

**HYDROLOGY AND HYDRAULIC  
CALCULATIONS  
FOR  
WEST MEADOW DETENTION POND  
AT  
S.H. 115 AND ACADEMY BOULEVARD**



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**HYDROLOGY AND HYDRAULIC  
CALCULATIONS  
FOR  
WEST MEADOW DETENTION POND  
AT  
S.H. 115 AND ACADEMY BOULEVARD**

**BY:**

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COLORADO SPRINGS, CO 80915**

**PRELIMINARY**

DATE 9/21/94

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## **DESIGN CRITERIA**

Project: WEST MEADOW DET. POND Job No: EW1026

Client: GATES By: TTW Date: 9/94

## DESIGN CRITERIA

REVIEW OF PAST CORRESPONDENCE OF THIS PROJECT WITH THE CITY AND FT. CARSON PERSONELL, DETENTION OF THE 100yr STORM FLOWS WERE NOT ADDRESSED. THUS, DESIGN OF THE DETENTION POND WAS BASED ON 100yr STORM FLOWS.

1. <u>INLET WORKS</u>	<u>HISTORIC FLOWS</u>	<u>DEV. FLOWS</u>	<u>DESIGN FLOWS</u>
72" CMP (UNDER SH. 115)	-	414 cfs	414 cfs
* 24" CMP (UNDER SH. 115)	19.1 cfs	19.1 cfs	20 cfs

\* HISTORIC FLOWS - MANNING'S EOS - GRAVITY FLOW.

2. <u>OUTLET WORKS - DETENTION POND</u>	<u>HISTORIC FLOWS</u>	<u>DEV. FLOWS</u>	<u>DESIGN FLOWS</u>
100yr INFLOW	-	497 cfs	497 cfs
100yr OUTFLOW	75 cfs	-	79 cfs

### 3. EMERGENCY SPILLWAY

THE EMERGENCY SPILLWAY IS DESIGNED TO CONVEY THE 100yr FULLY DEVELOPED FLOW OVER THE DAM WITH A 1.0 FT. FREEBOARD. THIS ASSUMES THAT THE OUTLET STRUCTURE IS PLUGGED AND THE IMPOUNDMENT IS FULL.

# 100 YEAR TR20 INFLOW HYDROGRAPHS

Project WEST MEADOW DET. POND		Job No EW1026
Client GATES LAND CO	By TMO	Date 9/94

1. 100 yr. TR 20 INFLOW HYDROGRAPH

TWO TR 20 HYDROGRAPH SCENARIOS WERE DEVELOPED. -  
THE FIRST SCENARIO MODELLED THE ENTIRE DRAINAGE  
BASIN AS DEVELOPED - BASED ON THE "CHEYENNE  
MEADOWS SOUTH AT CHEYENNE MOUNTAIN RANCH FINAL  
DRAINAGE STUDY, JUNE 1986. REVISED RAINFALL AND  
LAND USES WERE INCORPORATED INTO THIS MODEL.  
 $Q_{100} = 497 \text{ cfs.}$

THE SECOND SCENARIO MODELLED THE DRAINAGE BASIN THAT  
CONTRIBUTED TO THE RUNOFF CONVEYED BY THE 72" CMP  
UNDER S.H. 115. THIS MODEL WAS USED TO DESIGN  
THE STORM DRAIN SYSTEM THAT WOULD EXTEND FROM THE  
72" CMP TO THE DET. POND

$Q_{100} = 414 \text{ cfs}$

2. 100 yr. OUTFLOW HYDROGRAPH

THE OUTFLOW HYDROGRAPH WAS DEVELOPED USING  
THE ORIFICE EQUATION -  $Q = CA (2gH)^{1/2}$  -  $C = 0.60$   
AND ASSUMING  $Q_{100} = 75 \text{ cfs.}$

REVISED  
 CN - 83  
 8-12-94  
 FILE  
 C:\TR20\EW1026\F2.F2a

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\*\*\*\*\*80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY\*\*\*\*\*

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JOB TR-20                                SUMMARY  NOPLOTS
TITLE  DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)
TITLE  FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR
5 RAINFL 7          0.2500
8      0.0000      0.0005      0.0015      0.0030      0.0045
8      0.0060      0.0080      0.0100      0.0120      0.0143
8      0.0165      0.0188      0.0210      0.0233      0.0255
8      0.0278      0.0320      0.0390      0.0460      0.0530
8      0.0600      0.0750      0.1000      0.4000      0.7000
8      0.7250      0.7500      0.7650      0.7800      0.7900
8      0.8000      0.8100      0.8200      0.8250      0.8300
8      0.8350      0.8400      0.8450      0.8500      0.8550
8      0.8600      0.8638      0.8675      0.8713      0.8750
8      0.8788      0.8825      0.8863      0.8900      0.8938
8      0.8975      0.9013      0.9050      0.9083      0.9115
8      0.9148      0.9180      0.9210      0.9240      0.9270
8      0.9300      0.9325      0.9350      0.9375      0.9400
8      0.9425      0.9450      0.9475      0.9500      0.9525
8      0.9550      0.9575      0.9600      0.9625      0.9650
8      0.9675      0.9700      0.9725      0.9750      0.9775
8      0.9800      0.9813      0.9825      0.9838      0.9850
8      0.9863      0.9875      0.9888      0.9900      0.9913
8      0.9925      0.9938      0.9950      0.9963      0.9975
8      0.9988      1.0000      1.0000      1.0000      1.0000
9 ENDTBL
6 RUNOFF 1 001      5 .295      83.0      0.59      1 1 1 1
  ENDDATA
7 INCREM 6          0.05
7 COMPUT 7 001 001 0.0      4.6      1.0      7 2 01 99
  ENDCMP 1
7 COMPUT 7 001 001 0.0      3.0      1.0      7 2 01 10
  ENDCMP 1
  ENDJOB 2
0*****END OF 80-80 LIST*****

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TR20 XEQ                                DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)                                JOB 1  PASS 1
REV 09/01/83                            FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR                                PAGE 1

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COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.



THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)  
 LINCOLN, NE (MIDWEST) -- 541-5318 (FTS), PORTLAND, OR (WEST) -- 423-4099 (FTS)  
 OR HYDROLOGY UNIT, ENGINEERING DIVISION, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

- 12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD  
 CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
- 5/02/83 - CORRECT COMPUTATIONS FOR ---
  1. DIVISION OF BASEFLOW IN DIVERT OPERATION
  2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
  3. CROSS SECTION DATA PLOTTING POSITION
  4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
  5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTYPEAK HYDROGRAPH
  6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
  7. BASEFLOW ENTERED WITH READHYD
  8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
- ENHANCEMENTS ---
  1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
  2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
- 09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS  
 CORRECT COMBINATION OF RATING TABLES FOR DIVERT  
 CHECK REACH ROUTING PARAMETERS FOR ACCEPTABLE LIMITS  
 ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE

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TR20 XEQ  
 REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR

JOB 1 PASS 1  
 PAGE 2

CUMULATIVE RAINFALL TABLE 7 TIME INCREMENT= .25

8	.0000	.0005	.0015	.0030	.0045
8	.0060	.0080	.0100	.0120	.0143
8	.0165	.0188	.0210	.0233	.0255
8	.0278	.0320	.0390	.0460	.0530

8	.7250	.7500	.7650	.7800	.7900
8	.8000	.8100	.8200	.8250	.8300
8	.8350	.8400	.8450	.8500	.8550
8	.8600	.8638	.8675	.8713	.8750
8	.8788	.8825	.8863	.8900	.8938
8	.8975	.9013	.9050	.9083	.9115
8	.9148	.9180	.9210	.9240	.9270
8	.9300	.9325	.9350	.9375	.9400
8	.9425	.9450	.9475	.9500	.9525
8	.9550	.9575	.9600	.9625	.9650
8	.9675	.9700	.9725	.9750	.9775
8	.9800	.9813	.9825	.9838	.9850
8	.9863	.9875	.9888	.9900	.9913
8	.9925	.9938	.9950	.9963	.9975
8	.9988	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 1  
 OUTPUT HYDROGRAPH = 5  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

RECORD ID  
 DATA FIELD VALUES = .2950 83.0000 .5900

EXECUTIVE CONTROL OPERATION INCREM

MAIN TIME INCREMENT = .05 HOURS

RECORD ID

EXECUTIVE CONTROL OPERATION COMPUT

FROM XSECTION 1

TO XSECTION 1

STARTING TIME = .00 RAIN DEPTH = 4.60 RAIN DURATION = 1.00 RAIN TABLE NO. = 7 ANT. MOIST. COND = 2  
 ALTERNATE NO. = 1 STORM NO. = 99 MAIN TIME INCREMENT = .05 HOURS

RECORD ID

OPERATION RUNOFF CROSS SECTION 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.21	498.21	(RUNOFF)
9.98	15.12	(RUNOFF)
12.97	11.49	(RUNOFF)

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .05 HOURS DRAINAGE AREA = .29 SQ.MI.  
 5.00 DISCHG .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01

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TR20 XEQ

REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR

JOB 1 PASS 1  
 PAGE 3

5.50	DISCHG	.07	.95	4.28	12.18	27.29	52.47	89.09	136.68	193.32	256.45
6.00	DISCHG	322.84	386.17	440.03	478.91	497.26	492.22	467.94	430.50	385.90	338.70
6.50	DISCHG	293.22	251.43	215.75	187.51	164.55	145.19	128.62	114.22	101.95	91.63
7.00	DISCHG	82.92	75.59	69.43	64.24	59.75	55.67	51.92	48.49	45.39	42.64
7.50	DISCHG	40.22	38.14	36.41	35.01	33.85	32.90	32.15	31.56	31.14	30.87
8.00	DISCHG	30.66	30.43	30.09	29.57	28.79	27.73	26.44	25.02	23.58	22.19
8.50	DISCHG	20.93	19.81	18.87	18.13	17.55	17.07	16.69	16.38	16.12	15.92
9.00	DISCHG	15.76	15.62	15.51	15.43	15.36	15.30	15.26	15.22	15.20	15.17
9.50	DISCHG	15.16	15.14	15.13	15.13	15.12	15.12	15.11	15.11	15.12	15.12
10.00	DISCHG	15.12	15.10	15.05	14.95	14.78	14.54	14.24	13.91	13.56	13.22
10.50	DISCHG	12.90	12.61	12.36	12.17	12.01	11.90	11.81	11.74	11.68	11.63
11.00	DISCHG	11.59	11.55	11.52	11.48	11.46	11.45	11.45	11.45	11.45	11.45

12.00	DISCHG	11.45	11.44	11.44	11.43	11.43	11.43	11.44	11.45	11.46	11.47
12.50	DISCHG	11.47	11.46	11.46	11.45	11.45	11.45	11.46	11.47	11.48	11.49
13.00	DISCHG	11.49	11.47	11.44	11.39	11.32	11.22	11.10	10.97	10.84	10.70
13.50	DISCHG	10.58	10.46	10.36	10.27	10.21	10.16	10.13	10.11	10.10	10.08
14.00	DISCHG	10.06	10.04	10.01	9.96	9.91	9.84	9.77	9.70	9.63	9.56
14.50	DISCHG	9.50	9.45	9.41	9.37	9.35	9.32	9.31	9.29	9.28	9.27

RUNOFF VOLUME ABOVE BASEFLOW = 2.50 WATERSHED INCHES, 476.39 CFS-HRS, 39.37 ACRE-FEET; BASEFLOW = .00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP

RECORD ID

COMPUTATIONS COMPLETED FOR PASS 1

EXECUTIVE CONTROL OPERATION COMPUT

RECORD ID

FROM XSECTION 1

TO XSECTION 1

STARTING TIME = .00 RAIN DEPTH = 3.00 RAIN DURATION = 1.00 RAIN TABLE NO. = 7 ANT. MOIST. COND = 2  
 ALTERNATE NO. = 1 STORM NO. = 10 MAIN TIME INCREMENT = .05 HOURS

OPERATION RUNOFF CROSS SECTION 1

PEAK TIME (HRS)	PEAK DISCHARGE (CFS)	PEAK ELEVATION (FEET)
6.23	243.40	(RUNOFF)
9.98	8.69	(RUNOFF)
12.98	6.66	(RUNOFF)

TIME (HRS)	FIRST HYDROGRAPH POINT = .00 HOURS	TIME INCREMENT = .05 HOURS	DRAINAGE AREA = .29 SQ. MI.
5.50	DISCHG .00 .06 .61 2.49 6.80 14.93 28.32 47.69 72.91 103.20		
6.00	DISCHG 137.21 171.48 202.44 226.88 241.08 242.79 233.85 217.32 196.36 173.47		
6.50	DISCHG 151.00 130.08 112.12 97.94 86.42 76.66 68.28 60.94 54.66 49.37		
7.00	DISCHG 44.89 41.11 37.93 35.24 32.90 30.76 28.78 26.96 25.31 23.85		
7.50	DISCHG 22.57 21.46 20.53 19.78 19.15 18.64 18.23 17.92 17.69 17.54		
8.00	DISCHG 17.44 17.31 17.12 16.84 16.40 15.80 15.07 14.27 13.45 12.66		
8.50	DISCHG 11.94 11.31 10.78 10.36 10.02 9.76 9.54 9.36 9.22 9.11		
9.00	DISCHG 9.02 8.94 8.88 8.83 8.80 8.77 8.74 8.73 8.71 8.70		

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TR20 XEQ

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)

JOB 1 PASS 2

REV 09/01/83

FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR

PAGE 4

9.50	DISCHG	8.69	8.69	8.68	8.68	8.68	8.68	8.68	8.68	8.68	8.68
10.00	DISCHG	8.69	8.68	8.65	8.59	8.50	8.36	8.19	8.00	7.80	7.61
10.50	DISCHG	7.42	7.26	7.12	7.01	6.92	6.85	6.80	6.76	6.73	6.71
11.00	DISCHG	6.68	6.66	6.64	6.62	6.61	6.61	6.60	6.61	6.61	6.61
11.50	DISCHG	6.61	6.60	6.60	6.59	6.59	6.59	6.60	6.60	6.61	6.62
12.00	DISCHG	6.62	6.61	6.61	6.61	6.61	6.61	6.62	6.62	6.63	6.64
12.50	DISCHG	6.64	6.64	6.63	6.63	6.63	6.63	6.64	6.64	6.65	6.66
13.00	DISCHG	6.66	6.65	6.63	6.60	6.56	6.50	6.44	6.36	6.29	6.21
13.50	DISCHG	6.14	6.07	6.01	5.96	5.93	5.90	5.88	5.87	5.86	5.85
14.00	DISCHG	5.84	5.83	5.81	5.79	5.76	5.72	5.68	5.64	5.60	5.56
14.50	DISCHG	5.52	5.49	5.47	5.45	5.44	5.42	5.41	5.41	5.40	5.40

RUNOFF VOLUME ABOVE BASEFLOW = 1.26 WATERSHED INCHES, 240.60 CFS-HRS, 19.88 ACRE-FEET; BASEFLOW = .00 CFS

EXECUTIVE CONTROL OPERATION ENDJOB

RECORD ID

1

TR20 XEQ  
REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR

JOB 1 SUMMARY  
PAGE 5

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED  
(A STAR(\*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH  
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION			RUNOFF AMOUNT (IN)	PEAK DISCHARGE				
						BEGIN (HR)	AMOUNT (IN)	DURATION (HR)		ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)	
	ALTERNATE	1	STORM	99										
XSECTION	1	RUNOFF	.29	7	2	.05	.0	4.60	24.00	2.50	---	6.21	498.21	1688.9
	ALTERNATE	1	STORM	10										
XSECTION	1	RUNOFF	.29	7	2	.05	.0	3.00	24.00	1.26	---	6.23	243.40	825.1

TR20 XEQ  
REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1 BASIN - 10 & 100 YR

JOB 1 SUMMARY  
PAGE 6

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.....	
		10	99
0 XSECTION	1	.29	
ALTERNATE	1	243.40	498.21

1END OF 1 JOBS IN THIS RUN

REVISED CN  
 FOR BASINS - 81.1  
 8-19-94  
 TMO  
 FILE  
 Q:\TR20\EW1026FI.T2

1

\*\*\*\*\*80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY\*\*\*\*\*

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JOB TR-20                                SUMMARY  NOPLOTS
TITLE  DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)
TITLE  FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR
5 RAINFL 7          0.2500
8          0.0000    0.0005    0.0015    0.0030    0.0045
8          0.0060    0.0080    0.0100    0.0120    0.0143
8          0.0165    0.0188    0.0210    0.0233    0.0255
8          0.0278    0.0320    0.0390    0.0460    0.0530
8          0.0600    0.0750    0.1000    0.4000    0.7000
8          0.7250    0.7500    0.7650    0.7800    0.7900
8          0.8000    0.8100    0.8200    0.8250    0.8300
8          0.8350    0.8400    0.8450    0.8500    0.8550
8          0.8600    0.8638    0.8675    0.8713    0.8750
8          0.8788    0.8825    0.8863    0.8900    0.8938
8          0.8975    0.9013    0.9050    0.9083    0.9115
8          0.9148    0.9180    0.9210    0.9240    0.9270
8          0.9300    0.9325    0.9350    0.9375    0.9400
8          0.9425    0.9450    0.9475    0.9500    0.9525
8          0.9550    0.9575    0.9600    0.9625    0.9650
8          0.9675    0.9700    0.9725    0.9750    0.9775
8          0.9800    0.9813    0.9825    0.9838    0.9850
8          0.9863    0.9875    0.9888    0.9900    0.9913
8          0.9925    0.9938    0.9950    0.9963    0.9975
8          0.9988    1.0000    1.0000    1.0000    1.0000
9 ENDTBL
6 RUNOFF 1 001      5 .232      81.1      0.47      1 1 1 1
6 RUNOFF 1 002      6 .063      90.4      0.41      1 1 1 1
6 ADDHYD 4 003    5 6 7          1 1 1 1
  ENDDATA
7 INCREM 6          0.05
7 COMPUT 7 001 003 0.0      4.6      1.0      7 2 01 99
  ENDCMP 1
7 COMPUT 7 001 003 0.0      3.0      1.0      7 2 01 10
  ENDCMP 1
  ENDJOB 2

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\*\*\*\*\*END OF 80-80 LIST\*\*\*\*\*

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TR20 XEQ                                DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)                                JOB 1  PASS 1
REV 09/01/83                            FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR                                PAGE 1

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COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)  
LINCOLN, NB (MIDWEST) -- 541-5318 (FTS), PORTLAND, OR (WEST) -- 423-4099 (FTS)  
OR HYDROLOGY UNIT, ENGINEERING DIVISION, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

- 12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD  
CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
- 5/02/83 - CORRECT COMPUTATIONS FOR ---
1. DIVISION OF BASEFLOW IN DIVERT OPERATION
  2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
  3. CROSS SECTION DATA PLOTTING POSITION
  4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
  5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTYPEAK HYDROGRAPH
  6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
  7. BASEFLOW ENTERED WITH READHYD
  8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
- ENHANCEMENTS ---
1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
  2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
- 09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS  
CORRECT COMBINATION OF RATING TABLES FOR DIVERT  
CHECK REACH ROUTING PARAMETERS FOR ACCEPTABLE LIMITS  
ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE

1

TR20 XEQ  
REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR

JOB 1 PASS 1  
PAGE 2

CUMULATIVE RAINFALL TABLE 7 TIME INCREMENT= .25

B .0000 .0005 .0015 .0030 .0045

8	.0165	.0188	.0210	.0233	.0255
8	.0278	.0320	.0390	.0460	.0530
8	.0600	.0750	.1000	.4000	.7000
8	.7250	.7500	.7650	.7800	.7900
8	.8000	.8100	.8200	.8250	.8300
8	.8350	.8400	.8450	.8500	.8550
8	.8600	.8638	.8675	.8713	.8750
8	.8788	.8825	.8863	.8900	.8938
8	.8975	.9013	.9050	.9083	.9115
8	.9148	.9180	.9210	.9240	.9270
8	.9300	.9325	.9350	.9375	.9400
8	.9425	.9450	.9475	.9500	.9525
8	.9550	.9575	.9600	.9625	.9650
8	.9675	.9700	.9725	.9750	.9775
8	.9800	.9813	.9825	.9838	.9850
8	.9863	.9875	.9888	.9900	.9913
8	.9925	.9938	.9950	.9963	.9975
8	.9988	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 1 RECORD ID  
 OUTPUT HYDROGRAPH = 5 DATA FIELD VALUES = .2320 81.1000 .4700  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 2 RECORD ID  
 OUTPUT HYDROGRAPH = 6 DATA FIELD VALUES = .0630 90.4000 .4100  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

STANDARD CONTROL OPERATION ADDHYD CROSS SECTION 3 RECORD ID  
 INPUT HYDROGRAPHS = 5,6 OUTPUT HYDROGRAPH = 7 DATA FIELD VALUES = .0000 .0000 .0000  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

EXECUTIVE CONTROL OPERATION INCREM . RECORD ID  
 + MAIN TIME INCREMENT = .05 HOURS

EXECUTIVE CONTROL OPERATION COMPUT RECORD ID  
 + FROM XSECTION 1  
 + TO XSECTION 3  
 STARTING TIME = .00 RAIN DEPTH = 4.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 7 ANT. MOIST. COND= 2  
 ALTERNATE NO.= 1 STORM NO.=99 MAIN TIME INCREMENT = .05 HOURS

OPERATION RUNOFF CROSS SECTION 1  
 1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 1  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR PAGE 3

PEAK TIME (HRS)	PEAK DISCHARGE (CFS)	PEAK ELEVATION (FEET)
6.15	414.00	(RUNOFF)
9.95	11.53	(RUNOFF)
12.91	8.79	(RUNOFF)

TIME (HRS)	FIRST HYDROGRAPH POINT =	.00 HOURS	TIME INCREMENT =	.05 HOURS	DRAINAGE AREA =	.23 SQ. MI.
5.50	DISCHG	.13 1.12 4.88 14.19	32.37 61.91 102.74	152.69 208.62 266.88		
6.00	DISCHG	323.60 371.20 403.32 413.93	399.71 365.98 321.25	273.07 227.05 187.05		

7.00	DISCHG	45.85	42.93	40.43	38.10	35.78	33.50	31.35	29.41	27.73	26.38
7.50	DISCHG	25.38	24.71	24.22	23.85	23.57	23.36	23.19	23.07	22.98	22.92
8.00	DISCHG	22.86	22.71	22.39	21.77	20.79	19.54	18.19	16.88	15.70	14.70
8.50	DISCHG	13.94	13.36	12.92	12.58	12.32	12.12	11.96	11.84	11.75	11.68
9.00	DISCHG	11.63	11.59	11.56	11.54	11.52	11.51	11.50	11.50	11.50	11.49
9.50	DISCHG	11.49	11.50	11.50	11.50	11.51	11.51	11.52	11.52	11.52	11.53
10.00	DISCHG	11.52	11.50	11.42	11.27	11.04	10.75	10.43	10.11	9.81	9.55
10.50	DISCHG	9.33	9.17	9.04	8.95	8.89	8.85	8.83	8.81	8.79	8.77
11.00	DISCHG	8.75	8.72	8.70	8.69	8.69	8.70	8.72	8.73	8.73	8.73
11.50	DISCHG	8.72	8.71	8.69	8.69	8.70	8.71	8.73	8.74	8.75	8.75
12.00	DISCHG	8.74	8.73	8.71	8.71	8.71	8.73	8.75	8.76	8.77	8.77
12.50	DISCHG	8.76	8.74	8.73	8.73	8.73	8.75	8.76	8.78	8.79	8.79
13.00	DISCHG	8.77	8.75	8.71	8.64	8.54	8.43	8.31	8.19	8.07	7.97
13.50	DISCHG	7.88	7.81	7.75	7.71	7.69	7.68	7.68	7.68	7.68	7.67
14.00	DISCHG	7.65	7.63	7.59	7.55	7.49	7.42	7.36	7.30	7.24	7.20
14.50	DISCHG	7.17	7.14	7.12	7.11	7.09	7.09	7.08	7.08	7.07	7.07

RUNOFF VOLUME ABOVE BASEFLOW = 2.34 WATERSHED INCHES, 350.86 CFS-HRS, 28.99 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RUNOFF CROSS SECTION 2

		PEAK TIME (HRS)	PEAK DISCHARGE (CFS)		PEAK ELEVATION (FEET)						
		6.09	163.57		(RUNOFF)						
TIME (HRS)	DISCHG	FIRST HYDROGRAPH POINT = .00 HOURS		TIME INCREMENT = .05 HOURS			DRAINAGE AREA = .06 SQ. MI.				
4.50	DISCHG	.00	.00	.00	.01	.02	.04	.06	.10	.14	.18
5.00	DISCHG	.24	.30	.38	.51	.67	.86	1.11	1.41	1.80	2.28
5.50	DISCHG	3.10	5.29	10.45	20.28	35.54	55.25	77.30	99.66	120.29	137.95
6.00	DISCHG	152.17	161.28	163.21	156.15	140.85	120.62	99.25	79.42	62.91	50.86
6.50	DISCHG	42.41	36.00	30.94	26.83	23.39	20.50	18.11	16.18	14.67	13.54
7.00	DISCHG	12.71	12.06	11.46	10.83	10.16	9.51	8.93	8.45	8.08	7.81
7.50	DISCHG	7.61	7.46	7.35	7.28	7.22	7.18	7.15	7.12	7.11	7.10
8.00	DISCHG	7.08	7.02	6.87	6.59	6.19	5.71	5.25	4.83	4.50	4.25
8.50	DISCHG	4.06	3.93	3.83	3.75	3.70	3.66	3.63	3.60	3.59	3.58
9.00	DISCHG	3.57	3.56	3.56	3.55	3.55	3.55	3.55	3.55	3.55	3.55
9.50	DISCHG	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55
10.00	DISCHG	3.55	3.54	3.51	3.44	3.34	3.22	3.11	3.01	2.92	2.85
10.50	DISCHG	2.80	2.76	2.73	2.71	2.70	2.70	2.70	2.69	2.69	2.68

1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 1  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR PAGE 4

11.00	DISCHG	2.67	2.67	2.66	2.66	2.66	2.67	2.68	2.68	2.68	2.68
11.50	DISCHG	2.67	2.66	2.66	2.66	2.67	2.67	2.68	2.68	2.68	2.68
12.00	DISCHG	2.67	2.67	2.66	2.66	2.67	2.67	2.68	2.68	2.68	2.68
12.50	DISCHG	2.67	2.67	2.66	2.66	2.67	2.68	2.68	2.69	2.69	2.68
13.00	DISCHG	2.67	2.66	2.64	2.62	2.58	2.54	2.50	2.46	2.43	2.40
13.50	DISCHG	2.37	2.35	2.34	2.33	2.33	2.33	2.34	2.34	2.34	2.33
14.00	DISCHG	2.32	2.31	2.30	2.28	2.26	2.24	2.22	2.20	2.19	2.18
14.50	DISCHG	2.17	2.16	2.16	2.15	2.15	2.15	2.15	2.15	2.15	2.15

RUNOFF VOLUME ABOVE BASEFLOW = 3.20 WATERSHED INCHES, 130.11 CFS-HRS, 10.75 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD CROSS SECTION 3

PEAK TIME (HRS) PEAK DISCHARGE (CFS) PEAK ELEVATION (FEET)



9.95 15.08 (NULL)  
 12.90 11.47 (NULL)

TIME (HRS)	FIRST HYDROGRAPH POINT = .00 HOURS			TIME INCREMENT = .05 HOURS			DRAINAGE AREA = .29 SQ. MI.				
4.50	DISCHG	.00	.00	.00	.01	.02	.04	.06	.10	.14	.18
5.00	DISCHG	.24	.30	.38	.51	.67	.86	1.11	1.41	1.80	2.28
5.50	DISCHG	3.23	6.41	15.32	34.46	67.91	117.15	180.04	252.35	328.91	404.83
6.00	DISCHG	475.77	532.49	566.53	570.08	540.56	486.61	420.50	352.48	289.96	237.91
6.50	DISCHG	198.09	168.31	145.07	126.22	110.32	96.96	85.74	76.45	68.95	63.09
7.00	DISCHG	58.56	54.98	51.89	48.93	45.94	43.01	40.28	37.85	35.81	34.18
7.50	DISCHG	32.99	32.17	31.58	31.13	30.79	30.53	30.34	30.20	30.09	30.02
8.00	DISCHG	29.94	29.73	29.26	28.37	26.98	25.25	23.44	21.71	20.20	18.95
8.50	DISCHG	18.00	17.29	16.75	16.33	16.02	15.77	15.59	15.45	15.34	15.26
9.00	DISCHG	15.20	15.15	15.12	15.09	15.07	15.06	15.05	15.05	15.04	15.04
9.50	DISCHG	15.04	15.05	15.05	15.05	15.06	15.06	15.07	15.07	15.07	15.08
10.00	DISCHG	15.07	15.04	14.93	14.71	14.38	13.97	13.54	13.11	12.73	12.40
10.50	DISCHG	12.13	11.93	11.77	11.66	11.59	11.55	11.52	11.50	11.48	11.45
11.00	DISCHG	11.42	11.39	11.36	11.35	11.36	11.37	11.39	11.41	11.41	11.41
11.50	DISCHG	11.39	11.37	11.36	11.35	11.36	11.38	11.41	11.43	11.43	11.43
12.00	DISCHG	11.41	11.39	11.38	11.37	11.38	11.40	11.43	11.44	11.45	11.45
12.50	DISCHG	11.43	11.41	11.40	11.39	11.40	11.42	11.45	11.47	11.47	11.47
13.00	DISCHG	11.45	11.41	11.35	11.25	11.12	10.97	10.81	10.65	10.50	10.37
13.50	DISCHG	10.25	10.16	10.09	10.04	10.02	10.01	10.01	10.02	10.01	10.00
14.00	DISCHG	9.98	9.94	9.89	9.83	9.75	9.66	9.58	9.50	9.43	9.37
14.50	DISCHG	9.33	9.30	9.28	9.26	9.25	9.24	9.23	9.22	9.22	9.22

RUNOFF VOLUME ABOVE BASEFLOW = 2.53 WATERSHED INCHES, 480.96 CFS-HRS, 39.75 ACRE-FEET; BASEFLOW = .00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP

RECORD ID

COMPUTATIONS COMPLETED FOR PASS 1

1

TR20 XEQ

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)

JOB 1 PASS 2

REV 09/01/83

FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR

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EXECUTIVE CONTROL OPERATION COMPUT

RECORD ID

FROM XSECTION 1

TO XSECTION 3

STARTING TIME = .00 RAIN DEPTH = 3.00 RAIN DURATION = 1.00 RAIN TABLE NO. = 7 ANT. MOIST. COND = 2  
 ALTERNATE NO. = 1 STORM NO. = 10 MAIN TIME INCREMENT = .05 HOURS

OPERATION RUNOFF CROSS SECTION 1

PEAK TIME (HRS)	PEAK DISCHARGE (CFS)	PEAK ELEVATION (FEET)
6.16	197.25	(RUNOFF)
9.97	6.48	(RUNOFF)

TIME (HRS)	FIRST HYDROGRAPH POINT = .00 HOURS			TIME INCREMENT = .05 HOURS			DRAINAGE AREA = .23 SQ. MI.				
5.50	DISCHG	.00	.07	.58	2.46	7.10	16.15	30.93	51.56	77.26	106.55
6.00	DISCHG	137.41	165.51	186.61	196.78	193.66	179.74	159.37	136.52	114.22	94.61
6.50	DISCHG	79.20	67.77	58.87	51.62	45.44	40.21	35.76	32.04	29.00	26.60
7.00	DISCHG	24.73	23.26	22.00	20.81	19.60	18.40	17.25	16.21	15.30	14.57
7.50	DISCHG	14.04	13.67	13.41	13.22	13.07	12.96	12.87	12.81	12.77	12.74

8.50	DISCHG	7.78	7.46	7.22	7.03	6.88	6.77	6.69	6.62	6.57	6.54
9.00	DISCHG	6.51	6.49	6.48	6.46	6.46	6.45	6.45	6.45	6.45	6.45
9.50	DISCHG	6.45	6.45	6.46	6.46	6.46	6.47	6.47	6.47	6.48	6.48
10.00	DISCHG	6.48	6.46	6.42	6.34	6.21	6.05	5.87	5.69	5.52	5.38
10.50	DISCHG	5.26	5.16	5.09	5.04	5.01	4.99	4.98	4.97	4.96	4.95
11.00	DISCHG	4.94	4.92	4.91	4.91	4.91	4.91	4.92	4.93	4.93	4.93
11.50	DISCHG	4.93	4.92	4.91	4.91	4.92	4.93	4.94	4.95	4.95	4.95
12.00	DISCHG	4.95	4.94	4.93	4.93	4.94	4.94	4.95	4.96	4.97	4.97
12.50	DISCHG	4.96	4.96	4.95	4.95	4.95	4.96	4.97	4.98	4.99	4.99
13.00	DISCHG	4.98	4.97	4.94	4.90	4.85	4.79	4.72	4.65	4.59	4.53
13.50	DISCHG	4.48	4.44	4.41	4.38	4.37	4.37	4.37	4.37	4.37	4.36
14.00	DISCHG	4.35	4.34	4.32	4.30	4.26	4.23	4.19	4.16	4.13	4.10
14.50	DISCHG	4.08	4.07	4.06	4.05	4.04	4.04	4.04	4.03	4.03	4.03

RUNOFF VOLUME ABOVE BASEFLOW = 1.15 WATERSHED INCHES, 171.81 CFS-HRS, 14.20 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RUNOFF CROSS SECTION 2

		PEAK TIME (HRS)	PEAK DISCHARGE (CFS)		PEAK ELEVATION (FEET)							
		6.10	92.99		(RUNOFF)							
TIME (HRS)	FIRST HYDROGRAPH POINT =	.00 HOURS		TIME INCREMENT =			.05 HOURS		DRAINAGE AREA =			.06 SQ. MI.
5.00	DISCHG	.00	.00	.00	.00	.00	.00	.01	.04	.10	.19	
5.50	DISCHG	.43	1.24	3.37	7.74	14.99	24.98	36.88	49.68	62.27	73.77	
6.00	DISCHG	83.58	90.45	92.98	89.97	81.80	70.45	58.20	46.71	37.10	30.09	
6.50	DISCHG	25.18	21.45	18.51	16.11	14.08	12.38	10.97	9.83	8.93	8.27	
7.00	DISCHG	7.77	7.38	7.03	6.65	6.24	5.84	5.49	5.19	4.97	4.80	
7.50	DISCHG	4.68	4.59	4.53	4.48	4.45	4.42	4.40	4.39	4.38	4.38	

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TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 2  
REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR PAGE 6

8.00	DISCHG	4.37	4.33	4.24	4.07	3.82	3.53	3.24	2.98	2.78	2.62
8.50	DISCHG	2.51	2.43	2.37	2.32	2.29	2.26	2.24	2.23	2.22	2.21
9.00	DISCHG	2.21	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
9.50	DISCHG	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
10.00	DISCHG	2.20	2.19	2.17	2.13	2.07	2.00	1.93	1.86	1.81	1.77
10.50	DISCHG	1.74	1.71	1.69	1.68	1.68	1.67	1.67	1.67	1.67	1.66
11.00	DISCHG	1.66	1.65	1.65	1.65	1.65	1.66	1.66	1.66	1.66	1.66
11.50	DISCHG	1.66	1.65	1.65	1.65	1.66	1.66	1.66	1.67	1.67	1.66
12.00	DISCHG	1.66	1.66	1.65	1.65	1.66	1.66	1.67	1.67	1.67	1.67
12.50	DISCHG	1.66	1.66	1.66	1.66	1.66	1.66	1.67	1.67	1.67	1.67
13.00	DISCHG	1.66	1.66	1.65	1.63	1.61	1.58	1.55	1.53	1.51	1.49
13.50	DISCHG	1.48	1.46	1.46	1.45	1.45	1.45	1.45	1.46	1.45	1.45
14.00	DISCHG	1.45	1.44	1.43	1.42	1.41	1.40	1.38	1.37	1.36	1.35
14.50	DISCHG	1.35	1.35	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34

RUNOFF VOLUME ABOVE BASEFLOW = 1.81 WATERSHED INCHES, 73.62 CFS-HRS, 6.08 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD CROSS SECTION 3

		PEAK TIME (HRS)	PEAK DISCHARGE (CFS)		PEAK ELEVATION (FEET)							
		6.14	286.87		(NULL)							
		9.97	8.68		(NULL)							
TIME (HRS)	FIRST HYDROGRAPH POINT =	.00 HOURS		TIME INCREMENT =			.05 HOURS		DRAINAGE AREA =			.29 SQ. MI.

5.50	DISCHG	.43	1.30	3.95	10.20	22.09	41.13	67.81	101.24	139.54	180.32
6.00	DISCHG	220.98	255.96	279.60	286.76	275.47	250.19	217.57	183.23	151.32	124.70
6.50	DISCHG	104.38	89.22	77.38	67.72	59.53	52.59	46.73	41.87	37.94	34.86
7.00	DISCHG	32.50	30.64	29.03	27.46	25.84	24.24	22.74	21.40	20.27	19.38
7.50	DISCHG	18.72	18.27	17.94	17.70	17.51	17.38	17.28	17.20	17.15	17.12
8.00	DISCHG	17.08	16.97	16.70	16.19	15.40	14.42	13.38	12.40	11.54	10.83
8.50	DISCHG	10.29	9.89	9.58	9.35	9.17	9.03	8.93	8.85	8.79	8.75
9.00	DISCHG	8.72	8.69	8.67	8.66	8.65	8.65	8.64	8.64	8.64	8.64
9.50	DISCHG	8.65	8.65	8.65	8.66	8.66	8.66	8.67	8.67	8.68	8.68
10.00	DISCHG	8.68	8.66	8.60	8.47	8.28	8.05	7.80	7.55	7.33	7.14
10.50	DISCHG	6.99	6.88	6.79	6.72	6.68	6.66	6.65	6.64	6.63	6.61
11.00	DISCHG	6.59	6.58	6.56	6.56	6.56	6.57	6.58	6.59	6.60	6.59
11.50	DISCHG	6.59	6.58	6.57	6.57	6.57	6.59	6.60	6.61	6.62	6.61
12.00	DISCHG	6.61	6.60	6.59	6.59	6.59	6.61	6.62	6.63	6.64	6.63
12.50	DISCHG	6.63	6.62	6.61	6.61	6.61	6.62	6.64	6.65	6.66	6.65
13.00	DISCHG	6.64	6.62	6.59	6.53	6.46	6.37	6.27	6.18	6.10	6.02
13.50	DISCHG	5.95	5.90	5.86	5.83	5.82	5.82	5.82	5.82	5.82	5.82
14.00	DISCHG	5.80	5.78	5.75	5.72	5.67	5.62	5.57	5.53	5.49	5.46
14.50	DISCHG	5.43	5.41	5.40	5.39	5.38	5.38	5.38	5.37	5.37	5.37

RUNOFF VOLUME ABOVE BASEFLOW = 1.29 WATERSHED INCHES, 245.43 CFS-HRS, 20.28 ACRE-FEET; BASEFLOW = .00 CFS

1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 3  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR PAGE 7

EXECUTIVE CONTROL OPERATION ENDCMP RECORD ID  
 + COMPUTATIONS COMPLETED FOR PASS 2

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID  
 1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 SUMMARY  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) 2 BASINS - 10 & 100 YR PAGE 8

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED  
 (A STAR(\*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH  
 A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	RAIN DRAINAGE AREA (SQ MI)	ANTEC TABLE #	MAIN MOIST COND	PRECIPITATION TIME INCREM (HR)	PRECIPITATION				PEAK DISCHARGE				
						BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)	
ALTERNATE	1	STORM	99											
XSECTION	1	RUNOFF	.23	7	2	.05	.0	4.60	24.00	2.34	---	6.15	414.00	1784.5
XSECTION	2	RUNOFF	.06	7	2	.05	.0	4.60	24.00	3.20	---	6.09	163.57	2596.4
XSECTION	3	ADDHYD	.29	7	2	.05	.0	4.60	24.00	2.53	---	6.13	572.63	1941.1

+



**SUPPLEMENTAL  
HYDROLOGIC AND HYDRAULIC  
CALCULATIONS  
FOR  
WEST MEADOW DETENTION POND  
AT  
S.H.115 AND ACADEMY BOULEVARD**

**BY:**

**DREXEL BARRELL  
740 WOOTEN, SUITE 108  
COLORADO SPRINGS, CO 80915**

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D.P.

Comment: MINOR CHANNEL

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0500 ft/ft
Discharge.....	20.00 cfs

Computed Results:

Depth.....	1.02 ft
Velocity.....	6.44 fps
Flow Area.....	3.11 sf
Flow Top Width...	5.09 ft
Wetted Perimeter.	5.57 ft
Critical Depth...	1.22 ft
Critical Slope...	0.0227 ft/ft
Froude Number....	1.45 (flow is Supercritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D.P.

Comment: MAJOR CHANNEL - PRELIMINARY DESIGN

Solve For Depth

Given Input Data:

Bottom Width.....	10.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0100 ft/ft
Discharge.....	414.00 cfs

Computed Results:

Depth.....	3.38 ft
Velocity.....	7.30 fps
Flow Area.....	56.68 sf
Flow Top Width...	23.53 ft
Wetted Perimeter.	25.12 ft
Critical Depth...	3.05 ft
Critical Slope...	0.0149 ft/ft
Froude Number....	0.83 (flow is Subcritical)

Trapezoidal Channel Analysis & Design  
Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D.P.

Comment: MAJOR CHANNEL - PRELIMINARY DESIGN

Solve For Depth

Given Input Data:

Bottom Width.....	10.00 ft
Left Side Slope..	4.00:1 (H:V)
Right Side Slope.	4.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0100 ft/ft
Discharge.....	414.00 cfs

Computed Results:

Depth.....	2.95 ft
Velocity.....	6.45 fps
Flow Area.....	64.20 sf
Flow Top Width...	33.57 ft
Wetted Perimeter.	34.30 ft
Critical Depth...	2.66 ft
Critical Slope...	0.0152 ft/ft
Froude Number....	0.82 (flow is Subcritical)

Open Channel Flow Module, Version 3.21 (c) 1990

Haestad Methods, Inc. \* 37 Brookside Rd \* Waterbury, Ct 06708



Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D.P.

Comment: 24" RCP CULVERT

Solve For Actual Depth

Given Input Data:

Diameter.....	2.00 ft
Slope.....	0.0100 ft/ft
Manning's n.....	0.013
Discharge.....	20.00 cfs

Computed Results:

Depth.....	1.46 ft
Velocity.....	8.13 fps
Flow Area.....	2.46 sf
Critical Depth....	1.61 ft
Critical Slope....	0.0081 ft/ft
Percent Full.....	73.08 %
Full Capacity.....	22.62 cfs
QMAX @.94D.....	24.34 cfs
Froude Number.....	1.22 (flow is Supercritical)

WATER SURFACE PROFILE LISTING

WEST MEADOW DETENTION BASIN  
 INLET CHANNEL ANALYSIS  
 DREXEL BARRELL - 10-4-94 - TMO

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/DIA	BASE/ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF			NORM DEPTH		ZR		
100.00	5915.00	1.806	5916.806	414.0	16.84	4.402	5921.208	0.00	3.049	5.00	10.00	2.00	0	0.00
7.04	0.12500					.100954	0.71			1.718		2.00		
107.04	5915.88	1.840	5917.720	414.0	16.44	4.199	5921.919	0.00	3.049	5.00	10.00	2.00	0	0.00
9.26	0.12500					.091339	0.85			1.718		2.00		
116.30	5917.04	1.910	5918.947	414.0	15.68	3.817	5922.764	0.00	3.049	5.00	10.00	2.00	0	0.00
6.06	0.12500					.079730	0.48			1.718		2.00		
122.36	5917.80	1.983	5919.778	414.0	14.95	3.470	5923.248	0.00	3.049	5.00	10.00	2.00	0	0.00
4.35	0.12500					.069619	0.30			1.718		2.00		
126.71	5918.34	2.058	5920.396	414.0	14.25	3.155	5923.551	0.00	3.049	5.00	10.00	2.00	0	0.00
3.26	0.12500					.060810	0.20			1.718		2.00		
129.97	5918.75	2.135	5920.882	414.0	13.59	2.868	5923.750	0.00	3.049	5.00	10.00	2.00	0	0.00
2.53	0.12500					.053132	0.13			1.718		2.00		
132.50	5919.06	2.214	5921.276	414.0	12.96	2.607	5923.883	0.00	3.049	5.00	10.00	2.00	0	0.00
1.97	0.12500					.046438	0.09			1.718		2.00		
134.47	5919.31	2.296	5921.605	414.0	12.35	2.370	5923.975	0.00	3.049	5.00	10.00	2.00	0	0.00
1.55	0.12500					.040599	0.06			1.718		2.00		
136.02	5919.50	2.381	5921.884	414.0	11.78	2.155	5924.039	0.00	3.049	5.00	10.00	2.00	0	0.00
1.22	0.12500					.035504	0.04			1.718		2.00		
137.24	5919.65	2.468	5922.123	414.0	11.23	1.959	5924.082	0.00	3.049	5.00	10.00	2.00	0	0.00
0.94	0.12500					.031058	0.03			1.718		2.00		
138.18	5919.77	2.558	5922.330	414.0	10.71	1.781	5924.111	0.00	3.049	5.00	10.00	2.00	0	0.00
0.71	0.12500					.027175	0.02			1.718		2.00		

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DETENTION BASIN  
 INLET CHANNEL ANALYSIS  
 DREXEL BARRELL - 10-4-94 - TMO

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD. EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF			NORM DEPTH		ZR		
138.89	5919.86	2.650	5922.511	414.0	10.21	1.619	5924.130	0.00	3.049	5.00	10.00	2.00	0	0.00
0.51	0.12500					.023785	0.01			1.718		2.00		
139.40	5919.93	2.745	5922.670	414.0	9.74	1.472	5924.142	0.00	3.049	5.00	10.00	2.00	0	0.00
0.34	0.12500					.020823	0.01			1.718		2.00		
139.74	5919.97	2.843	5922.811	414.0	9.28	1.338	5924.149	0.00	3.049	5.00	10.00	2.00	0	0.00
0.20	0.12500					.018234	0.00			1.718		2.00		
139.94	5919.99	2.944	5922.936	414.0	8.85	1.216	5924.152	0.00	3.049	5.00	10.00	2.00	0	0.00
0.06	0.12500					.015962	0.00			1.718		2.00		
140.00	5920.00	3.049	5923.049	414.0	8.43	1.105	5924.154	0.00	3.049	5.00	10.00	2.00	0	0.00
TRANS STR	0.01000					.008847	0.13					2.00		
155.00	5920.15	3.970	5924.120	414.0	4.03	0.252	5924.372	0.00	2.665	5.00	10.00	4.00	0	0.00
12.92	0.01000					.002989	0.04			2.947		4.00		
167.92	5920.28	3.854	5924.133	414.0	4.23	0.277	5924.410	0.00	2.665	5.00	10.00	4.00	0	0.00
3.08	0.01000					.003230	0.01			2.947		4.00		
171.00	5920.31	3.827	5924.137	414.0	4.27	0.284	5924.421	0.00	2.665	5.00	10.00	4.00	0	0.00
TRANS STR	0.01000					.007292	0.15					4.00		
191.00	5920.51	3.276	5923.786	414.0	7.63	0.905	5924.691	0.17	3.049	5.00	10.00	2.00	0	0.00
43.61	0.01000					.010653	0.46			3.381		2.00		
234.61	5920.95	3.381	5924.327	414.0	7.31	0.829	5925.156	0.16	3.049	5.00	10.00	2.00	0	0.00
7.81	0.01000					.010004	0.08			3.381		2.00		
242.42	5921.02	3.381	5924.405	414.0	7.31	0.829	5925.234	0.16	3.049	5.00	10.00	2.00	0	0.00
HYDRAULIC JUMP												2.00		

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DETENTION BASIN  
 INLET CHANNEL ANALYSIS  
 DREXEL BARRELL - 10-4-94 - TMO

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
242.42	5921.02	2.737	5923.761	414.0	9.77	1.483	5925.244	0.26	3.049	5.00	10.00	2.00	0	0.00
2.64	0.01000					.023557	0.06		3.381			2.00		
245.06	5921.05	2.670	5923.721	414.0	10.11	1.587	5925.308	0.27	3.049	5.00	10.00	2.00	0	0.00
4.00	0.01000					.026423	0.11		3.381			2.00		
249.06	5921.09	2.577	5923.668	414.0	10.60	1.745	5925.413	0.29	3.049	5.00	10.00	2.00	0	0.00
4.17	0.01000					.030196	0.13		3.381			2.00		
253.23	5921.13	2.487	5923.619	414.0	11.12	1.920	5925.539	0.31	3.049	5.00	10.00	2.00	0	0.00
4.26	0.01000					.034517	0.15		3.381			2.00		
257.49	5921.18	2.399	5923.574	414.0	11.66	2.112	5925.686	0.34	3.049	5.00	10.00	2.00	0	0.00
4.28	0.01000					.039468	0.17		3.381			2.00		
261.77	5921.22	2.314	5923.532	414.0	12.23	2.323	5925.855	0.37	3.049	5.00	10.00	2.00	0	0.00
4.26	0.01000					.045142	0.19		3.381			2.00		
266.03	5921.26	2.231	5923.491	414.0	12.83	2.555	5926.046	0.40	3.049	5.00	10.00	2.00	0	0.00
4.22	0.01000					.051646	0.22		3.381			2.00		
270.25	5921.30	2.151	5923.453	414.0	13.45	2.811	5926.264	0.43	3.049	5.00	10.00	2.00	0	0.00
4.14	0.01000					.059106	0.24		3.381			2.00		
274.39	5921.34	2.074	5923.418	414.0	14.11	3.092	5926.510	0.46	3.049	5.00	10.00	2.00	0	0.00
4.06	0.01000					.067663	0.27		3.381			2.00		
278.45	5921.38	1.998	5923.382	414.0	14.80	3.401	5926.783	0.50	3.049	5.00	10.00	2.00	0	0.00
3.96	0.01000					.077485	0.31		3.381			2.00		
282.41	5921.42	1.926	5923.350	414.0	15.52	3.741	5927.091	0.54	3.049	5.00	10.00	2.00	0	0.00
3.85	0.01000					.088760	0.34		3.381			2.00		

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DETENTION BASIN  
 INLET CHANNEL ANALYSIS  
 DREXEL BARRELL - 10-4-94 - TMO

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD. EL.	SUPER ELEV	CRITICAL DEPTH	HGT/DIA	BASE/ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
286.26	5921.46	1.855	5923.318	414.0	16.28	4.115	5927.433	0.59	3.049	5.00	10.00	2.00	0	0.00
3.74	0.01000					.101710	0.38		3.381			2.00		
290.00	5921.50	1.786	5923.286	414.0	17.07	4.527	5927.813	0.00	3.049	5.00	10.00	2.00	0	0.00
13.54	0.09068					.115587	1.57		1.878			2.00		
303.54	5922.73	1.728	5924.456	414.0	17.81	4.924	5929.380	0.00	3.049	5.00	10.00	2.00	0	0.00
10.48	0.09068					.131537	1.38		1.878			2.00		
314.02	5923.68	1.663	5925.341	414.0	18.68	5.416	5930.757	0.00	3.049	5.00	10.00	2.00	0	0.00
7.96	0.09068					.150876	1.20		1.878			2.00		
321.98	5924.40	1.601	5926.001	414.0	19.59	5.958	5931.959	0.00	3.049	5.00	10.00	2.00	0	0.00
6.49	0.09068					.173120	1.12		1.878			2.00		
328.47	5924.99	1.541	5926.530	414.0	20.54	6.554	5933.084	0.00	3.049	5.00	10.00	2.00	0	0.00
5.53	0.09068					.198715	1.10		1.878			2.00		
334.00	5925.49	1.482	5926.972	414.0	21.55	7.209	5934.181	0.00	3.049	5.00	10.00	2.00	0	0.00
TRANS STR	0.01000					.064285	0.06					2.00		
335.00	5925.50	5.396	5930.896	414.0	15.45	3.709	5934.605	0.00	5.396	6.00	0.00	0.00	0	0.00
23.08	0.02353					.028812	0.66		6.000			0.00		
358.08	5926.04	5.855	5931.898	414.0	14.74	3.372	5935.270	0.00	5.396	6.00	0.00	0.00	0	0.00
14.55	0.02353					.030573	0.44		6.000			0.00		
372.63	5926.39	6.000	5932.385	414.0	14.64	3.329	5935.714	0.00	5.396	6.00	0.00	0.00	0	0.00
642.37	0.02353					.032392	20.81		6.000			0.00		
1015.00	5941.50	11.807	5953.307	414.0	14.64	3.329	5956.636	0.00	5.396	6.00	0.00	0.00	0	0.00



699.48 .  
 710.00 .  
 720.52 .  
 731.03 .  
 741.55 .  
 752.07 .  
 762.59 .  
 773.10 .  
 783.62 .  
 794.14 .  
 804.66 .  
 815.17 .  
 825.69 .  
 836.21 .  
 846.72 .  
 857.24 .  
 867.76 .  
 878.28 .  
 888.79 .  
 899.31 .  
 909.83 .  
 920.34 .  
 930.86 .  
 941.38 .  
 951.90 .  
 962.41 .  
 972.93 .  
 983.45 .  
 993.97 .  
 1004.48 .  
 1015.00 .

I C H W E R

5915.00 5919.16 5923.33 5927.49 5931.65 5935.82 5939.98 5944.15 5948.31 5952.47 5956.64

NOTES

1. GLOSSARY

- I = INVERT ELEVATION
- C = CRITICAL DEPTH
- W = WATER SURFACE ELEVATION
- H = HEIGHT OF CHANNEL
- E = ENERGY GRADE LINE
- X = CURVES CROSSING OVER
- B = BRIDGE ENTRANCE OR EXIT
- Y = WALL ENTRANCE OR EXIT

2. STATIONS FOR POINTS AT A JUMP MAY NOT BE PLOTTED EXACTLY





WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 1 IS -

WEST MEADOW DETENTION BASIN

HEADING LINE NO 2 IS -

INLET CHANNEL ANALYSIS

HEADING LINE NO 3 IS -

DREXEL BARRELL - 10-4-94 - TMO

WATER SURFACE PROFILE - ELEMENT CARD LISTING

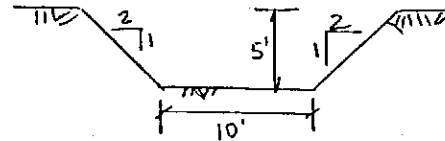
ELEMENT NO	DESCRIPTION	U/S DATA	STATION	INVERT	SECT	W S ELEV	RADIUS	ANGLE	ANG PT	MAN H
1	IS A SYSTEM OUTLET		100.00	5915.00	1	5918.00				
2	IS A REACH		140.00	5920.00	1		0.00	0.00	0.00	0
3	IS A TRANSITION		155.00	5920.15	2					
4	IS A REACH		171.00	5920.31	2		0.00	0.00	0.00	0
5	IS A TRANSITION		191.00	5920.51	1					
6	IS A REACH		290.00	5921.50	1		140.00	0.00	0.00	0
7	IS A REACH		334.00	5925.49	1		0.00	0.00	0.00	0
8	IS A TRANSITION		335.00	5925.50	3					
9	IS A REACH		1015.00	5941.50	3		0.00	0.00	0.00	0
10	IS A SYSTEM HEADWORKS		1015.00	5941.50	3	5948.50				

NO EDIT ERRORS ENCOUNTERED-COMPUTATION IS NOW BEGINNING

Project WEST MEADOW DET. POND - PLUNGE POOL - BASIN	Job No EW10226
Client GATES	By TMO
	Date 10/94

### PLUNGE POOL DESIGN CALCULATIONS - REVISED FOR CHANNEL ALTERNATIVE

- ASSUME: 1) HIGH TAILWATER CONDITIONS  
(D.P. NEARLY AT CAPACITY)  
2)  $Q_{100} = 414$  CFS  
3) INLET CHANNEL



- 1)  $V_0 = Q/A = 414/24.58 = 16.84$  FPS
- 2)  $Y_c = (A/2)^{1/2} = (24.58/2)^{1/2} = 3.5$  (BRINK DEPTH)
- 3)  $F = V_0 / (32.2 \times Y_c)^{1/2} = 16.84 / (32.2 \times 3.5)^{1/2} = 1.59$

PREVIOUS DESIGN USES  $D_{50} = 18'' = 1.5'$

CHECK  $D_{50}/Y_c = 0.45$       $D_{50} = 0.45(3.5) = 1.57' \sim 18.9''$  OK

REFER TO FIGURE 10-C.4. - USE  $0.41 < D_{50}/Y_c < 0.50$  LINE

$h_s/Y_c = 1.06$       $h_s = (1.06)(3.5) = 3.7' \sim 4'$

PREVIOUS DESIGN -  $h_s = 7'$  OK

CHECK -  $h_s/D_{50} = 3.7/1.5 = \underline{2.47}$  OK BETWEEN 2 & 4.

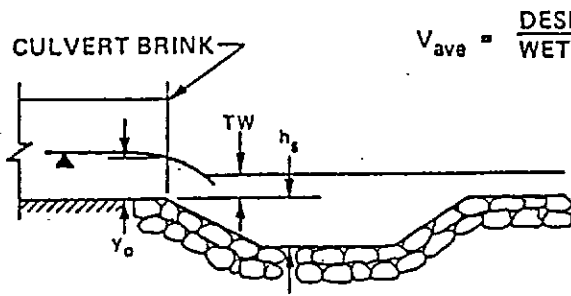
USE:  $D_{50} = 18''$  - TYPE H RIPRAP  
 $h_s = 4'$   
 $L_s = 10h_s = 40'$   
 $L_B = 15h_s = 60'$

DESIGNED FOR:  
 $D_{50} = 18''$   
 $h_s = 6'$   
 $L_s = 78'$   
 $L_B = 88'$

REFER TO FIGURE 10-C.5 FOR GENERAL LAYOUT OF PLUNGE POOL

NOTE: TOP OF RIPRAP & TOP OF BEAM PER FIG. 10-C.5 IS FOR CONTAINMENT OF FLOWS WITHIN A DOWNSTREAM CHANNEL - SEE NOTE "B"

OUR CONDITION - FLOWS ARE CONTAINED WITHIN THE DET. BASIN



$$V_{ave} = \frac{\text{DESIGN DISCHARGE} - Q}{\text{WETTED AREA AT BRINK OF CULVERT}}$$

$d_{50}$  = THE MEDIAN SIZE OF ROCK BY WEIGHT. ROUNDED ROCK OR ANGULAR ROCK.

$y_e$  = EQUIVALENT BRINK DEPTH  
 = BRINK DEPTH FOR BOX CULVERT

$$= \left( \frac{A}{2} \right)^{1/2} \text{ FOR NON-RECTANGULAR SECTIONS}$$

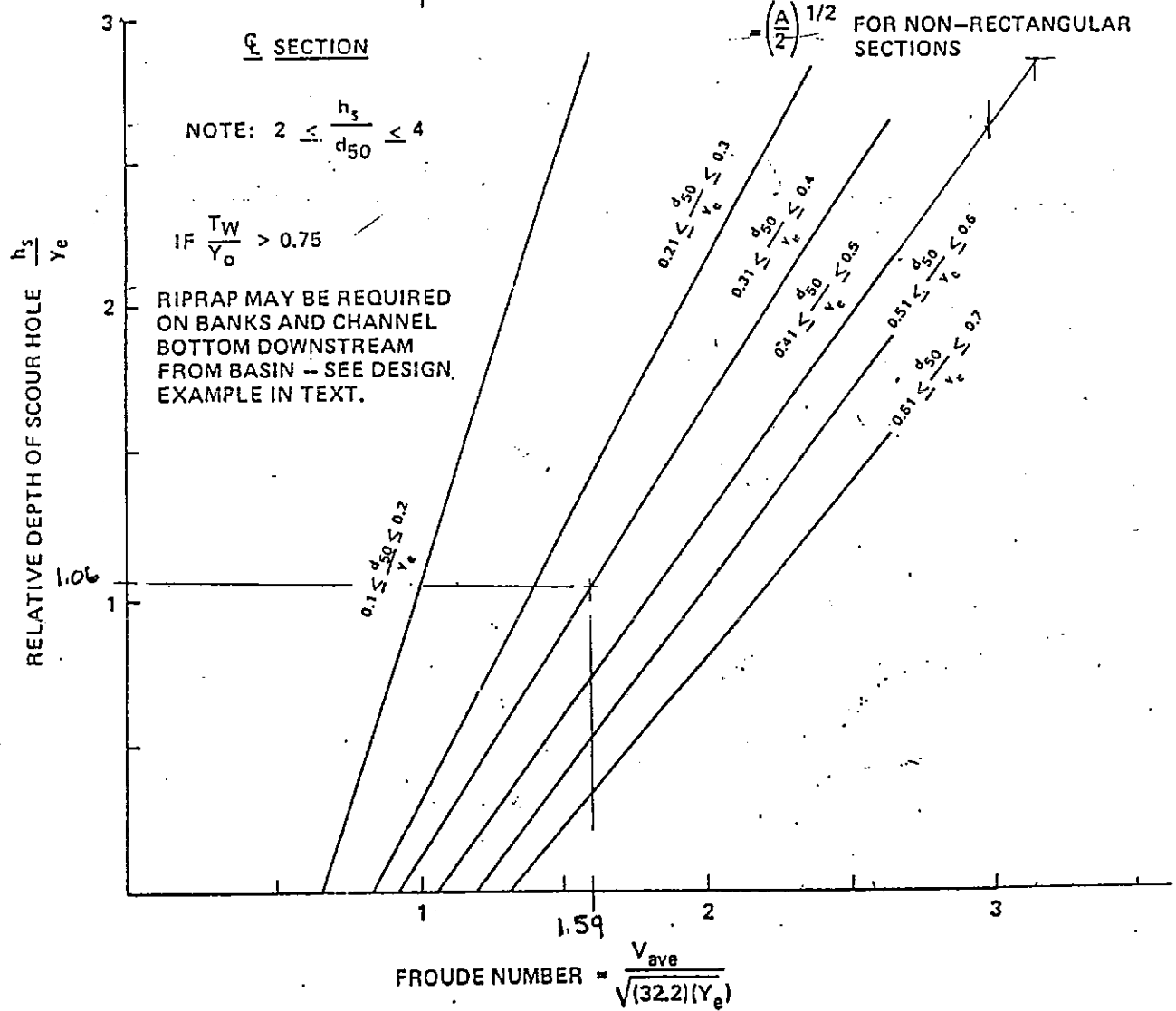


FIGURE 10-C.4 RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

Project FT. CARSON D. POND.	Job No EW 102C
Client GATER LAND CO.	By TMO
	Date 8-12-94

DEVELOPED CURVE No. - REVISED - ASSESSING  
1/3 to 1/2 ac  
RES. LOTS

BASIN 01 - D.A. = 148.6 AC

DA.	CN	DA x CN	SOIL	LAND USE
3.3	85	280.5	B	MULTIFAMILY
44.6	71	3,166	B	1/3 to 1/2 ac. LOTS R-1
35.0	81	2,835	C	1/3 to 1/2 ac. LOTS
22.8	86.5	1,972	C	School <small>50/400. 50/100 OPEN</small>
5.1	80.5	410.55	B	School "
4.0	92	368	B	BUS. CENTER
6.6	94	620.	C	BUS. CTR
12.9	90	1161	C	MULTIFAMILY
6.2	83.5	517.7	B	ROAD & R-O-W
8.1	88.5	716.85	C	ROAD & R-O-W
<u>148.6</u>		<u>12,048.8</u>		

CN = 81.08

NO CHANGE IN BASIN 02: CN = 90.4  
(DA = 40 ac)

COMBINED CN =  $\frac{148.6 (81.08) + 40 (90.4)}{188.6}$   
= 83.06 ~ 83

Project FT. CARSON DETENTION POND  
UPDATED HYDROLOGY

Job No  
EW-1026

Client GATES LAND CO.

By  
RM

Date  
8/11/94

## TIME OF CONCENTRATION

BASIN 01 REACH 1: L=300'

$$S = \frac{40}{300} = 13.3\%$$

LADY C<sub>10</sub> = .25 (B. 5010)

$$T_1 = \frac{1.87(1-.25)\sqrt{300}}{\sqrt[3]{13.3}} = 11.6 \text{ MIN.}$$

REACH 2: L=3000

$$S = \frac{6540 - 6290}{3000} = 8.3\%$$

NORMAL DEPTH:

$$B.W. = 5'$$

$$D = 1.5'$$

$$Z = 4:1$$

$$n = 0.045$$

$$Q = 15L \text{ (REASONABLE)}$$

$$V = 9.2$$

$$F_r = 1.6$$

$$T_2 = \frac{3000}{60(9.2)} = 5.4 \text{ MIN.}$$

REACH 3: L=2160

$$S = \frac{6290 - 6050}{2160} = 11.1\%$$

$$B.W. = 5'$$

$$D = 1.5'$$

$$Z = 4:1$$

$$n = 0.045$$

$$Q = 1.75$$

$$V = 10.6$$

$$F_r = 1.9$$

$$T_3 = \frac{2160}{60(10.6)}$$

$$= 3.4 \text{ MIN.}$$

REACH 4: L=2480

$$S = \frac{6050 - 5936}{2480} = 4.6\%$$

$$D = 1' \text{ (TO BANK)}$$

$$B.W. = 5'$$

$$Z = 5:1$$

$$n = 0.045$$

$$Q = 55$$

$$V = 5.4$$

$$F_r = 1.2$$

$$T_4 = \frac{2480}{60(5.4)} = 7.7 \text{ MIN.}$$

Project <u>FT. CARSON DETENTION POND</u> <u>UPDATED HYDROLOGY</u>	Job No <u>EW-1026</u>
Client <u>GATES LAND CO.</u>	By <u>RM</u> Date <u>8/11/94</u>

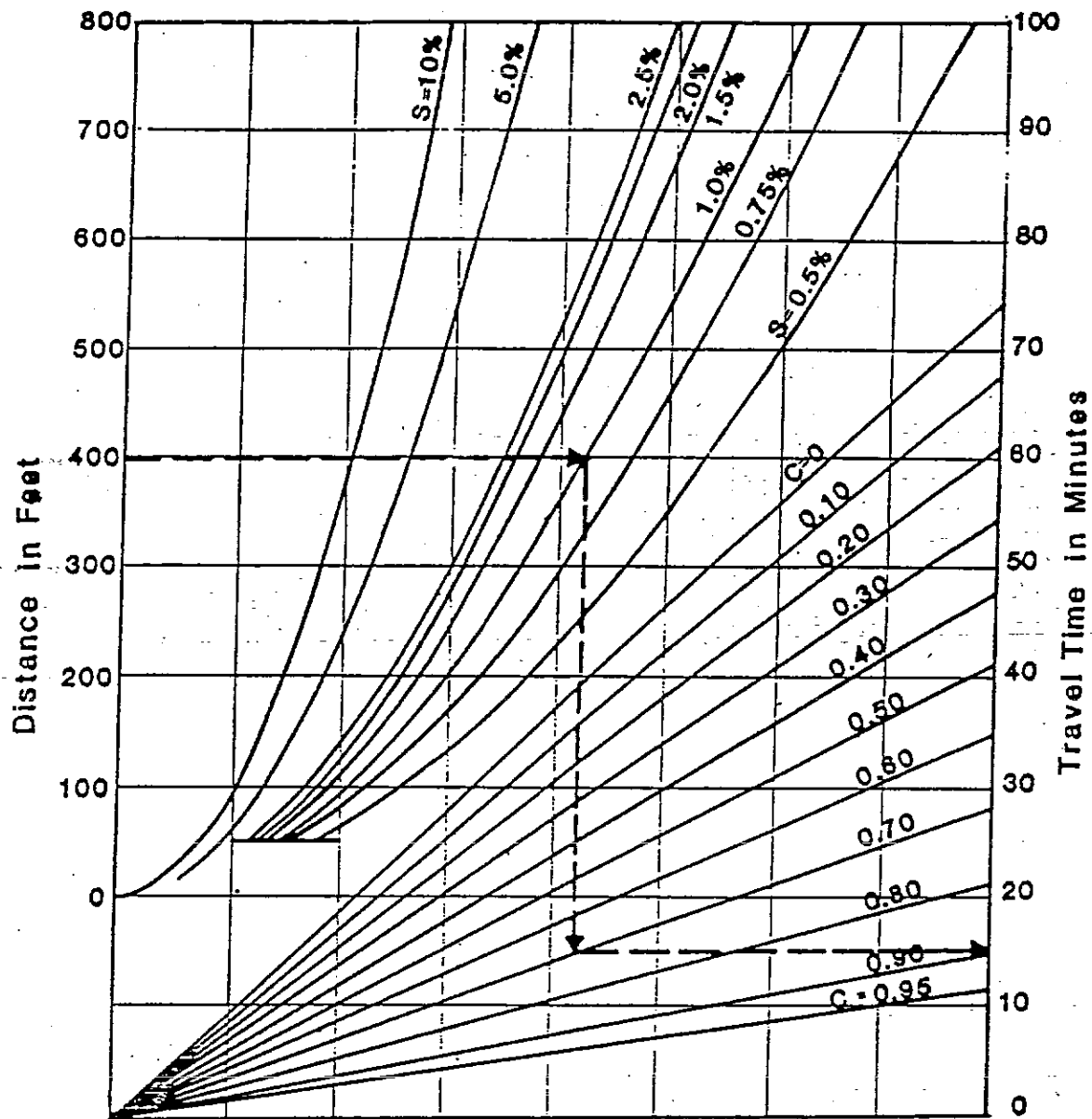
DEVELOPED CURVE NO.

BASIN 01 : (D.A. = 148.6 AC.)

<u>REVISED CN</u>	<u>D.A.</u>	<u>CN</u>	<u>DA x CN</u>	<u>SOIL</u>	<u>LAND USE</u>
8/12 -	3.3	85	280.5	B	MULTIFAMILY
71 - 3166.6	44.6	75	3345	B	R-1-9000
81 - 2835	35.0	83	2905	C	R-1-9000
-	22.8	86.5	1972.2	C	SCHOOL (50% BUS, 50% D.A.)
-	5.1	80.5	410.55	B	SCHOOL
-	4.0	92	368.0	B	BUS. CENTER
-	6.6	94	620.4	C	BUS. CENTER
-	12.9	90	1161.0	C	MULTIFAMILY
-	6.2	83.5	517.7	B	ROAD/ROW (50% PARK, 50% L/S)
-	8.1	88.5	716.85	C	ROAD/ROW
<u>12048.8</u>	<u>148.6</u>		<u>12,297.2</u>		
<u>CN = 81.1</u>		<u>CN =</u>	<u>82.8</u>		

BASIN 02 : (D.A. = 40.0)

<u>D.A.</u>	<u>CN</u>	<u>DA x CN</u>	<u>SOIL</u>	<u>LAND USE</u>
4.0	88.5	354.0	C	ROAD
5.6	90	504.0	C/D	ROAD
10.2	90	918.0	C	M/F
20.2	91	1838.2	C/D	M/F
<u>40.0</u>		<u>3614.2</u>		
		<u>CN =</u>	<u>90.4</u>	



REFERENCE : Wright - McLaughlin Engineers, Urban Storm Drainage Criteria Manual, Vol. 1.  
 Denver Regional Council of Governments, Denver, Co. 1977



HDR Infrastructure, Inc.  
 A Centerra Company

The City of Colorado Springs / El Paso County  
 Drainage Criteria Manual

Overland Flow Curves

5-10

Date  
 OCT. 1987

Figure

5-2



TABLE 5-1

## RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	"C" FREQUENCY			
		10		100	
		A&B*	C&D*	A&B*	C&D*
Business					
Commercial Areas	95	0.90	0.90	0.90	0.90
Neighborhood Areas	70	0.75	0.75	0.80	0.80
Residential					
1/8 Acre or less	65	0.60	0.70	0.70	0.80
1/4 Acre	40	0.50	0.60	0.60	0.70
1/3 Acre	30	0.40	0.50	0.55	0.60
1/2 Acre	25	0.35	0.45	0.45	0.55
1 Acre	20	0.30	0.40	0.40	0.50
Industrial					
Light Areas	80	0.70	0.70	0.80	0.80
Heavy Areas	90	0.80	0.80	0.90	0.90
Parks and Cemeteries	7	0.30	0.35	0.55	0.60
Playgrounds	13	0.30	0.35	0.60	0.65
Railroad Yard Areas	40	0.50	0.55	0.60	0.65
Undeveloped Areas					
Historic Flow Analysis- Greenbelts, Agricultural	2	0.15	0.25	0.20	0.30
Pasture/Meadow	0	0.25	0.30	0.35	0.45
Forest	0	0.10	0.15	0.15	0.20
Exposed Rock	100	0.90	0.90	0.95	0.95
Offsite Flow Analysis (when land use not defined)	45	0.55	0.60	0.65	0.70
Streets					
Paved	100	0.90	0.90	0.95	0.95
Gravel	80	0.80	0.80	0.85	0.85
Drive and Walks	100	0.90	0.90	0.95	0.95
Roofs	90	0.90	0.90	0.95	0.95
Lawns	0	0.25	0.30	0.35	0.45

\* Hydrologic Soil Group

9/30/90

TABLE 5-4  
 RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL  
 COVER COMPLEXES - RURAL CONDITIONS  
 (Antecedent Moisture Condition II, and Ia = 0.2 S)  
 (From: U.S. Dept. of Agriculture,  
 Soil Conservation Service, 1977)

<u>Land Use</u>	<u>Cover Treatment or Practice</u>	<u>Hydrologic Condition</u>	<u>Runoff Curve Number by Hydrologic Soil Group</u>			
			<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes <u>1/</u> or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) <u>2/</u> (hard surface) <u>2/</u>		----	72	82	87	89
		----	74	84	90	92

1/ Close-drilled or broadcast  
2/ Including right-of-way

TABLE 5-5  
 RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL  
 COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/  
 (Antecedent Moisture Condition II)  
 (From: U.S. Dept. of Agriculture,  
 Soil Conservation Service, 1977)

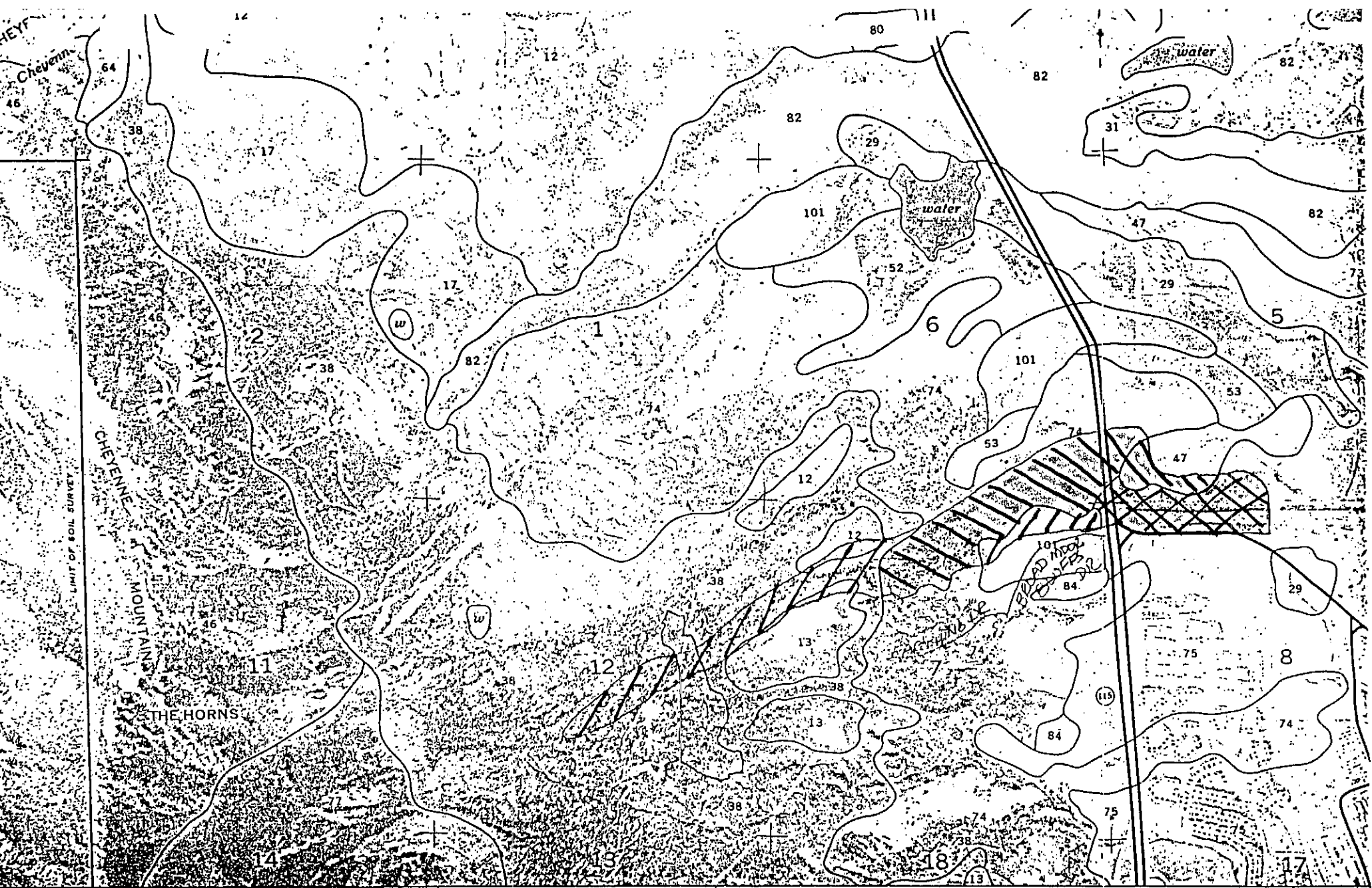
<u>Land Use</u>	<u>Hydrologic Soil Group</u>			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Open spaces, lawns, parks, golf courses, cemeteries, etc.				
Good condition: grass cover on 75% or more of the area	39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area	49*	69	79	84
Commercial and Business areas (85% Impervious)	89*	92	94	95
Industrial Districts 72% Impervious)	81*	88	91	93
Residential: <u>2/</u>				
<u>Acres per Dwelling Unit</u>	<u>Average %</u>			
	<u>Impervious</u> <sup>3/</sup>			
1/8 acre or less	65	77*	85	90
1/4 acre	38	61*	75	83
1/3 acre	30	57*	72	81
1/2 acre	25	54*	70	80
1 acre	20	51*	68	79
Paved parking lots, roofs, driveways, etc.	98	98	98	98
Streets and Roads:				
paved with curbs and storm sewers	98	98	98	98
gravel	76*	85	89	91
dirt	72*	82	87	89



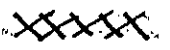
1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

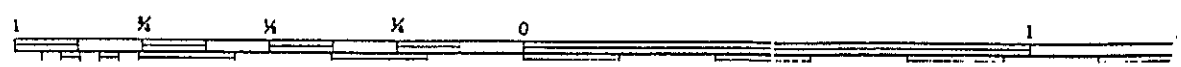
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

\* Not to be used wherever overlot grading or filling is to occur.



-  B
-  C
-  C/D

soil survey map was compiled by the U.S. Department of Agriculture, Conservation Service, and cooperating agencies. Base maps are



NOMOGRAPH FOR ESTIMATING M  
FOR A TRAPEZOIDAL CHANNEL

$$Q = XA^M$$

D = MAXIMUM DEPTH (FT)

B = BOTTOM WIDTH (FT)

Z = SIDE SLOPE

$$AREA = BD + ZD^2$$

AREA  
(FT<sup>2</sup>)

EXAMPLE

$$D/B = 1.0$$

$$Z = 5.0$$

$$AREA = 1000 \text{ FT}^2$$

$$M = 1.44$$

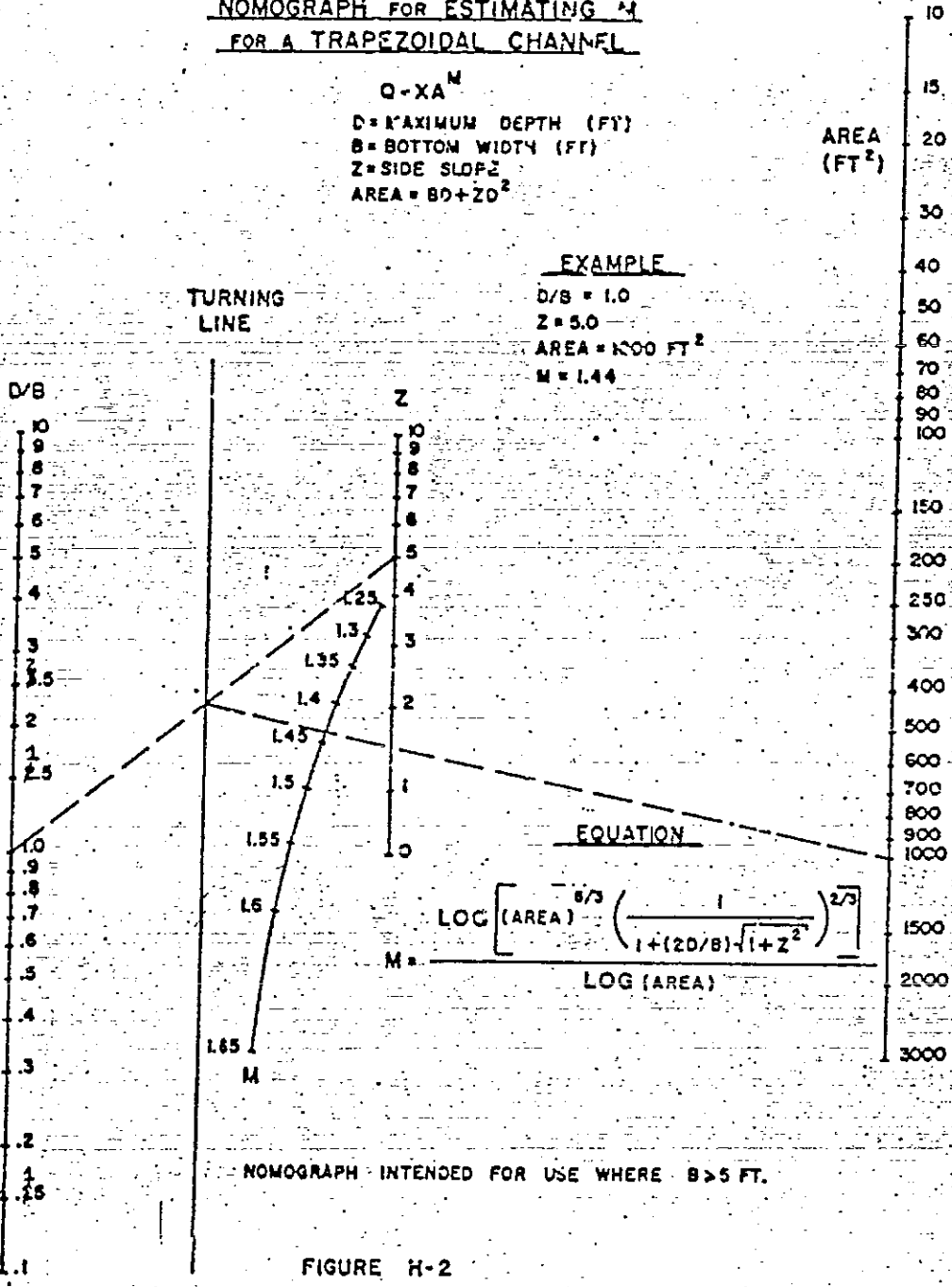


FIGURE H-2

### NOMOGRAPH FOR ESTIMATING X FOR A TRAPEZOIDAL CHANNEL

$$Q = XA^M$$

SLOPE = BOTTOM SLOPE (FT/FT)

n = MANNING'S n

B = BOTTOM WIDTH (FT)

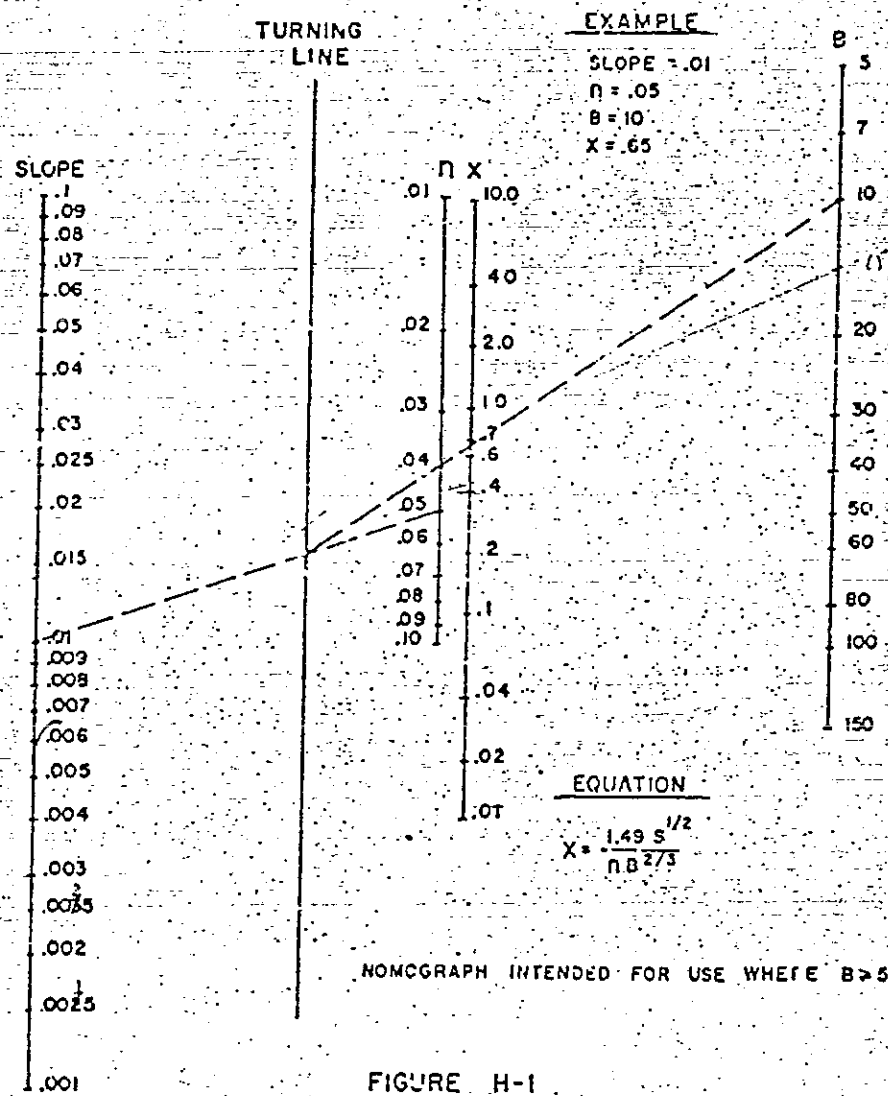


FIGURE H-1

286

# **100 year FLOOD ROUTING**

**Pond volume**

**Outflow rates**

**Inflow Hydrograph Routing**

Project	WEST MEADOW DET. POND	Job No	EW1026
---------	-----------------------	--------	--------

Client	GATES LAND CO.	By	TMO	Date	9/94
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## 100 YR. FLOOD ROUTING

- HAESTAD METHODS' POND 2 COMPUTER PROGRAM WAS UTILIZED IN ROUTING THE 100YR STORM RUNOFF PRODUCED BY THE TR20 HYDROGRAPH.

- ALSO INCLUDED IN THE POND 2 PROGRAM WERE THE THE DETENTION POND VOLUME CALCULATIONS AND THE OUTLET STRUCTURE RELEASE RATES CALCULATIONS

A SUMMARY OF THE OUTPUT FOR THE 100YR FLOOD ROUTING FOLLOWS:

PEAK INFLOW = 497.26 CFS

PEAK OUTFLOW = 79.1 CFS

PONDING ELEV = 5920.07

STORAGE VOLUME = 21.5 AC-FT.



POND-2 Version: 5.17

S/N:

FORT CARSON DET. POND - REVISED HYDROLOGY  
REVISED POND VOLUME - 8-12-94

CALCULATED 09-15-1994 14:29:42  
DISK FILE: FCARSONR.VOL

Planimeter scale: 1 inch = 40 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	$A1+A2+\text{sqr}(A1*A2)$ (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
5,907.50	0.00	0.00	0.00	0.00	0.00
5,909.00	31.47	1.16	1.16	0.58	0.58
5,909.50	*I*	1.17	3.49	0.58	1.16
5,910.00	32.21	1.18	3.51	1.17	1.75
5,912.00	43.96	1.61	4.18	2.79	4.53
5,914.00	50.02	1.84	5.17	3.45	7.98
5,916.00	56.34	2.07	5.86	3.90	11.89
5,918.00	62.91	2.31	6.57	4.38	16.27
5,920.00	69.71	2.56	7.30	4.87	21.14
5,920.50	*I*	2.62	7.78	1.30	22.43
5,922.00	76.77	2.82	8.07	5.38	26.51
5,924.00	81.17	2.98	8.70	5.80	32.31

\*I\* ---> Interpolated area from closest two planimeter readings.

\* Incremental volume computed by the Conic Method for Reservoir Volumes.

Outlet Structure File: FCARSON .STR

POND-2 Version: 5.17

S/N:

Date Executed:

Time Executed:

\*\*\*\*\*  
WEST MEADOW DETENTION POND - FT CARSON OUTFALL  
1.0 ft X 4.75 ft ORIFICE OPENING - OUTLET STRUCTURE  
DREXEL BARRELL & CO  
\*\*\*\*\*

>>>>> Structure No. 1 <<<<<<  
(Input Data)

CULVERT-BX  
Box Culvert (With Inlet Control)

E1 elev.(ft)?	5907.5
E2 elev.(ft)?	5924.0
Height (ft)?	1
Width (ft)?	4.75
Inv. el.(ft)?	5907.5
Slope (ft/ft)?	0.005
T1 ratio?	
T2 ratio?	
K Coeff.?	0.0613
M Coeff.?	0.755
c Coeff.?	0.0423
Y Coeff.?	0.82
Form 1 or 2?	1
Slope factor?	-0.5

Outlet Structure File: FCARSON .STR

POND-2 Version: 5.17  
Date Executed:

S/N:  
Time Executed:

\*\*\*\*\*  
WEST MEADOW DETENTION POND - FT CARSON OUTFALL  
1.0 ft X 4.75 ft ORIFICE OPENING - OUTLET STRUCTURE  
DREXEL BARRELL & CO  
\*\*\*\*\*

Outflow Rating Table for Structure #1  
CULVERT-BX Box Culvert (With Inlet Control)

\*\*\*\*\* INLET CONTROL ASSUMED \*\*\*\*\*

Elevation (ft)	Q (cfs)	Computation	Messages
5907.50	0.0	No headwater	
5908.00	4.4	Equ.1: HW =.5	dc=.298 Ac=1.416
5908.50	12.2	Equ.1: HW =1.0	dc=.59 Ac=2.801
5909.00	19.1	Submerged: HW =1.5	
5909.50	25.2	Submerged: HW =2.0	
5910.00	29.9	Submerged: HW =2.5	
5910.50	34.1	Submerged: HW =3.0	
5911.00	37.8	Submerged: HW =3.5	
5911.50	41.2	Submerged: HW =4.0	
5912.00	44.3	Submerged: HW =4.5	
5912.50	47.2	Submerged: HW =5.0	
5913.00	50.0	Submerged: HW =5.5	
5913.50	52.5	Submerged: HW =6.0	
5914.00	55.0	Submerged: HW =6.5	
5914.50	57.4	Submerged: HW =7.0	
5915.00	59.7	Submerged: HW =7.5	
5915.50	61.9	Submerged: HW =8.0	
5916.00	64.0	Submerged: HW =8.5	
5916.50	66.1	Submerged: HW =9.0	
5917.00	68.0	Submerged: HW =9.5	
5917.50	70.0	Submerged: HW =10.0	
5918.00	71.9	Submerged: HW =10.5	
5918.50	73.7	Submerged: HW =11.0	
5919.00	75.5	Submerged: HW =11.5	
5919.50	77.2	Submerged: HW =12.0	
5920.00	79.0	Submerged: HW =12.5	
5920.50	80.6	Submerged: HW =13.0	
5921.00	82.3	Submerged: HW =13.5	
5921.50	83.8	Submerged: HW =14.0	
5922.00	85.4	Submerged: HW =14.5	
5922.50	87.0	Submerged: HW =15.0	

Outlet Structure File: FCARSON .STR

POND-2 Version: 5.17

S/N:

Date Executed:

Time Executed:

>>>> CONTINUED from previous page <<<<<

Outflow Rating Table for Structure #1  
CULVERT-BX Box Culvert (With Inlet Control)

\*\*\*\*\* INLET CONTROL ASSUMED \*\*\*\*\*

Elevation (ft)	Q (cfs)	Computation Messages
5923.00	88.5	Submerged: HW =15.5
5923.50	90.0	Submerged: HW =16.0
5924.00	0.0	E = or > E2=5924.0

Used Unsubmerged Equ. Form (1) for elev. less than 5908.74 ft  
Used Submerged Equation for elevations greater than 5908.99 ft  
HW=Headwater (ft) dc=Critical depth (ft) Ac=Area (sq.ft) at dc

Transition flows interpolated from the following values:  
E1=5908.74 ft; Q1=16.63 cfs; Dc=.72 ft; E2=5908.99 ft; Q2=19.0 cfs

Outlet Structure File: FCARSON .STR

POND-2 Version: 5.17  
Date Executed:

S/N:  
Time Executed:

\*\*\*\*\*  
WEST MEADOW DETENTION POND - FT CARSON OUTFALL  
1.0 ft X 4.75 ft ORIFICE OPENING - OUTLET STRUCTURE  
DREXEL BARRELL & CO.  
\*\*\*\*\*

\*\*\*\*\* COMPOSITE OUTFLOW SUMMARY \*\*\*\*

Elevation (ft)	Q (cfs)	Contributing Structures
5907.50	0.0	1
5908.00	4.4	1
5908.50	12.2	1
5909.00	19.1	1
5909.50	25.2	1
5910.00	29.9	1
5910.50	34.1	1
5911.00	37.8	1
5911.50	41.2	1
5912.00	44.3	1
5912.50	47.2	1
5913.00	50.0	1
5913.50	52.5	1
5914.00	55.0	1
5914.50	57.4	1
5915.00	59.7	1
5915.50	61.9	1
5916.00	64.0	1
5916.50	66.1	1
5917.00	68.0	1
5917.50	70.0	1
5918.00	71.9	1
5918.50	73.7	1
5919.00	75.5	1
5919.50	77.2	1
5920.00	79.0	1
5920.50	80.6	1
5921.00	82.3	1
5921.50	83.8	1
5922.00	85.4	1
5922.50	87.0	1
5923.00	88.5	1
5923.50	90.0	1
5924.00	0.0	

Outlet Structure File: FCARSON .STR

POND-2 Version: 5.17  
Date Executed:

S/N:  
Time Executed:

\*\*\*\*\*  
WEST MEADOW DETENTION POND - FT CARSON OUTFALL  
1.0 ft X 4.75 ft ORIFICE OPENING - OUTLET STRUCTURE  
DREXEL BARRELL & CO  
\*\*\*\*\*

Outlet Structure File: FCARSON .STR  
Planimeter Input File: FCARSONR.VOL  
Rating Table Output File: FCARSON .PND

Min. Elev.(ft) = 5907.5 Max. Elev.(ft) = 5924 Incr.(ft) = .5

Additional elevations (ft) to be included in table:  
\* \* \* \* \*

\*\*\*\*\*  
SYSTEM CONNECTIVITY  
\*\*\*\*\*

Structure	No.	Q Table	Q Table
CULVERT-BX	1	->	1

Outflow rating table summary was stored in file:  
FCARSON .PND

```

*****
*
*   FORT CARSON DET. POND - REVISED HYDROLOGY *
*   Drexel Barrell & Co           8-13-94   *
*
*
*
*****
  
```

Inflow Hydrograph: FCARSONF.HYD  
 Rating Table file: FCARSON .PND

----INITIAL CONDITIONS----  
 Elevation = 5907.50 ft  
 Outflow = 0.00 cfs  
 Storage = 0.00 ac-ft

GIVEN POND DATA

INTERMEDIATE ROUTING  
 COMPUTATIONS

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + 0 (cfs)
5907.50	0.0	0.000	0.0	0.0
5908.50	12.2	0.077	37.5	49.7
5909.50	25.2	0.619	299.8	325.0
5910.50	34.1	1.948	943.0	977.1
5911.50	41.2	3.504	1695.9	1737.1
5912.50	47.2	5.167	2500.8	2548.0
5913.50	52.5	6.942	3359.7	3412.2
5914.50	57.4	8.831	4274.2	4331.6
5915.50	61.9	10.836	5244.8	5306.7
5916.50	66.1	12.958	6271.6	6337.7
5917.50	70.0	15.184	7348.9	7418.9
5918.50	73.7	17.518	8478.9	8552.6
5919.50	77.2	19.991	9675.5	9752.7
5920.50	80.6	22.607	10941.7	11022.3
5921.50	83.8	25.355	12271.6	12355.4
5922.50	87.0	28.234	13665.4	13752.4
5923.50	90.0	31.249	15124.8	15214.8

Time increment (t) = 3.0 min.

Pond File: FCARSON .PND  
 Inflow Hydrograph: FCARSONF.HYD  
 Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH

ROUTING COMPUTATIONS

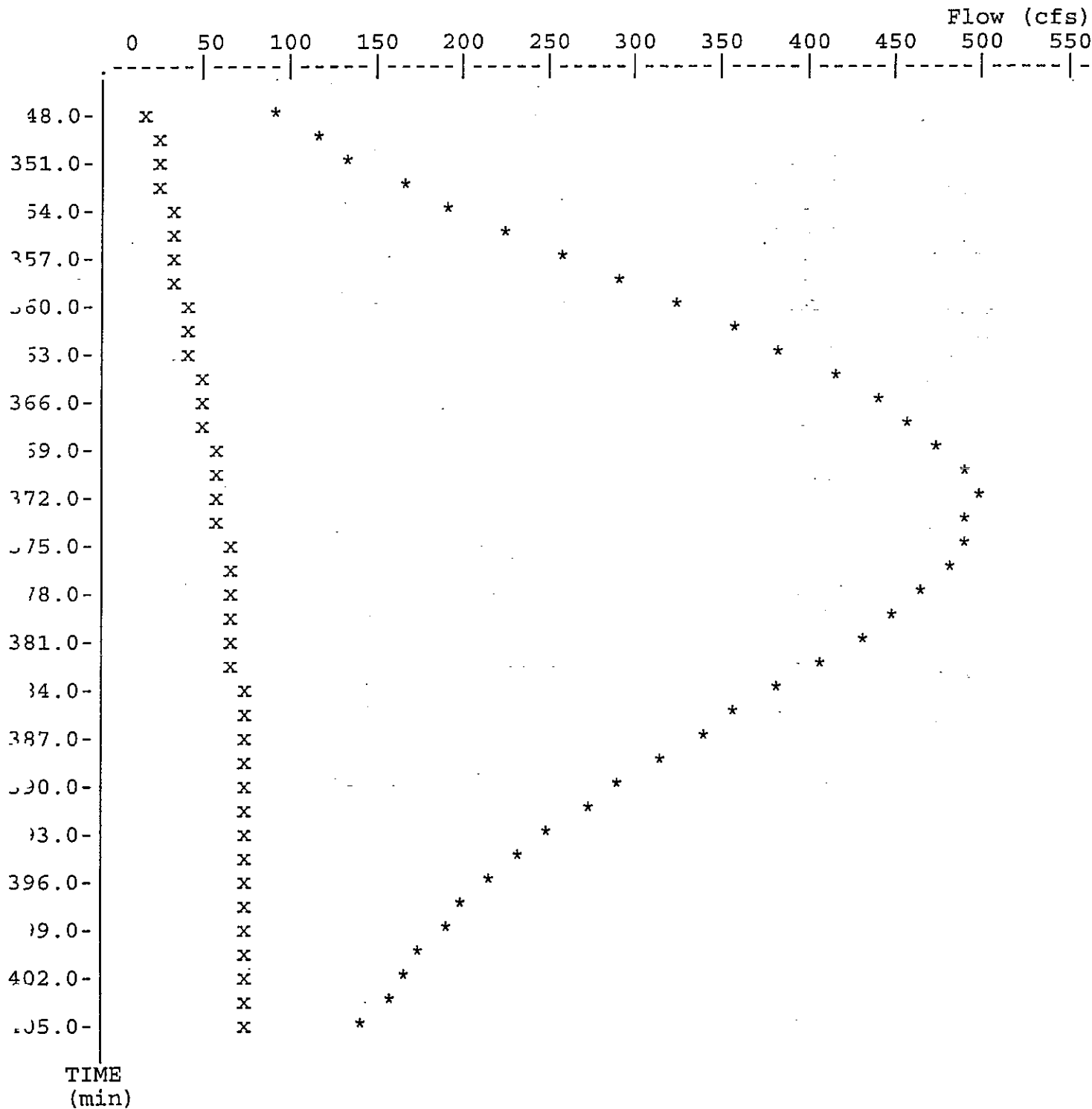
TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - 0 (cfs)	2S/t + 0 (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
300.0	0.00	---	0.0	0.0	0.00	5907.50
303.0	0.00	0.0	0.0	0.0	0.00	5907.50
306.0	0.00	0.0	0.0	0.0	0.00	5907.50
309.0	0.00	0.0	0.0	0.0	0.00	5907.50
312.0	0.00	0.0	0.0	0.0	0.00	5907.50
315.0	0.00	0.0	0.0	0.0	0.00	5907.50
318.0	0.00	0.0	0.0	0.0	0.00	5907.50
321.0	0.00	0.0	0.0	0.0	0.00	5907.50
324.0	0.00	0.0	0.0	0.0	0.00	5907.50
327.0	0.01	0.0	0.0	0.0	0.00	5907.50
330.0	0.07	0.1	0.0	0.1	0.02	5907.50
333.0	0.95	1.0	0.5	1.1	0.26	5907.52
336.0	4.28	5.2	2.9	5.8	1.42	5907.62
339.0	12.18	16.5	9.9	19.4	4.76	5907.89
342.0	27.29	39.5	25.1	49.3	12.12	5908.49
345.0	52.47	79.8	75.2	104.9	14.81	5908.70
348.0	89.09	141.6	176.6	216.8	20.09	5909.11
351.0	136.68	225.8	349.9	402.4	26.26	5909.62
354.0	193.32	330.0	619.8	679.9	30.04	5910.04
357.0	256.45	449.8	999.6	1069.6	34.96	5910.62
360.0	322.84	579.3	1499.5	1578.9	39.72	5911.29
363.0	386.17	709.0	2119.1	2208.5	44.69	5912.08
366.0	440.03	826.2	2846.0	2945.3	49.64	5912.96
369.0	478.91	918.9	3656.2	3765.0	54.38	5913.88
372.0	497.26	976.2	4514.8	4632.4	58.79	5914.81
375.0	492.22	989.5	5378.9	5504.3	62.71	5915.69
378.0	467.94	960.2	6206.8	6339.0	66.11	5916.50
381.0	430.50	898.4	6967.5	7105.3	68.87	5917.21
384.0	385.90	816.4	7641.6	7783.9	71.19	5917.82
387.0	338.70	724.6	8220.0	8366.2	73.09	5918.34
390.0	293.22	631.9	8702.7	8851.9	74.57	5918.75
393.0	251.43	544.7	9095.9	9247.4	75.73	5919.08
396.0	215.75	467.2	9409.8	9563.1	76.65	5919.34
399.0	187.51	403.3	9658.4	9813.1	77.36	5919.55
402.0	164.55	352.1	9854.6	10010.4	77.89	5919.70
405.0	145.19	309.7	10007.8	10164.4	78.30	5919.82
408.0	128.62	273.8	10124.4	10281.6	78.62	5919.92
411.0	114.22	242.8	10209.5	10367.2	78.85	5919.98
414.0	101.95	216.2	10267.7	10425.7	79.00	5920.03
417.0	91.63	193.6	10303.1	10461.3	79.10	5920.06
420.0	82.92	174.6	10319.3	10477.6	79.14	5920.07
423.0	75.59	158.5	10319.5	10477.8	79.14	5920.07
426.0	69.43	145.0	10306.4	10464.6	79.11	5920.06
429.0	64.24	133.7	10281.9	10440.0	79.04	5920.04
432.0	59.75	124.0	10248.0	10405.9	78.95	5920.01



Pond File: FCARSON .PND  
 Inflow Hydrograph: FCARSONF.HYD  
 Outflow Hydrograph: OUT .HYD

EXECUTED: 08-13-1994  
 08:38:39

Peak Inflow = 497.26 cfs  
 Peak Outflow = 79.14 cfs  
 Peak Elevation = 5920.07 ft



\* File: FCARSONF.HYD Qmax = 497.3 cfs  
 x File: OUT .HYD Qmax = 79.1 cfs

HYDROGRAPH FILE  
OUT .HYD

08-13-1994 08:40:42

Time (min)	Flow (cfs)	Time (min)	Flow (cfs)
756.0	36.75	870.0	13.41
759.0	36.27	873.0	13.04
762.0	35.81	876.0	12.70
765.0	35.35	879.0	12.39
768.0	34.91	882.0	11.69
771.0	34.47	885.0	10.53
774.0	34.01	888.0	9.94
777.0	33.40	891.0	9.62
780.0	32.80	894.0	9.46
783.0	32.22	897.0	9.37
786.0	31.65		
789.0	31.10		
792.0	30.56		
795.0	30.03		
798.0	29.52		
801.0	29.01		
804.0	28.52		
807.0	28.03		
810.0	27.56		
813.0	27.09		
816.0	26.64		
819.0	26.19		
822.0	25.76		
825.0	25.33		
828.0	24.23		
831.0	22.89		
834.0	21.69		
837.0	20.59		
840.0	19.60		
843.0	18.70		
846.0	17.88		
849.0	17.13		
852.0	16.45		
855.0	15.83		
858.0	15.26		
861.0	14.74		
864.0	14.26		
867.0	13.82		

# HYDRAULICS OF THE INLET PIPE & PLUNGE POOL

Project WEST MEADOW DET. POND		Job No EW1026
----------------------------------	--	------------------

Client GATES	By TMS	Date 9/94
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1. INLET PIPE HYDRAULICS

INITIAL DESIGN OF THE INLET PIPE WAS BASED ON THE MANNING'S EQUATION -  $Q = \frac{1.486}{n} R^{2/3} A S^{1/2}$

FINAL DESIGN INCORPORATED A WSPG (WATER SURFACE AND PRESSURE GRADIENT - HYDRAULIC ANALYSIS) MODEL OF THIS INLET PIPE.

2. PLUNGE POOL DESIGN

THE PLUNGE POOL DESIGN FOLLOWED THE CITY OF COL. SPRINGS / EL PASO COUNTY DRAINAGE CRITERIA MANUAL. THE PLUNGE POOL DESIGN USED THE MANNING'S EQUATION FOR THE REQUIRED HYDRAULIC INFORMATION

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D. POND

Comment: INLET PIPE ANALYSIS

Solve For Actual Depth

Given Input Data:

Diameter.....	5.00 ft
Slope.....	0.0380 ft/ft
Manning's n.....	0.013
Discharge.....	434.00 cfs

Computed Results:

Depth.....	3.56 ft
Velocity.....	29.05 fps
Flow Area.....	14.94 sf
Critical Depth....	4.92 ft
Critical Slope....	0.0251 ft/ft
Percent Full.....	71.14 %
Full Capacity.....	507.70 cfs
QMAX @.94D.....	546.13 cfs
Froude Number.....	2.82 (flow is Supercritical)

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D. POND

Comment: INLET PIPE ANALYSIS

Solve For Actual Depth

Given Input Data:

Diameter.....	5.50 ft
Slope.....	0.0230 ft/ft
Manning's n.....	0.013
Discharge.....	414.00 cfs

Computed Results:

Depth.....	3.77 ft
Velocity.....	23.88 fps
Flow Area.....	17.33 sf
Critical Depth....	5.23 ft
Critical Slope....	0.0132 ft/ft
Percent Full.....	68.46 %
Full Capacity.....	509.28 cfs
QMAX @.94D.....	547.84 cfs
Froude Number.....	2.29 (flow is Supercritical)

WATER SURFACE PROFILE LISTING

WESTMEADOW DET. BASIN INLET PIPE ANALYSIS  
 COLORADO SPRINGS, CO. SH 115 & ACADEMY BLVD  
 DREXEL BARRELL & CO TMO 8-18-94

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
100.00	5916.00	4.247	5920.247	434.0	24.41	9.253	5929.500	0.00	4.917	5.00	0.00	0.00	0	0.00
0.25	0.03794					.026166	0.01		3.559			0.00		
100.25	5916.01	4.248	5920.257	434.0	24.40	9.248	5929.505	0.00	4.917	5.00	0.00	0.00	0	0.00
45.42	0.03794					.025272	1.15		3.559			0.00		
145.67	5917.73	4.513	5922.246	434.0	23.27	8.407	5930.653	0.00	4.917	5.00	0.00	0.00	0	0.00
27.33	0.03794					.024728	0.68		3.559			0.00		
173.00	5918.77	4.917	5923.687	434.0	22.18	7.641	5931.328	0.00	4.917	5.00	0.00	0.00	0	0.00
TRANS STR	0.03750					.020885	0.17					0.00		
181.00	5919.07	7.490	5926.560	434.0	18.27	5.182	5931.742	0.00	5.272	5.50	0.00	0.00	0	0.00
JUNCT STR	0.04000					.015951	0.06					0.00		
185.00	5919.23	8.298	5927.528	414.0	17.43	4.715	5932.243	0.00	5.229	5.50	0.00	0.00	0	0.00
128.00	0.02297					.015199	1.95		3.767			0.00		
313.00	5922.17	8.268	5930.438	414.0	17.43	4.715	5935.153	0.00	5.229	5.50	0.00	0.00	0	0.00
37.00	0.07405					.015199	0.56		2.596			0.00		
350.00	5924.91	7.102	5932.012	414.0	17.43	4.715	5936.727	0.00	5.229	5.50	0.00	0.00	0	0.00
TRANS STR	0.07375					.012377	0.10					0.00		
358.00	5925.50	8.135	5933.635	414.0	14.64	3.329	5936.964	0.00	5.396	6.00	0.00	0.00	0	0.00
680.00	0.02353					.032570	22.15		6.000			0.00		
1038.00	5941.50	14.283	5955.783	414.0	14.64	3.329	5959.112	0.00	5.396	6.00	0.00	0.00	0	0.00





- I - INVERT ELEVATION
- C - CRITICAL DEPTH
- W - WATER SURFACE ELEVATION
- H - HEIGHT OF CHANNEL
- E - ENERGY GRADE LINE
- X - CURVES CROSSING OVER
- B - BRIDGE ENTRANCE OR EXIT
- Y - WALL ENTRANCE OR EXIT

2. STATIONS FOR POINTS AT A JUMP MAY NOT BE PLOTTED EXACTLY



WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	1 IS A SYSTEM OUTLET	*	*	*															
	U/S DATA	STATION	INVERT	SECT							W S ELEV								
		100.00	5916.00	1							5920.07								
ELEMENT NO	2 IS A REACH	*	*	*															
	U/S DATA	STATION	INVERT	SECT								RADIUS	ANGLE	ANG PT	MAN H				
		173.00	5918.77	1								0.013	0.00	0.00	0.00	0			
ELEMENT NO	3 IS A TRANSITION	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		181.00	5919.07	2								0.013							
ELEMENT NO	4 IS A JUNCTION	*	*	*	*	*	*	*	*	*									
	U/S DATA	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4						
		185.00	5919.23	2	4	0	0.013	20.0	0.0	5922.70	0.00	80.00	0.00						
ELEMENT NO	5 IS A REACH	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		185.00	5919.23	2								0.013	0.00	0.00	0.00	0			
ELEMENT NO	6 IS A REACH	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		313.00	5922.17	2								0.013	0.00	0.00	62.00	0			
ELEMENT NO	7 IS A REACH	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		350.00	5924.91	2								0.013	0.00	0.00	65.00	0			
ELEMENT NO	8 IS A TRANSITION	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		358.00	5925.50	3								0.013							
ELEMENT NO	9 IS A REACH	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		1038.00	5941.50	3								0.024	0.00	0.00	0.00	0			
ELEMENT NO	10 IS A SYSTEM HEADWORKS	*	*	*															
	U/S DATA	STATION	INVERT	SECT															
		1038.00	5941.50	3															
												W S ELEV							
												5948.50							

NO EDIT ERRORS ENCOUNTERED-COMPUTATION IS NOW BEGINNING

WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 1 IS -

WESTMEADOW DET. BASIN INLET PIPE ANALYSIS

HEADING LINE NO 2 IS -

COLORADO SPRINGS, CO. SH 115 & ACADEMY BLVD

HEADING LINE NO 3 IS -

DREXEL BARRELL & CO TMO 8-18-94

Project WEST MEADOW DET. POND. - PLUNGE POOL - RIPRAP BASIN	Job No EW1026
Client GATES	By TMO
	Date 9/94

### Plunge Pool DESIGN CALCULATIONS

REF. EL PASO CO. DRAINAGE  
MANUAL

ASSUME: HIGH TW.  
60" RCP  
 $Q_{100} = 434$  CFS.

A = FLOW AREA - SEE MANNINGS  
OUTPUT

1.)  $V_0 = Q/A = 434/14.94 = 29.05$  FPS

2.)  $y_e = (A/2)^{1/2} = (14.94/2)^{1/2} = 2.73$  FT (BRINK DEPTH)

3.)  $F = V_0 / (32.2 \times y_e)^{1/2} = 29.05 / (32.2 \times 2.73)^{1/2} = 3.10$

TRY  $D_{50}/y_e = 0.45$       $D_{50} = 0.45(y_e) = 0.45(2.73) = 1.23$  FT  $\rightarrow 14.7" \sim 15"$

USE  $D_{50} = 18" - (1.5')$

REVISED  $D_{50}/y_e = 1.5/2.73 = 0.55$

REFER TO FIG. 10-C.4 USE  $0.51 < D_{50}/y_e < 0.60$  LINE

$h_s/y_e = 2.5$       $h_s = (2.5)(2.73) = 6.82 \sim 7$  FT

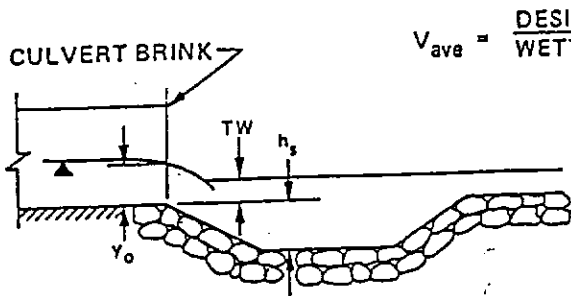
#### Check

$h_s/D_{50} = 6.82/1.5 = 4.55 \approx 4.0$  CLOSE OK

USE:  $D_{50} = 18"$  TYPE H RIPRAP  
 $h_s = 7$  FT - DESIGN IS 8 FT  
 $L_s = 10 h_s = 70$  FT.  
 $L_B = 15 h_s = 105$  FT.

REFER TO FIGURE 10-C.5 FOR GENERAL LAYOUT OF PLUNGE POOL

NOTE: TOP OF RIPRAP & TOP OF BERM PER FIG. 10-C.5 IS FOR CONTAINMENT OF FLOWS WITHIN A DOWNSTREAM CHANNEL - SEE NOTE "B" OUR CONDITION - FLOWS ARE CONTAINED WITHIN THE DET. BASIN.



$$V_{ave} = \frac{\text{DESIGN DISCHARGE} - Q}{\text{WETTED AREA AT BRINK OF CULVERT}}$$

$d_{50}$  = THE MEDIAN SIZE OF ROCK BY WEIGHT. ROUNDED ROCK OR ANGULAR ROCK.

$y_e$  = EQUIVALENT BRINK DEPTH = BRINK DEPTH FOR BOX CULVERT

$$= \left(\frac{A}{Z}\right)^{1/2} \text{ FOR NON-RECTANGULAR SECTIONS}$$

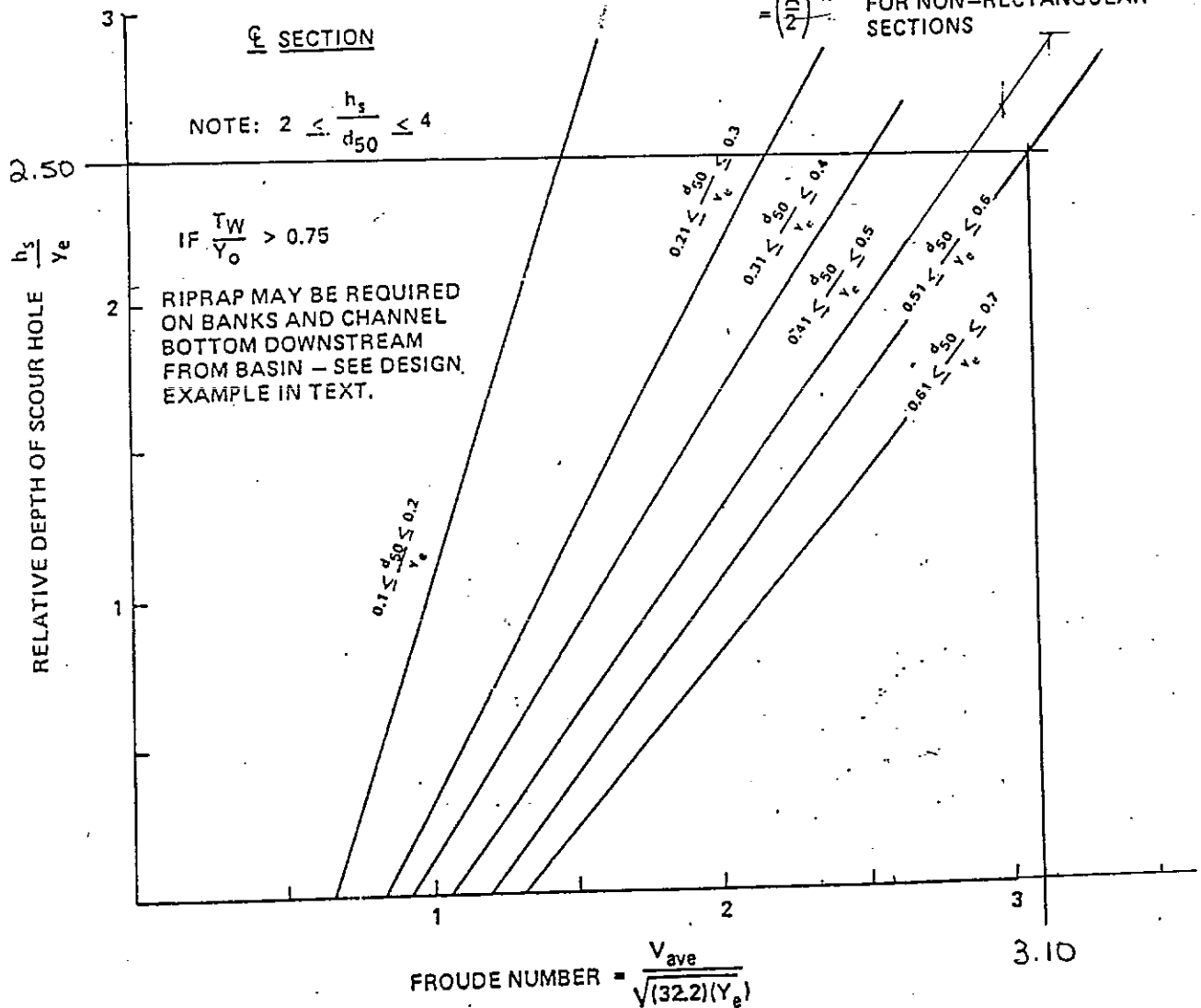
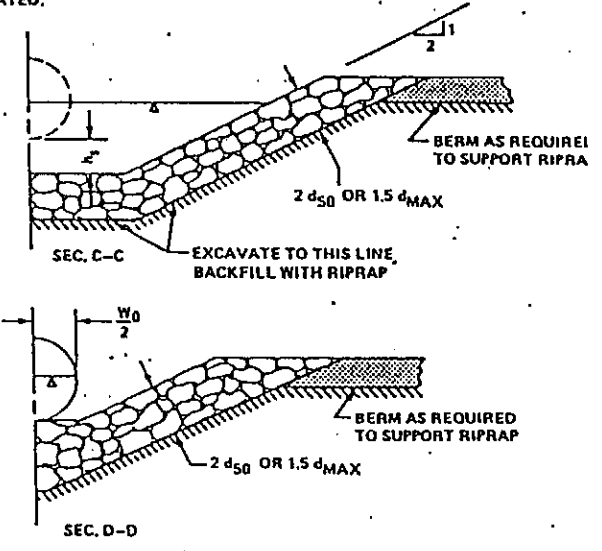
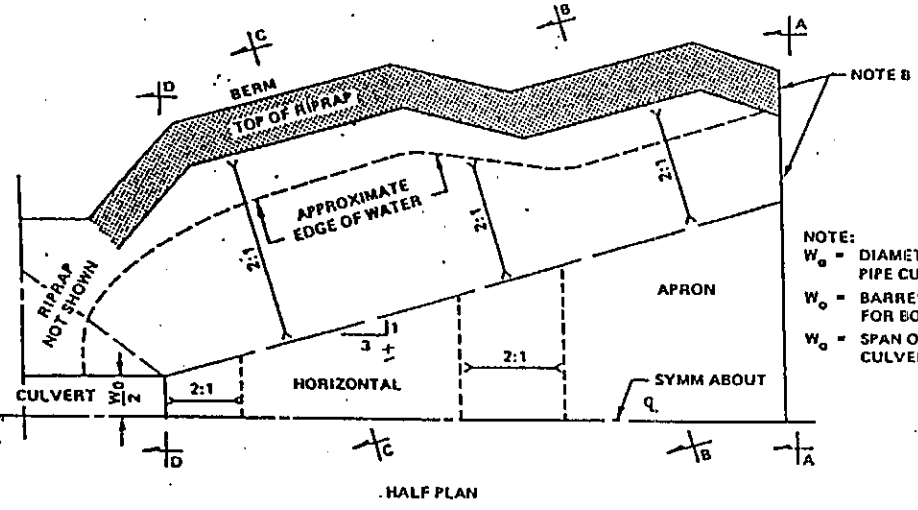
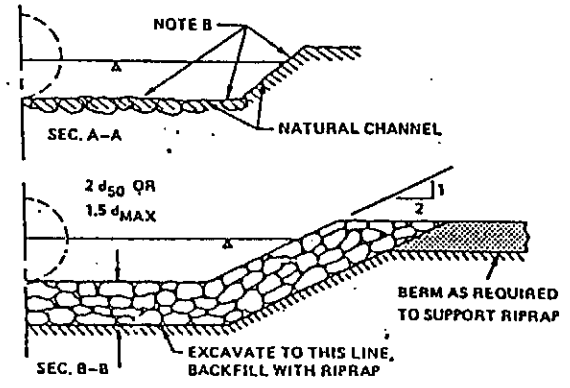
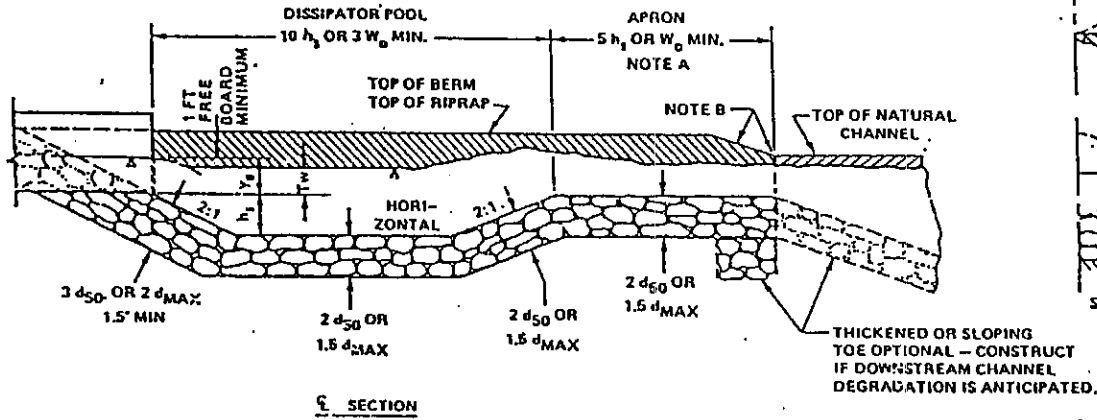


FIGURE 10-C.4 RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

The City of Colorado Springs / El Paso County Drainage Criteria Manual  10-46	Date 9-30-90
	Figure 10-C.4

NOTE A - IF EXIT VELOCITY OF BASIN IS SPECIFIED, EXTEND BASIN AS REQUIRED TO OBTAIN SUFFICIENT CROSS-SECTIONAL AREA AT SECTION A-A SUCH THAT  $Q_{avg} / (\text{CROSS SECTION AREA AT SEC. A-A}) = \text{SPECIFIED EXIT VELOCITY}$ .

NOTE B - WARP BASIN TO CONFORM TO NATURAL STREAM CHANNEL. TOP OF RIPRAP IN FLOOR OF BASIN SHOULD BE AT THE SAME ELEVATION OR LOWER THAN NATURAL CHANNEL BOTTOM AT SEC. A-A.



NOTE:  
 $W_0$  = DIAMETER FOR PIPE CULVERT  
 $W_0$  = BARREL WIDTH FOR BOX CULVERT  
 $W_0$  = SPAN OF PIPE-ARCH CULVERT

The City of Colorado Springs / El Paso County Drainage Criteria Manual  Details of Riprapped Culvert Energy Basin	Date 9-30-90
	Figure 10-C.5

10-47

**HYDRAULICS OF OUTLET WORKS, STORM DRAIN  
SYSTEM AND EMERGENCY SPILLWAY**



Project WEST MEADOW DET. POND - OUTFALL - STORM DRAIN PIPE		Job No EW1026
Client GATES LAND CO	By TMO	Date 9/94

### 1.) OUTLET WORKS

THE OUTLET STRUCTURE WAS DESIGNED TO CONVEY THE Q<sub>100</sub> RELEASE RATE OF 75CFS USING THE ORIFICE EQUATION

$$Q = CA(2gH)^{1/2}$$

REFER TO THE "100YR FLOOD ROUTING" SECTION FOR RELEASE RATE CALCULATIONS

### 2.) STORM DRAIN PIPE SYSTEM - OUTFALL PIPE

- INITIAL DESIGN OF THE OUTFALL PIPE WAS BASED ON THE MANNING'S EQUATION -  $Q = \frac{n}{1.486} R^{2/3} A S^{1/2}$

- FINAL DESIGN INCORPORATED A WSPG MODEL OF THE STORM DRAIN SYSTEM.

- A TR20 MODEL OF THE BASIN THAT INCLUDES WEST MEADOW DRIVE WAS DEVELOPED TO COMPUTE THE RUNOFF WITHIN THE STREET.

THE 100YR PEAK RUNOFF WAS COMPUTED TO BE 25CFS

### 3.) EMERGENCY SPILLWAY

THE SPILLWAY WAS DESIGNED TO CONVEY THE 100YR DEVELOPED RUNOFF - 497CFS. THE BROADCASTED WEIR EQUATION WAS USED TO CALCULATE THE LENGTH OF THE WEIR -  $Q = CLH^{3/2}$

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D. POND

Comment: OUTLET PIPE ANALYSIS

Solve For Actual Depth

Given Input Data:

Diameter.....	3.00 ft
Slope.....	0.0200 ft/ft
Manning's n.....	0.013
Discharge.....	79.00 cfs

Computed Results:

Depth.....	2.10 ft
Velocity.....	14.94 fps
Flow Area.....	5.29 sf
Critical Depth....	2.76 ft
Critical Slope....	0.0122 ft/ft
Percent Full.....	70.02 %
Full Capacity.....	94.33 cfs
QMAX @.94D.....	101.47 cfs
Froude Number.....	1.90 (flow is Supercritical)

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D. POND

Comment: OUTLET PIPE ANALYSIS

Solve For Actual Depth

Given Input Data:

Diameter.....	3.00 ft
Slope.....	0.0220 ft/ft
Manning's n.....	0.013
Discharge.....	79.00 cfs

Computed Results:

Depth.....	2.03 ft
Velocity.....	15.54 fps
Flow Area.....	5.08 sf
Critical Depth....	2.76 ft
Critical Slope....	0.0122 ft/ft
Percent Full.....	67.57 %
Full Capacity.....	98.93 cfs
QMAX @.94D.....	106.42 cfs
Froude Number.....	2.04 (flow is Supercritical)

Circular Channel Analysis & Design  
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: WEST MEADOW D. POND

Comment: OUTLET PIPE ANALYSIS

Solve For Actual Depth

Given Input Data:

Diameter.....	3.50 ft
Slope.....	0.0121 ft/ft
Manning's n.....	0.013
Discharge.....	104.00 cfs

Computed Results:

Depth.....	2.70 ft
Velocity.....	13.08 fps
Flow Area.....	7.95 sf
Critical Depth....	3.11 ft
Critical Slope....	0.0095 ft/ft
Percent Full.....	77.03 %
Full Capacity.....	110.67 cfs
QMAX @.94D.....	119.05 cfs
Froude Number.....	1.40 (flow is Supercritical)

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DET. BASIN - OUTFALL PIPE ANALYSIS  
 COLORADO SPRINGS, CO - SH 115 & ACADEMY BLVD  
 DREXEL BARRELL & CO TMO 8-19-94

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
1000.00	5879.28	2.652	5881.932	104.0	13.30	2.745	5884.677	0.00	3.112	3.50	0.00	0.00	0	0.00
37.89	0.01254					.012552	0.48		2.652			0.00		
1037.89	5879.76	2.652	5882.407	104.0	13.30	2.745	5885.152	0.00	3.112	3.50	0.00	0.00	0	0.00
129.61	0.01254					.012577	1.63		2.652			0.00		
1167.50	5881.38	2.647	5884.027	104.0	13.32	2.755	5886.782	0.00	3.112	3.50	0.00	0.00	0	0.00
5.00	0.02000					.012414	0.06		2.221			0.00		
1172.50	5881.48	2.683	5884.163	104.0	13.14	2.682	5886.845	0.00	3.112	3.50	0.00	0.00	0	0.00
236.79	0.01222					.012228	2.90		2.683			0.00		
1409.29	5884.37	2.683	5887.057	104.0	13.14	2.682	5889.739	0.00	3.112	3.50	0.00	0.00	0	0.00
191.20	0.01222					.011757	2.25		2.683			0.00		
1600.49	5886.71	2.787	5889.498	104.0	12.66	2.489	5891.987	0.00	3.112	3.50	0.00	0.00	0	0.00
54.23	0.01222					.010779	0.58		2.683			0.00		
1654.72	5887.37	2.935	5890.309	104.0	12.07	2.262	5892.571	0.00	3.112	3.50	0.00	0.00	0	0.00
12.78	0.01222					.009892	0.13		2.683			0.00		
1667.50	5887.53	3.112	5890.642	104.0	11.51	2.056	5892.698	0.00	3.112	3.50	0.00	0.00	0	0.00
JUNCT STR	0.10000					.007838	0.02					0.00		
1670.00	5887.78	4.706	5892.486	79.0	8.21	1.047	5893.533	0.00	2.778	3.50	0.00	0.00	0	0.00
TRANS STR	0.10000					.010097	0.03					0.00		
1672.50	5888.03	3.767	5891.797	79.0	11.18	1.939	5893.736	0.00	2.761	3.00	0.00	0.00	0	0.00
36.06	0.02041					.014029	0.51		2.083			0.00		
1708.56	5888.77	3.537	5892.303	79.0	11.18	1.939	5894.242	0.00	2.761	3.00	0.00	0.00	0	0.00
HYDRAULIC JUMP												0.00		

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DET. BASIN - OUTFALL PIPE ANALYSIS  
 COLORADO SPRINGS, CO - SH 115 & ACADEMY BLVD  
 DREXEL BARRELL & CO TMO 8-19-94

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD. EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
1708.56	5888.77	2.083	5890.849	79.0	15.08	3.532	5894.381	0.00	2.761	3.00	0.00	0.00	0	0.00
213.75	0.02041					.020446	4.37		2.083			0.00		
1922.31	5893.13	2.083	5895.212	79.0	15.08	3.532	5898.744	0.00	2.761	3.00	0.00	0.00	0	0.00
31.03	0.02041					.020452	0.63		2.083			0.00		
1953.34	5893.76	2.082	5895.845	79.0	15.08	3.533	5899.378	0.00	2.761	3.00	0.00	0.00	0	0.00
204.16	0.02041					.021719	4.43		2.083			0.00		
2157.50	5897.93	1.995	5899.925	79.0	15.82	3.887	5903.812	0.00	2.761	3.00	0.00	0.00	0	0.00
5.00	0.04000					.022568	0.11		1.660			0.00		
2162.50	5898.13	2.022	5900.152	79.0	15.59	3.775	5903.927	0.00	2.761	3.00	0.00	0.00	0	0.00
94.86	0.02070					.023329	2.21		2.072			0.00		
2257.36	5900.09	1.950	5902.044	79.0	16.24	4.095	5906.139	0.00	2.761	3.00	0.00	0.00	0	0.00
61.73	0.02070					.026054	1.61		2.072			0.00		
2319.09	5901.37	1.871	5903.242	79.0	17.03	4.503	5907.745	0.00	2.761	3.00	0.00	0.00	0	0.00
43.41	0.02070					.029394	1.28		2.072			0.00		
2362.50	5902.27	1.798	5904.068	79.0	17.86	4.954	5909.022	0.00	2.761	3.00	0.00	0.00	0	0.00
TRANS STR	0.10000					.032396	0.16					0.00		
2367.50	5902.77	2.463	5905.233	79.0	16.14	4.046	5909.279	0.00	2.463	2.50	0.00	0.00	0	0.00
0.69	0.01719					.035057	0.02		2.500			0.00		
2368.19	5902.78	2.500	5905.282	79.0	16.09	4.021	5909.303	0.00	2.463	2.50	0.00	0.00	0	0.00
262.81	0.01719					.036781	9.67		2.500			0.00		
2631.00	5907.30	7.731	5915.031	79.0	16.09	4.021	5919.052	0.00	2.463	2.50	0.00	0.00	0	0.00
2.00	0.01500					.037096	0.07		2.500			0.00		

WATER SURFACE PROFILE LISTING  
 WEST MEADOW DET. BASIN - OUTFALL PIPE ANALYSIS  
 COLORADO SPRINGS, CO - SH 115 & ACADEMY BLVD  
 DREXEL BARRELL & CO TMO 8-19-94

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
2633.00	5907.33	8.372	5915.702	79.0	16.09	4.021	5919.723	0.00	2.463	2.50	0.00	0.00	0	0.00
TRANS STR	0.04250					.059754	0.24					0.00		
2637.00	5907.50	7.830	5915.330	79.0	17.56	4.786	5920.116	0.00	1.000	1.00	4.75	0.00	0	0.00
0.50	0.00000					.082412	0.04		0.000			0.00		
2637.50	5907.50	7.872	5915.372	79.0	17.56	4.786	5920.158	0.00	1.000	1.00	4.75	0.00	0	0.00
WALL ENTRANCE												0.00		
2637.50	5907.50	16.940	5924.440	79.0	0.01	0.000	5924.440	0.00	0.092	24.00	500.00	4.00	0	0.00





WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO	14 IS A REACH	*	*	*						
	U/S DATA	STATION	INVERT	SECT	N		RADIUS	ANGLE	ANG PT	MAN H
		2637.50	5907.50	5	0.013		0.00	0.00	0.00	0

ELEMENT NO	15 IS A WALL ENTRANCE			*						
	U/S DATA	STATION	INVERT	SECT	FP					
		2637.50	5907.50	6	0.500					

ELEMENT NO	16 IS A SYSTEM HEADWORKS			*						
	U/S DATA	STATION	INVERT	SECT		W S ELEV				
		2637.60	5907.52	6		5910.00				

NO EDIT ERRORS ENCOUNTERED-COMPUTATION IS NOW BEGINNING



WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 1 IS -

WEST MEADOW DET. BASIN - OUTFALL PIPE ANALYSIS

HEADING LINE NO 2 IS -

COLORADO SPRINGS, CO - SH 115 & ACADEMY BLVD

HEADING LINE NO 3 IS -

DREXEL BARRELL & CO TMO 8-19-94

REVISED

Flows  
IN

WEST MEADOW  
Dr.

1

\*\*\*\*\*80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY\*\*\*\*\*

JOB TR-20 SUMMARY NOPLOTS  
TITLE DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
TITLE FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8

5 RAINFL 7		0.2500							
8	0.0000	0.0005	0.0015	0.0030	0.0045				
8	0.0060	0.0080	0.0100	0.0120	0.0143				
8	0.0165	0.0188	0.0210	0.0233	0.0255				
8	0.0278	0.0320	0.0390	0.0460	0.0530				
8	0.0600	0.0750	0.1000	0.4000	0.7000				
8	0.7250	0.7500	0.7650	0.7800	0.7900				
8	0.8000	0.8100	0.8200	0.8250	0.8300				
8	0.8350	0.8400	0.8450	0.8500	0.8550				
8	0.8600	0.8638	0.8675	0.8713	0.8750				
8	0.8788	0.8825	0.8863	0.8900	0.8938				
8	0.8975	0.9013	0.9050	0.9083	0.9115				
8	0.9148	0.9180	0.9210	0.9240	0.9270				
8	0.9300	0.9325	0.9350	0.9375	0.9400				
8	0.9425	0.9450	0.9475	0.9500	0.9525				
8	0.9550	0.9575	0.9600	0.9625	0.9650				
8	0.9675	0.9700	0.9725	0.9750	0.9775				
8	0.9800	0.9813	0.9825	0.9838	0.9850				
8	0.9863	0.9875	0.9888	0.9900	0.9913				
8	0.9925	0.9938	0.9950	0.9963	0.9975				
8	0.9988	1.0000	1.0000	1.0000	1.0000				
9 ENDTEL									
6 RUNOFF 1 001	5	.0075	93.0	0.16	1 1 1 1				
6 RUNOFF 1 002	6	.0031	98.0	0.19	1 1 1 1				
6 ADDHYD 4 003	5 6 7				1 1 1 1				
ENDATA									
7 INCREM 6		0.05							
7 COMPUT 7 001 003	0.0	4.6	1.0	7 2 01 99					
ENDCMP 1									
7 COMPUT 7 001 003	0.0	3.0	1.0	7 2 01 10					
ENDCMP 1									
ENDJOB 2									

0\*\*\*\*\*END OF 80-80 LIST\*\*\*\*\*

1

TR20 XEQ  
REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8

JOB 1 PASS 1  
PAGE 1

0

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

CHESTER, PA (NORTHEAST) -- 215-499-3933, FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)  
LINCOLN, NB (MIDWEST) -- 541-5318 (FTS), PORTLAND, OR (WEST) -- 423-4099 (FTS)  
OR HYDROLOGY UNIT, ENGINEERING DIVISION, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

- 12/17/82 - CORRECT PEAK RATE FACTOR FOR USER ENTERED DIMHYD  
CORRECT REACH ROUTING PEAK TRAVEL TIME PRINTED WITH FULLPRINT OPTION
- 5/02/83 - CORRECT COMPUTATIONS FOR ---
1. DIVISION OF BASEFLOW IN DIVERT OPERATION
  2. HYDROGRAPH VOLUME SPLIT BETWEEN BASEFLOW AND ABOVE BASEFLOW
  3. CROSS SECTION DATA PLOTTING POSITION
  4. INTERMEDIATE PEAK WHEN "FROM" AREA IS LARGER THAN "THRU" AREA
  5. STORAGE ROUTED REACH TRAVEL TIME FOR MULTYPEAK HYDROGRAPH
  6. ORDERING "FLOW-FREQ" FILE FROM SUMMARY TABLE #3 DATA
  7. BASEFLOW ENTERED WITH READHYD
  8. LOW FLOW SPLIT DURING DIVERT PROCEDURE #2 WHEN SECTION RATINGS START AT DIFFERENT ELEVATIONS
- ENHANCEMENTS ---
1. REPLACE USER MANUAL ERROR CODES (PAGE 4-9 TO 4-11) WITH MESSAGES
  2. LABEL OUTPUT HYDROGRAPH FILES WITH CROSS SECTION/STRUCTURE, ALTERNATE AND STORM NO'S
- 09/01/83 - CORRECT INPUT AND OUTPUT ERRORS FOR INTERMEDIATE PEAKS  
CORRECT COMBINATION OF RATING TABLES FOR DIVERT  
CHECK REACH ROUTING PARAMETERS FOR ACCEPTABLE LIMITS  
ELIMINATE MINIMUM REACH TRAVEL TIME WHEN ATT-KIN COEFFICIENT EQUALS ONE

1

TR20 XEQ

REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)

FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8

JOB 1 PASS 1  
PAGE 2

CUMULATIVE RAINFALL TABLE 7

TIME INCREMENT= .25

8

.0000 .0005 .0015 .0030 .0045

8	.0165	.0188	.0210	.0233	.0255
8	.0278	.0320	.0390	.0460	.0530
8	.0600	.0750	.1000	.4000	.7000
8	.7250	.7500	.7650	.7800	.7900
8	.8000	.8100	.8200	.8250	.8300
8	.8350	.8400	.8450	.8500	.8550
8	.8600	.8638	.8675	.8713	.8750
8	.8788	.8825	.8863	.8900	.8938
8	.8975	.9013	.9050	.9083	.9115
8	.9148	.9180	.9210	.9240	.9270
8	.9300	.9325	.9350	.9375	.9400
8	.9425	.9450	.9475	.9500	.9525
8	.9550	.9575	.9600	.9625	.9650
8	.9675	.9700	.9725	.9750	.9775
8	.9800	.9813	.9825	.9838	.9850
8	.9863	.9875	.9888	.9900	.9913
8	.9925	.9938	.9950	.9963	.9975
8	.9988	1.0000	1.0000	1.0000	1.0000

9 ENDTBL

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 1 RECORD ID  
 OUTPUT HYDROGRAPH = 5 DATA FIELD VALUES = .0075 93.0000 .1600  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 2 RECORD ID  
 OUTPUT HYDROGRAPH = 6 DATA FIELD VALUES = .0031 98.0000 .1900  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

STANDARD CONTROL OPERATION ADDHYD CROSS SECTION 3 RECORD ID  
 INPUT HYDROGRAPHS = 5,6 OUTPUT HYDROGRAPH = 7 DATA FIELD VALUES = .0000 .0000 .0000  
 OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

EXECUTIVE CONTROL OPERATION INCREM RECORD ID  
 + MAIN TIME INCREMENT = .05 HOURS

EXECUTIVE CONTROL OPERATION COMPUT RECORD ID  
 + FROM XSECTION 1  
 + TO XSECTION 3  
 STARTING TIME = .00 RAIN DEPTH = 4.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 7 ANT. MOIST. COND= 2  
 ALTERNATE NO.= 1 STORM NO.=99 MAIN TIME INCREMENT = .05 HOURS

OPERATION RUNOFF CROSS SECTION 1  
 1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 1  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8 PAGE 3

PEAK TIME (HRS) PEAK DISCHARGE (CFS) PEAK ELEVATION (FEET)  
 5.98 25.11 (RUNOFF)

TIME (HRS)	FIRST HYDROGRAPH POINT =	.00 HOURS	TIME INCREMENT =	.05 HOURS	DRAINAGE AREA =	.01 SQ.MI.
4.00	DISCHG	.00 .00 .00 .01	.01	.02 .03 .04 .05 .06		
4.50	DISCHG	.07 .08 .09 .09	.10	.11 .12 .13 .13 .14		
5.00	DISCHG	.15 .17 .24 .32	.37	.41 .48 .62 .77 .87		
5.50	DISCHG	.98 2.39 7.34 13.28	17.57	20.32 22.12 23.29 24.08 24.64		



PEAK TIME (HRS) 5.98 PEAK DISCHARGE (CFS) 36.07 PEAK ELEVATION (FEET) (NULL)

TIME (HRS)	DISCHG	FIRST HYDROGRAPH POINT = .00 HOURS	TIME INCREMENT = .05 HOURS	DRAINAGE AREA = .01 SQ. MI.
2.00	.01	.01	.01	.02
2.50	.02	.02	.02	.03
3.00	.03	.03	.03	.04
3.50	.04	.04	.04	.05
4.00	.08	.09	.10	.20
4.50	.24	.25	.26	.32
5.00	.35	.39	.51	1.16
5.50	1.75	3.77	10.91	33.83
6.00	35.86	33.21	24.02	34.82
6.50	3.10	2.97	2.61	3.34
7.00	1.84	1.79	1.61	1.85
7.50	1.23	1.23	1.23	1.23
8.00	1.23	1.18	1.00	1.23
8.50	.62	.62	.62	.62
9.00	.62	.62	.62	.62
9.50	.62	.62	.62	.62
10.00	.62	.60	.56	.62
10.50	.46	.46	.46	.46
11.00	.46	.46	.46	.46
11.50	.46	.46	.46	.46
12.00	.46	.46	.46	.46
12.50	.46	.46	.46	.46
13.00	.46	.45	.44	.40
13.50	.40	.40	.40	.40
14.00	.40	.39	.39	.37

1

TR20 XEQ DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND) JOB 1 PASS 1  
 REV 09/01/83 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8 PAGE 5

14.50 DISCHG .37 .37 .37 .37 .37 .37 .37 .37 .37 .37 .37  
 RUNOFF VOLUME ABOVE BASEFLOW = 3.64 WATERSHED INCHES, 24.89 CFS-HRS, 2.06 ACRE-FEET; BASEFLOW = .00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP RECORD ID  
 + COMPUTATIONS COMPLETED FOR PASS 1

EXECUTIVE CONTROL OPERATION COMPUT RECORD ID  
 + FROM XSECTION 1  
 + TO XSECTION 3  
 STARTING TIME = .00 RAIN DEPTH = 3.00 RAIN DURATION = 1.00 RAIN TABLE NO. = 7 ANT. MOIST. COND = 2  
 ALTERNATE NO. = 1 STORM NO. = 10 MAIN TIME INCREMENT = .05 HOURS







SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED  
 (A STAR(\*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH  
 A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION			RUNOFF AMOUNT (IN)	PEAK DISCHARGE			
						BEGIN (HR)	AMOUNT (IN)	DURATION (HR)		ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 99													
XSECTION 1	RUNOFF	.01	7	2	.05	.0	4.60	24.00	3.48	---	5.98	25.11	3348.5
XSECTION 2	RUNOFF	.00	7	2	.05	.0	4.60	24.00	4.03	---	5.98	10.96	3534.8
XSECTION 3	ADDHYD	.01	7	2	.05	.0	4.60	24.00	3.64	---	5.98	36.07	3402.9
ALTERNATE 1 STORM 10													
XSECTION 1	RUNOFF	.01	7	2	.05	.0	3.00	24.00	2.05	---	5.99	15.35	2046.6
XSECTION 2	RUNOFF	.00	7	2	.05	.0	3.00	24.00	2.55	---	5.98	7.08	2283.1
XSECTION 3	ADDHYD	.01	7	2	.05	.0	3.00	24.00	2.19	---	5.99	22.42	2115.5

TR20 XEQ  
 REV 09/01/83

DREXEL BARRELL JOB NO. EW-1026 (FT. CARSON DET. POND)  
 FUT. CONDITIONS (FULL DEV., 24 HR. STORMS) - 1st Filing N1 & N8

JOB 1 SUMMARY  
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SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.....	
		10	99
0 XSECTION 1	.01		
+-----			
ALTERNATE 1		15.35	25.11
0 XSECTION 2	.00		
+-----			
ALTERNATE 1		7.08	10.96
0 XSECTION 3	.01		
+-----			
ALTERNATE 1		22.42	36.07

LEND OF 1 JOBS IN THIS RUN

Project WEST MEADOW DET. POND.	Job NO EW1026	
Client GATES LAND CO	By TMO	Date 9/94

## SPILLWAY DESIGN

USE BROAD-CRESTED WEIR EQUATION -  $Q = CLH^{3/2}$

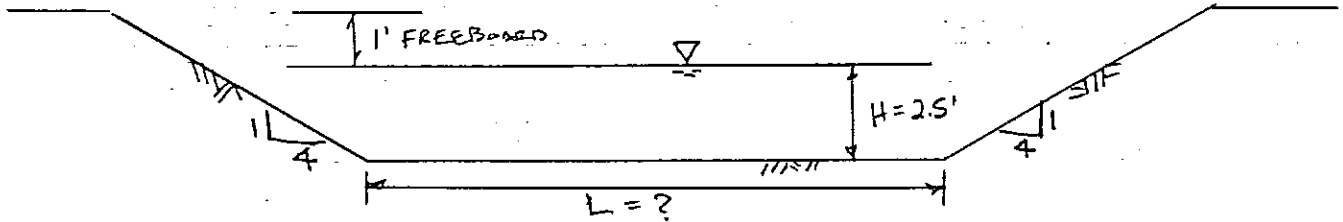
$$Q_{100} = 497 \text{ cfs}$$

$$H = 2.5 \text{ FT}$$

$$C = 3.1 \text{ (CITY OF CO. SPRINGS DRAINAGE MANUAL)}$$

$$C = 2.63 \text{ (BRATER \& KING)}$$

SOLVE FOR L - LENGTH OF WEIR



$$L = Q / C H^{3/2}$$

$$L_{3.1} = 497 / (3.1) (2.5)^{3/2} = 40.56 \text{ FT} \sim \underline{\underline{40 \text{ FT}}}$$

$$L_{2.63} = 497 / (2.63) (2.5)^{3/2} = 47.8 \text{ FT} \sim \underline{\underline{48 \text{ FT}}}$$

SINCE THE WEIR LENGTH VARIES w/ DEPTH (SIDE SLOPES)

USE WEIR LENGTH = 40 FT