ACT/007/005

SKYLINE MINE

UTAH FUEL CO.

VOLUME 5

SLOPE STABILITY

EVALUATIONS

WORK COPY

RECEIVED
JUL 19 1989
DIVISION OF
OIL, GAS & MINING

VOLUME 5

TABLE OF CONTENTS

TAB	CONTENTS
1	Slope Stability Evaluations and Access Road Embankments - Sedimentation Ponds
2	Estimate of Peak Flow Discharge
3	Mine Site CSP Design
4	Portal Area Swale and Concrete V-Ditch Design
5	Undisturbed Areas Drainage Ditch Designs
6	Disturbed Area Drainage Portal Area
7	Stage Volume Portal Area
8	Topsoil Diversions
9	Train Loadout Undisturbed Area Drainage
10	Train Loadout Disturbed Drainage
11	Train Loadout Area Swale Design
12	Hydrology Study Culvert East End Train Loadout CU-16
13	Loadout Area Sedimentation Pond
14	Drainage Control Waste Rock Disposal Site
15	Waste Rock Disposal Sediment Pond
16	Waste Rock Disposal Area Capacity and Schedule
17	Reclamation Costs
18	Reclaimed Channel Designs
19	Hydrology Study South Fork Breakout Area

INTRODUCTION

The typical ditch cross-sections used for calculations of flow in this volume represents the minimum cross-sections found in the field. Actual configurations may vary from the designed cross sections but in all cases will meet or exceed the designed cross sectional areas.

SECTION 1

SLOPE STABILITY EVALUATIONS AND ACCESS ROAD EMBANKMENTS

SEDIMENTATION PONDS

- Total runoff volume = 326,700 cu.ft.
- Peak inflow rate = 65 cfs

The above precipitation data was developed from the clear creek summit station records presented in the National Oceanographic and Admospheric Administration literature and summarized in the following table:

Table 2-1 Estimated Return Periods for Short Duration Precipitation (Inches)

Station: Clear Creek Summit — Elevation: 9630 ft.
Latitude: 39° 39' — Longitude: 111° 12'

Return Period (years)	DURATION 5 min	10 min	15 min	30 min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.10	.16	.20	.28	.35	.46	.57	.84	1.08	1.33
2	.12	.19	.25	.34	.43	.57	.70	1.04	1.34	1.65
5	.16	.24	.31	.43	.54	.72	.90	1.34	1.73	2.14
10	.19	.29	.37	.51	.65	.86	1.06	1.55	1.99	2.45
25	.24	.38	.48	.66	.84	1.08	1.31	1.88	2.39	2.92
50	.25	.38	.48	.67	.85	1.13	1.40	2.07	2.67	3.29
100	.27	.42	.53	.73	.93	1.24	1.54	2.29	2.96	3.65

Sources: National Oceanographic and Atmospheric Administration, and Utah State University

3.0 LOADOUT AREA POND CRITERIA

The following criteria was used for the design of the sedimentation pond:

A. Construction area - 5.3 acre

B. Sediment storage volume @ 0.1 AF per acre of disturbed area - 23,100 cu.ft. (.53 AF)

C. Pond design storm - 10 year return frequency, 24-hr duration event

Exhibit 4.13-1 (Continued)

June 6, 1980

Coastal States Energy Company
411 West 7200 South
Suite 200
Midvale, UT 84047

Attention: Mr. Roland Heath

Gentlemen:

Consultation
Slope Stability Evaluations and Access
Road Embankments
Proposed Sedimentation Ponds
Skyline Coal Project
Near Scofield, Utah
For Coastal States Energy Company

This letter is written in response to a telephone conversation between Mr. Roland Heath of Coastal States Energy Company and Mr. Bill Gordon of Dames & Moore on June 6, 1980 during which Mr. Heath requested that Dames & Moore provide comment and supporting documentation regarding slope geometry proposed for the subject sedimentation pond and access road embankments.

The sedimentation pond is proposed near the coal storage and railroad facilities of the Skyline Mine Coal Project. Present design concepts are those shown on Drawing No. 3-201-C, dated March 6, 1980, as prepared by Kaiser Engineers of Oakland, California. Proposed geometry of the pond consists of a maximum upstream slope of 2.0 horizontal to 1.0 vertical with a minimum eight-foot crest width. Downstream slopes required at the eastern end of the proposed pond are proposed using slope ratios of 2.0 horizontal to 1.0 vertical. The remainder of the pond will be formed below existing and/or proposed final grade. Maximum embankment height forming the pond will be eight feet with the pond bottom being established at elevation 7915. Crest elevation will be elevation 7923.

Proposed pond construction is shown in section on Figure 1 of the attachments whereby the inner slopes of the pond and pond bottom will be formed by a three-foot-thick impervious liner placed on the constructed embankment section or on excavated slopes and bottom. Overlying the three-foot impervious liner will be a 12-inch coarse granular material. Maximum pond water levels are anticipated to be at elevation 7920 for a 10-year storm and elevation 7922 for a 100-year storm.

Slope stability analyses for the proposed pond configuration was performed for both upstream and downstream slopes considering both the end of construction and long-term stability utilizing chart solutions developed by Huang*. Analyses performed using these chart solutions in addition to all estimated soil properties and assumptions used for these analyses are stated on Figures 1 through 3.

Results of these analyses indicate that for the end-of-construction case, proposed geometry for upstream and downstream slopes utilizing 2.0 horizontal to 1.0 vertical slope ratios will provide factors of safety in excess of 2.0. Similarly, for the long-term stability case, minimum factors of safety on the order of 2.0 or greater can be demonstrated.

Although a majority of the proposed access road will be formed in cuts, there are portions that will require the construction of compacted earth embankments to provide desired grade. Proposed slope configurations for these access road embankments include utilizing slope ratios of 1.5 horizontal to 1.0 vertical. Maximum slope heights for these embankment fills are not anticipated to exceed 25 to 30 feet. Analyses performed to evaluate embankment stability of the proposed slopes indicate that a factor of safety equal to 1.8 can be provided utilizing the proposed slope configuration. Calculations and assumptions made in performing these analyses are shown on Figure 4.

oOo

*Huang, T.H., 1975, "Stability Charts of Earth Embankments," proceedings 54th Annual Meeting of the TRB, Washington, D.C., Jan., 1975.

We trust the information provided in this letter and in the accompanying calculations satisfies your immediate need to demonstrate the stability and adequate factors of safety provided by the present design concepts proposed for both the sedimentation pond and access road embankments. If you have any questions or if we can be of further service, please feel free to contact us.

Yours very truly,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

John F. Wallace
Project Engineer
Professional Engineer 5123
State of Utah

WJG/JFW/pc

Attachments: Figures 1 through 4

cc: Mr. Joe Hilton
c/o Morrison-Knudsen
2 Morrison-Knudsen Plaza
Post Office Box 7808
Boise, ID 83729

SB-SLOPE DATA WORKSHEET

File: _____ Description: _____

Project: SKYLINE SEDIMENT POND

Location: _____

Point Data			Line Data					Soils Data				
No.	X	Y	No.	Left point	Right point	Soil No.	Phreatic Line (Y/N)	No.	Density	Cohesion	Phi	Ru
1	5000	7915	1	1	2	1		1	120pcf	200psf	23°	
2	5020	7915	2	2	3	1		2	125pcf	0psf	45°	
3	5036	7923	3	3	4	1		3	125pcf	100psf	40°	
4	5044	7923	4	7	8	2		4				
5	5076	7907	5	8	9	2		5				
6	5100	7907	6	9	10	2		6				
7	5000	7914	7	11	12	3		7				
8	5020	7914	8	12	10	3		8				
9	5036	7922	9	10	4	3		9				
0	5042	7922	0	4	5	3		10				
1	5000	7911	1	5	6	3		11				
2	5020	7911	2					12				
3	5000	7922	3					13				
4			4					14				
5			5					15				
6			6					16				
7			7					17				
8			8					18				
9			9					19				
0			0									

Free water line left point: 13

right point: 3

Seismic coefficients:

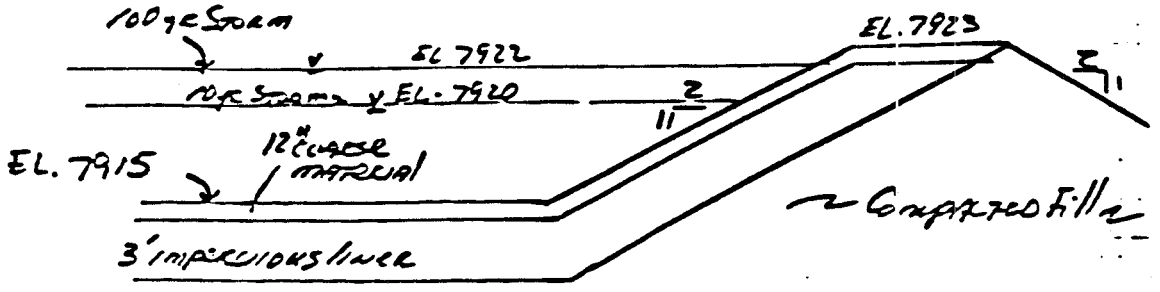
horizontal = _____

vertical = _____

Tension crack depth =

Line load	left X	right X	load
1			
2			
3			
4			
5			

Slope Stability Evaluation of Sedimentation Ponds



Proposed Slope geometry ref Dwg: 3-201-C prepared by Kaiser Eng dated 3-6-80

Estimated Soil Properties

Impervious liner	Coarse Material	Compacted Fill	
$\gamma = 120$ pcf	$\gamma = 125$ pcf	$\gamma = 125$ pcf	
$S_u = 1000$ psf	$\phi = 45°$	$\phi = 40°$	$\phi = 35°$
$\bar{\phi} = 23°$	$\bar{c} = 0$	$\bar{c} = 100$ psf	$c = 250$ psf
$\bar{c} = 200$ psf			

Assumptions for estimating Soil Properties

1) Impervious liner - moderately plastic soil compacted to 90% ASTM D-1557 max γ_{dry} min PI = 10

2) Coarse Material - random gravel cobble mixture - relatively clean -

3) Compacted fill - processed blast rock or available sand and gravel natural soils at site - compacted to 90% max γ_{dry} based on ASTM-D1557

DAMES & MOORE

Figure 1

REVISIONS BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

Analysis of upstream Slope

End of Construction Case

No water in Pond - shear strength of compacted clay liner governs stability - S_u = 1000 psf γ_s = 120 pcf

Maximum slope height = 8 ft

Based on Stability Charts developed by Hoeg (1975) Fig 1

For a minimum Stability Number N_s = 5.5 (2:1 slope) assuming infinite depth of clay soil D=10 and r=1

an undrained shear strength S_u or c-cohesion equal to 175 psf is required for a F.S. = 1.0

Based on $N_s = \frac{\gamma H}{c}$ where N_s = 5.5, γ = 120 psf, H = 8', c = ?

$$c = \frac{120 \times 8}{5.5} \Rightarrow 174 \text{ psf}$$

$C_{available}$ = 1000 psf ∴ $F.S. = \frac{1000}{174} = \underline{5.7}$

if compacted fill controlled End of Construction Stability for γ = 125 ϕ = 33° c = 250 psf

As per Hoeg (1975) fig 4 S = 2:1

$$C.F. = \frac{100 \times 250}{125 \times 8} = 25$$

For C.F. = 25 use 20 conservative ϕ = 33° R_u = 0

F.S. > 2.5 off Chart

The preceding sequence is applicable for both upstream + downstream slopes

CHECKED BY ____
COPY TO EO ____

(9-72) PRINTED IN U.S.A.

REVISIONS BY DATE TO EO
BY DATE TO EO

Long Term Stability

Upstream Slope

Assume Lower material (clay) controls stability

Fully saturated $R_u = 0.5$ - conservative does not include driving resistance offered by pool in effecting rapid drawdown.

$\bar{\phi} = 23°$ $\bar{c} = 200$ psf $H = 8$ $R_u = 0.5$ $\gamma = 120$ $S = 2.0$

$$CF = \frac{100\bar{c}}{\gamma H} = \frac{100(200)}{8 \times 120} = 20.8$$

From fig 4 (Huang, 1975)

for 2:1 slope F.S. $\cong$ 2.0

Downstream Slope

worst case est $R_u = 0.30$ typically slope should be unsaturated as a result of the intermittant pool

For $\gamma = 125$ $\bar{\phi} = 40°$ $\bar{c} = 100$ psf $R_u = 0.3$

$$C.F. = \frac{100 \times 100}{8 \times 125} = 30.8$$

As per Fig 4 (Huang, 1975)

F.S. $\gtrsim$ 2.0

for $\bar{c} = 50$ CF = 15 $R_u = 0.5$

F.S. $\cong$ 2.0

Similarly this argument can be applied to upstream slope w/ $R_u = 0.5$ if compared fill would govern stability assumed

CHECKED BY DATE
COPY TO EO

REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

Slope Stability Evaluation of Access Road
Embankment Slopes Slope Ratio 1.5H:1V

Assumptions:

1) Embankment slopes will be constructed of properly compacted earth rock fill developed from natural on site soil and/or blast rock from excavation operations on site.

2) Compacted Earth Fill Properties

$\gamma = 125$ $\bar{\phi} = 40°$ $\bar{c} = 100$ psf

$\phi = 35°$ $c = 250$ psf

3) Maximum Slope Heights on the order of 25-30 feet

4) Slopes are unsaturated

Analyses - Based on Huang Charts - 1975 attached

End of Construction - Total Stress 30 ft high slope

$\phi = 35°$ $c = 250$ psf $\gamma = 125$ pcf

from figure 4. $CF = \frac{100 \times 250}{125 \times 30} = 6.7$ $R_u = 0$

$\phi = 35°$ $CF = 6.7$

for 1.5:1 (H:V) slope F.S. $\Rightarrow$ 1.80

Long Term Stability - Effective Stress Parameters

$\gamma = 125$ $\bar{\phi} = 40°$ $\bar{c} = 100$ psf 30' slope $R_u = 0$

$CF = \frac{100 \times 100}{125 \times 30} = 2.7$

for 1.5:1 (H:V) slope F.S. = 1.80

Conclusion

Slopes are safe at 1.5H:1V

BY ____ DATE ____
CHECKED BY ____
COPY TO EO ____

SECTION 2

ESTIMATE OF PEAK FLOW DISCHARGE

KAISER ENGINEERS

JOB No. 78097

SHEET 1 OF 7

SKYLINE MINE FINAL DESIGN
ESTIMATED OF PEAK FLOW DISCHARGE

DESIGNED BY BM DATE 10-30-79
CHECKED BY [illegible] DATE 11.10.80

1. OBJECTIVE OF THIS CALCS IS TO ESTIMATE THE PEAK FLOW DISCHARGE.

2. REFERENCES.

NOAA ATLAS 2, volume VI UTAH, (O.S.M) {Book 2 March 13-19 79
PART II, PRELIMINARY DESIGN {Book 3 " "

3. CRITERIA FOR UNDERGROUND Drainage system AT THE PORTAL AREA

a. Q. Discharge To be designed for 100 YR STORM rainfall frequency.

b. Soil Conservation method To be used for estimate of flow (peak discharge)

c. inlets and outlets to be protected by errosion Control materials (Gunite or Riprap).

CALCULATION: Form No. E-6 Rev. 10-71

KAISER ENGINEERS

JOB No. 78097

SHEET 1 OF 7

SKYLINE MINE FINAL DESIGN

ESTIMATED OF PEAK FLOW DISCHARGE

DESIGNED BY BY DATE 10-30-79

CHECKED BY GAC DATE 11.10.8

1. OBJECTIVE OF THIS CALCS IS TO ESTIMATE THE PEAK FLOW DISCHARGE.

2. REFERENCES.

NOAA ATLAS 2, Volume VI UTAH, (O.S.M) {Book 2 March 13-1979
PART II, PRELIMINARY DESIGN {Book 3 " "

3. CRITERIA FOR UNDERGROUND Drainage SYSTEM AT THE PORTAL AREA

a. Q = Discharge To be designed for 100 YR STORM rainfall frequency.

b. Soil Conservation method To be used for estimate of flow (peak discharge)

c. Inlets and outlets to be protected by errosion Control materials (Gunite or Riprap).

CALCULATION Form No. E-6 Rev. 10-71

CONT'D

DATA FROM NOAA ATLAS 2, VOLUME VI-UTAH

REFER TO FIG. 18: SUBJECT PROJECT: LOCATED IN REGION 1

DEVELOPMENT OF RAIN FALL FREQUENCY DURATION & INTENSITY CURVES FOR THE REGION GOVERNING THE SUBJECT PROJECT AREA

& REGION OF APPLICABLE " "

FROM NOAA ATLAS 2, Volume VI-UTAH	TABLE 11
EQUATION	CORR COEFF
$Y_2 = -0.011 + 0.942[(x_1)(x_1/x_2)]$	0.95
$Y_{100} = 0.494 + 0.755[(x_3)(x_3/x_4)]$	0.9

Y_2 = 2 YEAR 1-Hr estimated Value
Y_{100} = 100 YEAR 1-Hr estimated Value

1. DETERMINE THE PLANT LOCATION [LATITUDE & LONGITUDE]

FROM SOLDIER SUMMIT QUADRANGLE USGS 15 MINUTE SERIES

LOCATION OF PLANT AREA ASSCALED IS:
LONGITUDE OR DEPARTURE $111^\circ 11' 26'' = 111.19^\circ$
LATITUDE $39^\circ 40' 57'' = 39.68^\circ$

LOCATING THE PLANT SITE, ON ISOPLUVIALS MAP OF NOAA ATLAS 2 — FIGURE 19, READS 2-YR 6-HR $x_1 = 1.05$ IN

FIG 25 2-YR 24 HR $x_2 = 1.65$ IN

FIG - 24 100-YR 6 HR $x_3 = 2.25$ IN

FIG 30 100-YR 24 HR $x_4 = 3.5$ IN

Form No. E-8 Rev. 10-71
CALCULATIO

KAISER ENGINEERS

Job No. 78097-

Sheet 5 of 7

SKYLINE MINE FINAL DESIGN

ESTIMATED PEAK FLOW DISCHARGE

DESIGNED BY B.Y. DATE 10-30-79

CHECKED BY [illegible] DATE 4.10.80

CONT'D

$Y_2 = -0.011 + 0.942 [1.05 (1.05/1.65)] = 0.618 \times (0.95) = 0.588$ IN

$Y_{100} = 0.494 + 0.755 [2.25 (2.25/3.5)] = 1.585 \times (0.90) = 1.427$ IN.

PRECIPITATION VALUES ON FIG 6 BELOW

BY PLOTING 100 YEARS & 2 YEARS PRECIPITATION VALUES WE DETERMINE THE 5, 10, 25, 50 YEARS RETURN PERIOD FOR PARTIAL DURATION SERIES.

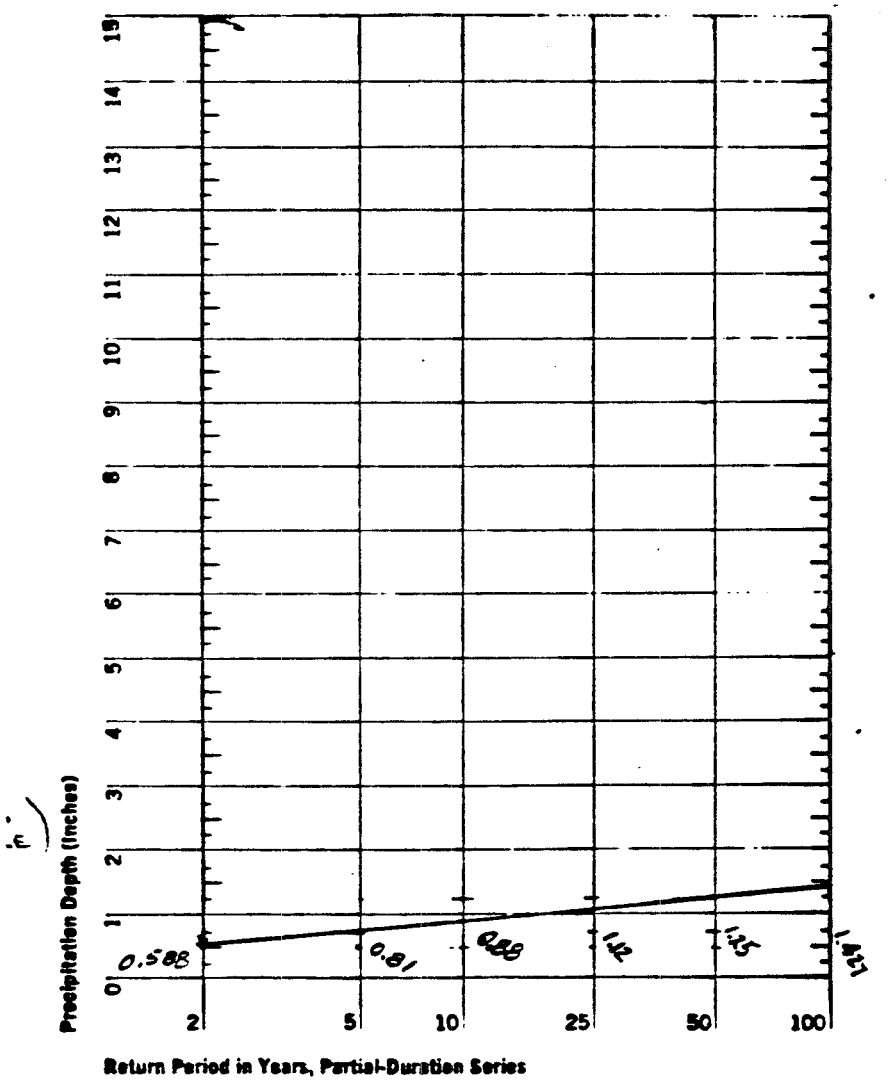


Figure 6. *Precipitation depth versus return period for partial-duration series.*

1 HR precipitation depth in inches

Form No. E-8 Rev. 10-71

CALCULATION

KAISER ENGINEERS

JOB No. 78097

SHEET 4 OF 7

SKYLINE MINE FINAL DESIGN

ESTIMATED PEAK FLOW DISCHARGE

DESIGNED BY [illegible] DATE 10-31-79

CHECKED BY [illegible] DATE 4.10.80

ESTIMATE OF 2 AND 3 HR PRECIPITATION VALUES

BY MATHEMATICAL SOLUTION REF. PAGE 16 VOLUM VII ATLAS

EQUATION
$$\begin{cases} 2\text{-hr} = 0.341(6\text{-hr}) + 0.659(1\text{-hr}) \\ 3\text{hr} = 0.569(6\text{-hr}) + 0.431(1\text{-hr}) \end{cases}$$

ESTIMATED PECIPITATION VALUES

2 YEARS

2HR = 0.341 X 1.05 + 0.659 X 0.588 = 0.743 IN

3HR = 0.569 X 1.05 + 0.431 X 0.588 = 0.851 IN

5 YEARS

2 HR = 0.341 X 1.32 + 0.659 X 0.81 = 0.984

3 HR = 0.569 X 1.32 + 0.431 X 0.81 = 1.100

10 YEARS

2HR = 0.341 X 1.5 + 0.659 X 0.88 = 1.091

3HR = 0.569 X 1.5 + 0.431 X 0.88 = 1.233

25 YEARS

2HR = 0.341 X 1.85 + 0.659 X 1.12 = 1.369

3HR = 0.569 X 1.85 + 0.431 X 1.12 = 1.535

50 YEARS

2HR = 0.341 X 2.05 + 0.659 X 1.25 = 1.523

3HR = 0.569 X 2.05 + 0.431 X 1.25 = 1.705

100 YEARS

2HR = 0.341 X 2.25 + 0.659 X 1.427 = 1.708

3HR = 0.569 X 2.25 + 0.431 X 1.427 = 1.895

CALCULATION Form No. E-8 Rev. 10-71

KAISER ENGINEERS

Job No. 78097

Sheet 5 of 7

SKYLINE MINE FINAL DESIGN

ESTIMATED PEAK FLOW DISCHARGE

DESIGNED BY BJ DATE 11-4-79

CHECKED BY HL DATE 4/10/80

ESTIMATE PRECIPITATION VALUES OF DURATION LESS THAN 1HR

DURATION IN MIN		5	10	15	30
RATIO T 1HR VAL FROM ATLAS TABLE 12.		0.29	0.45	0.57	0.79
2 YEARS	0.588	2.029	1.307	1.032	0.744
5 YEARS	0.81	2.793	1.800	1.421	1.025
10 YEARS	0.88	3.034	1.956	1.544	1.114
25 YEARS	1.12	3.862	2.489	1.965	1.418
50 YEARS	1.25	4.310	2.778	2.193	1.582
100 YEARS	1.427	4.921	3.171	2.504	1.806

PRECIPITATION DEPTH-DURATION TABLE IN INCHES

YEARS	MINUTES				HOURS					
	5	10	15	30	1	2	3	6	12	24
2	2.029	1.307	1.032	0.744	0.588	0.743	0.851	1.05	1.37	1.64
5	2.793	1.800	1.421	1.025	0.81	0.984	1.100	1.32	1.685	2.05
10	3.034	1.956	1.544	1.114	0.88	1.091	1.233	1.50	1.965	2.43
25	3.862	2.489	1.965	1.418	1.12	1.369	1.535	1.85	2.35	2.85
50	4.310	2.778	2.193	1.582	1.25	1.523	1.705	2.05	2.575	3.10
100	4.921	3.171	2.504	1.806	1.427	1.708	1.895	2.25	2.875	3.5

CALCULATION Form No. E-8 Rev. 10-71

6-19-89
G. TAYLOR
REVISED 12-13-89

SKYLINE MINE SITE
ESTIMATED PEAK FLOW DISCHARGE

1. OBJECTIVE OF THESE CALCULATIONS IS TO ESTIMATE THE PEAK FLOW DISCHARGE USING THE SOIL CONSERVATION METHOD

REFERENCE

1. MAP 3.2.4-2 ECCLES CREEK WATERSHED AREA
2. SLOPE: Σ CONTOUR × CONTOUR INTERVAL / AREA × 100
3. PERMIT APPENDIX VOLUME A-2 SOILS AND VEGTATION

AREA NO.	AREA IN ACRES (1)	CN (3)	HYDRAULIC LENGTH (FT)	Σ OF CONTOURS (FT)	SLOPE % (2)	CONTOUR INTERVAL (FT)
MIDDLE BRANCH (M-B)	256.04	65	4729.77	88,224.39	39.55	50
SOUTH BRANCH (S-B)	335.67	65	5525.18	103,493.58	35.39	50
NORTH BRANCH (N-B)	148.64	70	3438.83	51,425.00	39.71	50
UDA-1	12.91	70	5134.37	5134.34	45.65	50
UDA-2	14.16	70	1945.96	5406.03	46.46	50
UDA-3	5.78	65	1533.38	1860.31	44.98	50
UDA-4	6.74	65	1899.53	2520.46	42.95	50

$Q_{10\text{-}24}$: 2.43 IN.
$Q_{25\text{-}24}$: 2.85 IN.
$Q_{50\text{-}24}$: 3.10 IN.
$Q_{100\text{-}24}$: 3.50 IN.

VALUES FROM PAGE 5 OF 7

6-19-89
REVISED 12-13-89

PEAK FLOW (CFS)

AREA No.	T_C 1)	Q_{10-24} 2)	Q_{25-24} 2)	Q_{50-24} 2)	Q_{100-24} 2)
M-B	.444	33.09	63.41	85.54	125.75
S-B	.532	38.17	73.99	100.5	148.32
N-B	.301	47.98	75.72	94.50	127.80
UDA-1	.203	2.22	3.70	4.69	6.40
UDA-2	.181	2.60			
UDA-3	.173	.524			
UDA-4	.206	.55	1.12	1.53	2.25

1) KENTS FORMULA

$$T_C = (\text{HYD. LENGTH})^{.8} \left((1000/(CN-10)+1)^{.7} / (1900\sqrt{\text{SLOPE}})\right) / .6$$

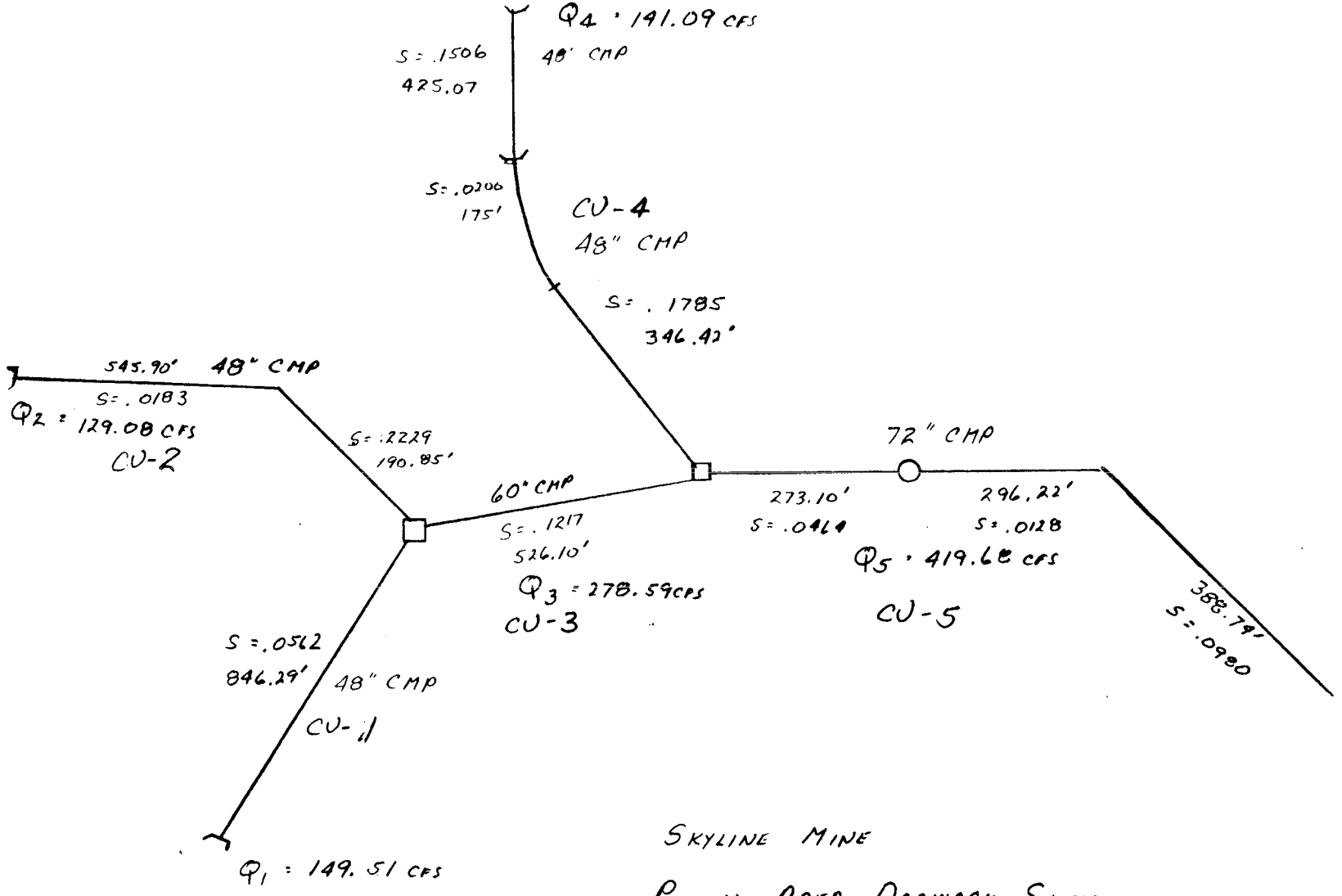
2) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 3

MINE SITE CSP DESIGN

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



SKYLINE MINE

PORTAL AREA DRAINAGE SYSTEM

UNDERGROUND CMP

3-21-89
G. TAYLOR

REFER TO SECTION 2 FOR INITIAL FLOW CALCULATIONS

$Q_{CV-1} = SB + UDA-4$

$= 148.32 + 1.19$

$= 149.51$ CFS

$Q_{CV-2} = MB + UDA-3 + \frac{3}{4} UDA-2$

$= 125.75 + .85 + 2.48$

$= 129.08$ CFS

$Q_{CV-3} = Q_1 + Q_2$

$= 149.51 + 129.08$

$= 278.59$ CFS

$Q_{CV-4} = NB + UDA-1 + \frac{1}{4} UDA$

$= 127.80 + 12.46 + .83$

$= 141.09$ CFS

$Q_{CV-5} = Q_3 + Q_4$

$= 278.59 + 141.09$

$= 419.68$ CFS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

CULVERT SELECTION - SIZE DETERMINATION

A. CU-1, 48" CMP

PEAK RUN OFF Q_{100-24} = 149.51 CFS SECTION 3 PAGE 2

HW = 7.5 FT.

HW/D = 7.5 FT / 4 FT = 1.88

FIGURE 4.28 PAGE 189 HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS 3RD EDITION

FROM THE NOMOGRAPH THE FLOW WOULD BE 148 CFS

THIS CULVERT IS PROPERLY SIZED

B. CU-2, 48" CMP

PEAK RUN OFF Q_{100-24} = 129.08 CFS

HW = 10 FT.

HW/D = 10/4 = 2.50

FIGURE 4.28 PAGE 189 HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS 3RD EDITION

FROM THE NOMOGRAPH THE FLOW WOULD BE 170 CFS

THIS CULVERT IS PROPERLY SIZED

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

C. CU-3, 60" CMP

PEAK RUN OFF Q_{100-24} = CU-1 + CU-2 = 149.51 + 129.08 = 278.59 cfs

HW = 10 ft

HW/D = 10/5 = 2.0

FIGURE 4.28 PAGE 189 HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS 3RD EDITION

FROM THE NOMOGRAPH THE FLOW WOULD BE 270 CFS

THIS CULVERT IS PROPERLY SIZE.

D. CU-4, 48" CMP

PEAK RUN OFF Q_{100-24} = 141.09 CFS

HW = 8 ft

HW/D = 8 ft/4 ft = 2

FIGURE 4.28 PAGE 189 HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS 3RD EDITION

FROM THE NOMOGRAPH THE FLOW WOULD BE 150 CFS

THIS CULVERT IS PROPERLY SIZED

E. CU-5, 72" CMP

PEAK RUN OFF Q_{100-24} = CU-3 + CU-4
= 278.59 + 141.09 = 419.68

HW = 12 ft

HW/D = 12'/6 ft = 2

FROM THE NOMOGRAPH THE FLOW WOULD BE 420 CFS

THIS CULVERT IS SIZE PROPERLY

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
REVISED
11-15-89

F. CD-1, 24" CMP

PEAK FLOW = DA-1 + DA-2 = 12.71 CFS + 16.42 CFS = 29.13 CFS
SECTION 6 PAGE 1 OF 3 VOL 5. 10YR-24HR.

HW = 3.8 FT

HW/D = 3.8/2 = 1.9

CHART 5 PAGE 5-25 HYDRAULIC ENGINEERING CIRCULAR No. 5
U.S. DEPT. OF TRANSPORTATION

FROM THE NOMOGRAPH THE FLOW WOULD BE 29 CFS
THIS CULVERT WILL WORK.

G. CD-2, 24" CM

PEAK FLOW DA-3 = 11.82 CFS 10YR-24HR. SECTION 6 PAGE 1 OF 8 VOL. 5

HW = 2.5 FT

HW/D = 2.5/2 = 1.25

CHART 5 PAGE 5-25 HYDRAULIC ENGINEERING CIRCULAR No. 5
U.S. DEPT. OF TRANSPORTATION

FROM THE NOMOGRAPH THE FLOW WOULD BE 17 CFS
THIS CULVERT WILL WORK

H. CD-3, 24 CMP

SAME PEAK FLOW AS CD-1

HW = 3.4

HW/D = 3.4/2 = 1.7

CHART 5 PAGE 5-25 HYDRAULIC ENGINEERING CIRCULAR No. 5
U.S. DEPT. OF TRANSPORTATION

FROM THE NOMOGRAPH THE FLOW WOULD BE 23 CFS
THIS CULVERT WILL NOT CARRY ALL THE FLOW BUT THE REMAINING WATER WILL FLOW OVER A CONCRETE ROAD AND INTO THE SEDIMENTATION POND.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

HYDROLOGY STUDY
CULVERT AT HIGHWAY
CROSSING AT SOUTH FORK

G. TAYLOR
REVISE 9-18-89

WATERSHED AREAS - MAP 3.2.4-2

WATERSHED	AREA (ACRES)	ΣC
MB	256.04	88,224.40
SB	335.67	103,493.60
NB	148.64	51,425.00
UDA-1	12.91	5,134.34
UDA-2	13.36	5,406.03
UDA-3	4.76	1,860.31
UDA-4	6.74	2,520.46
UDA-5	56.72	19,985.00
UDA-6	181.24	73,210.00
UDA-7	44.25	22,410
TOTAL	1,060.34	373,669.14

SLOPE = ΣCi / AREA

= 373,669.14 (50) / 1,060.34 × 43,560 = 40.45 %

ADD RECLAIMED AREAS

NB RECLAIM = 4.37

SB RECLAIM = 4.54

MB RECLAIM = 5.19

14.10

INPUT VALUES

AREA = 1,074.44
ΣC = 373,669.14
SLOPE = 39.90 %
CN WTD = 61

NB, UDA-1, UDA-2 = 174.91 @ CN = 70
MB, SB, UDA-3, UDA-4, UDA-5 = 674.04 @ CN = 65
UDA-6 = 181.24 @ 72
UDA-7 = 44.25 @ 64

70(.163) + 65(.627) + 72(.169) + 64(.041) / .163 + .627 + .169 + .041 = 67.92

CN WTD = 67

H_L = 7876 FT.

9-18-89

DETERMINE T_c KENT'S FORMULA

APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTRUBED AREAS, OKLAHOMA TECHNICAL PRESS

$T_c = L/0.6$ HOURS

$L = l^{.8}(S+1)^{.7}/1900\,Y^{.5}$

l = HYDRAULIC LENGTH
$S = (1000/CN - 10)$
Y = SLOPE

T_c = 0.632 HOURS

			PEAK FLOW
	$Q_{10\text{-}24}$ =	2.43 IN	145.0 CFS
SECTION 2 PAGE 5 OF 7	$Q_{25\text{-}24}$ =	2.85 IN	264.9 CFS
	$Q_{50\text{-}24}$ =	3.10 IN	350.8 CFS
	$Q_{100\text{-}24}$ =	3.5 IN	540.2 CFS

DETERMINE IF PRESENT ARCH PIPE CULVERT WILL HANDLE THE FLOW OF 540.2 CFS

USE MANNING FORMULA

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

HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION, PRODUCTS AMERICAN IRON AND STEEL INSTITUTE, 3RD EDITION

A = 38 SQ. FT.

n = .024

R = 1.67

S = .03

$Q = 38\text{ FT}^2 \times 1.486/.024 \times (1.67)^{2/3} \times (.03)^{1/2}$

$= 38(61.92)(1.41)(.17)$

$= 574.64$ CFS

THE 8'-2" x 5'-9" STR. PLATE PIPE ARCH WILL HANDLE THE FLOW.

G. TAYLOR
11-15-89

PEAK FLOW FOR 25YR - 24HR WAS THE DESIGN EVENT

NOMOGRAPH FIGURE 4 31 A PAGE 192 HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS

HW = 11.75 FT

HW/D = 11.75/5.75 = 1.99

PROJECTING FACE

FROM THE NOMOGRAPH THE FLOW WOULD BE 475 CFS
TH PIPE-ARCH WILL WORK

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
6-22-89

INLET STRUCTURE - MIDDLE FORK

DROP INLET SPILLWAY - MAP 3.2.6-1C

Q_{25-24} = 85.54 CFS

SECTION 2, VOL. 5.

Q_{100-24} = 125.75 CFS

WEIR FLOW

$Q = CLH^{3/2}$ EQ 4.1 PAGE 231(1) $C = 3.0$, $L = 15.71$

$Q = 3.0\,(15.71)\,H^{3/2}$

$Q = 47.13\,H^{3/2}$

ORIFICE FLOW

$Q = C'a\sqrt{2gH}$ EQ 4.2 PAGE 231(1) $C' = .60$, $a = 19.63$

$= (.6)(19.63)(8.02)\sqrt{H}$

$Q = 94.48\sqrt{H}$

PIPE FLOW

$Q = a(2gH')^{1/2} / (1 + K_e + K_b + K_c L)^{1/2}$ EQ 4.4 PAGE 232 (1)

$H' = H + 18 - .6(4)$

$H' = H + 15.6$

$K_c = 1.0$
$K_b = .5$
$K_e = .0129$

$a = 12.57$
$L = 826$ FT

$Q = 12.57(2gH + 15.6)^{1/2} / (1 + 1.0 + .5 + .0129(826))^{1/2}$

$= 100.81(H + 15.6)^{1/2} / 3.63$

$Q = 27.79(H + 15.6)^{1/2}$

1) APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS
OKLAHOMA TECHNICAL PRESS

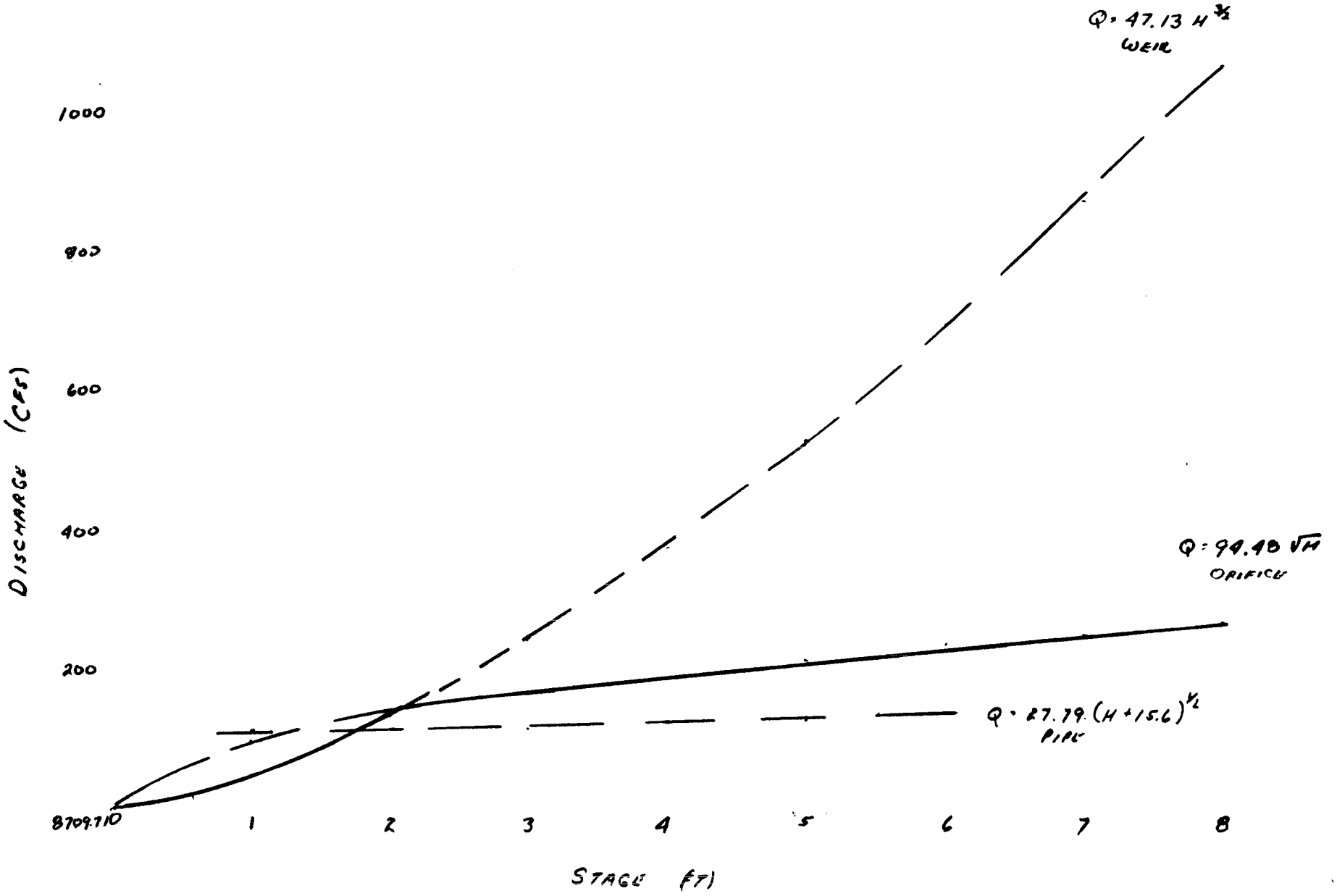
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

HEAD (FT)	Q_{WEIR} (CFS)	$Q_{ORIFICE}$ (CFS)	Q_{PIPE} (CFS)
1	47.13	94.48	113.23
2	133.30	133.62	116.59
3	244.89	163.65	119.85
4	377.04	188.97	123.03
5	526.93	211.27	126.13
6	692.67	231.44	129.16
7	872.86	249.98	132.11
8	1,066.43	267.24	135.00
9	1272.51	283.45	137.83

THE AVAILABLE HEAD IS 26 FT. FROM MAP 3.2.6-1C

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



STAGE DISCHARGE CURVE

I CD-4, 24" CMP

PEAK FLOW ARA-1 = 4.82 CFS SECTION 6 PAGE 1 OF 8

FIGURE 18.6 PAGE 277 HANDBOOK OF DRAINAGE AND CONSTRUCTION PRODUCTS, 1958 PRINTING

BASED ON A DISCHARGE OF 4.82 CFS, A SLOPE = .05 AND n = .021 THE PIPE SIZE SHOULD BE A 12" CULVERT

THE 24" CULVERT WILL WORK

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 4

PORTAL AREA SWALE AND CONCRETE V-DITCH DESIGN

G. TAYLOR
REVISED
11-16-89

PORTAL AREA SWALE AND CONCRETE V-DITCH
REFER TO MAP 3.2.1-1

A. SW-1 DETERMINE DEPTH OF FLOW

PEAK FLOW DA-1 = 12.71 CFS 10YR-24HR (SECTION 6, VOL. 5)

USE MANNING FORMULA

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

A: AREA
R: HYDRAULIC RADIUS
n: ROUGHNESS
S: SLOPE

$A \quad Zd^2/2 + Zd^2/2$

$R: \quad Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$

n: .016 ASPHALT PAVEMENT, ROUGH TEXTURE
S: .07 (FIELD SURVEY, NOV. 1989)

$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$= (25d^2/2 + 14.29d^2/2) \times 1.486/.016 \times (25d/4\sqrt{25^2+1} + 14.29d/4\sqrt{14.29^2+1})^{2/3} \times (.07)^{1/2}$

$= (12.5d^2 + 7.15d^2) \times 92.88 \times (.25d + .25d)^{2/3} \times .26$

$= (19.65d^2) \times 92.88 \times (.50d)^{2/3} \times .26$

TRY $d = .3$ FT.

$Q = (19.65(.3)^2) \times 92.88 \times (.50(.3)^{2/3} \times .26$

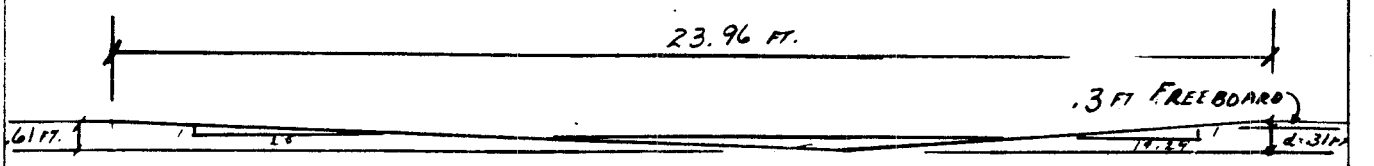
$= 11.98$ CFS

TRY $d = .31$

$Q = (19.65(.31)^2) \times 92.88 \times (.5(.31))^{2/3} \times .26$

$= 13.08$

USE $d = .31$ FT.



$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.016 \times (.16)^{2/3} \times (.07)^{1/2}$

$= 92.88 \quad .29 \times .26$

$= 7.05$ FPS

$n = .016$
$R = .5(.31) = .16$
$S = .07$

B SW-2 DETERMINE DEPTH OF FLOW

PEAK FLOW DA-1 + DA-2 = 12.71 + 16.42 = 29.13 CFS 10 YR-24 HR
(SECTION 6, VOL. 5)

$Q = 29.13$ CFS
$A = zd^2/2 + zd^2/2$
$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$
$n = .016$ ASPHALT PAVEMENT, ROUGH TEXTURE
$S = .02$ (FIELD SURVEY, NOV. 1959)

$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$= (50d^2/2 + 25d^2/2) \times 1.486/.016 \times (50d/4\sqrt{50^2+1} + 25d/4\sqrt{25^2+1})^{2/3} \times (.02)^{1/2}$

$= (25d^2 + 1250d^2) \times 92.88 \times (.25d + .25d)^{2/3} \times .14$

$= (37.50d^2) \times 92.88 \times (.5d)^{2/3} \times .14$

TRY $d = .4$

$Q = 37.50(.4)^2 \times 92.88 \times (.5(.4))^{2/3} \times .14$

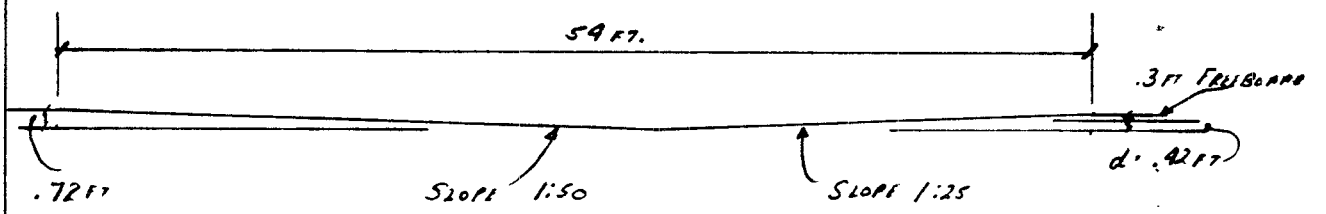
$= 26.54$ CFS

TRY $d = .42$

$Q = 37.50(.42)^2 \times 92.88 \times (.5(.42))^{2/3} \times .14$

$= 30.23$ CFS

USE $d = .42$ FT.



$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.016 \times (.21)^{2/3} \times (.02)^{1/2}$

$= 92.88 \times .35 \times .14$

$= 4.60$ FPS

$n = .016$
$R = .5(.42) = .21$
$S = .02$

G. TAYLOR
REVISED
11-13-89

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

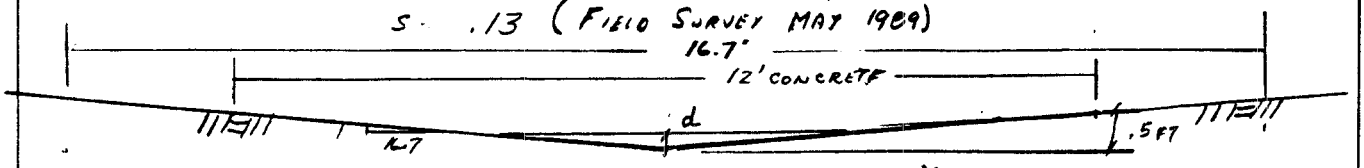
D. SW-4 - DETERMINE DEPTH OF FLOW

PEAK FLOW = ARA-1 = 4.82 CFS (SECTION 6, VOL. 5)

USING MANNING FORMULA

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

$Q = 4.82$ CFS
$A = Zd^2$
$R = Zd / 2\sqrt{Z^2+1}$
$n = .014$ CONCRETE LINED, REGULAR FINISH
$S = .13$ (FIELD SURVEY MAY 1989)



$$Q = Zd^2 \times 1.486/n \times (Zd/2\sqrt{Z^2+1})^{2/3} \times (S)^{1/2}$$

$$Q = 16.7(d)^2 \times 1.486/.014 \times (Zd/2\sqrt{(16.7)^2+1})^{2/3} \times (.13)^{1/2}$$

$$Q = 16.7(d)^2 \times 106.91 \times (16.7d/33.96)^{2/3} \times .36$$

TRY $d = .3$ FT

$$Q = 16.7(.3)^2 \times 106.91 \times (16.7(.3)/33.96)^{2/3} \times .36$$
$$= 16.09 \text{ CFS.}$$

G. TAYLOR
REVISED
11-13-89

TRY $d = .1$ FT

$$Q = 16.7(.1)^2 \times 106.14 \times \left(16.7(.1)/33.46\right)^{2/3} \times .36$$

$$= .86 \text{ CFS}$$

TRY $d = .2$ FT

$$Q = 16.7(.2)^2 \times 106.14 \times \left(16.7(.2)/33.46\right)^{2/3} \times .36$$

$$= 5.45 \text{ CFS}$$

TRY $d = .19$ FT.

$$Q = 16.7(.19)^2 \times 106.14 \times \left(16.7(.19)/33.46\right)^{2/3} \times .36$$

$$= 4.75 \text{ CFS}$$

THE DEPTH OF FLOW WILL BE ≈ .19 FT. THE DEPTH OF THE SWALE IS .6 FT. SWALE WILL WORK AS BUILT WITH 3 FT FREEBOARD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
REVISED
11-13-89

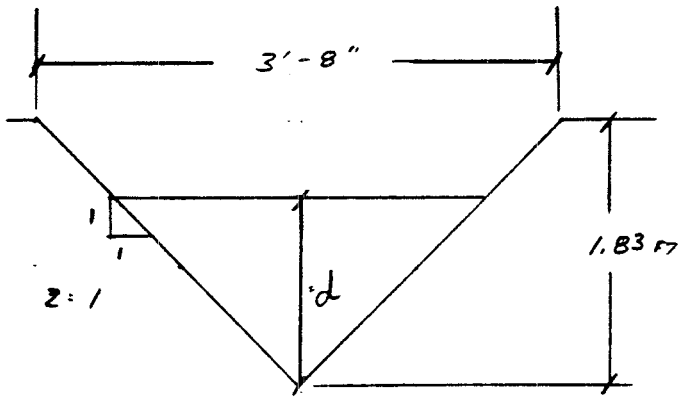
G DD-3 DETERMINE DEPTH OF FLOW

PEAK FLOW = DA-1 = (12.71 cfs)2 = 25.42 cfs
SECTION 2 VOL 5

USE MANNING FORMULA

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

Q = 25.42 cfs
A = $z d^2$
R = $z d / 2\sqrt{z^2+1}$
n = .014 CONCRETE LINED, REGULAR FINISH
S = .05 (MAP 3.2, 1-1) (FIELD SURVEY, MAY 1989)



$$Q = z d^2 \times 1.486/n \times \left(z d / 2\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$

$$Q = d^2 \times 1.486/.014 \times \left(d / 2\sqrt{(1)^2+1}\right)^{2/3} \times (.05)^{1/2}$$

$$Q = d^2 \times 106.14 \times \left(d/2.83\right)^{2/3} \times .22$$

TRY: d = .5 FT.

$$Q = (.5)^2 \times 106.14 \times \left(.05/2.83\right)^{2/3} \times .22$$

= .39 CFS

TRY d = 1 FT.

$$Q = (1)^2 \times 106.14 \times \left(1/2.83\right)^{2/3} \times .22$$

= 11.63 CFS

G. TAYLOR
REVISED
11-13-89

TRY $d = 1.3$ FT

$$Q = (1.3)^2 \times 106.14 \times \left(\frac{1.3}{2.83}\right)^{.67} \times .22$$

$$= 23.43 \text{ CFS}$$

TRY $d = 1.34$

$$Q = (1.34)^2 \times 106.14 \times \left(\frac{1.34}{2.83}\right)^{2/3} \times .22$$

$$= 25.41 \text{ CFS}$$

THE DEPTH OF FLOW WILL BE ≈ 1.34 FT. THE DEPTH OF THE DITCH IS 1.83 FT. THE DITCH WILL WORK AS BUILT WITH .3 FT. FREEBOARD.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 5

UNDISTURBED AREAS
DRAINAGE DITCH DESIGNS

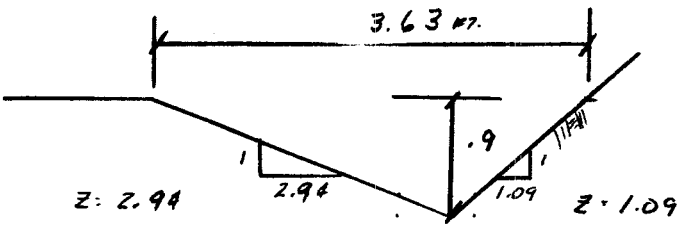
G. Taylor
6-26-89
Revised
11-15-89
Revised
12-13-89

Intercepter Ditch Design For 10 yr. -24 hr. Event

I Ditch DU-1 Map 3.2.1-1

DU-1 will intercept water from area UDA-1, Map 3.2.4-2 $Q_{10-24} = 2.22$ cfs Section 2, Vol. 5

Typical Ditch



Field Survey June 1989

A. Use Manning Formula to determine depth of flow

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

S = .10 Field Survey
n = .030 Earth Channel with considerable growth

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$Q = 1.486/n \left(zd^2/2 + zd^2/2\right)\left(zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}\right)^{2/3} S^{1/2}$

$= 1.486/.03 \left(2.94d^2/2 + 1.09d^2/2\right)\left(2.94d/4\sqrt{(2.94)^2+1} + 1.09d/4\sqrt{(1.09)^2+1}\right)^{2/3} (.10)^{1/2}$

$= 49.53 \left(1.47d^2 + .55d^2\right)\left(.24d + .18d\right)^{2/3} \times .32$

$2.22 = 49.53 \times (2.02d^2) \times (.42d)^{2/3} \times .32$

Try $d = .46$ ft

$2.22 = 49.53 \times (2.02(.46)^2) \times (.42(.46))^{2/3} \times .32$

$= 49.53 \times .43 \times (.19)^{2/3} \times .32$

$= 49.53 \times .43 \times .33 \times .32$

$= 49.53 (.05)$

$= 2.25$ cfs

DITCH DESIGN

DEPTH OF DITCH: FLOW DEPTH + FREE BOARD

$.46 + .3$

$= .49$

PRESENT DITCH WILL WORK AS SHOWN ON PAGE 1 OF THIS SECTION.

B. VELOCITY

$$V = 1.486/n \; R^{2/3} \; S^{1/2}$$

$$= 1.486/n \left(2d/4\sqrt{2^2+1} + 2d/4\sqrt{2^2+1} \right)^{2/3} S^{1/2}$$

$$= 1.486/.030 \left(2.49(.46)/4\sqrt{(2.49)^2+1} + 1.09(.46)/4\sqrt{1.09^2+1} \right)^{2/3} (.10)^{1/2}$$

$$= 49.53 \, (.11 + .08)^{2/3} \times (.10)^{1/2}$$

$$= 5.21 \text{ fps}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT C138 PAGE 3 OF 32
COMPUTED CAB DATE 11/89
CHECKED DATE

Runoff calculations for Drainage Ditches

(1) Ditch North Side of Coal pile - UDA-2 (information provided by Gary Taylor)

Undisturbed Area covered by existing ditch = 13.36 Ac
Additional Area covered by ditch extension = 0.80 Ac

Total Area = 14.16 Ac

CN = 70

T_c = .177 hr + 15 seconds (to account for additional ditch length)

T_c = .181 hr

Rainfall depth = 2.43 in. (10-yr, 24-hr storm)

Use Sedimot II to calculate runoff volume =

(Ref: Mayes, J.G. 1983, User's Guide to SEDIMOT II - PC Version. Oklahoma Technical Press. Stillwater, Oklahoma.)

Results: (See Sedimot II output, attached)

Runoff volume = 0.4983 Ac-Ft
Peak discharge = 2.6 cfs

```
*****************************************************************
                    -- SEDPC --
          SEDIMOT II MODEL FOR THE IBM PC/XT
          CONVERTED BY TECH ENGINEERING INC.
             VERSION 1.10 NOVEMBER 17,1983
*****************************************************************
```

```
*****************************************************************
*****************************************************************
```

UNIVERSITY OF KENTUCKY COMPUTER MODEL
OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
FOR MORE INFORMATION CONTACT THE AGRICULTURAL
ENGINEERING DEPARTMENT

THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

VERSION DATE 9-23-83

DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

```
*****************************************************************
*****************************************************************
```

```
*****************************************************************
*                                                               *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.     *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                      *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                   *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PEAK 24 HOUR PERIOD                            *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                            *
*                                                               *
*    ALL CONCENTRATIONS ARE IN ML/L.                            *
*                                                               *
*****************************************************************
```

5/32

****

WATERSHED IDENTIFICATION CODE

DITCH NORTH SIDE OF COAL PILE -UDA-2

****

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	2.43	INCHES

* *

JUNCTION 1, BRANCH 1, STRUCTURE 1

* *

***** RESULTS FROM SUBWATERSHED 1 *****

*** HYDROGRAPH AND SEDIMENT GRAPH ***
(TWO CONSECUTIVE VALUES PER LINE)

TIME (HR)	DISCHARGE (CFS)	TIME (HR)	DISCHARGE (CFS)
.00	.000	.10	.000
.20	.000	.30	.000
.40	.000	.50	.000
.60	.000	.70	.000
.80	.000	.90	.000
1.00	.000	1.10	.000
1.20	.000	1.30	.000
1.40	.000	1.50	.000
1.60	.000	1.70	.000
1.80	.000	1.90	.000
2.00	.000	2.10	.000
2.20	.000	2.30	.000
2.40	.000	2.50	.000
2.60	.000	2.70	.000
2.80	.000	2.90	.000
3.00	.000	3.10	.000
3.20	.000	3.30	.000
3.40	.000	3.50	.000
3.60	.000	3.70	.000
3.80	.000	3.90	.000
4.00	.000	4.10	.000

7/32

15.00	.447	*	15.10	.440
15.20	.435	*	15.30	.430
15.40	.426	*	15.50	.424
15.60	.421	*	15.70	.420
15.80	.419	*	15.90	.419
16.00	.419	*	16.10	.404
16.20	.373	*	16.30	.348
16.40	.330	*	16.50	.318
16.60	.312	*	16.70	.307
16.80	.302	*	16.90	.297
17.00	.293	*	17.10	.288
17.20	.285	*	17.30	.281
17.40	.278	*	17.50	.275
17.60	.273	*	17.70	.271
17.80	.269	*	17.90	.268
18.00	.267	*	18.10	.266
18.20	.265	*	18.30	.265
18.40	.266	*	18.50	.266
18.60	.267	*	18.70	.268
18.80	.268	*	18.90	.269
19.00	.269	*	19.10	.270
19.20	.270	*	19.30	.271
19.40	.271	*	19.50	.272
19.60	.272	*	19.70	.273
19.80	.274	*	19.90	.274
20.00	.275	*	20.10	.267
20.20	.250	*	20.30	.237
20.40	.227	*	20.50	.220
20.60	.217	*	20.70	.214
20.80	.211	*	20.90	.208
21.00	.205	*	21.10	.203
21.20	.201	*	21.30	.199
21.40	.197	*	21.50	.195
21.60	.194	*	21.70	.193
21.80	.192	*	21.90	.191
22.00	.190	*	22.10	.190
22.20	.189	*	22.30	.189
22.40	.189	*	22.50	.190
22.60	.190	*	22.70	.190
22.80	.190	*	22.90	.191
23.00	.191	*	23.10	.191
23.20	.191	*	23.30	.191
23.40	.192	*	23.50	.192
23.60	.192	*	23.70	.192
23.80	.193	*	23.90	.193
24.00	.193	*	24.10	.176
24.20	.140	*	24.30	.111
24.40	.089	*	24.50	.075
24.60	.067	*	24.70	.060
24.80	.053	*	24.90	.047
25.00	.041	*	25.10	.035
25.20	.030	*	25.30	.025
25.40	.021	*	25.50	.017
25.60	.013	*	25.70	.010

8/32

25.80	.008	*	25.90	.005
26.00	.003	*	26.10	.002
26.20	.001	*	26.30	.000

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	14.16	70.00	.181	.000	.000	.00	3.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)
1	2.60	.42

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.4983	ACRE-FT
PEAK DISCHARGE	=	2.6006	CFS
AREA	=	14.1600	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS

* * * * * * * * * * * *
NULL STRUCTURE
* * * * * * * * * * * *

*** RUN COMPLETED ****

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT C138 PAGE 9 OF 32
COMPUTED CKB DATE 11/89
CHECKED DATE

② Ditch South Side of Coal pile - UDA-3 (information provided by Gary Taylor)

Undisturbed area for existing ditch, UDA3 = 4.76 Ac
Additional Area for ditch extension = 1.02 Ac

Total Undisturbed Area = 5.78 Ac

CN = 65

Tc = .169 hr + 15 seconds (to account for additional ditch length)

Tc = .173 hr

Rainfall depth = 2.43 inches (10-year 24-hr storm)

Use Sedimot II to calculate runoff volume.

Results: (See Sedimot II output attached)

Runoff Volume = .1309 Ac-Ft
Peak discharge = .5237 cfs

10/32

```
*****************************************************************
                    -- SEDPC --
          SEDIMOT II MODEL FOR THE IBM PC/XT
          CONVERTED BY TECH ENGINEERING INC.
             VERSION 1.10 NOVEMBER 17,1983
*****************************************************************


*****************************************************************
*****************************************************************

      UNIVERSITY OF KENTUCKY COMPUTER MODEL
      OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
      FOR MORE INFORMATION CONTACT THE AGRICULTURAL
      ENGINEERING DEPARTMENT

      THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
      THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
      MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

      VERSION DATE 9-23-83

      DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
      ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
      CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

*****************************************************************
*****************************************************************


*****************************************************************
*                                                               *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.     *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                      *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                   *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PEAK 24 HOUR PERIOD                            *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                            *
*                                                               *
*     ALL CONCENTRATIONS ARE IN ML/L.                           *
*                                                               *
*****************************************************************
```

11/32

****

WATERSHED IDENTIFICATION CODE

DRAINAGE DITCH UBA-3, SOUTH SIDE OF COAL PILE

****

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	2.43	INCHES

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

***** RESULTS FROM SUBWATERSHED 1 *****

*** HYDROGRAPH AND SEDIMENT GRAPH ***
(TWO CONSECUTIVE VALUES PER LINE)

TIME (HR)	DISCHARGE (CFS)	******* *	TIME (HR)	DISCHARGE (CFS)
.00	.000	*	.10	.000
.20	.000	*	.30	.000
.40	.000	*	.50	.000
.60	.000	*	.70	.000
.80	.000	*	.90	.000
1.00	.000	*	1.10	.000
1.20	.000	*	1.30	.000
1.40	.000	*	1.50	.000
1.60	.000	*	1.70	.000
1.80	.000	*	1.90	.000
2.00	.000	*	2.10	.000
2.20	.000	*	2.30	.000
2.40	.000	*	2.50	.000
2.60	.000	*	2.70	.000
2.80	.000	*	2.90	.000
3.00	.000	*	3.10	.000
3.20	.000	*	3.30	.000
3.40	.000	*	3.50	.000
3.60	.000	*	3.70	.000
3.80	.000	*	3.90	.000
4.00	.000	*	4.10	.000

4.20	.000	*	4.30	.000
4.40	.000	*	4.50	.000
4.60	.000	*	4.70	.000
4.80	.000	*	4.90	.000
5.00	.000	*	5.10	.000
5.20	.000	*	5.30	.000
5.40	.000	*	5.50	.000
5.60	.000	*	5.70	.000
5.80	.000	*	5.90	.000
6.00	.000	*	6.10	.000
6.20	.000	*	6.30	.000
6.40	.000	*	6.50	.000
6.60	.000	*	6.70	.000
6.80	.000	*	6.90	.000
7.00	.000	*	7.10	.000
7.20	.000	*	7.30	.000
7.40	.000	*	7.50	.000
7.60	.000	*	7.70	.000
7.80	.000	*	7.90	.000
8.00	.000	*	8.10	.000
8.20	.000	*	8.30	.000
8.40	.000	*	8.50	.000
8.60	.000	*	8.70	.000
8.80	.000	*	8.90	.000
9.00	.000	*	9.10	.000
9.20	.000	*	9.30	.000
9.40	.000	*	9.50	.000
9.60	.000	*	9.70	.000
9.80	.000	*	9.90	.000
10.00	.000	*	10.10	.000
10.20	.000	*	10.30	.000
10.40	.000	*	10.50	.000
10.60	.000	*	10.70	.000
10.80	.000	*	10.90	.000
11.00	.000	*	11.10	.000
11.20	.000	*	11.30	.000
11.40	.000	*	11.50	.000
11.60	.000	*	11.70	.000
11.80	.018	*	11.90	.134
12.00	.364	*	12.10	.524
12.20	.480	*	12.30	.427
12.40	.379	*	12.50	.362
12.60	.363	*	12.70	.338
12.80	.319	*	12.90	.307
13.00	.303	*	13.10	.298
13.20	.285	*	13.30	.274
13.40	.266	*	13.50	.259
13.60	.251	*	13.70	.237
13.80	.224	*	13.90	.213
14.00	.203	*	14.10	.191
14.20	.173	*	14.30	.160
14.40	.152	*	14.50	.146
14.60	.141	*	14.70	.138
14.80	.135	*	14.90	.133

3/32

15.00	.131	*	15.10	.129
15.20	.128	*	15.30	.127
15.40	.126	*	15.50	.126
15.60	.125	*	15.70	.125
15.80	.125	*	15.90	.125
16.00	.126	*	16.10	.122
16.20	.112	*	16.30	.104
16.40	.099	*	16.50	.096
16.60	.094	*	16.70	.092
16.80	.091	*	16.90	.090
17.00	.088	*	17.10	.087
17.20	.086	*	17.30	.085
17.40	.084	*	17.50	.083
17.60	.083	*	17.70	.082
17.80	.082	*	17.90	.082
18.00	.081	*	18.10	.081
18.20	.081	*	18.30	.081
18.40	.082	*	18.50	.082
18.60	.082	*	18.70	.082
18.80	.083	*	18.90	.083
19.00	.083	*	19.10	.083
19.20	.084	*	19.30	.084
19.40	.084	*	19.50	.084
19.60	.084	*	19.70	.085
19.80	.085	*	19.90	.085
20.00	.085	*	20.10	.083
20.20	.078	*	20.30	.073
20.40	.070	*	20.50	.068
20.60	.067	*	20.70	.066
20.80	.066	*	20.90	.065
21.00	.064	*	21.10	.063
21.20	.063	*	21.30	.062
21.40	.061	*	21.50	.061
21.60	.061	*	21.70	.060
21.80	.060	*	21.90	.060
22.00	.060	*	22.10	.059
22.20	.059	*	22.30	.059
22.40	.060	*	22.50	.060
22.60	.060	*	22.70	.060
22.80	.060	*	22.90	.060
23.00	.060	*	23.10	.060
23.20	.060	*	23.30	.060
23.40	.061	*	23.50	.061
23.60	.061	*	23.70	.061
23.80	.061	*	23.90	.061
24.00	.061	*	24.10	.056
24.20	.044	*	24.30	.035
24.40	.028	*	24.50	.023
24.60	.021	*	24.70	.018
24.80	.016	*	24.90	.014
25.00	.012	*	25.10	.010
25.20	.009	*	25.30	.007
25.40	.006	*	25.50	.005
25.60	.004	*	25.70	.003

25.80	.002	*	25.90	.001
26.00	.001	*	26.10	.000

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	5.78	65.00	.173	.000	.000	.00	3.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)
1	.52	.27

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.1309	ACRE-FT
PEAK DISCHARGE	=	.5237	CFS
AREA	=	5.7800	ACRES
TIME OF PEAK DISCHARGE	=	12.10	HRS

* * * * * * * * * * * *
NULL STRUCTURE
* * * * * * * * * * * *

*** RUN COMPLETED ****

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT CPB PAGE 15 OF 32
COMPUTED CAB DATE 11/89
CHECKED DATE

Drainage Ditches - Sizing

① Ditch North side of coal pile = (UDA-2)

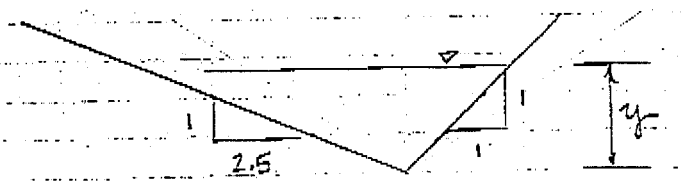
10-year 24-hour Q = 2.6 cfs

Manning's n = .03

Extend existing V-ditch west to clear additional disturbed area and drain to new culvert inlet structure. (see Figure 1-1)

slope = .10 (from topography map)

Extend existing ditch w/ similar geometry:



Compute y using Manning's Equation (Chow, 1959)

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

$$A = \frac{1}{2}y^2 + \frac{1}{2}(2.5y^2) = 1.75y^2$$

$$P = \sqrt{y^2+y^2} + \sqrt{y^2+(2.5y)^2} = \sqrt{2}\,y + \sqrt{7.25}\,y = 4.11y$$

$$R = \frac{A}{P} = \frac{1.75y^2}{4.11y} = 0.43y$$

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT C134 PAGE 16 OF 32
COMPUTED CAB DATE 11/89
CHECKED DATE

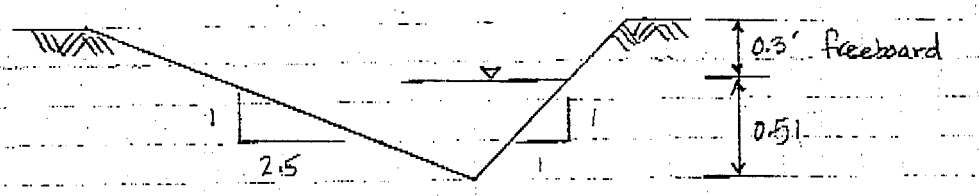
$$2.6 = \frac{1.49}{.03}(1.75y^2)(0.43y)^{2/3}(.10)^{1/2}$$

$$0.0946 = y^2(0.43y)^{2/3}$$

$$0.16660 = y^{8/3} \qquad y = 0.51' \quad (.51)$$

Min. Depth of Ditch = 0.51' + 0.30' (freeboard)
= 0.81 feet (9.7")

North Ditch extension geometry:



Check Velocity of flow:

$V = \frac{Q}{A}$ $\quad A = 1.75y^2 = 0.455\ ft^2$

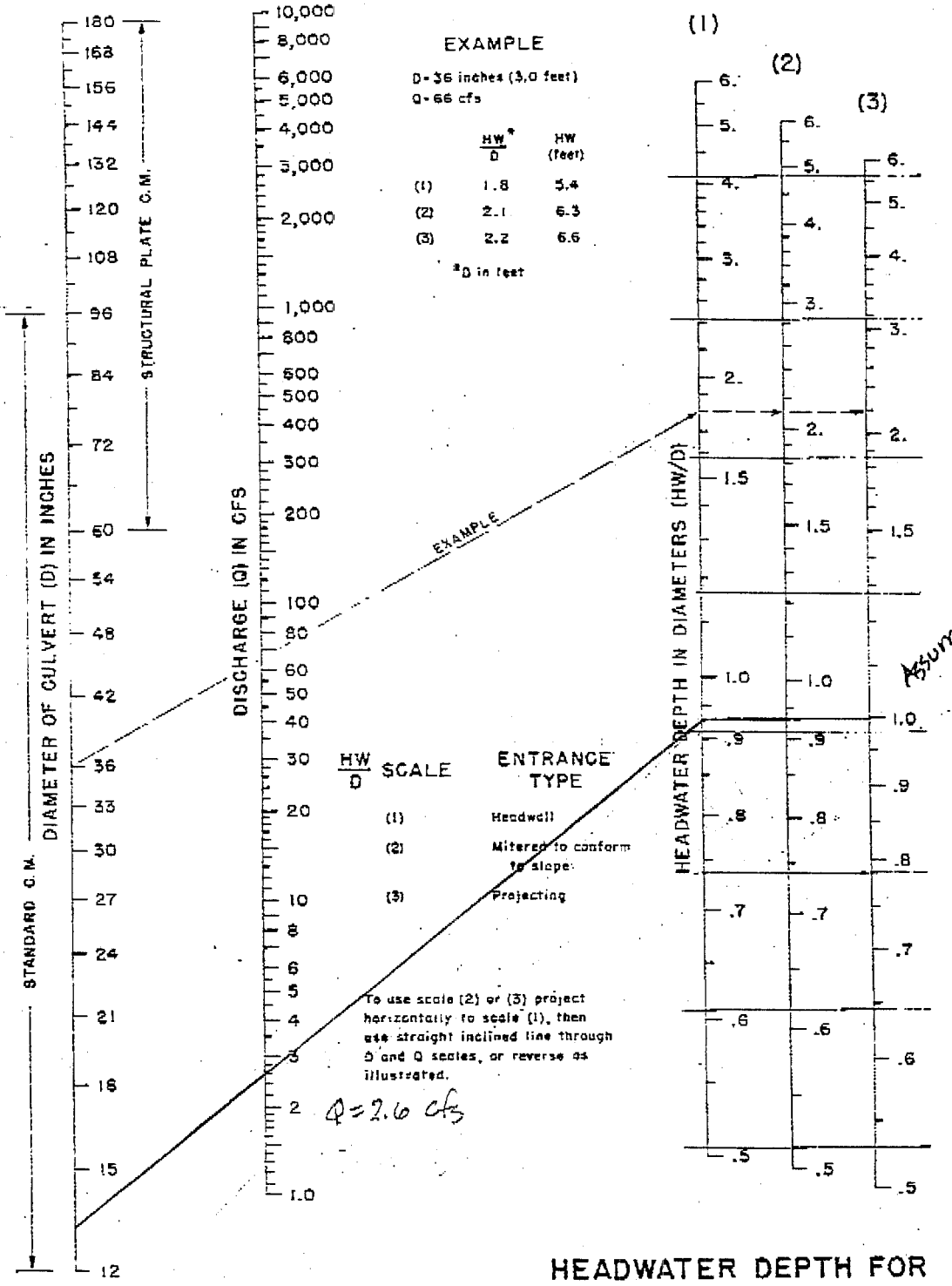
$V = \frac{2.6\ cfs}{.455\ ft^2} = 5.7\ ft/sec$ OKAY

Length of ditch extension approximately 60 feet (from topo map). Connect ditch to CMP.

CMP culvert size ⇒ Assume inlet control.

Using attached Fig B-1 = 12" inlet is too small. Use 15" or 18" CMP inlet, and connect to 12" CMP or use 15" or 18" CMP throughout entire culvert length (approx. 50 feet)

17/32



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Ref: U.S. Department of Transportation. 1965. Hydraulic Charts for the Selection of Highway Culverts. HEC No. 5. Federal Highway Administration. Washington, D.C.

Figure B-1

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT C138 PAGE 18 OF 32
COMPUTED CAB DATE 11/89
CHECKED DATE

(2) Ditch South Side of Coal pile: (UDA-3)

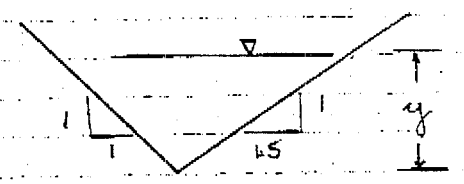
10-year 24-hour $Q = 0.524$ cfs

$n = 0.03$

Extend existing V-ditch west to clear additional disturbed area and drain to new culvert inlet structure (See Figure 1-1).

Slope $= \frac{10}{60} = .167$ (from topo map)

Extend existing ditch w/ similar geometry:



Compute y using Manning's Eq. (Chow, 1959)

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

$$A = \frac{1}{2}y^2 + \frac{1}{2}y(1.5y) = 1.25y^2$$

$$P = \sqrt{y^2+y^2} + \sqrt{y^2+(1.5y)^2} = \sqrt{2}\,y + \sqrt{3.25}\,y = 3.22y$$

$$R = \frac{A}{P} = \frac{1.25y^2}{3.22y} = 0.39y$$

$$0.524 = \frac{1.49}{.03}(1.25y^2)(0.39y)^{2/3}(.167)^{1/2}$$

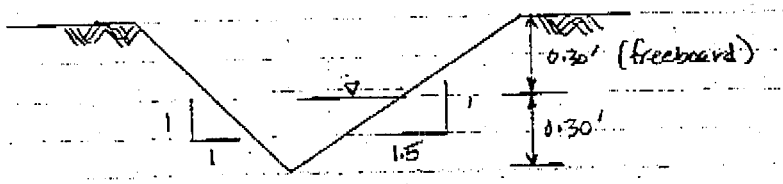
$$.0394 = y^{8/3} \qquad y = 0.30 \text{ ft.} = 3.6''$$

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT C138 PAGE 19 OF 32
COMPUTED CRB DATE 11/89
CHECKED DATE

Min. Depth of South ditch = .30' ± 0.30' (freeboard)
= 0.60' (7.2")

South ditch extension Geometry ⇒



Check flow velocity ⇒

$V = \frac{Q}{A}$ $A = 1.25y^2 = 1.25(.30)^2 = 0.11 \text{ ft}^2$

$V = \frac{.524}{0.11} = 4.7$ ft/sec OKAY

Length of ditch extension approximately 70 feet. Connect ditch to CMP. Use existing CMP if appropriate. 12" diameter size more than sufficient.

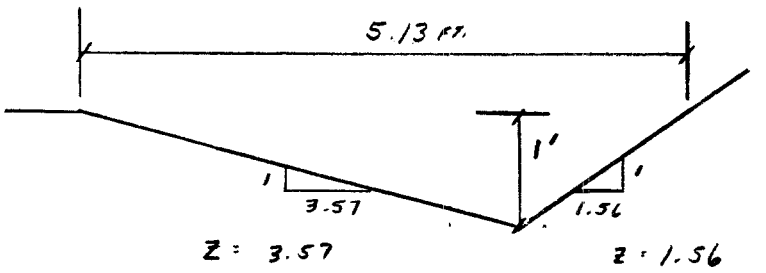
G. Taylor
Revised
11-15-89

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

IV Ditch DU-4 Map 3.2.1-1

DU-4 will intercept water from area UDA-4, Map 3.2.4-2 Q_{10-24} = .55 cfs Section 2, Vol. 5

Typical Ditch



Field Survey
June, 1989

A. Use Manning Formula to Determine Depth on Flow

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

S = .19 Field Survey
n = .030 Earth Channel with Considerable Growth

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$$Q = 1.486/n \times \left(Zd^2/2 + Zd^2/2\right) \times \left(Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}\right)^{2/3} S^{1/2}$$

$$= 1.486/.03 \times \left(3.57d^2/2 + 1.56d^2/2\right)\left(3.57d/4\sqrt{3.57^2+1} + 1.56d/4\sqrt{1.56^2+1}\right)^{2/3} (.19)^{1/2}$$

$$.55 = 49.53 \times \left(1.79d^2 + .78d^2\right) \times \left(.24d + .21d\right)^{2/3} \times .44$$

TRY $d = .22$ FT.

$$.34 = 49.53 \times \left(1.79(.22)^2 + .78(.22)^2\right) \times \left(.24(.22) + .21(.22)\right)^{2/3} \times .44$$

$$= 49.53 \times (.09 + .04) \times (.05 + .04)^{2/3} \times .44$$

$$= 49.53 \times (.12) \times .21 \times .44$$

$$= .58 \text{ cfs}$$

.20
.22

DITCH DESIGN

DEPTH OF FLOW = FLOW DEPTH + FREE BOARD

$= .22' + .3'$

$= .52$ FT.

PERSENT DITCH WILL WORK AS SHOWN ON PAGE 6 OF THIS SECTION.

B. VELOCITY

$$V = 1.486/n \; R^{2/3} \; S^{1/2}$$

$$= 1.486/n \left(Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}\right)^{2/3} S^{1/2}$$

$$= 1.486/.030 \left(3.57(.22)/4\sqrt{3.57^2+1} + 1.56(.22)/4\sqrt{1.56^2+1}\right)^{2/3} \times (.19)^{1/2}$$

$$= 49.53 \times (.05 + .04)^{2/3} \times .44$$

$$= 49.53 \times .21 \times .44$$

$$= 4.50 \text{ FPS}$$

NO ERROSION CONTROL MATERIAL WILL BE NEEDED

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
11-16-89

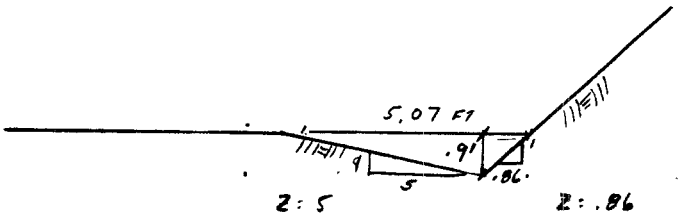
DITCH DU-5 MAP 3.2.1-1

APPROXIMATELY 1.22 ACRES OF WATER SHED UDA-2 ARE DIVERTED TO DU-5 ON THE WEST SIDE OF THE TOPSOIL STOCKPILE. OR 1.22 ACRES / 13.36 ACRES = .09 x100 9% OF THE RUNOFF

SECTION 2, VOL. 5 STATES THAT THE 10YR-24HR EVENT FOR UDA-2 IS 1.31 CFS. THE FLOW FOR DU-5 IS AS FOLLOWS

1.31 CFS x .09 = .12 CFS

DU-5 MUST BE DESIGNED TO HANDLE .12 CFS



FIELD SURVEY
NOV. 1989

USE MANNING EQUATION TO DETERMINE DEPTH OF FLOW

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

$$A = zd^2/2 + zd^2/2$$

$$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$$

$n = .11$ CHANNEL NOT MAINTAINED, DENSE WEEDS

$S = .012$ AVG SLOPE MAP 3.2.1-1

$$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$$

$$= (5d^2/2 + .86d^2/2) \times 1.486/.11 \times (5d/4\sqrt{5^2+1} + .86d/4\sqrt{.86^2+1})^{2/3} \times (.012)^{1/2}$$

$$= (2.5d^2 + .43d^2) \times 13.51 \times (.25d + .16d)^{2/3} \times .11$$

$$= 2.93d^2 \times 13.51 \times (.41d)^{2/3} \times .11$$

TRY $d = .1$ FT

$$Q = 2.93(.1)^2 \times 13.51 \times (.41(.1))^{2/3} \times .11$$

$$= .01 \text{ CFS}$$

TRY $d = .34$

$$Q = 2.93(.34)^2 \times 13.51 \times (.41(.34))^{2/3} \times .11$$

$$= .13 \text{ CFS}$$

DITCH DESIGN

TOTAL DEPTH = FLOW DEPTH + FREEBOARD

= .34 + .3

= .64

PRESENT DITCH WILL WORK AS SHOWN

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.11 \times (.14)^{2/3} \times (.012)^{1/2}$

$= 13.51 \quad .27 \times .11$

$= .40$ FPS

$S = .012$
$R = .41(.34) = .14$
$n = .11$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
11-16-89

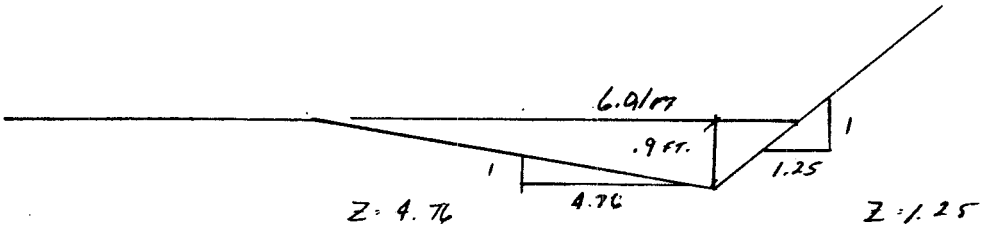
DITCH DU-6 MAP 3.2.1-1

APPROXIATELY 2.07 ACRES OF WATER SHED UDA-1 ARE DIVERTED TO DU-6 ON THE EAST SIDE OF THE TOPSOIL STOCKPILE OR 2.07 ACRES / 12.91 ACRES = .16 × 100 16% OF THE RUNOFF

SECTION 2, VOL. 5 STATES THAT THE 10 YR - 24 HR EVENT FOR UDA-1 IS 4.88 CFS. THE FLOW FOR DU-6 IS AS FOLLOWS

4.88 CFS × .16 = .78 CFS

DU-6 MUST BE DESIGNED TO HANDLE .78 CFS



USE MANNING EQUATION TO DETERMINE DEPTH OF FLOW

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

$A = Zd^2/2 + Zd^2/2$

$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$

$n = .065$ CHANNEL NOT MAINTAINED, CLEAN BOTTOM BRUSH ON THE SIDES

$S = .016$ AVG. SLOPE MAP 3.2.1-1

$$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3}$$

$$= (4.76d^2/2 + 1.25d^2/2) \times 1.486/.065 \times (4.76d/4\sqrt{4.76^2+1} + 1.25d/4\sqrt{1.25^2+1})^{2/3} \times (.016)^{1/2}$$

$$= (2.38d^2 + .63d^2) \times 22.86 \times (.24d + .20d)^{2/3} \times .13$$

$$= 3.01d^2 \times 22.86 \times (.44d)^{2/3} \times .13$$

TRY $d = .4$ FT.

$$Q = 3.01(.4)^2 \times 22.86 \times (.44(.4))^{2/3} \times .13$$

$$= .45 \text{ CFS}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRY $d = .49$ FT.

$Q = 3.01(.49)^2 \times 22.86 \times (.49(.49))^{2/3} \times .13$

$= .77$ CFS

DITCH DESIGN

TOTAL DEPTH = FLOW DEPTH + FREEBOARD

$= .49$ FT $+ .3$ FT

$= .79$ FT.

PRESENT DITCH WILL WORK AS SHOWN

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.065 \times (.22)^{2/3} \times (.016)^{1/2}$

$= 22.86 \quad .36 \times .13$

$= 1.07$ FPS

$S = .016$
$R = .49(.49) = .22$
$n = .065$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

INTERCEPTOR CULVERT DESIGN

I CULVERT CU-8 MAP 3.2.1-1

CU-8 WILL RECEIVE WATER FROM DU-1, $Q_{100-24} = 12.46$ CFS
SECTION 5, VOL 5 PAGE 10

CU-8 - 24" ϕ

USE MANNING FORMULA

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

$S = .381$
$n = .024$ CORRUGATED METAL PIPE

$Q = 1.486/n \; \pi d^2/4 \; (\pi d^2/4 / \pi d)^{2/3} \; S^{1/2}$

$Q = 1.486/.024 \; \pi(2)^2/4 \; (\pi(2)^2/4 / \pi(2))^{2/3} \; (.39)^{1/2}$

$= 61.917 \times 3.14 \times (.5)^{2/3} \times .62$

$= 75.80$ CFS FULL FLOW

THE CULVERT HAS THE CAPACITY TO HANDLE THE 100 YR-24 EVENT.

II CULVERT CU-9 MAP 3.2.1-1

CU-9 WILL RECEIVE WATER FROM DU-2, $Q_{100-24} = 3.30$
SECTION 5, VOL. 5, PAGE 11

CU-9 - 24" ϕ

USE MANNING FORMULA

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

$S = .82$
$n = .024$ CORRUGATED METAL PIPE

$Q = 1.486/n \; \pi d^2/4 \; (\pi d^2/4 / \pi d)^{2/3} \; S^{1/2}$

$= 1.486/.024 \; \pi(2)^2/4 \; (\pi(2)^2/4 / \pi(2))^{2/3} \; .82^{1/2}$

$= 61.92 \times 3.14 \times (.5)^{2/3} \times .91$

$= 111.26$ CFS FULL FLOW

THE CULVERT HAS THE CAPACITY TO HANDLE THE 100 YR-24 HR EVENT.

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

G. TAYLOR
8-30-89

CULVERT CU-8 MAP 3.2.1-1

24" Ø CMP

Q_{10-24} = 4.88 CFS SECTION 2, VOL. 5

DETERMINE INLET AND OUTLET CONTROL

A. INLET CONTROL

USE INLET CONTROL NOMOGRAPH - PAGE 189 [1]

HW/D = 24/24 = 1.0 GRAPH #3

Q = 12 CFS

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

K_e = 0.9 PAGE 181 [1]

L' = 205 FT × .44 = 90.20 FT

USE OUTLET CONTROL NOMOGRAPH - PAGE 194 [1]

Q = 10.5 CFS

THE PIPE WILL HANDLE THE FLOW

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE & HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
8-30-89

CULVERT CU-9 MAP 3.2.1-1

24" Φ CMP

Q_{10-29} = 1.31 CFS SECTION 2, VOL. 5

DETERMINE INLET AND OUTLET CONTROL

A. INLET CONTROL

USE INLET CONTROL NOMOGRAPH - PAGE 189[1)]

HW/D = 24/24 = 1.0 GRAPH 3

Q = 12 CFS

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

Kc = 0.9 PAGE 181[1)]

L' = 125 FT × .44 = 55 FT

USE OUTLET CONTROL NOMOGRAPH - PAGE 194[1)]

Q = 9 CFS

THE PIPE WILL HANDLE THE FLOW

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

III CULVERT CU-10 MAP 3.2.1-1

CU-10 WILL RECEIVE WATER FROM DU-2, $Q_{100-24} = 3.30$
SECTION 5, VOL. 5 PAGE 11

CU-10 - 24"ϕ

USE MANNING FORMULA

$S = .45$
$n = .024$ CORRUGATED METAL PIPE

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

$= 1.486/n \; \pi d^2/4 \; (\pi d^2/4 / \pi d)^{2/3} \; S^{1/2}$

$= 1.486/.024 \; \pi (2)^2/4 \; (\pi (2)^2/4 / \pi (2))^{2/3} (.45)^{1/2}$

$= 61.92 \times 3.14 \times (5)^{2/3} \times .67$

$= 81.87$ CFS FULL FLOW

THE CULVERT HAS THE CAPACITY TO HANDLE THE 100 YR-24 HR EVENT.

IV CULVERT CU-11 MAP 3.2.1-1

CU-11 WILL RECEIVE WATER FROM DU-3, $Q_{100-24} = .85$
SECTION 5, VOL. 5 PAGE 13

CU-11 - 24"ϕ

USE MANNING FORMULA

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

$S = .45$
$n = .024$ CORRUGATED METAL PIPE

$Q = 1.486/n \; \pi d^2/4 \; (\pi d^2/4 / \pi d)^{2/3} \; S^{1/2}$

$= 1.486/.030 \; \pi (2)^2/4 \; (\pi (2)^2/4 / \pi (2))^{2/3} (.45)^{1/2}$

$= 61.92 \times 3.14 \times (5)^{2/3} \times .67$

$= 81.87$ CFS FULL FLOW

THE CULVERT HAS THE CAPACITY TO HANDLE THE 100 YR-24 HR EVENT

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
8-30-89

CULVERT CU-10 MAP 3.2.1-1

24" Ø CMP

Q_{10-24} = 1.31 CFS SECTION 2, VOL. 5

DETERMINE INLET AND OUTLET CONTROL

A. INLET CONTROL

USE INLET CONTROL NOMOGRAPH - PAGE 189 [1]

HW/D = 24/24 = 1.0 GRAPH 3

Q = 12 CFS

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

GRAPHS FOR OUTLET CONTROL WILL NOT. THE LENGTH OF THE PIPE IS TO SHORT

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
8-30-99

CULVERT CU-11 MAP 3.2.1-1

24" Ø CMP

Q_{10-24} = .24 SECTION 2, VOL. 5

DETERMINE INLET AND OUTLET CONTROL

A. INLET CONTROL

USE INLET CONTROL NOMOGRAPH - PAGE 189

HW/D - 24/24 = 1.0 GRAPH 3

Q = 12 CFS

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

GRAPHS FOR OUTLET CONTROL WILL NOT WORK. THE LENGTH OF THE PIPE IS TO SHORT

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCT THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

V CULVERT CU-12 MAP 3.2.1-1

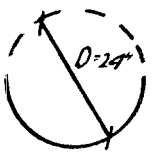
CU-12 WILL RECEIVE WATER FROM DU-3, $Q_{100-24} = .85$ CFS
SECTION 5, VOL.5, PAGE 13

CU-12 24" HALF ROUND

USE MANNING FORMULA

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

$S = .13$
$n = .024$ CORRUGATED METAL PIPE



$A = \pi d^2/4 / 2 = \pi d^2/8$

$R = \pi d^2/8 / \pi d/2 = \cancel{\pi} d^2/8 \cancel{\pi} \cancel{d} = d/4$

$Q = 1.486/n \times \pi d^2/8 \times (d/4)^{2/3} \; S^{1/2}$

$= 1.486/.024 \times \pi (2)^2/8 \times (2/4)^{2/3} \; (.13)^{1/2}$

$= 61.92 \times 1.57 \times (.5)^{2/3} \times .36$

$= 22.00$ CFS

THE HALF ROUND HAS THE CAPACITY TO HANDLE THE 100YR-24HR EVENT

REFERENCE : SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPARTMENT OF THE INTERIOR
OFFICE OF SURFACE MINING

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 6

DISTURBED AREA DRAINAGE
PORTAL AREA

PORTAL AREA

6-20-89
G. TAYLOR
REVISED
11-27-89

DISTURBED AREA DRAINAGE -1) MAP 3.2.1-1

AREA	ACRES 1)	H_L 1)	Δ ELEVATION 1)	T_c 2)	CN 3)	Q (CFS) 10-24
DA-1	9.21	891.8'	8810 - 8690 = 130'	.050	88	12.71
DA-2	12.03	1191.21'	8800 - 8680 = 120'	.074	88	16.42
DA-3	7.91	650.38'	8670 - 8578 = 92'	.040	90	11.82

2) KIRPICH FORMULA

$$T_c = \left[11.9\, L^3/H \right]^{.0385}$$

T_c = HOURS
L = HYDRAULIC LENGTH (MILES)
H = Δ ELEVATION (FT)

AREA	ACRES	CN 3)	H_L	Z OF CONTOUR (FT)	SLOPE %	CONTOUR INTERVAL	T_c 4)	Q 10-24
ARA-1	4.6	82	1151.4	12,982	64.79	10	.056	4.92

3) WT. AVG. BASED ON CN=90 FOR DISTURBED AREA AND CN=70 FOR UNDISTURBED AREA

4) KENT FORMULA

$$T_c = \left(\frac{L^{.8} \left(\left(1000/CN - 10 \right) + 1 \right)^{.7}}{1900\ S^{1/2}} \right) / .6$$

T_c = HOURS
L = HYD. LENGTH
CN = CURVE NUMBER
S = SLOPE

A. DITCHES IN AREA DA-1 WILL BE DESIGNED TO CARRY A PEAK FLOW OF 12.71 CFS. THE DITCH DESIGN WILL BE TYPICAL FOR DD-1,

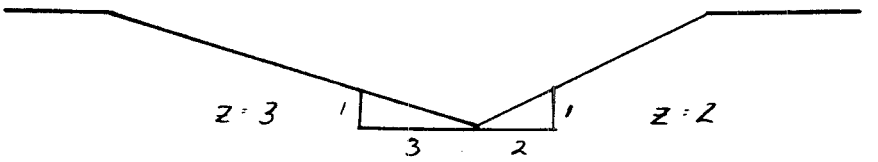
USING MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE

G. TAYLOR - 11-16-89

THE DITCH WILL BE A V SHAPE CUT BY A MOTOR GRADER WITH A FREEBOARD OF .3 FT.



DETERMINE DEPTH OF FLOW

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$n = .0225$ EARTH CHANNEL, WELL CONSTRUCTED, IN GOOD CONDITION
$S = .0375$ (MAP 3.2.1-1) AVG. SLOPE FOR DITCH
$Q = 12.71$ CFS (SECTION 6, VOL 5)

$Q = (zd^2/2 + zd^2/2) \times 1.49 S^{1/2}/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$= (3d^2/2 + 2d^2/2) \times 1.49 S^{1/2}/.0225 \times (3d/4\sqrt{3^2+1} + 2d/4\sqrt{2^2+1})^{2/3} \times (.0375)^{1/2}$

$Q = (1.5d^2 + d^2) \times 66.04 \times (.24d + .22d)^{2/3} \times .19$

TRY $d = .4$ FT.

$Q = (1.5(.4)^2 + (.4)^2) \times 66.04 \times (.24(.4) + .22(.4))^{2/3} \times .19$

$= 1.61$ CFS

TRY d .95

$Q = (1.5(.95)^2 + (.95)^2) \times 66.04 (.24(.95) + .22(.95))^{2/3} \times .19$

$= 16.26$ CFS

TRY $d = .85$

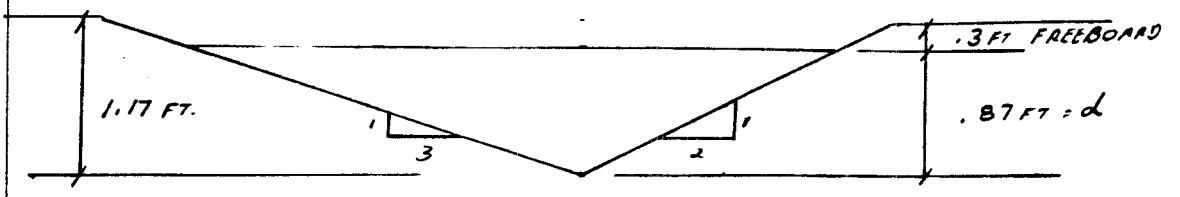
$Q = (1.5(.85)^2 + (.85)^2) \times 66.04 \times (.24(.85) + .22(.85))^{2/3} \times .19$

$= 12.08$ CFS

TRY $d = .87$

$Q = (1.5(.87)^2 + (.87)^2) \times 66.04 \times (.24(.87) + .22(.87))^{2/3} \times .19$
$= 12.85$ CFS

G. Taylor 11-16-99



TYPICAL DITCH
FOR DD-1

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$

$n = .0225$
$R = (.24(.87) + .22(.87)) = .40$
$S = .0375$

$$= 1.486/.0225 \times (.40)^{2/3} \times (.0375)^{1/2}$$

$$= 66.04 \times .54 \times .19$$

$$= 6.79 \text{ fps}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
REVISED
11-16-89

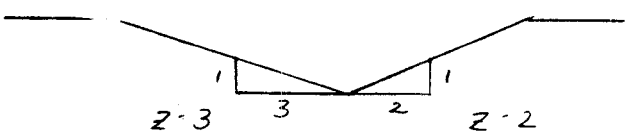
B DITCH IN AREA ARA-1 WILL BE DESIGNED TO CARRY A PEAK FLOW OF 4.82 CFS FOR 10YR-24HR SECTION 6 VOL. 5.

USING MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE

THE DITCH WILL BE A V SHAPE CUT WITH A MOTOR GRADER WITH A FREEBOARD OF .3FT.



DETERMINE DEPTH OF FLOW DD-2

$$A = zd^2/2 + zd^2/2$$

$$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$$

n = .0225 EARTH CHANNEL, WELL CONSTRUCTED, IN GOOD CONDITION
S = .0746 MAP 3.2.1-1 AVG. SLOPE FOR DITCH
Q = 4.82 CFS

$$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$$

$$= (3d^2/2 + 2d^2/2) \times 1.486/.0225 \times (3d/4\sqrt{3^2+1} + 2d/4\sqrt{2^2+1}) \times (.0746)^{1/2}$$

$$Q = (1.5d^2 + d^2) \times 66.04 \times (.24d + .22d)^{2/3} \times .27$$

TRY $d = .6$

$$Q = (1.5(.6)^2 + (.6)^2) \times 66.04 \times (.24(.6) + .22(.6))^{2/3} \times .27$$

$$= 6.77 \text{ CFS}$$

TRY $d = .5$ FT

$Q = (1.5(.5)^2 + (.5)^2) \times 66.04 \times (.24(.5) + .22(.5))^{2/3} \times .27$

$= 4.16$ CFS

TRY $d = .55$ FT.

$Q = (1.5(.55)^2 + (.55)^2) \times 66.04 \times (.24(.55) + .22(.55))^{2/3} \times .27$

$= 5.37$ CFS

TRY $d = .53$ FT

$Q = (1.5(.53)^2 + (.53)^2) \times 66.04 \times (.24(.53) + .22(.53)) \times .27$

$= 4.86$ FT.

USE A $d = .53$ FT FOR DEPTH OF FLOW

TYPICAL DITCH
FOR OD-2

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$n = .0225$
$R = (.24(.53) + .22(.53)) = .24$
$S = .0746$

$= 1.486/.0225 \times (.24)^{2/3} \times (.0746)^{1/2}$

$= 66.04 \times .38 \times .27$

$= 6.85$ FPS ROCK CHANNEL

C. DITCH DD-4 MAP 3.2.1-1

USE MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE
Q = 4.82 cfs 10YR-24hr
SECTION 6, VOL 5.

Z = 20

Q = 4.82
A = zd^2
R $zd / 2\sqrt{z^2+1}$
n = .016 ASPHALT, ROUGH
S = .03 (FIELD SURVEY MAY, 1989)

$Q = zd^2 \times 1.486/n \times (zd/2\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$= 20d^2 \times 1.486/.016 \times (20d/2\sqrt{20^2+1})^{2/3} \times (.03)^{1/2}$

$= 20d^2 \times 92.88 \times (.50d)^{2/3} \times .17$

TRY d = .26 FT.

$Q = 20(.26)^2 \times 92.88 \times (.5(.26))^{2/3} \times .17$

= 5.44 cfs

TRY d = 24 FT

$Q = 20(.24)^2 \times 92.88 \times (.5(.24))^{2/3} \times .17$

= 4.39 cfs

TRY d = .25 FT

$Q = 20(.25)^2 \times 92.88 \times (.5(.25))^{2/3} \times .17$

= 4.90 cfs

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.016 \times (.13)^{2/3} \times (.03)^{1/2}$

$= 92.88 \times .25 \times .17$

$= 3.99$ FPS

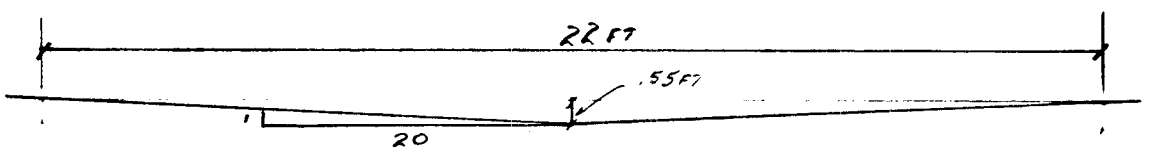
$n = .016$
$R = .5(.25) = .13$
$S = .03$

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= .25$ FT $+ .3$ FT

$= .55$ FT

DITCH DESIGN



TYPICAL DITCH
DD-4

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

D. DD-5

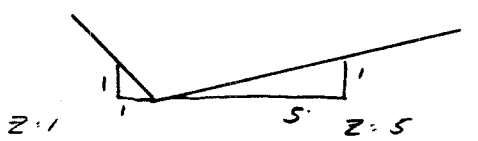
DITCHES IN AREA DA-3 WILL BE DESIGNED TO CARRY A PEAK FLOW OF 11.82 CFS 10YR-24HR EVENT SECTION 6, VOL. 5

USING MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE

THE DITCH WILL BE IN A V SHAPE WITH A FREEBOARD OF .3FT



DETERMINE DEPTH OF FLOW

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

n = .045 ROCK CHANNEL, JAGGED AND IRREGULAR

S = .016 MAP 3.2.1-1 AVG SLOPE FOR DITCH

$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$= 1d^2/2 + 5d^2/2 \times 1.486/.045 \times (1d/4\sqrt{1^2+1} + 5d/4\sqrt{5^2+1})^{2/3} \times (.016)^{1/2}$

$= .5d^2 + 2.5d^2 \times 33.02 \times (.18d + .25d)^{2/3} \times .13$

$= 3.0d^2 \times 33.02 \times (.43d)^{2/3} \times .13$

TRY d = 1FT

$Q = 3(1)^2 \times 33.02 \times (.43(1))^{2/3} \times .13$

$= 7.32$ CFS

TRY $d = 1.3$ FT

$Q = 3(1.3)^2 \times 33.02 \times (.43(1.3))^{2/3} \times .13$

$= 14.74$ CFS

TRY $d = 1.2$ FT

$Q = 3(1.2)^2 \times 33.02 \times (.43(1.2))^{2/3} \times .13$

$= 11.90$ CFS

USE $d = 1.2$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= 1.2$ FT $+ .3$ FT

$= 1.5$ FT

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

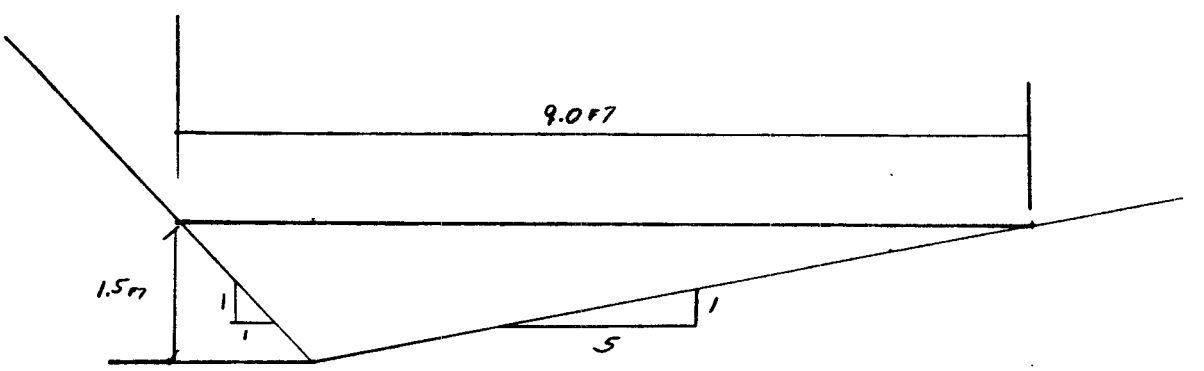
$= 1.486/.045 \times (.52)^{2/3} \times (.016)^{1/2}$

$= 33.02 \quad .64 \times .13$

$= 2.68$ FPS

$n = .045$
$R = .43(1.2) = .52$
$S = .016$

DITCH DESIGN



TYPICAL DESIGN FOR
DITCH DD-5

SECTION 7

STAGE VOLUME
PORTAL AREA

NOTE:

Revision 3, dated 11/27/89 to drawing 3.2.1-1 moved the boundary of area tributary to the mine sedimentation pond up the hill and increased this area by 1.21 Ac. This increase in drainage area represents only a 3.35% increase which is within the limits of accuracy of the engineering techniques used and therefore does not warrant any recalculation of the pond hydrology.

6-19-89
G. TAYLOR

PORTAL AREA
STAGE VOLUME

SIZING POND

1. SEDIMENT VOLUME

0.1 AC.-FT / AC. FOR EACH ACRE OF DISTURBED AREA

VOL. = 0.1 AC-FT/AC × 33.79 AC. (MAP 3.2 1-1)

= 3.39 AC-FT = 147,189 CU.FT

USE 147,190 CU.FT

2. STORM DETENTION

10 YR. - 24 HR STORM

P = 2.43 IN SECTION 2 PAGE 5 OF 7 1)

CN = 88 BASED CN: 90 FOR DISTURBED AREA AND CN: 70 FOR UNDISTURBED AREA.

S = 1000/CN - 10 EQ 2.39 PAGE B1
= 1000/88 - 10
= 1.36

APPLIED HYD. AND SEDIMENTOLOGY FOR DISTRUBED AREA BARFIELD AND HAHN 2)

Q = (P - .2S)²/P + .8S EQ 2.38 PAGE
= (2.43 - .2(1.36))²/2.43 + .8(1.36)
= 4.65/3.52
= 1.32 ÷ 12 IN/FT = .11 FT.

33.79 ACRES × 43,560 SQFT/AC × .11 FT = 162,259 CU.FT

USE 162,260 CU.FT

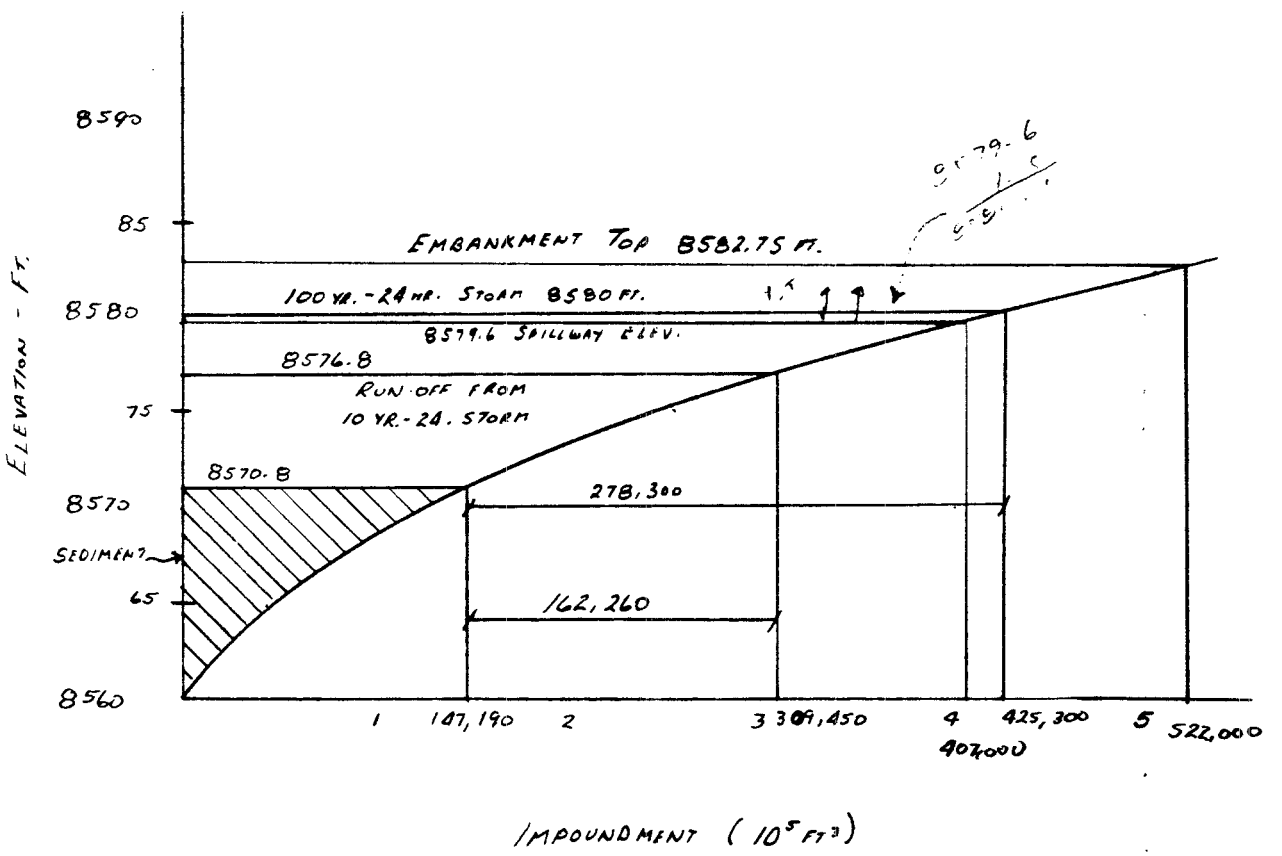
THEREFORE THE TOTAL STORAGE / DETENTION CAPACITY OF THE POND SHOULD NOT BE LESS THAN:

V_T = 147,190 + 162,260 = 309,450 CU.FT.

REVISED 9-19-89
G. TAYLOR

3. POND CAPACITY (MAP 3.2.1-2B)

	ELEVATION	AREA (FT^2)	AVG AREA (FT^2)	Δ VOL. (FT^3)	ACC. VOL (FT^3)
	8560	3,054			
			8,927	44,635	44,635
INTERPOLATED CONTOUR	8565	14,800			
			17,900	89,500	134,135
	8570	21,000			
			24,200	121,000	255,135
INTERPOLATED CONTOUR	8575	27,400			
			30,500	140,300	395,435
	8579.6	33,600			



IMPOUNDMENT ($10^5 FT^3$)

407,000 CU.FT. - 309,450 CU.FT. = REMAINING WATER STORAGE FOR MINE DISCHARGE 97,550 CU.FT. OR 729,674 GALLONS

4. 100 YR - 24 HR STORM

$P = 3.5$ IN SECTION 2 PAGE 5 OF 7

$CN = 88$ BASED CN: 90 FOR DISTURBED AREA AND CN = 70 FOR UNDISTURBED AREA.

$L_c = .101$ HRS

$S = 1000/88 - 10 = 1.36$ EQ 239 PAGE 81

$Q = (P - .2S)^2 / P + .8S$ APPLIED HYDROLOGY 2) AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS BARFIELD AND HAHN

$= (3.5 - .2(1.36))^2 / 3.5 + .8(1.36$ EQ 238 PAGE 81

$= (3.5 - .27)^2 / 3.5 + 1.09$

$= 10.93 / 4.59$

$= 2.27$ INCH $\div 12$ IN/FT $= .19$ FT

33.79 ACRE $\times$ 43560 SQ FT/AC. $\times$ .19 FT $=$ 278,432.95 2 -

USE 278,430 CUFT.

REFERENCE

1) SOIL CONSERVATION SERVICE - URBAN HYDROLOGY FOR SMALL WATERSHEDS, TR-55, 1986

2 BARFIELD, B. J., R.C. WARNER, C.T. HAHN APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS. OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

POTAL AREA DROP INLET
STAGE DISCHARGE CURVE

CN = 88

MAX FLOW LENGTH = 1951.98 FT (MAP 3.2.1-1)

DISTURBED AREA = 33.79 AC. (MAP 3.2.1-1)

CONCENTRATION TIME = .101 HRS KIRPICH FORMULA $t_c = .0078\,L^{.77}(L/H)^{.385}$

10 YR - 24 HR = 2.43 IN
100 YR - 24 HR = 3.5 IN
} SECTION 2 PAGE 5

MINE DISCHARGE

321,000 GAL/DAY ÷ 24 DAY/HR = 13,375 GAL/HR ÷ 60 MIN/HR = 222.92 GPM

222.92 GPM × .00228 = .51 CFS

PEAK FLOW

10 YR - 24 HR = 45.62 CFS + .51 CFS = 46.13 CFS

100 YR - 24 HR = 74.30 CFS + .51 CFS = 74.81 CFS

DATA - MAP - 3.2.1-2A

SPILLWAY CREST ELEVATION - 8579.6
JUNCTION OF RISER AND BARREL EL = 8567.9
SPILLWAY OUTLET ELEVATION - 8566.0
MAX. AVAILABLE WATER ELEVATION - 8582.75 → 8581.75
RISER DIA. = 48"
BARREL DIA. = 30"

WEIR FLOW

$Q = CLH^{3/2}$ C = 3 L = 12.57 FT

$Q = 37.70\,H^{3/2}$

EQ. 4.1 PAGE 230 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS OKLAHOMA TECHNICAL PRESS

REVISED 9-18-89
G. TAYLOR

ORIFICE FLOW

$Q = C'a\sqrt{2gH}$

$C' = .60$
$a = 12.57\ FT^2$

EQ. 4.2 PAGE 230 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - OKLAHOMA TECHNICAL PRESS

$= 60.51\sqrt{H}$

PIPE FLOW

$Q = a(2gH')^{1/2} / (1 + K_e + K_b + K_c L)^{1/2}$

EQ 4.4 PAGE 231

$a = 4.91\ FT^2$
$L = 63\ FT$
$K_e = 1.0$
$K_b = .5$
$K_c = .0129$ TABLE 4.1 PAGE 233

$H' = H + 12.35 - 1.50$
$= H + 10.85$

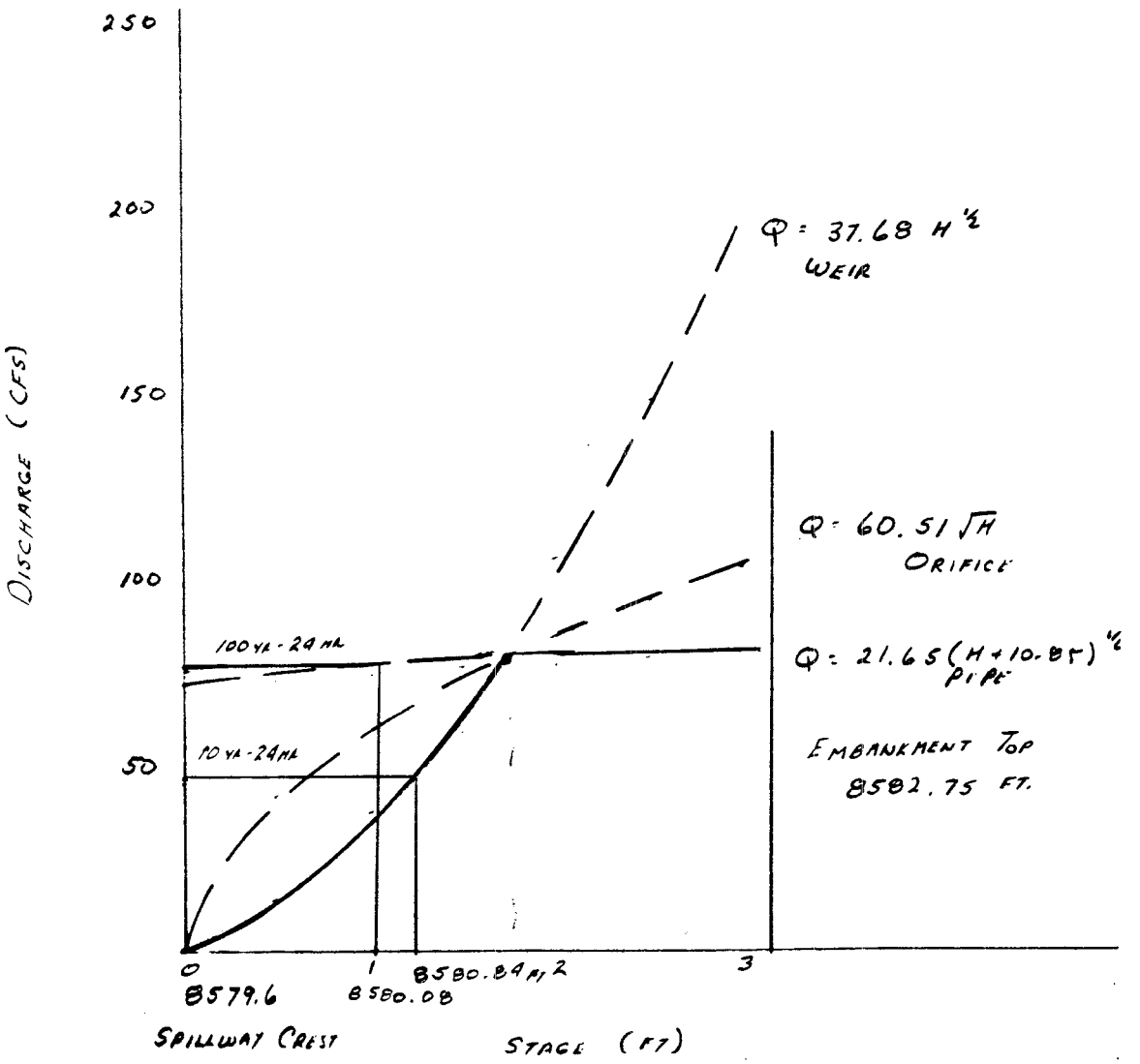
$Q = 4.91(2g\ H + 10.85)^{1/2} / (1 + 1 + .5 + .0129(63))^{1/2}$
$= 39.40(H + 10.85)^{1/2} / 1.82$
$= 21.65(H + 10.85)^{1/2}$

EXH.)

H	Q_{WEIR}	$Q_{ORIFICE}$	Q_{PIPE}
0	0	0	71.31
.5	13.33	42.79	72.94
1.0	37.70	60.51	74.53
1.5	69.26	74.11	76.08
2.0	106.63	85.57	77.61
2.5	149.02	95.67	79.10
3.0	195.89	104.80	80.57

REVISE 9-18-99
G. TAYLOR

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD



STAGE - DISCARGE CURVE

SECTION 8

TOPSOIL DIVERSIONS

G. TAYLOR
6-26-89

TOPSOIL DIVERSIONS

THIS IS A TEMPORARY DIVERSION FOR THE NORTH BRANCH OF ECCLES CREEK. THE DIVERSION CONSISTS OF A 36"Ø HALF ROUND CMP, 36"Ø FULL ROUND AND A 24"Ø PLASTIC PIPE. SINCE THIS IS A TEMPORARY DIVERSION, IT MUST PASS THE 10 YR-24 HR. STORM EVENT. FROM SECTION 2, VOL 5 PAGE 7 OF 7 THE PEAK FLOW 10YR-24HR IS 47.98 CFS.

I CU-13 MAP - 3.2.1-1

USE MANNING FORMULA

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

$S = .07$ (MAP 3.2.1-1)
$n = .024$ CORRUGATED METAL PIPE

$A = \pi d^2/8$

$R = \pi d^2/8 \,/\, \pi d/2 = \frac{\pi d^2}{8} \cdot \frac{2}{\pi d} = d/4$

$Q = 1.486/n \times \pi d^2/8 \times (d/4)^{2/3} \times S^{1/2}$

$= 1.486/.024 \times \pi (3)^2/8 \times (3/4)^{2/3} \times (.07)^{1/2}$

$= 61.92 \times 3.53 \times (.75)^{2/3} \times .26$

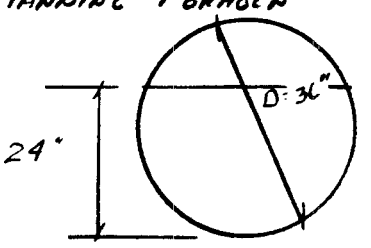
$= 47.69$ CFS

THE HALF ROUND WILL CARRY THE FLOW

II CU-14 MAP - 3.2.6-1A

USE MANNING FORMULA

$S = .09$ (MAP 3.2.1-1)
$n = .024$ CORRUGATED METAL PIPE



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

$\theta = 4 \cos^{-1}\sqrt{d/D} = 4 \cos^{-1}\sqrt{24/36} = 141.06°$

$A = D^2/8 \left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)$

$R = \frac{450}{\pi(360-\theta)} \left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)$

PAGE 4.3 SURFACE MINING WATER DIVERSION DESIGN MANUAL - U.S DEPT. OF THE INTERIOR - OFFICE OF SURFACE MINING

G. TAYLOR
REVISED 11-15-84

$$Q = \frac{1.486}{n} \frac{D^2}{8}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right) \times \left(\frac{45D}{\pi(360-\theta)}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)\right)^{2/3} S^{1/2}$$

$$= \frac{1.486}{.024} \frac{(3)^2}{8}\left(2\pi - \frac{\pi(141.04)}{180} + \sin 141.04\right) \times \left(\frac{45(3)}{\pi(360-141.04)}\left(2\pi - \frac{\pi 141.04}{180} + \sin 141.04\right)\right)^{2/3} \times .09$$

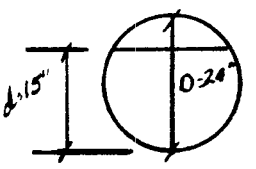
$$= 61.92 \times 3.59 \times (.63)^{2/3} \times .30$$

$$= 48.93 \text{ CFS}$$

THE 36" CULVERT WILL CARRY THE FLOW

II CU-15 MAP 3.2.1-1

USE MANNING FORMULA



$S = .25$ (MAP 3.2.1-1)
$n = .014$ PLASTIC

$$\theta = 4\cos^{-1}\sqrt{d/D} = 4\cos^{-1}\sqrt{15/24} = 151.04$$

$$A = \frac{D^2}{8}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)$$

$$R = \frac{45D}{\pi(360-\theta)}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)$$

PAGE 4.3 SURFACE MINING WATER DIVERSION DESIGN MANUAL - U.S. DEPT. OF THE INTERIOR - OFFICE OF SURFACE MINING

$$Q = \frac{1.486}{n} \frac{D^2}{8}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)\left(\frac{45D}{\pi(360-\theta)}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)\right)^{2/3} S^{1/2}$$

$$= \frac{1.486}{.014} \frac{(2)^2}{8}\left(2\pi - \frac{\pi 151.04}{180} + \sin 151.04\right)\left(\frac{45(2)}{\pi(360-151.04)}\left(2\pi - \frac{\pi(151.04)}{180} + \sin 151.04\right)\right)^{2/3} (.25)^{1/2}$$

$$= 106.14 \times 1.58 \times (.44)^{2/3} \times .5$$

$$= 48.51 \text{ CFS}$$

THE PLASTIC PIPE WILL CARRY THE FLOW

REFERRENCE:

1) SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPARTMENT OF THE INTERIOR
OFFICE OF SURFACE MINING

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 9

TRAIN LOADOUT
UNDISTURBED AREA DRAINAGE

TRAIN LOADOUT
UNDISTURED AREA DRAINAGE

G. TAYLOR
6-20-89
REVISED
11-20-89

DESIGN CRITERIA

LS-1 - MAP 3.2.8-3 WATERSHED AREAS TO THE DIVERSION DITCH UDD-1

SOIL SURVEY

TYPE	1) PERCENT	1) HYD GROUP	2) CN
VINTA FAMILY LOAM	45	B	55
TOZE FAMILY FINE SAND LOAM	35	B	55
COMODORE BOULDERY LOAM	15	D	77
MIDFORK FAMILY BOULDERY LOAM	5	B	55

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2 TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN
CN-55 FOREST LAND GOOD COVER CN-77 FOREST LAND GOOD COVER

CN: $.45(55) + .35(55) + .15(77) + .05(55) / .45 + .35 + .15 + .05$

$= 24.75 + 19.25 + 11.55 + 2.75 / 1$

$= 58.30$ USE **58**

AREA

$25 \times 13,696$ FT²/UNIT $=$ 342,450 FT²

SLOPE

$L = \Sigma C_i / AREA$

$= (1.425)(80) / 342,450$

$= .33$ OR 33%

KEIT FORMULA

$t_c = (L^{.8} (1000/CN - 10) + 1)^{.7} / 1900\, Y^{1/2} / .6$

L = 1000 ft
Y = .33
CN = 58

$t_c = ((1000)^{.8} (1000/58 - 10) + 1)^{.7} / 1900\, (.33)^{1/2} / .6$

= (209.51 / 1,091.47) / .6

= .32 HRS

EQ = 2.59 PAGE 102
EQ = 2.60
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

KIRPICH FORMULA

$t_c = .0078\, L^{.77} (L/H)^{.385}$

L = 1000 ft
H = 8160 - 8000
= 160

$t_c = .0078\, (1000)^{.77} (1000/160)^{.385}$

= 3.23 minutes / 60 min/hr

= .054 HRS USE = .1 HRS

Q_{10-24} = 2.43 in

Q_{25-24} = 2.85 in

Q_{50-24} = 3.10 in

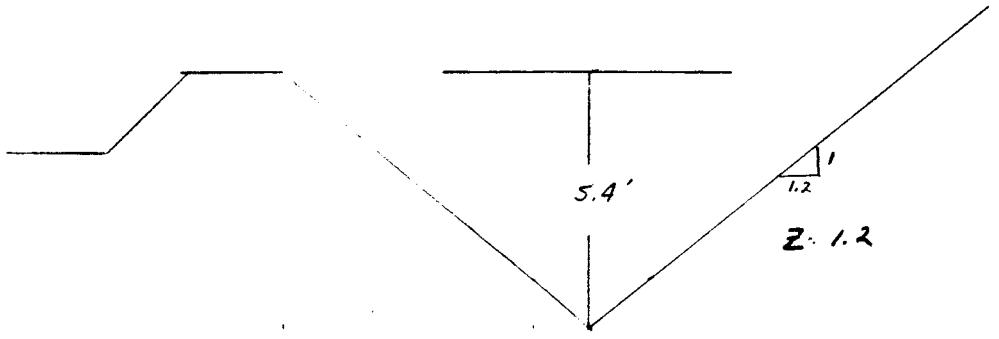
Q_{100-24} = 3.5 in

SECTION 2, VOL. 5 PAGE 5 OF 7

	Q_{10-24}	Q_{25-24}
T_c = .68 HRS	.23 CFS	1.24 CFS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

UDD-1 - MAP 3.2.1-3



USE MANNING FORMULA

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

$$A = z d^2$$

$$R = z d / 2\sqrt{z^2+1}$$

$S = .16$ MAP 3.2.1-3

$Q = 1.24$ CFS SECTION 9 VOL. 5

$n = .032$ - EARTH BOTTOM RUBBLE SIDES

$$Q = z d^2 \times 1.486/n \times \left(z d / 2\sqrt{z^2+1} \right)^{2/3} \times S^{1/2}$$

$$= 1.2 d^2 \times 1.486/.032 \times \left(1.2 d / 2\sqrt{(1.2)^2+1} \right)^{2/3} \times (.16)^{1/2}$$

$$= 1.2 d^2 \times 46.44 \times \left(1.2 d / 3.12 \right)^{2/3} \times .4$$

$$1.24 = 1.2 d^2 \left(1.2 d / 3.12 \right)^{2/3} \times 18.56$$

$$.07 \text{ CFS} = 1.2 d^2 \left(1.2 d / 3.12 \right)^{2/3}$$

TRIAL d

d (FT)	Q
.5	.099
.4	.055
.45	.075
.43	.066
.44	.071

d = .44 ft THE DEPTH OF THE FLOW WILL BE ≈ .44 ft. THE DEPTH OF THE DITCH IS 5.4 ft. THE DITCH WILL WORK AS BUILT

VELOCITY

USE MANNING FORMULA

$$V = \frac{1.486}{n} \times R^{2/3} \times S^{1/2}$$

$$= \frac{1.486}{.032} \times (.17)^{2/3} \times (.16)^{1/2}$$

$$= 46.44 \times .31 \times .4$$

$$= 5.76 \text{ FPS}$$

THIS IS BELOW THE EROSION VELOCITY OF 6 FPS SO RIPRAP WILL NOT BE NECESSARY.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRAIN LOADOUT
CULVERT DESIGN
30"Ø CMP - CU-6

USE PEAK FLOW RATE OF 1.24 CFS - MAP 3.2.1-3

Q = 1.24 CFS — SECTION 9, VOL. 5
L = 240 FT
S = .008 } MAP 3.2.1-3

USE MANNING FORMULA

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

$R = .5768D/1.9576$ — D = DEPTH OF FLOW

$A = \pi D^2/4 = \pi (2.5)^2/4 = 4.91$ SQFT.

$n = .024$

$S = .008$

$Q = 4.91 FT^2 \times 1.486/.024 \times (.5768D/1.9576)^{2/3} \times (.008)^{1/2}$

$= 4.91 FT^2 \times 61.92 \times (.5768D/1.9576)^{2/3} \times .089$

$= 27.06 (.5768D/1.9576)^{2/3}$

TRAIL d

d	Q
.1	2.74
.05	1.60
.04	1.38
.03	1.14
.032	1.19
.034	1.24

$d = .034 FT \times 12 = .41$ IN

THE 30 IN CULVERT WILL HANDLE THE FLOW

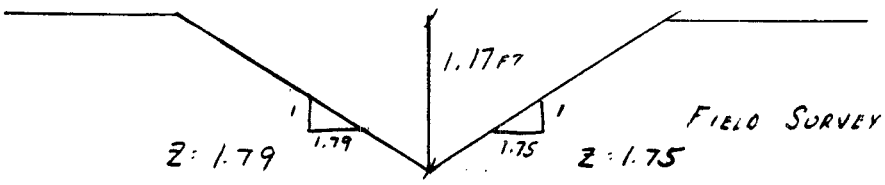
1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) BARFIELD, B.J., R.C. WARNER, C.T. HAAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

VDO - 2 - MAP 3.2.1-3

G. Taylor
11-17-89



FIELD SURVEY NOV. 1989

Q_{25-24} = .27 CFS SECTION 12 VOL. 5

USE MANNING FORMULA

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

n = .10 CHANNEL NOT MAINTAINED - DENSE WEEDS HIGH AS FLOW DEPTH
S = .03 MAP 3.2.1-3

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times (zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$= (1.79\,d^2/2 + 1.75\,d^2/2) \times 1.486/.10 \times (1.79d/4\sqrt{1.79^2+1} + 1.75d/4\sqrt{1.75^2+1})^{2/3} \times (.03)^{1/2}$

$= (.90\,d^2 + .88\,d^2) \times 14.86 \times (.22d + .22d)^{2/3} \times .17$

$= (1.78\,d^2) \times 14.86 \times (.44d)^{2/3} \times .17$

TRY d = .3 FT

$Q = (1.78(.3)^2) \times 14.86 \times (.44(.3))^{2/3} \times .17$

= .10 CFS

TRY d = .4 FT

$Q = (1.78(.4)^2) \times 14.86 \times (.44(.4))^{2/3} \times .17$

= .22 CFS

TRY $d = .43$ FT.

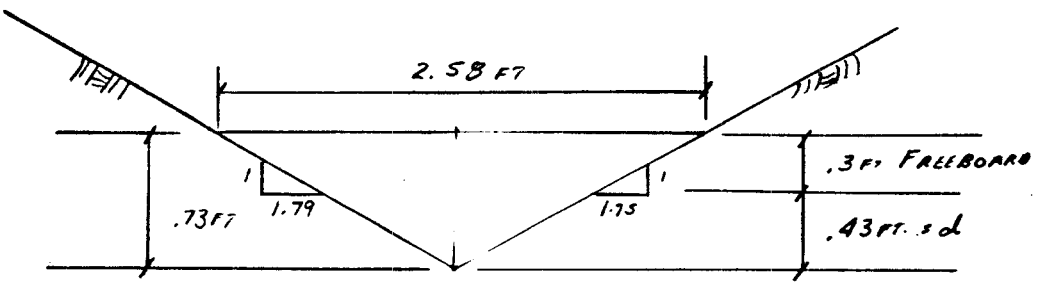
$$Q = (1.79(.43)^2) \times 14.86 \times (.44(.43)^{2/3} \times .17$$

$$= .27 \text{ CFS.}$$

TOTAL DEPTH = FLOW DEPT + FREEBOARD

= .43 FT + .3 FT

= .73 FT.



TYPICAL UDO-2 MINIMUM
DITCH DESIGN

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DITCH UDD-3 MAP 3.2.1-3

AREA IN SQ.FT (1)	CN (2)	HYDRAULIC LENGTH (1)	Σ OF CONTOURS	SLOPE % (3)	CONTOUR INTERVAL
67,518	69	1,680	2,365	35.03	10

1) MAP 3.2.1-3

2) * SILAS SOIL GROUP - C - 65% HYD. SOIL GROUP + CN = 74
BRYCAN SOIL GROUP - B - 35% HYD. SOIL GROUP CN = 61

$74(.65) + 61(.35) / .65 + .35 = 48.10 + 21.35 / 1 = 69.45$ USE 69

* SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPT. OF AGRICULTURE - SOIL CONSERVATION SERVICE

\+ APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HARN

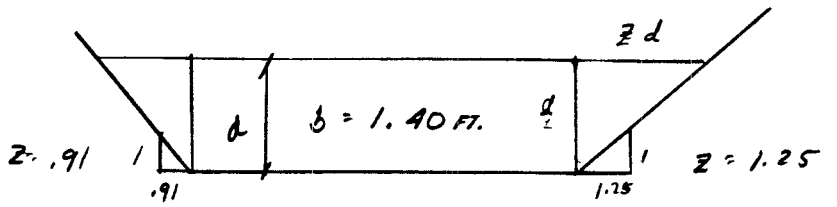
3) % SLOPE = Σ CONTOURS * CONTOUR INTERVAL / AREA

AREA NO	t_c (4)	Q_{10-24}	Q_{25-24}	Q_{50-24}	Q_{100-24}
		PEAK FLOW (CFS)(5)			
	.19 HRS	.54			1.57

4) KENT'S FORMULA
$T_c = (\text{HYD. LENGTH})^{.8} ((1000/CN - 10) + 1)^{.7} / (1900 \sqrt{\text{SLOPE}})^{1/2}$

5) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972

USE $Q_{100-yr} = 1.57$



USE MANNING FORMULA

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

$$A = bd + zd^2/2 + zd^2/2$$

$$R = bd + zd^2/2 + zd^2/2 \Big/ d\sqrt{z^2+1} + b + d\sqrt{z^2+1}$$

$S = .03$ MAP 3.2.1-3

$n = .010$ CHANNEL NOT MAINTAINED, DENSE WEEDS, HIGH AS FLOW DEPTH

$$Q = \left(bd + zd^2/2 + zd^2/2\right) \times 1.486/n \times \left(bd + zd^2/2 + zd^2/2 \Big/ d\sqrt{z^2+1} + b + d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= \left(1.40d + \frac{.91d^2}{2} + 1.25\,d/2\right) \times 1.486/.010 \times \left(1.40d + .91d^2/2 + 1.25d^2/2 \Big/ d\sqrt{.91^2+1} + 1.40 + d\sqrt{1.25^2+1}\right)^{2/3} \times (.03)^{1/2}$$

$$= 1.40d + .46d + .63d^2 \times 148.60 \times \left(1.40d + .46d^2 + .63d^2 \Big/ d(1.35) + 1.40 + d\,1.60\right)^{2/3} \times .17$$

$$= \left(1.40d + 1.08d^2\right) \times 148.60 \times \left(1.40d + 1.08d^2 \Big/ 1.40 + 2.95d\right)^{2/3} \times .17$$

TRAIL d

d FT	Q (CFS)
.1	.75
.15	1.49
.16	1.66

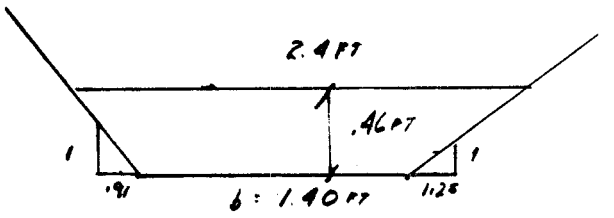
USE d = .16 FT.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .16 + .3

= .46 FT

DITCH DESIGN



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 10

TRAIN LOADOUT
DISTURBED DRAINAGE

G. Taylor
6-20-89
Revised
11-27-89

Train Loadout
Disturbed Drainage

Assumed: All Diversions Map 3.2.1-3 for 10 yr - 24 hr. Peak Flow from entire disturbed areas

Area	Hydraulic Length	Σ Contours 3)	CN	Slope % 3)	Δ Elev. ft
12.56	1962.99	10,043.21	90	18.36	(8150-7914): 232'

T_c 2) Hr	T_c 3)
.102	.149

Notes:

1) Kirpitch's Formula - $t_c = .0078\, L^{.77} (L/H)^{.385}$

2) Kent Formula - $t_c = L^{.8} \left(\left(\frac{1000}{CN} - 10 \right) + 1 \right)^{.7} \Big/ 1900\, S^{1/2} / .6$

3) Σ Contours - is for available contours only. This essentially is a "pad area" slope. Assume slope for undisturbed and weighted average for slope in Peak Calculation.

Use Kirpitch T_c for Peak Flow Calculations

P_{10-24} - 2.43 in.
P_{25-24} - 2.85 in
P_{100-24} - 3.50 in.

} Section 2, Vol. 5

Q_{10-24} - 18.41 cfs

Q_{25-24} - 22.49 cfs

Q_{100-24} - 29.12 cfs

I DITCHES AT THE LOADOUT AREA WILL BE DESIGNED TO CARRY A PEAK FLOW OF Q_{10-24} = 18.41 CFS SECTION 10, VOL. 5 PAGE 1. THIS WILL BE A TYPICAL DESIGN FOR DD-7, DD-8, DD-9, DD-10 + DD-11

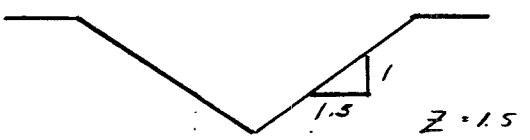
USE MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE

THE DITCH WILL BE A V-SHAPE CUT BY A MOTOR GRADER WITH A FREEBOARD OF .3FT

A. DETERMINE DEPTH OF FLOW



$A = Zd^2$
$R = Zd/2\sqrt{Z^2+1}$ } PAGE 4.3 SURFACE MINING WATER DIVERSION DESIGN MANUAL
n = .040 SMALL DRAINAGE DITCH
S .029 (MAP 3.2.1-3) AVG. SLOPE
Q = 18.41 CFS

$$Q = \frac{1.486}{n} \times Zd^2 \times \left(\frac{Zd}{2\sqrt{Z^2+1}}\right)^{2/3} \times S^{1/2}$$

$$= 1.486/.04 \times 1.5d^2 \times \frac{1.5d}{2\sqrt{1.5^2+1}} \times (.029)^{1/2}$$

$$18.41 = 37.15 \times 1.5d \times \left(\frac{1.5d}{3.61}\right)^{2/3} \times .17$$

TRY d = 1.2 FT

$$Q = 37.15 \times 1.5(1.2)^2 \times \left(\frac{1.5(1.2)}{3.61}\right)^{2/3} \times .17$$

$$= 8.56 \text{ CFS}$$

TRY $d = 1.4$ FT.

$Q = 37.15 \times 1.5(1.4)^2 \times \left(1.5(1.4)/3.61\right)^{2/3} \times .17$

$= 12.92$ CFS

TRY $d = 1.5$ FT.

$Q = 37.15 \times 1.5(1.5)^2 \times \left(1.5(1.5)/3.61\right)^{2/3} \times .17$

$= 15.53$ CFS

TRY $d = 1.6$ FT

$Q = 37.15 \times 1.5(1.6)^2 \times \left(1.5(1.6)/3.61\right)^{2/3} \times .17$

$= 18.45$ CFS

USE DEPTH OF FLOW 1.6 FT.

B. DETERMINE VELOCITY

$V = 1.486/n \; R^{2/3} \; S^{1/2}$ EQ 3.21 PAGE 157 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAAN

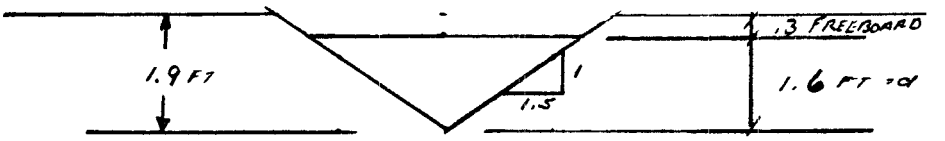
$R = 1.5(1.6)/3.61 = .66$

$V = 1.486/.04 \times (.66)^{2/3} \times (.029)^{1/2}$

$= 37.15 \times .76 \times .17$

$= 4.80$ FPS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD



TYPICAL DRAINAGE DITCH
FOR DD-7, DD-8, DD-9, DD-10 + DD-11

REFERENCE

1) SURFACE MINING WATER DIVERSION DESIGN MANNUAL
UNITED STATES DEPARTMENT OF THE INTERIOR
OFFICE OF SURFACE MINING.

2. BARFIELD, B.J., R.C. WARNER, C.T. HAAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 11

TRAIN LOADOUT AREA
SWALE DESIGN

SECTION 11

G. TAYLOR
9-23-91
1 of 2

SWALE SW-10 AT THE LOADOUT AREA WILL BE DESIGNED TO CARRY A PEAK FLOW OF Q_{10-24} = 18.91 CFS SECTION 10, VOL. 5 PAGE 1

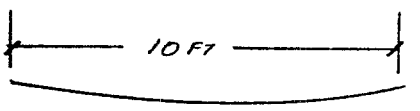
USE MANNING FORMULA

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

A = AREA
n = ROUGHNESS
R = HYDRAULIC RADIUS
S = SLOPE

THE SWALE WILL BE A PARABOLA WITH A FREE BOARD OF .3 FT.

A. DETERMINE DEPTH OF FLOW



$A = 2/3\, d\, T \qquad T = 10$

$R = 2dT^2/3T^3 + 8d^2$

PAGE 4.3 SURFACE MINING WATER DIVERSION DESIGN MANUAL

n: .015 CONCRETE, SMOOTH FINISH

S: .0438

$$Q = 1.486/n \times 2/3\, d\, T \times (2dT^2/3T^3 + 8d^2)^{2/3} \times S^{1/2}$$

$$= 1.486/.015 \times 6.67d \times (200d/3{,}000 + 8d^2)^{2/3} \times (.0438)^{1/2}$$

$$= 99.07 \times 6.67d \times (200d/3{,}000 + 8d^2)^{2/3} \times .21$$

$$= 20.73 \times 6.67d \times (200d/3{,}000 + 8d^2)^{2/3}$$

TRAIL d

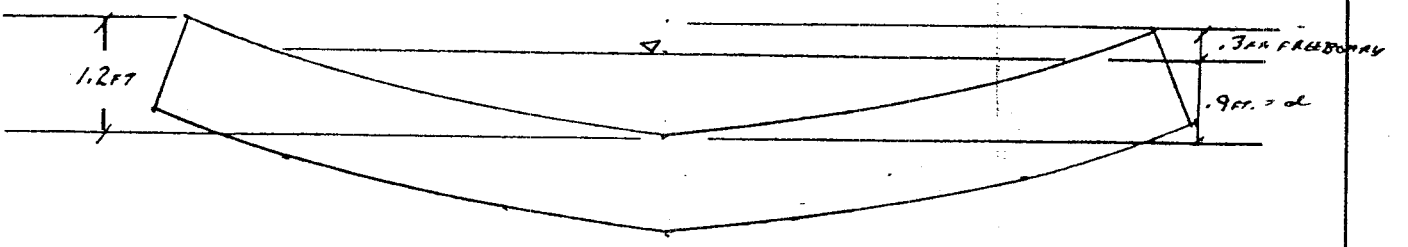
d (ft)	Q (cfs)
.5	7.08
1	22.49
.9	18.87

USE A DEPTH OF .9 FT.

DOCM DEPTH = 0.35'

V = 7.87

9-23-91
2 of 1



SWALE - 10

REFERENCE

1) SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPARTMENT OF THE INTERIOR
OFFICE OF SURFACE MINING.

REGISTERED PROFESSIONAL ENGINEER
8632
WILLIAM W.
SHRIVER
STATE OF UTAH

Wm W. Shriver
9-23-91

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 12

HYDROLOGY STUDY
CULVERT EAST END
TRAIN LOADOUT
CU-16

HYDROLOGY STUDY
CULVERT EAST END
TRAIN LOADOUT
CU-16

G. TAYLOR
6-20-89
REVISED
11-17-89

WATER SHED LS-2 MAP 3.2.8-3

SOIL SURVEY -

SOIL TYPE	1) PERCENT	1) HYD. GROUP	2) CN
UNITA FAMILY LOAM	45	B	55
TOZE FAMILY FINE SANDY LOAM	35	B	55
COMODORE BOULDERY LOAM	15	D	77
MIDFORK FAMILY BOULDERY LOAM	5	B	55

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAAN
CN: 55 FOREST LAND GOOD COVER, CN: 77 FOREST LAND POOR COVER

$$CN = 55(.45) + 55(.35) + 77(.15) + 55(.05) / .45 + .35 + .15 + .05$$

$$= 24.75 + 19.25 + 11.55 + 2.75 / 1$$

$$= 58.30 \quad \text{USE} \quad \underline{58}$$

AREA

$$6 \times 13{,}698 = 82{,}188 \text{ SQ. FT.}$$

SLOPE

$$L = \Sigma CL / \text{AREA}$$

$$= 360 \times 80 / 82{,}188$$

$$= .35 \text{ OR } 35\%$$

CONCENTRATION TIME

KENTS FORUMLA - PAGE 102 - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$$t_c = L^{.8}\left(\left(1000/CN - 10\right) + 1\right)^{.7} / 1900\, Y^{1/2} / .6$$

$L = 1200$ FT
$Y = .35$
$CN = 58$

$$= 1200^{.8}\left(\left(1000/58 - 10\right) + 1\right)^{.7} / 1900\,(.35)^{1/2} / .60$$

$$= 1{,}272.17 / 1{,}124.06 / .60$$

$$= .019 \text{ HRS}$$

KIRPICH - PAGE 102 - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$$t_c = .0078\, L^{.77}\,(L/H)^{.385}$$

$L = 1200$
$H = 8100 - 7800$
$= 220$

$$= .0078\,(1200)^{.77}\,(1200/220)^{.385}$$

$$= 1.83 \times 1.92$$

$$= 3.52 \text{ MIN.}$$

$$= .058 \text{ HRS}$$

$P_{10\text{-}24} = 2.43$ IN
$P_{25\text{-}29} = 2.85$ IN
$P_{30\text{-}39} = 3.10$ IN
$P_{40\text{-}49} = 3.5$ IN

SECTION 2, VOL. 5

$t_c = .189$ SCS UNIT HYDROGRAPH METHOD (NEN-4, 1972)

$Q_{10\text{-}24} = .05$ CFS $Q_{25\text{-}29} = .27$ CFS

CULVERT SELECTION - CU-16 18" HALF ROUND MAP 3.2.1-3

USE MANNING FORMULA

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

$S = .47$ (MAP 3.2.1-3)
$n = .029$ CORRUGATED METAL PIPE

$A = \pi d^2/8$

$R = \pi d^2/8 \,/\, \pi d/2 = \pi d^2/8 \times 2/\pi d = d/4$

PEAK FLOW $Q_{23\text{-}28} = .27$ CFS

$Q = 1.486/n \times \pi d^2/8 \times (d/4)^{2/3} \times S^{1/2}$

$= 1.486/.029 \times \pi d^2/8 \times (d/4)^{2/3} \times (.47)^{1/2}$

$= 61.92 \times \pi d^2/8 \times (d/4)^{2/3} \times .69$

TRY $d = .31$ FT

$Q = 1.486/.029 \times \pi (.31)^2/8 \times (.31/4)^{2/3} \times (.47)^{1/2}$

$= 61.92 \times .04 \times .18 \times .69$

$= .31$ CFS

THE DEPTH OF FLOW WILL BE $\approx .31$ FT. THE DEPTH OF THE HALF ROUND IS 1.50 FT. THE HALF ROUND WILL WORK AS BUILT WITHOUT .3 FT FREEBOARD.

REFERENCE:

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) BARFIELD, B.J., R.C. WARNER, C.T. HAHN APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
6-20-89
REVISED 11-17-89

TRAIN LOADOUT
CULVERT DESIGN
24" Ø CMP

USE THE PEAK FLOW RATE Q_{100-24} = 29.12 CFS FROM SECTION 10, VOL 5 MAP 3.2.1-3 FOR CD-5, CD-6, CD-7 AND CD-8
SELECTE CD 3 INSURE THAT THE 24" Ø CMP WILL HANDLE THE FLOW. THIS WILL BE A TYPICAL CALCULATION FOR ALL 24" Ø CMP.

Q = 29.12 CFS SECTION 10, VOL. 5
L = 70 FT. MAP 3.2.1-3
S = .057 (MAP 3.2.1-3)

USE MANNING FORMULA

$$Q = A \times 1.486/n \times R^{2/3} \times S^{1/2} \qquad R = \frac{.5768D}{1.9578} \quad D = \text{depth of flow}$$

$$A = \pi D^2/4 = \frac{\pi (2)^2}{4} = 3.14 \text{ ft}^2$$

n = .024 CORRUGATED METAL PIPE

S = .057 (MAP 3.2.1-3)

$$Q = 3.14 \text{ ft}^2 \times 1.486/.024 \times (.5768D/1.9578)^{2/3} \times (.057)^{1/2}$$

$$= 3.14 \text{ ft}^2 \times 61.92 \times (.5768D/1.9578)^{2/3} \times .24$$

$$= 3.14 \text{ ft}^2 \times 14.78 \times (.5768D/1.9578)^{2/3}$$

TRY d = 1.7 FT.

$$Q = 3.14 \text{ ft}^2 \times 14.78 \times (.5768(1.7)/1.9578)^{2/3}$$

$$= 29.20 \text{ CFS}$$

USE 1.7 FT OR = 20.4 IN.

ALL 24" Ø CMP WILL PASS THE 100 YR - 24 HR EVENT, WITHOUT ANY BACKWATER EFFECT

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRAIN LOADOUT
CULVERT DESIGN
24"Ø CMP - CD-8

G. TAYLOR
8-30-89

DETERMINE IF THERE IS INLET OR OUTLET CONTROL

A. INLET CONTROL

Q_{10-24} = 18.41 CFS FROM SECTION 10, VOL. 5 MAP 3.2.1-3

USE THE INLET CONTROL NOMOGRAPH - PAGE 189[1)]

HW/D = 36/24 = 1.50 GRAPH #3

Q = 18 CFS FOR 24"Ø CMP

B. OUTLET CONTROL

K_e = 0.9 PAGE 181[1)]

L' = 70 FT x .44 = 30.80

PAGE 194[1)] - L' IS NOT PART OF THE NOMOGRAPH

REFERENCES

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS
THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
6-20-89

TRAIN LOADOUT
CULVERT DESIGN
36"ϕ CMP - CD-9

USE THE PEAK FLOW RATE Q_{100Yr} = 29.12 CFS FROM SECTION 10, VOL.5

Q = 29.12 CFS SECTION 10, VOL 5
L = 40 FT (MAP 3.2.1-3)
S = .5/40 = .0125 (MAP 3.2.1-3) MAX. SLOPE

USE MANNING FORMULA

$Q = A \times 1.486/n \times R^{2/3} \times S^{1/2}$ $R = .5768D/1.9578$ D = DEPTH OF FLOW

$A = \pi D^2/4 = \pi(3)^2/4 = 7.07\ FT^2$

$n = .024$

$Q = 7.07\ FT^2 \times 1.486/.024 \times (.5768D/1.9578)^{2/3} \times (.0125)^{1/2}$

$= 7.07\ FT^2 \times 61.92 \times (.5768D/1.9578)^{2/3} \times .11$

$= 7.07 \times 6.92 \times (.5768D/1.9578)^{2/3}$

TRY d = 1.3 FT.

$Q = 7.07 \times 6.92 \times (.5768(1.3)/1.9578)^{2/3}$

= 25.72 CFS

TRY d = 1.5 FT

$Q = 7.07 \times 6.92 \times (.5768(1.5)/1.9578)^{2/3}$

= 28.31 CFS

TRY d = 1.7 FT

$Q = 7.07 \times 6.92 \times (.5768(1.7)/1.9578)^{2/3}$

= 30.78

TRY d = 1.6 FT

$Q = 7.07 \times 6.92 \times (.5768(1.6)/1.9578)^{2/3}$

= 29.56

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

USE 1.6 FT OR 19.2 IN.

THE 36" Ø CMP WILL PASS THE 100 YR-24 HR EVENT WITHOUT ANY BACKWATER EFFECT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRAIN LOADOUT
CULVERT DESIGN
36"Ø CMP - CD-9

G. TAYLOR
8-30-89

DETERMINE IF THERE IS INLET OR OUTLET CONTROL

A. INLET CONTROL

Q_{10-24} = 18.41 CFS FROM SECTION 10, VOL. 5, MAP 3.2.1-3

USE INLET CONTROL NOMOGRAPH PAGE 189 [1]

HW/D = 36/36 = 1.0 GRAPH #3

Q = 33 CFS FOR 36"Ø CMP

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

GRAPHS FOR OUTLET CONTROL WILL NOT WORK. THE LENGTH OF THE PIPE IS TO SHORT.

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTURCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
6-29-89

HYDROLOGY STUDY
CULVERT CD - 12

WATER SHED - LS - 3 MAP 3.2.8-3

SOIL SURVEY -

SOIL TYPE	1) PERCENT	1) HYD. GROUP	2) CN
UNITA FAMILY LOAM	45	B	55
TOZE FAMILY FINE SANDY LOAM	35	B	55
COMODORE BOULDERY LOAM	15	D	77
MIDFORK FAMILY BOULDERY LOAM	5	B	55

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAHN.
CN-55 FOREST LAND GOOD COVER, CN-77 - FOREST LAND POOR COVER

CN = $.45(55) + .35(55) + .15(77) + .05(55) / .45 + .35 + .15 + .05$

= $24.75 + 19.25 + 11.55 + 2.75 / 1$

= 58.30 USE **58**

AREA

123 × 13,698 = 1,684,854 SQ FT

SLOPE

L = Z CONTOUR i / AREA

= 7,260 × 80 / 1,684,854

= .34 OR 34%

CONCENTRATION TIME

KENTS FORMULA EQ. 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD & HAAN

$t_c = L^{.8}(1000/CN - 10 +)^{.7} / 1900\ Y^{1/2} / 60$

$L = 3600$
$Y = .34$
$CN = 58$

$= 3600^{.8}\left(\left(\frac{1000}{58} + 0\right) + 1\right)^{.7} / 1900\,(.34)^{1/2} / 60$

$= 3063.67 / 1{,}107.99 / 60$

$= 2.76$ MIN $\div$ 60 MIN/HR

$= .046$ HRS

KIRPICH FORMULA EQ 2.58 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$t_c = .0078\ L^{.77}\ (L/H)^{.385}$

$L = 3600$
$H = 8800 - 800 = 800$

$= .0078\ (3600)^{.77}\ (3600/800)^{.385}$

$= 4.27 \times 1.784$

$= 7.62$ MIN

$= .127$ HRS

$P_{10\text{-}24} = 2.43$ IN
$P_{25\text{-}24} = 2.85$ IN
$P_{50\text{-}24} = 3.10$ IN
$P_{100\text{-}24} = 3.5$ IN

SECTION 2, VOL. 5

t_c : SCS UNIT HYDROGRAPH METHOD (NEH-4, 1973)

$Q_{10\text{-}24}$ - 1.23 CFS
$Q_{25\text{-}24}$ - 6.00 CFS
$Q_{50\text{-}24}$ - 9.63 CFS
$Q_{100\text{-}24}$ - 16.14 CFS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

CULVERT SELECTION - CD-12 30" ϕ CMP MAP 3.2.1-3

USE MANNING FORMULA

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

S = .09 (MAP 3.2.1-3)
n = .024 CORRUGATED METAL PIPE
Q_{100-20} = 16.14 CFS

$A = \pi d^2/4$

$R = \pi d^2/4 \,/\, \pi d = \pi d^2/4 \cdot \frac{1}{\pi d} = d/4$

$Q = \frac{1.486}{n} \times \pi d^2/4 \times (d/4)^{2/3} \times S^{1/2}$

$= 1.486/.024 \times \pi d^2/4 \times (d/4)^{2/3} \times (.09)^{1/2}$

$= 61.92 \times \pi d^2/4 \times (d/4)^{2/3} \times .30$

$16.14 = 61.92 \times \pi d^2/4 \times (d/4)^{2/3} \times .30$

TRY d = 1.47 FT.

$Q = 1.486/.024 \times \pi (1.47)^2/4 \times (1.47/4)^{2/3} \times .30$

$= 61.92 \times 1.70 \times .51 \times .30$

$= 16.15$ CFS

THE 30" ϕ CMP WILL CARRY THE 100 YR - 24 HR EVENT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
8-30-89

CULVERT CD-12
30" Ø · CMP

DETERMINE IF THERE IS INLET OR OUTLET CONTROL

A. INLET CONTROL

Q_{10-24} = 1.23 CFS SECTION 12, VOL. 5, MAP 3.2.1-3

USE INLET CONTROL NOMOGRAPH - PAGE 189 [1]

HW/D = 30"/30 = 1.0 GRAPH #3

Q = 20 CFS FOR 30" Ø CMP

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

K_e = 0.9 PAGE 181 [1]

L' = 95 FT × .61 = 57.95 FT.

USE OUTLET CONTROL NOMOGRAPH - PAGE 194 [1]

Q = 18 CFS FOR 30" Ø CMP

THE PIPE WILL HANDLE THE FLOW

REFERENCE

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

HYDROLOGY STUDY
CULVERT CD-10

G. TAYLOR
6-20-89
REVISED
11-17-89

WATER SHED - FOR CD-10 MAP 3.2.8-3

SOIL SURVEY	1) PERCENT	1) HYD. GROUP	2) CN
CURRCANTI FAMILY LOAM	24	B	66
PATHEAD EXTREMELY BOULDERY FINE SANDY LOAM	10	C	77
PATHEAD EXTREMELY STONY LOAM	10	C	77
PERMA FAMILY	8	B	66
MIDFORK FAMILY BOULDERY LOAM	11	B	55
TRAG STONY LOAM	5	C	77
CROYDON LOAM	4	B	66
FALCON STONY SANDY LOAM	1	C	77
VINTA FAMILY LOAM	12	B	55
TOZE FAMILY FINE SANDY LOAM	12	B	55
COMODORE BOULDERY LOAM	2	D	77
ROCK OUTCROP	1	D	83

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAAN
CN = 55 - FOREST LAND GOOD COVER, CN = 66 FOREST LAND POOR COVER
CN = 77 FOREST LAND POOR COVER, CN = 83 FOREST LAND POOR COVER

CN = 66(.24) + 77(.1) + 77(.1) + 66(.08) + 55(.11) + 77(.05) + 66(.04) + 77(.01) + 55(.11) + 55(.12) + 77(.02) + 83(.01) //

= 15.84 + 7.70 + 7.70 + 5.28 + 6.05 + 3.85 + 2.64 + .77 + 6.60 + 6.60 + 1.54 + .83 //

= 65.40 USE 65

G. Taylor
Revised 11-17-09

$S = 1000/CN - 10$

$= 1000/71 - 10$

$= 14.08 - 10$

$= 4.08$

Area of the Water Shed

$10,174.39 \cdot .0149 in^2 = 151.60 in^2 \times 22.96$ acres $/in^2 = 3,480.7$ acres

$3,480.7$ acres $\times 43,560$ ft^2/acre $= 151,619,292.1$ sq ft.

Time Parameters

Concentration Time

Kirpich Eq 2.58 page 102 Applied Hydrology and Sedimentology for Disturbed Areas - Barfield and Haan

$t_c = .0078 L^{.77} (L/H)^{.385}$

$L = 18,150$
$H = 1,920$

$t_c = .0078 (18,150)^{.77} (18,150/1920)^{.385}$

$= .0078 (1,902.55)(2.37)$

$= 35.24$ mins

$= .59$ hrs

Lag Time

$t_L = L^{.8} (S+1)^{.7} / 1900 Y^{1/2}$ Eq 2.60 page 102 Applied Hydrology and Sedimentology for Disturbed Areas - Barfield and Haan

$Y = \Sigma C i / Area$

$i = 80$ ft and 400 ft

$A = 151,967,771.9$ sq ft.

G Taylor
Revised 11-17-85

	Σ C		
	600		9920
	900		9840
	1200		9760
	1800		9680
80' C	6975		9600
	16 050		9520
	28 200		9440
	44 250		9360
	50 925		9280
	64 950	215,850 x 80	9200
400' C	48 975		8800
	22 200		8400
	1200	72,375 x 400	8000

$$Y = (215,850 \times 80) + (72,375 \times 400) / 3,480.7 \times 43,560$$

$$= 46,218,000 / 151,619,292.1$$

$$= 30.48\%$$

$$t_L = (18,150)^{.8} (4.09+1)^{.7} / 1900 (30.41)^{.5}$$

$$= (2,553.30)(3.12) / 1900 (5.51)$$

$$= 7,966.30 / 10,469$$

$$= .76 \text{ HRS}$$

$$= 45.6 \text{ MINS.} \quad \text{USE } 46 \text{ MINS.}$$

G. TAYLOR
REVISED
11-17-89

$t_L = .6\, t_c$

$46 = .6\, t_c$

$76.67 = t_c$

76.67 MINS $= t_c$

$t_c = 1.28$ HR

PEAK FLOW USING SCS CURVE METHOD

EVENT	PEAK FLOW
2 YR - 24 HR	
10 YR - 24 HR	212.3 CFS
50 YR - 24 HR	524.2 CFS
100 YR - 24 HR	768.5 CFS

DETERMINE MAXIMUM FLOW OF THE PIPE

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

$n = .035$

$R \quad .83$

$S = .03$ (MAP 3.2.1-3) MAX SLOPE

$A = 15.69$ SQ FT

$Q = 15.69 \text{ SQ FT} \left(1.486/.035\right) (.83)^{.66} (.03)^{.5}$

$= (15.694\text{ FT})(42.46)(.88)(.17)$

$= 99.35$ CFS

REFERENCE:

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) BARFIELD, B.J., R.C. WARNER, C.T. HAAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Hydrometrics, Inc.
727 Airport Road • Helena, Montana 59601 • (406) 443-4150

November 17, 1988

Gary E. Taylor
Senior Mining Engineer
Utah Fuel Company
P. O. Box 719
Helper, UT 84526

Dear Gary,

Attached are flow capacity computations for the 72-inch diameter half-round CMP culvert with gravel invert at the Skyline Mine. Based on our telephone conversation, I assumed that inlet rather than outlet conditions controlled the flow. Flow capacities for various water depths above the top of the culvert are:

Depth of Water Above Top of Pipe - Feet	Discharge Capacity - CFS
0	125
2	150
6	190
10	225

Please let me know if you have any questions.

Sincerely,

Bob

Robert D. Braico, P. E.
Civil/Environmental Engineer

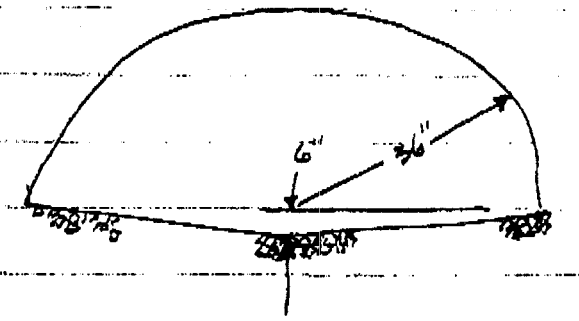
RDB:jy

Enclosures

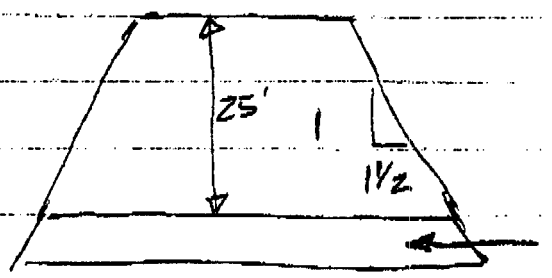
11/3/88

1/6

Utah Fuel Co. - Skyline Mine



half-round CMP w/ gravel invert. Inlet is flared concrete with total width of 32'. Culvert is 161' long and installed on 3% slope. Discharge is to natural drainage w/o obstructions.



Need to calculate maximum discharge when:

ⓐ Water surface at inlet is at top of pipe
Q = 125 cfs

ⓑ Water surface is 2' ab. top of inlet
Q = 150 cfs

ⓒ 6' ab. inlet
Q = 190 cfs

ⓓ 10' ab. inlet
Q = 225 cfs

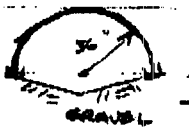
Answers From Smyoot 11-17-88 Comps

UTAH FUEL. CO. SKYLINE MINE

S.M.y 11-17-88 p.2

CULVERT HYDRAULICS OF HORSESHOE STRUCTURAL PLATE ARCH SPAN = 6'-0" R = 36" RISE = 36" + 6" = 42"

INLET CONTROL (ASSUME THIS CONDITION EXISTS)



2"

FIND HW/D FOR GIVEN CONDITIONS

L = 161'
S = 3%

a.) HW = D ∴ HW/D = 1.0

FOR CMPA ↓ FOR CMP ↓

b.) HW = D + 2 D = 3.5' ∴ HW = 5.5'

$HW/D = 5.5/3.5 = 1.57$ $\frac{8.5}{6} = 1.42$

c.) HW = D + 6 D = 3.5 ∴ HW = 9.5 $\frac{12.5}{6} = 2.0$

$\frac{HW}{D} = \frac{9.5}{3.5} = 2.71$

d.) HW = D + 10 D = 3.5 HW = 13.5 $\frac{16.5}{6} = 2.25$

$\frac{HW}{D} = \frac{13.5}{3.5} = 3.86$

FIND ENTRANCE LOSS COEF. FOR INLET SECTION

INLET IS FLARED CONCRETE W/ TOTAL WIDTH = 32'

→ ASSUME SIMILAR TO PIPE

WITH HEADWALL, 45° WINGWALL &

GROOVED EDGE INLET (SOCKET END) $K_e = 0.2$

$K_o = 1.0$

UTAH FUEL C. 3/6
SKYLINE MINE Co.
SMY 11-17-88
p. 3

Adjustments to use nomographs

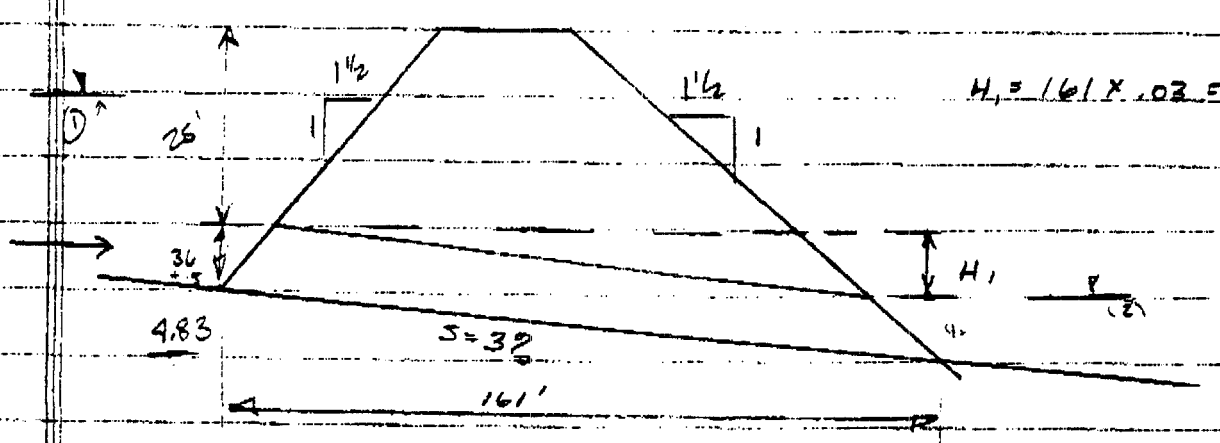
Dia. or Equiv. Dia.	Dimensions	Area ft^2	
60"	44" x 72"	17.6	
54"	40" x 65"	14.3	.82
66"	round	23.8	
72"	"	28.3	14.14
78"	"	33.2	16.59

FIND AREA
GIVEN PIPE:

$$A = \frac{\pi 3^2}{2} + \frac{1}{2} D(.5) = \frac{28.27}{2} + .25 = 14.89\ ft^2$$

(See Nomographs p. 5 & 6)

X-SECTION



$H_1 = 161 \times .03 = 4.83$

USING NOMOGRAPHS		a)	b)	c)	d)
1) CMPA	18% above 40" x 65"	83 cfs	130	175	210
2) CMP ½	30% above 72" ø	108	160	210	250

UTAH FUEL CO. 4/6
SKYLINE MINE
11-17-88 smyost
p. 4

Bernolli Equation

$$\frac{V_1^2}{2g} + y_1 + z_1 = \frac{V_2^2}{2g} + y_2 + z_2 + \sum h_L$$

$s \times L + H$

$$s \times L + H = \sum H_L$$

where H = Δ above pipe

$$(.03)(161) + H = \sum H_L$$

$$4.83 + H = \sum H_L$$

$\sum H_L$ = entrance loss + outlet loss + friction loss

$$= K_e \frac{V^2}{2g} + K_o \frac{V^2}{2g} + \frac{2.87\, n^2 l V^2}{d^{4/3}}$$

$K_e = 0.2$

$K_o = 1.0$

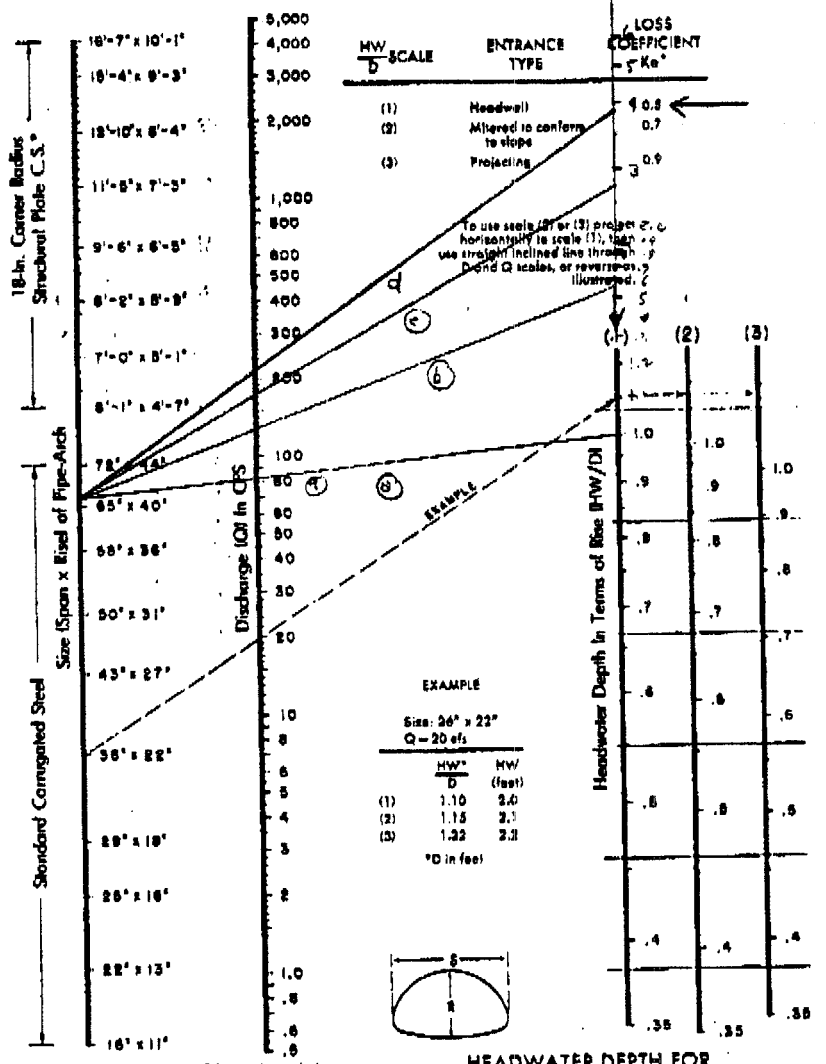
$n = .027$

$l = 161$

$$d = \sqrt{\frac{A \cdot 4}{\pi}} = \sqrt{\frac{14.89 \cdot 4}{\pi}} = 4.354' = 52.25''$$

$$\therefore \sum H_L = V^2(.0660) \rightarrow V = \sqrt{\frac{\sum H_L}{(.0660)}}$$

	H	$\sum H_L$	V	Q = A·V = 14.89 × V	Use
a)	0	4.83 ft	8.55 fps	127.35 cfs	125 ←
b)	2	6.83	10.17	151.44	150 ←
c)	6	10.83	12.81	190.70	190 ←
d.	10	14.83	14.99	223.15	225 ←



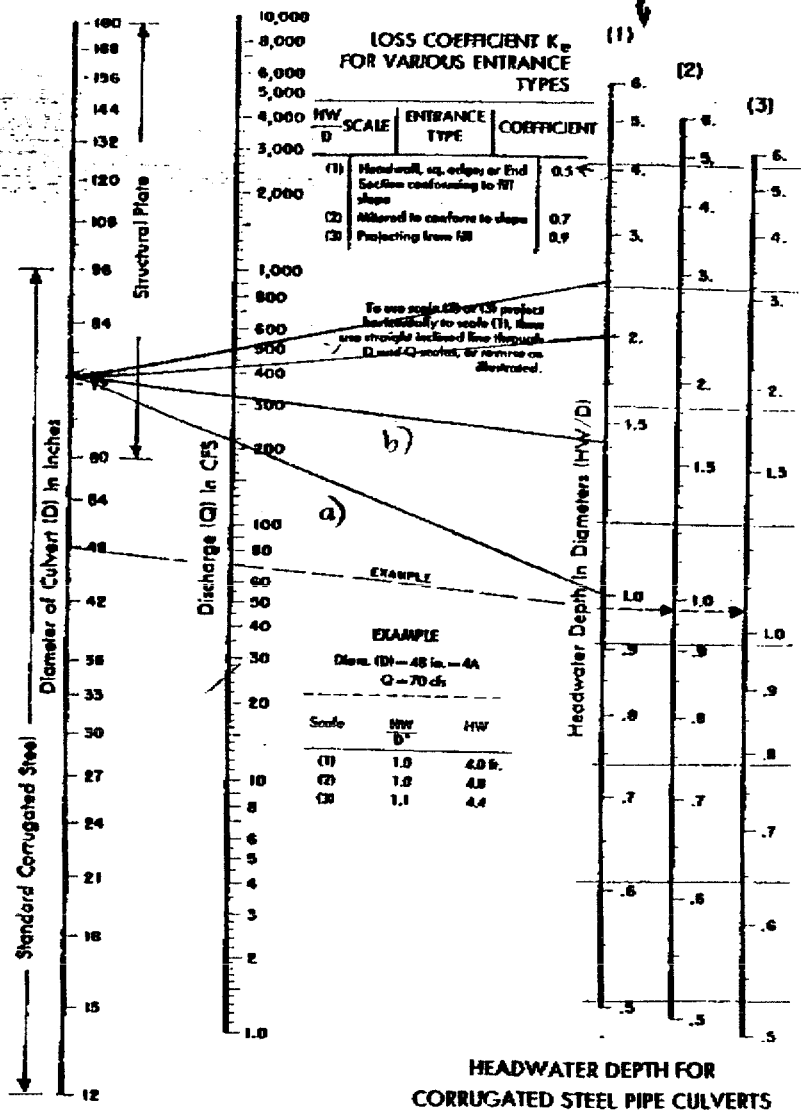
*Additional Sizes Not Dimensioned Are Listed In Fabricator's Catalog

Bureau of Public Roads Jan. 1963

HEADWATER DEPTH FOR CORRUGATED STEEL PIPE-ARCH CULVERTS WITH INLET CONTROL

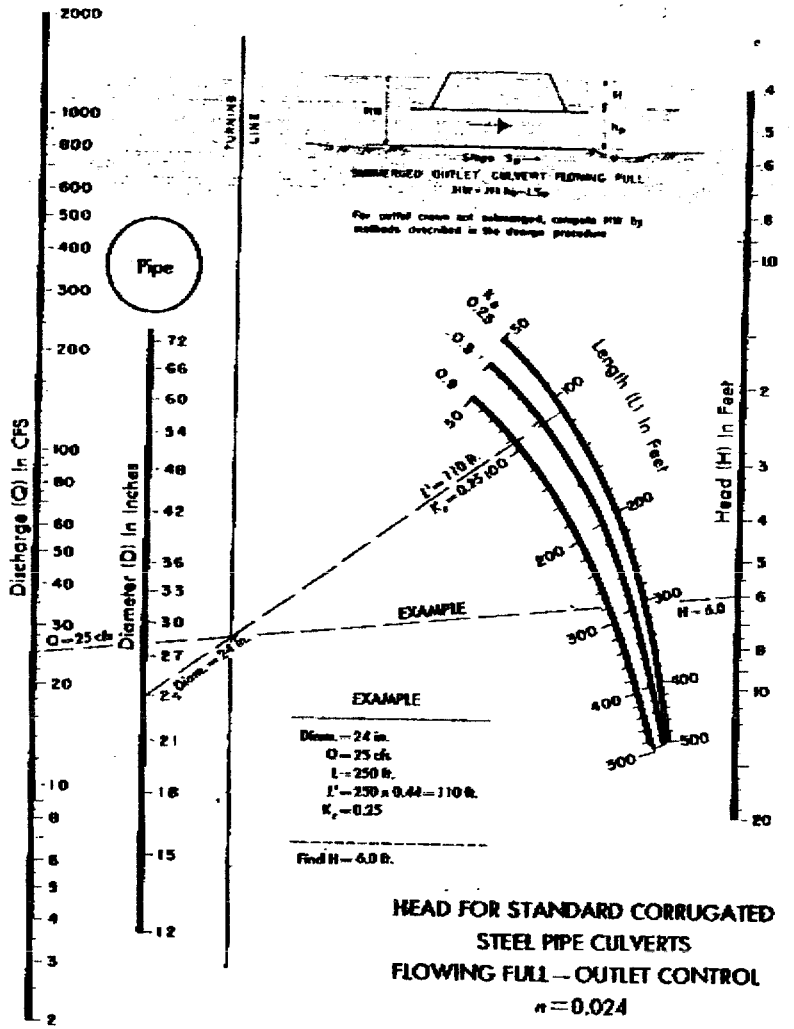
Fig. 4-20. *Inlet control* and headwater depths for corrugated steel *pipe-arch* culverts. Headwater depth should be kept low because pipe-arches are generally used where headroom is limited.

Reference: Handbook of Steel Drainage & Highway Construction Products. 1971.



HEADWATER DEPTH FOR CORRUGATED STEEL PIPE CULVERTS WITH INLET CONTROL

Fig. 15. Inlet Control Nomograph for corrugated steel pipe culverts.



HEAD FOR STANDARD CORRUGATED STEEL PIPE CULVERTS FLOWING FULL — OUTLET CONTROL

$n = 0.024$

Fig. 16. Outlet Control Nomograph for corrugated steel pipe culverts with submerged outlet and flowing full.

LENGTH ADJUSTMENT FOR IMPROVED HYDRAULICS

Pipe Diameter in Inches	Roughness Factor n' for Helical Corr.*	Length Adjustment Factor $\left(\frac{n'}{n}\right)^2$
12	.011	.21
24	.016	.44
36	.019	.61
48	.020	.70

*Other values of roughness, n, are applicable to paved pipe, lined pipe and pipe with 3 x 1 in. corrugations. See page 31. To use the above chart for these types of pipe and pipe-arches, use "adjusted length factors" computed per the equation, page 29.

60" 23.8
72" 28.3
78" 32.2

Sky line
5 mi
P.6
6/6

$S = 1000/CN - 10$

$= 1000/71 - 10$

$= 14.08 - 10$

$= 4.08$

AREA OF THE WATER SHED

$6,686 \times .0149\ IN^2 = 99.62\ IN^2 \times 22.96\ ACRES/IN^2 = 2,287.31\ ACRES$

$2,287.31\ ACRES \times 43,560\ D'/ACRE = 99,635,107.90$

TIME PARAMETERS

CONCENTRATION TIME

KIRPICH - EQ 2.58 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$t_c = .0078\ L^{.77}\ (L/H)^{.385}$

$L = 15,400$ FT
$H = 1,760$ FT

$t_c = .0078\ (15,400)^{.77}\ (15,400/1,760)^{.385}$

$= .0078\ (1,676.45)\ (2.31)$

$= 30.19$ MIN

$= .50$ HRS

LAG TIME

$t_L = L^{.8}\ (S+1)^{.7} / 1900\ Y^{1/2}$ EQ 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

$Y = \Sigma\ C_i\ i / AREA$

$i = 90$ FT

$A = 99,635,107.90$

Σc_i	CONTOUR
400	9920
800	9840
1100	9760
1700	9680
4500	9600
9300	9520
17200	9440
26250	9360
33350	9280
40250	9200
40250	9120
40250	9040
38250	8960
30000	8880
32250	8800
28000	8720
24700	8640
23500	8560
22,300	8480
17,700	8400
13,450	8320
8400	8240
4200	8160
458,100	

$y = 458{,}100 \times 90 / 99{,}635{,}107.90$

$= .37$ OR 37%

$t_1 = (15{,}400)^{.8} (4.08 \times 1)^{.7} / 1900 (37)^{.5}$

$= (2{,}238.01)(3.12) / 1{,}900 (6.08)$

$= 6{,}995.04 / 11{,}557.25$

$= .60$ HRS

$= 36.26$ MINS USE 36 MINS.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 13

LOADOUT AREA
SEDIMENTATION POND

TRAIN LOADOUT AREA
STAGE VOLUME

G. TAYLOR
6-20-89

SIZING POND

1. SEDIMENT VOLUME

0.1 AC.-FT. /AC FOR EACH ACRE OF DISTURBED AREA

VOL. = 0.1 AC-FT./AC × 12.56 ACRES (MAP 3.2.1-3)

= 1.26 AC-FT × 43,560 = 54,711.3

USE 54,710 CU. FT.

2. STORM DETENTION

CN = CN FOR PAD (AC. OF PAD) + CN FOR UNDISTURBED GROUND (AC. OF AREA) / TOTAL AC.

= 90(8.46) + 64(3.92)/12.56 = 80.60

= 81

10 YR - 24 HR STORM

P = 2.43 IN. SECTION 2 PAGE 5 OF 7, VOL. 5

S = 1000/CN - 10 EQ 2.39 PAGE 81 APPLIED HYD. AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

= 1000/81 - 10

= 2.35

Q = (P - .25)² / P + .8S EQ 2.38 PAGE 81

= (2.43 - .2(2.35))² / 2.43 + .8(2.35)

= .89 IN ÷ 12 IN/FT = .07 FT.

12.56 AC. × 43,560 SQ.FT./AC. × .07 FT. = 40,674

USE 40,670 CU.FT.

THEREFORE THE TOTAL STORAGE/DETENTION CAPACITY OF THE POND SHOULD NOT BE LESS THAN

V_T = 54,710 + 40,670 = 95,380 CU. FT.

3. POND CAPACITY (MAP 3.2.1-3)

ELEVATION	AREA (FT^2)	AVG. AREA (FT^2)	Δ VOL (FT^3)	ACC. VOL. (FT^3)
7914	2,600			
		6,000	12,000	12,000
7916	9,400			
		11,000	22,000	34,000
7918	12,600			
		13,440	22,980	56,980
7919.71	14,280			

POND TO SMALL

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

LOADOUT AREA DROP INLET
STAGE DISCHARGE CURVE

CN: 90 DISTURBED AREA

MAX FLOW LENGTH - 1962.94 FT.

CONCENTRATION TIME - .102 HRS

10 YR - 24 HR - 2.43 IN } SECTION 2 PAG 5 of 7

100 YR - 24 HR - 3.50 IN

PEAK FLOW

10 YR - 24 HR = 13.91 CFS } SCS UNIT HYDROGRAPH METHOD NSH-4, 1972

100 YR - 24 HR - 29.12 CFS

DATA - MAP 3.2.1-4A

SPILLWAY CREST ELEVATION	-	7919.71
JUNCTION OF RISER AND BARREL ELEV.	-	7915.79
SPILLWAY OUTLET ELEVATION	-	7911.60
MAX. AVAILABLE WATER ELEV.	-	7923
DIA. RISER	=	36 IN.
DIA. BARREL	=	18 IN.

WEIR FLOW

$Q = CLH^{3/2}$ C = 3 EQ 4.1

L = 9.42 PAGE 23D

APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

$Q = 28.27\ H^{3/2}$

ORIFICE FLOW

$Q = C'a\sqrt{2gH}$ C' = .60 EQ 4.2

a = 7.07 PAGE 23D

APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA, OKLAHOMA TECHNICAL PRESS

$Q = 34.04\sqrt{H}$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PIPE FLOW

$$Q = a(2gH')^{1/2} / (1 + K_e + K_b + K_c L)^{1/2}$$

EQ 4 4
PAGE 232
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS.

$$H' = H + 8.11 - .6(1.5)$$
$$= H + 7.21$$

$K_e = 1.0$
$K_b = 5$
$K_c = .0476$
$a = 1.77$
$L = 60$

$$Q = 1.77\,[2g\,(H + 7.21)]^{1/2} / (1 + 1.0 + .5 + .0476\,(60))^{1/2}$$

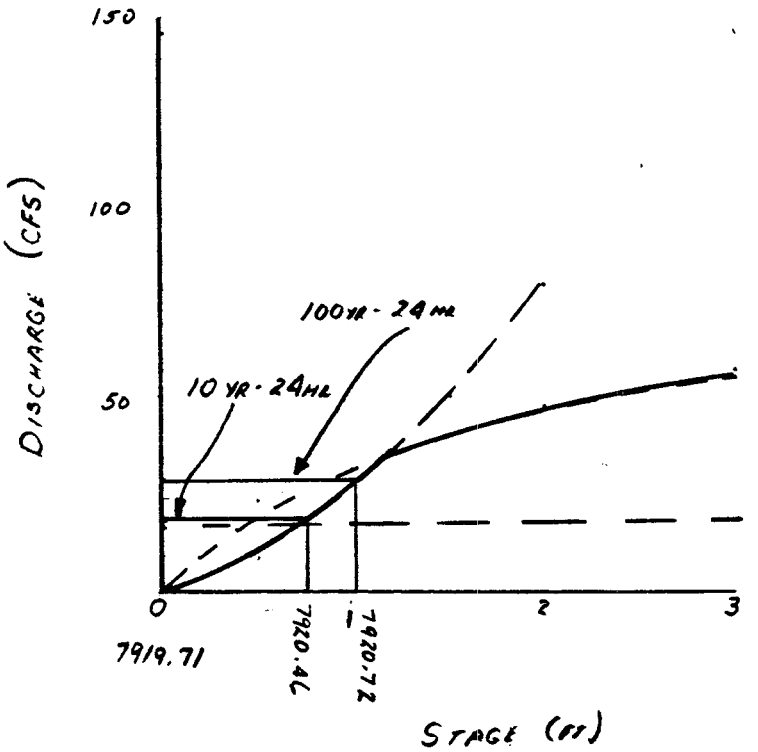
$$= 1.77\,(64.4\,(H + 7.21))^{1/2} / 2.31$$

$$Q = 6.15\,(H + 7.21)^{1/2}$$

H	Q WEIR	Q ORIFICE	Q PIPE
0	0	0	16.51
.5	9.99	24.07	17.08
1.0	28.27	32.04	17.62
1.5	51.94	41.69	18.15
2.0	79.96	48.14	18.66
2.5	111.75	53.82	19.16
3.0	146.90	58.96	19.65

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD



STAGE - DISCHARGE CURVE

SKYLINE MINE SEDIMENTATION POND
HYDRAULIC CALCULATIONS

UTAH FUEL COMPANY
Helper, Utah

Prepared by

EARTHFAX ENGINEERING, INC.
Salt Lake City, Utah

August 29, 1989

REGISTERED PROFESSIONAL ENGINEER
No. 8435
CAROL A.
BJORK
STATE OF UTAH

Carol A. Bjork
Aug. 29, 1989

SKYLINE MINE SEDIMENTATION POND HYDRAULIC CALCULATIONS

1.0 GENERAL

Upon the request of Utah Fuel Company, the existing sedimentation pond located at the load out facilities was evaluated to verify the present pond capacity. The minimum sediment storage volume and the runoff storage volume based on the 10-year, 24-hour storm event was calculated. In addition, the 25-year and 100-year, 24-hour storm events were routed through the sedimentation pond to determine the adequacy of the existing primary spillway.

The hydrology and hydraulic calculations were performed using the computer model SEDIMOT II. SEDIMOT II was developed by the University of Kentucky, Department of Agricultural Engineering, for the design of runoff and sediment control structures (Mayes, 1983).

2.0 POND CAPACITY

2.1 Runoff Volume. The runoff calculations for the existing watershed were performed by the SEDIMOT II model. The required input data

for the model are presented in Attachment A. The analysis was conducted for the 10-year, 24-hour storm event of 2.43 inches. The watershed information was provided by Mr. Gary Taylor of Utah Fuel Company. The size of the watershed is 12.56 acres, 8.3 of which is disturbed, and 4.26 of which is undisturbed (heavily vegetated forest). The computation of the runoff volume assumed an average curve number of 82 and a time of concentration of 0.102 hours.

The results of the SEDIMOT II calculations are presented in Attachment A. In summary, the total runoff volume entering the pond is 0.99 acre-foot, and the peak discharge is 12.9 cubic feet per second.

2.2 Sediment Storage. The annual sediment volumes entering the pond were calculated using a modified version of the universal soil loss equation (Israelson, 1984). The modified universal soil loss equation is:

$$A = R \times K \times LS \times VM$$

where,

A = computed amount of soil loss per unit area for the time interval represented by factor R (tons per acre per year).

R = rainfall factor. R values for Utah presented by Israelson (1984).

K = soil erodibility factor. K values for Utah presented by Israelson (1984). (tons per acre per year per unit of R).

LS = topographic factor based on length and steepness of slope. (dimensionless).

VM = erosion control factor based on vegetative, chemical, or mechanical measures. (dimensionless).

The calculations for the annual sediment yield from the disturbed and undisturbed areas are presented in Attachment A. The undisturbed drainage area contributes 0.003 acre-foot of sediment to the pond on an annual basis. The disturbed drainage area contributes 0.067 acre-foot of sediment to the pond yearly. Thus, the total annual sediment volume entering the pond is 0.07 acre-foot.

As required by the Utah Division of Oil, Gas & Mining (1987), UMC 817.46, the pond must contain a minimum sediment storage capacity equal to the 3-year sediment volume. Thus, the required sediment storage for the pond was determined to be 0.21 acre-foot from undisturbed and disturbed areas over a 3-year period.

Based on the elevation-capacity curve presented in Attachment A, the pond elevation which corresponds to the maximum sediment storage volume is 7915.6 feet. In addition, the 60% clean-out level is at 7915.2 feet.

2.3 Summary. In order to prevent the pond from spilling during the design storm event, a pond capacity of 1.20 acre-feet (0.99 acre-foot of runoff volume and 0.21 acre-foot of sediment storage) would be needed. Based on the elevation-capacity curve presented in Attachment A, the existing

permanent pool capacity of the sedimentation pond at the primary spillway elevation is 1.18 acre-foot. Thus, the existing pond will spill approximately 0.02 acre-foot of water during the design event with maximum sediment storage volume utilized. The primary spillway, if raised approximately 0.80 inches, would allow the pond to totally contain the design storm event.

The above discussion assumes that the pond would be empty of water down to the maximum sediment storage elevation prior to the occurrence of the design storm event. The existing sedimentation pond was constructed with a decant system which provides drainage down to the approximate maximum sediment storage elevation and, thus, the assumption is reasonable.

3.0 PRIMARY SPILLWAY

Based on the watershed information and sedimentation pond spillway data presented by Mr. Gary Taylor of Utah Fuel Company, and a sediment storage volume of 0.21 acre-foot, the 25-year and 100-year, 24-hour storm events were routed through the sediment pond using the computer model SEDIMOT II. The purpose was to determine the maximum stage and flow volume through the primary spillway. All stormflow discharging from the pond exits through the primary spillway since the pond was constructed without an emergency spillway outlet. The results of these analysis are contained in Attachment B.

The results provided by the SEDIMOT II model can be considered conservative since the program assumes that the sedimentation pond is full of water up to the primary spillway elevation prior to the storm event. This assumption was verified by Ms. Pamela Schwab of Civil Software Design, the current distributors of the SEDIMOT II software. Thus, based on SEDIMOT II calculations, outflow from the pond begins as soon as the storm runoff enters the pond.

Because the Skyline Mine sedimentation pond has the capability of releasing the stored water down to the maximum sediment storage level, it is reasonable to assume that this condition would exist prior to a storm event. Thus, the actual maximum stage during the design storm events would be less than that computed by SEDIMOT II.

From the analysis of the 25-year storm event, the maximum inflow rate is 17.3 cubic feet per second (cfs) and the maximum outflow rate is 9.4 cfs. The corresponding high water level is 7920.68, 0.97 foot above the primary spillway flowline.

From the analysis of the 100-year storm event, the maximum inflow rate is 24.2 cfs and the maximum outflow rate is 13.1 cfs. The corresponding water surface elevation is 7921.2 feet, 1.5 feet above the primary spillway flowline.

ATTACHMENT A

Pond Capacity Calculations

The elevation of the crest of the pond embankment is approximately 7922.0 feet. During the 100-year, 24-hour storm event, a freeboard of approximately 0.8 feet exists between the maximum stage elevation and the crest elevation.

4.0 REFERENCES

Barfield, B.J., R.C. Warner, and C.T. Haan. 1983. Applied Hydrology and Sedimentology for Disturbed Areas. Oklahoma Technical Press. Stillwater, Oklahoma.

Mayes, J.G. 1983. User's Guide to SEDIMOT II - PC Version. Oklahoma Technical Press. Stillwater, Oklahoma.

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation - Frequency Atlas of the Wester United States. Volume VI Utah. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. Silver Spring, Maryland.

U.S. Environmental Protection Agency. 1976. Erosion and Sediment Control. Surface Mining in the Eastern U.S. EPA-625/3-76-006.

Utah Division of Oil, Gas and Mining. 1987. Utah Coal Mining and Reclamation Regulatory Program. Rules Pertaining to Underground Coal Mining Activities. Chapter I. Utah Department of Natural Resources. Salt Lake City, Utah.

ATTACHMENT A

Pond Capacity Calculations

Runoff calculations
10-Year 24-hour storm event

Information provided by Gary Taylor of Utah Fuel Co:

Watershed Area = 12.56 Acres
CN = 82 (combined disturbed + undisturbed area)
Tc = 0.102 hrs
precip = 2.43 inches

SEDIMOT II results presented on next pages.

Summary: Peak discharge = 12.9 cfs
Runoff volume = 0.99 Ac-feet

```
*****************************************************************
                          -- SEDPC --
               SEDIMOT II MODEL FOR THE IBM PC/XT
               CONVERTED BY TECH ENGINEERING INC.
                  VERSION 1.10 NOVEMBER 17,1983
*****************************************************************
```

```
*****************************************************************
*****************************************************************

       UNIVERSITY OF KENTUCKY COMPUTER MODEL
       OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
       FOR MORE INFORMATION CONTACT THE AGRICULTURAL
       ENGINEERING DEPARTMENT

       THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
       THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
       MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

       VERSION DATE 9-23-83

       DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
       ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
       CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

*****************************************************************
*****************************************************************
```

```
*****************************************************************
*                                                               *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.     *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                      *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                   *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PEAK 24 HOUR PERIOD                            *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                            *
*                                                               *
*     ALL CONCENTRATIONS ARE IN ML/L.                           *
*                                                               *
*****************************************************************
```

****

WATERSHED IDENTIFICATION CODE

10-YR, 24-HOUR STORM HYDROLOGY

****

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPITATION DEPTH	=	2.43	INCHES

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

***** RESULTS FROM SUBWATERSHED 1 *****

*** HYDROGRAPH AND SEDIMENT GRAPH ***
(TWO CONSECUTIVE VALUES PER LINE)

TIME (HR)	DISCHARGE (CFS)	******* *	TIME (HR)	DISCHARGE (CFS)
.00	.000	*	.10	.000
.20	.000	*	.30	.000
.40	.000	*	.50	.000
.60	.000	*	.70	.000
.80	.000	*	.90	.000
1.00	.000	*	1.10	.000
1.20	.000	*	1.30	.000
1.40	.000	*	1.50	.000
1.60	.000	*	1.70	.000
1.80	.000	*	1.90	.000
2.00	.000	*	2.10	.000
2.20	.000	*	2.30	.000
2.40	.000	*	2.50	.000
2.60	.000	*	2.70	.000
2.80	.000	*	2.90	.000
3.00	.000	*	3.10	.000
3.20	.000	*	3.30	.000
3.40	.000	*	3.50	.000

3.60	.000	*	3.70	.000
3.80	.000	*	3.90	.000
4.00	.000	*	4.10	.000
4.20	.000	*	4.30	.000
4.40	.000	*	4.50	.000
4.60	.000	*	4.70	.000
4.80	.000	*	4.90	.000
5.00	.000	*	5.10	.000
5.20	.000	*	5.30	.000
5.40	.000	*	5.50	.000
5.60	.000	*	5.70	.000
5.80	.000	*	5.90	.000
6.00	.000	*	6.10	.000
6.20	.000	*	6.30	.000
6.40	.000	*	6.50	.000
6.60	.000	*	6.70	.000
6.80	.000	*	6.90	.000
7.00	.000	*	7.10	.000
7.20	.000	*	7.30	.000
7.40	.000	*	7.50	.000
7.60	.000	*	7.70	.000
7.80	.000	*	7.90	.000
8.00	.000	*	8.10	.000
8.20	.000	*	8.30	.000
8.40	.000	*	8.50	.000
8.60	.000	*	8.70	.000
8.80	.000	*	8.90	.000
9.00	.000	*	9.10	.000
9.20	.000	*	9.30	.000
9.40	.000	*	9.50	.000
9.60	.000	*	9.70	.000
9.80	.000	*	9.90	.000
10.00	.000	*	10.10	.000
10.20	.022	*	10.30	.036
10.40	.050	*	10.50	.064
10.60	.107	*	10.70	.131
10.80	.154	*	10.90	.177
11.00	.199	*	11.10	.352
11.20	.403	*	11.30	.453
11.40	.501	*	11.50	.549
11.60	5.844	*	11.70	8.148
11.80	10.026	*	11.90	11.577
12.00	12.869	*	12.10	2.568
12.20	2.606	*	12.30	2.642
12.40	2.678	*	12.50	2.712
12.60	1.407	*	12.70	1.416
12.80	1.425	*	12.90	1.433
13.00	1.441	*	13.10	1.057
13.20	1.061	*	13.30	1.066
13.40	1.070	*	13.50	1.074
13.60	.838	*	13.70	.841
13.80	.843	*	13.90	.846
14.00	.848	*	14.10	.607
14.20	.609	*	14.30	.610

14.40	.611	*	14.50	.612
14.60	.613	*	14.70	.615
14.80	.616	*	14.90	.617
15.00	.618	*	15.10	.619
15.20	.620	*	15.30	.622
15.40	.623	*	15.50	.624
15.60	.625	*	15.70	.626
15.80	.627	*	15.90	.628
16.00	.629	*	16.10	.378
16.20	.379	*	16.30	.379
16.40	.379	*	16.50	.380
16.60	.380	*	16.70	.380
16.80	.381	*	16.90	.381
17.00	.382	*	17.10	.382
17.20	.382	*	17.30	.383
17.40	.383	*	17.50	.384
17.60	.384	*	17.70	.384
17.80	.385	*	17.90	.385
18.00	.385	*	18.10	.386
18.20	.386	*	18.30	.387
18.40	.387	*	18.50	.387
18.60	.388	*	18.70	.388
18.80	.388	*	18.90	.389
19.00	.389	*	19.10	.389
19.20	.390	*	19.30	.390
19.40	.390	*	19.50	.391
19.60	.391	*	19.70	.392
19.80	.392	*	19.90	.392
20.00	.393	*	20.10	.262
20.20	.262	*	20.30	.262
20.40	.262	*	20.50	.263
20.60	.263	*	20.70	.263
20.80	.263	*	20.90	.263
21.00	.263	*	21.10	.263
21.20	.264	*	21.30	.264
21.40	.264	*	21.50	.264
21.60	.264	*	21.70	.264
21.80	.264	*	21.90	.265
22.00	.265	*	22.10	.265
22.20	.265	*	22.30	.265
22.40	.265	*	22.50	.266
22.60	.266	*	22.70	.266
22.80	.266	*	22.90	.266
23.00	.266	*	23.10	.266
23.20	.267	*	23.30	.267
23.40	.267	*	23.50	.267
23.60	.267	*	23.70	.267

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	12.56	82.00	.102	.000	.000	.00	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)
1	12.87	.95

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.9911	ACRE-FT
PEAK DISCHARGE	=	12.8694	CFS
AREA	=	12.5600	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS

* * * * * * * * * * * *
NULL STRUCTURE
* * * * * * * * * * * *

*** RUN COMPLETED ****

SEDIMENT VOLUME CALCULATIONS

Disturbed Area to Pond:

Calculated using a planimeter & topo map, Scale: 1" = 50'. Plate of Disturbed area boundary.

8.1 in²
41.1
44.8
35.8
14.9

144.7 in² = 361,750 ft²
= 8.3 acres

Undisturbed Area to Pond:

12.56 Ac − 8.3 = 4.26 Acres

Information provided by Gary Taylor @ Utah Fuel.

POND Stage-area curve =

(Stage)	Elev	map in²	ft²*	Acres	Volume (Ac-ft)	Cum Vol. (Ac-ft)
0	7914	7.13	2852	.065	.269	0
2	7916	22.20	8880	0.204	.454	.269
4	7918	27.25	10,900	0.250	.543	.723
6	7920	31.92	12,768	0.293	.617	1.266
8	7922	38.59	15,436	0.354		1.913
5.71	7919.71	(Spillway)		0.287		1.18 (from curve)

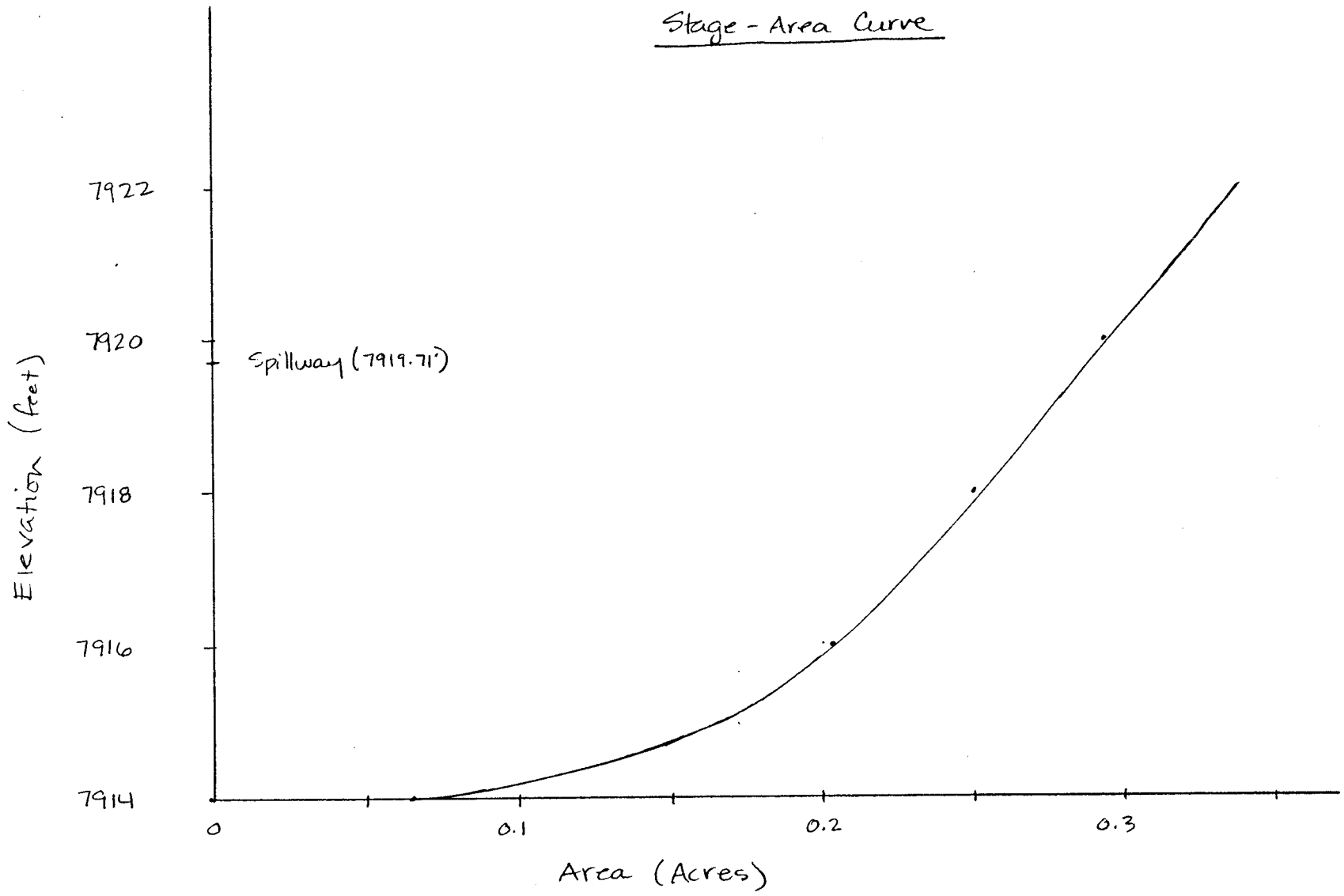
* note: map scale is 1" = 20'

PROJECT C117-02 PAGE 8 OF 13
COMPUTED CAB DATE 4/26/89
CHECKED DATE

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

Skyline Mine
Sedimentation Pond

Stage - Area Curve

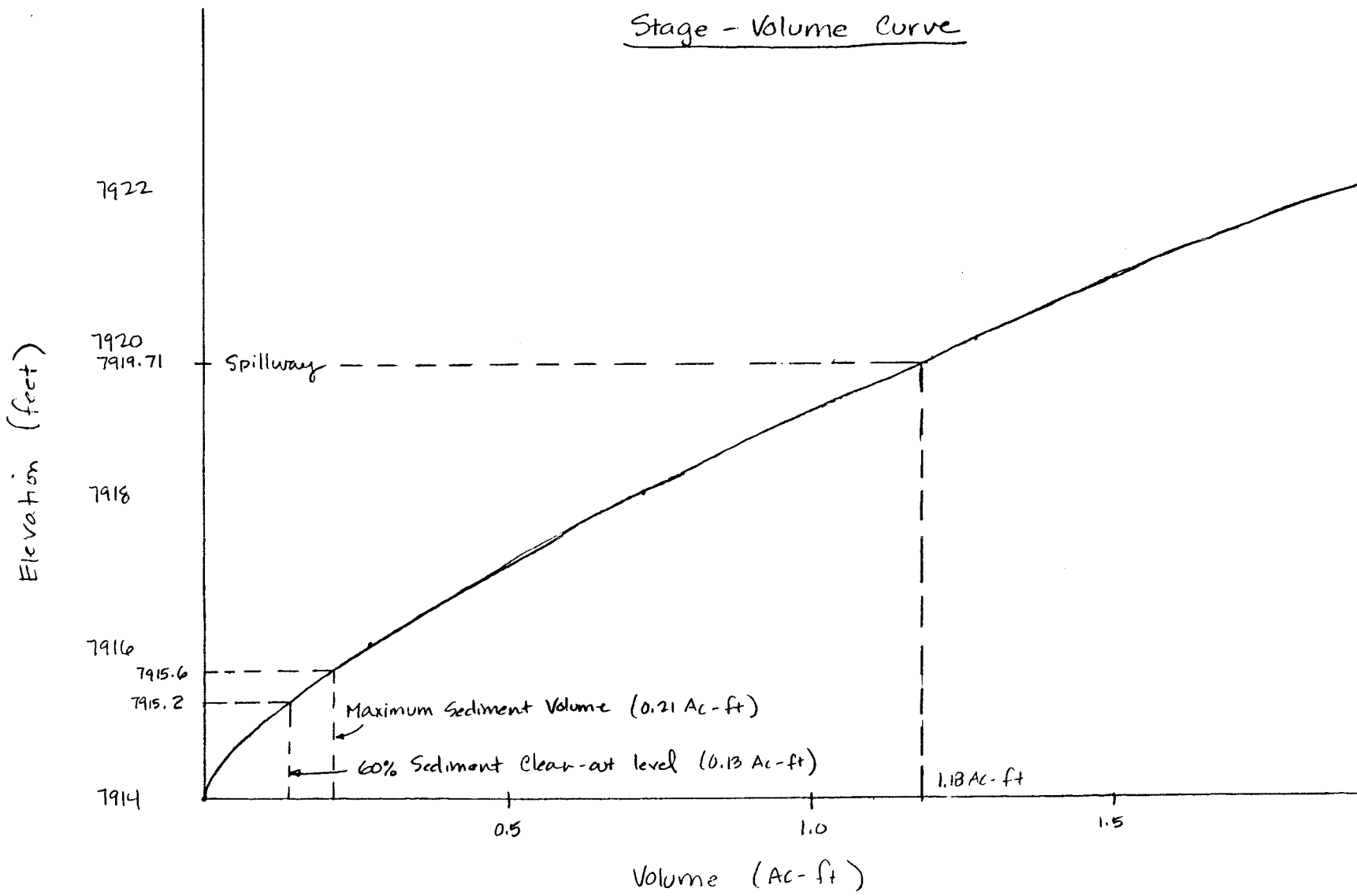


PROJECT C117-02 PAGE 9 OF 13
COMPUTED CAB DATE 8/26/89
CHECKED DATE

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

Skyline Mine
Sedimentation Pond

Stage - Volume Curve



Sediment Storage Volume

Disturbed Area

Refer to Topo Map of Disturbed Area For Area Boundaries. Scale: 1" = 50'

Area 1 = 7.46 Acres (from topo map. Area calculated using planimeter)

$$\text{Ave. Slope} = \frac{8005 - 7920}{1500'} = .057$$

Use U.S.L.E.

$A = R \cdot K \cdot LS \cdot VM$ (Ref: Israelson, C.E., J.E. Fletcher, F.W. Haws, E.K. Israelson. 1984. Erosion + Sedimentation in Utah. Utah Water Research Laboratory. Logan, Utah.)

R = 17 (Israelson, 1984)

K = Soil erodibility Index
= 0.20 (from Map provided by Israelson, et al)

$$LS = \left(\frac{650 + 4150s + 65s^2}{10{,}000 + s^2}\right)\left(\frac{l}{72.6}\right)^m$$

(Ref: Clyde, et al, 1978. Manual of Erosion Control Principles + Practices. Utah Water Research Lab. - Logan)

s = 5.7% (from topo)
l = 1500' (approx. length of disturbed area - from topo)
m = 0.5 (Clyde, et al 1978 - based on slope)

LS = 2.41

VM - Control factor. Assume disturbed area is compacted soil + scraped. A worst-case condition

VM = 1.20

$$A = (17)(.20)(2.41)(1.20) = 9.83 \text{ tons/AC/year}$$

= 73.3 tons/year

= 1630 ft^3/year (for a unit weight of 90 lbs/ft^3)

Area 2 = 0.52 Acres (Area computed from Topo map using planimeter)

Slope length = 50'
Slope = 1:1

K = 0.20
R = 17

LS = 29.87 (Israelson, et al, 1984)

VM = 0.90 (Israelson, et al, 1984) Assume a rough and irregular tracked surface to approximate existing rocky conditions.

A = (.20)(17)(29.87)(0.90) = 91.4 tons/Ac = 47.5 tons
= 1056 ft3 (assuming 90lb/ft3)
= .024 Ac-ft.

Area 3 = 0.32 Acres (Area calculated from Topo map using a planimeter)

Slope length = 60'
Slope = $\frac{10}{22}$ = 45%

K = 0.2
R = 17

LS = 11.77 (Israelson, et al, 1984)

VM = 0.90 (Israelson, et al, 1984) Assume a rough and irregular tracked surface to approximate existing rocky conditions.

A = (.20)(17)(11.77)(0.90) = 36 tons/Ac = 11.5 tons
= 256 ft3 (assuming 90lb/ft3)
= .006 Ac-ft

Undisturbed Area Contributing to pond:

Total Land Area contributing to pond = 12.56 Acres
(Gary Taylor, Utah fuel)

Undisturbed Area to pond = 12.56 − 8.30 = 4.26 Acres

Undisturbed Area is heavily wooded + vegetated with conifers + brush

Slope length ≈ 450 ft
Slope ~ 50%

K = 0.20
R = 17

LS = 37.81 (Israelson, 1984)

VM = .01 (Israelson, 1984) Assume permanent seedings.

A = (.20)(17)(37.81)(.01) = 1.29 tons/Ac = 5.5 tons
= 122 ft3 (assuming 90 lb/ft3)
= .003 Ac-ft

Total Sediment to pond:

Disurbed Area:

Area 1	.037 Ac-ft/yr
Area 2	.024 Ac-ft/yr
Area 3	.006 Ac-ft/yr
Undisturbed Area	.003 Ac-ft/yr
	.070 Ac-ft/year

For 3-year period, total sediment to pond = 0.21 Ac-ft.

Contributions to pond:

Runoff volume = 0.99 Ac-ft
3-yr Sediment Storage = 0.21 Ac-ft

Total: 1.20 Ac-ft

Permanent pool capacity to primary spillway elevation = 1.18 Ac-feet. (refer to Stage-capacity curve).

The sedimentation pond nearly contains the design storm event and 3-year sediment volume without spilling. The spillway would need to be raised $\frac{.02 \text{ ac-ft}}{.3 \text{ Ac}}$ = .067 ft = 0.80 inches to provide total containment based on these calculations.

ATTACHMENT B

Primary Spillway Calculations

25-year and 100-year, 24 hour storm events.

Precipitation: 25-year, 24 hour = 2.9 inches
(Miller, 1973) 100-year, 24 hour = 3.6 inches

Pond information provided by Gary Taylor of Utah Fuel Co.:

Pond Length = 164 ft.
Riser diameter = 36" Rolled Plate
Barrel diameter = 18" Steel Pipe
Barrel Length = 60 ft.
Head draw elevation difference = 8.11 feet to top of pipe = 8.11 + 0.4(1.5') = 8.71' to a point 0.6 times the diameter above the pipe invert (Barfield, 1983)

Calculate Dead Space: Ref: EPA. 1976. Erosion and Sediment control. Surface Mining in the Eastern U.S. EPA 625/3-76-006

Effective pond width = $\frac{\text{Area}}{\text{Length}} = \frac{12{,}500 ft^2}{164 ft} = 76.2$ ft

$\frac{\text{Length}}{\text{eff. width}} = \frac{164}{76.2} = 2.1$ Efficient System

Assume dead space = 20% for an Efficient System (Sedimot II Users Manual).

Revised Stage - Area curve which accounts for sediment storage of 0.21 Acre-feet.

Stage	Elev	Area
0	7915.6	.176
0.4	7916.0	.204
2.4	7918.0	.250
4.11	7919.71	.287
4.4	7920.0	.293
6.4	7922.0	.354

Sedimot II output on following pages:

Summary of results:

25-year Storm:
runoff volume = 1.36 Ac-ft
peak inflow = 17.3 cfs
peak outflow = 9.4 cfs
Max stage = 5.08' = elev. 7920.68'

100-year Storm:
runoff volume = 1.95 Ac-ft
peak inflow = 24.2 cfs
peak outflow = 13.1 cfs
Max stage = 5.6' = 7921.2' elev.

```
*****************************************************************
                        -- SEDPC --
              SEDIMOT II MODEL FOR THE IBM PC/XT
              CONVERTED BY TECH ENGINEERING INC.
                 VERSION 1.10 NOVEMBER 17,1983
*****************************************************************


*****************************************************************
*****************************************************************

       UNIVERSITY OF KENTUCKY COMPUTER MODEL
       OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
       FOR MORE INFORMATION CONTACT THE AGRICULTURAL
       ENGINEERING DEPARTMENT

       THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
       THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
       MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

       VERSION DATE 9-23-83

       DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
       ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
       CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

*****************************************************************
*****************************************************************


*****************************************************************
*                                                               *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.     *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                      *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                   *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PEAK 24 HOUR PERIOD                            *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                            *
*                                                               *
*     ALL CONCENTRATIONS ARE IN ML/L.                           *
*                                                               *
*****************************************************************
```

****

WATERSHED IDENTIFICATION CODE

25-YR, 24-HR STORM EVENT

****

INPUT PARTICLE SIZE-PERCENT FINER DISTRIBUTIONS

SIZE,MM	.250	.100	.050	.010	.005	.001
	.000					
PCT FINER NO. 1	100.000	50.000	35.000	19.000	15.000	6.000
	.000					

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPATION DEPTH	=	2.90	INCHES
SPECIFIC GRAVITY	=	2.50	
LOAD RATE EXPONENT FACTOR	=	1.50	
SUBMERGED BULK SPECIFIC GRAVITY	=	1.25	

* *

JUNCTION 1, BRANCH 1, STRUCTURE 1

* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	12.56	82.00	.102	.000	.000	.00	.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.00	.0	.00	.000	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	17.34	1.30	.00	.100	1.000	1.000

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	1.3614	ACRE-FT
PEAK DISCHARGE	=	17.3377	CFS
AREA	=	12.5600	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
BETA	=	1.0000	
RAINFALL EROSITIVITY FACTOR	=	48.89	EI UNIT
PEAK CONCENTRATION	=	.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	.00	ML/L
PEAK SETTLEABLE CONCENTRATION	=	.00	MG/L
TOTAL SEDIMENT YIELD	=	.0000	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0001	MM
TIME OF PEAK CONCENTRATION	=	.00	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-24.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

* *

POND RESULTS

* *

***** CONTROL VARIABLES OPTIONS *****

FLOW	FRACTN	ISDO	NRHP	NSP	NCSTR
3	0	2	300	6	2

***** DROP SPILLWAY INPUTS *****

ENTRANCE LOSS COEFFICIENT	=	1.0000	
BEND LOSS COEFFICIENT	=	.5000	
WEIR COEFFICIENT	=	3.1000	
ORIFICE COEFFICIENT	=	.6000	
MANNING COEFFICIENT	=	.0240	
BARREL DIAMATER	=	18.00	INCHES
RISER DIAMETER	=	36.00	INCHES
LENGTH OF PIPE	=	60.00	FEET
VERTICAL HEAD DROP	=	8.71	FEET

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.176	.00	.00	.00
.40	.204	.39	.00	.08
2.40	.250	2.26	.00	.53
4.11	.287	3.81	.00	.99
4.40	.293	4.07	4.56	1.07
6.40	.354	5.75	18.85	1.72

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.989	ACRE-FT
DEAD STORAGE	=	20.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	1.361	ACRE-FT
OUTFLOW ROUTED VOLUME	=	1.361	ACRE-FT
STORM VOLUME DISCHARGED (PLUG FLOW)	=	1.361	ACRE-FT
POND VOLUME AT PEAK STAGE	=	1.294	ACRE-FT
PEAK STAGE	=	5.081	FT
PEAK INFLOW RATE	=	17.338	CFS
PEAK DISCHARGE RATE	=	9.426	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.00	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	.00	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
BASIN TRAP EFFICIENCY	=**********		PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	.28	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	.28	HRS
DETENTION TIME INCLUDING STORED FLOW	=	.28	HRS
SEDIMENT LOAD DISCHARGED	=	.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-25.40	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

8/12

```
*****************************************************************
                        -- SEDPC --
              SEDIMOT II MODEL FOR THE IBM PC/XT
              CONVERTED BY TECH ENGINEERING INC.
                 VERSION 1.10 NOVEMBER 17,1983
*****************************************************************


*****************************************************************
*****************************************************************

       UNIVERSITY OF KENTUCKY COMPUTER MODEL
       OF SURFACE MINE HYDROLOGY AND SEDIMENTOLOGY
       FOR MORE INFORMATION CONTACT THE AGRICULTURAL
       ENGINEERING DEPARTMENT

       THE UK MODEL IS A DESIGN MODEL DEVELOPED TO PREDICT
       THE HYDRAULIC AND SEDIMENT RESPONSE FROM SURFACE
       MINED LANDS FOR A SPECIFIED RAINFALL EVENT (SINGLE STORM)

       VERSION DATE 9-23-83

       DISCLAIMER: NEITHER THE UNIVERSITY NOR ANY OF ITS EMPLOYEES
       ACCEPT ANY RESPONSIBILITY OR LEGAL LIABILITY FOR THE
       CONCLUSIONS DRAWN FROM THE RESULTS OF THIS MODEL

*****************************************************************
*****************************************************************


*****************************************************************
*                                                               *
*     THE FOLLOWING VALUES ARE NOW PREDICTED BY SEDIMOT II.     *
*     THEY CAN BE FOUND IN SUMMARY TABLES.                      *
*      1. PERIOD OF SIGNIFICANT CONCENTRATION                   *
*      2. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      3. VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION      *
*         DURING PEAK 24 HOUR PERIOD                            *
*      4. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PERIOD OF SIGNIFICANT CONCENTRATION            *
*      5. ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION           *
*         DURING PEAK 24 HOUR PERIOD                            *
*                                                               *
*     ALL CONCENTRATIONS ARE IN ML/L.                           *
*                                                               *
*****************************************************************
```

****

WATERSHED IDENTIFICATION CODE

100-YR, 24-HR STORM EVENT

****

INPUT PARTICLE SIZE-PERCENT FINER DISTRIBUTIONS

SIZE,MM	.250	.100	.050	.010	.005	.001
	.000					
PCT FINER NO. 1	100.000	50.000	35.000	19.000	15.000	6.000
	.000					

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPATION DEPTH	=	3.60	INCHES
SPECIFIC GRAVITY	=	2.50	
LOAD RATE EXPONENT FACTOR	=	1.50	
SUBMERGED BULK SPECIFIC GRAVITY	=	1.25	

* *
JUNCTION 1, BRANCH 1, STRUCTURE 1
* *

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	12.56	82.00	.102	.000	.000	.00	.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART OPT	SURF COND
1	1	.00	.0	.00	.000	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	24.23	1.87	.00	.100	1.000	1.000

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	1.9526	ACRE-FT
PEAK DISCHARGE	=	24.2297	CFS
AREA	=	12.5600	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
BETA	=	1.0000	
RAINFALL EROSITIVITY FACTOR	=	78.30	EI UNIT
PEAK CONCENTRATION	=	.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	.00	ML/L
PEAK SETTLEABLE CONCENTRATION	=	.00	MG/L
TOTAL SEDIMENT YIELD	=	.0000	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0001	MM
TIME OF PEAK CONCENTRATION	=	.00	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-24.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

* *

POND RESULTS

* *

***** CONTROL VARIABLES OPTIONS *****

FLOW	FRACTN	ISDO	NRHP	NSP	NCSTR
3	0	2	300	6	2

***** DROP SPILLWAY INPUTS *****

ENTRANCE LOSS COEFFICIENT	-	1.0000	
BEND LOSS COEFFICIENT	-	.5000	
WEIR COEFFICIENT	-	3.1000	
ORIFICE COEFFICIENT	-	.6000	
MANNING COEFFICIENT	-	.0240	
BARREL DIAMATER	-	18.00	INCHES
RISER DIAMETER	-	36.00	INCHES
LENGTH OF PIPE	-	60.00	FEET
VERTICAL HEAD DROP	-	8.71	FEET

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.176	.00	.00	.00
.40	.204	.39	.00	.08
2.40	.250	2.26	.00	.53
4.11	.287	3.81	.00	.99
4.40	.293	4.07	4.56	1.07
6.40	.354	5.75	18.85	1.72

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	.989	ACRE-FT
DEAD STORAGE	=	20.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	1.953	ACRE-FT
OUTFLOW ROUTED VOLUME	=	1.953	ACRE-FT
STORM VOLUME DISCHARGED (PLUG FLOW)	=	1.953	ACRE-FT
POND VOLUME AT PEAK STAGE	=	1.461	ACRE-FT
PEAK STAGE	=	5.600	FT
PEAK INFLOW RATE	=	24.230	CFS
PEAK DISCHARGE RATE	=	13.134	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.00	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	.00	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
BASIN TRAP EFFICIENCY	=**********		PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	.31	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	.31	HRS
DETENTION TIME INCLUDING STORED FLOW	=	.31	HRS
SEDIMENT LOAD DISCHARGED	=	.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-25.50	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

*** RUN COMPLETED ****

6/19

EarthFax

EarthFax
Engineering Inc.
Engineers/Scientists
7324 South 1300 East
Suite 100
Midvale, Utah 84047
Telephone 801 561-1555

May 9, 1989

Gary Taylor
Utah Fuel Company
P.O. Box 719
Helper, Utah 84526

Subject: Sedimentation pond hydraulic calculations

Dear Mr. Taylor:

Attached are the results of our SEDIMOT II model run of the Skyline sedimentation pond. We used the input values provided by yourself on May 3, 1989.

The results (summarized on the last page of the output) indicate the following:

- Peak inflow rate = 12.9 cfs
- Peak outflow rate = 8.1 cfs
- Peak stage = 6.25 ft (i.e., 0.54 ft above the principal spillway)
- Detention time = 0.26 hr

USED CN: 82

Please let me know if you need assistance in interpreting the data or additional support.

Sincerely,

Richard B. White

Richard B. White, P.E.
Principal Hydrologist

Attachment

REGISTERED PROFESSIONAL ENGINEER
No. 7102
RICHARD B. WHITE
STATE OF UTAH

INPUT PARTICLE SIZE-PERCENT FINER DISTRIBUTIONS

SIZE,MM	.250	.100	.050	.010	.005	.001	.000
PCT FINER NO. 1	100.000	50.000	35.000	19.000	15.000	6.000	.000

**********INPUT VALUES**********

STORM DURATION	=	24.00	HOURS
PRECIPATION DEPTH	=	2.43	INCHES
SPECIFIC GRAVITY	=	2.50	
LOAD RATE EXPONENT FACTOR	=	1.50	
SUBMERGED BULK SPECIFIC GRAVITY	=	1.25	

* *

JUNCTION 1, BRANCH 1, STRUCTURE 1

* *

***** RESULTS FROM SUBWATERSHED 1 *****

*** PARTICLE SIZE DISTRIBUTION OF SEDIMENT ***

SIZE,MM	.2500	.1000	.0500	.0100	.0050	.0010
PERCENT FINER	100.0000	50.0000	35.0000	19.0000	15.0000	6.0000
SIZE,MM	.0001					
PERCENT FINER	.0000					

*** HYDROGRAPH AND SEDIMENT GRAPH ***

(TWO CONSECUTIVE VALUES PER LINE)

TIME (HR)	DISCHARGE (CFS)	SED DISC (MG/L)	******* *	TIME (HR)	DISCHARGE (CFS)	SED DISC (MG/L)
.00	.000	.000	*	.10	.000	.000
.20	.000	.000	*	.30	.000	.000
.40	.000	.000	*	.50	.000	.000
.60	.000	.000	*	.70	.000	.000
.80	.000	.000	*	.90	.000	.000
1.00	.000	.000	*	1.10	.000	.000
.20	.000	.000	*	1.30	.000	.000
.40	.000	.000	*	1.50	.000	.000
60	.000	.000	*	1.70	.000	.000
.80	.000	.000	*	1.90	.000	.000
2.00	.000	.000	*	2.10	.000	.000
2.20	.000	.000	*	2.30	.000	.000
2.40	.000	.000	*	2.50	.000	.000
2.60	.000	.000	*	2.70	.000	.000
2.80	.000	.000	*	2.90	.000	.000
3.00	.000	.000	*	3.10	.000	.000
3.20	.000	.000	*	3.30	.000	.000
3.40	.000	.000	*	3.50	.000	.000
3.60	.000	.000	*	3.70	.000	.000
3.80	.000	.000	*	3.90	.000	.000
4.00	.000	.000	*	4.10	.000	.000
4.20	.000	.000	*	4.30	.000	.000
4.40	.000	.000	*	4.50	.000	.000
4.60	.000	.000	*	4.70	.000	.000
4.80	.000	.000	*	4.90	.000	.000
5.00	.000	.000	*	5.10	.000	.000
5.20	.000	.000	*	5.30	.000	.000
5.40	.000	.000	*	5.50	.000	.000
5.60	.000	.000	*	5.70	.000	.000
5.80	.000	.000	*	5.90	.000	.000
6.00	.000	.000	*	6.10	.000	.000
.20	.000	.000	*	6.30	.000	.000
.40	.000	.000	*	6.50	.000	.000
60	.000	.000	*	6.70	.000	.000
80	.000	.000	*	6.90	.000	.000
7.00	.000	.000	*	7.10	.000	.000
7.20	.000	.000	*	7.30	.000	.000
7.40	.000	.000	*	7.50	.000	.000
7.60	.000	.000	*	7.70	.000	.000

[illegible]	[illegible]	[illegible]	*	8.70	.000	.000
9.00	.000	.000	*	9.10	.000	.000
9.20	.000	.000	*	9.30	.000	.000
9.40	.000	.000	*	9.50	.000	.000
9.60	.000	.000	*	9.70	.000	.000
9.80	.000	.000	*	9.90	.000	.000
10.00	.000	.000	*	10.10	.000	.000
10.20	.022	.000	*	10.30	.036	.000
10.40	.050	.000	*	10.50	.064	.000
10.60	.107	.000	*	10.70	.131	.000
10.80	.154	.000	*	10.90	.177	.000
11.00	.199	.000	*	11.10	.352	.000
11.20	.403	.000	*	11.30	.453	.000
11.40	.501	.000	*	11.50	.549	.000
11.60	5.844	.000	*	11.70	8.148	.000
11.80	10.026	.000	*	11.90	11.577	.000
12.00	12.869	.000	*	12.10	2.568	.000
12.20	2.606	.000	*	12.30	2.642	.000
12.40	2.678	.000	*	12.50	2.712	.000
12.60	1.407	.000	*	12.70	1.416	.000
12.80	1.425	.000	*	12.90	1.433	.000
13.00	1.441	.000	*	13.10	1.057	.000
13.20	1.061	.000	*	13.30	1.066	.000
13.40	1.070	.000	*	13.50	1.074	.000
13.60	.838	.000	*	13.70	.841	.000
13.80	.843	.000	*	13.90	.846	.000
14.00	.848	.000	*	14.10	.607	.000
14.20	.609	.000	*	14.30	.610	.000
14.40	.611	.000	*	14.50	.612	.000
14.60	.613	.000	*	14.70	.615	.000
14.80	.616	.000	*	14.90	.617	.000
15.00	.618	.000	*	15.10	.619	.000
15.20	.620	.000	*	15.30	.622	.000
15.40	.623	.000	*	15.50	.624	.000
15.60	.625	.000	*	15.70	.626	.000
15.80	.627	.000	*	15.90	.628	.000
16.00	.629	.000	*	16.10	.378	.000
16.20	.379	.000	*	16.30	.379	.000
16.40	.379	.000	*	16.50	.380	.000
16.60	.380	.000	*	16.70	.380	.000
16.80	.381	.000	*	16.90	.381	.000
17.00	.382	.000	*	17.10	.382	.000
17.20	.382	.000	*	17.30	.383	.000
17.40	.383	.000	*	17.50	.384	.000
17.60	.384	.000	*	17.70	.384	.000
17.80	.385	.000	*	17.90	.385	.000
18.00	.385	.000	*	18.10	.386	.000
18.20	.386	.000	*	18.30	.387	.000
18.40	.387	.000	*	18.50	.387	.000
18.60	.388	.000	*	18.70	.388	.000
18.80	.388	.000	*	18.90	.389	.000
19.00	.389	.000	*	19.10	.389	.000
19.20	.390	.000	*	19.30	.390	.000
19.40	.390	.000	*	19.50	.391	.000
19.60	.391	.000	*	19.70	.392	.000
19.80	.392	.000	*	19.90	.392	.000
20.00	.393	.000	*	20.10	.262	.000
20.20	.262	.000	*	20.30	.262	.000
20.40	.262	.000	*	20.50	.263	.000
20.60	.263	.000	*	20.70	.263	.000
20.80	.263	.000	*	20.90	.263	.000

22.20	.265	.000	*	22.30	.265	.000
22.40	.265	.000	*	22.50	.266	.000
[illegible].60	.266	.000	*	22.70	.266	.000
[illegible].80	.266	.000	*	22.90	.266	.000
[illegible].00	.266	.000	*	23.10	.266	.000
23.20	.267	.000	*	23.30	.267	.000
23.40	.267	.000	*	23.50	.267	.000
23.60	.267	.000	*	23.70	.267	.000

*** HYDRAULIC INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	AREA ACRES	CURVE NUMBER	TC HR	TT HR	ROUTING COEFFICIENTS K-HRS	X	UNIT HYDRO
1	12.56	82.00	.102	.000	.000	.00	.0

*** SEDIMENT INPUT VALUES FOR SUBWATERSHEDS ***

WATER SHED	SEG NUM	SOIL K	LENGTH FEET	SLOPE PCT	CP VALUE	PART DPT	SURF COND
1	1	.00	.0	.00	.000	1.0	.0

* * * COMPUTED VALUES FOR INDIVIDUAL WATERSHEDS * * *

WATERSHED	PEAK FLOW (CFS)	RUNOFF (INCHES)	SEDIMENT TONS	DIAM (MM)	DELIVERY RATIO 1	DELIVERY RATIO 2
1	12.87	.95	.00	.100	1.000	1.000

NOTE: SEDIMENT DOES NOT INCLUDE POSSIBLE DEPOSITION BY DELIVERY RATIO 2

***** SUMMARY TABLE FOR TOTAL WATERSHED *****

RUNOFF VOLUME	=	.9911	ACRE-FT
PEAK DISCHARGE	=	12.8694	CFS
AREA	=	12.5600	ACRES
TIME OF PEAK DISCHARGE	=	12.00	HRS
BETA	=	1.0000	
RAINFALL EROSITIVITY FACTOR	=	33.27	EI UNIT
PEAK CONCENTRATION	=	.00	MG/L
PEAK SETTLEABLE CONCENTRATION	=	.00	ML/L
PEAK SETTLEABLE CONCENTRATION	=	.00	MG/L
TOTAL SEDIMENT YIELD	=	.0000	TONS
REPRESENTATIVE PARTICLE SIZE	=	.0001	MM
TIME OF PEAK CONCENTRATION	=	.00	HRS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-24.00	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

* *

POND RESULTS

* *

***** CONTROL VARIABLES OPTIONS *****

FLOW	FRACTN	ISDO	NRHP	NSP	NCSTR
3	0	2	300	7	2

***** DROP SPILLWAY INPUTS *****

ENTRANCE LOSS COEFFICIENT = [illegible]

RISER DIAMETER	=	36.00	INCHES
LENGTH OF PIPE	=	60.00	FEET
VERTICAL HEAD DROP	=	8.71	FEET

***** BASIN GEOMETRY *****

STAGE (FT)	AREA (ACRES)	AVERAGE DEPTH (FT)	DISCHARGE (CFS)	CAPACITY (ACRES-FT)
.00	.060	.00	.00	.00
2.00	.216	1.43	.00	.28
4.00	.289	3.12	.00	.78
5.70	.326	4.57	.00	1.30
6.00	.345	4.82	4.80	1.40
7.00	.365	5.64	17.98	1.76
8.00	.398	6.45	18.86	2.14

***** STORM EVENT SUMMARY *****

TURBULENCE FACTOR	=	1.00	
PERMANENT POOL CAPACITY	=	1.304	ACRE-FT
DEAD STORAGE	=	20.00	PERCENT
TIME INCREMENT OUTFLOW	=	.10	HRS
VISCOSITY	=	.009	CM**2/SEC
INFLOW RUNOFF VOLUME	=	.991	ACRE-FT
OUTFLOW ROUTED VOLUME	=	.991	ACRE-FT
STORM VOLUME DISCHARGED (PLUG FLOW)	=	.991	ACRE-FT
POND VOLUME AT PEAK STAGE	=	1.493	ACRE-FT
PEAK STAGE	=	6.250	FT
PEAK INFLOW RATE	=	12.869	CFS
PEAK DISCHARGE RATE	=	8.089	CFS
PEAK INFLOW SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.0000	ML/L
PEAK EFFLUENT SETTLEABLE CONCENTRATION	=	.00	MG/L
STORM AVERAGE EFFLUENT CONCENTRATION	=	.00	MG/L
AVERAGE EFFLUENT SEDIMENT CONCENTRATION	=	.00	MG/L
BASIN TRAP EFFICIENCY	=**********		PERCENT
DETENTION TIME OF FLOW WITH SEDIMENT	=	.26	HRS
DETENTION TIME FROM HYDROGRAPH CENTERS	=	.26	HRS
DETENTION TIME INCLUDING STORED FLOW	=	.26	HRS
SEDIMENT LOAD DISCHARGED	=	.00	TONS
PERIOD OF SIGNIFICANT CONCENTRATION	=	-25.50	HRS
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
VOLUME WEIGHTED AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PERIOD OF SIGNIFICANT CONCENTRATION	=	.00	ML/L
ARITHMETIC AVERAGE SETTLEABLE CONCENTRATION DURING PEAK 24 HOUR PERIOD	=	.00	ML/L

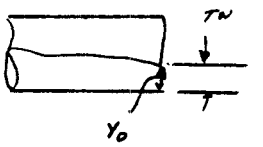
*** RUN COMPLETED ****

OUTLET PROTECTION AT LOADOUT SEDIMENTATION POND

ASSUME TAILWATER $TW < \frac{1}{2} D$ OR $TW = D - .60$
$= 1.5 FT - .9 FT$
$= .6 FT$

LENGTH OF BARREL - 60 FT.
Δ ELEVATION - 8.11 FT
SLOPE - .07
TIME DURATION - 30 min ASSUMED
Q - 18.41 SECTION 13 PAGE
DIA. - 1.5 FT.

DETERMINE BRINK DEPTH



$Q/D^{2.5} = 18.41/(1.5)^{2.5} = 6.68$

$TW/D = .6/1.5 = .40$

$Y_0/D = 1.00$

$Y_0 = 1.00(1.5) = 1.5$ PIPE IS FLOWING FULL

DETERMINE AREA OF FLOW

$A = CD^2$ $Y_0 = d$ $d/D = \frac{1.5}{1.5} = 1$

$C = .78$ TABLE 7.9 PAGE 539 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

$A = .78(1.5)^2$
$= 1.76 FT^2$

CALCULATE EQUIVALENT DEPTH

$Y_E = (A/2)^{1/2} = (1.76/2)^{1/2} = .94$ FT.

SINCE $TW = .6 < .5D = .75$ USE TABLE 7.8 PAGE 530

CALCULATE DEPTH OF SCOUR

$H_s = \alpha (Y_e)^{\gamma} (Q/Y_e^{2.5})^{\beta} t^{\theta}$ EQ 7.5 PAGE 529

$= .82 (.94)^{.10} \times (18.41/(.94)^{2.5})^{.375} \cdot (30)^{.10}$
$= 3.42$ FT.

CALCULATE WIDTH OF SCOUR

$$W_s \propto (y_c)^{\gamma} (Q/y_c^{2.5})^{\beta} t^{\theta}$$

$\alpha = .55$
$\beta = .915$
$\theta = .15$
$\gamma = 1$

$$= .55 (.99)^1 (18.91/(.99)^{2.5})^{.915} (30)^{.15}$$
$$= 14.26 \text{ FT.}$$

CALCULATE LENGTH OF SCOUR

$$L_s \propto (y_c)^{\gamma} (Q/y_c^{2.5})^{\beta} t^{\theta}$$

$\alpha = 1.67$
$\beta = .71$
$\theta = .125$
$\gamma = 1.0$

$$= 1.67 (.99)^1 (18.91/.99^{2.5})^{.71} (30)^{.125}$$
$$= 21.20 \text{ FT.}$$

CALCULATE VOLUME OF SCOUR

$$V_s = \alpha (y_c)^{\gamma} (Q/y_c^{2.5})^{\beta} t^{\theta}$$

$\alpha = .29$
$\beta = 2$
$\theta = .375$
$\gamma = 3$

$$= .29 (.99)^3 (18.91/.99^{2.5})^2 (30)^{.375}$$
$$= 398.26 \text{ FT}^3$$

CALCULATE VELOCITY

$$V = Q/A$$

$Q = 18.91$ CFS
$A = 1.76$ FT. AREA OF FLOW

$$= 18.19/1.76$$
$$= 10.31 \text{ FPS}$$

RIPRAP WILL BE NEEDED

CALCULATE FROUDE NUMBER

$$Fr = V / (g\, y_c)^{1/2} =$$

EQ 3.10 PAGE 152 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA, OKLAHOMA TECHNICAL PRESS

$$= 10.31/(32.2(.99))^{1/2}$$
$$= 1.87$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

ASSUME d_{50} SUCH THAT $.25 < d_{50}/y_c < .45$

$d_{50} / y_c < .45$

so, $d_{50} < .45(.94) = .42$ ft

$d_{50}/y_c > .25$

so $d_{50} > .25(.94$ ft$) = .24$ ft

$.24 \leq d_{50}/y_c \leq .42$ ft

$h_s/y_c = 1.48$ FIG. 7.23 PAGE 537

$h_s = 1.48(.94) = \underline{1.39 \text{ ft}}$

CHECK THAT $2 < h_s/d_{50} < 4$ OK USE d_{50} AVG. $= .33$ ft.

LENGTH OF ENERGY DISSIPATION POOL

$W = 1.5$ ft - DIA.

$$\text{MAX}[10 h_s, 3 W_o] = [10(1.39)(3)(1.5)]$$
$$= [13.39, 4.5]$$
$$= 13.39$$

OVERALL BASIN LENGTH

$$\text{MAX}[15 h_s, 4 W_o] = [15(1.39), 4(1.5)]$$
$$= [20.85 \text{ ft}, 6.00]$$
$$= 20.85 \text{ ft.}$$

RIPRAP GRADATION

		Size in	%
$1.25 D_{50}$	-	5	30
D_{50}	-	.4	50
$.5 D_{50}$	-	2	10
$.2 D_{50}$	-	.80	10

FILTER BLANKET DESIGN.

ASSUME BASE MATERIAL

D_{85} = .09 in
D_{50} = .024 in
D_{15} = .006 in

RIPRAP PROPERTIES

D_{85} = 4.25 in
D_{50} = 4.00 in
D_{15} = .75 in.

FILTER BLANKET WITH RESPECT TO BASE MATERIAL

D_{50} (FILTER)/D_{50} (BASE) < 40

so, D_{50} (FILTER) < 40 × .024 = .96 in

D_{15} (FILTER)/D_{15} (BASE) < 40

so, D_{15} (FILTER) < 40 × .006 = .24 in

D_{15} (FILTER)/D_{85} (BASE) < 5

so, D_{15} (FILTER) < 5 × .09 = .45 in

D_{15} (FILTER)/D_{15} (BASE) > 5

so, D_{15} (FILTER) > 5 .03 in.

.03 in < D_{15} (FILTER) < .24 in

D_{50} (FILTER) < .96 in.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

FILTER BLANKET WITH RESPECT TO RIPRAP MATERIAL

$D_{50}(\text{RIPRAP}) / D_{50}(\text{FILTER}) < 40$

SO, $D_{50}(\text{FILTER}) > 4/40 = .10$ IN

$D_{15}(\text{RIPRAP}) / D_{15}(\text{FILTER}) < 40$

SO, $D_{15}(\text{FILTER}) > .75/40 = .02$ IN.

$D_{15}(\text{RIPRAP}) / D_{85}(\text{FILTER}) < 5$

SO, $D_{85}(\text{FILTER}) > .75/5 = .15$ IN.

$D_{15}(\text{RIPRAP}) / D_{15}(\text{FILTER}) > 5$

SO, $D_{15}(\text{FILTER}) < .75/5 = .15$ MIN

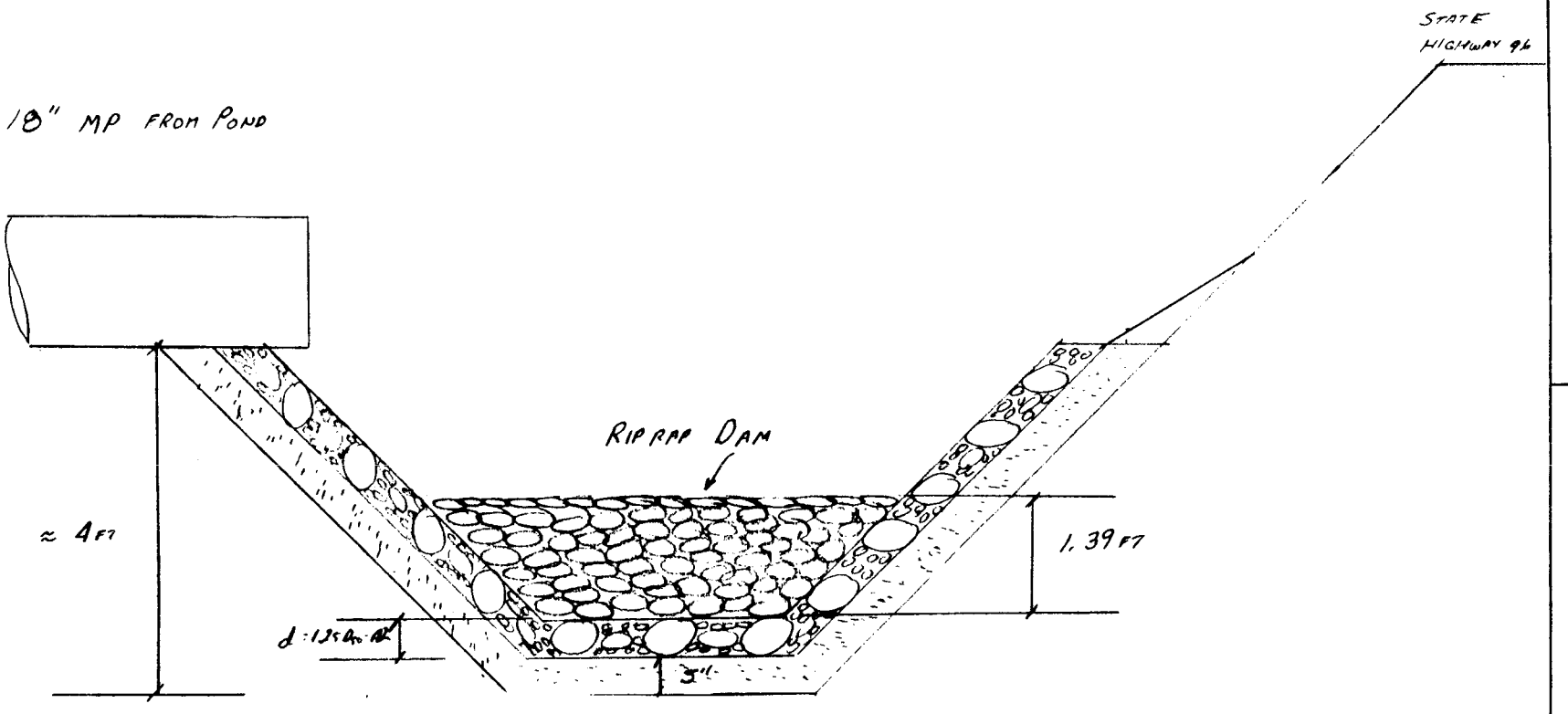
$.02\text{IN.} < D_{15}(\text{FILTER}) < .15$ MIN

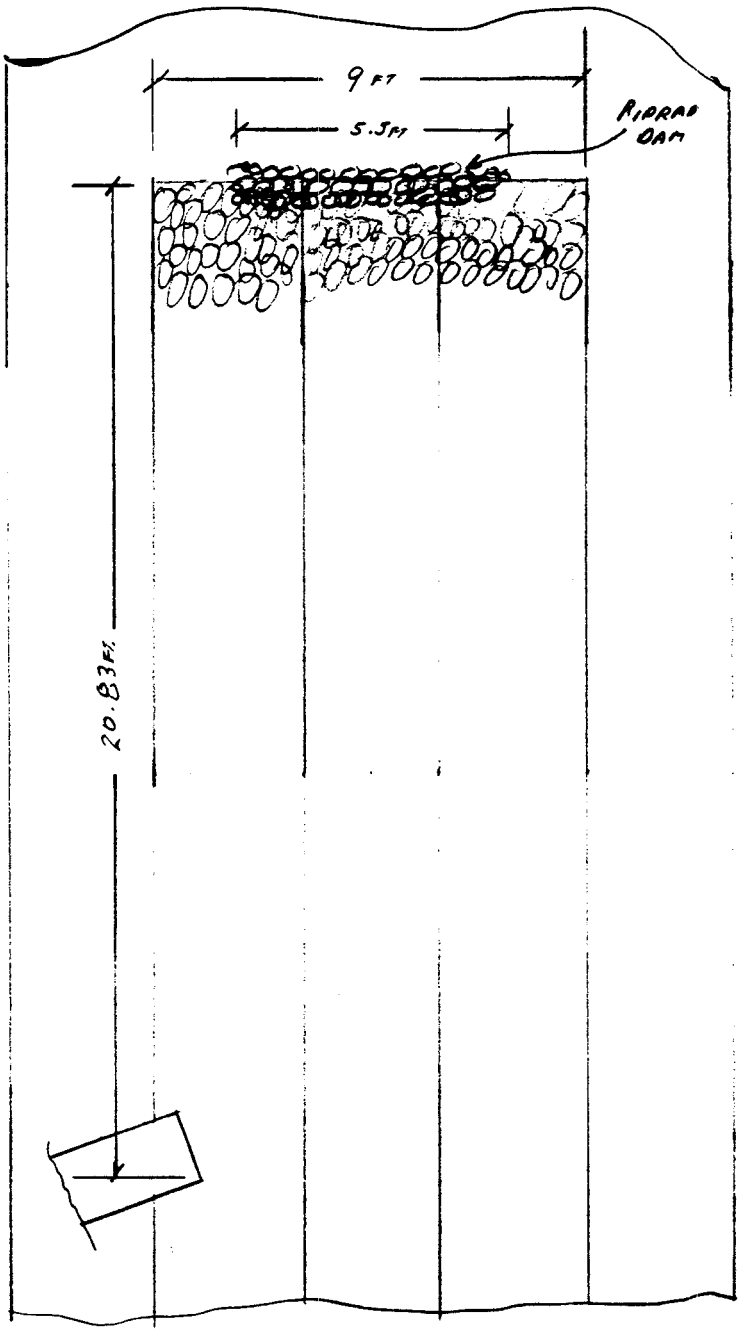
$D_{50}(\text{FILTER}) > .10$ IN

$D_{85}(\text{FILTER}) > .15$ MIN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS





STATE HIGHWAY 96

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 13

G. TAYLOR
7-9-91

TRAIN LOADOUT SEDIMENTATION POND EMERGENCY SPILLWAY

DETERMINE FLOW RATE FOR 25 YR -6 HR EVENT

USING SCS TYPE B METHOD

25 YR - 6 HR. 1.88 INCHES OF PRECIPITATION (1)

CN = 82

SLOPE = .057

HYD. DISTANCE = 1,500 FT.

AREA - 12.56 ACRES

Q = 5.26 CFS OR 2,361 GPM

USE A HORIZONTAL CRESTED WEIR

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

EQU. 5-10 PAGE 5-3 HANDBOOK OF HYDRAULICS FIFTH EDITION

H = HEAD = .4 FT

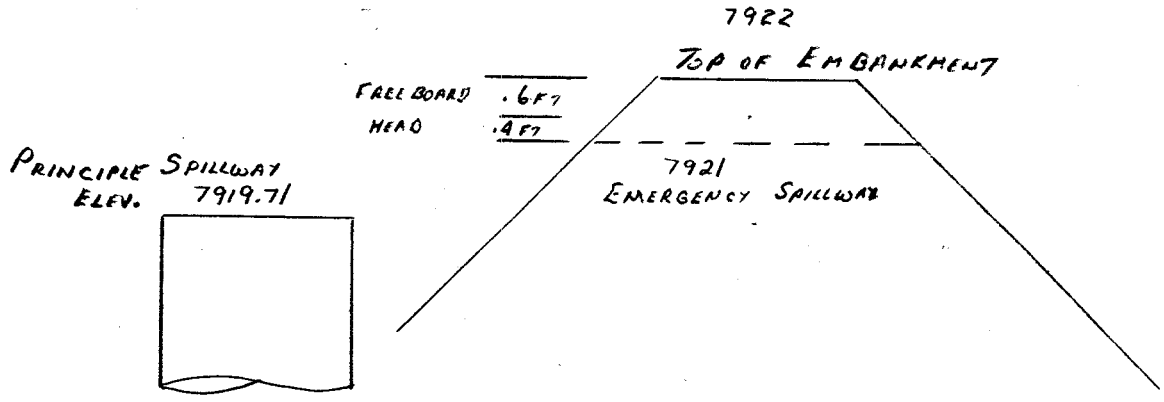
L = LENGTH OF WEIR = 10 FT

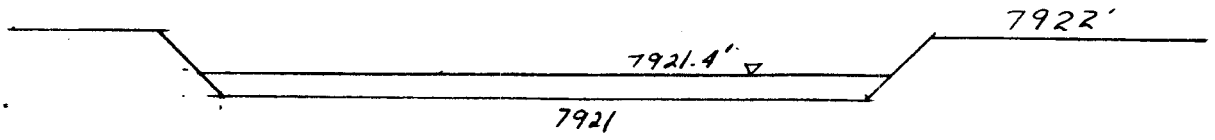
C = COEFFICIENT = 2.56

TABE 5-3 PAGE 5-16 HANDBOOK OF HYDRAULICS FIFTH EDITION

$Q = 2.56\ (10)\ (.4)^{1.5}$

= 6.48 CFS





FRONT VIEW

CALCULATE VELOCITY

A = 10 FT X 15 FT = 150 SQ. FT MAR. 3.2.1-3

Q = 5.26 CFS

V = Q/A

= 5.26 CFS/150 SQ FT

= .04 FPS

RIPRAP IS NOT NEEDED

NOTE:

THE 10 YEAR - 24 HOUR EVENT GENERATES A FLOW RATE OF 18.41 CFS. THIS FLOW RATE WILL PASS THROUGH THE PRINCIPLE SPILLWAY REQUIRING ONLY .75 FEET OF HEAD, REFER TO THE STAGE - DISCHARGE CURVE SECTION 13 PAGE 5 OF 18 VOLUME 5. THERE IS 1.29 FEET OF ELEVTIONAL DIFFERENCE BETWEEN THE PRINCPLE SPILLWAY AND THE EMERGENCY SPILLWAY.

REFERENCE:

1) VOLUME 5, SECTION 1 PAGE 1 NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION, AND UTAH STATE UNIVERSITY

2) KING, H. W AND E. F. BRATER 1963 HANDBOOK OF HYDRAULICS. McGRAW-HILL. NEW YORK, NEW YORK.

REGISTERED PROFESSIONAL ENGINEER
8632
WILLIAM W.
SHRIVER
STATE OF UTAH

Wm W. Shriver
7-18-91

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 14

DRAINAGE CONTROL
WASTE ROCK DISPOSAL SITE

WASTE ROCK DISPOSAL SITE
CHANNEL DESIGN DU-5

G. TAYLOR
12-13-99

1 DRAINAGE BASIN CHARACTERISTICS 1) MAP 3.2.8-3

AREA	ACRES 1)	C_N 2)	H_L	Σ OF CONTOURS (FT)	SLOPE %	CONTOUR INTERVAL	T_C 3)	Q 100-24 4)
DU-5	283.07	63	5,053.64	55,280.53	35.87	80	.51	106.6

Q 10-24
21.26 cfs

2) SOIL SURVEY

TYPE	* PERCENT	* HYD GROUP	† CN
CURECANTI	25	B	60
PATHEAD	10	C	73
TRAG	65	C	63

* SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

† TABLE 2.2 PAGE 2-7, 2-8 TR-55 MANUAL SECOND ED. JUNE 1986 - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

$$CN = .25(60) + .10(73) + .65(63) / .25 + .10 + .65 =$$

$$= 15 + 7.30 + 40.95 / 1$$

$$= 63.25 \quad \text{USE } \underline{63}$$

3) HATHWAY FORMULA

4) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

2) Drainage Ditch Design

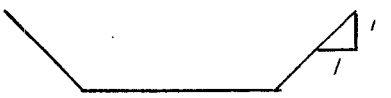
a) Determine Depth of Flow

$S = .03$ Actual Field Measurement of Temporary Channel Avg. Slope

$n = .035$ Stony Bed, weeds on Bank

$A = bd + zd^2$

$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$



Use Manning Formula

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

$= bd + zd^2 \times 1.486/n \times \left(bd + zd^2/b + 2d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$

$= 4d + d^2 \times 1.486/.035 + \left(4d + d^2/4 + 2d\sqrt{(1)^2+1}\right)^{2/3} \times (.03)^{1/2}$

$106.6 = 4d + d^2 \times 42.46 \times \left(4d + d^2/4 + 2.83(d)\right)^{2/3} \times .17$

Trail d

d	CFS
2.0	100.17
2.05	104.81
2.07	106.70

Use 2.07 ft

USE $d = 1.7$ FT

b) DETERMINE VELOCITY

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$

$$R = bd + zd^2/b + 2d\sqrt{z^2+1}$$

$$= 4(2.07) + (1)(2.07)^2/4 + 2(2.07)\sqrt{(1)^2+1}$$

$$= 8.24 + 4.28 / 4 + 5.85$$

$$= 12.56 / 9.86$$

$$= 1.27$$

$$V = 1.486/.035 \times (1.27)^{2/3} \times (.03)^{1/2}$$

$$= 42.46 \times 1.18 \times .17$$

$$= 8.49 \text{ FPS}$$

THE VELOCITY IS ABOVE 6 FPS, RIPRAP WILL BE NEEDED.

3. DESIGN RIPRAP SIZE

DESIGN FLOW - 106.6 CFS
CHANNEL SLOPE - .03

FROM FIG. 2 PAGE 11-6 (1)

$D_{50} = .75$ FT.

RIPRAP GRADATION

		Size	%
$1.25\ D_{50}$	=	11.25 IN	30
D_{50}	=	9 IN	50
$.5\ D_{50}$	=	4.5 IN	10
$.2\ D_{10}$	=	1.2 IN	10

4. DESIGN FILTER BLANKET.

ASSUME BASE MATERIAL

D_{85} = .09 IN
D_{50} = .024 IN
D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 9.56 IN
D_{50} = 9 IN
D_{15} = 1.69 IN

a) EVALUATE THE NEED OF A FILTER BLANKET

D_{15} (RIPRAP) / D_{85} (BASE) < 5

1.69 / .09 = 18.78 > 5

D_{15} (RIPRAP) / D_{15} (BASE) < 40

1.69 / .006 = 281.67 > 40

THE FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

b) FILTER BLANKET WITH RESPECT TO BASE MATERIAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 x .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (FILTER) < 40 x .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 x .09 = .45 IN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

D_{15} (FILTER) / D_{15} (BASE) > 5

so, D_{15} (FILTER) > 5 x .006 = .03 in.

.03 in < D_{15} (FILTER) < .45 in

D_{50} (FILTER) < .96 in

c) FILTER BLANKET WITH RESPECT TO RIPRAP

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

so, D_{50} (FILTER) > 9/40 = .23 in.

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

so, D_{15} (FILTER) > 1.69/40 = .04 in.

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so, D_{85} (FILTER) > 1.69/5 = .34 in

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so, D_{15} (FILTER) < 1.69/5 = .34 in.

.04 in < D_{15} (FILTER) < .34 in.

D_{50} (FILTER) > .23 in

D_{85} (FILTER) > .34 in.

d) THICKNESS OF FILTER BLANKET

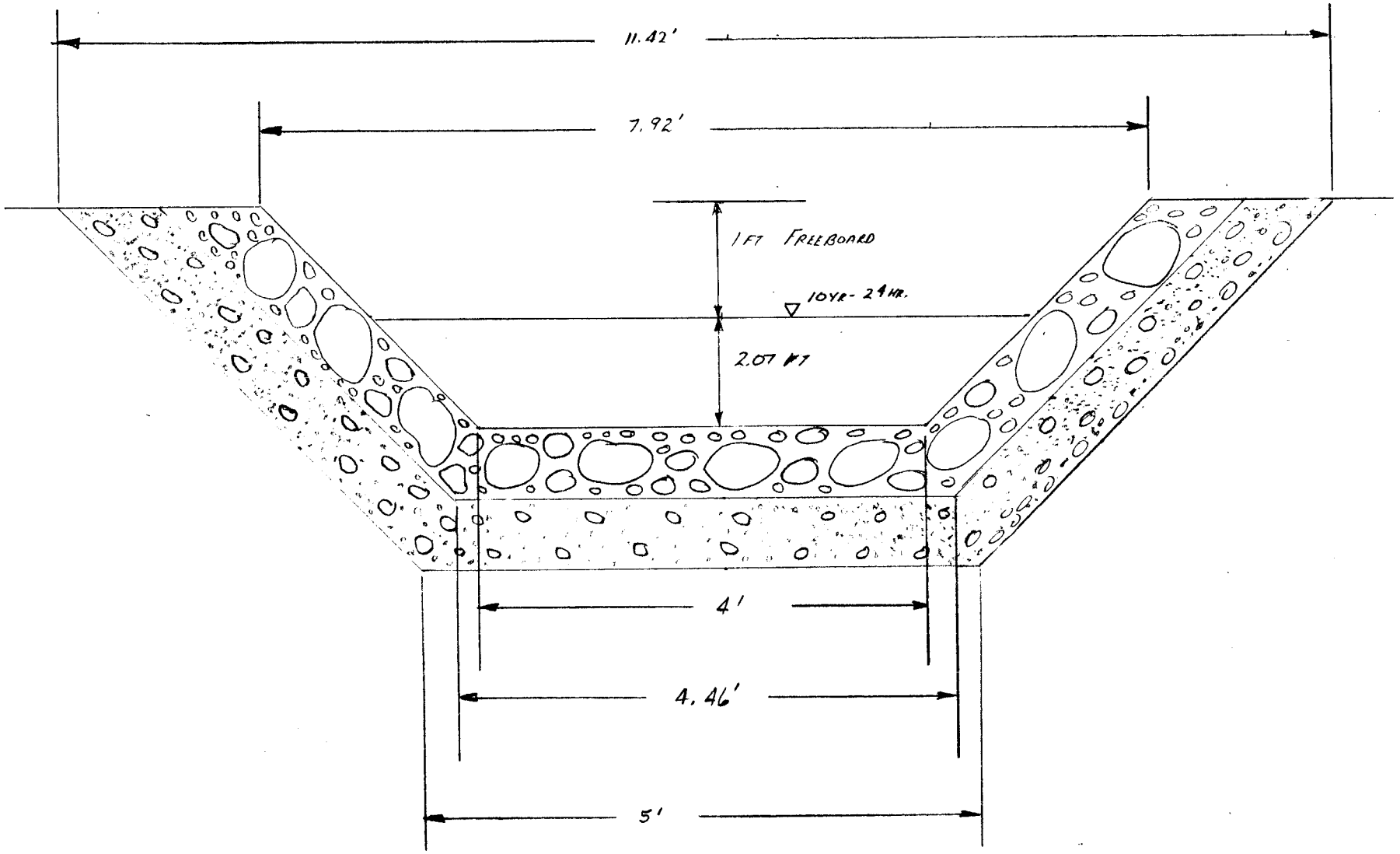
THICKNESS = MAX D_{50} = 9 in.

REFERENCE : 1) HYDRAULIC ENGINEERING CIRCULAR No. 11 - U.S. DEPARTMENT OF TRANSPORTATION

2) SURFACE MINING WATER DIVERSION DESIGN MANUAL, UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF SURFACE MINING.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSIONS
FOR DU-5

G. TAYLOR
REVISED
11-9-89

AREA No.	AREA IN SQ. FT. (1)	CN (2)	HYDRAULIC LENGTH (1)	Σ OF CONTOURS	SLOPE % (3)	CONTOUR INTERVAL
SW-11	5,210	87	235	55	10.56	10
SW-12	13,500	87	730	155	11.48	10
SW-13	20,250	87	874	195	9.63	10
SW-14	13,800	87	680	80	5.80	10

1). MAP 3.2.8-1 ACCESS ROAD TO ROCK WASTE DISPOSAL

2) TRAG SOIL GROUP - C HYD. SOIL GROUP; SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

CN = 87 STREETS AND ROADS DIRT - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

3) % SLOPE = Σ CONTOURS x CONTOUR INTERVAL / AREA

PEAK FLOW (CFS)

AREA No	T_c (4)	Q_{10-24} (5)	Q_{25-24} (5)	Q_{50-24} (5)	Q_{100-24} (5)
SW-11	.15				.3
SW-12	.12				.65
SW-13	.11				.97
SW-14	.13				.70

4) KENT'S FORMULA - $t_c = L^{0.8}(S+1)^{0.7} / 1900 Y^{0.5} / 0.6$ EQ 2.59 + 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

5) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

WASTE ROCK DISPOSAL SITE
SWALES

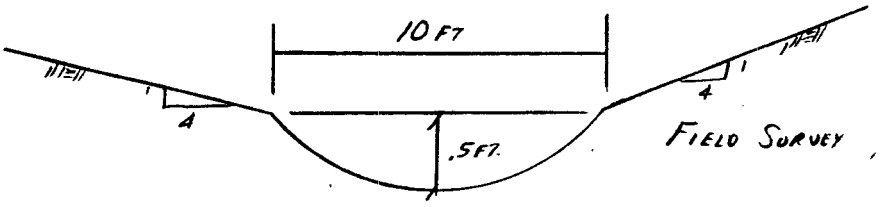
G TAYLOR
11-17-89

A. SW-10 MAP 3.2.8-1

PEAK FLOWS 100YR-24HR - 106.6 CFS
10YR-24HR 29.26 CFS

USE MANNING FORMULA

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



FIELD SURVEY, NOV. 1989

$A = 2/3\, dT$
$R = 2dT^2/3T^2 + 8d^2$ } PAGE 4.3 SURFACE MINING WATER DIVERION DESIGN MANUAL SEPT. 1972 - OSM

$n = .014$ CONCRETE LINED, REGULAR FINISH
$S = .05$
$T = 10$ FT
$d = .5$ FT

$$Q = 2/3\, dT \times 1.486/n \times (2dT^2/3T^2 + 8d^2)^{2/3} \times S^{1/2}$$

$$= 2/3\, d\, 10 \times 1.486/.014 \times (2d\, 10^2/3\, 10^2 + 8d^2)^{2/3} \times (.05)^2$$

$$= 6.67d \times 106.14 \times (200d/300 + 8d^2)^{2/3} \times .22$$

TRY $d = .40$ FT

$$Q = 6.67(.40) \times 106.14 \times (200(.40)/300 + 8(.40)^2)^{2/3} \times .22$$

$= 25.62$ CFS

TRY $d = .37$ FT

$$Q = 6.67(.37) \times 106.14 \times (200(.37)/300 + 8(.37)^2)^{2/3} \times .22$$

$= 22.51$ CFS

TRY $d = .36$ FT

$$Q = 6.67(.36) \times 106.14 \times \left(200(.36)/300 + 8(.36)\right)^{2/3} \times .22$$

$$= 21.50$$

SWALE WILL WORK FOR 10YR - 24HR EVENT.

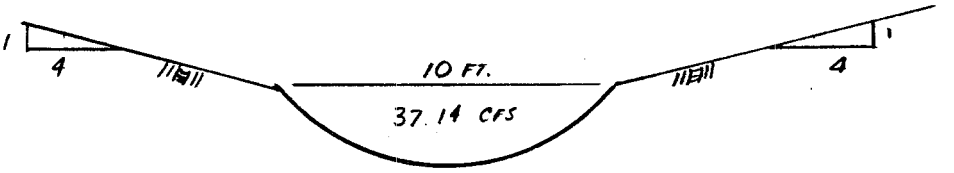
$Q_{100-24} = 106.6$ - FLOW OF SWALE 10YR - 24HR

WHEN SWALE 10 IS FULL

$$Q = 6.67(.5) \times 106.14 \times \left(200(.5)/300 + 8(.5)\right)^{2} \times .22 = 37.14$$

$$Q_{100-24} = 106.6 - 37.14$$
$$= 69.46 \text{ CFS}$$

RECLAMATION SWALE SW-10



A TRAPEZOID FORMED WITH DIRT WILL ACT AS THE SWALE

$Z = 4$

$A = bd + zd^2$

$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$

$n = .023$ EARTH, UNIFORM SECTION

$$Q = bd + zd^2 \times 1.486/n \times \left(bd + zd^2 / b + 2d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= 10d + 4d^2 \times 1.486/.023 \times \left(10d + 4d^2 / 10 + 2d\sqrt{4^2+1}\right)^{2/3} \times (.05)^{1/2}$$

$$= 10d + 4d^2 \times 64.61 \times \left(10d + 4d^2 / 10 + 8.25d\right)^{2/3} \times .22$$

TRY $d = .62$ FT.

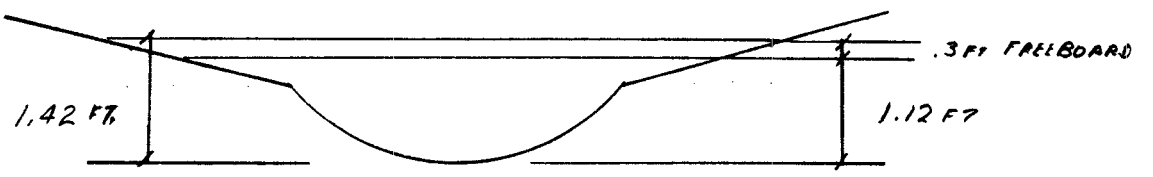
$$Q = 10(.62) + 4(.62)^2 \times 64.61 \times \left(10(.62) + 4(.62)^2/10 + 8.25(.62)\right)^{.25} \times .22$$

$$= 70.22$$

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= .5$ FT $+ .62$ FT $+ .3$ FT

$= 1.42$ FT



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SWALES SW-11, SW-12, SW-13 AND SW-14 WILL BE DESIGNED FOR THE 100 YR - 24 HR AS THE FLOWS FOR THE ROAD AT 10 YR - 24 HR EVENTS ARE TO SMALL. THE OVERLAND FLOW TO THE DITCHS WILL BE EQUALLY DIVIDED BETWEEN THE FOUR SWALES.

Q_{100-24} = 90.9 CFS SECTION 14, VOL. 5

DITCH FLOW TO SWALES = 90.9/4 = 22.73 CFS

B SW-11

TOTAL FLOW = OVERLAND + ROAD

= 22.73 CFS + .3 CFS

= 23.03 CFS

Z = 33.33 Z = 20

USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$A = Zd^2/2 + Zd^2/2$

$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$

n = .023 EARTH, UNIFORM SECTION, GRAVELY SOIL

S = .03 FIELD SURVEY, NOV. 1999

$$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times \left(Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= (33.33d^2/2 + 20d^2/2) \times 1.486/.023 \times \left(33.33d/4\sqrt{33.33^2+1} + 20d/4\sqrt{20^2+1}\right)^{2/3} \times (.03)^{1/2}$$

$$= 16.67d^2 + 10d^2 \times 64.61 \times (.25d + .25d)^{2/3} \times .17$$

$$= (26.67d^2) \times 64.61 \times (.50d)^{2/3} \times .17$$

TRY d = .3 FT

$$Q = 26.67(.3)^2 \times 64.61 \times (.50(.3))^{2/3} \times .17$$

= 7.90 CFS.

TRY $d = .46$

$Q = 26.67(.46)^2 \times 64.61 \times (.5(.46))^{2/3} \times .17$

$= 23.16$

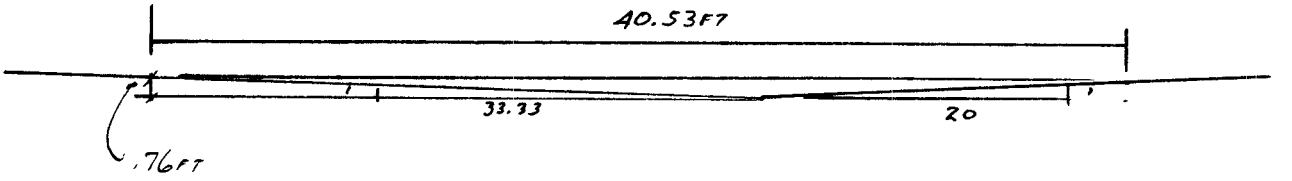
USE .46 FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .46 FT + .3 FT

= .76 FT

SWALE DESIGN



C SW - 12

TOTAL FLOW = OVERLAND + ROAD

= 22.73 CFS + .65 CFS

= 23.38 CFS

USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$n = .023$

$S = .08$ FIELD SURVEY, NOV. 1989

$$Q = \left(\frac{zd^2}{2} + \frac{zd^2}{2}\right) \times \frac{1.486}{n} \times \left(\frac{zd}{4\sqrt{z^2+1}} + \frac{zd}{4\sqrt{z^2+1}}\right)^{2/3} \times S^{1/2}$$

$$= \left(\frac{25d^2}{2} + \frac{9.09d^2}{2}\right) \times \frac{1.486}{.023} \times \left(\frac{25d}{4\sqrt{25^2+1}} + \frac{9.09d}{4\sqrt{9.09^2+1}}\right)^{2/3} \times (.08)^{1/2}$$

$$= (12.50d^2 + 4.55d^2) \times 64.61 \times (.25d + .25d)^{2/3} \times .28$$

$$= (17.05d^2) \times 64.61 \times (.50d)^{2/3} \times .28$$

TRY $d = .5$ FT

$$Q = (17.05(.5)^2) \times 64.61\,(.50(.5)^{2/3} \times .28$$

$$= 30.46 \text{ CFS}$$

TRY $d = .45$ FT.

$$Q = (17.05(.45)^2) \times 64.61 \times (.50(.45)^{2/3} \times .28$$

$$= 22.99 \text{ CFS}$$

TRY $d = .46$ FT.

$$Q = (17.05(.46)^2) \times 64.61 \times (.5(.46)^{2/3} \times .28$$

$$= 24.38 \text{ CFS}$$

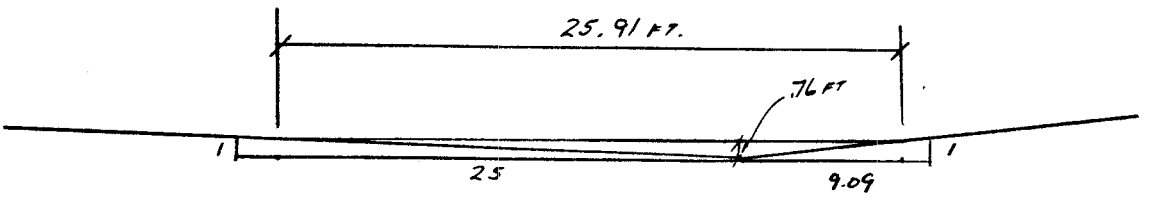
USE .46 FT

SWALE DESIGN

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .46 FT + .3 FT

= .76 FT.



D. SW - 13

TOTAL FLOW = OVERLAND + ROAD

= 22.73 CFS + .97 CFS

= 23.70 CFS

USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$A = Zd^2/2 + Zd^2/2$

$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$

$n = .023$

$S = .03$

$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$= (25d^2/2 + 8.33d^2/2) \times 1.486/.023 \times (25d/4\sqrt{25^2+1} + 8.33d/4\sqrt{8.33^2+1})^{2/3} \times (.03)^{1/2}$

$= (12.5d^2 + 4.17d^2) \times 64.61 \times (.25d + .25d)^{2/3} \times .17$

$= (16.67\,d^2) \times 64.61 \times (.5d)^{2/3} \times .17$

TRY $d = .46$ FT.

$Q = (16.67(.46)^2) \times 64.61 \times (.5(.46))^{2/3} \times .17$

$= 14.47$ CFS

TRY $d = .55$ FT.

$Q = (16.67(.55)^2) \times 64.61 \times (.5(.55))^{2/3} \times .17$

$= 23.32$ CFS

TRY $d = .56$

$Q = (16.67(.56)^2) \times 64.61 \times (.5(.56)^{2/3} \times .17$

$= 24.97$

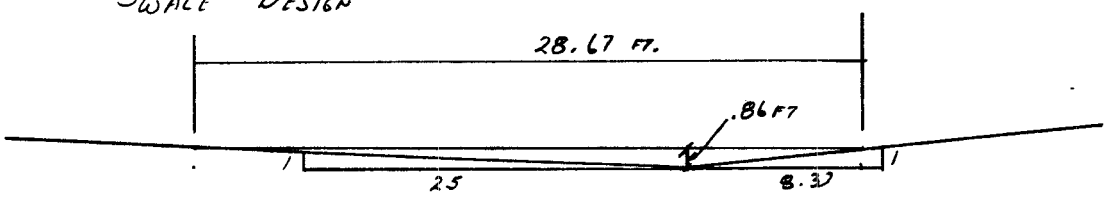
USE $d = .56$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .56 FT + .3 FT

= .86 FT.

SWALE DESIGN



E SW-14

TOTAL FLOW = OVERLAND + ROAD

= 22.73 CFS + .70 CFS

= 23.43 CFS

USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$A = zd^2/2 + zd^2/2$

$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$n = .023$

$S = .08$ FIELD SURVEY, NOV. 1989

$$Q = \left(\frac{Zd^2}{2} + \frac{Zd^2}{2}\right) \times \frac{1.486}{n} \times \left(\frac{2d}{4\sqrt{2d^2+1}} + \frac{Zd}{4\sqrt{Z^2+1}}\right)^{2/3} \times S^{1/2}$$

$$= \left(\frac{100d^2}{2} + \frac{14.29d^2}{2}\right) \times \frac{1.486}{.023} \times \left(\frac{100d}{4\sqrt{100^2+1}} + \frac{14.29d}{4\sqrt{14.29^2+1}}\right)^{2/3} \times (.02)^{1/2}$$

$$= (50d^2 + 7.15d^2) \times 64.61 \times (.25d + .22d)^{2/3} \times .28$$

$$= (57.12\,d^2) \times 64.61 \times (.50\,d)^{2/3} \times .28$$

TRY $d = .3$ FT

$$Q = (57.12(.3)^2) \times 64.61 \times (.5(.3))^{2/3} \times .28$$

$$= 26.09 \text{ CFS}$$

TRY $d = .28$ FT

$$Q = (57.12(.28)^2) \times 64.61 \times (.5(.28))^{2/3} \times .28$$

$$= 21.70 \text{ FT}$$

TRY $d = .29$ FT

$$Q = (57.12(.29)^2) \times 64.61 \times (.5(.29))^{2/3} \times .28$$

$$= 23.83$$

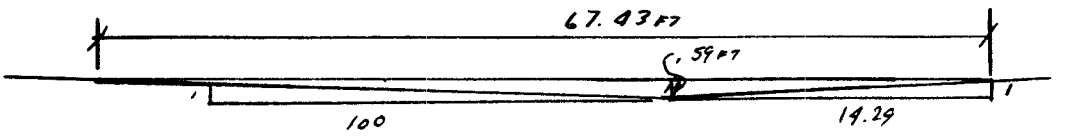
USE $d = .29$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .29 FT + .3 FT

= .59 FT

SWALE DESIGN

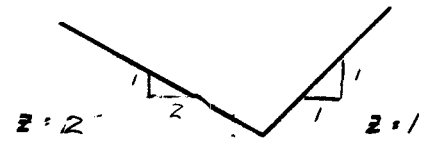


DITCH UDD-2 MAP 3.2.8-1

DETERMINE DEPTH OF FLOW FOR 10YR-24HR

USE MANNING FORMULA

PEAK FLOW $Q_{10-24} = 21.26$ CFS SECTION 14, VOL. 5



$n = .035$ STONY BED
$S = .13$

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

$$A = Zd^2/2 + Zd^2/2$$
$$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$$

$$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3} \times S^{1/2}$$

$$= (2d^2/2 + d^2/2) \times 1.486/.035 \times (2d/4\sqrt{2^2+1} + d/4\sqrt{1^2+1})^{2/3} \times (.13)^{1/2}$$

$$21.26 = (.d^2 + .5d^2) \times 42.46 \times (.22d + .18d)^{2/3} \times .36$$

TRAIL d

d	Q
1.4	30.47
1.2	20.19
1.23	21.57

VELOCITY

$$V = 1.486/n \; R^{2/3} \; S^{1/2}$$

$$V = 1.486/n \; (.22d + .18d)^2 \; S^{1/2}$$

$$V = 1.486/.035 \times [.22(1.23)^2 + .18(1.23)] \times (.13)^{1/2}$$

$$= 42.46 \times (.49)^{2/3} \times .36$$

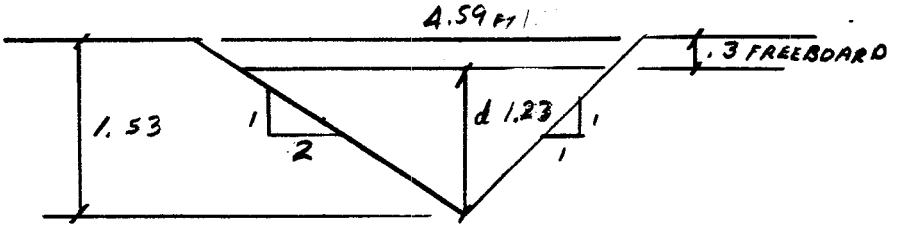
$$= 9.50 \text{ FPS}$$

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH WAS CONSTRUCTED IN ROCK.

G. TAYLOR
REVISED
11-9-89

DITCH DESIGN

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD
= 1.23 + .3
= 1.53

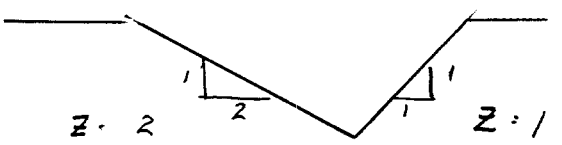


UDD-2 DITCH
DIMENSIONS
FOR 10YR - 24HR EVENT

DETERMINE DEPTH OF FLOW FOR 100YR - 24HR

USE MANNING FORMULA

PEAK FLOW $Q_{100-24} = 106.6$ CFS



$n = .035$ STONEY BED
$S = .13$

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

$$A = zd^2/2 + zd^2/2$$

$$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$$

$$Q = (zd^2/2 + zd^2/2) \times 1.486/n \times \left(zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= (2d^2/2 + 1d^2/2) \times 1.486/.035 \times \left(2d/4\sqrt{(2)^2+1} + d/4\sqrt{(1)^2+1}\right)^{2/3} \times (.13)^{1/2}$$

$$106.6 = (d^2 + .5d^2) \times 42.46 \times (.22d + .18d) \times .36$$

TRAIL d

d FT	Q CFS
2.8	193.94
2.5	143.30
2.3	114.70
2.24	106.88

VELOCITY

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$

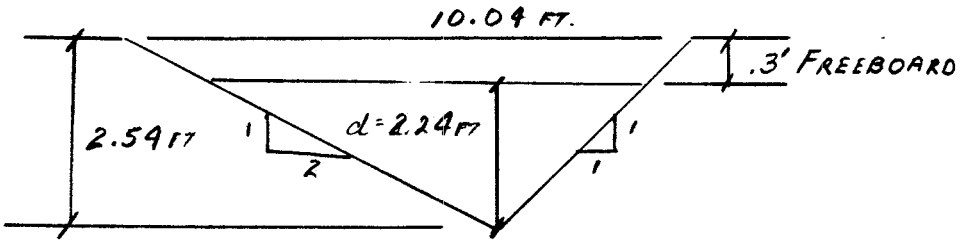
$$= 1.486/n \times (.22d + .18d)^{2/3} \times S^{1/2}$$

$$= 1.486/.035 \times (.22(2.24) + .18(2.24))^{2/3} \times (.13)^{1/2}$$

$$= 42.46 \times .93 \times .36$$

$$= 14.20 \text{ FPS}$$

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH WILL BE CONSTRUCTED IN ROCK.



UDD-2 DITCH
DIMENSIONS
FOR 100 YR - 24 HR.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

WASTE ROCK DISPOSAL SITE
ACCESS ROAD DITCH
DESIGN

ACCESS ROAD DITCH AREA - MAP 3.2.8-1

AREA IN SQ FT. (1)	CN (2)	HYDRAULIC LENGTH (1)	Σ OF CONTOURS	SLOPE % (3)	CONTOUR INTERVAL
3,684,762	74	3,600	14,650	31.31	80

1) MAP 3.2.8-3

2) TRAG SOIL GROUP - C HYD. SOIL GROUP, SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

C: 74 RANGE LAND GOOD COVER - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

3) % SLOPE . Σ CONTOURS × CONTOUR INTERVAL / AREA

PEAK FLOW (CFS)

AREA NO	T_c	$Q_{10\text{-}24}$	$Q_{25\text{-}24}$	$Q_{50\text{-}24}$	$Q_{100\text{-}24}$
	.315	38.6			90.9

4) KENT FORMULA $t_c = L^{0.8}(S+1)^{0.7} / 1900\, Y^{0.5} / 0.6$ EQ 2.59 + 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

5) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DITCHS DD-12, DD-13, DD-14 AND DD-15 WILL BE DESIGNED FOR THE 100YR-24HR. THE OVERLAND FLOW TO THE DITCHES WILL BE EQUALLY DIVIDED BETWEEN THE FOUR DITCHES

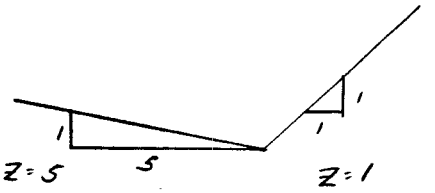
$Q_{100-24} = 90.9$ SECTION 14, VOL. 5

DITCH FLOW $= 90.9/4 = 22.73$ CFS $= Q$

A. DD-12 DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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



$n = .035$ STONEY BED
$S = .12$ MAP 3.2.8-1

$$A = Zd^2/2 + Zd^2/2$$
$$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$$

$$Q = (Zd^2/2 + Zd^2/2) \times 1.486/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3} \times S^{1/2}$$

$$= (5d^2/2 + 1d^2/2) \times 1.486/.035 \times (5d/4\sqrt{5^2+1} + d/4\sqrt{1^2+1})^{2/3} \times (.12)^{1/2}$$

$$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d) \times .35$$

$$= (3d^2) \times 42.46 \times (.43d)^{2/3} \times .35$$

TRY $d = .5$ FT

$$Q = (3(.5)^2) \times 42.46\ (.43(.5)^{2/3} \times .35$$

$= 3.98$ CFS

TRY $d = 1$ FT

$$Q = (3(1)^2) \times 42.46\ (.43(1))^{2/3} \times .35$$

$= 25.33$ CFS

TRY $d = .96$

$$Q = (3(.96)^2) \times 42.46 \cdot (.43(.96))^{2/3} \times .35$$

$= 22.71$ CFS

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.035 \times (.41)^{2/3} \times (.12)^{1/2}$

$= 42.46 \quad (.55) \times .35$

$= 8.13$ FPS

$R = (.43(.96) = .41$
$S = .12$
$n = .035$

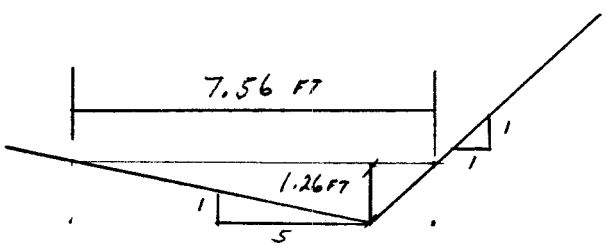
EVEN TROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .96 FT + .3 FT

= 1.26 FT.

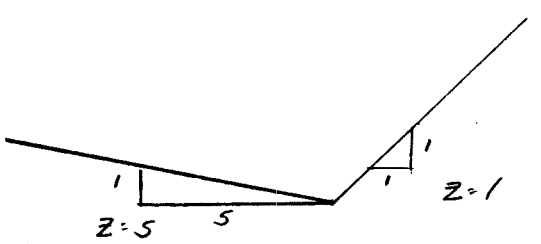
DITCH DESIGN



B. DD - 13 DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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



$n = .035$
$S = .11$ MAP 3.2.8-1

$A = Zd^2/2 + Zd^2/2$

$R = Zd^2/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$

$Q = (Zd^2/2 + Zd^2/2) \times 1.49/n \times (Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$= (5d^2/2 + 1d^2/2) \times 1.49/.035 \times (5d/4\sqrt{5^2+1} + 1d/4\sqrt{1^2+1})^{2/3} \times (.11)^{1/2}$

$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d)^{2/3} \times .33$

$= 3d^2 \times 42.46 \times (.43d)^{2/3} \times .33$

TRY $d = .96$ FT

$Q = (3(.96)^2) \times 42.46 \times (.43(.96))^{2/3} \times .33$

$= 21.41$ CFS

TRY $d = .98$ FT

$Q = (3(.98)^2) \times 42.46 \times (.43(.98))^{2/3} \times .33$

$= 22.63$ CFS

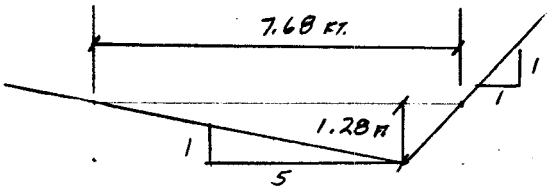
USE $d = .98$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= .98$ FT $+ .3$ FT

$= 1.28$ FT.

DITCH DESIGN



VELOCITY

$R = (.43(.98)) = .42$

$S = .11$

$n = .035$

$V = 1.49/n \times R^{2/3} \times S^{1/2}$

$= 1.49/.035 \times (.42)^{2/3} \times .33$

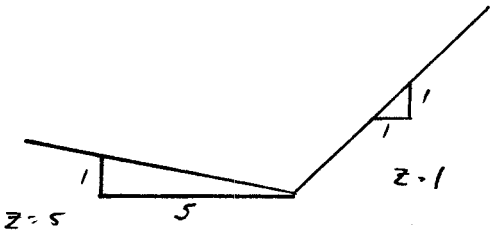
$= 7.87$ FPS

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

C DD - 14 DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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



$n = .035$
$S = .08$ MAP 3.2.8-1

$$A = Zd^2/2 + Zd^2/2$$
$$R = Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}$$

$$Q = \left(Zd^2/2 + Zd^2/2\right) \times 1.486/n \times \left(Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= \left(5d^2/2 + 1d^2/2\right) \times 1.486/.035 \times \left(5d/4\sqrt{5^2+1} + d/4\sqrt{1^2+1}\right)^{2/3} \times (.08)^{1/2}$$

$$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d)^{2/3} \times .27$$

$$= 3d^2 \times 42.46 \times (.43d)^{2/3} \times .27$$

TRY $d = 1.0$ FT

$$Q = 3(1)^2 \times 42.46\,(.43(1))^{2/3} \times .27$$

$$= 19.54 \text{ CFS}$$

TRY $d = 1.05$ FT

$$Q = 3(1.05)^2 \times 42.46 \times (.43(1.05))^{2/3} \times .27$$ 22.26

$$= 22.26 \text{ CFS}$$

TRY $d = 1.06$ FT

$$Q = 3(1.06)^2 \times 42.46 \times (.43(1.06))^{2/3} \times .27$$

$$= 22.83 \text{ CFS}$$

USE $d = 1.06$ FT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.035 \, (.46)^{2/3} \times (.08)^{1/2}$

$= 42.46 \; .59 \times .28$

$= 7.09$

$R = (.43(1.06)) = .46$
$S = .08$
$n = .035$

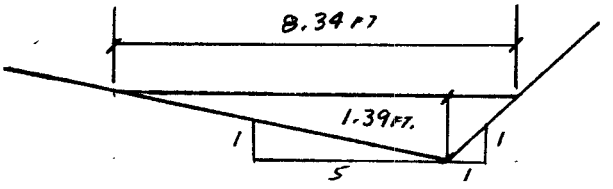
EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= 1.06 FT. + .3 FT

= 1.39 FT

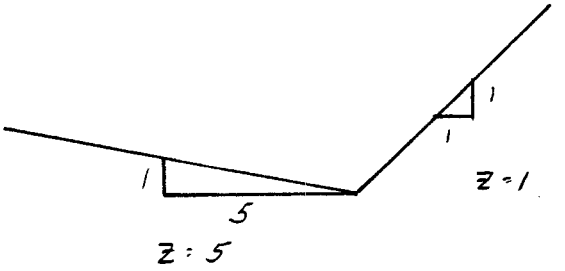
DITCH DESIGN



D. DD-15 DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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



$n = .035$
$S = .06$ MAP 3.2.B-1

$A = zd^2/2 + zd^2/2$
$R = zd/4\sqrt{z^2+1} + zd/4\sqrt{z^2+1}$

$$Q = \left(2d^2/2 + 2d^2/2\right) \times 1.486/n \times \left(2d/4\sqrt{2^2+1} + 2d/4\sqrt{2^2+1}\right)^{2/3} \times S^{1/2}$$

$$= 5d^2/2 + 1d^2/2 \times 1.486/.035 \times \left(5d/4\sqrt{5^2+1} + d/4\sqrt{1^2+1}\right)^{2/3} \times (.06)^{1/2}$$

$$= 2.5d^2 + .5d^2 \times 42.46 \times (.25d + .18d)^{2/3} \times .24$$

$$= 3d^2 \times 42.46 \times (.43d)^{2/3} \times .24$$

TRY $d = 1.1$ FT

$$Q = 3(1.1)^2 \times 42.46 \times (.43(1.1))^{2/3} \times .24$$

$$= 22.40 \text{ CFS}$$

TRY $d = 1.11$ FT

$$Q = 3(1.11)^2 \times 42.46 \times (.43(1.11))^{2/3} \times .24$$

$$= 22.95 \text{ CFS}$$

USE $d = 1.11$ FT

VELOCITY

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$

$$= 1.486/.035 \times (.48)^{2/3} \times .24$$

$$= 42.46 \; .61 \times .24$$

$$= 6.39 \text{ FPS}$$

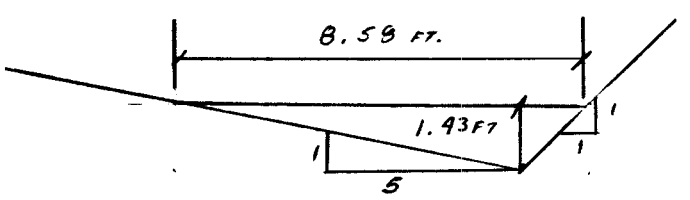
$R = .43(1.11) = .48$
$S = .06$
$n = .035$

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$$= 1.11 + .3$$

$$= 1.43 \text{ FT}$$



SECTION 15

WASTE ROCK DISPOSAL
~~SEDIMENT POND~~
Runoff volume calculation

WASTE ROCK DISPOSAL
SEDIIMENT POND

G. TAYLOR
6-30-99
REVISED 11-21-99

SIZING POND - DISPOSAL SITE - MAP 4.K.1-18

1. RUNOFF FROM UNDISTURBED AREA

a) AREA

READING	FACTOR	AREA FT²	ACRES
5	13,698	68,490	1.57

b) SOIL SURVEY

SOIL TYPE	PERCENT[1]	HYD GROUP[1]	CN[2]
CURECANTI FAMILY LOAM	30	B	66
PATHEAD EXTREMELY BOULDERY FINE SANDY LOAM	25	C	77
PATHEAD EXTREMELY STONY LOAM	25	C	77
PERMA FAMILY SOILS	13	B	66
MIDFORK FAMILY SOILS	7	B	66

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HANN
CN=66 FOREST LAND POOR COVER CN=77 FOREST LAND POOR COVER

$$CN = \frac{.30(66) + .25(77) + .25(77) + .13(66) + .07(66)}{.3 + .25 + .25 + .13 + .7}$$

$$= 19.80 + 19.25 + 19.25 + 8.58 + 4.62$$

$$= 71.50 \quad \text{USE } \underline{\underline{72}}$$

$S = 1000/CN - 10 = 3.89$ EQ 2.39

$Q = (P - .25)^2 / P + 0.85$ EQ 2.39

} PAGE 81 APPLIED HYDROLOGY AND SEDIMETOLOGY FOR DISTURBED AREAS, BARFIELD AND HANN

$P_{10-24} = 2.45$ IN

$P_{25-24} = 2.85$ IN

} SECTION 2, VOL 5 PAGE 5

Q - 10 YR - 24 HR

Q_{10-24} = $[2.45 IN - .2(3.89)]^2 / 2.45 + .8(3.89)$

= $2.80 / 5.56$

= .50 INCHES

Q = 25 YR - 24 HR

Q_{25-24} = $[2.85 - .2(3.89)]^2 / 2.85 + .8(3.89)$

= $4.29 / 5.96$

= .72 INCHES

c) RUNOFF VOLUMES

10 YR - 24 HR

RV = $QA / 12 IN/FT$

= .50 IN X 1.57 ACRES / 12 IN/FT = .07 ACRE-FT

2,850 CU. FT.

25 YR - 24 HR

RV = .72 IN X 1.57 ACRES / 12 IN/FT = .09 ACRE-FT

4,100 CU. FT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

2. RUNOFF FROM DISTURBED AREA - MAP 4.16.1-1B

a) AREA

PLANIMETER READING	FACTOR	AREA - FT²	ACRES
9113	10	91,130	2.09

c) SOIL AND CURVE NUMBER

ROCK - SANDSTONE AND SHALES

CN = 89 DIRT LOW INFILTRATION RATE

S = 1000/89 - 10 = 1.24 EQ 2.39

Q = $(P - .25)^2 / P + .85$ EQ 2.38

PAGE 81 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAAN.

Q = 10 YR - 24 HR

Q = $(2.45 - .2(1.24))^2 / 2.45 + .8(1.24)$

= 4.85/3.44

= 1.41 IN.

Q = 25 YR - 24 HR

= $[2.85 - .2(1.24)]^2 / 2.85 + .8(1.24)$

= 6.77/3.83

= 1.77 IN.

c) RUNOFF VOLUME

10 YR - 24 HR

RV = QA/12 IN/FT

= 1.41 IN x 2.09 ACRES/12 IN/FT = .25

10,697 CU. FT.

25YR - 24 HR

RV = QA/12 IN/FT

= 1.77 IN x 2.09 ACRE/12 IN/FT = .31 9 ACRE - FT

13,428 CU. FT.

3 SEDIMENT VOLUME

0.1 AC - FT FOR EACH ACRE DISTURBED

VOL. = 0.1 AC-FT/AC x 2.09 AC

= .2090 AC-FT = 9,100 CF. FT.

4 TOTAL VOLUME

THE TOTAL STORAGE / DETENTION CAPACITY OF THE POND SHOULD BE LESS THAN :

10 YR - 24 HR

22,697 CU. FT

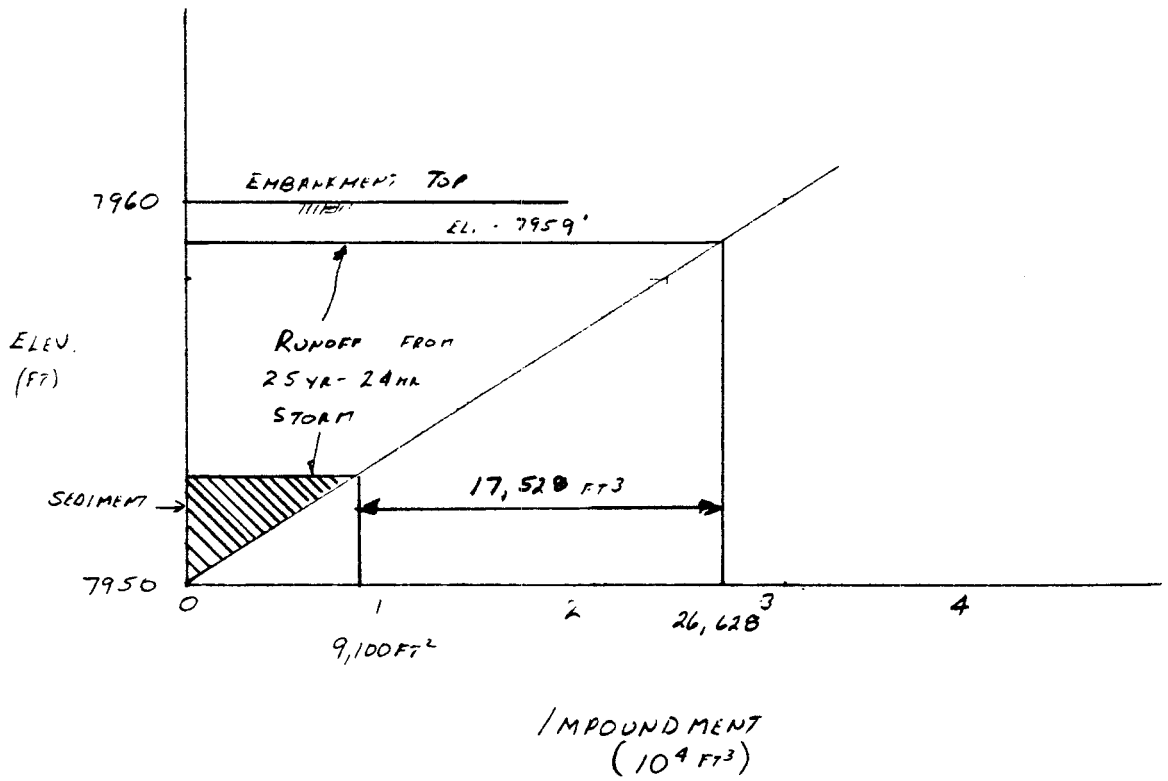
25 YR - 24 HR

26,628 CU. FT

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

5 POND CAPACITY

ELEV.	AREA (FT)^2	AVE AREA (FT)^2	VOLUME
7950	1560		
		3100	31,000
7960	4640		



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DITCH DD-16 MAP 4.16.1-1B

AREA IN SQ.FT (1)	CN (2)	HYDRAULIC LENGTH (1)	Σ OF CONTOURS	SLOPE % (3)	CONTOUR INTERVAL
81,870	84	840	2,210	26.99	10

1) MAP 4.16.1-1B

2) *SILAS SOIL GROUP - C 65% HYD SOIL GROUP †CN: 86
BAYCAN SOIL GROUP - B 35% HYD SOIL GROUP CN: 79

86(.65) + 79(.35) / .65 + .35 = 55.90 + 27.65 / 1 = 83.55 USE 84

* SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPT. OF AGRICULTURE - SOIL CONSERVATION SERVICE

† APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

3) % SLOPE = Σ CONTOURS × CONTOUR INTERVALS / AREA

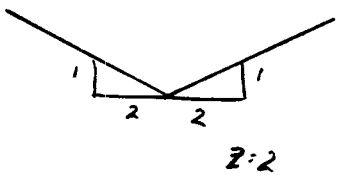
AREA NO.	t_c (4)	PEAK FLOW (CFS) (5) Q_{10-24}	Q_{25-24}	Q_{50-24}	Q_{100-24}
	.077 HR				3.68

4) KEN'S
$t_c = L^{.8} (S+1)^{.7} / 1900\, Y^{.5} / .6$ EQ. = 2.60 PAGE 102
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURB. AREAS - BARFIELD AND HAAN

5) SCS UNIT HYDROGRAPH METHOD (NEH - 4, 1972)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DETERMINE DEPTH OF FLOW



$Z = 2$

PEAK FLOW - 3.68 CFS = Q_{100-20}

USE MANNING FORMULA

$n = .023$ UNIFORM - NOT VEG.
$S = .027$

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

$$A = Zd^2$$
$$R = Zd/2\sqrt{Z^2+1}$$

$$Q = Zd^2 \times 1.486/n \times \left(Zd/2\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= 2d^2 \times 1.486/.023 \times \left(2d/2\sqrt{2^2+1}\right)^{2/3} \times (.027)^{1/2}$$

$$= 2d^2 \times 64.61 \times (.45d)^{2/3} \times .16$$

TRY $d = .6$ FT

$$Q = 2(.6)^2 \times 64.61 \times (.45(.6))^{2/3} \times .16$$

$$= 3.10 \text{ CFS}$$

TRY $d = .64$ FT

$$Q = 2(.64)^2 \times 64.61 \times (.45(.64))^{2/3} \times .16$$

$$= 3.68 \text{ CFS}$$

USE $d = .69$ FT.

VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.023\ (.29)^{2/3} \times (.027)^{1/2}$

$= 4.61$ FPS

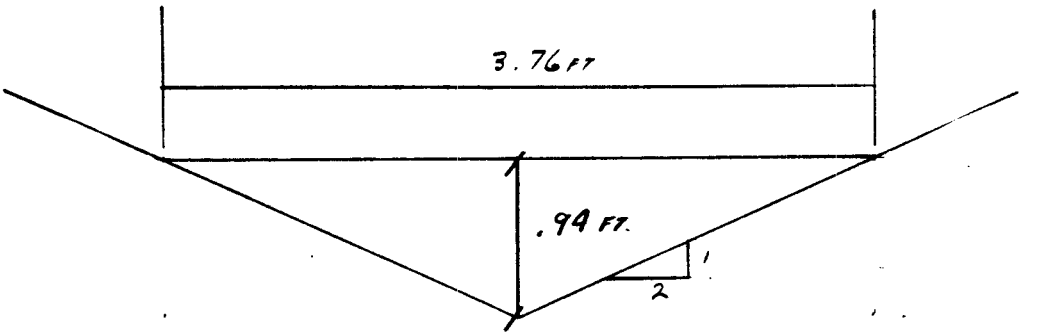
$R = .45(.64) = .29$
$S = .027$
$n = .023$

TOTAL DEPTH = DEPTH OF FLOW + FREE BOARD

$= .64$ FT $+ .3$ FT

$= .94$

DITCH DESIGN



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 16

WASTE ROCK DISPOSAL AREA CAPACITY AND SCHEDULE

REVISED 9-18-89
G. TAYLOR

THE DISPOSAL AREA WAS DESIGNED TO HOLDS 131,000 YD³ OF MATERIAL. AS OF 13 AUGUST 1987, 11,541 YD³ HAD BEEN PLACED AT THE DISPOSAL SITE

YEAR	VOLUME STORED YD³	ACC. VOL. YD³
1984		131,000
1987	11,541	119,459
1988	20,000	99,459
1989	10,000	89,459
1990	10,000	79,459
1991	10,000	69,459
1992	10,000	59,459
1993	10,000	49,459
1994	10,000	39,459
1995	10,000	29,459
1996	10,000	19,459
1997	10,000	9,459
1998	8472	987

THE REMAINING 987 YD³ WILL BE USED FOR SEDIMENT STORAGE AND WATER DETENTION.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 17

RECLAMATION COSTS

G. TAYLOR
6-30-89
REVISE INDEX PAGE

TABLE OF CONTENT

RECLAMATION EQUIPMENT 1-1a

RECLAMATION COST CALCULATION - REMOVAL BUILDING + EQUIP. 2-3

MINE SITE MATERIAL BALANCE 4-10

WATER TANK RECLAMATION COST 11-15

MINE SITE RECLAMATION COST
1. BACKFILLING AND GRADING 16-20
2. TOPSOIL ADDITION AND RIPPING 21-25
3. DRAINAGE RECONSTRUCTION 26-35

LOADOUT SITE MATERIAL BALANCE 36-37

LOADOUT SITE RECLAMATION COST
1. BACKFILLING AND GRADING 38-39
2. TOPSOIL ADDITION AND RIPPING 40-42
3. SEDIMENTATION BACKFILL 43
4. CULVERT DESIGN 44-52
5 RECLAMATION SEDIMENT POND 53-55
6 INTERCEPT DITCH 56-57

WASTE ROCK DISPOSAL 58-59

SOUTH FORK BREAKOUT 60-63

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

RECLAMATION EQUIPMENT LIST (1)

EQUIPMENT	1) EQUIPMENT RATES MONTHLY (176 HRS)	WEEKLY (40 HRS)	HOURLY	OPERATING RATES
769C OFF HIGHWAY TRUCK	9,465	2935	93.50	22.65
988B WHEEL LOADER	12,535	4265	170.00	42.00
D6 D TRACK TYPE TRACTOR	6,005	2420		11.80
D8L " " "	12,665	4,350		28.50
631 D WHEEL TRACTOR SCRAPER	17,665	6,005		49.60
14G MOTOR GRADER	5,980	2,030		18.65
245 BACKHOE	19,695	6,500		43.[illegible]
10 T DUMP TRUCK	3,050	945		12.95
3/4 T 4x4 PICKUP	550	170		2.00
410 8-62 HP TRACTOR	2425	825		6.70
MULCHER		100		

LABOR RATES

FOREMAN	33.65/HR
OPERATOR	30.35/HR
TEAMSTER	29.60/HR
LABORER	23.65/HR

DEMOLITION COSTS

CONCRETE	.22/FT^3
STEEL	.16/FT^3
MIX	.17/FT^3
GUARD RAIL	.4.95/FT
FENCE	.1.22/FT
PAVING	1.48/YD^2
DISPOSAL (SITE)	5.10/YD^3
DISPOSAL (OFF-SITE)	8.00/YD^3

1) BLUE BOOK RENTAL RATES

RECLAMATION COST CALCULATION

DESCRIPTION	UNITS	UNIT COST	SUBTOTAL
BUILDING AND EQUIPMENT REMOVAL	TONS		
EQUIPMENT REMOVAL			
1,500 × 75%	1,125	$140/TON	157,500
STEEL FRAME BUILDING REMOVAL	FT.	$0.17/FT³ OF VOLUME	
SHOP - WAREHOUSE	1,856,000		315,520
	113,000		19,210
ADMINISTRATION BUILDING	78,000		13,260
MINE #1 TRANSFER TOWER	96,000		16,320
MINE #2 + 3 DRIVE HOUSE	180,000		30,600
CRUSHER - RAW COAL	88,000		14,900
TRUCK LOADOUT	30,000		5,100
RAILCAR LOADOUT	118,000		20,060
TRANSFER TOWERS	169,000		28,560
			463,530
CONCRETE AND BLACKTOP REMOVAL	FT³ OR YD²		
UPPER TERRACE CONVEYOR	972 FT³	$.22/FT³	210
MIDDLE TERRACE SHOP WAREHOUSE FOUNDATION	5,130 FT³	$.22/FT³	1,130
TRANSFER TOWER FOUNDATION MINE #1	1,782 FT³	$.22/FT³	390
CONVEYOR FOUNDATION	1,458 FT³	$.22/FT³	320
SILO	18,360	$.22/FT³	4,040

PARKING AREA	140 YD²	1.42/YD²	200
DISPOSAL	1,026 YD³	5.10/YD³	5,230
LOWER TERRACE			
CRUSHER FOUNDATION	2,916 FT³	.22/FT³	640
MINE 2 + 3 DRIVE HOUSE	3,660 FT³	.22/FT³	800
CONVEYOR FOUNDATION	2,430 FT³	.22/FT³	530
TRUCK LOADOUT FOUNDATION	270 FT³	.22/FT³	60
ROAD AND STORAGE	14,670 YD²	1.48/YD²	21,700
DISPOSAL	340 YD³	5.10/YD³	1,730
ROAD			
CONVEYOR - TRANSFER TOWER FOUNDATIONS	32,400 FT³	.22/FT³	7,130
DISPOSAL	1,200 YD³	5.10/YD³	6,120
CONCRETE REMOVAL - LOADOUT			
SILO SITES	162,000 FT³	.22/FT³	35,640
RAILCAR LOADOUT	6,700 FT³	.22/FT³	1,470
PAVING	4,660 YD²	1.48/YD²	6,900
DISPOSAL	6,784 YD³	5.10/YD³	34,600
BACKFILLING - PORTAL AREA - SECTION 17, VOL. 5 PAGE 16			
MINE #1	6,940		6,940
MINE #2 + #3	6,940		6,940

MINE SITE
MATERIAL BALANCE

AREA	CUT (YD^3)	FILL (YD^3)
LOWER BENCH (SECTION 17, VOL. 5 PAGES 5+6)	39,719	103,352
MIDDLE BENCH (SECTION 17, VOL. 5 PAGE 7)	159,200	7,360
UPPER BENCH		
WEST FORK (SECTION 17, VOL. 5 PAGE 8)	46,607	48,744
SOUTHWEST FORK (SECTION 17, VOL. 5 PAGE 9)	15,667	85,800
WATER TANK (SECTION 17, VOL. 5 PAGE 10)		1,683
	261,193	246,939

ASSUMPTION

THE CUT AND FILL MATERIAL VOLUMES WILL BALANCE OF THE COMPACTION OF THE FILL

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

LOWER BENCH

CUT	FILL
SECTION A-A' - MAP 4.4.2-1B	
71 × 40 □' = 2,840 □'	N 66 × 40 □' = 2,640 □'
SECTION B-B' - MAP 4.4.2-1B	
51 × 40 □' = 2,040 □'	N 15 × 40 □' = 600 □' 11 × 40 □' = 440 □' S 65 × 40 □' = 2,600 □'
SECTION C-C' MAP 4.4.2-1B	
19 × 40 □' = 760 □'	N 112 × 40 □' = 4,480 □' S 52 × 40 □' = 2,080 □'

CUT MATERIAL

2,840 SECTION A-A'
2,040 SECTION B-B'
4,880 ÷ 2 = 2,440 □' × 270 FT. = 658,800 CU. FT.

2,040 SECTION B-B'
760 SECTION C-C'
2,800 ÷ 2 = 1,400 □ × 233 FT. = 326,200 CU. FT.

760 □' ÷ 2 = 380 □ × 230 FT = 87,400 CU. FT.

1,072,400 CU. FT. ÷ 27 = 39,719 YD^3

FILL MATERIAL

NORTH SIDE

2,640 SECTION A-A'
1,040 SECTION B-B'
3,680 ÷ 2 = 1,840 □' × 270 FT = 496,800 CU. FT

1,040 SECTION B-B'
4,480 SECTION C-C'
5,520 ÷ 2 = 2,760 □' × 233 FT = 643,080 CU. FT

4,480 □' ÷ 2 = 2,240 □' × 230 FT = 515,200 CU. FT.

1,655,080 CU. FT ÷ 27 = 61,299 YD³

SOUTH SIDE

2,600 ÷ 2 = 1,300 □' × 270 FT = 351,000 CU. FT

2,600 SECTION B-B'
2,080 SECTION C-C'
4,680 ÷ 2 = 2,340 □' × 233 FT = 545,220 CU. FT.

2,080 ÷ 2 = 1,040 □' × 230 FT = 239,200 CU. FT.

1,135,420 CU. FT. ÷ 27 = 42,053 YD³

103,352 YD³

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

MIDDLE BENCH

CUT FILL

SECTION E-E MAP 4.4.2-1B

144 × 40□' = 5,760□'

SECTION F-F' MAP 4.4.2-1B

55 × 40□' = 2,200□' 24 × 40□' = 960□'

CUT MATERIAL

5,760□' × 540 FT = 3,110,400 CU.FT

2,200□' × 540 FT = 1,188,000 CU.FT

4,298,400 CU.FT. ÷ 27 = 159,200 YD³

FILL MATERIAL

960□' × 207 FT = 198,720 CU.FT ÷ 27 = 7,360 YD³

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

UPPER BENCH

CUT | FILL

WEST FORK

SECTION G-G' MAP - 4.4.2-1B

73 × 40 □' = 2,920 □'

N
121 × 40 □' = 4,840 □'

SECTION H-H' MAP - 4.4.2-1B

30 × 40 □ = 1,200 □'

N
25 × 40 □' = 1,000 □'

S
33 × 40 □' = 1,320 □'

CUT MATERIAL

2,920 □' ÷ 2 = 1,460 □' × 455 FT = 664,300 CU.FT

2920
1,200
4,120 ÷ 2 = 2,060 □' × 268 FT = 552,080 CU.FT.

1,200 ÷ 2 = 600 □' × 70 FT = 42,000 CU.FT.

1,258,380 CU.FT ÷ 27 = 46,607 YD³

FILL MATERIAL

NORTH SIDE

4,840 □' ÷ 2 = 2,420 □' × 135 FT = 326,700 CU.FT.

4890
1000
5,840 ÷ 2 = 2,920 □' × 250 FT = 730,000 CU.FT.

1000 ÷ 2 = 500□' × 70 FT = 35,000 CU. FT.

1,091,700 CU. FT. ÷ 27 = 40,433 YD³

SOUTH SIDE

1320 ÷ 2 = 660□' × 340 FT = 224,400 CU. FT. ÷ 27 = 8,311 YD³

SOUTHWEST FORK

CUT	FILL
25 × 40□' = 1,000□'	198 × 40□' = 7,920□'

CUT MATERIAL

1,000□ ÷ 2 = 500□' × 846 FT = 423,000 CU. FT. ÷ 27 = 15,667 YD³

FILL MATERIAL

7,920□' ÷ 2 = 3,960 × 355 FT = 1,405,800 CU. FT.

7,920□ ÷ 2 = 3,960 × 230 FT = 910,800 CU. FT.

2,316,600 CU. FT. ÷ 27 = 85,800 YD³

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

WATER TANK - MAP 4.4.2-1F

FILL

SECTION A-A'

40 × 6 □' = 240 □'

SECTION B-B'

61 × 6 □' = 366 □'

FILL

240
366
606 ÷ 2 = 303 □' × 150 FT = 45,450 CU FT ÷ 27 = 1,683 YD³

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

WATER TANK SITE
RECLAMATION

MATERIAL TO BE HAULED

1,683 YD^3 OF FILL MATERIAL

USE 35 TON OFF-HIGHWAY TRUCK

HEAPED CAPACITY - 30.8 YD^3 PAGE 416 CATERPILLAR PERFORMANCE HANDBOOK, EDITION 19

LOAD FACTOR

25% ROCK, 75% EARTH = .80 PAGE 889

LOAD BANK CUBIC YARDS = LCY X. LF
= 30.8 X. 8
= 24.64 BCY

NUMBERS OF LOADS REQUIRED

1,683 YD^3 ÷ 24.64 BCY = 68.3 TRIPS

EQUIPMENT NEEDED

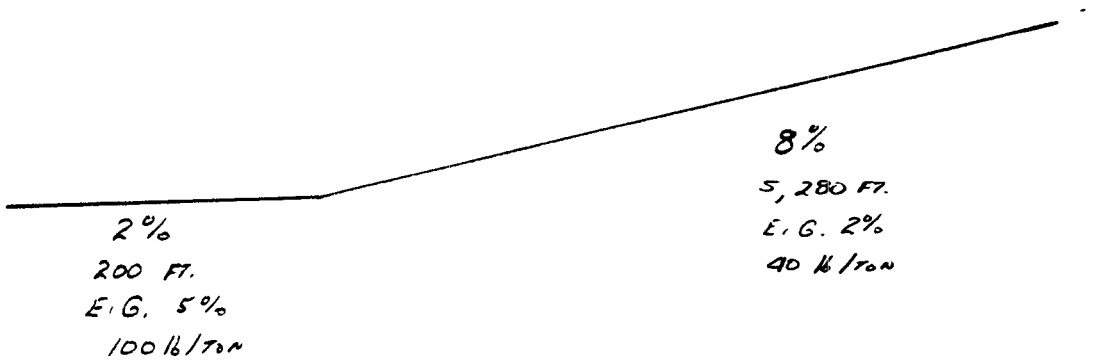
3 - 769C OFF HIGWAY TRUCK
1 - 988B WHEEL LOADER
1 - D8L TRACTOR

MATERIAL

DESCRIPTION	- 25% ROCK, 75% EARTH
BANK DENSITY	- 2,840
LOAD FACTOR	- .80
SHRINKAGE FACTOR	- .87
TRACTION FACTOR	- .70
ALTITUDE	- 8,600 - 93% DERATED

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

JOB LAYOUT - HAUL AND RETURN



SEC 1 - TOTAL EFFECTIVE GRADE = 5% + 2% = 7%
SEC 2 - TOTAL EFFECTIVE GRADE = 2% + 8% = 10%

1. ESTIMATE PAYLOAD
   $30.8\ yd^3 \times .8 \times 2840 = 69,977.6$ lbs USE <u>70,000 lbs</u>

2. MACHINE WEIGHT

EMPTY	68,000 lbs	OR	34 TON
LOADED	70,000 lbs		35 TON
	138,000 lbs		69 TON

3. USABLE PULL

   LOADED (WEIGHT ON DRIVING WHEELS 66.7%)
   $.70 \times 138,000$ lbs $\times .667 = 64,432$

   EMPTY (WEIGHT ON DRIVING WHEELS 50.4%)
   $.70 \times 138,000 \times .504 = 48,686$

4. COMPARE TOTAL RESISTENCE TO TRACTIVE EFFORT ON HAUL

   GRADE RESISTANCE

   SEC. 1 20 lb/TON × 69 TON × 2 = 2,760

   SEC 2 20 lb/TON × 69 TON × 8 = 11,040 lbs

ROLLING RESISTENCE

SEC. 1 100 lb/ton × 69 = 6,900 lbs

SEC 2 40 lb/ton × 69 = 2,760 lb

TOTAL RESISTENCE

SEC 1 6,900 lbs + 2,760 = 9,660

SEC. 2 11,090 lbs + 2,760 = 13,900 lbs

TRAVEL TIME

SEC 1 .31 min
SEC 2 6.67 min
6.98

5. COMPARE TOTAL RESISTENCE TO TRACTIVE EFFORT ON RETURN

GRADE ASSISTANCE

SEC. 1 20 lb/ton × 34 ton × 2 = 1,360 lbs

SEC. 2 20 lb/ton × 34 × 8 = 5,440 lbs

ROLLING RESISTENCE

SEC. 1 100 lb × 34 tons = 3400 lbs

SEC 2 40 lbs × 34 ton = 1,360 lbs

TOTAL RESISTENCE

SEC. 1 3,400 lbs − 1,360 = 2,040 lbs

SEC 2 1,360 − 5,440 = −4,080 lbs

TRAVEL TIME

SEC. 1 .2 min
SEC 2 3.70 min
3.90 mins

6. ESTIMATED CYCLE TIME

TOTAL TRAVEL TIME	=	10.88 MIN.
TRUCK MANEUVER	=	.7 MIN.
DUMP TIME	=	1.2 MIN.
LOADING TIME		.55 MIN.
		13.33 MIN.

7. ESTIMATED PRODUCTION

CYCLES/HR = 60 MIN/HR ÷ 13.33 MIN/CY.
= 4.50 CYCLES/HR

HOURLY UNIT PRODUCTION = 24.64 × 4.50
= 110.91 BCY

ADJUSTED PRODUCTION = 110.91 (.83)
= 92.05 BCY

HOURLY FLEET PRODUCTION = 92.05 × 3
= 276.16 BCY/HR

$1,683 \times 10^3$ ÷ 276.16 BCY/HR = 6.09 HRS

COST OF FILL AND GRADING

FILL

769 @	= ($22.65/HR × 6.09 + $95.50 × 6.09) × 3	=	2,122.06
988B @	= $42.00/HR × 6.09 HRS + 170.00 × 6.09)	=	1,291.08
OPERATOR	= $30.35/HR × 6.09 HRS	=	184.83
TEAMSTER	= $29.60/HR × 6.09 HRS × 3	=	449.43
			4,047.40
	SUPERVISOR		194.05

GRADING

D8L @	= $28.50/HR × 6.09 + 108.75 × 6.09	=	835.85	
OPERATOR	= $30.35/HR × 6.09	=	184.83	
			1020.68	
	SUPERVISOR		49.94	1,069.62
FOREMAN	= $33.65/HR × 6.09	=	204.93	
PICKUP	= $2.0/HR × 6.09 + 4.35 × 6.09	=	38.06	
			242.99	

WATER TANK TOPSOIL

TOPSOIL NEEDED

150 ft × 90 ft × 2.5 ft = 33,750 ft³ ÷ 27 = 1250 yd³

1- 769 C Off Highway Truck
1- 988 B Wheel Loader
1- D8L Tractor

HOURLY UNIT PRODUCTION

24.64 BCY × 4.50 cycle/hr = 110.88 BCY/hr

EFFICIENCY PROD.

110.88 BCY/hr × .83 = 92.03 BCY/hr

1250 yd³ ÷ 92.03 BCY/hr = 13.58 hrs

COST

769 C @	= 13.58 hrs × (93.50 + 22.65)	=	1,577.32
988 B @	= 13.58 hrs × (170.00 + 42)	=	2,878.96
D8L @	= 13.58 hrs × (108 + .28 co)	=	1,853.67
Pick up @	= 13.58 hrs × (4.25 + 2.00)	=	84.88
Operator @	= $30.35/hr × 13.58 hr	=	412.15
Teamster	= $24.60/hr × 13.58 hr	=	334.07
Foreman	= $33.65/hr × 13.58 hr	=	456.97
			7,598.02

USE = $7,600

RIPPING

TRACTOR @	.3 hr × ($6.70/hr + 20.63)	=	8.20
OPERATOR @	$30.35/hr × .3 hr	=	9.11
LABORER @	$23.65/hr × 3 hr × 3		21.29
HAY $200/ACRE	.3	=	60.00
			98.60 ≈ $100.00

PORTAL BACKFILL

MINE SIZE SILO 680 YD^3

RAIL LOADOUT SILO: 6,000 YD^3

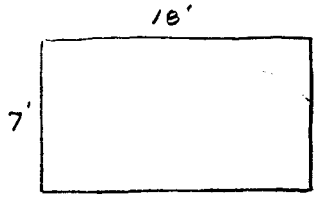
6,680 YD^3

TOTAL ENTRIES TO BACKFILL - 10

6,680 YD^3 ÷ 10 = 668 YD^3 / ENTRY SWELL FACTOR OF 20%

USE 915 LHD TO BACKFILL PORTALS

DESCRIPTION - CONCRETE
LOAD FACTOR - .80



≈ 80% OF THE ENTRY CAN BE FILLED

7' x 18' = 126 FT^2 ÷ 9 FT^2/YD^3 = 14 YD^3

668 YD^3 x 1.2 = 801.6 YD^3 ÷ 14 YD^3 = 57.26 YD x 3 = 171.77

≈ THE 172 FT OF EACH PORTAL WOULD BE FILLED

NUMBER OF TRIPS

7 YD^3 x .8 = 5.6 YD^3

801.6 ÷ 5.6 = 143.14 TRIPS / ENTRY

TRAVEL TIME

3.5 ~~MILES~~ / HR x 5,280 FT ~~MILE~~ x .02 HR/MIN = 308 FT/MIN

TOTAL DISTANCE TRAVELED
200 + 280 = 480 FT ÷ 308 FT/MIN = 1.56 MIN

TOTAL TRAVEL TIME	=	3.12 MIN
LOAD	=	.15 MIN
DUMP	=	.12 MIN
CARD, POSITION	=	.13 MIN
		3.52 MIN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

ESTIMATE PRODUCTION

CYCLES /HR = 60 MIN /HR ÷ 3.52 MIN = 17.03 CYCLES /HR

HOURLY UNIT PRODUCTION

5.6 YD^3 × 17.03 CYCLES /HR = 95.36 YD^3/HR

ADJUSTED PRODUCTION

95.36 × .83 = 79.15 YD^3/HR

HOURLY FLEET PRODUCTION

79.15 YD^3/HR × 2 = 158.30 YD^3/HR

TOTAL HOURS

801.6 YD^3 ÷ 158.30 YD^3/HR = 5.06 HR × 10 = 50.64 HRS

USE 2 - 915 E

915 E @	89.8 /HR	× 50.64 HRS	× 2	= 9,100
OPERATOR @	30.35 /HR	× 50.64 HRS	× 2	= 3,073.85
FORMAN @	33.65 /HR	× 50.64 HRS	× 1	= 1,704.04
				13,877.89 ≈ 13,800 /2 = 6,900

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PRODUCTIVITY FOR SCRAPERS

1. BACKFILL AND GRADE BENCHES

2. CHARACTERIZATION OF SCRAPER USED

CAT 631 $21\ YD^3$ (STRUCK) + $31\ YD^3$ (HEAPED) / 2 = $26\ YD^3$ AVG. CAPACITY

A D8L DOZER WILL ASSIST THE SCRAPER IN LOADING

DESCRIPTION OF SCRAPER ROUTE % GRADE THIS WOULD BE TYPICAL FOR THE MINE SITE

1000 FT. HAUL AT - 4%
1000 FT HAUL AT + 8%

CYCLE TIME

LOAD TIME	.6 MIN
LOADED TRIP TIME	.8 MIN
MANEUVER TIME	.7 MIN
RETURN TRIP TIME	.9 MIN
	3.00 MIN.

CYCLES / HOUR WORK FACTOR HOURS 50 MIN ÷ 3.00 CYCLE/MIN = 16.67 CYCLES/HR

HOURLY PRODUCTION

$26\ YD^3 \times 16.67$ CYCLES/HR = $433.33\ YD^3/HR$

PUSHER CYCLE TIME = 140% LOAD TIME = .8 MIN = 1.09 MIN.

NUMBER OF SCRAPERS / PUSHER = 3.00 MIN / 1.09 MIN = 2.75 (USE 3)

THEREFORE, THREE SCRAPERS ARE REQUIRED PER PUSHER

ASSUME A SCRAPER FLEET OF 3 AND 1 PUSHER

A. LOWER BENCH

1. PRODUCTION RATE

$433.33\ YD^3$/MACHINE/HR × 3 = $1,299.99\ YD^3/HR$

$103,352\ YD^3 \div 1299.99$ = 79.5 HRS

2. FILLING AND GRADING COST

USE THE WEEKLY RATE FOR THE EQUIPMENT

631 @ $6,005/wk × 2 wks × 3 + 49.60 × 79.5 hr × 3	=	47,859.60
D8 @ 4,350/wk × 2 wk + 28.50 × 79.5 hr × 2	=	21,931.50
OPERATOR $30.65/hr × 79.5 hrs × 5	=	12,183.38
		81,974.48
FOREMAN $33.65/hr × 79.5	=	2,675.18
PICK-UP $170/wk × 2 wks + 2.00 × 79.5	=	499.00
		3,174.18
		85,148.66

DIVIDE 85,148.66 EQUALY BETWEEN BACKFILLING AND GRADING.

B. MIDDLE BENCH

1. PRODUCTION RATE

7,360 YD^3 ÷ 1,299.99 YD^3/HR = 5.66 HRS

2 FILLING AND GRADING COST

631 @ $150/hr × 5.66 hrs × 3 + 49.60 × 5.66 × 3	=	3,391.33
D8 @ $108.75 × 5.66 hrs × 2 + 28.50 × 5.66 × 2	=	1,553.67
OPERATORS $30.65/hr × 5.66 hrs × 5	=	867.40
		5,812.40
FOREMAN @ $33.65/hr × 5.66 hrs	=	190.46
PICKUP @ $4.25/hr + $2.00/hr × 5.66	=	35.38
		225.84
		6,038.24

DIVIDE 6,038.24 EQUALY BETWEEN BACKFILLING AND GRADING

C. UPPER BENCH

1. PRODUCTION RATE

134,544 YD^3 ÷ 1,299.99 YD^3/HR = 103.5 HRS

2. FILLING AND GRADING COST

USE THE WEEKLY RATE FOR THE EQUIPMENT

631 @ $6,005/wk × 2.59 wks × 3 + 49.60 × 103.5 × 3	=	62,059.65
D8 @ 4,350/wk × 2.59 wks × 2 + 28.50 × 103.5 × 2	=	28,432.50
OPERATOR $30.65/hr × 103.5 hr × 5	=	15,861.38
	=	106,353.53
FOREMAN @ $33.65/hr × 103.5	=	3,482.78
PICK-UP @ $170/wk × 2.59 wks + $2.00 × 103.5	=	647.30
		110,483.61

DIVIDE $110,483.61 EQUALY BETWEEN BACKFILLING AND GRADING.

REFERENCE CATERPILLAR PERFORMANCE HANDBOOK, EDITION 19

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TOPSOIL BALANCE
MINE SITE

	YD^3		YD^3
TOPSOIL STOCKPILE			131,742
WATER TANK SITE	1,250		
LOWER BENCH	26,310		
MIDDLE BENCH	29,750		
UPPER BENCH	74,400		
		131,710	
			32

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TOPSOIL PRODUCTION

1. AMOUNTS NEEDED ON EACH BENCH

LOWER

NORTH SIDE

700 FT × 270 FT = 189,000 FT² × 2.5 FT = 472,500 CU.FT ÷ 27 = 17,500

SOUTH SIDE

700 FT. × 170 FT = 119,000 FT² × 2.0 FT. = 238,000 CU.FT ÷ 27 = 8,814.81

MIDDLE BENCH

NORTH SIDE

600 FT × 480 FT × 2.5 FT = 720,000 CU.FT. ÷ 27 = 26,666.67

SOUTH SIDE

260 FT × 160 FT × 2 FT = 83,200 CU FT ÷ 27 = 3,081.48

UPPER BENCH

NORTH SIDE

1000 FT × 400 FT × 2.5 FT = 1,000,000 CU.FT. ÷ 27 = 37,040

SOUTH SIDE

1300 FT × 300 FT × 2 FT = 1,008,000 CU.FT. ÷ 27 = 37,360

2. SPREAD TOPSOIL

a) USE SCRAPERS

CAT 631 $21 yd^3$ (STRUCK) + $31 yd^3$ (HEAPED)/2 = $26 yd^3$ AVG. CAPACITY

A D8L DOZER WILL ASSIST THE SCRAPERS IN LOADING

DESCRIPTION OF SCRAPER ROUTE % GRADE THIS WOULD BE TYPICAL FOR THE MINE SITE

1,800 FT HAUL AT -10%

1,800 FT HAUL AT +10%

LOAD TIME	.6 MIN
LOADED TRIP TIME	2.7 MIN
MANEVER TIME	.7 MIN.
RETURN TIME	1.7 MIN
	5.7 MIN.

CYCLES / HOUR WORK FACTOR HOURS 50 MIN ÷ 5.7 MIN = 8.77 CYCLES/HR

HOURLY PRODUCTION

26 YD³ × 8.77 CYCLES/HR = 228.07 YD³/HR

PUSHER CYCLE TIME = 140% (LOAD TIME) + .25 MIN = 1.09 MIN.

NUMBER OF SCRAPER / PUSHER = 5.7 MIN / 1.09 MIN = 5.23 (USE 5)

THEREFORE, FIVE SCRAPERS ARE REQUIRED PER PUSHER

ASSUME A SCRAPER FLEET OF 5 AND 1 PUSHER

3. LOWER BENCH

PRODUCTION RATE

228.07 YD³/HR × 5 = 1,140.35

26,310 YD³ ÷ 1,140.35 YD³/HR = 23.07 HRS

COST

L31 @	(150.13 + 49.60) 23.07 × 5	= 23,039.86
D8 @	(103.75 + 29.50) 23.07	= 3,166.36
OPERATOR	30.35 × 23.07 × 6	= 4,201.05
		30,406.27
FOREMAN	= 33.65 × 23.07	= 776.31
PICKUP	= (4.25 + 2) 23.07	= 144.19
		920.50
		31,326.77

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

RIPPING

14G GRADER

14G @ (50.75 + 18.65) 23.07	=	1601.06
OPERATOR $30.35/HR × 23.07	=	700.17
		2,301.23
TRACTOR @ (20.63 + 6.70) 23.07	=	630.39
OPERATOR 30.35 × 23.07	=	700.17
LABORER 23.65 × 23.07 × 3	=	1634.82
MULCHER 2.50 × 23.07	=	57.68
HAY $200/AC × 9.8	=	1960.00
		4,984.69
		7,286.12
		7,290

4. MIDDLE BENCH

PRODUCTION RATE

29,750 YD³ ÷ 1,140.35 YD³/HR = 26.09 HR

COST

631 @ (150.13 + 49.60) 26.09 × 5	=	26,054.79
D8 @ (108.75 + 28.50) 26.09	=	3,580.85
OPERATOR 30.35 × 26.09 × 6	=	4,750.99
		34,386.62
FOREMAN 33.65 × 26.09	=	877.93
PICK-UP (4.25 × 2) 26.09	=	163.06
		1040.99
		35,427.61
		35,430

RIPPING

14G @ (50.75 + 18.65) 26.09	=	1,910.65
OPERATOR $30.35/HR 26.09	=	791.83
		2,702.48

TRACTOR @ (20.63 + 6.70) 26.09	=	713.04
OPERATOR 30.35 × 26.09	=	791.83
LABORER 23.65 × 26.09 × 3	=	1851.09
MULCHER 2.5 × 26.09	=	65.23
HAY $200/AC × 10	=	2000.00
		5,421.19
		8,023.67
		8,020

5 UPPER BENCH.

PRODUCTION RATE

74,400 YD³ ÷ 1,140.35 YD³/HR = 65.24 HRS

COST

USE THE WEEKLY RATE

631 @ [6,005 × 1.63 + (49.60)(65.24)] 5	=	65,087.65
D8 @ 4,350 × 1.63 + (28.50) 65.24	=	8,949.84
OPERATOR 30.35 × 65.24 × 6	=	11,880.20
		85,917.69
FOREMAN 33.65 × 65.24	=	2,195.33
PICK-UP 170 × 1.63 + 2 × 65.24	=	407.58
		2,602.91
		88,520.60
		88,520

RIPPING

HAG @ 2,030 × 1.63 + 19.65 × 65.24	=	4,525.63
OPERATOR 30.65 HR × 65.24	=	1,999.61
		6,525.24
TRACTOR @ 825 × 1.63 + 6.70 × 65.24	=	1,781.86
OPERATOR 30.35 × 65.24	=	1,980.03
LABORER 23.65 × 65.24 × 3	=	4,628.78
MULCHER 100 × 1.63	=	163.00
HAY $200/AC × 11.3	=	2,260.00
		10,813.67
		17,338.91
		17,340

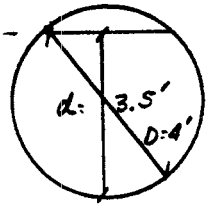
DRAINAGE RECONSTRUCTION

1. UPPER BENCH

A. BACKFILL - 48" Φ CMP

STREAM A - 590
STREAM B - 589 FT
1168 FT

ASSUME PIPE FILLS WITHIN 6 IN. OF THE TOP



CIRCLE > ½ FULL

$$\text{AREA} = D^2/8\,(2\pi - \pi\theta/180 + \sin\theta)$$

$$\theta = 4\cos^{-1}\sqrt{d/D} = 4\cos^{-1}\sqrt{3.5/4} = 82.82$$

$$\text{AREA} = (4)^2/8\,(2\pi - \pi(82.82)/180 + \sin 82.82)$$

$$= 7.69 \text{ SQ. FT.}$$

$$7.69\ D' \times 1168\ \text{FT} = 8{,}991.92\ \text{CU.FT.} \div 27 = 332.66\ \text{YD}^3$$

COST

MATERIAL

332.66 YD³ × $25.50/YD³ (DELIVERED) = $8,482.92

PUMP - AQUALIGHT $25.00/HR

PUMP RATE - 30 YD³/HR

332.66 YD³ ÷ 30 YD³/HR = 11.09 HRS

11.09 HRS × $25.00/HR = $277.22

LABOR

$23.65/HR × 3 MEN × 11.09 HRS = $786.89

CMP BACKFILL COST

MATERIAL	-	8,482.92
EQUIPMENT	-	277.22
LABOR	-	786.84
		9,546.98
		9,550

B. STREAM CHANNEL COST

1. STREAM A

FILTER BLANKET

34.83 ft² × 850 ft = 29,608.33 cu.ft ÷ 27 = 1,096.60 yd³

1,096.60 yd³ × $9.50/yd³ = $10,417.75

RIPRAP

39.48 ft² × 850 ft = 33,558 cu ft ÷ 27 = 1,242.89 yd³

1,242.89 yd³ × $11.50/yd³ = $14,293.22

MATERIAL TO BE PLACED WITH A 245 EXCAVATORS

BUCKET - 4.25 yd³ FOR FILTER BLANKET
2.87 yd³ FOR ROCK

CYCLE TIME

LOAD BUCKET	= .13 MIN
SWING LOADED	= .07 MIN
DUMP BUCKET	= 1.00 MIN
SPREAD MATERIAL	= 1.50 MIN
SWING EMPTY	= .07 MIN
	2.77 MIN

CATERPILLAR PERFORMANCE HANDBOOK, EDITION 19

FILTER BLANKET - EQUIPMENT HRS

50 MIN/HR ÷ 2.77 CYCLE/MIN = 18.05 CYCLE/HR

18.05 CYCLE/HR × 4.25 yd³ = 76.71 yd³/HR

1,096.60 yd³ ÷ 76.71 yd³/HR = 14.29 HRS

RIPRAP - EQUIPMENT HRS

1805 CYCLES/HR × 2.87 YD³ = 51.80 YD³/HR

1,242.89 YD³ ÷ 51.80 YD³/HR = 23.99 HR

2. STREAM B

FILTER BLANKET

34.93 FT² × 870 FT = 30,302.10 CU. FT. ÷ 27 = 1,122.30 YD³

1,122.30 YD³ × $9.50/YD³ = $10,661.85

RIPRAP

39.48 FT² × 870 FT = 34,347.60 CU. FT. ÷ 27 = 1,272.13 YD³

1,272.13 YD³ × $11.50/YD³ = $14,629.53

FILTER BLANKET

1,122.30 YD³ ÷ 76.71 YD³/HR = 14.63 HRS

RIPRAP

1,272.13 YD³ ÷ 51.80 YD³/HR = 24.56 HRS

3. TOTAL STREAM CHANNEL COST

CMP BACKFILL			
MATERIAL	-	8,482.92	
EQUIPMENT	-	277.22	
LABOR	-	796.69	
		9,546.83	$9,550
STREAM A			
MATERIAL	-	24,293.22	$24,290
STREAM B			
MATERIAL	-	25,291.38	$25,290

EQUIPMENT STRIPPER A & B

245 TOTAL HOURS 77.47

USE WEEKLY RATE

6,500 /WK × 1.99 WK + 43.95 × 77.47 HRS = 15,993.69 $16,000

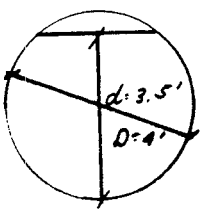
LABOR

OPERATOR	$30.35/HR × 77.47 =	2,351.21	
LABORER	$23.65/HR × 77.47 × 3 =	5,496.50	
		7,847.71	7,850
			82,980

2. MIDDLE BENCH

A. BACK FILL - CMP

48" Φ CMP



CIRCLE > 1/2 FULL

$$\text{AREA} = \frac{D^2}{8}\left(2\pi - \frac{\pi\theta}{180} + \sin\theta\right)$$

$$\theta = 4\cos^{-1}\sqrt{d/D} = 4\cos^{-1}\sqrt{3.5/4} = 82.92$$

$$A = \frac{(4)^2}{8}\left(2\pi - \frac{\pi(82.92)}{180} + \sin 82.92\right)$$
$$= 7.69 \text{ SQ. FT.}$$

7.69 SQ.FT × 410 FT = 3,152.90 CU.FT ÷ 27 = 116.77 YD³

COST

MATERIAL

116.77 YD³ × $25.50 = 2,977.64

PUMP - AQUALIGHT $25.00

PUMP RATE 30 YD³/HR

116.77 YD³ ÷ 30 YD³/HR = 3.89 HR

3.89 HR × $25/HR = 97.31

LABOR

$23.65/HR × 3 × 3.89 = $276.00

B. STREAM CHANNEL COST

1. STREAM C

FILTER BLANKET

34.83 FT² × 720 FT = 25,077.60 FT³ ÷ 27 = 928.8 YD³

928.8 YD³ × $9.50/YD³ = $8,823.60

RIPRAP

39.48 FT² × 720 FT = 28,425.60 FT³ ÷ 27 = 1,052.80 YD³

1,052.80 YD³ × $11.50/YD³ = $12,107.20

FILTER BLANKET - EQUIPMENT HRS

928.8 YD³ ÷ 76.71 YD³/HR = 12.11 HRS

RIPRAP - EQUIPMENT HRS

1052.8 YD³ ÷ 51.80 YD³/HR = 20.32 HRS

2. STREAM D

FILTER BLANKET

116.61 FT² × 540 FT = 62,969.40 FT³ ÷ 27 = 2,332.20 YD³

2,332.20 YD³ × $9.50/YD³ = $22,155.90

RIPRAP

TOTAL SQUARE FT. OF RIPRAP IS 101.40 ONLY 20% OF THE TOTAL WILL HAVE TO BE PURCHASED BECAUSE LARGER SIZE MATERIAL WILL BE FOUND ON THE SITE.

101.40 FT² x .2 = 20.28 FT²

20.28 FT² x 540 = 10,951.20 FT³ ÷ 27 = 405.60 YD³

405.60 YD³ x $11.50/YD³ = 4,664.40

FILTER BLANKET EQUIPMENT HRS

2,332.20 YD³ ÷ 76.71 YD³/HR = 30.40 HRS

RIPRAP - EQUIPMENT

405.60 YD³ ÷ 51.80 Y/HR = 7.83 HR

LARGE RIPRAP

101.40 FT² x .3 = 30 FT³ x 540 = 16,200 FT³ ÷ 27 = 600 YD³

LOAD BUCKET	.24 MIN
SWING LOADED	.07 MIN
DUMP BUCKET	1.00 MIN
SPREAD MATERIAL	1.50 MIN
SWING EMPTY	.07 MIN
	2.88 MIN

50 MIN/HR ÷ 2.88 MIN/CYCLE = 17.36 CYCLES/HR

17.36 CYCLES/HR x 2.87 YD³ = 49.83 YD³/HR

600 YD³ ÷ 49.83 YD³/HR = 12.04 HRS

3. TRANSITION FROM STREAM B TO STREAM D

FILTER BLANKET

93 FT² x 92 FT = 8,556 FT³ ÷ 27 = 316.89 YD³

316.89 YD³ x $9.50/YD³ = $3,010.44

RIPRIP

TOTAL SQUARE FT. OF RIPRAP IS 90 SQ. FT. ONLY 20% OF THE TOTAL WILL HAVE TO BE PURCHASED BECAUSE LARGER SIZE MATERIAL WILL BE FOUND ON THE SITE.

90 SQ. FT × .2 = 18 FT²

18 FT² × .92 FT = 1,656 FT³ ÷ 27 = 61.33 YD³

61.33 YD³ × $11.50 = 705.33

LARGE RIPRAP

90 FT² × .3 = 27 FT² × .92 FT = 2,484 FT³ ÷ 27 = 92 YD³

FILTER BLANKET - EQUIPMENT HRS

613.08 YD³ ÷ 76.71 YD³/HR = 7.99 HRS

RIPRAP

61.32 YD³ ÷ 51.91 YD³ = 1.18 HRS

92 YD³ ÷ 49.83 YD³/HR 1.85 HRS

3.03 HRS

4 TRANSITION FROM STREAM C TO STREAM D

FILTER BLANKET

57.40 FT² × 35 FT = 2009 FT² ÷ 27 = 74.41 YD³

74.41 YD³ × $9.50/YD³ = 706.87

RIPRAP

TOTAL SQUARE FT. OF RIPRAP IS 46.37 SQ. FT. ONLY 20% OF THE TOTAL WILL HAVE TO BE PURCHASED BECAUSE LAGRER SIZE MATERIAL WILL BE FOUND ON THE SITE.

46.37 SQ. FT × .2 = 9.27 FT²

9.27 FT² × 35 FT = 324.56 FT³ ÷ 27 = 12.02 YD³

12.02 YD³ × $11.50 /YD³ = $138.23

LARGE RIPRAP

46.37 FT² × .3 = 13.91 FT² × 35 FT = 486.89 FT² ÷ 27 YD³ = 18.03 YD³

FILTER BLANKET - EQUIP. HRS

74.41 YD³ ÷ 76.71 YD³/HR = .97 HRS

RIPRAP

12.02 YD³ ÷ 51.91 YD³/HR = .23 HRS

18.03 YD³ ÷ 49.83 YD³/HR = .36 HRS

.59

C. TOTAL STREAM CHANNEL COST

CMP BACKFILL			
MATERIAL	-	2,977.64	
EQUIPMENT	-	97.31	
LABOR	-	276.00	
		3,350.95	3,350
STREAM C			
MATERIAL		20,930.90	20,930
STREAM D			
MATERIA		26,820.30	26,920
TRANSITION B TO D			
MATERIAL		3,715.77	3,720
TRANSITION C TO D			
MATERIAL		845.10	850

EQUIPMENT HOURS FOR STREAM C + D, TRANSITIONS B to D + C to D

245 TOTAL HOURS 94.31 HRS

USE WEEKLY RATE

6,500 × 2.36 wk + 43.95 × 94.31 = 19,470.30 19,470

LABOR

OPERATOR $30.35/HR × 94.31/HR = 2,862.31
LABORER 23.65/HR × 94.31/HR × 3 = 6,691.29
9,553.60 9,550
84,690

3 LOWER BENCH

A. STREAM CHANNEL COST

1 STREAM E

FILTER BLANKET

81 FT² × 730 FT = 59,130 FT³ ÷ 27 = 2,190 YD³

2,190 YD³ × $9.50/YD³ = $20,805

RIPRAP

TOTAL SQ. FT. OF RIPRAP IS 72 FT² ONLY 20% OF THE TOTAL WILL HAVE TO BE PURCHASED BECAUSE LARGER SIZE MATERIAL WILL BE FOUND ON THE SITE

72 FT² × .2 = 14.40 FT²

14.40 FT² × 730 FT = 10,512 FT³ ÷ 27 = 389.33 YD³

389.33 YD³ × $11.50/YD = $4,477.33

LARGE RIPRAP

72 FT² × .3 = 21.60 FT² × 730 FT = 15,769 FT³ ÷ 27 YD³ = 584 YD³

FILTER BLANKET - EQUIPMENT HRS

2,190 YD³ ÷ 76.71 YD³ = 28.55 HRS

RIPRAP

389 33 YD³ ÷ 51.8 YD³/HR = 7.51 HRS

584 YD³ ÷ 49.83 YD³/HR = 11.72 HRS

19.23 HRS

B. TOTAL STREAM CHANNEL COST

STREAM E

MATERIAL 25,282.33 = 25,280

EQUIPMENT HOURS

245 TOTAL HOURS 47.88

USE WEEKLY RATE

$6,500/WK × 1.20 WK + 43.95 × 47.88 = 9,884.83 = 9880

LABOR:

OPERATOR - $30.35/HR × 47.88 = 1,453.16
LABORER - $23.65/HR × 47.88 = 1,132.36
2,585.52 2,590

37,750

LOADOUT SITE MATERIAL BALANCE

CUT

SECTION A - A' MAP - 4.4.2-1D

75 × 40 FT² = 3,000 FT²

2,340 FT² × 280 FT = 655,200 FT³ ÷ 27 = 24,267 YD³

SECTION B - B' MAP 4.4.2 - 1D

42 × 40 FT² = 1,680 FT²

2200 FT² × 500 FT = 1,100,000 FT³ ÷ 27 = 40,741 YD³

SECTION C - C' MAP 4.4.2 - 1D

68 × 40 FT² = 2,720 FT²

1660 FT² × 500 FT = 830,000 FT² ÷ 27 = 30,741 YD³

SECTION D - D' MAP 4.4.2 - 1D

15 × 40 FT² = 600 FT²

96,149 YD³

FILL

SECTION C - C' MAP 4.4.2 - 1D

90 × 40 FT² = 3600 FT²

3,060 FT² × 500 = 1,530,000 ÷ 27 = 56,667

SECTION D - D' MAP 4.4.2 - 1D

63 × 40 FT² = 2,520 FT²

$2{,}300\ ft^2 \times 420\ ft = 966{,}000\ ft^3 \div 27 =$ $35{,}778\ yd^3$

SECTION E - E' MAP 4.4.2 - 1P

$52 \times 40\ ft^2 = 2{,}080\ ft^2$

SED. POND

$18 \times 40\ ft^2 = 720\ ft^2 \times 150\ ft = 108{,}000\ ft^3 \div 27 =$ $4{,}000\ yd^3$

$96{,}445\ yd^3$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PRODUCTIVITY FOR SCRAPERS

1. BACKFILL AND GRADING

2. CHARACTERIZATION OF SCRAPER USED

CAT 631 $21 YD^3$ (STRUCK) + $31 YD^3$ (HEAPED)/2 = $26 YD^3$ AVG. CAPACITY

A D8L DOZER WILL ASSIST THE SCRAPER IN LOADING

DESCRIPTION OF SCRAPER ROUTE % GRADE THIS WOULD BE TYPICAL FOR THE LOADOUT SITE

1700 FT @ -4 %
1700 FT @ +4 %

CYCLE TIME

LOAD TIME	-	.6
LOADED TRIP TIME	-	1.20
MANEUVER TIME	-	.7
RETURN TRIP TIME	-	1.10
		3.60 MIN.

CYCLES/HOUR = WORK FACTOR HOURS 50 MIN/HR ÷ 3.60 MIN = 13.89 CYCLES/HR

HOURLY PRODUCTION.

$26 YD^3 \times 13.89$ CYCLES/HR = $361.11 YD^3/HR$

PUSHER CYCLE TIME = 140% LOAD TIME + .25 MIN = 1.09 MIN

NUMBER OF SCRAPERS/PUSHER = 3.60/1.09 = 3.30 (USE 3)

THEREFORE, THREE SCRAPERS ARE REQUIRED PER PUSHER

ASSUME, A SCRAPER FLEET OF 3 AND 1 PUSHER

TOTAL FLEET PRODUCTION RATE

$361.11 YD^3/HR$ /UNIT × 3 UNITS = $1,083.33 YD^3/HR$

$96,149 YD^3 \div 1,083.33 YD^3/HR$ = 88.75 HRS

FILLING AND GRADING COST

USE THE WEEKLY RATE FOR THE EQUIPMENT

631 @ (6,005/wk × 2.22 + 49.60 × 88.75) 3	=	53,199.30
D8 @ 4,350/wk × 2.22 + 28.50 × 88.75 × 2	=	24,372.75
OPERATOR 30.65/HR × 88.75 × 5	=	13,600.94
		91,172.99
FOREMAN - 33.65/HR × 88.75	=	2,986.44
PICK-UP - 170/wk × 2.22 + 2.00 × 5.375	=	554.90
		3,541.34
		94,714 33

DIVIDE 94,710 EQUALLY BETWEEN BACKFILLING AND GRADING

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TOPSOIL BALANCE
LOADOUT SITE

	YD^3	
TOPSOIL STOCKPILE		35,589 YD^3
WASTE DISPOSAL SITE	3,480	
LOADOUT SITE	32,109	

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

13,101

TOPSOIL PRODUCTION
LOADOUT SITE

1. CHARACTERIZATION OF SCRAPER USED

CAT 631 $21 YD^3$ (STRUCK) + $31 YD^3$ (HEAPED) / 2 = $26 YD^3$ AVG. CAPACITY

A DBL DOWER WILL ASSIST THE SCRAPER IN LOADING

DESCRIPTION OF SCRAPER ROUTE TO GRADE THIS WOULD BE TYPICAL FOR THE LOADOUT SITE

1700 FT @ -4%
1700 FT @ -4%

CYCLE TIME

LOAD TIME	.6 MIN
LOADED TRIP TIM	1.2 MIN
MANEUVER TIME	.7 MIN
RETURN TRIP TIME	1.1 MIN
	3.60 MIN

CYCLES / HOUR = WORK FACTOR HOURS = 50 MIN/HR ÷ 3.60 MIN = 13.89 CYCLES/HR

HOURLY PRODUCTION

$26 YD^3$ × 13.89 CYCLES/HR = $361.11 YD^3/HR$

PUSHER CYCLE TIME = 140% LOAD TIME = .25 MIN = 1.09 MIN

NUMBER OF SCRAPERS / PUSHER = 3.60/1.09 = 3.30 (USE 3)

THEREFORE, THREE SCRAPERS ARE REQUIRED PER PUSHER

ASSUME, A SCRAPER FLEET OF 3 AND 1 PUSHER

TOTAL FLEET PRODUCTION RATE

$361.11 YD^3/HR$ × 3 = $1,083.33 YD^3/HR$

$32,109 YD^3$ ÷ $1,083.33 YD^3/HR$ = 29.6 HRS

TOPSOIL ADDITION

631 @	(6,005 x .74 + 49.60 x 29.64) x 3	=	17,741.41
DO	4,350 x .74 + 28.50 x 29.64	=	4,063.74
OPERATORS	$30.35/HR x 29.64 x 4	=	3,598.30
			25,403.45
FOREMAN	$33.65/HR x 29.64	=	997.39
PREVIO	170 x .74 + 200 x 29.60	=	185.00
			1182.47
			26,585.92
			USE
			26,590.00

RIPPING

146 GRADING

146 @	5,980 x .75 + 18.65 x 29.64	=	4977.99
OPERATOR	30.35/HR x 29.64	=	899.57
			5,877.56
TRACTOR @	(20.63 + 6.70) 29.64	=	810.06
OPERATOR	30.35 x 29.64	=	899.57
LABORERS	23.65 x 29.64 x 3	=	2102.96
MULCHER	2.50 x 29.64	=	74.10
HAY	$200/AC x 8.7	=	1740.00
			5,626.69
			11,504.25
			USE
			11,500

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SEDIMENTATION POND :
AT LOADOUT BACKFILL

1. BACKFILL

USE 245 EXCAVATOR

BUCKET SIZE - 4.24 YD^3

PRODUCTION RATE

LOAD BUCKET	-	.24 MIN
SWING LOADED	-	.12 MIN
DUMP BUCKET	-	.05 MIN
SPREAD MATERIAL	-	1.00 MIN
[illegible]	-	4.00 MIN
[illegible]	-	.10 MIN
		5.51 MIN

50 MIN/HR ÷ 5.51 MIN/CYCLE = 9.07 CYCLES/HR.

9.07 CYCLES/HR × 4.25 YD^3 = 38.57 YD^3/HR

4000 YD^3 ÷ 38.57 YD^3/HR = 103.72 HR

2. COST

USE WEEKLY RATE ON THE 245

245 @	6500 × 2.59 WK × 43.25 × 103.72	= 21,384.44
OPERATOR	30.35 × 103.72	= 3,147.90
LABORER	23.65 × 103.72 × 2	= 4,905.96
FOREMAN	- 33.65 × 103.72	= 3,490.18
PICKUP	= 170 × 2.59 × 2.00 × 103.72	= 647.74
		33,576.22
		USE
		33,580

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G TAYLOR
REVISED
11-17-89

RECLAMATION LOADOUT SITE
CHANGE OUT ARCH CULVERT
FOR CMP CD-17

REPLACE ARCH CULVERT AT THE WEST END OF THE LOADOUT SITE WITH AN ARCH CULVERT THAT WILL PASS THE 100 YR. - 24 HR. STORM EVENT.

DRAINAGE AREA - 3,490.76 ACRES - MAP 3.2.8-3

HYDRAULIC LENGTH - 18,150 FT. FROM THE CULVERT TO SOUTH ECCLES CANYON DRAINAGE

ΣCI = 46,218,000 SECTION 12, VOL 5

SLOPE - 30.93 % SECTION 12, VOL. 5

CN = 65 SECTION 12, VOL. 5

RATHWAY COEFF. = 0.7

		P(IN)	Q CFS
SECTION 2	S.FT 10-24	2.43	212.3
	50-24	3.10	524.2
	100-24	3.5	768.5

DETERMINE THE SIZE OF THE ARCH CULVERT

USE MANNING FORMULA

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

TRY AN ARCH THAT SPANS - 8'-7" AND HAS A RISE OF 5'-11"

$A = 40\ FT^2$

$n = .024$

$S = .03$

SURFACE MINING WATER DIVERSION DESIGN MANUAL UNITED STATE DEPT OF INTERIOR, OFFICE SURFACE OF MINING.

$$R = \frac{2dT^2}{\frac{1}{2}\sqrt{16d^2+T^2}} - \frac{T^2}{8d}\sinh^{-1}\frac{4d}{T}$$

$$= \frac{40}{\frac{1}{2}\sqrt{16(5.92)^2+(8.57)^2}} - \frac{(8.57)^2}{8(5.92)}\sinh^{-1}\frac{4(5.92)}{8.57}$$

$= 2.87$

$Q = 40 \times 1.486/.024 \times (2.37)^{4/3} \times (.03)^{1/2}$

$= 40 \times 61.92 \times 2.03 \times .17$

$= 854.74$ cfs

USE A 8'-7" SPAN WITH A 5'-11" RISE

DETERMINE GAUGE SIZE

TYPE OF ROAD	-	OFF HIGHWAY
SIZE OF OPENING	-	MULTI-PLATE PIPE ARCH 8'-7" x 5'-11"
DEPTH OF COVER	-	10 FT
LIVE LOAD	-	H-15
TABLE	-	9-10 PAGE 113
GAGE SIZE	-	No. 10

HANDBOOK OF DRAINAGE AND CONSTRUCTION PRODUCTS 1958 EDITION

USE A STANDARD - 8'-7" x 5'-11" No. 10 PIPE-ARCH

DETERMINE VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.024 \times (2.37)^{2/3} \times (.03)^{1/2}$

$= 12.73$ FPS

RIPRAP WILL BE NEEDED

DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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

$A = 2/3\, dT$

$R = 2/3\, dT / 1/2 \sqrt{16d^2 + T^2} + \frac{T^2}{8d} \sinh^{-1} \frac{8d}{T}$

$n = .017$

$S = .03$

$$Q = \frac{2}{3} dT \times \frac{1.486}{n} \times \left(\frac{\frac{2}{3} dT}{\frac{1}{2}\sqrt{16d^2 + T^2}} + \frac{T^2}{8d} \sinh^{-1}\frac{4d}{T} \right)^{2/3} \times S^{1/2}$$

$$820.58 = \frac{2}{3} d7 \times \frac{1.486}{.017} \times \left(\frac{5.71d}{\frac{1}{2}\sqrt{16d^2 + (18.57)^2}} + \frac{18.57^2}{8d} \sinh^{-1}\frac{4d}{18.57} \right)^{2/3} \times .03^{1/2}$$

$$820.58 = 5.71d \times 87.41 \left(\frac{5.71d}{\frac{1}{2}\sqrt{16d^2 + 73.99}} + \frac{73.99}{8d} \sinh^{-1}\frac{4d}{8.57} \right)^{2/3} \times .17$$

$$55.22 = 5.71d \times \left(\frac{5.71d}{\frac{1}{2}\sqrt{\underbrace{16d^2 + 73.99}_{11.81}}} + \underbrace{\frac{73.99}{8d}}_{2.77} \underbrace{\sinh^{-1}\frac{4d}{8.57}}_{1.69} \right)^{2/3}$$

TRY d

d (FT)	Q (CFS)
5	46.51
5.5	52.47
5.6	53.67

d = 5.6 FT.

DETERMINE VELOCITY AT FLOW DEPTH

$$V = \frac{1.486}{n} \times R^{2/3} \times S^{1/2}$$

$$= \frac{1.486}{.017} \times \left(\frac{5.71d}{\frac{1}{2}\sqrt{\underbrace{16d^2 + 73.99}_{1.96}}} + \underbrace{\frac{73.99}{8d}}_{2.77} \underbrace{\sinh^{-1}\frac{4d}{8.57}}_{1.69} \right)^{2/3} \times (.03)^{1/2}$$

$$= 87.41 \times (2.17)^{2/3} \times (.03)^{1/2}$$

$$= 87.41 \times 1.68 \times .17$$

$$= 24.99$$

RIPRAP IS STILL NEEDED

DETERMINE RIPRAP AND FILTER BLANKET SIZE

a) RIPRAP SIZE

THE BOTTOM OF THE ARCH-PIPE WILL BE A TRIANGULAR CHANNEL WITH 2:1 SIDE SLOPES

$D_{50} = 2.08$

FROM TABLE 5.2 PAGE 5.21 THE DESIGN D_{50} = 2.25 FT

$D_{MAX} = 1.25\ D_{50}$

$= 1.25\,(2.25) = 2.81$ FT.

RIPRAP GRADATION

	SIZE	%
$1.25\ D_{50}$	2.81	30
D_{50}	2.25	50
$.5\,D_{50}$	1.13	10
$.2\,D_{50}$	.45	10

FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

$D_{85} = .09$ IN

$D_{50} = .029$ IN

$D_{15} = .006$ IN

RIPRAP PROPERTIES

$D_{85} = 28.66$ IN

D_{50} 27 IN

D_{15} 5.06 IN

FILTER BLANKET WITH RESPECT TO BASE MATERIAL

$D_{50}(\text{FILTER})/D_{50}(\text{BASE}) < 40$

SO, $D_{50}(\text{FILTER}) < 40 \times .029 = .96$ IN

$D_{15}(\text{FILTER})/D_{15}(\text{BASE}) < 40$

SO, $D_{15}(\text{FILTER}) < 40 \times .006 = .24$ IN

$D_{15}(\text{FILTER})/D_{85}(\text{BASE}) < 5$

SO $D_{15}(\text{FILTER}) < 5 \times .09 = .45$ IN

$D_{15}(\text{FILTER})/D_{15}(\text{BASE}) > 5$

SO $D_{15}(\text{FILTER}) > 5 \times .006 = .03$ IN.

$.03 < D_{15}(\text{FILTER}) < .24$ IN.

$D_{50}(\text{FILTER}) < .96$ IN.

FILTER BLANKET WITH RESPECT TO THE RIPRAP MATERIAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO D_{50} (FILTER) > 27/40 = .68 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 5.06/40 = .13 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

SO D_{85} (FILTER) > 5.06/5 = 1.01 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 5

SO D_{15} (FILTER) < 5.06/5 = 1.01 IN.

.13 IN < D_{15} (FILTER) < 1.01 IN

D_{50} (FILTER) > .68 IN

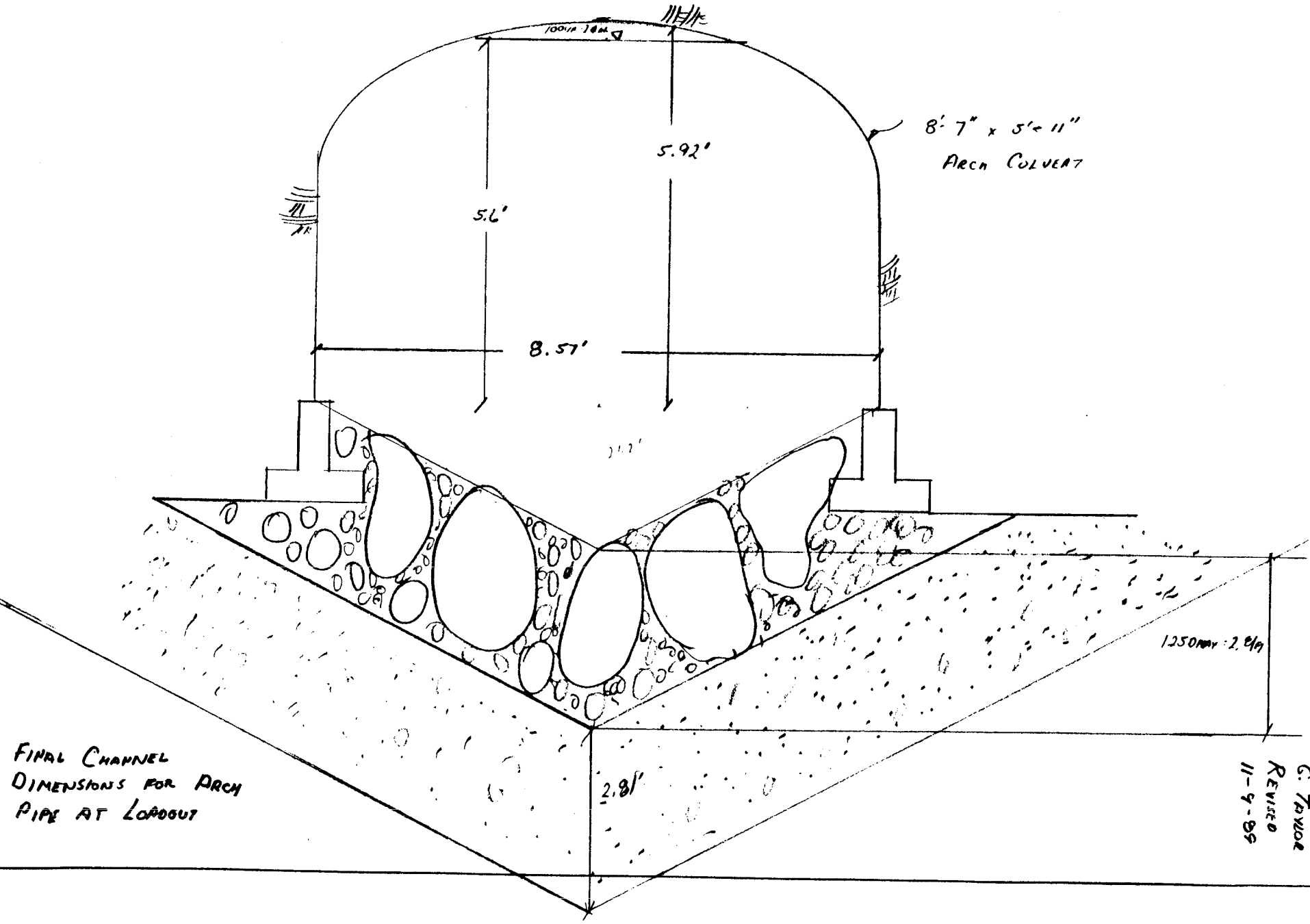
D_{85} (FILTER) > 1.01 IN

THICKNESS OF FILTER BLANKET EQUAL
MAX D_{50} = 2.81 FT.

HYDRAULIC ENGINEERING CIRCULAR
No. 11. U.S. DEPT OF TRANSPORTATION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSIONS FOR ARCH PIPE AT LOPOGUT

G. TAYLOR
REVISED
11-4-89

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

RECLAMATION COST

COST OF MATERIALS

FILTER BLANKET

20.14 FT × 2 = 40.28 FT² × 160 FT = 6,449.27 CU.FT ÷ 27 = 238.68 YD³

238.68 YD³ × $9.50 = $2,267.43

RIPRAP

40.28 FT² OF THIS TOTAL ONLY 20% OF WILL HAVE TO BE PURCHASED.

40.28 FT² × .2 = 8.06 FT²

8.06 FT² × 160 FT = 1,288.96 FT³ ÷ 27 = 47.74 YD³

47.74 YD³ × $11.50/YD = $549.00

CONCRETE

2.50 FT² × 160 FT = 400 FT² ÷ 27 = 14.81 YD³

14.81 YD³ × $400/YD = 5,925.93

ARCH - PIPE

160 FT × $30/FT = $4,800

$13,542.36
USE
13,540

EXCAVATION

USE 24S

CYCLE TIME

LOAD TIME	.07 MIN
SWING TIME	.12 MIN
DUMP BUCKET	.05 MIN
SWING TIME	.12 MIN
	.36 MIN.

CATERPILLAR PERFORMANCE HANDBOOK, EDITION 19

LOAD FACTOR

4.25 YD³ BUCKET SIZE × .95 = 4.04 YD³

50 min/hr ÷ .36 min/cycle = 138.86 cycle/hr

138.86 cycle/hr × 4.04 yd³ = 561.11 yd³/hr

Amount of Material to Move

10 ft (depth) × 20 ft (width) × 160 ft (long) = 32,000 ft³ ÷ 27 = 1,185.19 yd³

1,185.19 yd³ ÷ 561.11 yd³/hr = 2.11 hrs

Cost of Excavation

245 (162.50 + 43.85) 2.11 = $435.40
Operator $30.35/hr × 2.11 = 64.04
$499.44 use $500

Install Filter Blanket and Riprap

238.69 yd³ ÷ 76.71 yd³/hr 3.11 hr

47.74 yd³ ÷ 51.81 yd³/hr = .92 hr

190.95 yd³ ÷ 49.83 yd/hr 3.83 hr
7.86 hr

245 (162.50 + 43.85) 7.86 = 1,621.91
Operator $30.35/hr × 7.86 = 238.65
Laborer $23.65/hr × 7.86 × 3 = 557.67
2,418.23 use 2420

Arch Pipe Install + Backfill

30 ft/day

160 ft ÷ 30 ft/day = 5.33 days

5.33 days × 8 hr/day = 42.67 hrs

245 6,500 × 1.57 wks + 43.85 × 62.67 = 12,953.08
Operator 30.35 × 62.67 = 1,902.03
Laborer 23.65 × 62.67 × 4 = 1,482.15
16,337.26 use 16,340

TOTAL COST

MATERIAL COST	13,540
EXCAVATION	500
FILTER BLANKET + RIPRAP	2,420
ARCH PIPE INSTALL + BACKFILL	16,340
	32,800

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
7-5-89

RECLAMATION SEDIMENT POND DESIGN

SIZING POND

1. SEDIMENT VOLUME

0.1 AC-FT/AC FOR EACH ACRE OF DISTURBED AREA

VOL. = 0.1 AC-FT/AC × 12.56 ACRES (MAP 3.2.1-3)

= 1.26 AC-FT × 43,560 = 54,711.36

USE 54,710 CU.FT

2. STORM DETENTION

A. DISTURBED AREA CN NUMBER AFTER RECLAMATION -

TYPE	PERCENT	HYD. GROUP	CN
SILAS LOAM	80	C	86
BRYCAN	20	B	79

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20 PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN
CN: 86 RANGE LAND POOR CONDITION CN: 79 RANGE LAND POOR CONDITION

CN = 86(.80) + 79(.20) / .8 + .2

= 68.80 + 15.80 //

= 84.60 USE 85

CN: 85 FOR 8.46 ACRES SECTION 13, VOL. 5

G. TAYLOR
REVISED 11-9-89

B. UNDISTURBED AREA CN NUMBER

LS-1 MAP 3.2.8-3

CN = 58 SECTION 9, VOL. 5
ACRES = 7.86 SECTION 9, VOL. 5

DA-7 CN = 64 SECTION 13, VOL. 5
ACRES = 3.92 SECTION 13, VOL. 5

C. AVG CN FOR RECLAMATION

CN = 85	8.46 ACRES	=	719.10
CN = 58	7.86 ACRES	=	455.88
CN = 64	3.92 ACRES	=	250.88
	20.24		

CN = 719.10 + 455.88 + 250.88 / 20.24

= 70.45 USE 71

10 YR - 24 HR STORM

P = 2.43 IN. SECTION 2, VOL 5 PAG 5 OF 7

S = 1000/CN - 10

= 1000/71 - 10

= 4.08

EQ. 2.39 PAGE 81 APPLIED HYDROLOGY SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

Q = (P - 0.25)² / P + 0.85

= (2.43 - .2(4.08))² / 2.43 + .8(4.08)

EQ. 2-38 PAGE 81 APPLIED HYDROLOGY SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

= .46 IN ÷ 12 IN/FT = .04 FT.

20.24 ACRES × 43,560 FT²/AC × .04 FT = 33,612.96 CU.FT

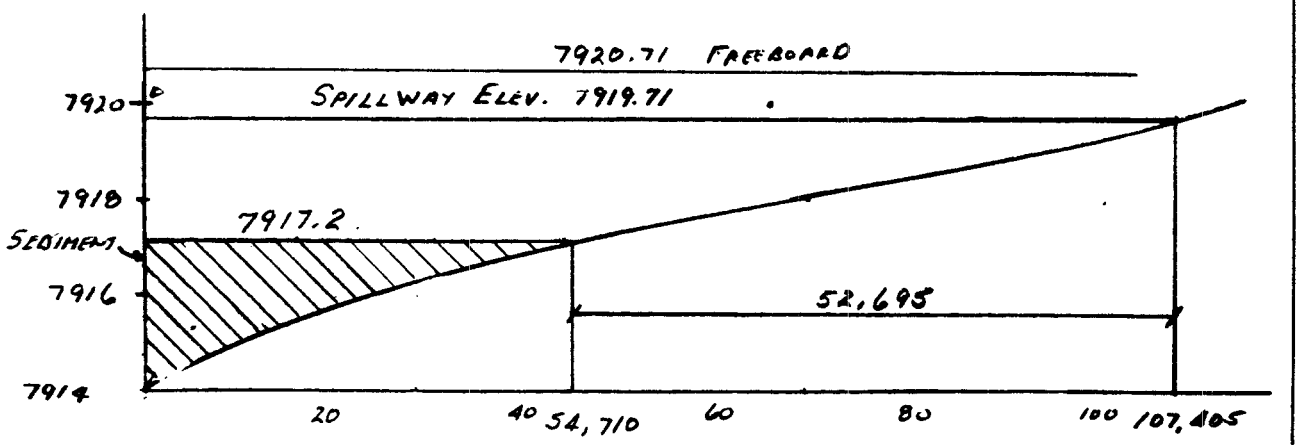
USE 33,610 CU.FT.

THEREFORE THE TOTAL STORAGE / DETENTION CAPACITY OF THE POND SHOULD NOT BE LESS THAN

$$V_T = 54,710 + 33,610 = 88,320 \text{ CU. FT.}$$

3. POND CAPACITY (MAP 4.4.2-1C)

ELEVATION	AREA (FT^2)	AVG. AREA (FT^2)	Δ VOL. (FT^3)	ACC. VOL. (FT^3)
7914	10,776			
		14,205	28,410	28,410
7916	17,634			
		20,178	40,356	68,766
7918	22,722			
		22,596	38,639	107,405
7919.71	22,470			



INTERCEPT DITCH DESIGN FOR PHASE I RECLAMATION AT TRAIN LOADOUT

UDD-3 MAP 3.2.1-3

DU-6 WILL INTERCEPT FROM THE RECLAIM SITE AND LS-1

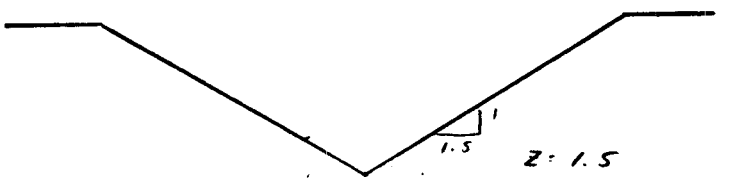
LS-1	Q_{10-24}	:	.23 CFS
LOADOUT	Q_{10-24}	:	18.41 CFS
			18.64 CFS

A. USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$n = .040$ SMALL DRAINAGE DITCH

$S = .04$



$Z = 1.5$

$A = Zd^2$

$R = Zd/2\sqrt{Z^2+1}$

PAGE 158 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

$Q = 1.486/n \times Zd^2 \times (Zd/2\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$= 1.486/.04 \times 1.5d^2 \times \left(1.5d/2\sqrt{1.5^2+1}\right)^{2/3} \times (.04)^{1/2}$

$18.64 = 37.15 \times 1.5d^2 \times (.42d)^{2/3} \times .20$

TRY $d = 1.51$ FT.

$18.64 = 37.15 \times 1.5(1.51)^2 \times (.42(1.51))^{2/3} \times .20$

$= 37.15 \times 3.42 \times .79 \times .20$

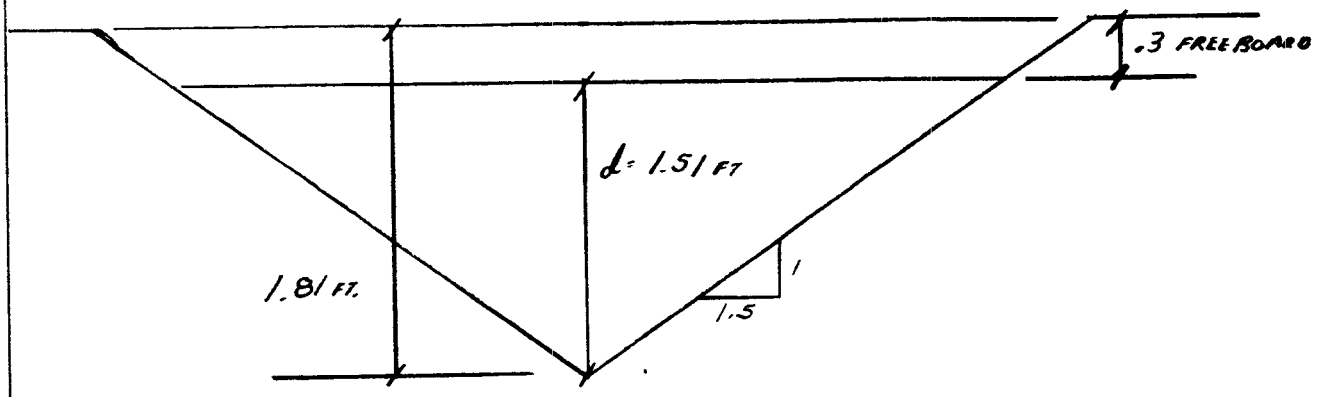
$= 18.73$ CFS

B. DITCH DESIGN

DEPTH OF DITCH = FLOW DEPTH + FREEBOARD

= 1.51 + .3

= 1.81 FT.



C. VELOCITY

$$V = 1.486/n \; R^{2/3} \; S^{1/2}$$

$$= 1.486/n \left(zd/2\sqrt{z^2+1} \right)^{2/3} S^{1/2}$$

$$= 1.486/.04 \left(1.5(1.51)/2\sqrt{1.5^2+1} \right)^{2/3} (.04)^{1/2}$$

$$= 37.15 \times .73 \times .20$$

$$= 5.42 \text{ FPS}$$

NO ERROSION CONTROL MATERIAL WILL BE NEEDED

WASTE ROCK DISPOSAL SITE

1. GRADING WILL DONE EACH TIME ADDITIONAL MATERIAL IS ADDED

2. TOPSOIL ADDITION

EQUIPMENT

3 - 10 TON DUMP TRUCK
1 - 988B WHEEL LOADER
1 - 14G MOTOR GRADER

ESTIMATED PRODUCTION TIME

CYCLE TIME

TRAVEL TIME	30. MIN
MANEUVER	.5 MIN
LOAD	.7 MIN
MANUVER	.5 MIN
DUMP	1.2 MIN
	32.9 MIN

CYCLE /HR

50 MIN/HR ÷ 32.9 MIN = 1.52 CYCLE/HR

PRODUCTION RATE

8.70 YD³ x .58 = 5.05 YD³

5.05 YD³ x 1.52 CYCLE /HR = 7.68 YD³/HR/UNIT

7.68 YD³/HR/UNIT x 3 UNITS = 23.05 YD³/HR

4,000 YD³ ÷ 23.05 YD³/HR = 173.54 HR

Cost

USE WEEKLY RATES

10T Dump Truck	-($945/wk × 4.34 wk + 12.95 × 173.54)3	= 6,347.23
988B	- $4,265 × 4.34 + 42.00 × 173.54	= 25,790.78
14G	- 2,030 × 4.34 + 18.65 × 173.54	= 12,046.72
Operator	- 30.35 × 173.54 × 2	= 10,533.86
Tamper	- 24.60 × 173.54 × 3	= 12,807.25
Foreman	- 33.65 × 173.54	= 5,839.62
Pick-up	- 170 × 4.34 × 2 × 173.54	= 1,084.88
		74,450.36
		use
		74,460

Ripping

14G	- (50.75 + 18.65) 2.3	- 138.90
Tractor	- (20.63 + 6.70) 2.3	- 62.85
Operator	- 30.35 × 2.3 × 2	- 139.61
Mulcher	- 2.50 × 2.3	- 5.75
Laborer	- 23.65 × 2.3 × 3	- 163.19
Foreman	- 33.65 × 2.3	- 77.40
Pick-up	- (4.25 × 2) 2.3	- 19.58
Hay	- $200/ac × 2.3	- 460.00
		1,061.58
		us
		1,060

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

South Fork Breakout

Fill Required

10 x 40 ft² 400 ft² x 190 ft = 76,000 ft² ÷ 27 = 2,814 yd³

Material Remove from the site - 2,840 yd³

Material will balance

Fill and Grading Cost - MAP

Fill from Knob

710 yd³

10 ton Dump Truck

Travel Time	-	15 min
Maneuver	-	.5 min
Load Time	-	.7 min
Maneuver	-	.5 min
Dump	-	1.2 min
		17.90 min

Cycle/hour

50 min/hour ÷ 17.90 min = 2.79 cycle/hr

Production Rate

8.70 yd³ x .58 = 5.05 yd³

5.05 yd³ x 2.79 cy/hr = 14.11 yd³/hr/unit

14.11 yd³/hr/unit x 2 = 28.21 yd³/hr

710 ÷ 28.21 yd³/hr = 25.17 hrs.

245 EXCAVATOR

2,130 YD^3

CYCLE TIME

LOAD BUCKET	.12 MIN	CATERPILLAR PERFORMANCE HANDBOOK EDITION 19
SWING LOADED	.12 MIN	
DUMP BUCKET	.05 MIN	
SWING EMPTY	.10 MIN	
	.39 MIN	

50 MIN/HR ÷ .39 MIN = 128.21 CYCLE/HR

PRODUCTION RATE

4.25 YD^3 × .95 LOAD FACTOR = 4.04 YD^3

4.04 YD^3 × 128.21 CYCLE/HR = 517.65 YD^3/HR

2,130 ÷ 517.65 YD^3/HR = 4.11 YD^3

FILLING AND GRADING

10 T TRUCK	(23.63 + 12.95) 25.17 HRS	-	920.72
988B LOADER	(170.00 + 42.00) 25.17 HRS	-	5,336.04
D6D TRACTOR	(60.50 + 11.80) 29.28 HRS	-	2,116.94
245 EXCAVATOR	(162.50 + 18.65) 4.11 HRS	-	749.53
OPERATOR	30.65 × 25.17 ×	-	771.46
OPERATOR	30.65 × 29.28	-	897.43
OPERATOR	30.65 × 4.11	-	125.97
TERMINAL	29.60 × 25.17 × 2	-	1,238.36
FOREMAN	33.65 × 29.28	-	985.27
PICK UP	(4.25 × 2) 29.28	-	183.00
			13,370.02
			USE
			13,320

TOPSOIL ADDITION

988 B WITH 8.25 YD³

CYCLE TIME

LOAD TIME	-	1.50 MIN
HAUL FULL	-	2.47 MIN
MANUVER	-	.5 MIN
DUMP	-	.5 MIN
MANUVER	-	.5 MIN
HAUL EMPTY	-	2.26 MIN
		7.73 MIN

BUCKET FACTOR

8.25 YD³ x .90 = 7.43 YD³/CYCLE

PRODUCTION RATE

50 MIN/HR ÷ 7.73 MIN = 6.73 CYCLE/HR

6.73 CYCLE/HR x 7.43 YD³/CYCLE = 50.03 YD³/HR

2990 YD³ ÷ 50.03 YD³/HR = 59.76 HRS

988 B LOADER	-	4265 x 1.49 + 42.00 x 59.76	- 8,882.27
D6D TRACTOR	-	2420 x 1.49 + 11.80 x 59.76	- 4,310.97
OPERATOR	-	30.35 x 59.76 x 2	- 3,627.43
FOREMAN	-	33.65 x 59.76	- 2,010.92
PICKUP	-	170 x 1.49 + 2 x 59.76	- [illegible]
			19,204.91
			USE
			19,200

MULCHER	-	2 x 2.50	= 5.00	
LABORER	-	23.65 x 2 x 3	= 141.90	
FOREMAN	-	33.65 x 2	= 67.30	
PICKUP	-	14.25 x 2 x 2	= 12.50	
HAY	-	200 lbs x .96	= 192.00	
			418.70	420
				19,620

RESTORE ROAD

8 FT × 3 FT × 12,000 FT = 288,000 FT³ ÷ 27 = 1,066.67 YD³

CYCLE TIME

LOAD TIME	=	1.00 MIN
SWING TIME	=	.12 MIN
DUMP	=	.05 MIN
COMPACTION	=	1.00 MIN
SWING TIME	=	.05 MIN
		2.22 MIN
TRAVEL TIME		1.00 MIN
		3.26 MIN

PRODUCTION RATE

50 MIN ÷ 3.26 MIN = 15.34 CYCLES/HR

15.34 CYCLE/HR × 4.04 YD³/CYCLE = 61.96 YD³/HR

1,066.67 YD³ ÷ 61.96 YD³/HR = 17.21 HRS

COST

245	(162.50 + 19.65) 17.21	=	3,119.42
OPERATOR	30.65 × 17.21	=	527.63
			3,646.05
			USE
			3,650

PORTAL SEAL

9 FT × 20 FT × 2.5 FT = 450 FT³ ÷ 27 = 16.67

16.67 YD³/PORTAL × 3 PORTAL = 50 YD³ × $400/YD = $20,000

4. 100 YR - 24 HR STORM

P = 3.5 SECTION 2, VOL 5 PAGE 5 of 7

CN = 71

S = 1000/CN - 10 EQ 2.39 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HAAN

= 1000/71 - 10

= 4.08

Q = (P - .25)²/P + .85 EQ 2.38 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA BARFIELD AND HAAN

= (3.5 - .2(4.08))²/3.5 + .8(4.08)

= 7.20/6.74

= 1.06 IN ÷ 12 IN/FT = .09 FT.

20.24 ACRES × 43,560 × .09 FT. = 78,207.07

USE 78,210 CU. FT.

REFERENCE

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) BARFIELD, B.J., R.C. WARNER, C.T. HAAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 18

RECLAIMED CHANNEL DESIGNS

G. TAYLOR
REVISED 11-26-85

TABLE OF CONTENTS

	PAGE
STREAM CHANNEL A	1-11
STREAM CHANNEL B	12-21
STREAM CHANNEL C	22-39
STREAM CHANNEL D	40-48
STREAM CHANNEL E	49-60
TRANSITION STREAM B TO D	61-65
TRANSITION STREAM C TO D	66-70

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
6-30-89

RECLAIM CHANNEL DESIGN
STREAM A

ELEV. 8693' - 8669'

MAP. 3.2.4-2
STREAM SLOPE = .0294 MAP 4.4.2-181

DESIGN FLOOD PLAIN FOR THE Q_{100-24} = SB + UD-4 - SUMMER FLOW

149.32 CFS + 1.19 CFS - 38.51 = 111.0 SECTION 2
VOL. 5, PAGE 7

DESIGN ALSO FOR A VEGETATED CHANNEL DESIGN - WITH A GRASS MIXTURE AND BUSHES.

THE CHANNEL WILL BE A TRAPEZOID

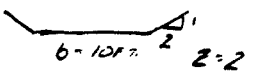
I. DETERMINE PERMISSIBLE VELOCITY

$V = 1.486/n \times R^{2/3} S^{1/2}$

R = HYDRAULIC RADIUS
S = SLOPE
n = .032 EARTH BOTTOM, RUBBLE SIDES
S = .0369 MAP 4.4.2-181

a) DETERMINE DEPTH OF FLOW

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



$A = bd + zd^2$
$R = bd + zd^2/b + 2d\sqrt{z^2+1}$
$Q = 111$ CFS

$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times (.0369)^{1/2}$

$Q = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .19$

$111.0 \text{ cfs} = 8.92 \times (10d + 2d^2) \times (10d + 2d^2/10 + 4.47d)^{2/3}$

$12.44 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRIAL d

d	Q
1.1	12.50

d 1.1

b) DETERMINE VELOCITY

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$R = (bd + 2d^2 / b + 2d\sqrt{2^2+1})$ $\quad d = 1.1$

$= 10d + 2d^2 / 10 + 2d\sqrt{2^2+1})$ $\quad b = 10$ FT

$= (10(1.1) + 2(1.1)^2 / 10 + 2(1.1)\sqrt{2^2+1})$ $\quad Z = 2$

$= 13.42 / 14.92$ $\quad S = .0369$

$= .90$

$V = 1.486/.035 \times (.90)^{2/3} \times (.0369)^{1/2}$

$= 46.44 \times .93 \times .19$

$= 8.31$ FPS

THE STREAM WILL NEED TO BE RIPRAPED

c. DETERMINE RIPRAP SIZE AND FILTER BLANKET

1) RIPRAP SIZE - MILD SLOPE

a. ASSUME $K_m = 6$ IN. $\quad K_m = D_{50}$

$n = 0.0395\ D_{50}^{1/6}$ $\quad$ EQ 4.18 PAGE 4.10

$= 0.0395\ (6/12)^{1/6}$ $\quad$ SURFACE MINING WATER

$= .035$ $\quad$ DIVERSION DESIGN MANUAL

b. CHARTS IN APPENDIX C PAGE C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q(n)$

$= .111 \quad (.035)$

$= 3.99$ ON A 4% SLOPE

$V_n = .27$

$V = V_n / n$

$V = .27/.035 =$

$V = 7.71$ FPS

$d = 1.1$ FT.

THERLFORE

$$R = 10(1 + 2(1.1)^2 / 10 + 2(1.1)\sqrt{(2)^2+1}$$

$$= .90$$

c $V^2/R^{.33} = (7.71)^2/(.90)^{.3} = 61.55$

FROM TABLE 6.4 PAGE 6.39 REQUIRED RIPRAP IS TYPE L (SURFACE MINING WATER DIVERSION DESIGN MANUAL

FROM TABLE 6.5 PAGE 6.40 TYPE L, $K_m = 9$ IN NOT $K_m = 6$ IN SURFACE MINING WATER DIVERSION DESIGN MANUAL

d. ASSUME $K_m = 9$ IN $K_m = D_{50}$

$n = 0.0395\ D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 0.0395\ (9/12)^{1/6}$

$= .038$

e. CHARTS IN APPENDIX C PAGE C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q_n$

$= 149.51\ (.039)$

$= 5.629$ ON A 27% SLOPE

$V_n = .27$

$V = V_n/n$

$= .27/.038$

$= 7.10$ FPS @ $d = 1.1$ FT

f. $V^2/R^{.33} = (7.10)^2/6.90^{.33} = 52.19$

FROM TABLE 6.4 PAGE 6.39 REQUIRED RIPRAP IS TYPE L (SURFACE MINING WATER DIVERSION DESIGN MANUAL)

FROM TABLE 6.5 PAGE 6.40 TYPE L, $K_n = 9$ IN (SURFACE MINING WATER DIVERSION DESIGN MANUAL)

g. CHECK FROUDE NUMBER

$F_R = V/\sqrt{gL}$ L = 1.18 EQ 4.6 PAGE 4.15 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 7.10/\sqrt{32.2(1.18)}$

$= 1.15 < 1$

g) RIPRAP SIZE - STEEP SLOPE
DESIGN - 111 CFS SLOPE - .0284 BOTTOM 10 FT

USE FIG 5.5 PAGE 5.19 SINCE THERE IS NO S=.0369 CURVE USE THE S=.05 CURVE. THIS WILL PROVIDE A CONSERVATIVE DESIGN.

10 FT @ 111 CFS = D_{50} = .75 FT
FROM TABLE 5.2 PAGE 5.21 SURFACE MINING WATER DIVERSION DESIGN MANUAL
D_{50} = .75 FT.

$D_{MAX} = 1.25(D_{50}) = 1.25(.75) = .99$ FT

RIPRAP GRADATION

1.25 D_{50}	= .99 FT	30%
D_{50}	= .75 FT	50%
.5 D_{50}	= .38 FT	10%
.2 D_{50}	= .15 FT	10%

2. FILTER BLANKET DESIGN
ASSUME BASE MATERIAL
D_{85} = .09 IN
D_{50} = .029 IN
D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 9.5 IN. D_{15} = 1.7 IN.

D_{50} = 9 IN.

a) EVALUATE THE NEED FOR FILTER BLANKET

D_{15} (RIPRAP) / D_{85} (BASE) < 5

2.7 / .09 = 30 < 5

D_{15} (RIPRAP) / D_{15} (BASE) < 40

2.7 / .006 = 450 < 40

FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

b) FILTER BLANKET WITH RESPECT TO BASE MATERIAL

D_{50} (FILTER) / D_{50} (BASE) < 40

so D_{50} (FILTER) < 40 x .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

so D_{15} (FILTER) < 40 x .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

EQ 5.2 PAGE 5.12
SURFACE MINING WATER
DIVERSION DESIGN MANUAL

so D_{15} (FILTER) < 5 x .09 = .45 IN.

D_{15} (FILTER) / D_{15} (BASE) > 5

so D_{15} (FILTER) > 5 x .006 = .03 IN

.03 IN. < D_{15} (FILTER) < .45 IN.

D_{50} (FILTER) < .96 IN.

c) FILTER BLANKET WITH RESPECT TO RIPRAP

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

so D_{50} (FILTER) > 9/40 = .225 IN.

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

so D_{15}(FILTER) > 1.7/40 = .04 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so D_{85} > 1.7/5 = .34 IN

EQ 5.2 PAGE 5.12
SURFACE MINING WATER
DIVERSION DESIGN MANUAL

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so D_{15} < 2.7/5 = .34 IN

.04 IN < D_{15} (FILTER) < .34 IN

D_{50} (FILTER) > .23 IN

D_{85} (FILTER) > .34 IN

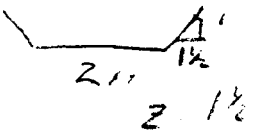
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

II SUMMER FLOW DITCH DESIGN

DESIGN FLOW Q_{10-24} + SM + UD-4 + SMR

38.17 + .34 + = 38.51 cfs
SECTION 2, VOL. 5 PAGE 7

A. DETERMINE FLOW DEPTH



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

$A = bd + zd^2$
$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$
$n = .032$
$S = .0369$

$$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$$

$$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2(d) + 1.5d^2/2 + 2d\sqrt{1.5^2+1})^{2/3} \times (.0369)^{1/2}$$

$$38.51 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + .361d)^{2/3} \times (.19)$$

$$38.51 = 8.92\,(2d + 1.5d^2) \times (2d + 1.5d^2/2 + 361d)^{2/3}$$

$$4.32 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 361d)^{2/3}$$

TRIAL d

d	Q
1.31	4.37

B DETERMINE VELOCITY

$$V = 1.486/n \; R^{2/3} \; S^{1/2}$$

$$V = 1.486/.032 \; (.77)^{2/3} \; (.0369)^{1/2}$$

$$= 46.44 \times .84 \times .19$$

$$= 7.50 \text{ FPS}$$

C. DETERMINE RIPRAP SIZE

1. RIPRAP SIZE - MILD SLOPE

a) ASSUME $K_m = 3$ IN $K_m = D_{50}$

$n = 0.0395\ D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE
$= 0.0395\ (3/12)^{1/6}$ MINING WATER DIVERSION
$= .031$ DESIGN MANUAL

b) CHARTS IN APPENDIX C C-5

$Q_n = Q_n$
$= 38.51\ (.031)$ SURFACE MINING WATER
$= 1.207$ DIVERSION DESIGN MANUAL

$V_n = .13$

$V = V_n/n$

$= .13/.031$

$= 4.194$ @ $d = 13/FT$

c) $V^2/R^{33} = (4.199)^2/(.77)^3 = 19.17$

TABLE 6.4 PAGE 6.39 DOES NOT GO BELOW 20 FT SURFACE MINING WATER DIVERSION DESIGN MANUAL

ASSUME 6 IN WILL WORK

d) CHECK FROUDE NUMBER

$F_R = V/\sqrt{gL}$ L = 1.9 EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 6.809/6.71$

$= 1.01 : 1$ THIS IS MARGINAL BUT SHOULD WORK.

$D_{50} = 6$ IN

RIPRAP GRADATION

$1.25\ D_{50}$	7.5	30
D_{50}	6 IN	50
$.5\ D_{50}$	3 IN	10
$.2\ D_{50}$	1.2 IN	10

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

D FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 IN

D_{50} = .024 IN

D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 6.38 IN

D_{50} = 6 IN

D_{15} = 1.13 IN

1. EVALUATE THE NEED FOR A BLANKET

$D_{15}(RIPRAP)/D_{85}(BASE) < 5$

$1.13/.09 = 20 < 5$

$D_{15}(RIPRAP)/D_{15}(BASE) < 40$

$1.13/.006 = 300 < 40$

FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

2. FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.1 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{50}(FILTER)/D_{50}(BASE) < 40$

SO $D_{50}(FILTER) < 40 \times .024 = .96$ IN

$D_{15}(FILTER)/D_{15}(BASE) < 40$

SO $D_{15}(FILTER) < 40 \times .006 = .24$

$D_{15}(FILTER)/D_{85}(BASE) < 5$

SO $D_{15} < 5 \times .09 = .45$ IN

D_{15} (FILTER) / D_{15} (BASE) > 5

so D_{15} (FILTER) > 5 × .006 = .03 IN

.03 IN < D_{15} (FILTER) < .45 IN

D_{50} (FILTER) < .96 IN

3. FILTER BLANKET WITH RESPECT TO RIPRAP
Eq 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

so D_{50} (FILTER) > 6/40 = .15 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

so D_{15} (FILTER) > 1.13 IN/40 = .03 IN.

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

D_{85} (FILTER) > 1.13/5 = .23 IN

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

D_{15} (FILTER) < 1.0/5 = .23 IN

.03 IN < D_{15} (FILTER) < .23 IN

D_{50} (FILTER) > .15 IN

D_{85} (FILTER) > .23 IN

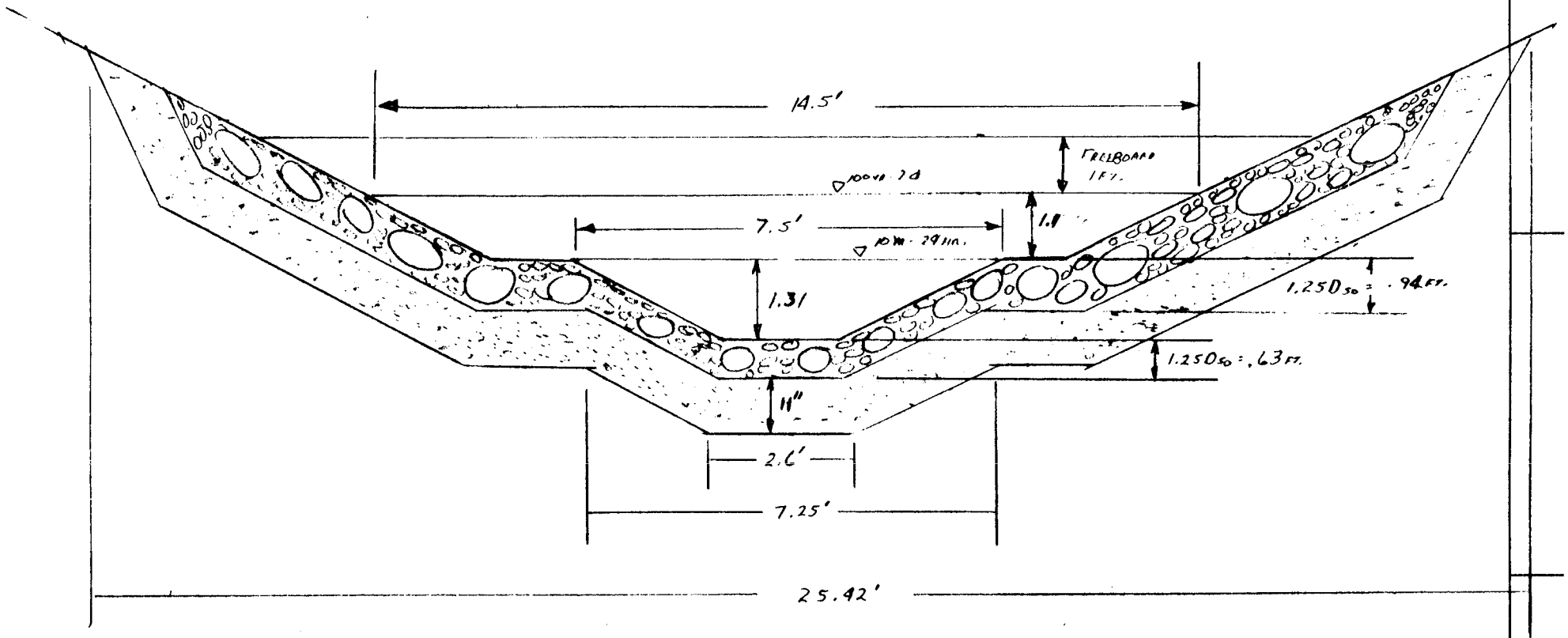
4. THICKNESS OF FILTER BLANKET (2)
THICKNESS = MAX D_{50} = .94 FT.

REFERENCE: 1. SURFACE MINING WATER DIVERSION DESIGN MANUAL, UNITED STATES DEPT. OF THE INTERIOR OFFICE OF SURFACE MINING

2. HYDRAULIC ENGINEERING CIRCULAR No. 11 - U.S. DEPARTMENT OF TRANSPORTATION.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSION FOR STREAM A

RECLAIM CHANNEL DESIGN
STREAM B

MAP 3.2.4-2

INITIAL SLOPE = .0747

DESIGN FLOOD PLAIN FOR THE Q_{100-24} = MB + UDA-2 + UDA-3 - SUMMER FLOW

$Q = 125.75 + 3.30 + .85 - 34.64 = 95.26$ cfs

SECTION 2, VOL. 5 PAGE 7

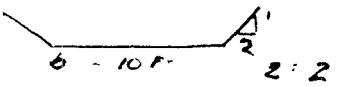
DESIGN CHANNEL TO BE A TRAPEZOID

I DETERMINE DEPTH OF FLOW

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

n = .032 EARTH BOTTOM WITH RUBBLE SIDES

S = .0452 - DESIGN SLOPE MAP 4.9.2-1B1



$A = bd + Zd^2$

$R = bd + Zd^2 / b + 2d\sqrt{Z^2+1}$

$Q = 95.26$ cfs

$Q = bd + 2d^2 \times 1.486/n \times (bd + 2d^2/b + 2d\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$= 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{2^2+1})^{2/3} \times (.0452)^{1/2}$

$= 10d + 2d^2 \times 46.44 \times 10d + 2d^2/10 + d(4.47))^{2/3} \times (.21)$

$95.26 = 9.87 \cdot (10d + 2d^2)(10d + 2d^2/10 + d(4.47))^{2/3}$

$9.65 = (10d + 2d^2)(10d + 2d^2/10 + d(4.47))^{2/3}$

TRIAL d

d (ft)	Q cfs
.9	8.82
.95	9.68

USE d = .95 ft.

II DETERMINE VELOCITY

$b = 10$ ft
$d = .95$ ft
$n = .032$
$S = .0452$

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$R = bd + 2d^2 / b + 2d\sqrt{z^2+1}$

$= 10(.95) + 2(.95)^2 / 10 + 2(.95)\sqrt{(2)^2+1}$

$= 11.31 / 14.25$

$= .79$

$V = 1.486/.032 \times (.79)^{2/3} \times (.0452)^{1/2}$

$= 46.44 \times .86 \times .21$

$= 8.49$ FPS

THE STREAM WILL NEED TO BE RIPRAPPED

III DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPRAP SIZE - MILD SLOPE

1. ASSUME $K_m = 9$ in $D_{50} = K_m$

$n = 0.0395\ D_{50}^{1/6}$
$= 0.0395\ (9/12)^{1/6}$
$= .038$

EQ. 4.18 PAGE 4-10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

2. CHARTS IN APPENDIX C PAGE C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL.

$Q_n = Q(n)$
$= 95.26\ (.038)$
$= 3.62$ CFS ON A 4½% SLOPE

$V_n = .31$

$V = V_n / n$

$V = .31/.038$

$V = 8.16$ FPS

$d = .95$ ft

3. $V^2/R^{.33} = (8.16)^2/(.79)^{.33} = 71.97.$

FROM TABLE 6.4 PAGE 6.39 REQUIRED RIPRAP IS TYPE M SURFACE MINING WATER DIVERSION DESIGN MANUAL.

FROM TABLE 6.5 PAGE 6.40 TYPE M, K_m = 12 IN SURFACE MINING WATER DIVERSION DESIGN MANUAL.

4 CHECK FROUDE NUMBER

$F_R = V/\sqrt{gL}$ $L = .95$ EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 8.16/\sqrt{32.2 \cdot .95}$

$= 1.48 > 1$

5. RIPRAP SIZE - STEEP SLOPE

DESIGN - 95.26 CFS SLOPE = .0452 BOTTOM 10 FT

USE FIG. 5.5 PAGE 5.19 SINCE THERE IS NO CURVE FOR S = .0452 USE S = .05 CURVE, THIS WILL PROVIDE A CONSERVATIVE DESIGN SURFACE MINING WATER DIVERSION DESIGN MANUAL

10 FT @ 95.26 CFS D_{50} = .70

FROM TABLE 5.2 PAGE 5.21 THE DESIGN

D_{50} = .75

$D_{MAX} = 1.25\ D_{50} = 1.25\ (.75) = .94$ FT

RIPRAP	GRADATION	
$1.25\ D_{50}$	.94 FT	30 %
D_{50}	.75 FT	50 %
$.5\ D_{50}$	.38 FT	10 %
$.2\ D_{50}$	.15 FT	10 %

6 DESIGN FILTER BLANKET

ASSUME BASE MATERIAL

D_{85} = .09 IN

D_{50} = .024 IN

D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 9.6 IN

D_{50} = 9 IN

D_{15} = 1.7 IN

a) EVALUATE THE NEED FOR FILTER BLANKET

D_{15} (FILTER) / D_{85} BASE <

$2.7/.09 = 30 < 5$

D_{15} (RIPRAP) / D_{15} (BASE) < 40

$1.7/.006 = 283 < 40$

FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

b) FILTER REQUIRED WITH RESPECT TO BASE MATERIAL
EQ 5.2 PAGE 5-12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 x .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (BASE) < 40 x .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 x .09 = .45 IN

D_{15} (FILTER) / D_{15} (BASE) > 5

D_{15} (FILTER) > 5 x .006 = .03 IN

.03 IN < D_{15} (FILTER) < .45 IN

D_{50} < .96 IN

c) FILTER REQUIRED WITH RESPECT TO RIPRAP
EQ 5.2 PAGE 5-12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO, D_{50} (FILTER) > 9/40 = .23 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO D_{15} (FILTER) > 1.7/40 = .04 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so D_{85} (FILTER) < 1.7/5 = .34 in

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so D_{15} (FILTER) < 2.7/5 = .54 in

.04 < D_{15} (FILTER) < .34 in

D_{50} (FILTER) > .23 in

D_{85} (FILTER) > .34 in

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

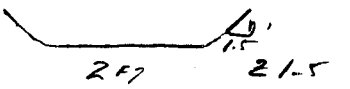
II Summer Flow Ditch Design

Design Flow $Q_{10\text{-}20}$ = MB + UDA-2 + UDA-3 + SMB

$Q = 33.09 + 1.31 + .24$ = 34.64 cfs

Section 2, Vol. 5, page 7

A. Determine depth of flow



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

$S = .025$

$n = .0452$

$A = bd + Zd^2$

$R = bd + Zd^2/b + 2d\sqrt{Z^2+1}$

$Q = bd + Zd^2 \times 1.486/n \times (bd + Zd^2/b + 2d\sqrt{Z^2+1})^{2/3} \times S^{1/2}$

$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 2d^2/2 + 2d\sqrt{2^2+1})^{2/3} \times (.0452)^{1/2}$

$34.64 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + 2d\sqrt{1.5^2+1})^{2/3} \times \ldots$

$34.64 = 9.87\,(2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$3.51 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

Table d

d	Q
1.2	3.66
1.18	3.54

use 1.18 ft.

B. Determine Velocity

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$V = 1.486/.032 \times (.71)^{2/3} \times (.0452)^{1/2}$

$= 46.44 \times .80 \times .21$

$= 7.76$ fps

C DETERMINE RIPRAP SIZE

1. RIPRAP SIZE - MILD SLOPE

a) ASSUME K_m = 6 in $K_m = D_{50}$

$n = .039 \, D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= .039 \, (6/12)^{1/6}$

$= .035$

b) CHARTS IN APPENDIX C C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q_m$

$= 39.64 \, (.035)$

$= 1.22$ CFS

$V_m = .25$

$V = V_m / n$

$V = .25 / .035 = 7.14$ @ d = 1.19 FT

c) $V^2 / R^{.33} = (7.14)^2 / (.71)^{.33} = 57.13$

TABLE 6.4 PAGE 6.39 DOES NOT GO TO THE 1½:1 SLOPE SURFACE MINING WATER DIVERSION DESIGN MANUAL

ASSUME 6 IN. WILL WORK

d) CHECK FROUDE NUMBER

$F_R = V / \sqrt{gL}$ L = 7.14 EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 7.14 / 6.16$

$= 1.16 < 1$ THIS IS MARGINAL BUT SHOULD WORK

$D_{50} = 6$ IN.

$D_{MAX} = 1.25 \, D_{50} = 1.25 \, (6) = 7.5$ IN.

RIPRAP GRADATION

$1.25 \, D_{50}$	7.5 in
D_{50}	6 in
$.50 \, D_{50}$	3 in
$.2 \, D_{50}$	1.2 in

D. FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 in

D_{50} = .024 in

D_{15} = .006 in

RIPRAP PROPERTIES

D_{85} = 6.38 in

D_{50} = 6 in.

D_{15} = 1.13 in.

1. EVALUATE THE NEED FOR A BLANKET

D_{15}(RIPRAP)/D_{85} (BASE) < 5

1.13/.09 = 20 < 5

D_{15} (RIPRAP)/D_{15} (BASE) < 40

1.13/.006 = 300 < 40

FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

2. FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.2 PAGE 512 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER)/D_{50} BASE < 40

SO D_{50} (FILTER) < 40 x .024 = .96 in

D_{15} (FILTER)/D_{15} (BASE) < 40

SO D_{15} (FILTER) < 40 x .006 = .24 in

D_{15} (FILTER)/D_{85} (BASE) < 5

SO D_{85}(FILTER) < 5 x .09 = .45 in

D_{15} (Filter) / D_{15} (Base) > 5

so, D_{15} (Filter) > 5 x .006 = .03 in

.03 in < D_{15} (Filter) < .45 in

D_{50} (Filter) < .96 in.

3. Filter Blanket with respect to Riprap
Eq 5.2 page 5.12 Surface Mining Water Diversion Design Manual
D_{50} (Riprap) / D_{50} (Filter) < 40

so D_{50} (Filter) > 6/40 = .15 in

D_{15} (Riprap) / D_{15} (Filter) < 40

so, D_{15} (Filter) > 1.13/40 = .03 in

D_{15} (Riprap) / D_{85} (Filter) < 5

so D_{15} (Filter) > 1.13/5 = .22 in.

D_{15} (Riprap) / D_{15} (Filter) < 5

so D_{15} (Filter) < 1.13/5 = .22 in.

.03 in < D_{15} (Filter) < .22 in

D_{50} (Filter) > .15 in

D_{85} (Filter) > .22 in.

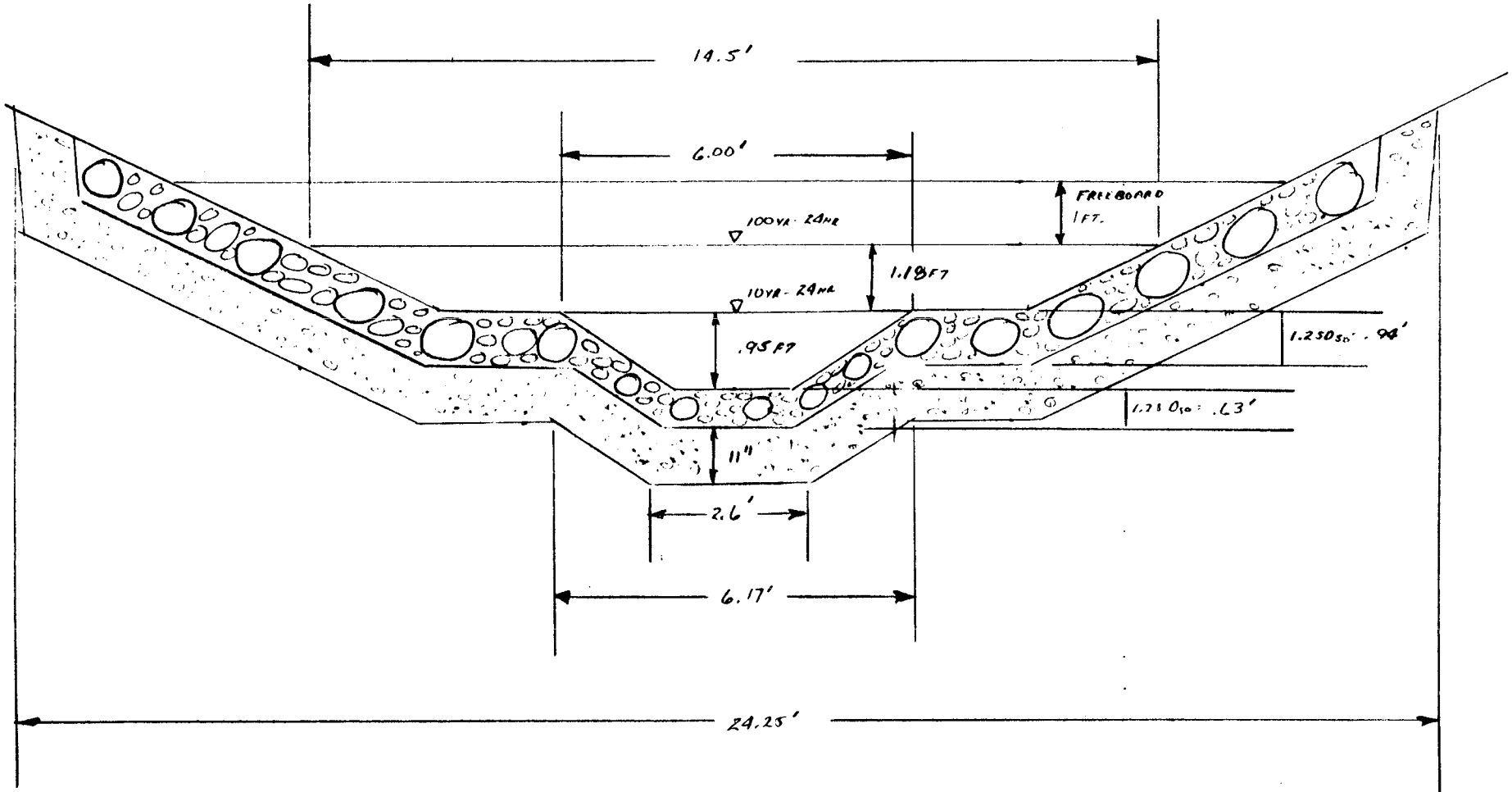
4. Thickness of Filter Blanket.[2]
Thickness = Max D_{50} = .94

Reference: 1. Surface Mining Water Diversion Design Manual; United States Dept. of the Interior, Office of Surface Mining.

2. Hydraulic Engineering Circular No. 11 - U.S. Department of Transportation.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSIONS FOR STREAM B

REVISED 10-2-89
G. TAYLOR
PAGE 4/18 TO 8/18

RECLAIM CHANNEL DESIGN
STREAM C

MAP 3.2.4-2
INITIAL SLOPE = .0643

DESIGN FLOOD PLAIN FOR THE Q_{100-24} = NB + UDA-1 - SUMMER FLOW

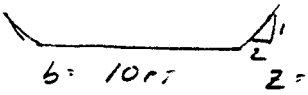
$Q = 127.80 + 12.96 - 52.86 = 87.40$ CFS
SECTION 2, VOL. 5 PAGE 7

DESIGN CHANNEL TO BE A TRAPEZOID

I. DETERMINE DEPTH OF FLOW

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

$n = .032$ EARTH BOTTOM WITH RUBBLE SLOPE
$S = .01$ DESIGN SLOPE MAP 4.4.2-1B1



$A = bd + Zd^2$
$R = bd + Zd^2 / b + 2d\sqrt{Z^2+1}$
$Q = 87.40$

$Q = bd + Zd^2 \times 1.486/n \times (bd + Zd^2/b + 2d\sqrt{Z^2+1})^{2/3} \times S^{1/2}$
$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{2^2+1})^{2/3} \times .0643^{1/2}$
$Q = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .25$
$87.4 = 11.78\,(10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

$7.43 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRAIL d

d	Q
.8	7.19
.82	7.50

USE d = .82 FT.

II Determine Velocity

$V = 1.486/n \; R^{2/3} \; S^{1/2}$

$b = 10$ ft
d .82
$n = .032$
S .0643

$R = bd + 2d^2/b + 2d\sqrt{2^2+1}$
$= 10(.82) + 2(.82)^2/10 + 2(.82)\sqrt{2^2+1}$
$= 9.54 / 13.67$
$= .70$

$V = 1.486/.032 \times (.70)^{2/3} \times (.0643)^{1/2}$

$= 46.44 \times (.79) \times .25$

$= 9.26$ fps

Stream will need riprap

III Determine Riprap Size and Filter Blanket

a) Riprap Size - Mild Slope

1 Assume $K_m = 9$ in $\quad K_m = D_{50}$

$n = .0395 \; D_{50}^{1/6}$ Eq 4.18 page 4-10
$= .0395 \; (9/12)^{1/6}$ Surface Mining Water
$= .038$ Diversion Design Manual -

2. Charts in Appendix C page C-5
Surface Mining Water
Diversion Design Manual -

$Q_n = Q_n$
$= (87.40)(.039)$
$= 3.32$

$V_n = .18$

$V = V_n/n$

$= .18/.038$

$= 2.63$ fps

3. $V^2/R^{.33} = \frac{(9.26)^2}{(.70)^{.33}} = 96.46$

FROM TABLE 6.4 PAGE 6.39 REQUIRED RIPRAP IS TYPE H SURFACE MINING WATER DIVERSION DESIGN MANNUAL

FROM TABLE 6.5 PAGE 6.40 TYPE L, $K_m = 10$. SURFACE MINING WATER DIVERSION DESIGN MANNUAL

4. CHECK FROUDE NUMBER

$Fr = V/\sqrt{gL}$ L .97 EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 9.26/\sqrt{(32.3)(.97)}$

$= 1.6071$

RIPRAP GRADATION

	SIZE	%
$1.25\ D_{50}$	22.5 IN	30
D_{50}	18 IN	50
$.50\ D_{50}$	9 IN	10
$.2\ D_{50}$	3.6 IN	10

C) FILTER BANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 in
D_{50} = .024 in
D_{15} = .006

RIPRAP PROPERTIES

D_{85} = 19 IN
D_{50} = 18 IN
D_{15} = 3.3 IN

a) BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED

b) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{50}(\text{FILTER})/D_{50}(\text{BASE}) < 40$

SO, $D_{50}(\text{FILTER}) < 40 \times .024 = .96$ IN

$D_{15}(\text{FILTER})/D_{15}(\text{BASE}) < 40$

SO, $D_{15}(\text{FILTER}) < 40 \times .006 = .24$ IN

$D_{15}(\text{FILTER})/D_{85}(\text{BASE}) < 5$

SO, $D_{15}(\text{FILTER}) < 5 \times .09 = .45$ IN.

$D_{15}(\text{FILTER})/D_{15}(\text{BASE}) > 5$

SO, $D_{15}(\text{FILTER}) > 5 \times .006 = .03$ IN.

$.03\text{IN} < D_{15}(\text{FILTER}) < .45$ IN

$D_{50}(\text{FILTER}) < .96$ IN.

c) FILTER BLANKET WITH RESPECT TO RIPRAP MATERIAL
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{50}(\text{RIPRAP})/D_{50}(\text{FILTER}) < 40$

SO $D_{50} > 18/40 = .45$ IN

$D_{15}(\text{RIPRAP})/D_{15}(\text{FILTER}) < 40$

SO, $D_{15}(\text{FILTER}) > 3.3/40 = .08$ IN

$D_{15}(\text{RIPRAP})/D_{85}(\text{FILTER}) < 5$

SO, $D_{85}(\text{FILTER}) > 3.3/5 = .66$ IN

$D_{15}(\text{RIPRAP})/D_{15}(\text{FILTER}) > 5$

$D_{15} < 3.3/5 = .66$ IN.

$.08 < D_{15}(\text{FILTER}) < .66$ IN

$D_{50}(\text{FILTER}) > .45$ IN

$D_{85} > .66$ IN

C. DETERMINE RIPRAP SIZE

1. RIPRAP SIZE - MILD SLOPE

a) ASSUME $K_n = 6$ in $K_n = D_{50}$

$n = .0395\ D_{50}^{1/6}$ EQ 4.10 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= .0395\ (6/12)^{1/6}$

$= .035$

b) CHARTS IN APPENDIX C C-1 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q\ n$

$= (52.86)(.035)$

$= 1.96$ cfs

$V_n = .32$

$V = V_n / n$

$= .32 / .035$

$= 9.14$ fps

$C = V^2/R^{1/2} = (9.92)^2/(.75)^{1/2} = 100.11$

TABLE 6.4 PAGE 6.39 DOES NOT GO THE 1½:1 SLOPE

ASSUME 9 IN. WILL WORK

d) CHECK FROUDE NUMBER

$F_R = V/\sqrt{gL}$ $L = 1.37$ EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 9.92/7.33$

$= 1.58 > 1$

$D_{50} = 6$ IN

RIPRAP GRADATION

	SIZE (IN)	%
1.25 D_{50}	11.25 in	30
D_{50}	9 in	50
.5 D_{50}	4 in	10
.2 D_{50}	1.8 in	10

D FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

$D_{85} = .09$ IN
$D_{50} = .024$ IN
$D_{15} = .006$ IN

RIPRAP PROPERTIES

$D_{85} = 9.5$ IN
$D_{50} = 9$ IN
$D_{15} = 1.7$ IN

1) BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED.

2) FILTER BANKET WITH RESPECT TO BASE MATERIAL
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

so, D_{50} (FILTER) < 40 x .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

so, D_{15} (FILTER) < 40 x .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) ≥ 5

so, D_{15} (FILTER) < 5 x .09 = .45 IN

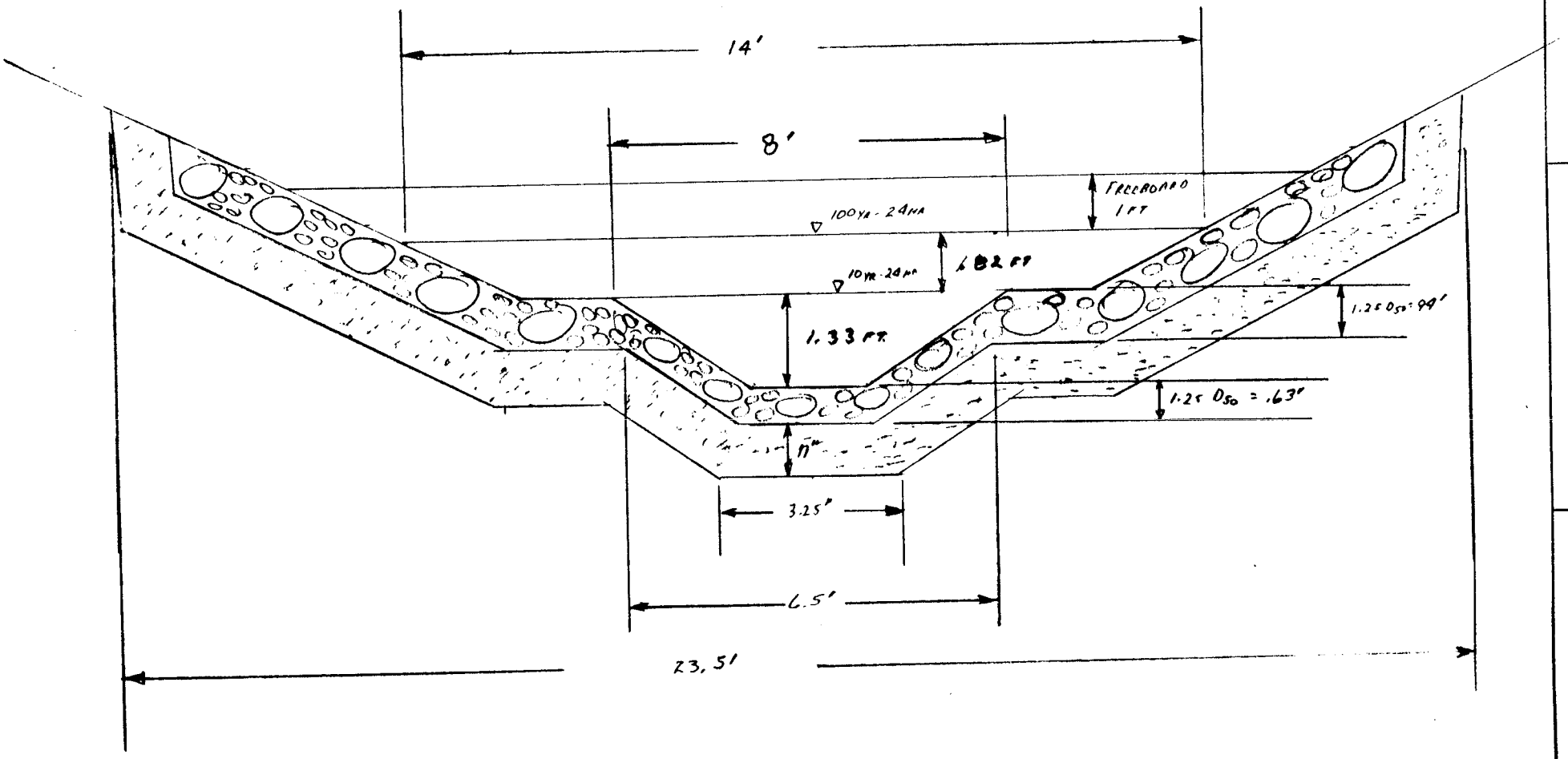
D_{15} (FILTER) / D_{15} (BASE) > 5

so, D_{15} (FILTER) > 5 x .006 = .03 IN

.03 < D_{15} (FILTER) < .45 IN

D_{50} (FILTER) < .96 IN

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSIONS FOR
STREAM C

MAP 3.2.4.2

INITIAL SLOPE = .1506 THIS WILL ALSO BE THE DESIGN SLOPE

DESIGN FLOOD PLAIN FOR THE $Q_{100\text{-}24}$ = NB + UDA + SUMMER FLOW

$Q = 127.80 + 12.46 - 52.86 = 87.40$ CFS

DESIGN CHANNEL TO BE A TRAPEZOID

I. DETERMINE DEPTH OF FLOW

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

$n = .032$ EARTH BOTTOM WITH RUBBLE SIDE
$S = .1506$ MAP 4.4.2-181

$A = bd + zd^2$
$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$ PAGE 158 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$Q = 87.40$

$$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$$
$$= 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{2^2+1})^{2/3} \times (.1506)^{1/2}$$
$$87.40 = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .39$$
$$4.85 = 10d + 2d^2 \times (10d + 2d^2/10 + 4.47d)^{2/3}$$

TRAIL d

d	Q
.6	4.39
.64	4.90

USE $d = .64$

II DETERMINE VELOCITY

$V = 1.486/n \; R^{2/3} \; S^{1/2}$

$b = 10$ ft
$d = .69$ ft
$n = .032$
$S = .1506$

$R = bd + 2d^2/10 + 2d\sqrt{2^2+1}$
$= 10(.64) + 2(.69)^2/10 + 2(.69)\sqrt{2^2+1}$
$= 7.22 / 12.86$
$= .56$

$V = 1.486/.032 \times (.56)^{2/3} \times (.1506)^{1/2}$

$= 46.44 \times (.56)^{2/3} \times .39$

$= 12.30$ FPS

THE STREAM WILL NEED RIPRAP.

III DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPAR SIZE - STEEP SLOPE

DESIGN - 87.40 CFS

CHANNEL SLOPE = .1506

10 FT BOTTOM WIDTH

USE TABLE 5.5 PAGE 5.18 (SURFACE MINING WATER DIVERSION DESIGN MANUAL - UNITED STATES DEPARTMENT OF THE INTERIOR - OFFICE OF SURFACE MINING) SINCE THERE IS NO CURVE FOR S = .15 USE THE S = .25 CURVE. THIS WILL PROVIDE A SLIGHTLY CONSERVATIVE DESIGN

10 FT @ 87.40 = D_{50} = .68 FT

FROM TABLE 5.2 PAGE 5.21 (SURFACE MINING WATER DIVERSION DESIGN MANUAL - UNITED STATES DEPARTMENT OF THE INTERIOR - OFFICE OF SURFACE MINING)

DESIGN D_{50} = .75 FT

$D_{MAX} = 1.25\, D_{50}$ = .94 FT.

RIPRAP GRADATION

	SIZE (FT)	%
$1.25\, D_{50}$	.94	30
D_{50}	.75	50
$.5\, D_{50}$	.38	10
$.2\, D_{50}$	.15	10

b) FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 IN.
D_{50} = .024 IN.
D_{15} = .006 IN.

RIPRAP PROPERTIES

D_{85} = 9.5 IN.
D_{50} = 9 IN.
D_{15} = 4.7 IN.

1. BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED.

2. FILTER BLANKET WITH RESPECT TO BASE MATERIAL EQ 5.2 PAGE 5.12 (SURFACE MINING WATER DIVERSION DESIGN MANUAL - U. S. DEPT. OF THE INTERIOR - OFFICE OF SURFACE MINING)

D_{50}(FILTER)/D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 × .024 IN = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (FILTER) < 40 × .006 IN = .24 IN.

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 × .09 = .45 IN

D_{15} (FILTER) / D_{15} (BASE) > 5

SO D_{15} (FILTER) > 5 × .006 = .03 IN.

.03 IN. < D_{15} (FILTER) < .45 IN.

D_{50} < .96 IN.

3) FILTER BLANKET WITH RESPECT TO RIPRAP
EQ 5.2 PAGE 5.12 (SURFACE MINING WATER DIVERSION DESIGN MANUAL - U.S. DEPT. OF INTERIOR - OFFICE OF SURFACE MINING)

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO, D_{50} (FILTER) > 9/40 = .23 IN.

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 1.7 IN/40 = .04 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

SO D_{85} (FILTER) > 1.7/5 = .34 IN.

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

SO D_{15} (FILTER) < 1.7/5 = .34 IN

.04 < D_{15} (FILTER) < .34 IN

D_{50} (FILTER) > .23 IN

D_{85} (FILTER) > .34 IN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

II Summer Flow Ditch Design

Design Flow Q_{10-24} = NB + UDA-1 Section 2, Vol. 5, page 7

$Q = 47.98 + 4.88 = 52.86$

A Determine Depth of Flow

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

$A = bd + zd^2$ Page 156 Applied Hydrology and Sedimentology $S = .1506$

$R = bd + zd^2/b + 2d\sqrt{z^2+1}$ $n = .032$ Earth Bottom for Disturbed Area - Barrier with rubble side

$Q = bd + zd^2 \times 1.486/n \left(bd + zd^2/b + 2d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$

$= 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + 3.61d)^{2/3} \times (.1506)^{1/2}$

$52.86 = 18.02\,(2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$2.93 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

Trail d

d	Q
1.0	2.55
1.05	2.81
1.07	2.91

$d = 1.07$ ft.

B Determine Velocity

$V = 1.486/n \times R^{2/3} \times S^{1/2}$

$= 1.486/.032 \times (.66)^{2/3} \times (.1506)^{1/2}$

$= 46.44 \times .76 \times .39$

$= 13.68$ fps

The stream will need riprap

C. DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPRAP SIZE - STEEP SLOPE

DESIGN - 52.86 CFS

CHANNEL SLOPE .1506

FROM FIG. 2 PAGE 11.6

USE OF RIPRAP FOR BANK PROTECTION - HYD. ENG. CIR. No. 11 U.S. DEPT. TRANSPORTATION

D_{50} = 1.75 IN.

D_{MAX} = 1.25 D_{50} = 2.19 FT.

RIPRAP GRADATION

	SIZE (IN)	%
$1.25 D_{50}$	2.19	30
D_{50}	1.75	50
$.5 D_{50}$	.88	10
$.2 D_{50}$	.35	10

b) FILTER BLANKET DESIGN

ASSUME BASED MATERIAL

D_{85} = .09 IN
D_{50} = .029 IN
D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 22.34 IN
D_{50} = 21 IN
D_{15} = 3.94 IN

1) BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED.

2) FILTER BLANKET WITH RESPECT TO BASE MATERIAL (SURFACE MINING WATER DIVERSION DESIGN MANUAL EQ 5.2 PAGE 5.12)

D_{50} (FILTER) / D_{50} (BASE) < 40

so, D_{50} (FILTER) < 40 × .024 = .96 in

D_{15} (FILTER) / D_{15} (BASE) < 40

so, D_{15} (FILTER) < 40 × .006 = .24 in

D_{15} (FILTER) / D_{85} (BASE) < 5

so, D_{15} (FILTER) < 5 × .09 = .45 in

D_{15} (FILTER) / D_{15} (BASE) > 5

so D_{15} (FILTER) > 5 × .006 = .03 in.

.03 in < D_{15} (FILTER) < .45 in

D_{50} (FILTER) < .96 in

3) FILTER BLANKET WITH RESPECT TO RIPRAP (EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL)

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

so D_{50} (FILTER) > 21/40 = .53 in

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

so, D_{15} (FILTER) > 3.99/40 = .10 in

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so, D_{85} (FILTER) > 3.99/5 = .79 in

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so D_{15} (FILTER) < 3.99/5 = .79 in

.10 in. < D_{15} (FILTER) < .79 in

D_{50} (FILTER) 7. 53 in

D_{85} (FILTER) 7. 79 in.

4) THICKNESS OF FILTER BLANKET
THICKNESS MAX D_{50} = 0.75

REFERENCE

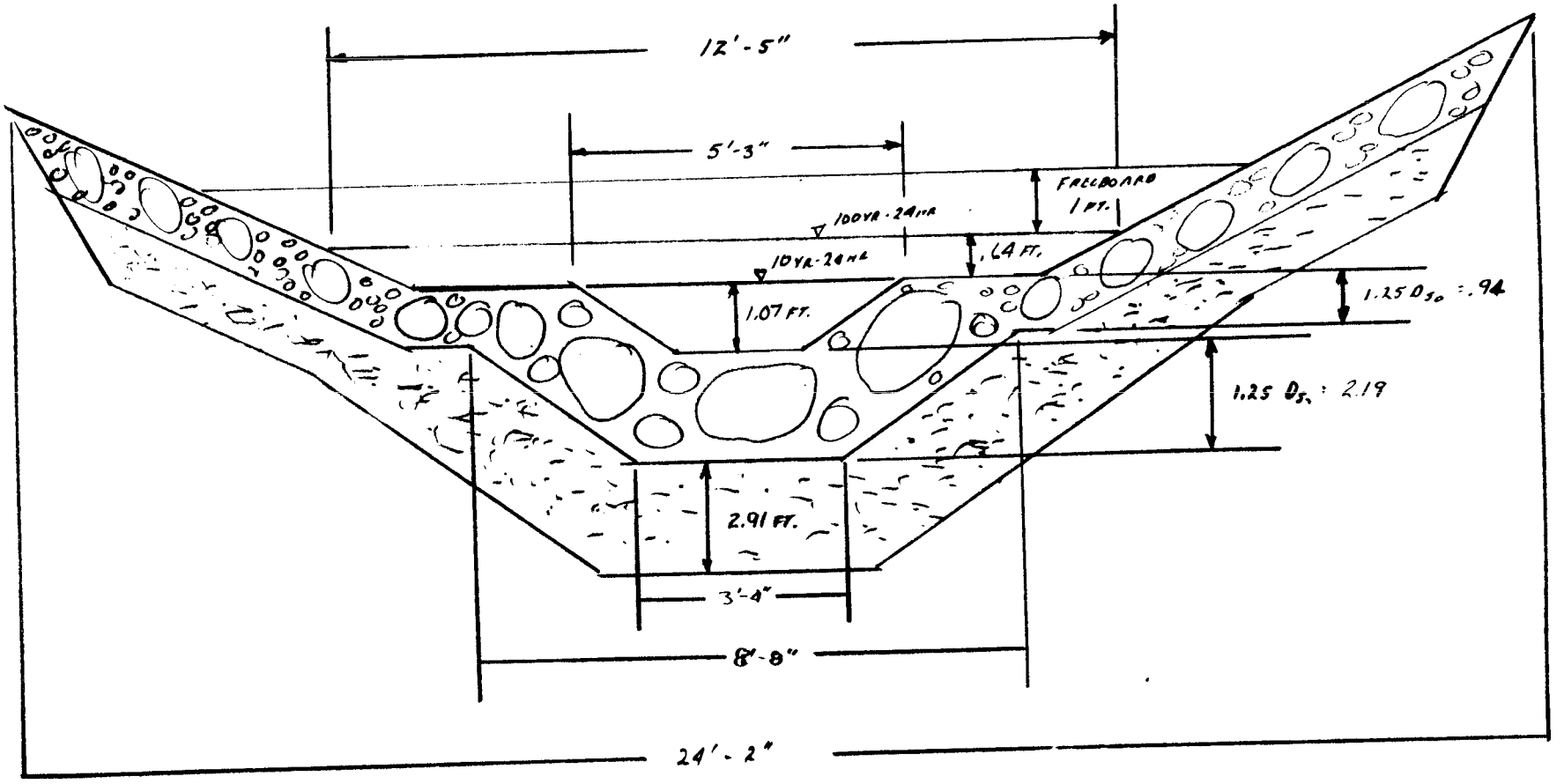
1) SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPT. OF THE INTERIOR
OFFICE OF SURFACE MINING

2) HYDRAULIC ENGINEERING CIRCULAR NO 11
UNITED STATES DEPT. OF TRANSPORTATION

3) BARFIELD, B.J., R.C. WARNER, C.T. HAAN, - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - OKLAHOMA TECHNICAL PRESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNE DIMENSIONS
FOR STREAM C

G. TAYLOR
REVISED 11-9-89

RECLAIM CHANNEL DESIGN
STREAM D

INITIAL SLOPE = .1667

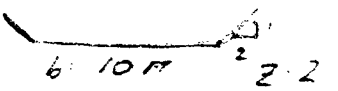
I DESIGN FLOOD PLAIN FOR THE Q_{100-20} = NB + MB + SB - SUMMER FLOW

$Q = 149.51 + 129.90 + 140.62 - 126.01 = 294.02$

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN SECTION 18, VOL. 5

DESIGN CHANNEL TO BE A TRAPEZOID

A. DETERMINE DEPTH FLOW



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

$A = bd + zd^2$

$R = bd + 2d^2/b + 2d\sqrt{z^2+1}$

$Q = 294.02$ CFS

$n = .032$ EARTH BOTTOM

$S = .1667$ MAP 4.4.2-181

$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times (.1667)^{1/2}$

$Q = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times .41$

$294.02 = 18.96 \times (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

$15.51 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRIAL d

d	Q	
1.2	14.56	100
1.25	15.65	

USE d = 1.25 FT

B DETERMINE VELOCITY

$n = .032$
$S = .1667$
$b = 10$ FT
$d = 1.25$ FT
$z = 2$

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$

$$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$$
$$= 10(1.25) + 2(1.25)^2 / 10 + 2(1.25)\sqrt{(2)^2+1}$$
$$= 15.62 / 15.58$$
$$= 1.00$$

$$V = 1.486/.032 \times (1.00)^{2/3} \times (.1667)^{1/2}$$

$$= 46.44 \times 1.00 \times .41$$

$$= 19.04 \text{ FPS}$$

THE STREAM WILL NEED RIPRAP

C DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPRAP SIZE - STEEP SLOPE (1)

DESIGN - 294.02 CFS

CHANNEL SLOPE - .1667

10 FT BOTTOM WIDTH

USE FIGURE 5.5 PAGE 5.18 SURFACE MINING WATER DIVERSION DESIGN MANUAL SINCE THERE IS NOT A CURVE FOR S=.16 USE THE S=.25 CURVE. THIS WILL PROVIDE A SLIGHTLY CONSERVATIVE DESIGN.

10 FT @ 294.02 CFS = D_{50} = 2.7 FT.

FROM TABLE 5.2 PAGE 5-21 THE SURFACE MINING WATER DIVERSION DESIGN MANUAL
DESIGN D_{50} = 2.75

$D_{MAX} = 1.25\ D_{50}$

$D_{MAX} = 1.25\ D_{50} = 1.25(2.75) = 3.44$ FT.

RIPRAP GRADATION

	SIZE (FT)	%
$1.25\ D_{50}$	3.44	300
D_{50}	2.75	50
$.5D_{50}$	1.38	10
$.2D_{50}$	.55	10

b) FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 IN
D_{50} = .024 IN
D_{15} = .006 IN.

RIRAP PROPERTIES

D_{85} = 35 IN
D_{50} = 33 IN
D_{15} = 6 IN

1. BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED.

2) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5-1 PAGE 5-12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50}(FILTER)/D_{50} (BASE) < 40

so, D_{50} (FILTER) < 40 x .024 = .96 IN

D_{15} (FILTER)/D_{15} (BASE) < 40

so, D_{15} (FILTER) < 40 x .006 = .24 IN

D_{15} (FILTER)/D_{85} (BASE) < 5

so, D_{15} (FILTER) < 5 x .09 = .45 IN

D_{15} (FILTER)/D_{15} (BASE) > 5

so, D_{15} (FILTER) > 5 x .006 = .03 IN

.03 IN < D_{15} (FILTER) < .24 IN

D_{50} (FILTER) < .96 IN

3) FILTER BLANKET WITH RESPECT TO RIPRAP

EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO, D_{50} (FILTER) > 33/40 = .83 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 6/40 = .15 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

SO, D_{85} (FILTER) > 6/5 = 1.2 IN

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

SO D_{15} (FILTER) < 6/5 = 1.2 IN

.15 IN < D_{15} (FILTER) < 1.2 IN

D_{50} (FILTER) > .83 IN

D_{85} (FILTER) > 1.2 IN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

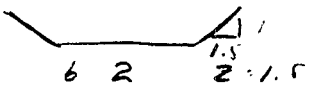
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

II SUMMER FLOW DITCH DESIGN

DESIGN FLOW Q_{10-24} = NB + MB + SB

$Q = 34.64 + 38.51 + 52.96 = 126.01$

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN SECTION 17, VOL. 5



A. DETERMINE DEPTH OF FLOW

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

$S = .1667$ MAP 4.4.2-181

$n = .032$ EARTH BOTTOM

$A = bd + zd^2$

$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$

$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$

$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 1.5d^2/2 + 2d\sqrt{(1.5)^2+1})^{2/3} \times (.1667)^{1/2}$

$126.01 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + 3.61d)^{2/3} \times .41$

$126.01 = 19.06\,(2d + 1.5d^2)\,(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$6.65 = (2d + 1.5d^2)\,(2d + 1.5d^2/2 + 3.61d)^{2/3}$

TRIAL d

d	Q
1.6	6.61

d 1.6 FT.

B. DETERMINE VELOCITY

$V = 1.486/n \; R^{2/3} \; S^{1/2}$

$= 1.486/.032 \times (.91)^{2/3} \times (.1667)^{1/2}$

$= 46.44 \times .94 \times .41$

$= 17.87$ FPS

THE STREAM WILL NEED RIPRAP

C DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPRAP SIZE - STEEP SLOPE

DESIGN - 126.01 CFS

CHANNEL SLOPE - .1667

FROM FIG. 2 PAGE 11.6 USE OF RIPRAP FOR BANK PROTECTION - HYD. ENG. CIR. No. 11 U. S. DEPT. OF TRANSPORTATION

D_{50} = 2.7 FT.

D_{MAX} = 1.25

D_{MAX} = 1.25 D_{50} = 1.25 (2.7) = 3.38 ft

RIPRAP GRADATION

	SIZE (ft)	%
1.25 D_{50}	3.38	30
D_{50}	2.70	50
.5 D_{50}	1.35	10
.2 D_{50}	.54	10

b) FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

D_{85} = .09 in
D_{50} = .029 in
D_{15} = .006 in

RIPRAP PROPERTIES

D_{85} = 34 in
D_{50} = 32.4 in
D_{15} = 6 in

1) BASED ON PASSED CALCULATION A FILTER BLANKET WILL BE NEEDED.

2) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.1 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL.

D_{50} (FILTER)/D_{50} (BASE) < 40

so, D_{50} (FILTER) < 40 × .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

so D_{15} (FILTER) < 40 × .006 = .24 IN

D_{15} (FILTER) / D_{85} BASE < 5

so, D_{15} (FILTER) < 5 × .09 = .45 IN.

D_{15} (FILTER) / D_{15} (BASE) > 5

so D_{15} (FILTER) > 5 × .006 = .03 IN

.03 IN < D_{15} (FILTER) < .45 IN

D_{50} < .96 IN

3) FILTER BLANKET WITH RESPECT TO RIPRAP
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP)/D_{50} (FILTER) < 40

so, D_{50} (FILTER) > 32.4/40 = .81 IN.

D_{15} (RIPRAP)/D_{15} (FILTER) < 40

so, D_{15}(FILTER) > 6/40 = .15 IN

D_{15} (RIPRAP)/D_{85}(FILTER) < 5

so D_{85} (FILTER) > 6/5 = 1.20 IN

D_{15} (RIPRAP)/D_{15} (FILTER) < 5

so D_{15} (FILTER) < 6/5 = 1.20 IN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

$.15 \text{ in} < D_{15}$ (FILTER) < 1.20

D_{50} (FILTER) $> .81$ in

D_{85} (FILTER) > 1.20 in

4) THICKNESS OF FILTER BLANKET.[2]

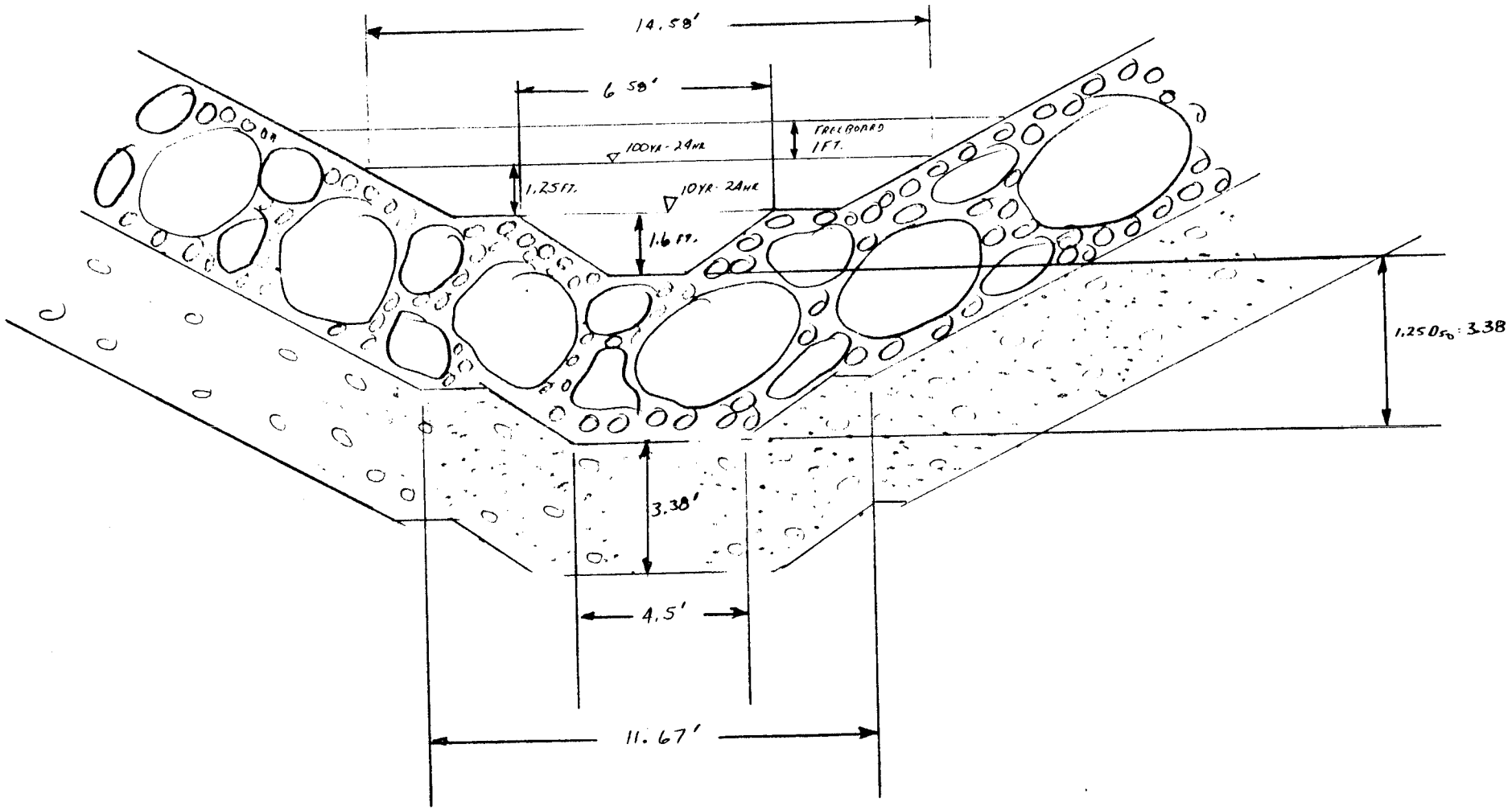
THICKNESS = MAX D_{50} · 3.30 FT

REFERENCES: 1. SURFACE MINING WATER DIVERSION DESIGN MANUAL UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF SURFACING MINING.

2. USE OF RIPRAP FOR BANK PROTECTION, HYDRAULIC ENGINEERING CIRCULAR No. 11, UNITED STATES DEPT. OF TRANSPORTATION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSION FOR
STREAM D

RECLAIM CHANNEL DESIGN
STREAM E

INITIAL SLOPE = .0396 (MAP

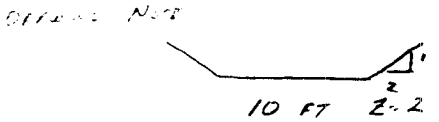
I. DESIGN FLOOD PLAIN FOR Q_{100-24} = NB + MB + SB

$Q = 149.51 + 129.90 + 140.62 = 420.03$ cfs − 126.01 (Summer Flow)
$= 294.02$

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN THIS SECTION 1B, VOL. 5

DESIGN CHANNEL TO BE A TRAPEZOID

A. DETERMINE DEPTH OF FLOW



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

$A = bd + zd^2$ $\qquad n = .032$

$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$ $\qquad S = .0396$ MAP 4A.2-1B1

$$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$$
$$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1}) \times (.0396)^{1/2}$$
$$294.02 = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .20$$
$$294.02 = 9.29(10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$$

$$31.82 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$$

TRIAL d

d	Q
2	36.41
1.9	33.16
1.8	30.08
1.82	30.64
1.84	31.25
1.86	31.87

USE d = 1.86

B. DETERMINE VELOCITY

$R = 1.39$
$S = .0396$
$n = .032$

$$V = 1.49/n \times R^{2/3} \times S^{1/2}$$

$$= 1.49/.032 \times (1.39)^{2/3} \times (.0396)^{1/2}$$

$$= 46.44 \times 1.247 \times .199$$

$$= 11.52 \text{ FPS}$$

THE STREAM WILL NEED RIPRAP

C. DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) RIPRAP SIZE - MILD SLOPE

1. ASSUME $K_m = 1$ $K_m = D_{50}$

$n = .0395\ D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL
$= .0395\ (1)^{1/6}$
$= .0395$

2. CHARTS IN APPENDIX C PAGE C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL.

$Q_n = Q\ n$
$= (294.02)(.0395)$
$= 11.61$ FOR 3 % SLOPE

$V_n = .38$

$V = V_n/n\ (1)$

$= .38/.0395$

$= 9.62$ FPS $d = 1.86$ FT

3. $V^2/R^{.33}\ (17) = (9.62)^2/(1.39)^{.33}$ $83.02\ R = 1.39$

TABLE 6.9 PAGE 6-39 REQUIRED RIPRAP IS TYPE H (SURFACE MINING WATER DIVERSION DESIGN MANUAL)
FROM TABLE 6-5 PAGE 6-40 K_m FOR A DEPTH OF 2.26 FT AND 3% SLOPE $K_m = 18$ IN
(SURFACE MINING WATER DIVERSION DESIGN MANUAL)
USE A $D_{50} = 18$ IN RIPRAP

4.) CHECK FROUDE NUMBER

$FR = V/\sqrt{gL}$ (1)

$= 10.89/\sqrt{(32.2)(2.26)}$

$= 1.23 > .8$ STEEP SLOPE

$L = 2.26$
EQ 4.6 PAGE 4.19
SURFACE MINING WATER
DIVERSION DESIGN MANUAL

B) RIPRAP SIZE - STEEP SLOPE

1) ASSUME $D_{50} = 18$ IN $= 1.5$ FT.

$n = .0395\, D_{50}^{1/6}$
$= .0395\,(1.5)^{1/6}$
$= .042$

2) CHECK FOR STABILITY

$\tau = \gamma d s$

$\gamma = 62.4$
$d = 2.6$
$s = .0396$

$\tau = 62.4\,(1.86)\,(.0396)$
$= 4.59$ LB/FT^2

$\eta_b = 21\tau/\gamma(S.G.-1)D_{50}$

$= 21(5.59)/62.4(2.36-1)1.5$

$= .76$

EQ 3.33 PAGE 199 (2)
APPLIED HYDROLOGY AND
SEDIMENTOLOGY FOR DISTURBED AREAS
S.G 2.36 BARFIELD AND HAAN

$SF = \cos\theta \tan\phi / \sin\theta + \eta_b \tan\phi$ EQ 3.28 PAGE 186

ϕ ANGLE OF RESPONSE FIGURE 3.14 PAGE 197
RIPRAP ROUND AND ANGULAR APPLIED HYDROLOGY AND
$\phi = 38°$ SEDIMENTOLOGY FOR DISTURBED
AREAS - BARFIELD AND HAAN

θ : SLOPE IN DEGREES

$\theta = \tan^{-1} .0396$
$= 2.27°$

SAFETY FACTOR = 1.2

$$SF = \cos(2.27)\tan(38) / \sin 2.27 + (.92)\tan 38$$

$$= (.999)(.781) / .04 + (.76)(.781)$$

$$= .781 / .868$$

$$= .90$$

D_{50} (FT)	MANNING n	ANGLE OF REPOSE (DEG)	DEPTH OF FLOW	TRACTIVE FORCE τ	STABILITY FACTOR η_b	S.F.
1.5	.042	38	1.86	4.59	.76	1.23

USE 1.5 FT = D_{50}

RIPRAP GRADATION

	SIZE (FT)	%
$2D_{50}$ =	3.0	30
D_{50} =	1.5	50
$.5D_{50}$ =	.75	10
$.2D_{50}$ =	.3	10

C) FILTER BLANKET DESIGN

ASSUME BASE MATERIAL (SCREEN ANALYSIS DONE)

D_{85} = .09 IN

D_{50} = .024 IN

D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85}	30.6 IN
D_{50}	18 IN
D_{15}	5.4 IN

a) BASED ON ABOVE CALCULATIONS A FILTER BANKLET WILL BE NEEDED.

b) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.1 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} < 40 × .024 = .96 IN.

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (FILTER) < 40 × .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 × .09 = .45 IN

D_{15} (FILTER) / D_{15} (BASE) > 5

SO, D_{15} (FILTER) > 5 × .006 = .03 IN

.03 IN < D_{15} (FILTER) < .45 IN

D_{50} (FILTER) < .96 IN

c FILTER BLANKET WITH RESPECT TO RIPRAP MATERIAL
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO, D_{50} (FILTER) > 18/40 = .45 IN.

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 5.4/40 = .14 IN.

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

SO, D_{85} (FILTER) > 5.4/5 = 1.08 IN

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

SO, D_{15} (FILTER) < 5.4/5 = 1.08 IN.

.14 IN < D_{15} (FILTER) < 1.08 IN

D_{50} (FILTER) > .45 IN

D_{85} (FILTER) > 1.08 IN.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

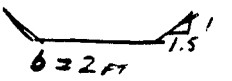
II SUMMER FLOW DITCH DESIGN

DESIGN FLOW Q_{10-24} = NB + MB + SB

$Q = 34.64 + 38.51 + 52.96 = 126.01$ CFS

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN SECTION 1B, VOL. 5

A. DETERMINE DEPTH OF FLOW



$n = .032$
$S = .0396$

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

$$A = bd + zd^2$$
$$R = bd + zd^2/b + 2d\sqrt{z^2+1}$$

$$Q = bd + zd^2 \times 1.486/n \times (bd + zd^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$$
$$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 1.5d^2/2 + 2d\sqrt{(1.5)^2+1})^{2/3} \times (.0396)^{1/2}$$
$$126.01 = 2d + 1.5d \times 46.44 \times 2d + 1.5d^2/2 + 3.61d)^{2/3} \times .20$$
$$126.01 = 9.24\,(2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$$

$$13.64 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$$

TRIAL d

d	Q
2.2	12.97
2.3	14.30
2.25	13.63

USE $d = 2.25$ FT.

B. DETERMINE VELOCITY

$$V = 1.486/n \times R^{2/3} \times S^{1/2}$$
$$= 1.486/.032 \times (1.20)^{2/3} \times (.0396)^{1/2}$$
$$= 46.44 \times 1.13 \times .20$$
$$= 10.44 \text{ FPS}$$

$R = 1.20$
$S = .0396$
$n = .032$

C. DETERMINE RIPRAP SIZE AND FILTER BLANKET

1. RIPRAP SIZE - MILD SLOPE

a) ASSUME $K_m = 1$ $K_m = D_{50}$

$n = .0395\ D_{50}^{1/6}$ EQ 4.18 PAGE 4.19
$= .0395\ (1)^{1/6}$ SURFACE MINING WATER
$= .0395$ DIVERSION DESIGN MANUAL

b) CHARTS IN APPENDIX C PAGE C-1

$Q_n = Q\ n$ SURFACE MINING WATER
$= 126.01\ (.0395)$ DIVERSION DESIGN MANUAL
$= 4.98$

$V_n = .30$

$V = V_n/n^{(1)}$

$= .30/.0395$

$= 7.60$ FPS

c) $V^2/R^{.33\ (1)} = (7.60)^2/(1.20)^{.33} = 51.05$ $R = 1.20$

TABLE 6.4 PAGE 6-39 REQUIRED RIPRAP IS TYPE L
(SURFACE MINING WATER DIVERSION DESIGN MANUAL)
FROM TABLE 6.5 PAGE 6-40 K_m FOR A DEPTH OF 2.25 FT AND 3% SLOPE K_m = 9 IN
(SURFACE MINING WATER DIVERSION DESIGN MANUAL)

2) REWORK RIPRAP SIZE FOR K_m = 9 IN.

a) $K_m = 9$ $K_m = D_{50}$

EQ. 4.18 PAGE 4.19
$n = .0395\ D_{50}^{1/6}$ SURFACE MINING WATER
$= .0395\ (9/12)^{.17}$ DIVERSION DESIGN MANUAL
$= .038$

b) CHARTS IN APPENDIX C PAGE C-1
SURFACE MINING WATER
$Q_n = Q_n$ DIVERSION DESIGN MANUAL
$= 126.01\ (.038)$
$= 4.74$

$V_n = .30$

$V = V_n / n$

$= .30 / .038$

$= 7.90$ FPS

c) $V^2/R^{.33} = (7.90)^2/(1.20)^{.33} = 58.69$

TABLE 6.4 PAGE 6-39 REQUIRED RIPRAP IS TYPE L
(SURFACE MINING WATER DIVERSION DESIGN MANUAL)
FROM TABLE 6.5 PAGE 6.40 K_m FOR A DEPTH
OF 2.25 FT AND 3% SLOPE K_m = 9IN.
SURFACE MINING WATER DIVERSION DESIGN MANUAL
USE 9IN RIPRAP

d) CHECK FROUDE NUMBER

$F_R = V/\sqrt{gL}$ L = 2.25 EQ 46 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 7.90/\sqrt{(2.25)(32.2)}$

$= .92 < 1$

$D_{50} = 9$IN.

RIPRAP GRADATION

	SIZE (IN)	%
$2D_{50}$	= 18	30
D_{50}	= 9	50
$.5D_{50}$	= 4.5	10
$.2D_{50}$	= 1.8	10

3. FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

$D_{85} = .09$ IN

$D_{50} = .024$ IN

$D_{15} = .006$ IN

RIPRAP PROPERTIES

D_{85} = 15.3 IN.
D_{50} = 9 IN.
D_{15} = 2.7 IN.

a) BASED ON PASSED CALCULATIONS A FILTER BLANKET WILL BE NEEDED.

b) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.1 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 × .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (FILTER) < 40 × .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 × .09 = .45 IN

D_{15} (FILTER) / D_{15} (BASE) > 5

SO, D_{15} (FILTER) > 5 × .006 = .03 IN

.03 < D_{15} (FILTER) < .24 IN

D_{50} (FILTER) < .96 IN.

c) FILTER BLANKET WITH RESPECT TO RIPRAP
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

SO D_{50} (FILTER) > 9/40 = .23 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 2.7/40 = .07 IN

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

SO, D_{85} (FILTER) > 2.7/5 = .54 IN

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so, D_{15} (FILTER) < $2.7/5$ = .54 IN

.07 IN < D_{15} (FILTER) < .54 IN

D_{50} (FILTER) > .23 IN

D_{85} (FILTER) > .54 IN

d) THICKNESS OF FILTER BLANKET

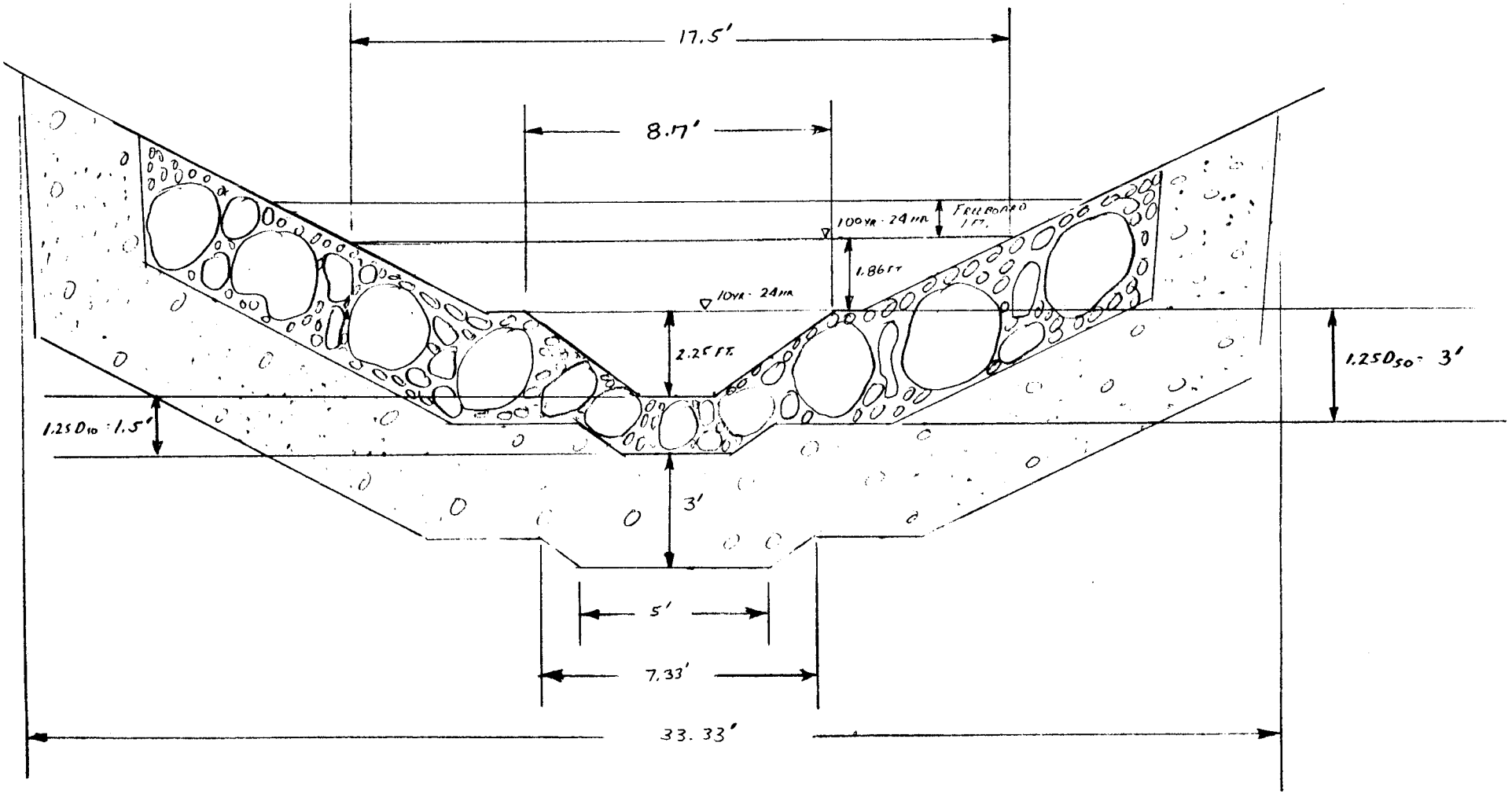
THICKNESS = MAX D_{50} = 3 FT.

REFERENCES : 1. SURFACE MINING WATER DIVERSION DESIGN MANUAL, UNITED STATES DEPT. OF INTERIOR, OFFICE OF SURFACE MINING.

2. BARFIELD, B. J., R. C. WARNER, C. T. HAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS, STILLWATER, OK

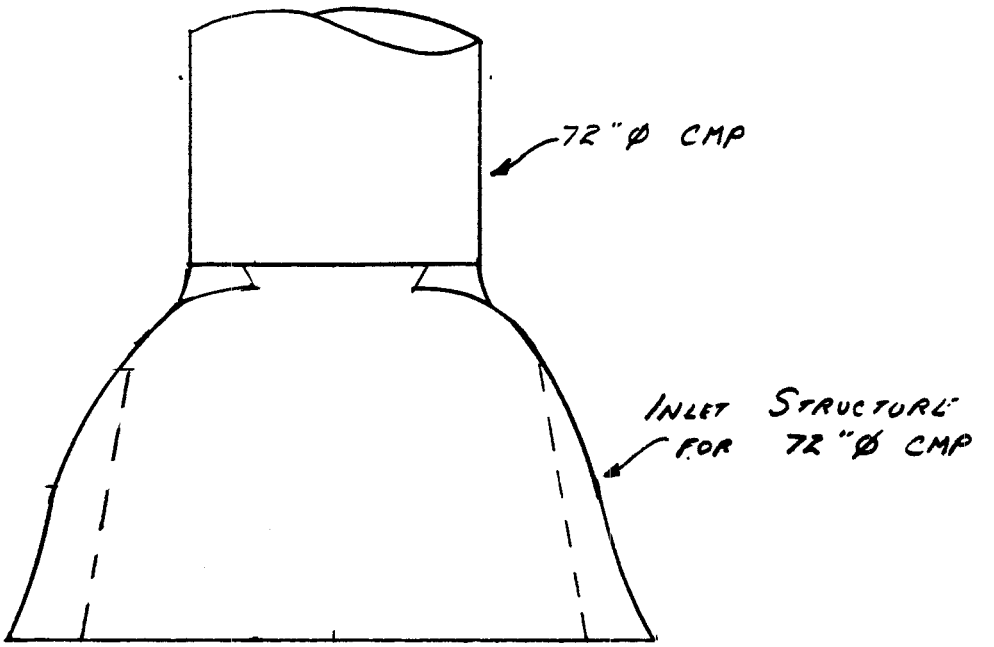
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

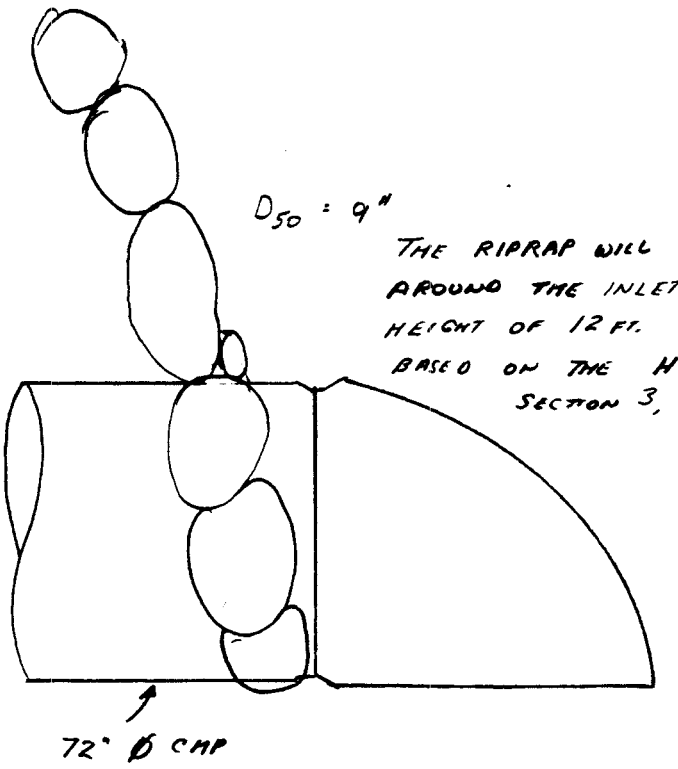
AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSION FOR
STREAM E

72" Ø CMP INLET STRUCTURE





22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRANSITION DESIGN FOR
MIDDLE BRANCH TO No 7 STREAM
(THIS WILL WORK FOR THE SOUTH BRANCH)

UPSTREAM CHANNEL

RIPRAP LINED
D_{50} = .75 FT.
S = .0452 MAP 4.4.2-1B1
BASE WIDTH = 10 FT.

DOWNSTREAM CHANNEL

RIPRAP LINED
D_{50} = 2.70
S = .1667 MAP 4.4.2-1B1
BASE WIDTH = 10 FT.

Q = 95.26 CFS

1) EVALUATE UPSTREAM CHANNEL SECTION PROPERTIES

$n = .0395\ D_{50}^{1/6}$
$= .0395\ (.75)^{.17}$
$= .0376$

EQ. 4.18 PAGE 4.10
SURFACE MINING WATER DIVERSION
DESIGN MANUAL

$Q_n = Q\,n$
$= 95.26\ (.0376)$
$= 3.58$

FROM THE CHARTS IN APPENDIX C C-5
SURFACE MINING WATER
DIVERSION DESIGN MANUAL

$V_n = .23$ $d = 1.13$

$V = V_n/n = .23/.0376 = 6.12$ FPS

2) EVALUATE DOWNSTREAM CHANNEL SECTION PROPERTIES

$n = .0395\ D_{50}^{1/6}$
$= .0395\ (2.7)^{.17}$
$= .0548$

EQ 4.18 PAGE 4.10
SURFACE MINING WATER DIVERSION
DESIGN MANUAL

$Q_n = Q\,n$
$= 95.26\ (.0548)$
$= 5.22$

FROM THE CHARTS IN APPENDIX C - C-5

$V_n = .49$ $d = .95$ FT.

SURFACE MINING WATER
DIVERSION DESIGN MANUAL

$V = V_n/n = .49/.0548 = 8.94$ FPS

3) COMPUTE CHANGE IN WATER SURFACE PROFILES

$\Delta W.S. = 1.15\ \Delta h$

$V_2 = 8.94$ FPS
$V_1 = 6.12$ FPS

$\Delta h = V_2^2/2g - V_1^2/2g$

$= 1.15\left(\frac{(8.94)^2}{2g} - \frac{(6.12)^2}{2g}\right)$

$= 1.15\ (1.29 - .58)$

$= .76$ FT

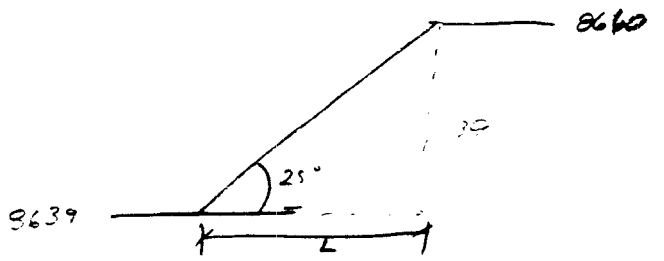
4) COMPUTE NECESSARY CHANGE

$\Delta BE. = d_1 - d_2 + \Delta W.S$

$= 1.13 - .95 + .76$

$= .94$ FT.

5.) COMPUTE LENGTH OF TRANSITION



$\tan\theta = \frac{8660 - 8639}{L}$

$\tan 25° = 21/L$

$= 48.07$ FT

6) DETERMINE RIPRAP SIZE AND FILTER BLANKET

a) DESIGN - 95.26 CFS
CHANNEL SLOPE - .46 BOTTOM WIDTH = 10 FT

USE FIG 5.5 PAGE 5.18
SINCE THERE IS NO CURVE FOR S=.47 USE S=.50 CURVE THIS WILL PROVIDE A SLIGHTLY CONSERVATIVE DESIGN. SURFACE MINING WATER DIVERSION DESIGN MANUAL

10 FT @ 95.26 CFS = D_{50} 2.3 FT.

FROM TABLE 5.2 PAGE 5.21 THE DESIGN
D_{50} = 2.5 FT.
SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{MAX} = 1.25\ D_{50} = 1.25(2.5) = 3.13$ FT

RIPRAP GRADATION

	SIZE (FT)	%
$1.25\ D_{50}$	3.13	30
D_{50}	2.5	50
$.5\ D_{50}$	1.25	10
$.2\ D_{50}$	.5	10

2) DESIGN FILTER BLANKET

ASSUME BASE MATERIAL

D_{85} = .09 IN
D_{50} = .029 IN
D_{15} = .006 IN

RIPRAP PROPERTIES

D_{85} = 32 IN
D_{50} = 30 IN
D_{15} = 5.63 IN

a) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ. 5.12 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 x .029 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO D_{15} (FILTER) < 40 x .006 = .24 IN.

D_{15} (FILTER) / D_{85} (BASE) < 5

SO D_{15} (FILTER) < 5 x .09 = .45 IN

D_{15} (FILTER) / D_{15} (BASE) > 5

SO D_{15} (FILTER) > 5 x .006 = .03

.03 IN < D_{15} (FILTER) < .45 IN.

D_{50} (FILTER) < .96 IN

b) FILTER BLANKET WITH RESPECT TO RIPRAP
EQ. 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP) / D_{50} (FILTER) < 40

so D_{50} (FILTER) > 30/40 = .75 IN

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

so, D_{15} (FILTER) > 5.6/40 = .14 IN.

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so, D_{85} (FILTER) > 5.6/5 = 1.12 IN

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so, D_{15} (FILTER) < 5.6/5 = 1.12 IN

.14 IN < D_{15} (FILTER) < 1.12 IN

D_{50} (FILTER) > .75 IN

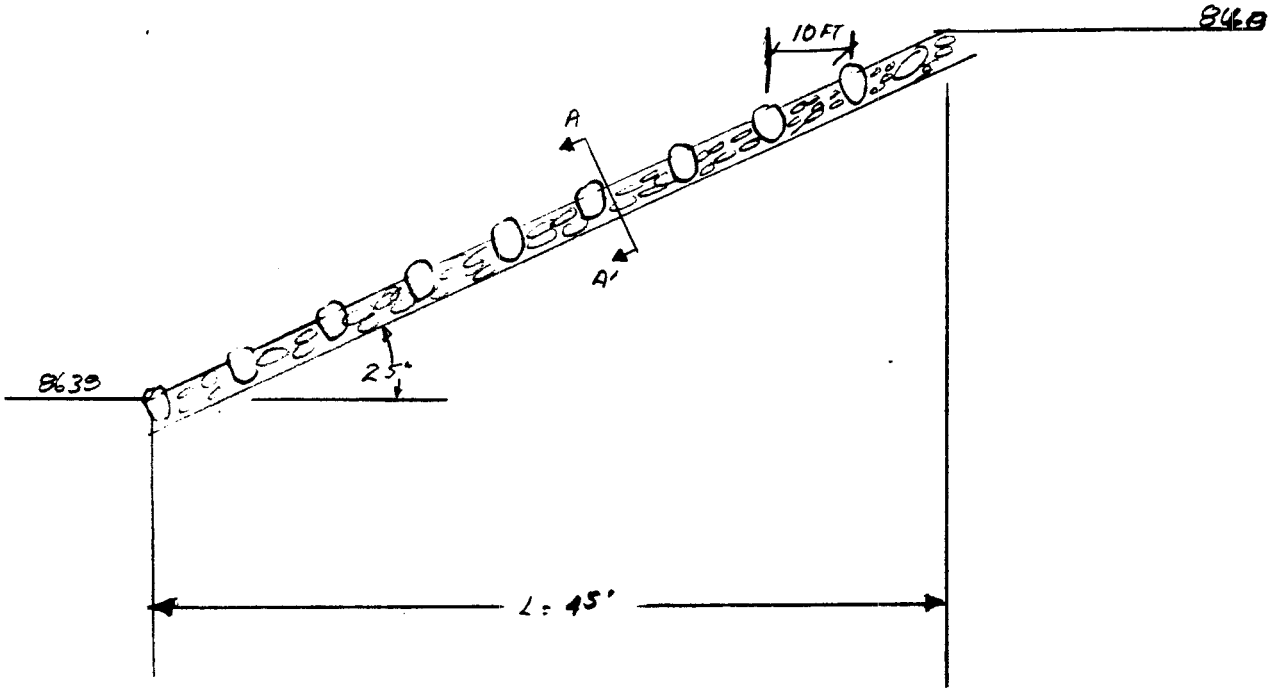
D_{85} (FILTER) > 1.12 IN.

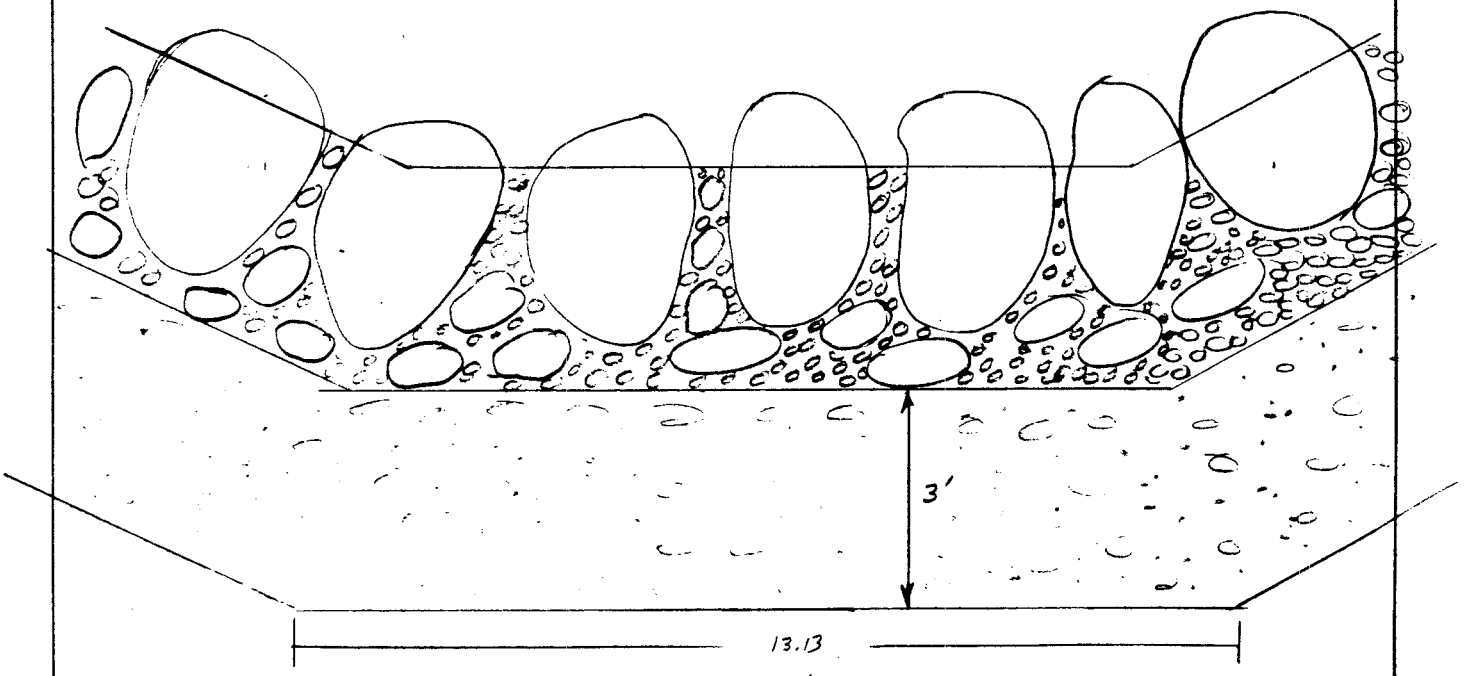
c) THICKNESS OF THE FILTER BLANKET.
THICKNESS = MAX D_{50} = 3.13'

REFERENCE: SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF SURFACE MINING.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G TAYLOR
REVISED
11-9-89





SECTION A-A'

FINAL CHANNEL DIMENSIONS
FOR TRANSITION MIDDLE
BRANCH TO STREAM D

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TRANSITION DESIGN FOR NORTH BRANCH TO MAIN STREAM.

UPSTREAM CHANNEL

RIPRAP LINED
$D_{50} = .75$ FT
$S = .01$ MAP 4.4.2-1B1
BASE WIDTH = 10 FT

DOWNSTREAM CHANNEL

RIPRAP LINED
$D_{50} = 2.7$
$S = .1667$ MAP 4.4.2-1B1
BASE WIDTH = 10 FT

$Q = 87.40$ CFS

1) EVALUATE UPSTREAM CHANNEL SECTION PROPERTIES

$n = .0395\ D_{50}^{1/6}$ — EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL
$= .0395\ (.75)^{1/6}$
$= .038$

$Q_n = Q\,n$
$= (87.40)(.038)$
$= 3.29$

FROM THE CHARTS IN APPENDIX C C-5

$V_n = .25$ $d = 1.07$ SURFACE MINING WATER DIVERSION DESIGN MANUAL

$V = V_n/n = .25/.038 = 6.58$

2) EVALUATE DOWNSTREAM CHANNEL SECTION PROPERTIES

$n = .0395\ D_{50}^{1/6}$ — EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL
$= .0395\ (2.7)^{1/6}$
$= .047$

$Q_n = Q\,n$
$= (87.40)(.047)$
$= 4.09$

FROM THE CHARTS IN APPENDIX C C-5

$V_n = .47$ $d = .85$ FT SURFACE MINING WATER DIVERSION DESIGN MANUAL

$V = V_n/n = .47/.038 = 12.37$

3) COMPUTE CHANGE IN WATER PROFILES

$\Delta S.\omega = 1.15\ \Delta h \qquad \Delta h = V_2^2/2g - V_1^2/2g$

$= 1.15\left(V_2^2/2g - V_1^2/2g\right)$

$= 1.15\left[(12.37)^2/2g - (6.56)^2/2g\right]$

$= 1.15\ (2.38 - .67)$

$= 1.15\ (1.71)$

$= 1.96$ FT.

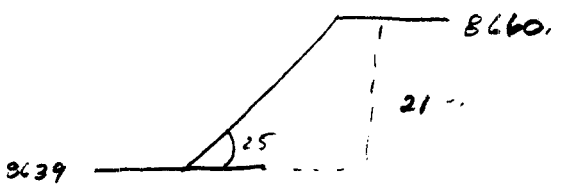
4) COMPUTE NECESSARY CHANGE

Δ B.E. $= d_2 - d_1 + \Delta$ W.S.

$= 1.07 - .85 + 1.96$

$= 2.18$ FT.

5) COMPUTE LENGTH OF TRANSITATION



$\tan\theta = (8660 - 8639)/L$

$\tan 25 = 21/L$

$L = 45$ FT.

6) DESIGN RIPRAP SIZE AND FILTER BLANKET

a) DESIGN = 87.40 CFS BOTTOM WIDTH = 10 FT.
CHANNEL SLOPE = .47

USE FIG. 5.5 PAGE 5-18
SINCE THERE IS NO CURVE FOR S=.47 USE S=.50 CURVE. THIS WILL PROVIDE A SLIGHTLY CONSERVATIVE DESIGN SURFACE MINING WATER DIVERSION DESIGN MANUAL

10 FT @ 87.40 CFS = D_{50} = 2.05 FT

FROM TABLE 5.2 PAGE 5-21 THE DESIGN
D_{50} = 2.25 FT. SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{MAX} = 1.25\ D_{50} = (1.25)(2.25) = 2.81$ FT

RIPRAP GRADATION

	SIZE (FT)	%
$1.25\ D_{50}$	2.81	30
D_{50}	2.25	50
$.5 D_{50}$	1.13	10
$.2 D_{50}$	.45	10

2) DESIGN FILTER BLANKET

ASSUME BASE MATERIAL

D_{85} : .09 IN
D_{50} : .024 IN
D_{15} : .006 IN

RIPRAP PROPERTIES

D_{85} : 29.66 IN
D_{50} : 27 IN
D_{15} : 5.96 IN

a) FILTER BLANKET WITH RESPECT TO BASE MATERIAL
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (FILTER) / D_{50} (BASE) < 40

SO, D_{50} (FILTER) < 40 × .024 = .96 IN

D_{15} (FILTER) / D_{15} (BASE) < 40

SO, D_{15} (FILTER) < 40 × .006 = .24 IN

D_{15} (FILTER) / D_{85} (BASE) < 5

SO, D_{15} (FILTER) < 5 × .09 = .45 IN.

D_{15} (FILTER) / D_{15} (BASE) > 5

SO, D_{15} (FILTER) > 5 × .006 = .03 IN.

.03 IN < D_{15} (FILTER) < .45 IN

D_{50} (FILTER) < .96 IN.

b) FILTER BLANKET WITH RESPECT TO RIPRAP
EQ 5.2 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

D_{50} (RIPRAP)/D_{50} (FILTER) < 40

so, D_{50} (FILTER) > 27/40 = .68 IN

D_{15} (RIPRAP)/ D_{15} (FILTER) < 40

so, D_{15} (FILTER) > 5.06/40 = .13 IN

D_{15} (RIPRAP)/D_{85} (FILTER) < 5

so, D_{85} (FILTER) > 5.06/5 = 1.01 IN

D_{15} (RIPRAP)/D_{15} (FILTER) > 5

so, D_{15} (FILTER) < 5.06/5 = 1.01 IN

.13 IN < D_{15} (FILTER) < 1.01 IN

D_{50} (FILTER) > .68 IN

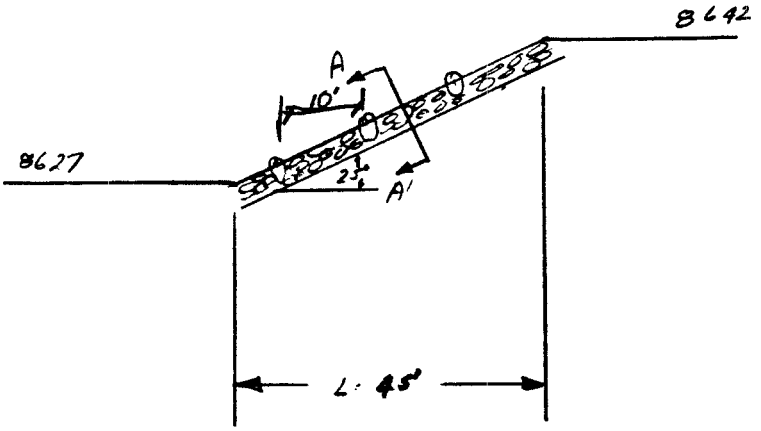
D_{85} (FILTER) > 1.01 IN.

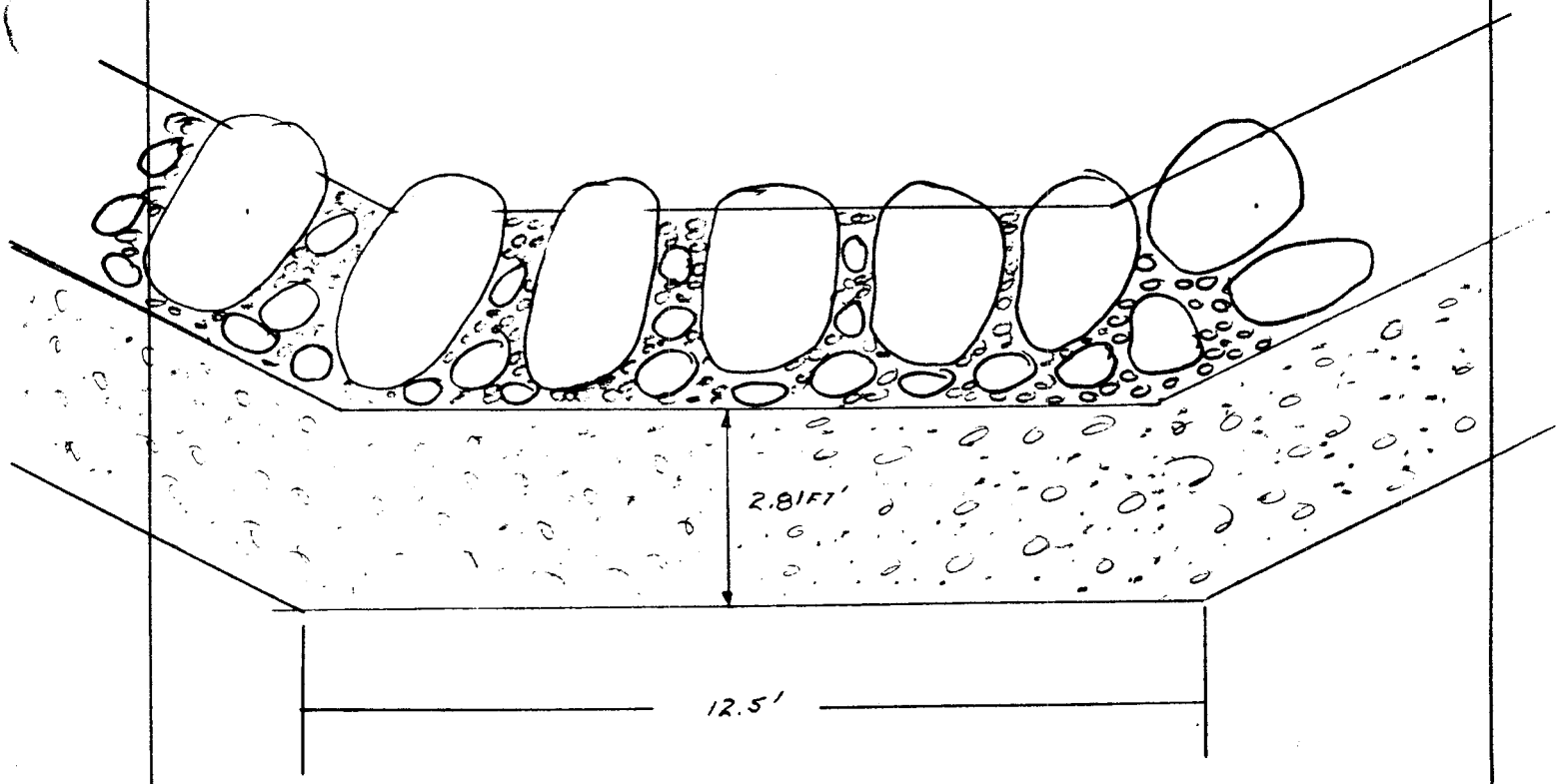
c) THICKNESS OF THE FILTER BLANKET
THICKNESS = MAX D_{50} = 2.81.

REFERENCE: SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF
SURFACE MINING.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
REVISED
11-9-89





SECTION A-A'

FINAL CHANNEL DIMENSIONS
FOR TRANSITION NORTH
BRANCH TO STREAM D

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SECTION 19

HYDROLOGY STUDY
SOUTH FORK BREAKOUT
AREA

HYDROLOGY STUDY
SOUTH FORK BREAKOUT
AREA

G. TAYLOR
7-5-89

MAP 3.2.4-2

SOIL TYPES

TYPE	1) PERCENT	1) HYD. GROUP	2) CN
UNITA FAMILY LOAM	50 %	B	55
TOZE FAMILY FINE SANDY LOAM	35 %	B	55
COMODORE BOULDERY LOAM	10 %	D	77
MIDFORK FAMILY BOUL	5%	B	55

1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

2) TABLE 2.20, PAGE 82 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, BARFIELD AND HAAN
CN = 55 - FOREST LAND GOOD COVER CN = 77 FOREST LAND POOR COVER

CN = $.5(55) + .35(55) + .10(77) + .05(55) / .5 + .35 + .10 + .05$

$= 27.50 + 19.25 + 7.70 + 2.75 / 1$

$= 57.20$ USE $\underline{57}$

$S = 1000/CN - 10$ Eq. 2.39 PAGE 81 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HAAN

$= 1000/57 - 10$

$= 7.54$

AREA OF THE WATER SHED

PLANIMETER READING = 3,228

$443 \times .0149 \text{ in}^2 = 6.60 \text{ in}^2 \times 22.96 \text{ ACRE/in}^2 = 151.55 \text{ ACRES}$

$151.55 \text{ ACRES} \times 43,560 \text{ ft}^2/\text{ACRES} = \underline{6,601,608.26 \text{ ft}^2}$

TIME PARAMETERS

CONCENTRATION TIME - KIRPICH

$t_c = .0078\, L^{0.77} (L/H)^{0.385}$

EQ 2.58 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HAAN.

$L = 3,850$ FT.

$H = 828$ FT

$t_c = .0078\,(3,850)^{0.77}\,(3850/828)^{.385}$

$= .0078\,(576.51)\,(1.81)$

$= 8.13$ MIN. USE .14 HRS

LAG TIME

$t_L = L^{0.8}(S+1)^{0.7} / 1900\, Y^{0.5}$

EQ 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

$Y = \Sigma c_i \times i$ / AREA IN SQ.FT

$i = 80$ FT

$A = 6,601,608.26$ SQ. FT.

ΣC_i		Contour
600	-	8,720
1,400	-	8,800
2,300	-	8,880
2,875	-	8,960
3,400	-	9,040
3,650	-	9,120
3,700	-	9200
3,300	-	9280
3,000	-	9360
2,200	-	9440
450	-	9,520
650	-	9,520
27,525 FT		

$y = 27{,}525 \text{ FT} \times 80 \text{ FT} / 6{,}601{,}608.26$

$= 2{,}202{,}000 / 6{,}601{,}608.26$

$= 33\%$

$t_L = (3{,}850)^{.8} (7.48+1)^{.7} / 1900 (33)^{.5}$

$= (738.53)(4.47) / 1900 (5.74)$

$= 3{,}301.23 / 10{,}906$

$= .30$

$= 18.16$ MIN. USE 18 MINS.

$t_L = 0.6\, t_c$ EQ. 2.59 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS · BARFIELD AND HARP

$18 = .6 (t_c)$

$t_c = 0.494$ HRS

PEAK FLOW USING SCS CURVE METHOD

EVENT	PEAK FLOW
2YR - 24 HR	7/CFS
10YR - 24 HR	3.8 CFS
25YR - 24 HR	12.5 CFS
50YR - 24 HR	24.6 CFS
100YR - 24 HR	39.1 CFS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

CULVERT SELECTION

USE 100 YR - 24 HR EVENT - 39.1 CFS = Q

SIZE OF CULVERT - FLAT SLOPE

$Q = 2.58\ D^{2.5}$

$D = (Q/2.58)^{1/2.5}$

$= (39.1/2.58)^{.4}$

$= 2.97$ FT $\times 12$ IN/FT

$= 35.6$ IN

USE A 36 IN CULVERT

EFFECT OF SLOPE

$S = 2.04/D^{1/3}$ $\qquad S = .14$

$.14 = 2.04/D^{.33}$

$D^{.33} = 2.04/.14$

$D^{.33} = 14.57$

$= 2.42$ FT $\times 12$ IN/FT

$= 29.05$ IN

USE 30 IN CULVERT

USE A 36 IN CULVERT TO HANDLE PEAK FLOW

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G. TAYLOR
8-31-89

DETERMINE INLET AND OUTLET CONTROL

A. INLET CONTROL

Q_{10-29}: 3.8 CFS SECTION 19, VOL. 5, MAP 3.2.11-1

USE INLET CONTROL NOMOGRAPH - PAGE 189[1]

HW/D = 1.0 GRAPH #3

Q = 33 CFS FOR 36" ϕ CMP

THE PIPE WILL HANDLE THE FLOW WITH HW EQUAL TO THE PIPE DIAMETER

B. OUTLET CONTROL

K_e = 0.9 · PAGE 181[1]

L' = 85 FT × .61 = 51.8 FT

USE OUTLET CONTROL NOMOGRAPH - PAGE 194[1]

Q = 29 CFS FOR 36" ϕ CMP

THE PIPE WILL HANDLE THE FLOW

REFERENCES:

1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DESIGN

GIVEN

PIPE DIA. - 36"
COVER - 15"
LIVE LOAD - 0
WEIGHT OF SOIL - 100 lb/ft³

DETERMINE WALL THICKNESS AND CORRUGATION

1 BACKFILL SOIL DENSITY
90% COMPACTION

2 DESIGN PRESSURE

$P_V = DL + LL$ $\quad$ $DL = H \times \omega$
$= 15 ft \times 100 lb/ft^3 + 0$ $\quad$ LL = NEGLIGIBLE FOR COVER
$= 1500 lb/ft^2$

3 RING COMPRESSION

$C = P_V \times S/2$ $\quad$ S = SPAN IN FT = 3 FT
$= 1,500 lb/ft^2 \times 3/2$
$= 1,500 lb/ft^2 \times 1.5 ft$
$= 2,250 lb/ft$

4 ALLOWABLE WALL STRESS
FIG 3-6 $f_c = 22,500 lb/in^2$ $\quad$ PAGE 105 - HANDBOOK OF STEEL
FOR $2\frac{2}{3} \times \frac{1}{2}$ IN. CORROGATION $\quad$ DRAINAGE AND HIGHWAY
CONSTRUCTION PRODUCTS

5 WALL CROSS - SECTIONAL AREA

$A = C/f_c$
$= 2,250 lb/ft / 22,500 lb/in^2$
$= .10 in^2/ft$

FROM TABLE 3-2, A SPECIFIED THICKNESS OF 0.064 IN. PROVIDES
AN WALL AREA OF .775 $\quad$ PAGE 107 HANDBOOK OF STEEL
DRAINAGE AND HIGHWAY CONSTRUCTION
PRODUCT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

6. $FF = D^2/EI$ = FLEXIBILITY FACTOR = .0433 MAX

D = DIA. = 36 IN
E = 30×10^6 LB/IN^2
I = .00189 IN^2/FT

$$FF = (36)^2 / 30 \times 10^6 \times .00189$$

$$= 1{,}296 / 56{,}700$$

$$= .02286$$

.02286 < .0433 THEREFORE $2\frac{2}{3} \times \frac{1}{2}$ IN. CORRUGATION IS OK

PURCHASE A 36 IN. DIA. PIPE WITH $2\frac{2}{3} \times \frac{1}{2}$ IN CORRUGATIONS.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

TEMPORARY CULVERT SELECTION

$Q = >1 \text{ CFS}$ USE 1 CFS 2 YR - 24 HR

SIZE OF CULVERT - FLAT SLOPE

$Q = 2.58 \; D^{2.5}$

$D = (Q/2.58)^{1/2.5}$

$= (1 \text{ CFS}/2.58)^{.4}$

$= .684 \text{ FT} \times 12 \text{ IN/FT}$

$= 8.21 \text{ IN.}$

NEED A 12 IN CULVERT

<u>USE A 18 IN. DIA CULVERT</u>

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

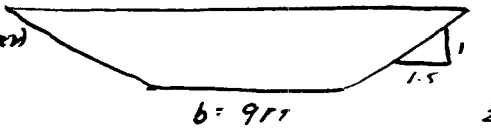
CHANNEL RECONSTRUCTION

TRAPEZOIDAL TYPE CHANNEL DESIGN

$Q = 39.1$ CFS

$S = .143$ FT/FT (FIELD SURVEY)

$n = .04$



$Z = \frac{1.5}{1} = 1.5$

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

$$= \frac{1.49}{n}\left[\frac{bd + zd^2}{b + 2d\sqrt{z^2+1}}\right]^{2/3} S^{1/2}(bd + zd^2)$$

$$39.1 = \frac{1.49}{.04}\left[\frac{9d + 1.5d^2}{9 + 3.61d}\right]^{2/3}(.143)^{.5}(9d + 1.5d^2)$$

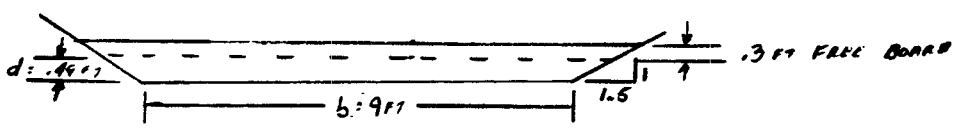
$$2.78 = \left[\frac{9d + 1.5d^2}{9 + 3.61d}\right]^{2/3}(9d + 1.5d^2)$$

4.0 1:4

$b = 9$ FT

TRIAL d FT	Q
.2	.63
.3	.80
.35	1.08
.4	1.98
.42	2.15
.44	2.33
.46	2.51
.48	2.69
.49	2.79

$d = .49$ FT.



DETERMINE RIPRAP D_{50} AND DESIGN FOR SF = 1.20

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

$n = .04$

$S = .143$ FT/FT

$R = \frac{bd + 2d^2}{b + 2d\sqrt{Z^2+1}} = \frac{9(.49) + 1.5(.49)^2}{9 + (.49)(2)\sqrt{1.5^2+1}} = \frac{4.77}{10.767} = .443$

$V = \frac{1.49}{.04} (.443)^{.66} (.143)^{.5}$

$= (37.25)(.568)(.38)$

$= 8.27$ FT/SEC.

STONE $D_{50} = 7.5$ IN $= .625$ FT.

CHECK n VALUE

$n = .0395 D_{50}^{.17}$ Eq. 3.34 PAGE 188 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAN.

$= .0395 (1.125)$

$= .036$

CHECK FOR STABILITY

$d = .49$ FT $S = 14.3$ $\gamma = 62.4$

$\tau = \gamma d S$

$= (62.4)(.49 \text{ ft})(.143) = 4.372$ lbs/ft^2

$n_b = \frac{21\tau}{\gamma(SG-1)D_{50}}$ SG - 2.36 Eq 3.33 PAGE 188 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAN

$n_b = \frac{21(4.372)}{(62.4)(2.36-1)(.63)}$

$= \frac{91.812}{53.464}$

$= 1.72$

SF MUST BE > 1

ϕ = 42° ANGULAR RIPRAP

14.3 % SLOPE

θ = 8°

$$SF_b = \cos\theta \tan\phi / \sin\theta + n_b \tan\phi$$

$$= (\cos 8°)(\tan 42) / (\sin 8°) + (1.72)(\tan 42)$$

$$= (.990)(.900) / (.139) + 1.549$$

$$= .896 / 1.688$$

$$= .521$$ UNDER DESIGNED RESIGN STREAM CHANNEL

EQ 3.26 PAGE 186 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HARP.

D_{50} (FT)	MANNING'S n	ANGLE OF REPOSE (DEG)	DEPTH OF CONVEY FLOW	TRACTIVE FORCE	STABILITY FACTOR	SAFETY FACTOR
.63	.036	42°	.49	4.372	1.72	.521
1.26	.041	42°	.49	4.372	.859	.982
1.6	.043	42°	.49	4.372	.676	1.192

D_{50} = 1.6 FT.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DETERMINE RIPRAP FOR BANK SF = 1.2

$D_{50} = 1.6$ FT, $n = .043$, $\theta = 8°$, $d = .49$ FT.

ASSUME

$$\tau_{max} = .76 \gamma d s$$

$$= .76 (62.4)(.49)(.043) = 3.323 \text{ lb/FT}^2$$

$$n = (21)(\tau_{max}) / \gamma (SG - 1) D_{50}$$

$$= (21)(3.323) / 62.4 (2.36 - 1) 1.6$$

$$= 69.783 / 135.782$$

$$= .514$$

EQ 3.37 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HARR

ASSUME UNIFORM FLOW

$$\lambda = \theta = 8°$$

SIDESLOPE

$$\alpha = \tan^{-1} 1/1.5$$

$$= 33.69°$$

$$B = \tan^{-1} \left[\cos\lambda / \frac{2 \sin\alpha}{n \tan\phi} + \sin\lambda \right]$$

$$= \tan^{-1} \left[.990 / 2(.555)/.514(.900) + .139 \right]$$

$$= \tan^{-1} (.390)$$

$$= 21.32°$$

EQ 3.36 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HARR

$$n' = n \left[\frac{1 + \sin(\lambda + B)}{2} \right]$$

$$= .514 \left[\frac{1 + \sin(8 + 21.32)}{2} \right]$$

$$= .514 \left[1.819/2 \right]$$

$$= .383$$

EQ. 3.38 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HARR

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Eq 3.35 page 190
Applied Hydrology and Sedimentology for Disturbed Area - Barfield and Hayes

$$SF = \cos\alpha \tan\phi / n' \tan\phi + \sin\alpha \cos\beta$$

$$= \cos 33.69 \tan 42 / (.383)(\tan 42) + (\sin 33.69)(\cos 21.32)$$

$$= (.8327)(.900) / .345 + (.555)(.932)$$

$$= .749 / .862$$

$$= .869$$

D_{50}	n	β	n'	SF
1.6	.514	21.32°	.383	.869
1.8	.456	19.21	.332	.90
2.0	.411	17.52	.294	.944
2.2	.374	16.09	.263	.979
2.5	.329	14.304	.227	1.009
2.7	.305	13.327	.208	1.03
3.0	.274	12.059	.184	1.06
3.5	.235	10.426	.155	1.09
4.0	.206	9.17	.133	1.12
5.0	.164	7.391	.104	1.17
5.5	.150	6.737	.094	1.18
6.0	.137	6.189	.085	1.19

Use 6 ft D_{50} for both channel bottom and sides

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

BASED ON THE CALCULATION THE BOTTOM AND SIDESLOPE RIPRAP WILL BE 1.6 FT = D_{50}

RIPRAP GRADATION

	SIZE FT	PERCENT
$2 D_{50}$	3.2	100
$1 D_{50}$	1.6	50
$.5 D_{50}$	.8	20
$.2 D_{50}$	.32	0

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

UNDERLYING FILTER

BASE MATERIAL

D_{50} = .600 mm

D_{85} = 2.36 mm

D_{15} = .150 mm

RIPRAP

D_{100} = 3.2 ft = 975.36 mm

D_{50} = 1.6 ft = 487.68 mm

D_{85} = 2.9 ft = 883.92 mm

D_{15} = .24 ft = 73.15 mm

D_0 = .10 ft = 30.48 mm

FILTER BLANKET WITH RESPECT TO BASE MATERIAL

(1) D_{50} (Filter) / D_{50} Base < 40

D_{50} (FILTER) < 40 × .6 = 24 mm

(2) D_{15} (Filter) / D_{15} Base) > 5

D_{15} (FILTER) > 5 × .150 = .75 mm

PAGE 195 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

D_{15} (Filter) / D_{15} (Base) < 40

D_{15} (FILTER) < 40 × .15 = 6.00 mm

(3) D_{15} (Filter) / D_{85} (Base) < 5

D_{15} (FILTER) < 5 × 2.36 = 11.80 mm

∴ WITH RESPECT TO THE BASE THE FOLLOWING MUST BE SATISFIED

.75 mm < D_{15} (FILTER) < 6.00 mm

D_{50} (FILTER) < 24 mm

FILTER MUST BE SIZED TO THE RIPRAP

(1) D_{50} (RIPRAP) / D_{50} (FILTER) < 40

D_{50} FILTER > 487.66/40 : 12.19 mm

(2) D_{15} (RIPRAP) / D_{15} FILTER > 5

PAGE 195 - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

D_{15} (FILTER) < 73.15 mm/5 : 14.63 mm

D_{15} (RIPRAP) / D_{15} (FILTER) < 40

D_{15} (FILTER) > 73.15 mm/40 : 1.83 mm

(3) D_{15} (RIPRAP) / D_{85} (FILTER) < 5

D_{85} (FILTER) > 73.15/5 : 14.63 mm

∴ FILTER MUST MEET THESE

D_{50} (FILTER) > 12.19 mm

1.83 mm < D_{15} (FILTER) < 14.65 mm

D_{85} (FILTER) > 14.65 mm

FILTER BLANKET MUST BE SIZED AS FOLLOWS

12.19 mm < D_{50} (FILTER) < 24 mm

.75 mm < D_{15} (FILTER) < 14.63 mm

D_{85} (FILTER) > 14.65 mm

THE FILTER BLANKET WILL BE AT LEAST 6 INCHES IN THICKNESS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

ENERGY DISSIPATOR FOR DISCHARGE END OF CULVERT 100YR-24 HR

$Q = VA$

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

D = TW = TAILWATER DEPTH
n = .024
S = .143 FIELD SURVEY

$39.1 = \frac{1.49}{.024} \left(\frac{.576 D}{1.957 D} \right)^{.66} (.143) \frac{\pi D^2}{4}$

$39.1 = 62.09 (.295 D)^{.66} (.143)(.785 D^2)$

$39.1 = 9.877 (.295 D)^{.66} (.785 D^2)$

$4.404 = (.295 D)^{.66} (.785 D^2)$

D	Q
1 FT	.351
2 FT	2.317
3 FT	6.518
2.5 FT	4.01
2.6 FT	4.45

D = 2.6 FT = TW

CALCULATE APRON WIDTH

$W_A = D + 2a \quad (TW < .5D)$

$W_A = D + .4 L_a \quad (TW \geq .5 D)$

$TW = 2.6 > .5D = 1.50$

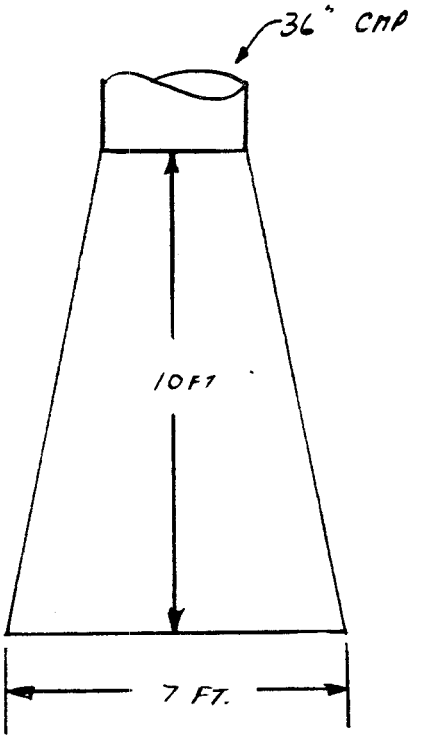
Q = 39.1 CFS D = 3 FT $d_{50} \approx .33$ FT $L_A = 10$ FT

$W_A = D + .4 L_A$

$= 3 \text{ FT} + .4 (10)$
$= 3 \text{ FT} + 4 \text{ FT}$
$= 7 \text{ FT}$

$d_{max} = 1.5 \times D_{50}$
$= 1.5 \times .33$
$= .50 \text{ FT} \quad 6''$

ENERGY DISSIPATOR



d_{50} : 4 in.

d_{max} : 6 in.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

REFERENCE

1. BARFIELD, B. J., R.C. WARNER AND C. T. HAAN, 1985 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS. OKLAHOMA TECHNICAL PRESS, STILLWATER, OKLAHOMA.

2. HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS. AMERICAN IRON AND STEEL INSTITUTE. WASHINGTON D.C. THIRD EDITION

3. HYDRAULIC DESIGN OF STILLING BASINS AND ENERGY DISSIPATORS UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION.

4. SOIL SURVEY OF CARBON AREA, UTAH, UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD