

STORM WATER & SUBDIVISION
101 W. COSTILLA , SUITE 113
COLORADO SPRINGS, CO 80903
(719) 578-6212

R
PUBLIC Y
COLORA

FINAL DRAINAGE REPORT
FOR STORM OUTFALL FACILITIES FROM
PORTIONS OF BROADMOOR BLUFFS

JU
AM
7, 8, 9, 10, 11

AND
CHEYENNE MEADOWS SOUTH
AT CHEYENNE MOUNTAIN RANCH
COLORADO SPRINGS, COLORADO
(BASIN A-23)

A



— DREXEL, BARRELL & CO. —

ENGINEERS — SURVEYORS

1700 38TH STREET

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RETURN WITHIN 2 WEEKS TO:
CITY OF COLORADO SPRINGS
STORM WATER & SUBDIVISION
101 W. COSTILLA , SUITE 113
COLORADO SPRINGS, CO 80903;
(719) 578-6212

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COLORADO SPRINGS, COLO.

FINAL DRAINAGE REPORT
FOR STORM OUTFALL FACILITIES FROM
PORTIONS OF BROADMOOR BLUFFS
AND
CHEYENNE MEADOWS SOUTH
AT CHEYENNE MOUNTAIN RANCH
COLORADO SPRINGS, COLORADO
(BASIN A-23)

JUN 10 1986
AM
7 8 9 10 11 12 1 2 3 4 5 6
PM

NOTE: THIS REPORT HAS BEEN ACCEPTED BY THE COLORADO DEPARTMENT OF HIGHWAYS AND FORT CARSON UNDER THE TITLE OF "FINAL DRAINAGE REPORT FOR PORTIONS OF BROADMOOR BLUFFS AND CHEYENNE MEADOWS SOUTH AT CHEYENNE MOUNTAIN RANCH, COLORADO SPRINGS, COLORADO", DATED AUGUST 1985, (SEE LETTERS IN EXHIBIT "G")

PREPARED BY:

DREXEL, BARRELL & CO.
1700 38TH STREET
BOULDER, COLORADO 80301

PREPARED FOR:

GATES LAND COMPANY
155 WEST LAKE AVENUE
COLORADO SPRINGS, CO 80906

REVISED JUNE 11, 1986
AUGUST 1, 1985
E-2528
(0176R)

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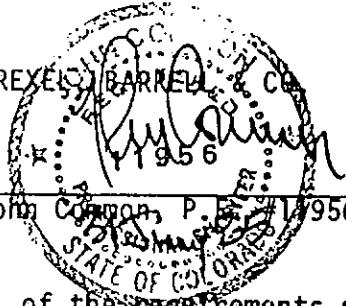
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CERTIFICATIONS

The attached drainage plan and report "Final Drainage Report for Portions of Broadmoor Bluffs and Cheyenne Meadows South at Cheyenne Mountain Ranch", were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by the negligent acts, errors, or omissions on my part in preparing this report.

For: DREXEL BARNETT & CO

By: _____
John Common, P.E. 1956



The developer has read and will comply with all of the requirements specified in this drainage report as approved by the City Engineer.

By: _____
Robert F. Svejksvsky
Title: Director of Engineering
Address: 155 West Lake Avenue
Colorado Springs, CO 80906

City of Colorado Springs:

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.


City Engineer 7/1/86

Conditions:

1. All construction in the Colorado highway right of way shall be in conformance with highway department requirements and shall be maintained by the Colorado Department of Highways.
2. Subject to the requirements of the Department of the Army, Headquarters, Fort Carson.
3. In subbasins K, L, IV, IVA, channels conveying flows from public facilities shall be lined per city specifications upon platting and prior to acceptance by City for maintenance.
4. All construction in the City of Colorado Springs jurisdiction shall be subject to final design requirements.

FLOODPLAIN STATEMENT

FOR
PORTIONS OF BROADMOOR BLUFFS AND
CHEYENNE MEADOWS SOUTH AT
CHEYENNE MOUNTAIN RANCH

The basin addressed in this report is not in a designated floodplain as shown on the Flood Insurance Rating Maps.

FINAL DRAINAGE REPORT
FOR STORM OUTFALL FACILITIES FROM
PORTIONS OF BROADMOOR BLUFFS
AND
CHEYENNE MEADOWS SOUTH
AT CHEYENNE MOUNTAIN RANCH
COLORADO SPRINGS, COLORADO
(BASIN A-23)

LOCATION

This report addresses a drainage basin of approximately 180 acres which includes portions of Neal Ranch Filing No. 2, Broadmoor Bluffs Park Filings No. 2, 3, 4 and 8, and Broadmoor Bluffs Estates in addition to some unplatted land in Broadmoor Bluffs and a part of Cheyenne Meadows South. With the exception of the Neal Ranch, all of the above parcels are a part of Cheyenne Mountain Ranch. This tributary area begins in the central part of Section 12 of T15S, R67W of the 6th P.M., Colorado Springs, Colorado. From there it traverses the N1/2 of Section 7, the SE1/4 of Section 6, and the S1/2 of Section 5, all in T15S, R66W of the 6th P.M.

More generally, the area lies to the north and to the west of the Fort Carson Military Reservation. The basin corresponds approximately to Basin A-23 as described in the Drainage Study, Fort Carson, Colorado prepared for the U.S. Army Corps of Engineers by Higgenbotham & Assoc., Morgan & Assoc., Inc., and Karcich & Weber, Inc., and dated August 1976 (Reference 1). To the east of State Highway 115, the basin is bounded on the north and east by Cheyenne Crest and Westmeadow Drive, and on the south by Academy Boulevard. To the west of Highway 115, it is bounded on the south by portions of Broadmoor Bluffs Estates, Neal Ranch Filing No. 2, and unplatted lands. To the north, the area is bounded by unplatted lands at the furthest west point. Proceeding to the east, it is bounded by the Sokal property, Broadmoor Bluffs Park Filings No. 2, 3, 4 and 8, and unplatted Gates Land Company holdings. See Appendix Exhibit "A" entitled vicinity map for additional information.

INTENT

The primary intent of this report is to determine the drainage facilities necessary to provide outfall for storm runoff from portions of Broadmoor Bluffs and Cheyenne Meadows South. This report is only for the outfall facilities and is not to be used to fulfill the City platting requirements for drainage reports.

The report also provides refined and updated information to addend a portion of the Drainage Study, Fort Carson, Colorado mentioned above, as well as two previous master drainage studies: Master Drainage Study for Cheyenne Mountain Ranch, prepared by Hartzell-Pfeiffenberger & Assoc., Inc. dated May 17, 1971 (Reference 2), and Master Drainage Report for Basin IV, IV-A, IV-B, and VII-B, Cheyenne Mountain Ranch, prepared by Drexel, Barrell & Co., dated July 18, 1983 (Reference 3).

It also compiles and includes information from two drainage reports which have been recently approved by the City of Colorado Springs. These reports cover most of the upper tributary area and are titled as follows: Drainage Study for Neal Ranch Filing No. 2, Broadmoor Bluffs Park Filing No. 8, and Farthing Drive, prepared by KKBNA, Inc. and dated June, 1984 (Reference 4), and the Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive and Preliminary Report for the Single-Family Portion of Broadmoor Bluffs Estates, Colorado Springs, Colorado, prepared by Drexel, Barrell & Co. and dated August, 1984 (Reference 5).

DESIGN REFERENCES

The drainage design criteria for individual sub-basin computations were taken from the City of Colorado Springs Determination of Storm Runoff Criteria Manual (Reference 6). Also referenced were the Soil Conservation Service Publications, "Procedures for Determining Peak Flows in Colorado", (March, 1980) Reference 7, "National Engineering Handbook, Section 4, Hydrology", (August, 1972) Reference 8, and "Technical Release 20 Program and User's Manual" (1982 Version) Reference 9.

METHODOLOGY

Flows were determined for the 6-hour initial 5-year and major 100-year rainfalls. In order to compare developed flows to the outfall rates acceptable under the Fort Carson Study (1), developed flows were computed using the SCS TR-20 computer program (9), as they were in the existing (1976) study.

HISTORIC BASIN RUNOFF

In order to ensure that the revised computer program would yield hydrographs comparable to those listed in the existing Fort Carson report, (1) historic flows were calculated for the basin. The values for area, CN, Tc, antecedent moisture condition, precipitation depth, and storm duration were given in Table IV-4 of the Fort Carson Study (see Appendix Exhibit "C"). These values were repeated in this analysis. Unknown variables include the original assumptions for rainfall distribution, runoff distribution, and the main time increment used to divide hydrograph computations, none of which appear in the existing report.

At this time, the SCS has not published a recommended Type II-A, 6-hour duration rainfall distribution. The rainfall distribution input for all computer runs is therefore based on the SCS 24-hour Type II-A storm being distributed over a 6-hour duration (See Exhibit F).

Runoff distribution is assumed to correspond to the standard SCS distribution as provided in the TR-20 Program.

The main time increments are calculated as 0.1 Tc to 0.2 Tc, as recommended in the TR-20 Manual (9). Variability of this parameter should have a negligible effect on computed runoff peaks and volumes.

DEVELOPED BASIN RUNOFF

In areas where approved drainage reports exist, the values used for area, CN, and Tc are maintained in this report. Where approved drainage reports are not available, the following assumptions are made. Area and type of development are determined from the latest available planning information (Cheyenne Mountain Ranch Master Plan, prepared by Denton Harper Marshall, Revision 6, June 1984). Soil types are taken from SCS soil maps of the area (see Exhibit B). Curve numbers (CN's) are developed based on the soil type and City of Colorado Springs Criteria. The historic time of concentration was also used for developed conditions, as the natural channel is to be maintained through Basin IV (see Exhibit "C"). Antecedent moisture condition, precipitation depth, storm duration, rainfall and runoff distributions are identical to those used for historic runoff calculations.

SEE COND.
OF APP'X
3

For both historic and developed runoff calculations, the basin flows are not routed, but rather assumed to flow unrestricted to the outfall point at Fort Carson, as in the existing study. The peak values for developed conditions obtained by this method should be fairly conservative, as no reduction in peak due to culvert routing is introduced.

EXISTING DRAINAGE CHARACTERISTICS

As mentioned previously, the basin with which this report is concerned corresponds approximately to Basin A-23 as described in the Fort Carson Drainage Study (Reference 1, PP. IV-2 to IV-6).

Historically, runoff to Fort Carson from Basin A-23 flowed unrestricted in natural swales from the west through State provided culverts under Colorado State Highway 115, across the area that is now Cheyenne Meadows South and on to the Fort Carson Military Reservation (see Exhibit A2). Construction of Academy Boulevard has temporarily obstructed this historic flow pattern, as the boulevard was constructed without provision for passing the flow.

In the previous Fort Carson Study, it was assumed that upon future development, an outfall under Academy Blvd. to "B" ditch would restore this historic pattern (PP. IV-2 and VII-1). This has been provided for in the drainage facilities planned in their study. The historic flow is 322.7 cfs as calculated using the SCS TR-20 computer program. This compares well to the flow of 301.2 cfs given in the previous Ft. Carson Study, Table IV-4, which is shown in Exhibit "C" (Reference 1).

In the previous study, the downstream drainage structures (primarily "B" ditch for this basin) were designed to receive runoff from a larger tributary area than is to outfall to this point using the planned development. The difference in area is primarily due to the flows from the eastern portion of

Cheyenne Meadows South being directed to the Cheyenne Meadows Drainage Channel, rather than to Fort Carson's "B" Ditch. Also, runoff from the western "tail" of the basin has been directed to the north as indicated in the approved drainage studies, due to its obstruction by Star Ranch Road. The changes in Basin A-23 boundaries due to the various developments is shown in Exhibits "A" and "A1", in addition to the Master Drainage Plan Map, Drexel, Barrell & Co. Dwg. No. 3D 544 (back pocket). A summary of historic basin flows as compared to developed is shown in Appendix Exhibit "C".

The western central portion of the basin also corresponds to Major Basin II of the approved drainage report for Broadmoor Bluffs Estates (Reference 5). References to sub-basin boundaries refer to those developed in the latter drainage report unless otherwise noted.

Existing site conditions west of Highway 115 range from grassy 4% slopes in Basin IV (Drexel, Barrell & Co. Master Study, July 1983) to heavily vegetated slopes of up to 30% in the most westerly basins. The tributary area east of Highway 115 has a much flatter slope (approximately 2%) and is vegetated primarily by grasses. Soils in the area are predominantly of the Razor series, changing to Jarre Tecolote series at the western end of the Basin. The existing drainage swale is heavily vegetated, ranging from natural grasses to scrub oak.

DESIGN DRAINAGE CHARACTERISTICS

Three basins totalling approximately 46.5 ac. of Neal Ranch Filing No. 2 make up the western-most tributary area of Basin A-23. This area corresponds to Basins 3, 4 and 5 of the August, 1984 Drexel, Barrell & Co. report, and Basins U-1-9, K-1 & 2, H-1-7 & U-1-3 and V-1-3 of the KKBNA study. The flow from these areas becomes concentrated at Swale "B" within Basin E. This swale continues easterly and crosses under the north extension of Broadmoor Bluffs Drive. Upon entering Basin K, a section of the natural swale is displaced by Broadmoor Bluffs Drive. A man-made swale diverts the flow back to the natural swale.

Runoff from Swale "B" outfalls through an existing 60" culvert under Broadmoor Bluffs Drive, and then continues in the natural swale to a 72" culvert under Colorado State Highway No. 115. The flow from this culvert outfalls to the east where it is joined by the flows from a 24" culvert which drains the interchange.

Drainage facilities for the basin area west of Broadmoor Bluffs Drive have already been designed and approved by the City of Colorado Springs (see "Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive and Preliminary Drainage Report for the Single-Family Portion of Broadmoor Bluffs Estates, a portion of Cheyenne Mountain Ranch, Colorado Springs, Colorado", by Drexel, Barrell & Co., approved 9-24-84) (Reference 5). Design details for Swale "B" and other facilities have also been included in this report, for convenience, in Appendix Exhibit "D".

A concrete lined channel is proposed to carry Basin A-23 flows from Highway 115 to their outfall at the intersection of Westmeadow Drive with Academy Boulevard. The channel will also pick up the incremental flow from approximately 40 acres of Cheyenne Meadows South (Basin IV-A of the Master Drainage Study prepared by Drexel, Barrell & Co., July, 1983) (Reference 3).

The flow from this channel is to be divided as it approaches the intersection of Westmeadow Drive and Academy Blvd. Flows of up to the historic 100 year flow of approximately 320 cfs are to be diverted to Fort Carson through the addition of a culvert or storm sewer system. This runoff is to discharge to the "B" Ditch located in the Fort Carson Military Reservation at approximately STA 35+00 (Exhibit E). This will meet the facility design limitations as outlined in the Drainage Study, Fort Carson, Colorado dated August, 1976 Chapter IV and VII. The culvert to carry these flows to the south has been preliminarily sized at 72 inches in diameter. Flows exceeding this allowable rate are to be diverted directly to the north to a proposed storm sewer system located within the Eastmeadow Drive right-of-way. A pipe approximately 48" in diameter will be required to begin the system to the north. This system is to outfall to the Cheyenne Meadows Drainage Channel. The diversion structure and associated drainage facilities are to be designed in detail at the time of development.

As mentioned previously, Exhibit "F" lists the computer input used with TR-20, and resulting hydrologic information. Additional information listed in the Appendix includes Exhibit "G", correspondence, and Exhibit "H" which cites references used in this report.

CONCLUSIONS

This study generates peak flow and runoff values for developed Basin A-23. Swale "B", which drains the basin east of Colorado State Highway 115 is to be privately maintained in its natural condition.* Related drainage facilities have been designed in previous reports (Drainage study for Neal Ranch Filing No. 2, Broadmoor Bluffs Park Filing No. 8, and Farthing Drive, prepared by KKBNA and dated June, 1984, and the Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive, and Preliminary Report for the Single-Family Portion of Broadmoor Bluffs Estates, Colorado Springs, Colorado, prepared by Drexel, Barrell & Co. and dated August, 1984).

* SEE COND.
OF APP'VL
3

A preliminary channel design was developed to provide for transfer of the flows across the southern portion of Cheyenne Meadows South. At the intersection of Westmeadow Drive and Academy Boulevard it is proposed that these flows be split. The historic basin flows are to be directed to the south, where they will outfall at approximately Station 35+00 at the "B" Ditch in the Fort Carson Military Reservation. Excess flows will be diverted directly to the north. The excess flows are to be carried to Cheyenne Meadows Drainage Channel via a proposed storm sewer system to be located in the Eastmeadow Drive right-of-way. The detailed design of the diversion structure, storm sewer system, and culvert system to the "B" Ditch is to be

undertaken at the time of development. The peak flow design limits given in the existing Fort Carson Drainage Study (1976), Table IV-4, (Reference 1) may be provided for by diverting a maximum peak flow of approximately 74 cfs to Cheyenne Meadows Drainage Channel. This will also limit the volume of runoff directed to Fort Carson to approximately historic rates (see Exhibit "C").

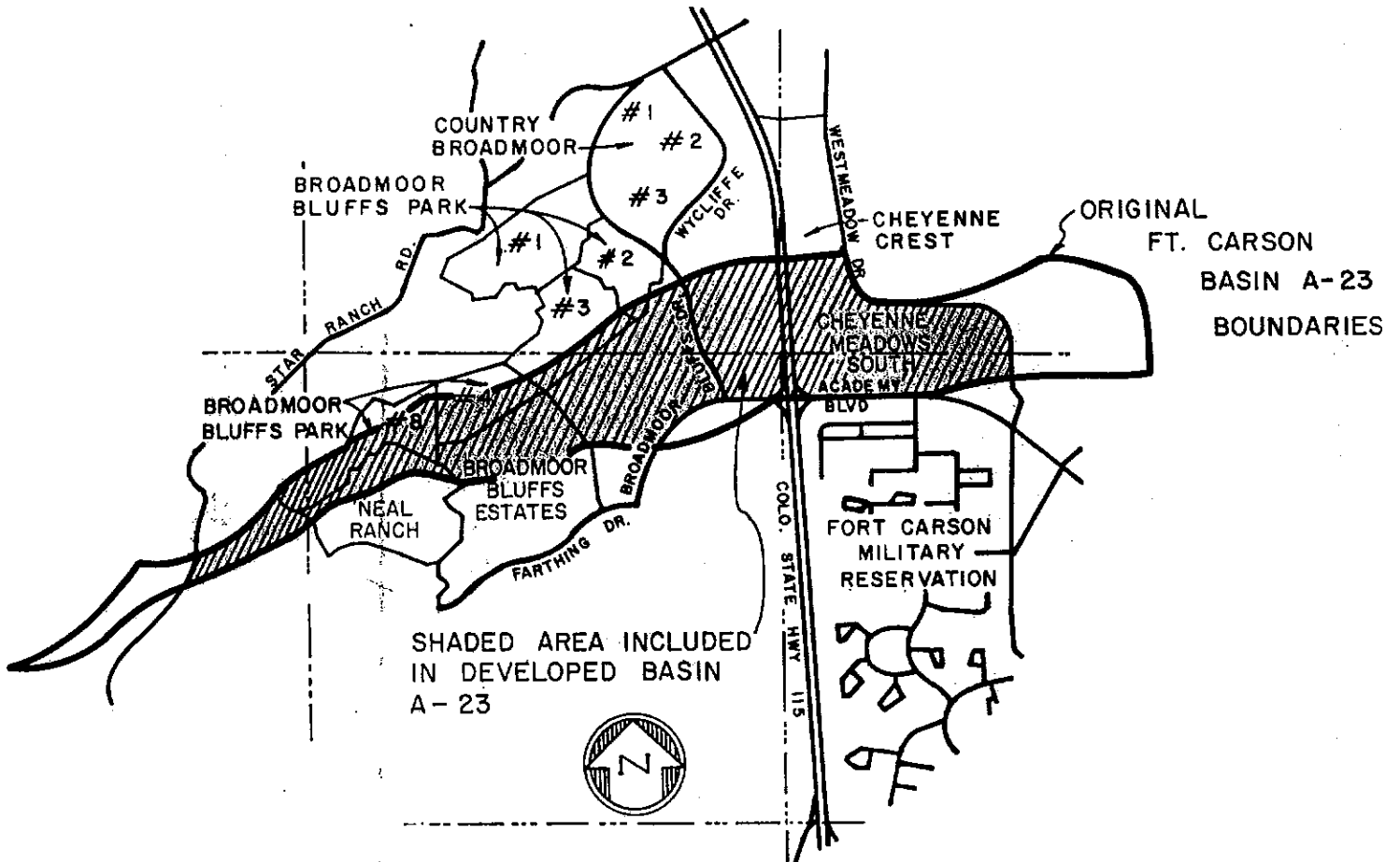
Copies of the calculations and examples of computer input and output for both historic and developed conditions, follow for your review.

Respectfully submitted,

A handwritten signature in black ink that reads "Bruce J. Buttner". The signature is written in a cursive style with a large, prominent initial "B".

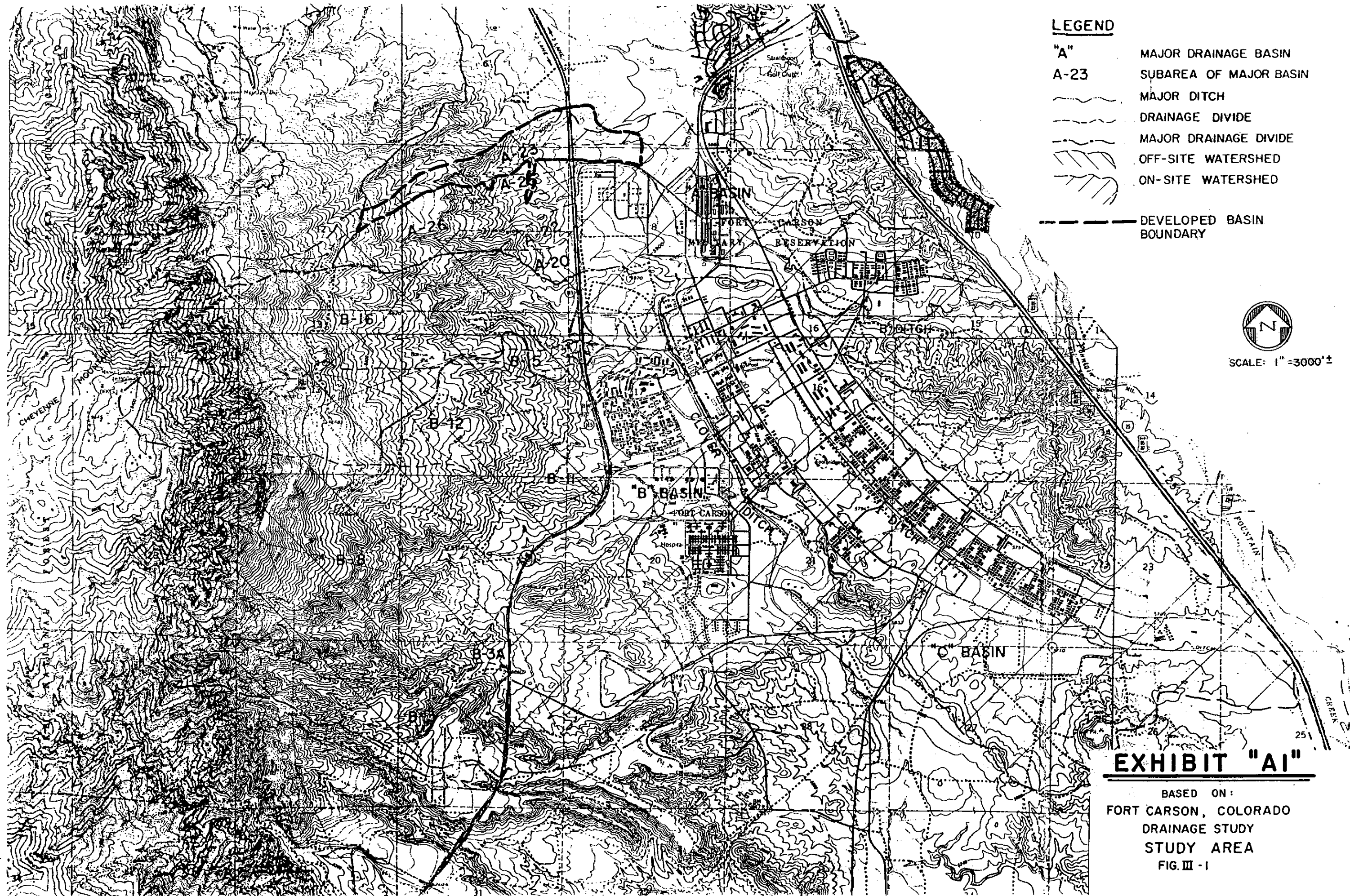
Bruce J. Buttner, P.E.
Drexel, Barrell & Co.

EXHIBIT "A"



VICINITY MAP

SCALE: 1" = 2000'



LEGEND

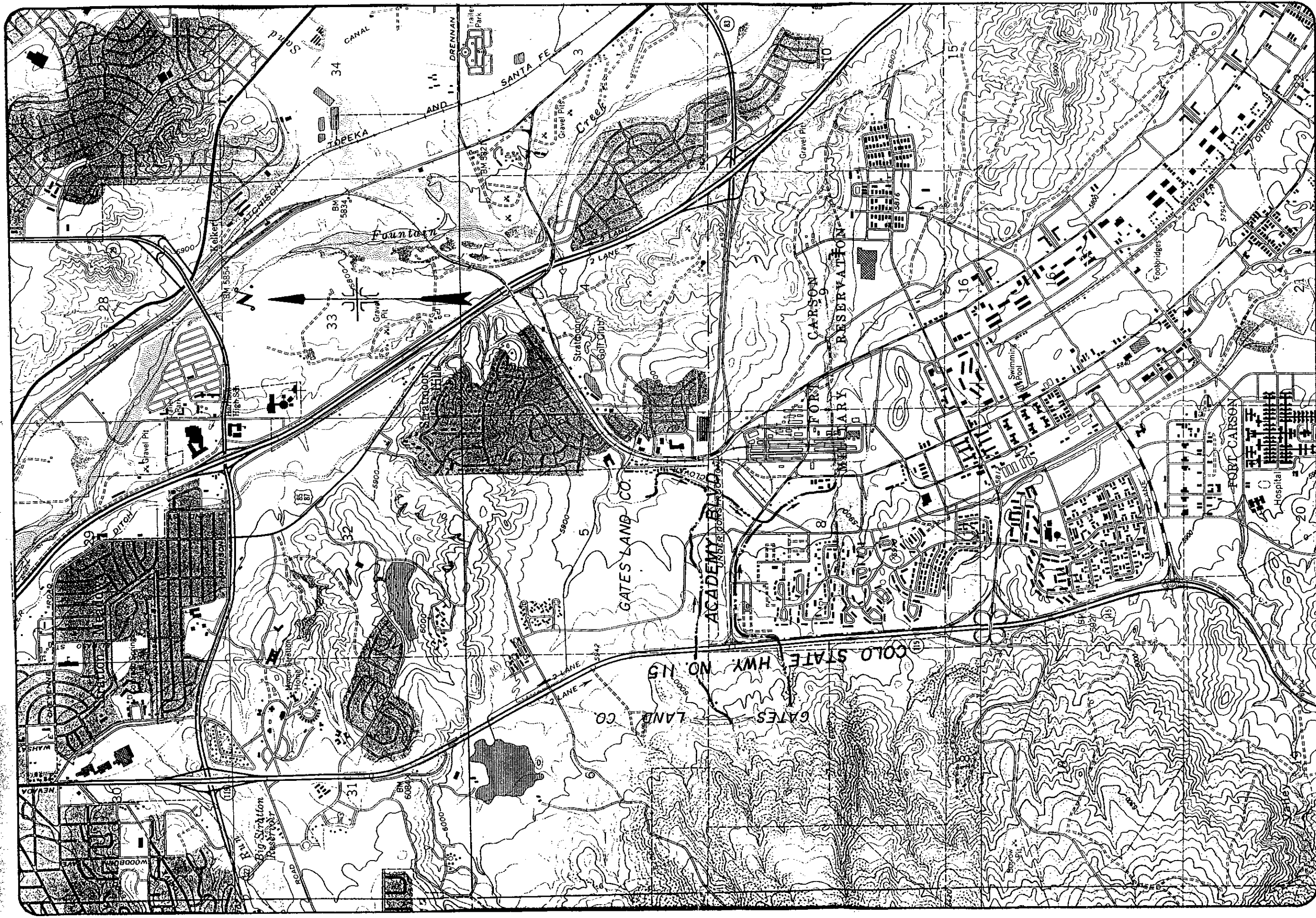
- "A" MAJOR DRAINAGE BASIN
- A-23 SUBAREA OF MAJOR BASIN
- MAJOR DITCH
- DRAINAGE DIVIDE
- MAJOR DRAINAGE DIVIDE
- OFF-SITE WATERSHED
- ON-SITE WATERSHED
- DEVELOPED BASIN BOUNDARY



SCALE: 1" = 3000' ±

EXHIBIT "A1"

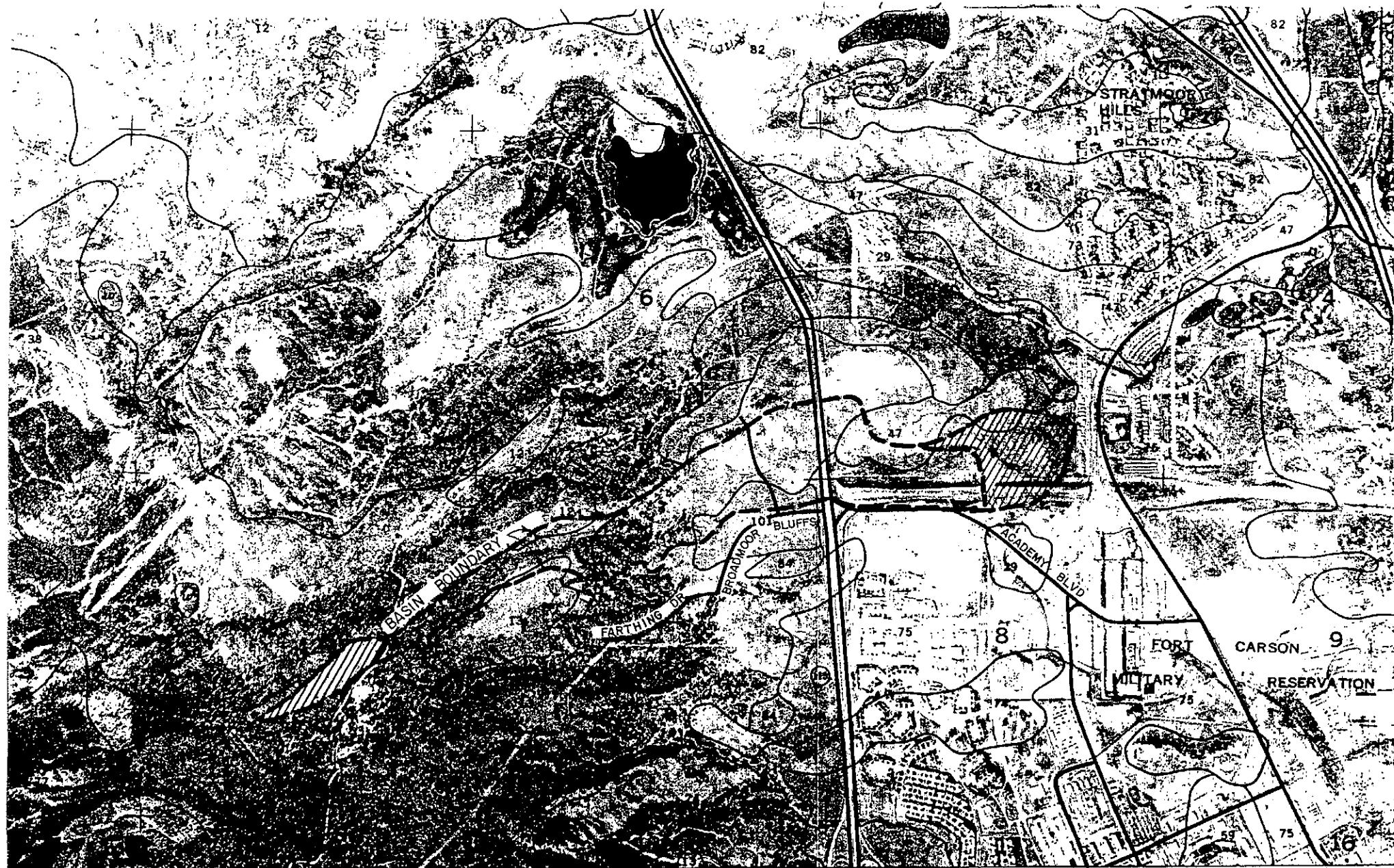
BASED ON:
 FORT CARSON, COLORADO
 DRAINAGE STUDY
 STUDY AREA
 FIG. III - I



**EXHIBIT A2 · HISTORIC CONDITION
CHEYENNE MEADOWS SOUTH
GATES LAND COMPANY**

PREPARED BY:
DREXEL, BARRELL & COMPANY
SOURCE OF MAP - U.S.G.S.
APPROX. SCALE : 1" = 2000'

E-2528
27 DEC. '84
IB 253



R. 67 W. | R. 66 W.

(Joins sheet 23)

EXHIBIT "B"

SOILS MAP



SCALE: 1" = 2000'

SEE NEXT PAGE FOR SOILS CLASSIFICATION

EXHIBIT "B"
HYDROLOGIC SOILS GROUPS
FOR
CHEYENNE MOUNTAIN RANCH

<u>NO.</u>	<u>CLASSIFICATION</u>	<u>HYDROLOGIC GROUP</u>
12	Bressner Sandy Loam	B
13	Bressner Sandy Loam	B
38	Jarre - Tecolote Complex	B
47	Limon Clay	C
74	Razor Stony Clay Loam	C
75	Razor-Midway Complex	C/D
101	Ustic Torrifluvents, Loamy	B

EXHIBIT "C"

FORT CARSON STUDY AND HISTORIC
FLOWS AS COMPARED TO
DEVELOPED FLOW

EXHIBIT "C"
SUMMARY TABLE
FORT CARSON STUDY AND HISTORIC RUNOFF
AS COMPARED TO DEVELOPED BASIN FLOW

Basin Description	Area		Tc, hrs	Antecedent Moisture Condition	100 Year Storm		5 year Runoff, cfs
	Mi ²	CN			Runoff Volume, ac - ft	Peak Runoff, cfs	
A-23 Original Study	0.430	72.2	0.64	II	27.8	301.2	-
A-23 Original Values Input, New Output	0.430	72.2	0.64	II	27.5	322.7	74.6
A-23 New Basin Boundaries, Developed Conditions	0.295	82.6	0.64*	II	30.1	396.3	139.7
			To Fort Carson		28.8	322.7	139.7
			To Cheyenne Meadows Drainage Channel		1.3	73.6	-

*In the previously approved report (Drexel, Barrell & Co., 8-84, Reference 5) the Tc from the western tributary boundary to Broadmoor Bluffs Drive was calculated as 0.43 hrs. Adding t_t in subsequent basins (IV and IV-A), a final Tc of $0.43 + 0.12 + 0.22 = 0.77$ hrs is obtained. This Tc was reduced to 0.64 hrs (equal to historic) for TR-20 computer runs. This is probably a good approximation of developed Tc, as the natural channel is to be maintained from the western basin boundary through Basin IV.

FORT CARSON DRAINAGE STUDY

MAJOR DRAINAGE FACILITIES ANALYSIS

"B" DITCH

TABLE IV-4
 BASIN "A"
 SHEET 1 OF 3

Location	Station	Flowline Elevation	Drainage Basin	BASIN CHARACTERISTICS						CHANNEL CHARACTERISTICS					STORM 100 Year, Future PRECIPITATION 3.6 Inches	Remarks
				Drainage Area (sq.mi.)	Curve Number "CN"	Time of Concentration (hr.)	Antecedent Moisture Condition	Runoff Volume (ac.-ft.)	Peak Runoff (cfs)	Reach Length (ft.)	Average Water Velocity (fps)	Accumulated Runoff Volume (ac.-ft.)	Peak Flow (cfs)	Water Surface Elevation		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Reservation Bndry.	0+00	5939.0	A-26	.544	57.9	.450	II	14.4	157.9			14.4	157.9	5940.5		
	9+70	5925.0	A-25	.067	76.0	.200	II	5.2	138.3	970	5.6	14.4	154.9	5926.3		
Center St.	20+00	5911.5								1030	5.5	19.6	192.1			
Drop Structure	21+00	5910.0								100	5.5	19.6	191.9	5913.0		
Drop Structure	21+30	5902.0								30	10.6	19.6	191.9	5912.5	Proposed drop structure	
	23+00	5901.5								170	5.5	19.6	191.8	5904.5		
Drop Structure	23+30	5893.5								30	10.6	19.6	191.8	5904.0	Proposed drop structure	
	25+00	5893.0								170	5.5	19.6	191.7	5896.0		
Drop Structure	25+30	5885.0								30	10.6	19.6	191.7	5895.5	Proposed drop structure	
	27+00	5884.5								170	5.5	19.6	191.6	5887.5		
Detention Reservoir	27+30	5876.5								30	10.6	19.6	191.6	5887.0	Proposed drop structure	
	E. Gordon Street	31+00	5869.8	A-24	.087	84.7	.335	III	13.6	293.6	370	5.5	19.6	191.4	5879.0	Proposed detention reservoir to
Fac. Eng. Facility	35+00	5868.0	A-23	.430	72.2	.64	II	27.8	301.2	400	6.4	32.7	100.2	5878.8	Discharge 100.5cfs under proposed	
	38+80	5866.5	A-22D	.005	93.7	.133	II	.7	25.6			60.5	346.4	5873.4	Begin proposed pipe section through	
	41+60	5865.4	A-21F	.002	96.0	.167	II	.4	10.4	380	6.9	60.5	345.4	5871.9	Fac. Engineering Facility	
	43+90	5864.5	A-22C	.013	94.9	.117	II	2.1	70.6	280	6.9	61.2	347.3	5871.9		
	45+10	5864.1	A-21E	.004	96.0	.133	II	.7	21.8	280	6.9	61.2	346.6	5870.8		
	46+50	5863.5	A-22	.004	90.9	.117	III	.6	22.6	230	7.0	61.6	346.9	5870.8		
	46+50	5863.5	A-21D	.116	76.4	.188	III	21.7	638.2	120	6.9	63.7	351.6	5869.9		
	51+50	5861.5	A-21C	.005	91.5	.133	II	.7	24.3	140	6.9	64.4	352.7	5869.6		
Salvage and Storage Yard	51+50	5861.5	A-22B	.012	91.0	.133	II	1.7	57.3	140	6.9	64.4	352.0	5869.0	End proposed pipe section	
	52+50	5861.2	A-21B	.003	91.0	.117	II	.5	14.5	500	6.0	65.0	353.5	5869.0	Begin channel improvements	
	52+50	5861.2	A-22A	.016	95.3	.142	II	2.5	84.5			86.7	848.4	5869.0		
	57+80	5859.0								100	6.1	86.7	821.1	5867.0	Proposed salvage and storage yard	
Specker Avenue	59+40	5858.5	A-21A	.007	86.7	.133	III	1.2	36.9			87.4	840.7	5867.0	Proposed salvage and storage yard	
										100	6.1	89.1	887.6	5867.0	bridge	
										100	6.1	89.1	887.6	5866.9		
										530	6.3	92.2	946.1	5864.6	Proposed Specker Ave. bridge	
										160	6.3	92.2	946.1	5864.6		
										640	6.4	93.4	971.9	5864.1		
												93.4	948.7	5864.1		

From: Reference 1
 Exhibit HQ 11
 2/2

EXHIBIT "D"
TYPICAL CHANNEL SECTIONS
AND
DOWNSTREAM CHANNEL DESIGN

Project	320 ADHOCK BLUFFS ESTATES	Job No	E 3098
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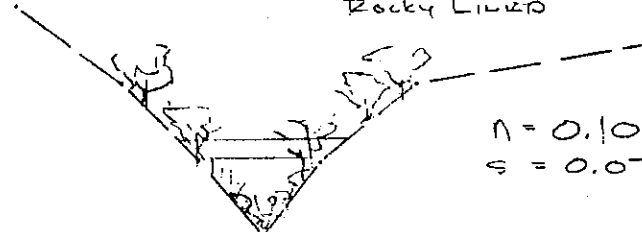
Client	GATES LAND CO.	By	JH	Date	AUGUST 18, 84
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SWALE "D"

BASIN "E" (JUST DOWNSTREAM)

Horiz 1" = 20' Vert 1" = 5'

SCRUBW/NAT GRASS
Rocky LINED



$n = 0.10$
 $s = 0.072$

$ifd = 2$
 $A = 13.5F$
 $WP = 13.6$
 $R = 0.956$
 $Q = 50.4 \text{ cfs}$ NA.

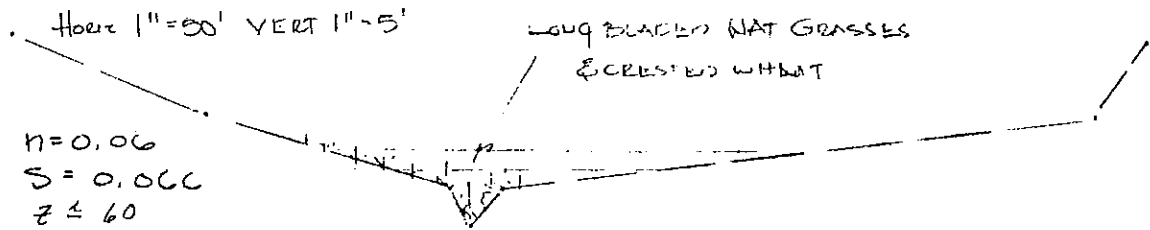
$ifd = 2.5$
 $A = 22.5SF$
 $WP = 18.7SF$
 $R = 1.20$
 $Q = 101.6 \text{ cfs}$ OR $v = 4.5 \text{ fps}$

Project: BROADMOOR BLIFFS ESTATES Job # E 3098

Client: GATES LAND CO. By: djh Date: AUGUST 18, 84

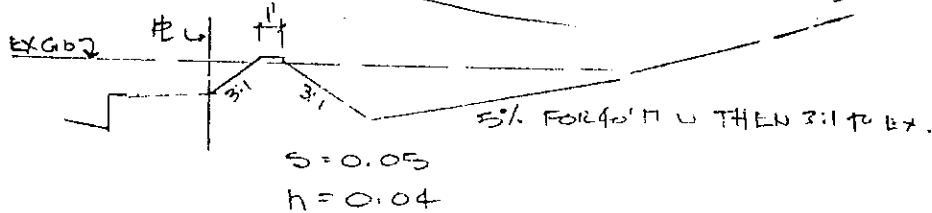
SWALE "B" (Cont'd)

MID BASIN 'K' Approx 300' Lg. of BROADMOOR BLIFFS #2.



$1.5d = 2'$	$1.5d = 1.5$	$1.5d = 1.75$
$A = 80.57$	$A = 27.5$	$A = 53.8$
$WP = 12.5'$	$WP = 7.0$	$WP = 10.0$
$R = 0.64$	$R = 0.393$	$R = 0.538$
$Q = 378 \text{ cfs NGI.}$	$Q = 94.1 \text{ cfs K.}$	$Q = 227 \text{ cfs OK}$
		$V = 4.2 \text{ fps OK}$

PROVIDE TEMPORARY BERM ALONG BROADMOOR BLIFFS TO DIVERT FLOWS TO CULVERT TILL SPECIFIC SITE DEVELOPMENT IS PROPOSED, (IE. FUTURE MULTIFAMILY, COMMERCIAL)



$1.5d = 1.5$
$A = 27$
$WP = 3.6$
$R = 0.75$
$Q = 12.5 \checkmark$
$V = 4.8 \text{ fps}$

Project: **BROADMOOR BLUFFS ESTATES** Job No: **E 3098**

Client: **GATES LAND CO.** By: **d/m** Date: **August 18, 84**

BASIN "K" (CONT'D)

POSSIBLE FUTURE SECTION

$S = 0.05$
 $n = 0.013$

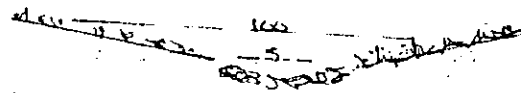


if $d = 1.15'$ $Q = 182 \text{ cfs}$ $v = 21.3 \text{ fps}$
if $d = 0.7'$ $Q = 69 \text{ cfs}$ $v = 16.2 \text{ fps}$

NOTE FOR BOTH BASIN J & K TEMPORARY CHANNEL SECTIONS HAVE BEEN DESIGNED UNTIL SPECIFIC DEVELOPMENT PLANS ARE PROPOSED. CONC. PAVS HAVE BEEN SHOWN AS A POSSIBLE IMPROVEMENT HOWEVER OTHER SECTIONS ARE WORKABLE & SHOULD BE ANALYZED WITH DETAILED SITE DEVELOPMENT

Eq

A)

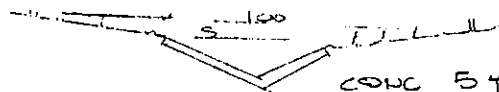


RIP RAP 5yr FLOW
GRASSED SLOPE 100 YEAR OVERFLOW

B)

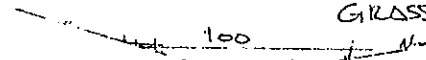
PIPED SYSTEMS

C)



CONC 5yr
GRASSED 100 YEAR

D)



PIPED 5yr
GRASSED 100 yr.

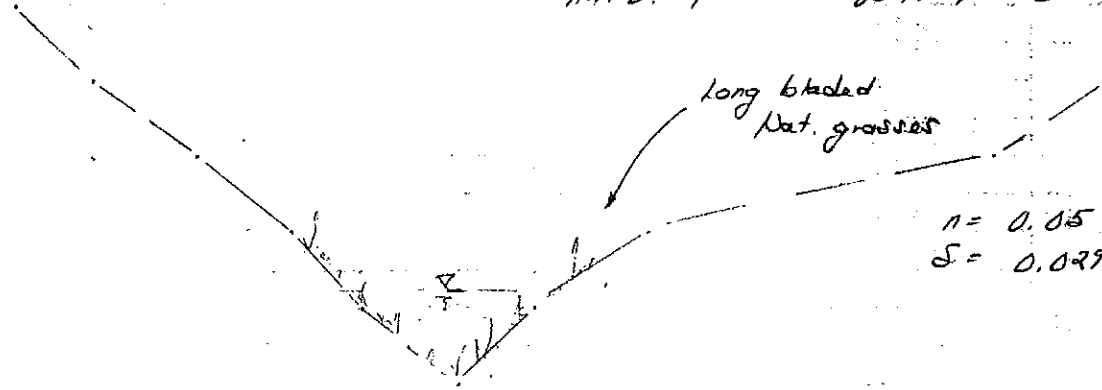


Project: Cheyenne Mountain Ranch Drainage Job No: E-9578

Client: Gates Land Co. By: CS Date: Dec. 4, 1984

Swale "B" (Cont'd)
Mid Basin IV:

Horiz. 1" = 50' Vert. 1" = 5'



$n = 0.05$
 $S = 0.0272$ } D-B
July 1983
addendum
Aug. 1984

If $d = 8'$
 $A = 101$ S.F.
 $WP = 67'$
 $R = 1.51$

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$Q = 677$ cfs — too lg.

$d = 2'$
 $A = 45$ S.F.
 $WP = 45.2'$
 $R = 1.00$
 $Q = 229$ cfs

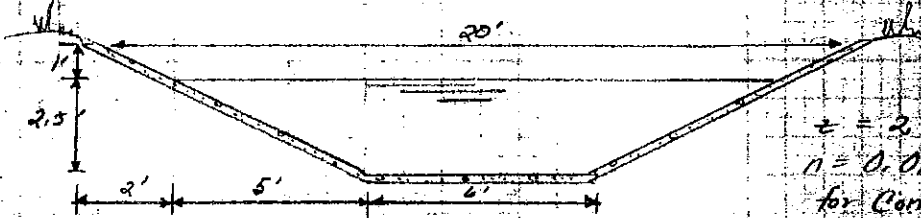
100 yr.
 $d = 2.5'$
 $A = 70$ S.F.
 $WP = 55.2'$
 $R = 1.27$
 $Q = 418$ cfs — O.K.
 $V = 6.0$ fps

5 yr.
 $d = 1.75'$
 $A = 28.75$ S.F.
 $WP = 35.1'$
 $R = 0.87$
 $Q = 128$ cfs —
 $V = 4.5$ cfs

Project _____ Job No. E-2628

Client Gates By CS Date 12-13-84

Channel Design - Basin IV-A



Channel Slope = 2%

$$y_{n100} = 2.17'$$

$$y_{n5} = 1.25'$$

$$Q_{100} = 296.2 \text{ cfs} \quad Q_{max} = 1048.6$$

$$Q_5 = 129.7 \text{ cfs} \quad V_{max} = 28.0$$

$$V_{100} = 17.8 \text{ fps}$$

$$V_5 = 12.3 \text{ fps}$$

$z = 2$
 $n = 0.015$
for concrete-lined channel

$$y_{critical} = 3.54'$$

$$y_{normal} = 2.04'$$

Channel Slope = 1.5%

$$y_{n100} = 2.33'$$

$$y_{n5} = 1.35'$$

$$Q_{100} = 296.2 \text{ cfs} \quad V_{100} = 16.0 \text{ fps}$$

$$Q_5 = 129.7 \text{ cfs} \quad V_{100} = 19.0 \text{ fps}$$

$$Q_{max} = 908.1 \text{ cfs} \quad V_{max} = 20.0 \text{ fps}$$

→ suggested alternative

Channel Slope = 1%

$$y_{n100} = 2.58'$$

$$y_{n5} = 1.51'$$

$$Q_{100} = 296.2 \text{ cfs} \quad V = 13.8 \text{ fps}$$

$$Q_5 = 129.7 \text{ cfs} \quad V = 10.4 \text{ fps}$$

$$Q_{max} = 741.5 \text{ cfs} \quad V = 16.2 \text{ fps}$$

EXHIBIT "E"

FORT CARSON STUDY
BASIN A-23 OUTFALL POINT
AT "B" DITCH

EXHIBIT "E"

- LEGEND**
- EXISTING FLOWLINE
 - - - PROPOSED FLOWLINE
 - ▭ CHANNEL IMPROVEMENTS
 - ▭ PROPOSED STRUCTURE
 - FUTURE FLOOD PLAIN LIMITS
 - EXISTING FLOOD PLAIN LIMITS
 - FUTURE WATER SURFACE

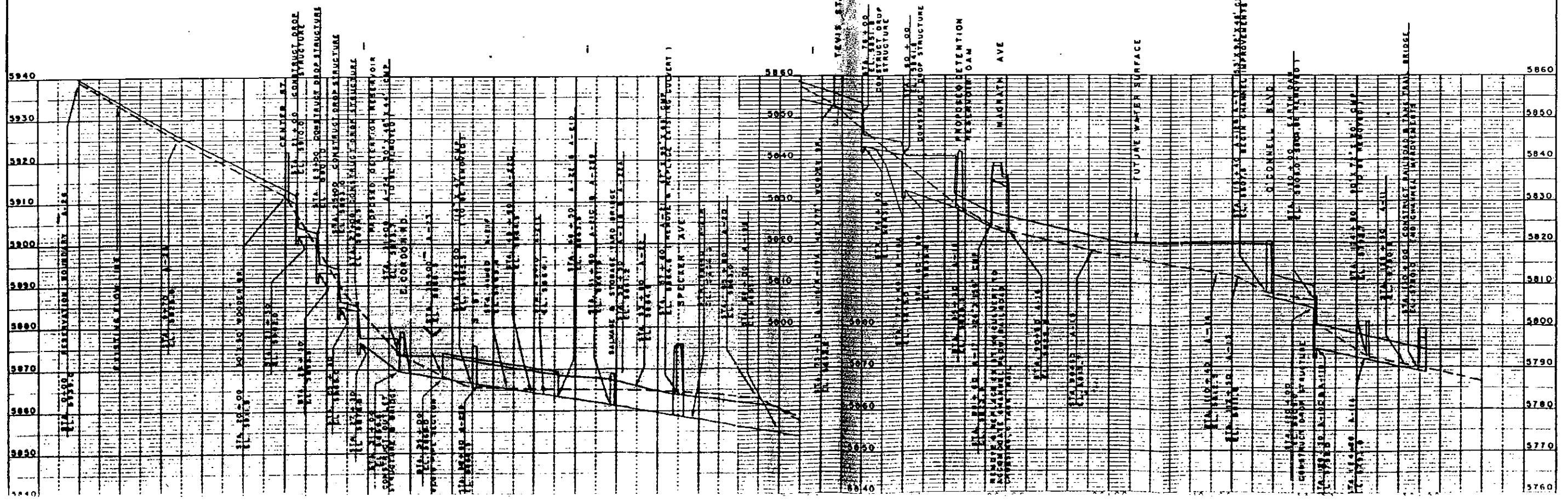
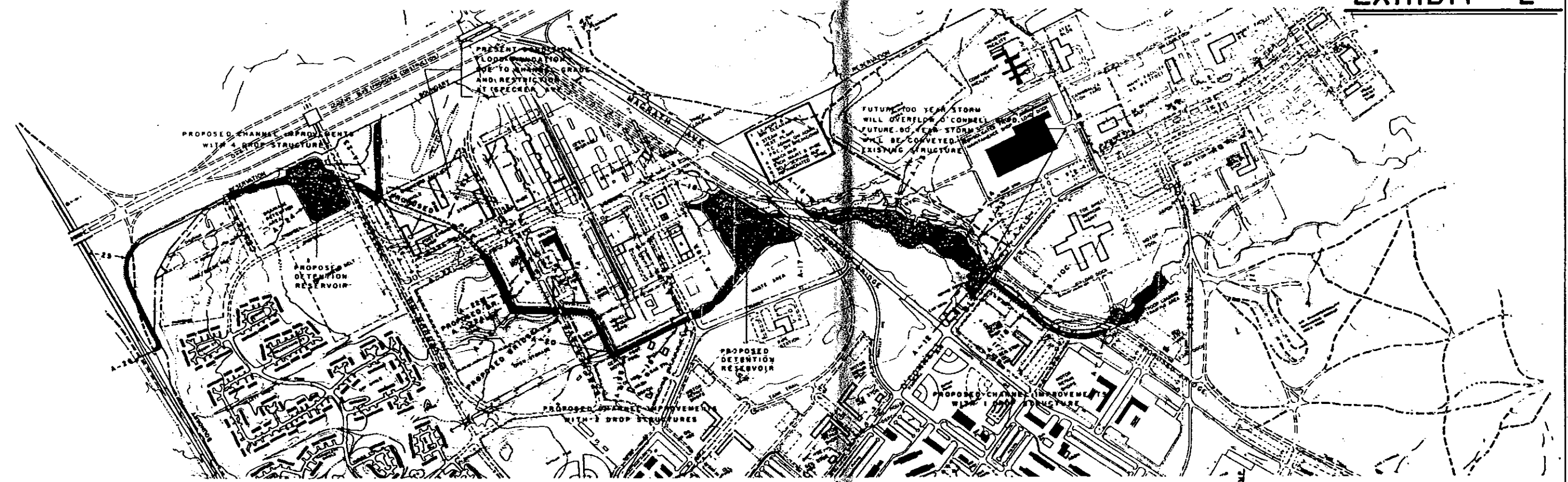
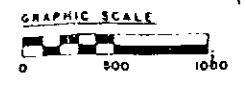


EXHIBIT "F"
RAINFALL DISTRIBUTION TABLE
CALCULATIONS

Project	Job No E-2528
---------	------------------

Client Gates	By CS	Date 12-12-84
-----------------	----------	------------------

Exhibit F Notes:

Computer Output from TR-20 follows for the Historic Basin + Developed Basin at the 100 yr. storm level. Note that the only change between these runs and the 5 year runs is the substitution of 2.1 in of rainfall for the 3.6 in on the COMPUT card.

Rainfall Distribution used is given in Rainfall Table 7 (see the listing under the Original Basin heading, page 6).

Runoff Distribution used is given in Table 4 DIMHYD (see page 3).

LXHEB1 "G" 1/12

LIST *Q/A 23*

11/09/84. 10.51.06.
LIST OF TROUT

1

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

JOB TR-20	FULLPRINT	10				
TITLE 002 ORIGINAL FT CARSON BASIN A-23		20				
TITLE 6 HR TYPE II-A, 100 YEAR DEPTH		30				
5 RAINFL 7	0.125	40				
8	0.0	0.0025	0.0050	0.0075	0.010	50
8	0.015	0.020	0.025	0.030	0.050	60
8	0.060	0.100	0.700	0.750	0.780	70
8	0.800	0.820	0.830	0.840	0.850	80
8	0.860	0.865	0.870	0.885	0.890	90
8	0.900	0.905	0.910	0.915	0.921	100
8	0.928	0.934	0.940	0.945	0.950	110
8	0.955	0.960	0.965	0.970	0.975	120
8	0.980	0.9825	0.985	0.9875	0.990	130
8	0.9925	0.995	0.9975	1.000	1.000	140
9 ENDTBL		150				
6 RUNDFF 1 001	7 0.43	<u>72.2</u>	0.640	1 1 1 1		160
ENDATA						170
7 LIST						180
7 INCREM 6	0.1					190
7 COMPUT 7 001 001	0.0	3.6	1.0	7 2 01 01		200
ENDCMP 1						210
ENDJOB 2						220

Original Ch

*****END OF 80-80 LIST*****
1

TR20 XEQ 11/09/84	ORIGINAL FT CARSON BASIN A-23	20	JOB 1	PASS
REV 09/01/83	6 HR TYPE II-A, 100 YEAR DEPTH	30		PAGE

FILE NO. 2
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.

EXHIBIT "F" 1/12

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1/2

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, RAINABLES 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 11/09/84
REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
6 HR TYPE II-A, 100 YEAR DEPTH

20
30

JOB 1 PASS
PAGE

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1/2

EXECUTIVE CONTROL OPERATION LIST

RECORD ID 18

LISTING OF CURRENT DATA

Standard SCS Dimensionless Hydrograph

(INPUT VALUE OF .020 NOT EQUAL TO COMPUTED VALUE; COMPUTED VALUE USED.)

4 DIMHYD	TIME INCREMENT				
	.0200				
8	0.0000	.0300	.1000	.1900	.3100
8	.4700	.6600	.8200	.9300	.9900
8	1.0000	.9900	.9300	.8500	.7800
8	.6800	.5600	.4600	.3900	.3300
8	.2800	.2410	.2070	.1740	.1470
8	.1260	.1070	.0910	.0770	.0660
8	.0550	.0470	.0400	.0340	.0290
8	.0250	.0210	.0180	.0150	.0130
8	.0110	.0090	.0080	.0070	.0060
8	.0050	.0040	.0030	.0020	.0010
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	ENDTEL				

COMPUTED PEAK RATE FACTOR = 484.00

Standard SCS 24-Hr. Type 1 Distribution

5 RAINFL 1	TIME INCREMENT				
	.5000				
8	0.0000	.0080	.0170	.0260	.0350
8	.0450	.0550	.0650	.0760	.0870
8	.0990	.1120	.1260	.1400	.1560
8	.1740	.1940	.2190	.2540	.3030
8	.5150	.5830	.6240	.6550	.6820
8	.7060	.7280	.7480	.7660	.7830
8	.7990	.8150	.8300	.8440	.8570
8	.8700	.8820	.8930	.9050	.9160
8	.9260	.9360	.9460	.9560	.9650
8	.9740	.9830	.9920	1.0000	1.0000
9	ENDTEL				

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TABLE NO.
5 RAINFL 2

TIME INCREMENT
.2500

Standard SCS 24-hr. Type II Distribution

1

TR20 XEQ 11/09/84
REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
6 HR TYPE II-A, 100 YEAR DEPTH

20
30

JOB 1 PASS
PAGE

8	0.0000	.0020	.0050	.0080	.0110
8	.0140	.0170	.0200	.0230	.0260
8	.0290	.0320	.0350	.0380	.0410
8	.0440	.0480	.0520	.0560	.0600
8	.0640	.0680	.0720	.0760	.0800
8	.0850	.0900	.0950	.1000	.1050
8	.1100	.1150	.1200	.1260	.1330
8	.1400	.1470	.1550	.1630	.1720
8	.1810	.1910	.2030	.2180	.2360
8	.2570	.2830	.3870	.6630	.7070
8	.7350	.7580	.7760	.7910	.8040
8	.8150	.8250	.8340	.8420	.8490
8	.8560	.8630	.8690	.8750	.8810
8	.8870	.8930	.8980	.9030	.9080
8	.9130	.9180	.9220	.9260	.9300
8	.9340	.9380	.9420	.9460	.9500
8	.9530	.9560	.9590	.9620	.9650
8	.9680	.9710	.9740	.9770	.9800
8	.9830	.9860	.9890	.9920	.9950
8	.9980	1.0000	1.0000	1.0000	1.0000

9 ENDTEL

TABLE NO.
5 RAINFL 3

TIME INCREMENT
.5000

Standard SCS 24-hr. Type IA Distribution

8	0.0000	.0100	.0220	.0360	.0510
8	.0670	.0830	.0990	.1160	.1350
8	.1560	.1790	.2040	.2330	.2680
8	.3100	.4250	.4800	.5200	.5500
8	.5770	.6010	.6230	.6440	.6640
8	.6830	.7010	.7190	.7360	.7530
8	.7690	.7850	.8000	.8150	.8300
8	.8440	.8580	.8710	.8840	.8960
8	.9080	.9200	.9320	.9440	.9560
8	.9670	.9780	.9890	1.0000	1.0000

9 ENDTEL

4/12

51
1,1

TABLE NO.	TIME INCREMENT		Standard SCS 48-hr. Type I Distribution		
5 RAINFL 4	.5000				
8	0.0000	.0040	.0080	.0120	.0160
8	.0200	.0250	.0300	.0350	.0400
8	.0450	.0500	.0550	.0600	.0650
8	.0700	.0750	.0810	.0870	.0930
8	.0990	.1050	.1110	.1180	.1250
8	.1320	.1400	.1480	.1560	.1650
8	.1740	.1840	.1950	.2070	.2200
1					

TR20 XEQ 11/09/84 ORIGINAL FT CARSON BASIN A-23 20 JOB 1 PASS
 REV 09/01/83 6 HR TYPE II-A, 100 YEAR DEPTH 30 PE 4

8	.2360	.2550	.2770	.3030	.4090
8	.5150	.5490	.5830	.6050	.6240
8	.6400	.6550	.6690	.6820	.6940
8	.7050	.7160	.7270	.7380	.7480
8	.7580	.7670	.7760	.7840	.7920
8	.8000	.8080	.8160	.8230	.8300
8	.8370	.8440	.8510	.8580	.8640
8	.8700	.8760	.8820	.8880	.8940
8	.9000	.9060	.9110	.9160	.9210
8	.9260	.9310	.9360	.9410	.9460
8	.9510	.9560	.9610	.9660	.9710
8	.9760	.9800	.9840	.9880	.9920
8	.9960	1.0000	1.0000	1.0000	1.0000
9	ENDTEL				

TABLE NO.	TIME INCREMENT		Standard SCS 48-hr. Type II Distribution		
5 RAINFL 5	.5000				
8	0.0000	.0020	.0050	.0080	.0110
8	.0140	.0170	.0200	.0230	.0260
8	.0290	.0320	.0350	.0380	.0410
8	.0440	.0510	.0550	.0590	.0630
8	.0630	.0670	.0710	.0750	.0790
8	.0840	.0890	.0940	.0990	.1040
8	.1090	.1140	.1200	.1260	.1330
8	.1400	.1470	.1540	.1620	.1710
8	.1810	.1920	.2040	.2170	.2330
8	.2520	.2770	.3180	.3680	.4380
8	.7290	.7520	.7700	.7850	.7980
8	.8090	.8190	.8290	.8380	.8460
8	.8540	.8610	.8680	.8740	.8800
8	.8860	.8920	.8970	.9020	.9070
8	.9120	.9170	.9210	.9250	.9290
8	.9330	.9370	.9410	.9450	.9490
8	.9530	.9570	.9600	.9630	.9660
8	.9690	.9720	.9750	.9780	.9810
8	.9840	.9870	.9900	.9930	.9960
8	.9980	1.0000	1.0000	1.0000	1.0000
9	ENDTEL				

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1/2

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TABLE NO. TIME INCREMENT
 5 RAINFL 6 .0200
 8 0.0000 .0080 .0162 .0246 .0333
 8 .0425 .0524 .0630 .0743 .0863
 8 .0990 .1124 .1265 .1420 .1595
 8 .1800 .2050 .2550 .3450 .4370
 1

6 Hr. Type B Storm
 for Emergency Spillway and Freeboard Hydrographs

TR20 XEQ 11/09/84
 REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
 6 HR TYPE II-A, 100 YEAR DEPTH

20 JOB 1 PASS

8 .5300 .6030 .6330 .6600 .6840
 8 .7050 .7240 .7420 .7590 .7750
 8 .7900 .8043 .8180 .8312 .8439
 8 .8561 .8678 .8790 .8898 .9002
 8 .9103 .9201 .9297 .9391 .9483
 8 .9573 .9661 .9747 .9832 .9916
 8 1.0000 1.0000 1.0000 1.0000 1.0000
 9 ENDTEL

TABLE NO. TIME INCREMENT
 5 RAINFL 7 .1250
 8 0.0000 .0025 .0050 .0075 .0100
 8 .0150 .0200 .0250 .0300 .0500
 8 .0600 .1000 .7000 .7500 .7800
 8 .8000 .8200 .8300 .8400 .8500
 8 .8600 .8650 .8700 .8850 .8900
 8 .9000 .9050 .9100 .9150 .9210
 8 .9280 .9340 .9400 .9450 .9500
 8 .9550 .9600 .9650 .9700 .9750
 8 .9800 .9825 .9850 .9875 .9900
 8 .9925 .9950 .9975 1.0000 1.0000
 9 ENDTEL
 1

6 Hr. Type II-A (as input)

TR20 XEQ 11/09/84
 REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
 6 HR TYPE II-A, 100 YEAR DEPTH

20 PAGE 6 JOB 1 PASS

0 STANDARD CONTROL INSTRUCTIONS
 6 RUNOFF 1 1 7 .4300 72.2000 .64001 1 0 1 0 1
 ENDATA

END OF LISTING
 1

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TR20 XEQ 11/09/84
REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
6 HR TYPE II-A, 100 YEAR DEPTH

30 7 20

JOB 1 PASS

EXECUTIVE CONTROL OPERATION INCREM

RECORD ID 19

MAIN TIME INCREMENT = .10 HOURS

EXECUTIVE CONTROL OPERATI COMPUT

RECORD ID 200

FROM XSECTION 1

RTING TIME = 0.00 RAIN DEPTH = 3.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 7 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .10 HOURS

OPERATION RUNOFF CROSS SECTION 1

OUTPUT HYDROGRAPH= 7

AREA= .43 SQ MI INPUT RUNOFF CURVE= 72. TIME OF CONCENTRATION= .64 HOURS

INTERNAL HYDROGRAPH TIME INCREMENT= .0853 HOURS

	PEAK TIME(HRS)	PEAK DISCHARGE(CFS)				PEAK ELEVATION(FEET)					
	1.90	322.73				(RUNOFF)					
	4.07	31.35				(R					
TIME(HRS)	FIRST HYDROGRAPH POINT =	0.00 HOURS				TIME INCREMENT = .10 HOURS			DRAINAGE AREA = .43 SQ.MI.		
1.00	DISCHG	0.00	0.00	0.00	0.00	3.36	29.70	100.54	211.59	298.47	322.71
2.00	DISCHG	301.46	250.57	196.58	155.67	125.54	102.02	84.59	70.96	60.28	52.64
3.00	DISCHG	48.82	47.12	45.80	44.27	41.53	37.66	34.35	32.13	31.04	30.97
4.00	DISCHG	31.24	31.33	30.95	30.12	29.12	28.21	27.49	27.01	26.71	26.52
5.00	DISCHG	26.36	25.99	25.05	23.27	21.05	18.91	17.13	15.86	15.01	14.46
6.00	DISCHG	14.04	13.46	12.31	10.42	8.10	5.86	4.03	2.72	1.85	1.24
7.00	DISCHG	.83	.57	.38	.26	.17	.11	.07	.04	.02	.01
8.00	DISCHG	0.00									

RUNOFF VOLUME ABOVE BASEFLOW = 1.20 WATERSHED INCHES, 332.84 CFS-HRS, 27.51 ACRE-FEET; BASEFLOW = 0.00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP

RECORD ID 2

COMPUTATIONS COMPLETED FOR PASS 1

EXECUTIVE CONTROL OPERATION ENDJOB

RECORD ID 2

1

7/12

8/112

TR20 XED 11/09/84
REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
6 HR TYPE II-A, 100 YEAR DEPTH

20
3 8

JOB 1 SUMMAR

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 MARK(?) I TH 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	1										
+ XSECTION 1	RUNOFF	.43	7	2	.10	0.0	3.60	6.00	1.20	---	1.90	322.73	750.

TR20 XED 11/09/84
REV 09/01/83

ORIGINAL FT CARSON BASIN A-23
6 HR TYPE II-A, 100 YEAR DEPTH

20
39

JOB 1 SUMMARY

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

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.....
0 XSECTION 1	.43	1
+ ALTERNATE	1	322.73

END OF 1 JOBS IN THIS RUN
RDY

8/112

LIST
ILLEGAL COMMAND.
OLD, TROUT
RDY-FDR
LIST

12/27/84. 15.01.41.
LIST OF TROUT

*Input File: NAR3
Job #: E-2528*

1

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

JOB TR-20							10
TITLE 022 BASIN A-23, INCLUDING PORTIONS OF BROW. BLUFFS ESTATES, NEAL PARK,							20
TITLE AND S. MEADOWS, 100 YEAR DEPTH, NO ROUTING							30
5 RAINFL 7		0.125					40
8	0.0	0.0025	0.0050	0.0075	0.010		50
8	0.015	0.020	0.025	0.030	0.050		60
8	0.060	0.100	0.700	0.750	0.780		70
8	0.800	0.820	0.830	0.840	0.850		80
8	0.860	0.865	0.870	0.885	0.890		90
8	0.900	0.905	0.910	0.915	0.921		100
8	0.928	0.934	0.940	0.945	0.950		110
8	0.955	0.960	0.965	0.970	0.975		120
8	0.980	0.9825	0.985	0.9875	0.990		130
8	0.9925	0.995	0.9975	1.000	1.000		140
9 ENDTEL							150
6 RUNOFF 1 001	7	0.295	82.6	0.640	1 1 1 1		160
6 DIVERT 6 001	7 1 2	322.7		002.0	1 1 1 1		165
ENDATA							170
7 INCREM 6		0.1					190
7 COMPUT 7 001 001		0.0	3.6	1.0	7 2 01 01		200
ENDCMP 1							210
ENDJOB 2							220

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

9/12

1K20 XEQ 12/27/84
REV 09/01/83

BASIN A-23, INCLUDING PORTIONS OF BROMR. BLUFFS ESTATES, NEAL PARK, 20
AND S. MEADOWS, 100 YEAR DEPTH, NO ROUTING 30

JOB 1 PASS
PAGE

EXECUTIVE CONTROL OPERATION INCREM

MAIN TIME INCREMENT = .10 HOURS

RECORD ID 19

EXECUTIVE CONTROL OPERATION COMPUT

FROM XSECTION 1
TO XSECTION 1

RECORD ID 2

STARTING TIME = 0.00 RAIN DEPTH = 3.60 RAIN DURATION = 1.00 RAIN TABLE NO. = 7 ANT. MOIST. COND = 2
ALTERNATE NO. = 1 STORM NO. = 1 MAIN TIME INCREMENT = .10 HOURS

OPERATION RUNOFF CROSS SECTION 1

OUTPUT HYDROGRAPH = 7

AREA = .30 SQ MI INPUT RUNOFF CURVE = 83. TIME OF CONCENTRATION = .64 HOURS

INTERNAL HYDROGRAPH TIME INCREMENT = .0853 HOURS

PEAK TIME (HRS)	PEAK DISCHARGE (CFS)	PEAK ELEVATION (FEET)
1.88	396.26	(RUNOFF)
4.06	27.78	(RUNOFF)

TIME (HRS)	FIRST HYDROGRAPH POINT = 0.00 HOURS	TIME INCREMENT = .10 HOURS	DRAINAGE AREA = .30 SQ. MI.
1.00 DISCHG	0.00 0.00 0.00 0.00	6.29 46.32 144.63	283.52 379.10 395.08
2.00 DISCHG	356.42 285.77 217.88 168.59	132.77 105.61 85.69	70.47 58.83 50.53
3.00 DISCHG	46.09 43.87 42.19 40.43	37.62 33.81 30.72	28.68 27.65 27.52
4.00 DISCHG	27.72 27.74 27.37 26.59	25.67 24.84 24.17	23.71 23.42 23.22
5.00 DISCHG	23.05 22.70 21.86 20.28	18.34 16.46 14.90	13.78 13.04 12.55
6.00 DISCHG	12.17 11.66 10.66 9.02	7.01 5.08 3.49	2.36 1.60 1.08
7.00 DISCHG	.72 .49 .33 .22	.15 .10 .06	.04 .02 .01
8.00 DISCHG	0.00		

RUNOFF VOLUME ABOVE BASEFLOW = 1.91 WATERSHED INCHES, 364.39 CFS-HRS, 30.11 ACRE-FEET; BASEFLOW = 0.00 CFS

10/12/84

OPERATION DIVERT CROSS SECTION 1
 INPUT HYDROGRAPH = 7 OUTPUT #1 HYDROGRAPH = 1 OUTPUT #2 HYDROGRAPH = 2
 XSECTION = 1 XSECTION = 1 DIVERTED XSECTION = 2

OUTPUT #1 HYDROGRAPH

PEAK TIME (HRS) PEAK DISCHARGE (CFS) PEAK ELEVATION (FEET)
 1.80 322.70 (DIVERT)
 4.06 27.78 * FIRST POINT OF FLAT PEAK (DIVERT)

TIME (HRS)	DISCHG	FIRST HYDROGRAPH POINT = 0.00 HOURS	TIME INCREMENT = .10 HOURS	DRAINAGE AREA = 0.00 SQ. MI.
1.00	DISCHG	0.00	0.00	0.00
2.00	DISCHG	322.70	285.77	217.88
3.00	DISCHG	46.09	43.87	42.19
4.00	DISCHG	27.72	27.74	27.37
5.00	DISCHG	23.05	22.70	21.86
6.00	DISCHG	12.17	11.66	10.66
7.00	DISCHG	.72	.49	.33

TR20 XEQ 12/27/84 BASIN A-23, INCLUDING PORTIONS OF BROMR. BLUFFS ESTATES, NEAL PARK, 20 JOB 1 PASS
 REV 09/01/83 AND S. MEADOWS, 100 YEAR DEPTH, NO ROUTING 30 PAGE

8.00 DISCHG 0.00

RUNOFF VOLUME ABOVE BASEFLOW = 1.91 WATERSHED INCHES, 348.73 CFS-HRS, 28.82 ACRE-FEET; BASEFLOW = 0.00 CFS

OUTPUT #2 DIVERTED HYDROGRAPH FOLLOWS

PEAK TIME (HRS) PEAK DISCHARGE (CFS) PEAK ELEVATION (FEET)
 1.88 73.56 (DIVERT)

TIME (HRS)	DISCHG	FIRST HYDROGRAPH POINT = 0.00 HOURS	TIME INCREMENT = .10 HOURS	DRAINAGE AREA = .30 SQ. MI.
1.00	DISCHG	0.00	0.00	0.00
2.00	DISCHG	33.72	0.00	0.00

RUNOFF VOLUME ABOVE BASEFLOW = .09 WATERSHED INCHES, 16.22 CFS-HRS, 1.34 ACRE-FEET; BASEFLOW = 0.00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP

COMPUTATIONS COMPLETED FOR PASS 1

RECORD ID 2

11/12

TR20 XEQ 12/27/84
REV 09/01/83

BASIN A-23, INCLUDING PORTIONS OF BRDMR. BLUFFS ESTATES, NEAL PARK, 20
AND S. MEADOWS, 100 YEAR DEPTH, NO ROUTING 30

JOB 1 SUMMAR
PAGE

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 1														
+	XSECTION 1	RUNOFF	.30	7	2	.10	0.0	3.60	6.00	1.91	---	1.88	396.26	1343.
	XSECTION 1	DIVERT	0.00	7	2	.10	0.0	3.60	6.00	1.91	---	1.80*	322.70*****	
	XSECTION 2	DIVERT	.30	7	2	.10	0.0	3.60	6.00	.09	---	1.88	73.56	249.4
1														

TR20 XEQ 12/27/84
REV 09/01/83

BASIN A-23, INCLUDING PORTIONS OF BRDMR. BLUFFS ESTATES, NEAL PARK, 20
AND S. MEADOWS, 100 YEAR DEPTH, NO ROUTING 30

JOB 1 SUMMARY
PAGE

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

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS.....
0 XSECTION 1	0.00	1
+		
ALTERNATE 1		322.70
0 XSECTION 2	.30	
+		
ALTERNATE 1		73.56
END OF 1 JOBS IN THIS RUN		
RDY		
LSC		

1/3/12

EXHIBIT "G"



DREXEL, BARRELL & CO.

ENGINEERS SURVEYORS

1700 38TH STREET

BOULDER, COLORADO 80301

(303) 442-4338

June 26, 1984

Ms. Nancy Vail
Headquarters
Fort Carson
4th Infantry Division (MECH)
A F Z C - F E - E E
Building 304
Fort Carson, CO 80913

Re: Cheyenne Meadows South

Dear Ms. Vail:

On behalf of Gates Land Company, and, as discussed at our meeting at Fort Carson on June 22, 1984, we respectfully submit this letter as a summary of discussions held at the meeting. A list of attendees at the meeting is attached.

. Exhibit A entitled "Historic Condition" and Exhibit B entitled "Existing Condition" both for Cheyenne Meadows South, Gates Land Company and prepared by Drexel, Barrell and Company, were discussed. It was agreed that both historic and existing rainfall runoff from an area of the Gates Land Company property north of Academy Boulevard and west of State Highway 115 drains on to Fort Carson at its north end.

. Jim Force introduced a report entitled "Drainage Study for Fort Carson, Colorado, Contract No. DACA-45-76-C-0037", prepared by Higginbotham and Associates, Morgan and Associates, Inc. and Karcich and Weber, Inc., for U.S. Army Engineer District, Omaha, Corps of Engineers, Omaha, Nebraska and dated August, 1976. Following a brief review of the drainage basin maps contained in the report, it was generally agreed that the drainage basin under discussion was depicted as Basin A-23 in the report. The basin drains into the Fort Carson "B" ditch.

. It was agreed that the proposed direction of flow was generally the same as the historic condition as depicted in the aforementioned "Drainage Study for Fort Carson".

. It was also agreed that the "Drainage Study for Fort Carson" would be used as a "starting point" for determining the acceptable flows to be discharged from the Gates Land Company property onto Fort Carson. Possible differences in methodologies and base data between those used in the "Drainage Study for Fort Carson" and those to be used by Drexel, Barrell and Company were discussed. It was mutually agreed that the determination of all flows should be done by the same methods employing the same base data.

. Nancy Vail will provide Gates Land Company (Bob Svejkovsky) with a copy of the "Drainage Report for Fort Carson". If necessary Gates Land Company will reproduce additional copies and return the original report to Fort Carson.

. Jim Force will coordinate for Fort Carson all technical matters relating to the drainage analysis.

We believe that this letter presents the primary items as discussed at our meeting. Please do not hesitate to contact us should you have any questions regarding this matter.

Very truly yours,

Bruce J. Buttner

Bruce J. Buttner, P.E.
Drexel, Barrell & Co.

cc: Bob Svejkovsky,
Gates Land Company.

Encl. as stated
E-2822
BJB/ea
(0872C)

Name	Organization	Telephone No.
Nancy Vail	DEH - ENVIRONMENT	579-4828
Jim FORCE ✓	DEH - ENGINEERING DESIGN	579-3317/5862
ALAN SUMMERFELD	SJA	579-5341
Bruce Butner	Drexel Barrell CO	303-442-4338
Bob Svejkovsky	Gates Land Co	576-8515
MARY BARBETZ	DEH - ENVIRONMENT	579-4828
BETTY HAMMERBECK	REAL PROPERTY - DEH	579-5487



REPLY TO
ATTENTION OF

Engineering Design Branch

DEPARTMENT OF THE ARMY
HEADQUARTERS, FORT CARSON
AND
HEADQUARTERS, 4TH INFANTRY DIVISION (MECHANIZED)
FORT CARSON, COLORADO 80913-5000

November 4, 1985

E-2528 64
CC: Bob Svej Kosky

RECEIVED
NOV 7 1985
ENGINEERING BRANCH

Drexel, Barrell & Company
1700 38th Street
Boulder, Colorado 80301

Dear Sirs:

Fort Carson has reviewed your final drainage report for portions of Broadmoor Bluffs and Cheyenne Meadows south at Cheyenne Mountain Ranch, dated August 1, 1985. The report appears to follow the guidelines established in the meeting on June 22, 1984. However, we have one major problem. The proposed outfall on Fort Carson as shown on Drawing 3D544 does not occur in the historical channel as shown in Exhibit A2. Fort Carson requires the outfall be in the historical channel and the flow be in the historical south westerly direction. The historical channel for this flow currently has a tube under Academy Boulevard east of our Gate Three.

Point of contact for this action is Mr. James Force, telephone (303) 579-5662.

Sincerely,

Henry T. Brown, Jr.
Colonel, Engineer
Director of Engineering
and Housing

SCH... ..

STATE OF COLORADO

DEPARTMENT OF HIGHWAYS

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



November 19, 1985

Drexel, Barrell & Co.
1700 - 38th Street
Boulder, CO. 80301



Cheyenne Mountain Ranch
S.H. 115-M.P. 43.5
S.H. 83-M.P. 0.49

Attn: Bruce J. Buttner

Dear Mr. Buttner:

The Colorado Department of Highways has reviewed the "Final Drainage Report For Portions of Broadmoor Bluffs and Cheyenne Meadows South At Cheyenne Mountain Ranch" dated August 1, 1985. Although the report is labeled "final", it appears to be a general proposal for work along State Highway 83. Our comments will address the potential problems involved with finalizing the design. Comments are as follows:

- 1) All SCS hydrology should be based on the 24 hour storm. (The City manual uses 6 hours which is no longer valid according to the SCS.)
- 2) Sizing of structures should follow our HW/D guidelines (see table 804.1A, Colorado Department of Highways' Design Manual).
- 3) The 90 degree bend in the culvert crossing State Highway 83 is not acceptable. The maximum miter should not exceed 22.5 degrees. A skewed crossing under State Highway 83 would be a preferred design. ✓
- 4) The sudden turn of the ditch at the outlet of the 72" box under State Highway 115 is not a good hydraulic situation. The Colorado Department of Highways uses three times the water surface width for a minimum radius. Also, the ditch should be constructed on the developer's property with future maintenance by others. The ditch should follow the existing drainage path. ✓
- 5) The present drainage in this area flows to the north. State Highway 83 was designed with the opinion that during high flows most of the flow would go north (as the contours show). The only drainage to the south was in the Clover Ditch which is now conveyed under State Highway 83 through a 24" culvert. With the design proposed in the report, we feel that the historic drainage path is being diverted.
- 6) If an agreement for accepting this drainage is made with Fort Carson, the developer will need to get some type of agreement between all parties involved.

Page Two
Drexel, Barrell & Co.
November 19, 1985

- 7) With added diverted flow to the south of State Highway 83, an analysis needs to be made on the effects to all downstream property-Fort Carson, State Highway 25, and others.

The above comments must be addressed and a final report and plans must be submitted before the Colorado Department of Highways will issue approval.

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

Sincerely,

R.Q. Brown
District Preconstruction Engineer

RQB/WP/hw
Enclosure

cc: Bob Svejkovsky/Gates Land Company
Gary Haynes/City of Co. Springs Eng. Div.

bcc: Sollee/ROW

E-2528/
E-2822

67 FIVE
APR 16 1986
GENERAL DELIVERY

STATE OF COLORADO

DEPARTMENT OF HIGHWAYS

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



April 15, 1986

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

Attn: Gary R. Haynes

Dear Mr. Haynes:

The Colorado Department of Highways has met with personnel from Gates Land Company and Drexel, Barrell & Co. to resolve problems concerning the "Final Drainage Report for Portions of Broadmoor Bluffs and Cheyenne Meadows South at Cheyenne Mountain Ranch" (dated August 1, 1985). Our initial comments on the report were sent to you and other involved parties on November 19, 1985. Following are the results of the discussion of the various items in our letter:

- 1) The Colorado Department of Highways had asked that the SCS hydrology be based on the 24 hour storm instead of the 6 hour storm. Drexel, Barrell & Co. agreed to resubmit calculations for the 24 hour storm. *Done*
- 2, 3,4) These three items concerned actual design details and will be considered when final design plans are submitted to the Colorado Department of Highways. Drexel, Barrell & Co. stated that information submitted for the area between State Highway 115 and Westmeadow Drive/Ft. Carson was conceptual rather than detailed.
- 5) This item stated that State Highway 83 was designed with the opinion that during high flows most of the water would flow to the northeast. Investigation shows that the historical flow is indeed to the southeast, as stated by Drexel, Barrell & Co., and that Fort Carson has acknowledged the historical flow. The design of the structures on State Highway 83, or lack of structures, was based on the presumption that future development by Gates Land Co. would re-direct the historical flow to the northeast. This was evidently a verbal discussion or agreement and was never formalized in writing. We have no objection to the concept of carrying the historical flow (within the limits of the Fort Carson Drainage Study) under State Highway 83 and diverting some flow (approximately 74 c.f.s.) to the northeast. The structures now being built under I-25 and Maxwell Street are sized to carry the total flow from this area and are more than adequate to handle only a partial diversion.

Page Two
City of Colorado Springs
Engineering Division
April 15, 1986

6 & 7) Although Fort Carson has acknowledged the historical flow and designed their facilities appropriately to handle that flow, the final design plans must be approved by them in writing.

If you have any question, please contact Walt Pachak in Pueblo at 544-6286.

Sincerely,

R.Q. Brown
District Preconstruction Engineer

RQB/WP/hw
Enclosure

cc: Bruce J. Buttner/Drexel, Barrell & Co. ✓
Robert F. Svejkovsky/Gates Land Company

G9
E-2528



DREXEL, BARRELL & CO.

ENGINEERS — SURVEYORS

1700 38TH STREET
BOULDER, COLORADO 80301
(303) 442-4338

OFFICES:
BOULDER
COLORADO SPRINGS

April 30, 1986

Mr. Alan B. Morrice, Drainage Engineer
El Paso County Department of Transportation
3105 Stone
Colorado Springs, Colorado 80907

Re: Cheyenne Meadows Drainage Channel Outfall,
Gates Land Company

Dear Mr. Morrice:

In response to your letter of April 15, and as discussed in our conversation of April 21, 1986, we are submitting the following documents for your review.

The original calculations, with review comments.

Two sets of computer printout showing hydrograph routing for both historic and developed conditions, and supporting calculations (41 sheets per set).

One set each of construction drawings for Curr Reservoir and for the Cheyenne Meadows Drainage Channel, both prepared by Hartzell-Pfeiffenberger Assoc., Inc., for Gates Land Co.

One print of the 100-scale topography used for historic channel section determination downstream of Colorado State Highway 115 (Drexel, Barrell & Co. Drawing No. E-78, Sheet 13R of 23).

The triangular hydrographs previously submitted were input to the EPA-Storm Water Management model (SWM2 for PC) which was used to perform reservoir and channel routing. The schematic drawings included in the calculations illustrate the order in which the routings were calculated.

The Curr Reservoir routing performed for developed conditions was based on the parameters that follow. The water level in the reservoir is assumed to be at the crest of the service spillway prior to storm routing. This is a conservative assumption, as the reservoir is often maintained below this level to meet irrigation needs. The discharge curve is taken directly from the as-built drawings for Curr Reservoir (Sheet 11). The channel immediately downstream of Curr Reservoir is as shown on Sheet 11 of 12 of the dam construction drawings. Channel routings downstream of State Highway 115 were based on sections taken from the Cheyenne Meadows Drainage Channel construction plans for developed conditions.

- 2 -

Historic flows are assumed to sheet flow, or flow in natural gullies to the eastern edge of State Highway 115. No routing occurs west of this point, as travel time is incorporated into the times of concentration for these basins. The channel sections used for historic conditions east of State Highway 115 were taken from 100-scale topography based on aerial photography of 1972.

Also enclosed is the 24-hour, 100-year diversion hydrograph developed for the Colorado Department of Highways for the proposed overflow from Cheyenne Mountain Ranch. Flows which exceed the historic flow of approximately 322 cfs to Ft. Carson are to be diverted to the Cheyenne Meadows Drainage Channel. Under the 24-hour 100-year storm conditions, these will peak at 6.17 hours with a flow 24.1 cfs. This peak will arrive approximately 5 hours behind the tributary peak flows calculated by the SWM2 routing and will thus leave the developed peak flow at the outfall point unaffected.

As anticipated, the routing procedure did not greatly affect the relationship of the developed peak to historic peak flows, although they are both smaller, due to the conservative nature of the original calculations. The routed peak 24-hour 100-year flows at the design point (Gate's eastern property line) are:

- Historic: 2930 cfs
- Developed: 2663 cfs

Please do not hesitate to call should you have any questions regarding this matter.

Sincerely,

Constell Steinhaus

Constell Steinhaus
Drexel, Barrell & Co.

Reviewed by:

Bruce J. Buttner

Bruce J. Buttner, P.E.

cc: Robert Svejksky

BJB/ea
E-2528
(2553C)

Cheyenne Meadows Drainage

611

SUBJECT: _____

DATE: June 3, 1986

FROM: Alan B. Morrice

TO. <input checked="" type="checkbox"/> ENG. ADMIN.	<input type="checkbox"/> INSP. SUPER.	<input type="checkbox"/> SURVEY SUPER.	<input type="checkbox"/> SYST. SUPER.
<input type="checkbox"/> ENG. SUPER.	<input type="checkbox"/> INSP. COORD.	<input type="checkbox"/> PR. ENG. TECH.	<input type="checkbox"/> SYST. ENG.
<input type="checkbox"/> DRAINAGE ENG.	<input type="checkbox"/> CONST. INSP.	<input type="checkbox"/> SR. ENG. TECH.	<input type="checkbox"/> SYST. TECH.
<input type="checkbox"/> DRAINAGE TECH.	<input type="checkbox"/> MATL. INSP.	<input type="checkbox"/> ENG. TECH.	<input type="checkbox"/> ALL PERSONNEL
<input type="checkbox"/> DRAFTSPERSON	<input type="checkbox"/> UTIL. INSP.	<input type="checkbox"/> OTHER	<input type="checkbox"/> CLERK / DISPATCHER

C.C. TO: PROJECT FILE SENDER BULLETIN BOARD

Don:

I have reviewed the most recent submittal (April 30, 1986) of hydrologic and hydraulic information for the subject areas.

Satisfactory hydrologic and hydraulic documentation for flows previously stated by the engineer as being detained to historic levels has been provided.

Regarding the channel construction drawings, which appear to be consistent with City standards, additional channel work is needed to satisfactorily outfall the storm runoff.

Concluded from today's meeting with myself, Max, and Bob Svejkovsky, was that the Loomis Avenue bridge, or immediately downstream of, shall be the outfall point of the Cheyenne Meadows drainage channel. Construction drawings for such work must be approved by the County Department of Transportation.

The county should have the ability to review and comment on all future drainage reports adjacent to and/or affecting county unincorporated areas.



Alan B. Morrice
Drainage Engineer

cc: Max L. Rothschild
Bob Adamczyk
✓ Bruce Butner

ABM/amh

EXHIBIT "H"

EXHIBIT "H"

1. Higgenbotham & Assoc., Morgan & Assoc., Inc., and Karcich & Weber, Inc. Drainage Study, Fort Carson, Colorado for the U.S. Army Corps of Engineers. August, 1976.
2. Hartzell - Pfeiffenberger & Assoc., Inc. Master Drainage Study for Cheyenne Mountain Ranch. May, 1971.
3. Drexel, Barrell & Co. Master Drainage Report for Basins IV, IV-A, IV-B, & VII-B, Cheyenne Mountain Ranch. July 18, 1983.
4. KKBNA, Inc. Drainage Study for Neal Ranch Filing No. 2, Broadmoor Bluffs Park Filing No. 8, and Farthing Drive. June, 1984.
5. Drexel, Barrell & Co. Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive and Preliminary Report for the Single-Family Portions of Broadmoor Bluffs Estates, Colorado Springs, Colorado. August, 1984.
6. City of Colorado Springs, "Determination of Storm Runoff Criteria" In: Subdivision Policy Manual and Public Works Design Manual, pp. 28-51. May, 1980.
7. U.S. Dept. of Agriculture Soil Conservation Service. Procedures for Determining Peak Flows in Colorado. March, 1980.
8. U.S. Department of Agriculture, Soil Conservation Service. "Section 4, Hydrology, "SCS National Engineering Handbook. August, 1972.
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EXHIBIT I

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COST ESTIMATE
OF
DRAINAGE IMPROVEMENTS
IN
CITY OF COLORADO SPRINGS
DRAINAGE EASEMENT

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>	<u>UNIT PRICE</u>	<u>TOTAL PRICE</u>
48 " RCP (C-76, CL-III)	L.F.	525	\$ 95	\$ 49,875
48" Flared End Section	EA.	3	1,400	4,200
Bend 22 1/2° 48" RCP	EA.	3	900	2,700
Concrete Transition Section (includes earthwork)	EA.	2	5,000	10,000
Concrete Channel (includes earthwork)	L.F.	409	130	53,170
Junction Box	EA	1	15,000	15,000
72" RCP (C-76, CL-III)	L.F.	33	190	6,270
48" RCP (C-76, CL-III)	L.F.	50	95	<u>4,750</u>
Total				\$145,965

COST ESTIMATE
 OF
 DRAINAGE IMPROVEMENTS
 IN
 FORT CARSON PROPERTY
 (NOT MAINTAINED BY CITY OF COLORADO SPRINGS)

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>	<u>UNIT PRICE</u>	<u>TOTAL PRICE</u>
72" RCP (C-76, CL-III)	L.F.	12	\$ 190	\$ 2,280
72" Flared End Section	EA.	1	3,000	3,000
Concrete Transition Section	EA.	1	5,000	5,000
Concrete channel (includes earthwork)	L.F.	455	130	59,150
Riprap Transition Section	EA.	1	6,000	<u>6,000</u>
Total				\$75,430

COST ESTIMATE
 OF
 DRAINAGE IMPROVEMENTS
 IN
 COLORADO DEPARTMENT OF HIGHWAYS RIGHT OF WAY
 (NOT MAINTAINED BY CITY OF COLORADO SPRINGS)

<u>ITEM</u>	<u>UNIT</u>	<u>QUANTITY</u>	<u>UNIT PRICE</u>	<u>TOTAL PRICE</u>
Riprap Transition Section (includes earthwork & bedding)	EA.	2	\$8,000	\$ 16,000
Grass lined channel (includes earthwork)	L.F.	1365	12	16,380
Riprap Drop Structure (includes bedding material)	EA.	4	7,000	28,000
48" Flared End Section	EA.	3	1,400	4,200
48" RCP (C-76-CL-III)	L.F.	245	95	23,275
72" RCP (C-76, CL-III)	L.F.	614	190	116,660
Offset Tee Manhole 48"	EA.	2	2,500	5,000
Bend 11-1/4° 72" RCP	EA.	2	1,100	2,200
Bend 22-1/2° 72" RCP	EA.	2	1,100	2,200
Bend 22-1/2° 48" RCP	EA.	3	900	2,700
Asphalt Patch	EA.	2	1,000	<u>2,000</u>
Total				\$218,615