

August 6, 1986

To: Technical File  
From: Dave Cline, Reclamation Hydrologist <sup>DJC</sup>  
Re: Exploration Road Stabilization Plan, Wildhorse Ridge  
Exploration Road, Beaver Creek Coal Company, CEP/015/007

Summary: On June 16, 1986 Beaver Creek Coal Company submitted NOV abatement plans for road stabilization for the Wildhorse Ridge Exploration Road. The abatement plans were reviewed in order to determine if the drainage controls submitted by the operator are technically adequate and in compliance with the regulations. After review of the plans it has been found that the plans as submitted are not technically adequate. Beaver Creeek Coal Company should be sent a deficieny letter outlining the areas that are not technically adequate along with the enclosed supporting documentation.

Body: The road stabilization plans submitted by Beaver Creek Coal Company state that the road has been designed and constructed under Class II standards with the exception of certain drainage controls. Basically, the drainage control portion of the plan calls for adding an additional culvert along side the existing 48 inch culvert in the Bear Creek channel, leaving existing 36 inch culverts 5 & 6 in place, and leaving existing 24 inch culverts 9 & 10 in place. All other existing culverts will be removed and replaced with water bars. The plan was reviewed in two stages to determine technical adequacy. The first stage involved determining if the culverts that are proposed to be left in place are adequate to pass the design flow and the second stage involved determining if the water bars are designed with the correct spacing and if the ditch between the water bars is capable of passing the design flow.

Peak flow values for three different design storms were computed in the analysis of culvert adequacy. The Peak program prepared by DSM was used to compute the peak flow values. Information regarding the curve number and rainfall depth were taken from the Co-op Bear Canyon Mine Plan. Watershed areas, hydraulic length, and watershed slope determinations were made using the area and line programs available at the Division. Peak flow values for the three labelled design events for Bear Creek Canyon are:

10yr-24hr  
(SCS Type II)  
373.58 cfs

10yr-6hr  
(Farmer-Fletcher)  
297.89 cfs

25yr-6hr  
(Farmer-Fletcher)  
433.06 cfs

The proposal by Beaver Creek states that 8.0 feet of headwall are available at the site for the culverts. The capacity of two 48 inch culverts with 8.0 feet of headwall is 300.00 cfs. Therefore the proposal for the two 48 inch culverts is adequate if the 10yr-6hr design storm is used. However, regulation UMC 817.163 requires that the water control system for a Class II road be designed to safely pass the peak runoff from a 10yr-24hr precipitation event at a minimum. Therefore, the proposal for the design of the two 48 inch culverts in Bear Creek should not be approved. Further analysis included as supporting documentation in this memo show that two 60 inch culverts with a headwall of 6.0 feet above the culvert invert would be capable of passing the 10yr-24hr precipitation event runoff.

Peak flow values for culverts 5&6 and 9&10 were also run using the three different design storms. Peak flow values for all three of these events are included with the supporting documentation in this memo. Results of these peak flow analyses show that all four of the culverts proposed to be left in place are not adequate to safely pass the design flows. The best scenario ( from Beaver Creek's perspective ) would require 5.2 feet of headwall above the 24 inch culvert inverts and 7.2 feet of headwall above the 36 inch culvert inverts. These designs are based on using the 10yr-6hr design event. Again, the regulations require the structures to safely pass the runoff from a 10yr-24hr precipitation event. Therefore, the proposal to leave culverts 5&6 and 9&10 should not be approved.

Analysis of the proposed water bars to replace the removed culverts shows that the spacing of the water bars on portions of the road exceeding 10% is not technically adequate. Approximately 35% of the road is greater than 10% grade. Therefore, it is recommended by this reviewer that the design spacing of 200 feet not be approved. However, designs for correct spacing of the water bars are included in the supporting documentation of this memo and could be stipulated. Designs for energy dissipators at the water bar outlets have not been included in the plans by Beaver Creek. These designs could also be stipulated by the Division if necessary. The proposed ditch on the inslope of the road was reviewed in order to determine if it is adequate to pass the design flow. A peak flow value was computed using a curve number of 85 and an area equivalent to the product of the water bar spacing times the road width. This peak flow value was used in conjunction with the continuity equation and manning's equation to determine ditch capacity and velocity at the design flow. The subsequent analysis showed that the ditch is more than adequate to pass the design flow. However, a channel lining will be required in order to prevent erosion at the design flow. No designs for a channel lining have been submitted by Beaver Creek. If necessary the channel lining design could be stipulated by the Division.

Recommendations: The plans as submitted by Beaver Creek Coal Company are not technically adequate in order to be approved. All of the culverts proposed to be left in place are under designed and are not capable of passing the required 10yr-24hr precipitation event runoff. The proposal for the water bars and the connecting inslope ditch are not technically adequate to be approved. The designs for the water bars and inslope ditch could be stipulated, however, this would require a complete design by the Division since no technical designs have been provided by Beaver Creek. The Division could either stipulate culverts that are adequate to pass the design flow or stipulate the removal of the culverts. If the culverts are stipulated to be removed, additional information will be required from Beaver Creek in order to design the channel after culvert removal. Therefore, Beaver Creek Coal Company should be sent a deficiency letter outlining the areas that are not technically adequate along with the enclosed supporting documentation.

cc: Wayne Hedberg  
Lowell Braxton  
Joe Helfrich

7000R-22

8/5/86

# Wildhorse Ridge Project

Reviewer: Dave Cline, Hydrologist

- Purpose:
- 1.) determine pk flow values
  - 2.) check culvert adequacy
  - 3.) check water bar spacing
  - 4.) design overflow swales for culverts
  - 5.) design channels for culvert removal

## 1.) Pk. flow determinations

- a.) 10-yr 24-hr. precip = 2.25" (Miller et al)
- b.) CN = 73 (Co-op Mine Plan)
- c.) SCS Type II Storm Distribution

## Bear Creek Drainage

$$T_c = (\text{Kents Formula}) \quad L / 0.6 \text{ hours}$$

$$L = \frac{2.8 (S+1)^{.7}}{1900 Y^{.5}}$$

$$L = 11,816 \text{ ft. (see printout)}$$

$$S = 3.7$$

$$Y = 48.290 \text{ (see printout)}$$

$$L = \frac{(11,816)^{0.8} (3.7+1)^{.7}}{(1900)(48.2)^{.5}} = .405$$

$$\therefore T_c = .676 \text{ hrs}$$

$$Q_p (\text{Peak Program}) = 223.46 \text{ cfs}$$

### Rt. Fork Bear Creek

$$T_c = \frac{L}{0.6 \text{ hrs}}$$

$$L = \frac{L^{0.8} (S+1)^{0.7}}{1400 \cdot 0.5}$$

$$L = 7,226 \text{ ft (see printout)}$$

$$S = 3.7$$

$$y = 63.9970 \text{ (see printout)}$$

∴

$$L = \frac{(7,226)^{0.8} (3.7+1)^{0.7}}{(1400)(63.9)^{0.5}} = .23$$

$$\therefore T_c = .396 \text{ hrs}$$

$$Q_p \text{ (Peak program)} = 150.12 \text{ cfs}$$

Peak flow to culverts 5+6

$$T_c = \frac{(5661)^{0.8} (3.7+1)^{0.7}}{1400 (61.4)^{0.5}} / .6$$

$$= .332$$

$$Q_p = 133.48 \text{ cfs}$$

Peak flow to culverts 9+10

$$T_c = \frac{(3354)^{0.8} (3.7+1)^{0.7}}{1400 (57.3)^{0.5}} / .6$$

$$= .226$$

$$Q_p = 57.39 \text{ cfs}$$

Proposal by BCCC - place two 48" culverts in Bear Creek with 8 feet of available headwall.

From: ADOT - Roadway Drainage, Part 4, 1984  
Chart 2-48: CMP Culvert w/ inlet control

$H_w = 8'$   $\therefore \frac{H_w}{D} = 2$

A 48" CMP w/  $\frac{H_w}{D} = 2$  is capable of passing 150 cfs. Therefore the two culverts in combination will pass 300 cfs.

The peak flow that will be delivered to the culverts from the Bear Creek and the Right Fork of Bear Creek is 373.58 cfs.

$\therefore$  The culverts are not adequate to pass the 10yr 24hr runoff.

Two 48" culverts would be capable of passing the design Q if 13.6 feet of headwall (9.6' above culvert) was available. If this design was to be used channel cross-sections would be required to determine entrance velocities at the culvert entrance.

Two 60" culverts would be capable of passing the design Q with 6.0' of available headwall (1' above culvert) or one 48" culvert and one 60" culvert would be capable of passing the design Q w/ 12.0' of headwall.

BCCC Proposal - leave culverts 5+6 (36")  
to pass the 10yr 24 hr runoff event

From: UDOT - Roadway Drainage, Part 4, 1984  
Chart 2-48 CMP Culvert w/ inlet control

$$Q = 133.5$$

$$\therefore \frac{H_w}{D} = 5.3 \text{ and headwall depth must be } 16.0 \text{ feet}$$

Therefore, the proposal to leave the culverts cannot be approved because there is not 16.0' feet of available headwall.

BCCC Proposal - leave culverts 9+10 (24")  
to pass the 10yr 24 hr event

$$Q = 58.0 \text{ cfs}$$

$$\therefore \frac{H_w}{D} = > 6.0 \text{ and headwall depth must be } > \text{ than } 12.0 \text{ feet.}$$

Therefore, the proposal to leave the culverts cannot be approved because there is not 12.0' of available headwall

8/5/86

Wildhorse Ridge

Reviewer: Dave Clive

Verify - ditch sizing & need for lining  
water bar spacing

Compute Peak Q

For sections of roads averaging ~ 10% gradient  
use 200' spacing (BCCC proposal)

Design storm: 10-yr 24hr - 2.25 inches

CN = use 85 for road before vegetation  
becomes established

$$t_c = L/0.6 = \frac{(200)^{0.8} (1.76+1)^{0.2}}{1400 (1.10)^{-5}} / 0.6$$

$$= .39 \text{ hours}$$

$$Q_p = .05 \text{ cfs}$$

BCCC proposal -  $s = 10\%$   
U-shaped ditch 1 foot deep  
24" top width

assume  $n = .025$

depth	area	R	velocity	Q
.2	.08	.22	6.8	.54
.5	.5	.22	6.8	.54
.8	1.23	.35	9.3	11.9
.1	.02	.04	2.19	.04
.05	.005	.02	1.39	.006

∴ ditch size is adequate to pass design flow  
without channel lining design

Water bar spacing: from Bartfield & Ham, 1978

- 10% - 213 ft
- 15% - 154 ft
- 18% - 137 ft

∴ Water bar spacing must be increased on all sections of road that are greater than 10%

Wildhorse Ridge Project

Peak flow values - using different distributions

Reviewer - Dave Cline

8/6/86

	<u>10yr 24hr</u>	<u>10yr 6hr</u>	<u>25yr 6hr</u>
Bear Creek	373	300	432
culverts 9+10	57.4	32.5	163
culverts 5+6	133	82	124

Culvert sizing as per BCC proposal

Bear Creek - 2 - 48 inch CMP

each culvert is capable of passing 150 cfs  
w/ 8.0' HW therefore the proposal is adequate -  
the 10yr 6hr (Fanner Fletcher) design is used

Culverts 9+10 - 24" CMP

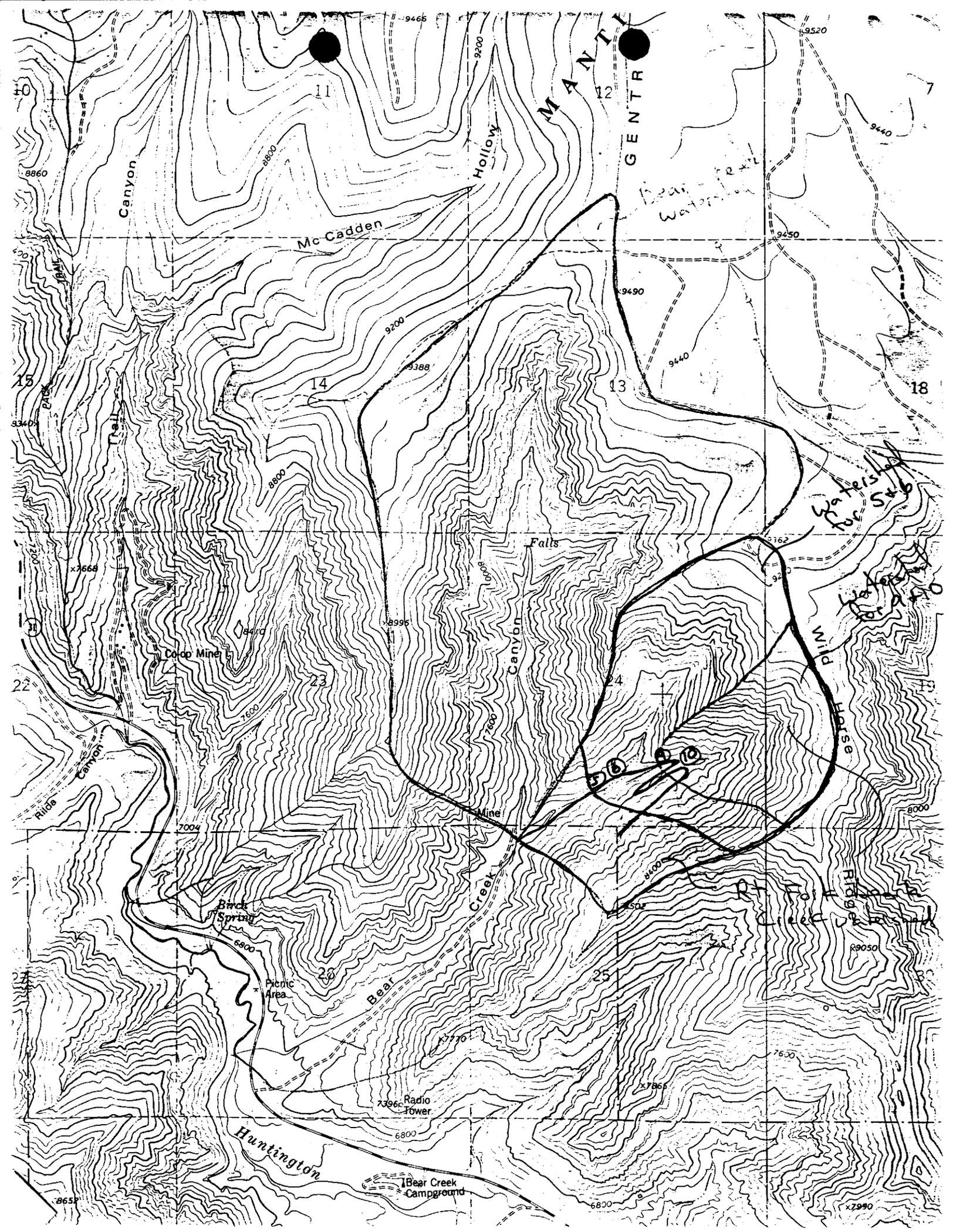
24" CMP is capable of passing 32.5 cfs

w/  $\frac{HW}{D} = 2.6$  in HW must be 5.2  
or 3.2 feet of headwall above culvert

Culverts 5+6 - 36" CMP

36" CMP is capable of passing 82 cfs

w/  $\frac{HW}{D} = 2.4$  in HW must be 7.2  
or 4.2 feet of headwall above culvert



# Wildhorse Ridge Project

## Watershed areas

Planimeter program Date: 08-05-1986 Time: 09:58:45

→ Drainage area to culvert in Bear Creek Canyon

Region 1 (MAP SCALE: 1 inch= 2000 feet)

AREA			PERIMETER		
		total			total
SQ. MILES:	1.652	1.652	MILES:	5.874	5.874
ACRES:	1,057.131	1,057.131	YARDS	10,337.680	10,337.680
SQ. FEET:	46,048,640.000	46,048,640.000	FEET:	31,013.050	31,013.050
SQ. YARDS:	5,116,516.000	5,116,516.000	METERS:	9,452.316	9,452.316
SQ IN(map)	11.512	11.512	INCHES (map):	15.507	15.507
SQ. METER:	4,278,059.000	4,278,059.000			

→ Drainage area of right fork of Bear Creek Canyon

Region 2 (MAP SCALE: 1 inch= 2000 feet)

AREA			PERIMETER		
		total			total
SQ. MILES:	0.795	2.447	MILES:	3.619	9.493
ACRES:	508.894	1,566.025	YARDS	6,369.521	16,707.200
SQ. FEET:	22,167,430.000	68,216,060.000	FEET:	19,108.560	50,121.610
SQ. YARDS:	2,463,047.000	7,579,563.000	METERS:	5,824.006	15,276.320
SQ IN(map)	5.542	17.054	INCHES (map):	9.554	25.061
SQ. METER:	2,059,421.000	6,337,480.000			

Wildhorse Ridge Project  
 Bear Creek Canyon  
 Hydraulic length & watershed slope

Planimeter program Date: 08-05-1986 Time: 10:21:46

Region 1 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	2.238	2.238
YARDS	3,938.865	3,938.865
FEET:	11,816.600	11,816.600
METERS:	3,601.523	3,601.523
INCHES (map):	5.908	5.908

} hydraulic length  
 11,816 ft

Region 2 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.317	2.555
YARDS	557.874	4,496.740
FEET:	1,673.622	13,490.220
METERS:	510.095	4,111.618
INCHES (map):	0.837	6.745

Region 3 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	2.019	4.574
YARDS	3,553.469	8,050.208
FEET:	10,660.410	24,150.620
METERS:	3,249.133	7,360.751
INCHES (map):	5.330	12.075

Region 4 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	2.736	7.310
YARDS	4,816.145	12,866.350
FEET:	14,448.440	38,599.060
METERS:	4,403.668	11,764.420
INCHES (map):	7.224	19.300

Region 5 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	3.030	10.340
YARDS	5,332.178	18,198.530
FEET:	15,996.540	54,595.600
METERS:	4,875.507	16,639.930
INCHES (map):	7.998	27.298

Region 6

(MAP SCALE: 1 inch = 2000 feet)

Line Lengths

total

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MILES:	2.427	12.767
YARDS	4,271.500	22,470.030
FEET:	12,814.500	67,410.100
METERS:	3,905.669	20,545.600
INCHES (map):	6.407	33.705

$$\begin{aligned}\text{Watershed slope} &= \frac{hL}{A} \\ &= \frac{(400)(55,594)}{(46,048,640)} \\ &= 48.290\end{aligned}$$

# Wildhorse Bridge Project

## Rt. Fk. Bear Creek Canyon

### Hydraulic length + watershed slope

Planimeter program Date: 08-05-1986 Time: 10:16:05

Planimeter program Date: 08-05-1986 Time: 10:17:31

Region 1 (MAP SCALE: 1 inch= 2000 feet)		
	Line Lengths	total
MILES:	1.369	1.369
YARDS	2,408.739	2,408.739
FEET:	7,226.218	7,226.218
METERS:	2,202.444	2,202.444
INCHES (map):	3.613	3.613

hydraulic length  
7,226 Ft.

Region 2 (MAP SCALE: 1 inch= 2000 feet)		
	Line Lengths	total
MILES:	0.287	1.655
YARDS	504.271	2,913.010
FEET:	1,512.812	8,739.029
METERS:	461.083	2,663.525
INCHES (map):	0.756	4.370

Region 3 (MAP SCALE: 1 inch= 2000 feet)		
	Line Lengths	total
MILES:	1.106	2.762
YARDS	1,947.248	4,860.258
FEET:	5,841.744	14,580.770
METERS:	1,780.477	4,444.003
INCHES (map):	2.921	7.290

Region 4 (MAP SCALE: 1 inch= 2000 feet)		
	Line Lengths	total
MILES:	1.757	4.518
YARDS	3,091.689	7,951.947
FEET:	9,275.066	23,855.840
METERS:	2,826.902	7,270.906
INCHES (map):	4.638	11.928

Region 5 (MAP SCALE: 1 inch= 2000 feet)		
	Line Lengths	total
MILES:	1.824	6.342
YARDS	3,209.377	11,161.320
FEET:	9,628.132	33,483.970
METERS:	2,934.512	10,205.420

Region 6 (MAP SCALE: 1 inch= 2000 feet

Line Lengths

total

MILES:	1.419	7.760
YARDS	2,496.932	13,658.260
FEET:	7,490.796	40,974.770
METERS:	2,283.083	12,488.500
INCHES (map):	3.745	20.487

Region 7 (MAP SCALE: 1 inch= 2000 feet

Line Lengths

total

MILES:	0.322	8.082
YARDS	566.607	14,224.860
FEET:	1,699.822	42,674.590
METERS:	518.080	13,006.580
INCHES (map):	0.850	21.337

$$\begin{aligned} \text{watershed slope} &= \frac{HL}{A} \\ &= \frac{(400)(35,446)}{(22,167,430)} \\ &= 63.9\% \end{aligned}$$

# Wildhorse Ridge Project Watershed Areas

Planimeter program Date: 08-05-1986 Time: 11:33:53

→ drainage area to culverts 9+10

Region 1 (MAP SCALE: 1 inch= 2000 feet)

AREA		total	PERIMETER		total
SQ. MILES:	0.236	0.236	MILES:	2.001	2.001
ACRES:	150.761	150.761	YARDS:	3,522.307	3,522.307
SQ. FEET:	6,567,168.000	6,567,168.000	FEET:	10,566.920	10,566.920
SQ. YARDS:	729,685.300	729,685.300	METERS:	3,220.640	3,220.640
SQ IN(map)	1.642	1.642	INCHES (map):	5.283	5.283
SQ. METER:	610,109.900	610,109.900			

→ drainage area to culverts 5+6

Region 2 (MAP SCALE: 1 inch= 2000 feet)

AREA		total	PERIMETER		total
SQ. MILES:	0.644	0.879	MILES:	3.034	5.035
ACRES:	411.980	562.742	YARDS:	5,339.896	8,862.202
SQ. FEET:	17,945,860.000	24,513,030.000	FEET:	16,019.690	26,586.610
SQ. YARDS:	1,993,984.000	2,723,669.000	METERS:	4,882.563	8,103.202
SQ IN(map)	4.486	6.128	INCHES (map):	8.010	13.293
SQ. METER:	1,667,225.000	2,277,335.000			

# Wildhorse Ridge Project

## Drainage to culverts 9+10

### hydraulic length & watershed slope

Planimeter program      Date: 08-05-1986      Time: 11:36:12

Region 1 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.635	0.635
YARDS	1,118.135	1,118.135
FEET:	3,354.406	3,354.406
METERS:	1,022.373	1,022.373
INCHES (map):	1.677	1.677

hydraulic length  
3,354.4 ft

Region 2 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.504	1.139
YARDS	886.697	2,004.833
FEET:	2,660.092	6,014.497
METERS:	810.756	1,833.129
INCHES (map):	1.330	3.007

Region 3 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.587	1.726
YARDS	1,032.398	3,037.231
FEET:	3,097.194	9,111.691
METERS:	943.979	2,777.108
INCHES (map):	1.549	4.556

Region 4 (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.692	2.418
YARDS	1,217.979	4,255.210
FEET:	3,653.938	12,765.630
METERS:	1,113.666	3,890.774
INCHES (map):	1.827	6.383

$$\begin{aligned}
 \text{Watershed slope} &= \frac{hL}{A} \\
 &= \frac{(400)(9,111)}{(6,567,169)} \\
 &= 57.3\%
 \end{aligned}$$

# Wildhorse Ridge Project

Drainage to culverts J+G  
hydraulic length & watershed slope

Planimeter program      Date: 08-05-1986      Time: 11:40:16

Region 1      (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	1.072	1.072
YARDS	1,887.105	1,887.105
FEET:	5,661.315	5,661.315
METERS:	1,725.485	1,725.485
INCHES (map):	2.831	2.831

} hydraulic length  
5,661.315

Region 2      (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	0.683	1.756
YARDS	1,202.941	3,090.046
FEET:	3,608.822	9,270.137
METERS:	1,099.915	2,825.400
INCHES (map):	1.804	4.635

Region 3      (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	1.408	3.163
YARDS	2,477.514	5,567.560
FEET:	7,432.543	16,702.680
METERS:	2,265.328	5,090.729
INCHES (map):	3.716	8.351

Region 4      (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	1.397	4.560
YARDS	2,458.601	8,026.161
FEET:	7,375.804	24,078.490
METERS:	2,248.036	7,338.764
INCHES (map):	3.688	12.039

Region 5      (MAP SCALE: 1 inch= 2000 feet)

Line Lengths		total
MILES:	1.413	5.974
YARDS	2,487.724	10,513.890
FEET:	7,463.171	31,541.660
METERS:	2,274.663	9,613.427
INCHES (map):	3.732	15.771

Region 6 (MAP SCALE: 1 inch= 2000 feet  
Line Lengths

		total
MILES:	0.322	6.296
YARDS	566.450	11,080.340
FEET:	1,699.349	33,241.010
METERS:	517.936	10,131.360
INCHES (map):	0.850	16.621

$$\begin{aligned}\text{watershed slope} &= \frac{hL}{A} \\ &= \frac{(400)(27,500)}{(17,945,860)} \\ &= 61.49\%\end{aligned}$$