Harrison Outfall

DRAINAGE CONDITIONS AT AND RECOMMENDED MODIFICATIONS TO THE HARRISON OUTFALL

Prepared For

GATES LAND COMPANY

Drexel Barrell & Co.

Engineers/Surveyors
Incorporated

Boulder,
Colorado Springs

4840 Pearl East Circle
Suite 114
Boulder, Colorado 80301

303 442 4338

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Prepared For

GATES LAND COMPANY

Prepared by:

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(303) 442-4338

February 12, 1997

Drexel Barrell & Co.

Engineers/Surveyors

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4840 Pearl East Circle
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303 442 4338

October 30, 1996
(Revised January 3, 1997)
(Revised January 17, 1997)
(Revised February 11, 1997)

Mr. Robert F. Svejkovsky
Gates Land Company
202 E. Cheyenne Mountain Blvd., Suite I
Colorado Springs, Colorado 80906

Re: Drainage Conditions at and Recommended Modifications to The Harrison Outfall **E4826**

Dear Mr. Svejkovsky:

In response to our discussions relative to the Harrison Outfall, Drexel Barrell has conducted research, collected information (dating back to 1956) and performed an analysis of the hydrologic conditions. We have reviewed the area, the impact of Interstate #25 and considered current and future drainage conditions on both the east and west side of the box culvert under the highway and along the west frontage road vicinity between the Harrison Box and the Sinton Underpass.

In addition, we have reviewed the situation relative to the "City of Colorado Springs and El Paso County Drainage Criteria Manual" and believe the data and information presented herein, demonstrates the recommended alternative and design calculations for the alternative, meets and exceeds any existing or previous criteria. The relative information, findings and design calculations for the recommended alternative are presented in this analysis and design report.

If you have any questions or comments please contact me at your convenience.

Sincerely,

Drexel Barrell & Co.

Clifford R. Brockman, P.E.
Vice President

Z:User/Cliff/E4826/Harrison Outfall

TABLE OF CONTENTS

BACKGROUND

The tributary basin draining to the Harrison Outfall and I-25 consists of approximately 960 acres (See Figure 1). Historically, the entire natural drainage outfall from this basin drained via a natural channel just south of the existing Harrison High School. In 1956 the Colorado Department of Highways (CDOH) constructed a 10' X 6' box culvert at this drainageway as part of their Interstate Highway #25 construction. This box was capable of receiving 350 cfs and passing it under I-25. Any flow greater than 350 cfs would first drain south along the highway frontage road and then overtop I-25.

The tributary area consists of runoff from west of Venetucci Boulevard (old Highway #85/87) and from flows generated between Venetucci Boulevard and I-25 (See Figures 1 and 1A). Since 1956, the basin boundaries have been modified by construction several times. The present day basin boundary is reflected in the 1994 Stratton Basin Outfall System Plan and consists of approximately 256 acres (See Figure 1A).

The drainage from this Harrison tributary is accommodated by the 10' X 6' box culvert under I-25. The 100 year historic flow, based on **current** (1988) City Drainage criteria, is calculated to be 760 cfs for the 960 acres. The 760 cfs is arrived at by viewing the basin as if it were open, undeveloped land with natural grasses and vegetation. Hydrologically, undeveloped land in the vicinity typically has SCS soil classifications of Type B and Type C. **Appendix A** shows the calculations and appurtenant information which supports this analysis. The capacity of the Harrison box culvert calculates to be 350 cfs flowing full, which is the capacity it was sized for by CDOH when it was originally designed (See Figure 2A and 2B).

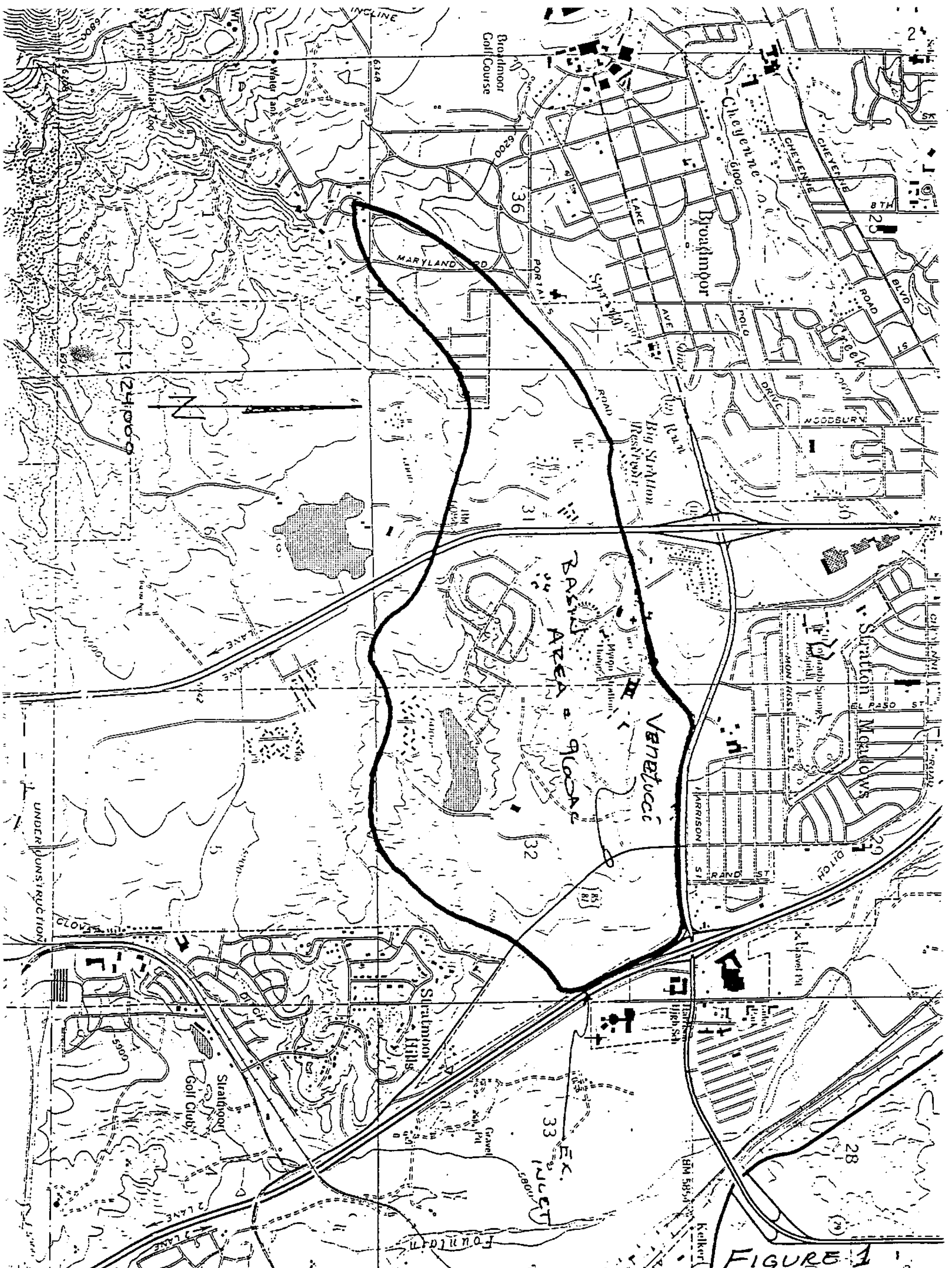
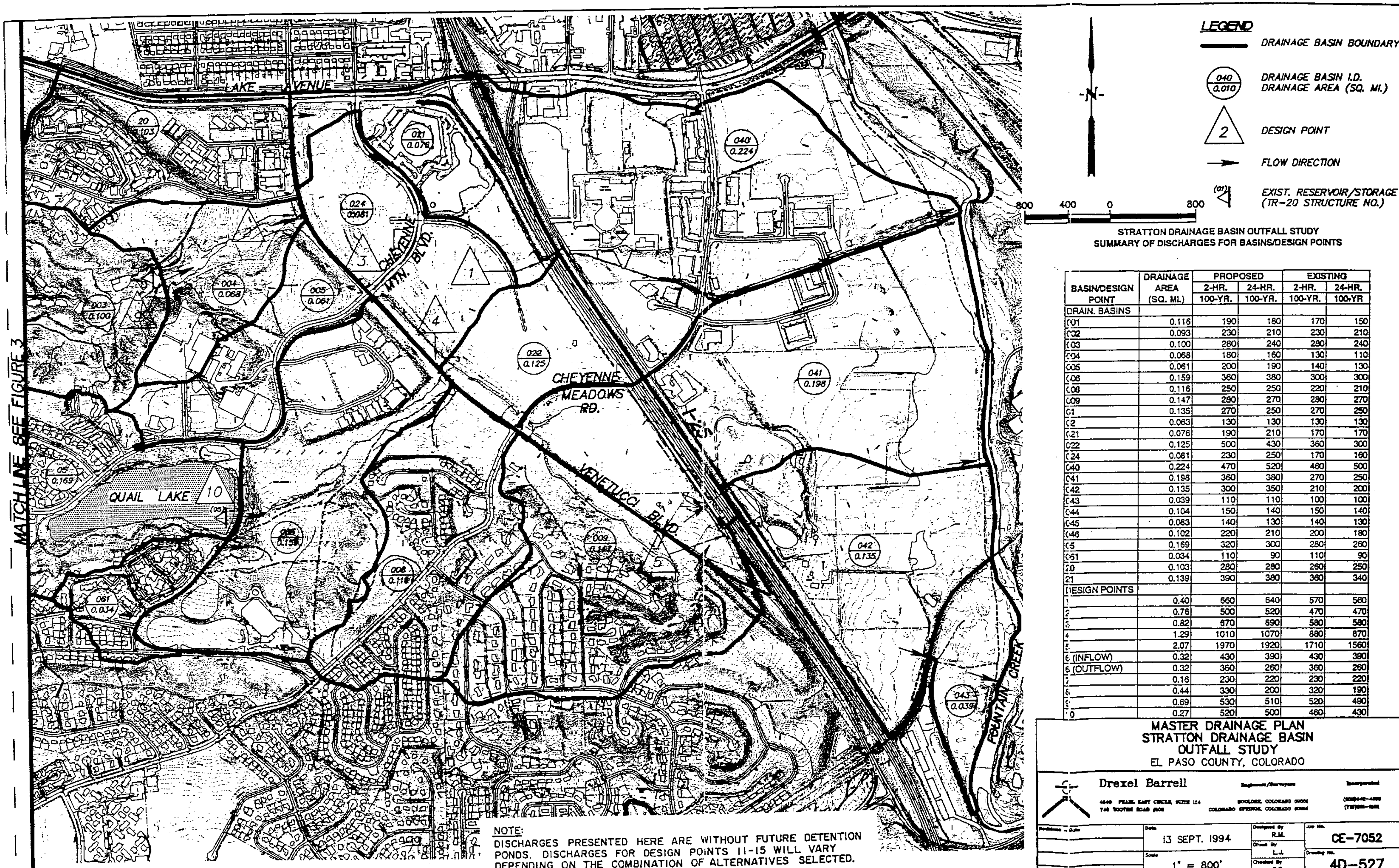

Venetucci
BASIN AREA = 900 AC
EX. INLET
Broadmoor
Broadmoor Golf Course
Cheyenne
Stratton Meadows
Stratmoor Hills
Stratmoor Golf Club
Big Stratton Reservoir
MARYLAND RD
WOODBURN AVE
EL PASO ST
HARRISON
RAND ST
LAKE AVE
POLO DRIVE
CHEYENNE ROAD
INCLINE
Water Tank
Fountain
Kelker
Gravel Pit
UNDER CONSTRUCTION
2 LANE
DITCH
36
31
32
33
28
29

FIGURE 1



STRATTON DRAINAGE BASIN OUTFALL STUDY
SUMMARY OF DISCHARGES FOR BASINS/DESIGN POINTS

BASIN/DESIGN POINT	DRAINAGE AREA (SQ. MI.)	PROPOSED 2-HR. 100-YR.	PROPOSED 24-HR. 100-YR.	EXISTING 2-HR. 100-YR.	EXISTING 24-HR. 100-YR
DRAIN. BASINS					
001	0.116	190	180	170	150
002	0.093	230	210	230	210
003	0.100	280	240	280	240
004	0.068	180	160	130	110
005	0.061	200	190	140	130
006	0.159	360	380	300	300
008	0.116	250	250	220	210
009	0.147	280	270	280	270
01	0.135	270	250	270	250
02	0.063	130	130	130	130
021	0.076	190	210	170	170
022	0.125	500	430	360	300
024	0.081	230	250	170	160
040	0.224	470	520	460	500
041	0.198	360	380	270	250
042	0.135	300	350	210	200
043	0.039	110	110	100	100
044	0.104	150	140	150	140
045	0.083	140	130	140	130
046	0.102	220	210	200	180
05	0.169	320	300	280	260
061	0.034	110	90	110	90
20	0.103	280	280	260	250
21	0.139	390	380	360	340
DESIGN POINTS					
1	0.40	660	640	570	560
2	0.76	500	520	470	470
3	0.82	670	690	580	580
4	1.29	1010	1070	880	870
5	2.07	1970	1920	1710	1560
6 (INFLOW)	0.32	430	390	430	390
6 (OUTFLOW)	0.32	360	260	360	260
7	0.16	230	220	230	220
8	0.44	330	200	320	190
9	0.69	530	510	520	490
10	0.27	520	500	460	430

NOTE:
DISCHARGES PRESENTED HERE ARE WITHOUT FUTURE DETENTION PONDS. DISCHARGES FOR DESIGN POINTS 11-15 WILL VARY DEPENDING ON THE COMBINATION OF ALTERNATIVES SELECTED.

MASTER DRAINAGE PLAN
STRATTON DRAINAGE BASIN
OUTFALL STUDY
EL PASO COUNTY, COLORADO

Drexel Barrell

Date	13 SEPT. 1994	Designed By R.M.	Job No. CE-7052
Scale	1" = 800'	Drawn By L.J. / Checked By C.B.	Drawing No. 4D-527

FIGURE 1A

Rating Table Report
HARRISON

Range Data:

	Minimum	Maximum	Increment
Discharge	0.00	350.00	10.00 cfs

Discharge (cfs)	HW Elev (ft)	HWi (ft)	HWo (ft)	Dn V (ft/s)	Dn depth (ft)
0.00	2.30	2.30	2.30	0.00	0.00
10.00	54.45	54.40	54.45	3.98	0.25
20.00	54.77	54.69	54.77	5.20	0.38
30.00	55.04	54.93	55.04	6.07	0.49
40.00	55.29	55.15	55.29	6.76	0.59
50.00	55.51	55.35	55.51	7.35	0.68
60.00	55.72	55.54	55.72	7.82	0.77
70.00	55.91	55.72	55.91	8.23	0.85
80.00	56.10	55.89	56.10	8.58	0.93
90.00	56.28	56.05	56.28	8.91	1.01
100.00	56.45	56.21	56.45	9.20	1.09
110.00	56.62	56.36	56.62	9.48	1.16
120.00	56.78	56.50	56.78	9.73	1.23
130.00	56.94	56.65	56.94	9.97	1.30
140.00	57.10	56.79	57.10	10.19	1.37
150.00	57.25	56.92	57.25	10.40	1.44
160.00	57.39	57.06	57.39	10.60	1.51
170.00	57.54	57.19	57.54	10.79	1.58
180.00	57.68	57.31	57.68	10.97	1.64
190.00	57.82	57.44	57.82	11.14	1.71
200.00	57.95	57.56	57.95	11.30	1.77
210.00	58.09	57.68	58.09	11.46	1.83
220.00	58.22	57.80	58.22	11.61	1.89
230.00	58.35	57.92	58.35	11.76	1.96
240.00	58.48	58.04	58.48	11.90	2.02
250.00	58.60	58.15	58.60	12.04	2.08
260.00	58.73	58.26	58.73	12.17	2.14
270.00	58.85	58.37	58.85	12.30	2.20
280.00	58.97	58.48	58.97	12.42	2.25
290.00	59.09	58.59	59.09	12.54	2.31
300.00	59.21	58.70	59.21	12.66	2.37
310.00	59.33	58.81	59.33	12.77	2.43
320.00	59.45	58.91	59.45	12.88	2.48
330.00	59.56	59.01	59.56	12.99	2.54
340.00	59.67	59.12	59.67	13.09	2.60
350.00	59.79	59.22	59.79	13.19	2.65

350 cfs @ 59.79'

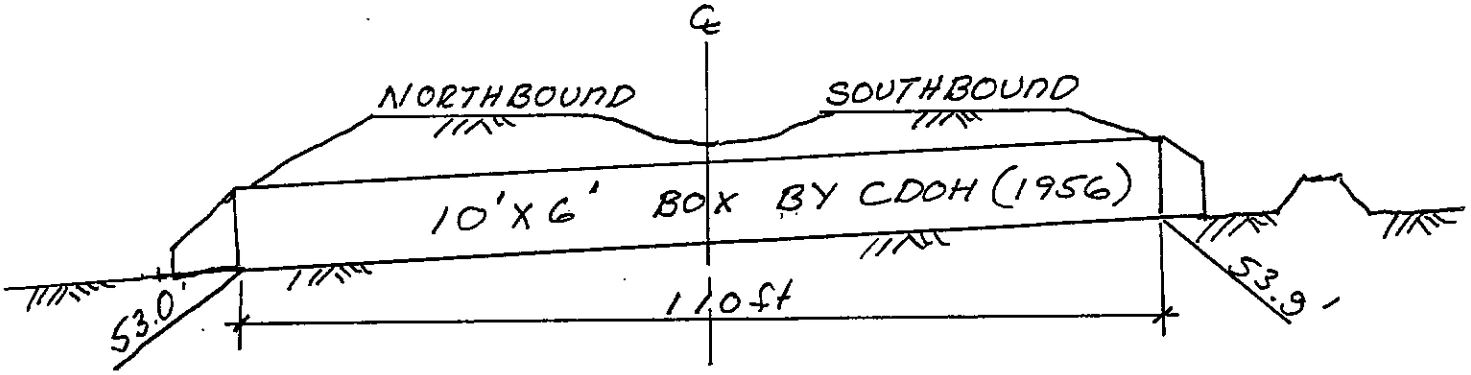


FIG. 2A

Culvert Calculator Report
HARRISON

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	60.00 ft	Headwater Depth/ Height	1.02
Computed Headwater Elevation	60.00 ft	Discharge	369.14 cfs
Inlet Control HW Elev	59.41 ft	Tailwater Elevation	2.30 ft
Outlet Control HW Elev	60.00 ft	Control Type	Outlet Control

Grades			
Upstream Invert	53.90 ft	Downstream Invert	53.00 ft
Length	110.00 ft	Constructed Slope	0.008182 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.76 ft
Slope Type	Steep	Normal Depth	2.53 ft
Flow Regime	Supercritical	Critical Depth	3.49 ft
Velocity Downstream	13.38 ft/s	Critical Slope	0.003288 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	10.00 ft
Section Size	10 x 6 ft	Rise	6.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	60.00 ft	Upstream Velocity Head	1.74 ft
Ke	0.50	Entrance Loss	0.87 ft

Inlet Control Properties			
Inlet Control HW Elev	59.41 ft	Flow Control	N/A
Inlet Type	45 ° non-offset wingwall flares	Area Full	60.0 ft²
K	0.49700	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	1
C	0.03390	Equation Form	2
Y	0.80300		

FIG 2B

Several events occurred between 1973 and 1994 which both reduced and diverted the historic flows from this basin. First, in 1973, Hartzell-Pfeiffenburger prepared a Drainage Report for the area titled **"The Master Drainage Plan Harrison Street- I-25 Vicinity, Cheyenne Mountain Ranch".**

This master plan took into account the fact that the box culvert had less capacity than would be required to pass either the 100 year historic or developed flows. Their drainage plan (which embraced the rational behind the installation of the 90" and 66" diameter stormwater drains currently along in Venetucci (proposed intercepting much of the flow coming from west of Venetucci (old Highway #85/87) and draining it south along the old highway (Venetucci Boulevard) alignment to discharge through the Sinton Outfall Box Culvert (a 12' X 11' box) under I-25.

Next, Quail Lake was constructed which attenuated the flows in the Quail Creek Basin by reservoir detention. Most recently, the K Basin detention ponds (K1 and K2) were constructed, which also reduced the flows coming from the west. Both of these major basins, which historically flowed to the Harrison Box Culvert (and several smaller basins), are all now diverted south to the Sinton Outfall Channel.

In 1985, Drexel Barrell & Co. prepared the **"Master Drainage Report for Cheyenne Mountain Center and Final Drainage Report for Cheyenne Mountain Center Filing #1 and Cheyenne Mountain Road'**, October 2, 1985. Figure 3 is a composite map from the 1985 master plan showing the total 100 year flow at the Harrison Box (Design point #4 on Figure 3) consisted of $Q=_{100}$ 350 cfs (the maximum box capacity before over topping) through the box and Q_{100} = 112 cfs which allowed to flow down the frontage road to the south ultimately to the Sinton Box Culvert. Thus, the total developed 100 year flow at the Harrison Box in 1985 was calculated to be **462 cfs**.

The 1985 Master Drainage Report utilized a 6 hour rainfall event to calculate the 5 year and 100 year rainfall and runoff amounts. This 6 hour rainfall event was criteria from the 1977 (as amended through 1985) City of Colorado Springs, **"Determination of Storm Runoff Criteria".** In 1994 the criteria used was increased to utilize the 24 hour rainfall event. This typically increases the "calculated" storm quantities in the range of 20% to 30%. Additionally, the 1985 report utilized an estimated total tributary area to the Harrison Box of 205 acres or 0.32 sq. miles (See figure 3A). The 1994 report established a tributary area of 256 acres or 0.40 sq. miles (See figure 6). The difference is principally because in 1994, new construction allowed the tributary areas to be easier to define. Existing buildings, pipelines, roads and parking lot drainages have allowed engineers to more precisely plot the exact drainage boundaries.

While computations show the two items discussed above tended to increase the flows from 1985 to 1994, it should be kept in mind simultaneously that construction of infrastructure was decreasing tributary area from 960 acres to 256 acres. This analysis uses the latest City Criteria and all historic vs. developed calculations are based on this latest criteria.

Appendix "B" shows the computations from the 1985 report which defined the 462 cfs as well as channel capacity calculations for the frontage road. Additionally, in Appendix "B" is the September 9, 1985 letter from CDOH allowing flows into their right-of-way where the west frontage road was to be abandoned.

The 1985 fully developed 100 year flow was 462 cfs of which 350 cfs was allowed to discharge through the 10' X 6' box.

In 1994 Drexel Barrell & Co. was retained by El Paso County to prepare the **Stratton Basin Outfall Master Plan**. The 1994 Master Plan took into account the previously noted revisions in drainage patterns created by both construction and the type of storm criteria utilized. The new 100 year developed flow to the Harrison Box is calculated **640 cfs.**

The 1994 fully developed 100 year flow is 640 cfs of which 350 cfs was allowed to discharge through the 10' X 6' box.

The 1994 plan proposed sending the overflow of **290 cfs** (640 minus 350) down the frontage road to the newly designed Sinton Outfall System. This system consisted of a 90" stormdrain, which reduced to a 72" under I-25, and a "Bubbler" which allowed surcharge flows to "Bubble Up" and flow through the Sinton Box Culvert. The system proposed extending the east lateral of collection storm pipe north up the frontage road. It consisted of a 78" and 66" diameter pipe lines terminating in the vicinity of Harrison Box Culvert. Approximately, 200 cfs would flow in the pipeline and 90 cfs ± would be allowed to continue flowing in CDOT right-of-way (See Figure 4).

<u>**Low Flow Considerations**</u>

The analysis of flow frequency vs. quantity of discharge has been developed in Appendix A for flows ranging from 2 year through 100 year events. It can be seen that the historic 5 year flow generated from the 960 acres of tributary land (assumed to be natural grasses and undeveloped) calculates to be **233 cfs** under current City criteria.

In 1985 the aforementioned (Master Drainage Report for Cheyenne Mountain Center...) drainage report, calculated the 5 year developed flow to be **218 cfs** at the Harrison Box Culvert (See Figure 3). The Harrison system would easily handle the 218 cfs flow to and through the box with no flow to be diverted to the south in the I-25 frontage road.

In March of 1995, an extension of the December, 1994 Master Plan was prepared. This report titled, **"Preliminary Drainage Study vs. Highway 85/87 (Venetucci Boulevard) and State Highway 29 (Lake Avenue) Colorado Springs, Colorado"**, shows the 5 year flows based on the latest City criteria. The 5 year flow at the Harrison Box, (based on the City 's latest criteria) is calculated to be **330 cfs** (See Figure 6).

In the 1994 Plan, the smaller more frequent event flows from the Harrison Basin would begin flowing through the box. The plan showed a weir and a "Box" inlet which would allow runoff to flow south along the Frontage Road. The weir releasing to the south (to the Frontage Road) was set at elevation 5857.1 ft. Thus, flow in the Harrison Box would be **140 cfs** when flow into the Sinton System at the frontage road started. This occurred at approximately time equaling 1.30 hours into the 100 year storm event. It is important to note although flows lag 1.3 hours, the 290 cfs peak flow still occurs at 6.1 hours into the storm event.

Following is a summary table of the various 100 year peak flows and times of peaks for both Sinton and Harrison under the 1994 plan.

Location	**1994 Existing Conditions 100 YR Q (cfs)**	**1994 Existing Conditions Time to Peak (Hours)**	**1994 Master Plan Q (cfs)**	**1994 Master Plan time to Peak (Hours)**
Sinton in Pipe	-	-	610	6.2
Sinton in Box	1920	6.3	750	6.2
TOTAL:	1920	-	1360	-
Harrison Box	350	6.1	350	6.1
Harrison South	290	6.1	290	6.1

Appendix "C" consists of select TR-20 sheets which were copied from the 1994 Master Plan.

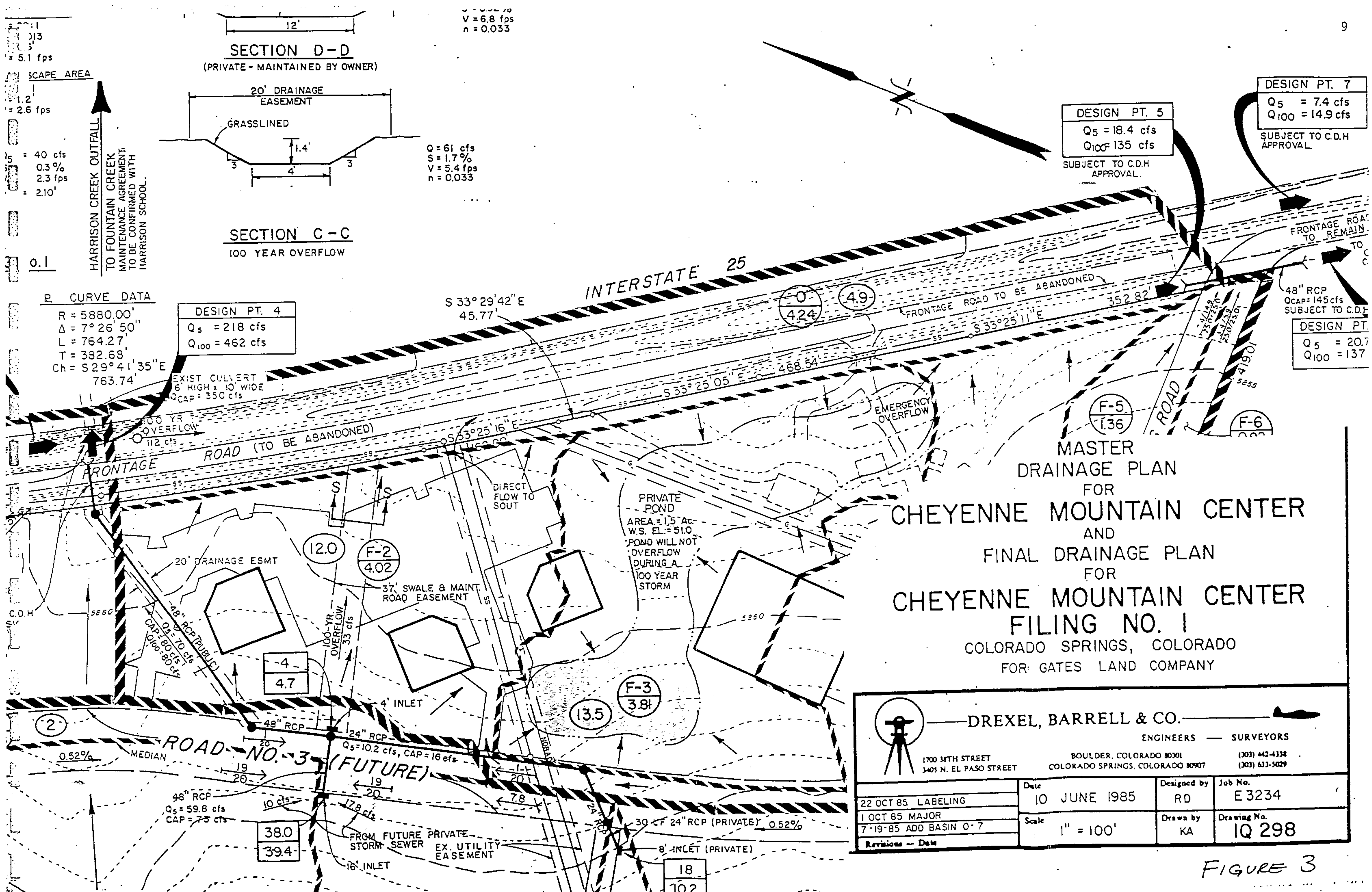

SECTION D-D
(PRIVATE - MAINTAINED BY OWNER)
V = 6.8 fps
n = 0.033
20' DRAINAGE EASEMENT
GRASSLINED
Q = 61 cfs
S = 1.7%
V = 5.4 fps
n = 0.033
SECTION C-C
100 YEAR OVERFLOW
HARRISON CREEK OUTFALL TO FOUNTAIN CREEK
MAINTENANCE AGREEMENT TO BE CONFIRMED WITH HARRISON SCHOOL.
CURVE DATA
R = 5880.00'
Δ = 7° 26' 50"
L = 764.27'
T = 382.68'
Ch = S 29° 41' 35" E
763.74'
DESIGN PT. 4
Q5 = 218 cfs
Q100 = 462 cfs
EXIST CULVERT 6' HIGH x 10' WIDE
QCAP = 350 cfs
100 YR OVERFLOW 112 cfs
INTERSTATE 25
FRONTAGE ROAD (TO BE ABANDONED)
FRONTAGE ROAD TO BE ABANDONED
S 33° 29' 42" E
45.77'
S 33° 25' 05" E
468.54'
S 33° 25' 11" E
352.82'
S 33° 25' 16" E
DESIGN PT. 5
Q5 = 18.4 cfs
Q100 = 135 cfs
SUBJECT TO C.D.H APPROVAL.
DESIGN PT. 7
Q5 = 7.4 cfs
Q100 = 14.9 cfs
SUBJECT TO C.D.H APPROVAL.
FRONTAGE ROAD TO REMAIN
48" RCP
QCAP = 145 cfs
SUBJECT TO C.D.H
DESIGN PT.
Q5 = 20.7
Q100 = 137
EMERGENCY OVERFLOW
DIRECT FLOW TO SOUT
PRIVATE POND
AREA = 1.5 Ac.
W.S. EL. = 51.0
POND WILL NOT OVERFLOW DURING A 100 YEAR STORM
20' DRAINAGE ESMT
48" RCP (PUBLIC)
37' SWALE & MAINT. ROAD EASEMENT
100-YR. OVERFLOW 33 cfs
4' INLET
48" RCP
24" RCP
Q5 = 10.2 cfs, CAP = 16 cfs
ROAD NO. 3 (FUTURE)
MEDIAN
0.52%
48" RCP
Q5 = 59.8 cfs
CAP = 75 cfs
FROM FUTURE PRIVATE STORM SEWER
EX. UTILITY EASEMENT
6' INLET
30 LF 24" RCP (PRIVATE)
8' INLET (PRIVATE)
MASTER DRAINAGE PLAN FOR CHEYENNE MOUNTAIN CENTER AND FINAL DRAINAGE PLAN FOR CHEYENNE MOUNTAIN CENTER FILING NO. 1
COLORADO SPRINGS, COLORADO
FOR: GATES LAND COMPANY
DREXEL, BARRELL & CO.
ENGINEERS — SURVEYORS
1700 38TH STREET
3405 N. EL PASO STREET
BOULDER, COLORADO 80301
COLORADO SPRINGS, COLORADO 80907
(303) 442-4338
(303) 633-5029
22 OCT 85 LABELING
1 OCT 85 MAJOR
7-19-85 ADD BASIN O-7
Revisions — Date
Date 10 JUNE 1985
Designed by RD
Job No. E 3234
Scale 1" = 100'
Drawn by KA
Drawing No. IQ 298

FIGURE 3

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project	Job №
ADDENDUM NO. 1	E-3234

Client	By	Date
GATES	RDD III	1 JULY 1985

UL. CHECKED 22 July 85 KR

*DESIGN POINT 4: CONTRIBUTING AREA = 205 AC

COMBINE BASINS O-1, ~~O-4~~ B5, ~~O-6~~ E1; ~~O-7~~ BASIN 'D'; PLUS SUB-BASINS A-1 THRU A-8 AND SUB-BASINS B-1 THRU B-4. DETERMINE QA/640's, THEN ADD. CHECK T_c @ DESIGN PT. 3 VS. T_c FOR BASIN O-7 AND USE LARGER TO DETERMINE q_p.

BASIN 'D' (~~O-7~~) → 5-YR QA/640 = (36.1/640) 1.49 = 0.0840
100-YR QA/640 = (36.1/640) 2.84 = 0.1602

A-3 → 5-YR QA/640 = (7.10/640) 1.87 = 0.0207
100-YR QA/640 = (7.10/640) 3.27 = 0.0363

A-4 → 5-YR QA/640 = (7.90/640) 1.67 = 0.0206
100-YR QA/640 = (7.90/640) 3.04 = 0.0375

A-5 → 5-YR QA/640 = (2.08/640) 1.49 = 0.0048
100-YR QA/640 = (2.08/640) 2.84 = 0.0092

A-7 → 5-YR QA/640 = (2.14/640) 1.05 = 0.0035
100-YR QA/640 = (2.14/640) 2.27 = 0.0076

A-8 → 5-YR QA/640 = (3.17/640) 1.67 = 0.0083
100-YR QA/640 = (3.17/640) 3.04 = 0.0151

B-2 → 5-YR QA/640 = (1.19/640) 1.87 = 0.0035
100-YR QA/640 = (1.19/640) 3.27 = 0.0061

B-3 → 5-YR QA/640 = (1.47/640) 1.87 = 0.0043
100-YR QA/640 = (1.47/640) 3.27 = 0.0075

USE T_c = 0.66 HR > 0.31 HR OF BASIN O-7

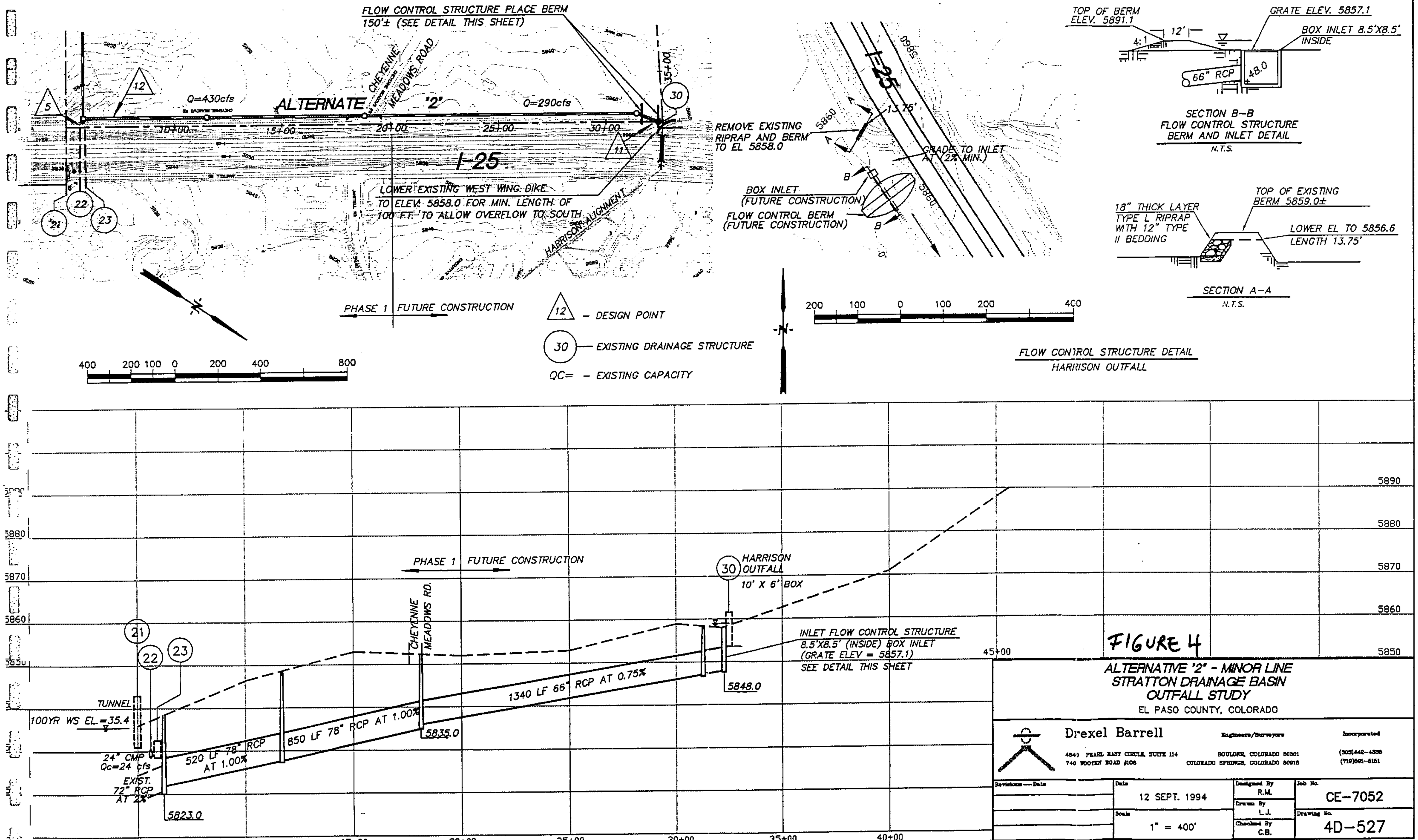
∴ q_p = 640 CSM/IN.

$Q_5 = 640(0.1903 + 0.0840 + 0.0207 + 0.0206 + 0.0048 + 0.0035 + 0.0083 + 0.0035 + 0.0043)$
$= 640(0.3400) = 218$ cfs

$Q_{100} = 640(0.4421 + 0.1602 + 0.0363 + 0.0375 + 0.0092 + 0.0076 + 0.0151 + 0.0061 + 0.0075)$
$= 640(0.7216) = 462$ cfs

FIGURE 3A

1700 38TH STREET (303) 442-4338
3405 N. EL PASO STREET (303) 633-5029



ALTERNATIVE '2' - MINOR LINE
STRATTON DRAINAGE BASIN
OUTFALL STUDY
EL PASO COUNTY, COLORADO

Drexel Barrell — Engineers/Surveyors — Incorporated
4840 PEARL EAST CIRCLE, SUITE 114 — BOULDER, COLORADO 80301 — (303)442-4338
740 WOOTEN ROAD #108 — COLORADO SPRINGS, COLORADO 80916 — (719)591-5151

Revisions — Date	Date	Designed By	Job No.
	12 SEPT. 1994	R.M.	CE-7052
	Scale	Drawn By	Drawing No.
	1" = 400'	L.J.	4D-527
		Checked By C.B.	

FIGURE 10

PROJ\ENG\CE7052\SHEET4.DWG XREF: 1117TOPO

DREXEL BARRELL

LAND SURVEYORS
CIVIL ENGINEERS

Project: HARRISON OUTFALL
Client: GATES
By: CB
Date: 12/96
Job No: E9826

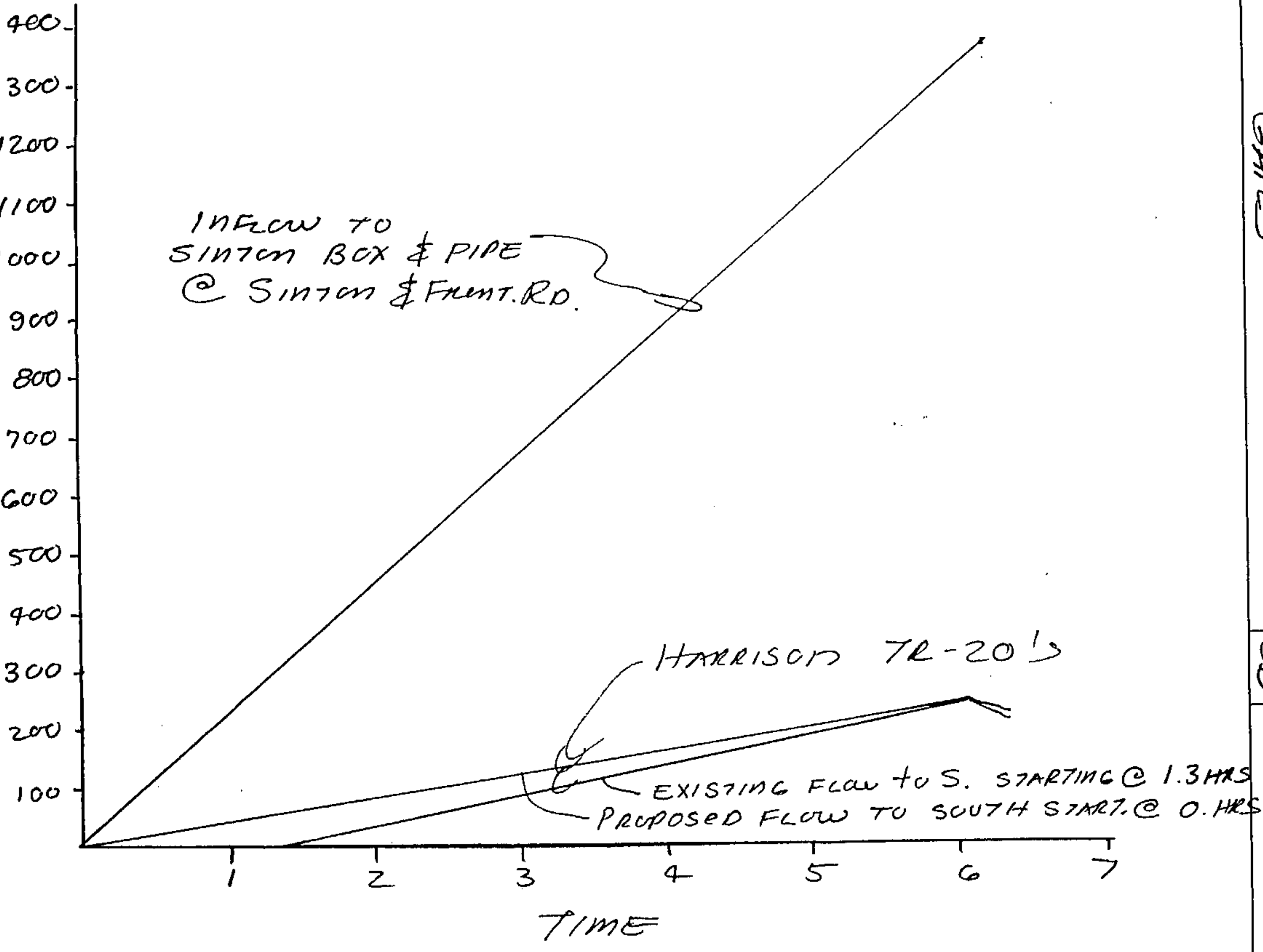


FIG 5.

4840 PEARL EAST CIRCLE, SUITE 114 (303) 442-4338
BOULDER, COLORADO 80301

740 WOOTEN RD. #108 (719) 591-5151
COLORADO SPRINGS, COLORADO 80915

TABLE 1

U.S. HIGHWAY 85/87 (VENETUCCI BOULEVARD)
AND STATE HIGHWAY 29 (LAKE AVENUE)
SUMMARY OF DISCHARGES FOR BASINS/DESIGN POINTS

BASIN	D.A. (SQ. MI.)	DISCHARGE 5-YR.	DISCHARGE 100-YR.	BASIN	D.A. (SQ. MI.)	DISCHARGE 5-YR.	DISCHARGE 100-YR.	DESIGN POINT	D.A. (SQ.MI./AC.)	DISCHARGE 5-YR.	DISCHARGE 100-YR.
MAJOR DRAINAGE				**MINOR DRAINAGE**				1	0.40 SQ.MI.	330	640
BASINS (TR-20)				**BASINS (TR-20)**				2	0.76 SQ.MI.	98	200
001	0.116	68	180	029	0.010	15	28	3	0.82 SQ.MI.	160	360
002	0.093	91	210	058	0.004	7	13	4	1.29 SQ.MI.	340	730
003	0.100	110	240	059	0.008	13	25	5	2.07 SQ.MI.	460	1360
004	0.068	74	160	069	0.007	13	23	6	0.24 SQ.MI.	230	490
005	0.061	110	190	081	0.043	44	92	7	0.041 SQ.MI.	74	122
006	0.159	190	380	082	0.050	56	120	8	0.036 SQ.MI.	64	110
008	0.116	120	250	083	0.023	30	61	9	0.005 SQ.MI.	10	17
009	0.147	120	270	091	0.095	77	180	10	0.3 AC.	1.3	24
01	0.135	96	250	092	0.014	15	33	11	0.010 SQ.MI.	15	28
02	0.063	54	130	093	0.033	36	78	12	1.36 AC.	5.6	10.3
021	0.076	120	210	094	0.005	5	11	13	0.005 SQ.MI.	12	23
022	0.125	250	430	**MINOR DRAINAGE**	**D.A.**			14	1.02 AC.	4.6	8.4
024	0.081	140	250	**BASIN (RATIONAL)**	**(AC.)**			15	0.061 SQ.MI.	110	190
040	0.224	270	520	101	1.36	5.6	10.3	16	0.39 AC.	1.8	3.3
041	0.198	190	380	102	0.36	1.7	3.1	17	0.159 SQ.MI.	190	380
042	0.135	200	350	103	0.36	1.7	3.1	18	0.007 SQ.MI.	13	23
043	0.039	57	110	104	0.29	1.4	2.5	19	1.12 AC.	4.4	8.3
044	0.104	51	140	105	0.17	0.8	1.5	20	0.76 AC.	3.1	5.7
045	0.083	48	130	106	0.07	0.3	0.6	21 (NORTH)	0.043 SQ.MI.	44	92
046	0.102	92	210	201	0.77	3.3	6.2	21 (SOUTH)	0.050 SQ.MI.	56	120
05	0.169	130	300	202	1.02	4.6	8.4	22	0.023 SQ.MI.	30	97
061	0.034	46	92	203	0.60	2.8	5.0	23	0.055 SQ.MI.	61	130
20	0.103	140	280	204	1.02	4.3	7.8	24	0.033 SQ.MI.	36	78
21	0.139	200	380	205	1.12	4.4	8.3				
MINOR DRAINAGE				206	0.70	3.3	6.0				
BASINS (TR-20)	-			207	0.99	3.8	7.1				
026	0.010	19	33	208	0.76	3.1	5.7				
027	0.005	10	17	209	0.82	3.7	6.8				
028	0.036	64	110	210	0.39	1.8	3.3				

FIGURE 6

DESIGN POINT 1 IS
THE HARRISON BOX AT I-25

RECOMMENDED ALTERNATIVE

100 Year Modifications

Currently the system is designed such that 140 cfs would be flowing in the box before any flow begins to flow south. It is proposed to "reroute" the flow split such that the first smaller more frequent flows would overtop the center weir to the south first (which is set at the invert of the existing bottom of the channel). A berm would direct the flows south until such time as it would over top and then flows to the east (The Harrison Box) would commence (See Appendix D). It should be noted that the flow split (although rerouting the smaller flows) would still peak with 350 cfs to the Harrison Box and 290 cfs to the Sinton Outfall. Both flows still total 640 cfs and would peak as before at 6.1 hours into the storm.

Since the peak would occur identical to that of the existing design, there would be no impact on the peak flow at Sinton. The peak 100 year flows at Sinton would remain 1360 cfs regardless of the rerouting. As shown on Figure 5 the rising limb would experience increases from t = 0 to a maximum of t = 1.33 hours. At 1.33 hours, the difference begins to converge until it is 0 at t = 6.1 hours. The hydraulic analysis and design of the diversion is presented in Appendix "D"

The design consists of two weirs set at different elevations. Appendix D and the preliminary design in the back of this report show the hydraulics, plan and geometry for the weirs.

It should also be noted that the World Arena chose not to extend the 66" pipe from just north of Cheyenne Mountain Road to the Harrison Box. Thus, our plan depicts a trapezoidal channel from the proposed overflow weir at the Harrison Box to the existing plunge inlet to the 66" which terminates approximately 750 ft south of the Harrison Channel.

Low Flow Modifications

Appendix "D" also presents the analysis of the design for the 5 year and lower events. The weir discharging east to the Harrison Box is set at elevation 5858.92 ft. The elevation of the weir discharging to the south and along the frontage road is set at 5856 ft. This means **109.8 cfs** will be discharging to the south before any flow begins to trickle over the weir flowing east. The 109.8 cfs is roughly the developed 2 year frequency flow (119 cfs). At the developed 5 year flow rate of **330 cfs, 132.4 cfs** will flow to the Harrison Box. This quantity of flow is also just higher than the developed 2 year return frequency flow. It is substantially less than the 330 cfs planned to discharge in 1994 Master Plan update and nearly 100 cfs less than **Q_5 233 cfs** of calculated historic flow. Thus, the Harrison

Channel should statistically see flows only greater than flows which exceed a 2 year frequency return event.

SUMMARY

1. The 100 year **historic undeveloped** flows from the 960 acres tributary from the Harrison Basin which reach the 10 ft x 6 ft, I-25 box culvert (Referred to as the Harrison Box) can be shown to be 760 cfs.

2. The 5 year **historic undeveloped** flows from this same basin can be shown to be 233 cfs.

3. The 100 year developed flows which reach the Harrison Box were shown to be 462 in 1985 and 640 in 1994 (Increase due to minor changes in drainage boundaries and change in city design criteria).

4. The 5 year developed flows which reach the Harrison Box were 218 cfs in 1985 and 330 cfs in 1994.

5. Although 760 cfs is demonstrated as historic, no more than 350 cfs has ever been proposed to flow east in the Harrison Box Outfall Channel, since this is the boxes maximum capacity.

6. This same 350 cfs can be demonstrated to be approximately a 10 year event, which is the maximum flow the Harrison Channel will experience in a 100 year event.

7. Smaller more frequent event flows up to 110 cfs can be rerouted flow (first) south to the Sinton Channel, (as opposed to east first) without any flow in the Harrison Channel or any impact to the Sinton Outfall System.

8. Flows to the east will just begin over-topping into the Harrison Box at just slightly less than the 2 year event (110 vs. 119 cfs).

9. When the Harrison Basin has a 5 year flow event (based on the latest criteria) of 330 cfs, the flow split will send 198 cfs south in the frontage road and 132 cfs east through the Harrison Box.

10. The 132 cfs just slightly above the 2 year frequency event of 119 cfs.

11. As an illustrative example, consider that the Harrison Channel might experience flows an average of 15 rainfall events and 10 snowfall events a year. Then with the proposed weir structure, the Harrison Box would only see flows about once in every thirty to forty or so occurrences.

APPENDIX "A"

Project: Harrison Outfall
Job No: E4826
Client: Gates Land Co.

Basin Information:

Area (A) = 960 Acres = 1.5 SQ. MI.
Soils Group - Generally B

Calculations (SCS Hydrograph Method, per Colorado Springs Criteria)

Overland Time of Concentration
$T_c = 1.87\ (1.1 - C_{10})\ L^{0.5}\ s^{-0.33}$
$C_{10} = 0.15$ (Historical Flow Analysis - Greenbelts, Agricultural)
L = 1270'
s = 4%
T_c = 40 minutes

Channel Flow (see attached Flowmaster calculations)
Based on upper stream reach and approximate stream course
Length = 18050 ft
Slope = 2.1%
T_c = length/velocity = 18050ft/6.84ft/s
T_c = 44 minutes

Total Travel Time = 84 minutes = 1.40 hours
$T_p = (0.133\ T_c/2) + .6T_c = 0.94$ (equation 5-8)

Peak Discharge = 330 csm/inch (Figure 5-11d)

Calculate Excess Runoff
SCS curve No. = 69 (Table 5-5, open space)

Design Storm	2	5	10	25	50	100
Rainfall (P)	2.2	2.8	3.2	3.5	3.9	4.5
Direct Runoff (Q)	0.24	0.47	0.67	0.95	1.20	1.53

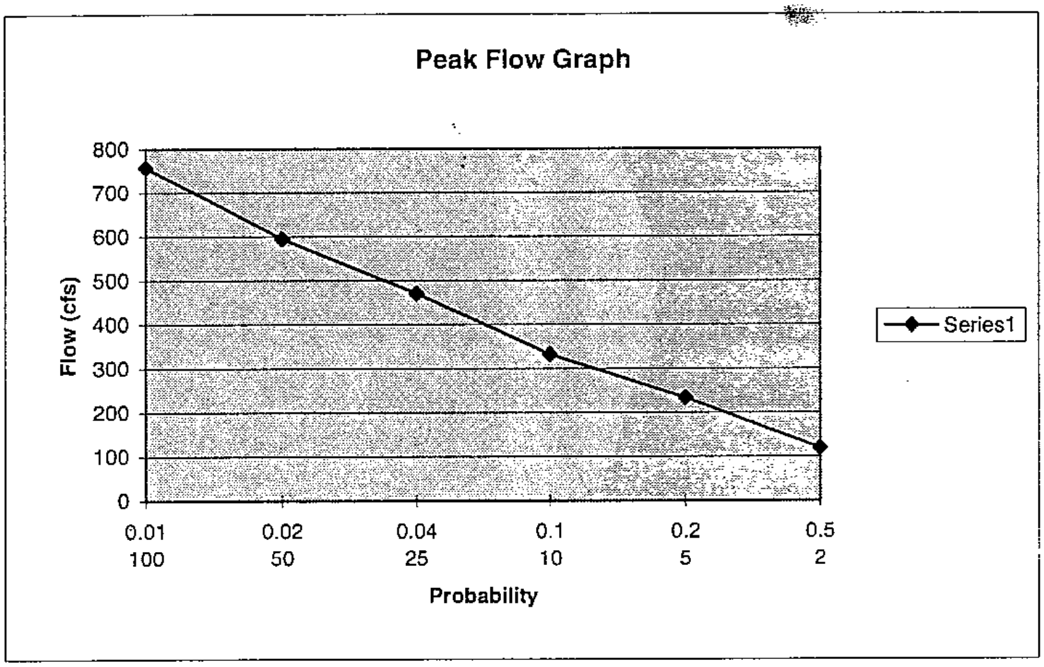
P_{100} from Figure 5-4e, other P's from Figure 5-6 (attached)
Direct Runoff from Figure 5-8

Flow Calculations
$q_p = A(csm/in)Q_p$

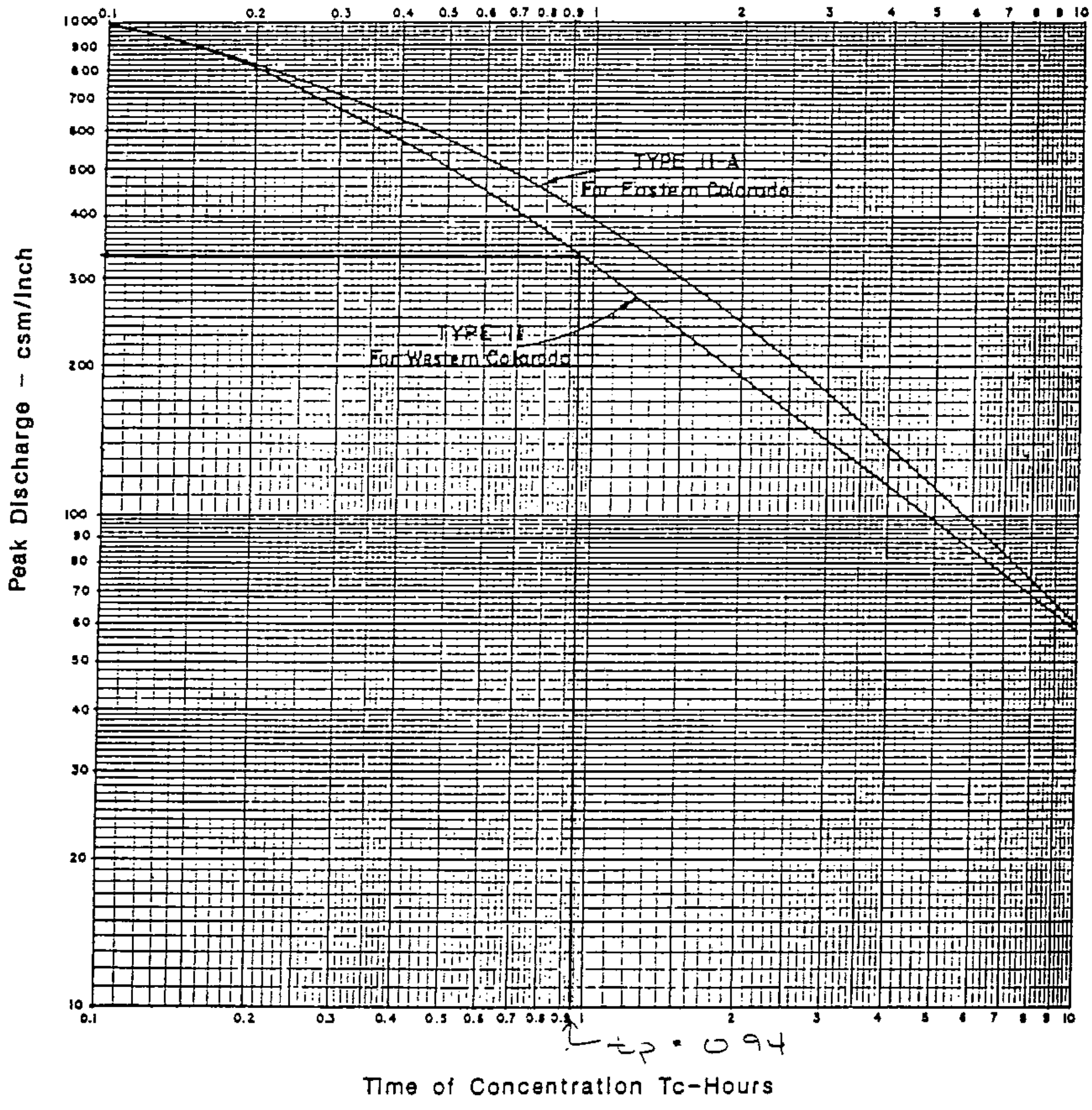
Design Storm	**2**	**5**	**10**	**25**	**50**	**100**
Area (SQ. MI.)	1.5	1.5	1.5	1.5	1.5	1.5
csm/in	330	330	330	330	330	330
Q_p (in)	.24	0.47	0.67	0.95	1.20	1.53
q_p (cfs)	**119**	**233**	**332**	**470**	**594**	**757**

Harrison Outfall

Design Storm (yrs)	Probability	Peak Dischage (cfs)
100	0.01	757
50	0.02	594
25	0.04	470
10	0.1	332
5	0.2	233
2	0.5	119



Peak Discharge In
csm Per Inch of Runoff
Versus
Time of Concentration, Tc
Type II Storm Distribution, 24 Hour
Type II-A Storm Distribution, 24 Hour



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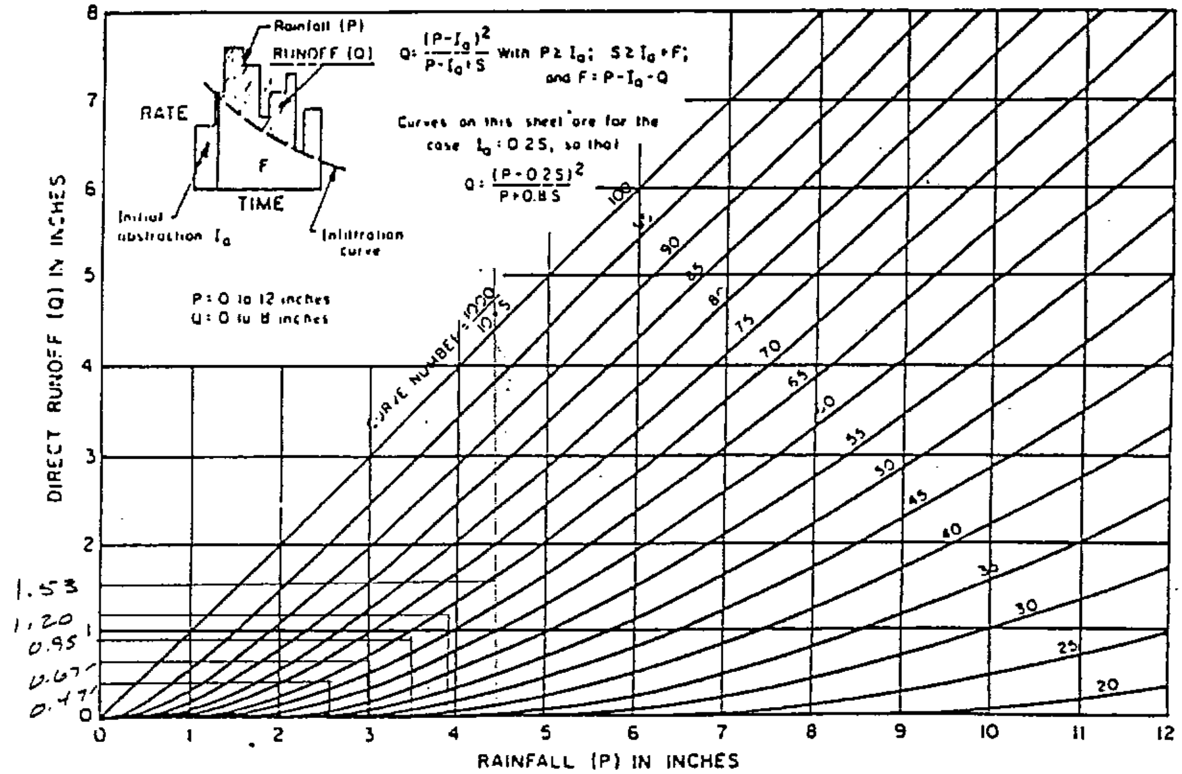
Drainage Criteria Manual

HDR Infrastructure, Inc.
A Centerra Company

Date
OCT. 1987

Figure
5-11d



REFERENCE : Mockus, Victor; Estimating direct runoff amounts from storm rainfall: Central Technical Unit, October 1955, Soil Conservation Service

HDR Infrastructure, Inc.
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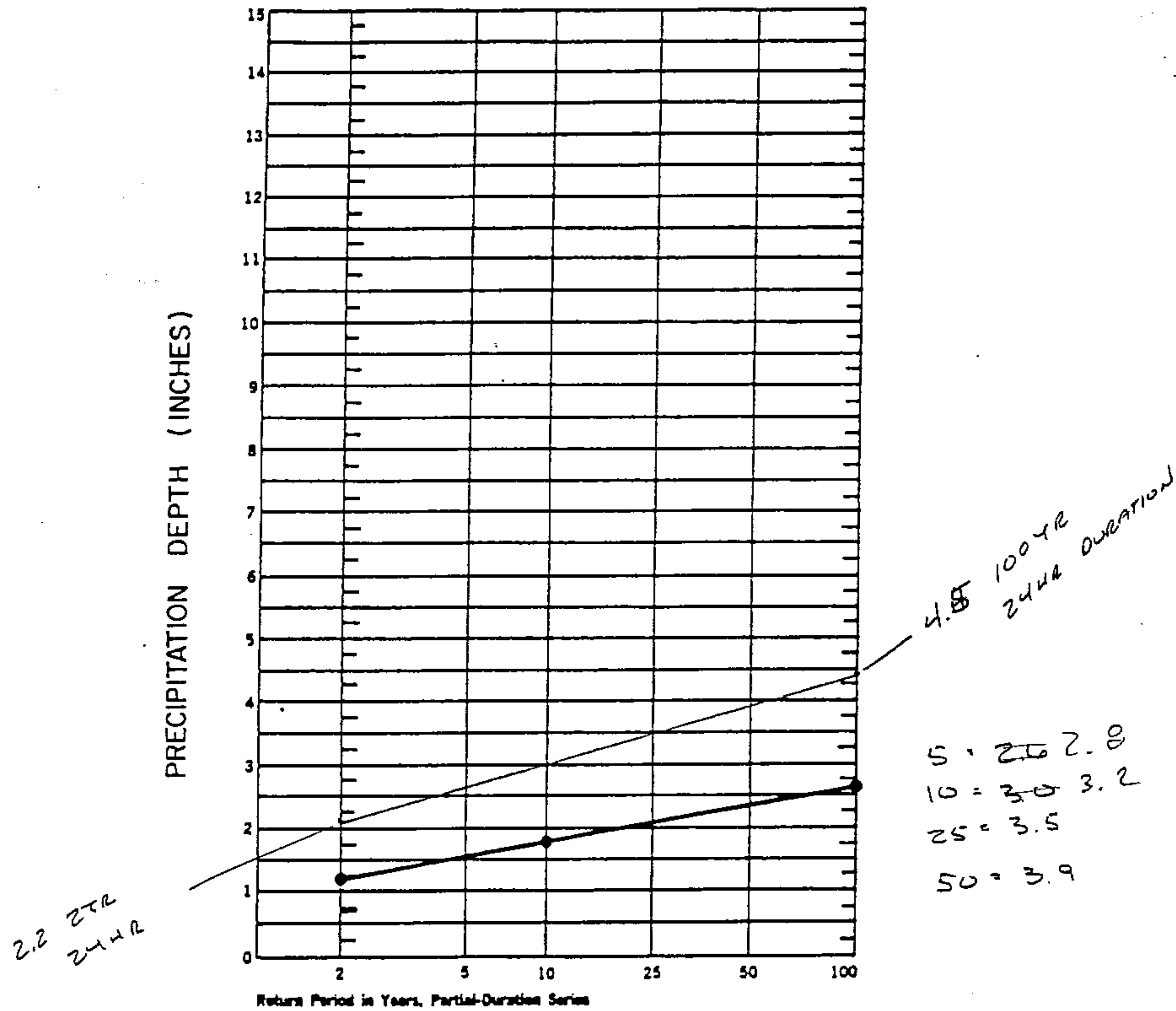
The City of Colorado Springs / El Paso County Drainage Criteria Manual	Date OCT. 1987
Graphical Relationship Among Precipitation, Curve Numbers, and Direct Runoff	Figure 5-8

7/7



EXAMPLE

2 yr. 1 hr rainfall (calculated) = 1.19"
100 yr. 1 hr rainfall (calculated) = 2.64"
10 yr. 1 hr rainfall (interpolated) = 1.78"

REFERENCE : NOAA Atlas 2, Volume 3 - Colorado

<u>NOTE</u>: This example is for Colorado Springs as indicated on the Isopluvials.

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Drainage Criteria Manual

RAINFALL DEPTH - DURATION RELATIONSHIP

Date
OCT. 1987

Figure
5 - 6

<u>APPENDIX “B’</u>

DREXEL, BARRELL & CO. LAND SURVEYORS / CIVIL ENGINEERS — E1 /9

Project NORTWEST PORTION, CHEYENNE MOUNTAIN CENTER HARRISON CREEK OUTFALL		Job Nº E-3234
Client GATES	By [illegible]	Date 1 MAY 1985

4 JUNE 85 [signature]

DETERMINE 5-YR. & 100-YR. PEAK DISCHARGE FOR HARRISON CREEK DRAINAGE CHANNEL

DESIGN POINT 1* (BASIN 0-1 AREA = 110 AC)

SOIL GROUP	ACREAGE	USE	CN	%	PRODUCT
12 (B)	1.4	OPEN (GOOD)	61	1.27	0.77
59 (C)	22.6	COMMERCIAL	94	20.55	19.32
82 (A/C)	5.9	OPEN (GOOD)	61	5.36	3.27
USE B	52.8	RES. (< 1/8 AC.)	85	48.00	40.80
86 (B)	12.7	OPEN (GOOD)	61	11.55	7.05
	14.6	RES. (< 1/8 AC.)	85	13.27	11.28
	110.0			100	82.49

USE CN = 82, ∴ $Q_5 = 0.71$ IN & $Q_{100} = 1.78$ IN.

T_c : 550' OVERLAND @ 3.5% (≃1.3 FPS) → 0.12 HR.
5500' CHANNEL w/ H = 165' (FROM FIG. II) → 0.38 HR.
0.50 HR.

$q_p = 730$ CSM/IN

$q_5 = 730\,(110/640)\,0.71$ = 89 cfs ✓ $q_{100} = 730\,(110/640)\,1.78$ = 223 cfs ✓

* SAME AS DESIGN POINT 5 IN HARTZELL - PFEIFFENBERGER "MASTER DRAINAGE PLAN, HARRISON STREET - I-25 AND VICINITY, CHEYENNE MOUNTAIN RANCH"; HOWEVER, REVISED BASIN ACREAGE AND UPDATED METHODOLOGY TO DETERMINE PEAK DISCHARGES.

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS E2/9

Job Nº E-3234

Client GATES

By RDOM Date 2 MAY 1985
4 June 85 [illegible]

DESIGN POINT 2: CONTRIBUTING AREA = 132 AC.

COMBINE BASINS O-1 ; ~~O-4~~ B-5 PLUS SUB-BASINS A-1, A-2, A-6, B-1 ; B-4. DETERMINE QA/640's, THEN ADD. ADD TRAVEL TIME IN CHANNEL @ 10 FPS TO T_c @ DESIGN PT. 1 TO DETERMINE q_p.

O-1 → 5-YR. QA/640 = (110/640) 0.71 = 0.1220
100-YR. QA/640 = (110/640) 1.78 = 0.3059

~~O-4~~ B-5 → RUNOFF CURVE NO = 94
∴ Q_5 = 1.49 IN ; Q_{100} = 2.84 IN
5-YR. QA/640 = (12.8/640) 1.49 = 0.0298
100-YR. QA/640 = (12.8/640) 2.84 = 0.0568

A-1 → 5-YR. QA/640 = (4.12/640) 1.49 = 0.0096
100-YR QA/640 = (4.12/640) 2.84 = 0.0183

A-2 → 5-YR. QA/640 = (2.39/640) 1.49 = 0.0056
100-YR QA/640 = (2.39/640) 2.84 = 0.0106

A-6 → 5-YR QA/640 = (3.28/640) 1.05 = 0.0054
100 YR. QA/640 = (3.28/640) 2.27 = 0.0116

B-1 → 5-YR QA/640 = (0.53/640) 1.87 = 0.0015
100-YR QA/640 = (0.53/640) 3.27 = 0.0027

B-4 → 5-YR QA/640 = (0.86/640) 1.87 = 0.0025
100-YR QA/640 = (0.86/640) 3.27 = 0.0044

USE T_c = 0.50 + (700/20 FPS + 1200/5 FPS)/60/60 = 0.58 HR
∴ q_p = 680 CSM/IN.

q_5 = 680 (0.1220 + 0.0298 + 0.0096 + 0.0056 + 0.0054 + 0.0015 + 0.0025)
= 680 (0.1764) = 120 cfs

q_{100} = 680 (0.3059 + 0.0568 + 0.0183 + 0.0106 + 0.0116 + 0.0027 + 0.0044)
= 680 (0.4103) = 279 cfs

Project		Job Nº E-3234
Client GATES	By KDDIII	Date 2 MAY 1985

4 JUNE 85 [signature]

DESIGN POINT 3: CONTRIBUTING AREA = 143. AC

COMBINE BASINS D-2, ~~D-4~~ B-5, ~~& D-6~~ E1; PLUS SUB-BASINS A-1, A-2, A-6, B-1 & B-4
DETERMINE QA/640's, THEN ADD. ADD TRAVEL TIME IN CHANNEL @ 5 FPS TO T_c @ DESIGN PT. 2 TO DETERMINE q_p.

~~D-6~~ E-1 → DETERMINE RUNOFF CURVE NUMBER

USE	CN	%	PRODUCT
OPEN	74	50.0	37.0
STREET, ROOF, PARKING	98	50.0	49.0
			86

(SEE PG. C15)

FROM TABLE 1, $Q_5 = 0.92$ IN. ; $Q_{100} = 2.10$ IN.

5-YR: $QA/640 = (9.7/640)\,0.92 = 0.0139$

100-YR $QA/640 = (9.7/640)\,2.10 = 0.0318$

USE $T_c = 0.58 + (1450/5\text{FPS})/60/60 = 0.66$ HR.

$\therefore q_p = 640$ CSM/IN.

$q_5 = 640\,(0.1764 + 0.0139) = 640\,(0.1903) = 122$ cfs

$q_{100} = 640\,(0.4103 + 0.0318) = 640\,(0.4421) = 283$ cfs

DETERMINE MAX. FLOW FROM 24" C.M.P UNDER LAKE AVE.:

$L = 265.4$, $\Delta H = 3.84'$ $\therefore$ $S = 0.0145$ %, $n = 0.024$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{0.024}\, 3.14\,(0.50)^{2/3}\,(0.0145)^{1/2}$$

$$= 14.7 \text{ cfs}$$

CHECK VS. OUTLET CONTROL:

$HW_{AVAIL} = 3'$, $h_o = 2.5'$; $LS_o = 3.84'$

$H = HW - h_o + LS_o = 4.34'$

FROM NOMOGRAPH, $Q = 20$ cfs ⟸ USE THIS.

ADDENDUM NO. 1 Job No E-3234

Project

Client GATES By RODIII Date 1 JULY 1985

UL. CHECKED 22 JULY 85 KR

DESIGN POINT 4: CONTRIBUTING AREA = 205 AC

COMBINE BASINS O-1, ~~O-4~~ B5, ~~O-6~~ E1, ~~O-7~~ BASIN 'D'; PLUS SUB-BASINS A-1 THRU A-8 AND SUB-BASINS B-1 THRU B-4. DETERMINE QA/640's, THEN ADD. CHECK T_c @ DESIGN PT. 3 VS. T_c FOR BASIN O-7 AND USE LARGER TO DETERMINE q_p.

BASIN 'D' ~~O-7~~ →	5-YR QA/640 = (36.1/640) 1.49 =		0.0840
	100-YR QA/640 = (36.1/640) 2.84 =		0.1602
A-3 →	5-YR QA/640 = (7.10/640) 1.87 =		0.0207
	100-YR QA/640 = (7.10/640) 3.27 =		0.0363
A-4 →	5-YR QA/640 = (7.90/640) 1.67 =		0.0206
	100-YR QA/640 = (7.90/640) 3.04 =		0.0375
A-5 →	5-YR QA/640 = (2.08/640) 1.49 =		0.0048
	100-YR QA/640 = (2.08/640) 2.84 =		0.0092
A-7 →	5-YR QA/640 = (2.14/640) 1.05 =		0.0035
	100-YR QA/640 = (2.14/640) 2.27 =		0.0076
A-8 →	5-YR QA/640 = (3.17/640) 1.67 =		0.0083
	100-YR QA/640 = (3.17/640) 3.04 =		0.0151
B-2 →	5-YR QA/640 = (1.19/640) 1.87 =		0.0035
	100-YR QA/640 = (1.19/640) 3.27 =		0.0061
B-3 →	5-YR QA/640 = (1.47/640) 1.87 =		0.0043
	100-YR QA/640 = (1.47/640) 3.27 =		0.0075

USE T_c = 0.66 HR > 0.31 HR OF BASIN O-7

∴ q_p = 640 csm/IN.

$q_5 = 640(0.1903 + 0.0840 + 0.0207 + 0.0206 + 0.0048 + 0.0035 + 0.0083 + 0.0035 + 0.0043)$
$= 640(0.3400) = 218$ cfs

$q_{100} = 640(0.4421 + 0.1602 + 0.0363 + 0.0375 + 0.0092 + 0.0076 + 0.0151 + 0.0061 + 0.0075)$
$= 640(0.7216) = 462$ cfs

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS E5/9

Project: CHEYENNE MOUNTAIN CENTER Box CULVERT OVER FLOW — ADDENDUM NO. 1		Job Nº E-3234
Client: GATES	By: CN	Date: 7-1-85

CHECKED 22 JUN 85 KE

FOR INLET CONTROL

Q = 350 CFS
B = 10'
Q/B = 35
H = 6'
WINGWALL FLARE 53° +/-

HW/D = 0.87 (FIG 804-1C Co. STATE DESIGN MANUAL

HW = 5.22'
HWel = 59.50 (ENTRANCE INVERT = 54.28)

FOR OUTLET CONTROL

A = 60 sf
Ke = 0.4 for WINGWALL OF 53° +/- and CROWN EDGE SQUARE ⇒ USE 0.5
L = 112 ft
n = 0.012
LS_o = 0.96' ⇒ USE 1.0'
H = 0.92 FROM FIGURE 804-1G Co STATE DESIGN MAN

$$HW = h_o + H - LS_o$$

$$h_o = (d_c + D)/2$$ d_c = 3.5' FROM FIG. 32, CONCRETE PIPE DESIGN MANUAL

$$= (3.5 + 6.0)/2$$

$$= 4.75$$

$$\therefore HW = 4.75 + 0.92 - 0.96$$

$$= 4.71 = 0.785D \; < 5.22'$$ THUS, INLET CONTROL

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

E6/9

Project

Job Nº E-3234

Client GATES

By [initials]

Date 1 JULY 1985

CHECKED 22 July 85 KR

OVERFLOW @ 6' x 10' BOX CULVERT

DESIGN AS BROAD-CRESTED WEIR:

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

IF Q = 112 cfs & H = 0.5', FIND L:

USE C = 3.1 FROM TABLE 5-9 KING AND BRATER

$$\therefore L = \frac{Q}{CH^{3/2}} = \frac{112}{3.1(0.5)^{1.5}}$$

$$= 102.19'$$

THE CREST ELEVATION OF THE WEIR SHOULD BE SET @ 59.0. weir length = 102.5'

See Cmst. Dwg 3D627, sheet 9 of 12 for Details

FINAL DESIGN SUBJECT TO APPROVAL.

Subject: DRAINAGE @ CHEYENNE MEADOWS ROAD
Job No: E-2669
Client: GATES
By: [illegible]
Date: 11 JULY 1985
Checked by CS 1-12-85

COMBINED BASIN FLOWS

DESIGN POINT ~~4~~ 5: CONTRIBUTING AREA = 11.21 AC + 100-YR. OVERFLOW

COMBINE BASINS ~~20~~ F-2, ~~22~~ F-4, & O, ADD QA/640'S AND USE ADJUSTED T_c TO DETERMINE q_p. ADD TRAVEL TIME OF 100-YR. OVERFLOW FROM HARRISON CREEK OUTFALL TO GET T_{c100}

$T_{c5} = 0.25 + 0.10 = 0.35$ HR $\therefore q_{p5} = 860$ csm/in
(0.25 = CHANNEL TIME IN BASIN O; 0.10 = BASIN 20 T_c)

* $T_{c100} = 0.66 + 0.25 = 0.91$ HR

$\therefore q_{p100} = 530$ csm/in.

$q_5 = 860(0.0094 + 0.0067 + 0.0051)$
$= 860(0.0214) = 18.4$ cfs

$q_{100} = 530(0.0178 + 0.0131 + 0.0173) + 112$ cfs
$= 530(0.0432) + 112 = 135$ cfs

* T_{c100} INCLUDES TRAVEL TIME FOR HARRISON CREEK OUTFALL = 0.66 HR. FROM APPENDIX G.

Project	Job No
	E-2669

Client	By	Date
GATES	RDD	11 JULY 1985

Checked by CS 7-23-85

DESIGN POINT ~~2~~ 6: CONTRIBUTING AREA = 12.13 AC + 100-YR OVERFLOW

COMBINE BASINS ~~20, 22, 24~~ F2, F4, F6 ; O; ADD QA/640's AND USE ADJUSTED T_c TO DETERMINE q_p. USE OVERFLOW TRAVEL TIME FOR T_{c100}.

$T_{c_5} = 0.35$ HR $\therefore q_{p_5} = 860$ csm/IN.

$T_{c100} = 0.91$ HR $\therefore q_{p100} = 530$ csm/IN.

$q_5 = 860\,(0.0214 + 0.0027)$
$= 860\,(0.0241) = 20.7$ cfs

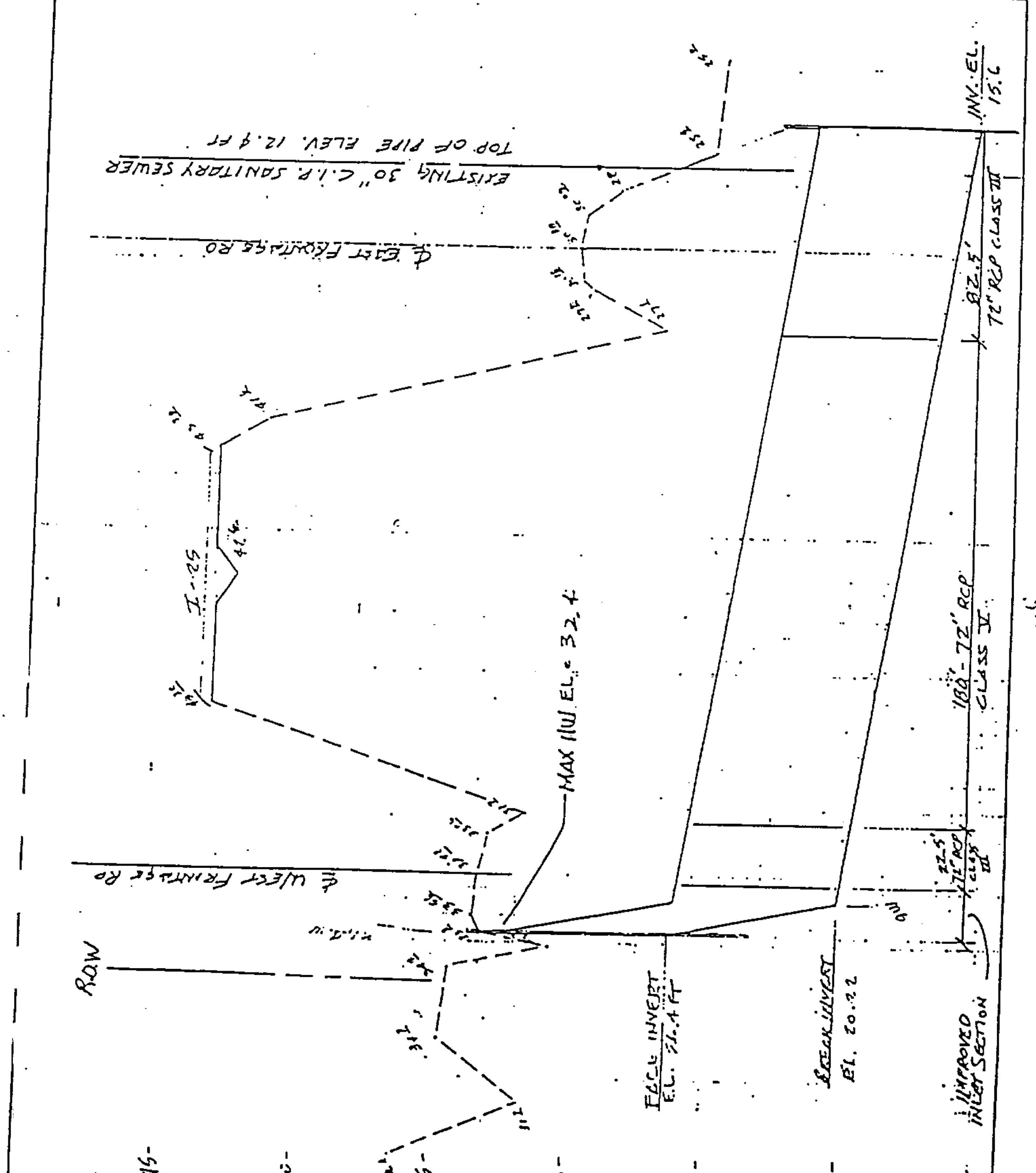
$q_{100} = 530\,(0.0432 + 0.0047) + 112$ cfs
$= 530\,(0.0479) + 112 = 137$ cfs

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

K1/5

Project: [illegible] CULVERT CROSSING AT UNDERPASS			Job No: 4-2875
Client: GATES	CROSS-SECTION AT PROPOSED CULVERT 63' NORTH OF UNDERPASS	By: DCM	Date: 3-2-84



Project: X-Sections of Existing Channel S of R

Job No: E-2669

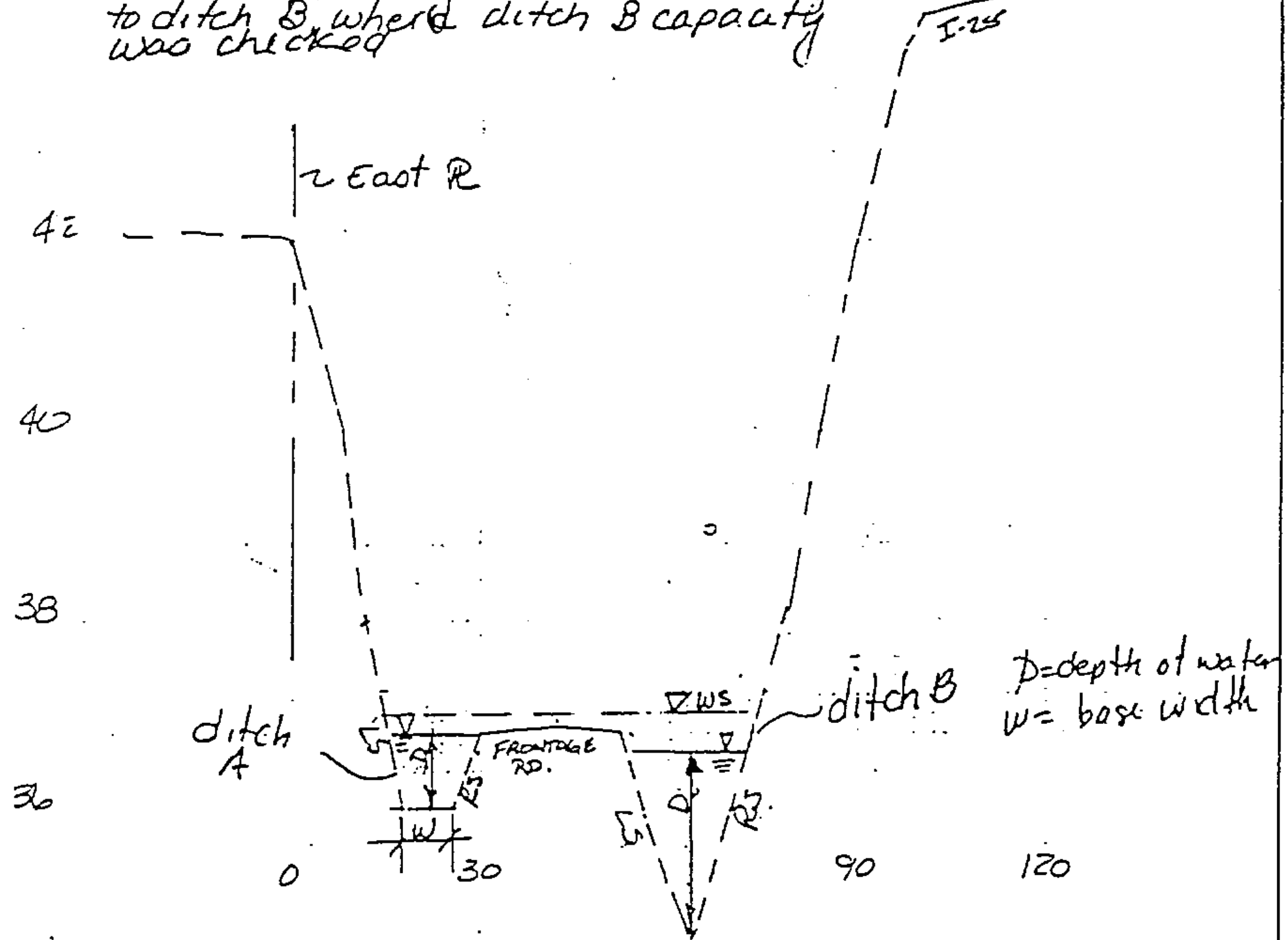
Client: GATES.

By: tdl

Date: 8-2-84

See D4R plan 3D291 for Section III

NOTE: The design flow is 144 cfs - ditch A was checked for its capacity and the rest of the will flow to ditch B, where ditch B capacity was checked



ditch A

using S = 1.33%
n = .04
D = .8
LS = 3:1
R = 3:1
W = 8'

has a capacity of
Q_c = 26 cfs
V = 3.18 fps

Q_D = 144-26 = 118 cfs.

Q_{Design} = 118 cf

ditch B

using n = .04
S = 1.33%
D = 2.0'
LS = 6:1
RS = 4:1
W = 0

has a capacity of
Q_c = 85 CFS
V = 4.24 FPS

The two ditches have a total capacity of 111 CFS
Therefore the remaining 144-111 = 33 CFS will flow in the road
using data
(Q_D = 33 CFS)
S = 1.33%
N = .04
LS = 3:1
RS = 4:1
W = 58'

D = 0.30'
Q_c = 33.67 CFS
V = 1.90 FPS

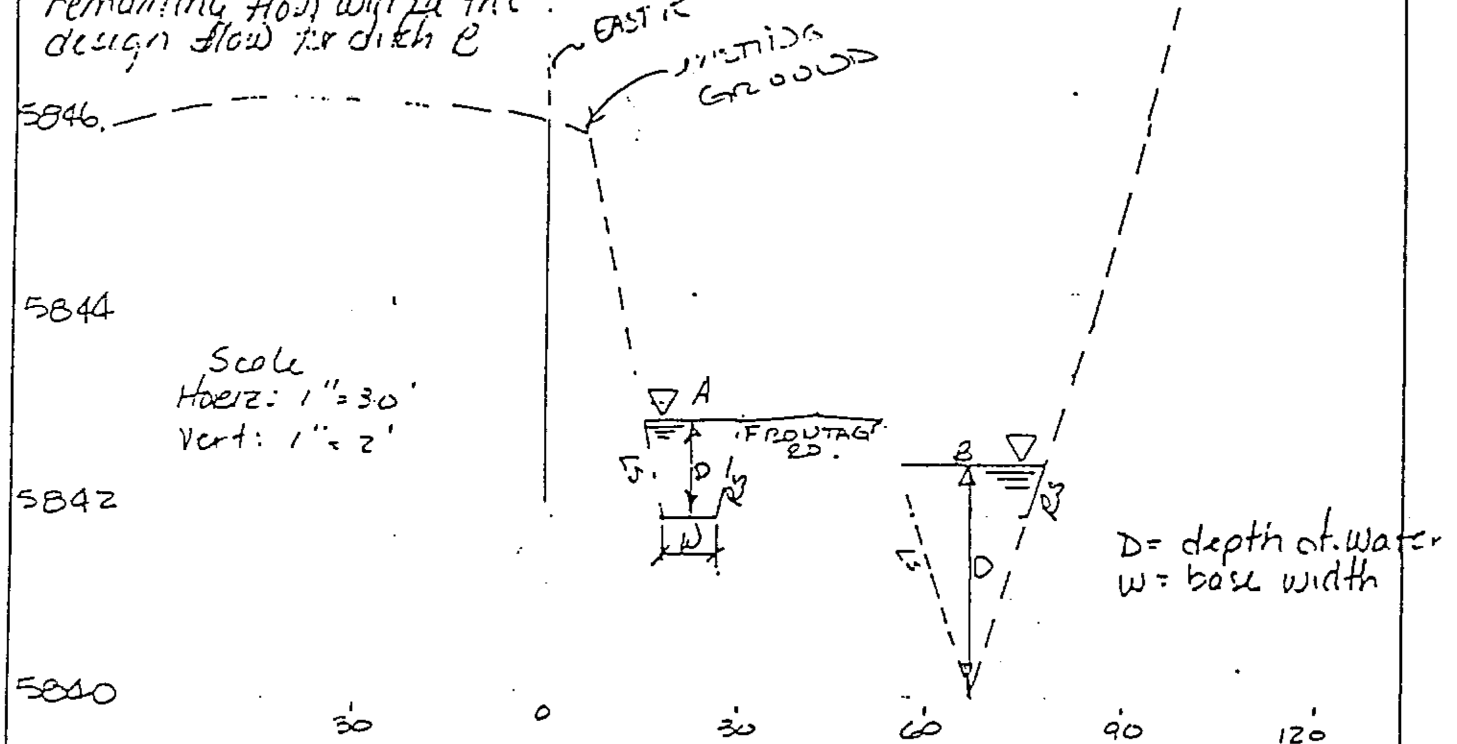
Project	Job No
X-SECTION OF EXISTING CHANNEL S OF RR	E-2669

Client	By	Date
GATES	td	8/2/84

See D & R plan 20291 for location of <u>SECTION II</u>

NOTE: Q_{100} = 144 cfs design flow

ditch A was checked for capacity and what is left will overflow to ditch B and that remaining flow will be the design flow for ditch B



<u>ditch A</u>

using $n = .04$
$S = 0.8\%$
$D = 1.0'$
$LS = 3:1$
$RS = 3:1$
$W = 9.0'$

Q_c = 34 cfs (max. capacity)
V = 2.83 fps

$\therefore Q_b = 144 - 34 = 110$ cfs
ditch B must carry Q_c = 87 cfs

<u>ditch B</u>

$n = .04$
$S = 0.8\%$
$LS = 6:1$
$RS = 5:1$
$W = 0$
$D = 2.34'$

Q_c = 110.19 CFS
V = 3.66 FPS

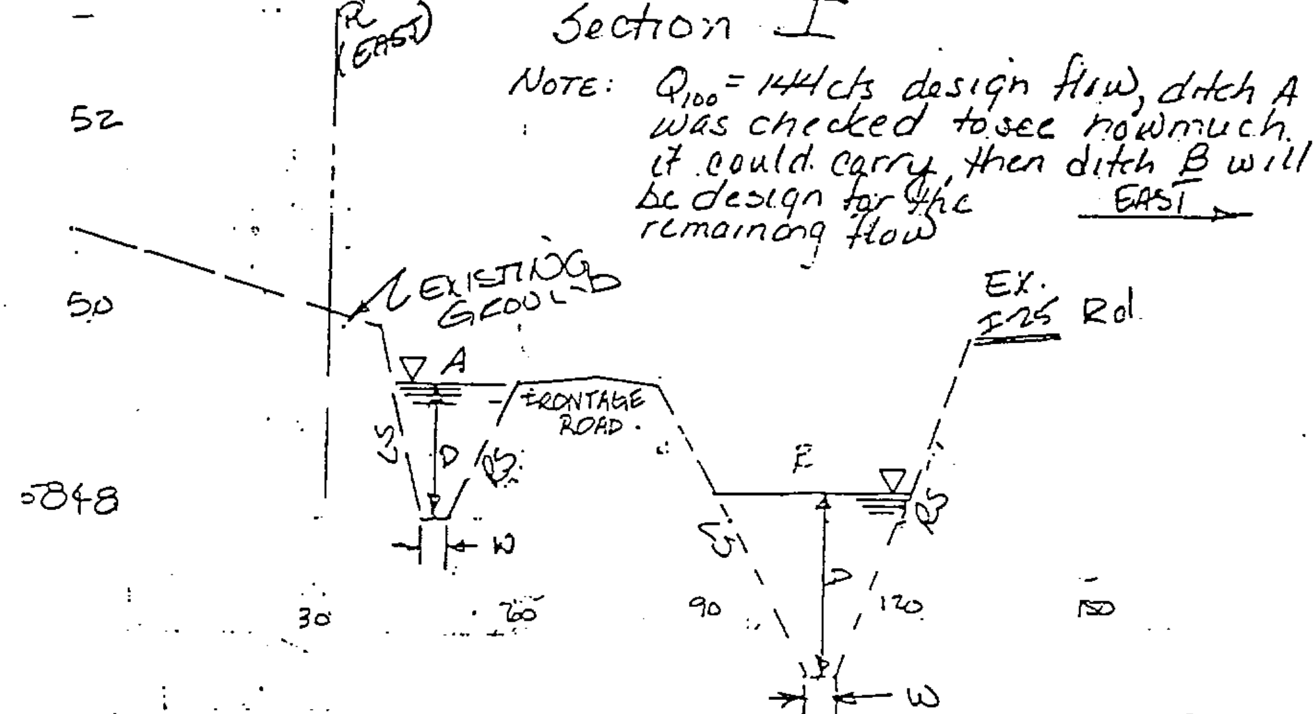
Project	Job No
X-Sections of Existing Channel S. of ℞	E-2669

Client	By	Date
Eales	td	8/2/94

see D4B plan 3D291 (included in the back pocket of this report.)

Section I

NOTE: Q_{100} = 144 cfs design flow, ditch A was checked to see how much it could carry, then ditch B will be design for the remaining flow



Horizontal scale: 1" = 30'
Vertical Scale: 1" = 2'

D = Depth of water
W = base width
Q_b = 144 - 52 = 92 cfs
Q_{design} = 92 cfs

ditch A
using n = .04
LS = 3.5:1
RS = 7:1
W = 5
S = 0.8%
D = 1.4'

It has capacity of
Q = 52 cfs
V = 3.02 fps

DITCH B
n = .04
RS = 5:1
LS = 8:1
W = 5'
D = 1.71'
S = 0.8 %
Q_c = 92 cfs
V = 3.34 fps

The proposed drainage along I-25 has received conceptual approval by the Colorado State Highway Department through their approval of Drexel Barrell's "Master Drainage Report for Cheyenne Mountain Center," dated March 15, 1984 + revised May 9, 1985. See the approval letter on pg. R7/10.

R7/10

STATE OF COLORADO

DEPARTMENT OF HIGHWAYS

District II
905 Erie - P.O. Box 536
Pueblo, Colorado 81002
(303) 544-6286

September 9, 1985

RECEIVED
PUBLIC WORKS/ENGINEERING
COLORADO SPRINGS, COLO.

SEP 10 1985
AM PM
7,8,9,10,11,12,1,2,3,4,5,6

City of Colorado Springs
Engineering Division
P.O. Box 1575
Colorado Springs, CO. 80901

Attn: Chris Smith

Dear Mr. Smith:

The Colorado Department of Highways has been working with the Gates Land Company on their proposed Cheyenne Mountain Center development in Colorado Springs and we have been requested by Gates to advise you of our comments on the master drainage plan for the development.

The "Drainage Report For Cheyenne Mountain Center" prepared by Drexel, Barrell and Co. and dated March 15, 1984 has been reviewed and is acceptable as a "master plan". Drexel, Barrell & Co. drawing No. 1Q249 was included as part of the submitted report. We have been requested to comment on several specific items contained in the report. Following are comments:

1) We approve the concept of carrying drainage within the highway right of way along the south side of State Highway 29 (Lake Avenue) and the west side of I-25 to the existing 6' high x 10' box culvert under I-25 at Harrison School. We realize that flow from the existing box will flow over the frontage road on the east side and that future improvements will probably be required, but we will not hold Gates Land Company responsible for those improvements. Flow above the capacity of the existing box culvert will continue south along the west side of I-25 in an open channel to a proposed 72" culvert under I-25. Gates Land Company has signed a contract with the State of Colorado to share in the cost of the 72" culvert. Construction of the culvert will be accomplished on an upcoming highway project. The 100-year flows on the west side of I-25 will be handled by the proposed 72" culvert, the existing drive-through box culvert, and an existing 48" culvert to the south. Flow from these structures will be directed to the proposed Sinton Outfall Channel (to be constructed by Gates Land Company) and carried to Fountain Creek. The Colorado Department of Highways will be responsible for the maintenance of the open drainage channel and structures within the State Highway 29 and I-25 rights of way.

2) The proposed storm sewer system paralleling State Highway 85 on the east side is also acceptable. Flow from the storm sewer will be directed towards I-25 and the structures mentioned above. The Colorado

Department of Highways will be responsible for maintenance of structures crossing State Highway 85 but will not be responsible for the maintenance of the proposed storm sewer system.

The final drainage reports for the northwest portion of the Cheyenne Mountain Center and for Cheyenne Meadows Road are currently being reviewed. Comments on those reports will be sent as soon as possible.

If you have any questions or need any additional information, please contact Walt Pachak in Pueblo at 544-6286.

Sincerely,

R. Q. Brown

R. Q. Brown
District Preconstruction Engineer

RQB/WP/hw

cc: Bob Svejkovsky/Gates Land Co.
Bruce J. Buttner/Drexel, Barrell & Co.

APPENDIX 'C'

ALTERNATIVE P2
PONDS K1 & K2E
STORM SEWER ALIGN. "2"
DATAFILE:
CE7052 P2.DAT

```
1

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

                                                    SUMMARY
JOB TR-20
TITLE    1 PROP. COND. 2: FULL DEV.:  PONDS K1 AND K2E W/ ST.S. ALIGN. "B"
TITLE      ALT.1:24-HR/AMC II ALT.2:2-HR/AMC III;ST.#1:100 YR. ST.#2: 10 YR
 5 RAINFL 9                   .0833
 8                 0.0       0.0173      0.0493      0.1201      0.2498
 8              0.4659       0.5696      0.6180      0.6551      0.6880
 8              0.7156       0.7433      0.7710      0.7986      0.8263
 8              0.8539       0.8755      0.8920      0.9084      0.9248
 8              0.9421       0.9576      0.9741      0.9888         1.0
 9 ENDTBL
 5 RAINFL 8                   .0833
 8                  .0        .0087       .0346       .0744       .1436
 8                .2647       .4810       .6021       .6713       .7249
 8                .7682       .8028       .8374       .8720       .8893
 8                .9066       .9170       .9273       .9377       .9481
 8                .9585       .9689       .9792       .9896         1.0
 9 ENDTBL
 5 RAINFL 7                     .25
 8                   0       0.0005      0.0015       .0030      0.0045
 8               0.006         .008         .01        .012       .0143
 8               .0165        .0188        .021       .0233       .0255
 8               .0278         .032        .039        .046        .053
 8                 .06         .075          .1          .4          .7
 8                .725          .75        .765         .78         .79
 8                  .8          .81         .82        .825         .83
 8                .835          .84        .845         .85        .855
 8                 .86        .8638       .8675       .8713        .875
 8               .8788        .8825       .8863         .89       .8938
 8               .8975        .9013        .905       .9088       .9125
 8               .9148         .918        .921        .924        .927
 8                 .93        .9325        .935       .9375         .94
 8               .9425         .945       .9475         .95       .9525
 8                .955        .9575         .96       .9625        .965
 8               .9675          .97       .9725        .975       .9775
 8                 .98        .9813       .9825       .9838        .985
 8               .9863        .9875       .9888         .99       .9913
 8               .9925        .9938        .995       .9963       .9975
 8               .9988          1.0         1.0         1.0         1.0
 9 ENDTBL
 5 RAINFL 9                  0.0833
 8                 0.0       0.0173      0.0493      0.1201      0.2498
 8              0.4659       0.5696      0.6180      0.6551      0.6880
 8              0.7156       0.7433      0.7710      0.7986      0.8263
 8              0.8539       0.8755      0.8920      0.9084      0.9248
 8              0.9421       0.9576      0.9741      0.9888         1.0
 9 ENDTBL
1

**********************80-80 LIST OF INPUT DATA (CONTINUED)**********************

 3 STRUCT      01
 8                             57.7         0.0         0.0
 8                             60.0        14.5          .8
 8                              62.         27.         1.4
 8                              64.         35.         7.3
 8                             64.5         74.         8.7
 8                             64.7        174.          9.
 8                              65.        495.         10.
 9 ENDTBL
 3 STRUCT      03
 8                     5978.8       0.0         0.0
 8                     5980.8       8.3         0.037
 8                     5982.8      14.9         0.295
 8                     5984.8      19.4         0.995
```

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                     5986.8     23.0      2.339
8                    5988.8     26.2      4.343
8                    5990.8     28.9      7.074
8                    5992.8     31.5      10.517
8                    5994.8     33.8      14.722
8                    5996.8     36.0      19.741
8                    5998.8     38.1      25.642
8                    6000.8     40.1      32.493
8                    6002.0     41.2      37.068
8
9 ENDTBL
3 STRUCT      04
                          34.        0.0        0.0
8                         35.       11.56       .121
8                         36.       55.06       .73
8                         38.       106.3      3.492
8                         40.       203.37     7.569
8                         42.       265.49     12.299
8                         42.6      278.52     13.938
8                         44.       429.07     17.806
8                         44.5      752.97     22.311
8                         48.      1667.44     31.002
8
9 ENDTBL
3 STRUCT      05
                          70.        0.0        0.0
8                         71.        52.        15.
8                         72.        227.       40.
8                         73.        560.       69.
8                         74.        820.       90.
8                         75.        915.       127.
8                         75.5      1180.       147.
8
9 ENDTBL
3 STRUCT      06
1
```

```
......................80-80 LIST OF INPUT DATA (CONTINUED)......................

8                    5955.0     0.0       0.0
8                    5957.0     15.3      0.072
8                    5959.0     46.9      0.303
8                    5961.0     68.3      0.795
8                    5963.0     84.5      1.666
8                    5965.0     97.9      3.104
8                    5967.0     109.8     5.141
8                    5969.0     120.4     7.878
8                    5970.0     125.4     9.541
9 ENDTBL
3 STRUCT      07
                     5909.      0.0       0.0
8                    5911.      17.9      0.208
8                    5913.      68.7      1.158
8                    5915.      124.7     3.165
8                    5917.      165.6     6.250
8                    5919.      188.0     10.258
8                    5920.      212.3     12.646
9 ENDTBL
6 RUNOFF 1 044       5 0.104    74.5      0.44          1      1   1
6 REACH  3    01 5   6 3300.    .5        1.33          1      1   1
6 RUNOFF 1 045       5 0.083    74.5      0.33          1      1   1
6 ADDHYD 4 045   5 6 7                                  1      1   1
6 RUNOFF 1    01     2 0.135    74.5       .22          1      1   1
6 ADDHYD 4    01 7 2 1                                  1      1   1
6 RESVOR 2    01 1   7           57.7                   1 1 1 1    1
6 RUNOFF 1    02     2           .063       79.6      .31      1   1
6 REACH  3 001   7   3           3000.       .5      1.331     1   1
6 REACH  3 002   2   4           3400.       .5      1.331     1   1
6 RUNOFF 1 001       5           .116       76.2      .41      1   1
6 RUNOFF 1 002       6           .053       79.0      .21     .1   1
6 ADDHYD 4    03 3 5 1                                  1 1 1 1    1
6 RESVOR 2    03 1   5 5978.8                           1 1 1 1    1
6 ADDHYD 4 003   6 4 1                                  1 1 1 1    1
6 RESVOR 2    99 1   2 5955.0                           1 1 1 1    1
6 REACH  3 003   5   1           1000.       .5      1.331     1   1
6 ADDHYD 4 003   1 2 4                                  1      1   1
6 RUNOFF 1 003       3           .100       79.       .11      1   1
6 ADDHYD 4    04 3 4 7                                  1 1 1 1    1
6 RESVOR 2    99 7   6            34.                   1 1 1 1    1
6 REACH  3 004   6   1           2300.       .5      1.331     1   1
6 RUNOFF 1 004       2           .068       81.       .21      1   1
6 RUNOFF 1 005       3           .061       92.       .21      1   1
```

```
 6 ADDHYD 4 005   1 2 6                                        1 1 1 1   1
 6 RESVOR 2    07 6   4 5909.                                  1 1 1 1   1
 6 ADDHYD 4 005   3 4 7                                        1     1   1
1


.....................80-80 LIST OF INPUT DATA (CONTINUED).....................

 6 REACH  3 007   7   1         3500.          .5         1.331     1   1
 6 RUNOFF 1 046      4 0.102        80.1          0.29        1     1   1
 6 RUNOFF 1    05     3         .169       80.1             .41     1   1
 6 ADDHYD 4    05 4 3 2                                       1     1   1
 6 RESVOR 2    05 2   3          70.                          1   1 1   1
 6 RUNOFF 1 061       4 0.034       85.           0.15        1     1   1
 6 ADDHYD 4 061   3 4 5                                       1     1   1
 6 REACH  3 006   5   4         2700.          .5         1.331     1   1
 6 RUNOFF 1 006       5         .159       88.             .41     1   1
 6 ADDHYD 4 007   4 5 6                                       1     1   1
 6 ADDHYD 4 007   1 6 7                                       1     1   1
 6 REACH  3 008   7   1          800.          .5         1.331     1   1
 6 RUNOFF 1 008       2         .116       85.             .41     1   1
 6 ADDHYD 4 008   1 2 7                                       1     1   1
 6 REACH  3 009   7   1         1100.          .5         1.331     1   1
 6 RUNOFF 1 009       2         .147       81.             .41     1   1
 6 ADDHYD 4 009   1 2 7                                     1 1     1   1
 6 RUNOFF 1    21     2 0.139       88.           0.26        1     1   1
 6 REACH  3    20 2   6 2200.       .5            1.33        1     1   1
 6 RUNOFF 1    20     2         .103       88.            .271     1   1
 6 ADDHYD 4    20 6 2 1                                       1     1   1
 6 REACH  3 021   1   2         5200.          .5         1.331     1   1
 6 RUNOFF 1 021       3         .076       54.             .41     1   1
 6 RUNOFF 1 024       1         .081       54.             .31     1   1
 6 ADDHYD 4    21 2 3 6                                       1     1   1
 6 ADDHYD 4    21 1 6 4                                       1     1   1
 6 DIVERT 6    21 4 2 3 350.                                  1 1 1 1   1
 6 RUNOFF 1 022       6         .125       54.             .11      1   1
 6 ADDHYD 4 023   3 6 1                                       1 1   1   1
 6 ADDHYD 4 050   1 7 5                                       1 1   1   1
 6 RUNOFF 1 040       1 .224        85.5          0.48        1     1   1
 6 REACH  3 040   2   3 3800.       .5            1.33        1     1   1
 6 ADDHYD 4 040   1 3 6                                       1     1   1
 6 RUNOFF 1 041       1 .158        87.1          0.57        1     1   1
 6 RUNOFF 1 042       1 .135        53.8          0.50        1     1   1
 6 REACH  3 042   5   2 2300.       .5            1.33        1     1   1
 6 ADDHYD 4 042   2 1 6                                       1     1   1
 6 RUNOFF 1 043       5 .039        88.0          0.23        1     1   1
 6 ADDHYD 4 051   5 6 7                                       1     1   1
   ENDATA
 7 INCREM 6                     .083
 7 COMPUT 7 044   051           0.0        4.50          1.07 2   1   1
   ENDCMP 1
   ENDJOB 2
0...............................END OF 80-80 LIST...............................
1
```

TR20 XEQ PROP. COND. 2: FULL DEV.: PONDS K1 AND K2E W/ ST.S. ALIGN. "B" JOB 1 PASS 1
REV 09/01/83 ALT.1:24-HR/AMC II ALT.2:2-HR/AMC III;ST.#1:100 YR. ST.#2: 10 YR PAGE 1

FILE NO. 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.

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.07	233.36	(RUNOFF)
9.52	4.32	(RUNOFF)
19.88	2.17	(RUNOFF)
23.87	1.10	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 3.81 WATERSHED INCHES, 186.93 CFS-HRS, 15.45 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RUNOFF CROSS SECTION 24

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.03	250.22	(RUNOFF)
9.52	4.60	(RUNOFF)
19.88	2.31	(RUNOFF)
23.82	1.18	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 3.81 WATERSHED INCHES, 199.15 CFS-HRS, 16.46 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD STRUCTURE 21

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.29	479.01	(NULL)
12.91	13.03	(NULL)
19.92	8.75	(NULL)
23.89	4.39	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 3.34 WATERSHED INCHES, 685.30 CFS-HRS, 56.63 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD STRUCTURE 21

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.13	641.70	(NULL)
12.85	16.51	(NULL)
19.91	11.06	(NULL)
23.84	5.57	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 3.43 WATERSHED INCHES, 884.45 CFS-HRS, 73.09 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION DIVERT STRUCTURE 21
1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
5.89	350.00 *	(DIVERT)
		* FIRST POINT OF FLAT PEAK
12.85	16.51	(DIVERT)
19.91	11.06	(DIVERT)
23.84	5.57	(DIVERT)

OUTPUT #1 HYDROGRAPH

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .08 HOURS DRAINAGE AREA = .00 SQ.MI.

3.32	DISCHG	.00	.00	.00	.00	.00	.00	.00	.01	.04	.13
4.15	DISCHG	.30	.56	.87	1.20	1.53	1.86	2.17	2.48	2.77	3.05
4.98	DISCHG	3.33	3.76	4.88	6.59	8.62	11.53	15.32	30.00	91.07	200.92
5.81	DISCHG	322.23	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00
6.64	DISCHG	350.00	324.67	274.31	230.49	194.05	164.11	138.95	117.87	100.95	87.82
7.47	DISCHG	77.61	69.62	63.32	58.41	54.62	51.73	49.56	47.75	45.29	42.13
8.30	DISCHG	39.01	36.34	34.07	32.00	30.08	28.38	26.93	25.74	24.78	24.04
9.13	DISCHG	23.47	23.04	22.72	22.48	22.31	22.18	22.09	22.03	21.98	21.95
9.96	DISCHG	21.93	21.88	21.60	21.06	20.45	19.90	19.38	18.89	18.44	18.06
10.79	DISCHG	17.73	17.45	17.19	16.97	16.83	16.74	16.69	16.63	16.57	16.51
11.62	DISCHG	16.48	16.49	16.51	16.50	16.48	16.45	16.44	16.46	16.49	16.50

TIME(HRS)											
12.45	DISCHG	16.48	16.45	16.44	16.47	16.50	16.51	16.49	16.45	16.35	16.36
13.28	DISCHG	15.54	15.72	15.50	15.29	15.10	14.96	14.85	14.74	14.62	14.51
14.11	DISCHG	14.39	14.24	14.09	13.95	13.84	13.73	13.63	13.55	13.47	13.41
14.94	DISCHG	13.37	13.32	13.21	12.99	12.72	12.48	12.27	12.07	11.89	11.72
15.77	DISCHG	11.57	11.45	11.35	11.27	11.21	11.16	11.12	11.10	11.08	11.07
16.60	DISCHG	11.06	11.05	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04
17.43	DISCHG	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04
18.26	DISCHG	11.04	11.05	11.05	11.05	11.05	11.05	11.05	11.05	11.05	11.05
19.09	DISCHG	11.05	11.05	11.05	11.05	11.06	11.06	11.06	11.06	11.06	11.06
19.92	DISCHG	11.06	11.06	10.53	10.50	9.90	9.31	8.77	8.27	7.79	7.37
20.75	DISCHG	7.01	6.70	6.42	6.18	5.99	5.88	5.81	5.76	5.69	5.62
21.58	DISCHG	5.58	5.57	5.58	5.59	5.57	5.54	5.51	5.52	5.55	5.57
22.41	DISCHG	5.56	5.53	5.51	5.52	5.55	5.57	5.56	5.53	5.51	5.52
23.24	DISCHG	5.55	5.57	5.56	5.53	5.51	5.52	5.55	5.57	5.56	5.53
24.07	DISCHG	5.41	5.02	4.41	3.80	3.27	2.78	2.32	1.88	1.49	1.16

RUNOFF VOLUME ABOVE BASEFLOW = 3.43 WATERSHED INCHES, 743.02 CFS-HRS, 61.40 ACRE-FEET; . BASEFLOW = .00 CFS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.13	251.70	(DIVERT)

OUTPUT #2 DIVERTED HYDROGRAPH, CROSS SECTION = 0

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .08 HOURS DRAINAGE AREA = .40 SQ.MI.

5.81	DISCHG	.00	84.01	186.74	269.34	251.32	256.21	208.18	166.10	126.80	81.25
6.64	DISCHG	28.95	.00								

RUNOFF VOLUME ABOVE BASEFLOW = .55 WATERSHED INCHES, 141.82 CFS-HRS, 11.72 ACRE-FEET; BASEFLOW = .00 CFS

1

OPERATION RUNOFF CROSS SECTION 22

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
5.94	430.57	(RUNOFF)
6.43	25.86	(RUNOFF)
6.53	21.48	(RUNOFF)
7.53	14.41	(RUNOFF)
9.52	7.14	(RUNOFF)
19.88	3.57	(RUNOFF)
23.71	1.86	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 3.81 WATERSHED INCHES, 307.50 CFS-HRS, 25.41 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD CROSS SECTION 23

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
5.99	605.55	(NULL)
6.53	21.48	(NULL)
7.53	14.41	(NULL)
9.52	7.14	(NULL)
19.88	3.57	(NULL)
23.71	1.86	(NULL)

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .08 HOURS DRAINAGE AREA = .52 SQ.MI.

3.32	DISCHG	.00	.00	.00	.00	.00	.00	.00	.06	.17	.40
4.15	DISCHG	.75	1.04	1.32	1.59	1.84	2.08	2.31	2.53	2.74	2.95
4.98	DISCHG	3.14	4.57	7.57	8.57	11.50	16.58	18.54	119.36	307.60	371.35
5.81	DISCHG	396.94	493.30	603.15	549.31	380.84	295.50	243.51	201.35	162.07	111.71
6.64	DISCHG	51.46	21.35	21.20	21.20	21.21	18.96	14.84	14.23	14.15	14.15
7.47	DISCHG	14.35	14.16	14.16	14.16	14.16	14.17	14.17	12.22	7.85	7.18
8.30	DISCHG	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09
9.13	DISCHG	7.09	7.09	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10
9.96	DISCHG	7.10	6.77	5.62	5.42	5.37	5.27	5.26	5.28	5.38	5.40
10.79	DISCHG	5.37	5.28	5.26	5.28	5.38	5.40	5.38	5.28	5.26	5.28
11.62	DISCHG	5.38	5.40	5.38	5.28	5.26	5.28	5.38	5.40	5.39	5.29
12.45	DISCHG	5.27	5.28	5.38	5.40	5.39	5.29	5.27	5.21	4.80	4.71
13.28	DISCHG	4.68	4.58	4.56	4.57	4.67	4.49	4.68	4.58	4.56	4.54
14.11	DISCHG	4.33	4.28	4.27	4.27	4.27	4.27	4.27	4.27	4.27	4.27
14.94	DISCHG	4.27	4.24	3.71	3.58	3.56	3.56	3.56	3.56	3.56	3.56
15.77	DISCHG	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
16.60	DISCHG	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56

17.43	DISCHG	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
18.26	DISCHG	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
19.09	DISCHG	3.56	3.56	3.56	3.57	3.57	3.57	3.57	3.57	3.57	3.57
19.92	DISCHG	3.57	3.56	2.47	1.93	1.86	1.76	1.72	1.71	1.80	1.85
20.75	DISCHG	1.85	1.77	1.72	1.71	1.80	1.85	1.85	1.77	1.72	1.71

1

21.58	DISCHG	1.80	1.85	1.85	1.77	1.72	1.71	1.79	1.85	1.85	1.78
22.41	DISCHG	1.72	1.71	1.79	1.85	1.85	1.78	1.72	1.71	1.79	1.85
23.24	DISCHG	1.85	1.78	1.72	1.71	1.78	1.85	1.85	1.78	1.72	1.71
24.07	DISCHG	.88	.32	.01	.00						

RUNOFF VOLUME ABOVE BASEFLOW = 1.33 WATERSHED INCHES, 448.52 CFS-HRS, 37.10 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION ADDHYD CROSS SECTION 50

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.21	1356.88	(NULL)

TIME(HRS) FIRST HYDROGRAPH POINT = .00 HOURS TIME INCREMENT = .08 HOURS DRAINAGE AREA = 2.07 SQ.MI.

3.32	DISCHG	.00	.00	.00	.00	.00	.00	.00	.06	.17	.40
4.15	DISCHG	.75	1.04	1.32	1.59	1.84	2.08	2.31	2.55	2.80	3.07
4.98	DISCHG	3.35	5.27	7.56	9.06	12.53	17.47	20.09	123.55	325.26	425.71
5.81	DISCHG	561.30	820.51	1147.82	1325.54	1356.36	1355.53	1301.06	1172.74	1000.09	834.57
6.64	DISCHG	650.19	547.86	499.23	465.51	441.31	421.12	403.14	390.63	379.41	368.51
7.47	DISCHG	357.83	347.81	338.67	330.35	321.50	313.15	304.33	293.62	280.13	269.56
8.30	DISCHG	258.25	245.16	231.24	218.07	206.18	195.80	186.76	178.86	171.93	165.82
9.13	DISCHG	159.85	154.09	148.86	144.31	140.45	137.19	134.43	132.06	130.00	128.19
9.96	DISCHG	126.58	124.77	122.33	120.27	118.25	116.21	114.08	112.03	110.20	108.48
10.79	DISCHG	106.51	105.42	104.13	102.97	101.98	100.99	100.05	99.12	98.31	97.58
11.62	DISCHG	96.96	96.30	95.67	95.00	94.44	93.52	93.30	93.03	92.57	92.06
12.45	DISCHG	91.65	91.26	90.98	90.63	90.28	89.87	89.55	89.18	88.41	87.86
13.28	DISCHG	87.29	86.55	85.83	85.14	84.58	84.00	83.46	82.89	82.44	82.00
14.11	DISCHG	81.37	80.86	80.36	79.85	79.34	78.85	78.39	77.57	77.55	77.24
14.94	DISCHG	76.51	76.57	75.71	75.16	74.62	73.59	73.32	72.64	72.02	71.46
15.77	DISCHG	70.95	70.50	70.09	69.71	69.37	69.05	68.76	68.48	68.22	67.98
16.60	DISCHG	67.75	67.53	67.32	67.12	66.92	66.73	66.56	66.38	66.22	66.05
17.43	DISCHG	65.90	65.74	65.59	65.45	65.31	65.17	65.03	64.90	64.77	64.64
18.26	DISCHG	64.51	64.37	64.24	64.11	63.97	63.84	63.70	63.57	63.43	63.30
19.09	DISCHG	63.16	63.03	62.90	62.77	62.65	62.52	62.40	62.27	62.15	62.03
19.92	DISCHG	61.91	61.79	60.90	59.55	58.75	57.63	56.36	55.05	53.88	52.82
20.75	DISCHG	51.86	50.93	50.15	49.48	48.85	48.44	47.96	47.45	47.01	46.63
21.58	DISCHG	46.35	46.05	45.75	45.39	45.07	44.79	44.55	44.36	44.10	43.76
22.41	DISCHG	43.46	43.19	42.99	42.76	42.50	42.17	41.87	41.61	41.42	41.21
23.24	DISCHG	40.95	40.63	40.32	40.03	39.80	39.54	39.24	38.87	38.51	38.20
24.07	DISCHG	36.98	35.62	34.58	33.31	31.83	30.25	28.70	27.26	25.94	24.71

RUNOFF VOLUME ABOVE BASEFLOW = 2.19 WATERSHED INCHES, 2932.28 CFS-HRS, 242.32 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RUNOFF CROSS SECTION 40

1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.13	516.27	(RUNOFF)
9.93	12.22	(RUNOFF)
12.90	9.23	(RUNOFF)
19.88	6.19	(RUNOFF)
23.90	3.12	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 3.34 WATERSHED INCHES, 483.20 CFS-HRS, 39.93 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION REACH CROSS SECTION 40

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
6.74	334.91	(NULL)

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 BEGIN (HR)	AMOUNT (IN)	DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)	
ALTERNATE 1 STORM 1															
XSECTION	61	RUNOFF	.03	7	2	.08	.0	4.50	24.00	2.92	---	5.57	91.81	2700.3	
XSECTION	61	ADDHYD	.31	7	2	.08	.0	4.50	24.00	2.49	---	6.04	135.82	445.3	
XSECTION	6	REACH	.31	7	2	.08	.0	4.50	24.00	2.48	---	6.78	103.73	340.1	
XSECTION	6	RUNOFF	.16	7	2	.08	.0	4.50	24.00	3.19	---	6.09	375.29	2360.3	
XSECTION	7	ADDHYD	.46	7	2	.08	.0	4.50	24.00	2.72	---	6.11	457.69	986.4	
XSECTION	7	ADDHYD	1.29	7	2	.08	.0	4.50	24.00	2.44	---	6.16	725.27	563.5	
XSECTION	8	REACH	1.29	7	2	.08	.0	4.50	24.00	2.44	---	6.25	717.16	557.2	
XSECTION	8	RUNOFF	.12	7	2	.08	.0	4.50	24.00	2.91	---	6.10	247.63	2134.7	
XSECTION	8	ADDHYD	1.40	7	2	.08	.0	4.50	24.00	2.48	---	6.21	915.30	652.4	
XSECTION	9	REACH	1.40	7	2	.08	.0	4.50	24.00	2.48	---	6.32	893.46	636.8	
XSECTION	9	RUNOFF	.15	7	2	.08	.0	4.50	24.00	2.55	---	6.11	272.24	1852.0	
XSECTION	9	ADDHYD	1.55	7	2	.08	.0	4.50	24.00	2.48	---	6.26	1071.26	691.1	DP 13
STRUCTURE	21	RUNOFF	.14	7	2	.08	.0	4.50	24.00	3.20	---	6.03	363.46	2758.7	
STRUCTURE	20	REACH	.14	7	2	.08	.0	4.50	24.00	3.15	---	6.25	312.50	2251.1	
STRUCTURE	20	RUNOFF	.10	7	2	.08	.0	4.50	24.00	3.19	---	6.03	280.08	2719.2	
STRUCTURE	20	ADDHYD	.24	7	2	.08	.0	4.50	24.00	3.19	---	6.10	494.15	2042.0	
XSECTION	21	REACH	.24	7	2	.08	.0	4.50	24.00	3.15	---	6.43	387.14	1595.8	
XSECTION	23	RUNOFF	.08	7	2	.08	.0	4.50	24.00	3.81	---	6.07	223.36	2807.3	
XSECTION	24	RUNOFF	.08	7	2	.08	.0	4.50	24.00	3.81	---	6.03	250.22	3089.1	
STRUCTURE	21	ADDHYD	.32	7	2	.08	.0	4.50	24.00	3.34	---	6.29	479.01	1506.3	
STRUCTURE	21	ADDHYD	.40	7	2	.08	.0	4.50	24.00	3.43	---	6.13	641.70	1608.3	
STRUCTURE	21	DIVERT	.00	7	2	.08	.0	4.50	24.00	3.43	---	5.89*	350.00*	**********	
XSECTION	0	DIVERT	.40	7	2	.08	.0	4.50	24.00	.55	---	6.13	291.70	731.1	DP 11
XSECTION	22	RUNOFF	.13	7	2	.08	.0	4.50	24.00	3.81	---	5.94	430.57	3447.8	
XSECTION	23	ADDHYD	.52	7	2	.08	.0	4.50	24.00	1.33	---	5.99	605.55	1155.6	DP 12
XSECTION	50	ADDHYD	2.07	7	2	.08	.0	4.50	24.00	2.19	---	6.21	1356.88	654.2	DP 5
XSECTION	40	RUNOFF	.22	7	2	.08	.0	4.50	24.00	3.34	---	6.13	516.27	2304.8	
XSECTION	40	REACH	.00	7	2	.08	.0	4.50	24.00	3.34	---	6.74	334.51	**********	
XSECTION	40	ADDHYD	.22	7	2	.08	.0	4.50	24.00	8.48	---	6.15	767.34	3425.6	
XSECTION	41	RUNOFF	.20	7	2	.08	.0	4.50	24.00	3.11	---	6.18	383.13	1935.0	
XSECTION	42	RUNOFF	.14	7	2	.08	.0	4.50	24.00	3.79	---	6.12	347.36	2573.0	
XSECTION	42	REACH	2.07	7	2	.08	.0	4.50	24.00	2.19	---	6.37	1288.04	621.0	
XSECTION	42	ADDHYD	2.21	7	2	.08	.0	4.50	24.00	2.28	---	6.29	1528.53	691.9	DP 14
XSECTION	43	RUNOFF	.04	7	2	.08	.0	4.50	24.00	3.19	---	6.02	107.50	2756.5	
XSECTION	51	ADDHYD	2.25	7	2	.08	.0	4.50	24.00	2.30	---	6.27	1555.11	691.8	DP 15

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/O *PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)

ALTERNATE 1 STORM 1

	3300	139	6.1	89	6.5	---	---	0	2.01	.08	1	.500	1.33	.365	.637	1227	.22	.25	.36
1	3000	251	6.2	140	6.6	---	---	0	2.01	.08	1	.500	1.33	.328	.557	964	.27	.41	.29
	3400	126	6.1	74	6.5	---	---	0	2.42	.08	1	.500	1.33	.521	.564	1297	.21	.25	.38
	1000	56	10.4	56	10.5	232	6.1	0	2.04	.08	1	.500	1.33	.003	1.000	522	.45	.17	.14
4	2300	449	6.0	354	6.1	---	---	0	2.16	.08	1	.500	1.33	.053	.789	640	.38	.17	.18
7	1500	341	6.1	306	6.2	---	---	0	2.29	.08	1	.500	1.33	.017	.857	447	.50	.08	.13
	2700	134	6.1	104	6.8	---	---	0	2.49	.08	1	.500	1.33	.048	.772	1014	.26	.75.	.29
r	800	724	6.1	712	6.2	533	6.2	0	2.44	.08	1	.500	1.33	.008	.584	158	.867	.08	.06
9	1100	913	6.2	853	6.3	1060	6.2	0	2.48	.08	1	.500	1.33	.013	.978	257	.749	.08	.07
1	2200	376	6.1	310	6.2	489	6.1	0	3.20	.08	1	.500	1.33	.211	.824	640	.38	.08	.18
	3200	489	6.1	385	6.4	---	---	0	3.19	.08	1	.500	1.33	.216	.787	872	.29	.17	.25
0	2800	350	5.9	325	6.7	---	---	0	.00	.08	1	.500	1.33	.114	.557	1125	.23	.83	.31
2	2300	1356	6.2	1285	6.4	---	---	0	2.19	.08	1	.500	1.33	.037	.548	486	.47	.17	.14

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

...ION/ RUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1
...CTURE 59	.69	
ALTERNATE 1		449.42
...UCTURE 21	.00	
...TERNATE 1		350.00
TRUCTURE 20	.24	
...TERNATE 1		494.15
...CTURE 7	.76	
ALTERNATE 1		399.93
...CTURE 5	.27	
...TERNATE 1		99.97
TRUCTURE 4	.69	
...TERNATE 1		449.42
...CTURE 3	.44	
ALTERNATE 1		35.68
...CTURE 2	.06	
...TERNATE 1		125.96

STRUCTURE 1	.32		
ALTERNATE 1		261.61	
XSECTION 0	.40		
ALTERNATE 1		251.70	
XSECTION 1	.32		
ALTERNATE 1		176.53	
XSECTION 2	.09		
ALTERNATE 1		206.98	
XSECTION 3	.10		
ALTERNATE 1		229.22	
XSECTION 4	.07		
ALTERNATE 1		161.61	

1

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

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.......... 1
XSECTION 5	.82	
ALTERNATE 1		343.51
XSECTION 6	.16	
ALTERNATE 1		375.29
XSECTION 7	1.29	
ALTERNATE 1		725.27
XSECTION 8	1.40	
ALTERNATE 1		915.30
XSECTION 9	1.55	
ALTERNATE 1		1071.26
XSECTION 21	.08	
ALTERNATE 1		213.36
XSECTION 22	.13	
ALTERNATE 1		430.97
XSECTION 23	.52	
ALTERNATE 1		605.55
XSECTION 24	.08	
ALTERNATE 1		250.22
XSECTION 40	.22	
ALTERNATE 1		767.34
XSECTION 41	.20	
ALTERNATE 1		383.13
XSECTION 42	2.21	
ALTERNATE 1		1528.51
XSECTION 43	.04	
ALTERNATE 1		107.50
XSECTION 44	.10	
ALTERNATE 1		139.43

1

EXECUTIVE CONTROL OPERATION ENDCMP   RECORD ID

COMPUTATIONS COMPLETED FOR PASS 1

1

EXECUTIVE CONTROL OPERATION ENDJOB   RECORD ID

1

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.)

ALTERNATE 1 STORM 1

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
XSECTION 44	RUNOFF	.10	7	2	.08	.0	4.50	24.00	2.01	---	6.14	139.43	1340.7
STRUCTURE 1	REACH	.10	7	2	.08	.0	4.50	24.00	2.01	64.53	6.47	88.86	854.4
XSECTION 45	RUNOFF	.08	7	2	.08	.0	4.50	24.00	2.01	---	6.08	128.75	1551.2
XSECTION 45	ADDHYD	.19	7	2	.08	.0	4.50	24.00	2.01	---	6.14	157.54	842.5
STRUCTURE 1	RUNOFF	.14	7	2	.08	.0	4.50	24.00	2.01	---	6.03	246.50	1825.5
STRUCTURE 1	ADDHYD	.32	7	2	.08	.0	4.50	24.00	2.01	64.50	6.05	389.76	1210.4
STRUCTURE 1	RESVOR	.32	7	2	.08	.0	4.50	24.00	2.01	64.78	6.25	261.61	812.5
STRUCTURE 2	RUNOFF	.06	7	2	.08	.0	4.50	24.00	2.42	---	6.06	125.56	1999.4
XSECTION 1	REACH	.32	7	2	.08	.0	4.50	24.00	2.00	---	6.60	140.30	435.7
XSECTION 2	REACH	.06	7	2	.08	.0	4.50	24.00	2.42	---	6.43	74.28	1175.0
XSECTION 1	RUNOFF	.12	7	2	.08	.0	4.50	24.00	2.14	---	6.12	176.93	1525.2
XSECTION 2	RUNOFF	.09	7	2	.08	.0	4.50	24.00	2.38	---	6.02	206.58	2225.6
STRUCTURE 3	ADDHYD	.44	7	2	.08	.0	4.50	24.00	2.03	6179.23	6.34	203.63	464.9
STRUCTURE 3	RESVOR	.44	7	2	.08	.0	4.50	24.00	2.04	5996.51	10.28*	35.68*	81.5
XSECTION 3	ADDHYD	.16	7	2	.08	.0	4.50	24.00	2.40	---	6.03	219.51	1407.1
STRUCTURE 99	RESVOR	.16	7	2	.08	.0	4.50	24.00	2.40	---	6.03	219.51	1407.1
XSECTION 3	REACH	.44	7	2	.08	.0	4.50	24.00	2.03	---	10.54*	35.68*	81.5
XSECTION 3	ADDHYD	.59	7	2	.08	.0	4.50	24.00	2.13	---	6.04	234.15	394.2
XSECTION 3	RUNOFF	.10	7	2	.08	.0	4.50	24.00	2.37	---	5.96	239.32	2353.2
STRUCTURE 4	ADDHYD	.69	7	2	.08	.0	4.50	24.00	2.16	44.03	5.98	449.42	647.6
STRUCTURE 99	RESVOR	.69	7	2	.08	.0	4.50	24.00	2.16	---	5.98	449.42	647.6
XSECTION 4	REACH	.69	7	2	.08	.0	4.50	24.00	2.16	---	6.13	355.43	512.2
XSECTION 4	RUNOFF	.07	7	2	.08	.0	4.50	24.00	2.55	---	6.02	161.61	2376.6
XSECTION 5	RUNOFF	.06	7	2	.08	.0	4.50	24.00	3.60	---	5.98	189.45	3105.7
XSECTION 5	ADDHYD	.76	7	2	.08	.0	4.50	24.00	2.19	---	6.08	484.25	635.5
STRUCTURE 7	RESVOR	.76	7	2	.08	.0	4.50	24.00	2.19	5919.14	6.49	199.93	262.4
XSECTION 5	ADDHYD	.82	7	2	.08	.0	4.50	24.00	2.29	---	6.04	343.51	417.4
XSECTION 7	REACH	.82	7	2	.08	.0	4.50	24.00	2.28	---	6.25	307.96	374.2
XSECTION 46	RUNOFF	.10	7	2	.08	.0	4.50	24.00	2.47	---	6.05	210.24	2061.1
STRUCTURE 5	RUNOFF	.17	7	2	.08	.0	4.50	24.00	2.47	---	6.11	302.31	1788.8
STRUCTURE 5	ADDHYD	.27	7	2	.08	.0	4.50	24.00	2.47	73.91	6.08	504.92	1863.2
STRUCTURE 5	RESVOR	.27	7	2	.08	.0	4.50	24.00	2.43	71.06	6.56	99.97	368.9

<u>APPENDIX "D"</u>

DREXEL BARRELL
LAND SURVEYORS
CIVIL ENGINEERS

Project	Job No
HARRISON OUTFALL MODIFICATIONS	E4826

Client	By	Date
GATES.	CMB	1/3/97

THE FOLLOWING APPENDIX IS A SUMMARY OF HYDRAULIC CALCULATIONS UTILIZED IN DESIGNING A DIVERSION STRUCTURE FOR THE HARRISON OUTFALL BOX CULVERT.

THE TRIBUTARY AREA COMPRISES 0.4 SQUARE MILES OF DEVELOPED LAND. A 100 YEAR STORM CONTRIBUTES APPROXIMATELY 640 Cfs OF RUNOFF.

THE DIVERSION STRUCTURE WAS DESIGNED USING THE FOLLOWING HYDRAULIC SOFTWARE PACKAGES:

- FLOWMASTER – HAESTAD METHODS – 1994-1995
- CULVERT MASTER – " " 1995
- POND-2 – " "

THE RESULTANT DIVERSION STRUCTURE WILL CONSIST OF TWO WEIRS (1 ÷ 2). AN EASTERN WEIR (1) WILL CONTROL FLOWS DISCHARGING INTO HARRISON OUTFALL BOX CULVERT TO 348.4 Cfs, ~~FOR~~ THE 100-YEAR STORM. A SOUTHERN WEIR (2) WILL CONTROL FLOWS DISCHARGING INTO THE I-25 BORROW DITCH TO 291.3 Cfs, ALSO THE 100-YEAR STORM. THE I-25 BORROW DITCH WILL CONVEY FLOWS SOUTH, EVENTUALLY DISCHARGING INTO SINTON OUTFALL.

THE CHANNEL (I-25 DITCH) WAS DESIGNED, TO CONVEY 291.3 Cfs, USING "FLOW MASTER".

4840 PEARL EAST CIRCLE, SUITE 114 (303)442-4338
BOULDER, COLORADO 80301
740 WOOTEN RD. #108 (719) 591-5151
COLORADO SPRINGS, COLORADO 80915

STRUCTURE 1

Worksheet for Trapezoidal Channel

Project Description	
Project File	g:\e4826\gates.fm2
Worksheet	STRUCTURE 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	40.00	ft
Discharge	350.00	cfs

Results		
Depth	1.04	ft
Flow Area	43.84	ft²
Wetted Perimeter	44.66	ft
Top Width	44.17	ft
Critical Depth	1.31	ft
Critical Slope	0.002340	ft/ft
Velocity	7.98	ft/s
Velocity Head	0.99	ft
Specific Energy	2.03	ft
Froude Number	1.41	
Flow is supercritical.		

ELEVATED WEIR RELEASING EAST TO THE HARRISON BOX

$Q_{EAST_{100}} = 350$ cfs

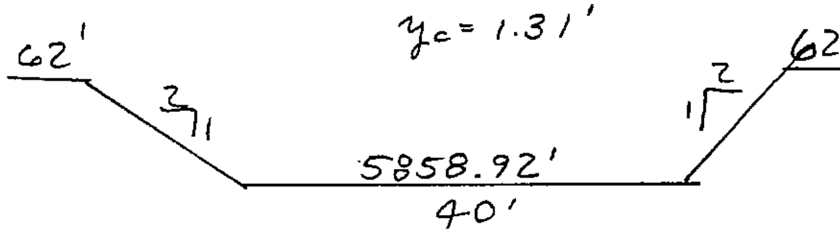
TRAP WEIR: $Q = 3.367 b h^{3/2}$

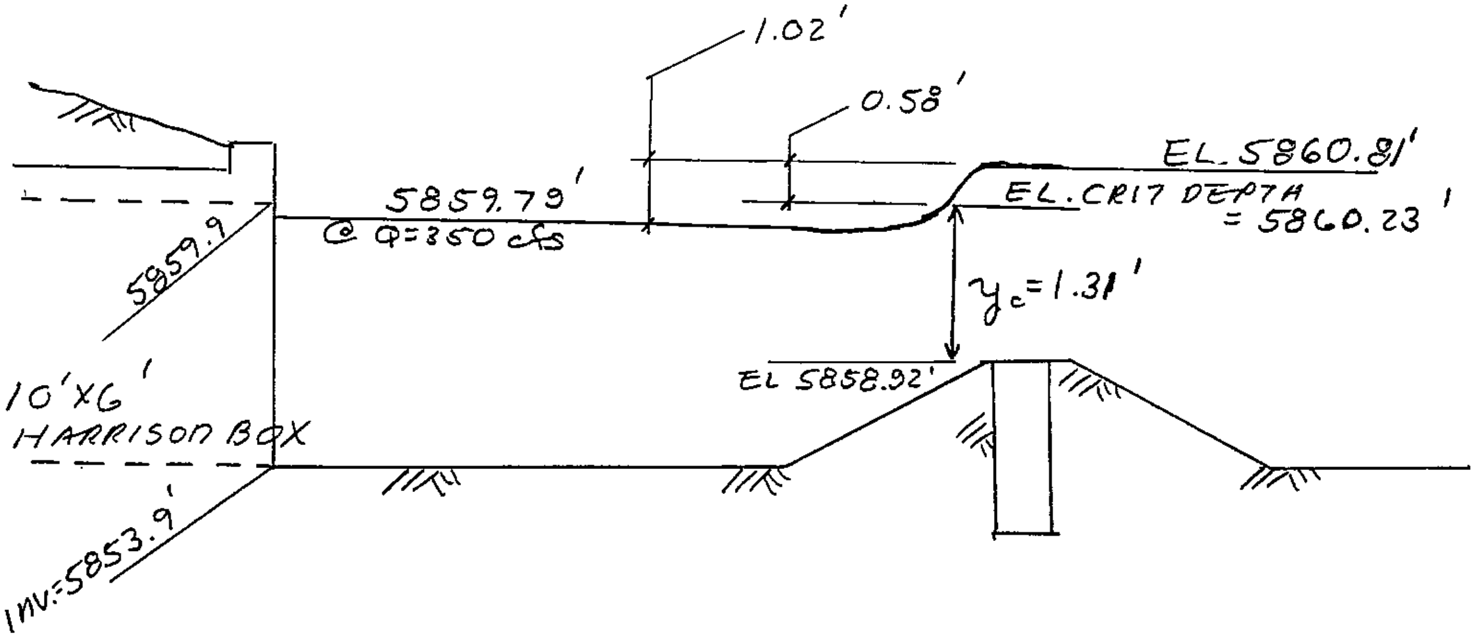
$Q = 350$ cfs

$b = 40'$

$h = 1.89'$

$y_c = 1.31'$



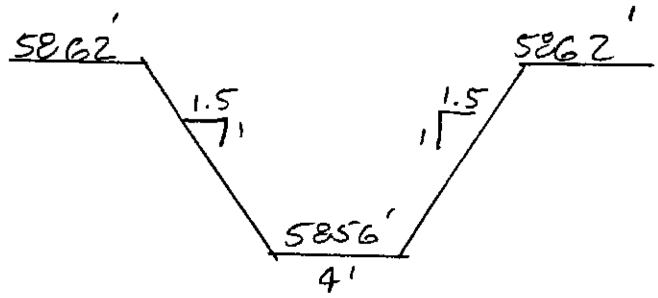


STRUCTURE 2
Worksheet for Trapezoidal Channel

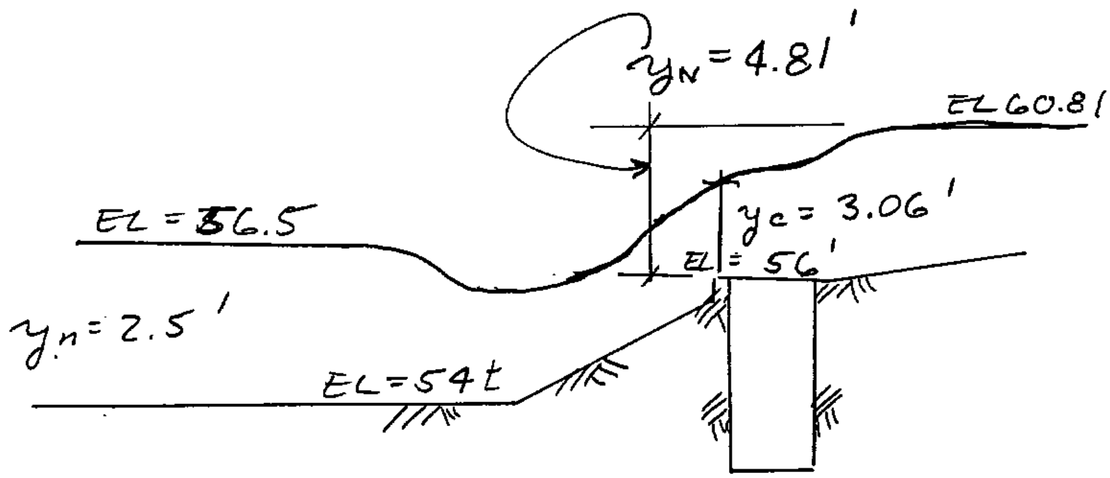
Project Description	
Project File	g:\e4826\gates.fm2
Worksheet	STRUCTURE 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

LOWER WEIR
DRAINING TO SOUTH

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Left Side Slope	1.500000	H : V
Right Side Slope	1.500000	H : V
Bottom Width	4.00	ft
Discharge	290.00	cfs



Results		
Depth	2.97	ft
Flow Area	25.12	ft²
Wetted Perimeter	14.71	ft
Top Width	12.91	ft
Critical Depth	3.60	ft
Critical Slope	0.002245	ft/ft
Velocity	11.55	ft/s
Velocity Head	2.07	ft
Specific Energy	5.04	ft
Froude Number	1.46	
Flow is supercritical.		



Outlet Structure File: HARRALT .STR

POND-2 Version: 5.20 S/N:
Date Executed: Time Executed:

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

Elevation (ft)	Q (cfs)	Contributing Structures
5858.90	108.3	1
5859.00	118.5	1 +2
5859.10	132.8	1 +2
5859.20	149.7	1 +2
5859.30	168.7	1 +2
5859.40	189.6	1 +2
5859.50	212.3	1 +2
5859.60	236.6	1 +2
5859.70	262.3	1 +2
5859.80	289.6	1 +2
5859.90	318.3	1 +2 Q_5 = 330 cfs @ 5859.94'
5860.00	348.5	1 +2
5860.10	380.0	1 +2
5860.20	412.6	1 +2
5860.30	446.8	1 +2
5860.40	482.2	1 +2
5860.50	518.9	1 +2
5860.60	556.8	1 +2
5860.70	595.8	1 +2
5860.80	636.2	1 +2
5860.90	677.8	1 +2 Q_{100} = 640 @ El: 5860.81'
5861.00	720.6	1 +2
5861.10	764.6	1 +2
5861.20	809.6	1 +2
5861.30	856.0	1 +2
5861.40	903.6	1 +2
5861.50	952.3	1 +2
5861.60	1002.2	1 +2
5861.70	1053.1	1 +2
5861.80	1105.3	1 +2

NOTES:

COMBINED RATING FLOW FOR BOTH WEIRS

Outlet Structure File: HARRSTR2.STR

POND-2 Version: 5.20 S/N:
Date Executed: Time Executed:

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

Elevation (ft)	Q (cfs)	Contributing Structures	
5858.90	0.0		
5859.00	2.8	2	
5859.10	9.5	2	
5859.20	18.5	2	
5859.30	29.3	2	
5859.40	41.8	2	
5859.50	55.7	2	
5859.60	71.0	2	
5859.70	87.5	2	5YR
5859.80	105.2	2	
5859.90	124.1	2	Q_{EAST} = 132.40 cfs @ 5859.94'
5860.00	144.1	2	
5860.10	165.1	2	
5860.20	187.1	2	
5860.30	210.2	2	
5860.40	234.2	2	
5860.50	259.2	2	
5860.60	285.2	2	
5860.70	312.0	2	
5860.80	339.8	2	Q_{EAST} = 342.67 cfs @ 5860.81'
5860.90	368.5	2	
5861.00	398.2	2	
5861.10	428.7	2	
5861.20	459.9	2	
5861.30	492.1	2	
5861.40	525.2	2	
5861.50	559.1	2	
5861.60	593.9	2	
5861.70	629.3	2	
5861.80	665.8	2	

STRUCTURE 1 (HARRISON)
RATING TABLE

Outlet Structure File: HARRSTR1.STR

POND-2 Version: 5.20 S/N:
Date Executed: Time Executed:

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

Elevation (ft)	Q (cfs)	Contributing Structures	
5858.90	108.3	1	
5859.00	115.7	1	Q to SOUTH = 108.8cfs WHEN FLOW TO HARRISON EQUALS "0"
5859.10	123.3	1	
5859.20	131.2	1	
5859.30	139.4	1	
5859.40	147.8	1	
5859.50	156.5	1	
5859.60	165.6	1	5 YR
5859.70	174.8	1	
5859.80	184.4	1	
5859.90	194.3	1	Q_{SOUTH} = 198.34cfs @ 5859.94'
5860.00	204.4	1	
5860.10	214.9	1	
5860.20	225.6	1	
5860.30	236.6	1	
5860.40	248.0	1	
5860.50	259.6	1	
5860.60	271.6	1	100YR
5860.70	283.8	1	
5860.80	296.4	1	Q_{SOUTH} = 297.68cfs @ 5860.81'
5860.90	309.2	1	
5861.00	322.4	1	
5861.10	336.0	1	
5861.20	349.7	1	
5861.30	363.9	1	
5861.40	378.4	1	
5861.50	393.2	1	
5861.60	408.4	1	
5861.70	423.8	1	
5861.80	439.6	1	

STRUCTURE 2 (FLOW TO SOUTH)
RATING TABLE

Outlet Structure File: HARRALT .STR

POND-2 Version: 5.20　　　　S/N:
Date Executed:　　　　　　　Time Executed:

Outlet Structure File:　　c:\pondpack\HARRALT .STR
Planimeter Input File:　　c:\pondpack\HARRISON.VOL
Rating Table Output File: c:\pondpack\HARRALT .PND

Min. Elev.(ft) = 5858.9　Max. Elev.(ft) = 5861.8　Incr.(ft) = .1

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

****
SYSTEM CONNECTIVITY
****

Structure	No.	Q Table		Q Table
WEIR-XY	1		->	1
WEIR-XY	2		->	2

Outflow rating table summary was stored in file:
c:\pondpack\HARRALT .PND

Outlet Structure File: HARRALT .STR

POND-2 Version: 5.20 S/N:
Date Executed: Time Executed:

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

WEIR-XY
Weir - Defined by X, Y Coordinates
E1 (ft) =5856. E2 (ft) =5862

X dist.(ft)	Y elev.(ft)
0	5862
9	5856
13	5856
22	5862

Outlet Structure File: HARRALT .STR

POND-2 Version: 5.20 S/N:
Date Executed: Time Executed:

>>>>>> Structure No. 2 <<<<<<
(Input Data)

WEIR-XY
Weir - Defined by X, Y Coordinates
E1 (ft) =5858.42 E2 (ft) =5862

X dist.(ft)	Y elev.(ft)
0	5862
6.18	5858.92
46.18	5858.92
52.36	5862

Culvert Calculator Report
HARRISON

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	60.00 ft	Headwater Depth/ Height	1.02
Computed Headwater Elevation	60.00 ft	Discharge	369.14 cfs
Inlet Control HW Elev	59.41 ft	Tailwater Elevation	2.30 ft
Outlet Control HW Elev	60.00 ft	Control Type	Outlet Control

Grades			
Upstream Invert	53.90 ft	Downstream Invert	53.00 ft
Length	110.00 ft	Constructed Slope	0.008182 ft/ft

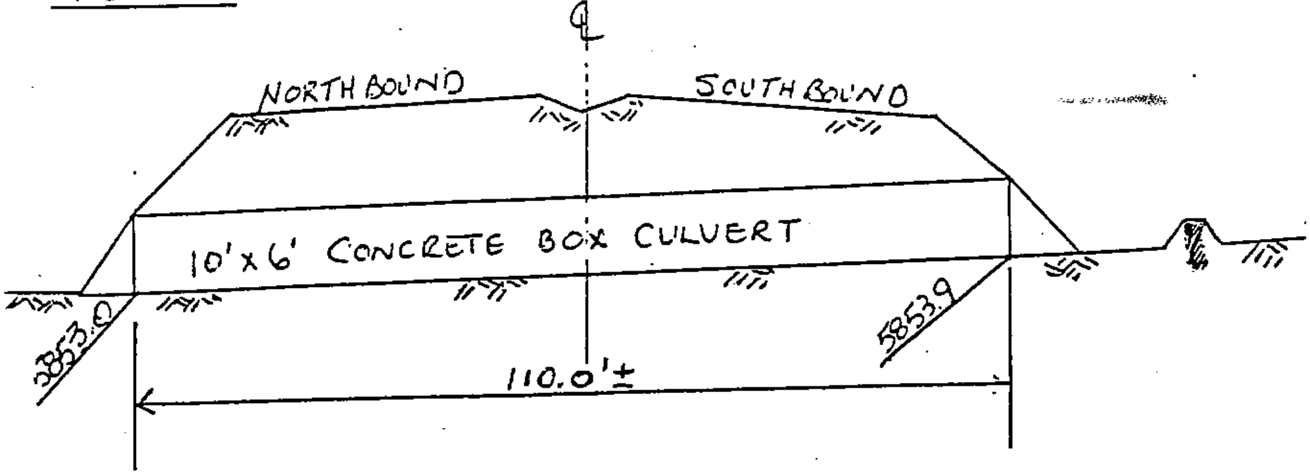
Hydraulic Profile			
Profile	S2	Depth, Downstream	2.76 ft
Slope Type	Steep	Normal Depth	2.53 ft
Flow Regime	Supercritical	Critical Depth	3.49 ft
Velocity Downstream	13.38 ft/s	Critical Slope	0.003288 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	10.00 ft
Section Size	10 x 6 ft	Rise	6.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	60.00 ft	Upstream Velocity Head	1.74 ft
Ke	0.50	Entrance Loss	0.87 ft

Inlet Control Properties			
Inlet Control HW Elev	59.41 ft	Flow Control	N/A
Inlet Type	45 ° non-offset wingwall flares	Area Full	60.0 ft²
K	0.49700	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	1
c	0.03390	Equation Form	2
Y	0.80300		

PROFILE : HARRISON CULVERT



NTS

Rating Table Report
HARRISON
10' x 6' BOX CULVERT

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	360.00	10.00 cfs

Discharge (cfs)	HW Elev (ft)	HWi (ft)	HWo (ft)
0.00	2.30	2.30	2.30
10.00	54.45	54.40	54.45
20.00	54.77	54.69	54.77
30.00	55.04	54.93	55.04
40.00	55.29	55.15	55.29
50.00	55.51	55.35	55.51
60.00	55.72	55.54	55.72
70.00	55.91	55.72	55.91
80.00	56.10	55.89	56.10
90.00	56.28	56.05	56.28
100.00	56.45	56.21	56.45
110.00	56.62	56.36	56.62
120.00	56.78	56.50	56.78
130.00	56.94	56.65	56.94
140.00	57.10	56.79	57.10
150.00	57.25	56.92	57.25
160.00	57.39	57.06	57.39
170.00	57.54	57.19	57.54
180.00	57.68	57.31	57.68
190.00	57.82	57.44	57.82
200.00	57.95	57.56	57.95
210.00	58.09	57.68	58.09
220.00	58.22	57.80	58.22
230.00	58.35	57.92	58.35
240.00	58.48	58.04	58.48
250.00	58.60	58.15	58.60
260.00	58.73	58.26	58.73
270.00	58.85	58.37	58.85
280.00	58.97	58.48	58.97
290.00	59.09	58.59	59.09
300.00	59.21	58.70	59.21
310.00	59.33	58.81	59.33
320.00	59.45	58.91	59.45
330.00	59.56	59.01	59.56
340.00	59.67	59.12	59.67
350.00	59.79	59.22	59.79
360.00	59.90	59.32	59.90

350cfs COMPUTED CAPACITY

CHANNEL CROSS-SECTION
Cross Section for Trapezoidal Channel

Project Description	
Project File	g:\e4826\gates.fm2
Worksheet	GATES-PROPOSED
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.040	
Channel Slope	0.006300	ft/ft
Depth	2.32	ft
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	20.00	ft
Discharge	290.00	cfs