SUMMARY SHEET

RIGHT OF WAY MARKERS

STATION	DIST. LEFT FEET	DIST. RIGHT FEET	RIGHT OF WAY MARKERS EACH	CONSTRUCTION SOURCE REFERENCE	STATION	DIST. LEFT FEET	DIST. RIGHT FEET	RIGHT OF WAY MARKERS EACH	CONSTRUCTION SOURCE REFERENCE	STATION	DIST. LEFT FEET	DIST. RIGHT FEET	RIGHT OF WAY MARKERS EACH	CONSTRUCTION SOURCE REFERENCE
P.C. 1+30.42	50	50	2											
P.T. 10+04.16	50	50	2											
15+00.0	50	50	2											
16+00.0	60	60	2											
P.C. 21+95.43	60	60	2											
P.T. 32+13.41	60	60	2											
47+00.0	60	60	2											
48+00.0	50	50	2											
P.C. 66+54.53	50	50	2											
P.T. 74+34.86	50	50	2											
94+00.0	50	50	2											
95+00.0	60	60	2											
109+00.0	60	60	2											
110+00.0	50	50	2											
132+00.0	50		1											
133+00.0	60		1											
P.C. 141+25.79	60	50	2											
P.T. 145+64.46	60	50	2											
155+00.0		50	1											
156+00.0		60	1											
P.C. 162+62.84	60	60	2											
165+00.0	60		1											
166+00.0	50		1											
P.T. 170+81.90	50	60	2											
178+00.0	50		1											
P.C. 179+50.13	80	60	2											
182+00.0	80	60	2											
183+00.0	50	90	2											
P.T. 187+12.09	50	90	2											
P.C. 190+67.94	50	90	2											
192+00.0	70		1											
P.T. 196+29.07	70	90	2											
197+85.04	80	70	2											
201+79.50	80	70	2											
207+00.0		70	1											
208+00.0	150	180	2											
208+75.72	150	180	2											
TOTAL			65							TOTAL				
USE TOTAL			70							USE TOTAL				

GUARDRAIL

FROM STATION	TO STATION	LEFT	RIGHT	BEAM GUARDRAIL LIN. FT.	APPROACH ELEMENT EACH	DOUBLE GUARDRAIL LIN. FT.	CONSTRUCTION SOURCE REFERENCE
175+00	183+00	X		800	2		
185+00	191+00		X	600	2		
203+00	208+75.72	X		575.72	2		
TOTAL				1975.72	6		
USE TOTAL				2000	6		

No.	Revision	By	Date

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF.
94106
415 - 861 - 3252

80 W. 100 NO. ST.
PRICE, UTAH
84501
801 - 637 - 6610

FISH CREEK ROAD

SUMMARY SHEET

ACCEPTED 10/2/81

Designed	Checked	Approved	Date
JM	REW	Ralph E. Wilson	Oct 5, 1981
Drawn	Date	Scale	Project Number
LNR	2-5-80	Not to scale	PE10-01-02

Sheet 3D

PLAN / PROFILE

NOTE BOOK	NOTES	BY	DATE
No.	ALIGNMENT CHECKED		
	GRADES CHECKED		
	R. W.'S WITNESSED		
	STRUCTURE EXCAVATIONS CHECKED		

HWY. R/W LINE

N. 41° 38' 18" E.

P.C. 204+32.08
N. 73475.2645
E. 56216.9709

Δ = 18° 51' 16" LT.
D = 4° 00' 00"
R = 1432.395'
T = 237.83'
L = 471.36'
P.I. 208+94.91
N. 73653.0000
E. 56375.0000

P.T. 211+28.44
N. 73827.2682
E. 56447.1118

N. 22° 47' 12" E.

P.C. 211+95.84
N. 74026.4345
E. 56651.8745

SEE SHEET 2 FOR SURVEY INFO.

Δ = 47° 41' 34" RT.
D = 7° 00' 00"
R = 818.51'
T = 361.80'
L = 681.33'
P.I. 216+57.44
N. 74360.0000
E. 56672.0000

P.T. 223+39.09
N. 74801.8937
E. 57013.0043

N. 70° 18' 46" E.

BEG. PROJ.
STA. 0+00
N. 74354.0000
E. 56775.0000

Sta. 1+50 log check dam req'd on r+l in exist channel

100' DRAINAGE EASEMENT REQ'D.

P.C. 0+42.42
N. 74354.0000
E. 56817.4200

N. 18° 50' 15" E.

250' DRAINAGE CHANNEL REQ'D. TYPE I

P.C. 2+10.46.82
N. 74510.1265
E. 57047.6849

Δ = 26° 04' 40" RT.
D = 2° 51' 39"
R = 1913.65'
T = 444.63'
L = 873.74'
P.I. 5+75.05
N. 74912.0000
E. 56912.0000

Sta. 8+20 log check dam req'd on r+l in exist channel

100' DRAINAGE EASEMENT REQ'D.

CUT / FILL

N. 40° 08' 54" E.

HWY. R/W LINE

150' DRAINAGE EASEMENT REQ'D.

P.T. 10+04.16
N. 75251.1625
E. 57198.2468

Δ = 18° 33' 57" LT.
D = 2° 15' 00"
R = 2546.479'
T = 832.24'
L = 1651.07'
P.I. 14+83.07
N. 74690.0000
E. 57490.0000

550' DRAINAGE CHANNEL

HWY. R/W LINE

HWY. R/W LINE

15+50 - 42" ø C.M.P. 14 Ga. Corr. Steel
2-M.E.S. Rip-Rap outlet. 110 - 12 mils

16+20 to 18+40 - 96" ø Fish Creek Road
2 M.E.S. Rip-Rap @ F-129 Wing
- Rip rap outlet

EMB. - 14653
EXC. - 828
BORROW - 16756

FISH CREEK

PROFILE

NOTE BOOK	NOTES	BY	DATE
No.	GRADES CHECKED		
	STRUCTURE EXCAVATIONS CHECKED		

+ 2.132 %

+ 1.715 %

+ 2.681 %

+ 2.132 %

400' V.C.

400' V.C.

PC 6094.60
PT 6098.56

PC 6054.72
PT 6058.68

FISH CREEK PROF. ELEV. = 6057.77

42" PIPE CULVERT REQ'D.

48" PIPE CULVERT REQ'D.

36" PIPE CULVERT REQ'D.

NO	REVISION	BY	DATE
1	CH. ROADWAY WIDTH	REN	9-61

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF.
94106
415 - 981 - 3232

90 W. 100 NO. ST.
PRICE, UTAH
84501
801 - 637 - 4800

FISH CREEK ROAD
COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	RLW	11/27/81	Ralph Wilson
Drawn	Date	R.A. Project No.	Project Number / Sheet
JMc	12-79		PE-10-01-02 / 4

PLAN
SURVEYED
PLOTTED
NOTE BOOK
No.
BY
DATE

PROFILE
SURVEYED
PLOTTED
NOTE BOOK
No.
GRADES CHECKED
R. & V. NOTES
STRUCTURE EXCAVATIONS CHECKED
BY
DATE

Sta 17+00 on LT ditch
dam type A read
exist channel
Sta 20+00 on LT ditch
check dam type A read
in ditch
Sta 25+00 on LT ditch
check dam type A read
in cut ditch
Sta 32+00 on LT check
dam type A read in
drainage channel
HWY. R/W LINE
DRAINAGE CHANNEL REQD. TYPE B
N. 40° 08' 56" E.
N. 09° 36' 34" E.
Δ = 30° 32' 22" LT.
D = 3° 00' 00"
R = 1909.859'
T = 521.59'
L = 1017.98'
P.I. 27+16.82
N. 76561.0000
E. 58309.0008
P.C. 24+95.43
N. 74167.4443
E. 57964.8302
P.T. 35+13.41
N. 75015.1210
E. 58390.1815
32°-59'-18" NE
2 MES. REQD
1 SAT. 2 MAR.
1 - 16" PIPE CMP
SURFACE DITCH REQD.
30'± 960' DRAINAGE EASEMENT REQ'D.
1st PIPE CULVERT REQD.
P.C. 44+91.11
P.T. 44+91.55
STA 45+00.00 P.I. 44+95.00
2.35%
2.35%
2.57%
EMB- 14653
EXC- 828
BORROW- 6756
EMB- 107511
EXC- 129010
BORROW- 0
B.P. sta 19+00
300' V.C.
4.17
45.54
45.42
42.39
44.41

NO.	REVISION	BY	DATE
1	CHANGE ROADWAY WIDTH	REN	9-81

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
315 MARKET STREET
SAN FRANCISCO, CALIF. 94108
415-981-3232
80 W., 100 NO. ST.
PRICE, UTAH 84501
801-637-6810

FISH CREEK
COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMC	REW	10/22/81 Gary A. Dame	Ralph Watkins
Drawn	Date	F.A. Project No.	Project Number/ Sheet
JMC	12-79		PE-10-01-02 5

PLAN
SURVEYED
PLOTTED
GRADES CHECKED
% & R/S NOTED
STRUCTURE NOTATIONS CHECKED
NOTE BOOK
No.
BY
DATE

6250 6225 6275 6300

Sta 5010 on rt & lt. check dam type A reqd. in cut ditch

Sta 6010 on rt & lt. check dam type A reqd. in cut ditch

Sta 7000 on rt & lt. check dam type A reqd. in cut ditch

STA 260 EL 6260.0 GR.

HWY. R/W LINE

CUT FILL

N. 9° 56' 34" E.

P.I. 66+54.53
N. 80467.9088
E. 5994.4628

Δ = 15° 56' 24" LT.
D = 2° 00' 00"
R = 2864.789'
T = 392.60'
L = 780.35'
P.I. 70+47.15
N. 80855.0000
E. 59030.0000

TANGENT TO CURVE
P.C. 74+54.46
N. 81245.4515
E. 58988.9811

N. 5° 50' 50" W.

SURFACE DITCH REQ'D

TANGENT TO CURVE
P.T. 62+98.81
N. 79235.1966
E. 59030.0000

50' ± ROAD RIGHT OF WAY EASEMENT REQ'D

305 280 395 403 575 870 820 830 965

EMB. 107,511
EXC. 129,010
BORROW 0

6270 6260 6250 6240 6230 6220 6210 6200 6190 6180

P.C. 61+99.58 P.T. 62+98.81 P.I. 62+10.58 sta. 50+00

+1.34% +3.500% +3.500%

44 45+00 46 47 48 49 50+00 51 52 53 54 55+00 56 57 58 59 60+00 61 62 63 64

6510 6300 6290 6280 6270 6260

62 70+00 71 72 73 74 75+00 76

PROFILE
SURVEYED
PLOTTED
GRADES CHECKED
% & R/S NOTED
STRUCTURE NOTATIONS CHECKED
NOTE BOOK
No.
BY
DATE

NO.	REVISION	BY	DATE
1	CHANGE ROADWAY WIDTH	REW	9-81

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF. 94106
415-981-3232
80 W. 100 NO. ST.
PRICE, UTAH 84501
801-637-8810

FISH CREEK
COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	REW	Gary A. Dorn 10/31/81	Ralph E. Webster
Drawn	Date	F.A. Project No.	Project Number / Sheet
JMc	12-79		PE-10-01-02 / 6

PLAN
SURVEYED
DRAWN
NOTE BOOK
No.
ACCURACY CHECKED
EL. OF BMS CHECKED

PROFILE
SURVEYED
DRAWN
NOTE BOOK
No.
GRADES CHECKED
R. R.'S NOTED
STRUCTURE LOCATIONS CHECKED

Sta 80+00 on r.+ e lt.
check dam type "A" reqd
in cut ditch

Sta 92+00 on r.+ e lt.
check dam type "A" reqd
in cut ditch

Sta 100+00 on r.+ e lt.
check dam type "A" reqd
in cut ditch

HWY. R/W LINE
CUT
FILL
SURFACE DITCH
ROAD
N03° 29' 30" W
HWY. R/W LINE
HWY. R/W LINE
HWY. R/W LINE

30' DRAINAGE EASEMENT REQ'D.

96' x 60' - 42" x 100' Pipe Culvert reqd
63° x-ing and 2 M.E.S. Rip-Rap
Road and channel improvement
reqd'd at outlet

MON
STA. 240
EL. 6416.19

STA 299
EL. 6422.8 GR.

EMB 107511
EXC 129010
BORROW 0

+3.500 %

42" Pipe Culvert reqd

+3.500 %

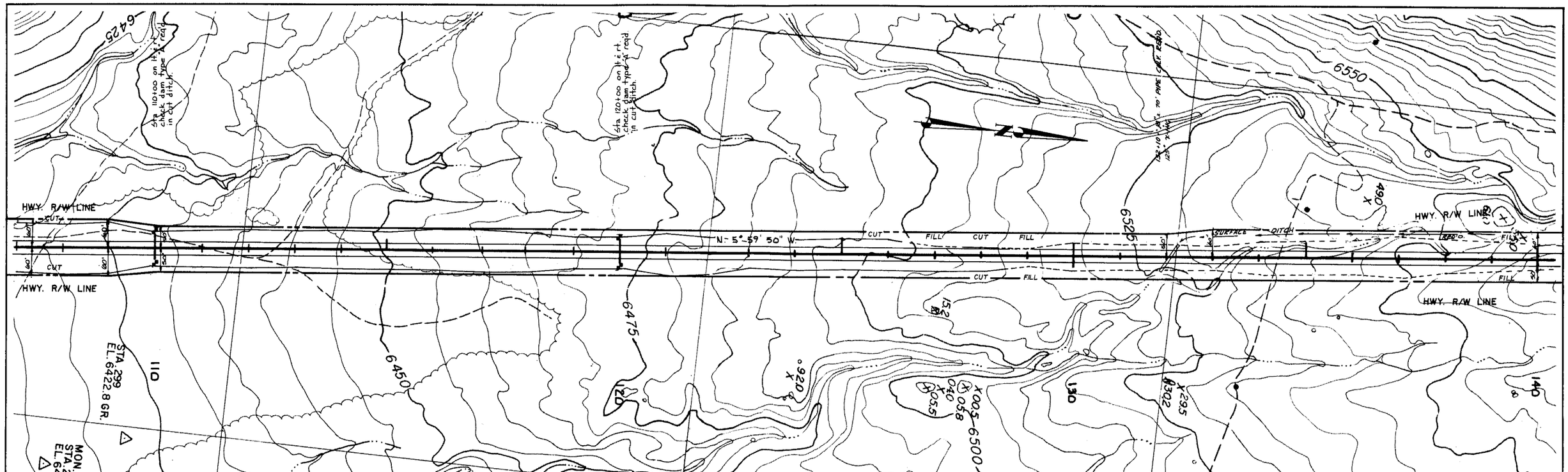
NO.	REVISION	BY	DATE
1	ROADWAY WIDTH CHANGED	REW	9-81

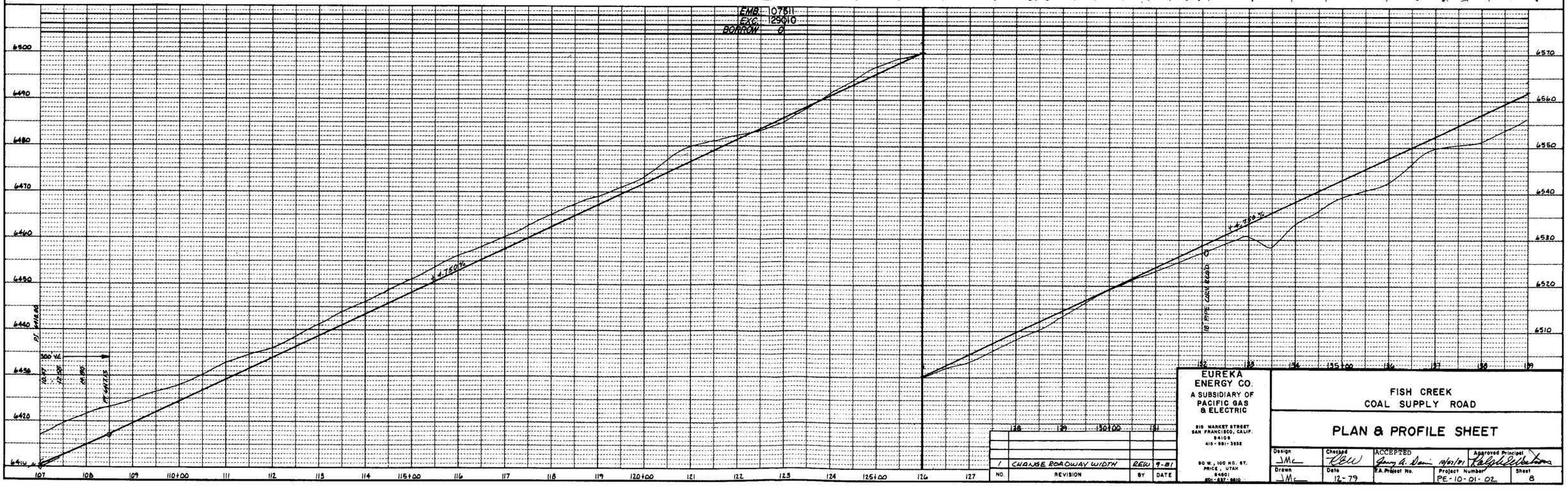
EUREKA
ENERGY CO.
A SUBSIDIARY OF
PACIFIC GAS
& ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF.
94106
415 - 981 - 8332
90 W., 100 NO. ST.
PRICE, UTAH
84501
801 - 637 - 4810

FISH CREEK
COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	REW	Gary A. Dunn 10/27/81	Ralph Seibold
Drawn	Date	F.A. Project No.	Project Number / Sheet
JMc	12-79		PE-10-01-02 / 7





NO.	REVISION	BY	DATE
1	CHANGE ROADWAY WIDTH	REW	9-81

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
315 MARKET STREET
SAN FRANCISCO, CALIF. 94106
415-981-3232

90 W. 100 NO. ST.
PRICE, UTAH 84501
801-637-5610

FISH CREEK COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	REW	Gary A. Davis 10/23/81	Ralph E. Watson
Drawn	Date	F.A. Project No.	Project Number
JMc	12-79		PE-10-01-02

Sheet 8

PLAN
NOTE BOOK
No.

PROFILE
NOTE BOOK
No.

Δ = 4° 25' 12" LT.
D = 1° 00' 00"
R = 5729.578'
T = 219.44'
L = 438.67'
PI. 148+45.23
N. 88118.0000
E. 58267.0000

PC. 141+25.79
N. 87899.7610
E. 58289.9272

PT. 145+64.46
N. 88333. 8461
E. 58227. 4476

HWY. R/W LINE

N. 05° 59' 50" W.

N. 10° 23' 02" W.

CUT

FILL

DRAINAGE CHANNEL RECD. TYPE 2

EMB 107511
EMB 129010
BORROW 0

Δ = 16° 14' 17" RT
D = 1° 58' 54"
R = 2890.554'
T = 412.54'
L = 819.06'
PI. 166+75.15
N. 90410. 0000
E. 57847. 0000

PC. 162+62.64
N. 90004.4132
E. 57921.5212

PT. 170+81.70
N. 90820. 1852
E. 57889. 0574

+ 4.75% ↗

- 1.00% ↘

+ 17.06% ↗

300' V.C.

PT. 155+00 ELEV. 6644.81

PC. 153+45.61 ELEV. 6648.87

NO.	REVISION	BY	DATE
1	CHANGE ROADWAY WIDTH	REW	9-81

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF. 94106
415 - 981- 3232

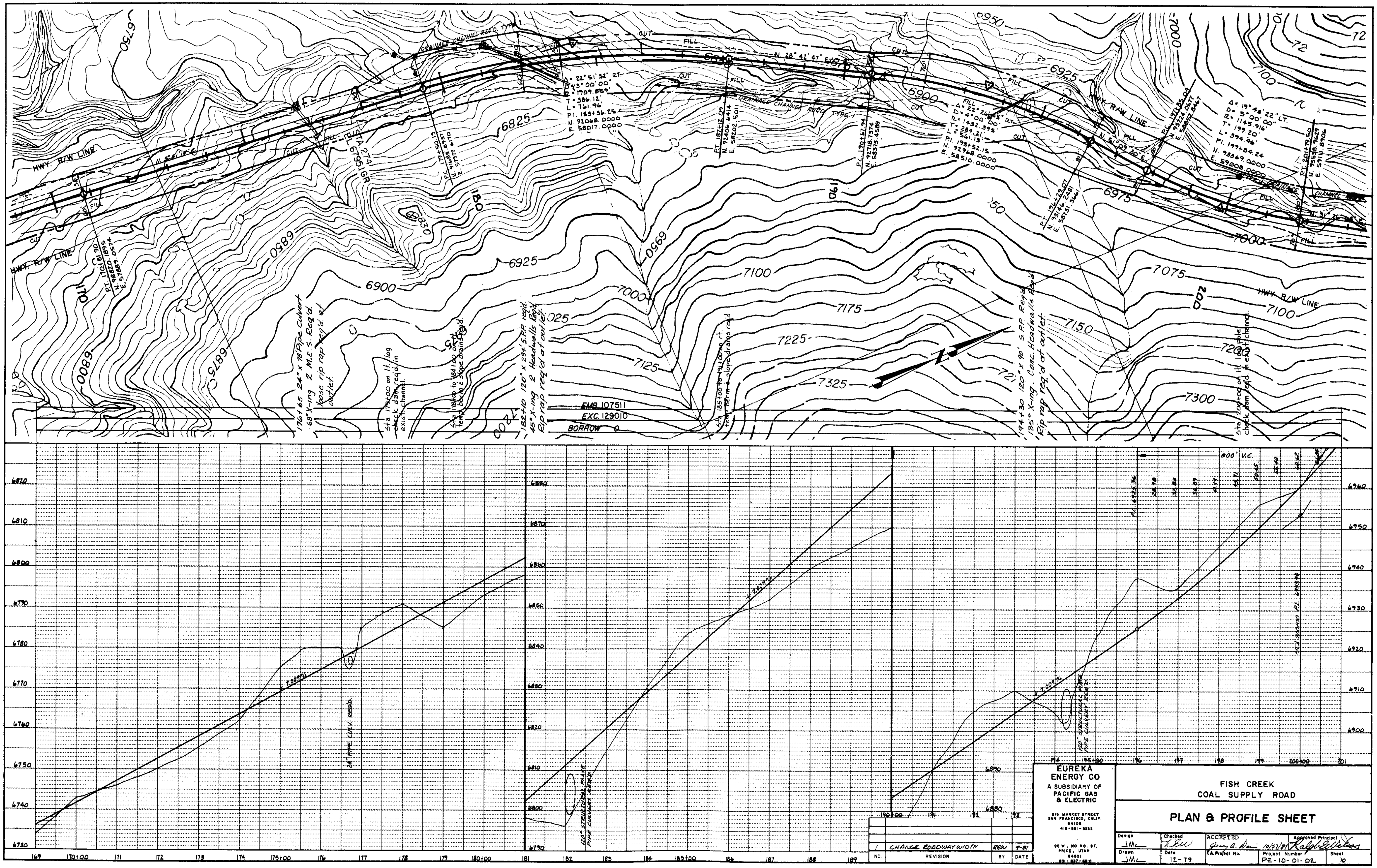
80 W., 100 NO., ST.
PRICE, UTAH
84501
801 - 637- 4810

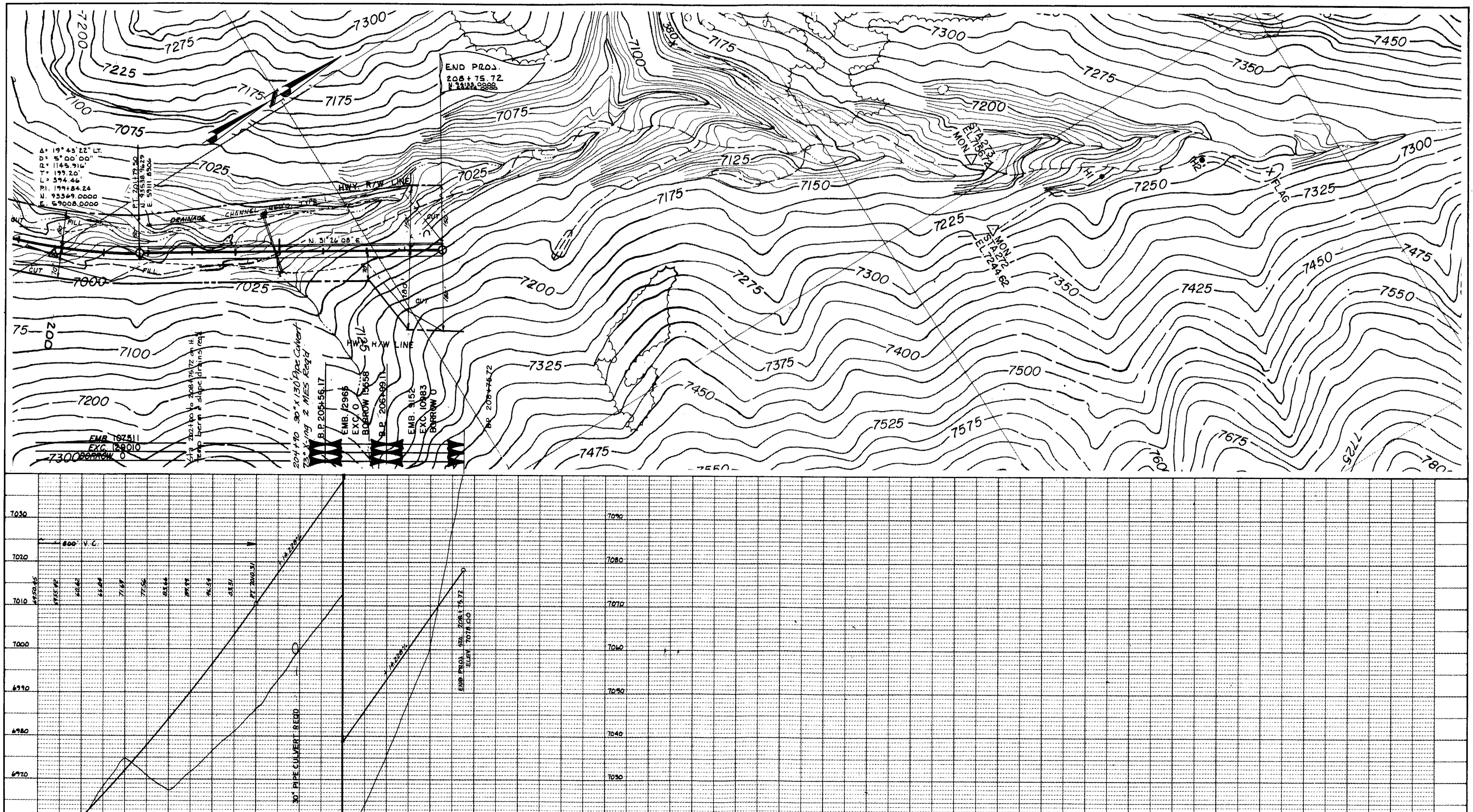
FISH CREEK
COAL SUPPLY ROAD

PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	REW	Jerry A. Dunn 10/27/81	Ralph E. Wilson
Drawn	Date	F.A. Project No.	Project Number
JMc	12-79		PE-10-01-02

Sheet 9


HWY. R/W LINE
DRAINAGE CHANNEL REQ'D. TYPE I
CUT
FILL
N. 28° 42' 47" E
N. 51° 09' 30" E
P.T. 170+81.90
N. 98820.1895
E. 57889.0574
STA 274
EL 6795 GR
P.C. 179+50.15
N. 91683.8957
E. 57977.6170
Δ = 22° 51' 32" RT.
D = 3° 00' 00"
R = 1909.859'
T = 386.12'
L = 761.96'
P.I. 183+36.25
N. 92068.0000
E. 58017.0000
P.T. 187+12.09
N. 92406.6414
E. 58202.5011
P.C. 190+67.94
N. 92718.7374
E. 58573.4589
Δ = 22° 26' 43" RT.
D = 4° 00' 00"
R = 1432.395'
T = 284.21'
L = 561.13'
P.I. 193+52.15
N. 92968.0000
E. 58510.0000
P.T. 196+29.07
N. 93146.2481
E. 58731.3661
P.C. 197+85.04
N. 93224.0677
E. 58852.8467
Δ = 19° 48' 22" LT.
D = 5° 00' 00"
R = 1145.916'
T = 199.20'
L = 394.46'
P.I. 199+84.24
N. 93369.0000
E. 59008.0000
P.T. 201+79.50
N. 93558.9629
E. 59111.8906
176+65 24" x 78' Pipe Culvert
68° X-ing 2 M.E.S. Req'd.
loose rip rap req'd. at outlet.
sta 177+00 on lt. log check dam req'd. in exist. channel.
sta 178+00 to 184+00 on rt. temp. berm & slope drains req'd.
182+10 120" x 234' S.P.P. req'd.
45° X-ing 2 Headwalls Req'd.
Rip rap req'd at outlet.
sta 185+00 to 191+00 on rt. temp. berm & slope drains req'd.
194+30 120" x 90' S.P.P. Req'd.
135° X-ing. Conc. Headwalls Req'd.
Rip rap req'd at outlet.
sta 200+00 on lt. log pole check dam req'd. in exist. channel.
EMB. 107511
EXC. 129010
BORROW 0
+7.009%
24" PIPE CULV. REQ'D.
120" STRUCTURAL PLATE PIPE CULVERT REQ'D.
800' V.C.
P.I. 6925.36
P.T. 200+00 P.I. 6953.40
169
170+00
171
172
173
174
175+00
176
177
178
179
180+00
181
182
183
184
185+00
186
187
188
189
190+00
191
192
193
194
195+00
196
197
198
199
200+00
201
EUREKA ENERGY CO
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET SAN FRANCISCO, CALIF. 94106 415-981-3232
90 W., 100 NO. ST. PRICE, UTAH 84501 801-637-6610
FISH CREEK
COAL SUPPLY ROAD
PLAN & PROFILE SHEET
1 CHANGE ROADWAY WIDTH REW 9-81
NO. REVISION BY DATE
Design JMc
Checked REW
ACCEPTED 10/27/81
Approved Principal
Drawn JMc
Date 12-79
F.A. Project No.
Project Number PE-10-01-02
Sheet 10



NO.	REVISION	BY	DATE
1	CHANGE ROADWAY WIDTH	REW	9-81

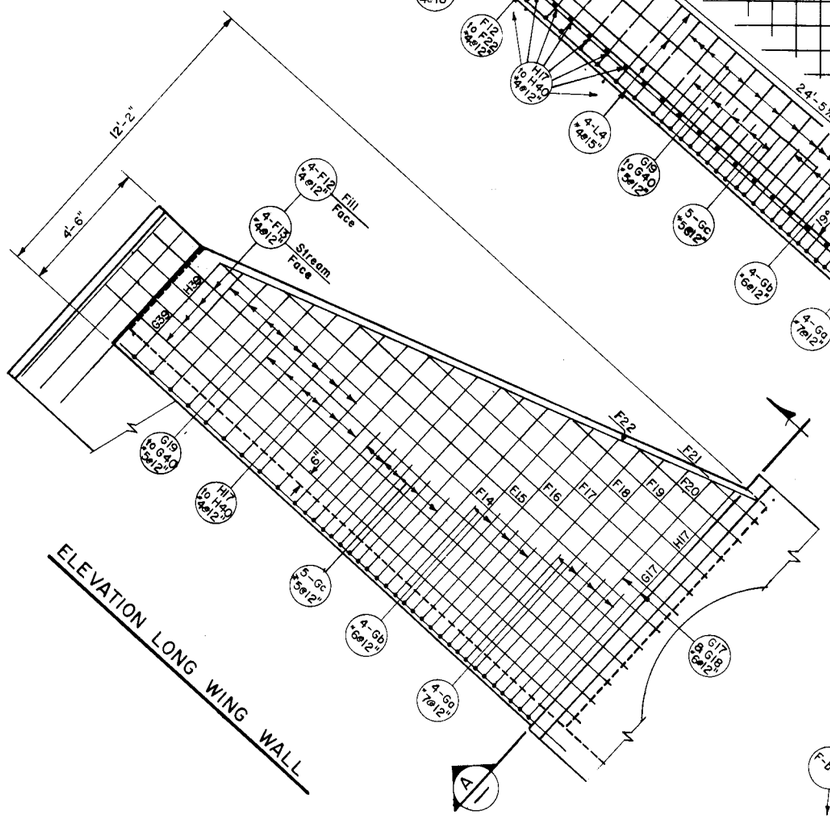
EUREKA ENERGY CO
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF.
94106
415-981-3232

90 W., 100 NO. ST.
PRICE, UTAH
84501
801-637-6610

FISH CREEK COAL SUPPLY ROAD

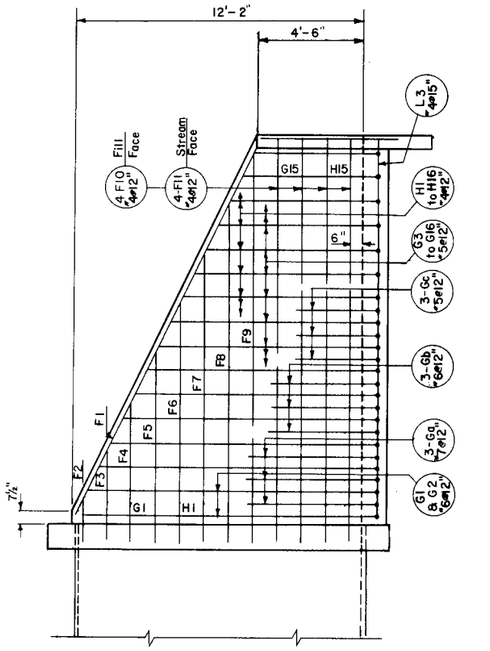
PLAN & PROFILE SHEET

Design	Checked	ACCEPTED	Approved Principal
JMc	REW	10/27/81	
Drawn	Date	F.A. Project No.	Project Number	Sheet
JMc	12-79		PE-10-01-02	11

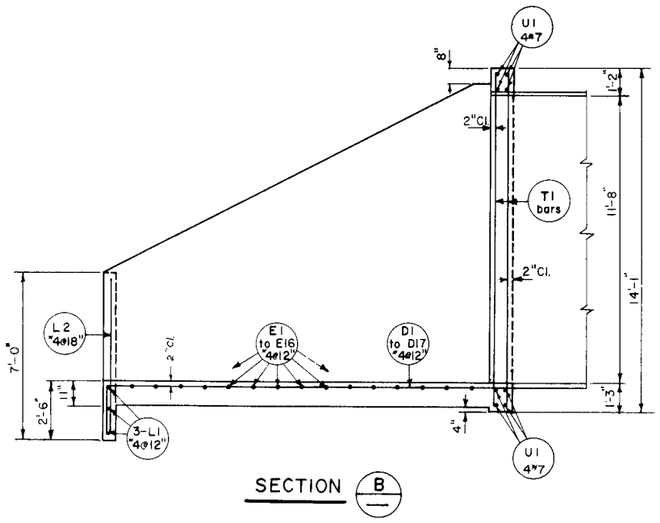


ELEVATION LONG WING WALL

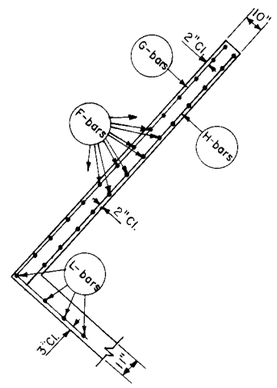
PLAN



ELEVATION SHORT WING WALL



SECTION B



SECTION

No	Revision	By	Date

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
215 MARKET STREET
SAN FRANCISCO, CALIF. 94106
415 - 981 - 3232
80 W. 100 NO. ST.
PRICE, UTAH 84501
801-637-6810

STANDARD HEADWALL for 132" STRUCTURAL PLATE PIPE

60° & 120° X-ING ANGLE

ACCEPTED 12/3/81

Designed	Checked	Approved	Date	Sheet
REW	JM	Ralph Webb	Oct 5, 1981	1 of 2
Drawn	Date	Scale	Project Number	Drawing No.
DG	7-80	NOT TO SCALE	PE-10-01-02	H-1

LOC.	MARK	SIZE	NO. BARS	L'GTH.	TOTAL L'GTH	a	SKETCH
Apron	D1	4	13	18'-9	243'-9	16'-8	
	D2		1	17'-7		15'-6	
	D3			16'-9		14'-8	
	D4			15'-10		13'-9	
	D5			14'-0		12'-11	
	D6			14'-1		12'-0	
	D7			13'-3		11'-2	
	D8			12'-5		10'-4	
	D9			11'-6	176'-4	9'-5	
	D10			10'-8		8'-7	
	D11			9'-9		7'-8	
	D12			8'-11		6'-10	
	D13			8'-1		6'-0	
	D14			7'-2		5'-1	
	D15			6'-4		4'-3	
	D16			5'-5		3'-4	
	D17	4	1	4'-7		2'-6	
Apron	E1	4	1	14'-3			
	E2			15'-5			
	E3			16'-7			
	E4			17'-9			
	E5			18'-11			
	E6			20'-1			
	E7			21'-3			
	E8			22'-5	368'-0		
	E9			23'-7			
	E10			24'-9			
	E11			25'-11			
	E12			27'-1			
	E13			28'-3			
	E14			29'-5			
	E15			30'-7			
	E16	4	1	31'-9			
Short Wing Wall	F1	4	2	17'-0			
	F2			2'-4			
	F3			4'-4			
	F4			6'-4			
	F5			8'-4			
	F6			10'-4	183'-4		
	F7			12'-4			
	F8			14'-4			
	F9		2	16'-4			
						a b θ	
	F10		4	19'-5	367'-4	16'-8 2'-9 90°	
	F11			18'-3		16'-8 1'-7 90°	
Long Wing Wall	F12			27'-8		24'-11 2'-9 139°	
	F13		4	26'-6		24'-11 1'-7 139°	
	F14		2	24'-3			
	F15			21'-2			
	F16			18'-1			
	F17			15'-0			
	F18			11'-11	266'-10		
	F19			8'-10			
	F20			5'-9			
	F21			2'-8			
	F22	4	2	25'-9			
						a h	
Wing Walls	Ga	7	7	8'-0	56'-0	2'-8 5'-4	
	Gb	6	7	6'-8	46'-8	2'-4 4'-4	
	Gc	5	8	5'-4	42'-8	2'-0 3'-4	

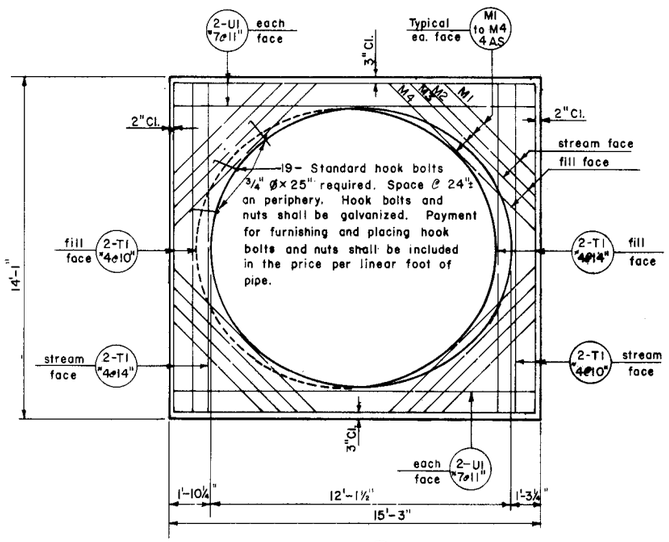
LOC.	MARK	SIZE	NO. BARS	L' GTH.	TOTAL L'GTH	a	h	SKETCH
Short Wing Wall	G1	6	1	16'-6	16'-6	4'-0	12'-6	
	G2	6		16'-3	16'-3		12'-3	
	G3	5		15'-9			11'-9	
	G4			15'-3			11'-3	
	G5			14'-9			10'-9	
	G6			14'-3			10'-3	
	G7			13'-9			9'-9	
	G8			13'-3			9'-3	
	G9			12'-9	175'-0		8'-9	
	G10			12'-3			8'-3	
	G11			11'-9			7'-9	
	G12			11'-3			7'-3	
	G13			10'-9			6'-9	
	G14			10'-3			6'-3	
	G15			9'-9			5'-9	
	G16	5		9'-3			5'-3	
Long Wing Wall	G17	6		16'-6	16'-6		12'-6	
	G18	6		16'-2	16'-2		12'-2	
	G19	5		15'-10			11'-10	
	G20			15'-6			11'-6	
	G21			15'-2			11'-2	
	G22			14'-10			10'-10	
	G23			14'-7			10'-7	
	G24			14'-3			10'-3	
	G25			13'-11			9'-11	
	G26			13'-7			9'-7	
	G27			13'-3			9'-3	
	G28			12'-11			8-11	
	G29			12'-7	273'-4		8'-7	
	G30			12'-3			8'-3	
	G31			11'-11			7'-11	
	G32			11'-7			7'-7	
	G33			11'-3			7'-3	
	G34			10'-11			6'-11	
	G35			10'-8			6'-8	
	G36			10'-4			6'-4	
	G37			10'-0			6'-0	
	G38			9'-8			5'-8	
	G39			9'-4			5'-4	
	G40	5	1	9'-0		4'-0	5'-0	
Short Wing Wall	H1	4	1	12'-6				
	H2			12'-3				
	H3			11'-9				
	H4			11'-3				
	H5			10'-9				
	H6			10'-3				
	H7			9'-9				
	H8			9'-3	143'-9			
	H9			8'-9				
	H10			8'-3				
	H11			7'-9				
	H12			7'-3				
	H13			6'-9				
	H14			6'-3				
	H15			5'-9				
	H16			5'-3				
Long W. Wall	H17			12'-6				
	H18			12'-2				
	H19			11'-10				
	H20			11'-6				
	H21	4	1	11'-2				

175'-4 of #7 bars @ 2.044 Lb/ft. = 358.4 Lb
112'-1 of #6 bars @ 1.502 Lb/ft. = 168.3 Lb
491'-0 of #5 bars @ 1.043 Lb/ft. = 512.1 Lb
2,610'-11 of #4 bars @ .668 Lb/ft. = 1,744.1 Lb

TOTAL = 2,782.9 Lb

Unless otherwise shown all dimensions are out to out of bars.

LOC.	MARK	SIZE	NO. BARS	L'GTH.	TOTAL L'GTH.	SKETCH
Long Wing Wall	H22	4	1	10'-10		
	H23			10'-7		
	H24			10'-3		
	H25			9'-11		
	H26			9'-7		
	H27			9'-3		
	H28			8'-11	210'-0	
	H29			8'-7		
	H30			8'-3		
	H31			7'-11		
	H32			7'-7		
	H33			7'-3		
	H34			6'-11		
	H35			6'-8		
	H36			6'-4		
	H37			6'-0		
	H38			5'-8		
	H39			5'-4		
	H40	4	1	5'-0		
Wing W. Ext. & Cut-Off W.	L1	4	3	37'-3	111'-9	
	L2		6	6'-7	39'-6	
	L3		4	15'-8	159'-0	
	L4	4	4	24'-1		
Headwall	M1	4	8	5'-9		
	M2			6'-9	232'-0	
	M3			7'-9		
	M4	4	8	8'-9		
	T1	4	8	13'-8	109'-4	
	U1	7	8	14'-11	119'-4	



Section C

GENERAL NOTES

Materials, construction, and workmanship shall be in accordance with the State of Utah Standard Specifications for Road and Bridge Construction, Edition of 1979, and supplements thereto which are in effect on the date of request for bids.

All reinforcing steel shall be deformed billet-steel bars conforming to ASTM designation A615-68, Grade 40.

Type II cement (low alkali) required.

Place full fill as far as practical before building headwall. Cure concrete 7 days before backfilling.

DESIGN DATA

The design is in accordance with AASHO Specifications of 1969.

fc = 1,200 p.s.i.
fs = 20,000 p.s.i.
n = 10

QUANTITIES

(for 1 Headwall only)

Class A Concrete (AE)	28.718	cu.yd.
Reinforcing Steel	2783	Lbs.

No.	Revision	By	Date

EUREKA ENERGY CO.
A SUBSIDIARY OF PACIFIC GAS & ELECTRIC
315 MARKET STREET SAN FRANCISCO, CALIF. 94106 415-981-5235
90 W., 100 NO. ST. PRICE, UTAH 84501 801-637-6810

STANDARD HEADWALL for 132" STRUCTURAL PLATE PIPE

60°- 120° X-ING ANGLE

ACCEPTED 10/31/80

Designed	Checked	Approved	Date	Sheet
R.E.W.	J.Mc.	Ralph L. Watson	Oct 5, 1979	2 of 2
Drawn	Date	Scale	Project Number	DRAWING No.
D.G.	7-80	NO SCALE	PE-10-01-02	H-1

ROUND CORRUGATED STEEL PIPE
2 2/3" X 1/2" CORRUGATIONS
RIVETED, SPOT WELDED OR HELICAL LOCK SEAM FABRICATION

DIAMETER OR SPAN IN	MIN. COVER IN.	MAXIMUM FILL HEIGHT (FT.) THICKNESS				
		0.064	0.079	0.109	0.138	0.168
12	12	84	91			
15	12	67	72			
18	12	55	60			
21	12	47	52	66		
24	12	41	46	58		
30	18	33	36	46		
36	18	27	30	39	40	
42	18	30	42	46	46	49
48	18	26	37	44	45	46
54	18		33	43	44	45
60	18			42	43	44
66	18			42	42	43
72	18				40	42
78	18					39
84	18					39

FOR 15"-36" DIAMETER & SPAN 18"-43" USE 4 1/2 RIVETS/FOOT.
FOR 42"-84" DIAMETER & SPAN 50"-86" USE 9 RIVETS/FOOT.

CORRUGATED STEEL PIPE ARCHES
2 2/3" X 1/2" CORRUGATIONS
RIVETED, WELDED OR HELICAL FABRICATION

PIPE DIM. SPAN-RISE INCHES	CORNER RADIUS INCHES	MIN. COVER INCHES	MIN. THICKNESS INCHES	MAX. FILL HEIGHT FEET
17 X 13	3	18	0.064	16
21 X 15	3	18	0.064	15
24 X 18	3	18	0.064	13
28 X 20	3	18	0.060	12
35 X 24	3	18	0.064	12
42 X 29	3 1/2	18	0.064	10
49 X 33	4	18	0.079	10
57 X 38	5	18	0.109	10
64 X 43	6	18	0.109	10
71 X 47	7	18	0.138	10
77 X 52	8	18	0.168	10
83 X 57	9	18	0.168	10

FOR 0.064 THICKNESS & 0.079 USE 5/16" DIAMETER RIVETS.
FOR 0.109, 0.138 & 0.168 THICKNESS USE 3/8" DIA. RIVETS.

FOR 12" THRU 36" DIA. & SPAN 18"- 43" USE 4 1/2 RIVETS / FT.

FOR 42" THRU 72" DIA. & SPAN 50"- 72" USE 9 RIVETS / FT.

FOR 0.060 & 0.075 THICKNESS USE 5/16" DIA. RIVETS.

FOR 0.105, 0.135 & 0.164 USE 3/8" DIA. RIVETS.

THE ABOVE SPECIFICATIONS ARE FOR "ROUND CORRUGATED ALUMINUM PIPE" AND "CORRUGATED ALUMINUM PIPE ARCHES."

ROUND CORRUGATED ALUMINUM STRUCTURAL PL. PIPE
9" X 2 1/2" CORRUGATIONS
BOLTED FABRICATION

PIPE DIAMETER INCHES	MIN. COVER INCHES	MAXIMUM FILL HEIGHT (FT.) THICKNESS						
		5 1/3"- 3/4" Ø ALUM. BOLTS / FT.				5 1/3" 3/4" Ø STEEL BLTS/FT		
		0.100	0.125	0.152	0.175	0.200	0.225	0.250
60	18	26	34	44	48	52	56	60
66	18	23	31	38	42	44	47	50
72	18	20	27	34	41	46	51	56
84	18	19	25	32	38	43	47	51
96	18	17	22	28	33	38	41	45
108	24	15	19	25	29	33	37	40
120	24	13	17	22	26	30	33	36
132	24	12	16	20	24	27	30	33
144	24		14	18	22	25	28	30
156	24		13	17	20	23	25	28
168	24			16	19	21	24	26
180	24				18	20	22	24

ALUMINUM STRUCTURAL PLATE PIPE NOT ACCEPTABLE IF PAVED INVERT REQUIRED.

ROUND CORRUGATED STEEL PIPE
5"x 1" & 3"x 1" CORRUGATIONS
RIVETED, SPOT WELDED OR HELICAL LOCK SEAM FABRICATION

DIAMETER OR SPAN INCHES	MIN. COVER INCHES	MAXIMUM FILL HEIGHT (FT.) THICKNESS				
		0.064	0.079	0.109	0.138	0.168
36	18	48	60	79	91	103
42	18	41	51	65	72	80
48	18	36	45	57	62	67
54	18	32	40	52	56	59
60	18	29	36	49	52	54
66	18	26	32	47	49	51
72	18	24	30	44	47	49
78	18	22	28	41	46	47
84	18	21	26	38	45	46
90	18	19	25	35	42	45
96	18	18	22	33	40	44
102	24	17	21	31	37	42
108	24		20	29	35	39
114	24		19	28	33	37
120	24			26	32	35

CORRUGATED STEEL PIPE ARCHES
5"x 1" & 3"x 1" CORRUGATIONS
RIVETED, WELDED OR HELICAL FABRICATION

PIPE DIM. SPAN-RISE INCHES	CORNER RADIUS INCHES	MIN. COVER INCHES	MIN. THICKNESS INCHES	MAX. FILL HEIGHT FEET
43 X 27	5	18	0.064	12
50 X 31	6	18	0.064	12
58 X 36	7	18	0.064	12
65 X 40	8	18	0.064	12
72 X 44	9	18	0.064	12
73 X 55	12	18	0.064	16
81 X 59	14	18	0.079	15
87 X 63	14	18	0.079	14
95 X 67	16	18	0.109	13
103 X 71	16	24	0.109	12
112 X 75	18	24	0.109	11
117 X 79	18	24	0.109	10
128 X 83	18	24	0.138	9

USE 8 RIVETS/FOOT FOR ALL DIAMETERS
FOR 0.064 & 0.079 THICKNESS USE 3/8" DIAMETER RIVETS.
FOR 0.109, 0.138 & 0.168 THICKNESS USE 7/16" DIAMETER RIVETS.

ROUND CORRUGATED STEEL STRUCTURAL PLATE PIPE
6" X 2" CORRUGATIONS
BOLTED FABRICATION 4-3/4" Ø BOLTS / FOOT

PIPE DIAMETER INCHES	MIN COVER INCHES	MAXIMUM FILL HEIGHT (FT.) THICKNESS						
		0.109	0.138	0.168	0.188	0.218	0.249	0.280
60	18	42	62	81	93	108*	119	129
66	18	38	56	73	84	91	99	107
72	18	35	51	67	74	80	86	92
78	18	32	47	62	67	71	76	81
84	18	30	44	57	61	65	69	73
90	18	28	41	54	58	61	64	67
96	18	26	38	50	55	57	60	62
102	30	24	36	47	52	54	56	59
108	30	23	34	45	50	52	54	56
114	30	22	32	42	48	50	52	53
120	30	21	31	40	46	49	50	52
126	30	20	29	38	44	48	49	50
132	30	19	28	36	42	47	48	49
144	30	17	25	33	38	45	46	47
156	30	16	23	31	35	43	45	46
168	30	15	22	28	33	40	44	45
180	30	14	20	27	31	37	43	44
192	30		19	25	29	35	41	43
204	36		18	23	27	32	38	42
216	36		17	22	25	31	36	40
228	36			21	24	29	34	37
240	36			20	23	28	33	36
252	36				22	26	31	34

* FILL HEIGHTS OVER 100' USED ONLY AFTER THOROUGH INVESTIGATION OF FOUNDATION MATERIAL.

ROUND CORRUGATED ALUMINUM PIPE
2 2/3" X 1/2" CORRUGATIONS
RIVETED, WELDED OR HELICAL FABRICATION

PIPE	MIN.	MAXIMUM FILL HEIGHT (FT.) THICKNESS				
		0.060	0.075	0.105	0.135	0.164
12	12	45	45	79		
15	12	30	36	60		
18	12	25	30	43		
21	12	21	25	35	30	
24	12	18	22	30	33	
30	18	15	18	25	27	28
36	18	12	15	23	24	25
42	18		21	22	22	23
48	18				22	22
54	18				21	21
60	18				17	21
66	18				12	16
72	18					12

CORRUGATED ALUMINUM PIPE ARCHES
9" X 2 1/2" CORRUGATIONS
BOLTED FABRICATION *

PIPE DIMENSION SPAN-PISE FEET	CORNER RADIUS INCHES	MIN COVER INCHES	MIN. THICKNESS INCHES	MAX. FILL HEIGHT FEET
5-11 Y 5-4	28.8	18	0.100	16
6-8 X 5-7	28.8	18	0.100	16
7-4 X 5-11	28.8	18	0.100	15
8-0 X 6-2	28.8	18	0.100	14
8-7 X 6-6	28.8	24	0.100	13
9-0 X 6-8	28.8	24	0.100	12
9-4 X 6-10	28.8	24	0.100	13
10-10 X 7-1	28.8	24	0.100	13
10-5 X 7-3	28.8	24	0.100	12
11-2 X 7-6	28.8	24	0.125	15
11-8 X 7-10	28.8	24	0.125	14
12-2 X 8-0	28.8	24	0.125	13
12-10 X 8-3	28.8	24	0.125	13
13-7 X 8-7	28.8	24	0.150	12
14-3 X 8-10	28.8	24	0.150	11
14-9 X 9-2	28.2	24	0.175	10
15-3 X 9-4	28.8	24	0.175	10
16-0 X 9-7	28.8	36	0.200	10
16-8 X 9-11	28.8	36	0.225	10
16-11 X 10-1	28.8	36	0.250	9

* THICKNESS TO 0.175 USE 5 1/3 - 3/4 Ø ALUM. BOLTS/FOOT
THICKNESS TO 0.200 & OVER USE 5 1/3 - 3/4 Ø STEEL BOLTS/FOOT

CORRUGATED STEEL PIPE ARCHES
6" X 2" CORRUGATIONS
BOLTED FABRICATION 4-3/4" Ø BOLTS / FOOT *

PIPE DIMENSION SPAN RISE FEET	CORNER RADIUS INCHES	MIN COVER INCHES	MIN. THICKNESS INCHES	MAX. FILL HEIGHT FEET
6-1 X 4-7	18	18	0.109	15
7-0 X 5-1	18	18	0.109	15
7-11 X 5-7	18	18	0.109	12
8-10 X 6-1	18	24	0.109	11
9-9 X 6-7	18	24	0.109	10
10-11 X 7-1	18	24	0.109	9
11-10 X 7-7	18	24	0.105	8
12-10 X 8-4	18	24	0.109	8
14-1 X 8-9	18	24	0.109	7
15-4 X 9-3	18	24	0.138	7
15-10 X 9-10	18	24	0.138	7
16-7 X 10-1	18	36	0.138	7
13-3 X 9-4	31	24	0.109	13
14-2 X 9-10	31	24	0.109	12
15-4 X 10-4	31	24	0.138	11
16-3 X 10-10	31	36	0.138	11
17-2 X 11-4	31	36	0.138	10
18-1 X 11-10	31	36	0.168	9
19-3 X 12-4	31	36	0.168	9
19-11 X 12-10	31	36	0.168	8
20-7 Y 13-2	31	36	0.188	8

CORRUGATED ALUMINUM PIPE ARCHES
2 2/3" X 1/2" CORRUGATIONS
RIVETED, WELDED OR HELICAL FABRICATION

PIPE DIM. SPAN RISE INCHES	CORNER RADIUS INCHES	MIN. COVER INCHES	MIN. THICKNESS INCHES	MAX FILL HEIGHT FEET
18 X 11	4 3/4	18	0.060	15
22 X 13	4 3/4	18	0.060	14
25 X 16	4 1/2	18	0.060	12
29 X 18	4 1/2	18	0.060	10
36 X 22	5	18	0.060	9
43 X 27	5 1/2	18	0.075	9
50 X 31	6	18	0.105	8
58 X 36	7	18	0.135	8
65 X 40	8	18	0.135	8
72 X 44	9	18	0.164	8

1. FILL HEIGHTS SHOWN ARE MAXIMUM FROM TOP OF PIPE TO TOP OF SUBGRADE FOR THICKNESS SHOWN FOR PIPE INSTALLED WITH ADEQUATE BEDDING AND BACKFILL IN ACCORDANCE WITH STATE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.

2. EXCEPT FOR STRUCTURAL PLATE PIPE, ONE THICKNESS SHALL BE USED FOR THE FULL LENGTH OF PIPE WHICH SHALL BE THE THICKNESS REQUIRED BY THE MAXIMUM HEIGHT OF FILL OVER THE PIPE.

3. THE NUMBER OF SPOT WELDS PER FOOT FOR SPOT WELDED PIPE SHALL BE AT LEAST EQUAL TO THE NUMBER OF RIVETS REQUIRED.

4. THE DEFLECTION OF THE PIPE SHALL NOT EXCEED 5% DURING CONSTRUCTION. IF IT EXCEEDS 5% IT SHALL BE CORRECTED AT THE CONTRACTORS EXPENSE.

5. FOR BEDDING DETAILS SEE STD. DWG. 605-20

6. GAGES SHOWN ARE ADEQUATE ONLY FOR FINISHED CONSTRUCTION. DURING CONSTRUCTION MINIMUM COVER SHALL BE PROVIDED TO PROTECT STRUCTURE FROM DAMAGE.

2-5-80 INC 5x1 CORR.
5-7-74 INCLUDED 12" PIPE - CHANGED CHARTS
3-27-73 CHANGED CHARTS

EUREKA ENERGY

SUPERSEDES

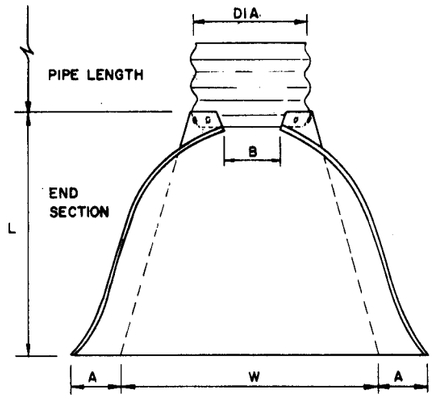
REVISIONS

Date	Appr.
3-27-73	
5-7-74	
2-5-80	

FILL HEIGHTS FOR PIPE CULVERTS

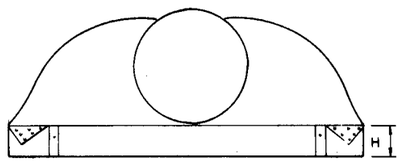
RECOMMENDED FOR APPROVAL:
Ralph Watson — PROJECT ENGINEER — Oct 5, 1981 — Date
ACCEPTED
Gary A. Dam — EUREKA ENERGY — 10/27, 1981

STD. DWG. NO. 605-1



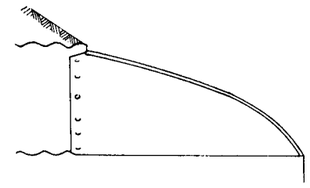
PLAN

PIPE DIA.	WT.	GAGE	END SECTION DIMENSIONS					
			A	B	H	L	W	TOE PLATE
12"	29#	16	4 3/4"	6"	6"	21"	24"	34"
15	39	16	6	8	6	26	30	40
18	52	16	7	9	6	31	36	46
21	63	16	8 1/4"	11	6	36	42	52
24	90	16	9 1/2"	12	6	42	48	58
30	145	14	12	15	7 1/2"	52 1/2"	60	70
36	274	14	14	18	9	63	72	85
42	417	12	16	21	10 1/2"	73 1/2"	84	103
48	502	12	18	27	12	78	90	114
54	630	12	18	30	12	84	102	130
60	826	12	18	33	12	87	114	146
66	914	12	18	36	12	87	120	162
72	998	12	18	39	12	87	126	178
78	1108	12	18	42	12	87	132	194
84	1200	12	18	45	12	87	138	210
TOLERANCE			1"	MAX.	1"	1 1/2"	2"	

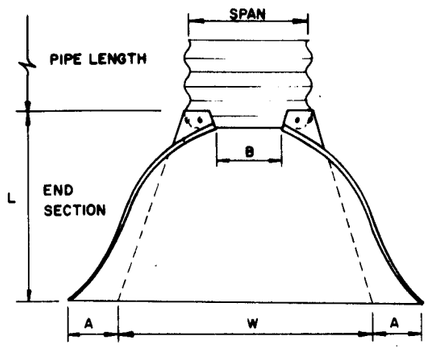


TYPICAL SECTION

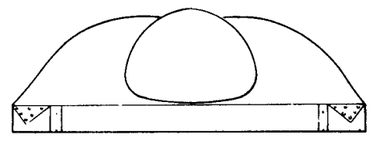
ELEVATION



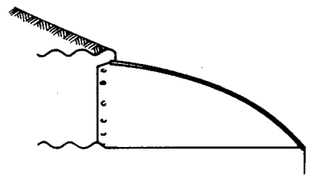
TYPICAL SECTION



PLAN



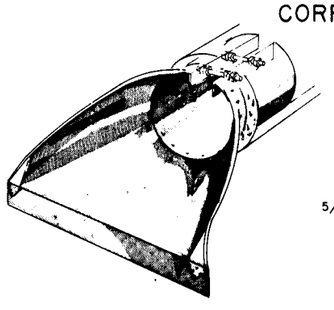
ELEVATION

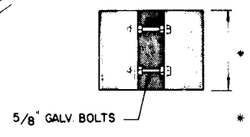


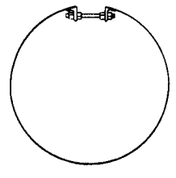
TYPICAL SECTION

SPAN	RISE	NOM. DIA.	WT.	GAGE	END SECTION DIMENSIONS					
					A	B	H	L	W	TOE PLATE
17	13	15"	32#	16	4 1/2"	9"	6"	19"	30"	40"
21	15	18	41	16	5 1/4	10	6	23	36	46
24	18	21	53	16	6 1/4	11 1/2	6	28	42	52
28	20	24	75	16	7	14	6	31 1/2	48	58
35	24	30	104	14	8 3/4	16	6	38 1/2	60	70
42	29	36	187	14	10 3/4	17 1/2	7 5/8	47	75	85
49	33	42	265	12	12 1/4	20	9 1/8	54	85	103
57	38	48	361	12	18	26	12	63	90	114
64	43	54	520	12	18	30	12	70	102	130
71	47	60	790	12	18	33	12	77	114	146
77	52	66	818	12	18	36	12	77	126	162
83	57	72	887	12	18	39	12	77	138	178
TOLERANCE					1"	MAX.	1"	1 1/2"	2"	

CORRUGATED METAL PIPE (ROUND)



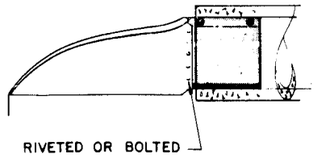


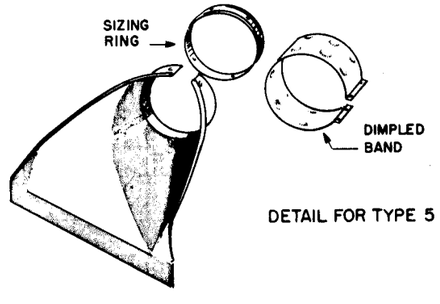


METAL INSERT

FOR CONNECTING CONCRETE PIPE TO METAL END SECTION

CORRUGATED METAL PIPE ARCHES

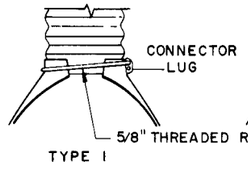




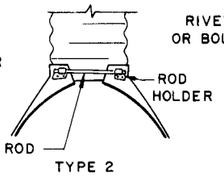
DETAIL FOR TYPE 5

NOTES

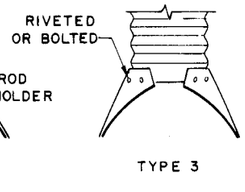
1. METAL CULVERT END SECTIONS SHALL MEET THE STANDARD SPECIFICATIONS.
2. METAL INSERTS SHALL BE USED TO CONNECT METAL END SECTIONS TO CONCRETE PIPES. FOR CONCRETE PIPE SIZES TO & INCLUDING 60" DIA. THE LENGTH OF THE INSERT SHALL BE 12" USING 2 BOLTS. FOR SIZES OVER 60" DIA. INSERT SHALL BE 18" & REQUIRES 3 BOLTS. THREE NUTS PER BOLT.
3. INSERT, BOLTS, WASHERS & RIVETS SHALL BE GALVANIZED.
4. GAGE OF INSERT SHALL BE THE SAME AS END SECTION.



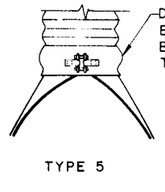
TYPE 1



TYPE 2

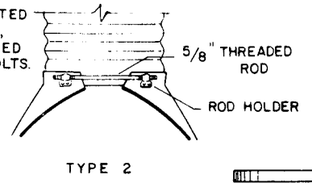


TYPE 3

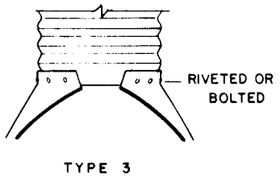


TYPE 5

DIMPLE OR STANDARD CORRUGATED BAND AS REQUIRED, WITH BAR, BOLT & STRAP FASTENER, BOLTED TO END SECTION WITH 3/8" BOLTS. SEE DETAIL



TYPE 2



TYPE 3

AS AN ALTERNATE USE 1" WIDE 12 GA. STRAP WITH STD. 6"x 1/2" DIA. BAND BOLT AND NUT.

METHODS OF ATTACHING END SECTION TO PIPE

9-6-77	ADDED ALTERNATE BAND
5-7-74	ADDED DETAIL FOR TYPE 5 & CHANGED CHART
6-1-71	TOOK OFF TOE PLATE EXTENSION.
2-20-71	CHANGED NOTE RE: TOE PLATE EXT.
1-6-70	ADDED METAL INSERT

EUREKA ENERGY

SUPERSEDES

REVISIONS

Date	Appr.
1-6-70	
2-20-71	
6-1-71	
5-7-74	
9-6-77	

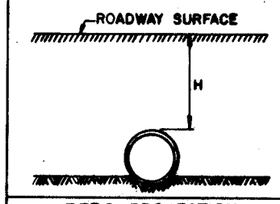
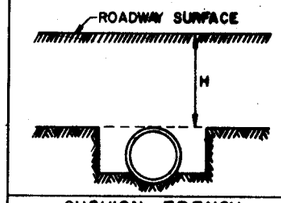
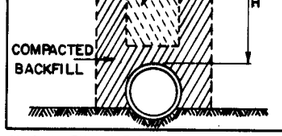
METAL CULVERT END SECTIONS

RECOMMENDED FOR APPROVAL:
Ralph L. Watson — PROJECT ENGINEER — Oct 5 1981 — Date
ACCEPTED
James G. Davis — EUREKA ENERGY — Oct 5 1981

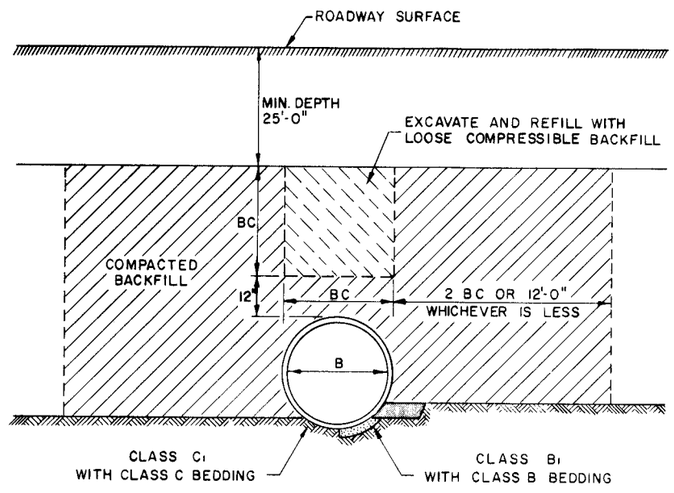
STD. DWG. NO. 605-2

TABLE I

***PERMISSIBLE HEIGHT OF COVER (H) FOR REINFORCED CONCRETE PIPE (EMBANKMENT CONDITION)**

TYPE OF INSTALLATION	PIPE CLASS	BEDDING CLASS		
		CLASS C	CLASS B	CLASS A
POSITIVE PROJECTION 	II	10'-0"	13'-0"	22'-0"
	III	14'-0"	17'-0"	27'-0"
	IV	21'-0"	26'-0"	40'-0"
	V	27'-0"	33'-0"	50'-0"
ZERO PROJECTION 	III	18'-0"	21'-0"	33'-0"
	IV	28'-0"	33'-0"	49'-0"
	V	34'-0"	41'-0"	60'-0"
CUSHION TRENCH 		CLASS C_1	CLASS B_1	
	III	28'-0"	35'-0"	
	IV	45'-0"	54'-0"	
	V	57'-0"	69'-0"	

* ALL FILL HEIGHTS BASED ON ULTIMATE D - STRENGTH AND A 1.33 SAFETY FACTOR.



NOTES

(1) THE DESIGN TABLE COVERS INSTALLATIONS UNDER EMBANKMENT CONDITIONS AND WILL ORDINARILY BE ADEQUATE FOR TRENCH CONDITIONS. SPECIAL DESIGN SHOULD BE UTILIZED FOR UNUSUAL TRENCH INSTALLATIONS.
(2) THIS STANDARD COVERS REINFORCED CIRCULAR CONCRETE PIPE FROM 12" TO 108" INTERNAL DIAMETER WHICH SHALL BE AVAILABLE IN MULTIPLES OF 3" FROM 12" TO 18" AND IN 6" MULTIPLES FROM 18" TO 108".

(3) STRENGTH REQUIREMENTS SHALL BE IN ACCORDANCE WITH STANDARD SPECIFICATIONS CLASS II SHALL BE THE MINIMUM STRENGTH PERMITTED, AND ALL PIPE CALLED FOR IN THE PLANS OR PROPOSAL WITHOUT CLASS DESIGNATION SHALL BE DETERMINED BY HEIGHT OF COVER (H) SELECTED ACCORDING TO TABLE I.

(4) THE MAXIMUM PERMISSIBLE FILL HEIGHT, MEASURED FROM TOP OF PIPE TO ROADWAY SURFACE, IS OBTAINED FROM THE DESIGN TABLE FOR EACH COMBINATION OF PIPE CLASS AND BEDDING CLASS.

(5) THE MINIMUM HEIGHT OF FILL BETWEEN THE TOP OF CULVERT AND ROADWAY FINISHED GRADE SHALL BE 1.0 FT. WITH A CUSHION TRENCH INSTALLATION THE MINIMUM FILL ABOVE THE COMPRESSIBLE MATERIAL SHALL BE 25 FT.

(6) WHERE MULTIPLE LINES OF PIPE ARE USED THE ADJACENT SIDES SHALL BE AT LEAST ONE HALF THE INSIDE PIPE DIAMETER APART, TO A MAXIMUM OF 3 FT.

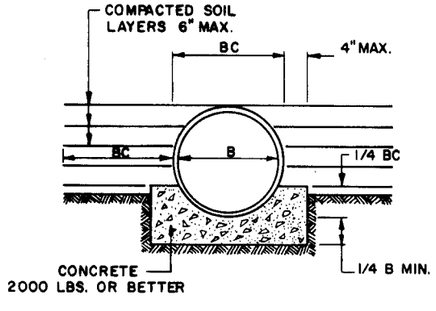
(7) SELECT BEDDING CLASS FROM TABLE I FOR EACH COMBINATION OF PIPE CLASS & HEIGHT OF COVER (H)

(8) CLASS A BEDDING SHALL PROVIDE A CONCRETE CRADLE OF 2000 LBS. CONCRETE OR BETTER, CONSTRUCTED MONOLITHICALLY WITHOUT HORIZONTAL CONSTRUCTION JOINTS. THE PIPE SHALL BE TEMPORARILY SUPPORTED TO LINE AND GRADE WITH APPROVED CRADLES AND THE CONCRETE POURED BENEATH THE PIPE TO INSURE UNIFORM BEARING.

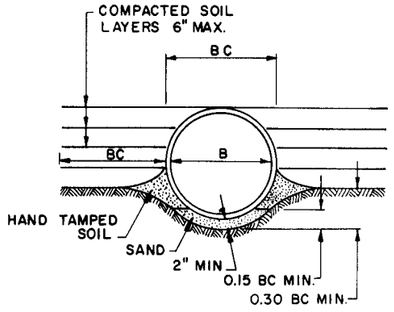
(9) CLASS B BEDDING SHALL PROVIDE AN ACCURATELY SHAPED SAND OR FINE GRANULAR MATERIAL BEDDING OVER AN EARTH FOUNDATION WITH COMPACTABLE SOIL TAMPED UNDER THE HAUNCHES IN LAYERS NOT EXCEEDING 6".

(10) CLASS C BEDDING SHALL PLACE THE PIPE IN A SOIL FOUNDATION SHAPED TO FIT THE LOWER PORTION OF THE PIPE WITH SOIL MATERIAL PLACED BY HAND AND TAMPED TO COMPLETELY FILL ALL SPACES UNDER AND ADJACENT TO THE PIPE.

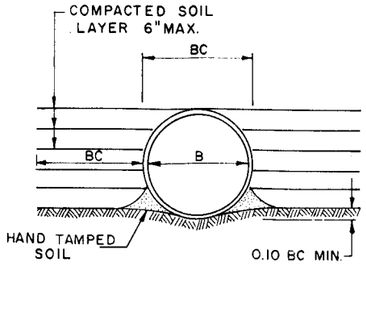
(11) CLASS B_1 OR C_1 (CUSHION TRENCH) BEDDING SHALL BE IN ACCORDANCE WITH CLASS B OR C AND THE FILL COMPACTED OVER AND ADJACENT TO THE PIPE AS SHOWN IN THE DETAIL. A TRENCH SHALL BE EXCAVATED EQUAL IN WIDTH TO THE OUTSIDE PIPE DIAMETER DIRECTLY OVER THE PIPE AND TO AN ELEVATION ONE FOOT ABOVE THE TOP OF THE PIPE. THE TRENCH WALLS SHALL BE KEPT AS NEARLY VERTICAL AS POSSIBLE. THE TRENCH SHALL THEN BE FILLED WITH LOOSE, HIGHLY COMPRESSIBLE SOIL MATERIAL. SAWDUST OR OTHER ORGANIC MATERIAL MAY BE USED TO FILL THE LOWER 1/4 TO 1/3 OF THE TRENCH IN ORDER TO INSURE HIGH COMPRESSIBILITY. THE TRENCH AND LOOSE BACKFILL SHALL NOT BE CARRIED CLOSER THAN 10 FT. (HORIZONTAL MEASUREMENT) TO THE OUTSIDE SLOPE OF FILL. THE OUTSIDE 10 FEET SHALL BE COMPOSED OF IMPERVIOUS MATERIAL THOROUGHLY COMPACTED. AFTER THE LOOSE BACKFILL IS COMPLETED, THE FILL SHALL BE COMPLETED BY NORMAL METHODS.
(12) BEDDING ON ROCK FOUNDATION WHERE UNYIELDING FOUNDATION IS ENCOUNTERED, THE EXCAVATION SHALL BE LOWERED AND AN EARTH CUSHION OF FINE COMPRESSIBLE MATERIAL PROVIDED TO THE DIMENSIONS SHOWN ON THE TYPICAL DETAIL. THIS CUSHION IS IN ADDITION TO THE REQUIREMENTS FOR THE SPECIFIED CLASS OF BEDDING.



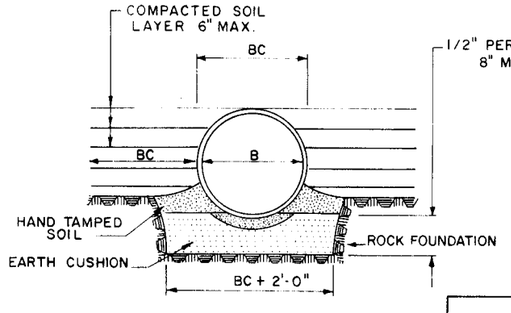
CLASS A BEDDING



CLASS B BEDDING



CLASS C BEDDING



BEDDING ON ROCK FOUNDATION (CLASS C OR B MODIFIED)

1-25-79 REDRAWN NO REVISION

EUREKA ENERGY

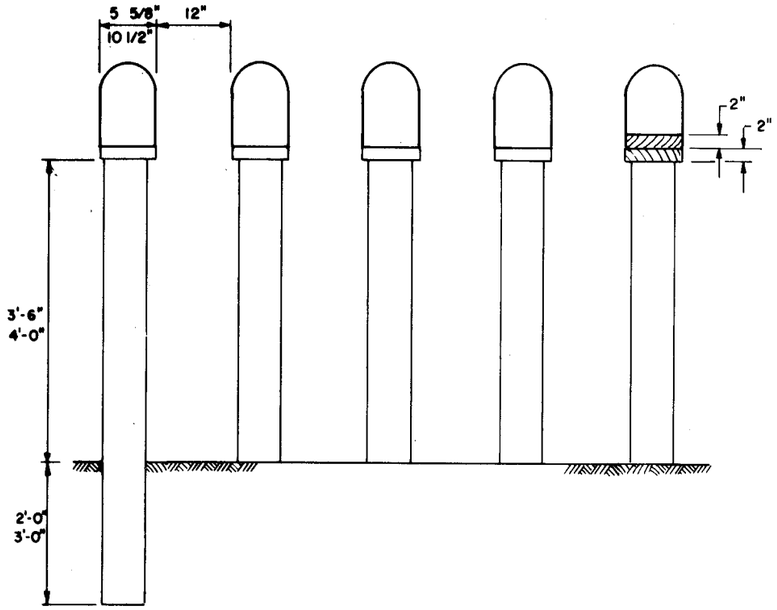
SUPERSEDES

REVISIONS
Date Appr.

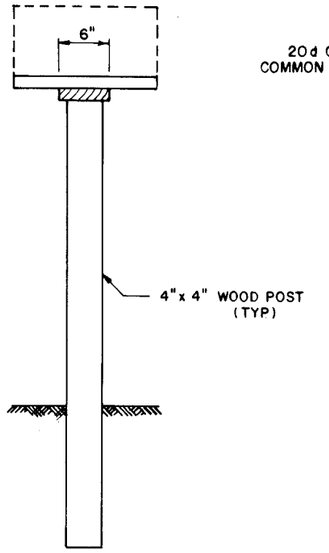
REINFORCED CONCRETE CULVERTS

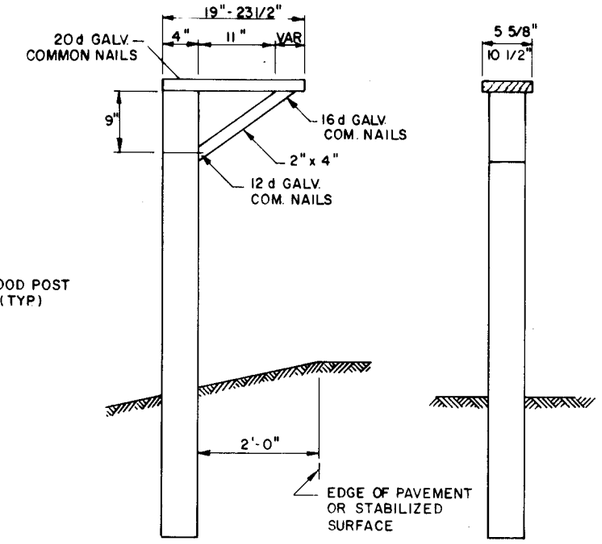
RECOMMENDED FOR APPROVAL:
Ralph E. Watson Oct 6 81
PROJECT ENGINEER
ACCEPTED
Jerry A. Davis Oct 27 81
EUREKA ENERGY

STD. DWG. NO. 605-20



MULTIPLE MAILBOX ARRARNGEMENT





SINGLE MAILBOX SUPPORT

NOTES:

(1) FOR INFORMATION REGARDING MATERIAL, CONSTRUCTION AND TREATMENT OF POSTS, SEE STANDARD SPECIFICATIONS.

(2) RIGHT OF WAY MARKERS SHALL BE PLACED AT EACH ANGLE POINT IN A RIGHT OF WAY LINE. WHERE THE RIGHT OF WAY PARALLELS THE CENTER LINE OF THE HIGHWAY AROUND A CURVE MARKERS SHALL BE PLACED ON EACH RIGHT OF WAY LINE OPPOSITE THE PS, SC, CS AND ST OR OPPOSITE THE PC AND PT.

(3) RIGHT OF WAY MARKERS SHALL BE PLACED IN ADDITION SO THAT NO INTERVAL WILL EXCEED 1,000 FEET. THESE INTERMEDIATE MARKERS SHOULD PREFERABLY BE ON SECTION LINES OR INTERSECTING PROPERTY LINES.

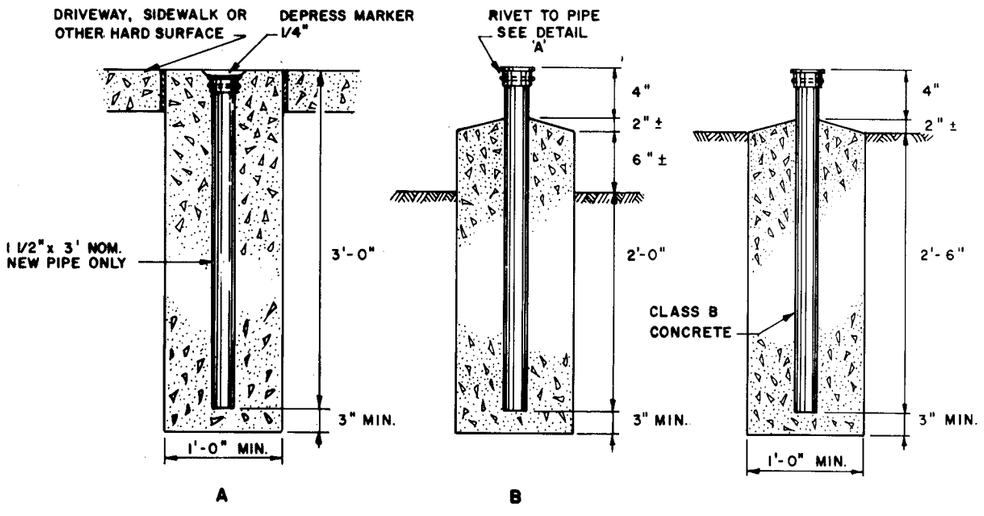
(4) ALL EXPOSED SURFACES OF THE BRONZE CAP ARE TO BE GROUND TO A SMOOTH SURFACE.

(5) ALL LETTERS ARE TO BE DEPRESSED A MINIMUM OF 1/16 INCH.

(6) 3/16 INCH LETTERS AND FIGURES SHALL BE USED.

(7) SET BRONZE CAP FLUSH WITH GROUND OR SURFACE WHEN SO DIRECTED BY THE ENGINEER AS INDICATED IN ALTERNATE 'A' INSTALLATION.

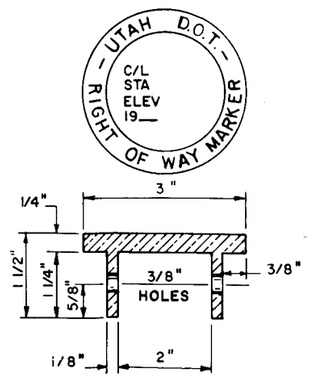
(8) USE ALTERNATE 'B' INSTALLATION WHEN PLACING MARKERS IN HEAVY BRUSH OR FOREST LANDS.



ALTERNATE INSTALLATIONS

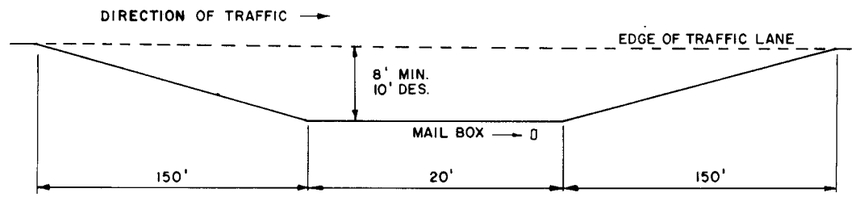
STANDARD INSTALLATION

R/W MARKER ELEVATION INSTALLATION



BRONZE CAP

DETAIL 'A'



MAIL BOX TURN OUT

RECOMMENDED FOR 50 MPH ROADS & OVER WITH ADT OF 450

9·9·80 DELETED RAIL (MULTIPLE ARR.)
7·5·77 REDRAWN - ADDITIONAL DIM. & INSTAL. TO MARKER

EUREKA ENERGY

SUPERSEDES

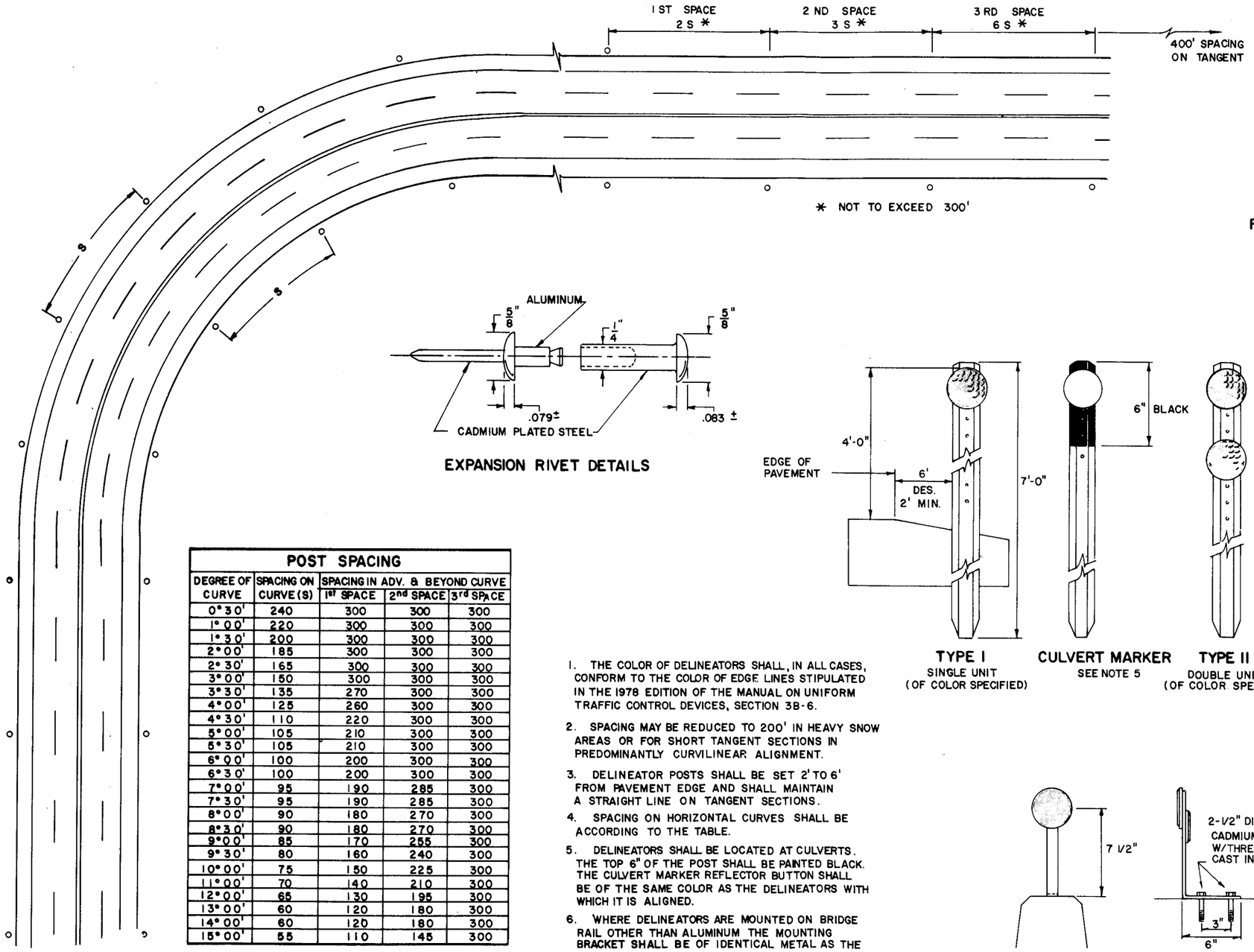
REVISIONS

Date	Appr.
7·5·77	
9·9·80	

R/W MARKER & MAIL BOX POSTS

RECOMMENDED FOR APPROVAL:
Ralph L. Watson — PROJECT ENGINEER — Oct 5 1981 (Date)
ACCEPTED
Jerry G. Dan — EUREKA ENERGY — oct 27 1981

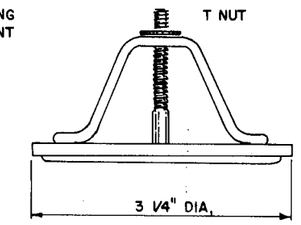
STD. DWG. NO. 725-1



POST SPACING				
DEGREE OF CURVE	SPACING ON CURVE (S)	SPACING IN ADV. & BEYOND CURVE		
		1st SPACE	2nd SPACE	3rd SPACE
0°30'	240	300	300	300
1°00'	220	300	300	300
1°30'	200	300	300	300
2°00'	185	300	300	300
2°30'	165	300	300	300
3°00'	150	300	300	300
3°30'	135	270	300	300
4°00'	125	260	300	300
4°30'	110	220	300	300
5°00'	105	210	300	300
5°30'	105	210	300	300
6°00'	100	200	300	300
6°30'	100	200	300	300
7°00'	95	190	285	300
7°30'	95	190	285	300
8°00'	90	180	270	300
8°30'	90	180	270	300
9°00'	85	170	255	300
9°30'	80	160	240	300
10°00'	75	150	225	300
11°00'	70	140	210	300
12°00'	65	130	195	300
13°00'	60	120	180	300
14°00'	60	120	180	300
15°00'	55	110	145	300

DEGREES NOT SHOWN MAY BE INTERPOLATED FROM TABLE

EXPANSION RIVET DETAILS



REFLECTOR ATTACHMENT WITH FLANGED CHANNEL POST

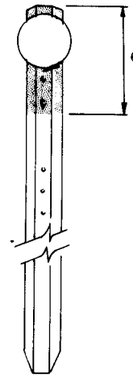
3/16"x 2 1/2" STAINLESS STEEL BOLT WITH ONE-WAY SLOT AND CADMIUM PLATED VANDAL RESISTANT NUT. THREADS SHALL BE DISTORTED AFTER INSTALLATION. EXPANSION RIVETS MAY BE USED AS A SUBSTITUTE FOR BOLTS - SEE DETAIL.

TYPE I
SINGLE UNIT
(OF COLOR SPECIFIED)

CULVERT MARKER
SEE NOTE 5

TYPE II
DOUBLE UNIT
(OF COLOR SPECIFIED)

A MINIMUM OF 18 3/8" DIA. HOLES ON 1" CENTERS BEGINNING 1" FROM TOP. MAY BE FULL LENGTH OF POST.



NO PASSING
SEE NOTE 8

1. THE COLOR OF DELINEATORS SHALL, IN ALL CASES, CONFORM TO THE COLOR OF EDGE LINES STIPULATED IN THE 1978 EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, SECTION 3B-6.
2. SPACING MAY BE REDUCED TO 200' IN HEAVY SNOW AREAS OR FOR SHORT TANGENT SECTIONS IN PREDOMINANTLY CURVILINEAR ALIGNMENT.
3. DELINEATOR POSTS SHALL BE SET 2' TO 6' FROM PAVEMENT EDGE AND SHALL MAINTAIN A STRAIGHT LINE ON TANGENT SECTIONS.
4. SPACING ON HORIZONTAL CURVES SHALL BE ACCORDING TO THE TABLE.
5. DELINEATORS SHALL BE LOCATED AT CULVERTS. THE TOP 6" OF THE POST SHALL BE PAINTED BLACK. THE CULVERT MARKER REFLECTOR BUTTON SHALL BE OF THE SAME COLOR AS THE DELINEATORS WITH WHICH IT IS ALIGNED.
6. WHERE DELINEATORS ARE MOUNTED ON BRIDGE RAIL OTHER THAN ALUMINUM THE MOUNTING BRACKET SHALL BE OF IDENTICAL METAL AS THE RAIL AND TREATED FOR CORROSION RESISTANCE. THE CENTER OF THE FIRST DELINEATOR SHALL BE 2 1/2" ABOVE THE RAIL.
7. FOR FREEWAY RAMP INSTALLATION SEE STANDARD DRAWING 726-1.
8. INSTALL AT BEGINNING AND END OF NO PASSING ZONE TO ASSIST CREWS IN ESTABLISHING PAINT LIMITS.

BRIDGE PARAPET OR MEDIAN BARRIER ATTACHMENT

10-14-80 ADDED NO PASSING DELINEATOR
5-8-80 POST SPACING (CHART) REDRAWN

EUREKA ENERGY

SUPERSEDES

REVISIONS

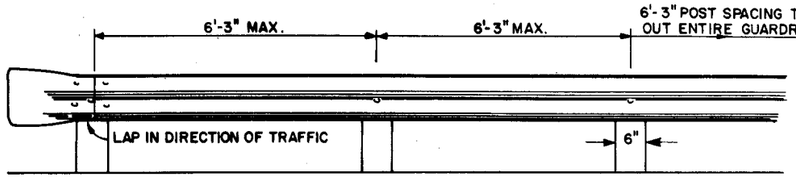
Date	Appr.
5-8-80	
10-14-80	

DELINEATION

OTHER THAN INTERSTATE

RECOMMENDED FOR APPROVAL
Ralph E. Watson — PROJECT ENGINEER — Oct 5 Date 19 81
ACCEPTED
Gary G. Dain — EUREKA ENERGY — Oct 5 19 81

STD. DWG. NO. 726-2



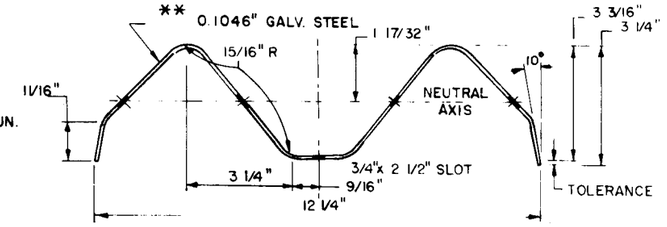
GUARDRAIL PLACED ON WIDE FILLS SHALL BE 2' INSIDE SLOPE BREAK AND SHALL BE MEASURED FROM GROUNDLINE RATHER THAN TOP OF PAVEMENT SEE STD DWG 815-1

** ALL DIMENSIONS SHALL CONFORM TO REQUIREMENTS OF ASTM DES. A-568 AND SUBJECT TO MANUFACTURING TOLERANCE.

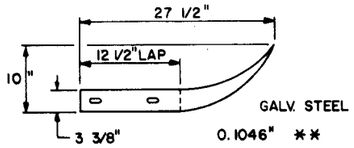
THE RAIL ELEMENTS SHALL BE SHOP CURVED TO FIT RADII FROM 20' TO 150'. RAIL ELEMENT NOT TO EXCEED 26'-01/2".

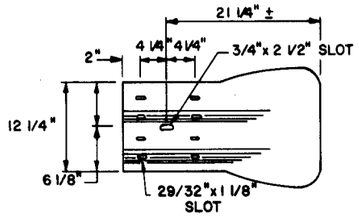
TRAILING END ELEMENT

ALL POST SPACING 6'-3" MAX. THROUGHOUT RUN. SEE STD. DWG 735-5 FOR STRUCT. APPROACH INSTALLATION.

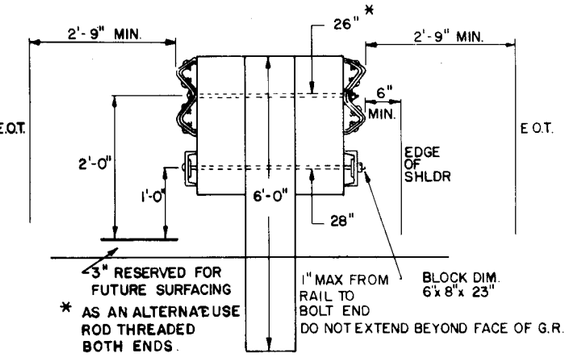


SECTION THRU RAIL ELEMENT

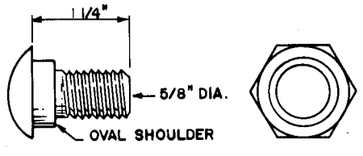




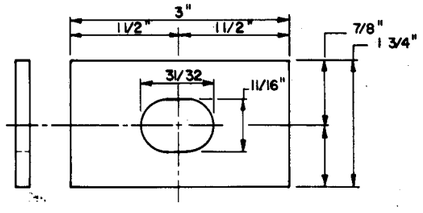
SINGLE GUARDRAIL



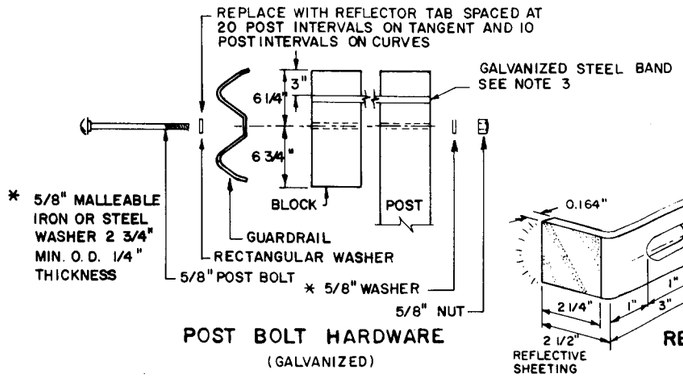
DOUBLE RAIL INSTALLATION
(MEDIAN BARRIER)
FOR WIDTHS 8 FT. AND LESS THAN 16 FT.



GALVANIZED SPLICE BOLT AND NUT

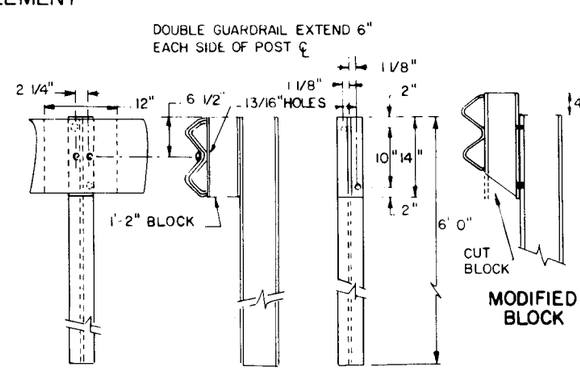


RECTANGULAR POST BOLT WASHER
(8 GAGE GALV.)



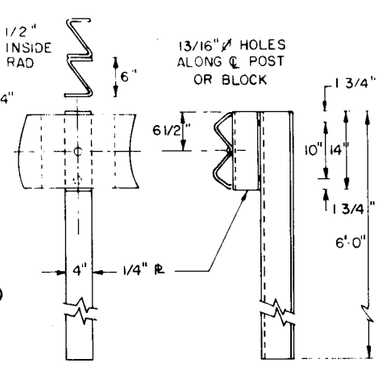
POST BOLT HARDWARE
(GALVANIZED)

DOUBLE GUARDRAIL EXTEND 6" EACH SIDE OF POST ℄



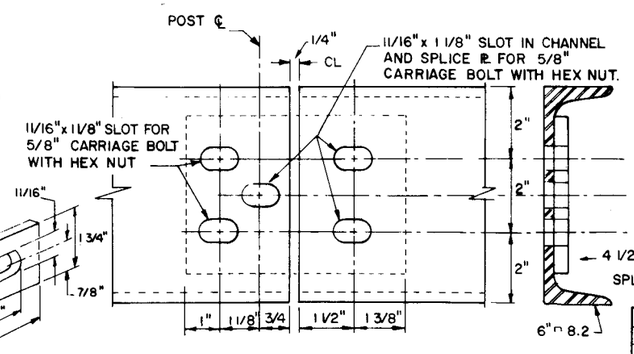
6 x 4B 8.5 NO.1 POST & BLOCK
ALL BOLTS 5/8" ∅ WITH HEX NUT & LOCK WASHER (GALVANIZED)

MODIFIED BLOCK

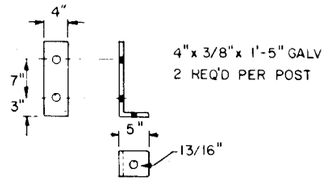


6"x 4" S SECTION POST & BLOCK
ALL BOLTS 5/8" ∅ WITH HEX NUT & LOCK WASHER (GALVANIZED)

REFLECTOR TAB
GALVANIZED



BOTTOM RAIL SPLICE
(RAIL SPLICES TO OCCUR AT POSTS ONLY)

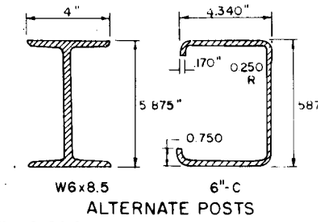


BRACKET DETAIL

(1) STEEL POSTS AND BLOCKS SHALL BE FABRICATED FROM MATERIAL CONFORMING TO AASHO M-183 (ASTM A-36) AND SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHO M-111 (ASTM A-123)

(2) EITHER STEEL POSTS AND BLOCKS OR WOOD POSTS AND BLOCKS MAY BE USED AT THE OPTION OF THE CONTRACTOR EXCEPT ONLY ONE TYPE OF POST AND BLOCK SHALL BE USED ON ANY ONE PROJECT.

(3) MANUFACTURED 3/4 x 035" ELECTRO GALV TYPE I, CLASS B, GRADE II BAND IN ACCORDANCE WITH FED. SPEC. QQ S-781E. TIGHTEN TO DEPRESS POST CORNERS 1/8".

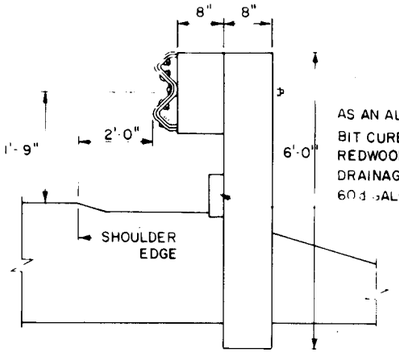


ALTERNATE POSTS

WOOD POST AND BLOCK
(6'-3" MAX POST SPACING)

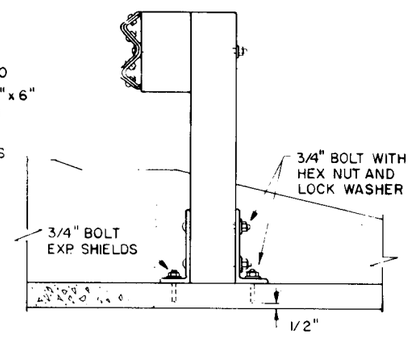
POSTS AND BLOCKS SHALL BE TREATED WOOD IN ACCORDANCE W/ STD. SPECS

DIMENSIONS: BLOCK - 6"x8"x 13"
POST - 6"x8"x 6'-0"
S 4 S OR ROUGH SAW



AS AN ALTERNATE TO BIT CURB USE A 2"x 6" REDWOOD PLANK IN DRAINAGE AREAS 60d GALV COM NAILS

STRUCTURE MOUNTING BRACKET
(SEE BRACKET DETAIL BELOW)



REDRAWN 6-26-81

EUREKA ENERGY

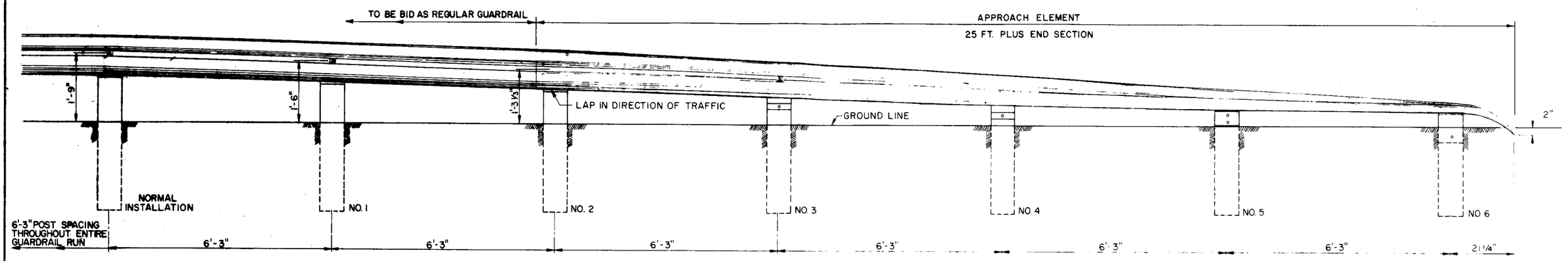
SUPERSEDES

REVISIONS
Date Appr.

BEAM GUARD RAIL

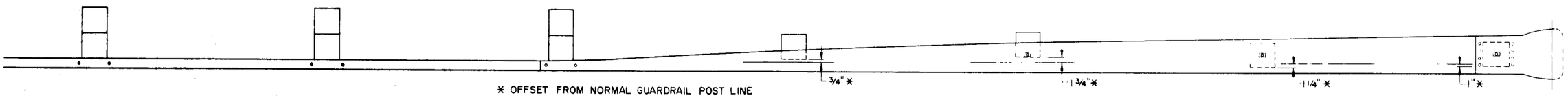
RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Date 19 81
ACCEPTED
EUREKA ENERGY — Date 19 81

STD. DWG. NO. 735-1



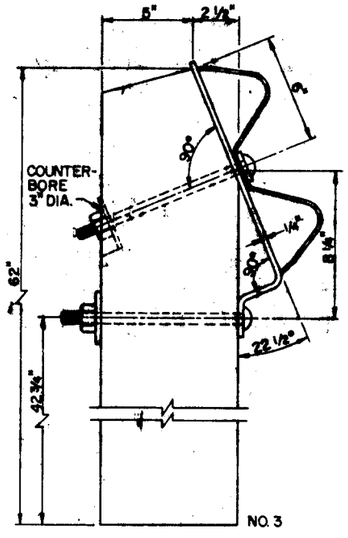
GUARDRAIL APPROACH ELEMENT
ELEVATION

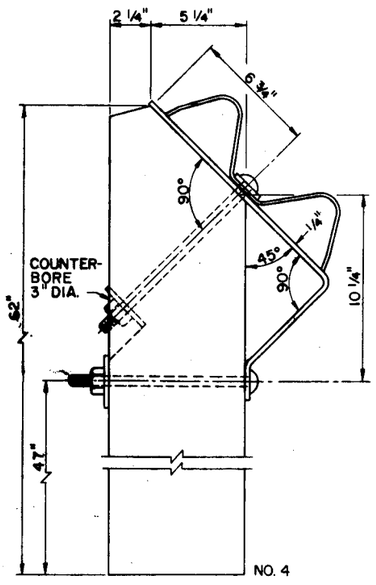
POSTS 1 AND 2 SHALL BE FULL LENGTH ADJUSTED TO PROPER HEIGHT

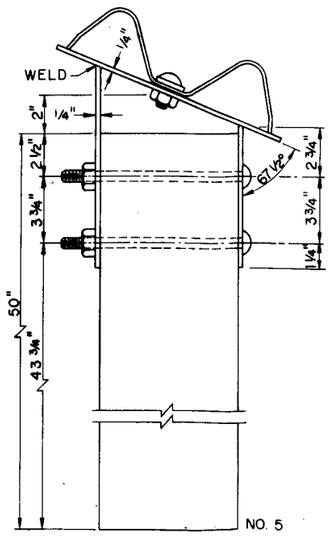


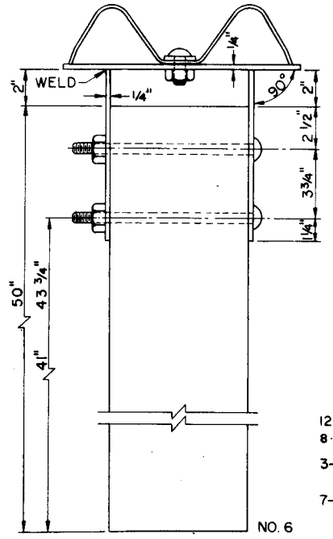
* OFFSET FROM NORMAL GUARDRAIL POST LINE

PLAN









··NOTES··

(1) THE APPROACH ELEMENT SHALL BE TWISTED TO HORIZONTAL AND SECURED TO THE POSTS, AS SHOWN, WITH THE END SECTION TIP BURIED.

(2) PLACE DELINEATOR POST ADJACENT TO THE BEGINNING OF THE APPROACH ELEMENT.

(3) THE APPROACH END ELEMENT SHALL BE TANGENT TO THE NORMAL GUARDRAIL LINE.

(4) FOR POST, RAIL AND TRAILING END ELEMENT DETAILS SEE STD. DWG. NO. 735-1. FOR GUARDRAIL INSTALLATION SEE STD. DWG NO. 735-3

(5) THE POST-RAIL BRACKET SHALL BE 7½" WIDE AND HAVE A 1" OVERHANG ON EACH SIDE OF THE GUARDRAIL.

(6) THE ELEMENT SHALL BE INSTALLED ON THE APPROACH GUARD RAIL AND ON TRAILING END OF GUARD RAIL IN MEDIANS AND ON ALL GUARD RAIL ON TWO LANE ROADS.

8-1-67 RAISED GUARDRAIL & ADDED NOTE 6
2-7-67 LOWERED GUARDRAIL AND POSTS 1 AND 2

12-5-72 TOOK OFF STRIPING
8-8-72 CHANGED POST LENGTH
3-2-71 DIMENSIONED APPR. ELEMENT.
7-7-70 INDICATED LENGTH TO BE PAINTED.

EUREKA ENERGY

SUPERSEDES

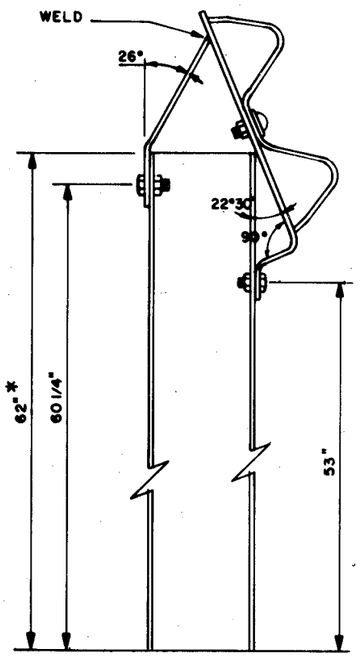
REVISIONS

Date	Appr.
2-7-67	
8-1-67	
7-7-70	
3-2-71	
8-8-72	
12-5-72	

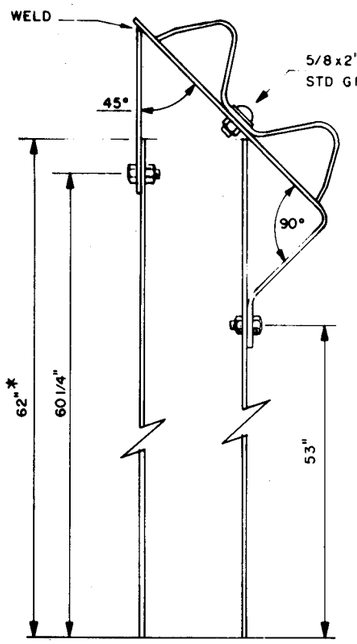
GUARDRAIL APPROACH ELEMENT INSTALLATION

RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Date: Oct 5, 19 81
ACCEPTED
EUREKA ENERGY — Oct 5, 19 81

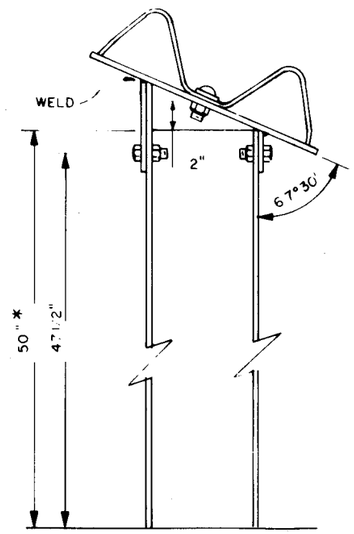
STD. DWG. NO. 735-2



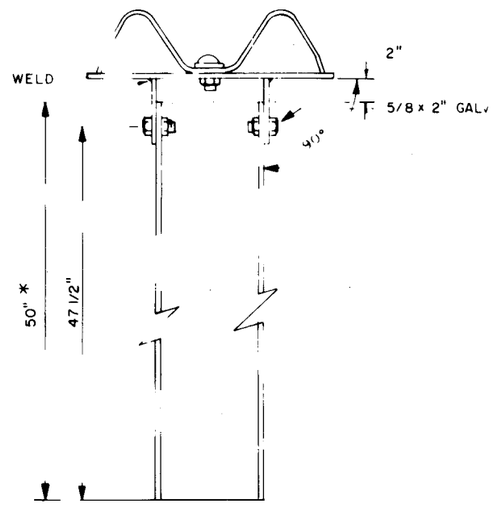
NO. 3



NO. 4



NO 5



NO. 6

* SEE NOTE 3

1 FOR INSTALLATION DETAILS SEE STANDARD DWG 735-2

2 THE BRACKET SHALL BE 7 1/2" x 1/4" AND SHALL HAVE A 1" OVERHANG ON EACH SIDE OF THE GUARDRAIL.

3 THESE ARE LENGTHS OF POSTS. DEPTH SHALL BE ADJUSTED TO PRODUCE A STRAIGHT LINE AT THE CENTER OF RAIL

1·23·80 CHANGED NO. 5 - ADDED NOTE 3
11·15·79 2" DIM.- RENUMBERED POSTS

EUREKA ENERGY

SUPERSEDES

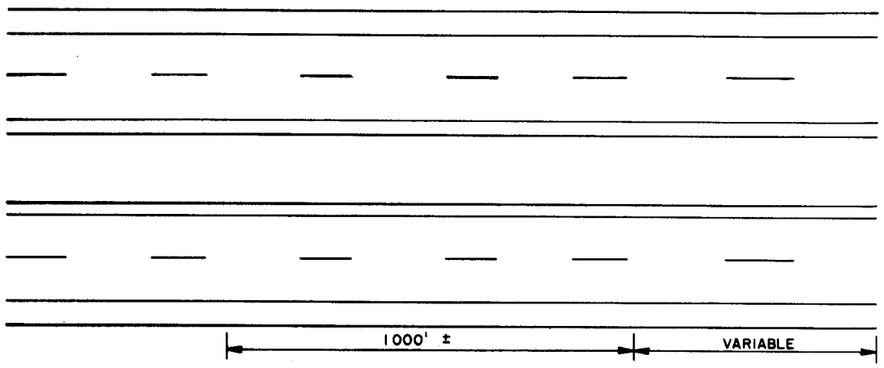
REVISIONS

Date	Appr.
11·15·79	
1·23·80	

TURN DOWN BRACKET FOR STEEL GUARDRAIL POSTS

RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Oct 5 19 81
ACCEPTED
EUREKA ENERGY — Oct 5 19 81

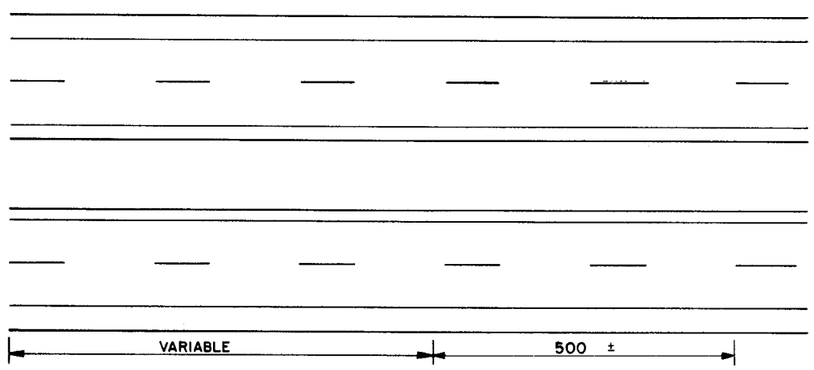
STD. DWG. NO. 735-2A



ROAD CONSTRUCTION NEXT 42 MILES

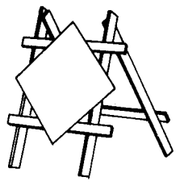
ROAD CONSTRUCTION AHEAD

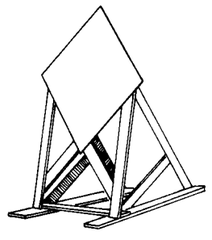
CONSTRUCTION WORK AREA

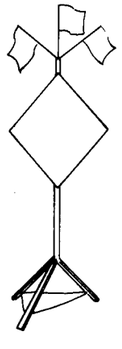


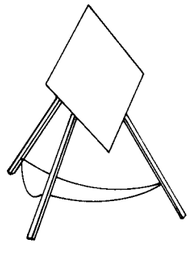
END CONSTRUCTION

THANK YOU



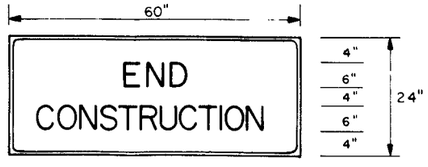




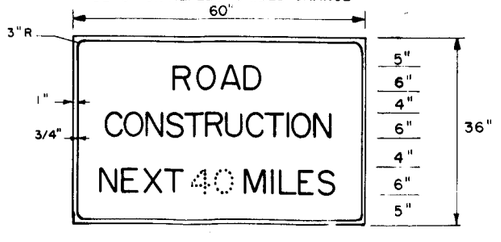


PORTABLE AND TEMPORARY MOUNTINGS

G 20-3
8" SERIES C
BLACK ON REFL ORANGE



G 20-2
5" SERIES C
BLACK ON REFLECTORIZED ORANGE



G 20-1
6" AND 3" SERIES C
BLACK ON REFLECTORIZED ORANGE

1 ALL SIGNS PLACED IN THE NORMAL TRAVELLED WAY SHALL BE CONSTRUCTED OF WOOD, PLASTIC OR FABRIC. METAL SIGNS SHALL NOT BE ALLOWED ON PORTABLE SUPPORTS

2 ALL CONSTRUCTION PROJECTS THROUGH WHICH TRAFFIC MUST PASS, SHALL HAVE A BLACK ON REFLECTORIZED ORANGE G20-1 "ROAD CONSTRUCTION" ADVANCE NOTIFICATION SIGN MOUNTED ON POSTS. THIS SIGN SHALL ALSO BE SUPPLEMENTED BY A BLACK ON ORANGE "ROAD CONSTRUCTION AHEAD" SIGN ON POST(S). THE END OF "PASS THROUGH" CONSTRUCTION AREAS SHALL BE DESIGNATED BY THE BLACK ON REFLECTORIZED ORANGE (1) G20-2 "END CONSTRUCTION" SIGN AND (2) G 20-3 'THANK YOU' ALL SIGNS SHALL BE MAINTAINED IN A CLEAN LEGIBLE PROPERLY MOUNTED INTACT CONDITION.

3 SPECIFIC REROUTING OR CHANNELIZING OF TRAFFIC THROUGH THE CONSTRUCTION WORK AREA SHALL COMPLY WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES OR AS DIRECTED BY THE ENGINEER

4 ALL TRAFFIC CONTROL DEVICES USED TO REGULATE, CONTROL, GUIDE OR WARN TRAFFIC WHILE PASSING THROUGH THE CONSTRUCTION AREAS, SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

5 ALL TEMPORARY (PORTABLE MOUNTINGS) FOR CONSTRUCTION SIGNS SHALL HAVE SUFFICIENT BALLAST TO MAINTAIN THE INTENDED POSITION REGARDLESS OF CLIMATIC CONDITIONS OR WIND LOADS FROM PASSING TRAFFIC.

6 PORTABLE AND TEMPORARY SIGNS SHALL BE MOUNTED A MINIMUM OF 12" ABOVE THE ROADWAY TO BOTTOM OF SIGNS SIGNS SHALL BE PLACED AT RIGHT ANGLES TO AND FACING THE LINE OF TRAFFIC THEY SERVE.

7 SEE STD. DWG. 745-60 FOR NO. OF POSTS REQUIRED FOR TEMPORARY INSTALLATION.

8. REFLECTORIZED ORANGE SHALL CONFORM TO STANDARD SPECIFICATIONS.

9. FABRIC SIGNS SHALL BE USED FOR DAYLIGHT OPERATIONS ONLY. IF WORK CONTINUES INTO NIGHTTIME, REFLECTORIZED SIGNS SHALL BE USED.

4-3-79 NOTE 9 ADDED - CHGED 6
8-15-78 CHANGED NOTES 3 & 4
ADDED NOTE 8

2-4-76 CONTR'S NAME-ORANGE

7-13-76 REMOVED CONTRACTOR'S NAME
8-15-73 ADDED NOTE 7

EUREKA ENERGY

SUPERSEDES

REVISIONS

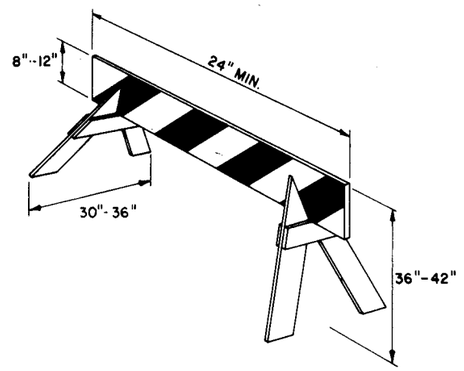
Date	Appr.
8-15-73	
2-4-76	
7-13-76	
8-15-78	
4-3-79	

CONSTRUCTION NOTIFICATION SIGNS

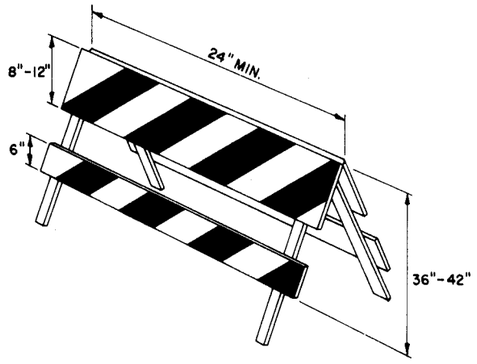
RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Oct. 5 Date 19 81

ACCEPTED
EUREKA ENERGY — Oct 27 19 81

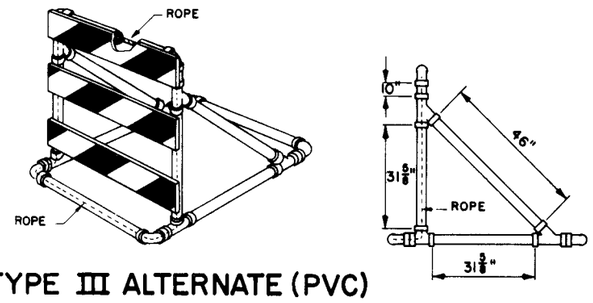
STD. DWG. NO. 745-1B



TYPE I



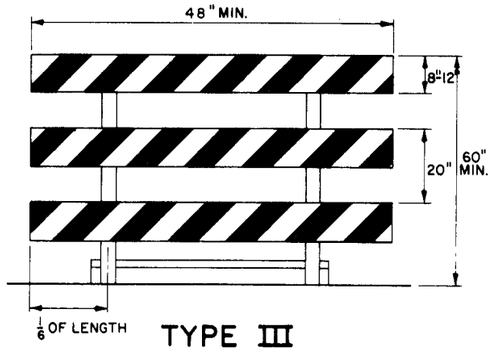
TYPE II



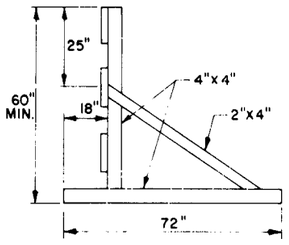
TYPE III ALTERNATE (PVC)

MATERIALS

30' - 3" PVC CONDUIT
6 - 3" PVC 90° ELBOWS
2 - 3" PVC TEES
4 - 3" PVC WYES
3 - 9" x 48" x .025" ANODIZED ALUMINUM FACE PANELS
12 - 1" NO. 14 PAN HEAD METAL SCREWS
15' - 3/16" NO. 6 SOLID BRAIDED NYLON ROPE
2 - 5/8" x 11" NO. 8 SPRING

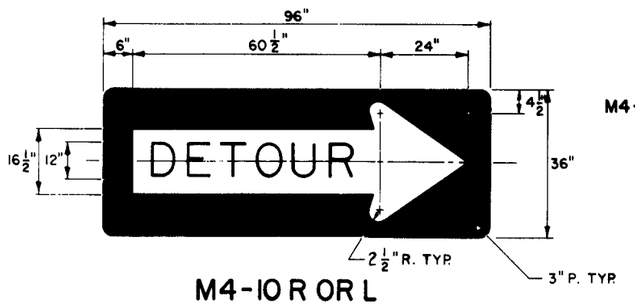


TYPE III



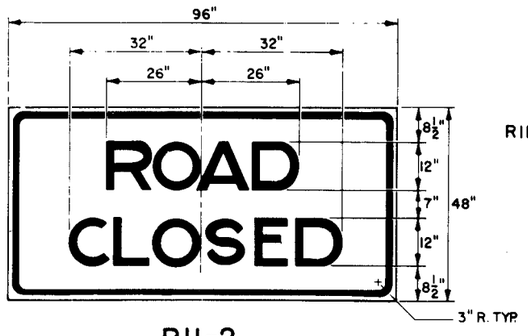
WOOD SUPPORT

STEEL SUPPORT



M4-10 R OR L

M4-10 R OR L: SERIES "D" LEGEND
BLACK LEGEND AND BACKGROUND
WITH REFLECTORIZED ORANGE ARROW.



R11-2

R11-2: SERIES "D" LEGEND
BLACK LEGEND AND BORDER ON
REFLECTORIZE WHITE BACKGROUND.
ALTERNATE SIGN USE R11-4.

7-8-80 ENLARGED VIEW OF SIGN (LOWER LEFT)
9-11-79 TYPE III 48" MIN - 6" STRIPE (NOTE 1) (NOTE 9)
4-3-79 ADDED NOTE 8
8-15-78 CHANGED NOTE 5 ADDED NOTE 7
1-4-77 REDRAWN ADDED PVC BARRICADE

NOTES.

1. TYPE I, II & III BARRICADES. EACH BARRICADE RAIL SHALL BE MARKED WITH ALTERNATE REFLECTORIZED ORANGE AND WHITE STRIPES 6 INCHES IN WIDTH AND SLANTING DOWNWARD AT AN ANGLE OF 45°. ORANGE FLAGS MAY BE USED ON BARRICADES DURING DAYLIGHT HOURS. SEE NOTE 9
2. THE DETOUR BARRICADES SHALL CONSIST OF A R11-2 OR -4 ROAD CLOSED (96"x48"), TWO 96"x36" M4-10R OR M4-10L SIGNS POINTING IN THE DIRECTION TRAFFIC IS TO TURN, AND AS MANY TYPE III BARRICADES AS ARE NEEDED TO BARRICADE THE ROADWAY. ALL SIGNS AND BARRICADES SHALL BE REFLECTORIZED. THE DETOUR ROUTE SHALL BE COMPLETELY SIGNED WITH NECESSARY GUIDE AND WARNING SIGNS BEFORE REROUTING IS EFFECTED.
3. TYPE III BARRICADES MAY BE MOUNTED ON POSTS OR PORTABLE SUPPORTS AS DIRECTED BY THE ENGINEER. ALL SUPPORTS SHALL BE PROVIDED WITH SUFFICIENT BALLAST TO MAINTAIN BARRICADE IN INTENDED POSITION REGARDLESS OF CLIMATIC CONDITIONS OR WIND LOADS FROM PASSING TRAFFIC.
4. STRIPES SHALL SLANT DOWNWARD IN THE DIRECTION OF THE DETOUR WITH THE LETTER L OR R ADDED TO THE NUMBER.
5. TRAFFIC CONTROL DEVICES: ALL SIGNS, BARRICADES & OTHER DEVICES USED TO REGULATE, CONTROL, GUIDE OR WARN TRAFFIC SHALL CONFORM TO THE STANDARDS SET FORTH IN THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
6. TYPE III ALTERNATE PVC. BARRICADE PVC CONDUIT SHALL BE TIED TOGETHER WITH ROPE THREADED INTO PIPE INTERIOR, AS INDICATED BY DOTTED LINE. USE # 6 3/16" DIA. SOLID BRAIDED NYLON OR EQUIVALENT
7. REFLECTORIZED ORANGE AND WHITE SHALL CONFORM TO STANDARD SPECIFICATIONS.
8. BALLAST SHALL NOT BE HIGHER THAN 12" ABOVE THE GROUND
9. FOR RAILS LESS THAN 3 FT. LONG USE 4" WIDE STRIPES.

EUREKA ENERGY

SUPERSEDES

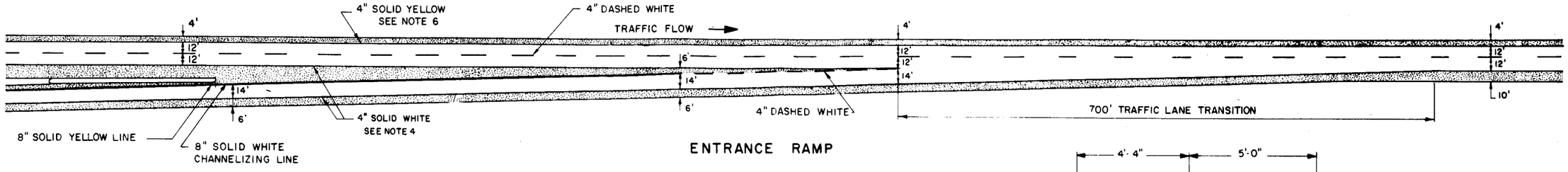
REVISIONS

Date	Appr.
1-4-77	
8-15-78	
4-3-79	
9-11-79	
7-8-80	

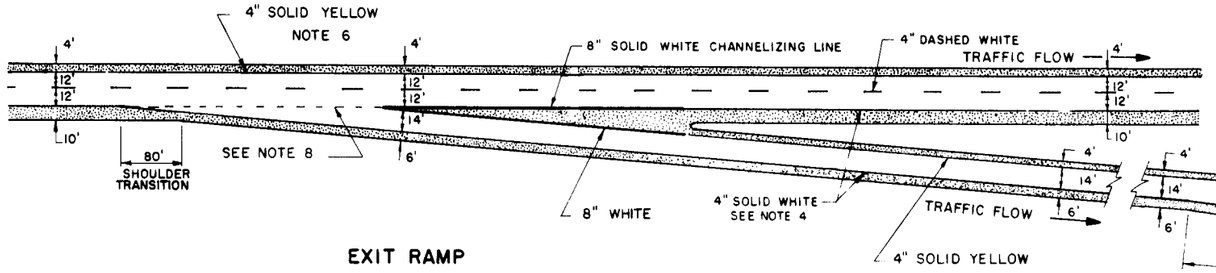
CONSTRUCTION SIGNING BARRICADES

RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Oct 5, 19 81
ACCEPTED
EUREKA ENERGY — Oct 5, 19 81

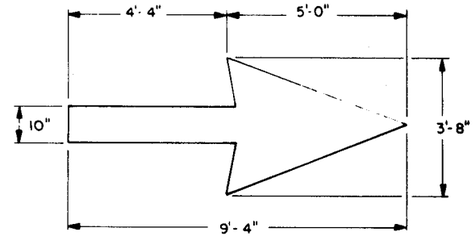
STD. DWG. NO. 745-1C



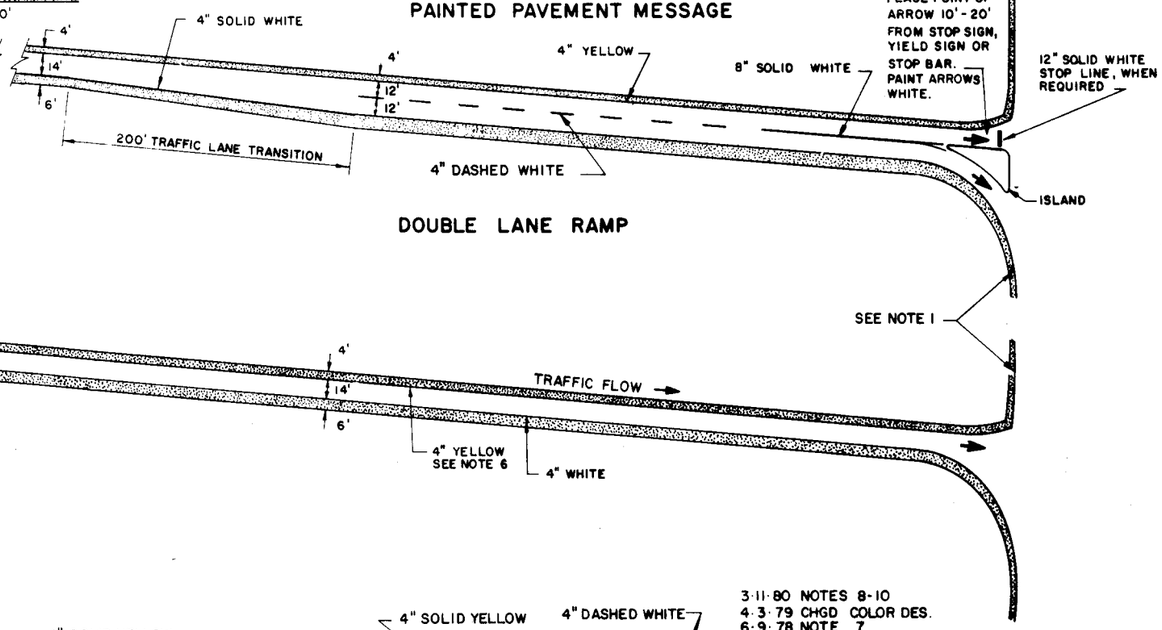
ENTRANCE RAMP



EXIT RAMP



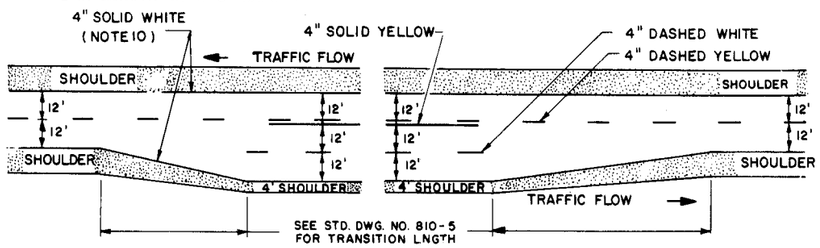
PAINTED PAVEMENT MESSAGE



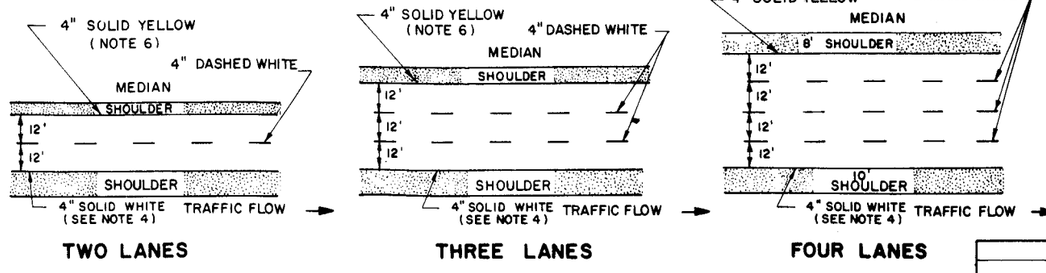
DOUBLE LANE RAMP

NOTES—

1. 4" SOLID RAMP SHOULDER MARKINGS SHALL TIE INTO EXISTING SHOULDER MARKINGS ON CROSS STREET WITH A GRADUAL TRANSITION. IF CROSS STREET HAS NO SHOULDER MARKINGS, RAMP SHOULDER MARKINGS SHALL BE DISCONTINUED AT CROSS STREET EDGE OF PAVEMENT.
2. ALL CONTINUOUS PAVEMENT MARKINGS SHALL BE FULLY REFLECTORIZED
3. ALL 4" DASHED WHITE PAINT MARKINGS SHALL BE 10 FEET IN LENGTH WITH 5 FEET REFLECTORIZED AND 5 FEET UNREFLECTORIZED AND HAVE A 30 FOOT GAP BETWEEN THE DASHES.
4. THE 4" SOLID WHITE LINE BETWEEN TRAVEL LANE AND RIGHT SHOULDER IS REQUIRED IN ALL CASES EXCEPT AS MODIFIED BY NOTE 10.
5. ALL CURBS WITHIN INTERCHANGE AREAS ARE TO BE PAINTED WITH REFLECTORIZED YELLOW PAINT EXCEPT WHERE OTHERWISE DESIGNATED BY THE ENGINEER.
6. THE LEFT EDGE OF EACH ROADWAY OF DIVIDED HIGHWAY AND STREETS SHALL BE PAINTED YELLOW.
7. A 4" SOLID YELLOW LINE IS REQUIRED 1 FT. FROM RAISED MEDIAN WITH YELLOW CURB.
8. A REFLECTORIZED DASHED LINE SHALL BE PAINTED THRU THE EXIT RAMP OPENING 2' IN LENGTH WITH 6' GAPS.
9. AN 8" SOLID BLACK PAINT LINE SHALL BE APPLIED ON NEWLY CONSTRUCTED CONCRETE PAVEMENT PRIOR TO APPLYING WHITE PAINT LINES. SUBSEQUENT BLACK LINE PAINTING WILL BE AT THE DISCRETION OF THE DISTRICT ENGINEER
10. ON TWO LANE TWO WAY ROADWAYS ALL PAVEMENT 26 FT. OR WIDER SHALL HAVE A 4" SOLID WHITE SHOULDER LINE. WHERE THE WIDTH OF PAVEMENT IS UNDER 26' THE SHOULDER LINES MAY BE PLACED ON SELECTED PAVEMENTS UPON WRITTEN JUSTIFICATION AND RECOMMENDATIONS OF THE DIST. DIRECTOR.



TWO LANE TWO WAY WITH TRUCK LANE



TWO LANES THREE LANES FOUR LANES

ROADWAY SECTIONS

3-11-80 NOTES 8-10
4-3-79 CHGD COLOR DES.
6-9-78 NOTE 7
5-9-78 CHANGED NOTE 4
2-23-78 WHITE ARROWS ENDOF RAMP
8-25-77 ADDED TRAFFIC FLOW ARROWS
6-5-77 CHANGED NOTE 3
3-8-77 YELLOW SHLDR - BLACK PAINT - REDRAWN

EUREKA ENERGY

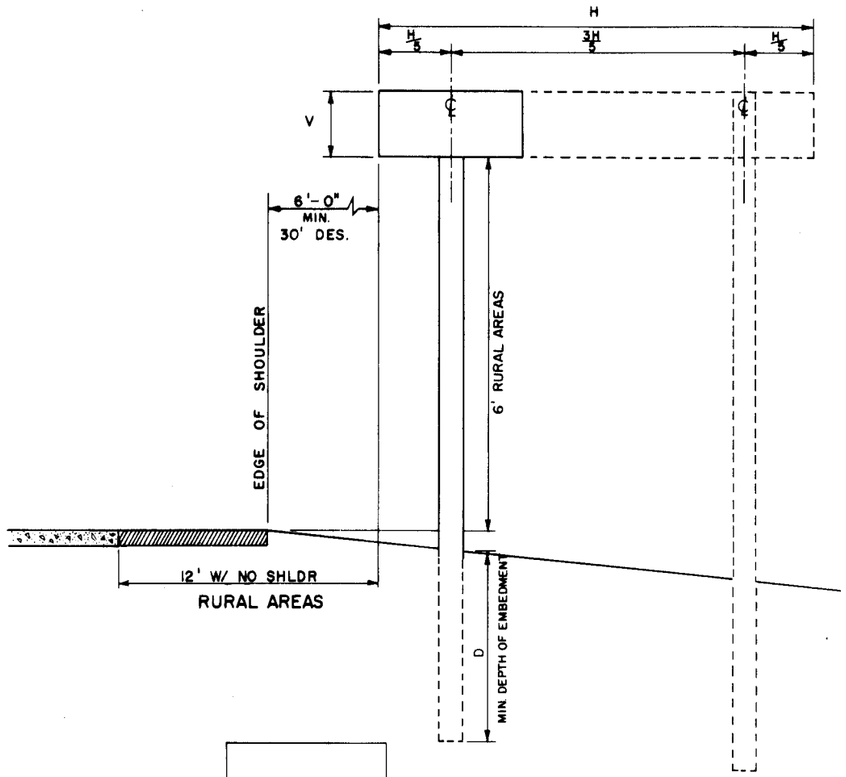
TYPICAL PAVEMENT MARKINGS

SUPERSEDES

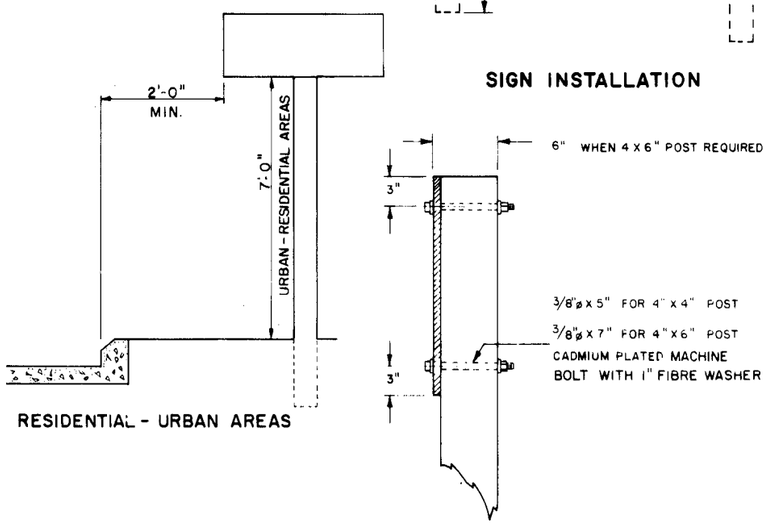
REVISIONS	
Date	Appr.
3-8-77	
6-5-77	
8-25-77	
2-23-78	
5-9-78	
6-9-78	
4-3-79	
3-11-80	

RECOMMENDED FOR APPROVAL,
PROJECT ENGINEER Ralph Watson Date Oct 5 1981
ACCEPTED
EUREKA ENERGY Date Oct 5 1981

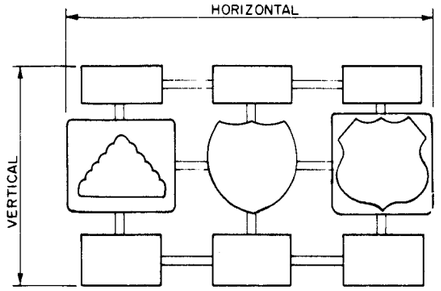
STD. DWG. NO. 745-41



SIGN INSTALLATION

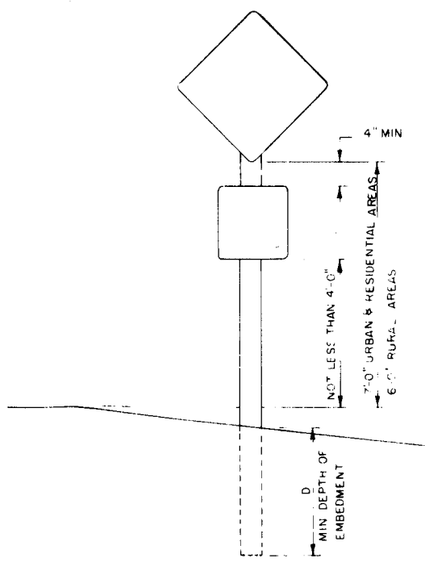


SIDE VIEW



ROUTE MARKERS

SEE CHART FOR SIGN DIMENSIONS AND POSTS REQUIRED



MULTIPLE SIGNS

SIGN AREA (SQ. FT.)	TYP. SIGN DIMENSIONS H HORIZONTAL (INCHES)	TYP. SIGN DIMENSIONS V VERTICAL (INCHES)	NUMBER OF POSTS REQUIRED	POST SIZE	EMBEDMENT (D) FEET
1.5	12	18	1	4 x 4	4
3.0	18	24	1	4 x 4	4
2.0	24	12	1	4 x 4	4
4.0	24	24	1	4 x 4	4
5.0	24	30	1	4 x 4	5
6.25	30	30	1	4 x 4	5
7.5	30	36	1	4 x 4	5
3.0	36	12	1	4 x 4	4
4.5	36	18	1	4 x 4	4
9.0	36	36	1	4 x 6	5
12.0	36	48	1	4 x 6	5
5.25	42	18	1	4 x 6	5
8.0	48	24	1	4 x 6	5
10.0	48	30	1	4 x 6	5
16.0	48	48	1	4 x 6	6
20.0	48	60	2	4 x 6	5
6.67	60	16	2	4 x 4	4
10.0	60	24	2	4 x 4	4
12.5	60	30	2	4 x 4	5
15 0	60	36	2	4 x 6	5
12.0	72	24	2	4 x 4	5
24 0	72	48	2	4 x 6	5
10 67	96	16	2	4 x 4	4
20 0	96	30	2	4 x 4	5
32 0	96	48	2	4 x 6	6

1. TRAFFIC SIGNS SHALL CONFORM TO THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS.
2. TIMBER POSTS SHALL CONFORM TO THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS.
3. MULTIPLE SIGN INSTALLATIONS, EXCLUDING ROUTE MARKERS, SHALL USE ONE 4"x6" POST.
4. DEPTH OF EMBEDMENT MAY BE REDUCED WITH WELL COMPACTED GRANULAR SOILS BUT NOT LESS THAN 4'-0"
5. SIGNS IN RESIDENTIAL OR URBAN AREAS SHALL HAVE A MINIMUM DISTANCE OF 2' FROM EDGE OF CURB TO EDGE OF SIGN.

6-30-81 CHG OFFSET DIM
4-27-81 DEL REF TO SPEC SEC NO.
1-9-79 PUT ON NOTE 5 AND RES.-URBAN DETAIL
1-4-77 30' DES. OFFSET
12-6-74 FRAMED U.S MARKER
6-1-71 CHANGED 'TAP' TO 'MACHINE' BOLT

EUREKA ENERGY

SUPERSEDES

REVISIONS Date	Appr.
6-1-71	
12-6-74	
1-4-77	
1-9-79	
4-27-81	
6-30-81	

HIGHWAY SIGNS OTHER THAN FREEWAYS

RECOMMENDED FOR APPROVAL
Ralph G. Watson — Oct 5, 1981
PROJECT ENGINEER — Date
ACCEPTED
Jerry A. Davis — Oct 27, 1981
EUREKA ENERGY

STD. DWG. NO. 745-60

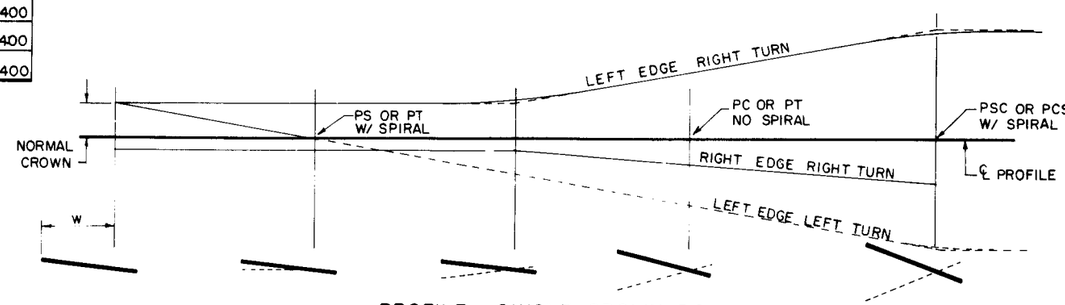
SUPERELEVATION MINIMUM TRANSITION LENGTH

V=30 MPH						V=40 MPH					V=50 MPH					V=60 MPH						V=70 MPH						
D	R	E	W			D	E	W			D	E	W			D	E	W				D	E	W				
			20	30	40			20	30	40			20	30	40			20	30	40	50			20	30	40	50	60
0 15'	22918	NC	0	0	0	0 15'	NC	0	0	0	0 15'	NC	0	0	0	0 15'	NC	200	200	200	200	0 15'	RC	200	200	200	200	300
0 30'	11459	NC	0	0	0	0 30'	NC	0	0	0	0 30'	RC	150	150	0	0 30'	RC	200	200	200	200	0 30'	RC	200	200	200	250	300
0 45'	7639	NC	0	0	0	0 45'	RC	150	150	150	0 45'	RC	150	150	150	0 45'	RC	200	200	200	200	0 45'	.021	200	200	200	250	300
1 00'	5730	NC	0	0	0	1 00'	RC	150	150	150	1 00'	RC	150	150	150	1 00'	.023	200	200	200	250	1 00'	.028	200	200	250	350	400
1 30'	3820	RC	100	100	150	1 30'	RC	150	150	150	1 30'	.025	150	150	150	1 30'	.033	200	200	300	350	1 30'	.040	200	300	400	500	600
2 00'	2865	RC	100	100	150	2 00'	.023	150	150	150	2 00'	.031	150	200	200	2 00'	.041	200	250	350	450	2 00'	.050	250	400	500	600	700
2 30'	2292	RC	100	100	150	2 30'	.028	150	150	200	2 30'	.037	150	200	300	2 30'	.046	200	300	400	500	2 30'	.056	300	450	550	700	800
3 00'	1910	.022	100	150	150	3 00'	.032	150	150	250	3 00'	.042	150	250	350	3 00'	.053	250	350	450	600	3 00'	.060	300	450	600	750	900
3 30'	1637	.025	100	150	200	3 30'	.036	150	200	250	3 30'	.046	200	300	400	3 30'	.056	250	350	500	600	3 18'	.060	300	450	600	750	900
4 00'	1432	.027	100	150	200	4 00'	.039	150	200	300	4 00'	.050	200	300	400	4 00'	.059	250	400	500	650							
5 00'	1146	.032	150	200	250	5 00'	.045	200	250	350	5 00'	.056	250	350	450	4 36'	.060	250	400	500	650							
6 00'	955	.036	150	200	300	6 00'	.049	200	250	350	6 00'	.059	250	350	450													
7 00'	819	.040	150	250	300	7 00'	.053	200	300	350	6 54'	.060	300	350	500													
8 00'	716	.043	150	250	350	8 00'	.056	200	300	400																		
9 00'	637	.045	200	250	350	9 00'	.058	200	300	400																		
10 00'	573	.048	200	300	400	10 00'	.059	200	300	400																		
11 00'	521	.050	200	300	400	11 00'	.060	200	300	400																		
12 00'	477	.052	200	300	400	11 20'	.060	200	300	400																		
13 00'	441	.073	200	350	400																							
14 00'	409	.055	200	350	450																							
16 00'	358	.057	250	350	450																							
18 00'	318	.059	250	350	450																							
20 00'	286	.060	250	350	450																							
21 00'	273	.060	250	350	450																							

V - DESIGN SPEED.
D - DEGREE OF CURVATURE
R - RADIUS OF CURVE FEET.
E - SUPERELEVATION FOOT PER FOOT.
W - CROSS SECTIONAL DISTANCE IN FEET FROM AXIS OF ROTATION (NORMALLY THE CONTROL LINE) TO THE OUTER EDGE OF THE SHOULDER. USE THE GREATER SIDE AND ROUND UP TO A MULTIPLE OF 10.
L = TRANSITION LENGTH
NC = NORMAL CROWN
RC = REMOVE ADVERSE CROWN AND SUPERELEVATE AT NORMAL CROWN.

INSTRUCTIONS

1. USE SPIRALS WITH CURVES THAT FALL BELOW THE HEAVY LINE IN TABLE, DO NOT USE SPIRALS ON LOW VOLUME ROADS, FRONTAGE ROADS OR RAMPS REGARDLESS OF SUPER ELEVATION. IF SPIRALS ARE USED, THE SPIRAL LENGTH SHALL BE THE TRANSITION LENGTH.
2. ADJUST THE 0.6L AND 0.4L DIMENSIONS (SEE PROFILE SKETCH) SO THAT THE BEGIN AND END POINTS OF THE TRANSITION FALL ON EVEN OR HALF STATIONS. MAKE CROWN RUNOUT APPROX. 4 W ADJUSTED TO A MULTIPLE OF 50' WHERE W IS THE VALUE DEFINED IN THE LEGEND.
3. CHECK FOR DRAINAGE IN THE ROADWAY WHERE THE CROSS SLOPE IS ZERO AND IN SIDE DITCHES.
4. THE LAST LINE OF EACH SECTION OF THE TABLE SHOWS MAXIMUM ALLOWABLE CURVATURE FOR THE GIVEN SPEED.
5. PLACE THE FOLLOWING INFORMATION CONSTRUCTION PLANS.
   RATE OF SUPPERELEVATION
   BEGIN AND END OF CROWN RUNOUT
   BEGIN AND END OF TRANSITION IF SPIRALS ARE NOT USED.

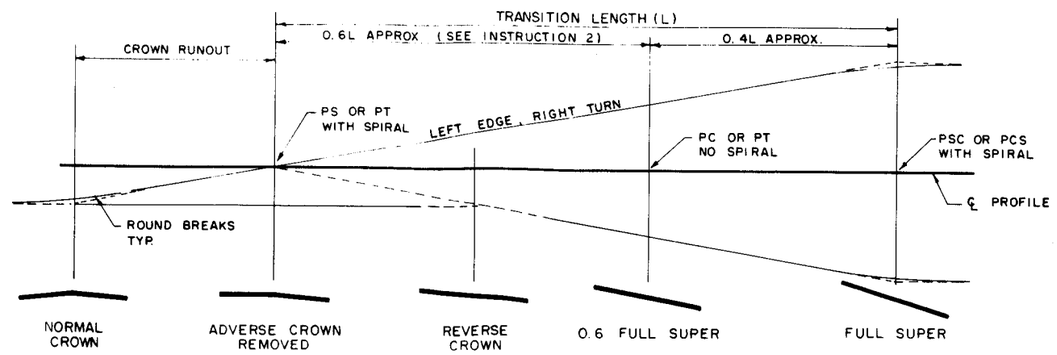


PROFILE - SINGLE CROWN ROAD

PAVEMENT WIDENING		
RADIUS ON INNER EDGE OF PAVEMENT	PAVEMENT WIDENING / FEET	
	1-LANE 1-WAY TURNING RDWY 14' PAVEMENT	2-LANE 2-WAY TURNING RDWY 24' PAVEMENT
50	6	11
75	4	8
100	3	6
150	2	5
200	2	3
300	1	2
400	1	2
500	1	1
TANGENT	0	0

CURVE WIDENING SHALL BE APPLIED TO THE INSIDE EDGE OF THE PAVEMENT WITH A SMOOTH TRANSITION EXTENDING THE SAME DISTANCE AS SUPERELEVATION RUNOFF.

NO WIDENING REQUIRED FOR 12' THROUGH TRAFFIC LANES WITHIN THE PERMISSIBLE LIMITS OF CURVATURE.



PROFILE - DOUBLE CROWN ROAD

10-14-80 R COLUMN UPPER LEFT

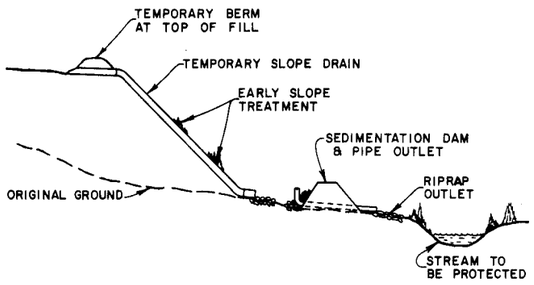
EUREKA ENERGY

SUPERSEDES	SUPERELEVATION AND WIDENING
EX. 805 1A	
" 1B	
REVISIONS	
Date Appr.	
10 14 80	

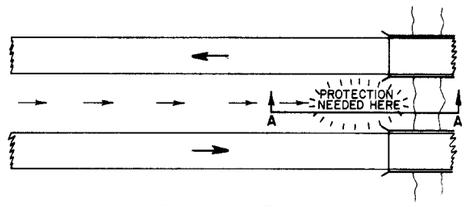
RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Oct 5 Date 19 81
ACCEPTED
EUREKA ENERGY — Oct 27 19 81

STD. DWG. NO. 805-1

EMBANKMENT CONSTRUCTION UTILIZING SILTATION CONTROLS



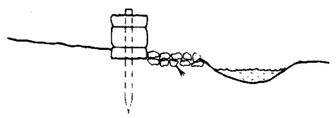
EXAMPLE OF PROTECTION



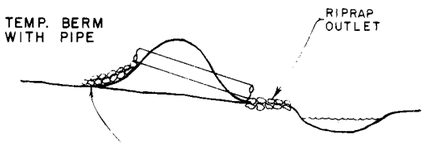
PLAN VIEW

TYPES OF PROTECTION

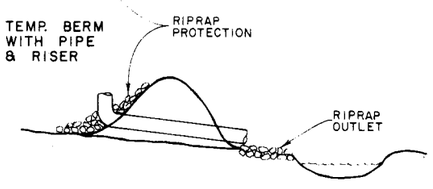
1- HAY BALES



2- TEMP. BERM WITH PIPE



3- TEMP. BERM WITH PIPE & RISER

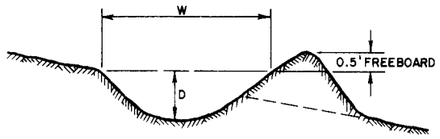


SECTION A-A

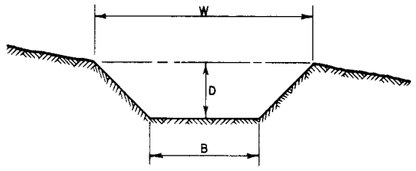
PROTECTION AT STREAM CROSSING MEDIAN & SIDE DITCHES

CONTOUR DITCHING

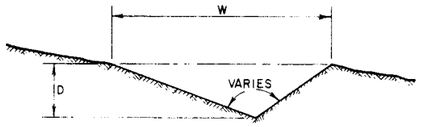
CROSS - SECTIONS



PARABOLIC



TRAPEZOIDAL



TRIANGULAR

DESIGN CRITERIA:

A. MAXIMUM GRADE — 1.5% IN BARE CHANNEL
2.5% IN VEGETATED CHANNEL
12 % IN ROCK-LINED CHANNEL

B. MINIMUM CHANNEL WIDTH (W) — 2 FEET

C. BACKSLOPE — 4:1 OR FLATTER

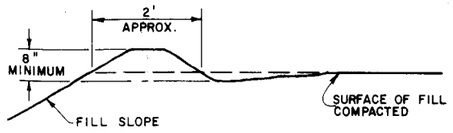
D. RIDGE SLOPE (CHANNEL SIDE) — 3 : 1 IF RIDGE IS UTILIZED

E. RIDGE SLOPE (DOWNHILL) — 2 : 1 OR FLATTER

F. MINIMUM DEPTH (D) — 1 FOOT

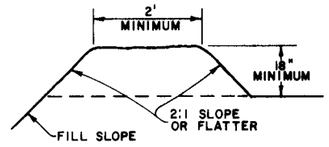
TEMPORARY BERMS

TYPE "A"

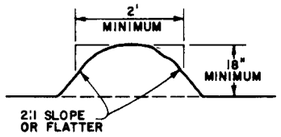


FILL BERM END VIEW

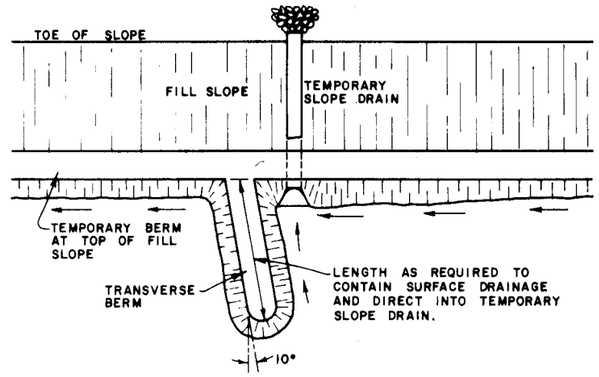
TYPE "B"



FILL BERM END VIEW



TRANSVERSE BERM END VIEW



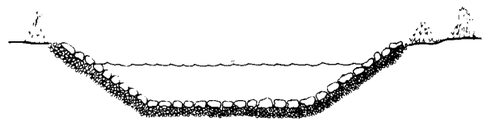
PLAN VIEW

DESIGN CRITERIA:

TYPE "B" TEMPORARY BERMS ARE DESIGNED TO ACCOMMODATE THE RUNOFF FROM APPROXIMATELY EIGHT (8) ACRES AND THE SPECIFIED INTERVAL FOR TEMPORARY SLOPE DRAINS OF 1000 FEET MAXIMUM WILL USUALLY KEEP THE DRAINAGE AREA WELL WITHIN THIS LIMITATION. IN SOME INSTANCES ON STEEP GRADES THE 1000 FOOT INTERVAL FOR TRANSVERSE TEMPORARY BERMS MAY BE INADEQUATE AND A CLOSER INTERVAL REQUIRED, AS DIRECTED BY THE PROJECT ENGINEER.

DIVERSION CHANNELS

SPECIFIC LINING SHALL BE LEFT TO THE CONTRACTORS CHOICE SUBJECT TO CONDITIONS STATED IN THE SPECIAL PROVISION COVERING THIS ITEM.



LARGE CHANNELS — USING RIPRAP LINING WITH GRAVEL FILTER MATERIAL

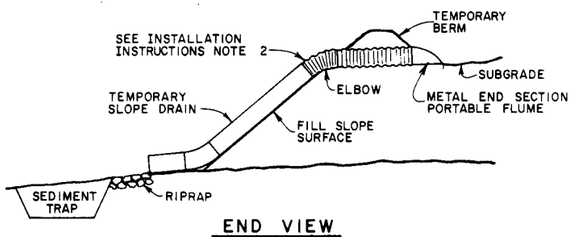
SMALL CHANNELS — USING GRAVEL

EUREKA ENERGY

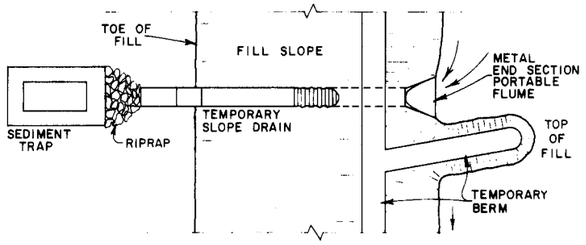
SUPERSEDES	TEMPORARY EROSION CONTROL - CONTOUR DITCHING AND TEMPORARY BERMS
REVISIONS Date Appr.	RECOMMENDED FOR APPROVAL Ralph G. Watson PROJECT ENGINEER 9-25 Date 10 81
	ACCEPTED Gary A. Davis EUREKA ENERGY Oct 27 10 81
	STD. DWG. NO. 1010

TEMPORARY SLOPE DRAINS

METAL, FLEXIBLE RUBBER, OR PLASTIC PIPE



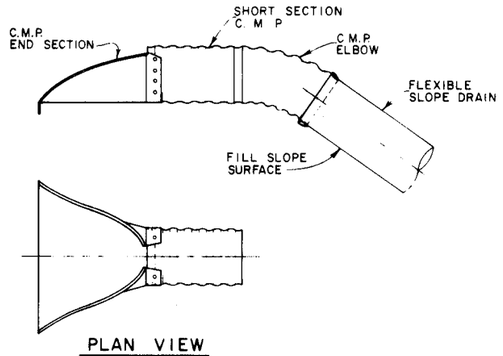
END VIEW



PLAN VIEW

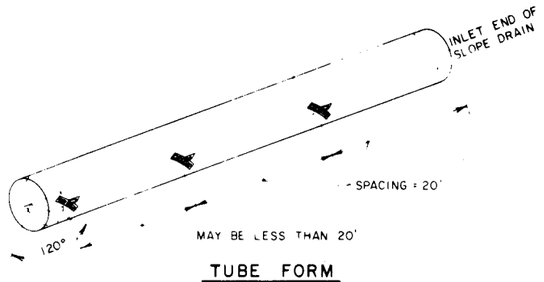
TYPICAL INSTALLATION

FLEXIBLE SLOPE DRAIN

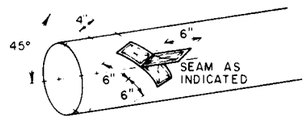


PLAN VIEW
C.M.P. END SECTION

TYPICAL DETAIL OF GROMMET ATTACHED TO FLEXIBLE PIPE



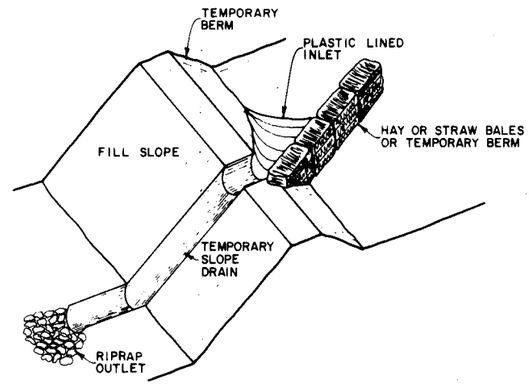
TUBE FORM



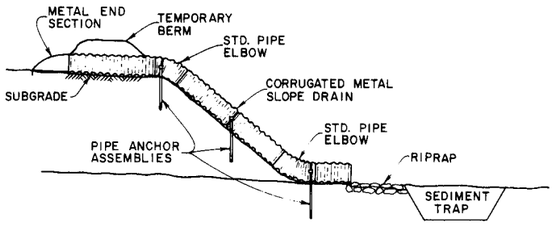
GROMMET DETAIL

EXAMPLE OF OPEN GUTTER SLOPE DRAIN

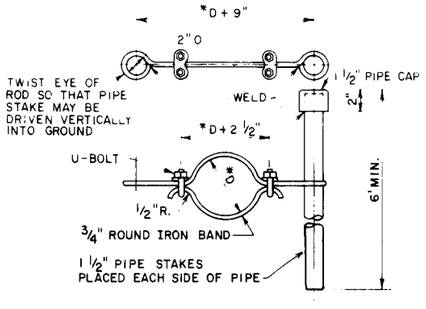
(HALF ROUND PIPE OR PLASTIC LINED)



CORRUGATED METAL PIPE



END VIEW



PIPE ANCHOR ASSEMBLY

NOTES:

PIPE ANCHORS TO BE PLACED ON EACH ELBOW AND AT 10'± INTERVALS ALONG SLOPE DRAIN AS DIRECTED BY THE ENGINEER.

A PIPE ANCHOR CONSISTS OF AN IRON BAND, 2 PIPE STAKES, AND ALL NECESSARY HARDWARE.

* D = DIAMETER OF PIPE PLUS 1/2"

DESIGN CRITERIA:

FOR SLOPE DRAINS CONSTRUCTED AT 1000 FOOT INTERVALS THE FOLLOWING ARE MINIMUM REQUIREMENTS.

A. USE 8" SMOOTH CONDUIT OR 12" CORRUGATED CONDUIT

B. MINIMUM SIZE HALF-ROUND SECTIONS OF PIPE SHALL BE 18"

C. FIBER MATTING AND PLASTIC SHEETING SHOULD NOT BE UTILIZED ON SLOPES STEEPER THAN 4:1 EXCEPT FOR, SHORT DISTANCES, 20' OR LESS, WHERE WATER CANNOT REACH EROSIVE VELOCITIES.

D. MINIMUM BOTTOM WIDTH OF A TEMPORARY GUTTER WILL BE 2' WITH A MINIMUM DEPTH OF GUTTER OF 8" WITH 2:1 SIDE SLOPES.

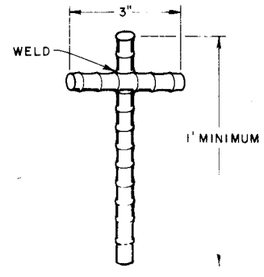
WHERE TEMPORARY SLOPE DRAINS ARE REQUIRED AT THE END OF CUT SECTIONS IT MAY BE NECESSARY TO INCREASE THE SIZE OF THE PIPE, HALF ROUND SECTION, OR GUTTER TO ACCOMMODATE A GREATER FLOW IF THE AREA TO BE DRAINED EXCEEDS 8 ACRES. THE CHART BELOW CAN BE USED AS A GUIDELINE FOR THE SIZES REQUIRED WHEN THE DRAINAGE AREA EXCEEDS 8 ACRES.

DRAINAGE AREA (ACRES)	SMOOTH PIPE SIZE	CORRUGATED PIPE SIZE	HALF ROUND PIPE SIZE	GUTTERS DEPTH	GUTTERS WIDTH
0 — 8	8"	12"	18"	8"	2'
8 — 11	10"	15"	21"	1'	2'
12 — 16	12"	18"	24"	1'	4'
16 — 20	15"	21"	30"	1'	6'
20 — 24	18"	24"	36"	1'	8'

INSTALLATION INSTRUCTIONS

FLEXIBLE SLOPE DRAINS

1. FABRICATE ONE STAKE FOR EACH GROMMET. THE STAKES SHOULD BE MADE OF 1/2 INCH REINFORCING ROD OR EQUIVALENT. A CROSS PIECE OF 1/2 INCH ROD, 3 INCHES LONG, SHOULD BE WELDED 1 INCH FROM THE UPPER END OF THE STAKE. THE STAKE SHOULD BE ABOUT 1 FOOT LONG. IF USED IN SOFT OR SANDY SOILS THE STAKE MUST BE LONGER



2. ATTACH THE INLET END OF THE SLOPE DRAIN TO THE CULVERT OUTLET WITH AN ELBOW AS SHOWN ABOVE.

3. UNROLL THE SLOPE DRAIN DOWN THE FILL SLOPE. MAKE SURE THAT THE OUTLET END IS ON SOLID GROUND, PREFERABLY ROCK. MAKE SURE ALSO THAT THE SLOPE DRAIN IS NOT IN A DITCH, IN A POSITION WHERE SLOUGH IS LIKELY TO COVER IT.

4. ONE STAKE REQUIRED FOR EACH GROMMET.

TEMPORARY PIPE

1. DEFINITION: A CONDUIT UTILIZED TEMPORARILY TO CARRY WATER UNDER A HAUL ROAD OR SEDIMENT DAM.

2. PURPOSE: TEMPORARY PIPE MAY BE USED AS THE PRINCIPAL SPILLWAY TO CARRY WATER THROUGH A SEDIMENT DAM AFTER THE SUSPENDED SOLIDS HAVE SETTLED OUT. THEY CAN ALSO BE USED TO PREVENT THE CONTRACTOR'S EQUIPMENT FROM COMING INTO DIRECT CONTACT WITH THE WATER WHEN CROSSING AN ACTIVE OR INTERMITTENT STREAM. AS WELL AS OTHER APPROVED PURPOSES.

3. DESIGN CRITERIA: THE SIZE OF TEMPORARY PIPE FOR USE AS PRINCIPAL SPILLWAYS SHALL BE DETERMINED IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED UNDER SEDIMENT BASINS ON STD. DWG. NO. 1013.

   THE SIZE OF TEMPORARY PIPE UNDER HAUL ROADS WILL BE LEFT TO THE CONTRACTOR'S DISCRETION, BUT SHOULD ACCOMMODATE A MINIMUM Q BASED ON A TWO-YEAR STORM.

4. CONSTRUCTION METHODS: ALL TEMPORARY PIPE SHALL BE INSTALLED IN THE SAME MANNER AS PERMANENT PIPES ARE INSTALLED ON THE PROJECT.

EUREKA ENERGY

SUPERSEDES

REVISIONS

Date Appr.

TEMPORARY EROSION CONTROL (TEMPORARY SLOPE DRAINS)

RECOMMENDED FOR APPROVAL:

Ralph Erickson — 9-26, 19 81
PROJECT ENGINEER — Date

ACCEPTED

Gary L. Davis — Oct 27, 1981
EUREKA ENERGY

STD. DWG. NO 1011

SEDIMENT STRUCTURES

SEDIMENT STRUCTURES

1 – SEDIMENT TRAPS

A. DEFINITION:

A SMALL EXCAVATED STORAGE AREA WITHOUT SPECIAL INLET AND OUTLET CONTROLS OR DEFINED SIDE SLOPES AND IS LIMITED TO DRAINAGE AREAS OF 10 ACRES OR LESS.

B. DESIGN CRITERIA:

1 – MINIMUM WIDTH 5' AND MAXIMUM WIDTH 20'

2 – MINIMUM LENGTH 25' AND MAXIMUM LENGTH 200'

3 – MINIMUM DEPTH 2' AND MAXIMUM DEPTH 6'

2 – SEDIMENT PONDS

A. DEFINITION:

AN EXCAVATED STORAGE AREA WITH ROCK RIPRAP PLACED IN INLET AND OUTLET AREAS WITH DEFINED SIDE SLOPES AND IS LIMITED TO DRAINAGE AREAS OF 50 ACRES OR LESS.

B. DESIGN CRITERIA:

1 – INLET AND OUTLET CHANNELS MUST BE LINED WITH RIPRAP.

2 – SIDE SLOPES SHOULD BE 2:1

3 – LIMITED TO A MINIMUM WIDTH OF 20' AND A MINIMUM DEPTH OF 4' BUT NOT TO EXCEED 10'.

3 – SEDIMENT BASINS

A. DEFINITION:

CONSISTS OF A DAM CREATED TO IMPOUND WATER WITH OR WITHOUT AN EXCAVATED STORAGE AREA AND LIMITED TO DRAINAGE AREAS OF 200 ACRES OR LESS.

B. DESIGN CRITERIA:

1 – SHOULD BE DESIGNED TO ACCOMMODATE $1/2$" OF RUNOFF FROM THE ENTIRE DRAINAGE AREA. THE REQUIRED VOLUME IN CUBIC FEET CAN BE OBTAINED BY MULTIPLYING THE DRAINAGE AREA IN ACRES BY 1,815.

2 – THE LENGTH SHOULD BE AT LEAST TWICE THE WIDTH AND A MINIMUM OF 50' LONG AND SHOULD HAVE A MINIMUM DEPTH OF 6'.

3 – WHEN POSSIBLE, THE MINIMUM AREA OF THE WATER SURFACE AT THE PRINCIPAL OUTLET ELEVATION SHOULD CONFORM TO THE FOLLOWING:

A (SQ. FT.) = 180 Q (CU. FT. PER SEC.)

WHERE Q IS BASED ON A 5-YEAR FREQUENCY. IF A Q VALUE IS AVAILABLE FOR THE DRAINAGE AREA FOR A FREQUENCY OTHER THAN 5-YEARS, THE Q VALUE FOR A 5-YEAR FREQUENCY CAN BE APPROXIMATE USING THE FOLLOWING TABLE:

$Q_5 = 0.85\ Q_{10}$

$Q_5 = 0.75\ Q_{25}$

$Q_5 = 0.65\ Q_{50}$

IT SHOULD BE NOTED THAT RUNOFF CALCULATIONS TO SIZE PIPE ORDINARLY ASSUME FOREST OR MEADOWS IN RURAL AREAS. THEREFORE IF THE DRAINAGE AREA EXCEEDS 20 ACRES AND MORE THAN 25% OF THIS AREA HAS BEEN DISTURBED THE RUNOFF SHOULD BE RECALCULATED BASED ON ACTUAL CONDITIONS.

4 – GENERAL NOTES

A. PURPOSE:

SEDIMENT BASINS, PONDS, AND TRAPS ARE CONSTRUCTED TO TRAP AND STORE SEDIMENT FROM ERODIBLE AREAS IN ORDER TO PROTECT PROPERTIES AND STREAM CHANNELS BELOW THE INSTALLATION FROM EXCESSIVE SILTATION. THESE STRUCTURES TRAP AND STORE SEDIMENT THAT UNAVOIDABLY OCCURS IN SPITE OF TEMPORARY EROSION CONTROL MEASURES IN USE.

B. CONDITIONS WHERE APPLICABLE:

SEDIMENT BASINS, PONDS, AND / OR TRAPS SHOULD BE CONSTRUCTED AT ALL LOCATIONS WHERE WATER IS CONCENTRATED AND HAS BEEN COLLECTED FROM AN AREA WHERE IT WILL PICK UP PARTICLES. SEDIMENT STRUCTURES SHOULD BE CONSTRUCTED AS CLOSE AS POSSIBLE TO THE SOURCE OF SEDIMENT. WHEN POSSIBLE, SEDIMENT STRUCTURES SHOULD BE BUILT OUTSIDE THE EXISTING WATERCOURSES TO MINIMIZE THE QUANTITY OF WATER TO BE TREATED.

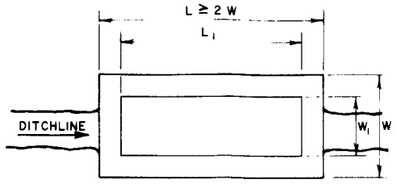
C. IN SOME AREAS THE MINIMUM DESIGN CRITERIA AS DEFINED HEREIN MAY BE UNFEASIBLE OR IMPOSSIBLE TO MEET. IN THESE CASES SEDIMENT STRUCTURES SHOULD BE CONSTRUCTED AS CLOSE AS POSSIBLE TO THE SPECIFIED DESIGN CRITERIA. UNDER THESE CIRCUMSTANCES IT WOULD BE DESIRABLE TO BUILD SEVERAL SMALL SEDIMENT STRUCTURES IN A SERIES TO ELIMINATE THE NEED FOR THE ONE LARGE STRUCTURE.

D. IN SPECIAL CASES WHERE SEDIMENT WOULD AFFECT HIGH QUALITY STREAMS THE STORAGE VOLUME, SURFACE AREA, AND DESIGN QUALITY OF DISCHARGE SHOULD BE INCREASED TO ASSURE THE CONTINUED HIGH QUALITY.

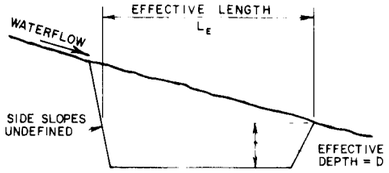
E. ALL SEDIMENT STRUCTURES MUST BE LOCATED AND DESIGNED SUCH THAT FAILURE OF THE STRUCTURE WOULD NOT RESULT IN LOSS OF LIFE; DAMAGE TO HOMES, COMMERCIAL OR INDUSTRIAL BUILDINGS, HIGHWAYS AND STREETS; OR IN INTERRUPTION OF THE USE OF SERVICE OR PUBLIC UTILITIES.

F. IN AREAS WHERE SEDIMENT STRUCTURES ARE CONSIDERED BY THE ENGINEER TO BE A SAFETY HAZARD TO THE PUBLIC OR TO CONSTRUCTION WORKERS, THEY ARE TO BE PROPERLY FENCED OR PROVIDED WITH ADEQUATE WARNING SIGNS, WHICHEVER IS DIRECTED BY THE ENGINEER.

TYPICAL SEDIMENT TRAP



PLAN VIEW

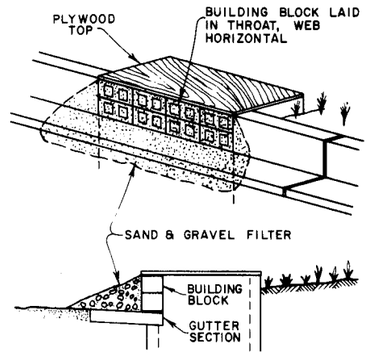


APPROXIMATION OF EFFECTIVE VOLUME

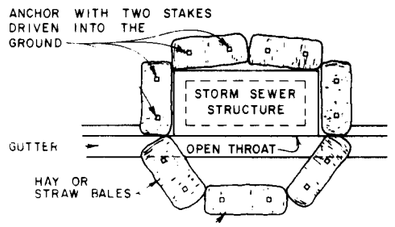
$$\frac{L_E\ W + L_1\ W_1}{2} + D$$

SIDE VIEW

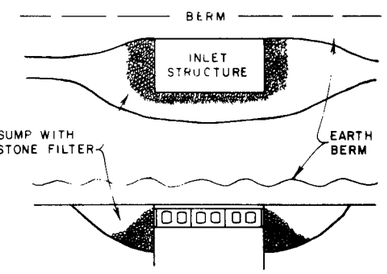
DRAIN INLET SEDIMENT TRAPS



SAND AND GRAVEL FILTER INLET SEDIMENT TRAP

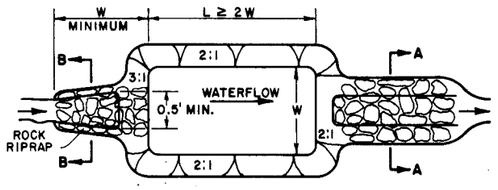


TEMPORARY BARRIER HAY OR STRAW BALES

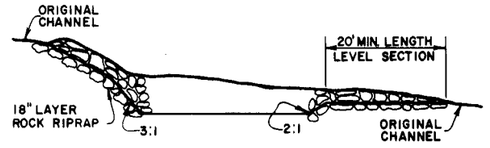


TEMPORARY SUMP – STONE FILTER INLET SEDIMENT TRAP

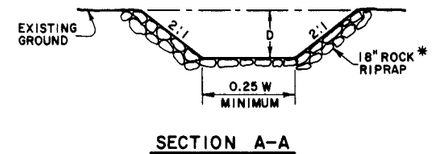
TYPICAL SEDIMENT POND



PLAN VIEW

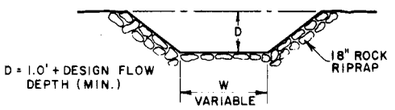


SIDE VIEW



SECTION A-A

*WITH PROPER DESIGN CONSIDERATIONS, ROCK RIP-RAP CAN BE ELIMINATED IN OUTLET CHANNEL.



$W_{VARIABLE}$ – VARIES FROM WIDTH OF STREAM AT INLET TO ONE-HALF WIDTH OF POND AT OUTLET.

SECTION B-B

EUREKA ENERGY

SUPERSEDES	TEMPORARY EROSION CONTROL (SEDIMENT STRUCTURES)
REVISIONS Date Appr.	RECOMMENDED FOR APPROVAL: PROJECT ENGINEER 9-25 19 81 Date
	ACCEPTED: EUREKA ENERGY Oct 6 7 19 81
	STD. DWG. NO. 1012

SEDIMENT STRUCTURES

SEDIMENT DAMS

1- GENERAL NOTES:

A. THE MAXIMUM HEIGHT OF THE DAM FROM THE LOWEST POINT ALONG THE CENTERLINE OF THE DAM TO THE CREST OF THE EMERGENCY SPILLWAY WILL NOT EXCEED 15'.

B. THE MINIMUM DAM THICKNESS AT THE TOP WILL BE AS FOLLOWS:

HEIGHT-FT.	THICKNESS
2'- 5'	10'
5'- 10'	12'
10'- 15'	14'

C. THE MINIMUM UPSTREAM SLOPE OF THE DAM WILL BE 3:1 AND THE MINIMUM DOWNSTREAM SLOPE WILL BE 5:1 EXCEPT WHEN AN EMERGENCY SPILLWAY IS PROVIDED AROUND THE END OF THE DAM ALLOWING THE DOWNSTREAM SLOPE TO BE 2:1.

D. THE DAM WILL BE CONSTRUCTED OF IMPERVIOUS MATERIAL, USUALLY A-6 OR A-7 WHEN AVAILABLE. WHERE SPILLWAYS ARE PROVIDED OVER THE DAM, THESE SPILLWAYS MUST BE LINED WITH ROCK TO PREVENT EROSION. IN CASES WHERE A STANDPIPE IS PROVIDED AND THE EMERGENCY SPILLWAY GOES AROUND THE END OF THE DAM NO ROCK WILL BE REQUIRED TO LINE THE DAM. IN CASES WHERE A STANDPIPE IS PROVIDED AND NO EMERGENCY SPILLWAY IS REQUIRED, THE TOP OF THE DAM AS WELL AS THE DOWNSTREAM FACE MUST BE LINED WITH ROCK.

E. FOR DAMS LESS THAN 5' IN HEIGHT AND A DRAINAGE AREA LESS THAN 20 ACRES, A CONDUIT SPILLWAY IS NOT REQUIRED.

F. FOR DRAINAGE AREAS LESS THAN 20 ACRES AN EMERGENCY SPILLWAY IS NOT REQUIRED.

G. COMBINED CAPACITY OF THE PIPE AND EMERGENCY SPILLWAYS WILL; WHERE APPLICABLE, BE DESIGNED TO HANDLE A TEN-YEAR FREQUENCY STORM. RUNOFF WILL BE FIGURED BY AN ACCEPTABLE METHOD AND SHOULD BE BASED ON SOIL COVER CONDITIONS EXPECTED TO PREVAIL DURING THE ANTICIPATED EFFECTIVE LIFE OF THE STRUCTURE.

IF A Q VALUE FOR A FREQUENCY OF OTHER THAN 10 YEARS IS AVAILABLE FOR THE DRAINAGE AREA, AND LESS THAN 25% OF THE AREA HAS BEEN DISTURBED, THE TEN-YEAR STORM CAN BE APPROXIMATED BY THE FOLLOWING TABLE:

$Q_{10} = 1.2\ Q_5$

$Q_{10} = 0.9\ Q_{25}$

$Q_{10} = 0.8\ Q_{50}$

H. THE DESIGN HEIGHT OF THE DAM WILL BE INCREASED 5% TO ALLOW FOR SETTLEMENT.

I. KEYWAYS ARE TO BE PROVIDED ON ALL DAMS OVER FIVE FEET IN HEIGHT. THIS KEYWAY IS TO BE A MINIMUM OF FIVE FEET WIDE AND TWO FEET DEEP, AND EXTEND THE FULL WIDTH OF THE CHANNEL, OR LENGTH OF THE DAM, PLUS UP EACH SLOPE TO THE HEIGHT OF THE DAM.

2- CONDUIT - PRINCIPAL SPILLWAY

A. IF THE PRINCIPAL SPILLWAY IS A CONDUIT THROUGH THE DAM, THE CONDUIT SHOULD BE DESIGNED TO CARRY A MINIMUM FLOW OF 0.2 I C.F.S. PER ACRE OF WATERSHED WITH THE MINIMUM SIZE CONDUIT BEING A 18".

B. IF A CONDUIT SPILLWAY IS USED, AN EMERGENCY SPILLWAY MUST BE PROVIDED WHEN THE DRAINAGE AREA EXCEEDS 20 ACRES. THE CREST ELEVATION OF THE EMERGENCY SPILLWAY MUST BE AT LEAST 1.5' ABOVE THE CREST ELEVATION OF THE PRINCIPAL SPILLWAY.

CONDUIT-PRINCIPAL SPILLWAY CONT.

C. WHEN THE PRINCIPAL SPILLWAY DESIGN IS A STANDPIPE ATTACHED TO A CONDUIT THE FOLLOWING MINIMUM REQUIREMENTS WILL BE OBSERVED:

DRAINAGE AREA-ACRES	PIPE CONDUIT DIA.-INCHES	STANDPIPE DIA.-INCHES	SQ. DROP INLET DIMENSIONS (FT.)	MINIMUM STANDPIPE HEIGHT (FT.)
0 - 100	18	30	2 x 2	3.0
100 - 150	24	36	2.5 x 2.5	4.0
150 - 200	30	42	3 x 3	5.0

3- RISER

A. THE CROSS-SECTIONAL AREA OF THE RISER MUST BE AT LEAST 1.5 TIMES THE CROSS-SECTIONAL AREA OF THE CONDUIT.

B. THE TOP $1/2$ TO $2/3$ OF THE RISER OR DROP INLET WILL BE PERFORATED WITH 1 $1/2$ INCH DIAMETER HOLES SPACED 8" VERTICALLY AND 10" TO 12" HORIZONTALLY.

C. AN ANTIVORTEX DEVICE MUST BE PROVIDED CONSISTING OF A THIN, VERTICAL PLATE NORMAL TO THE CENTERLINE OF THE DAM AND FIRMLY ATTACHED TO THE TOP OF THE RISER. THE PLATE DIMENSIONS ARE:

LENGTH = DIAMETER OF THE RISER PLUS 12"
HEIGHT = DIAMETER OF THE CONDUIT

D. THE RISE SHALL HAVE AN ATTACHED BASE WITH SUFFICIENT WEIGHT TO PREVENT FLOTATION OF THE RISER. TWO ACCEPTABLE BASES ARE:

1- A CONCRETE BASE 18" THICK WITH THE RISER IMBEDDED 6" INTO THE BASE. THE BASE SHOULD BE SQUARE WITH EACH DIMENSION 1FT GREATER THAN THE RISER DIAMETER.

2- A 1/4" MINIMUM THICKNESS STEEL PLATE WELDED ALL AROUND THE BASE OF THE RISER TO FORM A WATERTIGHT CONNECTION. THE PLATE SHALL BE SQUARE WITH EACH SIDE EQUAL TO 2 TIMES THE RISER DIAMETER. THE PLATE SHALL HAVE 2' OF STONE, GRAVEL OR TAMPED EARTH PLACED ON IT TO PREVENT FLOTATION.

E. TRASH RACKS MUST BE ATTACHED TO THE TOP OF THE RISER WITH OPENINGS NO LARGER THAN $3/4$ OF THE CONDUIT DIAMETER AND NO SMALLER THAN 4 INCHES.

F. THE LOWER $1/3$ OF THE RISER MUST BE COVERED IN A CONE SHAPED MANNER WITH SUITABLE FILTER MATERIAL.

G. A MINIMUM OF ONE ANTI SEEP COLLAR MUST BE UTILIZED ON EACH CONDUIT THROUGH A SEDIMENT DAM AND SHOULD BE LOCATED AT THE CENTERLINE OF THE DAM.

4- EMERGENCY SPILLWAY

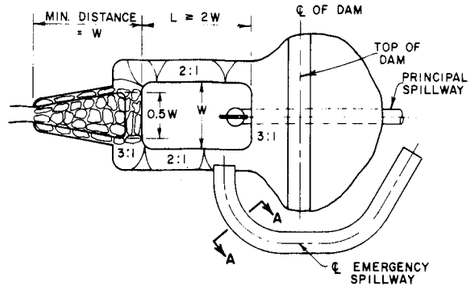
A. THE TOP OF THE DAM MUST BE AT LEAST 1 ABOVE THE MAXIMUM DESIGN FLOW ELEVATION OF THE EMERGENCY SPILLWAY.

B. THE MINIMUM BOTTOM WIDTH OF AN EMERGENCY SPILLWAY IS 8'.

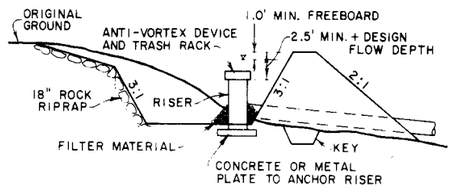
C. THE MINIMUM LEVEL DISTANCE OF THE EMERGENCY SPILLWAY IN THE DIRECTION OF FLOW IS 20' UNLESS THE EMERGENCY SPILLWAY GOES OVER THE DAM.

D. THE EMERGENCY SPILLWAY MUST BE PLACED IN UNDISTURBED GROUND AND CANNOT BE PLACED IN EMBANKMENT AREAS.

TYPICAL SEDIMENT DAM
WITH PRINCIPAL SPILLWAY

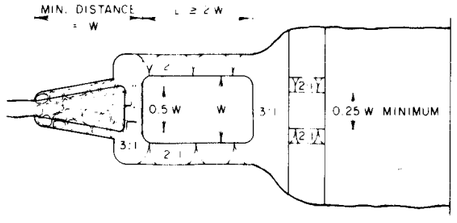


PLAN VIEW

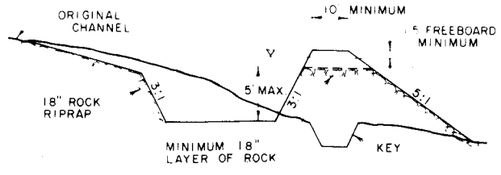


SIDE VIEW

TYPICAL SEDIMENT DAM
WITHOUT CONDUIT SPILLWAY

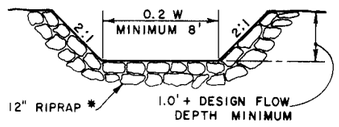


PLAN VIEW



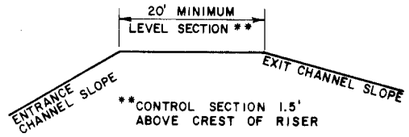
SIDE VIEW

EMERGENCY SPILLWAY

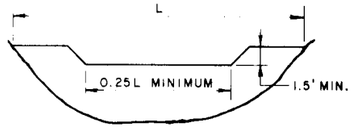


SECTION A-A

ROCK RIPRAP NOT REQUIRED IN OUTLET CHANNEL IF VELOCITY IS LESS THAN 6 F.P.S.
IF EMERGENCY SPILLWAY HAS TO BE BUILT OVER THE SEDIMENT DAM, THE DAM MUST BE LINED WITH AT LEAST 18" OF ROCK AND THE DOWNSTREAM FACE OF THE DAM MUST BE 5:1 SLOPE.



EMERGENCY SPILLWAY PROFILE

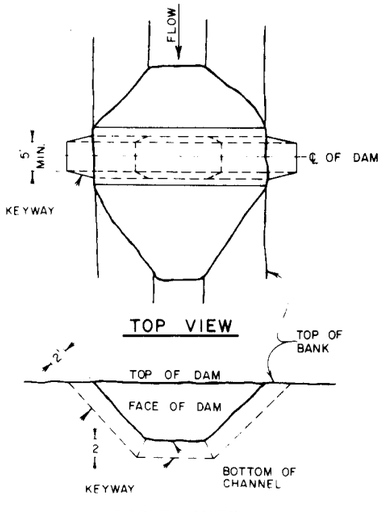


FRONT VIEW OF DAM

NO EMERGENCY SPILLWAY DESIGN
DOWNSTREAM FACE- 5:1 SLOPE LINED WITH ROCK

DETAIL OF KEYWAY

SEE SEDIMENT DAMS; GENERAL NOTE I

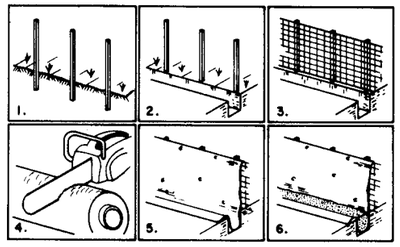


TOP VIEW

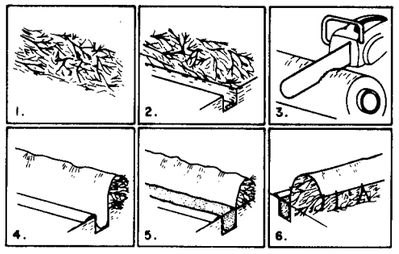
FRONT VIEW

SEDIMENT BARRIERS

1- "POST AND MESH" INSTALLATIONS SHALL BE SUPPORTED BY GALVANIZED STEEL WIRE MESH (14 GAGE MIN., 6" x 6" OPENINGS MAXIMUM) AND WOOD OR STEEL POSTS 5' IN LENGTH.



2- "BRUSH BARRIER" INSTALLATIONS SHALL BE SUPPORTED BY EITHER WINDROWS OF BRANCHES, BRUSH OR SIMILAR MATERIAL; OR BY ROWS OF STRAW BALES.



3- GENERAL NOTES:

A- FILTER FABRIC: STANDARD BURLAP (7-1/2 OZ. PER SQUARE FOOT) MAY BE USED FOR INSTALLATIONS OF SHORT DURATION. MORE ROT-RESISTANT FABRICS ARE ADVISED FOR INSTALLATION PERIODS IN EXCESS OF 2 TO 3 MONTHS. (NAMES OF SUGGESTED MANUFACTURES AND PRODUCTS ARE AVAILABLE UPON REQUEST.)

B- THE FABRIC IS CUT ON SITE TO THE DESIRED WIDTH, UNROLLED ALONG THE LENGTH OF THE BARRIER AND DRAPED OVER THE BARRIER. THE FABRIC TOE IS SECURED WITH ROCKS OR DIRT AND THE FABRIC COVERING THE BARRIER IS SECURED TO THE BARRIER WITH TWINE, STAPLES, OR SIMILAR DEVICES.

C- AFTER THE CONSTRUCTION AREA IS STABILIZED AND EROSION ACTIVITY CURTAILED, THE SEDIMENT BARRIERS ARE REMOVED AND THE CONTAINED SEDIMENT IS LEVELED, SEEDED, AND MULCHED. SPECIAL PROTECTION OF THE SEED BED MAY BE NECESSARY IF THE LAYERS ARE OVER A FOOT THICK.

EUREKA ENERGY

SUPERSEDES

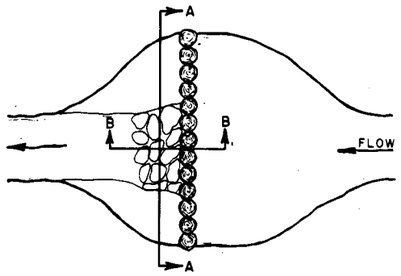
REVISIONS
Date Appr

TEMPORARY EROSION CONTROL (SEDIMENT STRUCTURES)

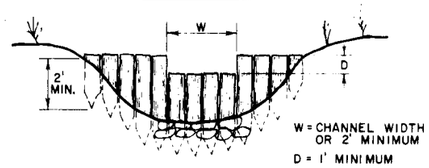
RECOMMENDED FOR APPROVAL
Ralph E. Watson 9-25 81
PROJECT ENGINEER
ACCEPTED
Gary S. Davis Oct 87 81
EUREKA ENERGY

STD. DWG. NO. 1013

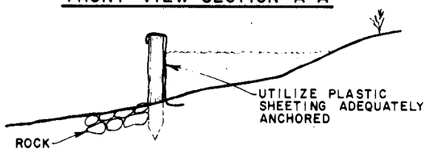
LOG & POLE CHECK DAMS



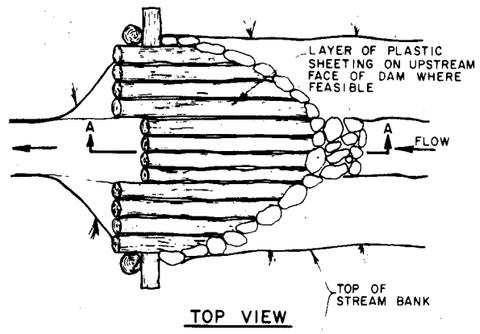
TOP VIEW



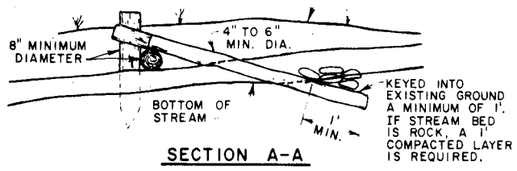
FRONT VIEW-SECTION A-A



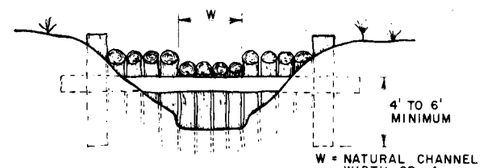
SIDE VIEW-SECTION B-B



TOP VIEW



SECTION A-A



UPSTREAM VIEW

CHECK DAMS:

1- DEFINITION: A BARRIER COMPOSED OF LOGS AND POLES, LARGE STONES, SAND BAGS, OR OTHER MATERIALS PLACED ACROSS A NATURAL OR CONSTRUCTED DRAINWAY.

2- PURPOSE: CHECK DAMS ARE TO BE UTILIZED TO RETARD STREAM FLOW AND CATCH SMALL SEDIMENT LOADS.

3- CONDITIONS WHERE APPLICABLE: CHECK DAMS ARE TO BE USED ONLY TO ASSIST IN SEDIMENT CONTROL AND ARE NOT SUBSTITUTES FOR SEDIMENT DAMS, PONDS, OR TRAPS. WHEN USED UPSTREAM FROM SEDIMENT BASINS, THESE CHECK DAMS WILL IN NO WAY REDUCE THE REQUIRED SEDIMENT CAPACITY OF THE SEDIMENT BASIN.

CHECK DAMS MAY BE USED IN LOCATIONS SUCH AS:

A- IN NATURAL DRAINWAYS CLOSE TO THE DISTURBED AREA TO CATCH INITIAL SEDIMENT LOADS.

B- IN CHANNELS CARRYING WATER OFF THE BENCH TOWARD A NATURAL DRAINWAY.

C- OTHER LOCATIONS WHERE SMALL LOCALIZED SEDIMENTATION PROBLEMS EXIST.

STONE CHECK DAMS SHOULD NOT BE UTILIZED WHERE THE UPSTREAM DRAINAGE AREA EXCEEDS 50 ACRES. LOG AND POLE STRUCTURES SHOULD NOT BE USED IN A DRAINWAY WHERE THE UPSTREAM DRAINAGE AREA EXCEEDS 5 ACRES.

4- DESIGN CRITERIA: A DESIGN IS NOT NEEDED FOR LOG AND POLE STRUCTURES. GENERALLY THEY WILL FOLLOW THE ABOVE DETAILS.

A DESIGN IS NOT REQUIRED FOR STONE CHECK DAMS; HOWEVER, THE FOLLOWING CRITERIA WILL BE USED:

A- TWENTY-FIVE PERCENT OF THE ROCK WILL BE 18" OR LARGER. THE REMAINING 75% SHALL BE WELL GRADED MATERIAL CONSISTING OF SUFFICIENT ROCK SMALL ENOUGH TO FILL THE VOIDS BETWEEN THE LARGER ROCKS

4- DESIGN CRITERIA CONT.:

B- THE DAM WILL BE KEYED INTO THE SIDES AND BOTTOM OF THE CHANNEL A MINIMUM DEPTH OF 2 FEET. MINIMUM WIDTH OF THE KEY WILL BE 3 FEET

C- UPSTREAM SLOPE AND DOWNSTREAM SLOPE WILL BE 3 HORIZONTAL TO 1 VERTICAL.

D- A WIER THE WIDTH OF THE CHANNEL BUT AT LEAST 2 FEET WIDE, AND A MINIMUM OF ONE FOOT DEEP WILL BE POSITIONED AT THE CENTER OF THE DAM.

E- MAXIMUM HEIGHT WILL BE 4 FEET (FROM LOWEST POINT ALONG CENTERLINE OF DAM TO CREST OF WIER).

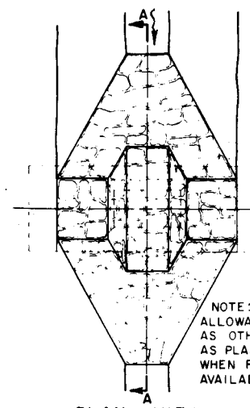
F- MINIMUM TOP WIDTH SHALL BE 5 FEET.

5- CONSTRUCTION METHODS: LOG CHECK DAMS WILL BE CONSTRUCTED FROM THE NATURAL MATERIALS AVAILABLE FROM THE CLEARING AND GRUBBING OPERATIONS. IF THE CLEARING AND GRUBBING ACTIVITIES ARE COMPLETE AND THE MATERIAL DISPOSED, THE CONTRACTOR MUST OBTAIN THIS MATERIAL FROM THE SOURCE OF HIS CHOOSING.

THE CONTRACTOR MAY OBTAIN THE ROCK NECESSARY FOR THIS CHECK DAM FROM THE UNCLASSIFIED EXCAVATION IF AVAILABLE OR FROM A BORROW PIT. THE CONTRACTOR MUST CLEAR THE SITE FOR CONSTRUCTION OF THE CHECK DAM AND EXCAVATE THE KEY ACCORDING TO THE ABOVE TYPICAL.

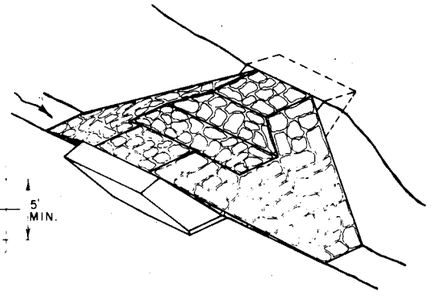
ANY OTHER TYPES OF MATERIALS AND METHODS UTILIZED TO CONSTRUCT CHECK DAMS MUST BE CLEARLY ILLUSTRATED IN THE CONTRACTOR'S EROSION CONTROL PLAN AND THUS, CAN BE REVIEWED AND APPROVED, APPROVED WITH MODIFICATIONS, OR DISAPPROVED IN CONJUNCTION WITH THE TOTAL PLAN. IN SOME CASES IT MIGHT BE ADVANTAGEOUS TO BUILD A SMALL NON-REINFORCED CONCRETE CHECK DAM SIMILAR TO THE VERTICAL LOG OR POLE STRUCTURE.

STONE CHECK DAM

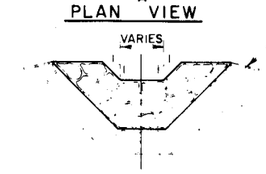


NOTE: DIRT CORE ALLOWABLE AS WELL AS OTHER MEANS SUCH AS PLASTIC TO SEAL DAM WHEN FINES ARE NOT AVAILABLE TO CHOKE STONE

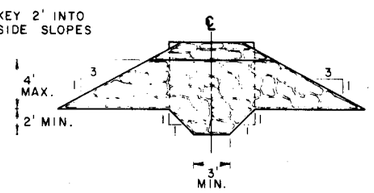
PLAN VIEW



NOTE: NEATNESS OF DRAWING LINES FOR CLARITY ONLY, NOT FOR CONSTRUCTION.



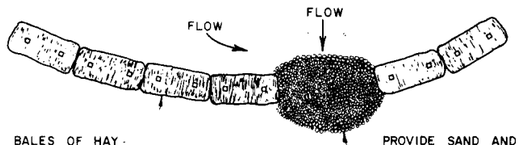
UPSTREAM ELEV.



SECTION A-A

HAY OR STRAW CHECK DAM

TYPE "C"



TOP VIEW

FRONT VIEW

HAY OR STRAW CHECK DAMS:

1- DEFINITION: BALES OF HAY OR STRAW USED AS A MEANS OF CONTROLLING POLLUTION AND EROSION.

2- PURPOSE: TO OBSTRUCT THE FLOW OF WATER TO ALLOW DEPOSIT OF SEDIMENT AND/OR DIVERT WATER TO A SLOPE DRAIN, SEDIMENT BASIN, SEDIMENT TRAP, OR OTHER EROSION CONTROL STRUCTURE.

3- CONDITIONS WHERE APPLICABLE:

A- USE AT THE BOTTOM OF EMBANKMENT SLOPES TO DIVERT RUNOFF FROM SHEET FLOW AND ALSO CATCH SOME OF THE SEDIMENT PICKED UP IN THE SHEET FLOW.

B- AS CHECK DAMS IN SMALL DITCHES AND DRAINAGE AREAS.

C- ON THE LOWER SIDE OF CLEARED AREAS TO CATCH SEDIMENT FROM SHEET FLOW.

D- AS WATERPROOF CORES FOR STONE SEDIMENT DAMS.

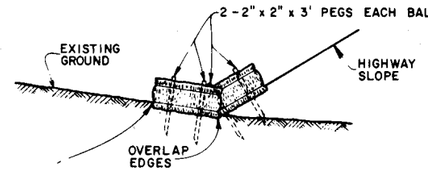
4- DESIGN CRITERIA: NONE

5- CONSTRUCTION METHODS:

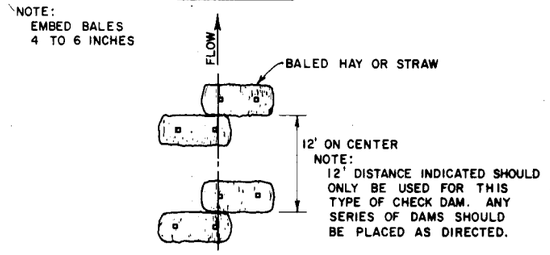
BALES OF HAY OR STRAW WILL BE UTILIZED TO CONTROL EROSION, TRAP SEDIMENT, AND DIVERT RUNOFF AS DIRECTED AND APPROVED BY THE PROJECT ENGINEER. WHEN USED TO TRAP SEDIMENT OR DIVERT RUNOFF, THE BALES MUST BE ADEQUATELY BRACED FROM BEHIND.

HAY OR STRAW CHECK DAMS

TYPE "A"



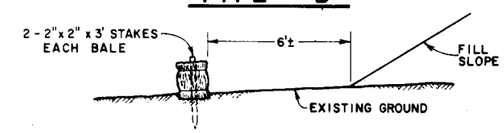
ELEVATION



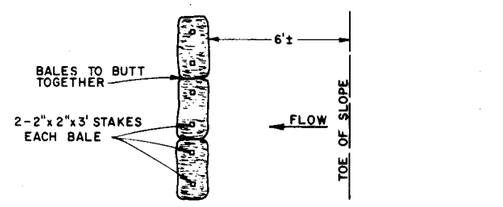
PLAN

TO BE USED WHERE THE EXISTING GROUND SLOPES TOWARDS THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.
BALES SHOWN IN THE ABOVE CONFIGURATION SHALL BE CONSIDERED AS ONE CHECK DAM WHEN MEASURED FOR PAYMENT.

TYPE "B"



ELEVATION



PLAN

TO BE USED WHERE THE EXISTING GROUND SLOPES AWAY FROM THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.

EUREKA ENERGY

SUPERSEDES

REVISIONS

Date	Appr.

TEMPORARY EROSION CONTROL (CHECK DAMS)

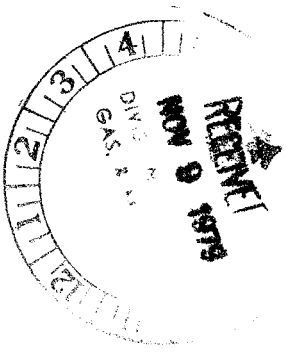
RECOMMENDED FOR APPROVAL:
PROJECT ENGINEER — Date 9-25 19 81

ACCEPTED
EUREKA ENERGY — Date Oct 27 19 81

STD. DWG. NO. 1014

LAW OFFICES OF
MARTINEAU, ROOKER, LARSEN & KIMBALL
A PROFESSIONAL CORPORATION
1800 BENEFICIAL LIFE TOWER
36 SOUTH STATE STREET
SALT LAKE CITY, UTAH 84111
TELEPHONE (801) 532-7840

CLAYTON J. PARR



November 8, 1979

Denise Dragoo
Division of Oil, Gas and Mining
1588 West North Temple
Salt Lake City, Utah 84116

Dear Denise:

Unfortunately, I was unable to attend the meeting of the Task Force on Wednesday so I did not have the opportunity to follow up with discussions with you on the conflict of interest question that we discussed on Tuesday.

As I read the conflict of interest provisions, they seem to be directed to remuneration of individuals. In the situation we discussed, a payment would simply be made to a state agency, which is not the state regulatory authority, for costs to be incurred in a study. I would think that a problem could arise only if individual employees of that agency would receive income that they would not otherwise be entitled to as part of their normal wages.

Nevertheless, I appreciate your concern and support your interest in fully exploring the question. To assist you in discussions with others on the subject, I have tried to set forth a carefully worded statement of the question that is presented and enclose a copy with this letter.

I would, in any event, like to discuss the matter with you further and will contact you after you return from Denver.

Very truly yours,

Clayton J. Parr

CJP:pf
Encl.
cc: D. Oglesby

Section 783.20 of the OSM regulations directs the state regulatory authority to consult with the state fish and wildlife management agency (and other agencies) having responsibilities for fish or wildlife or their habitats to determine the level of detail and the areas of studies designed to gather fish and wildlife resources information to be required in a permit application. Is there a violation of Part 705 of the OSM conflict of interest regulations if an applicant reimburses costs incurred by the State Division of Wildlife Resources in performing a study, the results of which are utilized by the applicant to meet section 783.20 requirements imposed by the DOGM, the state regulatory authority.

EUREKA ENERGY COMPANY

A SUBSIDIARY OF PACIFIC GAS AND ELECTRIC COMPANY

77 BEALE STREET • SAN FRANCISCO, CALIFORNIA 94106 • (415) 781-4211 • TWX 910-372-6587

October 29, 1979

Mr. Ron W. Daniels, Coordinator
Division of Oil, Gas and Mining
1588 West North Temple
Salt Lake City, UT 84116

Dear Mr. Daniels:

At the request of Eureka Energy Company, the Utah Division of Wildlife Resources recently completed a report of available wildlife resources information (re: 30 CFR 783.20 and 784.21) for the permit area of Eureka's Sage Point-Dugout Canyon Project. A copy of the report (October 11, 1979) is enclosed for your review and comment. I have also enclosed a copy of an October 17, 1979 letter from DWR requesting Eureka's participation in ongoing studies of terrestrial wildlife in the mine permit area.

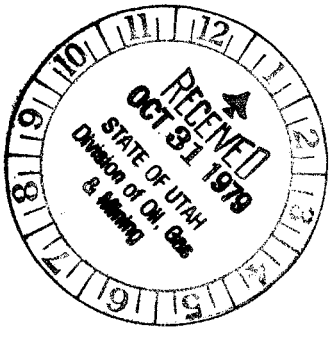
I will contact you soon to arrange a meeting to discuss both the report and the ongoing studies in the context of Eureka's permit application under the Permanent Regulatory Program.

Sincerely yours,

P. BRUCE BENZLER
Administrative Engineer

Enclosures

cc: RFGoudge
CJParr
PBAnderson



state of utah

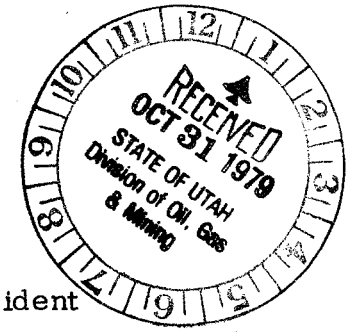
DIVISION OF WILDLIFE RESOURCES

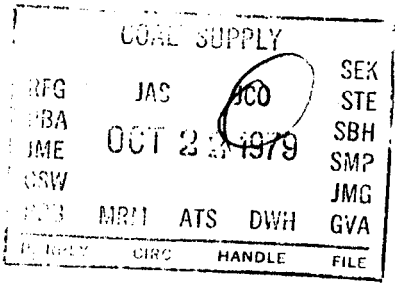
DOUGLAS F. DAY
Director

1596 West North Temple/Salt Lake City, Utah 84116/801-533-9333

Reply To SOUTHEASTERN REGIONAL OFFICE
455 West Railroad Avenue, Box 840, Price, Utah 84501
(801) 637-3310

October 17, 1979





Mr. John C. Osmond, President
Eureka Energy Company
215 Market Street - Room 258
San Francisco, CA 94106

Attention: Bob Goudge

Dear Mr. Osmond:

Utah Division of Wildlife Resources has need to evaluate impacts from development of coal resources in relation to terrestrial, vertebrate wildlife. As you know, we have been evaluating your Sage Point-Dugout Canyon Project to serve as one part of a long term research project for the purposes of studying responses of wildlife to a coal mining operation. We are now at a point in time where initiation of a study would be timely and some sources of funding may be available for the first year of research which will cost $24,752.00.

Utah Division of Wildlife Resources is committed to funding 18 percent ($4,377.00) of the first years study which would be conducted only on the Sage Point-Dugout Canyon Project area. The Bureau of Land Management believes they will have $10,000.00 (40 percent of the funding) available for use in wildlife research at the Sage Point-Dugout Canyon Project--BLM should know positively during the week of November 5 to 9, 1979; their Washington D.C. office has made favorable recommendations for funding. What is needed to sufficiently fund the first year of study and provide for a completion report is an additional $10,375.00, which amounts to 42 percent of the funding. It is hoped that Eureka Energy Company can participate to that level.

Enclosed is a detailed cost proposal and work plan for the first year of study. It is important to note that data collected during this first year of study will completely satisfy the company's needs for terrestrial wildlife resource information for inclusion with application for a mine permit. If the upcoming winter is not a typical winter, a second winter period of study will be needed for satisfactory identification of mule deer migration and movement paths.

It is hoped that during the upcoming year that additional commitments for funding can be secured to expand the study to include three mine projects and to extend for five years. A detailed copy of the complete study proposal for a five year period will follow in a few days.

Your immediate consideration for funding of the first year of study will be appreciated. It is hoped that Eureka will be interested and able to participate in ultimate funding that will allow the study to continue on their project area for the full five years. Please contact Larry Dalton (801-637-3310) our Resource Analyst as appropriate for any arrangements or further information.

Sincerely,

Larry J. Wilson, Supervisor
Southeastern Region

LJW:LBD:trw

cc: Darrell Nish, Chief Resource Analyst
Bill McMahn, BLM State Wildlife Biologist

Enclosure

Cost Proposal for Sage Point-Dugout Canyon project for field work only in fiscal year October 1979 through September 1980.

Personnel Services		$20,098.00
Resource Analyst 23-8 - Supervision for 1.3 months @ $1,768/month	$2299.00*	
Benefits 22%	506.00*	
Biologist 17-2 @ $1036/month for 14 months	14,504.00	
Benefits 8%	1160.00	
Typist 12-1 @ $754/month for 2 months	1508.00	
Benefits 8%	121.00	
Travel	None	0
Current Expenses		3,332.00
Motor vehicle operation @ $.18/mile for 9,900 miles	1782.00	
Other equip. operation 20 hr. aircraft (cesna 185) @ $37.50/hr.	750.00	
Office Supplies	200.00	
Photo Supplies	150.00	
Small Tools	200.00	
Office Space	250.00*	
Capital Outlay		1,322.00
200 Sherman traps @ $5.00 ea.	1,000.00*	
Six Tomphaw traps @ $12.00 ea.	72.00*	
200 Snap traps @ $1.25 ea.	250.00*	
GRAND TOTAL		$24,752.00

* $4,377.00 that would be committed by Utah Division of Wildlife Resources

WORK PLAN FOR SAGE POINT-DUGOUT CANYON PROJECT

Month	Week 1	Week 2	Week 3	Week 4
October 1979	Lay out transects.	Lay out transects.	Lay out transects.	Lay out transects.
November 1979	2 day deer use. Lay out transects.	2 day deer use. Lay out transects.	2 day deer use. Lay out transects. aircraft - 1 hr.)	2 day deer use. (aircraft - 1 hrs.) Lay out transects.
December 1979	2 day deer use. (aircraft - 1 hrs.)	2 day deer use. (aircraft - 1 hr.)	(aircraft - 1 hr.) 3 day deer use. 2 day medium-size mammal survey.	3 day deer use. (aircraft - 1 hrs.)
January 1980	2 day deer use. (aircraft - 1 hrs.)	(aircraft - 1 hr.) 3 day deer use. 2 day medium-size mammal survey.	3 day deer use. (aircraft - 1 hr.)	3 day deer use. (aircraft - 1 hrs.)
February 1980	3 day deer use. (aircraft - 1 hr.)	4 day deer use. (aircraft - 1 hrs.)	(aircraft - 1 hr.) 3 day deer use. 2 day medium-size mammal survey.	4 day deer use. (aircraft - 1 hrs.)
March 1980	4 day deer use. (aircraft - 1 hr.)	3 day deer use. (aircraft - 1 hrs.) 2 day raptor survey.	(aircraft - 1 hr.) 3 day deer use. 2 day medium-size mammal survey.	3 day deer use. 2 day Emlen transects.
April 1980	3 day deer use. (aircraft - 1 hrs.)	2 day deer use. 2 day raptor survey. (aircraft - 1 hr.)	2 day Emlen transects. 2 day raptor survey.	3 day deer use. 2 day survey of right-of-ways for evidences of black footed ferrets.
May 1980	1 day winter pellet count. 2 day deer use. 1 day browse utilization.	2 day Emlen transects. 2 day winter pellet counts. 1 day raptor survey.	3 day browse utilization. 2 day winter pellet count.	2 day Emlen transects. 3 day raptor survey.

Month	Week 1	Week 2	Week 3	Week 4
June 1980	5 day mammal trapping.	2 day Emlen transects. 3 day survey of right-of-ways for evidences of black-footed ferrets.	5 day mammal trapping.	2 day reptile and amphibian survey. 2 day medium-size mammal survey. 1 day maintenance of transect
July 1980	2 day Emlen transects.	Vegetation surveys - site typing	Vegetation surveys - site typing	Vacation
August 1980	Maintenance of transects. Vegetation surveys - site typing.	2 day Emlen Vegetation surveys - site typing.	5 day mammal trapping	2 day reptile and amphibian survey. 1 day medium-size mammal survey.
September 1980	2 day Emlen transects. 3 day vegetation survey - site typing.	5 day vegetation survey -	5 day browse measurements.	5 day browse measurements.
October 1980	Prepare draft report first years data.	Prepare draft report first years data.	Complete draft report first years data.	DWR staff review of draft report. Cooperators review of draft report.
November 1980	2 day deer use.* Prepare final report first years data (cooperators complete review of draft report).	2 day deer use.* Prepare final report first years data (incorporate cooperators comments)	2 day deer use.* 2 day final review by RA 3 day final typing and proofing.	2 day deer use.* 1 day final typing and proofing. 1 day review by RA and biologist. 1 day for corrections if needed.

state of utah

DIVISION OF WILDLIFE RESOURCES

DOUGLAS F. DAY
Director

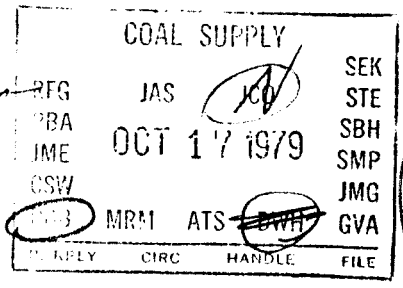
1596 West North Temple/Salt Lake City, Utah 84116/801-533-9333

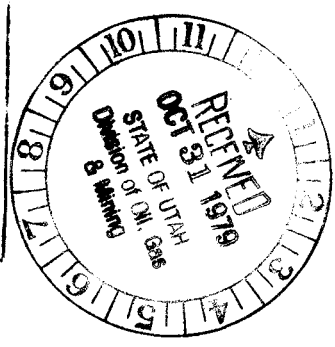
Reply To SOUTHEASTERN REGIONAL OFFICE
455 West Railroad Avenue, Box 840, Price, Utah 84501
(801) 637-3310

October 11, 1979

Mr. John C. Osmond
Eureka Energy
215 Market Street - Room 258
San Francisco, CA 94106

Attention: Robert F. Goudge
Box 1506
Price, Utah 84501





Dear Mr. Osmond:

I want to take this opportunity to extend thanks for the assistance Bob Goudge, your project coordinator, provided Larry Dalton in becoming familiar with surface facilities on the mine plan areas encompassed by Eureka's Sagepoint-Dugout Canyon project. I believe that you will find the enclosed information helpful at filing a mine and reclamation plan.

In response to your request for wildlife resources information (30 CFR, part 783.20) and the Division's recommendations concerning a wildlife plan (30 CFR, part 784.21) to accompany your permit application, the attached map delineating high value habitats for wildlife and supporting narrative for those use areas and other high interest wildlife species are provided. Since the primary or secondary premining and assumed postmining use of the mine plan area was and will be wildlands inhabited by wildlife, suggested vegetative species (seed list along with potential material supply sources for seed and seedlings) for use in enhancement and/or reclamation work that would benefit wildlife are included (30 CFR, parts 817.97 d 4, 817.97 d 5, 817.97 d 9, part 817.116 b 3 IV and part 817.117 c 2). Also, note that Utah's Division of Oil, Gas and Mining is the regulatory authority for approval of the mining and reclamation plan.

Thank you for an opportunity to assist Eureka Energy in complying with OSM's permanent regulatory program for surface coal mining and reclamation and the resultant protection of Utah's wildlife resources. If the scientific name or other information relative to status of any wildlife

species referenced is needed, please consult the Division publication 78-16 "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah" that is enclosed.

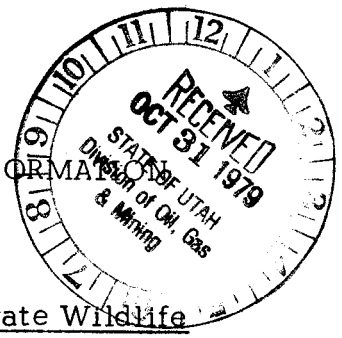
If we can be of any further service, please contact Larry Dalton as appropriate.

Sincerely,

Larry J. Wilson, Supervisor
Southeastern Region

LJW:LBD:trw

cc: Darrell Nish
East Carbon C.O.
Clark Johnson
Cleon Feight
Patrick J. Farmer
Leon Berggren



30 CFR, PART 783.20 FISH AND WILDLIFE RESOURCE INFORMATION
SAGE POINT-DUGOUT CANYON PROJECT

General Wildlife Resource Information--All Species of Vertebrate Wildlife

The mine plan area for the Sage Point-Dugout Canyon Project encompasses a portion of the West Tavaputs Plateau in Carbon County, Utah. This area drains into the Price River system which flows into the Green River and ultimately into the Colorado River. The Division publication No. 78-16 "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah" adequately identifies occurrence, relative abundance, status, population trend and habitat use areas for wildlife species that inhabit the West Tavaputs Plateau. Generally speaking, the mine plan area is inhabited on occasion and during different seasons of the year by about 354 species of vertebrate wildlife, (11 fish species, 5 amphibian species, 14 reptile species, 244 bird species and 80 mammal species), some of which are considered to be high interest species for the habitats and local area represented. It is interesting to note that 84 percent of these species are protected. High interest wildlife are defined as all game species; any economically important species; and any species of special aesthetic, scientific or educational significance. This definition would include all federally listed, threatened and endangered species of wildlife.

Since Utah's Division of Oil, Gas and Mining and the U.S. Fish and Wildlife Service have each been provided with a copy of the publication "Vertebrate Wildlife that Inhabit Southeastern Utah" there is no apparent reason why all of the species that occur on the mine plan area should be listed in the application for a mining permit.

A ranking and display (figure 1) of vertebrate, terrestrial and aquatic wildlife use areas and habitats has been developed. Crucial-Critical wildlife use areas followed in respective importance by High-Priority, Substantial Value and Limited Value wildlife use areas require various levels of protection from man's activities and developments.

Crucial-critical wildlife use areas are "sensitive use areas" necessary to sustain the existence and perpetuation of one or more species of wildlife during critical periods in their life cycles. These areas are limited and lie within high-priority wildlife use areas. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 1 or 2 are classified as being crucial-critical. Biological intricacies dictate that significant disturbances cannot be tolerated by the members of an ecological assemblage on crucial-critical sites. Professional opinion is that disturbance to crucial-critical use areas or habitats will result in irreversible changes in species composition and/or biological prodictivity of an area.

High-priority wildlife use areas are "intensive use areas" for one or more species of wildlife. "Intensive use areas" are not limited and in conjunction with limited value use areas form the substantial value distribution for a wildlife species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 3 are classified as being of high-priority. In addition, wildlife use areas where

surface disturbance or underground activities may result in subsidence that could interrupt underground aquifers and could result in a potential for local loss of ground water and decreased flows in seeps and springs should be considered as being of high-priority to wildlife.

Substantial value wildlife use areas are "existence areas" for one or more species of wildlife. "Existence areas" represent a herd or population distribution and are formed by the merging of high-priority and limited value wildlife use areas for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as class 4 are classified as being of substantial value.

Limited value wildlife use areas are "occasional use areas" for one or more species of wildlife. "Occasional use areas" are not limited and are part of the substantial value wildlife use area for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as class 5 or 6 are classified as being of limited value.

Mapping

Vegetation

It is recommended that the company's primary effort be placed on identifying species of vegetation in each association for the purposes of reclamation. Identification of each vegetation association on

appropriately scaled maps along with supportive narration will be required. This information may be available from land management agencies or other sources in government. If not, the services of private consultants may be needed.

It is believed that if satisfactory reclamation is achieved and man's disturbance does not continue or become a factor that most species of wildlife displaced from the mine plan area will return. Without doubt the key to success for enhancing or restoring wildlands will be development of habitats so that the postmining condition as compared to the premining condition will have similar species, frequency and distribution of permanent plants in each vegetative type that will allow for natural plant succession.

Wildlife Use Areas

Figure 1 displays mapable, high value habitat use areas for high interest wildlife on and adjacent to the mine plan area. This display includes stream sections and bodies of water used by high interest fish species and known seeps, springs, wetlands and riparian zones. It should be noted that there are high interest wildlife distributions that are so broad that they cover the entire map and therefore are not illustrated. However, all vertebrate species of high interest wildlife and their distributions are discussed in the following narrative. The narrative also identifies the need, if any, for studies that would be required in order to prepare and evaluate a Fish and Wildlife plan for 30 CFR, part 784.21.

Water

The company will be required to identify and monitor all surface waters for potential impacts from subsidence. Much of this information is available from various governmental sources and should be plotted on the same map with the wildlife use area distribution, dut to the value of water to wildlife. The services of a private consultant may be needed to fulfill all the requirements associated with hydrologic monitoring.

Fish and Wildlife Inventory

Aquatic Use Areas

Macrophytes

Since none of the surface waters associated with the project support high interest fish species, the company should not be required to collect any information relative to macrophytes for the ultimate purpose of reclamation. If desired, this information would have to be secured through the services of a private consultant.

Macroinvertebrates

Since none of the surface waters associated with the project support high interest fish species, the company should not be required to collect information relative to macroinvertebrates for the ultimate purpose of reclamation of a high interest fishery. Soldier Creek and Dugout Creek may support "biological communities" (30 CFR, part 816.57) which would

necessitate designation of stream buffer zones. Studies for determination of "biological communities" will have to be secured by the company through the services of a private consultant.

Fish--High Interest Species

None of the streams associated with the project are of significant value to Utah Division of Wildlife Resources' fishery management programs. All of the streams on the mine plan area are ranked as having only limited value for any sport fishery. There are no known game fish species on or adjacent to the mine plan area. But, the perennial streams do support as many as 11 species of non-game fishes, all of which are protected (reference the "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah"). The drainages represent either class 5 or class 6 waters in Utah--class 1 streams are the best blue ribbon waters and class 6 streams are dewatered during portions of the year. Due to the limited opportunity for a sport fishery, no specific data has been collected on the mine plan or adjacent areas (figure 1).

It is not recommended that the company be required to provide for any fishery studies. Utah Division of Wildlife Resources has already conducted low levels of study on the project area; these are sufficient since species occurrence, relative abundance, status, population trend and preferred habitat use areas are documented in the afore mentioned publication.

If mine operations are planned that would alter, destroy or discharge effluents into any perennial stream, appropriate state and federal permits along with reclamation plans would be required of the company. Achievement of reclamation would demand detailed studies of stream velocity correlated to flow, representatives of the stream channel profile, gradient, pool-riffle ratio, substrata types and percent representation and surface water information required for 30 CFR, part 779.16. If modification of flows is anticipated, instream flow requirements must be determined to meet the needs of the existing fishery and "biological community". Such baseline information would allow for development of mitigation or reclamation plans that would allow for maintenance or re-establishment of any fishery or "biological community". This information is not generally available and would necessitate the services of a private consultant.

It is important to note that no federally listed threatened or endangered fish species inhabit the mine plan or adjacent areas. The endangered humpback chub and Colorado squawfish inhabit the Green and Colorado rivers. Additionally, the humpback (razorback) sucker and the bonytail chub also inhabit the Green and Colorado rivers. It is likely that these species will one day be listed as threatened and endangered, respectively. It is not believed that implementation and operation of the company's project will impact these species.

Terrestrial Use Areas

Unique Habitat Types

The riparian zones associated with drainage bottoms (ephemeral or intermittent), or perennial streams--30 CFR, part 701.5--seeps, springs, wetlands and flood plains are ranked as being crucial-critical to all aquatic and terrestrial wildlife species. These areas are highly productive in terms of herbage produced and use by wildlife as compared to surrounding areas (figure 1).

Amphibians

Five species of amphibians, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located (reference the "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah"). None of these amphibians are federally listed as threatened or endangered species. It is not recommended that the company be required to provide for any studies concerning amphibians. Utah Division of Wildlife Resources has already conducted low levels of study on the project area; these are sufficient since species occurrence, relative abundance, status, population trend and preferred habitat use areas are documented in the afore mentioned publication.

Reptiles

Fourteen specie of reptiles, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located (reference the "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah"). None of those reptiles are federally listed as threatened or endangered species. It is not recommended that the company be required to provide for any studies concerning reptiles. Utah Division of Wildlife Resources has already conducted low levels of study on the project area; these are sufficient since species occurrence, relative abundance, status, population trend and preferred habitat use areas are documented in the afore mentioned publication.

To date no snake dens, which are protected, have been identified on or adjacent to the mine plan area.

Birds

Two hundred forty-four species of birds, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located (reference the "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah"). For all of those species of avifauna Utah Division of Wildlife Resources has already conducted low levels of study on the project area; these are sufficient since species occurrence, season of inhabitation, relative abundance, status, population trend and preferred habitat use areas are documented in the afore mentioned

publication. Therefore, it is recommended that the company only be required to provide for intensive raptor surveys. Baseline raptor studies will be addressed in the following discussions which are oriented only to species of high interest to the state of Utah.

Ruffed and blue grouse inhabit the mountain brush, aspen and spruce-fir vegetation zones on and adjacent to the mine plan area. Both of these grouse nest and brood their yound between early March and mid August. This is a crucial-critical time period for maintenance of their populations.

Ruffed grouse for the most part are dependent upon wildlands vegetated by aspen and spruce-fir vegetation and that are located within one-quarter mile of stream courses. It is within this zone that drumming logs and nests (March 1 to May 30) are usually located. This zone is also a crucial-critical, yearlong use area for ruffed grouse. Mature clones of male aspen trees are crucial-critical winter use areas for ruffed grouse between December 1 and February 28 each year (figure 1).

Blue grouse utilize the mountain brush and spruce-fir areas of wildlands and are not dependent upon stream courses. The mountain brush zones provide crucial-critical breeding territories for blue grouse between March 15 and June 15 each year. The high elevation, mature stands of Douglas fir are crucial-critical winter range for blue grouse during December, January and February each year (figure 1).

A substantial value, yearlong use area for sage grouse is located throughout the higher montane elevations of the mine plan and adjacent areas. This same area also represents high-priority, summer range for sage grouse between August 16 and November 14 each year. There are no known crucial-critical strutting grounds and their associated brooding areas or wintering areas for sage grouse on the mine plan or adjacent areas (figure 1).

The entire mine plan and adjacent areas provide substantial value, yearlong habitats for chukar. Nesting occurs during April and May and brooding extends into mid July. This is a crucial-critical period for maintenance of the population. Nesting and brooding areas have not been identified to date. Winter ranges (December 1 to February 15) and all water sources on a yearlong basis are crucial-critical for chukars on their use areas (figure 1).

Mourning doves normally inhabit the entire mine plan and adjacent area between May 1 and September 15 each year; they nest throughout most of this period. Successful nesting activities and any water sources are crucial-critical to maintenance of the mourning dove population.

The mine plan and adjacent areas provide only limited value habitats for waterfowl. Stock ponds and perennial streams can become locally important during peak migration periods in the spring (March 15 to May 15) and fall (August 15 to October 15).

The mine plan and adjacent areas provide habitats for turkey vultures, bald and golden eagles, four species of falcons, nine species of hawks and nine species of owls. Nesting habitat exists for most of these species and each species has a specific crucial-critical period for which their aerie needs protection from disturbance. Generally speaking aeries need protection from significant or continual disturbance within a radius of one-quarter mile of the nest; only during the period of time that the nest is occupied. Species specific protective stipulations are available from Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service.

It is important to note that golden eagles are year-around residents of the mine plan and adjacent areas. It is likely that they nest in the same general area. Golden eagle nests are extremely sensitive to disturbance within a one-quarter mile radius of the nest when active between the period of April 15 and June 15. The one-quarter mile buffer zone may need to be increased to one-half mile if the disturbance originates from above and in direct line of sight to the eagle aerie.

The endangered bald eagle is a winter resident (November 15 to March 15) on the mine plan and adjacent areas. As a result, the area represents a substantial value, winter use area for bald eagles. There are no known or suspected high priority concentration areas or crucial-critical roost trees for bald eagles on or adjacent to the mine plan area. Therefore, it is not currently recommended that Eureka be required to conduct any

studies relavent to bald eagles.

The endangered peregrine falcon is a year-around resident of Carbon and Emery counties. No sightings are known to have been made on or adjacent to the mine plan area, however, their occasional presence would not be unlikely. Additionally, no aeries are known or suspected to be on or adjacent to the mine plan area. Therefore, no studies should be required of the applicant concerning peregrines.

Currently, little is known concerning numbers of raptor breeding territories or locations of aerie sites on or adjacent to the mine plan area. Due to the extreme sensativity of these birds to disturbance, high levels of study are required. It is not recommended that the company be required to conduct extensive raptor studies over the entire mine plan or adjacent areas. It is recommended, however, that they be required to provide for a baseline intensive inventory of raptor breeding territories and identification of aerie sites within a one-mile radius of proposed portal facilities, load-out sites or any other facility development that will result in continual or significant disturbances during the raptor breeding season (February through June). These type of studies can be accomplished by contracting Utah's Division of Wildlife Resources, the U.S. Fish and Wildlife Service or qualified private consultants.

Mammals

Eighty species of mammals, of which 26 percent are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located (reference the "Species List of Vertebrate Wildlife that Inhabit Southeastern Utah"). For all of those species of mammals Utah Division of Wildlife Resources has already conducted low levels of study on the project area--species occurrence, relative abundance, status, population trend and preferred habitat use areas are documented in the afore mentioned publication. Those studies are sufficient except for data needs relative to the suspected presence of the endangered black-footed ferret. Therefore, it is recommended that the company not be required to provide for studies of all mammals. Studies, if needed, concerning the black-footed ferret will be addressed in the following discussions which are oriented only to species of high interest to the state of Utah.

Mule deer (herd unit 27b) and elk (Range Creek herd unit) normally utilize the high-priority summer ranges between May 16 and October 31 each year. Fawning/calving and rearing processes for deer and elk take place on the summer range between May 16 and July 15. In the instance of moose their population is sparse and the higher elevation areas (summer range) are ranked as being of only substantial value for moose. Use by moose of the summer range usually extends from May 16 through November 30.

Elk utilize the high-priority winter range between November 1 and May 15 each year and during the same period mule deer migrate to lower areas which serve as high-priority and crucial-critical winter ranges. During the winter (December 1 to May 15) moose are attracted to crucial-critical riparian areas. Some riparian areas are utilized as yearlong range by moose. The crucial-critical, yearlong ranges for moose are not only critical for wintering activities but also to calving activities of moose between May 15 and July 15 each year (figure 1).

The habitats lower in elevation than the high-priority winter range for mule deer are ranked as being of only limited value to deer and are utilized by small numbers of deer as yearlong range (herd unit 27b and 29). The riparian areas are critical to the survival of these deer (figure 1).

Agriculture areas on or adjacent to the mine plan area are utilized yearlong by mule deer. Their use is intensified during the winter and spring periods resulting in significant depredation to agricultural crops.

Pronghorn antelope are found (Icelander herd) yearlong on their habitat use area. Therefore, the entire use area is ranked as being of yearlong, high-priority value to the antelope herd. Crucial-critical periods include the fawning season (May 12 to June 20) and periods of severe snow conditions during winter (figure 1).

It should be noted that the entire lease area provides substantial value, yearlong habitat for cougar and black bear. Crucial-critical periods for these species are when females are accompanied by their young.

The entire mine plan and adjacent areas provide substantial value, yearlong habitats for cottontail rabbits (mountain cottontail above 7,000 feet elevation and desert cottontail below 7,000 feet elevation). The young are born between April and July each year. This is a crucial-critical period for maintenance of the population.

The snowshoe hare is entirely dependent upon the fir-spruce vegetation type as a yearlong habitat use area. The coniferous vegetation provides crucial-critical breeding areas for the snowshoe hare between April 1 and August 15 each year (figure 1).

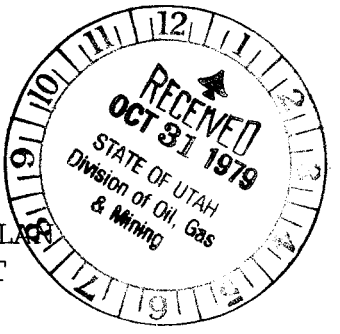
The mine plan and adjacent areas provide substantial value habitats for kit fox and bobcats--both of these species are high interest wildlife. Almost nothing is known of population dynamics and habitat use areas for these two species on or adjacent to the mine plan area. Generally speaking bobcats inhabit (substantial value use area) the montane habitats extending from the pinion-juniper vegetation type up to the highest elevations in the area of concern. The substantial value use area for kit fox is associated with the desert shrub community and may extend into the pinion-juniper vegetation type. Without doubt a crucial-critical period for both of these species is when they are rearing young. Dens while being inhabited are also crucial-critical use areas for both species.

Portions of the mine plan and adjacent areas provide substantial value habitats for several of Utah's furbearer--beaver, ermine, long-tailed weasel, mink, black-footed ferret (potential habitat), badger, striped skunk,

spotted skunk and muskrats (note the muskrat is not a furbearer but is a high interest species). For all of these species their breeding/rearing seasons, dens, lodges or prairie dog colonies in the instance of a verified black-footed ferret are of crucial-critical value to maintenance of the populations.

It is important to note that areas supporting prairie dogs on or adjacent to the mine plan area are potential habitats for the endangered black-footed ferret. Utah lies on the western edge of the black-footed ferrets historic range and a specimen was verified from the Blanding area in the early 1950's. Unverified sightings of black-footed ferrets have persisted from throughout southeastern Utah to the present. It is recommended that Eureka not be required to conduct extensive studies on or adjacent to the mine plan area. It is, however, recommended that Eureka either avoid impacting prairie dog colonies or secure consultation from the U.S. Fish and Wildlife Service concerning right-of-ways and special use permits on federal lands as to whether or not any evidence of black-footed ferrets can be found in prairie dog colonies to be impacted. If physical evidence exists indicating presence of black-footed ferrets, Eureka should be required to provide for intensive studies concerning black-footed ferrets in prairie dog colonies to be impacted.

Currently, there are no other known high interest wildlife species or their habitat use areas on or adjacent to the mine plan area. It is not unreasonable to suspect that in the future some additional species of wildlife may become of high interest to the local area, Utah or the nation. If such is the case, the required periodic updates of mine and reclamation plans can be adjusted and appropriate recommendations made.



30 CFR, PART 784.21 FISH AND WILDLIFE PLAN
SAGE POINT-DUGOUT CANYON PROJECT

Utah Division of Wildlife Resources provides the following recommendations in order to secure required baseline data and to minimize disturbances and impacts on wildlife and their habitats that could be impacted during mining and reclamation operations at Eureka Energy's Sage Point-Dugout Canyon Project. The recommendations also address how enhancement of the wildlife resource and their habitats as discussed in 30 CFR, 783. 20 can be achieved. These are consistent with the performance standards of 30 CFR, 817.97. In instances where it would be necessary to restore or could be beneficial to enhance high value habitats for fish and wildlife (30 CFR, part 817.97 d 4 and 817.97 d 5); or that the primary or secondary postmining land use will be for wildlife habitat (30 CFR, part 817.97 d 9) and rangeland seedings are to be used, recommended seed lists and rates of application are provided (30 CFR, parts 817.111 through 817.117; note 817.116 a, 817.116 b 3 IV and 817.117 c 2).

The mine plan and adjacent areas are inhabited on occasion and during different seasons of the year by about 354 species of vertebrate wildlife. Use areas for the "high interest" species from this group of wildlife have been ranked into four levels of importance. The most valuable to an individual species or ecological assemblage are the crucial-critical areas followed in respective importance by high-priority, substantial value and

limited value use areas. Each type of use area requires various and specific levels of protection from man's activities. Additionally due to the variability of vegetation communities in each use area, various and specific technologies in reclamation will need to be evaluated for possible enhancements of wildland habitats or the required level of reclamation.

It is recommended that the company make significant effort to educate all employees associated with their mine operation of the intricate values of the wildlife resource associated with the mine plan area, adjacent areas and the local area. Each employee should be advised not to unnecessarily or without proper permits harass or take any wildlife. (Apprehension of wildlife violators has increased by nearly 250 percent during recent years in the region). It is especially important that wildlife not be harrassed during winter periods, breeding seasons and early in the rearing process. Exploration should be limited as much as possible during these crucial-critical periods.

During winter wildlife are always in a depleted condition. Unnecessary disturbance by man causes them to use up critical and limited energy reserves which, often times, results in mortality. In less severe cases, the fetus being carried by mammals may be aborted or absorbed by the animal, thus reducing reproductive success of a population.

During breeding seasons disturbance by man can negatively affect the number of breeding territories for some species of wildlife. Disturbance can also interrupt courtship displays and preclude timely interactions between breeding animals. This could result in reduced reproductive success and ultimate reductions in population levels.

Early in the rearing process young animals need the peace and tranquility normally afforded by remote wildlands. It is also during this period that young animals gain the strength and ability to elude man and other predators. This allows the young animal to develop in relatively unstressed situations and to utilize habitats that are secure from predators. Disturbance by man can compromise this situation and result in abandonment of the young by the female, increased accidents that result in mortality to young animals or increased natural predation. It is recommended that employees be cautioned against disturbing young animals or females with young if accidentally located.

Employees associated with mining operations should be instructed that when wildlife are encountered during routine work that they not stop vehicles for viewing purposes. Moving traffic is less disturbing to wildlife than traffic that stops or results in out of the vehicle activities. If viewing is desireable, the vehicle should only be slowed, but not stopped.

There are no recommendations for a wildlife plan that would enhance any game fisheries associated with the company's mining operation. It is recommended that if waters of suitable quality for use by non-game fishes or other wildlife are developed through the mining operation that appropriate permits be secured and the water discharged into local drainages.

If mine operations occur that physically or chemically damages any perennial stream (class 1 through 5 waters) beyond the impact of mere crossings, detailed reclamation plans will be required. Since no game fish or threatened or endangered fish species inhabit the company's mine plan or adjacent areas, reclamation plans need not address macroinvertebrates or macophytes. In order to achieve reclamation, the company would have to provide for measurement of the physical characters of the stream prior to disturbance--surface water information required in 30 CFR, part 779.16, data on stream velocity, gradient, width, depth, pool-riffle ratio and substrate types.

Reclamation that would achieve development of a stream channel similar in character to the channel that existed prior to mining would allow for natural re-establishment of macroinvertebrates, macrophytes and the non-game fish population. This would adequately mitigate for disturbance and temporary loss of those resources. There would be no mitigation for displacement and possible loss of other wildlife species dependent upon the non-game fishes as a prey source. It is believed that impacts on these species would not be significant.

It is also recommended that adequate precautions be taken to keep all forms of coal from being inadvertently deposited in perennial stream channels or other drainages that would allow coal to be transported to a perennial stream during periods of run-off. This would include blow coal from haulage trucks, railroads or other transportation systems or storage piles along with larger particles from similar and other sources. If needed to control blow coal, haulage systems should be covered, or the surface of the coal appropriately sprayed in order to solidify it against wind movement or travel speeds reduced so that no coal is allowed to blow from the transportation system.

Utah Division of Wildlife Resources reaffirms all of the recommendations in 30 CFR, parts 817.44, 817.57 and 817.126 for protection of stream channels and their associated riparian and wetland zones. It is recommended that all natural wetlands and riparian vegetation along streams, drainage bottoms, or around seeps and springs be maintained. Roads and other facility developments should not destroy these limited, highly productive and specialized habitats. Roads crossing through those areas should do so in a manner that is least damaging to the habitat. Wetlands and riparian habitats are ranked as crucial-critical habitats and are the most productive sites in terms of herbage and biota produced as compared to other local habitat types. It is probable that a majority of the vertebrate wildlife that inhabit the mine plan area make some use of riparian or wetland areas.

It is important to note that roads and other surface facilities to be constructed should as far as practicable be placed at sites where they will not compromise wildlife or their use areas. Also, surface facilities, including roads, should be screened if possible from wildlife use areas by vegetation or terrain.

It is important that any use or storage of coal on the mine plan area be done in such a way that it will not be allowed to enter any perennial stream courses. The impacts of coal on aquatic ecosystems are many and varied; therefore, coal must be kept out of aquatic ecosystems.

There are no specific recommendations for enhancement of habitats for amphibians and reptiles. However, any enhancement of habitat which provides a greater diversity of vegetation will also benefit amphibians and reptiles. It is important to note that all of these species are protected by Utah law. It is urged that individual specimens not be destroyed. This is especially true for snakes which are a valuable component of the ecosystem.

Snake dens are ranked as being crucial-critical to the population and are protected by law. If a den is located, it should be reported to the Utah Division of Wildlife Resources. Snake dens can be moved but only with intensive efforts that may take a year or more (snakes are caught and removed in the spring and fall). Thus, construction of

facility developments may take place in denning locations if there is sufficient lead-time to relocate the occupants. To date, no snake dens have been identified at locations that will be impacted by the company's project.

Several species of grouse and the chukar inhabit the project area. No recommendations to lessen impacts on these species can be made other than those suggestions made earlier and recommended reclamation that will be discussed later.

No studies concerning upland game birds are recommended for purposes of determining mitigation, enhancement projects or reclamation techniques.

It is recognizable that development and operation of a mining project will in some cases negatively impact many wildlife species through physical destruction of habitats and continual disturbance that makes other habitats unavailable or less desireable to an individual animal. It is also true that impacts that are negative to one species may be beneficial to another species. In the instance of avifauna it is recommended that the company plant native and/or ornamental berry producing shrubs around surface facilities. This will provide food and cover for many of the smaller species of birds, resulting in enhancement of their substantial value and high-priority habitats. This action would also mitigate for disturbances and destruction of avifauna habitats at other sites on the mine plan and adjacent areas.

No studies concerning small birds, mourning doves or waterfowl are recommended for purposes of determining mitigation, enhancement projects or reclamation techniques.

It is important to note that the nests of all birds (except the house sparrow, starling and ferral pigeon) when active and their eggs are protected by federal (Federal Migratory Bird Treaty Act) or state laws (Utah Code 23-17-1 and 23-17-2).

Several species of raptors inhabit the mine plan area. A list would include cliff nesting falcons, golden eagles (year-around resident) and bald eagles (winter resident--November 15 to March 15). To date, location of most raptor nests and other parameters concerning their populations in the project area are not known. As a result the company must provide for a one-season, intensive inventory of raptor breeding territories and identification of aerie sites. This inventory should not extend beyond a one-mile radius of proposed portal facilities, load-out sites or any other facility development that will result in continual or significant disturbances during the raptor breeding season (February through June). It is suggested that this study be conducted prior to any development and that the services of a qualified raptor biologist be secured. A helicopter could be utilized for satisfactory identification and verification of active aerie sites. Breeding territories can be determined from ground reconnaissance.

If located, nests when active should not be disturbed and abandoned stick nests of raptors are never to be damaged during inactive periods. Every effort should be made to eliminate man's disturbance within visual sight or one-fourth mile of an active raptor nest. This effort is demanded in the instance of golden eagles and cliff nesting falcons since they are sensitive to disturbance and could abandon the nest. Termination of man's use of a site would not be required if eagles or falcons constructed the nest after mining had been initiated, since it would demonstrate the birds willingness to tolerate mining activities and the associated disturbance by man. Disturbance that would come from above and within view of a raptor nest should be precluded if possible for a distance of at least one-half mile.

Roost trees for eagles, if located, must not be disturbed.

As a general comment, whenever active raptor nests are observed or roose trees located, they should be reported to the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service.

Design and construction of all electrical power lines and other transmission facilities shall be designed in accordance with guidelines set forth in "Environmental Criteria for Electric Transmission System" published by the USDI and USDA in 1970 and/or the REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

Several species of big game and small game animals inhabit the project area. Other than for mule deer, there are no recommendations to

lessen impacts except those suggestions made earlier and recommended reclamation that will be discussed later.

No studies concerning game animals other than mule deer are recommended for purposes of determining mitigations, enhancement projects or reclamation techniques.

In the instance of mule deer there is serious concern in regards to their migrations between high-priority summer and high-priority and/or crucial-critical winter ranges in relation to a proposed coal conveyor on the mine plan area. 30 CFR, part 816.97 (c) (2) specifically states that "no new barriers shall be created in known and important wildlife migration routes". Without proper planning this conveyor would represent a barrier to mule deer movement. It is recommended that the company provide for intensive studies along the proposed conveyor route in order to determine patterns of deer movement. This information can then be utilized in conjunction with other known techniques so that deer crossing structures can be designed and properly placed in coordination with construction of the conveyor. The economic burden of the structures will be the responsibility of the company. Such a study for initial placement of crossing structures would require a minimum of two winter periods and should be initiated during the 1979-80 winter. Additionally, follow-up studies must continue for at least two additional winters in order to determine effectiveness and need, if any, for additional crossing structures.

The agricultural lands that lie on the mine plan and adjacent areas attract significant use during the winter and spring periods by mule deer. In the past this use by deer has caused depredation complaints by the landowners and resulted in extraordinary, but unsuccessful attempts to herd the deer from the fields. Depredation payments have also been necessitated to off-set loss of crops to the landowner.

It is recommended that since the company now owns those lands that they arrange for no depredation complaints to be made in the future. Allowing the deer to feed on the croplands will mitigate for disturbance and loss of their crucial-critical and high-priority habitats that will be occupied by facility developments associated with the project. This will also serve as mitigation for the myriad of negative impacts that will be experienced by local wildlife from the total project.

The mine plan and adjacent areas provide habitats for several of Utah's furbearers and a multitude of non-game animals. For all of these species other than the black-footed ferret there are no recommendations to lessen impacts except those suggestions made earlier and recommended reclamation that will be discussed later.

It is recommended that destruction of any prairie dog colonies be avoided since they could serve as the primary source of prey for potential black-footed ferrets in the area.

No studies concerning furbearers and non-game animals are recommended for purposes of determining mitigations, enhancement projects or reclamation techniques. However, if prairie dog colonies are to be destroyed, the company must provide for a determination of whether or not black-footed ferrets are present. The U.S. Fish and Wildlife Service would be the agency of authority for such a determination. The level of study could become extreme if an intensive survey of colonies to be impacted disclosed physical evidences indicating the presence of black-footed ferrets. If no evidence of black-footed ferrets could be found then it should be recommended that development of the project be allowed.

In situations where wildland habitats have been or will be disturbed, reclamation is required. Also, there are sites where enhancement of wildland habitats through vegetation treatments and/or seedings and transplants of seedlings could benefit wildlife. The attached tables (1 through 10) depict recommended seed lists for several vegetative associations and application rates for rangeland seedings that would benefit wildlife. If seed for a plant species is not available, suitable alternates are also listed. For some vegetation associations, plant species are recommended that will assist in erosion control of special sites such as roadbanks. Seedling transplants from nursery stock or nearby rangelands would also be acceptable for enhancement or

reclamation of wildlands. In either instance, tables 1 through 10 provide lists of vegetation species by habitat association that would benefit wildlife.

Temporary control of rodents may be required to ensure a successful rangeland treatment. It is recommended that the county agent be consulted in this area of concern. Poisoned oats are the most common and acceptable method for rodent control, however, only licensed persons may apply the treatment.

Currently, there are some new concepts in methodology for revegetation that are being successfully implemented in other parts of the nation and world. One promising method is a procedure where a large scoop removes, from a natural and stabilized site, a small area of earth intact with vegetation and subsurface soils for placement on a site to be reclamated. This same procedure can be utilized when disturbing pristine sites, except that the native vegetation is stored for use in latent reclamation. Another meritorius method for stimulating natural revegetation, in combination with other reclamation techniques, is to plan facility developments so that islands of natural, native vegetation remain. This will allow for natural vegetation to spread from the islands. These techniques can also be useful for enhancement of poor quality sites that currently exist on the mine plan area.

Encapsulation of seed and fertilizer for several releases over a period of years after a single application is a new and possibly advantageous procedure. This technique along with soil stabilizing structures has been successfully used in South Africa. Dr. J. Van Wyk in the Department of Botany at Potchefstroom University in South Africa could provide additional information on this new technique.

There are also new specialized techniques coming to the forefront for stabilization of problem sites such as roadbanks and steep slopes. It is important that these sites be promptly and permanently revegetated in order to reduce siltation into local riverine systems. This will mitigate for damage to aquatic wildlife populations and habitats from siltation. Enhancement of existing problems, sites or reclamation of disturbed sites can mitigate for salt loading of local river systems. It is believed that natural, nonpoint sources represent 50 percent of the salinity in the upper basin of the Colorado River system into which this mine plan area drains.

It is recommended the company make numerous contacts with appropriate agencies, institutions and persons to ensure that enhancement or reclamation projects achieve the required degree of permanency, plant diversity, extent of cover and capability of regeneration to ensure plant succession. Generally speaking, seeding should be accomplished as late in the fall as possible. Seedling transplants need to be coordinated

with local soil moisture conditions. It is paramount that suitable vegetation be maintained and/or reestablished if the life requirements of wildlife are to be satisfied in the postmining period. Success in this area of concern along with cessation of man's disturbances will likely result in a natural reinvasion and the resultant inhabitation by most wildlife species of an impacted site.

It is important to note that enhancement or reclamation projects that are to benefit wildlife must be properly designed so that all the life requirements of the target species are considered in conjunction with forage. Water must be provided or be present and thermal cover along with escape and hiding cover has to be in abundance. Loafing areas and travelways between the many types of use areas must also be provided. In order to meet these goals a considerable degree of consultation will be required between the company and Utah Division of Wildlife Resources.

In instances where revegetation projects are to be planned over coal waste areas, heavy metal uptake by the plants must be evaluated. It is recommended that the company initiate an appropriate long term monitoring program to determine the magnitude and resolutions, if needed, for this problem.

There is also some concern for the effects that subsidence may have on sources of water that support existing wildlife populations and their habitats. If hydrologic monitoring shows a significant reduction or total loss of

ground and/or surface waters, the company should immediately consult the Division of Wildlife Resources and the U.S. Fish and Wildlife Service on emergency procedures if needed. A significant local loss of water may demand temporary or permanent alternative sources of water to be established by the company for use by wildlife.

It is recommended that persistent pesticides not be utilized on the mine plan area. Other alternate pesticides or forms of control should be utilized. Additionally, all hazards associated with the mine operation should be fenced or covered to preclude use by wildlife; of special concern would be toxic materials.

Hunting and other state and federal wildlife regulations must be adhered to by sportsmen utilizing the mine plan area.

COMMON AND BOTANICAL NAMES FOR VEGETATION SPECIES IN THE ATTACHED TABLES THAT HAVE BEEN SUGGESTED FOR USE WITH ENHANCEMENT OR RECLAMATION PROJECTS THAT WOULD BENEFIT WILDLIFE

Common Name	Botanical Name
Alfalfa, (Ladak, Nomad, Rambler, Teton, Travois)	Medicago sativa
Alfalfa, sickle	M. falcatus
Alfileria	Erodium cicutarium
Alkaligrass, nuttall	Puccinellia airoides
Angelica, small-leaf	Angelica pinnata
Apache-plume	Fallugia paradoxa
Ash, singleleaf	Fraxinus anomala
Aspen, quaking	Populus tremuloides
Aster, alpine leafybract	Aster foliaceus
Aster, Engelmann	A. engelmannii
Aster, Pacific	A. chilensis adscendens
Aster, smooth (or blue)	A. glaucodes
Balsamroot, arrowleaf	Balsamorhiza sagittata
Balsamroot, cutleaf	B. macrophylla
Barberry, creeping	Berberis repens
Barberry, Fremont	B. fremontii
Barley, bulbous	Hordeum bulbosum
Barley, meadow	H. brachyantherum
Bassia, fivehook (alkaliweed, ragweed, smotherweed)	Bassia hyssopifolia
Bitterbrush, antelope	Purshia tridentata
Bitterbrush, desert	P. glandulosa
Blackbrush	Coleogyne ramosissima
Bladdersenna, common	Colutea arborescens
Bluegrass, big	Poa ampla
Bluegrass, bulbous	P. bulbosa
Bluegrass, Canada	P. compressa
Bluegrass, Kentucky	P. pratensis
Bluegrass, Nevada	P. nevadensis
Bluegrass, Sandberg	P. secunda
Bouncing-bet	Saponaria officinalis
Boxelder	Acer negundo negundo
Brome, cheatgrass	Bromus tectorum tectorum
Brome, meadow	B. erectus
Brome, mountain	B. carinatus
Brome, nodding	B. anomalus
Brome, red (foxtail)	B. rubens
Brome, smooth (northern)	B. inermis
Brome, smooth (southern)	B. inermis
Brome, subalpine	B. tomentellus
Buffaloberry, roundleaf	Shepherdia rotundifolia
Buffaloberry, russet	S. canadensis
Buffaloberry, silver	S. argentea
Burnet, small	Sanguisorba minor
Buttercup, bur	Ranunculus testiculatus
Cacti	Cactaceae
Canarygrass, reed	Phalaris arundinacea
Ceanothus, Martin	Ceanothus martinii
Ceanothus, redstem	C. sanguineus
Ceanothus, snowbrush	C. velutinus
Checkermallow, Oregon	Sidalcea oregana
Cherry, Bessey (sand)	Prunus besseyi
Chokecherry, black (common)	P. virginiana melanocarpa

Common Name	Botanical Name
Cinquefoil, bush	Potentilla fruticosa
Cliffrose, Stansbury	Cowania mexicana stansburiana
Clover, alsike	Trifolium hybridum
Clover, strawberry	T. fragiferum
Collomia, slenderleaf	Collomia linearis
Columbine, Colorado	Aquilegia coerulea
Cotoneaster, Peking	Cotoneaster acutifolia
Cowparsnip, common	Heracleum lanatum
Creosotebush, spreading	Larrea divaricata
Crownvetch, coronilla	Coronilla varia
Currant, golden	Ribes aureum
Currant, gooseberry	R. montigenum
Currant, squaw	R. cereum inebrians
Currant, sticky	R. viscosissimum viscosissimum
Cypress, Arizona	Cupressus arizonica
Cypress, Belvedere summer	Kochia scoparia
Daisy, common oxeye	Chrysanthemum leucanthemum
Dandelion, common	Taraxacum officinale
Deathcamas	Zigadenus spp.
Dogwood, redosier	Cornus stolenifera stolenifera
Douglas-fir	Pseudotsuga menziesii menziesii
Dropseed, sand	Sporobolus cryptandrus
Dropseed, spike	S. contractus
Elder, blueberry	Sambucus cerulea
Elder, redberry	S. racemosa pubens microbotrys
Ephedra, green	Ephedra viridis
Ephedra, Nevada	E. nevadensis
Eriogonum, cushion	Eriogonum ovalifolium
Eriogonum, Wyeth	E. heracleoides
Fescue, hard sheep	Festuca ovina duriscula
Fescue, reed (alta or tall)	F. arundinacea
Fescue, sulcata sheep	F. sulcata
Fescue, Thurber	F. thurberi
Fir, subalpine	Abies lasiocarpa
Fir, white	A. concolor
Flax, Lewis (or blue)	Linum lewissi
Fleabane, Oregon	Erigeron speciosus macranthus
Forestiera, New Mexican	Forestiera neomexicana
Forestiera, New Mexican olive	F. phillyneoides
Foxtail, barley	Hordeum jubatum jubatum
Foxtail, meadow	Alopecurus pratensis
Foxtail, reed	A. arundinaceus
Galleta	Hilaria jamesii
Geranium, sticky	Geranium viscosissimum
Gianthyssop, nettleleaf	Agastache urticifolia glaucifolia
Globemallow, gooseberryleaf	Sphaeralcea grossulariaefolia
Globemallow, stream	S. rivularis
Goldeneye, Nevada showy	Viguiera multiflora nevadensis
Goldeneye, Canada	Solidago canadensis
Goldenrod, low	S. multiradiata
Goldenrod, Parry	S. parryi
Goosefoot	Chenopodium spp.
Greasewood, black	Sarcobatus vermiculatus vermiculatus
Goldeneye, showy	Viguiera multiflora

Common Name	Botanical Name
Serviceberry, Utah	A. utahensis utahensis
Snowberry, longflower	Symphoricarpos longiflorus
Snowberry, mountain	S. oreophilus
Solomon-plume, fat	Smilacina racemosa amplexicaulis
Sophora, Arizona	Sophora arizonica
Spruce, Colorado blue	Picea pungens
Spruce, Engelmann	P. engelmannii
Squirreltail, bottlebrush	Sitanion hystrix
Squaw-apple	Peraphyllum ramosissimum
Starwort, tuber	Stellaria jamesiana
Sumac, Rocky Mountain smooth	Rhus glabra cismontana
Sumac, skunk bush	R. trilobata trilobata
Sweetanise	Osmorhiza occidentalis
Sweetclover, white	Melilotus alba
Sweetclover, yellow	M. officinalis
Sweetroot, spreading	Osmorhiza chilensis (divaricata)
Sweetvetch, Utah	Hedysarum boreale utahensis
Tansymustard, flixweed	Descurainia sophia
Tansymustard, pinnate	D. pinnata
Tarweed, cluster	Madia glomerata
Tenella weed	Chorispora tenella
Timothy	Phleum pratense
Tumblemustard	Sisymbrium altissimum
Valerian, edible	Valeriana edulis
Vetch, American	Vicia americana minor
Vetch, bramble	V. tenuifolia
Violet, goosefoot	Viola purpurea
Virginsbower, western	Clematis ligusticifolia
Wheatgrass, bearded	Agropyron subsecundum
Wheatgrass, bearded bluebunch	A. spicatum
Wheatgrass, beardless bluebunch	A. spicatum inerme
Wheatgrass, bluestem	A. smithii
Wheatgrass, crested (Fairway)	A. cristatum
Wheatgrass, crested ((Standard)	A. desertorum
Wheatgrass, intermediate	A. intermedium
Wheatgrass, pubescent or stiffhair	A. trichophorum
Wheatgrass, Scribner	A. scribneri
Wheatgrass, Siberian	A. sibiricum
Wheatgrass, slender	A. trachycaulum
Wheatgrass, tall	A. elongatum
Wildrye, blue	Elymus glaucus
Wildrye, Colorado	E. ambiguus ambiguus
Wildrye, creeping	E. triticoides
Wildrye, Great Basin	E. cinereus
Wildrye, mammoth	E. giganteus
Wildrye, Russian	E. junceus
Wildrye, sabulosa	E. sabulosus
Wildrye, Salina	E. salina
Wildrye, yellow	E. flavescens
Willow, Gyer	Salix exigua stenophylla
Willow, purpleosier	S. purpurea purpurea

Common Name	Botanical Name
Painted-cup, Northwestern	Castilleja hispida
Peachbrush, desert	Prunus fasciculata
Peashrub, Siberian	Caragana arborescens
Peavine, flat	Lathyrus sylvestris
Peavine, perennial	L. latifolius
Peavine, thickleaf	L. lanszwertii
Peavine, Utah	L. utahensis
Penstemon, Eaton	Penstemon eatonii
Penstemon, littlecup	P. sepalulus
Penstemon, low	P. humilis
Penstemon, Palmer	P. palmeri
Penstemon, Rydberg	P. rydbergii
Penstemon, sidehill	P. platyphyllus
Penstemon, thickleaf	P. pachyphyllus
Penstemon, toadflax	P. linarioides
Penstemon, Wasatch	P. cyananthus
Pine, pinyon	Pinus edulis
Pine, ponderosa	P. ponderosa
Pine, singleleaf pinyon	P. monophylla
Plum, American	Prunus americana
Quackgrass	Agropyron repens
Rabbitbrush, Douglas	Chrysothamnus viscidiflorus viscidiflorus
Rabbitbrush, dwarf	C. depressus
Rabbitbrush, Parry	C. parryi parryi
Rabbitbrush, rubber	C. nauseosus nauseosus
Rabbitbrush, small	C. stenophyllus
Rasberry, American red	Rubus idaeus sachalinensis
Redtop	Agrostis alba
Reedgrass, chee	Calamagrostis epigeios
Rhubarb, garden	Rheum rhapenticum
Ricegrass, Indian	Oryzopsis hymenoides hymenoides
Rose, Woods	Rosa woodsii ultramontana
Rush, Baltic	Juncus balticus
Russian-olive	Elaeagnus angustifolia
Russianthistle	Salsola kali tenuifolia
Rye, mountain	Secale montanum
Rye, winter	S. cereale
Sacaton, alkali	Sporobolus airoides airoides
Sagebrush, Louisiana	Artemisia ludoviciana ludoviciana
Sagebrush, tarragon	A. dracunculus
Sagebrush, big	A. tridentata tridentata
Sagebrush, black	A. arbuscula nova
Sagebrush, bud	A. spinescens
Sagebrush, fringed	A. frigida
Sagebrush, silver	A. cana cana
Salsify, vegetable-oyster	Tragopogon porrifolius
Saltbush, fourwing	Atriplex canescens
Saltbush, Gardner	A. gardneri
Saltbush, shadscale	A. confertifolia
Saltgrass, inland	Distichlis spicata stricta
Salt-tree, Siberian	Halimodendron halodendron
Sedge, ovalhead	Carex festivella
Seepweed (pickleweed)	Suaeda spp.
Serviceberry, Saskatoon	Amelanchier alnifolia

Common Name	Botanical Name
Groundsel, butterwood	Senecio serra
Hair-grass, tufted	Deschampsia caespitosa
Halogeton	Halogeton glomeratus
Hawthorn, river	Crataegus douglasii rivularis
Helianthella, oneflower	Helianthella uniflora
Honeylocust, common	Gleditsia triacanthos
Honeysuckle, bearberry	Lonicera involucrata
Honeysuckle, Tatarian	L. tatarica
Hopsage, spineless	Grayia brandegei
Hopsage, spiny	G. spinosa
Iodine bush	Allenrolfea occidentalis
Iris, German (common iris)	Iris germanica
Ivesia, Gordon	Ivesia gordonii
Juniper, Rocky Mountain	Juniperus scopulorum
Juniper, Utah	J. osteosperma
Knotweed, Douglas	Polygonum douglasii douglasii
Larkspur	Delphinium spp.
Leptotaenia, carrotleaf	Lomatium dissectum
Lettuce, prickly	Lactuca serriola
Ligusticum, Porter	Ligusticum porteri
Lilac, common	Syringa vulgaris
Lilac, late	S. villosa
Locust, black	Robinia pseudoacacia
Lomatium, nineleaf	Lomatium triternatum
Lomatium, Nuttall	L. nuttallii
Lupine, mountain	Lupinus alpestris
Lupine, Nevada	L. nevadensis
Lupine, silky	L. sericeus
Lupine, silvery	L. argenteus
Maple, bigtooth	Acer grandidentatum
Maple, Manchurian	A. mandshuricum
Maple, Rocky Mountain	A. glabrum
Matrimony-vine	Lycium halimifolium
Medick black	Medicago lupulina
Mesquite	Prosopis spp.
Milkvetch, chickpea	Astragalus cicer
Milkvetch, sicklepod	A. falcatus
Milkvetch, Snakeriver plains	A. filipes
Milkvetch, tall	A. galegiformis
Mountain-mahogany, curlleaf	Cercocarpus ledifolius ledifolius
Mountain-mahogany, littleleaf	C. ledifolius intricatus
Mountain-mahogany, true or birchleaf	C. montanus montanus
Muhly, mat	Muhlenbergia richardsonis
Mustard, African	Malcolmia africana
Needlegrass, green	Stipa viridula
Needlegrass, Letterman	S. lettermani
Oak, Gambel (shrubby)	Quercus gambelii
Oatgrass, tall	Arrhenatherum elatius
Orchardgrass	Dactylis glomerata

Common Name	Botanical Name	Common Name	Botanical Name
Willow, Scouler	S. scouleriana		
Winterfat, common	Eurotia lanata lanata		
Woad, Dyers	Isatis tinctoria		
Wormwood, oldman	Artemisia abrotanum		
Wyethia, mulesears	Wyethia amplexicaulis		
Yarrow, western	Achillea milefolium lanulosa		
Yellowbrush	Chrysothamnus viscidiflorus lanceolatus		
Yucca	Yucca spp.		
Yucca, Joshua-tree	Yucca brevifolia brevifolia		

Table 1. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed mountain brush associations characterized by Gambel oak, bigtooth maple, black chokecherry and serviceberry. Also included are acceptable alternatives if seed for a plant species is not available. Alternatives marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	North exposures and shady areas		Sunny exposures (south, west, east)	
	Broadcast	Drilled	Broadcast	Drilled
	-Pounds per acre-			
Grasses:				
Fairway crested wheatgrass	2	1	2	1
Smooth brome (southern strains)	4	2	2	1
Intermediate wheatgrass	4	2	2	1
Pubescent wheatgrass	0	0	2	1
Bluestem wheatgrass	0	0	1	1/2
Orchardgrass	1	1/2	1	1/2
Russian wildrye	0	0	1	1/2
Tall oatgrass	1	1/2	0	0
Forbs:				
Alfalfa (Nomad, Rambler, Travois, Ladak-equal parts)	2	1	2	1
Chickpea milkvetch	0	0	1	1/2
Utah sweetvetch	0	0	1	1/2
Yellow sweetclove	0	0	1	1/2
Arrowleaf balsamroot	1	1/2	1	1/2
Pacific aster	1	1/2	1	1/2

Mixture for tall mountain brush type, shaded sites.	
Species	Seeding per acre
	Pounds
Grasses:	
Smooth brome (southern strain)	5
Fairway crested wheatgrass	1
Intermediate wheatgrass	3
Orchardgrass (Utah grown)	2
Tall oatgrass	1
Mountain brome	1
Forbs:	
Alfalfa (creeping strains or Ladak)	1
Pacific aster	1/4
Oneflower helianthella	1/2
Showy goldeneye	1/4
Totals	15

Table 1. Continued

Species	North exposures and shady areas		Sunny exposures (south, west, east)	
	Broadcast	Drilled	Broadcast	Drilled
	-Pounds per acre-			
Shrubs:				
Rubber rabbitbrush	1/2	1/4	1/2	1/4
Douglas rabbitbrush	1/2	1/4	1/2	1/4
Big sagebrush	0	0	1/2	1/4
Fourwing saltbush	0	0	1	1/2
Totals	17	8 1/2	20 1/2	10 1/4
Shrubs for pits, major disturbance areas, cleat marks, and drilled areas:				
Antelope bitterbrush	1	1/2	2	1
Golden currant	1/2	1/4	1/2	1/4
Birchleaf mountain mahogany	1	1/2	1/2	1/4
Curlleaf mountain mahogany	0	0	1/2	1/4
Cliffrose	0	0	1/2	1/4
Green ephedra	1/2	1/4	1/2	1/4
Fourwing saltbush	0	0	1	1/2
Woods rose	1	1/2	1/2	1/4
Saskatoon serviceberry	0	0	1	1/2
Totals	4	2	7	3 1/2

Table 1. Continued

Alternate Species for Mountain Brush Associations

Grasses:

- Bearded bluebunch wheatgrass
- Beardless bluebunch wheatgrass
- Big bluegrass *
- Bluestem wheatgrass
- Bottlebrush squirreltail *
- Bulbous barley*
- Bulbous bluegrass*
- Great Basin wildrye
- Green needlegrass*
- Hard sheep fescue
- Indian ricegrass*
- Kentucky bluegrass*
- Meadow brome*
- Mountain rye *
- Sand dropseed*
- Siberian wheatgrass
- Slender wheatgrass
- Standard crested wheatgrass
- Sulcata sheep fescue
- Tall wheatgrass *
- Winter rye *

Forbs:

- American vetch*
- Bouncing-bet
- Bramble vetch*
- Common cowparsnip*
- Cutleaf balsamroot
- Eaton penstemon*
- German iris*
- Gooseberryleaf globemallow*
- Lewis (or blue) flax
- Louisiana sagebrush*
- Low penstemon*
- Nevada showy goldeneye
- Nuttall lomatium
- Palmer penstemon*
- Parry goldenrod*
- Sicklepod milkvetch
- Sidehill penstemon*
- Silky lupine*
- Small burnet
- Stream globemallow*
- Sweetanise*
- Tall milkvetch*
- Tarragon sagebrush*
- Thickleaf penstemon*
- Toadflax penstemon*
- Wasatch penstemon*
- Cushion eriogonum*

Shrubs:

- Apache-plume*
- Arizona cypress*
- Black common chokecherry*
- Black sagebrush
- Blueberry elder *
- Boxelder*
- Common bladdersenna*
- Common lilac*
- Creeping barberry*
- Desert bitterbrush*
- Desert peachbrush*
- Dwarf rabbitbrush*
- Fringed sagebrush*
- Gambel oak*
- Gardner saltbush*
- Longflower snowberry*
- Martin ceanothus*
- Mountain snowberry*
- Nevada ephedra*
- New Mexican forestiera*
- Oldman wormwood (stem cuttings)*
- Parry rabbitbrush*
- Peking cotoneaster*
- Purpleosier willow*
- Redberry elder*
- Rocky Mountain sumac*

Table 1. Continued

Alternate Species for Mountain Brush Associations		
Shrubs: (continued)		
Rocky Mountain juniper*	Skunk bush sumac*	Winterfat*
Roundleaf buffaloberry*	Squaw apple*	Wyeth eriogonum
Russian-olive*	Tatarian honeysuckle*	Yellowbrush
Siberian peashrub*	Utah serviceberry	
Silver buffaloberry*	Western virginsbower*	

Table 4. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed aspen and associated conifers, characterized by mountain snowberry, slender wheatgrass, mountain brome and sticky geranium. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Shade	Openings	Alternate Species	
	-Pounds per acre-			
Grasses:			Grasses:	
Smooth brome (equal portions of northern and southern strains)	4	4	Bearded wheatgrass	Nodding brome
Orchardgrass (Intermountain area)	2	1	Blue wildrye	Slender wheatgrass
Tall oatgrass	2	1	Fairway crested wheatgrass	Subalpine brome
Intermediate wheatgrass	0	2	Meadow brome	Thurber fescue
Mountain brome	1	1		
Meadow foxtail	1	1		
Kentucky bluegrass	1 1/2	1 1/2		
Forbs:				
Alfalfa	0	1	Forbs:	
Chickpea milkvetch	0	1	Alpine leafybract aster	Pacific aster
Mountain lupine	2	1	American vetch	Porter ligusticum
Silky lupine	1	1	Bramble vetch	Small-leaf angelica
Common cowparsnip	1	0	Butterweed groundsel	Smooth aster
Sweetanise	1	1	Colorado columbine	Spreading sweetroot
Showy goldeneye	1 1/2	1 1/2	Engelmann aster	Sticky geranium
			Low goldenrod	Thickleaf peavine
			Nettleleaf gianthyssop	Utah peavine
			Northwestern painted-cup	Vegetable-oyster salsify
			Oregon checkermallow	

Table 2 . Continued

Species	Shade	Openings	Alternate Species	
	-Pounds per acre-			
Shrubs:			Shrubs:	
Antelope bitter brush	0	1	Big sagebrush	Creeping barberry
Mountain snowberry	1	1/2	Bigtooth maple	Redberry elder
Rubber rabbitbrush	1	1/2	Blueberry elder	Woods rose
Totals	18	18		

Table 3 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed wet and semi-wet meadows. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Semi-wet soil		Wet soil		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Semi-wet	Wet
	-Pounds per acre-					
Grasses:					Grasses and Sedges:	
Reed canarygrass	4	2	8	4	Great Basin wildrye	Meadow barley
Meadow foxtail	3	1 1/2	2	1	Kentucky bluegrass	Ovalhead sedge
Redtop	1	1/2	1	1/2	Meadow barley	Tufted hairgrass
Smooth brome (northern strain)	3	1 1/2	0	0	Ovalhead sedge	
Timothy	1	1/2	1	1/2		
Forbs:					Forbs:	
Alsike clover	1	1/2	3	1 1/2	Alpine leafybract aster	Edible valerian
Strawberry clover	2	1	3	1 1/2	Pacific aster	Pacific aster
Black medick	2	1	0	0		
Oregon checkermallow	2	1	0	0		
Totals	19	9 1/2	18	9		

Table 4 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Inland Saltgrass Associations, characterized by inland saltbrush, alkali sacaton, nuttall alkaligrass and creeping wildrye. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Wet Lands		Dry Lands		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled		
	-Pounds per acre-					
Grasses:					Grasses:	
Russian wildrye	4	2	4	2	Alkali sacaton	Reed canarygrass
Tall wheatgrass	2	1	1	1/2	Bluestem wheat-	Salina wildrye
Fairway crested wheatgrass	0	0	2	1	grass	Slender wheatgrass
Tall fescue	2	1	0	0	Meadow foxtail	
Great Basin wildrye	2	1	2	1	Quackgrass	
Forbs:					Forbs:	
Yellow sweetclover	4	2	4	2	Alfalfa (creeping	Black medick
Strawberry clover	2	1	1	0	strain or Ladak)	Fivehook bassia
Pacific aster	1	1/2	1	1/2	Belvedere summer cypress	
Shrubs:					Shrubs:	
Gardner saltbush	3	1 1/2	3	1 1/2	American plum	Russian-olive
Fourwing saltbush	0	0	4	2	Black greasewood	Silver buffaloberry
					Purpleosier willow	Tatarian honeysuckle
Totals	20	10	21	10 1/2	Rubber rabbitbrush	Winterfat

Table 5 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Shadscale Associations. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Application		Alternate Species	
	Broadcast	Drilled		
Grasses:			Grasses:	
Russian wildrye	1 1/2	1	Alkali sacaton	Sand dropseed
Fairway crested wheatgrass	1 1/2	1	Bottlebrush squirreltail	Spike dropseed
Standard crested wheatgrass	1 1/2	1	Salina wildrye	Bluestem wheatgrass
Indian ricegrass	1 1/2	1		
Forbs:			Forbs:	
Gooseberryleaf globemallow	1 1/2	1	Lewis (or blue) flax	Small burnet
Alfalfa	1 1/2	1		
Shrubs:			Shrubs:	
Winterfat	1 1/2	1	Big sagebrush	Parry rabbitbrush
Fourwing saltbush	1 1/2	1	Black sagebrush	Rubber rabbitbrush
			Bud sagebrush	Small rabbitbrush
Totals	12	8	Fringed sagebrush	Yellowbrush

Table 6 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Blackbush Associations, characterized by blackbush, creosotebush, Joshua tree, red brome and galleta grass. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Application		Alternate Species	
	Broadcast	Drilled		
	-Pounds per acre-			
Grasses:			Grasses:	
Pubescent wheatgrass	2	1	Alkali sacaton	Orchardgrass (Mediterranean type)
Intermediate wheatgrass	2	1		
Fairway crested wheatgrass	1	1/2	Bluestem wheatgrass	Russian wildrye
Sand dropseed	1	1/2	Standard crested wheatgrass	Spike dropseed
Forbs:			Forbs:	
Alfalfa	2	1	Alfileria	Nevada showy goldeneye
Small burnet	3	1 1/2	German iris	Palmer penstemon
Gooseberryleaf globemallow	1	1/2	Lewis flax	Toadflax penstemon
Shrubs:			Shrubs:	
Fourwing saltbush	5	2 1/2	Antelope bitterbrush	Desert peachbrush
Winterfat	3	1 1/2	Apache-plume	Longflower snowberry
			Cliffrose	Utah serviceberry
Totals	20	10	Desert bitterbrush	

Table 7 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Subalpine Herblands and Aspen Openings, characterized by redberry elder, western yarrow, Letterman needlegrass and mountain brome. Also included are acceptable alternates if seed for a plant species is not available. Alternates marked with an asterisk(*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Well drained soils		Moist soils		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Well drained Soils	Moist Soils
Grasses:						
Smooth brome (northern strains)	3	1 1/2	4	2		
Smooth brome (southern strains)	3	1 1/2	4	2		
Intermediate wheatgrass	1	1/2	0	0		
Meadow foxtail	1	1/2	2	1		
Subalpine brome	1	1/2	1	1/2		
Tall oatgrass	1	1/2	0	0		
Orchardgrass (Intermountain area)	1	1/2	0	0		
Mountain brome	1	1/2	0	0		
Reed canarygrass	0	0	2	1		
Forbs:						
Alfalfa (creeping type or Ladak)	1	1/2	1	1/2		
Mountain lupine	2	1	2	1		
Common cowparsnip	0	0	1	1/2		
Sweetanise	1	1/2	1	1/2		
Chickpea milkvetch	2	1	0	0		
Grasses:						
					Bearded wheatgrass	Kentucky bluegrass
					Hard sheep fescue	Meadow barley
					Kentucky bluegrass	Meadow brome
					Slender wheatgrass	Ovalhead sedge
					Sulcata sheep fescue	Timothy
					Timothy	
Forbs:						
					Lewis (or blue) flax	Alpine leafybract aster
					Nuttall lomatium	Fat solomon-plume
					Oneflower helianthella	Low goldenrod
					Oregon fleabane	Pacific aster
					Porter ligusticum	Edible valerian
					Showy goldeneye	
					Silky lupine	
					Smooth aster	

Table 7. Continued

Species	Well drained soils		Moist soils		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled	Well drained Soils	Moist Soils
Shrubs:					Shrubs:	
Mountain snowberry	1	1/2	0	0	Big sagebrush	Bush cinquefoil
Yellowbrush	1	1/2	0	0	Bush cinquefoil	Geyer willow
					Parry rabbitbrush	Scouler willow
Totals	20	10	18	9	Redberry elder	Silver sagebrush
					Rubber rabbitbrush	
					Silver sagebrush	
					Squaw currant	
					Sticky currant	
					Woods rose	
					Wyeth eriogonum	

Table 8 . Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Black Greasewood Association, characterized by black greasewood, shadscale saltbush, Gardner saltbush, bottlebrush, squirreltail and alkali sacaton. Also included are acceptable alternatives if seed for a plant species is not available. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Wet to moist soils with high water table. Broadcast	Wet to moist soils with high water table. Drilled	Dry soils with low water table. Broadcast	Dry soils with low water table. Drilled	Alternate Species	
	-Pounds per acre-					
Grasses:					Grasses:	
Tall wheatgrass	3	1 1/2	1	1/2	Alkali sacaton	Creeping wildrye
Fairway crested wheatgrass	1	1/2	3	1 1/2	Bluestem wheatgrass	Great Basin wildrye
Pubescent or intermediate wheatgrass	1	1/2	1	1	Bottlebrush squirreltail	Reed canarygrass
Reed fescue	2	1	0	0		
Russian wildrye	2	1	4	2		
Quackgrass[1]	2	1	2	1		
Forbs:						
Strawberry clover	1	1/2	0	0		
Yellow sweetclover	3	1	2	1		
Shrubs:					Shrubs:	
Fourwing saltbush	1	1/2	2	1	Big sagebrush	Russian-olive
Gardner saltbush	1	1/2	1	1/2	Russet buffaloberry	Yellowbrush
Rubber rabbitbrush	1/2	1/4	1	1/2		
Winterfat	0	0	1	1/2		
Totals	17 1/2	8 1/4	18	9 1/2		

[1] Not recommended if site is near agricultural areas onto which it might spread.

Table 9. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Big Sagebrush Associations, characterized by big sagebrush, rubber rabbitbrush, Nevada ephedra, bluebunch wheatgrass, and Indian ricegrass. Also included are acceptable alternatives if seed for a plant species is not available. Alternates marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species	Precipitation less than 11 inches		Precipitation 11 inches or more		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled		
Grasses:					**Grasses:**	
Fairway crested wheatgrass	3	2	4	2	Alkali sacaton*	Indian ricegrass
Standard crested wheatgrass	2	1	0	0	Bottlebrush squirreltail	Orchardgrass*
Bearded bluebunch wheatgrass	1/2	1/2	1	1/2	Bulbous barley*	Sand dropseed*
Bluestem wheatgrass	1/2	1/2	1	1/2	Bulbous bluegrass*	Siberian wheatgrass
Intermediate wheatgrass	1/2	1/2	1	1	Great Basin wildrye	Smooth brome
Pubescent wheatgrass	1/2	1	1	1	Hard sheep fescue*	(southern strain)*
Russian wildrye	1	1	1	1		Winter rye*
Forbs:					**Forbs:**	
Alfalfa (Rambler, Nomad or Ladak - equal amount of each)	1	1	1	1	Bouncing-bet*	Pacific aster*
Utah sweetvetch	0	0	1/2	1/2	Cushion eriogonum*	Palmer penstemon*
Arrowleaf balsamroot	1/2	1/4	1/2	1/2	Cutleaf balsamroot*	Showy goldeneye*
Small burnet	0	0	1/2	1/2	Eaton penstemon*	Silky lupine*
Shrubs:					Gooseberryleaf globemallow*	
Fourwing saltbush	1	1/2	1	1/2	Lewis flax	Smooth aster*
Rubber rabbitbrush	1/2	1/2	1/2	1/2	Louisiana sagebrush*	Vegetable-oyster salsify*
					Nevada lupine*	
					Nevada showy goldeneye*	Wasatch penstemon*
					Oneflower helianthella*	Sicklepod milkvetch
Totals:	11	8-3/4	13	9-1/2		

Table 9 . Continued

Species	Precipitation less than 11 inches		Precipitation 11 inches or more		Alternate Species	
	Broadcast	Drilled	Broadcast	Drilled		
Shrubs:					Shrubs:	
Shrubs for separate planting in major disturbance areas - pits, tractor cleat marks, and dozer scalps:					Big sagebrush	Martin ceanothus*
Antelope bitterbrush	2	1	3	2	Black sagebrush	Nevada ephedra
Cliffrose or desert bitterbrush	1	1/2	1-1/2	1	Bud sagebrush*	Rocky Mountain smooth sumac*
Fourwing saltbush	2	2	2	2	Desert peachbrush*	Spineless hopsage*
Utah serviceberry	1	1	1	1	Douglas rabbitbrush	Spiny hopsage*
Winterfat	1-1/2	1	1	1	Gardner saltbush*	Squaw-apple*
Totals:	7-1/2	5-1/2	8-1/2	7	Green ephedra	Wyeth eriogonum*
					Longflower snowberry*	

Table 10. Recommended seed mixtures that will benefit wildlife through enhancement of moderately disturbed Pinyon-Juniper Associations, characterized by green ephedra, big sagebrush, antelope bitterbrush, bluebunch wheatgrass, and Sandburg bluegrass. Also included are acceptable alternatives if seed for a plant species is not available. Alternatives marked with an asterisk (*) are for use in special treatments such as erosion control or roadbank stabilization. If disturbance was severe and total reclamation is needed, increase amount of seed by a factor of 2 to 3 times. Information assembled from Plummer, A.P., D.R. Christensen and S.B. Monsen. 1968. Restoring big game range in Utah. Utah Division of Fish and Game (now Utah Division of Wildlife Resources) Publication No. 68-3. 183 pp. Also from personal contacts with A. Perry Plummer.

Species Mixture	Lower elevation (Precipitation less than 12 in.)		Upper elevation (Precipitation 12 in. or more)	
	Broadcast	Drilled	Broadcast	Drilled
Grasses:				
Fairway crested wheatgrass	4	2	3	1-1/2
Standard crested wheatgrass	1	1	1	1/2
Bluestem wheatgrass	1	1/2	0	0
Intermediate wheatgrass	1	1/2	1	1
Pubescent wheatgrass	1	1/2	1	1
Russian wildrye	1	1/2	1	1/2
Smooth brome (southern strain)	0	0	1	1
Forbs:				
Alfalfa (Rambler, Nomad, Travois, or Ladak - equal amount of each	1	1	2	1
Chickpea milkvetch	0	0	1	1/2
Utah sweetvetch	1	1/2	1	1/2
Yellow sweetclover	1	1/2	1	1/2
Arrowleaf balsamroot	1	1/2	1	1/2
Small burnet	1	1	1	1

Alternate Species	
Grasses:	
Bearded or beardless blue-bunch wheatgrass	Mountain rye*
Bottlebrush squirreltail	Orchardgrass
Bulbous barley	Sheep fescue
Bulbous bluegrass	Siberian wheatgrass
Great Basin wildrye	Sulcata sheep fescue
Hard fescue	Tall wheatgrass*
Indian ricegrass	Winter rye*
Meadow brome*	
Forbs:	
Lewis flax	Cutleaf balsamroot*
Nevada showy goldeneye	Sicklepod milkvetch
Nuttall lomatium	Oneflower helianthella *
Pacific aster	Palmer penstemon*
Showy goldeneye	Parry goldenrod*
Eaton penstemon*	Silky lupine*
Gooseberryleaf globemallow*	Small aster*
Louisiana sagebrush*	Tarragon sagebrush*
Nevada lupine*	Thickleaf penstemon
Bouncing-bet*	Toadflax penstemon*
Bramble vetch*	Vegetable-oyster
German iris*	Wasatch penstemon*

Table 10 . Continued

Species Mixture	Lower elevation (Precipitation less than 12 in.) Broadcast	Lower elevation (Precipitation less than 12 in.) Drilled	Upper elevation (Precipitation 12 in. or more) Broadcast	Upper elevation (Precipitation 12 in. or more) Drilled
Shrubs:				
Big sagebrush	1	1/2	1	1/2
Black sagebrush	1	1/2	1	1/2
Rubber rabbitbrush	1	1/2	1	1/2
Winterfat	1	1/2	1	1/2
Fourwing saltbush	1	1	1	1
Totals:	19	11-1/2	20	12-1/2
Shrubs for pits, major disturbance areas, and tractor cleat marks by dribblers:				
Antelope bitterbrush	2	1	3	2
Cliffrose or desert bitterbrush	1	1/2	0	0
Fourwing saltbush	2	2	1-1/2	1
Utah serviceberry	1	1/2	0	0
Green ephedra	1	1/2	1	1
Birchleaf mountain-mahogany	1	1/2	1-1/2	1
Curlleaf mountain-mahogany	1	1/2	1-1/2	1
Woods rose	0	0	1	1
Golden currant	0	0	1/2	1/4
Totals:	9	5-1/2	10	7-1/4

Alternate Species	
Shrubs:	
Nevada ephedra	Longflower snowberry*
Littleleaf mountain-mahogany	Martin ceanothus*
Squaw-apple	Mountain snowberry*
Tatarian honeysuckle	Peking cotoneaster*
Apache-plume*	Rocky Mountain smooth sumac
Arizona cypress*	Roundleaf buffaloberry*
Black common chokecherry*	Russian-olive*
Blueberry elder*	Siberian peashrub*
Common lilac*	Skunk bush sumac*
Desert peachbrush*	Spineless hopsage*
Fringed sagebrush*	Spiny hopsage*
Gardner saltbush*	Wyeth eriogonum*

[illegible] 1/2 German iris Palmer penstemon

Gooseberryleaf globemallow 1 1/2 Lewis flax [illegible]

[illegible] Shrubs:

[illegible]rowing saltbush 5

Table 10 . Continued

Species Mixture	Lower elevation (Precipitation less than 12 in.) Broadcast	Lower elevation (Precipitation less than 12 in.) Drilled	Upper elevation (Precipitation 12 in. or more) Broadcast	Upper elevation (Precipitation 12 in. or more) Drilled
Shrubs:				
Big sagebrush	1	1/2	1	1/2
Black sagebrush	1	1/2	1	1/2
Rubber rabbitbrush	1	1/2	1	1/2
Winterfat	1	1/2	1	1/2
Fourwing saltbush	1	1	1	1
Totals:	19	11-1/2	20	12-1/2
Shrubs for pits, major disturbance areas, and tractor cleat marks by dribblers:				
Antelope bitterbrush	2	1	3	2
Cliffrose or desert bitterbrush	1	1/2	0	0
Fourwing saltbush	2	2	1-1/2	1
Utah serviceberry	1	1/2	0	0
Green ephedra	1	1/2	1	1
Birchleaf mountain-mahogany	1	1/2	1-1/2	1
Curlleaf mountain-mahogany	1	1/2	1-1/2	1
Woods rose	0	0	1	1
Golden currant	0	0	1/2	1/4
Totals:	9	5-1/2	10	7-1/4

Alternate Species	
Shrubs:	
Nevada ephedra	Longflower snowberry*
Littleleaf mountain-mahogany	Martin ceanothus*
Squaw-apple	Mountain snowberry*
Tatarian honeysuckle	Peking cotoneaster*
Apache-plume*	Rocky Mountain smooth sumac
Arizona cypress*	Roundleaf buffaloberry*
Black common chokecherry*	Russian-olive*
Blueberry elder*	Siberian peashrub*
Common lilac*	Skunk bush sumac*
Desert peachbrush*	Spineless hopsage*
Fringed sagebrush*	Spiny hopsage*
Gardner saltbush*	Wyeth eriogonum*

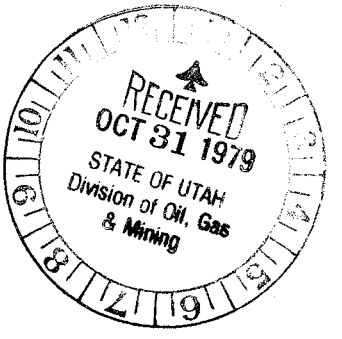
[illegible] 3 1 1/2 German iris Palmer penstemon

Gooseberryleaf globemallow 1 1/2 Lewis flax [illegible]

Shrubs:

[illegible]rwing saltbush 5

EFFECTS OF COAL MINING ACTIVITIES ON AQUATIC ECOSYSTEMS



A Literature Review

prepared by

Utah Division of Wildlife Resources

Vicky F. Ramakka

September, 1979

TABLE OF CONTENTS

INTRODUCTION

Impacts on aquatic systems from coal mining fall into two general categories; damage to biota and habitat from sediment deposition and interruption of natural processes due to sublethal and on occasion lethal effects of toxic substances. An overview of these two categories is presented in this report with each section followed by information specifically applicable to southeastern Utah.

PART I: SEDIMENTATION

A. Overview of Effects of Sedimentation

The magnitude of impact from sedimentation is dependent on the physical properties of the sediment (size, shape, density) and of the water affected (velocity, temperature, flow, turbulence). The extent of impact is also dependent upon the time of year sedimentation occurs and whether a large amount of material is flushed into the system at one time or whether there is a gradual input.

Effects of sedimentation are grouped under five categories and discussed below.

1. Effects Upon Fishes

Cordone and Kelley (1961) discuss research efforts which showed direct fish mortality due to large amounts of silt which appeared to coat the gills, imparing the functions of circulation, respiration, excretion and probably salt balance. How this process works was described by

Ellis (1937, as quoted by Cordone and Kelley 1961), as follows:

> "...the precipitate coated the gill fillaments and filled the filament interspaces so that the water pumped through the mouth and onto the gills for the aeration of the blood could not reach the cells of the gill filaments. Consequently, the aeration of the blood with its accompanying gas exchanges was prevented and sooner or later death followed from a combination of anoxemia and carbon-dioxide retention."

Physical damage from sediments has also been reported.

> "... Experiments ... have demonstrated that rock powders, blast-furnace slags, cinder particles and even coal washings will cut and injure both fish gills and the mantle and gills of unionid molluscs if the particles be larger than those which will pass through a 1,000 mesh (to the inch) screen. In the actual tests the larger the particles, and the greater their hardness and angularity, the greater the possibility of injury to gill structures. These abrasive injuries not only cut the gills but provide entrance for disease organisms..." (Ellis 1944, as quoted by Cordone and Kelley 1961).

However, Gammon (1970) summarizes several studies which indicate some species of fish can tolerate high concentrations of sediment for short periods of time. This ability is mandatory for survival under natural conditions in streams and rivers. Cordone and Kelley (1961) caution against relating direct mortality to sediment itself. They cite a case in which contents of a holding pond for a clay products plant were washed into a river, apparently causing fish mortality; further investigation showed the water was also contaminated by mine wastes which were toxic to fish.

Another effect of sedimentation is the reduction of cover and the resultant increase in predation when pools and riffle areas are filled with sediment, becoming unavailable to adult trout, salmon and their fry (Cordone and Kelley 1961).

A less obvious effect of sedimentation is changes in fish behavior. Gammon (1970) summarizes reports of observed behavior changes including avoidance of turbidity, cessation of feeding and decreased migration.

2. Eggs and Fry

While adult fish can tolerate certain amounts of sedimentation, eggs and fry are especially vulnerable. The effect is clearly described by Peters (1962, p. 275).

> "Clean, permeable gravels provide the nursery areas in the stream environment for trout embryos. Water seeps through the gravels into the redd delivering oxygen to the developing trout embryos and washing away metabolic waste products produced by the embryos."
>
> "The suspended sediment present during the incubation period can greatly affect the survival rate of developing trout embryos. In a stream with large sediment concentrations, sediments will be deposited in trout redds, clogging the pore spaces between the gravels. Consequently, the seepage rate will decrease and the supply of oxygen to the redd will diminish."
>
> "Continuous large sediment concentrations in a stream during the trout egg incubation period can determine the recruitment of young-of-the-year trout to the population..."

Cordone and Kelley (1961) reviewed several research studies and concluded that the effects of sedimentation, even moderate

deposition, are detrimental to alevins and especially eggs of salmonids. They quote from a study of brown trout in Scotland as follows:

> "As we have seen, silt is not very dangerous in the normal stream if excess occurs only at intervals. The character of such normal streams can however be altered drastically by allowing the washings of quarries, gravel pits, mines, etc., to flow into streams untreated. In many cases the quantities allowed to enter the streams may be small and the material in suspension may in itself be of a non-toxic character, but as has been shown above, continuous application of small quantities over the redds may be much more detrimental to the welfare of the alevins than sudden flushes of large quantities." (Stuart 1953, as quoted by Cordone and Kelley 1961).

3. Bottom Fauna

Innumerable invertebrates inhabit the bottoms of streams and play important roles in the food chain. Various studies upstream and downstream of disturbance sites (such as placer mining operations and gravel washing plants) have shown drastic reductions in bottom organisms due to increases in sediment (Cordone and Kelley 1961). A typical study researched the effects of stonedust sediment from a crushed limestone quarry in Indiana (Gammon 1970). The density of macroinvertebrates was found to decrease to about 40% of normal when more than 80 mg/l inert solids were added to the normal suspended solids load. For 20 to 40 mg/l introduced for a part of each day, the population density was generally about 75% of normal. There was little change in species diversity as most species were similarly decimated.

Such decreases in bottom organisms are directly related to changes in characteristics of stream bed materials. Species density and diversity

are associated with different types of bottom materials, with rubble being the most productive and silt and sand quite unproductive. Rubble produces a fairly stable bottom, an abundance of small interstices which provide shelter and a large surface area for growth of microscopic plants that are the basic food of most smaller acquatic animals. (Cordone and Kelley 1961).

The result of introducing large amounts of sediment, then, is to increase the relative proportion of finer materials on stream bottoms, which will eventually cause a decline in bottom organisms. This declining supply of food sources for fish is probably the most important indirect effect of sedimentation.

4. Aquatic Plants

Algae and other green plants are the basis of the food chain and critical to the entire stream community. Plants are affected physically by sediment which may wear them down by abrasion, blanket them with silt, or act as a barrier to the free exchange of gases necessary for photosynthesis. In addition, turbidity caused by sedimentation decreases light penetration and thus the rate of photosynthesis, which can cause considerable impact on a stream's ecology (Cordone and Kelley 1961).

5. Chemical and Physical Characteristics

Cordone and Kelley (1961) found limited information on chemical and physical effects of sedimentation. The few studies reported indicated

that siltation did not affect dissolved oxygen, pH, the salt complex or amount of electrolytes. Silt was found to interfere with heat transmission, which is most significant in lakes which have an annual "turn over" of thermally stratified layers. Oxygen concentration may be affected if sediment contains considerable organic material. Light penetration is especially influenced by turbidity.

B. Causes of Sedimentation from Coal Mining in Southeastern Utah

All phases of coal mining--construction, operation and reclamation--can produce conditions which result in soil erosion. Significant amounts of sediment may enter a stream due to erosion from land clearance for mine facilities, from topsoil stock piles and from surfaces exposed by mining. "Recent studies of the impact of eight mines in southeastern Utah found that in every case coal wastes and silt was [sic] being washed into the surrounding watershed by storm water run-off..." (McAda 1977, pp. 128-129).

Road construction and coal haul roads can be a major contributor to stream sedimentation. Of the total area directly disturbed by a mining operation, roads may constitute ten percent (Grim and Hill 1974, as cited by McAda 1977). Poorly constructed haul roads are subject to erosion throughout the life of a mine and possibly afterwards.

Coal mines in southeastern Utah are generally located in steep canyons and their access roads often parallel the adjacent stream

flowing out of the canyon. Spillage from trucks hauling coal occurs regularly. Much of this material is washed into stream beds.

Pockets of accumulated coal have been observed in Huntington Creek below stockpile storage yards by John Livesay, Fisheries Manager, Utah Division of Wildlife Resources. This filling in of stream bottoms decreases the available habitat for aquatic organisms.

The silt and coal particles being washed into the area's streams are probably producing one or more of the detrimental effects of sedimentation discussed in the preceding overview section. These effects occur over a long term and are not readily observed, but they steadily erode the quality of aquatic habitats.

> "Another category of solid found in mine effluents is the total dissolved solids (TDS) such as calcium, sodium, bicarbonates and sulphates. These minerals add to the salinity and conductivity of water and depending on the mine site, may be quite high in concentration. Effluent analysis of several unsettled mine discharges of presently operating mines in Utah showed the following TDS ranges.

Parameter	Concentration
TDS (Total Dissolved Solids)	574 - 4790 mg/l
TSS (Total Suspended Solids)	8.3 - 23
SO_4	825 - 2260
Calcium	66 - 188
Potassium	348
Chlorides	8 - 170
Sodium	76

"Effluents from these mines ranged from 0.21 to 3 cubic feet per second (cfs) (Southeastern Utah Assoc. Governments, 1977).

"It should be mentioned that TDS concentration of the waters in southeastern Utah are quire high naturally. Naturally occurring levels of dissolved solids are frequently higher than those of mine effluents. Runoff from irrigated land may contribute 4 tons of salt per acre; that from forest lands amounts to 0.3 tons per acre...

"Mines frequently produce significant quantities of water of better quality than is locally available. This phenomena occurs because as water percolates down through layers of mancos shale and sandstone, it becomes progressively more saline. A mine may act as a drain in a mountain, interrupting the ground water and bringing it to the surface at lower salinity than that emerging through natural processes. It was concluded in recent studies of coal mine impacts in southeastern Utah, that coal mining did not contribute significantly to TDS concentrations of waters surrounding the mines..." (McAda 1977, pp. 127-128).

A second report provides more detailed information on the concentration of total dissolved solids in effluents from selected mines (Waddell et al. 1979. p. 64).

Mine	Dissolved solids concentration in mine effluent (mg/L)	Stream and sampling site	Dissolved solids concentration in stream above mine[1] (mg/L)
Utah No. 2	482	Pleasant Valley Creek (Price River tributary), site 09310691	230
Sunnyside	1,600	Grassy Trail Creek (Price River tributary), site 09314320	255-820

Mine	Dissolved-solids concentration in mine effluent (mg/L)	Stream and sampling site	Dissolved-solids concentration in stream above mine[1] (mg/L)
King No. 2	671	Cedar Creek (Huntington Creek tributary)	671[2]
Wilberg	551	Grimes Wash (Cottonwood Creek tributary), site 09324500	141-666
Convulsion Canyon	276	Quitchupah Creek (Muddy Creek tributary), site 09331805	421
Emery	5,100	Christiansen Wash (Muddy Creek tributary)	([3])

[1]Ranges are for samples collected during 1975-77; single entries are for samples collected concurrently with samples of mine effluent.
[2]All flow from mine.
[3]No sample collected.

The total effect of these mine discharges cannot be calculated because the average discharges were not recorded and some mines discharge continuously and others intermittently. However, all these mines had been observed at some time discharging more than 100 gal./min. It can be seen that mines may be contributing between hundreds up to thousands mg/L total dissolved solids to receiving streams.

PART II: TRACE ELEMENTS

A. Overview of Effects of Trace Elements

Trace elements are generally defined as having a relative abundance in the earth's crust of 0.1 percent (one part per thousand) or less. A limited amount of trace elements occur naturally in aquatic ecosystems but the rate that trace elements are released into the environment is rapidly increasing due to man's activities.

Trace elements occur within aquatic systems as free ionic forms, inorganic ion pairs, inorganic complexes, organic complexes, inorganic colloids, organic colloids, and in living organisms and their remains. The concentration of these forms is continually changing due to temperature, salinity, solubility, water hardness, chemical speciation, biological activity and other environmental and chemical factors (Dvorak 1978).

In aquatic ecosystems, micro organisms are active in the processing and conversion of trace metals. Wastewater treatment processes utilize micro organisms to remove heavy metal ions, but concentrations that are too high can inhibit microbial action by poisoning the enzyme systems (Dvorak 1978).

Aquatic plants are known to concentrate trace elements. The mechanism of trace element uptake is a two step process with first, the ion being adsorbed to the cell wall and then transported through the cell wall to internal tissues through an ion exchange process. Aquatic plants can be

affected by trace elements in a variety of ways, including changes in physiology, productivity, community composition and species abundance (Dvorak 1978).

Fish are affected by trace elements either by direct mortality when concentrations are high or by indirect sublethal effects when concentrations or exposures are chronic. Uptake occurs primarily through active or passive absorption by the gills and from ingestion of contaminated food; contamination through ingestion is considered most prevalent.

> "The direct lethal effect can be caused by physiological action of trace elements in different tissues or organs of fish. In many cases, the cause of death is the interference of the trace element with some enzyme system...
>
> "The second class of toxic effects of trace elements on fishes is the sublethal or chronic effects. These include inhibition or interference with neurophysiological activity, enzyme activity, and hormonal balance; increased susceptibility to disease or parasites; and teratogenic, carcinogenic and mutagenic effects. Other sublethal effects at the organism level are reduced growth, behavioral modifications, reduced survival, reduced reproductive capacity and reduced fitness." (Dvorak 1978, p. 96).

Other effects discussed by Dvorak are reduction in feeding, increased susceptibility to predation and avoidance of contaminated water.

Trace metals are especially important with regard to processes of bioaccumulation (the ability of an organism to concentrate an element above abiotic environmental levels), bioconcentration (the influence of weight and length), and biomagnification (the tendency for trace elements to be concentrated with trophic level transfer).

> "... trace elements are predominately associated with the sediments, which act as both sink and reservoir; relatively small amounts are found dissolved in the water. From the sediments, trace elements are accumulated by both rooted vegetation and benthic invertebrates. Phytoplankton both adsorb trace elements to their cell walls as well as absorb them. Grazers and lower-order consumers seem to concentrate trace elements to the highest degree. The greatest bioaccumulation or concentration factors are found in sediment or detrital feeders. Higher order consumers or predators accumulate trace elements both from water and food, but food appears to be the major source. Some discrimination appears to occur at this trophic transfer since trace element concentrations are usually lower in predators than in their prey. Although this is contradictory to biomagnification theory, several studies have indicated this occurrence..." (Dvorak 1978, p. 100).

Another consideration in the effects of trace elements in aquatic systems is the possibility of additive, synergistic or antagonistic effects. Whitton and Say (1975) discuss several examples of this phenomenon with respect to heavy metals. One study showed that zinc plus cadmium showed an additive toxic effect in soft water, while combinations of zinc plus nickel, and zinc plus copper were synergistic in their toxic effects.

Dvorak (1978, p. 165) in reference to coal-fired power plants states that "... next to nothing is known of the effects of long term exposure to very low concentrations of gaseous and trace element environmental contaminants." Several areas of needed research are identified with those for aquatic systems appearing below.

"1. Field data on trace element toxicities to aquatic organisms (most current standards have been obtained from laboratory bioassays).

2. Trace element transformations and reactions in surface waters and groundwaters.

3. Trace element cycling in aquatic ecosystems, including differential uptake of ionic and chelated forms, biomagnification factors, bioaccumulation-elimination and turnover rates, and determination of final sinks where trace elements are no longer available to biota.

4. Synergistic effects of heat and other contaminants on trace-element toxicities, and sublethal effects on aquatic organisms." (Dvorak 1978, p. 166).

B. Trace Elements from Coal Mining in Southeastern Utah

Table I shows the chemical composition of coal samples from the Wasatch Plateau and Book Cliffs coal fields. Several trace elements occur in the coal. Removing soil and overburden for mine facilities also exposes new surfaces which undergo mineral leaching. The extent to which these elements are released into aquatic environments of Southeastern Utah is not known.

When asked whether coal particles in streams may be contributing trace elements to the water, both Dick Jewell (Hydrologist, Bureau of Land Management, Price) and Norm Larsen (Chemistry Instructor, College of Eastern Utah) indicated they felt it was unlikely that any chemical release occurred, but also said they knew of no studies on the topic. Norm Larsen indicated solubility tests would have to be made and that solubility rates

may change as coal particles are subject to pulverization over long periods of time. After reviewing the list of trace elements found in local coal beds, Mr. Larsen noted several which are known to be environmental toxicants in other situations and especially pointed out flourine (70 ppm in whole coal from the Wasatch Plateau) which must be kept at very low levels in public drinking water supplies.

There is limited information on coal solubility.

> "Coal pile runoff and seepage are similar in quality to acid mine drainage. Sulfides in the coal are oxidized, forming soluble sulfate. At the same time, iron may enter into solution, and the hydrogen ion concentration is elevated. In addition, trace elements, i.e. zinc, copper and chromium, enter into solution. Coal pile runoff also contains large concentrations of total dissolved solids... Information on the solubility of other minor and trace elements in coal is not available at this time." (Rolan 1977, p. 28).

Concentrations of pollutants in coal pile runoff and leachate (mg/l).

Pollutant	Mean	Range
pH	2.7	2.1-3.0
Iron	19,540	0.17-93,000
Sulfate	9,006	525-21,920
Zinc	3.64	1.6-23.0
Copper	2.10	1.6-3.4
Chromium	3.27	0-15.7
Total Dissolved Solids	16,440	720-44,050

Original source: Anderson, W.C. & M.P. Youngstrom, 1976. Journal of Environmental Engineering Div., ASCE, Vol. EE6, 1239-1253 (Rolan 1977, p. 31).

The alkaline nature of the region's water tends to reduce the availability of trace elements to aquatic fauna.

> "The pH of the environment has a pronounced effect on the form and therefore the uptake of certain trace elements, primarily heavy metals. When the solution is acidic, most heavy metal ions are liberated into solution and available for uptake through the gills. When the pH is basic, hydroxides are formed and the complexes are taken up through food sources. For example, Merlini and Pozzi (1977) found that the uptake of lead was three times greater at pH 6 than at 7.5. Tsai et al. (1975) determined that inorganic mercury was less available for uptake by fish in alkaline water than in acidic water. Mercury complexes formed under alkaline conditions were postulated as the reason for reduced uptake..." (Dvorak 1978, p. 96).

For a study of effects of surface mining in the western states, water quality was monitored along Trout Creek, Colorado, which received runoff from strip-mining operations. The mine operation was found to have no detectable impact in terms of increasing concentrations of arsenic, iron, manganese, selenium and zinc. "Chemical equilibrium calculations indicate that alkaline precipitation processes can maintain the low concentrations of Al, Cd, Cu, Fe, Pb, and Zn [aluminum, cadmium, copper, iron, lead, and zinc, respectively]. The general alkaline characteristics of western streams and aquifers suggests that such precipitation equilibria will limit the soluble heavy metal concentrations." (Skogerbee et al. 1979, p. iv).

Generally, coal mining in southeastern Utah is not considered to have an impact on water chemistry. In the final Central Coal EIS, the following summary is given in regard to opening new mines in the area.

> "The chemical quality of the water is not likely to be affected by coal-mining or a changed regimen of ground-water movement through mined-out areas because, (1) the sulfur content of the coal is low, generally less than 1 percent and therefore sollution would add very little sulfur to ground water, (2) the quantities of water per unit area and rates of water movement associated with the coal and the overburden material are small--average is less than 40 acre-feet per year per square mile, and (3) most of the water in the study area is highly alkaline--concentrations of bicarbonate are 100-300 mg/L--which would allow immediate buffering of acid mine water and some precipitation of sulfur contained in ground water. A recent study of mine drainage and water quality in Colorado shows essentially no coal mine drainage problems, which is attributed mainly to the low sulfur content of western coal (Wentz, 1974)." (Dept. of Interior 1979, p. IV-6).

On the other hand, additional information in the Central Coal EIS (Dept. of Interior 1979) indicates there is a problem with trace element pollutants. The chemical quality of surface water in headwater areas is considered relatively good, but it deteriorates downstream. Concentrations of trace elements and heavy metals in the headwater areas are generally less than the maximum limits recommended for public supply and for aquatic life (Table II). However, in the middle and lower reaches of the Price and San Rafael Rivers and Muddy Creek, concentrations of at least 11 elements were found to commonly or occasionally be in excess of recommended limits. Coal mines on tributaries of these water courses may contribute a portion of this excess, but there is no information whether it is significant.

> "Water from some of the coal mines contains greater concentrations of arsenic, iron, manganese, and selenium than have been detected in streams according to unpublished data from the Southeastern Utah Association of Governments' 208 Water Quality Program, which may indicate that present enforcement of mitigations is somewhat remiss. Data on concentrations of other metals and trace elements in coal mine effluent are not available; however, concentrations of dissolved solids are comparable to that of nearby streams." (Dept. of Interior 1979, p. II-26).

In regard to the new mine plans reviewed in the Central Coal EIS, it was felt reasonable enforcement of effluent standards would prevent comtamination by trace elements.

More detailed information on the range of concentrations of several elements in mine effluents is given by McAda (1977, p. 126) as adopted from the 1977, 208 Water Quality Plan prepared by the Southeastern Utah Association of Governments.

Element	Concentration in Discharge
Aluminum	0.03
Arsenic	0.0006-0.22
Cadmium	0.001
Copper	0.009-0.05
Iron	0.04-1.45
Lead	0.005-0.05
Mercury	0.0001
Nickel	0.001
Zinc	0.077
Selenium	0.04-0.62

A comparison of these values to standards for public water supply and aquatic life (Table II) shows some concentrations exceed the

recommended limits. It should be noted that criteria for human consumption varies considerably from that for aquatic life, so that water which meets standards for public supply may be toxic to fish.

The U.S. Geological Survey has also conducted analyses in regard to dissolved metals in effluents from mines in the Wasatch Plateau and Book Cliffs coal fields. Some of the results follow:

> "The concentrations of arsenic, chromium, lead, mercury, and selenium did not exceed the recommended maximum contaminant levels set by the Environmental Protection Agency... Analyses also made for total metals (dissolved plus undissolved) in the outflow from the Utah No. 2 mine indicated that the concentrations of some of the undissolved (suspended) metals were several times greater than those of the dissolved metals. Dissolved arsenic was 0 µg/L as compared to 11 µg/L total; dissolved iron, 20 µg/L as compared to 2,600 µg/L total; and dissolved lead, 0 µg/L as compared to 100 µg/L total [note: µ equals 0. 000 001]. The dissolved and undissolved concentrations of lithium, zinc, and selenium were about the same. The undissolved metals are relatively harmless as long as physical parameters such as pH and redox potential of the water do not allow the toxic metals, such as arsenic and lead, to dissolve. If the undissolved material eventually migrates into an anaerobic zone, such as may exist in the bottom of reservoirs or lakes, the metals may then dissolve. Thus the undissolved material, although relatively harmless in that state, may pose a future threat if the proper solubility criteria are induced in the water." (Waddell et al. 1979, p. 65).

The varied effects of trace elements on aquatic biota are discussed in the Overview Section and additional information appears in Table III. Certain trace elements have been found in mine effluents. There appears to be no information whether coal particles accumulated

in stream beds release trace elements, even considering they undergo decades and decades of abrasion and physical break-down. While alkaline water tends to precipitate chemicals from strip-mine runoff and mitigate their effects, no studies have been conducted on this topic in this area where underground mining predominates. Therefore, it appears that further investigation is needed to answer the question of whether coal mining activities contribute significantly to the concentration of trace elements in stream waters and if so, whether there is any impact on the aquatic biota.

MISCELLANEOUS IMPACTS

Other effects of coal mining on aquatic ecosystems as identified by McAda (1977) include:

Disruption of natural aquifers which can affect surrounding streams.

Subsidence which could impound ground water or disrupt stream channels and flows from seeps and springs.

Pollution from miscellaneous pollutants such as oil, grease, herbicides and pesticides. The 208 Water Quality Assessment conducted by the Southeastern Utah Association of Governments showed that monitoring of eight mine sites did not reveal excessive oil pollution (greater than the 10 mg/l guideline), but that surface films characteristic of spilled oil were frequently observed.

Increasing demands on water for municipal purposes and more water oriented recreation due to a larger population drawn by industrial development.

Possible production of good quality water since coal seams frequently act as shallow ground water aquifers. This seepage is pumped out of the mine, usually does not contain leached metals or suspended solids after being allowed to settle and may then be used for irrigation or other purposes.

REFERENCES CITED

Cordone, A. J. and D. W. Kelly. 1961. The influences of inorganic sediment on the aquatic life of streams. Cal. Fish and Game 47 (2) : 189-228.

Dept. of Interior. 1979. Development of coal resources in Central Utah. Final Environmental Impact Statement Regional Analysis Part 1. U.S. Geological Survey.

Dvorak. A. J., Project Leader. 1978. Impacts of coal-fired power plants on fish, wildlife and their habitats. Fish and Wildlife Service FWS/OBS - 78/29.

Ellis, M. M. 1937. Detection and measurement of stream pollution. U.S. Dept. of Commerce, Bur. Fisheries, Bull. 22, 48:365-437.

_____. 1944. Water purity standards for fresh-water fishes. U.S. Fish and Wildl. Serv., Spec. Sci. Rept. 2, 18 pp. (As cited by Cordone and Kelley 1961).

Gammon, J. 1970. The effect of inorganic sediment on stream biota. Water Pollution Control Ser., Water Quality Office, EPA, Washington, D.C. 141 p.

Grim, E. and R. Hill. 1974. Environmental protection in surface mining of coal. EPA-6702-74-093. National Environmental Research Center, Cincinnati, Ohio. 275 pp. (As cited by McAda 1977).

McAda, C., Project Coordinator. 1977. A survey of endangered, threatened and unique fish in southeastern Utah streams within the coal planning area. Utah Cooperative Fishery Research Unit, Utah State University, Logan.

Merlini, M. and G. Pozzi. 1977. Lead and freshwater fishes. Part 1, Lead accumulation and water pH. Environ. Pollut. 12: 167-172. (As cited by Dvorak 1978).

Peters, J. C. 1962. The effects of stream sedimentation on trout embryo survival. Pp.275-279 in Biological problems of water pollution. 34th seminar, 1962. Public Health Service Publ. 999-WP-25. HEW, Washington, D.C.

Rolan, R. G. 1977. Design and implementation of an environmental monitoring program for ERDA fossil fuel facilities. Task Summary Report III. Prepared for ERDA by Dalton-Dalton-Little-Newport, Cleveland, Ohio.

Skogerboe, R. K., C. S. LaVallee, M. M. Miller, and D. L. Dick. 1979. Environmental effects of Western Coal Surface Mining, Part III - The Water Quality of Trout Creek, Colorado. U. S. Environmental Protection Agency, EPA-600/3-79-008.

Southeastern Utah Association of Governments. 1977. Waste water quality management, 208 plan, Emery, Carbon and Grand Co. 511 pp. with appendices. (As cited by McAda 1977).

Stuart, T. A. 1953. Spawning migration, reproduction and young stages of loch trout (Salmo trutta L.). Scottish Home Dept., Freshwater and Salmon Fisheries Research, No. 5, 39 pp. (As cited by Cordone and Kelley 1961).

Tsai, S. C., G. M. Bosh and F. Matsumura. 1975. Importance of water pH in accumulation of inorganic mercury in fish. Bull. Environ. Contam. Toxical. 13:188-194. (As cited by Dvorak 1978)

Waddell, K. M., P. K. Contratto, C. T. Sumsion, and J. R. Butler. 1979. Hydrological Reconnaissance of the Wasatch Plateau-Book Cliffs Coal Fields Area, Utah. U. S. Dept. of Interior, Geological Survey, Salt Lake City. Open-file Report 79-988.

Wentz, D. A. 1974. Effects of mine drainage on the quality of streams in Colorado, 1971-1972: Colorado Water Resources Circular No. 21, 117 p. (As cited by Dept. of Interior 1979)

Whitton, B. A. and P. J. Say. 1975. Heavy Metals. Pages 286-311 in Whitton, B. A., ed., River Ecology. U. of California Press, Berkeley.

TABLE I. Average (arithmetic mean) composition and observed range of 10 major and minor oxides and 20 trace elements in coal ash, and contents of seven additional trace elements in 48 Wasatch Plateau field coal samples. All samples were ashed at 525°C. (Table taken directly from Final Central Coal EIS, Dept. of Interior, 1979, p. II-14).

Oxide or element	Average (arithmetic mean)	Observed range	
		Minimum	Maximum
Major and minor oxides in ash (percent)			
Ash	11.45	1.8	36.6
Silica (SiO_2)	53	21	84
Aluminum oxide (Al_2O_3)	16	6.2	29
Calcium oxide (CaO)	6.1	.86	25
Magnesium oxide (MgO)	1.05	.42	2.53
Sodium oxide (Na_2O)	3.64	.11	8.41
Potassium oxide (K_2O)	.75	.062	2.2
Ferric oxide (Fe_2O_3)	3.9	.83	12
Manganese oxide (MnO)	.010	.003	.026
Titanium dioxide (TiO_2)	.92	.42	1.7
Sulfur trioxide (SO_3)	4.2	.66	10
Trace elements in ash (parts per million)			
Boron (B)	1,000	200	3,000
Barium (Ba)	700	70	3,000
Beryllium (Be)	15	<3	50
Cadmium (Cd)	.9	1.0	2.0
Cobalt (Co)	15	<10	50
Chromium (Cr)	100	30	200
Copper (Cu)	95	32	266
Gallium (Ga)	30	10	70
Lithium (Li)	111	15	288
Molybdenum (Mo)	10	<7	20
Niobium (Nb)	20	<20	50
Nickel (Ni)	50	10	200
Lead (Pb)	55	<25	195
Scandium (Sc)	20	<10	50
Strontium (Sr)	1,000	100	5,000
Vanadium (V)	100	70	300
Yttrium (Y)	70	30	300
Ytterbium (Yb)	7	3	15
Zinc (Zn)	84	19	237
Zirconium (Zr)	200	100	500
Trace elements in whole coal (parts per million)			
Arsenic (As)	1.0	<0.5	3
Fluorine (F)	70	<20	240
Mercury (Hg)	.05	.01	.21
Antimony (Sb)	.3	<.1	.7
Selenium (Se)	1.7	.8	5.7
Thorium (Th)	1.7	<3.0	5.2
Uranium (U)	1.3	.2	3.5

TABLE I.(cont.) Average (arithmetic mean) composition and observed range of 10 major and minor oxides and 20 trace elements in coal ash, and contents of seven additional trace elements in eight Book Cliffs field coal samples. All samples were ashed at 525°C. (Table taken directly from Final Central Coal EIS, Dept. of Interior, 1979, p. II-13.)

Oxide or element	Average (arithmetic mean)	Observed range	
		Minimum	Maximum
Major and minor oxides in ash (percent)			
Ash	8.75	6.0	12.4
Silica (SiO_2)	47	38	62
Aluminum oxide (Al_2O_3)	19	13	25
Calcium oxide (CaO)	8.4	2.5	15
Magnesium oxide (MgO)	1.64	.71	2.65
Sodium oxide (Na_2O)	1.83	.79	3.51
Potassium oxide (K_2O)	.37	.05	.77
Ferric oxide (Fe_2O_3)	5.9	1.5	19
Manganese oxide (MnO)	.13	.003	.39
Titanium dioxide (TiO_2)	1.1	.67	1.5
Sulfur trioxide (SO_3)	4.0	1.7	5.9
Trace elements in ash (parts per million)			
Boron (B)	1,000	700	1,500
Barium (Ba)	1,000	300	2,000
Beryllium (Be)	7	<3	7
Cadmium (Cd)	1.0	<1.0	1.0
Cobalt (Co)	10	<10	15
Chromium (Cr)	50	30	70
Copper (Cu)	59	22	95
Gallium (Ga)	30	20	30
Lithium (Li)	187	63	328
Molybdenum (Mo)	10	<7	15
Niobium (Nb)	20	20	30
Nickel (Ni)	20	15	30
Lead (Pb)	44	30	60
Scandium (Sc)	15	15	30
Strontium (Sr)	1,500	500	3,000
Vanadium (V)	70	70	100
Yttrium (Y)	50	30	70
Ytterbium (Yb)	5	3	5
Zinc (Zn)	72	42	88
Zirconium (Zr)	300	200	300
Trace elements in whole coal (parts per million)			
Arsenic (As)	0.6	0.5	1.0
Fluorine (F)	54	20	110
Mercury (Hg)	.03	.01	.04
Antimony (Sb)	.2	.2	.3
Selenium (Se)	1.9	1.5	2.4
Thorium (Th)	2.6	3.0	3.9
Uranium (U)	.7	.3	.9

TABLE II. Water quality criteria developed by the National Academy of Science and National Academy of Engineering, 1973. (Table taken directly from Final Central Coal EIS, Dept. of Interior, 1979, p. II-27).

Chemical parameter	Public supply limit (mg/L)	Aquatic life threshold (mg/L)	Chemical parameter	Public supply limit (mg/L)	Aquatic life threshold (mg/L)
Aluminum	-	[1]0.1	Lead	0.05	[1]0.03
Arsenic	0.1	0.1	Manganese (soluble)	0.05	--
Barium	1.0	1.0	Mercury	0.002	[1]0.05
Cadmium	0.01	[1] [3]0.3	Nickel	--	0.01
		[1] [4]0.004	Nitrate-Nitrogen	10.0	--
Chloride	250	--	Nitrite-Nitrogen	1.0	--
Chromium	0.05	0.05	Selenium	0.01	10.0
Cobalt	--	5.0	Silver	--	0.001
Copper	1.0	[3]0.015-0.033	Sulfate	250	--
		[4]0.011-0.018	Zinc	5.0	0.005
Cyanide	0.2	--	Unionized ammonia	--	0.02
Flouride	[2]1.4-2.4	--	Free chlorine	--	0.01
Iron (soluble)	0.3	--			

[1]Recommended maximum level.
[2]Dependent upon ambient temperature.
[3]Hard water.
[4]Soft water.

Table III. Behavior and toxicity of selected trace elements to aquatic biota. (Table taken directly from Dvorak, 1978, pp. 245-251.)

The following is a generic discussion of the behavior of selected trace elements in aquatic systems. The degree of toxicity of these elements is often dependent on the elemental valence. A toxicity table based on bioassay determinations for the selected elements is also included. Additional information on trace-element behavior and toxicity relative to power plant operation is available in Becker and Thatcher (1973).

ARSENIC

Arsenic may be biologically concentrated through aquatic food chains; benthic algae, molluscs, crustacea, and fish can concentrate arsenic to levels 200, 650, 400, and 700 times as great as those in the environment, respectively (Braunstein et al. 1977). Freshwater organisms generally contain lower concentrations of arsenic than their marine counterparts; concentration ratios reported for saltwater fish range from 10 to 100 times higher than those reported for freshwater fish (Woolson 1975). In general, arsenic is toxic to aquatic organisms within the range of 1.0 to 45 mg/L arsenite (McKee and Wolf 1963). The arsenite ion is generally considered more toxic than arsenate (Ferguson and Gavis 1972; Braunstein et al. 1977).

CADMIUM

In a study by Mathis and Cummings (1973), benthic organisms appear to concentrate cadmium in higher concentrations than other aquatic organisms. Also, anadromous fish species appear to be quite sensitive to cadmium (Jones 1939). Model projections by Dvorak et al. (1977) indicate that cadmium enrichment potential in some basins appears to be considerable, particularly in the Northwest Region where large spawning runs of salmon and trout occur.

CHROMIUM

Chromium toxicity to aquatic organisms is dependent on several factors, particularly the ionic state, pH, and water hardness. Trivalent chromium often appears to be the ionic form most poisonous to fish. Fish may tolerate various chromium salts, but invertebrates are more sensitive to chromium salts (Becker and Thatcher 1973).

COPPER

Toxicity of copper and copper sulfate to aquatic organisms varies considerably and is dependent on such factors as temperature, turbidity, water hardness, and the carbon dioxide content of the water. Cupric ions introduced to natural waters of pH 7 or above will quickly precipitate as copper hydroxide or as basic copper carbonate (Braunstein et al. 1977).

LEAD

Lead may be taken up by fish and aquatic invertebrates through the body surface (including the gills) or through ingestion of other organisms (Adams 1975). In aquatic systems, lead is readily complexed and poorly soluble (Lake Mich. Enforcement Conf. 1972). As most lead is found in bottom sediments (Warnick and Bell 1969), benthic communities may be adversely affected. Toxicity of lead to aquatic organisms generally occurs at concentrations greater than 0.01 mg/L.

MANGANESE

Freshwater invertebrates accumulate manganese (valence state unknown) in greater concentrations than their marine counterparts; however, marine fish accumulate manganese in greater concentrations than freshwater fish.

MERCURY

Methylmercury is very soluble in water and thus is readily accumulated by aquatic organisms and concentrated in tissues (Schmidt-Nielsen 1974). Organic mercurial compounds are more toxic to aquatic organisms than are inorganic mercurials, partly because of a more rapid uptake of organic mercurials (Braunstein et al. 1977). Mercury is poorly scavenged by current stack-gas cleaning equipment.

NICKEL

Nickel compounds are only moderately toxic to aquatic organisms, and adverse impacts to aquatic systems resulting from coal combustion are probably small.

SELENIUM

Selenium has been shown to be carcinogenic and teratogenic, but it is antagonistic to the carcinogenic and teratogenic effects of cadmium and arsenic (Braunstein et al. 1977). Selenium compounds also have a protective effect against the toxic action of mercury compounds (Koeman et al. 1975). Selenium generally becomes tied-up in sediments of aquatic systems, and invertebrates tend to concentrate higher levels of selenium than fish.

ZINC

Zinc is relatively toxic to fish and other aquatic organisms, and it may combine with copper or nickel to produce a synergistic toxic effect (Brown and Dalton 1970). Zinc sulfate is highly soluble in water and its degree of toxicity to aquatic organisms is dependent on the species involved as well as various chemical conditions of the water body. In addition, the toxicity of zinc in aquatic systems is strongly influenced by water hardness. Zinc emissions from coal-fired power plants may reach concentrations injurious to aquatic systems.

TABLE III. Continued

Organism	Element (mg/L)	Remarks[b]	Reference
		Arsenic	
Aquatic organisms (general)	1.1-45	Lethal, arsenite	Ferguson and Gavis (1972)
Daphnia magna	2.85	LC_{50}, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.52	16% reproductive impairment	Biesinger and Christensen (1972)
Oncorhynchus gorbuscha	5.0	Lethal, 10 days	McKee and Wolf (1963)
Oncorhynchus keta	8.4	LC_{50}, 48 hours	McKee and Wolf (1963)
Trout	7.6	Tolerated, 30 days	McKee and Wolf (1963)
Trout	5.0	Tolerated, 24 hours	McKee and Wolf (1963)
Alburnus alburnus	2.2	Lethal, 72 hours	McKee and Wolf (1963)
Alburnus alburnus	1.1-1.6	Tolerated, 11 days	McKee and Wolf (1963)
Cyprinus carpio	3.1	Lethal, 4-6 days	McKee and Wolf (1963)
Cyprinus carpio	2.2	Tolerated, 13 days	McKee and Wolf (1963)
Minnows	11.6	Lethal, 36 hours	McKee and Wolf (1963)
Minnows	60	Lethal, 16 hours	McKee and Wolf (1963)
Minnows	29	LC_{50}, 48 hours	McKee and Wolf (1963)
Minnows	15	Tolerated, 96 hours	McKee and Wolf (1963)
Lucioperca sp.	1.1-2.2	Lethal, 48 hours	McKee and Wolf (1963)
Lucioperca sp.	0.7-1.1	Tolerated, 11 days	McKee and Wolf (1963)
		Cadmium	
Ephemerella subvaria (mayfly)	2.0	LC_{50}, 96 hours	Warnick and Bell (1969)
Daphnia magna	0.005	LC_{50}, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.0017	LC_{50}, 3 weeks 16% reproductive impairment	Biesinger and Christensen (1972)
Eurypanopeus depressus (mud crab)	4.9	LC_{50}, 72 hours	Collier et al. (1973)
Eurypanopeus depressus	11.0	LC_{100}	Collier et al. (1973)
Pimephales promelas (fathead minnow)	0.029	LC_{50}, 30 days	Pickering and Gast (1972)
Fish (general)	0.029-73.5	LC_{50}, 96 hours	Eisler (1971)
Lepomis macrochirus	80	LC_{50}, 11 months (adults)	Eaton (1974)
Lepomis macrochirus	1.94	LC_{50}, 96 hours (fry)	Pickering and Gast (1972)
Lepomis cyanellus	2.84	LC_{50}, 96 hours (fry)	Pickering and Henderson (1964)
Carassius auratus	2.34	LC_{50}, 96 hours (fry)	Pickering and Henderson (1964)
Poecilia reticulata	1.27	LC_{50}, 96 hours (fry)	Pickering and Henderson (1964)
Lepomis gibbosus	1.5	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)
Cyprinus carpio	0.24	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)

Organism	Element (mg/L)	Remarks[b]	Reference
		Cadmium (contd.)	
Anguilla rostrata	0.82	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)
Roccus americanus	8.4	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)
Roccus saxatilis	1.1	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)
Fundulus diaphanus	0.11	LC_{50}, 96 hours (fry)	Rehwolt et al. (1972)
		Chromium	
Daphnia magna	<1.2	Threshold immobilization, 64 hours	Anderson (1950)
Daphnia magna	0.33	16% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.60	50% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Acroneuria lycorias	32	LC_{50}, 7 days	Warnick and Bell (1969)
Ephemerella subvaria	16	LC_{50}, 96 hours	Warnick and Bell (1969)
Hydropsyche betteri	32	LC_{50}, 7 days	Warnick and Bell (1969)
Hexagenia (nymphs)	8.6	Mortality, 96 hours	Winona State College (1970)
Lepomis macrochirus	71.9	LC_{50}, 96 hours Cr^{3+}	Pickering and Henderson (1964)
Fathead minnow	64.7	LC_{50}, 96 hours Cr^{3+}	Pickering and Henderson (1964)
Fathead minnow	2.0	Reproductive impairment, 10 months	Pickering and Henderson (1964)
Carassius auratus	37.5	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lebistes reticulatus	30.0	LC_{50}, 96 hours	Pickering and Henderson (1964)
Brook trout	0.40	Reproductive impairment, 2 years	Lake Mich. Enforcement Conf. (1972)
Brook trout	50.0	TL_m, 96 hours	Lake Mich. Enforcement Conf. (1972)
Rainbow trout	0.40	Reproductive impairment, 2 years	Lake Mich. Enforcement Conf. (1972)
Rainbow trout	69.0	TL_m, 96 hours	Lake Mich. Enforcement Conf. (1972)
Largemouth bass	195	TL_m, 48 hours	Fromm and Schiffman (1958)
Largemouth bass	94	TL_m, 80 hours	Fromm and Schiffman (1958)
		Copper	
Daphnia magna	0.022	LC_{50}, 16% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.035	LC_{50}, 50% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Acroneuria lycomas	8.3	LC_{50}, 96 hours	Warnick and Bell (1969)
Ephemerella subvaria	0.32	LC_{50}, 48 hours	Warnick and Bell (1969)

Organism	Element (mg/L)	Remarks[b]	Reference
		Copper (contd.)	
Hydropsyche betteri	32	LC_{50}, 14 days	Warnick and Bell (1969)
Orconectes resticus	3	LC_{50}, 96 hours	Hubschman (1967)
Campeloma decisum	1.7	LC_{50}, 96 hours	Arthur and Leonard (1970)
Physa integra	0.039	LC_{50}, 96 hours	Arthur and Leonard (1970)
Gammarus pseudolimnaeus	0.020	LC_{50}, 96 hours	Arthur and Leonard (1970)
Pimephales promelas	0.023	LC_{50}, 96 hours	Pickering and Henderson (1964)
Pimephales promelas	0.018	Reproductive impairment, 10 months	Mount and Stephan (1969)
Pimephales promelas	0.075	LC_{50}, 96 hours	Mount and Stephan (1969)
Lepomis macrochirus	0.66	LC_{50}, 96 hours	Pickering and Henderson (1964)
Carassius auratus	0.036	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lebistes reticulatus	0.036	LC_{50}, 96 hours	Pickering and Henderson (1964)
Salvelinus fontinalis	0.10	LC_{50}, 96 hours	McKim and Benoit (1971)
Salvelinus fontinalis	0.03	43% survivial of adults, 8 months	McKim and Benoit (1971)
Ictalurus nebulosus	0.18	LC_{50}, 96 hours	Brungs et al. (1973)
Sockeye and pink salmon	0.025	Mortality, retarded development	Martens et al. (1970)
Rainbow trout	0.037	Reduced egg and fry survival	McKim and Eaton (1972)
Steelhead	0.03	Fry mortality, 96 hours	Chapman (1972)
Lake trout	0.111	Reduced egg and fry survival	McKim and Eaton (1972)
Brown trout	0.037	Reduced egg and fry survival	McKim and Eaton (1972)
		Lead	
Daphnia magna	0.45	LC_{50}, 48 hours	Biesinger and Christensen (1972)
Daphnia magna	1-0.3	LC_{50}, 3 weeks	Biesinger and Christensen (1972)
Acroneuria lycorias	64.0	LC_{50}, 14 days	Warnick and Bell (1969)
Ephemerella subvaria	16.0	LC_{50}, 7 days	Warnick and Bell (1969)
Hydropsyche betteri	32.0	LC_{50}, 7 days	Warnick and Bell (1969)
Pimephales promelas	5.6	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lepomis macrochirus	23.8	LC_{50}, 96 hours	Pickering and Henderson (1964)
Carassius auratus	31.4	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lebistes reticulatus	20.6	LC_{50}, 96 hours	Pickering and Henderson (1964)
Coho salmon	0.3	Fry mortality, 96 hours	Chapman (1972)
Chinook salmon	1.0	Fry mortality, 96 hours	Chapman (1972)

Organism	Element (mg/L)	Remarks[b]	Reference
		Lead (contd.)	
Steelhead	0.6	Fry mortality, 96 hours	Chapman (1972)
Brook trout	0.5	Fry mortality, 3 weeks	McKim and Eaton (1972)
Fathead minnow	5.58	LC_{50}, 96 hours	Pickering and Henderson (1964)
		Manganese	
Daphnia magna	5.20	Reproductive impairment, 3 weeks	Lake Mich. Enforcement Conf. (1972)
Daphnia magna	5.7	LC_{50}, 3 weeks	Lake Mich. Enforcement Conf. (1972)
Daphnia magna	4.1	16% reproductive impairment, 3 weeks	Lake Mich. Enforcement Conf. (1972)
Anguilla japonica	4.1	Lethal	Doudoroff and Katz (1953)
		Mercury	
Macrocystis pyrifera	50	50% reduction in photosynthesis, 4 days	Nuzzi (1972)
Phytoplankton	100	Complete inactivation, 4 days	Nuzzi (1972)
Nitzschia delicatissima	0.1	Reduced growth and photosynthesis	Nuzzi (1972)
Daphnia magna	0.13	LC_{50}, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	6.7	50% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	3.4	10% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	5.0	LC_{50}, 48 hours	Biesinger and Christensen (1972)
		Nickel	
Daphnia magna	0.51	LC_{50}, 48 hours	Biesinger and Christensen (1972)
Daphnia magna	0.13	50% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.03	16% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Acroneuria lycorias	33.5	LC_{50}, 96 hours	Warnick and Bell (1969)
Ephemerella subvaria	4.0	LC_{50}, 96 hours	Warnick and Bell (1969)
Hydropsyche betteri	64.0	LC_{50}, >14 days	Warnick and Bell (1969)
Pimephales promelas	4.58	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lepomis macrochirus	5.18	LC_{50}, 96 hours	Pickering and Henderson (1964)

Organism	Element (mg/L)	Remarks[b]	Reference
		Nickel (contd.)	
Carassius auratus	9.82	LC_{50}, 96 hours	Pickering and Henderson (1964)
Lebistes reticulatus	4.45	LC_{50}, 96 hours	Pickering and Henderson (1964)
Rainbow trout	32	LC_{50}, 48 hours	Brown and Dalton (1970)
		Selenium	
Fathead minnows (fry)	2.9	LC_{50}, 96 hours	Cardwell et al. (1976)
Bluegill juveniles	40.0	LC_{50}, 96 hours	Cardwell et al. (1976)
		Zinc	
Selenastrum capricornutum	0.5	Not tolerated	Bartlett et al. (1974)
Daphnia magna	0.10	LC_{50}, 48 hours	Biesinger and Christensen (1972)
Daphnia magna	0.158	LC_{50}, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.07	16% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Daphnia magna	0.102	50% reproductive impairment, 3 weeks	Biesinger and Christensen (1972)
Acroneuria lycorias	32	LC_{50}, 14 days	Warnick and Bell (1969)
Ephemerella subvaria	16	LC_{50}, 10 days	Warnick and Bell (1969)
Hydropsyche betteri	32	LC_{50}, 11 days	Warnick and Bell (1969)
Pimephales promelas	0.96	LC_{50}, 96 hours	Pickering and Henderson (1964)
Salmo gairdneri	0.5	LC_{50}, 48 hours	Lloyd (1960)
Lepomis macrochirus	6.44	LC_{50}, 96 hours	Pickering and Henderson (1964)
Carassius reticulatus	1.27	LC_{50}, 96 hours	Pickering and Henderson (1964)
Coho salmon	0.14	Fry mortality, 96 hours	Chapman (1972)
Chinook salmon	0.30	Fry mortality, 96 hours	Chapman (1972)
Steelhead	0.30	Fry mortality, 96 hours	Chapman (1972)
Rainbow trout	4.6	LC_{50}, 5 days	Ball (1967)

[a]Adapted from Dvorak et al. (1977). Common names and scientific names for the organisms are used exactly as they were given in the original references.

[b]LC_{50} is the lethal concentration to 50% of a population. LC_{100} is the lethal concentration to 100% of a population. TL_{50} is the tolerance limit for 50% of a population. TL_m is the median tolerance limit.

POSSIBLE SOURCES FOR TRANSPLANTS

Harper's Nursery
1830 E. McKellips Road
Mesa, Arizona 85201

Powderhorn Nursery
10100 E. Cactus Road
Scottsdale, Arizona 85237

Clyde Robins
Native Seeds and Plants
P.O. Box 2091
Castro Valley, Calif. 94546

Sweets Progressive Landscape Service
Star Route
Oakhurst, Calif. 93644
(Propogates shrubs native in the mountains for roadside control)

Western Evergreen, Inc.
14201 West 44th Avenue
Golden, Colorado 80401

Kroh Nursery
Loveland, Colo. 80537

Kaylor Nursery, John
Lenore, Idaho 84541

Mountain Home Nurseries
Deborgia, Montana 59830

Moran, E. C.
Stanford, Montana 59479

Plumfield Nursery, Inc.
2105 N. Nye St., Box 410
Fremont, Nebraska 68025

Pacific Coast Nursery, Inc.
Rt. 1, Box 320
Portland, Oregon 97321

Sherwood Nursery Co.
13020 N.E. Rose Parkway
Portland, Oregon 97230

Native Plants (801-466-5332)
P.O. Box 15526
2842 South West Temple
Salt Lake City, Utah
(This is the greenhouse address.)

Native Plants
440 Wakara Way
Salt Lake City, Utah 84108
(This is the office in town.)

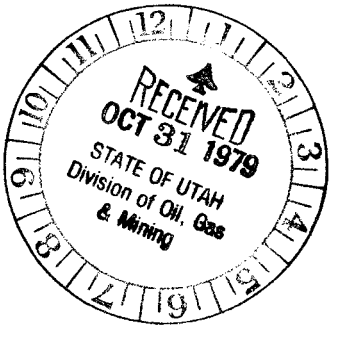
Paul Sjoblom
State Forestry and Fire Control
231 E. 4th South
Salt Lake City, Utah 84111
(You might be able to contact the Clark-McNary Nursery through him)

Heather Acres
Route 3, Box 231
Elma, Washington 98541

Heather Acres
4730 - 132nd Place NE
Marysville, Washington 98270

Steward Nursery, W.M.
Route 2, Box 225
Maple Valley, Washington 98038

Kruse Nursery, Inc.
E. 3900 Sprague Avenue
Spokane, Washington 99202



WILDLAND SEED COLLECTORS

Desert Seed
Box 68
Morristown, Arizona 85342

Desert Botanical Garden
Box 5415
Phoenix, Arizona 85010

Desert Plants
2735 E. Camelback
Phoenix, Arizona 85016

Arizona Cypress Gardens
Star Route 2
Sedonna, Arizona 86336

Arizona, University of Desert
Biology State
P.O. Box A.B.
Superior, Arizona 85273
(Exchanges seed with research organizations and botanical gardens)

Tanque Verde Nursery
Route 2, Box 774 P
Tucson, Arizona 85715

Thornton, Bill
3014 North Fremont
Tucson, Arizona 85719

Stephenson, Virginia L.
Box 926
Colorado Springs, Colorado 89099

Iliff Gardens
4750 East Iliff Avenue
Denver, Colorado 80222

Mile High Seed Company (303-242-3122)
Box 1988
Grand Junction, Colorado

Applewood Seed Company
12125 W. 26th Avenue
Lakewood, Colorado 80215

Longmont Seed Company
Longmont, Colorado 80501

Northrup King & Company (208-342-8977)
520 South Ninth Street
Boise, Idaho

Loring Jones (208-882-8040)
Northplain Seed Producers
P.O. Box 9107
Moscow, ID 83843

Moran, E.C.
Stanford, Montana 59479
(Woody plant seed only)

Lawrence, S.S.
Box 405
Las Vegas, Nevada 89100

S.M. Clark
P.O. Box 606
Cedar City, Utah 84720

C. & S. Seed Enterprises
c/o Eric Christensen
Ephraim, Utah 84627

Gary L. Jorgensen
P.O. Box 102
Ephraim, Utah 84627

John Plummer
Ephraim, Utah 84627

Lloyd Stevens
Ephraim, Utah 84627

Roger Stewart (801-283-4423)
Ephraim, Utah 84627

Wildland Seed Collectors (Continued)

Jacklin Seed Co., Inc.
Dishman, Washington 99213

English, Carl S.
8546 30th Avenue
Seattle, Washington

Game Food Nurseries
Box 3710
Oshkosh, Wisconsin 54901
(Aquatic game foods)

COMMERCIAL SEED COLLECTORS

These are seed companies which deal mainly in grass and legume seed, although they do have small assortments of browse seed. Each has a price list and species lists which they supply.

Emac Seed Co.
Rt. 1, Box 850
Willcox, AZ 85643

Robin, Clyde
P.O. Box 603
Arcata, California 95521

Clyde Robin Seed Co., Inc.
Mr. Steven R. Atwood, V.P.
P.O. Box 2091
Castro Valley, CA 94546

Environmental Seed Producers Inc.
P.O. Box 5904,
El Monte, Calif. 91734

Berger & Plate Co.
P.O. Box 7697
San Francisco, CA 94120

S & S Seed
382 Arboleda Rd.
Santa Barbara, CA 93110

Arkansas Valley Seeds
Box 270
Rocky Ford, Colorado 81067

Arkansas Valley Seed Co.
Attn: Robert Appleman
3131 E. Alameda, Apt. 2104
Denver, Colorado 80209

Carhart, Ross O.
Dove Creek, CO 81324

Mile High Seed Co.
Box 1988
Grand Junction, Colo. 81501

Western Evergreens, Inc.
14201 West 44th Avenue
Golden, Colorado 80401
(Specialize Yucca)

Longmont Seed Co.
51 Bowen Street
P.O. Box 923
Longmont, Colo. 80501

Northrup King & Co.
P.O. Box 192
Longmont, Colo. 80501

Mile-High Seed Co.
Box 1988
Grand Junction, Colo. 81501

Timerline Tree Seed
Rye Star Route, Box 145
Pueblo, Colorado 81004

Arkansas Valley Seeds, Inc.
Box 270
Rocky Ford, Colo. 81067

Beaver Enterprises
3416 Tamarack
Boise, Idaho 83702

Northrup King & Co.
Box 7746
Boise, Idaho 83707

Northrup King and Co.
520 S. 9th
Boise, Idaho 83703

The Gooding Seed Co.
Box 57
Gooding, Idaho 83330

Northplan Seed Producers
Box 9107
Moscow, Idaho 83843

Delbert Winterfeld
Box 97
Swan Valley, Idaho 83449

Globe Seed & Feed Co. Inc.
Box 445
Twin Falls, Idaho 83301

Globe Seed and Feed Co.
Mr. L.H. Haslam
Truck Lane
Twin Falls, Idaho

Sasaki and Sasaki Farm
Rt. 1 Box 173-B
Weiser, Idaho 83672

Sharp Bros. Seed Co. (316-398-2231)
P.O. Box 11
Healy, KS 67850

Cenex Seed Co.
P.O. Box 1748
Billings, MT 59103

Montana Seeds, Inc.
Rt. 3,
Conrad, Montana 59424

Christensen, Art
Box 186
Dillon, Montana 59725

Eisenman Seed Co.
Fairfield, Montana 59436

Lawyer Nursery, David A.
Plains, Montana 59859

Moran, E.C.
Stanford, Montana 59479

Curtis and Curtis, Inc.
Star Route, Box 8A
Clovis, New Mexico

Miller Seed Co.
P.O. Box 81823
Lincoln, Nebraska 68501

Plumfield Nurseries, Inc.
210 N. Nye Avenue
Box 410
Freemont, Nebraska 68025

Simpson Timber Company
P.O. Box 308
Albany, Oregon 97321

Dick Haynes, Farmterials, Inc.
Baker, Oregon 97814

Mallery, D.B.
1506 NE Northview
Bend, Oregon 97701

Coos Grand Supply
1085 S. Second St.
Coos Bay, Oregon 97420

Nomad Alfalfa, Inc.
P.O. Box 217
Forest Grove, Oregon 97116

McFarland Trading Co.
P.O. Box 68
Hubbard, Oregon 97032

Siskiyou Rare Plant Nursery
522 Franquette Street
Medford, Oregon 97501

Garrison, C.C.
103 Southeast Third Avenue
Milton-Freewater, Oregon 97862

North Coast Seed Co.
P.O. Box 12185
Portland, Oregon 97212

Conifer Seed Company
5182 Sunnyside Road
Salem, Oregon 97302

Reforestation Services, Inc.
P.O. Box 3291
Salem, Oregon 97302

Hansmeier & Son, Inc.
Bristol, SD 57219

Sharp Bros. Seed Co.
4378 Canyon Dr.
Amarillio, TX 79109

Horsely-Cummings Seed Co.
Mr. Dave Cummings (801-723-5246)
P.O. Box H
Brigham City, Utah 84302

Steven Bros.
P.O. Box 496
Ephraim, Utah 84627

Boyd E. Globe & Sons
Gunnison, Utah 84634

Charles Inouye
Gunnison, Utah 84634

Rocky Mountain Landscaping
& Sprinkler
P.O. Box 624
Ogden, Utah 84401

Northrup-King & Co.
380 West 8th South
P.O. Box 148
Salt Lake City, Utah 84111

Jacklin Seed Company, Inc.
Dishman, WA 99213

Western Tree Seed Company
Route 1, Box 99
Granite Falls, Washington 98252

Esses Tree Seed Co.
401 South 7th Street
Montesano, Washington 98563

Manning Seed Co.
Roy, Washington 98580

Robert Dye Seed Ranch, Inc.
Pomerdy, WA 99347

Jacklin Seed Co. (Div. of the
Vaughn-Jacklin Corp.)
Mr. John Thorne, Ph.D., Research Direct
(509-926-6241)
E 8803 Sprague Ave.
Spokane, WA 99206

Brown Seed Company
P.O. Box 1792
Vancouver, WA 98663

Etheridge, Paul H.
Star St., Box 235B
Powell, WY 82435

Vic's Enterprises
319 McKinley
Rawlins, WY 82301

Northplan Seed Products
P.O. Box 9107
Moscow, ID 83843

ABC Seed
343 East Broadmor Drive
Tempe, AZ 85282

Advance Seed Company
310 South 24th Avenue
Phoenix, AZ 85008

Apache Coat Seed Company
1 412 East Pierce Street
Phoenix, AZ 85006

Bill Thornton
1619 East Eighth
Tucson, AZ 85719

Camelot Nurseries, Inc.
6030 Mockingbird Lane
Scottsdale, AZ 85251

Catalina Heights Nursery
6047 East Pima
Tucson, AZ 85716

Emac Seed Company
Box 338
Wilcos, AZ 85643

Ferry-Morse Seed Company
310 South 24th Avenue
Phoenix, AZ 85005

Germain's Inc.
Box 1347
Glendale, AZ 85301

Greenland Nursey
7909 East 22nd St.
Tucson, AZ 85710

Harlow Hursey
5620 East Pima
Tucson, AZ 85716

Liefgreen Seed Company
Glendale, AZ 85301

Mrs. Dorothy Fultz
611 West Vine Avenue
Mesa, AZ 85201

Northrup-King and Company
Box 6069
Phoenix, AZ 85005

Perry's Plants, Inc.
3221 East Baseline
Phoenix, AZ 85054

Silverbell Nursery
2730 North Silverbell Road
Tucson, AZ 85705

Tip Top Nurseries
2941 North Forty-third Avenue
Phoenix, AZ 85031

Valley Seed Company
Box 1110
Phoenix, AZ 83635

Applewood Nursery and Seed Co.
15001 West 32nd Avenue
Route 3, Box 84
Golden, CO 80401

Arkansas Valley Seeds
Rocky Ford, CO 81067

Dean Swift
Box 24
Jaroso, CO 81138

George Kelly
McElmo Creek Route
Cortez, CO 81321

Neco, Inc.
Box 1178
Cahone, CO 81320

Northrup King and Co.
Box 998
Longmont, CO 80501

Northrup King and Company
1621 West 12th Avenue
Denver, CO 80204

Ross O. Carhart
Dove Creek, CO 81324

San Juan Native Nursery
Box 302
Pagosa Springs, CO 89117

Steamboat Landscaping, Inc.
Box 1521
Steamboat Springs, CO 80477

Robert Appleman
Arkansas Valley Seed Company
3131 East Alameda, Spt. 2104
Denver, CO 80209

Timberline Tree Seed
Rye Star Route Box 145
Pueblo, CO 81104

Yellow Pine Nurseries
Box 192
Kiowa, CO 80117

Environmental Landscapes, Inc.
2442 West Evans Avenue
Denver, CO 80202

Sharp Brothers Seed Company
Healy, KS 67850

A.L. Bruce Seed Company
Townsend, MT 59664

Adsit Farm and Ranch Services
Decker, MT 59025

Art Christensen
Box 186
Dillon, MT 59725

Arthur DeGrand
Baker, MT 59313

Ben Lund
Big Sandy, MT 59520

Bennie Gevig
Plevna, MT 59334

Bitter Root Nursery
Corvallis, MT 59828

Boyd Crawford
Fort Benton, MT 59442

Canyon Creek Nursery
West
Billings, MT 59101

Cenex Seed Company
Box 1748
Billings, MT 59103

David A. Lawyer Nursery
Plains, MT 59859

Eisenman Seed Company
Fairfield, MT 59436

F.B. Arnett
Columbia Falls, MT 59072

Frank Rose
1020 Popular Street
Missoula, MT 59801

Gerald H. Tohman
Route 2
Geraldine, MT 59446

Gilbert Ehli
Sweetgrass, MT 59484

Hayden Porter
Decker, MT 59025

James Crandall
Scobey, MT 59263

Joe Lincoln
Valier, MT 59486

K and K Seed Company
Route 3
Conrad, MT 59425

Ken Coulter
Brusett, MT 59318

Marchie's Nursery
1845 South Third West
Missoula, MT 59801

Mart Crestainger
Baker, MT 59313

Montana Seeds, Inc.
Route 3
Conrad, MT 59425

Nathan Manakee
Cascade, MT 59421

Northrup-King and Company
Box 389
Billings, MT 59103

Powder River Seed Company
Box 673
Broadus, MT 59317

R.M. Gregor Landscaping
1310 Greene Street
Helena, MT 69501

Robert Hungate
Stanford, MT 59479

Snowline Tree Company, Inc.
Highway 93 South
Kalispell, MT 59901

State Nursery Company
West
Helena, MT 59601

Thomas F. Burns
Chinook, MT 59523

Tom Adsit
Decker, MT 59025

Valley Nursery
Box 845
2801 North Montana Avenue
Helena, MT 59601

Wallace Edland
Scobey, MT 59263

Wanner Nursery
Corvallis, MT 59828

Wesley Adolph
Roundup, MT 59072

Western Seed and Supply, Inc.
Box 57
Charlo, MT 59824

Willia, Skorupa
Bridger, MT 59014

Cactiflor
Box 787
Balew, NM 87002

Curtis and Curtis Seed and Supply, Inc.
Star Route, Box 8A
Clovis, NM 88101

C.H. Diebold
Box 330, RFD 3
Los Lunas, NM 87031

Dan Cristo
New Mexico Native Plant Nursery
of S.W.S.H.
309 West College Avenue
Silver City, NM 88061

Grasslands Resources, Inc.
Santa Fe, NM 87501

Jose Montano, Director
Mora Research Center
Box 357
Mora, NM 87732

Leslie Clayshulte
Agricultural Seed Company
Drawer A
Mesquite, NM 88048

Mountain States Chemical Co., Inc.
316 Industrial Northeast
Albuquerque, NM 87107
Mountain Valley Nursery
Box 81
Lincoln, NM 88338

Sam Donaldson
70 San Juan
Los Alamos, NM 87544

Clinton Sidwell
Battle Mountain, NV 89820

Dan Aten
Battle Mountain, NV 89820

S.S. Lawrence
Box 405
Las Vegas, NV 89100

Fey's Nursery and Seed Company
Sheldon, ND 58068

Forestry Seed Market
Box 156
Sheldon, ND 58068

Lincoln-Oakes Nurseries
Box 1601
Bismarck, ND 58501

State Forest Nursery
Bottineau, ND 58318

Arvid Mahalan
Sturgis, SD 57785

Clark Dale Nursery
Milbank, SD 57252

Clarkdale Nursery
Rural Route 1
Twin Brooks, SD 57269

Clyde Barr
Prairie Gem Ranch
Smithwick, SD 57782

Gurney Seed and Nursery Company
Second and Capital
Yankton, SD 57078

Hansmeier and Sons, Inc.
Bristol, SD 57219

Merl Gunderson Nursery
Rapid City, SD 57701

Robert D. Larson
Alzada Route
Belle Fourche, SD 57717

Sexauer Company
Brookings, SD 57350

Boyd E. Goble and Sons
Gunnison, UT 84634

John C. Cook
387 North 800 East
American Fork, UT 84003

Kent Jorgensen
130 East Second North
Ephraim, UT 84627

Kyle Christensen
4485 Ebony Avenue
Salt Lake City, UT 84107

Mark Plummer
190 North Second West
Ephraim, UT 84627

Porter Walton Company
Box 1919
522 South Third West
Salt Lake City, UT 84110

Ron Stevenson
Ephraim, UT 84627

Roy Grosbeck
3522 West Cambridge
Granger, UT 84119

Steve Regan Company
451 South 400 West
Salt Lake City, UT 84101

Stevens Brother's Wildland Seed
and Nursery
Box 496
Ephraim, Utah 84627

William Roger Steward and Sons
Box 124
Ephraim, UT 84627

Carroll Riggs Seed Company
Shoshoni, WY 82649

Clouds Seed Company
P.O. Box 937
Sheridan, WY 82801

Mrs. Leone Byrne
Lyman, WY 82937

Paul Etheridge
Star Route 1, Box 235-B
Powell, WY 82435

Paul Schiltz
Star Route, Box 223
Powell, WY 82435

Yoder Grain and Lumber Company
Torrington, WY 82240

Figure 1. Key for mapable, high-value habitat use areas for wildlife.

Wildlife Use Areas	Use Area Ranking		
	Substantial-Value	High-Priority[2]	Crucial-Critical[2]
		Aquatic Use Areas	
Stream Sections and Lakes[1]	[s-cw-2-4-yl]	[h-cw-2-3-yl]	[c-cw-2-1-yl]
		Terrestrial Use Areas	
Wetlands, Riparian Zones, Seeps and Springs			
Bison	Herd Distribution s-b-yl		Winter Range c-b-wt 12-1 to 4-15 Summer Range c-b-su 4-15 to 11-30

[1] Streams: The first letter (c) identifies one of the four use areas ranking--c, crucial-critical; h, high-priority; s, substantial value; l, limited value. The second group of letters (cw) identifies the primary type of fishery for which a water is managed--cw, cold water fishery; ww, warm water fishery; ng, non-game fishery. The first number (2) identifies the stream section. The second number (3) identifies one of the six stream classes defined by Utah Division of Wildlife Resources for Utah's State Water Plan. The last letters (yl) identify a need for a yearlong protection of this water.

[1] Lakes: Notations are the same as stream sections except the numeral that identified stream section has been replaced with the name of the body of water.

Game fish species that inhabit the stream sections or lakes are identified on the map overlays.

[2] The dates given for various use areas or activities of terrestrial wildlife identify when a species is normally present or participating in an activity and also denotes the period when protection from disturbance is needed.

Figures 1. Continued

Wildlife Use Areas	Use Area Ranking		
	Substantial-Value	High-Priority[2]	Crucial-Critical[2]
Bighorn Sheep Desert (dbs) Rocky Mountain(mbs)	Herd Distribution s-dbs-yl s-dbs-yl	Tallus Slopes (ewes and lambs) h-dbs-yl 1-1 to 12-31 Mesa Tops-- 1 mile radius (rams) h-dbs-yl 1-1 to 10-31	Rutting Season (tallus slopes) c-dbs-rt 11-1 to 12-31 Lambing Season (tallus slopes) c-dbs-la 5-1 to 6-15
Black Bear	Population Distribution s-bb-yl		
Cougar	Population Distribution s-c-yl ENTIRE MINE PLAN AREA		
Elk	Herd Distribution s-c-yl	Winter Range h-e-wt 11-1 to 5-15 Summer Range h-e-su 5-16 to 10-31	Winter Range c-e-wt 11-1 to 5-15
Mountain Goat	Herd Distribution s-mg-yl		
Moose	Herd Distribution s-m-yl		Yearlong c-m-yl (RIPARIAN) 1-1 to 12-31
Mule Deer	Herd Unit NO. s-d-yl	Winter Range h-d-wt 11-1 to 5-15 Summer Range h-d-su 5-16 to 10-31	Winter Range c-d-wt 11-1 to 5-15 Summer Range c-d-su 5-16 to 10-31
Pronghorn Antelope	Herd Distribution s-pa-yl	Yearlong Range h-pa-yl 1-1 to 12-31	Winter Season c-pa-wt severe snow conditions Fawning Season c-pa-fa 5-12 to 6-20

Figure 1. Key for mapable, high-value habitat use areas for wildlife.

Wildlife Use Areas	Use Area Ranking		
	Substantial-Value	High-Priority[2]	Crucial-Critical[2]
	Terrestrial Use Areas		
Abert Squirrel	Population Distribution s-as-yl		Nest Trees c-as-wt 1-1 to 12-31
Band-tailed Pigeon	Summer Distribution s-btp-su	Intensive Use Area h-btp-su 4-15 to 10-15	Breeding Season c-btp-bs 5-15 to 8-15
Blue Grouse	Population Distribution s-bg-yl	Brooding Area h-bg-b 6-1 to 8-15	Breeding Territory and Nesting (Mountain brush zone) c-bg-btn 3-15 to 6-15 Winter Range (mature, high elevation stands of Douglas fir) c-bg-wt 12-1 to 2-28
California Quail	Population Distribution s-cq-yl		Croplands and Riparian Zones c-cq-yl 1-1 to 12-31 Nesting Season c-cq-n 4-15 to 5-30
Chukar	Population Distribution s-ck-yl (entire mine plan area)		Winter Range c-ck-wt 12-1 to 2-15 Nesting Season c-ck-n 4-1 to 5-30
Cottontail Rabbit Mountain cottontail found above 7,000 feet elevation. Desert cottontail found below 7,000 feet elevation.	Population Distribution s-mc-yl (entire mine plan area) s-dc-yl		Nesting Season c-mc or dc-n 4-1 to 7-31

Figure 1. Continued

Wildlife Use Areas	Use Area Ranking		
	Substantial Value	High-Priority[2]	Crucial-Critical[2]
	Terrestrial Use Areas		
Gambel Quail	Population Distribution s-gq-yl		Riparian Zones c-gq-yl 1-1 to 12-31 Nesting Season c-gq-n 4-15 to 5-30
Merriams Turkey	Population Distribution s-mt-yl	Winter Range h-mt-wt 12-1 to 3-31 Summer Range h-mt-su 6-1 to 11-30	Display and Nesting Area c-mt-n 4-1 to 5-30 Roost Trees (0.5 mile radius buffer zone) c-mt-rt 1-1 to 12-31
Mourning Dove	Population Distribution s-du-su (ENTIRE MINE PLAN AREA)		Nesting Season c-du-n 5-1 to 8-31
Pheasant Ring-necked White-winted	Population Distribution s-rnp-yl s-wp-yl		Croplands and Adjacent Riparian and Wetlands c-rnp or wp-yl 1-1 to 12-31 Nesting Season c-rnp or wp-n 5-15 to 7-15
Ruffed Grouse	Population Distribution s-rg-yl	Summer Range (0.25 miles each side of stream courses) h-rg-su 3-11 to 11-30	Brooding Areas (0.25 miles each side of stream courses) c-rg-b 6-1 to 8-15 Winter Range (clone of mature male Aspen near stream) c-rg-wt 12-1 to 2-28 Drumming Log c-rg-dr

Figure 1. Continued

Wildlife Use Areas	Use Area Ranking		
	Substantial Value	High-Priority[2]	Crucial-Critical[2]
		Terrestrial Use Areas	
Sage Grouse	Population Distribution s-sa-yl	Summer Range s-sa-su 8-16 to 11-14	Strutting Grounds and associated brooding area c-sa-st,b 3-15 to 8-15 Winter Range c-sa-wt 11-15 to 3-14
Snowshoe Hare	Population Distribution s-sh-yl		Nesting Season (spruce-fir and lodgepole pine forests) c-sh-n 4-1 to 8-15
Waterfowl	Population Distribution (all wetlands, stream courses, ponds and lakes) s-wa-yl	Peak Migration (all wetlands, stream courses, ponds and lakes) h-wa-m 3-15 to 5-15 (spring) 8-15 to 10-15 (fall) Brooding and Mounting Season (all wetlands, stream courses, ponds and lakes) h-wa-bm 7-16 to 8-15	Nesting Season c-wa-n 3-15 to 7-15

Figure 1. Key for mapable, high-value habitat use areas for wildlife.

Wildlife Use Areas	Use Area Ranking		
	Substantial-Value	High-Priority[2]	Crucial-Critical[2]
	Terrestrial Use Areas		
Vultures, Accipiters, Buteos (Hawks only), Herriers, Osprey, Merlin, American Kestrel and Owls	Population Distribution (The entire area provides habitat use areas for several species.)	Breeding Territory Surrounds an aerie site	Aerie Site Species specific symbols identified on map-protection needed in 0.25 mile radius buffer zone when in use.
Golden Eagle (common year-around resident)	Population Distribution (The entire area provides habitat use areas for this species.)		Aerie Site  2-15 to 6-15
Bald Eagles	Winter Distribution (Entire area between 11-15 and 3-15 each year)	Winter Concentration h-be-wt 11-15 to 3-15	Roost Tree 11-15 to 3-15
Cliff Nesting Falcon			Aerie Site  3-1 to 6-30