
302	16.5		0.88	3/8	0.48	15.4	1A	10'				0.62	0.45	14.4	16.5	0	OK
301	16.5		0.88	3/8	0.48	15.4	1A	10'				0.62	0.45	14.4	16.5	0	OK

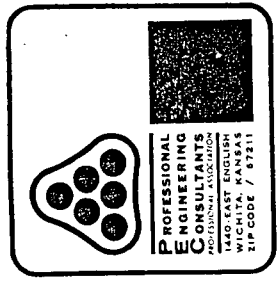
10

Date 12.17.95 Page of Comp by MMS

Project BRADLEY FARM END ADD 36-95785-3050 CK by

Item

MAJOR STORM CHECK



NODE	Tc MIN	i _{100/12}	Q ₂ cfs	Q ₁₀₀ cfs	Q _{pipe} cfs	Q _{100-Qp} cfs	Σ Q cfs	So %	Bk-Bk Street Width	MAX DISCHARGE (cfs) @ d =			REMARKS
										T.C.	T.C.	T.C.	
100	15		5	35.4	} ASSUME PIPE BLOCKAGE/FAILURE					T.C.	T.C.	T.C.	
103	15		125	125							+0.3'	+0.41'	+0.52'
				160			160	0.5	32	110	140	200	OK
202													
201							14.7						
							3.5						
302	15			59									
301	15			106									
				165									

OK ABOVE AT 0.50% DE BY INSPECTION AT 0.55%



Date _____ Page _____ of _____

Project WILSON ESTATES

Item BASIN HYDROLOGY

PRE-DEVELOPED
BASIN #

<u>BASIN #</u>	<u>A</u>	<u>C₁₀₀</u>	<u>L₁₀₀</u>	<u>Q₁₀₀</u>
4	38.5 Ac	0.67	7.36	190 cfs
9	48.3 Ac	0.67	7.36	238 cfs

POST-DEVELOPED

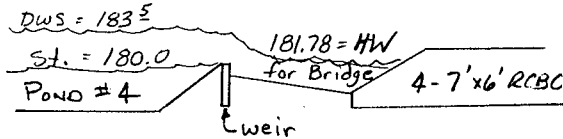
<u>BASIN #</u>	<u>A</u>	<u>C₁₀₀</u>	<u>L₁₀₀</u>	<u>Q₁₀₀</u>
4	38.5	0.76	7.36	215 cfs
9	48.3	0.76	7.36	270 cfs

NOTE:

BASINS # 1-3, 5, 6, and 8 are calculated within HEC-1
 BASIN # 7 is previously calculated as shown later in this report.

Basins No. 1, 2, 3, and 9, contribute runoff to a series of proposed ponds to be built upstream of the proposed 4 - 7' X 6' RCBC at the road crossing the Middle Branch of Gypsum Creek.

All requirements for sizes and elevations of Ponds # 1 thru 3 are summarized on the drainage plan map. The outlet for Pond #1 is a 6' square drop inlet at elevation 198.0 with a 54" outlet pipe to Pond #2. Ponds #2 and #3 are each controlled by a 5' spillway and channel at elevations 195.0 and 186.0 respectively. Pond #3 drains to Pond #4, which is to be constructed by damming off the creek using a 75' concrete weir at elevation 180.0. The following weir calculations show a maximum rise of 3.5' to elevation 183.5.



$$Q = CLH^{3/2}$$

$$Q_{free} = 3.0(L)(3.5)^{3/2}$$

$$\frac{1243}{3.0 \times 3.5^{3/2}} = L_{free}$$

$$63.3' = L_{free}$$

$$\frac{D_{dn}}{D_{up}} = \frac{1.78}{3.5} = 0.5$$

$$L_{sub} = \frac{63.3}{0.84} = 75'$$

$$\frac{Q_{dn}}{Q_{up}} = 0.84 \text{ (Fig. E-5)}$$

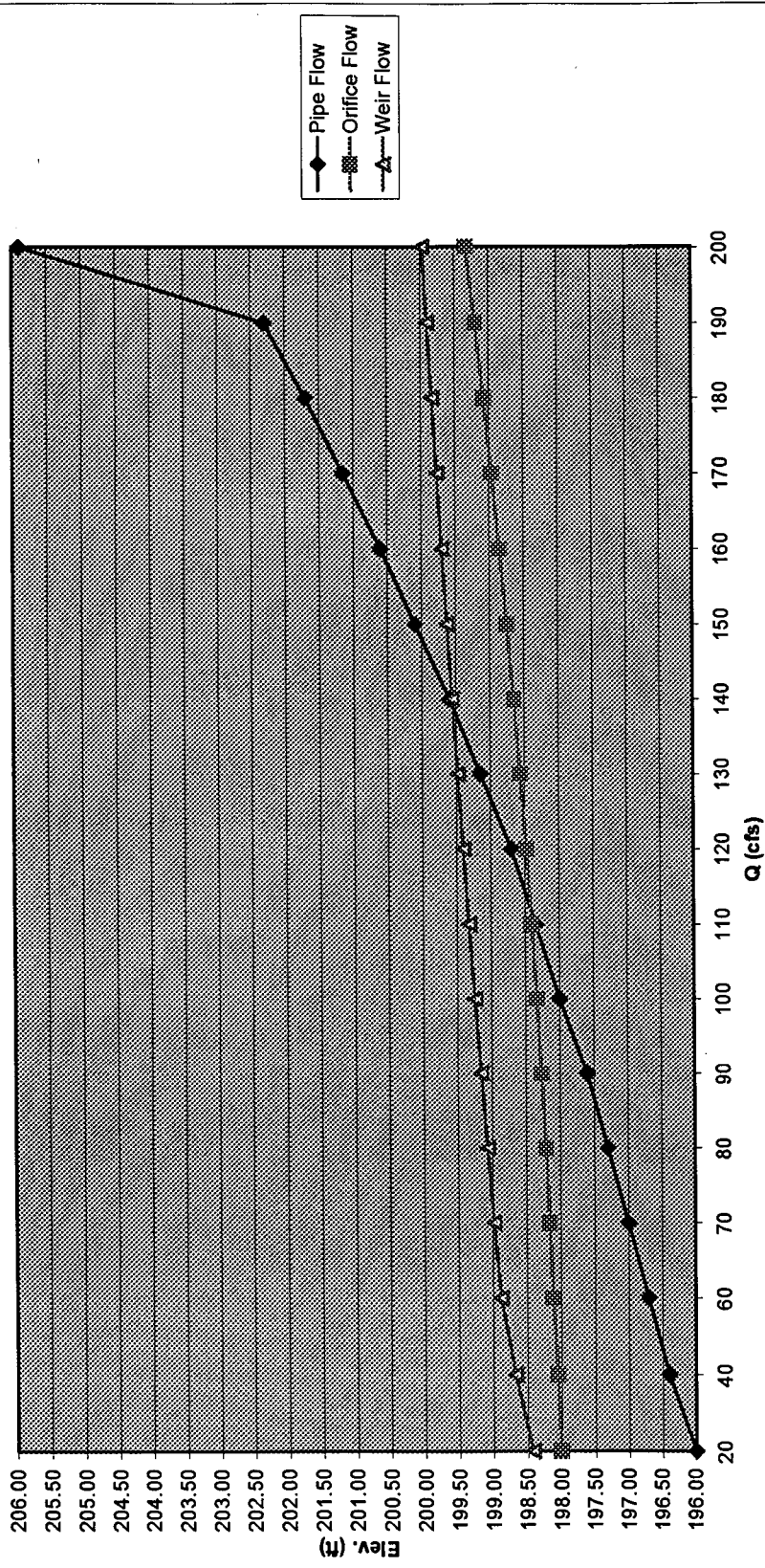
Because the pond is within the creek, Q_{100} for analysis of Pond #4, and the box culvert downstream of the weir is 1243 cfs, as defined by the Federal Emergency Management Agency (FEMA) Flood Insurance Study (F.I.S.), despite the reduction of peak on-site flows provided by the proposed detention storage.

The peak stage of Pond #4 of 183.5 is slightly higher than the published Base Flood Elevation (B.F.E.) for a short reach of the creek just upstream of the new RCBC, (up to Section Q. See FEMA B.F.E.'s within) but is lower than the B.F.E.'s for the next reach of the creek up to near the South side of 21st St. (near Sec. S)

The proposed box culvert at the road crossing was designed to handle the 100-year flow of the creek, being 1243 cfs. The culvert run shows a maximum headwater elevation of 181.78, assuming a 25' bottom width channel with 4:1 side slopes on 0.3% grade to the South as tailwater control. This will likely require some channel cleaning and/or widening south of the box.

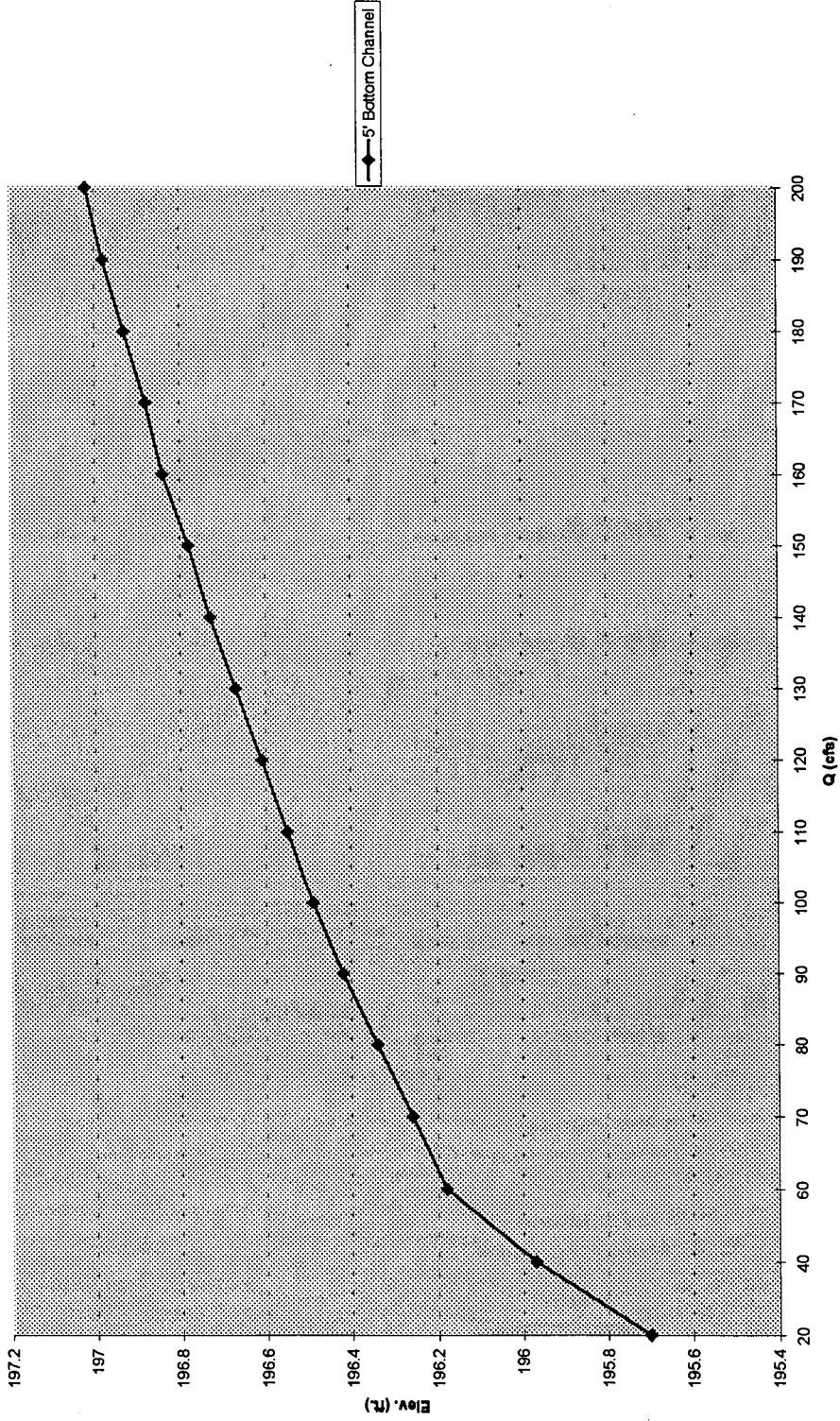
STAGE-DISCHARGE

POND #1



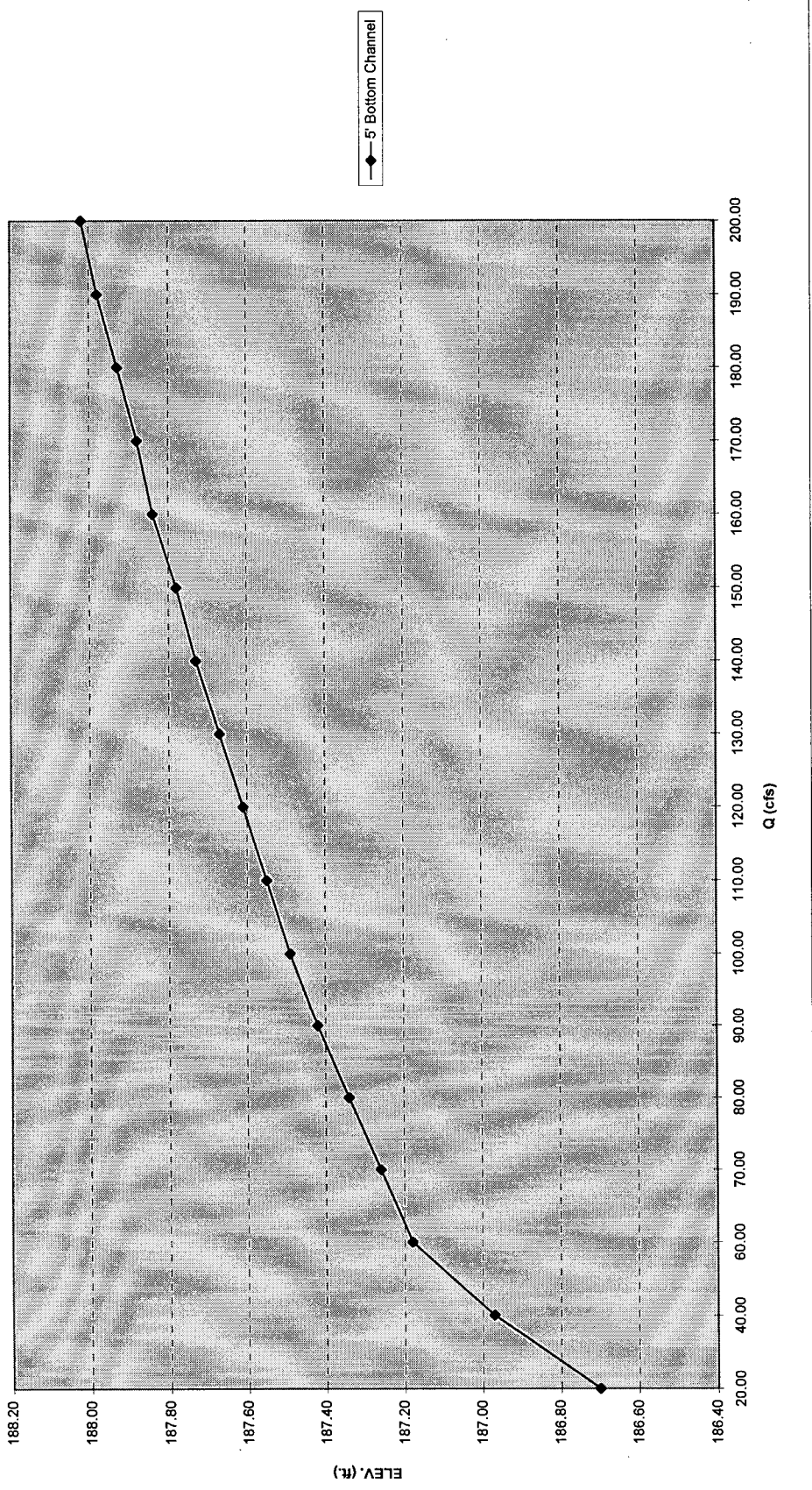
STAGE-DISCHARGE

POND #2



STAGE - DISCHARGE

POND #3



CURRENT DATE: 11-20-1995
 CURRENT TIME: 16:44:23

FILE DATE: 11-17-1995
 FILE NAME: BRADLEY

 FHWA CULVERT ANALYSIS
 HY-8, VERSION 3.2

C	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
U	L	V		BARRELS	SPAN	RISE	MANNING	INLET
	ELEV.	ELEV.	LENGTH	SHAPE	(FT)	(FT)	n	TYPE
	(FT)	(FT)	(FT)	MATERIAL				
1	191.00	189.00	250.01	1 RCP	4.50	4.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

 SUMMARY OF CULVERT FLOWS (CFS) FILE: BRADLEY DATE: 11-17-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
197.97	100	100	0	0	0	0	0	0	1
198.33	110	110	0	0	0	0	0	0	1
198.72	120	120	0	0	0	0	0	0	1
199.14	130	130	0	0	0	0	0	0	1
199.61	140	140	0	0	0	0	0	0	1
200.08	150	150	0	0	0	0	0	0	1
200.59	160	160	0	0	0	0	0	0	1
201.13	170	170	0	0	0	0	0	0	1
201.70	180	180	0	0	0	0	0	0	1
202.29	190	190	0	0	0	0	0	0	1
205.90	200	200	0	0	0	0	0	0	1
210.00	261	261	0	0	0	0	0	0	OVERTOPPING

 SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: BRADLEY DATE: 11-17-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
197.97	0.00	100	0	0.00
198.33	0.00	110	0	0.00
198.72	0.00	120	0	0.00
199.14	0.00	130	0	0.00
199.61	0.00	140	0	0.00
200.08	0.00	150	0	0.00
200.59	0.00	160	0	0.00
201.13	0.00	170	0	0.00
201.70	0.00	180	0	0.00
202.29	0.00	190	0	0.00
205.90	0.00	200	0	0.00

<1> TOLERANCE (FT) = 0.010

<2> TOLERANCE (%) = 1.000

```

*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   MAY 1991 *
*   VERSION 4.0.1E *
*   Lahey F77L-EM/32 version 5.01 *
*   Dodson & Associates, Inc. *
* RUN DATE 11/27/95 TIME 10:38:23 *
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *
*****

```

```

X   X XXXXXXX XXXX   X
X   X X   X   X   XX
X   X X   X   X   X
XXXXXX XXXX   X   XXXX X
X   X X   X   X   X
X   X X   X   X   X
X   X XXXXXXX XXXX   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 -AMSK- 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

```

LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1         ID      Bradley Fair Drainage Plan
2         ID      5-, 10-, 25-, & 100-Year Storms
3         ID      Professional Engineering Consultants
4         ID      Wichita, Ks
5         ID      DRC 11/20/95
6         ID      File: T:\DAR\HEC1\BRADLEY.ih1
7         IT      6 01FEB95 0600 0 02FEB95 1154
8         IN      30 01FEB95 0600
9         IO      3 0
10        JR      PREC 0.5902 0.6875 0.8125 1.000
          *DIAGRAM
          *

11        KK      UNDEV      UNDEVELOPED CONDITIONS
12        BA      .08906
13        PB      7.8
14        PC      0.08 .09 .10 .11 .12 .133 .147 .163 .181 .204
15        PC      .235 .283 .663 .735 .772 .799 .820 .835 .850 .865
16        PC      .880 .890 .900 .910 .916 .925 .934 .943 .952 .958
17        PC      .964 .970 .976 .982 .988 .994 1.000
18        LS      0 76 0
19        UD      0.20
          *
          *

20        KK      BASIN1      COMMERCIAL DEVELOPED CONDITIONS
21        BA      .08906
22        PB      7.8
23        PC      0.08 .09 .10 .11 .12 .133 .147 .163 .181 .204
24        PC      .235 .283 .663 .735 .772 .799 .820 .835 .850 .865
25        PC      .880 .890 .900 .910 .916 .925 .934 .943 .952 .958
26        PC      .964 .970 .976 .982 .988 .994 1.000
27        LS      0 92 0
28        UD      0.15
          *
          *
          * 54" OUTLET PIPE FOR POND #1

29        KK      POND1
30        RS      1 ELEV 198
31        SA      2.75 3.5
32        SE      198 201
33        SQ      0 40 60 80 90 100 110 120 130 140
34        SQ      150 160 170 180 190 200
35        SE      198.0 198.65 198.9 199.05 199.15 199.25 199.3 199.4 199.5 199.6
36        SE      200.1 200.6 201.15 201.7 202.35 205.9
          *
          *

37        KK      BASIN2      COMMERCIAL DEVELOPED CONDITIONS
38        BA      0.004
39        PB      7.8
40        PC      0.08 .09 .10 .11 .12 .133 .147 .163 .181 .204
41        PC      .235 .283 .663 .735 .772 .799 .820 .835 .850 .865
42        PC      .880 .890 .900 .910 .916 .925 .934 .943 .952 .958
    
```

HEC-1 INPUT

LINE	ID	1	2	3	4	5	6	7	8	9	10
43	PC	.964	.970	.976	.982	.988	.994	1.000			
44	LS	0	.92	0							
45	UD	0.15									
	*										
	*										
46	KK	INTO2	COMBINE HYDROGRAPHS FOR BASIN 2 AND OUT OF POND #1								
47	HC	2									
	*										
	*										
	*	5' SPILLWAY FOR POND #2									
48	KK	POND2									
49	RS	1	ELEV	195							
50	SA	0.5	0.8								
51	SE	195	197								
52	SQ	0	40	60	80	90	100	110	120	130	140
53	SQ	150	160	170	180	190	200				
54	SE	195	195.95	196.18	196.35	196.42	196.5	196.56	196.61	196.67	196.72
55	SE	196.78	196.84	196.89	196.93	196.98	197.02				
	*										
	*										
56	KK	BASIN3	COMMERCIAL DEVELOPED CONDITIONS								
57	BA	.00456									
58	PB	7.8									
59	PC	0.08	.09	.10	.11	.12	.133	.147	.163	.181	.204
60	PC	.235	.283	.663	.735	.772	.799	.820	.835	.850	.865
61	PC	.880	.890	.900	.910	.916	.925	.934	.943	.952	.958
62	PC	.964	.970	.976	.982	.988	.994	1.000			
63	LS	0	.92	0							
64	UD	0.15									
	*										
	*										
65	KK	INTO3	COMBINE HYDROGRAPHS FOR BASIN 3 AND OUT OF POND #2								
66	HC	2									
	*										
	*										
	*	5' SPILLWAY FOR POND #3									
67	KK	POND3									
68	RS	1	ELEV	186							
69	SA	0.5	0.8								
70	SE	186	189								
71	SQ	0	40	60	80	90	100	110	120	130	140
72	SQ	150	160	170	180	190	200				
73	SE	186	186.95	187.18	187.35	187.42	187.5	187.56	187.61	187.67	187.72
74	SE	187.78	187.84	187.89	187.93	187.98	188.02				
	*										
75	ZZ										

SCHMATIC DIAGRAM OF STREAM NETWORK

INPUT			
LINE	(V) ROUTING	(--->) DIVERSION OR PUMP FLOW	
NO.	(.) CONNECTOR	(<---) RETURN OF DIVERTED OR PUMPED FLOW	
11	UNDEV		
	.		
20	.	BASIN1	
	.	V	
	.	V	
29	.	POND1	
	.	.	
37	.	.	BASIN2
	.	.	.
46	.	INTO2.....	
	.	V	
	.	V	
48	.	POND2	
	.	.	
56	.	.	BASIN3
	.	.	.
65	.	INTO3.....	
	.	V	
	.	V	
67	.	POND3	

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* MAY 1991
* VERSION 4.0.1E
* Lahey F77L-EM/32 version 5.01
* Dodson & Associates, Inc.
* RUN DATE 11/27/95 TIME 10:38:23
*****
```

```
*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 551-1748
*****
```

Bradley Fair Drainage Plan
 5-, 10-, 25-, & 100-Year Storms
 Professional Engineering Consultants
 Wichita, Ks
 DRC 11/20/95
 File: T:\DAR\HEC1\BRADLEY.ih1

```
9 IO      OUTPUT CONTROL VARIABLES
          IPRNT      3  PRINT CONTROL
          IPLOT      0  PLOT CONTROL
          QSCAL      0. HYDROGRAPH PLOT SCALE

IT        HYDROGRAPH TIME DATA
          NMIN       6  MINUTES IN COMPUTATION INTERVAL
          IDATE      1FEB95  STARTING DATE
          ITIME      0600  STARTING TIME
          NQ         300  NUMBER OF HYDROGRAPH ORDINATES
          NDDATE     2FEB95  ENDING DATE
          NDTIME     1154  ENDING TIME
          ICENT      19  CENTURY MARK

          COMPUTATION INTERVAL  0.10 HOURS
          TOTAL TIME BASE      29.90 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
```

```
JP        MULTI-PLAN OPTION
          NPLAN      1  NUMBER OF PLANS

JR        MULTI-RATIO OPTION
          RATIOS OF PRECIPITATION
          0.59      0.69      0.81      1.00
```

*** ** ** ** **

```
*****
*
* UNDEV *          UNDEVELOPED CONDITIONS
*
*****
```

```
8 IN      TIME DATA FOR INPUT TIME SERIES
          JXMIN      30  TIME INTERVAL IN MINUTES
          JXDATE     1FEB95  STARTING DATE
          JXTIME     600  STARTING TIME
```

SUBBASIN RUNOFF DATA

```
12 BA     SUBBASIN CHARACTERISTICS
          TAREA      0.09  SUBBASIN AREA
```

PRECIPITATION DATA

```
13 PB     STORM      7.80  BASIN TOTAL PRECIPITATION

14 PI     INCREMENTAL PRECIPITATION PATTERN
```


BRADLEY FAIR PONDS #1, #2, AND #3

11-27-1995

0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

27 LS SCS LOSS RATE
 STRTL 0.17 INITIAL ABSTRACTION
 CRVNER 92.00 CURVE NUMBER
 RTIMP 0.00 PERCENT IMPERVIOUS AREA

28 UD SCS DIMENSIONLESS UNITGRAPH
 TLAG 0.15 LAG

UNIT HYDROGRAPH
 10 END-OF-PERIOD ORDINATES

102. 217. 147. 61. 28. 12. 5. 2. 1. 0.

TOTAL RAINFALL = 7.80, TOTAL LOSS = 0.95, TOTAL EXCESS = 6.85

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)			
+	343.	6.00	53.	16.	13.	13.
			(INCHES)	5.534	6.846	6.846
			(AC-FT)	26.	33.	33.

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASINI
 FOR PLAN 1, RATIO = 0.59

TOTAL RAINFALL = 4.60, TOTAL LOSS = 0.90, TOTAL EXCESS = 3.70

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)			
+	191.	6.00	29.	9.	7.	7.
			(INCHES)	3.026	3.703	3.703
			(AC-FT)	14.	18.	18.

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASINI
 FOR PLAN 1, RATIO = 0.69

TOTAL RAINFALL = 5.36, TOTAL LOSS = 0.92, TOTAL EXCESS = 4.44

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)			
+	227.	6.00	35.	11.	9.	9.
			(INCHES)	3.622	4.444	4.444
			(AC-FT)	17.	21.	21.

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASINI
 FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 0.94, TOTAL EXCESS = 5.40

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)			
+	274.	6.00	42.	13.	10.	10.
			(INCHES)	4.388	5.402	5.402

(AC-FT) 21. 26. 26. 26.
 CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
 FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 0.95, TOTAL EXCESS = 6.85

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 343.	6.00	(CFS)	53.	16.	13.	13.
		(INCHES)	5.534	6.846	6.846	6.846
		(AC-FT)	26.	33.	33.	33.

CUMULATIVE AREA = 0.09 SQ MI

*** **

 * *
 29 KK * POND1 *
 * *

HYDROGRAPH ROUTING DATA

30 RS	STORAGE ROUTING	1 NUMBER OF SUBREACHES	
	NSTPS	ELEV	TYPE OF INITIAL CONDITION
	ITYP	198.00	INITIAL CONDITION
	RSVRIC	0.00	WORKING R AND D COEFFICIENT
	X		
31 SA	AREA	2.8	3.5
32 SE	ELEVATION	198.00	201.00
33 SQ	DISCHARGE	0. 40. 60. 80. 90. 100. 110. 120. 130. 140.	150. 160. 170. 180. 190. 200.
35 SE	ELEVATION	198.00 198.65 198.90 199.05 199.15 199.25 199.30 199.40 199.50 199.60	200.10 200.60 201.15 201.70 202.35 205.90

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	9.35
ELEVATION	198.00	201.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

	0.00	1.84	2.57	3.02	3.32	3.62	3.78	4.08	4.39	4.71
STORAGE	0.00	1.84	2.57	3.02	3.32	3.62	3.78	4.08	4.39	4.71
OUTFLOW	0.00	40.00	60.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
ELEVATION	198.00	198.65	198.90	199.05	199.15	199.25	199.30	199.40	199.50	199.60
STORAGE	6.31	7.97	9.35	9.88	11.87	14.32	29.88			
OUTFLOW	150.00	160.00	167.27	170.00	180.00	190.00	200.00			
ELEVATION	200.10	200.60	201.00	201.15	201.70	202.35	205.90			

*** *** *** *** ***

HYDROGRAPH AT STATION POND1
 FOR PLAN 1, RATIO = 0.59

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 128.	6.20	(CFS)	29.	9.	7.	7.
		(INCHES)	3.006	3.703	3.703	3.703

		(AC-FT)	14.	18.	18.	18.
PEAK STORAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)					
4.	6.20		1.	0.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)					
199.48	6.20	198.41	198.13	198.10	198.10	

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND1
FOR PLAN 1, RATIO = 0.69

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+ (CFS)	(HR)					
143.	6.20	(CFS)	34.	11.	9.	9.
		(INCHES)	3.599	4.444	4.444	4.444
		(AC-FT)	17.	21.	21.	21.

			6-HR	24-HR	72-HR	29.90-HR
PEAK STORAGE	TIME					
+ (AC-FT)	(HR)					
5.	6.20		1.	0.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)					
199.75	6.20	198.48	198.15	198.12	198.12	

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND1
FOR PLAN 1, RATIO = 0.81

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+ (CFS)	(HR)					
151.	6.20	(CFS)	42.	13.	10.	10.
		(INCHES)	4.361	5.402	5.402	5.402
		(AC-FT)	21.	26.	26.	26.

			6-HR	24-HR	72-HR	29.90-HR
PEAK STORAGE	TIME					
+ (AC-FT)	(HR)					
7.	6.20		2.	1.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)					
200.17	6.20	198.59	198.19	198.15	198.15	

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND1
FOR PLAN 1, RATIO = 1.00

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+ (CFS)	(HR)					
165.	6.20	(CFS)	53.	16.	13.	13.
		(INCHES)	5.503	6.846	6.846	6.846
		(AC-FT)	26.	33.	33.	33.

PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE		
+ (AC-FT)	(HR)	6-HR	24-HR	72-HR	29.90-HR
9.	6.20	2.	1.	1.	1.

PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE		
+ (FEET)	(HR)	6-HR	24-HR	72-HR	29.90-HR
200.85	6.20	198.79	198.25	198.20	198.20

CUMULATIVE AREA = 0.09 SQ MI

*** **

```

*****
*      *
37 KK *  BASIN2 *      COMMERCIAL DEVELOPED CONDITIONS
*      *
*****
    
```

```

8 IN      TIME DATA FOR INPUT TIME SERIES
          JXMIN      30  TIME INTERVAL IN MINUTES
          JXDATE     1FEB95  STARTING DATE
          JXTIME     600  STARTING TIME
    
```

SUBBASIN RUNOFF DATA

```

38 BA      SUBBASIN CHARACTERISTICS
          TAREA      0.00  SUBBASIN AREA
    
```

PRECIPITATION DATA

```

39 PB      STORM      7.80  BASIN TOTAL PRECIPITATION
    
```

```

40 PI      INCREMENTAL PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
          0.01  0.01  0.01  0.01  0.01  0.01  0.08  0.08  0.08  0.08
          0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
          0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
    
```

```

44 LS      SCS LOSS RATE
          STRTL      0.17  INITIAL ABSTRACTION
          CRVNER     92.00  CURVE NUMBER
          RTIMP      0.00  PERCENT IMPERVIOUS AREA
    
```

```

45 UD      SCS DIMENSIONLESS UNITGRAPH
          TLAG      0.15  LAG
    
```

UNIT HYDROGRAPH
10 END-OF-PERIOD ORDINATES

5. 10. 7. 3. 1. 1. 0. 0. 0.

TOTAL RAINFALL = 7.80, TOTAL LOSS = 0.95, TOTAL EXCESS = 6.85

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW		
+ (CFS)	(HR)		6-HR	24-HR	72-HR
		(CFS)			
+ 15.	6.00		2.	1.	1.
		(INCHES)	5.534	6.846	6.846

BRADLEY FAIR PONDS #1, #2, AND #3

11-27-1995

(AC-FT) 1. 1. 1. 1.

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN2
FOR PLAN 1, RATIO = 0.59

TOTAL RAINFALL = 4.60, TOTAL LOSS = 0.90, TOTAL EXCESS = 3.70

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 9.	6.00		1.	0.	0.	0.
		(INCHES)	3.026	3.703	3.703	3.703
		(AC-FT)	1.	1.	1.	1.

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN2
FOR PLAN 1, RATIO = 0.69

TOTAL RAINFALL = 5.36, TOTAL LOSS = 0.92, TOTAL EXCESS = 4.44

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 10.	6.00		2.	0.	0.	0.
		(INCHES)	3.622	4.444	4.444	4.444
		(AC-FT)	1.	1.	1.	1.

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN2
FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 0.94, TOTAL EXCESS = 5.40

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 12.	6.00		2.	1.	0.	0.
		(INCHES)	4.388	5.402	5.402	5.402
		(AC-FT)	1.	1.	1.	1.

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN2
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 0.95, TOTAL EXCESS = 6.85

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 15.	6.00		2.	1.	1.	1.
		(INCHES)	5.534	6.846	6.846	6.846
		(AC-FT)	1.	1.	1.	1.

CUMULATIVE AREA = 0.00 SQ MI

*** **

 * * * * *
 46 KK * INTO2 * COMBINE HYDROGRAPHS FOR BASIN 2 AND OUT OF POND #1
 * * * * *

47 HC HYDROGRAPH COMBINATION
 ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

*** *** *** *** ***

HYDROGRAPH AT STATION INTO2
 FOR PLAN 1, RATIO = 0.59

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 133.	6.20	(CFS)	30.	9.	7.	7.
		(INCHES)	3.006	3.703	3.703	3.703
		(AC-FT)	15.	18.	18.	18.
CUMULATIVE AREA =			0.09 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION INTO2
 FOR PLAN 1, RATIO = 0.69

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 151.	6.10	(CFS)	36.	11.	9.	9.
		(INCHES)	3.599	4.444	4.444	4.444
		(AC-FT)	18.	22.	22.	22.
CUMULATIVE AREA =			0.09 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION INTO2
 FOR PLAN 1, RATIO = 0.81

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 160.	6.10	(CFS)	44.	14.	11.	11.
		(INCHES)	4.361	5.402	5.402	5.402
		(AC-FT)	22.	27.	27.	27.
CUMULATIVE AREA =			0.09 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION INTO2
 FOR PLAN 1, RATIO = 1.00

PEAK FLOW + (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 174.	6.10	(CFS)	55.	17.	14.	14.
		(INCHES)	5.503	6.846	6.846	6.846
		(AC-FT)	27.	34.	34.	34.
CUMULATIVE AREA =			0.09 SQ MI			

 * *
 48 KK * POND2 *
 * *

HYDROGRAPH ROUTING DATA

49 RS	STORAGE ROUTING											
	NSTPS	1	NUMBER OF SUBREACHES									
	ITYP	ELEV	TYPE OF INITIAL CONDITION									
	RSVRC	195.00	INITIAL CONDITION									
	X	0.00	WORKING R AND D COEFFICIENT									
50 SA	AREA	0.5	0.8									
51 SE	ELEVATION	195.00	197.00									
52 SQ	DISCHARGE	0.	40.	60.	80.	90.	100.	110.	120.	130.	140.	
		150.	160.	170.	180.	190.	200.					
54 SE	ELEVATION	195.00	195.95	196.18	196.35	196.42	196.50	196.56	196.61	196.67	196.72	
		196.78	196.84	196.89	196.93	196.98	197.02					

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	1.29
ELEVATION	195.00	197.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.54	0.69	0.80	0.85	0.91	0.95	0.99	1.03	1.07
OUTFLOW	0.00	40.00	60.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
ELEVATION	195.00	195.95	196.18	196.35	196.42	196.50	196.56	196.61	196.67	196.72
STORAGE	1.12	1.16	1.20	1.23	1.27	1.29	1.30			
OUTFLOW	150.00	160.00	170.00	180.00	190.00	195.00	200.00			
ELEVATION	196.78	196.84	196.89	196.93	196.98	197.00	197.02			

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 110. TO 200.
 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** **

HYDROGRAPH AT STATION POND2
 FOR PLAN 1, RATIO = 0.59

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)	(CFS)				
+ 132.	6.20	30.	9.	7.	7.	
		(INCHES)	3.005	3.703	3.703	3.703
		(AC-FT)	15.	18.	18.	18.
PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
			6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)					
+ 1.	6.20	0.	0.	0.	0.	
PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
			6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)					
+ 196.68	6.20	195.57	195.18	195.15	195.15	

CUMULATIVE AREA = 0.09 SQ MI

*** **

HYDROGRAPH AT STATION POND2
 FOR PLAN 1, RATIO = 0.69

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR

BRADLEY FAIR PONDS #1, #2, AND #3

11-27-1995

+	(CFS)	(HR)	(CFS)	36.	11.	9.	9.
+	150.	6.20	(INCHES)	3.597	4.444	4.444	4.444
			(AC-FT)	18.	22.	22.	22.
PEAK STORAGE	TIME			MAXIMUM AVERAGE STORAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)		0.	0.	0.	0.
	1.	6.20					
PEAK STAGE	TIME			MAXIMUM AVERAGE STAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)		195.65	195.21	195.17	195.17
	196.78	6.20					

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND2
FOR PLAN 1, RATIO = 0.81

PEAK FLOW	TIME			MAXIMUM AVERAGE FLOW			
				6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)	44.	14.	11.	11.
+	159.	6.20	(INCHES)	4.359	5.402	5.402	5.402
			(AC-FT)	22.	27.	27.	27.
PEAK STORAGE	TIME			MAXIMUM AVERAGE STORAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)		0.	0.	0.	0.
	1.	6.20					
PEAK STAGE	TIME			MAXIMUM AVERAGE STAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)		195.74	195.25	195.20	195.20
	196.83	6.20					

CUMULATIVE AREA = 0.09 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND2
FOR PLAN 1, RATIO = 1.00

PEAK FLOW	TIME			MAXIMUM AVERAGE FLOW			
				6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)	(CFS)	55.	17.	14.	14.
+	174.	6.20	(INCHES)	5.500	6.846	6.846	6.846
			(AC-FT)	27.	34.	34.	34.
PEAK STORAGE	TIME			MAXIMUM AVERAGE STORAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)		1.	0.	0.	0.
	1.	6.20					
PEAK STAGE	TIME			MAXIMUM AVERAGE STAGE			
				6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)		195.87	195.30	195.24	195.24
	196.91	6.20					

CUMULATIVE AREA = 0.09 SQ MI

*** **

* *
56 KK * BASIN3 * COMMERCIAL DEVELOPED CONDITIONS
* *

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN3
FOR PLAN 1, RATIO = 0.69

TOTAL RAINFALL = 5.36, TOTAL LOSS = 0.92, TOTAL EXCESS = 4.44

+ PEAK FLOW (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
12.	6.00	2.	1.	0.	0.	
		(INCHES) 3.622	4.444	4.444	4.444	
		(AC-FT) 1.	1.	1.	1.	

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN3
FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 0.94, TOTAL EXCESS = 5.40

+ PEAK FLOW (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
14.	6.00	2.	1.	1.	1.	
		(INCHES) 4.388	5.402	5.402	5.402	
		(AC-FT) 1.	1.	1.	1.	

CUMULATIVE AREA = 0.00 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN3
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 0.95, TOTAL EXCESS = 6.85

+ PEAK FLOW (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
18.	6.00	3.	1.	1.	1.	
		(INCHES) 5.534	6.846	6.846	6.846	
		(AC-FT) 1.	2.	2.	2.	

CUMULATIVE AREA = 0.00 SQ MI

*** **

* *
65 KK * INTO3 * COMBINE HYDROGRAPHS FOR BASIN 3 AND OUT OF POND #2
* *

66 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

*** *** *** *** ***

HYDROGRAPH AT STATION INTO3
FOR PLAN 1, RATIO = 0.59

+ PEAK FLOW (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR

+ 137. 6.20 (INCHES) 32. 10. 8. 8.
 (AC-FT) 3.004 3.703 3.703 3.703
 16. 19. 19. 19.

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION INTO3
 FOR PLAN 1, RATIO = 0.69

PEAK FLOW + (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 156.	6.20	38.	12.	9.	9.	
		(INCHES) 3.596	4.444	4.444	4.444	
		(AC-FT) 19.	23.	23.	23.	

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION INTO3
 FOR PLAN 1, RATIO = 0.81

PEAK FLOW + (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 169.	6.10	46.	14.	11.	11.	
		(INCHES) 4.358	5.402	5.402	5.402	
		(AC-FT) 23.	28.	28.	28.	

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION INTO3
 FOR PLAN 1, RATIO = 1.00

PEAK FLOW + (CFS)	TIME (HR)	(CFS)	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ 187.	6.10	58.	18.	14.	14.	
		(INCHES) 5.500	6.846	6.846	6.846	
		(AC-FT) 29.	36.	36.	36.	

CUMULATIVE AREA = 0.10 SQ MI

*** **

 * *
 67 KK * POND3 *
 * *

HYDROGRAPH ROUTING DATA

68 RS	STORAGE ROUTING										
	NSTPS	1	NUMBER OF SUBREACHES								
	ITYP	ELEV	TYPE OF INITIAL CONDITION								
	RSVRIC	186.00	INITIAL CONDITION								
	X	0.00	WORKING R AND D COEFFICIENT								
69 SA	AREA	0.5	0.8								
70 SE	ELEVATION	186.00	189.00								
71 SQ	DISCHARGE	0.	40.	60.	80.	90.	100.	110.	120.	130.	140.
		150.	160.	170.	180.	190.	200.				

73 SE	ELEVATION	186.00	186.95	187.18	187.35	187.42	187.50	187.56	187.61	187.67	187.72
		187.78	187.84	187.89	187.93	187.98	188.02				

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	1.93
ELEVATION	186.00	189.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.52	0.65	0.76	0.80	0.85	0.89	0.92	0.96	1.00
OUTFLOW	0.00	40.00	60.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
ELEVATION	186.00	186.95	187.18	187.35	187.42	187.50	187.56	187.61	187.67	187.72

STORAGE	1.04	1.08	1.11	1.14	1.17	1.20	1.93
OUTFLOW	150.00	160.00	170.00	180.00	190.00	200.00	444.95
ELEVATION	187.78	187.84	187.89	187.93	187.98	188.02	189.00

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 100. TO 445.
 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

*** *** *** *** ***

HYDROGRAPH AT STATION POND3
 FOR PLAN 1, RATIO = 0.59

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 134.	6.20	32.	10.	8.	8.	
		(INCHES)	3.003	3.703	3.703	3.703
		(AC-FT)	16.	19.	19.	19.
PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
+ (AC-FT)	(HR)		6-HR	24-HR	72-HR	29.90-HR
+ 1.	6.20	0.	0.	0.	0.	
PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
+ (FEET)	(HR)		6-HR	24-HR	72-HR	29.90-HR
+ 187.69	6.20	186.60	186.19	186.16	186.16	

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND3
 FOR PLAN 1, RATIO = 0.69

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
+ (CFS)	(HR)		6-HR	24-HR	72-HR	29.90-HR
		(CFS)				
+ 156.	6.20	38.	12.	9.	9.	
		(INCHES)	3.595	4.444	4.444	4.444
		(AC-FT)	19.	23.	23.	23.
PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
+ (AC-FT)	(HR)		6-HR	24-HR	72-HR	29.90-HR
+ 1.	6.20	0.	0.	0.	0.	
PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
+ (FEET)	(HR)		6-HR	24-HR	72-HR	29.90-HR
+ 187.81	6.20	186.67	186.22	186.18	186.18	

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND3

FOR PLAN 1, RATIO = 0.81

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW				
		6-HR	24-HR	72-HR	29.90-HR	
+ (CFS)	(HR)					
+ 168.	6.20	46.	14.	11.	11.	
		(INCHES)	4.356	5.402	5.402	5.402
		(AC-FT)	23.	28.	28.	28.
PEAK STORAGE		MAXIMUM AVERAGE STORAGE				
+ (AC-FT)	(HR)	6-HR	24-HR	72-HR	29.90-HR	
1.	6.20	0.	0.	0.	0.	
PEAK STAGE		MAXIMUM AVERAGE STAGE				
+ (FEET)	(HR)	6-HR	24-HR	72-HR	29.90-HR	
187.88	6.20	186.77	186.26	186.21	186.21	

CUMULATIVE AREA = 0.10 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION POND3
FOR PLAN 1, RATIO = 1.00

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW				
		6-HR	24-HR	72-HR	29.90-HR	
+ (CFS)	(HR)					
+ 186.	6.10	58.	18.	14.	14.	
		(INCHES)	5.497	6.846	6.846	6.846
		(AC-FT)	29.	36.	36.	36.
PEAK STORAGE		MAXIMUM AVERAGE STORAGE				
+ (AC-FT)	(HR)	6-HR	24-HR	72-HR	29.90-HR	
1.	6.10	1.	0.	0.	0.	
PEAK STAGE		MAXIMUM AVERAGE STAGE				
+ (FEET)	(HR)	6-HR	24-HR	72-HR	29.90-HR	
187.96	6.10	186.90	186.31	186.25	186.25	

CUMULATIVE AREA = 0.10 SQ MI

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION				
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	
				0.59	0.69	0.81	1.00	
HYDROGRAPH AT +	UNDEV	0.09	1	FLOW TIME	106. 6.10	138. 6.10	179. 6.10	242. 6.10
HYDROGRAPH AT +	BASIN1	0.09	1	FLOW TIME	191. 6.00	227. 6.00	274. 6.00	343. 6.00
ROUTED TO +	POND1	0.09	1	FLOW TIME	128. 6.20	143. 6.20	151. 6.20	165. 6.20
				** PEAK STAGES IN FEET **				
			1	STAGE TIME	199.48 6.20	199.75 6.20	200.17 6.20	200.85 6.20
HYDROGRAPH AT +	BASIN2	0.00	1	FLOW TIME	9. 6.00	10. 6.00	12. 6.00	15. 6.00
2 COMBINED AT +	INTO2	0.09	1	FLOW TIME	133. 6.20	151. 6.10	160. 6.10	174. 6.10
ROUTED TO +	POND2	0.09	1	FLOW TIME	132. 6.20	150. 6.20	159. 6.20	174. 6.20
				** PEAK STAGES IN FEET **				
			1	STAGE TIME	196.68 6.20	196.78 6.20	196.83 6.20	196.91 6.20
HYDROGRAPH AT +	BASIN3	0.00	1	FLOW TIME	10. 6.00	12. 6.00	14. 6.00	18. 6.00
2 COMBINED AT +	INTO3	0.10	1	FLOW TIME	137. 6.20	156. 6.20	169. 6.10	187. 6.10
ROUTED TO +	POND3	0.10	1	FLOW TIME	134. 6.20	156. 6.20	168. 6.20	186. 6.10
				** PEAK STAGES IN FEET **				
			1	STAGE TIME	187.69 6.20	187.81 6.20	187.88 6.20	187.96 6.10

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

CURRENT DATE: 11-22-1995
CURRENT TIME: 08:45:46

FILE DATE: 11-21-1995
FILE NAME: BRADLY#4

FHWA CULVERT ANALYSIS
HY-8, VERSION 3.2

SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
175.50	175.00	90.00	4 RCB	7.00	6.00	.012	CONVENTIONAL

SUMMARY OF CULVERT FLOWS (CFS) FILE: BRADLY#4 DATE: 11-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
180.77	1000	1000	0	0	0	0	0	0	1
180.85	1024	1024	0	0	0	0	0	0	1
180.94	1049	1049	0	0	0	0	0	0	1
181.03	1073	1073	0	0	0	0	0	0	1
181.12	1097	1097	0	0	0	0	0	0	1
181.21	1122	1122	0	0	0	0	0	0	1
181.30	1146	1146	0	0	0	0	0	0	1
181.39	1170	1170	0	0	0	0	0	0	1
181.48	1194	1194	0	0	0	0	0	0	1
181.62	1219	1219	0	0	0	0	0	0	1
181.78	1243	1243	0	0	0	0	0	0	1
186.00	2189	2189	0	0	0	0	0	0	OVERTOPPING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: BRADLY#4 DATE: 11-21-1995

HEAD ELEV (FT)	HEAD ERROR (FT)	TOTAL FLOW (CFS)	FLOW ERROR (CFS)	% FLOW ERROR
180.77	0.00	1000	0	0.00
180.85	0.00	1024	0	0.00
180.94	0.00	1049	0	0.00
181.03	0.00	1073	0	0.00
181.12	0.00	1097	0	0.00
181.21	0.00	1122	0	0.00
181.30	0.00	1146	0	0.00
181.39	0.00	1170	0	0.00
181.48	0.00	1194	0	0.00
181.62	0.00	1219	0	0.00
181.78	0.00	1243	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 11-22-1995
 CURRENT TIME: 08:45:46

FILE DATE: 11-21-1995
 FILE NAME: BRADLY#4

 CULVERT # 1

PERFORMANCE CURVE FOR 4 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
1000	180.77	179.91	5.27	4.67	5-S2	0.00	0.00	0.00	11.93
1024	180.85	179.98	5.35	4.84	5-S2	0.00	0.00	0.00	12.01
1049	180.94	180.03	5.44	5.01	5-S2	0.00	0.00	0.00	12.09
1073	181.03	180.09	5.53	5.18	5-S2	0.00	0.00	0.00	12.16
1097	181.12	180.15	5.62	5.35	5-S2	0.00	0.00	0.00	12.24
1122	181.21	180.21	5.71	5.51	5-S2	0.00	0.00	0.00	12.31
1146	181.30	180.26	5.80	5.62	5-S2	0.00	0.00	0.00	12.38
1170	181.39	180.32	5.89	5.79	5-S2	0.00	0.00	0.00	12.45
1194	181.48	180.37	5.98	5.95	5-S2	0.00	0.00	0.00	12.52
1219	181.62	180.43	6.07	6.12	5-S2	0.00	0.00	0.00	8.02
1243	181.78	180.48	6.16	6.28	5-S2	0.00	0.00	0.00	8.10

El. inlet face invert 175.50 ft El. outlet invert 175.00 ft
 El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT *****

INLET STATION (FT) 0.00
 INLET ELEVATION (FT) 175.50
 OUTLET STATION (FT) 90.00
 OUTLET ELEVATION (FT) 175.00
 NUMBER OF BARRELS 4.00
 SLOPE (V-FT/H-FT) 0.0056
 CULVERT LENGTH ALONG SLOPE (FT) 90.00

***** CULVERT DATA SUMMARY *****

BARREL SHAPE BOX
 BARREL SPAN 7.00 FT
 BARREL RISE 6.00 FT
 BARREL MATERIAL CONCRETE
 BARREL MANNING'S N 0.012
 INLET TYPE CONVENTIONAL
 INLET EDGE AND WALL SQUARE EDGE (30-75 DEG. FLARE)
 INLET DEPRESSION NONE

CURRENT DATE: 11-22-1995
CURRENT TIME: 08:45:46

FILE DATE: 11-21-1995
FILE NAME: BRADLY#4

TAILWATER

***** REGULAR CHANNEL CROSS SECTION *****

BOTTOM WIDTH (FT) 25.00
SIDE SLOPE H/V (X:1) 4.0
CHANNEL SLOPE V/H (FT/FT) 0.003
MANNING'S N (.01-0.1) 0.040
CHANNEL INVERT ELEVATION (FT) 175.00
CULVERT NO.1 OUTLET INVERT ELEVATION 175.00 FT

***** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

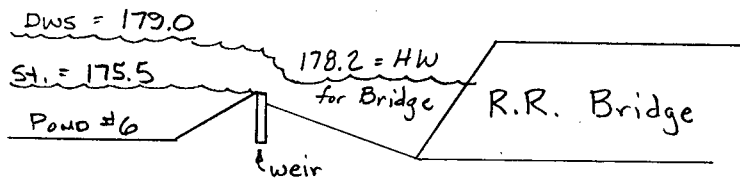
FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
1000.00	179.91	0.362	4.55	0.92
1024.30	179.98	0.362	4.59	0.93
1048.60	180.03	0.362	4.61	0.94
1072.90	180.09	0.363	4.64	0.95
1097.20	180.15	0.363	4.67	0.96
1121.50	180.21	0.363	4.70	0.98
1145.80	180.26	0.363	4.73	0.99
1170.10	180.32	0.363	4.76	1.00
1194.40	180.37	0.364	4.78	1.01
1218.70	180.43	0.364	4.81	1.02
1243.00	180.48	0.364	4.83	1.03

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH (FT) 35.00
CREST LENGTH (FT) 50.00
OVERTOPPING CREST ELEVATION (FT) 186.00

Basin #5 drains to an existing pond, No. 5. However, the pond will have to be modified to meet the size and elevation requirements shown on the drainage plan map. The outlet for the pond is a 54" RCP with a 6' square drop inlet structure at elevation 181.5. Pond #5 discharges into Pond #6, which is to be constructed by damming the creek at elevation 175.5 using a 97' weir. Maximum stage for Pond #6 is 197.0, using FEMA defined $Q_{100} = 1243$ cfs. *Pond no. 6 also collects runoff from Basin #4.*

The tailwater elevation used in analysis of Pond #5 was assumed to be 2.0' above the static pool elevation of Pond #6, or 177.5. FEMA's BFE just upstream of the railroad bridge of 178.2 was used the tailwater elevation for analysis of flow over the weir control structure for Pond #6. The following are the weir length calculations for Pond #6.



$$Q = CLH^{1.5}$$

$$Q_{free} = 3.0(L)(2.5)^{1.5}$$

$$\frac{1243}{3.0 \times 3.5^{1.5}} = L_{free}$$

$$63.3 = L_{free}$$

$$\frac{D_{dn}}{D_{up}} = \frac{2.7}{3.5} = 0.77$$

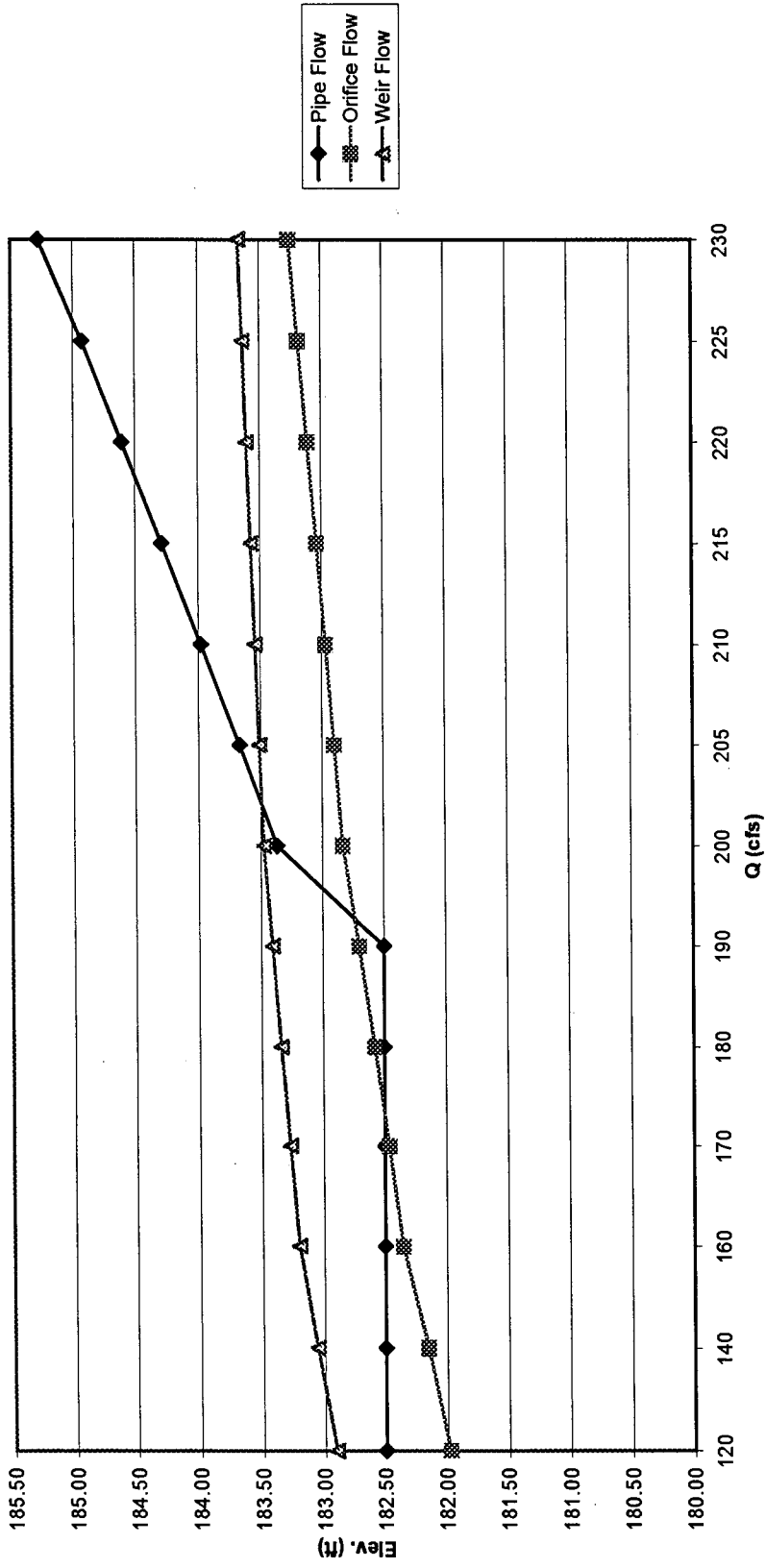
$$\frac{Q_{dn}}{Q_{up}} = 0.65$$

$$L_{sub} = \frac{63.3}{0.65} = \underline{97'}$$

A short reach of the creek (from Pond #6 to approximately Section O) will have a maximum stage higher than the published B.F.E.'s. However, the rise occurs only this property and will not affect any neighboring property, upstream or downstream.

STAGE - DISCHARGE

POND #5



CURRENT DATE: 11-22-1995
 CURRENT TIME: 16:08:43

FILE DATE: 11-22-1995
 FILE NAME: BRADLY#5

 FHWA CULVERT ANALYSIS
 HY-8, VERSION 3.2

C	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
U	L	V						
	INLET	OUTLET	CULVERT	BARRELS	SPAN	RISE	MANNING	INLET
	ELEV.	ELEV.	LENGTH	SHAPE	(FT)	(FT)	n	TYPE
	(FT)	(FT)	(FT)	MATERIAL				
1	174.00	171.50	250.01	1 RCP	4.50	4.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

 SUMMARY OF CULVERT FLOWS (CFS) FILE: BRADLY#5 DATE: 11-22-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
183.37	200	200	0	0	0	0	0	0	1
183.67	205	205	0	0	0	0	0	0	1
183.98	210	210	0	0	0	0	0	0	1
184.29	215	215	0	0	0	0	0	0	1
184.61	220	220	0	0	0	0	0	0	1
184.93	225	225	0	0	0	0	0	0	1
185.28	230	230	0	0	0	0	0	0	1
185.65	235	235	0	0	0	0	0	0	1
186.01	240	240	0	0	0	0	0	0	7
186.21	245	242	0	0	0	0	0	3	3
186.34	250	244	0	0	0	0	0	6	3
186.00	240	240	0	0	0	0	0	0	OVERTOPPING

 SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: BRADLY#5 DATE: 11-22-1995

HEAD	HEAD	TOTAL	FLOW	% FLOW
ELEV(FT)	ERROR(FT)	FLOW(CFS)	ERROR(CFS)	ERROR
183.37	0.00	200	0	0.00
183.67	0.00	205	0	0.00
183.98	0.00	210	0	0.00
184.29	0.00	215	0	0.00
184.61	0.00	220	0	0.00
184.93	0.00	225	0	0.00
185.28	0.00	230	0	0.00
185.65	0.00	235	0	0.00
186.01	-0.01	240	0	0.09
186.21	0.00	245	-0	-0.01
186.34	-0.00	250	0	0.00

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

```

*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   MAY 1991 *
*   VERSION 4.0.1E *
*   Lahey F77L-EM/32 version 5.01 *
*   Dodson & Associates, Inc. *
* RUN DATE 11/27/95 TIME 10:03:23 *
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 551-1748 *
*****

```

```

X X XXXXXX XXXX X
X X X X X XX
X X X X X
XXXXXXXX XXXX X XXXX X
X X X X X
X X X X X
X X XXXXXX XXXX XXX

```

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

THE DEFINITIONS OF VARIABLES -RTIME- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSK- 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

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

1 ID Bradley Fair Drainage Plan
 2 ID Pond #5
 3 ID 5-, 10-, 25-, & 100-Year Storms
 4 ID Professional Engineering Consultants
 5 ID Wichita, Ks
 6 ID DRC 11/20/95
 7 ID File: T:\DAR\HEC1\BRADLEY2.ih1
 8 IT 6 01FEB95 0600 0 02FEB95 1154
 9 IN 30 01FEB95 0600
 10 IO 3 0
 11 JR PREC 0.5902 0.6875 0.8125 1.000

*DIAGRAM
 *

12 KK UNDEV UNDEVELOPED BASIN
 13 BA .11992
 14 PB 7.8
 15 PC 0.08 .09 .10 .11 .12 .133 .147 .163 .181 .204
 16 PC .235 .283 .663 .735 .772 .799 .820 .835 .850 .865
 17 PC .880 .890 .900 .910 .916 .925 .934 .943 .952 .958
 18 PC .964 .970 .976 .982 .988 .994 1.000
 19 LS 0 80 0
 20 UD 0.15

*
 *

21 KK BASIN1 RESIDENTIAL DEVELOPED CONDITIONS
 22 BA .11992
 23 PB 7.8
 24 PC 0.08 .09 .10 .11 .12 .133 .147 .163 .181 .204
 25 PC .235 .283 .663 .735 .772 .799 .820 .835 .850 .865
 26 PC .880 .890 .900 .910 .916 .925 .934 .943 .952 .958
 27 PC .964 .970 .976 .982 .988 .994 1.000
 28 LS 0 87 0
 29 UD 0.15

*
 * 54" OUTLET FROM POND #5

30 KK PONDS
 31 RS 1 ELEV 181.5
 32 SA 2.75 3.5
 33 SE 181.5 186
 34 SQ 0 140 160 170 180 190 200 205 210 215
 35 SQ 220 225 230
 36 SE 181.5 183.05 183.2 183.27 183.4 183.45 183.49 183.65 184.0 184.3
 37 SE 184.6 184.9 185.3

*
 ZZ

SCHMATIC DIAGRAM OF STREAM NETWORK

INPUT	(V) ROUTING	(--->)	DIVERSION OR PUMP FLOW
LINE			
NO.	(.) CONNECTOR	(<---)	RETURN OF DIVERTED OR PUMPED FLOW
12	UNDEV		
	.		
21	.	BASIN1	
	.	V	
	.	V	
30	.	POND5	

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* MAY 1991
* VERSION 4.0.1E
* Lahey F77L-EM/32 version 5.01
* Dodson & Associates, Inc.
* RUN DATE 11/27/95 TIME 10:03:23
*****
```

```
*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 551-1748
*****
```

Bradley Fair Drainage Plan
 Pond #5
 5-, 10-, 25-, & 100-Year Storms
 Professional Engineering Consultants
 Wichita, Ks
 DRC 11/20/95
 File: T:\DAR\HEC1\BRADLEY2.ih1

```
10 IO      OUTPUT CONTROL VARIABLES
           IPRNT      3  PRINT CONTROL
           IPLOT      0  PLOT CONTROL
           QSCAL      0. HYDROGRAPH PLOT SCALE

11         HYDROGRAPH TIME DATA
           NMIN       6  MINUTES IN COMPUTATION INTERVAL
           IDATE      1FEB95  STARTING DATE
           ITIME      0600  STARTING TIME
           NQ         300  NUMBER OF HYDROGRAPH ORDINATES
           NDDATE     2FEB95  ENDING DATE
           NDTIME     1154  ENDING TIME
           ICENT      19  CENTURY MARK

           COMPUTATION INTERVAL  0.10 HOURS
           TOTAL TIME BASE      29.90 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

12 JP      MULTI-PLAN OPTION
           NPLAN      1  NUMBER OF PLANS

13 JR      MULTI-RATIO OPTION
           RATIOS OF PRECIPITATION
           0.59      0.69      0.81      1.00
```

*** ** ** ** **

```
*****
*
* UNDEV *          UNDEVELOPED BASIN
*
*****
```

```
9 IN      TIME DATA FOR INPUT TIME SERIES
           JXMIN      30  TIME INTERVAL IN MINUTES
           JXDATE     1FEB95  STARTING DATE
           JXTIME     600  STARTING TIME
```

SUBBASIN RUNOFF DATA

```
13 BA     SUBBASIN CHARACTERISTICS
           TAREA      0.12  SUBBASIN AREA
```

PRECIPITATION DATA

```
14 PB     STORM      7.80  BASIN TOTAL PRECIPITATION
```


CUMULATIVE AREA = 0.12 SQ MI

```

***          ***          ***          ***          ***
HYDROGRAPH AT STATION UNDEV
FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 2.25, TOTAL EXCESS = 4.09

PEAK FLOW      TIME          MAXIMUM AVERAGE FLOW
+ (CFS)        (HR)          6-HR      24-HR      72-HR      29.90-HR
+ 289.         6.00          (CFS)
                (INCHES)    43.        13.        11.        11.
                (AC-FT)    3.362     4.087     4.087     4.087
                (AC-FT)    22.        26.        26.        26.
    
```

CUMULATIVE AREA = 0.12 SQ MI

```

***          ***          ***          ***          ***
HYDROGRAPH AT STATION UNDEV
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 2.36, TOTAL EXCESS = 5.44

PEAK FLOW      TIME          MAXIMUM AVERAGE FLOW
+ (CFS)        (HR)          6-HR      24-HR      72-HR      29.90-HR
+ 384.         6.00          (CFS)
                (INCHES)    58.        18.        14.        14.
                (AC-FT)    4.469     5.438     5.438     5.438
                (AC-FT)    29.        35.        35.        35.
    
```

CUMULATIVE AREA = 0.12 SQ MI

```

*****
*          *
21 KK      * BASIN1 *          RESIDENTIAL DEVELOPED CONDITIONS
*          *
*****
    
```

```

9 IN      TIME DATA FOR INPUT TIME SERIES
          JXMIN      30      TIME INTERVAL IN MINUTES
          JXDATE     1FEB95  STARTING DATE
          JXTIME     600     STARTING TIME
    
```

SUBBASIN RUNOFF DATA

```

22 BA      SUBBASIN CHARACTERISTICS
          TAREA      0.12  SUBBASIN AREA
    
```

PRECIPITATION DATA

```

23 PB      STORM      7.80  BASIN TOTAL PRECIPITATION
    
```

```

24 PI      INCREMENTAL PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.01  0.01  0.01  0.01  0.01
          0.01  0.01  0.01  0.01  0.01  0.08  0.08  0.08  0.08  0.08
          0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
          0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
    
```

0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

28 LS SCS LOSS RATE
 STRTL 0.30 INITIAL ABSTRACTION
 CRVNR 87.00 CURVE NUMBER
 RTIMP 0.00 PERCENT IMPERVIOUS AREA

29 UD SCS DIMENSIONLESS UNITGRAPH
 TLAG 0.15 LAG

UNIT HYDROGRAPH
 10 END-OF-PERIOD ORDINATES

137. 292. 198. 82. 37. 16. 7. 3. 1. 0.

TOTAL RAINFALL = 7.80, TOTAL LOSS = 1.54, TOTAL EXCESS = 6.26

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)	(CFS)				
+ 434.	6.00	66.	20.	16.	16.	
		(INCHES)	5.112	6.255	6.255	6.255
		(AC-FT)	33.	40.	40.	40.

CUMULATIVE AREA = 0.12 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
 FOR PLAN 1, RATIO = 0.59

TOTAL RAINFALL = 4.60, TOTAL LOSS = 1.41, TOTAL EXCESS = 3.20

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)	(CFS)				
+ 226.	6.00	34.	10.	8.	8.	
		(INCHES)	2.627	3.195	3.195	3.195
		(AC-FT)	17.	20.	20.	20.

CUMULATIVE AREA = 0.12 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
 FOR PLAN 1, RATIO = 0.69

TOTAL RAINFALL = 5.36, TOTAL LOSS = 1.45, TOTAL EXCESS = 3.91

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)	(CFS)				
+ 275.	6.00	41.	13.	10.	10.	
		(INCHES)	3.210	3.910	3.910	3.910
		(AC-FT)	21.	25.	25.	25.

CUMULATIVE AREA = 0.12 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
 FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 1.50, TOTAL EXCESS = 4.84

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)	(CFS)				
+ 339.	6.00	51.	16.	13.	13.	
		(INCHES)	3.967	4.841	4.841	4.841

(AC-FT) 25. 31. 31. 31.
 CUMULATIVE AREA = 0.12 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
 FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 1.54, TOTAL EXCESS = 6.26

PEAK FLOW + (CFS)	TIME (HR)	MAXIMUM AVERAGE FLOW				
		6-HR	24-HR	72-HR	29.90-HR	
+ 434.	6.00	(CFS)	66.	20.	16.	16.
		(INCHES)	5.112	6.255	6.255	6.255
		(AC-FT)	33.	40.	40.	40.

CUMULATIVE AREA = 0.12 SQ MI

*** ***

 * *
 30 KK * POND5 *
 * *

HYDROGRAPH ROUTING DATA

31 RS	STORAGE ROUTING										
	NSTPS	1	NUMBER OF SUBREACHES								
	ITYP	ELEV	TYPE OF INITIAL CONDITION								
	RSVRC	181.50	INITIAL CONDITION								
	X	0.00	WORKING R AND D COEFFICIENT								
32 SA	AREA	2.8	3.5								
33 SE	ELEVATION	181.50	186.00								
34 SQ	DISCHARGE	0.	140.	160.	170.	180.	190.	200.	205.	210.	215.
		220.	225.	230.							
36 SE	ELEVATION	181.50	183.05	183.20	183.27	183.40	183.45	183.49	183.65	184.00	184.30
		184.60	184.90	185.30							

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	14.03
ELEVATION	181.50	186.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	4.45	4.90	5.12	5.51	5.67	5.79	6.28	7.38	8.33
OUTFLOW	0.00	140.00	160.00	170.00	180.00	190.00	200.00	205.00	210.00	215.00
ELEVATION	181.50	183.05	183.20	183.27	183.40	183.45	183.49	183.65	184.00	184.30
STORAGE	9.30	10.28	11.62	14.03						
OUTFLOW	220.00	225.00	230.00	238.75						
ELEVATION	184.60	184.90	185.30	186.00						

*** *** *** *** ***

HYDROGRAPH AT STATION POND5
 FOR PLAN 1, RATIO = 0.59

PEAK FLOW + (CFS)	TIME (HR)	MAXIMUM AVERAGE FLOW				
		6-HR	24-HR	72-HR	29.90-HR	
+ 148.	6.20	(CFS)	34.	10.	8.	8.
		(INCHES)	2.618	3.195	3.195	3.195

		(AC-FT)	17.	20.	20.	20.
PEAK STORAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)				
	5.	6.20	1.	0.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)				
	183.11	6.20	181.87	181.61	181.59	181.59
		CUMULATIVE AREA =	0.12 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION POND5
FOR PLAN 1, RATIO = 0.69

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+	(CFS)	(HR)				
	185.	6.20				
		(CFS)	41.	13.	10.	10.
		(INCHES)	3.200	3.910	3.910	3.910
		(AC-FT)	20.	25.	25.	25.
PEAK STORAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)				
	6.	6.20	1.	0.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)				
	183.43	6.20	181.95	181.64	181.61	181.61
		CUMULATIVE AREA =	0.12 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION POND5
FOR PLAN 1, RATIO = 0.81

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+	(CFS)	(HR)				
	208.	6.20				
		(CFS)	51.	16.	13.	13.
		(INCHES)	3.954	4.841	4.841	4.841
		(AC-FT)	25.	31.	31.	31.
PEAK STORAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(AC-FT)	(HR)				
	7.	6.20	2.	0.	0.	0.
PEAK STAGE	TIME					
			6-HR	24-HR	72-HR	29.90-HR
+	(FEET)	(HR)				
	183.89	6.20	182.06	181.67	181.64	181.64
		CUMULATIVE AREA =	0.12 SQ MI			

*** *** *** *** ***

HYDROGRAPH AT STATION POND5
FOR PLAN 1, RATIO = 1.00

			6-HR	24-HR	72-HR	29.90-HR
PEAK FLOW	TIME					
+	(CFS)	(HR)				
	223.	6.20				
		(CFS)	66.	20.	16.	16.
		(INCHES)	5.095	6.255	6.255	6.255
		(AC-FT)	33.	40.	40.	40.

PEAK STORAGE + (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	29.90-HR
10.	6.20	2.	1.	1.	1.
PEAK STAGE + (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	29.90-HR
184.78	6.20	182.28	181.74	181.69	181.69
CUMULATIVE AREA =		0.12 SQ MI			

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				0.59	0.69	0.81	1.00
HYDROGRAPH AT							
+ UNDEV	0.12	1	FLOW	179.	227.	289.	384.
			TIME	6.00	6.00	6.00	6.00
HYDROGRAPH AT							
+ BASIN1	0.12	1	FLOW	226.	275.	339.	434.
			TIME	6.00	6.00	6.00	6.00
ROUTED TO							
+ POND5	0.12	1	FLOW	148.	185.	208.	223.
			TIME	6.20	6.20	6.20	6.20
			** PEAK STAGES IN FEET **				
		1	STAGE	183.11	183.43	183.89	184.78
			TIME	6.20	6.20	6.20	6.20

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



Date _____ Page _____ of _____

Project BRADLEY FAIR II / WILSON ESTATES

Item BASIN # 6

$$A_{dev} = 23.15 \text{ Ac.}$$

$$A_{undevel.} = 28.85 \text{ Ac.}$$

Q DEVELOPED

$$C_{100} = 0.76$$

$$L_{100} = 7.36$$

$$A = 23.15$$

$$Q_{100} = 0.76 (7.36)(23.15)$$

$$Q_{100} = 129.5 \text{ cfs}$$

Q UNDEVELOPED

$$C_{100} = 0.67$$

$$L_{100} = 7.36$$

$$A = 28.85$$

$$Q_{100} = 0.67 (7.36)(28.85)$$

$$Q_{100} = 142.3 \text{ cfs}$$

$$Q_{100} (\text{DEV.}) < Q_{100} (\text{UNDEV.})$$

DETENTION STORAGE NOT REQUIRED

4.5' HEAD REQ'D FOR 129.5 cfs in 5'x4' RCBC. (Proposed Part of Webb Rd. Project)
1.0' + 4.5' + 186.5 ft = 192.0 ⇒ min. pad for Lots adjacent to Box.

NOTE: 100-YEAR FLOW DOES NOT TOP WEBB RD.

THEREFORE, SET MIN PAD LOTS ADJACENT TO WEBB RD.

$$\text{AT ELEV. } 192.12 + 1.0' = \underline{193.12 \text{ or higher}}$$

⊕ Low Pt. WEBB + 1.0' ↗

PROJECT: WILSON ESTATES

CULVERT DESIGN FORM

DESIGNER / DATE: _____
 REVIEWER / DATE: _____

STATE: _____ OF _____
 SHEET _____ OF _____

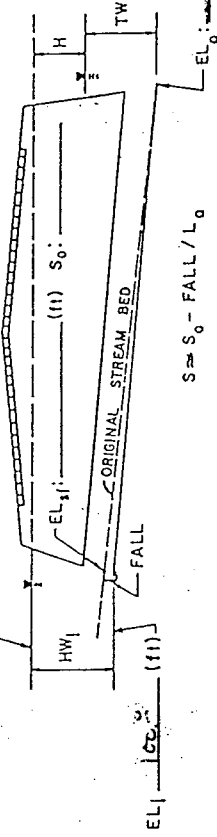
HYDROLOGICAL DATA

METHOD: RATIONAL
 DRAINAGE AREA: 23.15 STREAM SLOPE: _____
 CHANNEL SHAPE: _____
 ROUTING: _____ OTHER: _____
 SEE ADD'L SHTS.

DESIGN FLOWS/TAILWATER

R.I. (YEARS) 100 FLOW (cfs) 129.5 TW (ft) _____

ROADWAY ELEVATION: 4 (ft)



$S \approx S_0 - \text{FALL} / L_0$
 $S =$ _____
 $L_0 =$ _____

HEADWATER CALCULATIONS

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N	INLET CONTROL			OUTLET CONTROL				CONTROL ELEVATION	OUTLET VELOCITY	COMMENTS
			HW1	FALL	EL _{hd}	TW	d _c	d _c + D / 2	h _o			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
5'x4' RCBC	129.5	1.1	4.4	104.4	2.8	3.4	3.4	0.5	1.2	4.6	104.4	

TECHNICAL FOOTNOTES:
 (1) USE Q/NB FOR BOX CULVERTS
 (2) HW₁ / D = HW / D OR HW₁ / D FROM DESIGN CHARTS
 (3) FALL = HW₁ - (EL_{hd} - EL_{s1}); FALL IS ZERO FOR CULVERTS ON GRADE

(4) EL_{hd} = HW₁ + EL₁ (INVERT OF INLET CONTROL SECTION)
 (5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.
 (6) h_o = TW or (d_c + D / 2) (WHICHEVER IS GREATER)
 (7) H = [1 + k_o + (29n² L) / R^{1.33}] V² / 2g
 (8) EL_{ho} = EL_o + H + h_o

SUBSCRIPT DEFINITIONS:
 0. APPROXIMATE
 1. CULVERT FACE
 hd. DESIGN HEADWATER
 h1. HEADWATER IN INLET CONTROL
 ho. HEADWATER IN OUTLET CONTROL
 i. INLET CONTROL SECTION
 o. OUTLET
 s1. STREAMBED AT CULVERT FACE
 TW. TAILWATER

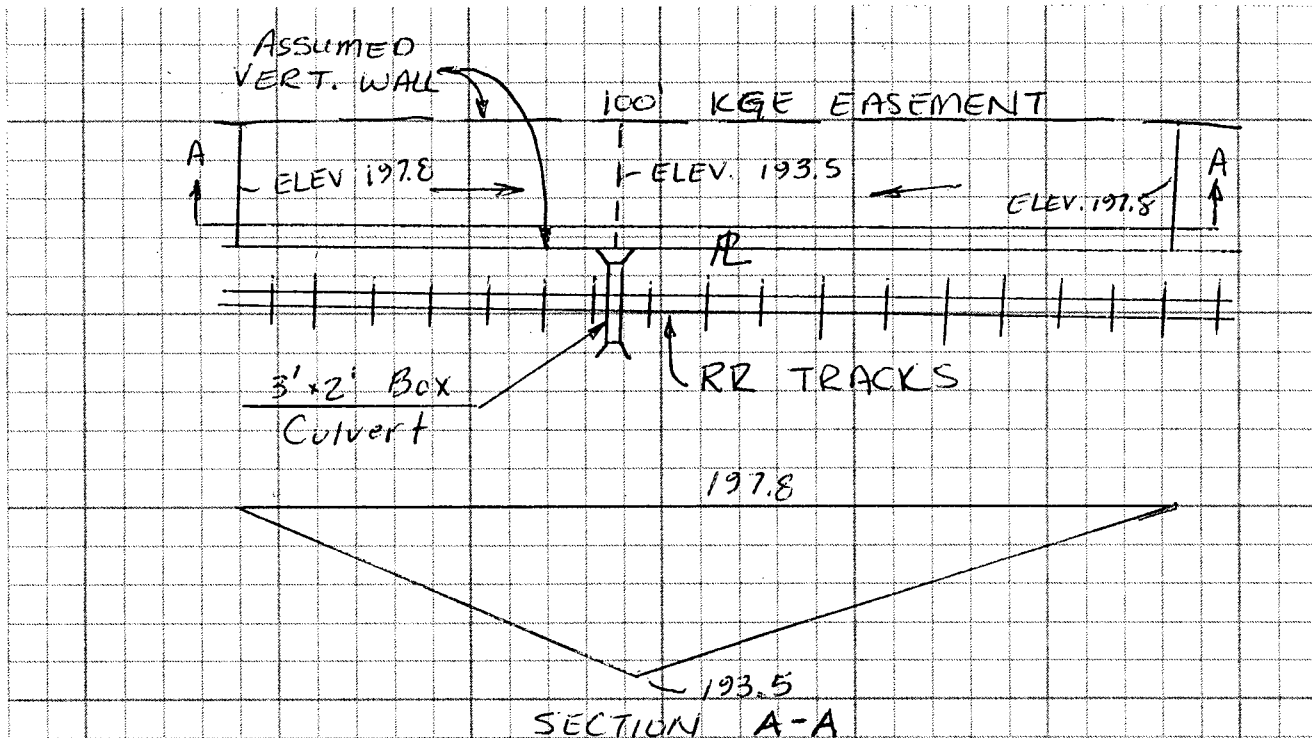
COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:
 SIZE: _____
 SHAPE: _____
 MATERIAL: _____
 ENTRANCE: _____

Basin #7 drains to the existing 2 - 5' X 4' RCBC under Webb Rd. North of 19th St. The attached table shows that the "C" factors used in the hydrology analysis of the basins flowing to the box represent developed conditions, and therefore, no further analysis of the basin is necessary.

WEBB ROAD (21ST TO 28TH STREETS NORTH) - SOUTH OF 21ST STREET													
DRAINAGE AREA	AREA ACRES	AREA ASSUM.	CS	C100	ICR	10/100	15	1/100	CS	Q100	PIPE SIZE	PIPE SLOPE	INLETS
AREA #8-1													
NORTH SIDE OF 21ST ST. N	7.17		0.54	0.68	42	31	2.68	5.32	10.38	25.94	30" RCP	0.40%	AREA INLET
C.O.W. WATER PUMP STA.													
AREA #8-2													
EXISTING 24" RCP							ASSUMED DESIGN Q = 30 CFS						
AREA #8-3													
NORTH SIDE OF 21ST ST. N	1.07		0.71	0.81	15	15	4.56	7.37	3.48	6.39			11"Ø-10" (SUMP)
WEST OF WEBB ROAD			0.56	0.70	42	31	2.68	5.32	12.4	30.7			
									42.4	60.7	48" RCP	0.20%	
AREA #8-4													
SOUTH SIDE OF 21ST ST. N													
WEST OF WEBB ROAD	0.98		0.71	0.81	15	15	4.56	7.37	9.17	6.85			11"Ø-5"
AREA #8-5													
EXISTING 30"Ø RCP							ASSUMED DESIGN Q = 85 CFS						
			0.56	0.71	42	31	2.68	5.32	14.3	34.8			
									129.3	150.0	48" RCP	1.20%	
AREA #8-6													
NORTH END OF WILSON PROPERTY	6.86		0.66	0.91	15	15	4.56	7.37	26.9	46.0	42" RCP	0.25%	AREA INLET (FUTURE)
AREA #8-8													
EAST SIDE OF WEBB RD.									2.40	4.42			
SOUTH OF 21ST ST. N.	0.74		0.71	0.81	15	15	4.56	7.37	CI=1.79	CI=2.95			
AREA #8-7									Obv=0.61	Obv=1.47	15" RCP	0.40% MIN.	11"Ø-10"
WEST SIDE OF WEBB RD.	0.74		0.71	0.81	15	15	4.56	7.37	2.40	4.42			
SOUTH OF 21ST ST. N.			0.70	0.80	42	31	2.68	5.32	CI=1.79	CI=2.95			
									Obv=0.61	Obv=1.47			
									38.9	74.7			
									148.0	190.0	66" RCP or 6"Ø RCB	0.35%	
AREA #8-0													
MIDDLE PART OF WILSON PROPERTY	11.2		0.66	0.91	15	15	4.56	7.37	43.9	75.1	48" RCP	0.30%	AREA INLET (FUTURE)
			0.76	0.94	42	31	2.68	5.32	86.6	12.9			
									174.0	244.0	REPLACE EXISTING 2 - 5' X 4' RCB WITH 2 - 6' X 4' RCB		

Basin No. 8 drains to the existing 3' X 2' stone and concrete box culvert under the railroad tracks near the southwest corner of the site. Runoff will be directed to the culvert via storm sewer and /or ditches. No detention ponds will be constructed within this basin. However, storage will occur naturally within the 100' KG&E easement. For use in the HEC-1 model, a pond with vee-shaped bottom and vertical sides at the property line and easement line was assumed, as shown:



Per the HEC-1 output, the peak Pre-Developed Q_{100} is 66 cfs, the peak Developed Q_{100} , with detention, is 30 cfs, and the maximum ponding elevation is 196.02.

1

CURRENT DATE: 12-13-1995
CURRENT TIME: 10:28:45

FILE DATE: 12-13-1995
FILE NAME: RR_3X2

FEWA CULVERT ANALYSIS
HY-8, VERSION 3.2

C	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
U	L	V						
	INLET	OUTLET	CULVERT	BARRELS	SPAN	RISE	MANNING	INLET
	ELEV.	ELEV.	LENGTH	SHAPE	(FT)	(FT)	n	TYPE
	(FT)	(FT)	(FT)	MATERIAL				
1	193.50	193.49	50.00	1 RCB	3.00	2.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: RR_3X2 DATE: 12-13-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
196.43	35	35	0	0	0	0	0	0	1
196.76	39	39	0	0	0	0	0	0	1
197.13	43	43	0	0	0	0	0	0	1
197.53	47	47	0	0	0	0	0	0	1
197.82	51	50	0	0	0	0	0	1	30
197.86	55	50	0	0	0	0	0	5	7
197.89	59	50	0	0	0	0	0	8	6
197.92	63	50	0	0	0	0	0	12	5
197.94	67	51	0	0	0	0	0	16	4
197.96	71	51	0	0	0	0	0	20	4
197.98	75	51	0	0	0	0	0	23	4
197.80	49	49	0	0	0	0	0	0	OVERTOPPING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RR_3X2 DATE: 12-13-1995

HEAD ELEV (FT)	HEAD ERROR (FT)	TOTAL FLOW (CFS)	FLOW ERROR (CFS)	% FLOW ERROR
196.43	0.00	35	0	0.00
196.76	0.00	39	0	0.00
197.13	0.00	43	0	0.00
197.53	0.00	47	0	0.00
197.82	-0.00	51	1	1.37
197.86	-0.00	55	0	0.87
197.89	-0.00	59	0	0.59
197.92	-0.00	63	0	0.66
197.94	-0.00	67	1	0.98
197.96	-0.00	71	1	0.87
197.98	-0.00	75	1	0.72

<1> TOLERANCE (FT) = 0.010

<2> TOLERANCE (%) = 1.000

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
*   MAY 1991
*   VERSION 4.0.1E
*   Lahey F77L-EM/32 version 5.01
*   Dodson & Associates, Inc.
*   RUN DATE 12/13/95 TIME 10:34:13
*****
    
```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 551-1748
*****
    
```

```

X X XXXXXX XXXX X
X X X X X XX
X X X X X X
XXXXXX XXXX X XXXX X
X X X X X X
X X X X X X
X X XXXXXX XXXX XXX
    
```

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

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

1

HEC-1 INPUT

PAGE 1

```

LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1         ID      Bradley Fair Drainage Plan
2         ID      Pond #5
3         ID      5-, 10-, 25-, & 100-Year Storms
4         ID      Professional Engineering Consultants
5         ID      Wichita, Ks
6         ID      DRC 11/20/95
7         ID      File: T:\DAR\HEC1\BRADLEY FAIR DRAINAGE PLAN
8         IT      6 01FEB95 0600 0 02FEB95 1154
9         IN      30 01FEB95 0600
10        IO      3 0
11        JR      PREC 0.5902 0.6875 0.8125 1.000
*
*DIAGRAM
*
12        KK      UNDEV      UNDEVELOPED BASIN
13        BA      .0206
14        PB      7.8
15        PC      0.08      .09      .10      .11      .12      .133      .147      .163      .181      .204
16        PC      .235      .283      .663      .735      .772      .799      .820      .835      .850      .865
17        PC      .880      .890      .900      .910      .916      .925      .934      .943      .952      .958
18        PC      .964      .970      .976      .982      .988      .994      1.000
19        LS      0      80      0
20        UD      0.15
*
*
21        KK      BASIN1      RESIDENTIAL DEVELOPED CONDITIONS
22        BA      .0206
23        PB      7.8
24        PC      0.08      .09      .10      .11      .12      .133      .147      .163      .181      .204
25        PC      .235      .283      .663      .735      .772      .799      .820      .835      .850      .865
26        PC      .880      .890      .900      .910      .916      .925      .934      .943      .952      .958
27        PC      .964      .970      .976      .982      .988      .994      1.000
28        LS      0      87      0
29        UD      0.15
*
*
*      3' X 2' BOX CULVERT UNDER RR TRACKS
*
30        KK      RRROW
31        RS      1      ELEV 193.5
32        SA      0      0.69 1.37 2.41
    
```

33	SE	193.5	194	196	197.8							
34	SQ	0	35	39	43	47	51	55	59	63	67	
35	SQ	71	75									
36	SE	193.5	196.43	196.76	197.13	197.53	197.82	197.86	197.89	197.92	197.94	
37	SE	197.96	197.98									
	*											
38	ZZ											

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
 NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

12 UNDEV
 .
 .
 21 . BASIN1
 . V
 . V
 30 . RRRROW

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

1*****
 * FLOOD HYDROGRAPH PACKAGE (HEC-1) *
 * MAY 1991 *
 * VERSION 4.0.1E *
 * Lahey F77L-EM/32 version 5.01 *
 * Dodson & Associates, Inc. *
 * RUN DATE 12/13/95 TIME 10:34:13 *

 * U.S. ARMY CORPS OF ENGINEERS *
 * HYDROLOGIC ENGINEERING CENTER *
 * 609 SECOND STREET *
 * DAVIS, CALIFORNIA 95616 *
 * (916) 551-1748 *

Bradley Fair Drainage Plan
 Pond #5
 5-, 10-, 25-, & 100-Year Storms
 Professional Engineering Consultants
 Wichita, Ks
 DRC 11/20/95
 File: T:\DAR\HEC1\BRADLEY2.ih1

10 IO OUTPUT CONTROL VARIABLES
 IPRNT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
 NMIN 6 MINUTES IN COMPUTATION INTERVAL
 IDATE 1FEB95 STARTING DATE
 ITIME 0600 STARTING TIME
 NQ 300 NUMBER OF HYDROGRAPH ORDINATES
 NDDATE 2FEB95 ENDING DATE
 NDTIME 1154 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL 0.10 HOURS
 TOTAL TIME BASE 29.90 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

JP MULTI-PLAN OPTION
 NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
 RATIOS OF PRECIPITATION
 0.59 0.69 0.81 1.00

		(CFS)				
+	31.	6.00	5.	1.	1.	1.
		(INCHES)	2.097	2.550	2.550	2.550
		(AC-FT)	2.	3.	3.	3.

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION UNDEV
FOR PLAN 1, RATIO = 0.69

TOTAL RAINFALL = 5.36, TOTAL LOSS = 2.15, TOTAL EXCESS = 3.21

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)				
		(CFS)				
+	39.	6.00	6.	2.	1.	1.
		(INCHES)	2.643	3.211	3.211	3.211
		(AC-FT)	3.	4.	4.	4.

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION UNDEV
FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 2.25, TOTAL EXCESS = 4.09

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)				
		(CFS)				
+	50.	6.00	7.	2.	2.	2.
		(INCHES)	3.362	4.087	4.087	4.087
		(AC-FT)	4.	4.	4.	4.

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION UNDEV
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 2.36, TOTAL EXCESS = 5.44

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)				
		(CFS)				
+	66.	6.00	10.	3.	2.	2.
		(INCHES)	4.469	5.438	5.438	5.438
		(AC-FT)	5.	6.	6.	6.

CUMULATIVE AREA = 0.02 SQ MI

*** **

```

*****
*
21 KK * BASIN * RESIDENTIAL DEVELOPED CONDITIONS
*
*****
    
```

```

9 IN TIME DATA FOR INPUT TIME SERIES
      JXMIN 30 TIME INTERVAL IN MINUTES
      JXDATE 1FEB95 STARTING DATE
      JXTIME 600 STARTING TIME
    
```

SUBBASIN RUNOFF DATA

			6-HR	24-HR	72-HR	29.90-HR
+	(CFS)	(HR)				
+	47.	6.00				
		(CFS)	7.	2.	2.	2.
		(INCHES)	3.210	3.910	3.910	3.910
		(AC-FT)	4.	4.	4.	4.

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
FOR PLAN 1, RATIO = 0.81

TOTAL RAINFALL = 6.34, TOTAL LOSS = 1.50, TOTAL EXCESS = 4.84

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW		
	(CFS)	(HR)	6-HR	24-HR	72-HR	29.90-HR
+	58.	6.00				
		(CFS)	9.	3.	2.	2.
		(INCHES)	3.967	4.841	4.841	4.841
		(AC-FT)	4.	5.	5.	5.

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION BASIN1
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 7.80, TOTAL LOSS = 1.54, TOTAL EXCESS = 6.26

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW		
	(CFS)	(HR)	6-HR	24-HR	72-HR	29.90-HR
+	74.	6.00				
		(CFS)	11.	3.	3.	3.
		(INCHES)	5.112	6.255	6.255	6.255
		(AC-FT)	6.	7.	7.	7.

CUMULATIVE AREA = 0.02 SQ MI

*** ** ** ** **

* *
30 KK * RRROW *
* *

HYDROGRAPH ROUTING DATA

31 RS	STORAGE ROUTING										
	NSTPS	1	NUMBER OF SUBREACHES								
	ITYP	ELEV	TYPE OF INITIAL CONDITION								
	RSVRIC	193.50	INITIAL CONDITION								
	X	0.00	WORKING R AND D COEFFICIENT								
32 SA	AREA	0.0	0.7	1.4	2.4						
33 SE	ELEVATION	193.50	194.00	196.00	197.80						
34 SQ	DISCHARGE	0.	35.	39.	43.	47.	51.	55.	59.	63.	67.
		71.	75.								
36 SE	ELEVATION	193.50	196.43	196.76	197.13	197.53	197.82	197.86	197.89	197.92	197.94
		197.96	197.98								

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	0.12	2.14	5.49
---------	------	------	------	------

ELEVATION 193.50 194.00 196.00 197.80

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.12	2.14	2.77	3.33	4.02	4.87	5.49	5.54	5.64
OUTFLOW	0.00	5.97	29.86	35.00	39.00	43.00	47.00	50.72	51.00	55.00
ELEVATION	193.50	194.00	196.00	196.43	196.76	197.13	197.53	197.80	197.82	197.86
STORAGE	5.71	5.79	5.84	5.89	5.94					
OUTFLOW	59.00	63.00	67.00	71.00	75.00					
ELEVATION	197.89	197.92	197.94	197.96	197.98					

*** *** *** *** ***

HYDROGRAPH AT STATION RRROW
FOR PLAN 1, RATIO = 0.59

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)				
+ 16.	6.30	(CFS)			
		(INCHES)	2.623	3.195	3.195
		(AC-FT)	3.	4.	4.
PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)				
+ 1.	6.30		0.	0.	0.
PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)				
+ 194.88	6.30	193.99	193.65	193.62	193.62

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION RRROW
FOR PLAN 1, RATIO = 0.69

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)				
+ 20.	6.30	(CFS)			
		(INCHES)	3.206	3.910	3.910
		(AC-FT)	4.	4.	4.
PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)				
+ 1.	6.30		0.	0.	0.
PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)				
+ 195.15	6.30	194.09	193.68	193.65	193.65

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION RRROW
FOR PLAN 1, RATIO = 0.81

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)				
+ 24.	6.30	(CFS)			
		(INCHES)	3.963	4.841	4.841
		(AC-FT)	4.	5.	5.
PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)				

2.	6.30	0.	0.	0.	0.
PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)				
195.49	6.30	194.23	193.72	193.68	193.68

CUMULATIVE AREA = 0.02 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION RRROW
FOR PLAN 1, RATIO = 1.00

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	29.90-HR
+ (CFS)	(HR)				
30.	6.30				
	(CFS)				
	(INCHES)	11.	3.	3.	3.
	(AC-FT)	5.105	6.255	6.255	6.255
		6.	7.	7.	7.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (AC-FT)	(HR)				
2.	6.30	1.	0.	0.	0.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	29.90-HR
+ (FEET)	(HR)				
196.02	6.30	194.45	193.79	193.73	193.73

CUMULATIVE AREA = 0.02 SQ MI

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				0.59	0.69	0.81	1.00
HYDROGRAPH AT							
+ UNDEV	0.02	1	FLOW	31.	39.	50.	66.
			TIME	6.00	6.00	6.00	6.00
HYDROGRAPH AT							
+ BASIN1	0.02	1	FLOW	39.	47.	58.	74.
			TIME	6.00	6.00	6.00	6.00
ROUTED TO							
+ RRROW	0.02	1	FLOW	16.	20.	24.	30.
			TIME	6.30	6.30	6.30	6.30
** PEAK STAGES IN FEET **							
1	STAGE	194.88	195.15	195.49	196.02		
	TIME	6.30	6.30	6.30	6.30		

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

The second portion of this drainage plan was devoted to Pond design and detention storage analysis for the entire site. The purpose of this analysis is to ensure that development of this property does not adversely affect any neighboring properties. To show this, there are four points of concentration where on-site runoff will exit the Willson Property, these being: 1. 3' X 2' box culvert under RR in SW corner, @. RR biidge at approximately center of section, 3. Proposed 5' X 4' RCBC at SE corner to be built with Webb Rd. Project byt County, and 4. 2 - 5' X 4' RCBC just north of 19th St.

Following are the peak Pre-Developed and Developed on-site generated Q_{100} 's for each point.

Point #	Contributing Basin	Q_{100} pre.	Q_{100} dev.
1	8	66	30
2	1-5,9	1083	894
3	6	142	130
4	RCBC and drainage system previously designed for Q_{100}		

In each case the peak developed flow is less than the peak pre-developed flow. This is accomplished through detention storage to be provided by construction of new ponds.

ATTACHMENT D

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
Single Family (Soil Group D)					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
Multi-Family (Soil Group D)					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
Single Family (Soil Group C)					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
Multi-Family (Soil Group C)					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
Single-Family (Soil Group B)					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
Multi-Family (Soil Group B)					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or Face Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
Undeveloped Urban Areas:					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>Soil Group A</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Soil Group B</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Soil Group C</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Soil Group D</u>					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

CITY OF WICHITA, KANSAS

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

TDF

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

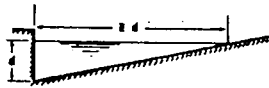
TABLE 3

FULL FLOW COEFFICIENT VALUES
CIRCULAR CONCRETE PIPE

$S = Q^2/K^2$
 $Q = K\sqrt{S}$
 $K = Q/\sqrt{S}$

D Pipe Diameter (inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{4/3} = K$		
			n=0.010	n=0.011	n=0.012
8	0.349	0.167	15.8	14.3	13.1
10	0.545	0.208	28.4	25.8	23.6
12	0.785	0.250	46.4	42.1	38.6
15	1.227	0.312	84.1	76.5	70.1
18	1.767	0.375	137	124	114
21	2.405	0.437	206	187	172
24	3.142	0.500	294	267	245
27	3.976	0.562	402	366	335
30	4.909	0.625	533	485	444
33	5.940	0.688	686	624	574
36	7.069	0.750	867	788	722
42	9.621	0.875	1308	1189	1090
48	12.566	1.000	1867	1698	1556
54	15.904	1.125	2557	2325	2131
60	19.635	1.250	3385	3077	2821
66	23.758	1.375	4364	3967	3636
72	28.274	1.500	5504	5004	4587
78	33.183	1.625	6815	6195	5679
84	38.485	1.750	8304	7549	6920
90	44.170	1.875	9985	9078	8321
96	50.266	2.000	11850	10780	9878
102	56.745	2.125	13940	12670	11620
108	63.617	2.250	16230	14760	13530
114	70.882	2.375	18750	17040	15620
120	78.540	2.500	21500	19540	17920
126	86.590	2.625	24480	22260	20400
132	95.033	2.750	27720	25200	23100
138	103.870	2.875	31210	28370	26010
144	113.100	3.000	34960	31780	29130
150	122.810	3.125	39000	35440	32570
156	133.000	3.250	43360	39360	36340
162	143.670	3.375	48060	43560	40460
168	154.820	3.500	53120	48060	44940
174	166.450	3.625	58560	52880	49780
180	178.560	3.750	64400	58040	54990
186	191.150	3.875	70660	63560	60580
192	204.220	4.000	77360	69460	66560
198	217.770	4.125	84520	75760	72940
204	231.800	4.250	92160	82480	79720
210	246.310	4.375	100300	89640	86990
216	261.300	4.500	108960	97260	94660
222	276.770	4.625	118180	105360	102740
228	292.720	4.750	127980	113960	111240
234	309.150	4.875	138380	123080	120160
240	326.060	5.000	149420	132740	129500
246	343.450	5.125	161040	142960	139260
252	361.320	5.250	173280	153760	149460
258	379.670	5.375	186180	165160	160090
264	398.500	5.500	199760	177180	171160
270	417.810	5.625	214060	189840	182680
276	437.600	5.750	229120	203160	194660
282	457.870	5.875	244980	217160	207100
288	478.620	6.000	261680	231860	220000
294	499.850	6.125	279260	247280	233380
300	521.560	6.250	297680	263440	247260
306	543.750	6.375	316980	280360	261660
312	566.420	6.500	337200	298060	276580
318	589.570	6.625	358380	316560	292040
324	613.200	6.750	380560	335880	308060
330	637.310	6.875	403780	356040	324660
336	661.900	7.000	428000	377060	341860
342	687.070	7.125	453280	398960	359680
348	712.820	7.250	479660	421760	378040
354	739.150	7.375	507180	445480	396960
360	766.060	7.500	535880	470140	416460
366	793.550	7.625	565700	495760	436560
372	821.620	7.750	596680	522360	457280
378	850.270	7.875	628860	550060	478640
384	879.500	8.000	662180	578880	499660
390	909.310	8.125	696680	608860	521360
396	939.700	8.250	732400	640040	543680
402	970.670	8.375	769380	672460	566640
408	1002.220	8.500	807560	706160	590260
414	1034.350	8.625	846980	741180	614560
420	1067.060	8.750	887680	777460	639560
426	1100.350	8.875	929600	815040	665260
432	1135.220	9.000	972780	853960	691660
438	1170.670	9.125	1017160	894260	718760
444	1207.700	9.250	1062780	935980	746560
450	1245.310	9.375	1109680	979160	775060
456	1283.500	9.500	1157880	1023760	804260
462	1322.270	9.625	1207320	1069800	834160
468	1361.620	9.750	1258040	1117260	864760
474	1401.550	9.875	1309980	1166040	896060
480	1442.060	10.000	1363180	1216260	928060
486	1483.250	10.125	1417660	1267860	960760
492	1525.020	10.250	1473460	1320860	994160
498	1567.370	10.375	1530600	1375260	1028260
504	1610.300	10.500	1589120	1431060	1063160
510	1653.810	10.625	1649060	1488260	1098860
516	1697.900	10.750	1710360	1546860	1135260
522	1742.570	10.875	1773060	1606860	1172360
528	1787.820	11.000	1837200	1668260	1210160
534	1833.650	11.125	1902840	1731060	1248660
540	1880.060	11.250	1969920	1795260	1287860
546	1927.050	11.375	2038480	1860860	1327760
552	1974.620	11.500	2108560	1927960	1368360
558	2022.770	11.625	2180180	1996560	1409660
564	2071.500	11.750	2253380	2066660	1451660
570	2120.810	11.875	2328100	2138260	1494360
576	2170.700	12.000	2404380	2211360	1537660
582	2221.170	12.125	2482260	2285960	1581560
588	2272.220	12.250	2561680	2362060	1626060
594	2323.850	12.375	2642680	2439660	1671160
600	2376.060	12.500	2725200	2518760	1716860
606	2428.850	12.625	2809280	2599360	1763160
612	2482.220	12.750	2894860	2681460	1809960
618	2536.170	12.875	2981980	2765060	1857260
624	2590.700	13.000	3070680	2850160	1905060
630	2645.810	13.125	3160980	2936760	1953360
636	2701.500	13.250	3252820	3024860	2002160
642	2757.770	13.375	3346240	3114460	2051460
648	2814.620	13.500	3441280	3205560	2101260
654	2872.050	13.625	3537980	3298160	2151560
660	2930.060	13.750	3636280	3392260	2202360
666	2988.650	13.875	3736120	3487860	2253660
672	3047.820	14.000	3837560	3584960	2305460
678	3107.570	14.125	3940540	3683560	2357760
684	3167.900	14.250	4045000	3783660	2410560
690	3228.810	14.375	4150980	3885260	2463860
696	3290.300	14.500	4258420	3988460	2517660
702	3352.370	14.625	4367360	4093160	2571960
708	3415.020	14.750	4477820	4199460	2626760
714	3478.250	14.875	4589840	4307360	2682060
720	3542.060	15.000	4703460	4416860	2737860
726	3606.450	15.125	4818720	4527960	2794160
732	3671.420	15.250	4935660	4640660	2850960
738	3736.970	15.375	5054220	4754960	2908260
744	3803.100	15.500	5174440	4870860	2966060
750	3869.810	15.625	5296260	4988360	3024360
756	3937.100	15.750	5419720	5107460	3083160
762	4004.970	15.875	5544860	5228160	3142460
768	4073.420	16.000	5671620	5350460	3202260
774	4142.450	16.125	5800040	5474360	3262560
780	4212.060	16.250	5930160	5600860	3323360
786	4282.250	16.375	6061920	5728960	3384660
792	4353.020	16.500	6195360	5858660	3446460
798	4424.370	16.625	6330520	5989960	3508760
804	4496.300	16.750	6467340	6122860	3571560
810	4568.810	16.875	6605860	6257360	3634860
816	4641.900	17.000	6746020	6393460	3698660
822	4715.570	17.125	6887860	6531160	3762960
828	4790.820	17.250	7031320	6670460	3827760
834	4866.650	17.375	7176440	6811360	3893060
840	4943.060	17.500	7323160	6953860	3958860
846	5020.050	17.625	7471520	7097960	4025160
852	5097.620	17.750	7621560	7243660	4091960
858	5175.770	17.875	7773240	7390960	4159260
864	5254.500	18.000	7926600	7539860	4227060
870	5333.810	18.125	8081680	7690360	4295360
876	5413.700	18.250	8238420	7842460	4364160
882	5494.170	18.375	8396860	7996160	4433460
888	5575.220	18.500	8556940	8151460	4503260
894	5656.850	18.625	8718700	8308360	4573560
900	5739.060	18.750	8882180	8466860	4644360
906	5821.850	18.875	9047320	8626960	4715660
912	5905.220	19.000	9214160	8788660	4787460
918	5989.170	19.125	9382740	8951960	4859760
924	6073.700	19.250	9553000	9116860	4932560
930	6158.810	19.375	9724980	9283360	5005860
936	6244.500	19.500	9898640	9451460	5079660
942	6330.770	19.625	10074020	9621160	5153960
948	6417.620	19.750	10251060	9792460	5228760
954	6505.050	19.875	10429800	9965360	5304060
960	6593.060	20.000	10610280	10140860	5379860
966	6681.650	20.125	10792460	10318960	5456160
972	6770.820	20.250	10976280	10499660	5532960
978	6860.570	20.375	11161780	10682960	5610260
984	6950.900	20.500	11348980	10867860	5688060
990	7041.810	20.625	11537820	11054360	5766360
996	7133.300	20.750	11728340	11242460	5845160
1002	7225.370	20.875	11920580	11432160	5924460
1008	7318.020	21.000	121144		

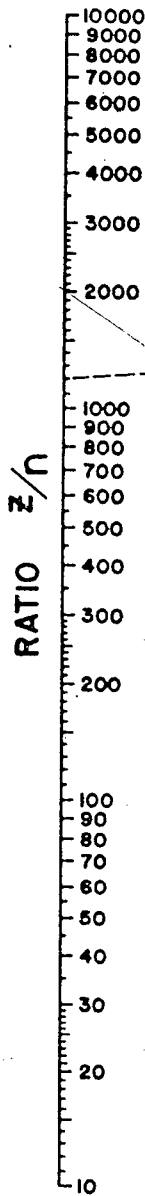
NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS



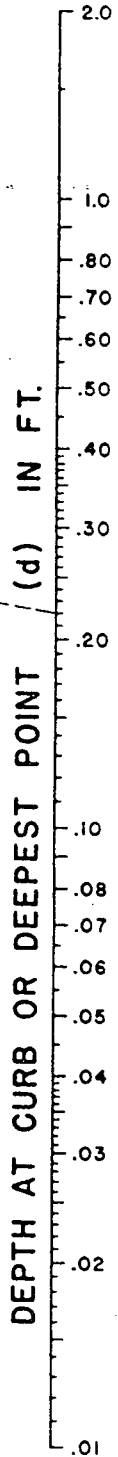
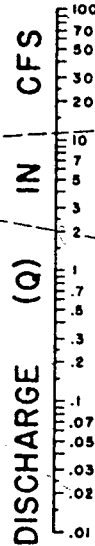
EQUATION: $Q = 0.85 \left(\frac{z}{n}\right)^{2/3} d^{5/3}$
 n IS ROUGHNESS COEFFICIENT IN MANNING
 FORMULA APPROPRIATE TO MATERIAL IN
 BOTTOM OF CHANNEL
 z IS RECIPROCAL OF CROSS SLOPE
 REFERENCE: H. R. S. PROCEEDINGS 1948,
 PAGE 150, EQUATION (14)

EXAMPLE (SEE DASHED LINES)

GIVEN: $z = 0.03$
 $z = 24$
 $n = .02$ $z/n = 1200$
 $s = 0.22$
 FIND: $Q = 2.0$ CFS



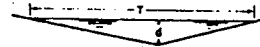
TURNING LINE



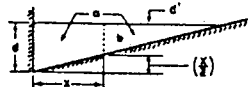
INSTRUCTIONS

1. CONNECT z/n RATIO WITH SLOPE (s) AND CONNECT DISCHARGE (Q) WITH DEPTH (d). THESE TWO LINES MUST INTERSECT AT TURNING LINE FOR COMPLETE SOLUTION.

2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH WITH $z = \frac{1}{2}$

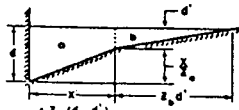


3. TO DETERMINE DISCHARGE Q_x IN PORTION OF CHANNEL HAVING WIDTH x :



DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION a . THEN USE NOMOGRAPH TO DETERMINE Q_x IN SECTION b FOR DEPTH $d' = d \left(\frac{x}{a}\right)$

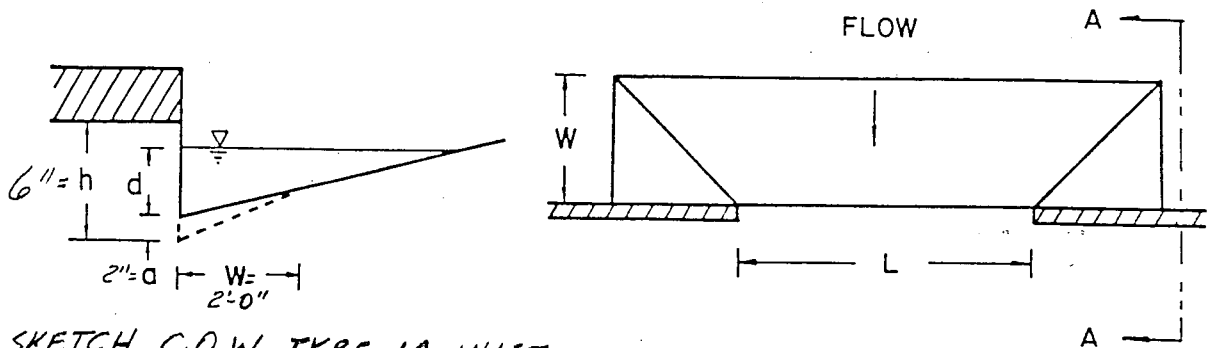
4. TO DETERMINE DISCHARGE IN COMPOSITE SECTION - FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE IN SECTION a AT ASSUMED DEPTH d ; OBTAIN Q_b FOR SLOPE RATIO z_b AND DEPTH d' . THEN $Q_c = Q_a + Q_b$



One foot is 0.3048m
 One cubic foot is 0.0283m³

$$\frac{1}{z} = \frac{3/8}{12} \quad z = 32$$

$$\frac{z}{n} = \frac{32}{0.016} = 2000$$



DEF. SKETCH, C.D.W. TYPE 1A INLET

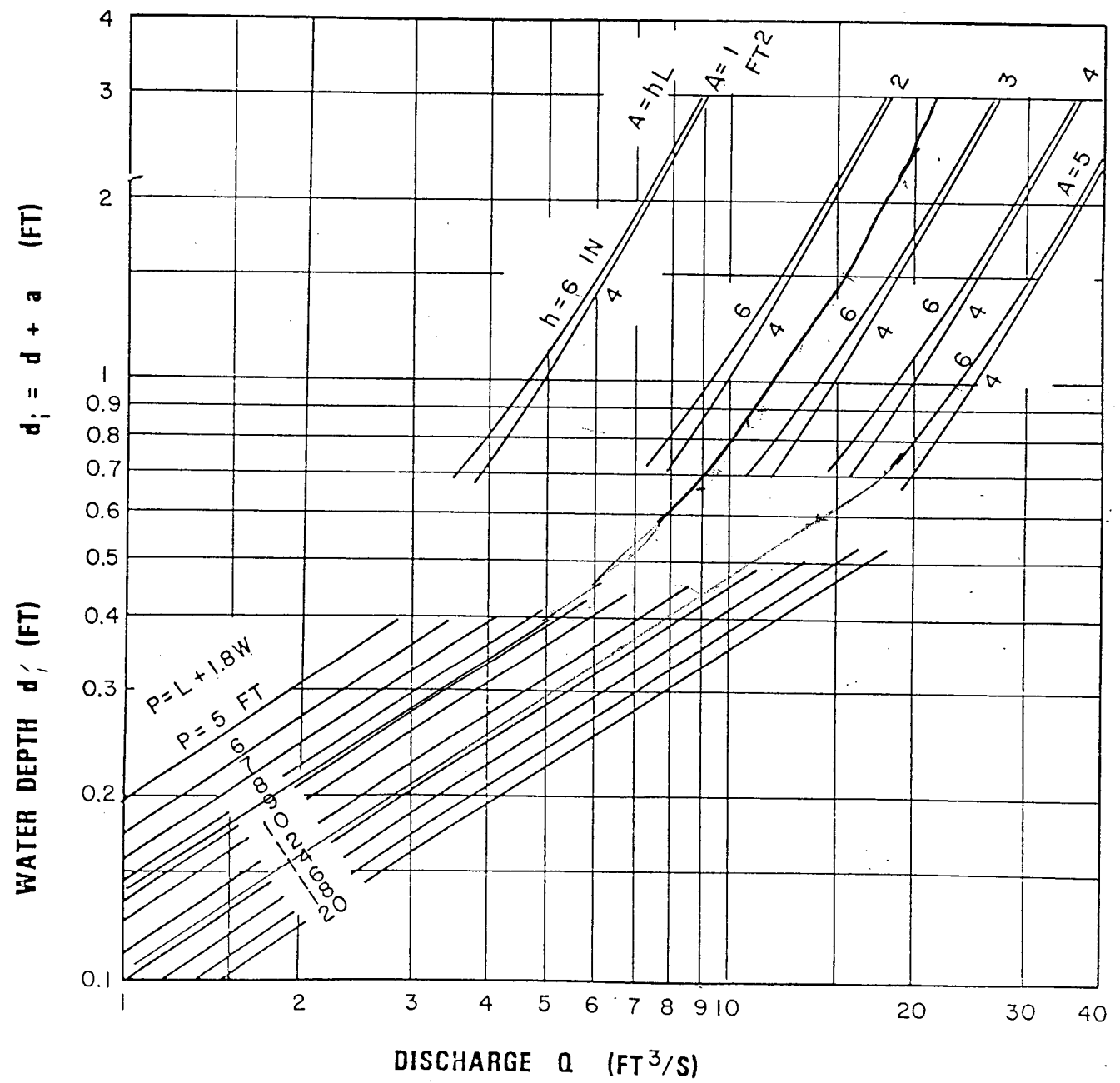


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, F.H.W.A., MAR., 1984

SOIL LEGEND

SYMBOL	HYDROLOGIC GROUP	NAME
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loams, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loam, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loam
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goesseil silty clay, 0 to 1 percent slopes
Gb	D	Goesseil silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan loam, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

FLOODING SOURCE		FLOODWAY				BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)	
MIDDLE BRANCH GYPSUM CREEK									
A	1000	109	690	2.7	1339.7	1339.7	1340.3	0.6	
B	1269	109	646	2.9	1339.8	1339.8	1340.4	0.6	
C	1391	32	270	7.0	1340.6	1340.6	1340.6	0.0	
D	1891	45	405	4.7	1341.2	1341.2	1341.9	0.7	
E	3760	70	202	9.3	1346.8	1346.8	1346.8	0.0	
F	3860	70	376	5.0	1348.0	1348.0	1348.5	0.5	
G	5010	119	626	3.0	1349.4	1349.4	1350.3	0.9	
H	5460	110	474	4.0	1350.1	1350.1	1350.8	0.7	
M	12,627	60 ²	216	5.8	1363.1	1363.1	1364.0	0.9	
N	12,821	80	478	2.6	1365.6	1365.6	1365.8	0.2	
O	13,611	150	530	2.3	1366.2	1366.2	1366.9	0.7	
P	15,301	75	399	3.1	1369.3	1369.3	1369.4	0.1	
Q	15,457	75	276	4.5	1370.8	1370.8	1370.8	0.0	
R	16,037	100	327	3.8	1372.6	1372.6	1373.4	0.8	
S	16,882	100	479	2.6	1376.1	1376.1	1376.3	0.2	

¹FEET ABOVE CONFLUENCE WITH GYPSUM CREEK
²THIS WIDTH IS BEYOND CORPORATE LIMITS

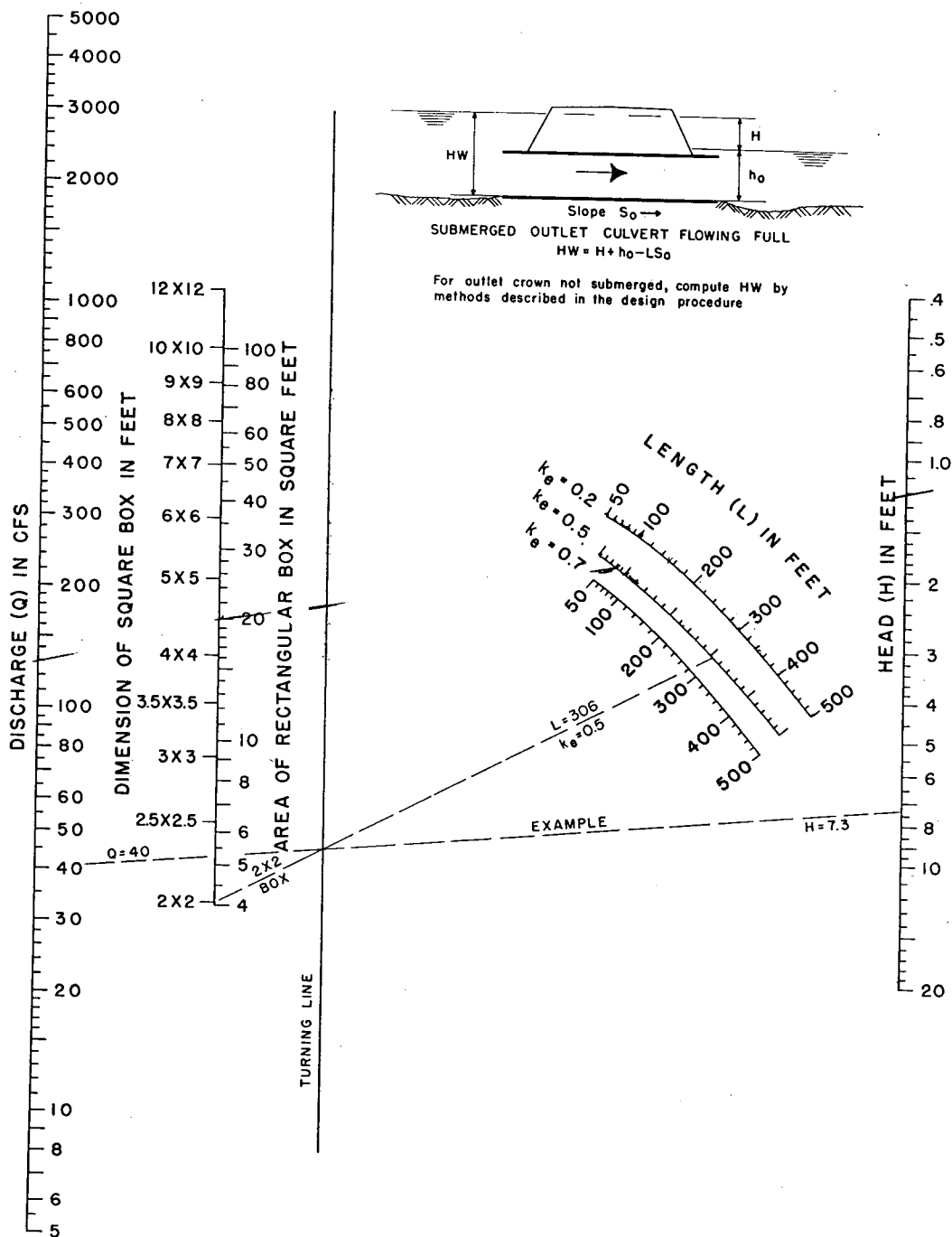
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF WICHITA, KS
 (SEDGWICK CO.)

FLOODWAY DATA

MIDDLE BRANCH GYPSUM CREEK

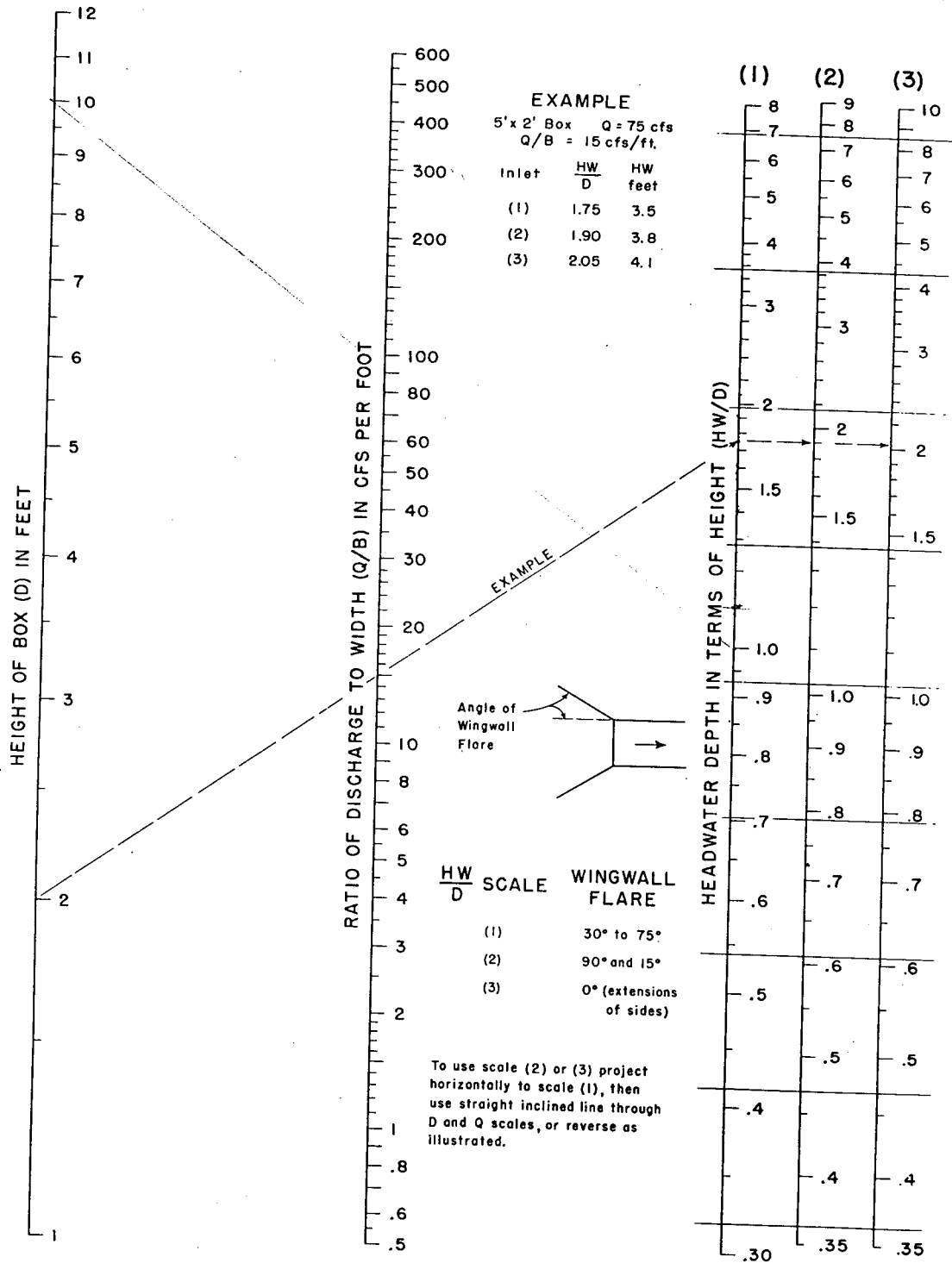
TABLE 4

CHART 8



HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
 $n = 0.012$

CHART I



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

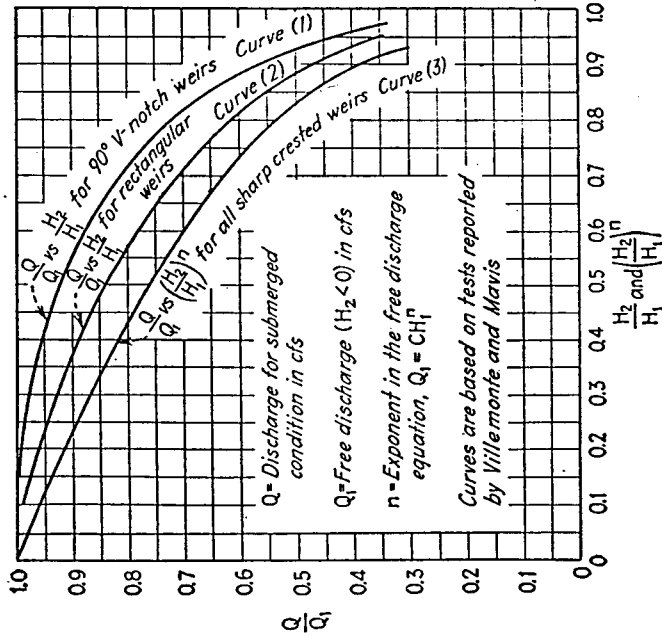
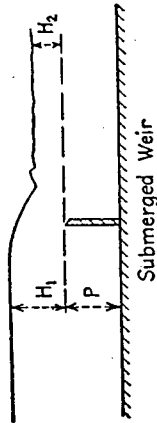


FIG. 5-5

the upstream side of the weir, H_1 , but also to the head on the downstream side, H_2 , and to a lesser extent, to the height of the weir crest above the floor of the channel, P . Early experiments by Francis (1848, 1883), Fteley and Stearns (1882), Bázin (1894), Cone (1916), and Cox (1928) have been summarized by Vennard and Weston.¹ They showed that the various test data could be presented in an orderly manner by selecting as variables Q/Q_1 and H_2/H_1 , where Q_1 is the discharge at the head H_1 , computed from the equation for free discharge (unsubmerged), which is expressed in general terms as follows:

$$Q_1 = CH_1^n \quad (5-49)$$

By plotting Q/Q_1 against H_2/H_1 , they found that the various data tended to fall on a single curve, except for small values of P/H_1 .

In 1947, Villemonte² presented the results of a series of tests on submerged sharp-crested weirs. He conducted tests on rectangular, triangular, parabolic, cusped, and proportional weirs. He showed that the results for all types could be represented by the single equation

$$\frac{Q}{Q_1} = \left[1 - \left(\frac{H_2}{H_1} \right)^n \right]^{0.385} \quad (5-50)$$

where n is the exponent in the free-discharge equation [Eq. (5-49)], and the other terms are as previously defined. This equation was found to satisfy all test results, with a maximum deviation of 5 per cent for some of the individual test results.

In 1949, Mavis³ presented results of tests on rectangular, triangular, parabolic, circular, suture, and cusped weirs. He found that a single equation could be used to express the results for all the tests. His equation with subscripts changed to conform with usage in this book is

$$\frac{Q}{Q_1} = 1 - \left(0.45S + \frac{0.40}{2^{(10-10S)}} \right) \quad (5-51)$$

¹ John K. Vennard and Ray F. Weston, Submergence Effect on Sharp-crested Weirs, *Eng. News-Record*, June 3, 1943, p. 818.

² James R. Villemonte, Submerged-weir Discharge Studies, *Eng. News-Record*, Dec. 25, 1947, p. 866.

³ F. T. Mavis, How to Calculate Flow over Submerged Thin-plate Weirs, *Eng. News-Record*, July 7, 1949, p. 65.