FLOODPLAIN ANALYSIS
AND
PRELIMINARY DRAINAGE STUDY

FOR

FALCON RIDGE
COLORADO SPRINGS

Job No. 5109947
December, 1983

MSM/SP Group

ENGINEERING • SURVEYING • ARCHITECTURE

FLOODPLAIN ANALYSIS
AND
PRELIMINARY DRAINAGE STUDY

FOR

FALCON RIDGE
COLORADO SPRINGS

Job No. 5109947
December, 1983

PREPARED FOR

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FLOODPLAIN ANALYSIS
AND
PRELIMINARY DRAINAGE STUDY
FOR
FALCON RIDGE SUBDIVISION
COLORADO SPRINGS, COLORADO
December, 1983
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PURPOSE OF STUDY

As required by current floodplain regulations of Colorado Springs, Colorado, the purpose of this study is to examine existing 100-year floodplain conditions on the Falcon Ridge site and to design appropriate flood protection measures. This report also investigates the resultant drainage pattern from the Falcon Ridge Subdivision site.

INTRODUCTION AND DESCRIPTION OF STUDY AREA

The proposed Falcon Ridge subdivision is located in Sections 1, 2, 11 and 12, Township 13 South, Range 67 West of the Sixth Principal Meridian, County of El Paso, State of Colorado. (See Vicinity Map - Figure 1, Appendix.) This site is presently in El Paso County and will be annexed into the City of Colorado Springs. The Falcon Ridge site is located on approximately 112.5 acres which is proposed for multi-family housing, single-family housing and a school site. The site is bordered on the north by existing Woodmen Road and undeveloped land with a few residences beyond, on the east by existing single-family estates, to the south by undeveloped land which is a future single-family development (Mt. Woodmen Estates and Discovery Subdivision), and on the west by existing single-family estates, and undeveloped land.

Woodmen Road is an existing two-lane street that will be upgraded to a 60-foot right-of-way with 8-inch ramp curb. All interior streets with a 60-foot right-of-way will have 36-foot flowline to flowline and all 50-foot right-of-way streets will have 28-foot flowline to flowline, with both type streets having 8-inch ramp curbs.

The underlying soils identified on the site are on the Truckton and Ustic torrifluents complexes as shown on the soil conservation survey soils maps. The offsite soils are of the Kettle and Travessilla complexes (see Appendix Figure 2).

100-YEAR FLOODPLAIN ANALYSIS

This report includes a hydrologic analysis of Dry Creek for the entire upstream basin, using the TR-20 computer program. For the portion of Dry Creek that flows through the Falcon Ridge site, the HEC-2 computer program was used to delineate the 100-year floodplain.

HYDROLOGIC ANALYSIS

The peak 100-year flood discharge for Dry Creek used in this report was obtained from a study conducted by KKBNA, Inc. This study is being completed at the time of this analysis and a preliminary copy of KKBNA's TR-20 computer program was obtained for this study (see Appendix for Summary Sheet). Design Point 32 is the upstream point of the Falcon Ridge Subdivision.

In the KKBNA study, the flood discharges were computed with 24 Hour Type II-A Rainfall Table, obtained from the United States Department of Agriculture Soil Conservation Service.

The KKBNA study for Dry Creek Basin will supercede the "Dry Creek Drainage Study for Colorado Springs", prepared by R. Keith Hook and Associates, Inc., November, 1966.

HYDRAULIC ANALYSIS

Present Conditions (Without Falcon Ridge). Design Point 32 has a peak 100-year runoff rate of 1725 cfs. Due to the fact that this runoff value is preliminary, MSM/SP Group has increased this value 30 percent to 2250 cfs, for the channelization of Dry Creek through Falcon Ridge Subdivision. This will provide for a conservative estimate of the 100-year frequency flood discharge rates for sizing of the channel and structures involved with the Dry Creek basin that flows through the site.

The existing 100-year floodplain is outside the channel at the upstream end of Falcon Ridge Subdivision. To convey the flood discharges into the proposed channel, a swale and berm will be built during the time of overlot grading of Falcon Ridge to act as a transition.

With Falcon Ridge and Flood Protection. For the Falcon Ridge Subdivision channelization, the HEC-2 computer program was utilized to determine the depth and width of the flood discharge. Two separate HEC-2 computer runs were used for Dry Creek. The first modeled the upper one-third, super-critical portion of the channel. The second HEC-2 computer run modeled the lower two-thirds, sub-critical portion of the channel.

The upper one-third has a slope of approximately 3.5 percent with a 6-foot deep, rip-rap lined channel (see Appendix 23 for cross section). The 100-year floodplain will be within a 60-foot wide easement along the upper one-third. Structures #3 and #4 are to be bridges, and will be located along this segment of the channel. A 9-foot concrete drop structure with a sill will dissipate energy by forcing a hydraulic jump beneath structure #3. (For details of the channel see MSM/SP Group construction plans.) Downstream of

structure #3, the channel will translate from a 60-foot wide easement to a 120-foot easement. Flow conditions throughout the 120-foot easement will be sub-critical. The channel depth will be approximately 10-feet with 3 feet of depth being rip-rap lined (see Appendix Sheet 26). The channel slope will be approximately 0.6 percent with 13 rip-rap drop structures. Eight drop structures will provide 2-foot drops and 5 drop structures will provide 4-foot drops. The 100-year floodplain will be within the channel easement. There will be a 12-foot wide maintenance road and bikeway along the channel within the easements. Structures #1 and #2 are to be culverts. Structure #2 will be a double 8-foot by 12-foot box culvert. Structure #1 will be a 5-foot by 3-foot box culvert and will release flow from the detention pond. A 140-foot wide by 3-foot deep concrete spillway, above the box culvert, will release the additional flow from the peak discharge that does not flow through Structure #1.

For the depth of water and velocities through the Falcon Ridge Subdivision, see the HEC-2 computer program output in the Appendix. The developed site with historic offsite was modeled with the TR-20 computer program along with the preliminary, historic Dry Creek basin TR-20 computer program developed by KKBNA. As expected, this showed that the Falcon Ridge flood discharges will reach Dry Creek before the peak 100-year storm for the Dry Creek basin reaches the Falcon Ridge site.

PRELIMINARY DRAINAGE STUDY

INTRODUCTION

It is proposed to develop the Falcon Ridge Subdivision consisting of approximately 112.5 acres which at the present time is undeveloped pasture land.

Historically, runoff drains easterly across the Falcon Ridge Subdivision in Dry Creek. The areas adjacent to Dry Creek drain north and south into Dry Creek.

The proposed drainage pattern will drain all historic offsite and developed onsite to Dry Creek without affecting the drainage patterns on adjacent properties.

Since no flood retention is required, only the peak 5-year and 100-year runoffs were investigated.

CRITERIA

Storm Drainage Criteria published by the City of Colorado Springs are the basis of this study. The initial storm evaluation is based on the 5-year event and the major storm evaluation is based on the 100-year event. The street curb and gutter, inlets, cross pans and storm sewer comprise the initial storm drainage system. The major storm drainage system consists of swales, street low points the Dry Creek channelization and other grading techniques in addition to the initial storm drainage system to safely convey major storm flows to the downstream property line of this subdivision.

The Modified SCS Method is the procedure used for the storm runoff determination of all sub-basins. Composite curve numbers for various types of land use are tabulated in Figures 3, 4 and 5, and are based on data presented in Figure 6 from the Colorado Springs Storm Drainage Criteria. Ground cover in open space areas (parks) are assumed to be in good condition.

For determining the rainfall in inches (p) from corresponding curve numbers, see Figure 7. For determining the peak discharge in cfs per square mile (q), a 6 hour duration Type II-A storm was used (Figure 8, Appendix). The initial time of concentration for developed conditions to the streets was assumed to be ten minutes. The time of flow in the streets was added to ten minutes. The initial time of concentration for streets only was assumed to be five minutes.

The allowable curb capacities for the various street types were determined from "Permissable Drainage Street Capacities with 8" Vertical Curbs" (Figure 9, Appendix). For the 5-year frequency storm, the maximum depth of flow at the gutter is defined by the flowline to the top-of-curb (8" inches for level curb). For the 100-year frequency storm runoff, the maximum depth was calculated to be 1-foot (Figures 10 and 11, Appendix).

inlets and storm sewer will be sized at the time of the final drainage study. Swales were sized for the 100-year frequency storm and with a maximum velocity of five feet per second. These swales can change to have higher velocities with the addition of erosion protection. In order to attain the five feet per second velocity and the indicated slopes, drop structures may be required. At the time of final design, swales will be designed so that the froude number does not exceed 1.0 on grass lined channels, and runoff, therefore, will not be supercritical.

DISCUSSION

The results of this preliminary drainage study are shown on the drainage plan enclosed in the back of this report, as well as in the computation sheets in the Appendix.

OFFSITE

There are nine offsite basins to the south, east and north that will flow onto this site. A major offsite basin has been analyzed in the "Historic Drainage and Floodplain Analysis for Mount Saint Francis Property", prepared by KKBNA. The Falcon Ridge Subdivision is a part of this study. However, for this preliminary drainage study, only the offsite areas adjacent to the site will be analyzed. The west boundary of the preliminary drainage study is the same as Design Point 15 for the Mount Saint Francis Property. The 100-year frequency peak runoff rates from the Mount Saint Francis property will be contained in the drainage channel for Dry Creek which traverses the Falcon Ridge Subdivision.

Offsite areas OS1 and OS2 consist of approximately 8.1 and 26.0 acres, respectively. Flow from these areas will drain from the west to the east in a swale along the east property line to the drainage channel (see Drainage Map). The peak 5-year and 100-year runoff rates will be 1.3 cfs and 7.7 cfs, respectively, for OS1 and 18.8 cfs and 61.3 cfs for OS2.

Offsite areas OS3, OS5 and OS6 consist of approximately 4.0 acres, 1.6 acres and 10.2 acres, respectively, and are located to the south of Falcon Ridge. These areas will sheet flow onto the single-family lots and eventually flow into the drainage channel through inlets and storm sewer. The runoff rates for OS3 will be 2.6 cfs and 8.6 cfs for the 5-year frequency storm and 100-year frequency storm, respectively. For OS5, the peak discharge rates for the 5-year and 100-year frequency storm will be 1.3 cfs and 5.1 cfs, respectively. The peak runoff for OS6 will be 10.2 cfs and 29.2 cfs, respectively, for the 5-year and 100-year frequency storms.

Offsite area OS4 contains approximately 75.0 acres. This basin will enter Falcon Ridge on the south along the school site. Grading will be needed along the property to ensure the peak runoff will flow to Swale I-I and enter the drainage channel (see Drainage Plan). The peak 5-year frequency and 100-year frequency runoff rates will be 79.5 cfs and 206.1 cfs, respectively.

Offsite areas OS7, OS8 and OS9 are located to the north of Woodmen Road. These basins contain approximately 13.2 acres, 42.7 acres and 30.0 acres, respectively. Basin OS7 is part of Design Point 15 from the Mount Saint Francis property and will flow to Woodmen Road and be conveyed to the drainage channel through a curb cut. Basins OS8 and OS9 presently flow across Woodmen Road. When Woodmen Road is improved, the peak discharge rates will be conveyed in the street and eventually discharge into Dry Creek. The peak discharge rates for OS8 and OS9 will be 2.6 cfs and 1.8 cfs for the 5-year frequency storm, and will be 32.5 cfs and 22.8 cfs for the 100-year frequency storm.

BASIN A

Basin A consists of approximately 60.1 acres and is located adjacent to the Dry Creek channel. This basin's runoff will flow to the low point in the streets and be conveyed to the Dry Creek channel by inlets, storm sewer and swales. The peak discharge rates will be 40.3 cfs for the 5-year frequency storm and 123.7 cfs for the 100-year frequency storm, respectively.

BASIN B

Basin B contains approximately 0.7 acres. This basin consists of back lots of single-family homes and Dry Creek. The runoff from Basin B will discharge directly into the Dry Creek channel. The peak runoff rates for the 5-year and 100-year frequency storms will be 1.1 cfs and 2.5 cfs, respectively.

BASIN C

Basin C, containing approximately 12.8 acres, is located in the southwest area of the site. Basin C is a future elementary school and some single-family back lots that will flow directly to Dry Creek. The peak discharge rates will be 5.1 cfs and 21.8 cfs for the 5-year and 100-year frequency storms, respectively.

BASIN D

Basin D contains approximately 6.9 acres of single-family housing back lots and Dry Creek. The runoff from the back lots will flow directly to the Dry Creek channel. The peak discharge rates for the 5-year frequency storm will be 4.0 cfs. The peak discharge for the 100-year frequency storms will be 13.3 cfs.

BASIN E

Basin E consists of 15.0 acres and is located in the central portion of this site. Basin E contains the backs of multi-family housing and Dry Creek. The multi-family areas will flow directly to the Dry Creek channel. The peak runoff rates will be 8.7 cfs and 28.8 cfs for the 5-year and 100-year frequency storms, respectively.

BASIN F

Basin F contains approximately 10.3 acres and is located in the easterly portion of the site. Basin F contains Dry Creek, the detention pond, single-family back lots and multi-family back lots. Runoff from the single-family and multi-family will flow directly to the Dry Creek channel and detention pond. The peak discharge rates for the 5-year frequency storm and 100-year frequency storm will be 6.0 cfs and 19.8 cfs, respectively.

BASIN G

Basin G consists of approximately 5.1 acres of single-family lots. Runoff from Basin G will flow to the low point in Dairy Ranch Road (see Drainage Map) and be conveyed in a swale offsite to the existing Dry Creek channel. The peak discharge rates will be 3.0 cfs and 9.7 cfs for the 5-year and 100-year frequency storms, respectively.

SHEET FLOW AREA

Basin SF1 contains approximately 1.7 acres and is located in the southeast area of the site. Basin SF1 consists of single-family back lots that historically flow offsite to the south. The peak discharge rates for the 5-year and 100-year frequency storms will be 1.0 cfs and 3.2 cfs, respectively.

DETENTION

Detention has been provided along Dry Creek in the eastern portion of the Falcon Ridge Subdivision (see Drainage Map). The City of Colorado Springs, in their drainage standards and specifications, does not require detention to attenuate the peak runoff rates. However, detention in the Dry Creek Basin is being required to reduce the peak developed flows to their historic runoff rates. For the Falcon Ridge Subdivision, a TR-20 computer program was run for the developed site with historic offsite, and was also run for historic site and historic offsite. The hydrographs from each TR-20 computer program run were plotted (see Appendix 42) and the difference in areas of each hydrograph was 9.3 acre-feet. The peak discharge rate for the developed site and historic offsite will be 615 cfs, while the historic offsite and historic site will be 350 cfs (see Appendix for TR-20 computer program run). From the increase in runoff due to development of the site, a detention pond was graded to have an oversized volume of 14.7 acre-feet. The outlet structure will be a 5-foot by 3-foot box culvert which will have a peak release rate of 236 cfs, substantially below the historic release rate of 350 cfs. As previously mentioned, additional flow will be released through the 140-foot wide by 3-foot deep concrete spillway above the box culvert.

DOWNSTREAM EFFECTS

Runoff from the development of Falcon Ridge Subdivision will be conveyed to Dry Creek via swales, inlets and storm sewer.

The development of Falcon Ridge Subdivision, with the over detention for higher frequency storms, will not adversely affect the downstream areas downstream of Falcon Ridge.

This floodplain analysis and preliminary drainage study is submitted for review and approval.

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Reviewed by: Edward G Beadenkopf
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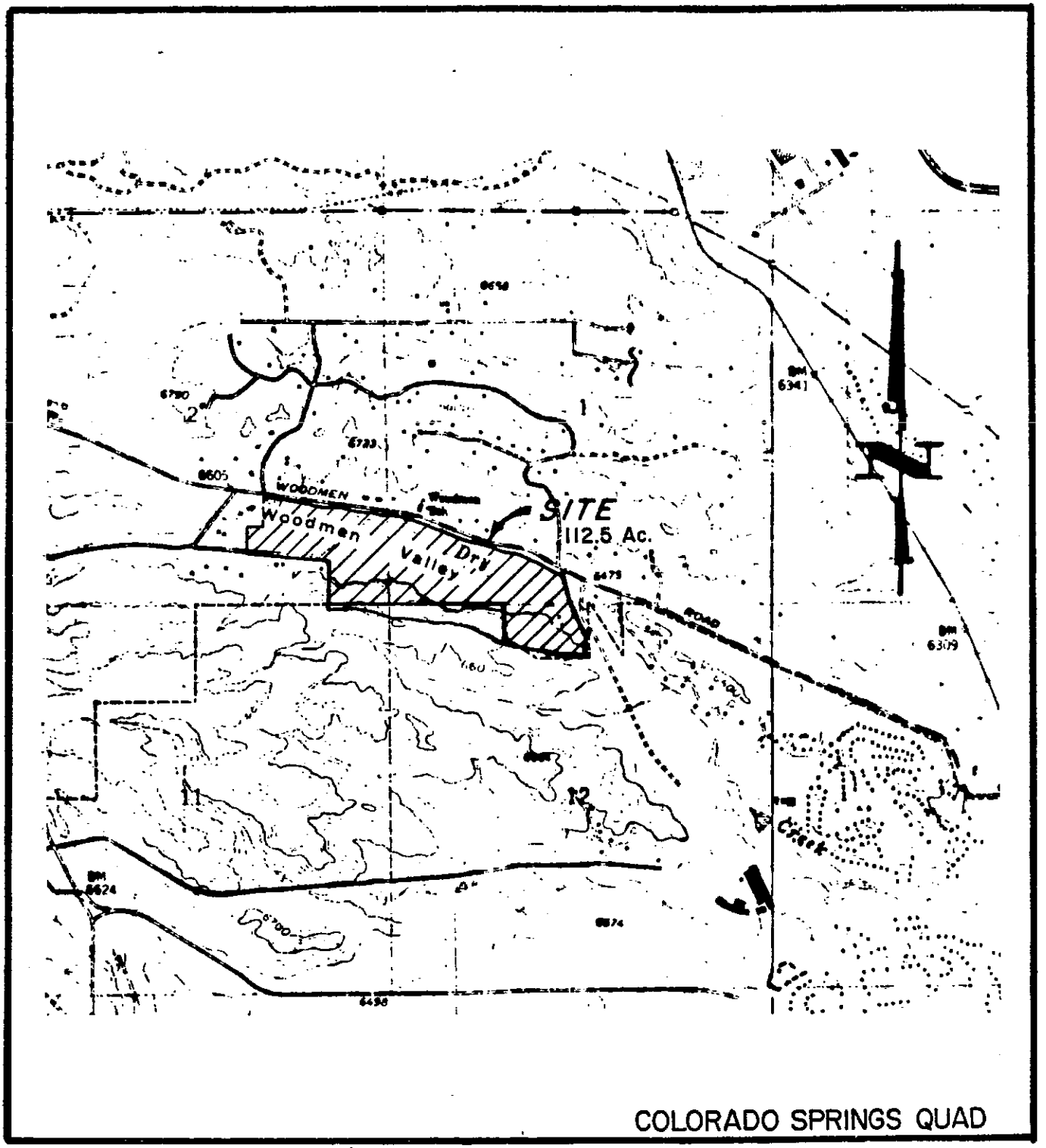
WM:djw

APPENDIX

FALCON RIDGE



VICINITY MAP
SCALE 1" = 2000'

SEC. 1, 2, 11 & 12
T13S, R67W

MSM/SP GROUP

FIGURE 1

SOILS MAP

FIGURE 2

MSM/SP Group

- ☑ DENVER, COLORADO
- ☐ COLORADO SPRINGS, COLORADO
- ☐ ALBUQUERQUE, NEW MEXICO
- ☐ CASPER, WYOMING
- ☐ KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET ____ OF ____
CALCULATED BY WMcCombie DATE 11-22-83
CHECKED BY CWHB DATE 11-22-83

COMPOSITE RUNOFF CURVE NUMBERS (OFFSITE)

AREA DESIGNATION	SOIL	AREA	LAND USE	%	CN	CN x %
OS1	B	8.1	MEADOW-GOOD	100	58	58
OS2	B	7	MEADOW-GOOD	26.9	58	1560.2
	D	19	FOREST-GOOD	73.1	77	5628.7
			COMPOSITE = 71.9			
OS3	B	1.0	MEADOW-GOOD	25	58	1450.0
	D	3.0	FOREST GOOD	75	77	5775.0
			COMPOSITE 72.2			
OS4	D	46.2	FOREST-POOR	61.6	83	5112.8
	D	28.8	FOREST-GOOD	38.4	77	2956.8
			COMPOSITE 80.7			
OS5	D	1.6	FOREST-GOOD		77	
OS6	D	10.2	FOREST-GOOD		77	
OS7	B	9.6	FOREST-GOOD	72.7	55	3998.5
	B	3.6	MEADOW-GOOD	27.3	58	1583.4
			COMPOSITE 55.8			

FIGURE 3

MSM/SP Group

- ☑ DENVER, COLORADO
- ☐ COLORADO SPRINGS, COLORADO
- ☐ ALBUQUERQUE, NEW MEXICO
- ☐ CASPER, WYOMING
- ☐ KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET ___ OF ___
CALCULATED BY WMcCombie DATE 4-22-83
CHECKED BY CMB DATE 11-23-83

Composite Runoff Curve Number (onsite)

Area Designation	Soil	Area	Landuse	%	CN	% x CN
A5	D	4.8	SF (1/3Ac)	47.2	86	4059.2
	B	5.37	SF (1/3Ac)	52.8	72	3801.6
			Composite	78.6		
A6	D	1.8	SF (1/3Ac)	22	86	1892
	B	6.4	SF (1/3Ac)	78	72	5616
			Composite =	75.1		
A8	D	1.6	SF (1/3Ac)	26.5	86	2279
	B	4.43	SF (1/3Ac)	73.5	72	5292
			Composite =	75.7		
C1	D	4.6	School-Good	31.8	80	2544
	B	8.23	School-Good	68.2	61	4160.2
			Composite	67.0		

FIGURE 4

MSM/SP Group

- [x] DENVER, COLORADO
- [ ] COLORADO SPRINGS, COLORADO
- [ ] ALBUQUERQUE, NEW MEXICO
- [ ] CASPER, WYOMING
- [ ] KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET ____ OF ____
CALCULATED BY W.McCombie DATE 11-22-83
CHECKED BY CWB DATE 11-22-83

COMPOSITE RUNOFF CURVE NUMBERS (OFFSITE)

AREA DESCRIPTION	SOIL	AREA	LANDUSE	CN	%	CN × %
OS8	B	34.4	FOREST-GOOD	55	80.6	4433.0
	B	8.3	MEADOW GOOD	58	19.4	1125.2
				COMPOSITE =		55.6
OS9	B	5.1	MEADOW-GOOD	58	16.4	951.2
	B	24.9	FOREST-GOOD	55	83.6	4598.0
				COMPOSITE =		55.5

FIGURE 5

- Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and I_a = 0.2S)

Land Use Description		Hydrologic Soil Group A	B	C	D
Cultivated land[1] :	without conservation treatment	72	81	88	91
:	with conservation treatment	62	71	78	81
Pasture or range land:	Poor condition	68	79	86	89
:	Good condition	39	61	74	80
Meadow:	Good condition	30	58	71	78
Wood or Forest land:	thin stand, poor cover, no mulch	45	66	77	83
:	good cover[2]	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.					
good condition:	grass cover on 75% or more of the area	39	61	74	80
fair condition:	grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)		89	92	94	95
Industrial districts (72% impervious).		81	88	91	93
Residential: [3]					
Average lot size	Average % Impervious[4]				
1/8 acre or less	65	77	85	90	92
1/5 acre	47	65	78	85	89
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
Paved parking lots, roofs, driveways, etc.-		98	98	98	98
Streets and roads:					
paved with curbs and storm sewers-		98	98	98	98
gravel		76	85	89	91
dirt		72	82	87	89

1. For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, August 1972.

2. Good cover is protected from grazing and litter and brush cover soil.

FIGURE 6

-- Determination of Runoff Depth in inches for selected CN's and rainfall amounts

Curve Number [1]	5-YR (P) Rainfall (Inches) 2.10	100-YR (P) Rainfall (Inches) 3.50
56	0.03	0.38
58	0.05	0.45
60	0.08	0.53
62	0.11	0.62
64	0.14	0.71
66	0.18	0.80
68	0.23	0.90
70	0.28	1.01
72	0.34	1.12
74	0.40	1.24
76	0.47	1.36
78	0.54	1.50
80	0.62	1.64
82	0.71	1.78
84	0.82	1.94
86	0.92	2.10
88	1.05	2.27
90	1.18	2.45
92	1.33	2.64
94	1.49	2.84
96	1.67	3.04
98	1.87	3.27

1/ To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use arithmetic interpolation or:

$$Q = \frac{CN\,(P + 2)^2 - 400\,(P+2 - \frac{100}{CN})}{CN\,(P - 8) + 800}$$

FIGURE 7

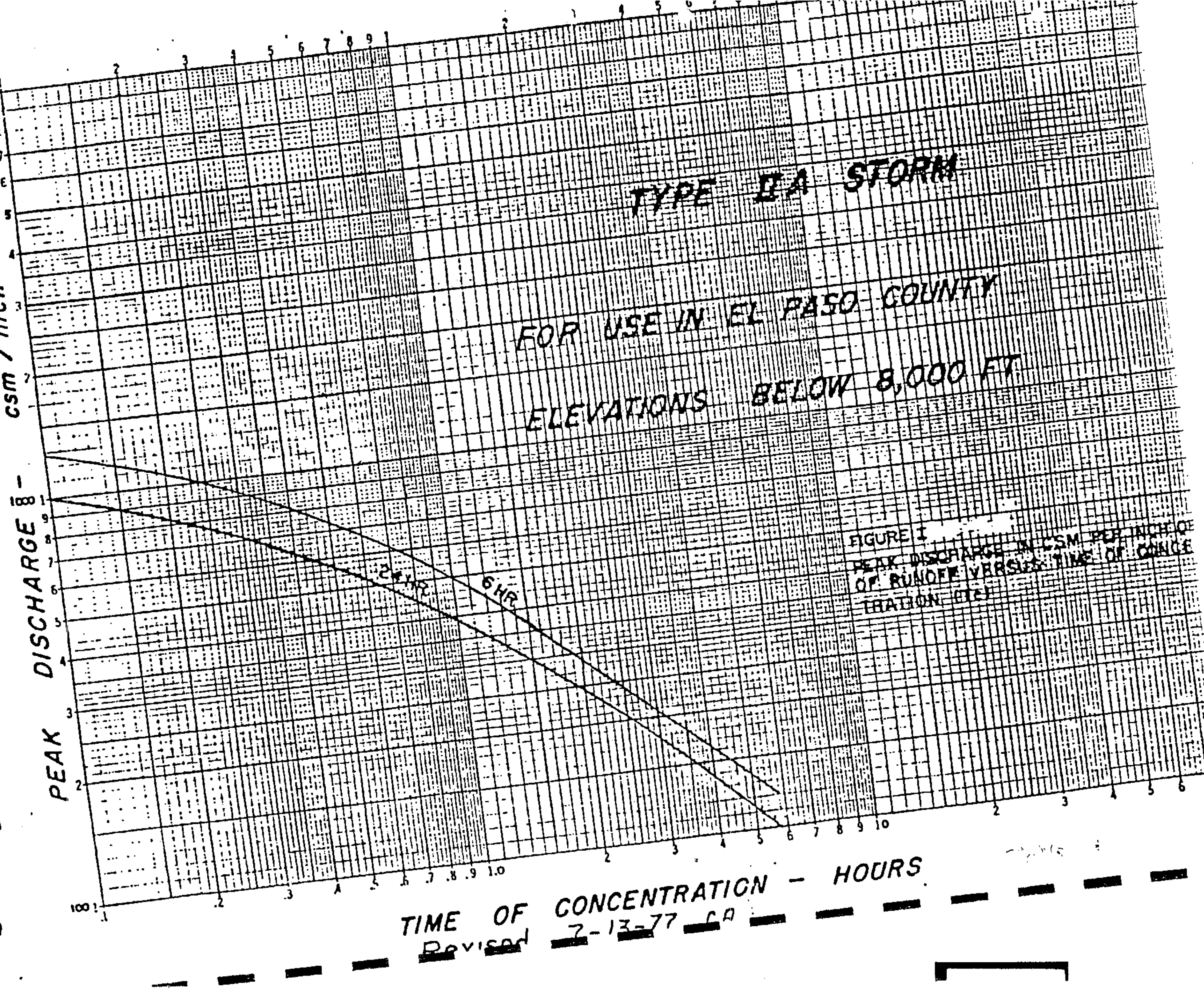

TYPE IIA STORM
FOR USE IN EL PASO COUNTY
ELEVATIONS BELOW 8,000 FT
PEAK DISCHARGE - csm / inch
TIME OF CONCENTRATION - HOURS
24 HR
6 HR
FIGURE I
Revised 7-13-77

FIGURE 8

Permissible Drainage Street Capacities with 8" Vertical Curbs *
8" Curb - Full Storm Water Capacity (with level curbs)

S %	34' Residential FPS	34' Residential CFS	36' Residential FPS	36' Residential CFS	40' Residential FPS	40' Residential CFS	34' One-Way Art. FPS	34' One-Way Art. CFS	60' & 76' Arterial FPS	60' & 76' Arterial CFS	S %
0.5	4.08	28.9	4.02	29.5	3.90	30.1		20.0		20.0	0.5
1.0	5.76	40.9	5.70	41.7	5.51	42.6		30.0		30.0	1.0
1.5	7.06	50.1	6.97	51.1	6.75	52.2	6.97	30.0	6.97	30.0	1.5
2.0	8.15	57.8	8.05	59.0	7.79	60.2	8.05	34.0	8.05	34.0	2.0
2.5	9.11	64.7	9.00	65.9	8.71	67.4	9.00	36.0	9.00	36.0	2.5
3.0	9.98	70.9	9.86	72.2	9.54	73.8	9.86	38.0	9.86	38.0	3.0
3.5	10.78	76.5	10.65	78.0	10.31	79.7	10.65	40.0	10.65	40.0	3.5
4.0	11.52	81.8	11.38	83.4	11.02	85.2	11.38	42.0	11.38	42.0	4.0
4.5	12.22	86.8	12.07	88.5	11.69	90.4	12.07	43.0	12.07	43.0	4.5
5.0	12.89	91.5	12.73	93.3	12.32	95.3	12.73	45.0	12.73	45.0	5.0
5.5	13.52	95.9	13.35	97.8	12.92	99.9	13.35	47.0	13.35	47.0	5.5
6.0	14.12	100.0	13.94	102.2	13.49	104.3	13.94	49.0	13.94	49.0	6.0

FIGURE 9

* Intermediate Values may be Obtained by Arithmetic Interpolation

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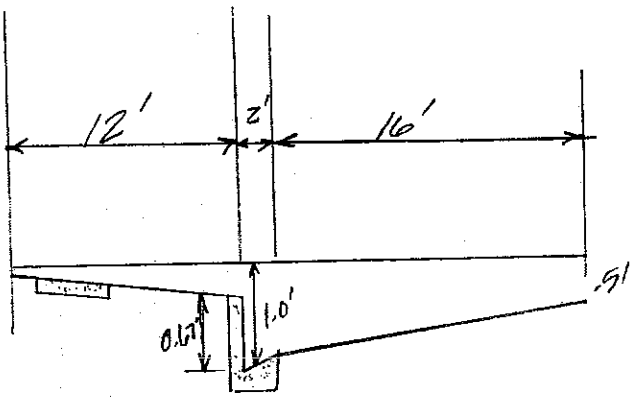
- [x] DENVER, COLORADO
- [ ] COLORADO SPRINGS, COLORADO
- [ ] ALBUQUERQUE, NEW MEXICO
- [ ] CASPER, WYOMING
- [ ] KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET ____ OF ____
CALCULATED BY WM DATE 12-6-83
CHECKED BY ____ DATE ____

STREET CAPACITY – 60 ROW 36' B-B



$S = 1.0\%$

$n = 0.025$

$$A = 2\left[\frac{.51+.83}{2}\times 16 + \frac{.83+1.0}{2}\times 2 + \frac{.33\times 16.5}{3}\right] = 30.5 ft^2$$

$$W_P = 2(16+2+.67+12+4.5) = 70.34 ft$$

$$R^{2/3} = \left(\frac{30.5}{70.34}\right)^{.667} = 0.57$$

$$Q = \frac{1.486}{.025}\times 30.5 \times .57 \times (.01)^{1/2} = 103.3 cfs$$

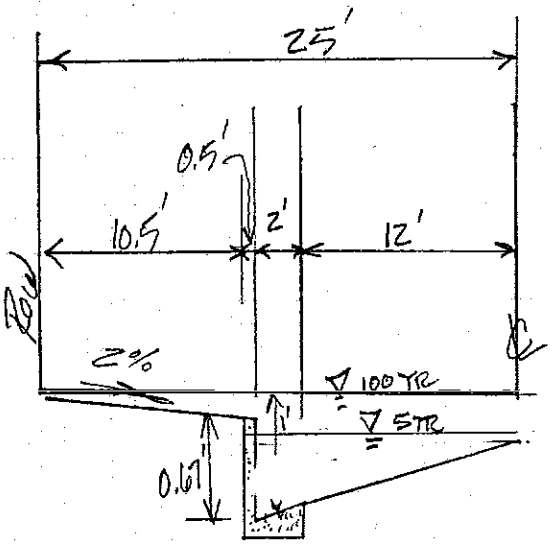
FIGURE 10

MSM/SP Group

☑ DENVER, COLORADO
☐ COLORADO SPRINGS, COLORADO
☐ ALBUQUERQUE, NEW MEXICO
☐ CASPER, WYOMING
☐ KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET ___ OF ___
CALCULATED BY WMcCombie DATE 11-22-83
CHECKED BY ___ DATE ___

STREET CAPACITY 50 ROW - 28' F-F



S = 1.0%

n = 0.017 (5 YR)
n = 0.025 (100 YR)

5 YEAR

$$A = 2\left[\frac{.09+.33}{2}\times 12 + \frac{.33+.5}{2}\times 2\right] = 6.7\,ft^2$$

$$Wp = 2(12+2+0.5) = 29\,ft$$

$$R^{2/3} = \left(\frac{6.7}{29}\right)^{.667} = 0.38$$

$$Q = \frac{1.486}{.017}\times 6.7 \times .38 \times (.01)^{1/2} = 22.3\,cfs$$

100 YR

$$A = 2\left[\frac{.59+.83}{2}\times 12 + \frac{.83+1.0}{2}\times 2 + \frac{.33+.12}{2}\times 11\right] = 14.5\,ft^2$$

$$Wp = 2(12+2+.5+11) = 51.0$$

$$R^{2/3} = \left(\frac{14.5}{51}\right)^{.667} = 0.43$$

$$Q = \frac{1.486}{.025}\times 14.5 \times .43 \times (.01)^{1/2} = 37.1\,cfs$$

FIGURE 11

SUBDIVISION FALCON RIDGE
LOCATION COLORADO SPRINGS
JOB NO. 5109947
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY WMCOMBIE DATE 11-22-83
CHECKED BY CMB DATE 11-22-83

MSM/SP GROUP
5455 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$ -in.	ΣAQ $mi.^2$ -in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	at HR (min)	
OS1	8.1			.05	.001		0.1	1280	1.3							.1	
	0.013	58		.45	.006		0.1	1280	7.7				3.3	900		.1	
OS2	26.0			.34	.015		.12	1250	18.8							.12	
	0.040	72		1.12	.045		.12	1250	56.9				6.5	1800		.12	
OS1+OS2						.016	.12	1250	20.0								
						.061	.12	1250	63.8								
OS3	4			.34	.02		0.1	1280	2.6							.1	
	.006	72		1.12	.0067		0.1	1280	8.6				6	500		.1	
OSA	75			.66	.077		.22	1030	79.5							.2	
	.117	81		1.71	.20		.22	1030	206.1				9.5	4400		.2	
OS5	1.6			.50	.001		.1	1280	1.3							.1	ASSUME t_c = 5 MIN
	.003	77		1.43	.004		.1	1280	5.1							.1	

SUBDIVISION FALCON RIDGE
LOCATION COLORADO SPRINGS
JOB NO. 5109947
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY W McCombie DATE 11-22-83
CHECKED BY CMB DATE 11-22-83

MSM/SP GROUP
5455 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
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RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
OS6	10.2			.5	.008		.1	1280	10.2							0.1	Assume t_c = 6 min
	.0159	77		1.43	.0228		.1	1280	29.2				10	350		0.1	
OS8	42.7			.03	.002		.1	1280	2.6							.1	Assume t_c = 6 min
	.0667	56		.38	.025		.1	1280	32.5				16	1000		.1	
OS9	30.0			.03	.001		.1	1280	1.8							.1	Assume t_c = 6 min
	.0069	56		.38	.0178		.1	1280	22.8				10	800		.1	

SUBDIVISION FALCON RIDGE
LOCATION COLORADO SPRINGS
JOB NO. 5109948
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY WMcCombie DATE 11-22-83
CHECKED BY CMB DATE 11-22-83

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COLORADO SPRINGS, COLORADO
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RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
A1	8.05			.34	.0044		.23	1010	4.5							10	INITIAL t_c = 10 MIN
	.013	72		1.12	.0146		.23	1010	14.7				1.2	840	3.5	4.0	TO CHANNEL
OS3+A1						.0016	.23	1010	6.5								
						.0213	.23	1010	21.5								
A2	2.64			.34	.0014		.19	1090	1.5							10	INITIAL t_c = 10 MIN
	.004	72		1.12	.0045		.19	1090	4.9				4.0	450	5	1.5	TO CHANNEL
A3	10.71			.34	.0058		0.22	1030	6.0							10	INITIAL t_c = 10 MIN
	.017	72		1.12	.019		0.22	1030	19.6				4.0	1200	6.2	3.2	
A4	0.62			.34	.0003		.17	1100	0.4							10	ASSUME t_c = 10 MIN
	.001	72		1.12	.0011		.17	1100	1.2								
A3+A4						.0061	.22	1030	6.3								
						.0201	.22	1030	20.7								

SUBDIVISION FALCON RIDGE
LOCATION COLORADO SPRINGS
JOB NO. 5109947
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY JMcCombie DATE 6-22-83
CHECKED BY CMB DATE 11-22-83

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COLORADO SPRINGS, COLORADO
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RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
A5	10.17			.58	.0092		.19	1090	10.1							10	INTIAL t_c=10MIN
	.0159	79		1.57	.025		.19	1090	27.2				6	700	8	1.5	
TOS5						.0102	.19	1090	11.1								
						.0290	.19	1090	31.6								
A6	8.2			.44	.0057		.21	1050	6.0							10	INTIAL t_c=10MIN
	.013	75		1.30	.017		.21	1050	17.7				3.5	1000	6.2	2.7	
TOS6						.0137	.21	1050	14.4								
						.0398	.21	1050	41.8								
A7	8.24			.36	.0044		.21	1050	4.6							10	INTIAL t_c=10MIN
	.0129	72		1.12	.0144		.21	1050	15.1				4	1100	6.5	2.8	
A8	6.03			.47	.0014		.20	1070	4.7							10	INTIAL t_c=10MIN
	.009	76		1.36	.0128		.20	1070	13.7				5	800	7	1.9	
A9	4.23			.36	.0022		0.21	1050	2.4							10	INTIAL t_c=ONMIN
	.0066	72		1.12	.0074		0.21	1050	7.8				4	800	5.6	2.4	
A8+A9						.0066	.21	1050	6.9								
						.0202	.21	1050	21.2								

SUBDIVISION Falcon Ridge
LOCATION Colorado Springs
JOB NO. 3109947
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY W McCombie DATE 11-22-83
CHECKED BY CMB DATE 11-23-83

MSM/SP GROUP
5455 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Q_p = (AQ)\, q$

Area Designation	A (Acres) (Mi²)	CN		Q in.	AQ mi.² -in.	ΣAQ mi.² -in.	t_c hr.	q csm/in.	Qp cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
A 10	0.51			.34	.0003		.17	1100	0.3							10	Assume tc = 10 min
	.0008	72		1.12	.0009		.17	1100	1.0							10	
A11	0.65			.34	.0003		.17	1100	0.3							10	Assume tc = 10 min
	.001	72		1.12	.0011		.17	1100	1.2								
A1→A11			[illegible]	[illegible]	[illegible]	.0388	.21	1050	40.3								
			[illegible]	[illegible]	[illegible]	.1176	.21	1050	123.7								
DESIGN POINT 15 from KKBNA									327.9								
DRAINAGE STUDY									1093.1								
B1	0.72			.87	.001		.17	1100	1.1							10	Assume tc = 10 min
	.0011	85		2.02	.0023		.17	1100	2.5							10	
C1	12.83			.20	.004		.1	1280	5.1							.1	
	0.02	67		.85	.017		.1	1280	21.8				12	1100		.1	

SUBDIVISION FALCON RIDGE
LOCATION COLORADO SPRINGS
JOB NO. 5109947
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR.
COMPUTATIONS BY WMcCOMBIE DATE 11-22-83
CHECKED BY CMB DATE 11-23-83

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RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN		Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm/in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in.	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
D1	6.9			.34	.0037		.17	1100	4.0							.17	ASSUME t_c = 10 MIN
	.0108	72		1.12	.012		.17	1100	13.3							.17	
E1	14.97			.34	.008		.17	1100	8.7							.17	ASSUME t_c = 10.0 MIN
	.0234	72		1.12	.026		.17	1100	28.8							.17	
F1	10.28			.34	.0055		.17	1100	6.0							10	ASSUME t_c = 10 MIN
	.0160	72		1.12	.018		.17	1100	19.8							10	
G1	5.05			.34	.0027		.17	1100	3.0								ASSUME t_c = 10 MIN
	.0079	72		1.12	.0088		.17	1100	9.7								
SF-1	1.68			.34	.0009		.17	1100	1.0							.17	ASSUME t_c = 10 MIN
	.0025	72		1.12	.0029		.17	1100	3.2								

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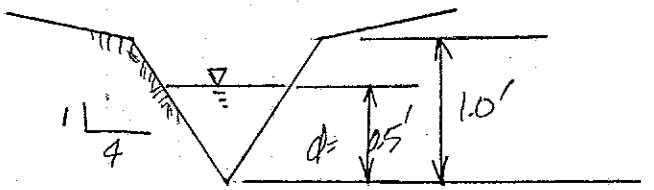
PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET 18 OF
CALCULATED BY WMcCombie DATE 11-23-83
CHECKED BY CMB DATE 11-23-83

SECTION A-A

$Q = 4.9$ cfs

$n = 0.035$
$S = 11\%$



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

At $d = 0.5'$

$$Q = \frac{1.486}{.035} \times 1.0 \times .389 \times (.11)^{1/2} = 5.5 \text{ cfs}$$

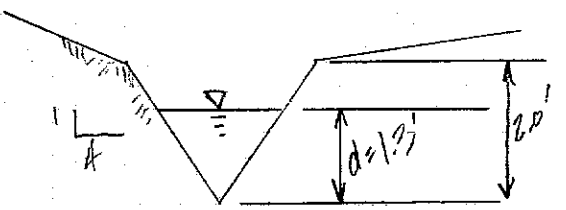
$V = 5.5$ fps

SECTION B-B

$Q_{100YR} = 31.6$ cfs

$n = 0.035$

$S = 2.25\%$



$$Q = \frac{1.486}{.035} \times 6.76 \times .735 \times (.0225)^{1/2} = 31.6 \text{ cfs}$$

$V = 4.7$ fps

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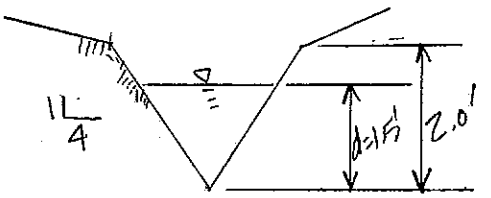
PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET 19 OF
CALCULATED BY WM DATE 11-23-83
CHECKED BY CMB DATE 11-23-83

SECTION C-C

Q_{100TR} = 41.8 cfs

$n = 0.035$

$S = 1.83\%$



$$Q = \frac{1.486}{.035} \times 9.0 \times .809 \times (.0183)^{1/2} = 41.8 \text{ cfs}$$

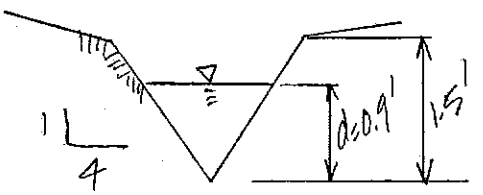
$V = 4.6$ fps

SECTION D-D

Q_{100TR} = 15.1 cfs

$n = 0.035$

$S = 3.65\%$



$$Q = \frac{1.486}{.035} \times 3.20 \times .575 \times (.0365)^{1/2} = 15.1 \text{ cfs}$$

$V = 4.7$ fps

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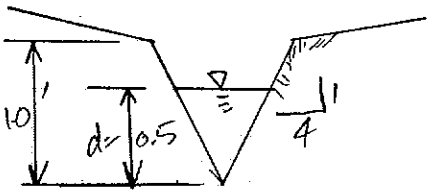
PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET 20 OF ____
CALCULATED BY WM DATE 11-23-83
CHECKED BY CWB DATE 11-23-83

SECTION E-E



$Q_{100YR} = 1.0$ cfs

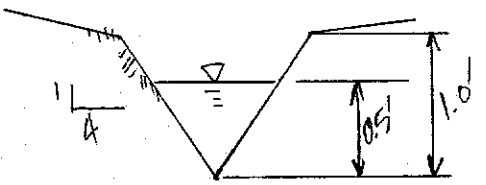
$n = 0.035$

$S = 1.0\%$

$$Q = \frac{1.486}{.035} \times 1.0 \times .389 \times (.01)^{1/2} = 1.7 \text{ cfs}$$

$V = 1.7$ fps

SECTION F-F



$Q_{100YR} = 1.2$ cfs

$n = 0.035$

$S = 1.0\%$

$$Q = \frac{1.486}{.035} \times 1.0 \times .389 \times (.01)^{1/2} = 1.7 \text{ cfs}$$

$V = 1.7$ fps

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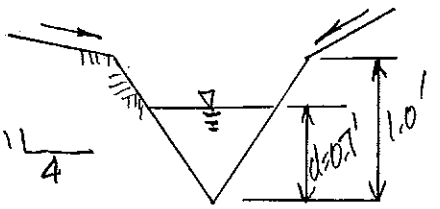
PROJECT FALCON RIDGE
JOB NUMBER 5109D7 SHEET 24 OF ____
CALCULATED BY WM DATE 11-23-83
CHECKED BY CMB DATE 11-23-83

SECTION G-G

$Q_{100YR} = 9.7$ cfs

$n = 0.035$

$S = 5.7\%$



$$Q = \frac{1.486}{.035} \times 1.96 \times .487 \times (.057)^{1/2} = 9.7 \text{ cfs}$$

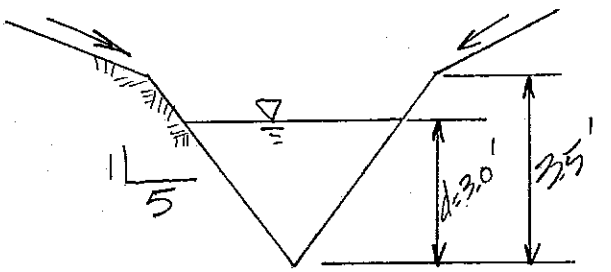
$V = 4.9$ fps

SECTION I-I

$Q_{100YR} = 206.1$ cfs

$n = 0.035$

$S = 0.70\%$



$$Q = \frac{1.486}{.035} \times 45.0 \times 1.29 \times (.007)^{1/2} = 206.2 \text{ cfs}$$

$V = 4.6$ fps

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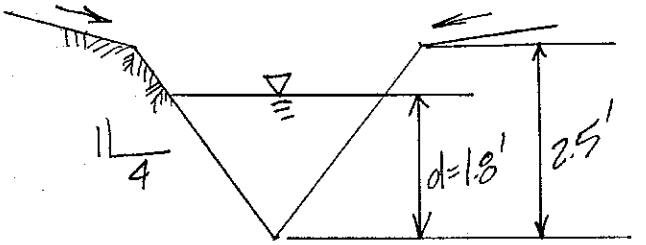
PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET 22 OF ____
CALCULATED BY WM DATE 11-28-85
CHECKED BY ____ DATE ____

SECTION H-H

$Q_{100\,YR} = 63.8$ cfs



$n = 0.035$

$S = 1.61\%$

$$Q = \frac{1.486}{.035} \times 12.96 \times .914 \times (.0161)^{1/2} = 63.8 \text{ cfs}$$

$V = 4.9$ fps

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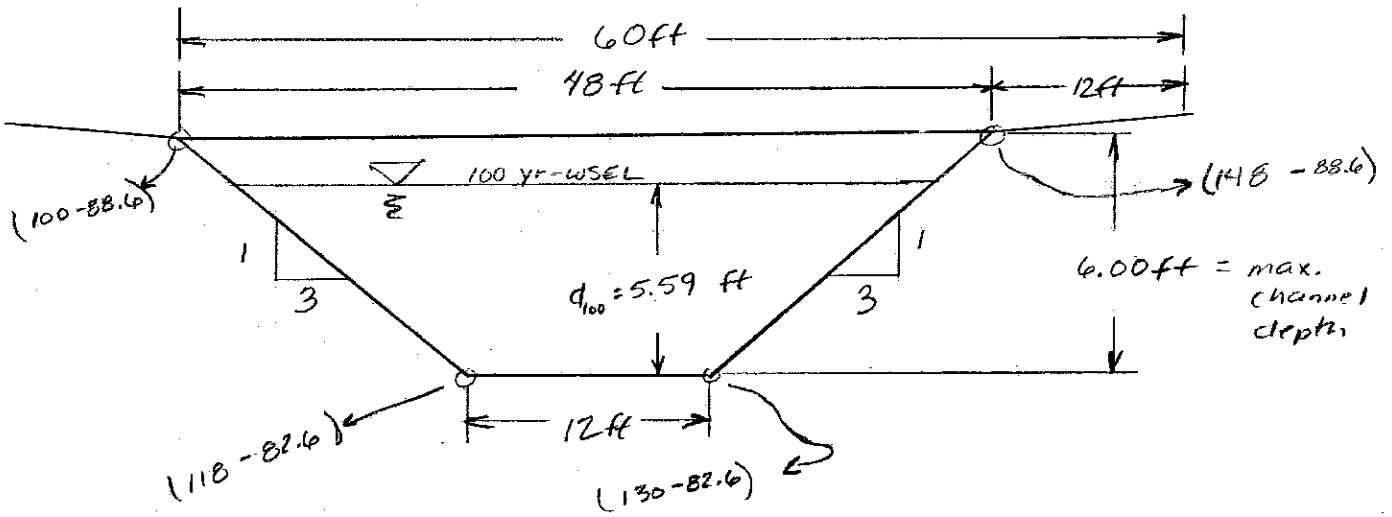
PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET 23 OF
CALCULATED BY CMB DATE 11/7/83
CHECKED BY WM DATE 12-7-83

Design Selection: "Upper V/3"

Typical X-sec



Rip Rap D_{50} = 2.5 ft

S_o = 3.5% d_{max} = 6.00 ft ⇒ Q = 2622 cfs

$(d_{max})_{\text{for riprap}}$ = 5.72 ft ⇒ Q = 2369 cfs

d_{100} = 5.59 ft ⇒ Q = 2250 cfs

$$F_r^2 = \frac{Q^2 T w}{g A^2} \qquad 1 = \frac{(2250)^2 (12 + 6Y)}{(32.2)\left[Y(12 + 3Y)\right]^3}$$

Y_c = 6.64 ft

For HEC-2 WSEL = 6600 + 82.6 + 6.64 = 6689.24

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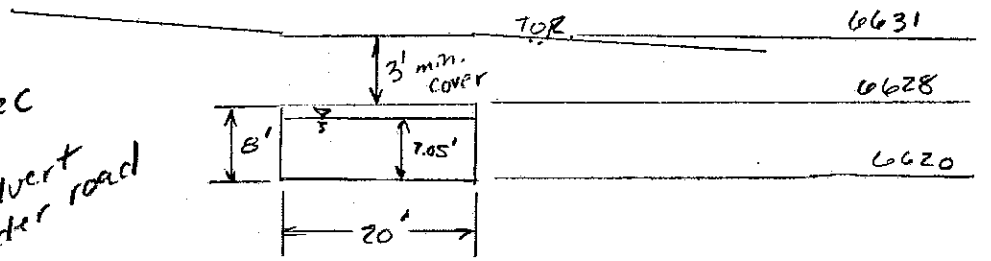
PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET 24 OF
CALCULATED BY CMB DATE 11/7/83
CHECKED BY WM DATE 12-7-83

X-sec at culvert under road



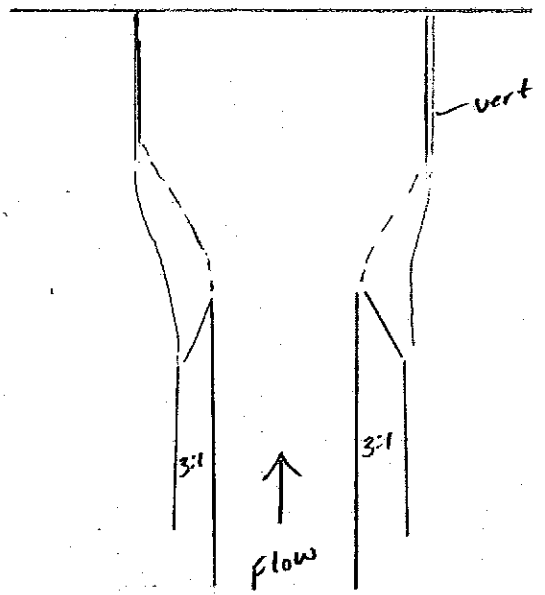
Increase side slopes to vertical:

$d_{100} = 7.05 < 8'$ ok $\Rightarrow Q = 2250$ cfs

$$F_R^2 = \frac{(2250)^2 (20)}{(32.2)(20 \times 7.05)^3} = 1.12 \therefore \text{super critical}$$

and no jump will be produced

Plan



$$S_o = \frac{(82' - 20')}{1755'} = 0.0353 \Rightarrow \text{use } 3.5\%$$

From HEC No. 15 Reprint March 1977

Chart 27 - "Design of Stable Channels with Flexible Linings"

From chart, determine whether 2.00ft riprap can be used:

$S_0 = 6.035$ For $D_{50} = 2.00$ ft $d_{max} = 4.7$ ft

Area = 122.7 ft²
R = 2.94 ft

$$Q = \frac{1.49}{.045}(122.7)(2.94)^{2/3}(.035)^{1/2}$$

$Q = 1560$ cfs < 1750 cfs ∴ no good

What size riprap will be needed, based on normal depth for 1750 cfs:

$Q = 1750$ cfs $\Rightarrow y_o = 4.96$ ft

$$D_{50} = \frac{S_o \gamma d_{max}}{S} = \frac{(.035)(62.4)(4.96)}{5}$$

$D_{50} = 2.17$ ft $\approx$ 2.2 ft

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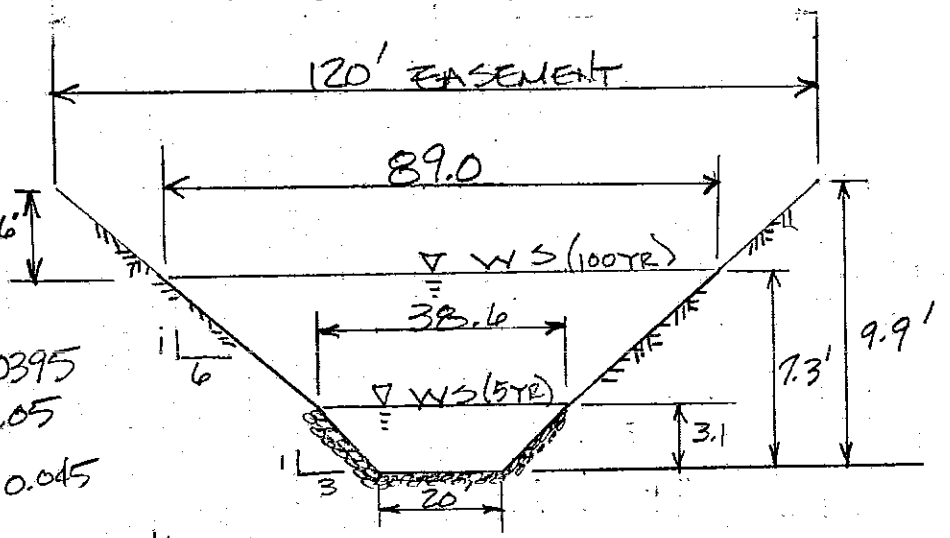
- ☐ KEMMERER, WYOMING

PROJECT FALCON RIDGE
JOB NUMBER 5109947 SHEET 26 OF ____
CALCULATED BY W.McCombie DATE 11-14-83
CHECKED BY ____ DATE ____

LOWER CHANNEL

TRICKLE CHANNEL Q_{DESIGN} = 460.6 cfs (5 YR ±)
ENTIRE CHANNEL Q_{DESIGN} = 2250 cfs (100 YR)



S = 0.6 %

$n_{(RIPRAP)}$ = 0.0395
$n_{(GRASS)}$ = 0.05
$n_{(COMPOSITE)}$ = 0.045

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

AT D = 3.1'

$$A = (20 \times 3.1) + (3.1 \times 3)3.1 = 90.8 \qquad WP = 20 + 2 \times 9.8 = 39.6$$

$$Q = \frac{1.486}{.0395} \times 90.8 \times \left(\frac{90.8}{39.6}\right)^{2/3} \times (.006)^{1/2} = 460.6 \text{ cfs} \qquad V = 5.1 \text{ fps}$$

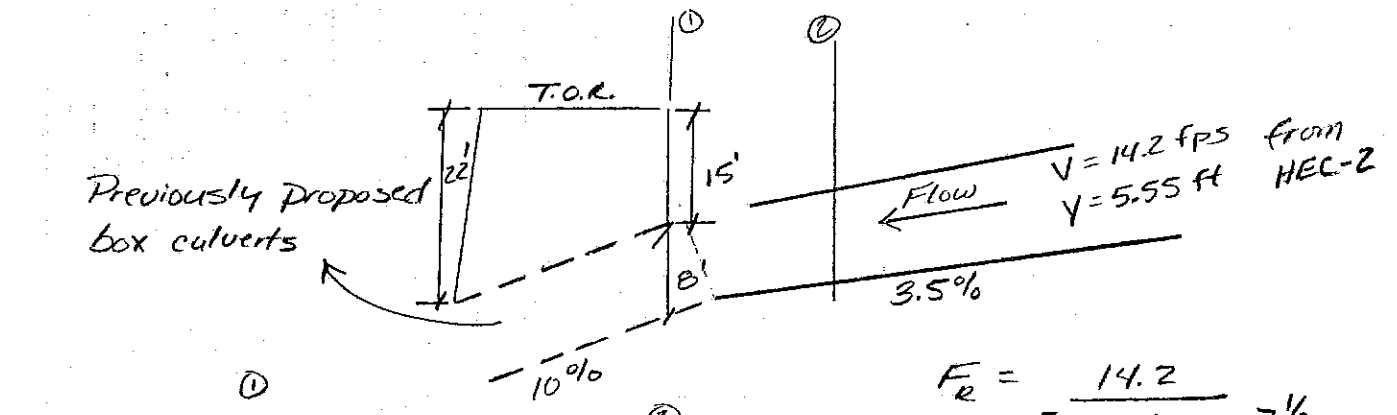
AT D = 7.3'

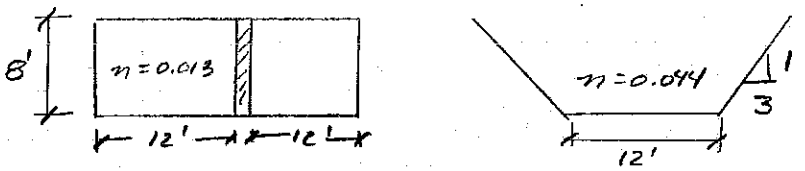
$$A = 90.8 + (38.6 \times 4.2) + (4.2 \times 0 \times 4.2) = 358.8$$

$$WP = 39.6 + 2(25.55) = 90.7$$

$$Q = \frac{1.486}{.045} \times 358.8 \times \left(\frac{358.8}{90.7}\right)^{2/3} \times (.006)^{1/2} = 2296.6 \text{ cfs}$$

$$V = 6.4 \text{ fps}$$





$$F_R = \frac{14.2}{[(32.2)(5.55)]^{1/2}}$$

$F_R = 1.06 > 1.00$

∴ the flow is supercritical, but due to the close proximity of the Froude No. to 1, the flow conditions are close to the transitional stage from supercritical to subcritical.

Certain factors that might cause the flow to jump to subcritical are: transitional losses from raising the channel sides from 3:1 to vertical; a pier loss at the face of the culvert; losses due to debris blockage (highly likely with 2250 cfs).

We feel the flow will jump to the conjugate depth: Y_2

$$\frac{Y_2}{Y_1} = \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right)$$

$$Y_2 = \frac{5.55}{2}\left(\sqrt{1+8(1.06)^2} - 1\right)$$

$Y_2 = 6.00$ ft (weak jump)

This flow depth is not greater than the top of the twin 8'x12' box culverts:

$$6.00' < 8'$$

However, the flow control has been changed to the inlet of the box culverts. To carry the 2250 cfs a headwater of ≈11ft would be required, which exceeds the 8' height of the culverts, AND WOULD BE OUTSIDE OF THE EASEMENT.

The option to design for larger culverts was not considered as favorable as constructing a bridge over the channel due to both economic factors as well as the uncertain hydraulic characteristics of supercritical flow.

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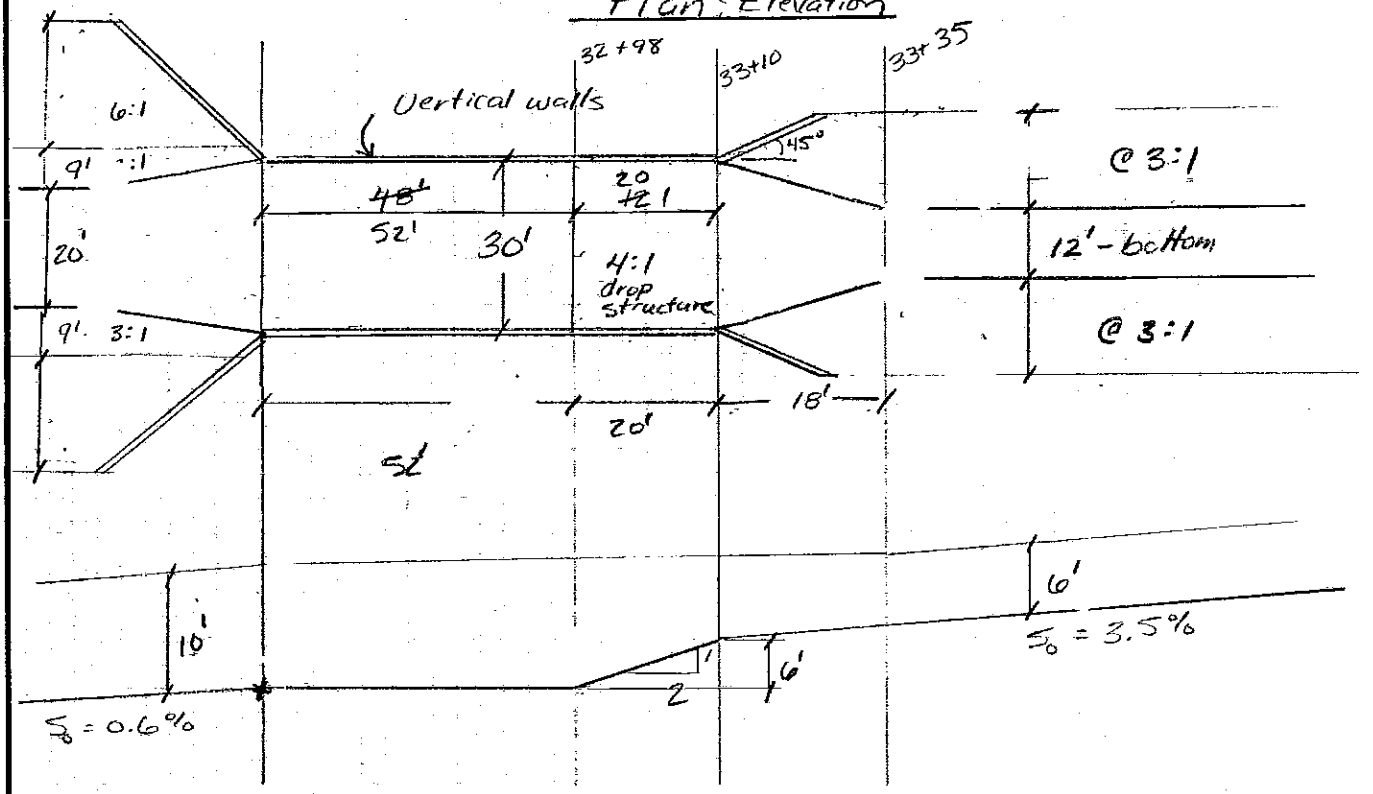
PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET 29 OF
CALCULATED BY CMB DATE 11/16/83
CHECKED BY WM DATE 12-7-83

Design of Concrete : (to replace Culvert #3)

Drop Structure

Plan & Elevation



Maintain constant depth at control sec 83+10 :

$$y_c = \sqrt[3]{q^2/g}$$

$$6 = \sqrt[3]{q^2/32.2}$$

$$q = \sqrt{6^3 \times 32.2}$$

$$q = 83.40 \text{ cfs/ft}$$

$$b = \frac{Q}{q} = \frac{2250 \text{ cfs}}{83.4 \text{ cfs/ft}}$$

$b = 26.98$ ft ⇒ Expand base of channel from 12 ft to 30 ft

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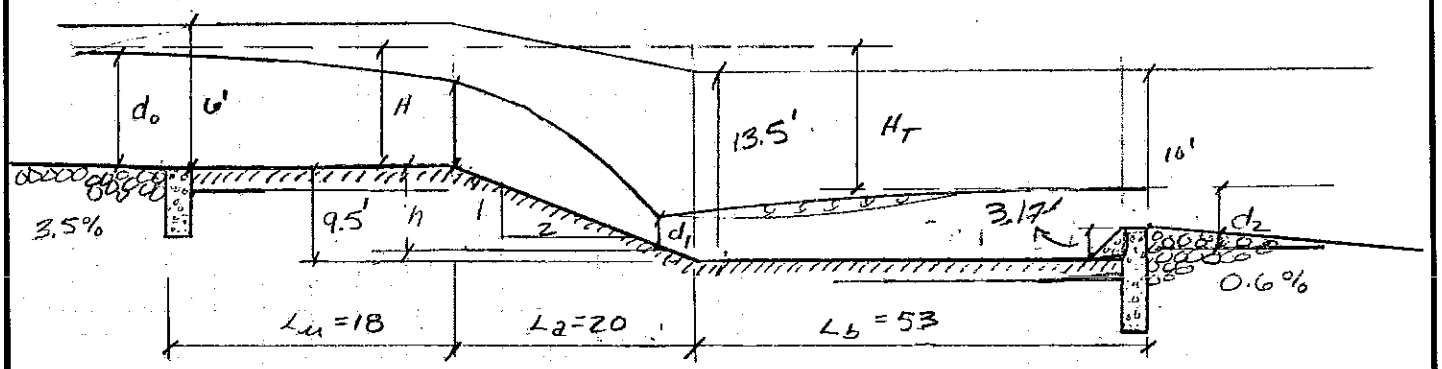
PROJECT Falcon Ridge
JOB NUMBER 5109917 SHEET 30 OF ____
CALCULATED BY CMB DATE 11/17/83
CHECKED BY WM DATE 12-9-83

Design of Hydraulic Jump at bottom of drop structure (loc. of dd culvert #3)



$d_o = 5.55$ ft $T_w = 6.28$ ft
base = 12 ft
3:1 side slopes

Assume no energy loss through transition.

$$V_o = \frac{2250 \text{ cfs}}{5.55(12 + 3(5.55))} = 14.2 \text{ fps}$$

$$H = d_o + V^2/2g = 5.55 + \frac{(14.2)^2}{(2)(32.2)} = 8.68$$

Head available at toe of sloped drop is:

$$H_T = 8.68 \text{ ft} + 6 \text{ ft} = 14.68$$

Let d_1 be the depth at the toe of the slope, solving $H_T = d_1 + V_1^2/2g$ by trial and error.

$$14.23 = d_1 + \frac{\left(\frac{2250}{30 d_1}\right)^2}{64.4}$$

$d_1 = 2.7$ ft
$V_1 = 27.78$ fps

Froude number at toe of sloped drop is:

$$F_r = \frac{V_1}{\sqrt{g d_1}} = \frac{27.78}{\sqrt{(32.2)(2.7)}} = 2.98$$

Determine d_2: (conjugate depth)

$$\frac{d_2}{d_1} = \frac{1}{2}\left(\sqrt{1 + 8F_{r_1}^2} - 1\right)$$

$$d_2 = \frac{2.7}{2}\left(\sqrt{1 + 8(2.98)^2} - 1\right) = 10.11 \text{ ft}$$

Determine jump length. From Fig. 2-4 of "Structures" in the USDCM, Vol. 2:

$$F_r = 2.88 \; ; \; \frac{L_b}{d_2} = 5.21$$

$$L_b = (10.11)(5.21) = 52.7 \text{ ft} \quad \text{Use } 55 \text{ ft}$$

The basin should be set at $9.95 - 6.28 = 3.67$ ft below the downstream channel bed. Use 3.50 ft

$L_2 = (6\text{ ft} + 3.67)\,2 = 19.34$ ft Use 20 ft
$L_u = 2(8.68) = 17.4$ ft use 18 ft

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PROJECT FALCON RIDGE
JOB NUMBER 5169947 SHEET 1 OF
CALCULATED BY W McCombie DATE 11-14-83
CHECKED BY DATE

SLOPED RIP-RAP DROP STRUCTURES (2 FT)

BOTTOM WIDTH = 20'
DEPTH = 7.3'
Q_{100} = 2311 cfs V = 6.5 fps

USE TRAPEZOIDAL LINED DROP OF 2' WITH 4:1 SLOPE AT DROP

$$H = d_0 + \frac{V^2}{2g} = 7.3 + \frac{(6.5)^2}{2g} = 8.0 \text{ feet}$$

$$H_T = 2 + 8 = 10.0 \text{ feet}$$

$$H_T = d_1 + \left(\frac{V_1^2}{2g}\right) \quad \text{by TRIAL \& ERROR} \quad V_1 = 20.2 \quad d_1 = 3.66'$$

$$F_R = \frac{V_1}{\sqrt{g d_1}} = 1.86$$

DETERMINE d_2:

$$\frac{d_2}{d_1} = \frac{1}{2}\left(\sqrt{1 + 8F_R^2} - 1\right) = 1.49$$

$$\therefore d_2 = 1.49 \times 3.66 = 5.45$$

FROM FIGURE 2.4

$F_R = 1.86$; $\frac{L_B}{d_2} = 4.0$

$L_b = 4.0 \times 5.45 = \underline{21.8 \text{ feet}}$

DUE TO A MEDIAN FROUDE NUMBER NO SILL IS REQUIRED

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PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET ___ OF ___
CALCULATED BY CMB DATE 11/17/83
CHECKED BY WH DATE 12-7-83

Sloped Rip-Rap Drop Structures
(4FT)

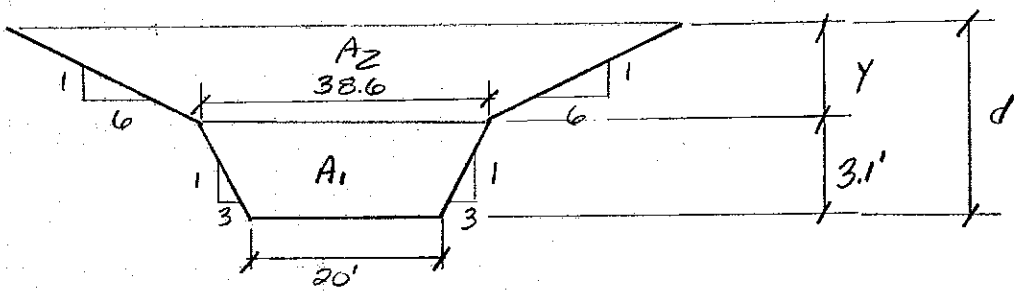
Bottom Width = 20'
Depth = 7.3'
Q = 2311 cfs
V = 6.5 fps

Use trapezoidal lined drop of 4' with 4:1 slope at drop

$$H = d_c + \frac{V^2}{2g} = 7.3 + \frac{(6.5)^2}{64.4} = 8.0 \text{ feet}$$

$$H_T = 4 + 8 = 12 \text{ feet}$$

$$H_T = d_1 + \frac{V_1^2}{2g}$$ by trial & error



$A_1 = 90.8 \text{ ft}^2$
$P = 39.6 \text{ ft}$

$$V^2 = \frac{Q^2}{A^2} = \frac{2250^2}{[90.8 + Y(38.6 + 6Y)]^2}$$

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PROJECT Falcon Ridge
JOB NUMBER 5109947 SHEET ___ OF ___
CALCULATED BY cmB DATE 11/18/83
CHECKED BY WL DATE 12-7-83

$$H_T = d_1 + \frac{2250^2}{\left\{90.8 + (d-3.1)\left[38.6+6(d-3.1)\right]\right\}^2} \Big/ 64.4$$

RCL 1

d	Y	Vel.	H_T
3.2	0.1	23.75	11.96
3.3	0.2	22.78	11.34
3.15	0.05	24.26	12.29
3.17	0.07	24.06	12.16
3.18	0.08	23.95	12.09
3.19	0.09	23.85	12.03

$V_1 = 23.85$ fps
$d_1 = 3.19$ ft

$$F_R = \frac{V_1}{\sqrt{g d_1}} = \frac{23.85}{\sqrt{(32.2)(3.19)}} = 2.35$$

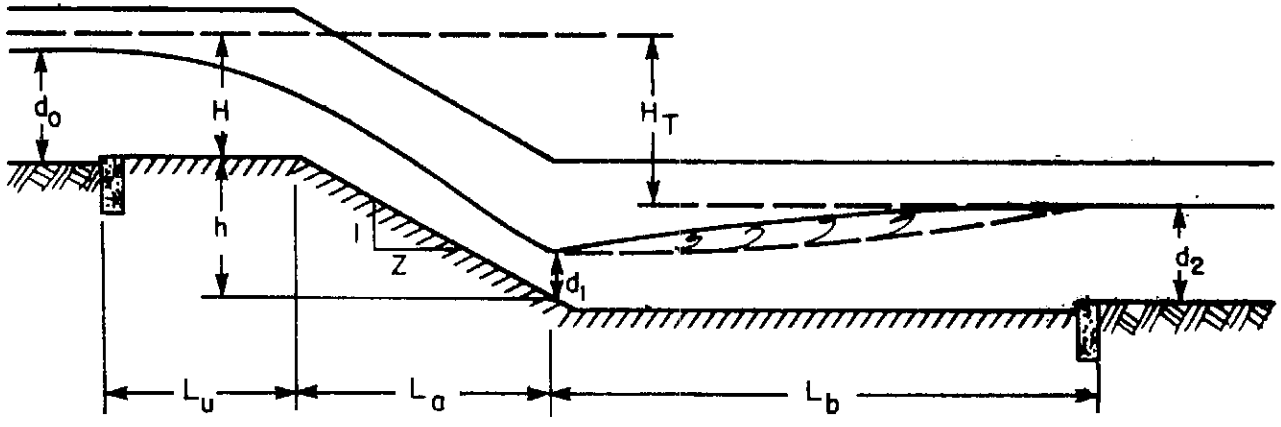
Determine d_2:

$$d_2 = \frac{3.19}{2}\left(\sqrt{1+8(2.35)^2} - 1\right) = 9.14 \text{ ft}$$

From Fig. 2.4:

$F_R = 2.35$ $\quad \frac{L_B}{d_2} = 4.7$

$L_B = (9.14)(4.7) = 42.96$ ft Use 43 ft



Definition sketch for a sloped drop structure.

MSM/SP Group	CULVERT DESIGN	Made By CMB	Date 11/16/83	Job No. 5109-47
		Checked By WM	Date 11-17-83	Sheet No.

For: Falcon Ridge Channel Design

HYDROLOGIC AND CHANNEL INFORMATION

DRAINAGE AREA _____

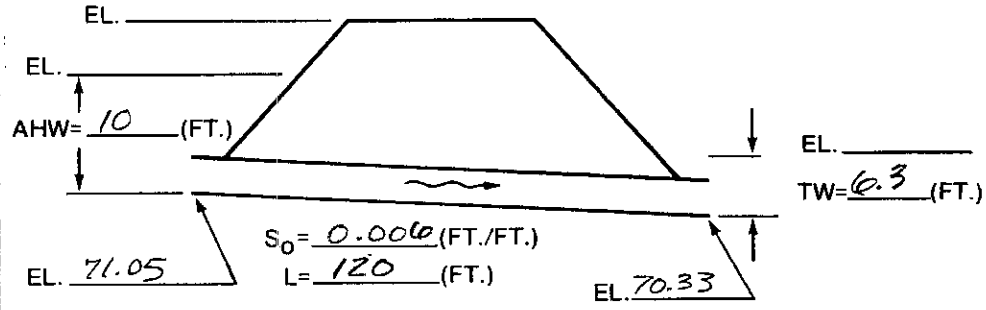
METHOD OF DISCHARGE DETERMINATION _____

Q_D = 2250 cfs

(DESIGN) Q_1 = _____(cfs) TW_1 = _____(FT.)

(CHECK) Q_2 = _____(cfs) TW_2 = _____(FT.)

STATION Culvert #2

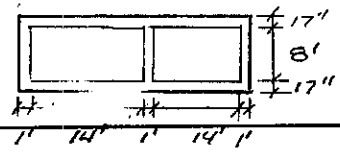


CULVERT DESIGN DATA				HEADWATER COMPUTATION												
				INLET CONT.		OUTLET CONTROL $HW=H+h_o-LS_o$								CONTROLLING HW	OUTLET VELOCITY	
NUMBER AND SIZE OPENINGS	Q PER BARREL	RATIO OF DISCHARGE TO WIDTH (Q/B)	ENTRANCE CONDITION	$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW			COMMENTS
① 2-8'x10'	1125	112.5	30°-75°	1.68	13.4											Inlet Control
② 2-10'x10'	1125	112.5	"	1.19	11.9											"
③ 2-8'x12'	1125	93.75	"	1.37	10.96											"
④ 2-8'x14'	1125	80.4	"	1.18	9.44	0.5	2.8	5.9	6.95	6.3	6.95	.72	9.03	9.44		"

SUMMARY & RECOMMENDATIONS: ④

$\frac{Q}{B} = \frac{2250 cfs}{2 \times 14 ft} = 80.4$

④



MSM/SP Group	CULVERT DESIGN	Made By WM	Date 12/7/83	Job No. 5109967
		Checked By	Date	Sheet No.

For:

HYDROLOGIC AND CHANNEL INFORMATION

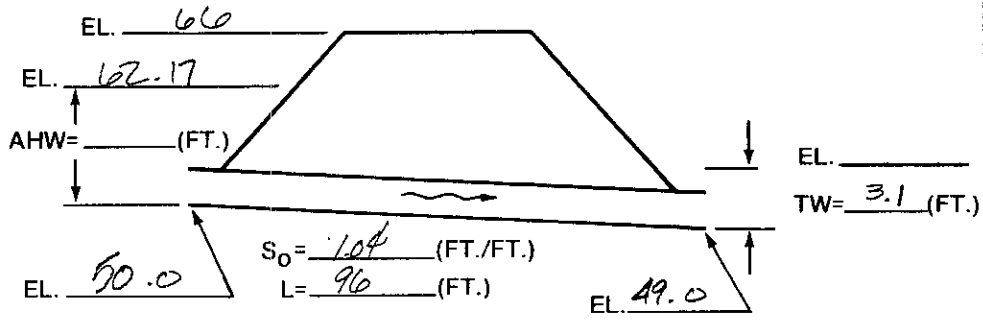
DRAINAGE AREA _____

METHOD OF DISCHARGE DETERMINATION _____

(DESIGN) Q_1 = 236 (cfs) TW_1 = _____ (FT.)

(CHECK) Q_2 = _____ (cfs) TW_2 = _____ (FT.)

STATION _____



CULVERT DESIGN DATA				HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COMMENTS
				INLET CONT.		OUTLET CONTROL $HW=H+h_o-LS_o$										
NUMBER AND SIZE OPENINGS	Q PER BARREL	RATIO OF DISCHARGE TO WIDTH (Q/B)	ENTRANCE CONDITION	$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW			
1-5'x3'	236	78.7	30°-75°	2.44	12.2	.5	7.3	5.8	5.4	3.1	5.4	1.0	11.7	12.2		INLET CONTROL

SUMMARY & RECOMMENDATIONS:

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PROJECT FALCON RIDGE
JOB NUMBER 5B9947 SHEET ____ OF ____
CALCULATED BY WM DATE 11-28-83
CHECKED BY ____ DATE ____

DETENTION POND VOLUME

ELEVATION	Δh	AREA (ACRES)	VOLUME (Ac-ft)	Σ Vol (Ac-ft)
50	0	0	0	0
52	2	.01	.03	.03
54	2	.41	.42	.45
56	2	.98	1.39	1.84
58	2	1.46	2.44	4.28
60	2	1.62	3.08	7.36
62	2	1.85	3.47	10.83
63.6	1.6	1.99	3.84	14.67

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PROJECT FALCON RIDGE - DETENTION POND
JOB NUMBER 5109947 SHEET ____ OF ____
CALCULATED BY W McCAMBLE DATE ____
CHECKED BY ____ DATE ____

OVERFLOW SPILLWAY

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

AT 2' DEEP for 2200 cfs

$L = 260'$ (1880 cfs $L = 260'$ $H = 1.8'$)

AT 1.5 DEEP

FOR 2200 cfs $L = 400'$ (1880 cfs $L = 400'$ $H = 1.35$)

AT 2.5' DEEP for 2200 cfs

$L = 185'$ (1880 cfs $L = 185'$ $H = 2.3'$)

AT 3' DEEP for 2200 cfs

$L = 141'$ (1880 cfs $L = 141'$ $H = 2.7'$)

PASS= 1

EXECUTIVE CONTROL CARD OPERATION INCREM, MAIN TIME INCREMENT= 0.08
EXECUTIVE CONTROL CARD OPERATION COMPUT, FROM XSECTN/STRUCT 1/ 0 TO XSECTN/STRUCT 2/ 0
STARTING TIME= 0.00 RAIN DEPTH= 4.50 RAIN DURATION= 1.00 RAIN TABLE NO.= 1 SOIL CONDITION= 2
ALTERNATE NO.= 1 STORM NO.= 1

FALCON RIDGE TR 20 11-9-83
DEVELOPED SITE / HISTORIC OFFSITE

SUBROUTINE RUNOFF CROSS SECTION 1
AREA= 0.50 INPUT RUNOFF CURVE= 70.0 TIME OF CONCENTRATION= 0.41

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
6.19	627.756	(RUNOFF)
9.93	18.909	(RUNOFF)
11.58	26.561	(RUNOFF)
12.56	18.069	(RUNOFF)
16.09	13.902	(RUNOFF)
16.78	11.602	(RUNOFF)
18.24	12.798	(RUNOFF)
18.86	10.725	(RUNOFF)
19.37	10.652	(RUNOFF)
19.87	10.677	(RUNOFF)

HYDROGRAPH, TZERO= 0.00 DELTA T= 0.08 DRAINAGE AREA= 0.50

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.83	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.66	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.49	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.32	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.15	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.98	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.81	DISCHG	5.84	50.19	196.36	435.52	608.73	615.39	497.92	350.32	246.43	185.83
6.64	DISCHG	144.47	114.32	92.52	77.56	68.37	62.26	56.89	51.06	45.56	41.80
7.47	DISCHG	39.61	38.33	37.55	37.10	36.85	36.76	36.70	36.28	34.63	31.34
8.30	DISCHG	27.44	24.18	21.99	20.68	19.87	19.37	19.09	18.92	18.82	18.77
9.13	DISCHG	18.74	18.73	18.74	18.75	18.78	18.80	18.82	18.84	18.86	18.88
9.96	DISCHG	18.90	18.79	18.18	16.83	15.17	13.48	11.86	10.46	9.42	8.72
10.79	DISCHG	8.37	8.41	8.90	9.89	11.84	14.89	18.43	21.77	24.60	26.36
11.62	DISCHG	26.31	24.12	20.65	17.12	14.16	12.20	11.55	12.43	14.24	16.07
12.45	DISCHG	17.37	18.02	17.93	16.96	15.45	13.80	12.21	10.83	9.74	9.00
13.28	DISCHG	8.58	8.59	9.06	9.72	10.13	10.00	9.51	9.23	9.44	10.01
14.11	DISCHG	10.62	11.08	11.35	11.52	11.63	11.70	11.75	11.78	11.80	11.81
14.94	DISCHG	11.83	11.84	11.84	11.85	11.86	11.86	11.87	11.88	11.88	11.89
15.77	DISCHG	11.93	12.18	12.80	13.58	13.89	13.25	11.99	10.88	10.46	10.66
16.60	DISCHG	11.08	11.43	11.60	11.50	11.00	10.25	9.73	9.75	10.20	10.57
17.43	DISCHG	10.48	9.89	9.05	7.98	6.94	6.58	7.57	9.63	11.55	12.62
18.26	DISCHG	12.79	12.41	11.61	10.69	10.02	9.93	10.33	10.71	10.60	10.08
19.09	DISCHG	9.65	9.69	10.19	10.62	10.56	10.07	9.64	9.68	10.19	10.64
19.92	DISCHG	10.59	10.04	9.21	8.17	7.04	6.04	5.29	4.84	4.73	5.07
20.75	DISCHG	5.80	6.56	7.16	7.54	7.77	7.92	8.01	8.06	8.10	8.12
21.58	DISCHG	7.98	7.47	6.64	5.80	5.14	4.73	4.48	4.33	4.24	4.18
22.41	DISCHG	4.14	4.12	4.11	4.10	4.09	4.09	4.09	4.09	4.09	4.09
23.24	DISCHG	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.07
24.07	DISCHG	3.82	3.20	2.32	1.50	0.91	0.57	0.35	0.21	0.13	0.08

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 1.6643 CFS-HRS= 537.04 ACRE-FT= 44.38

HYDROGRAPH 1 PUNCHED OUTPUT REQUESTED AT THIS POINT

HISTORIC SITE / HISTORIC OFFSITE

SUBROUTINE RUNOFF CROSS SECTION 2
AREA= 0.49 INPUT RUNOFF CURVE= 65.0 TIME OF CONCENTRATION= 0.56

PEAK TIMES	PEAK DISCHARGES	PEAK ELEVATIONS
6.30	348.002	(RUNOFF)
9.94	15.958	(RUNOFF)
11.65	20.586	(RUNOFF)
12.64	14.807	(RUNOFF)
16.14	11.335	(RUNOFF)
16.83	9.855	(RUNOFF)
18.35	10.333	(RUNOFF)
18.90	9.060	(RUNOFF)
19.43	8.937	(RUNOFF)
19.93	8.925	(RUNOFF)

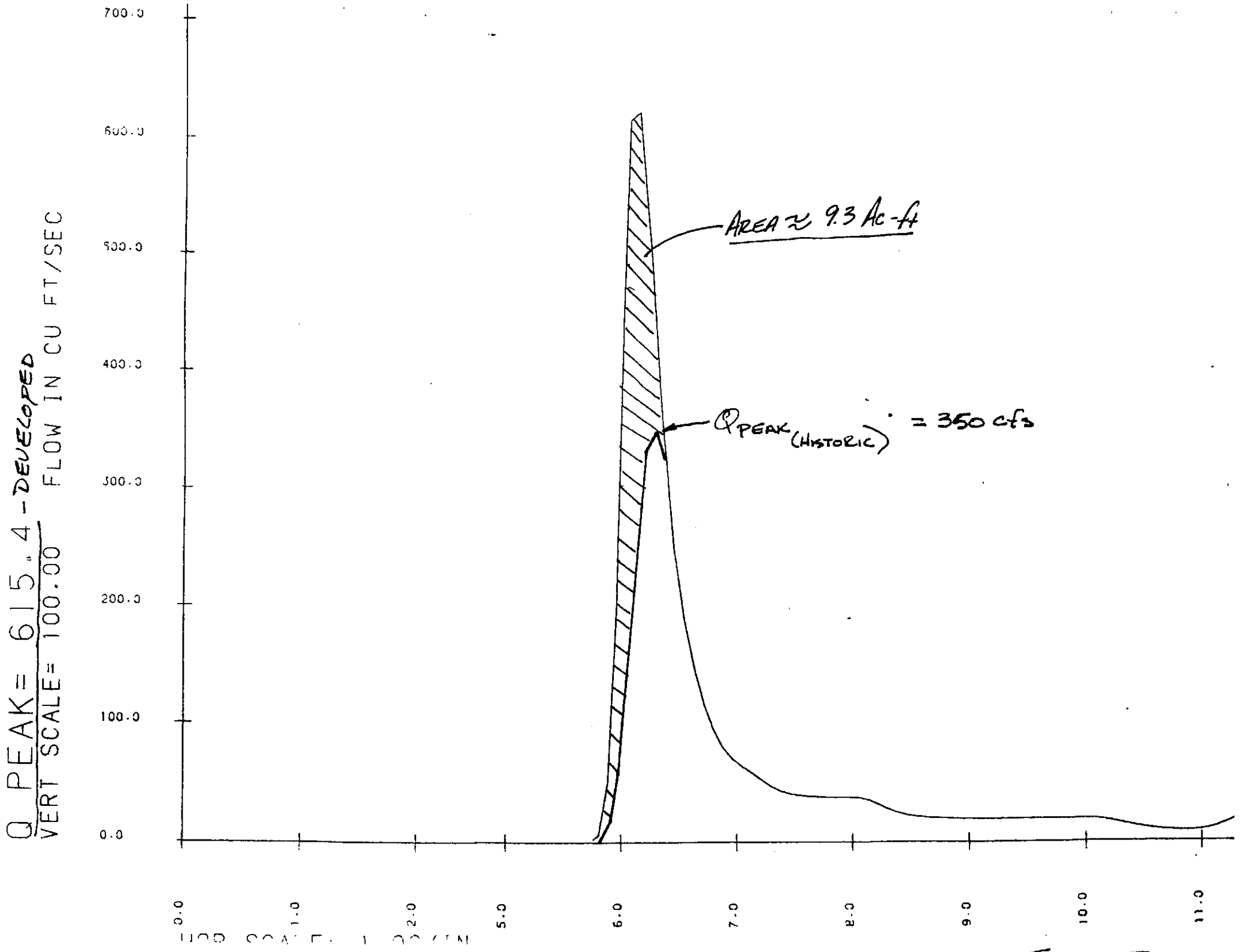
HYDROGRAPH, TZERO= 0.00 DELTA T= 0.08 DRAINAGE AREA= 0.49

TIME											
0.00	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.83	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.66	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.49	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.32	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.15	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.98	DISCHG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.81	DISCHG	2.99	19.68	66.37	153.86	262.29	331.60	347.65	320.59	268.52	210.35
6.64	DISCHG	164.09	133.93	110.67	92.41	78.42	67.93	60.05	53.77	48.24	43.60
7.47	DISCHG	39.90	37.07	34.94	33.34	32.16	31.53	31.28	30.89	30.02	28.45
8.30	DISCHG	26.28	23.86	21.61	19.82	18.58	17.71	17.11	16.68	16.39	16.19
9.13	DISCHG	16.07	15.99	15.94	15.90	15.89	15.89	15.89	15.90	15.91	15.94
9.96	DISCHG	15.96	15.90	15.65	15.09	14.16	12.99	11.75	10.55	9.51	8.67
10.79	DISCHG	8.06	7.71	7.68	8.09	9.04	10.60	12.69	15.07	17.43	19.48
11.62	DISCHG	20.51	20.35	19.15	17.25	15.10	13.09	11.67	11.29	11.70	12.53
12.45	DISCHG	13.50	14.32	14.77	14.70	14.03	13.05	11.93	10.79	9.75	8.91
13.28	DISCHG	8.27	7.91	7.89	8.08	8.30	8.40	8.34	8.20	8.13	8.31
14.11	DISCHG	8.62	8.97	9.29	9.54	9.71	9.83	9.91	9.97	10.02	10.06
14.94	DISCHG	10.08	10.10	10.12	10.13	10.15	10.16	10.17	10.18	10.18	10.19
15.77	DISCHG	10.22	10.35	10.63	11.01	11.29	11.29	10.91	10.29	9.75	9.50
16.60	DISCHG	9.49	9.64	9.80	9.85	9.70	9.34	8.97	8.76	8.74	8.83
17.43	DISCHG	8.88	8.75	8.38	7.74	7.05	6.60	6.67	7.30	8.34	9.41
18.26	DISCHG	10.10	10.33	10.17	9.76	9.30	8.99	8.93	9.02	9.05	8.93
19.09	DISCHG	8.73	8.61	8.65	8.81	8.94	8.85	8.68	8.58	8.63	8.79
19.92	DISCHG	8.92	8.86	8.50	7.91	7.15	6.35	5.62	5.02	4.63	4.57
20.75	DISCHG	4.79	5.17	5.60	6.00	6.32	6.54	6.69	6.80	6.87	6.91
21.58	DISCHG	6.85	6.66	6.28	5.77	5.23	4.77	4.40	4.14	3.96	3.84
22.41	DISCHG	3.75	3.69	3.64	3.61	3.59	3.58	3.57	3.56	3.55	3.55
23.24	DISCHG	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.51
24.07	DISCHG	3.37	3.06	2.56	1.98	1.46	1.03	0.71	0.50	0.35	0.24

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 1.3255 CFS-HRS= 419.17 ACRE-FT= 34.64

HYDROGRAPH 2 PUNCHED OUTPUT REQUESTED AT THIS POINT

ENDCMP


Q PEAK= 615.4 - DEVELOPED
VERT SCALE= 100.00 FLOW IN CU FT/SEC
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
AREA ≈ 9.3 Ac-ft
Q PEAK (HISTORIC) = 350 cfs
0.0
1.0
2.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0

FALCON RIDGE
DETENTION POND
ROUTING INPUT
(USING 5'x3' box)

HYDRO-3 ROLTING INPUT

ELEVATION	STORAGE(AC.-FT.)	DISCHARGE(CFS)
50.000	0.000	0.000
52.000	0.030	34.100
54.000	0.420	114.200
56.000	1.840	153.200
58.000	4.280	184.100
60.000	7.360	210.600
62.000	10.830	234.000
63.600	14.670	251.200

FALCON RIDGE

RESERVOIR ROUTING LOWER POND

TIME IN HOURS	AVERAGE INFLOW PERIOD	OUTFLOW END OF PERIOD	ELEVATION END OF PERIOD	VOLUME END OF PERIOD
0.166	6.	9.23	50.54	0.01
0.249	50.	54.82	52.52	0.13
0.332	195.	126.07	54.61	0.85
0.415	432.	165.74	56.81	2.83
0.498	604.	196.77	58.96	5.75
0.581	610.	218.54	60.68	8.54
0.664	494.	231.09	61.75	10.40
0.747	347.	235.60	62.15	11.19
0.830	244.	235.87	62.17	11.25
0.913	184.	234.29	62.03	10.90
0.996	143.	230.29	61.68	10.28
1.079	113.	224.96	61.23	9.49
1.162	92.	218.89	60.71	8.59
1.245	77.	212.42	60.16	7.63
1.328	69.	204.55	59.54	6.66
1.411	62.	196.30	58.92	5.70
1.494	56.	188.21	58.31	4.76
1.577	51.	178.53	57.64	3.84
1.660	45.	167.34	56.92	2.96
1.743	41.	156.77	56.23	2.12
1.826	39.	140.21	55.33	1.37
1.909	38.	122.48	54.42	0.72
1.992	37.	83.03	53.22	0.27
2.075	37.	44.62	52.26	0.08
2.158	37.	37.91	52.10	0.05
2.241	36.	36.70	52.06	0.04
2.324	36.	36.45	52.06	0.04
2.407	36.	36.06	52.05	0.04
2.490	34.	34.63	52.01	0.03
2.573	31.	29.46	51.73	0.03

PEAK DISCHARGE = 236 cfs

PEAK VOLUME 11.25 Ac-ft

PEAK OUTFLOW= 235.87 CFS
TIME TO PEAK= 0.830 HOURS
MAXIMUM WSEL= 62.17
MAXIMUM VOLUME= 11.25 AC.-FT.

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*********************************************************
*  WATER SURFACE PROFILES                               *
*  VERSION OF NOVEMBER 1976                             *
*  UPDATED MARCH 1982                                   *
*                                                       *
*  RUN DATE   8-DEC-83 TIME   15:08:02                  *
*********************************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616              *
*  (916) 440-2105 (FTS) 448-2105        *
*****************************************
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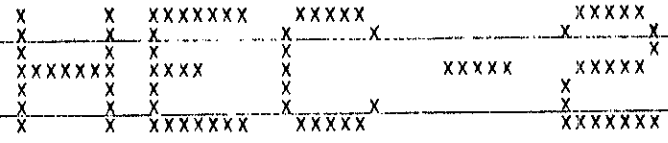

FALCON RIDGE CHANNEL

12-8-83

SUPER CRITICAL (UPPER 1/3)

THIS RUN EXECUTED 8-DEC-83 15:08:02

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**************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED MARCH 1982
   ERROR CORR -  01,02,03,04,05
   MODIFICATION -  50,51,52,53,54,55
**************************************************
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INPUT SUPERCRITICAL

```
C
T1      FALCON RIDGE CHANNEL, COLORADO SPRINGS
T2      M.S.M./SP GROUP, INC. 570 W. 44TH AVENUE, DENVER, CO.
T3      JOB NO. 51099-47 NOV 4, 1983 C. BRAND
J1  ICHECK     INQ     NINV     IDIR     STRT    METRIC    HVINS        Q      WSEL      FQ
        0.      2.       0.       1. -1.000000      0.00      0.0       0.  6589.240   0.000
J2  NPROF     IPLOT     PRFVS    XSECV    XSECH     FN      ALLDC     IBW      CHNIM    ITRACE
     1.000     0.000    -1.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
J3  VARIABLE CODES FOR SUMMARY PRINTOUT
    38.000    43.000    1.000    3.000   42.000    8.000   26.000   53.000   54.000    0.000
J6  IHLEQ     ICOPY
     1.000     0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000

NC    0.044     0.044     0.044     0.100     0.300     0.000     0.000     0.000     0.000     0.000
QT    2.000  2250.000  1750.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
      SUPERCRITICAL FLOW-UPSTREAM CONTROL
X1   50.500     5.000   190.000   275.000    50.000    50.000    50.000     0.000  6500.000     0.000
GR   87.000     0.000    86.000    90.000    84.000   190.000    84.000   275.000    87.000   290.000

X1   50.000     7.000   145.000   230.000    50.000    50.000    50.000     0.000  6500.000     0.000
GR   84.000     0.000    82.000    85.000    80.000   145.000    80.000   230.000    82.000   240.000
GR   84.000   252.000    86.000   265.000     0.000     0.000     0.000     0.000     0.000     0.000

X1   49.500    12.000   170.000   225.000    50.000    50.000    50.000     0.000  6500.000     0.000
GR   84.000     0.000    82.000    40.000    80.000    78.000    78.000   108.000    76.000   140.000
GR   74.000   170.000    74.000   225.000    76.000   240.000    78.000   245.000    80.000   257.000
GR   82.000   265.000    84.000   275.000     0.000     0.000     0.000     0.000     0.000     0.000

X1   49.000    13.000   113.000   160.000    50.000    50.000    50.000     0.000  6500.000     0.000
GR   80.000     0.000    78.000    22.000    76.000    43.000    74.000    66.000    72.000    86.000
GR   70.000   103.000    68.000   113.000    68.000   160.000    70.000   172.000    72.000   180.000
GR   74.000   190.000    76.000   194.000    78.000   203.000     0.000     0.000     0.000     0.000
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X1	48.500	10.000	80.000	140.000	50.000	50.000	50.000	0.000	6500.000	0.000
GR	78.000	0.000	76.000	20.000	74.000	45.000	72.000	58.000	70.000	70.000
GR	68.000	80.000	62.000	105.000	62.000	117.000	68.000	140.000	70.000	170.000
X1	48.000	4.000	100.000	148.000	100.000	100.000	100.000	0.000	6500.000	0.000
GR	66.250	100.000	60.250	118.000	60.250	130.000	66.250	148.000	0.000	0.000
X1	47.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	46.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	45.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	44.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	43.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	42.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	41.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	40.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	39.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	38.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	37.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	36.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	35.000	0.000	100.000	148.000	100.000	100.000	100.000	0.000	-3.500	0.000
X1	34.000	0.000	100.000	148.000	44.000	44.000	44.000	0.000	-3.500	0.000
X1	33.560	0.000	100.000	148.000	18.000	18.000	18.000	0.000	-1.540	0.000
NC	0.013	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	33.380	4.000	100.000	130.000	20.000	20.000	20.000	0.000	0.000	0.000
GR	6514.500	100.000	6508.500	100.000	6508.500	130.000	6514.500	130.000	0.000	0.000
X1	33.180	4.000	100.000	130.000	52.000	52.000	52.000	0.000	0.000	0.000
GR	6512.200	100.000	6499.000	100.000	6499.000	130.000	6512.200	130.000	0.000	0.000
X1	33.660	0.000	100.000	130.000	1.000	1.000	1.000	0.000	0.000	0.000
EJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

THIS RUN EXECUTED 8-DEC-83 15:08:20

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MARCH 1982
  ERROR CORR -  01,02,03,04,05
  MODIFICATION -  50,51,52,53,54,55
**************************************************
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Summary Supercritical

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

JOB NO. 51099-47 NOV 4,

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	EG	ELMIN	DEPTH	VCH	SSTA	ENDST
*	50.500	2250.00	6586.29	6587.04	6584.00	2.29	7.73	63.98	286.45
*	50.500	1750.00	6585.98	6586.69	6584.00	1.98	7.40	90.93	284.91
	50.000	2250.00	6581.49	6584.59	6580.00	1.49	14.87	100.23	237.46
	50.000	1750.00	6581.27	6584.03	6580.00	1.27	13.94	106.94	236.34
	49.500	2250.00	6576.02	6579.53	6574.00	2.02	16.07	139.70	240.05
	49.500	1750.00	6575.77	6578.75	6574.00	1.77	14.71	143.55	238.22
	49.000	2250.00	6570.28	6574.85	6568.00	2.28	17.92	100.70	173.08
	49.000	1750.00	6569.96	6573.94	6568.00	1.96	16.66	103.22	171.73
	48.500	2250.00	6566.47	6570.88	6562.00	4.47	16.86	86.38	134.13
	48.500	1750.00	6565.96	6569.87	6562.00	3.96	15.85	88.49	132.19
*	48.000	2250.00	6566.57	6568.63	6560.25	6.32	11.51	100.00	148.00
*	48.000	1750.00	6565.89	6567.68	6560.25	5.64	10.72	101.07	146.93
	47.000	2250.00	6562.06	6565.64	6556.75	5.31	15.19	102.08	145.92
	47.000	1750.00	6561.43	6564.63	6556.75	4.68	14.36	103.96	144.04
	46.000	2250.00	6558.95	6561.81	6553.25	5.70	13.58	100.91	147.09
	46.000	1750.00	6558.35	6560.81	6553.25	5.10	12.57	102.70	145.30
	45.000	2250.00	6555.26	6558.45	6549.75	5.51	14.33	101.48	146.52
	45.000	1750.00	6554.62	6557.46	6549.75	4.87	13.51	103.40	144.60
	44.000	2250.00	6551.80	6554.90	6546.25	5.55	14.14	101.34	146.66
	44.000	1750.00	6551.19	6553.88	6546.25	4.94	13.16	103.15	144.85
	43.000	2250.00	6548.30	6551.42	6542.75	5.55	14.19	101.38	146.62
	43.000	1750.00	6547.66	6550.42	6542.75	4.91	13.32	103.26	144.74

SECNO	Q	CWSEL	EG	ELMIN	DEPTH	VCH	SSTA	ENDST
42.000	2250.00	6544.79	6547.93	6539.25	5.54	14.21	101.39	146.61
42.000	1750.00	6544.17	6546.91	6539.25	4.92	13.28	103.23	144.77
41.000	2250.00	6541.29	6544.43	6535.75	5.54	14.20	101.39	146.61
41.000	1750.00	6540.68	6543.42	6535.75	4.93	13.29	103.24	144.76
40.000	2250.00	6537.79	6540.93	6532.25	5.54	14.20	101.39	146.61
40.000	1750.00	6537.18	6539.92	6532.25	4.93	13.30	103.25	144.75
39.000	2250.00	6534.29	6537.43	6528.75	5.54	14.20	101.39	146.61
39.000	1750.00	6533.68	6536.42	6528.75	4.93	13.29	103.24	144.76
38.000	2250.00	6530.79	6533.93	6525.25	5.54	14.20	101.39	146.61
38.000	1750.00	6530.18	6532.92	6525.25	4.93	13.30	103.24	144.76
37.000	2250.00	6527.29	6530.43	6521.75	5.54	14.20	101.39	146.61
37.000	1750.00	6526.68	6529.42	6521.75	4.93	13.30	103.24	144.76
36.000	2250.00	6523.79	6526.93	6518.25	5.54	14.20	101.39	146.61
36.000	1750.00	6523.17	6525.92	6518.25	4.92	13.31	103.25	144.75
35.000	2250.00	6520.29	6523.43	6514.75	5.54	14.20	101.39	146.61
35.000	1750.00	6519.67	6522.41	6514.75	4.92	13.28	103.23	144.77
34.000	2250.00	6516.79	6519.93	6511.25	5.54	14.20	101.39	146.61
34.000	1750.00	6516.18	6518.92	6511.25	4.93	13.29	103.24	144.76
33.560	2250.00	6515.25	6518.39	6509.71	5.54	14.20	101.39	146.61
33.560	1750.00	6514.64	6517.38	6509.71	4.93	13.29	103.24	144.76
33.380	2250.00	6512.52	6517.91	6508.50	4.02	18.62	100.00	130.00
33.380	1750.00	6511.70	6516.86	6508.50	3.20	18.23	100.00	130.00
33.180	2250.00	6501.39	6516.66	6499.00	2.39	31.36	100.00	130.00
33.180	1750.00	6500.90	6515.59	6499.00	1.90	30.76	100.00	130.00
33.660	2250.00	6501.58	6514.69	6499.00	2.53	29.06	100.00	130.00
33.660	1750.00	6501.09	6513.20	6499.00	2.09	27.93	100.00	130.00

```
**********************************************************
*  WATER SURFACE PROFILES                                *
*  VERSION OF NOVEMBER 1976                              *
*  UPDATED MARCH 1982                                    *
*                                                        *
*  RUN DATE   8-DEC-83 TIME   16:07:57                   *
**********************************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616              *
*  (916) 440-2105 (FTS) 448-2105        *
*****************************************
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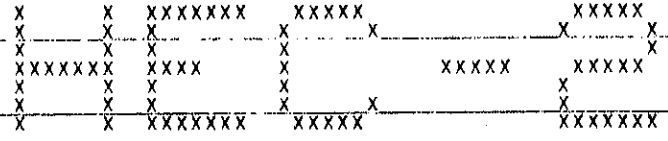

FALCON RIDGE CHANNEL

12-8-83

SUBCRITICAL REACH (LOWER 2/3)

THIS RUN EXECUTED 8-DEC-83 16:08:00

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MARCH 1982
  ERROR CORR -  01,02,03,04,05
  MODIFICATION -  50,51,52,53,54,55
**************************************************
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INPUT - SUBCRITICAL

```
T1      FALCON RIDGE-SUB CRITICAL
T2      MSM/SP GROUP
T3      NOV 1983 J.N. 5109947 W MCCOMBIE
J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
        0.       2.        0.        0.  0.000000      0.00      0.0       0.  6465.990     0.000
J2  NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE
    1.000      0.000    -1.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
J3  VARIABLE CODES FOR SUMMARY PRINTOUT
   38.000     43.000     1.000     3.000    42.000     8.000    26.000    53.000    54.000     0.000

QT      2.000  2250.000  1750.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
NC      0.030     0.040     0.030     0.100     0.300     0.300     0.000     0.000     0.000     0.000
X1      5.200     8.000   183.000   205.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   6466.000   142.000  6454.000   183.000  6452.000   195.000  6450.000   200.000  6450.000   204.000
GR   6457.000   205.000  6462.000   235.000  6466.000   240.000     0.000     0.000     0.000     0.000

X1      8.500    13.000   130.700   189.300   260.000   370.000   350.000     0.000     0.000     0.000
GR   6500.000     0.000  6488.000    10.000  6475.800    60.000  6471.800    80.000  6469.300    90.000
GR   6465.800   100.000  6459.000   130.700  6455.900   150.000  6455.900   170.000  6459.000   189.300
GR   6476.000   260.000  6486.000   300.000  6496.000   340.000     0.000     0.000     0.000     0.000

X1      9.840     6.000    41.200    79.800   130.000   130.000   130.000     0.000     0.000     0.000
GR   6466.700     0.000  6459.800    41.200  6456.700    50.500  6456.700    70.500  6459.800    79.800
GR   6466.700   121.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

X1     10.000     0.000    41.200    79.800    16.000    16.000    16.000     0.000     4.000     0.000

X1     10.840     0.000    41.200    79.800    84.000    84.000    84.000     0.000     0.500     0.000

X1     11.000     0.000    41.200    79.800    16.000    16.000    16.000     0.000     4.000     0.000

X1     11.840     0.000    41.200    79.800    84.000    84.000    84.000     0.000     0.500     0.000

X1     12.000     0.000    41.200    79.800    16.000    16.000    16.000     0.000     4.000     0.000
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NC	0.013	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	13.250	4.000	146.000	174.000	125.000	125.000	125.000	0.000	0.000	0.000
X5	-1.000	3.860	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	6498.600	146.000	6470.500	146.000	6470.500	174.000	6498.600	174.000	0.000	0.000
NC	0.030	0.040	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	13.400	6.000	41.200	79.800	15.000	15.000	15.000	0.000	0.000	0.000
GR	6480.500	0.000	6473.600	41.200	6470.500	50.500	6470.500	70.500	6473.600	79.800
GR	6480.500	121.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	13.560	0.000	41.200	79.800	16.000	16.000	16.000	0.000	0.500	0.000
X1	14.170	0.000	41.200	79.800	61.000	61.000	61.000	0.000	0.400	0.000
X1	14.250	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	14.920	0.000	41.200	79.800	67.000	67.000	67.000	0.000	0.400	0.000
X1	15.000	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	15.920	0.000	41.200	79.800	92.000	92.000	92.000	0.000	0.550	0.000
X1	16.000	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	17.220	0.000	41.200	79.800	122.000	122.000	122.000	0.000	0.700	0.000
X1	17.300	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	18.520	0.000	41.200	79.800	122.000	122.000	122.000	0.000	0.700	0.000
X1	18.600	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	19.200	0.000	41.200	79.800	60.000	60.000	60.000	0.000	0.400	0.000
X1	19.280	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	26.420	0.000	41.200	79.800	714.000	714.000	714.000	0.000	4.300	0.000
X1	26.500	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	29.920	0.000	41.200	79.800	342.000	342.000	342.000	0.000	2.100	0.000
X1	30.000	0.000	41.200	79.800	8.000	8.000	8.000	0.000	0.250	0.000
X1	32.660	4.000	0.000	32.000	266.000	266.000	266.000	0.000	0.000	0.000
GR	6494.200	0.000	6484.200	1.000	6484.200	31.000	6494.200	32.000	0.000	0.000
NC	0.013	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	32.670	4.000	0.000	32.000	1.000	1.000	1.000	0.000	0.000	0.000
GR	6494.200	0.000	6480.700	1.000	6480.700	31.000	6494.200	32.000	0.000	0.000

X1	33.180	0.000	0.000	32.000	51.000	51.000	51.000	0.000	0.000	0.000
X1	33.380	4.000	0.000	32.000	20.000	20.000	20.000	0.000	0.000	0.000
GR	6496.200	0.000	6490.200	1.000	6490.200	31.000	6496.200	32.000	0.000	0.000
X1	33.560	0.000	0.000	32.000	18.000	18.000	18.000	0.000	0.000	0.000
NC	0.030	0.040	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	33.570	4.000	100.000	148.000	1.000	1.000	1.000	0.000	0.000	0.000
GR	6496.200	100.000	6490.200	118.000	6490.200	130.000	6496.200	148.000	0.000	0.000
EJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

THIS RUN EXECUTED 8-DEC-83 16:08:59

HEC2 RELEASE DATED NOV 76 UPDATED MARCH 1982
ERROR CORR - 01,02,03,04,05
MODIFICATION - 50,51,52,53,54,55

SUMMARY - SUBCRITICAL

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

NOV 1983 J.N. 5109947 W

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	EG	ELMIN	DEPTH	VCH	SSTA	ENDST
	5.200	2250.00	6465.99	6466.16	6450.00	15.99	3.91	142.03	239.99
*	5.200	1750.00	6457.84	6460.02	6450.00	7.84	12.29	169.87	210.06
	8.500	2250.00	6466.08	6466.25	6455.90	10.18	3.53	99.21	218.73
*	8.500	1750.00	6459.97	6461.43	6455.90	4.07	9.74	126.33	193.33
	9.840	2250.00	6466.01	6466.35	6456.70	9.31	5.19	4.12	116.88
*	9.840	1750.00	6461.56	6463.26	6456.70	4.86	10.62	30.67	90.33
*	10.000	2250.00	6466.29	6468.14	6460.70	5.59	11.25	26.35	94.65
*	10.000	1750.00	6465.57	6467.26	6460.70	4.87	10.59	30.61	90.39
	10.340	2250.00	6467.04	6468.66	6461.20	5.84	10.58	24.59	96.11
*	10.340	1750.00	6466.07	6467.76	6461.20	4.87	10.61	30.64	90.36
*	11.000	2250.00	6470.81	6472.64	6465.20	5.61	11.19	26.22	94.78
*	11.000	1750.00	6470.06	6471.76	6465.20	4.86	10.62	30.66	90.34
	11.840	2250.00	6471.52	6473.16	6465.70	5.82	10.63	24.99	96.01
*	11.840	1750.00	6470.57	6472.26	6465.70	4.87	10.60	30.63	90.37
*	12.000	2250.00	6475.31	6477.14	6469.70	5.61	11.19	26.22	94.79
*	12.000	1750.00	6474.57	6476.26	6469.70	4.87	10.59	30.61	90.39
*	13.250	2250.00	6479.17	6480.50	6470.50	8.67	9.27	146.00	174.00
*	13.250	1750.00	6475.44	6477.93	6470.50	4.94	12.64	146.00	174.00
	13.400	2250.00	6480.34	6480.62	6470.50	9.84	4.74	0.96	120.04
	13.400	1750.00	6474.60	6477.33	6470.50	4.10	13.33	35.18	85.82
	13.560	2250.00	6480.31	6480.65	6471.00	9.31	5.19	4.15	116.85
*	13.560	1750.00	6475.87	6477.56	6471.00	4.87	10.61	30.64	90.36

	SECNO	Q	CWSEL	EG	ELMIN	DEPTH	VCH	SSTA	ENDST
	14.170	2250.00	6480.31	6480.71	6471.40	8.91	5.57	6.51	114.49
*	14.170	1750.00	6476.27	6477.96	6471.40	4.87	10.60	30.63	90.37
	14.250	2250.00	6480.28	6480.73	6471.65	8.63	5.85	8.16	112.84
*	14.250	1750.00	6476.52	6478.21	6471.65	4.87	10.60	30.64	90.36
	14.920	2250.00	6480.30	6480.82	6472.05	8.25	6.28	10.45	110.55
*	14.920	1750.00	6476.92	6478.61	6472.05	4.87	10.61	30.66	90.34
	15.000	2250.00	6480.26	6480.85	6472.30	7.96	6.64	12.17	108.83
*	15.000	1750.00	6477.17	6478.36	6472.30	4.87	10.60	30.63	90.37
	15.920	2250.00	6480.30	6481.03	6472.85	7.45	7.36	15.23	105.77
*	15.920	1750.00	6477.72	6479.41	6472.85	4.87	10.61	30.64	90.36
	16.000	2250.00	6480.24	6481.08	6473.10	7.14	7.86	17.10	103.90
*	16.000	1750.00	6477.96	6479.66	6473.10	4.87	10.62	30.66	90.34
	17.220	2250.00	6480.37	6481.48	6473.80	6.57	8.89	20.47	100.53
*	17.220	1750.00	6478.67	6480.36	6473.80	4.87	10.60	30.63	90.37
	17.300	2250.00	6480.23	6481.58	6474.05	6.18	9.71	22.77	98.23
*	17.300	1750.00	6478.92	6480.61	6474.05	4.87	10.61	30.64	90.36
	18.520	2250.00	6480.64	6482.21	6474.75	5.89	10.43	24.54	96.46
*	18.520	1750.00	6479.62	6481.31	6474.75	4.87	10.60	30.63	90.37
*	18.600	2250.00	6480.61	6482.44	6475.00	5.61	11.18	26.21	94.79
*	18.600	1750.00	6479.87	6481.56	6475.00	4.87	10.60	30.64	90.36
*	19.200	2250.00	6480.99	6482.84	6475.40	5.59	11.24	26.33	94.67
*	19.200	1750.00	6480.27	6481.96	6475.40	4.87	10.61	30.66	90.34
*	19.280	2250.00	6481.24	6483.09	6475.65	5.59	11.24	26.33	94.67
*	19.280	1750.00	6480.52	6482.21	6475.65	4.87	10.60	30.63	90.37
	26.420	2250.00	6485.74	6487.40	6479.95	5.79	10.69	25.13	95.87
*	26.420	1750.00	6484.82	6486.51	6479.95	4.87	10.61	30.64	90.36
*	26.500	2250.00	6485.81	6487.64	6480.20	5.61	11.19	26.22	94.78
*	26.500	1750.00	6485.06	6486.76	6480.20	4.87	10.62	30.66	90.34
	29.920	2250.00	6488.03	6489.74	6482.30	5.73	10.86	25.51	95.40
*	29.920	1750.00	6487.17	6488.86	6482.30	4.87	10.60	30.63	90.37
*	30.000	2250.00	6488.15	6489.99	6482.55	5.60	11.21	26.25	94.75
*	30.000	1750.00	6487.42	6489.11	6482.55	4.87	10.61	30.64	90.36
*	32.660	2250.00	6489.73	6492.48	6484.20	5.53	13.32	0.45	31.55
*	32.660	1750.00	6488.90	6491.22	6484.20	4.70	12.23	0.53	31.47

	SECNO	Q	CWSEL	EG	ELMIN	DEPTH	VCH	SSTA	ENDST
	32.670	2250.00	6492.05	6492.70	6480.70	11.35	6.43	0.16	31.84
	32.670	1750.00	6483.99	6488.81	6480.70	3.29	17.62	0.76	31.24
	33.180	2250.00	6492.07	6492.71	6480.70	11.37	6.42	0.16	31.84
	33.180	1750.00	6484.00	6488.79	6480.70	3.30	17.56	0.76	31.24
*	33.380	2250.00	6495.72	6498.42	6490.20	5.52	13.18	0.08	31.92
*	33.380	1750.00	6494.88	6497.17	6490.20	4.68	12.15	0.22	31.78
	33.560	2250.00	6496.34	6498.50	6490.20	6.14	11.81	0.00	32.00
*	33.560	1750.00	6494.37	6497.17	6490.20	4.67	12.16	0.22	31.78
*	33.570	2250.00	6496.50	6498.58	6490.20	6.30	11.58	100.00	148.00
*	33.570	1750.00	6495.83	6497.63	6490.20	5.63	10.76	101.11	146.89