SECTION 1

SLOPE STABILITY EVALUATIONS AND ACCESS ROAD EMBANKMENTS

SEDIMENTATION PONDS

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

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

John F. Wallace

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

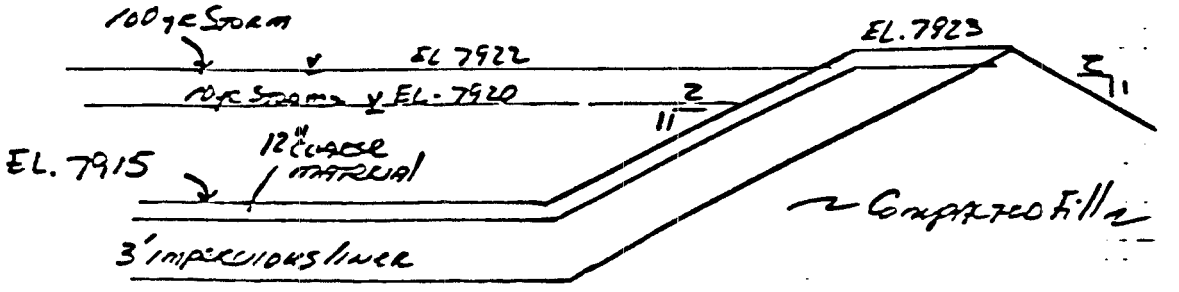
WJG/JFW/pc

Attachments: Figures 1 through 4

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

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

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

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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_T = 120 pcf

Maximum slope height = 8 ft

Bredon 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 Y=1

An undrained shear strength S_u or C-cohesion Equal to 175 psf is required for a F.S. = 1.0

Bredon $N_s = \frac{\gamma H}{C}$ when N_s = 5.5, γ = 120 psf, H = 8', C = ?

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

Available = 1000 psf $\therefore$ F.S. = $\frac{1000}{174}$ = **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

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DAMES & MOORE

Figure 2

REVISIONS BY DATE TO EO
BY DATE TO EO

Long Term Stability

Upstream Slope

Assume Liner material (clay) controls Stability

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

$\bar{\phi} = 23°$ $\bar{c} = 200$ psf $H = 8$ $R_u = 0.5$ $\gamma = 120$ $S = 20$

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

From fig 4 (Hunter, 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 (Hunter, 1975)

$$F.S. \geq 2.0$$

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

$F.S. = 2.0$

Similarly this argument can be applied to upstream slope w/ $R_u = 0.5$ if compacted fill were to govern stability

ASSUMED

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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 material on site soil and/or blast rock from excavation operations on site.

2) Compacted Earth Fill Properties

$\gamma = 125$ $\phi = 40°$ $C = 100$ 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

$\gamma = 125$ $\phi = 40°$ $C = 100$ 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

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SHEET 4

PRINTED IN U.S.A.

June 6, 1980

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

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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 BY DATE 10-30-79

CHECKED BY SAC DATE 4.10.80

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

2. REFERENCES.

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

SKYLINE MINE FINAL DESIGN
ESTIMATED PEAK FLOW DISCHARGE

DESIGNED BY KH DATE 10-30-79
CHECKED BY [illegible] DATE 4.10.80

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 [illegible]

FROM. NOAA ATLAS 2, Volume VI-UTAH	TABLE II
EQUATION	CORR Coeff
$Y_2 = -0.011 + 0.942[(x1)(x1/x2)]$	0.95
$Y_{100} = 0.494 + 0.755[(x3)(x3/x4)]$	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 AS SCALED 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 — READS

FIGURE 19,	2-YR 6-HR	$x1 = 1.05$ IN	
FIG 25	2-YR 24 HR	$x2 = 1.65$ IN	
FIG 24	100-YR 6 HR	$x3 = 2.25$ IN	
FIG 30	100-YR 24 HR	$x4 = 3.5$ IN	

orm No. E-8 Rev. 10-71

CALCULATIO

SKYLINE MINE FINAL DESIGN
ESTIMATED PEAK FLOW DISCHARGE

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

CHECKED BY GHC 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 WE DETERMINE THE 5, 10, 25, 50 YEARS RETURN PERIOD FOR PARTIAL DURATION PRECIPITATION VALUES SERIES.

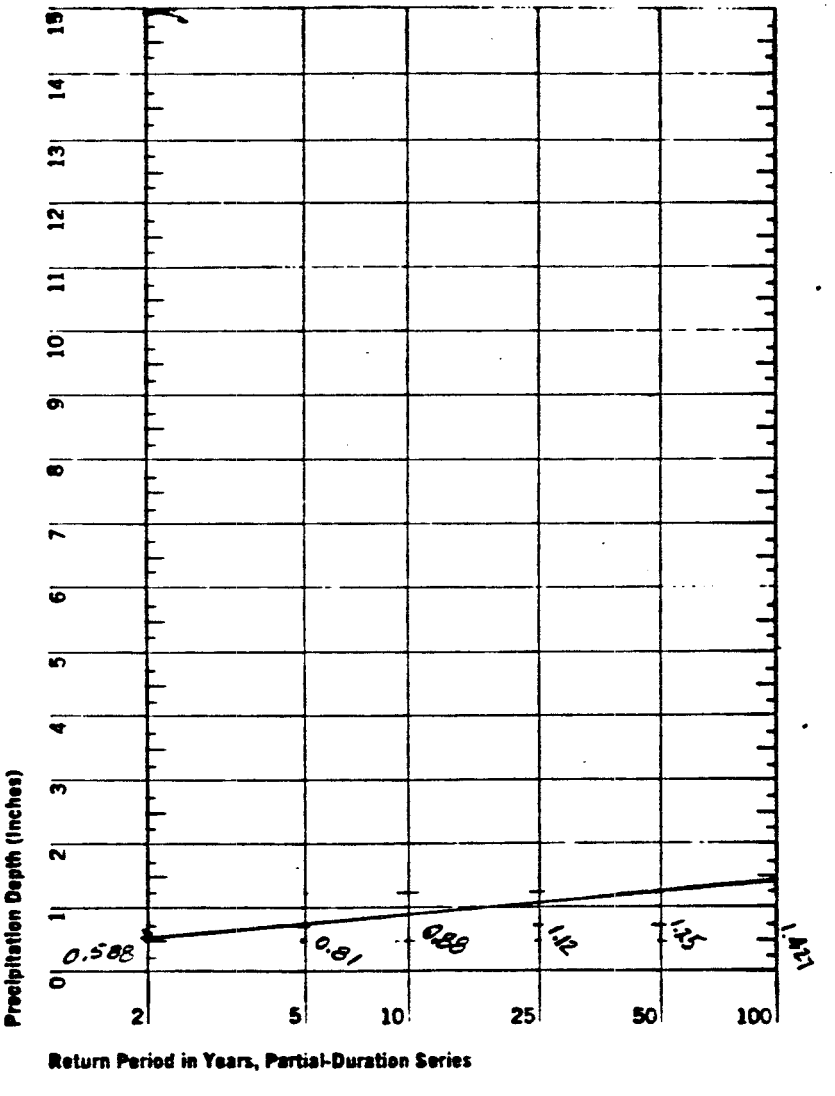


Figure 6. *Precipitation depth versus return period for partial-duration series.*

1 HR PRECIPITATION depth IN INCHES

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

KAISER ENGINEERS

Job No. 78097

Sheet 4 of 7

SKYLINE MINE FINAL DESIGN

ESTIMATED PEAK FLOW DISCHARGE

DESIGNED BY BJ DATE 10-31-79

CHECKED BY SMH DATE 4.10.80

ESTIMATE OF 2 AND 3 HR PRECIPITATION [illegible] VALUES

BY MATHEMATICAL SOLUTION REF. PAGE 16 VOLUM VII ATLAS

EQUATION
$$\begin{cases} 2\text{-hr} = 0.341(6\text{-hr}) + 0.659(1\text{-hr}) \\ 3\text{hr} = 0.569(6\text{-hr}) + 0431(1\text{-hr}) \end{cases}$$

ESTIMATED PECIPITATION VALUES

2 YEARS

$2HR = 0.341 \times 1.05 + 0.659 \times 0.588 = 0.743$ IN

$3HR = 0.569 \times 1.05 + 0.431 \times 0.588 = 0.851$ IN

5 YEARS

$2HR = 0.341 \times 1.32 + 0.659 \times 0.81 = 0.984$

$3HR = 0.569 \times 1.32 + 0.431 \times 0.81 = 1.100$

10 YEARS

$2HR = 0.341 \times 1.5 + 0.659 \times 0.88 = 1.091$

$3HR = 0.569 \times 1.5 + 0.431 \times 0.88 = 1.233$

25 YEARS

$2HR = 0.341 \times 1.85 + 0.659 \times 1.12 = 1.369$

$3HR = 0.569 \times 1.85 + 0.431 \times 1.12 = 1.535$

50 YEARS

$2HR = 0.341 \times 2.05 + 0.659 \times 1.25 = 1.523$

$3HR = 0.569 \times 2.05 + 0.431 \times 1.25 = 1.705$

100 YEARS

$2HR = 0.341 \times 2.25 + 0.659 \times 1.427 = 1.708$

$3HR = 0.569 \times 2.25 + 0.431 \times 1.427 = 1.895$

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 BJ DATE 11-4-79

CHECKED BY JHC DATE 4.10.80

ESTIMATE PRECIPITATION VALUES OF DURATION LESS THAN 1 HR

DURATION IN MIN	5	10	15	30
RATIO T 1 HR 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

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

6-19-89
G. TAYLOR

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 VEGETATION

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

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	3438.93	51,426.00	39.71	50
UDA-1	12.91	70	5134.37	5134.34	45.65	50
UDA-2	13.36	70	1945.96	5406.03	46.46	50
UDA-3	4.76	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

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	4.88	7.65	9.38	12.46
UDA-2	.177	1.31	2.02	2.49	3.30
UDA-3	.169	0.24	0.45	0.60	0.85
UDA-4	.206	0.34	0.63	0.83	1.19

1) $T_C = \dfrac{(\text{HYD. LENGTH})^{.8}\ ((1000/(CN-10))+1)^{.7}}{(1900\sqrt{\text{SLOPE}})/1.6}$ — KENTS FORMULA

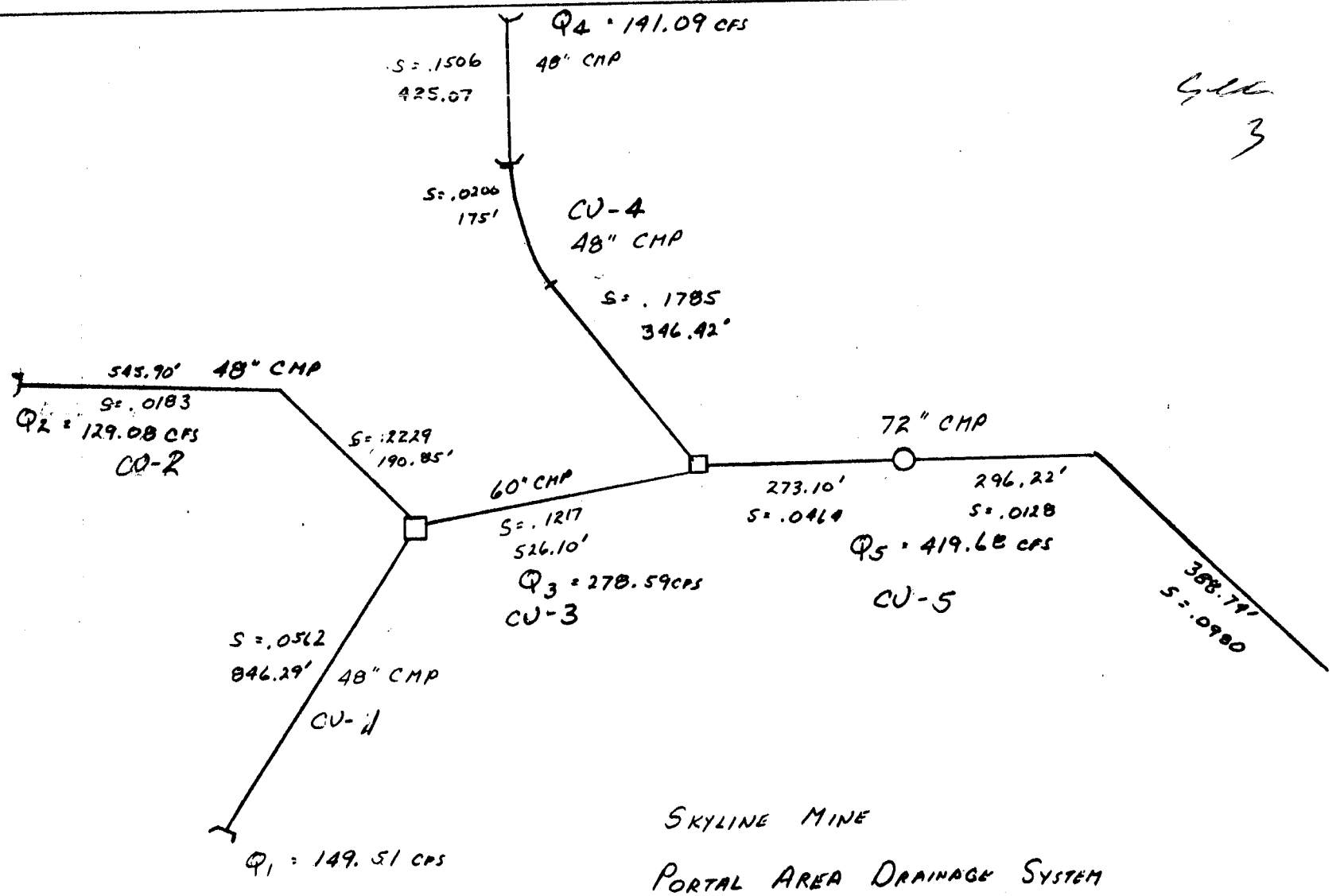
2) SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

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 RATIONAL FOR INITIAL FLOW CALCULATIONS

Q_{CV-1} = SB + UDA-A

= 148.32 + 1.19

= 149.51 CFS

Q_{CV-2} = MB + UDA-3 + ¾ 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 + ¼ 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
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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
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C, CU-3, 60" CMP

PEAK RUN OFF Q_{100-24} = CU-1 + CU-2 = 149.51 + 128.08 = 278.59 cfs

HW = 10 FT

$HW/D = 10/5 = 2.0$

FIGURE 4.20 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.

$HW/D = 8\text{ FT}/4\text{ FT} = 2$

FIGURE 4.20 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

$HW/D = 12\text{ FT}/6\text{ FT} = 2$

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 8 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

4. 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	56.73	19,985.00
UDA-6	181.28	73,210.00
UDA-7	44.25	22,410
TOTAL	1,060.34	373,669.14

SLOPE : $\Sigma C_i / AREA$

: 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 VALVES

AREA = 1,079.44
ΣC = 373,669.14
SLOPE = 39.90%
CN_{WTD} = 67

NB, UDA-1, UDA-2 = 179.91 @ 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 = 67.91

CN_{WTD} = 67

H_L = 7876 FT.

9-18-89

DETERMINE T_c KENT'S FORMULA — APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED 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_{10-24}	= 2.43 in	145.0 cfs (46.79)
Q_{25-24}	= 2.65 in	269.9 cfs (266.32)
Q_{50-24}	= 3.10 in	350.8 cfs
Q_{100-24}	= 3.5 in	540.2 cfs (506.46)

SECTION 2
PAGE 5 OF 7

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

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

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

$= 574.64$ cfs

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

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

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
THIS 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

$Q_{25\text{-}24} = 85.54$ CFS

$Q_{100\text{-}24} = 125.75$ CFS

SECTION 2, VOL. 5.

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

WEIR FLOW

$Q = C L H^{3/2}$ 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)

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

$H' = H + 15.6$

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

$a = 12.57$
$L = 826$ FT

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

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

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

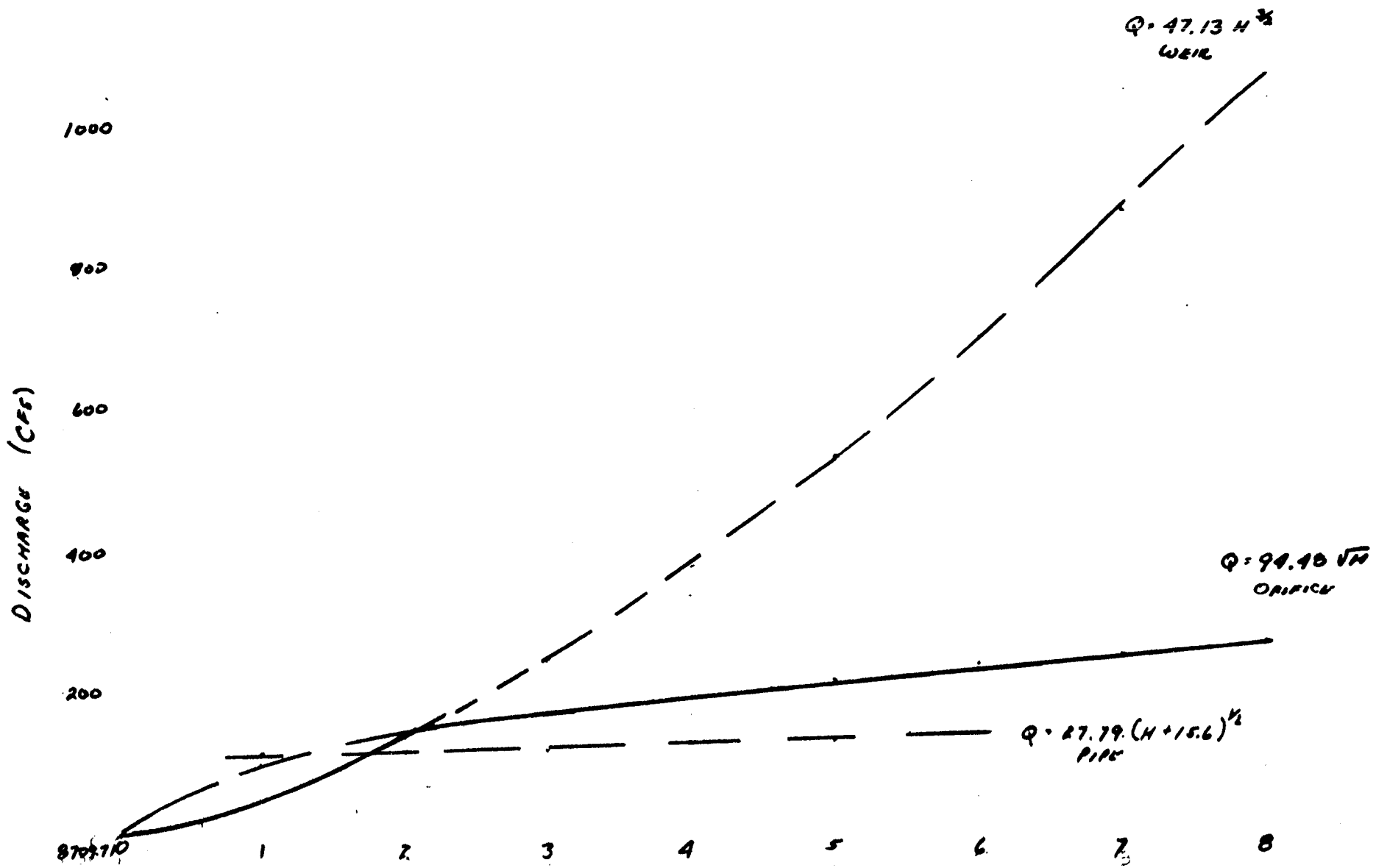
1) APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS
OKLAHOMA TECHNICAL PRESS

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

HEAD (FT)	(CFS) Q WEIR	Q ORIFICE	Q PIPE
1	47.13	94.46	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.L-1C

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



STAGE DISCHARGE CURVE

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

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

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

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

SW-4

Z = 25

14.29 : 1

Z = 14.29

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

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

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

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

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.

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

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

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

n = .016 ASPALT PAVEMENT, ROUGH TEXTURE
S = .07 (FIELD SURVEY, NOV. 1989)

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

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

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

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

TRY $d = .3$ FT.

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

$= 11.98$ CFS

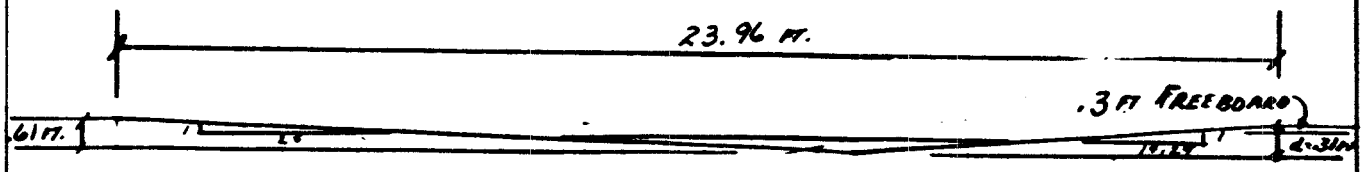
TRY $d = .31$

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

$= 13.08$

USE $d = .31$ FT.

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



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

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

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

$= 7.05$ 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
$A = 2d^2/2 + 2d^2/2$
$R = 2d/4\sqrt{2^2+1} + 2d/4\sqrt{2^2+1}$
$n = .016$ ASPALT PAVEMENT, ROUGH TEXTURE
$S = .02$ (FIELD SURVEY, NOV. 1989)

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

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

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

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

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

TRY $d = .4$

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

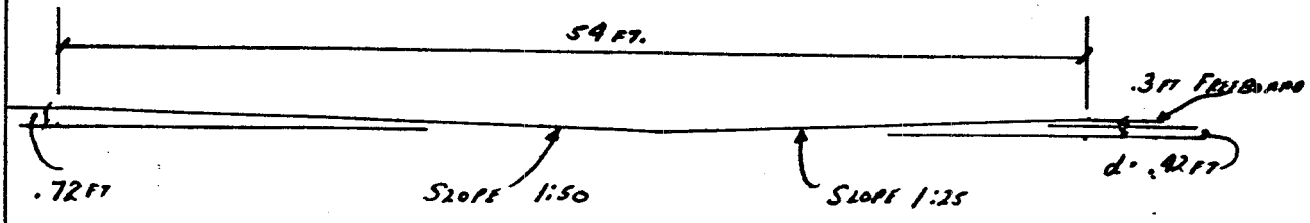
$= 26.54$ CFS

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.



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

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

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

$= 4.60$ 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

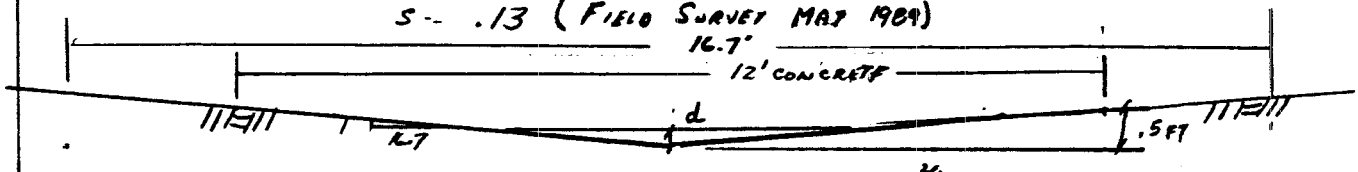
D, SW-4 - DETERMINE DEPTH OF FLOW

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



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

$$Q = 16.7(d)^2 \times 1.486/.014 \times \left(z d / 2\sqrt{(1.7)^2+1}\right)^{2/3} \times (.13)^{1/2}$$

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

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
11-13-09

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 1.5 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

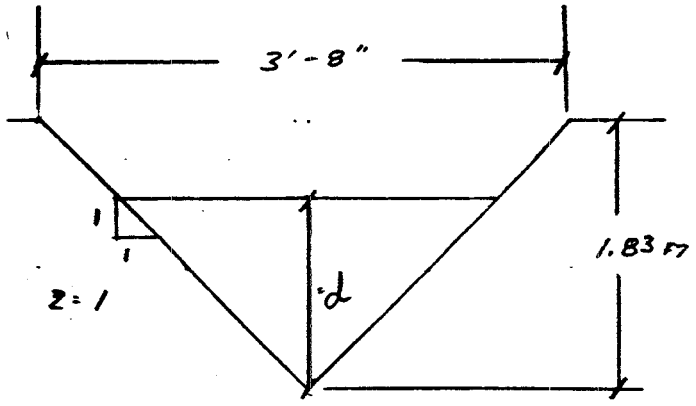
G DD-3 DETERMINE DEPTH OF FLOW

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



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

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

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

TRY $d = .5$ FT.

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

$= .39$ CFS

TRY $d = 1$ FT.

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

$= 11.63$ CFS

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

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 $d = 1.34$

$$Q = (1.34)^2 \times 106.14 \times \left(\frac{1.34}{2.83}\right)^{.67} \times .22$$

$$= 25.41 \text{ CFS}$$

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. FREE BOARD.

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

SECTION 5

UNDISTURBED AREAS
DRAINAGE DITCH DESIGNS

SEDIMENT TRAP
AND STREAM CHANNEL DESIGN

G. TAYLOR
10-15-90

1. ASSUMPTIONS

a. POND WIDTH 50 FT
b. DESIGN FLOW - 25 YR - 24 HR - 63.41 CFS - SECTION 2, VOLUME 5
c. TRAP WILL FUNCTION FOR TEMPERATURE DOWN TO 40°F
d. RETAIN 25% OF SEDIMENT HAVING A PARTICLE DIAMETER OF .0024 IN OR LARGER

2. DIMENSIONS OF THE POND

$\frac{LW}{Q} = F$

PAGE 563 BARFIELD, B.J., R.C. WARNER, C.T. HAAN
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR
DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

$F = 40$

FIGURE 7.36 PAGE 564

$LW/Q = 40$

$L(50)/63.41 = 40$

$L = (40)(63.41)/50$

$L = 2536.40/50$

$L = 50$ FT.

REMOVAL EFFICIENCY OF VARIOUS PARTICLE SIZES IS SHOWN BELOW

PARTICLE SIZE (IN)	TRAP EFFICIENCY (%)
.0002	.11
.0003	.50
.0006	2.0
.0012	8.0
.0024	25.0
.0049	69.0
.0098	96.0

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

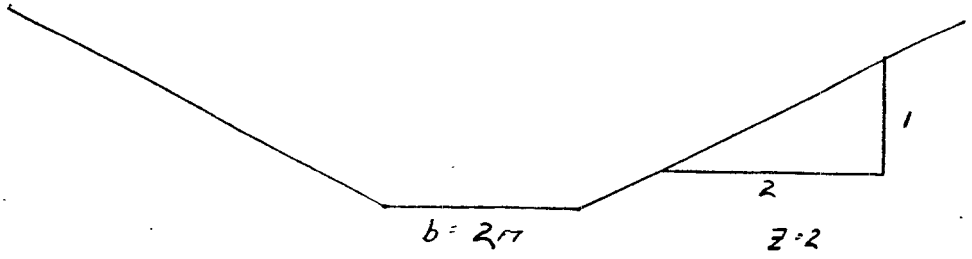
3 Stream Channel Design

Annual Flow - 1.9 cfs SCS Unit Hydrograph Method
2 yr - 24 hr

A. Annual Flow Design - Trapozio Channel

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

$S = .01$
$n = .033$ Dense weeds or Aquatic plants



$A = bd + zd^2$

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

$Q = 1.9$ cfs

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

$Q = 2d + 2d^2 \times 1.49/.033 \times (2d + 2d^2/2 + 2d\sqrt{2^2+1})^{2/3} \times (.01)^{1/2}$

$Q = 2d + 2d^2 \times 45.03 (2d + 2d^2/2 + 4.47d)^{2/3} \times .10$

$1.9 = 2d + 2d^2 \times 4.50 \times (2d + 2d^2/2 + 4.47d)^{2/3}$

$.42 = 2d + 2d^2 \times (2d + 2d^2/2 + 4.47d)^{2/3}$

Trail d

d (ft)	Q (cfs)
.3	.29
.4	.50
.38	.45
.36	.41
.37	.43

$d = .43$

$V = 1.49/n \times R^{2/3} \cdot S^{1/2}$

$R = 2d + 2d^2/2 + 2d\sqrt{2^2+1} = 1.01/3.65 = .28$

$S = .01$

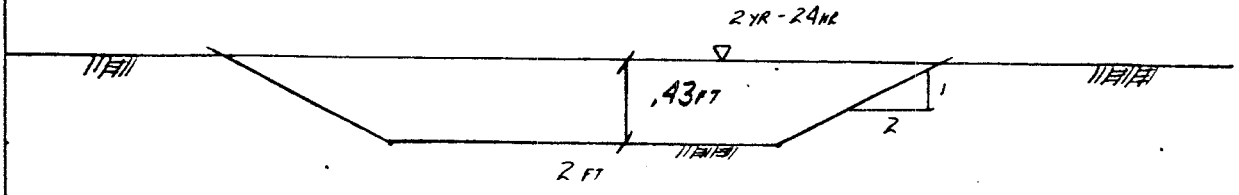
$n = .033$

$= 1.49/.033 \times (.28)^{.67} \times (.01)^{.5}$

$= 45.03 \times .57 \times .10$

$= 2.55$ FPS

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



STREAM CHANNEL WEST OF
COAL STORAGE

Wm W. Shinn
12-21-90

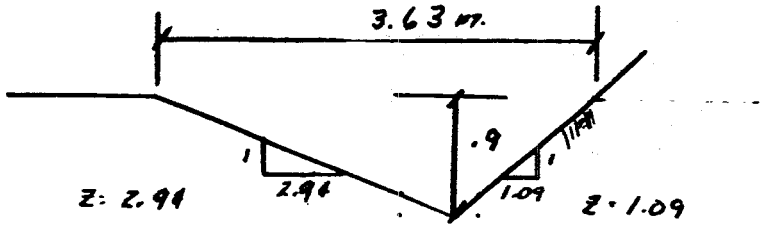
INTERCEPTER DITCH DESIGN FOR 10 YR. -24 HR. EVENT

G. Thomas
6-26-89
REVISED
11-15-89

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} = 4.88 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

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

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

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

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

$= 49.53 \left(1.97d^2 + .55d^2\right)(.24d + .18d)^{2/3} \times .32$

$4.88 = 49.53 \left(1.97d^2 + .55d^2\right)(.24d + .18d)^{2/3} \times .32$

Try $d = .61$ Ft

$4.88 = 49.53 \cdot \left(1.47(.61)^2 + .55(.61)^2\right) \times (24(.61) + .18(.61))^{2/3} \times .32$

$= 49.53 \left(.55 + .20\right) \times (.15 + .11)^{2/3} \times .32$

$= 49.53 \left(.75\right) \times (.26)^{2/3} \times .32$

$= 49.53 \cdot (.75) \times (.41) \times .32$

$= 4.62$

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

DITCH DESIGN

DEPTH OF DITCH = FLOW DEPTH + FREE BOARD

.61 + .3

= .91

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

B. VELOCITY

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

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

$= \frac{1.486}{.030} \left(\frac{2.49(.61)}{4\sqrt{(2.49)^2+1}} + \frac{1.09(.61)}{4\sqrt{1.09^2+1}}\right)^{2/3} (.10)^{1/2}$

$= 49.53 (.14 + .11)^{2/3} \times (.10)^{1/2}$

$= 6.30$ FPS

DUE TO SLOPE STEEPEST ERROSION CONTROL MATERIAL MUST BE USED

C DETERMINE RIPRAP SIZE

FIG. 2 PAGE 11-6 - RIPRAP FOR BANK PROTECTION HYDRAULIC ENGINEERING CIRCULAR No. 11 - U.S DEPT. OF TRANSPORTATION.

D_{50} = .25 FT OR 3 IN.

RIPRAP GRADATION

$1.25\ D_{50}$	-	3.75 IN	30%
D_{50}	-	3.00 IN	50%
$.5\ D_{50}$	-	1.50 IN	10%
$.2\ D_{50}$	-	.60 IN	10%

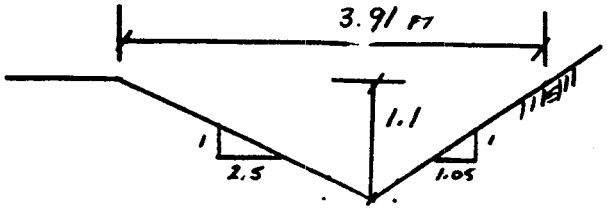
NO FILTER BLANKET WILL BE NEEDED THIS IS BASED ON FIELD INSPECTION.

G. Taylor
Revised
11-15-85

II Ditch DU-2 Map 3.2.1-1

DU-2 will intercept water from area UOA-2, Map 3.2.4-2 $Q_{10-24} = 1.31$ CFS Section 2, Vol. 5

Typical Ditch



Field Survey
June, 1989

A. Use Manning Formula to Determine Depth of Flow

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

$S = .15$ Field Survey
$n = .030$ Earth Channel with considerable growth

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

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

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

$= 1.486/.03 \left(2.5d^2/2 + 1.05d^2/2\right)\left(2.5d/4\sqrt{(1.5)^2+1} + 1.05d/4\sqrt{(1.05)^2+1}\right)^{2/3} (.15)^{1/2}$

$1.31 = 49.53 \left(1.25d^2 + .53d^2\right)(.23d + .18d)^{2/3} .39$

Try $d = .40$ FT.

$1.31 = 49.53 \times (1.25(.40)^2 + .53(.40)^2) \times (.23(. \quad + .18(\quad))^{2/3} \times .32$

$= 49.53 \times (.20 + .08) \times (.09 + .07)^{2/3} \times .32$

$= 49.53 \times (.28) \times (.16)^{2/3} \times .32$

$= 49.53 \times .28 \times .29 \times .32$

$= 1.32$

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

G. Taylor
Revised
11-15-89

DITCH DESIGN

DEPTH OF FLOW = FLOW DEPTH + FREE BOARD

= .40' + .30'

= .70 FT

PRESENT DITCH WILL WORK AS SHOWN ON PAGE 3 OF THIS SECTION

B. VELOCITY

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

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

$= \frac{1.486}{.03} \left(\frac{2.5(.40)}{4\sqrt{2.5^2+1}} + \frac{1.05(.40)}{4\sqrt{1.05^2+1}} \right)^{2/3} (.15)^{1/2}$

$= 49.53 \times (.09 + .07)^{2/3} \times .39$

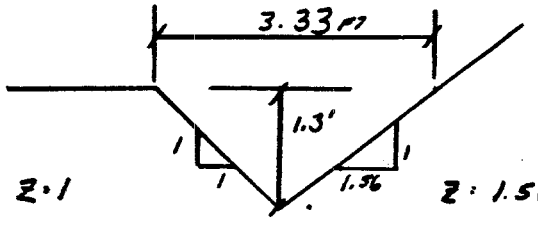
= 5.66 FPS

NO ERROSION CONTROL MATERIAL WILL BE NEEDED

III DITCH DU-3 MAP 3.2.1-1

DU-3 WILL INTERCEPT WATER FROM AREA UDA-3, MAP 3.2.4-2 Q_{10-24} = .24 CFS SECTION 2, VOL. 5

TYPICAL DITCH



FIELD SURVEY
JUNE, 1989

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

A. USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$S = .25$ FIELD SURVEY
$n = .030$ EARTH CHANNEL WITH CONSIDERABLE GROWTH

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

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

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

$= 1.486/.030 \times \left(\frac{1d^2}{2} + \frac{1.56d^2}{2}\right)\left(1d/4\sqrt{1^2+1} + 1.56d/4\sqrt{.56^2+1}\right)^{2/3} \times (.25)^{1/2}$

$.24 = 49.53 \times (.5d^2 + .78d^2) \times (.18d + .21d)^{2/3} \times .50$

Try $d = .2$ FT

$.24 = 49.53 \times (.5(.2)^2 + .78(.2)^2) \times (.18(.2) + .21(.2))^{2/3} \times .50$

$= 49.53 \times (.02 + .03) \times (.04 + .04)^{2/3} \times .50$

$= 49.53 \times .05 \times (.08)^{2/3} \times .50$

$= 49.53 \times .05 \times .19 \times .50$

$= .24$

DITCH DESIGN

DEPTH OF FLOW = FLOW DEPTH + FREE BOARD

$= .2' + .3'$

$= .5$ FT

PRESENT DITCH WILL WORK AS SHOWN ON PAGE 4 OF THIS SECTION

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

G. Taylor
Revised
11-15-89

B. Velocity

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

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

$= \frac{1.486}{.03} \left(\frac{1(.2)}{4\sqrt{1^2+1}} + \frac{1.56(.2)}{4\sqrt{1.56^2+1}}\right)^{2/3} (.25)^{1/2}$

$= 49.53 \times (.04 + .04)^{2/3} \times .50$

$= 49.53 \times (.08)^{2/3} \times .50$

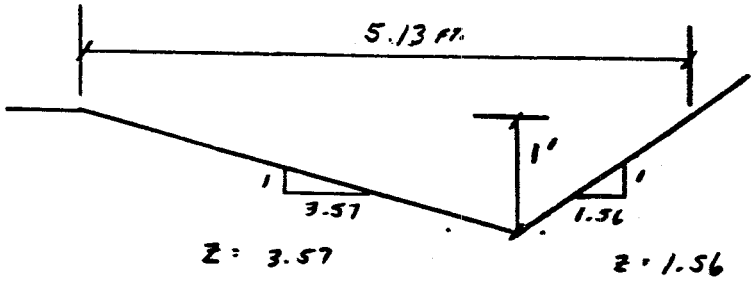
$= 4.46$ FPS

No errosion control material will be needed

IV Ditch DU-4 Map 3.2.1-1

DU-4 will intercept water from area UDA-4, Map 3.2.4-2 $Q_{10-24} = .34$ cfs Section 2, Vol. 5

Typical Ditch



Field Survey
June, 1989

A. Use Manning Formula to Determine Depth on Flow

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

S = .19 Field Survey
n = .030 Earth Channel with considerable growth

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

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

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

$$Q = \frac{1.486}{n} \times \left(2d^{5/2} + 2d^{5/2}\right) \times \left(\frac{2d}{4\sqrt{2^2+1}} + \frac{2d}{4\sqrt{2^2+1}}\right)^{2/3} S^{1/2}$$

$$= \frac{1.486}{.03} \times \left(3.57d^{5/2} + 1.56d^{5/2}\right)\left(\frac{3.57d}{4\sqrt{3.57^2+1}} + \frac{1.56d}{4\sqrt{1.56^2+1}}\right)^{2/3} (.19)^{1/2}$$

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

Try $d = .18$ ft.

$$.34 = 49.53 \times (1.79(.18)^2 + .78(.18)^2) \times (.24(.18) + .21(.18))^{2/3} \times .44$$

$$= 49.53 \times (.06 + .02) \times (.04 + .04)^{2/3} \times .44$$

$$= 49.53 \times (.08) \times .19 \times .44$$

$$= .34$$

DITCH DESIGN

DEPTH OF FLOW = FLOW DEPTH + FREE BOARD

$= .34' + .3'$

$= .68$ FT.

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

B. VELOCITY

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

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

$$= \frac{1.486}{.030}\left(\frac{3.57(.18)}{4\sqrt{3.57^2+1}} + \frac{1.56(.18)}{4\sqrt{1.56^2+1}}\right)^{2/3} \times (.19)^{1/2}$$

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

$$= 49.53 \times .19 \times .44$$

$$= 4.05 \text{ FPS}$$

NO ERROSION CONTROL MATERIAL WILL BE NEEDED

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

DITCH DU-5 MAP 3.2.1-1

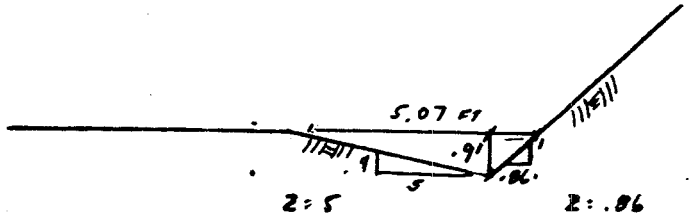
G. TAYLOR
11-16-89

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 x 100 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

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

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

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

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

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

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

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

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

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

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

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

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

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

$= .40$ 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

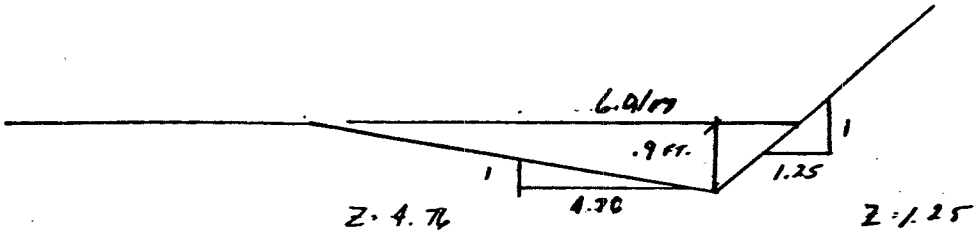
APPROXIATELY 2.07 ACRES OF WATER SHED UDA-1 ARE DIVERTED TO DU-6 ON THE EAST SIDE OF THE TOPSOIL STOCKPILE OR 2.07 ACRES / 12.91 ACRES = .16 x 100 16 % OF THE RUNOFF

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 x .16 = .78 CFS

DU-6 MUST BE DESIGNED TO HANDLE .78 CFS

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



USE MANNING EQUATION TO DETERMINE DEPTH OF FLOW

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

$A = 2d^2/2 + 2d^2/2$

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

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

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

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

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

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

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

TRY $d = .4$ FT.

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

$= .45$ CFS

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

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

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

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

$= 1.07$ FPS

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

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

INTERCEPTER 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

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

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

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

$Q = \frac{1.486}{.024} \frac{\pi (2)^2}{4} \left(\frac{\pi (2)^2/4}{\pi (2)}\right)^{2/3} (.38)^{1/2}$

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

$= 75.80$ 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

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

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

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

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

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

$= 111.26$ CFS FULL FLOW

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

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

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

Kc = 0.9 page 181 [1]

L' = 205 ft x .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
8-30-05

CULVERT CU-9 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 NOMOGRAM - PAGE 189[1]

HW/D = 24/24 = 1.0 GRAM 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' = 125 FT + .44 = 55 FT

USE OUTLET CONTROL NOMOGRAM - PAGE 190[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, $Q_{100-24} = 2.30$
SECTION 5, VOL. 5 PAGE 11

CU-10 - 24"ϕ

USE MANNING FORMULA

S = .45
n = .024 CORRUGATED METAL PIPE

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

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

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

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

$= 81.87$ 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

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

S = .45
n = .024 CORRUGATED METAL PIPE

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

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

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

$= 81.87$ 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
8-30-95

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

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

REFERENCES:

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

G. Taylor
8-30-99

CULVERT CU-11 MAP 3.2.1-1

24" ϕ 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 - $^{29}/_{24}$ = 1.0 GRAM 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 PRODUCTS 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, $Q_{DU-3} = .85$ 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

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

$R = \pi d^2/8 / \pi d/2 = \pi d^2/8 \cdot 2/\pi d = d/4$

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

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

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

$= 22.00$ 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

PORTAL AREA

6-20-89
G. TAYLOR
REVISED
4-27-89

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	881.8'	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

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

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

AREA	ACRES	CN 3)	H_L	Σ OF CONTOUR (FT)	SLOPE %	CONTOUR INTERVAL	T_c 4)	Q 10-24
ARA-1	4.6	82	1151.4	12,982	64.79	10	.05	4.82

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

4) KENT FORMULA

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

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 SECTION 6. THE DITCH DESIGN WILL BE TYPICAL FOR DD-1,

USING MANNING FORMULA

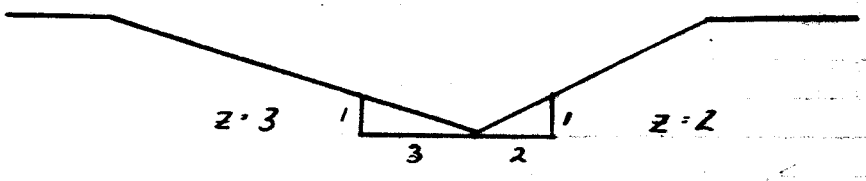
$$Q = A \times 1.486/n \times R^{2/3}\,S^{1/2}$$

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

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD
NOV
DIV. OIL, GAS

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)

$$Q = \left(Zd^2/2 + Zd^2/2\right) \times 1.49/n \times \left(Zd/4\sqrt{Z^2+1} + Zd/4\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= \left(3d^2/2 + 2d^2/2\right) \times 1.49/.0225 \times \left(3d/4\sqrt{13} + 2d/4\sqrt{13}\right)^{2/3} \times (.0375)^{1/2}$$

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

TRY $d = .4$ FT.

$$Q = (1.5(.4)^2 + (.4)^2) \times 66.04 \times (.24(.4) + .22(.4))^{2/3} \times .15$$

$= 1.61$ CFS

TRY $d = .95$

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

$= 16.26$ 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

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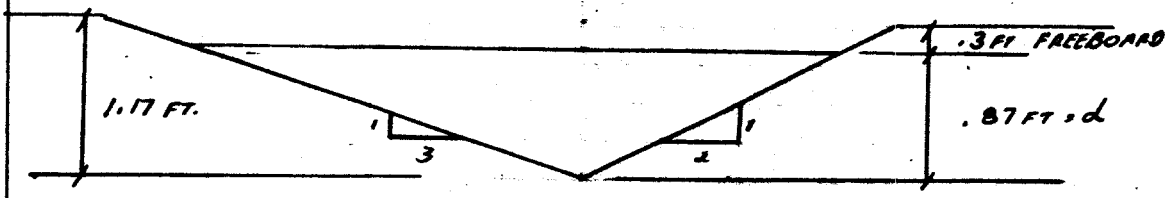
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

G Taylor 11-16-89



TYPICAL DITCH
FOR DD-1

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

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

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

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

$= 6.79$ FPS

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

C. TAYLOR
REVISED
11-16-89

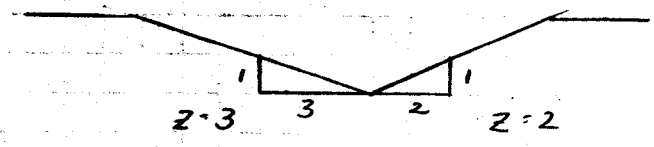
B DITCH IN AREA ARA-1 WILL BE DESIGNED TO CARRY A PEAK FLOW OF 4.82 CFS FOR 10YR-24 HR SECTION 6 VOL. 5.

USING MANNING FORMULA

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

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

$$A = \frac{2d^2}{2} + \frac{2d^2}{2}$$

$$R = \frac{2d}{4\sqrt{2^2+1}} + \frac{2d}{4\sqrt{2^2+1}}$$

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

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

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

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

TRY $d = .6$

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

$$= 6.77 \text{ CFS}$$

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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.

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

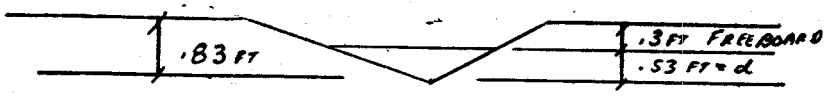
$= 5.37$ CFS

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 DD-2

$V = 1.49/n \times R^{2/3} \times S^{1/2}$

$n = .0225$
$R = (.24(.53) + .22(.53)) = .24$
$S = .0796$

$= 1.49/.0225 \times (.24)^{2/3} \times (.0796)^{1/2}$

$= 66.09 \times .38 \times .27$

$= 6.85$ FPS ROCK CHANNEL

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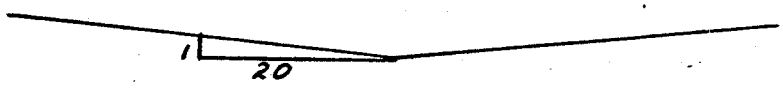
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

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 10 YR-24 HR
SECTION 6, VOL 5.



$Z = 20$

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

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

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

$= 20d^2 \times 92.88 \times (50d)^{1/3} \times .17$

TRY $d = .26$ FT.

$Q = 20(.26)^2 \times 92.88 \times (.5(.26))^{1/3} \times .17$

$= 5.44$ CFS

TRY $d = .24$ FT.

$Q = 20(.24)^2 \times 92.88 \times (.5(.24))^{1/3} \times .17$

$= 4.39$ CFS

TRY $d = .25$ FT.

$Q = 20(.25)^2 \times 92.88 \times (.5(.25))^{1/3} \times .17$

$= 4.90$ CFS

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

VELOCITY

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

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

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

$= 3.99$ FPS

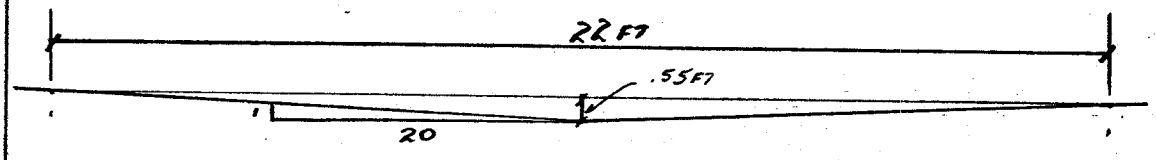
$n = .016$
$R = .5(.25) = .13$
$S = .03$

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

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

$= .55$ FT.

DITCH DESIGN



TYPICAL DITCH
DD-4

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

Sec. 6

6-19-90
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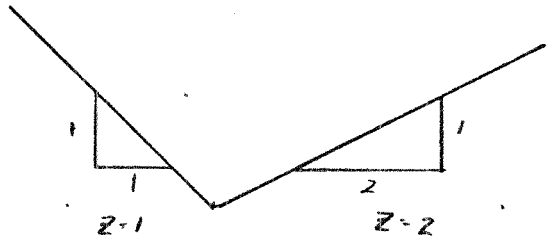
D. DD-5

DITCH WILL HANDLE WATER FROM DD-7 AND AREA DA-3
THE PEAK FLOW WILL BE 29.13 CFS + 11.82 CFS = 40.95 CFS
10 YR - 24 HRS.

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



DETERMINE THE DEPTH OF FLOW

USE MANNING FORMULA

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

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

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

n = .045 ROCK CHANNEL, JAGGED AND IRREGULAR

S = .054 MAP 3.2.1-1 AVG. SLOPE FOR DITCH

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

$40.95 = 1.486/.045 \times (1d^2/2 + 2d^2/2) \times (1d/4\sqrt{1^2+1} + 2d/4\sqrt{2^2+1})^{2/3} \times (.054)^{1/2}$

$40.95 = 33.02 \times (.5d^2 + d^2)^2 \times (.13d + .22d)^{2/3} \times .23$

$40.95 = 7.70 \times d^4(1.5) \times (.40d)^{2/3}$

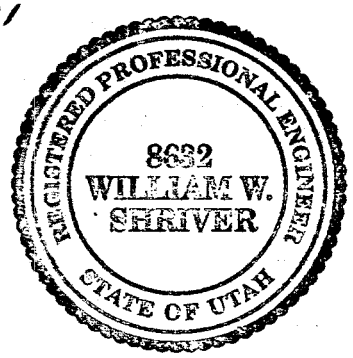
$5.32 = d^4(1.5) \times (.40d)^{2/3}$

6-19-90
G. Taylor

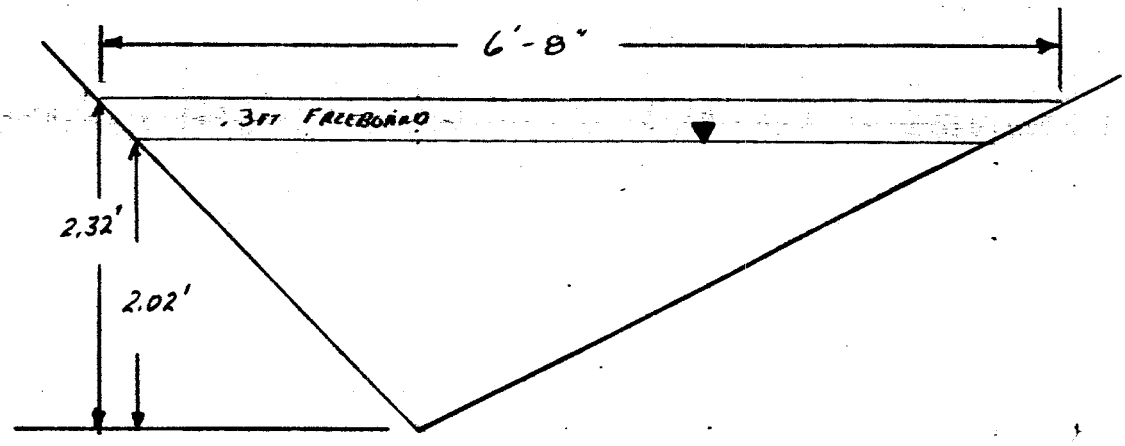
TRIAL d

d (FT)	Q(CFS)
1.0	.81
1.5	2.40
2.0	5.17
2.02	5.31

d = 2.02 FT



Wm W. Shriver, 11-21-90



TYPICAL DESIGN FOR
DITCH DD-S

DETERMINE VELOCITY

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

$= \frac{1.486}{.045} \times (.81)^{2/3} \times (.054)^{1/2}$

$= 33.02 \quad .87 \times .23$

$= 6.65$ FPS

R = .81
S = .054
n = .045

NO PROTECTION WILL BE NEEDED BECAUSE CHANNEL IS IN ROCK

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

E. DD-6

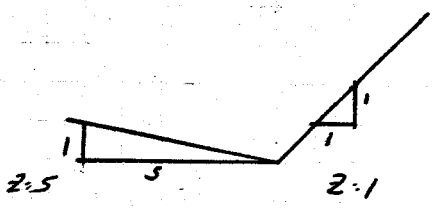
DITCHES IN AREA DA-1 WILL BE DESIGNED TO CARRY A PEAK FLOW OF 12.71 CFS 10yr-24hr EVENT SECTION 6, VOL. 5.

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 .3 FT



DETERMINE DEPTH OF FLOW

$A = 2d^2/2 + 2d^2/2$

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

n = .043 EARTH, UNIFORM SECTION. ROCK JAGGED AND IRREGULAR

S = .076 MAP 3.2.1-1 AVG. SLOPE FOR DITCH

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

$= 5d^2/2 + 1d^2/2 \times 78.21 \times (5d/4\sqrt{5^2+1} + 1d/4\sqrt{1^2+1})^{2/3} \times (.076)^{1/2}$

$= 2.5d^2 + .5d^2 \times 78.21 \times (.25d + .10d)^{2/3} \times .28$

$= 3.0d^2 \times 78.21 \times (.43d)^{2/3} \times .26$

TRY $d = 1.2$ FT.

$Q = 3(1.2)^2 \times 78.21 \times (.43(1.2))^{2/3} \times .26$

$= 60.73$ CFS

TRY $d = .6$ FT

$Q = 3(.6)^2 \times 78.21 \times (.43(.6))^{2/3} \times .26$

$= 9.54$ CFS

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

Try $d = .8$ ft

$Q = 3(.8)^2 * 78.21 * (.43(.8))^{4/9} * .28$

$= 20.57$ cfs

Try $d = .67$ ft

$Q = 3(.67)^2 * 78.21 * (.43(.67))^{4/9} * .28$

$= 12.81$

use $d = .67$

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= .67$ ft $+ .3$ ft

$= .97$ ft.

VELOCITY

$V = 1.49 R^{2/3} S^{1/2} / n$ $\quad n = .019$, $R = .43(.67) = .29$, $S = .0765$

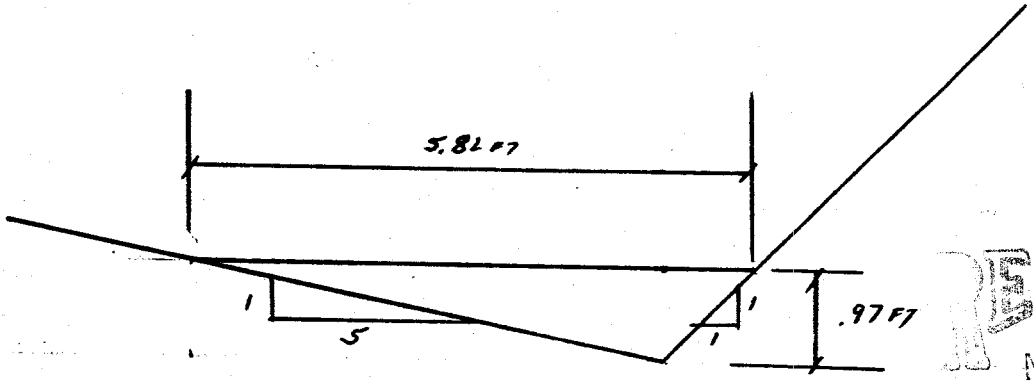
$= 1.49 / .019 * (.29)^{2/3} * (.0765)^{1/2}$

$= 78.21 * .43 * .28$

$= 9.90$ FPS

DITCH HAS ROCK IN ALL READY RIPRAP WILL NOT BE NEEDED

DITCH DESIGN



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G. TAYLOR
REVISED 10-11-90

CHANNEL DESIGN FROM MIDDLE BENCH TO LOWER BENCH
DD-7

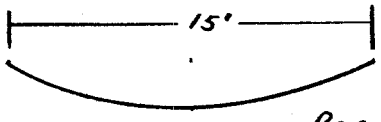
PEAK FLOW OF CHANNEL IS FROM DA-1 AND DA-2

DA-1 = 12.71 CFS
DA-2 = 16.42 CFS
} SECTION 6, VOLUME 5, PAGE 1/11

TOTAL FLOW = 29.13 CFS

SLOPE = 64.76 % MAP 3.2.1-1

A. DETERMINE DEPTH OF FLOW (ASSUME CRITICAL DEPTH AS WE WILL HAVE SUPER CRITICAL FLOW IN THIS DITCH)



PARABOLA

USE MANNING FORMULA

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

$A = {}^{2}/_{3}\,dT$
$R = 2dT^2/37^2 + 8d^2$
$S = .6476$
$n = .020$ GUNITE, WAVY SECTION
$T = 15$ FT.
$Q = 29.13$ CFS

$Q = 1.486/n \times (2dT^2/37^2 + 8d^2)^{2/3} \times {}^{2}/_{3}\,dT \times S^{1/2}$

$29.13 = 1.486/.02 \times (2d(15)^2/3(15)^2 + 8d^2)^{2/3} \times {}^{2}/_{3}\,d(15) \times (.6476)^{1/2}$

$29.13 = 74.30 \times (450d^2/675 + 8d^2)^{2/3} \times 10d \times .80$

$.49 = (450d^2/675 + 8d^2)^{2/3} \times 10d$

TRAIL d

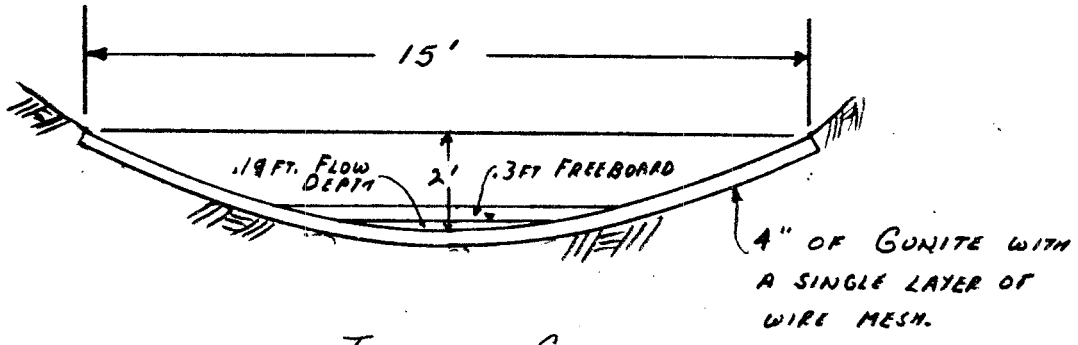
d FT	Q CFS
.1	.16
.15	.32
.17	.40
.18	.43
.19	.48

USE $d = .49$ FT

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

6-14-90
6. Taylor
Revised 10-11-90

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



Typical Channel

NOTE: The design and flow Calculations for this Diversion Facility were performed under my direction and to the best of my Professional Knowledge are Correct.

REGISTERED PROFESSIONAL ENGINEER
8682
WILLIAM W. SHRIVER
STATE OF UTAH

Wm W. Shriver 11-1-90

SECTION 7

STAGE VOLUME
PORTAL AREA

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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.

Insert in front of
Eng. Calcs. Sec. 7

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-i)

= 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 } APPLIED HYD. AND SEDIMENTOLOGY FOR DISTRUBED AREA BARFIELD AND HANN 2)

$= 1000/88 - 10$

$= 1.36$

$Q = (P - .25)^2 / P + .85$ Eq 2.38 PAGE }

$= (2.43 - .2(1.36))^2 / 2.43 + .8(1.36)$

$= 4.65 / 3.52$

$= 1.32 \div 12$ IN/FT $= .11$ FT.

33.79 ACRES × 43,560 SQ FT/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.

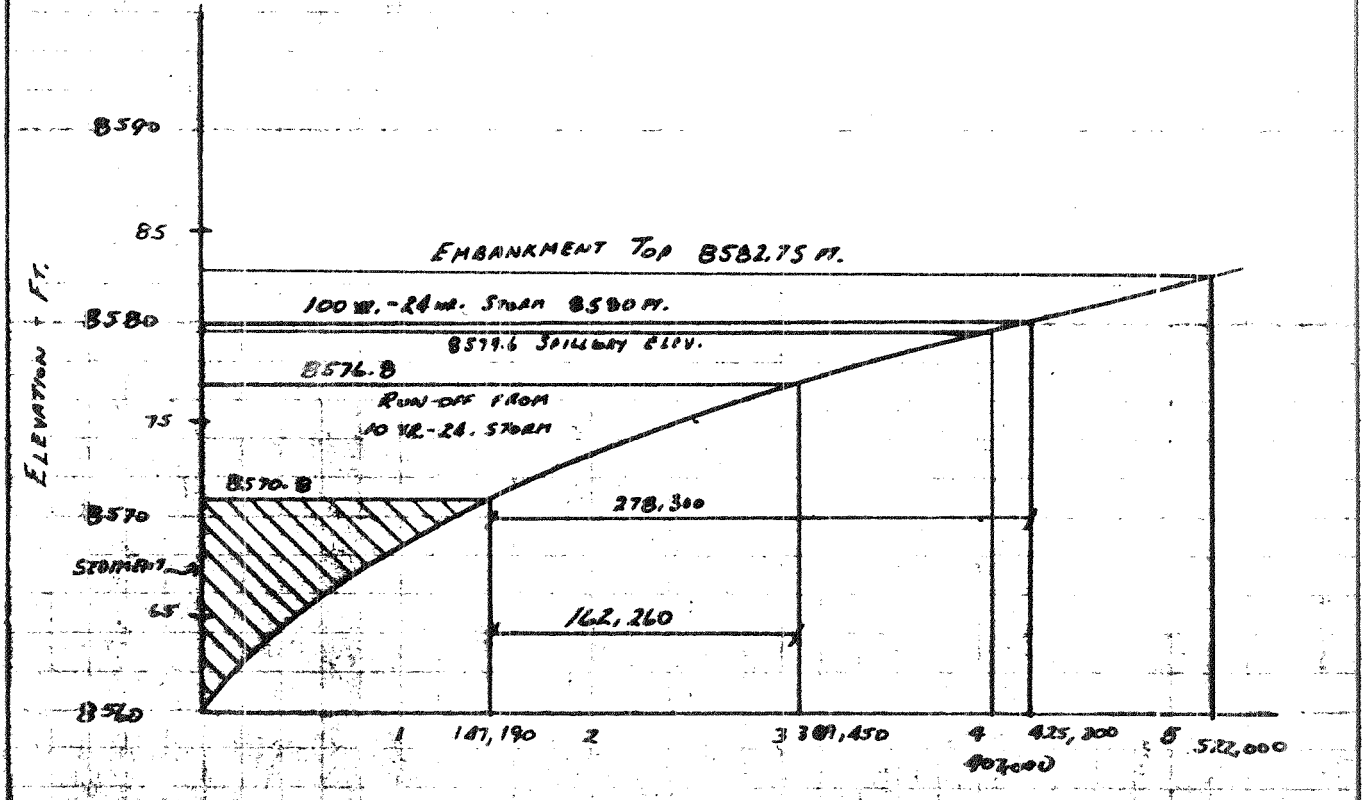
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

REVISED 9-19-05
G. TAYLOR

3. POND CAPACITY (MAP 3.2.1-2B)

	ELEVATION	AREA (FT²)	AVG AREA (FT²)	Δ VOL. (FT³)	ACC. VOL (FT³)
	8560	3,054			
INTERMEDIATE CONTROL	8565	14,800	8,927	44,635	44,635
	8570	21,000	17,900	89,500	134,135
INTERMEDIATE CONTROL	8575	27,400	24,200	121,000	255,135
	8579.6	33,600	30,500	140,300	395,435

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



+ 307,000 CU. FT. = 309,450 CU. FT. = REMAINING WATER STORAGE FOR MINE DISCHARGE 97,550 CU. FT. OR 729,674 GALLONS

REVISED 9-18-89
C. TAYLOR

ORIFICE FLOW

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

$= 60.51 \sqrt{H}$

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

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

PIPE FLOW

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

EQ. 4.4 PAGE 231

$a = 9.91 \text{ FT}^2$
$L = 63 \text{ FT}$
$K_e = 1.0$
$K_b = .5$
$K_c = .0129$

TABLE 4.1 PAGE 233

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

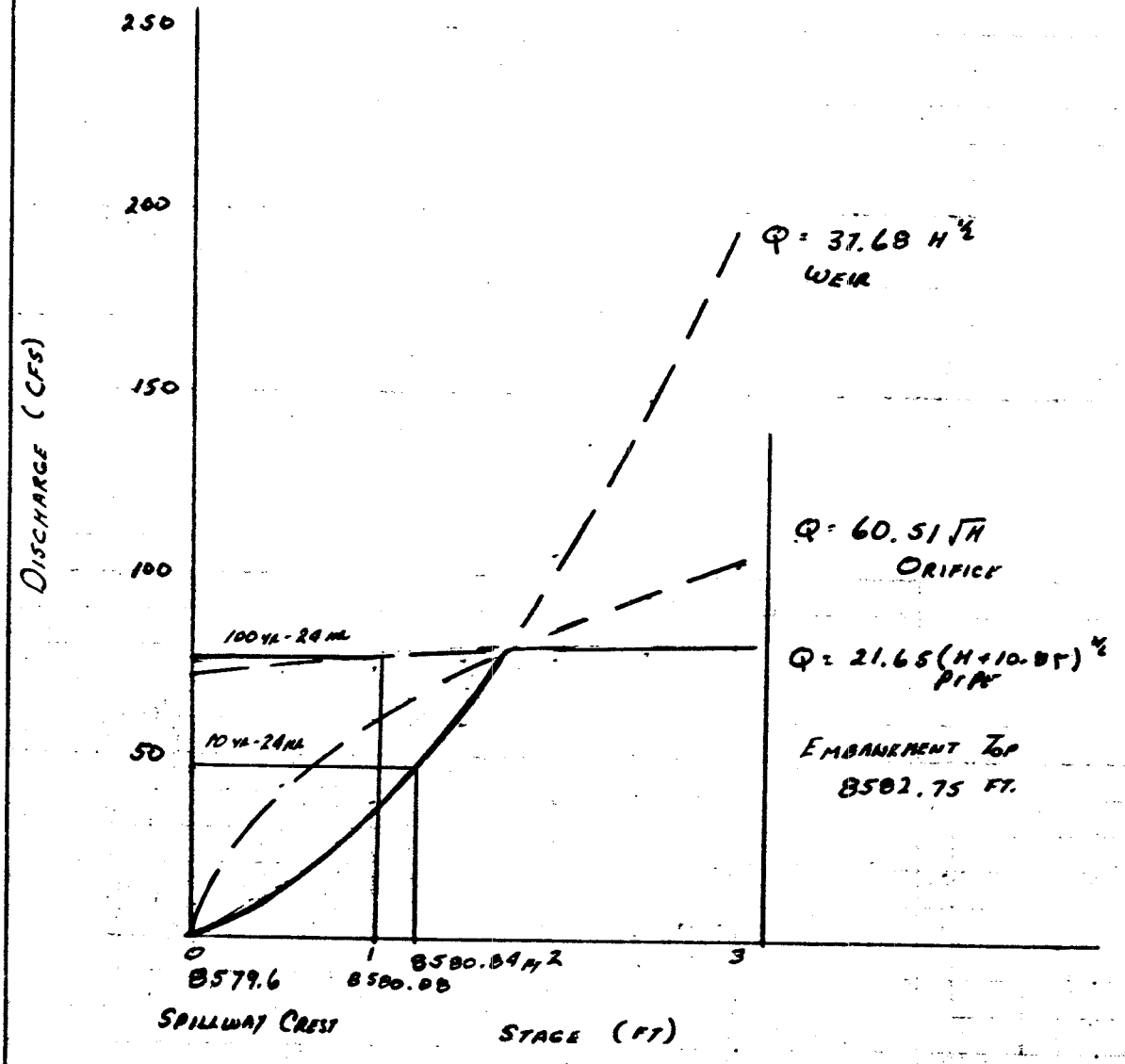
$Q = 4.91 (2g H + 10.85)^{1/2} / (1 + 1 + .5 + .0129((3))^{1/2}$
$= 39.40 (H + 10.85)^{1/2} / 1.82$
$= 21.65 (H + 10.85)^{1/2}$

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

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

REVISE 9-18-89
C. Tanner

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



STAGE - DISCARGE CURVE

TRAIN LOADOUT
CULVERT DESIGN
24"Ø CMP - CO-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

Section 12.

B. OUTLET CONTROL

K_c = 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

TRAIN LOADOUT
CULVERT DESIGN
36"Ø CMP - CO-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 CONSTRUCTION PRODUCTS THIRD EDITION

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

$Q_{10\text{-}24}$ = 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

Ke = 0.9 PAGE 181 [1]

L' = 95 FT X .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

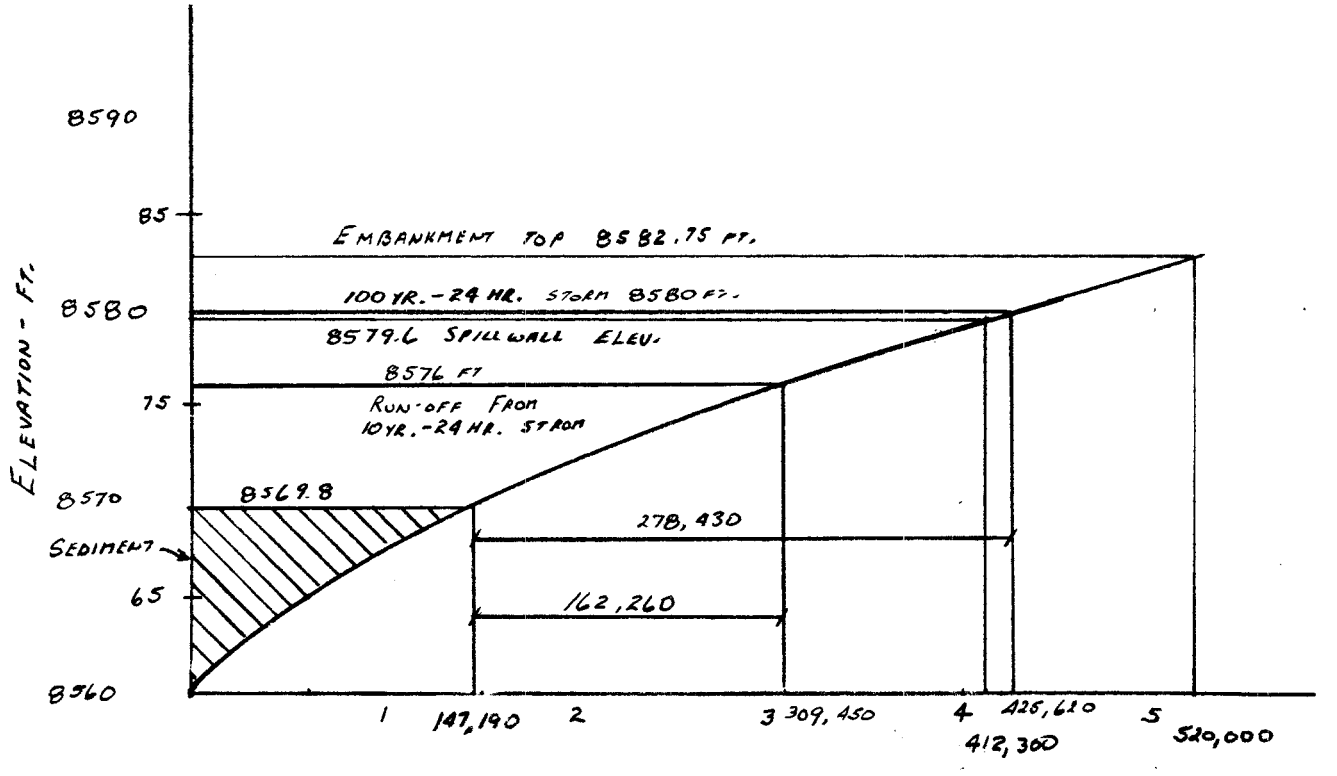
1) HANDBOOK OF STEEL DRAINAGE + HIGHWAY CONSTRUCTION PRODUCTS THIRD EDITION

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

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	9,800			
			12,300	61,500	61,500
INTERPOLATED CONTOUR	8565	14,800			
			17,900	89,500	151,000
	8570	21,000			
			24,200	121,000	272,000
INTERPOLATED CONTOUR	8575	27,400			
			30,500	140,300	412,300
	8579.6	33,600			

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



412,300 CU.FT − 309,450 CU.FT. = REMAINING WATER STORAGE FOR MINE DISCHARGE 102,850 CU.FT. OR 769,318 GALLONS

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

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.

t_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 TECHNICA PRESS BARFIELD AND HAAN EQ 238 PAGE 8/

$= (3.5 - .2(1.36))^2 / 3.5 + .8(1.36$

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

$= 10.43 / 4.59$

= 2.27 INCH ÷ 12 IN/FT = .19 FT

33.79 ACRES × 43560 SQ FT/AC. × .19 FT = 278,432.98 2 -

USE 279,430 CU FT.

REFERENCE

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

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

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

Q_{100}

74.30 CFS

$Q_{25\text{-}6} = 26.84$

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
RISER DIA. = 48"
BARREL DIA. = 30"

WEIR FLOW

$Q = C L H^{3/2}$

$C = 3$
$L = 12.57$ FT

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

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

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

ORIFICE FLOW

$Q = C' a \sqrt{2gH}$ $\quad C' = .60$ Eq 4.2 page 230

$a = 12.57$ FT^2

$Q = 60.51 \sqrt{H}$

Applied Hydrology and Sedimentology for Disturbed Areas · Oklahoma Technical Press

PIPE FLOW

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

$a = 4.91$ FT^2
$L = 63$ FT
K_e 1.0
$K_b = .5$
$K_c = .0129$ Table 4.1 Page 233

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

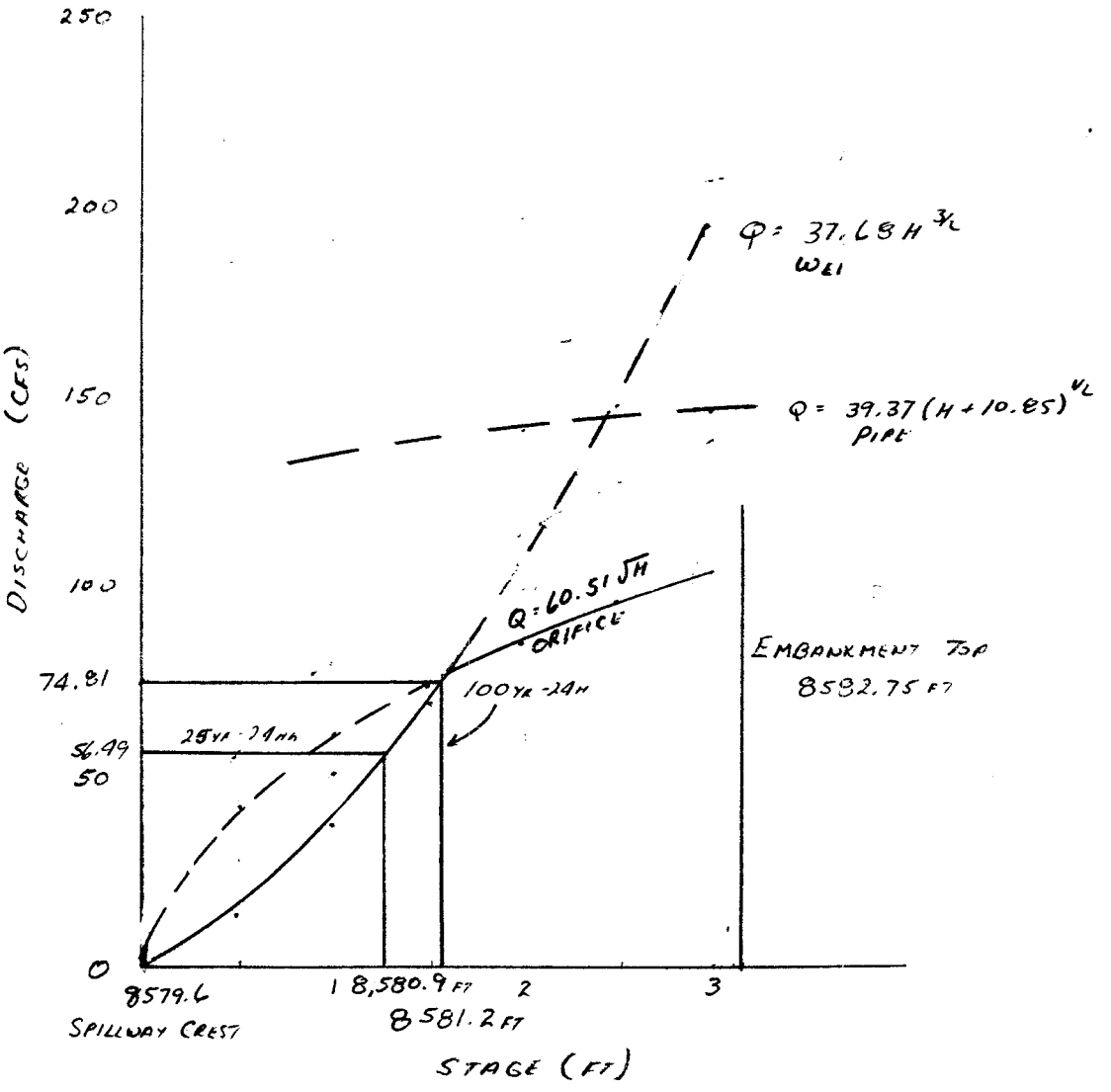
$Q = 4.91 (2g(H + 10.85))^{1/2} / (1 + 1 + .5 + .0129(63))^{1/2}$

$= (4.91)(8.02)(H + 10.85)^{1/2} / 1.82$

$Q = 39.37 (H + 10.85)^{1/2}$

H	Q WEIR	Q ORIFICE	Q PIPE
0	0	0	0
.5	13.33	42.79	132.64
1.0	37.70	60.51	135.53
1.5	69.26	74.11	138.36
2.0	106.63	85.57	141.13
2.5	149.02	95.67	143.85
3.0	195.89	104.80	146.52

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



STAGE - DISCHARGE CURVE

SECTION 8

TOPSOIL DIVERSIONS

Topsoil Diversions

G. Taylor
6-26-09

This is a temporary diversion for the North Branch of Eccles Creek. The diversion consists of a 36"ϕ half round CMP, 36"ϕ full round and a 24"ϕ 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

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

$A = \pi d^2/8$

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

S = .07 (Map 3.2.1-1)
n = .024 Corrugated Metal Pipe

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

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

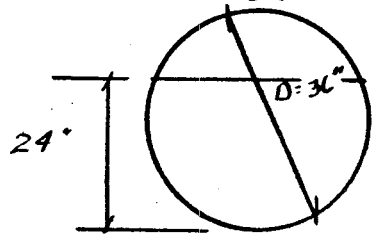
$= 61.92 \times 3.53 \times (.75)^{2/3} \times .26$

$= 47.69$ 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

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

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

$A = D^2/8\,(2\pi - \pi\theta/180 + \sin\theta)$

$R = \frac{45\theta}{\pi(360-\theta)}\,(2\pi - \pi\theta/180 + \sin\theta)$

Page 4.3 Surface Mining Water Diversion Design Manual - U.S Dept. of the Interior - Office of Surface Mining

G. Taylor
Revised 4-15-87

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

$= \frac{1.486}{.024} \frac{(3)^2}{8}\left(2\pi - \frac{\pi(148.08)}{180}+\sin 148.08\right) \times \left(\frac{45(3)}{\pi(360-148.08)}\left(2\pi - \frac{\pi 148.08}{180}+\sin 148.08\right)\right)^{2/3} \times .09$

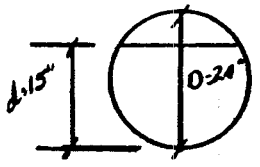
$= 61.92 \times 3.59 \times (.63)^{2/3} \times .30$

$= 48.93$ 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

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

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

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

$= 48.51$ 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
UINTA 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

$$CN: \frac{.45(55) + .35(55) + .15(77) + .05(55)}{.45 + .35 + .15 + .05}$$

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

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

AREA

$$25 \times 13,698 \text{ FT}^2/\text{UNIT} = 342,450 \text{ FT}^2$$

SLOPE

$$L = \Sigma Ci/AREA$$

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

$$= .33 \quad \text{OR} \quad 33\%$$

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

KERN FORMULA

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

L = 1000 FT.
Y = .33
CN = 58

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

$= (209.51 / 1,091.47) / .6$

$= .32$ HRS

$\bar{E}_Q$ = 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 $T_C = 0.167$

$Q_{10-24} = 2.43$ IN

$Q_{25-24} = 2.85$ IN SECTION 2, VOL. 5 PAGE 5 OF 7

$Q_{50-24} = 3.10$ IN

$Q_{100-24} = 3.5$ IN

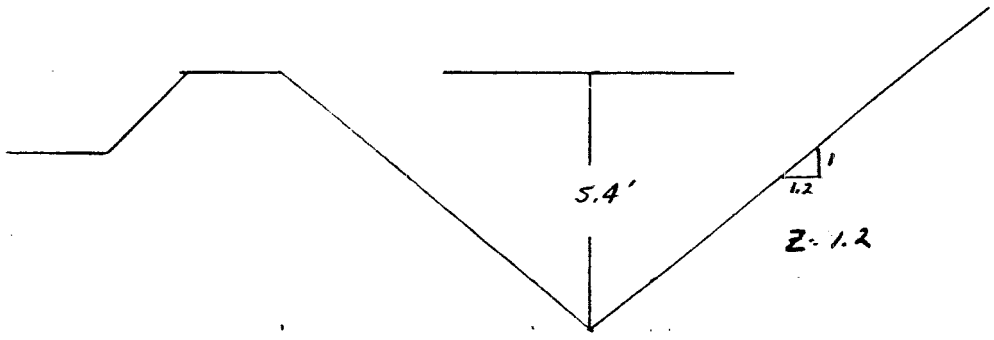
	Q_{10-24}	Q_{25-24}
$T_C = .18$ HRS	.23 CFS	1.24 CFS

0.24

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

UDD-1 - MAP 3.2.1-3



USE MANNING FORMULA

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

$$A = z d^2$$

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

$S = .16$ MAP 3.2.1-3
$Q = 1.24$ CFS SECTION 9 VOL. 5
$n = .032$ - EARTH BOTTOM RUBBLE SIDES

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

$$= 1.2 d^2 \cdot 1.486/.032 \times \left(1.2d / 2\sqrt{(0.2)^2+1} \right)^{2/3} \times (.16)^{1/2}$$

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

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

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

TRAIL 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 WITHOUT .3 FT. FREE BOARD.

VELOCITY

USE MANNING FORMULA

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

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

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

$= 5.76$ 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

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

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

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

Q = 1.24 CFS
L = 240 FT } MAP 3.2.1-3
S = .008

SECTION 9, VOL. 5

USE MANNING FORMULA

$Q = A \times 1.486/n \times R^{2/3} \times S^{1/2}$ $R = .5768D/1.957E$ D = DEPTH OF FLOW

$A = \pi 0^2/4 , \pi (2.5)^2/4 = 4.91$ SQ FT.

$n = .024$

$S = .008$

$Q = 4.91 FT^2 \times 1.486/.024 \times (.5768D/1.957E)^{2/3} \times (.008)^{1/2}$

$= 4.91 FT^2 \times 61.92 \times (.5768D/1.957E)^{2/3} \times .089$

$= 27.06 (.5768D/1.957E)^{2/3}$

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

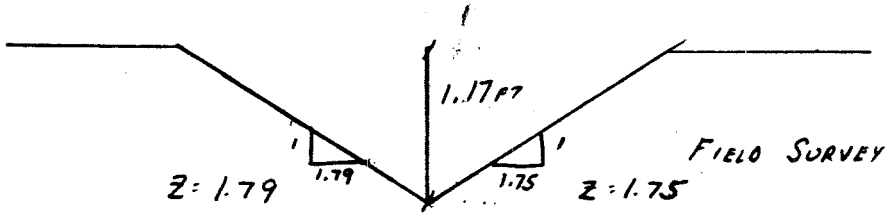
1) SOIL SURVEY OF CARBON AREA, UTAH - UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

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

UDO - 2 - MAP 3.2.1-3

G. TAYLOR
11-17-89

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



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

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

TRY $d = .43$ FT.

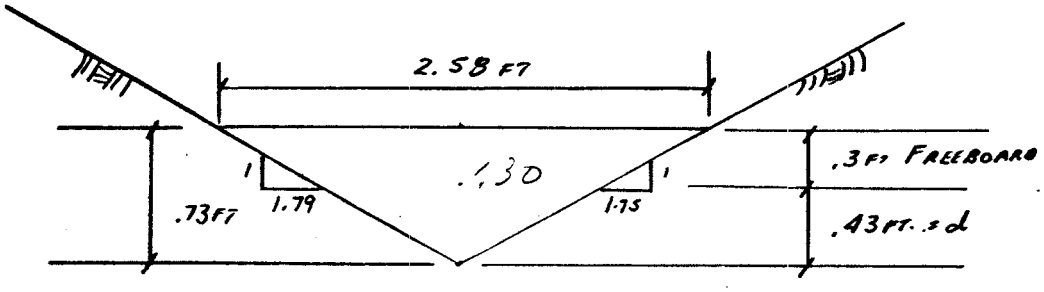
$Q = (1.78(.43)^2) \times 14.86 \times (.49(.43)^{2/3} \times .17$

$= .27$ CFS.

TOTAL DEPTH = FLOW DEPT + FREEBOARD

$= .43$ FT $+ .3$ FT

$= .73$ FT.



TYPICAL UDD-2 MINIMUM DITCH DESIGN

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 HAHN

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

PEAK FLOW (CFS)(5)

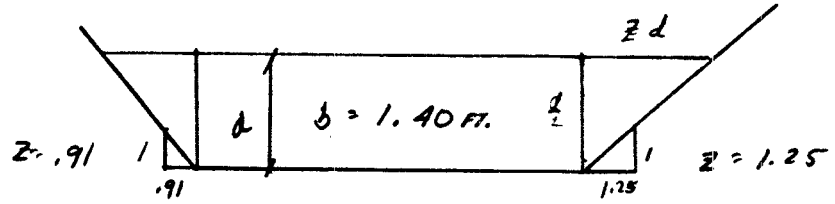
AREA NO	t_c (9)	Q_{10-24}	Q_{25-24}	Q_{50-24}	Q_{100-24}
	.19 HRS	.54			1.57

4) KENT'S FORMULA
$T_c = (\text{HYD. LENGTH})^{.8} ((1000/CN - 10) + 1)^{.7} / (1900 \sqrt{\text{SLOPE}}) / 1.6$

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

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

USE $Q_{100-24} = 1.57$



USE MANNING FORMULA

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

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

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

$S = .03$ MAP 3.2.1-3

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

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

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

$$= 1.40d + .46d + .63d^2 \times 148.60 \times \left(1.40d + .46d^2 + .63d^2 \;/\; d(1.35) + 1.40 + d\,1.10\right)^{1/2} \times .17$$

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

TRAIL d

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

USE $d = .16$ FT.

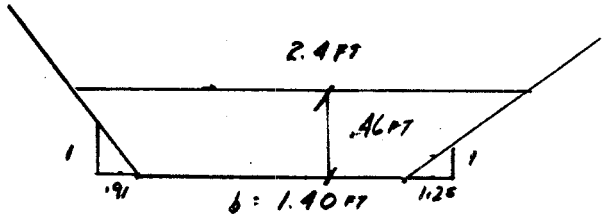
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

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

TRAIN LOADOUT
DISTURBED DRAINAGE

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

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 HA 2)	T_c 3)
.102	.149

NOTES:

1) KIRPITCH'S FORMULA - $t_c = .0078\, L^{.77} (L/H)^{.385}$

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

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

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

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-N

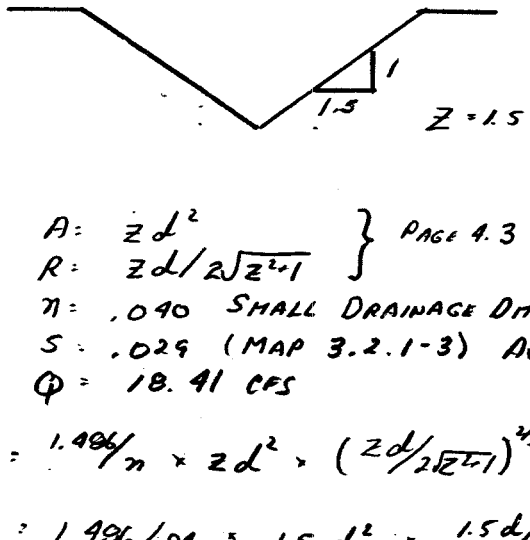
USE MANNING FORMULA

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

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

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

$$= 8.56 \text{ CFS}$$

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

TRY $d = 1.4$ FT.

$Q = 37.15 \times 1.5(1.4)^2 \times \left(1.5(1.4)/2.61\right)^{4/3} \times .17$

$= 12.92$ 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 HANN

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

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

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

$= 4.80$ FPS

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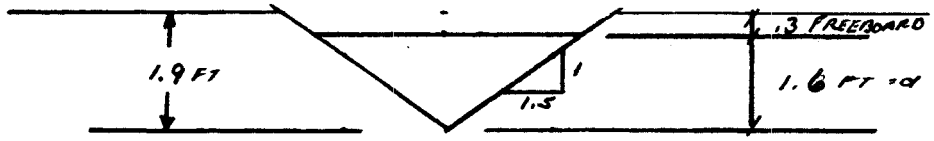
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

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



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

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NOV 28 1989
DIVISION OF
OIL, GAS & MINING

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

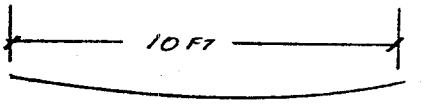
USE MANNING FORMULA

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

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



$A = {}^{2}/_{3}\, d\, T \quad T = 10$

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

} PAGE 4.3 SURFACE MINING WATER DIVERSION DESIGN MANUAL

n: .015 CONCRETE, SMOOTH FINISH

S: .0438

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

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

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

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

TRAIL d

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

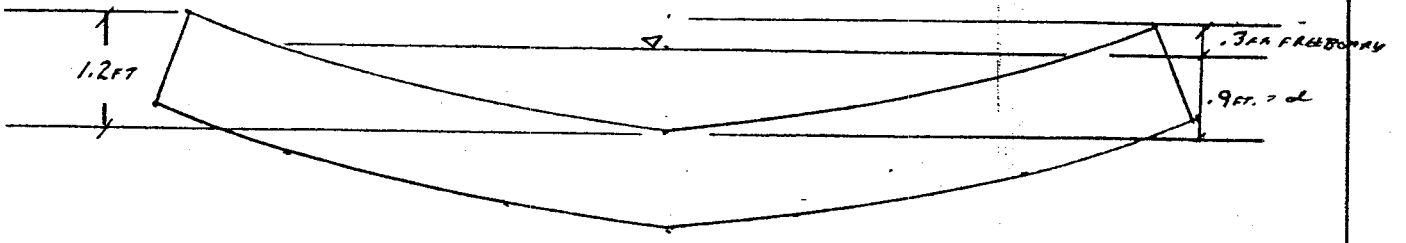
USE A DEPTH OF .9 FT.

DOCM DEPTH = 0.35'

R

V = 1.87

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



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

SECTION 12

HYDROLOGY STUDY
CULVERT EAST END
TRAIN LOADOUT
CU-16

HYDROLOGY STUDY
CULVERT EAST END
TRAM LOADOCT
CU-16

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

WATER SHED LS-2 MAP 3.2.8-2

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

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

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

$= 58.30$ USE 58

AREA

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

SLOPE

$L = \Sigma Ci / AREA$

$= 360 \times 80 / 82,188$

$= .35$ OR 35%

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

CONCENTRATION TIME

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

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

L = 1200 FT
Y = .35
CN = 58

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

$$= 1,272.17 / 1,124.06 / 60$$

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

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_{10-24} = 2.43 IN
P_{25-24} = 2.85 IN
P_{50-24} = 3.10 IN
P_{100-24} = 3.5 IN

SECTION 2, VOL. 5

t_c = .189 R

SCS UNIT HYDROGRAPH METHOD (NEH-4, 1972)

Q_{10-24} = .05 CFS Q_{25-24} = .27 CFS

R

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

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

USE MANNING FORMULA

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

$S = .47$ (MAP 3.2.1-3)
$n = .024$ 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 $Q_{25\text{-}24} = .27$ CFS

$$Q = \frac{1.49}{n} \times \pi d^2/8 \times (d/4)^{2/3} \times S^{1/2}$$

$$= \frac{1.49}{.024} \times \pi d^2/8 \times (d/4)^{2/3} \times (.47)^{1/2}$$

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

TRY $d = .31$ FT

$$Q = \frac{1.49}{.024} \times \pi (.31)^2/8 \times (.31/4)^{2/3} \times (.47)^{1/2}$$

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

$$= .31 \text{ CFS}$$

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. HAAN APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - OKLAHOMA TECHNICAL PRESS

TRAIN LOADOUT
CULVERT DESIGN
24"Ø CMP

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

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
SELECTED 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

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

D = DEPTH OF FLOW

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

n = .024 CORRUGATED METAL PIPE

S = .057 (MAP 3.2.1-3)

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

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

$$= 3.14 \text{ FT}^2 \times 14.78 \times \left(\frac{.5768D}{1.9578}\right)^{2/3}$$

TRY d = 1.7 FT.

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

= 29.20 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 - CO-9

USE THE PEAK FLOW RATE $Q_{100/10}$ = 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

TRAN LOADOUT
CULVERT DESIGN
36"Ø CMP - CO-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 CONSTRUCTION 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 = $\frac{.45(55) + .35(55) + .15(77) + .05(55)}{.45 + .35 + .15 + .05}$

= $\frac{24.75 + 19.25 + 11.55 + 2.75}{1}$

= 58.30 USE **58**

AREA

123 * 13,698 = 1,684,854 SQ FT

SLOPE

L = $\frac{\Sigma \text{ CONTOUR } i}{\text{AREA}}$

= $\frac{7,260 * 80}{1,684,854}$

= .34 OR 34%

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

CONCENTRATION TIME

KENTS FORMULA Eq. 2.60 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD & HAAN

$t_c = L^{.8}\left(\frac{1000}{CN} - 10 + 1\right)^{.7} / 1900 \cdot Y^{1/2} / 60$ $\quad L = 3600$, $Y = .34$, $CN = 58$

$= 3600^{.8}\left(\left(\frac{1000}{58} - 10\right) + 1\right)^{.7} / 1900 (.34)^{1/2} / 60$

$= 3063.67 / 1,107.99 / 60$

$= 2.76 \text{ min} \div 60 \text{ min/hr}$

$= .046$ ~~HRS~~ error 0.46 hrs.

KIRPICH FORMULA Eq 2.58 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

$t_c = .0078\, L^{.77}\, (L/H)^{.385}$ $\quad L = 3600$

$H = 8800 - 800 = 800$

$= .0078\,(3600)^{.77}\,(3600/800)^{.385}$

$= 4.27 \times 1.784$

$= 7.62 \text{ min}$

$= .127 \text{ hrs}$

P_{10-24}	= 2.43 in	SECTION 2, VOL. 6
P_{25-24}	= 2.85 in	
P_{50-24}	= 3.10 in	
P_{100-24}	= 3.5 in	

t_c : SCS UNIT HYDROGRAPH METHOD (NEH-4, 1973)

Q_{10-24} - 1.23 cfs 0.93 cfs $\quad Q_{50-24}$ - 9.63 cfs

Q_{25-24} - 6.00 cfs $\quad Q_{100-24}$ - 16.14 cfs

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
$Q_{n=.24} = 16.14$ 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.

$Q = 1.486/.024 \times \pi 1.47^2/4 \cdot (1.47/4)^{2/3} \times .30$

$= 61.92 \times 1.70 \times .51 \times .30$

$= 16.15$ 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

$Q_{10\text{-}24}$ = 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 X .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
CURRANTI 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 HANN
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: $[66(.24) + 77(.10) + 77(.10) + 66(.08) + 55(.11) + 77(.05) + 66(.04) + 77(.01) + 55(.11) + 55(.12) + 77(.02) + 83(.01)]/1$

$= 15.84 + 7.70 + 7.70 + 5.28 + 6.05 + 3.85 + 2.64 + .77 + 6.60 + 6.10 + 1.54 + .83/1$

$= 65.40$ USE 65

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

G. Tasse
Revised 11-17-09

$S = 1000/CN - 10$

$= 1000/71 - 10$

$= 14.08 - 10$

$= 4.08$

AREA OF THE WATER SHED

$10,174.39 \times .0149 in^2 = 151.60 - 2 \times 22.96 \text{ ACRES}/IN^2 = 3,480.7 \text{ ACRES}$

$3,480.7 \text{ ACRES} \times 43,560 \text{ ft}^2/\text{ACRE} = 151,619,292.1 \text{ SQ FT.}$

TIME PARAMETERS

CONCENTRATION TIME

KIRPICH Eq 2.58 PAGE 102 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

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

$L = 18,150$
$H = 1,920$

$t_c = .0078 (18,150)^{.77} (18,150/1920)^{.385}$

$= .0078 (1,902.55)(2.37)$

$= 35.24 \text{ MINS}$

$= .59 \text{ HRS}$ $tc = 1.37 hrs$ w/ slope = 35%

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

$y = \Sigma Ci/\text{AREA}$

$i = 80 \text{ FT}$ AND 400 FT

$A = 151,967,771.9 \text{ SQ. FT.}$

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

G Taylor
Revised 11-17-89

	ΣC		
	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

$$Y = (215,850 \times 80) + (72,375 \times 400) / 3,480.7 \times 43,560$$

$$= 46,218,000 / 151,619,292.1$$

$$= 30.48\%$$

$$t_L = (18,150)^{.8} (4.08+1)^{.7} / 1900 (30.41)^{.5}$$

$$= (2,553.30)(3.12) / 1900 (5.51)$$

$$= 7,966.30 / 10,469$$

$$= .76 \text{ hrs}$$

$$= 45.66 \text{ mins.} \quad \text{use } 46 \text{ mins.}$$

G. TAYLOR
REVISED
11-17-09

$t_L = .6\ t_c$

$46 = .6\ t_c$

$76.67 = t_c$

$76.67 \text{ MINS} = t_c$

$t_c = 1.28 \text{ HR}$

PEAK FLOW USING SCS CURVE METHOD

EVENT	PEAK FLOW
2 YR - 24 HR	
10 YR - 24 HR	212.3 CFS 222 cfs
50 YR - 24 HR	529.2 CFS
100 YR - 24 HR	768.5 CFS 813

DETERMINE MAXIMUM FLOW OF THE PIPE

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

$n = .035$

$R = .83$

$S = .03$ (MAP 3.2.1-3) MAX SLOPE

$A = 15.69 \text{ SQ FT}$

$Q = 15.69 \text{ SQ FT} \left({}^{1.486}/_{.035}\right) (.83)^{.66} (.03)^{.5}$

$= (15.69_{SQ FT})(42.46)(.88)(.17)$

$= 99.35 \text{ CFS}$

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

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

18/24

Hydrometrics, Inc.

927 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

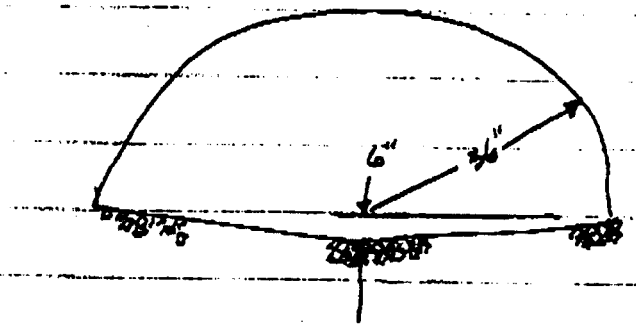
Enclosures

11/24

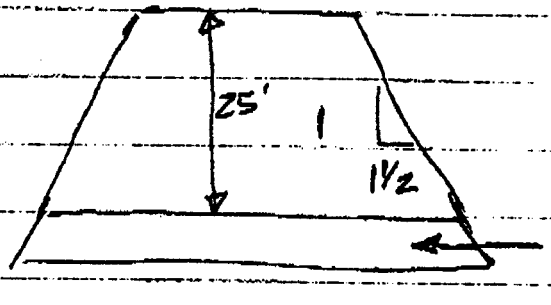
11/3/88.

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:

(a) Water surface at inlet is at top of pipe
Q = 125 cfs

(b) Water surface is 2' ab. top of inlet
Q = 150 cfs

(c) 6' ab. inlet
Q = 190 cfs

(d) 10' ab. inlet
Q = 225 cfs

Answers
From Smyrl
11-17-88
Comps

20/24

2/6

UTAH FUEL. CO. SKYLINE MINE

S.My 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)

FIND HW/D FOR GIVEN CONDITIONS

L = 161'
S = 3%

FOR CMPA ↓ FOR CMP ↓

a.) HW = D ∴ HW/D = 1.0

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 $\frac{12.5}{6} = 2.08$

$\frac{HW}{D} = \frac{9.5}{3.5} = 2.71$

d.) HW = D + 10 D = 3.5 HW = 13.5 $\frac{16.5}{6} = 2.75$

$\frac{HW}{D} = \frac{13.5}{3.5} = 3.86$

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) $K_e = 0.2$

$K_e = 1.0$

24/24

UTAH FUEL C. 3/6
SKYLINE MINE Co.
SMy 11-17-88
p. 3

Adjustments to use nomographs

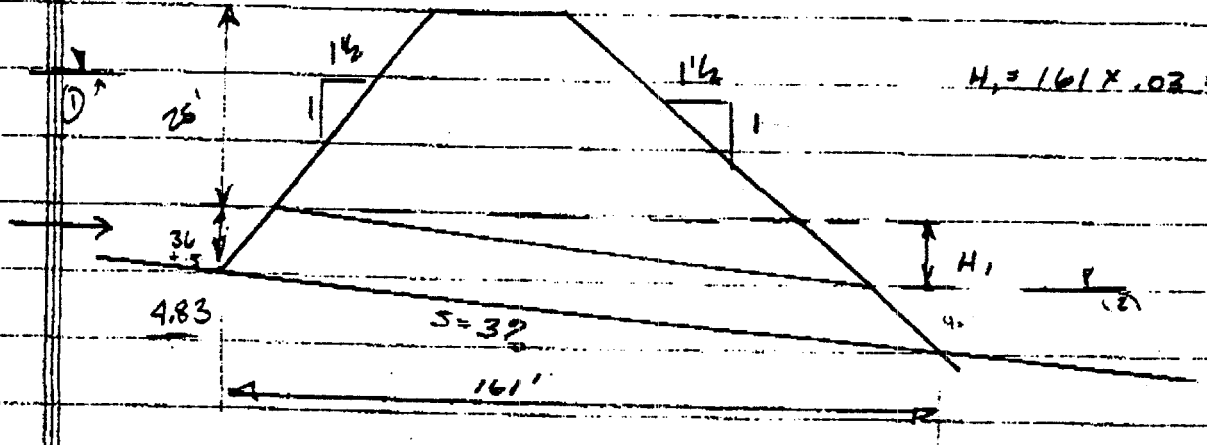
Dia. or Equiv. Dia.	Dimensions	Area ft^2	
60"	44" x 72"	17.6	
54"	40" x 65"	14.3	.82
66"	round	23.8	
72"	"	28.3	14.14 .5
78"	"	33.2	16.59 .7

FIND AREA GIVEN PIPE:

$$A = \frac{\pi 3^2}{2} + \frac{1}{2} D^3 (.5) = \frac{28.27}{2} + .125 = 14.89\ ft^2$$

(See Nomographs p. 5 & 6)

X-SECTION



$H_1 = 161 \times .02 = 4.83$

USING NOMOGRAPHS a) b) c) d)

1) CMPA 16⅔ above 40"x65" 83 cfs 130 175 210

2) CMP ½ 30⅔ above 72"ø 105 160 210 250

UTAH FUEL CO. 4/6
SKYLINE MINE
11-17-88 smyost
p. 4

Bernoulli Equation

$$\frac{V_1^2}{2g} + y_1 + z_1 = \frac{V_2^2}{2g} + y_2 + z_2 + \Sigma h_L$$

$S \times L + H = \Sigma' H_L$ where H = Δ above pipe

$(.03)(161) + H = \Sigma H_L$

$4.83 + H = \Sigma H_L$

$\Sigma' H_L$ = entrance loss + outlet loss + friction loss

$= K_e \frac{V^2}{2g} + K_o \frac{V^2}{2g} + \frac{2.87\, n^2 l V^2}{d^{4/3}}$

$K_e = 0.2$

$K_o = 1.0$

$n = .027$

$l = 161$

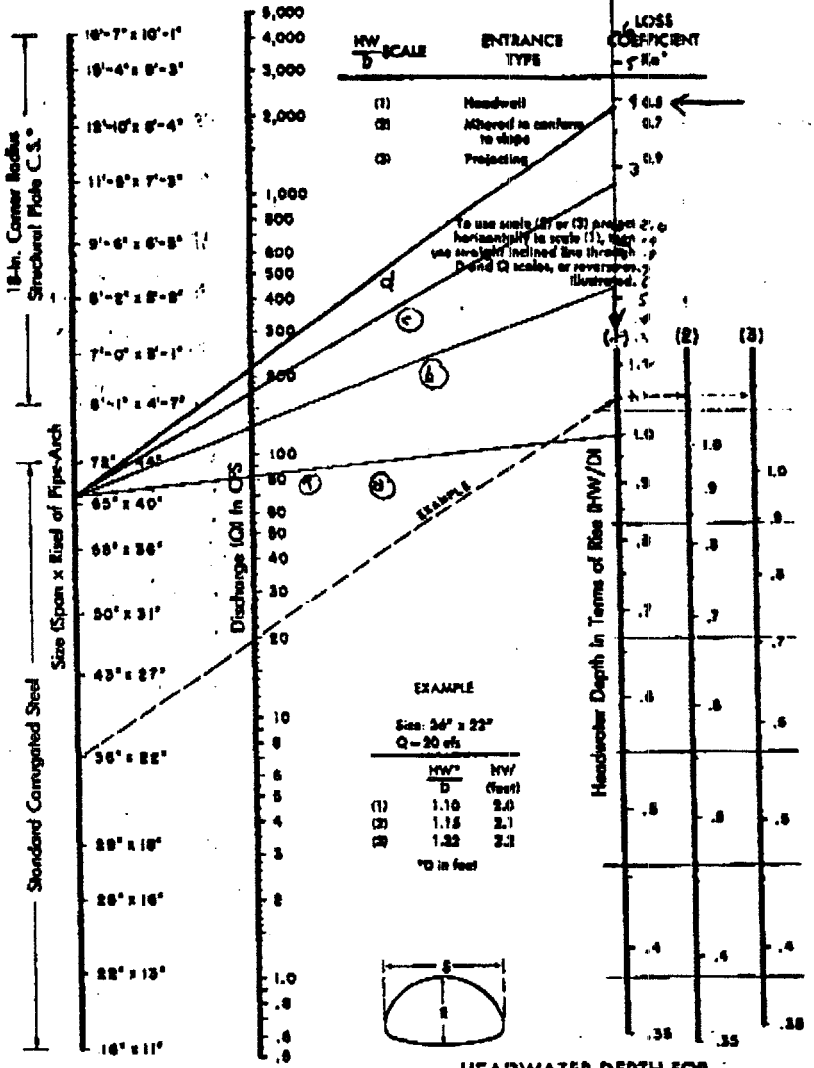
$d = \sqrt{\frac{A \cdot 4}{\pi}} = \sqrt{\frac{19.89 \cdot 4}{\pi}} = 4.354' = 52.25''$

$\therefore \Sigma' H_L = V^2 (.0660) \rightarrow V = \sqrt{\frac{\Sigma H_L}{(.0660)}}$

	$H + \Sigma H_L$	V	$Q = A \cdot V = 19.89 \times V$	Use
a)	4.83 ft	8.55 fps	127.35 cfs	125 ←
b)	6.83	10.17	151.44	150 ←
c)	10.83	12.81	190.76	190 ←
d.	14.83	14.99	223.15	225 ←

these do check w/ nomographs. ↗

1)



*Additional Sizes Not Dimensioned Are Listed In Fabricator's Catalog

Bureau of Public Roads Jan. 1963

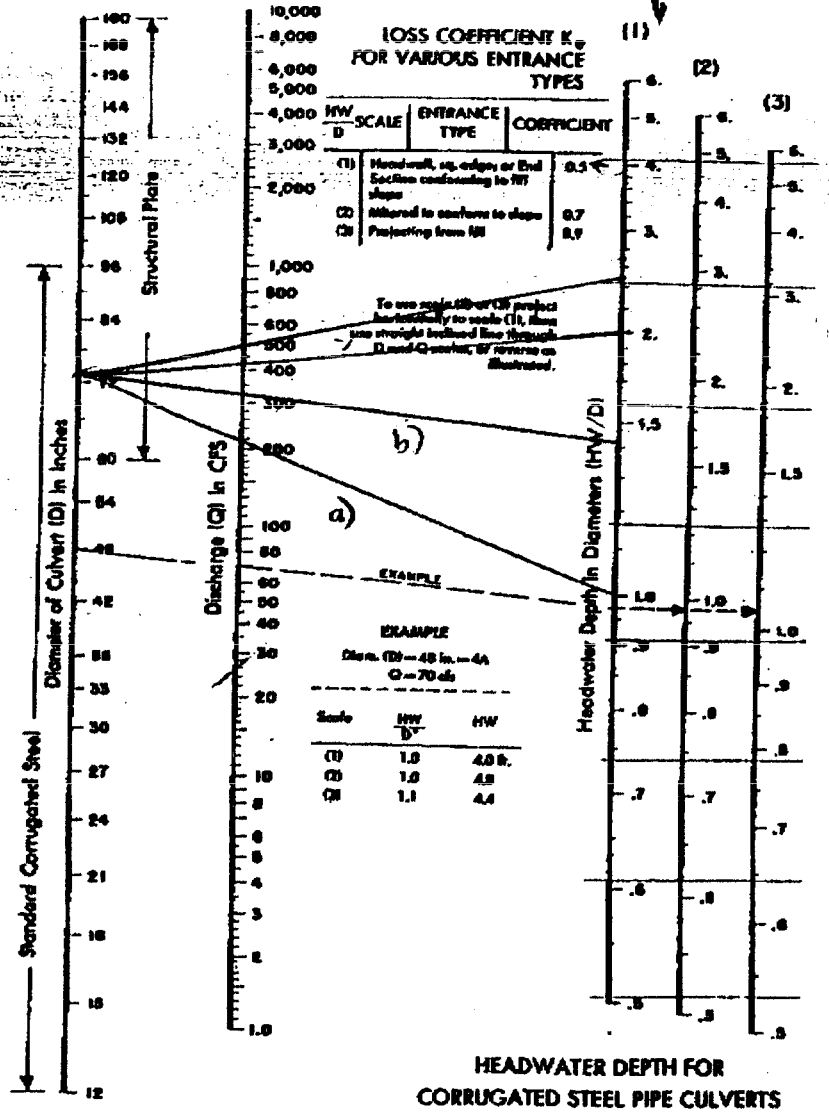
HEADWATER DEPTH FOR CORRUGATED STEEL PIPE-ARCH CULVERTS WITH INLET CONTROL

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.

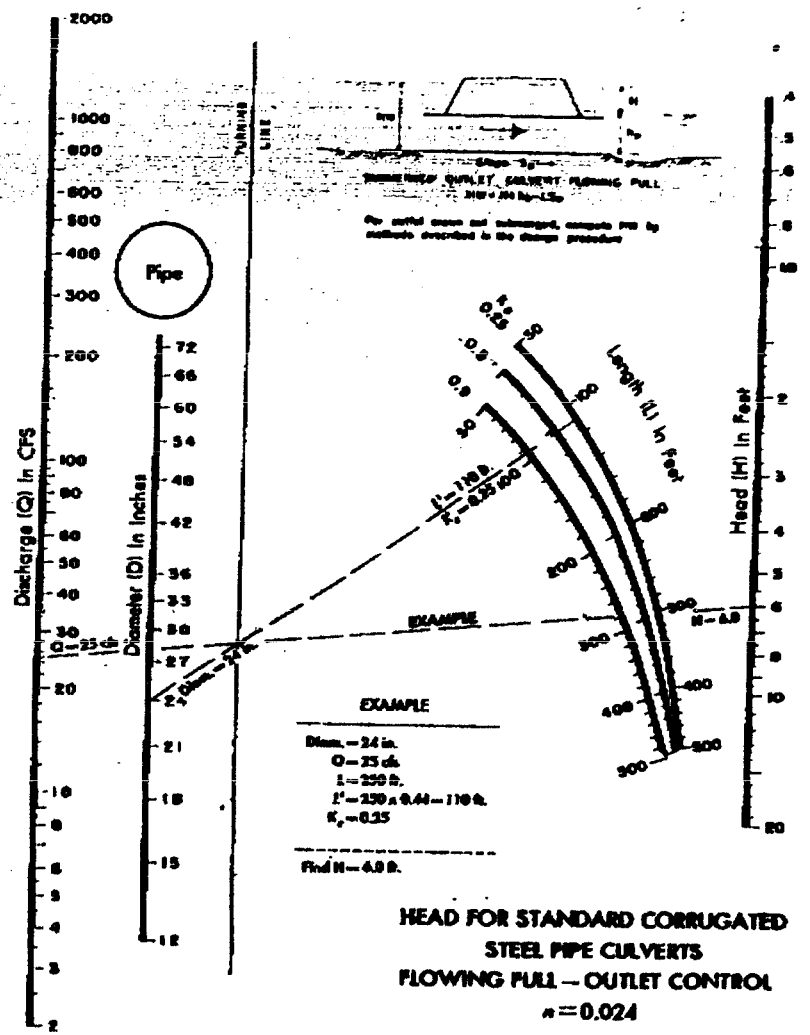
NOV 17 '88 16:38 HYDROMETRICS 14064434155

Fig. 2



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 COVERED 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.

SECTION 13

LOADOUT AREA
SEDIMENTATION POND

RECEIVED
SEP 14 1989
DIVISION OF
OIL, GAS & MINING

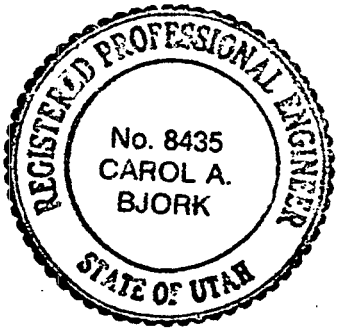
SKYLINE MINE SEDIMENTATION POND
HYDRAULIC CALCULATIONS

UTAH FUEL COMPANY
Helper, Utah

Prepared by

EARTHFAX ENGINEERING, INC.
Salt Lake City, Utah

August 29, 1989



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.

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'. Plot 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)		0.267		1.18 (from curve)

* note: map scale is 1" = 20'

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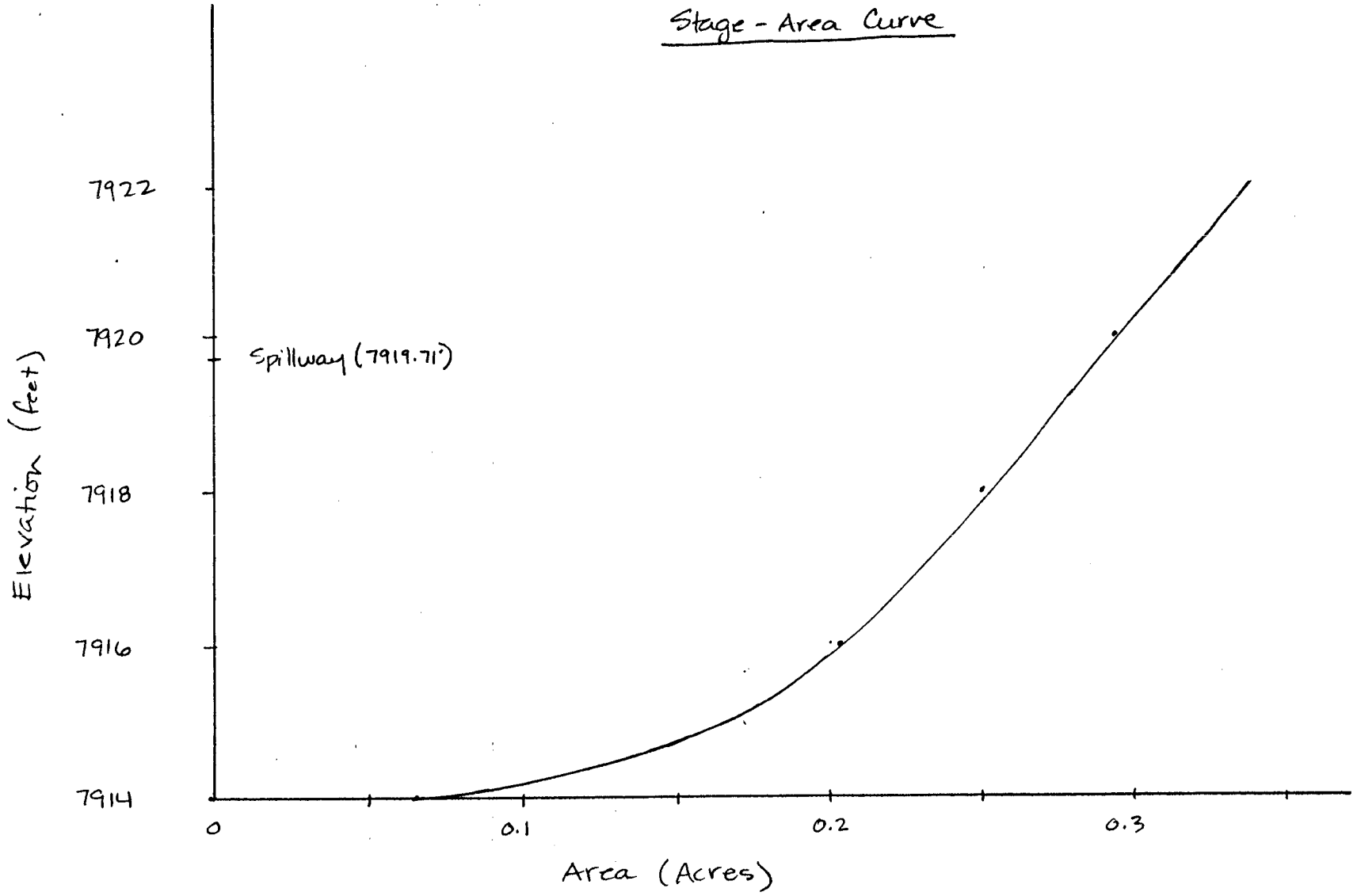
COMPUTED CAB DATE 8/26/89
CHECKED DATE

Skyline Mine
Sedimentation Pond

Stage - Area Curve



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PROJECT C117-02 PAGE 9 OF 13
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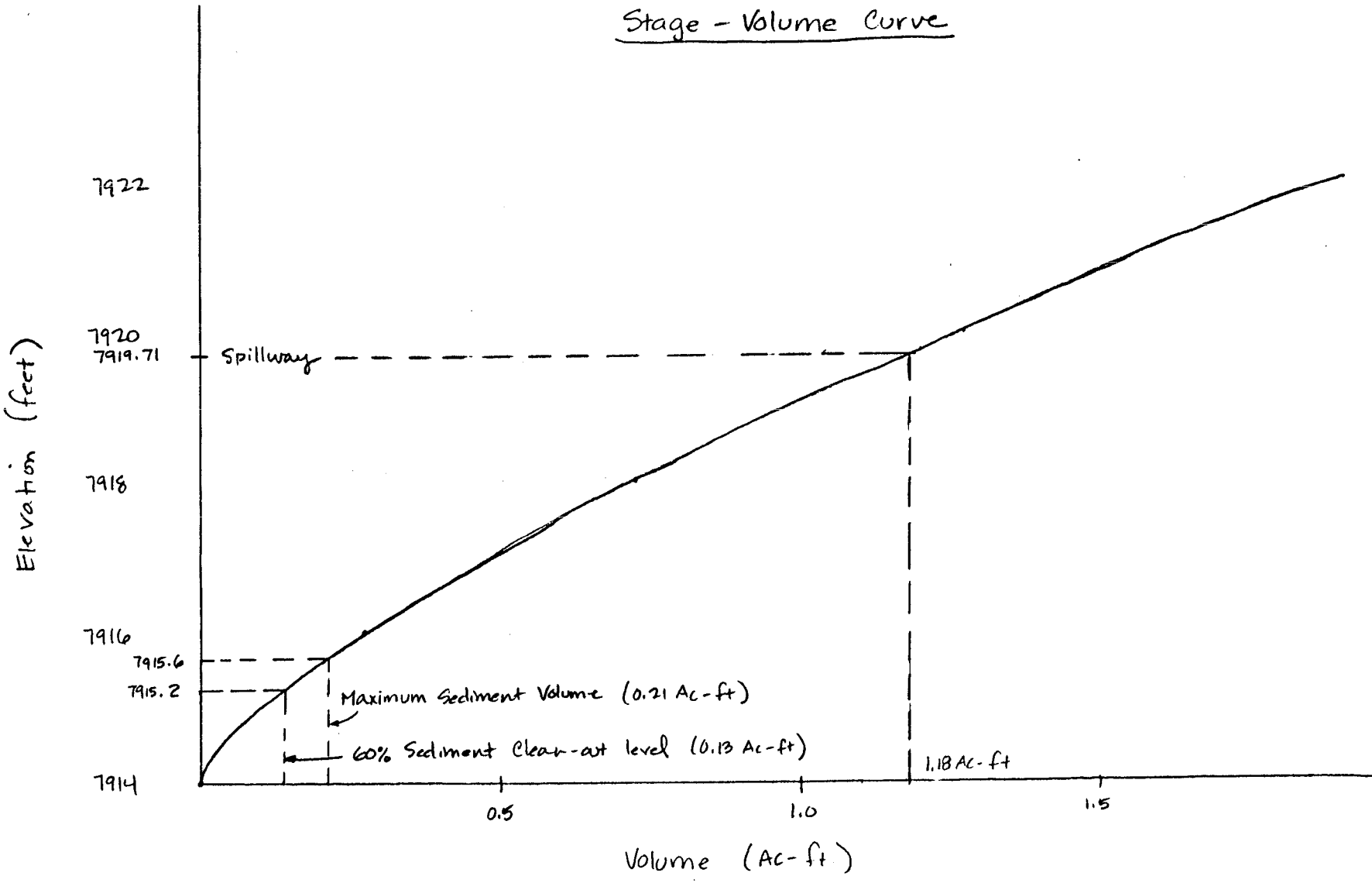
Skyline Mine
Sedimentation Pond

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)

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)

$LS = \left(\frac{650 + 4150s + 65s^2}{10{,}000 + s^2}\right)\left(\frac{\ell}{72.6}\right)^m$ (Ref: Clyde, et al, 1978. Manual of Erosion Control Principles + Practices. Utah Water Research Lab. - Logan)

$s = 5.7\%$ (from topo)
$\ell = 1500'$ (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

$A = (17)(.20)(2.41)(1.20) = 9.83$ tons/Ac/year

= 73.3 tons/year

= 1630 ft³/year (for a unit weight of 90 lbs/ft³)

= 0.037 Ac-ft/year

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 $\frac{.02 \text{ ac-ft}}{.3 \text{ Ac}} = .067 \text{ ft} = 0.80 \text{ inches}$ to provide total containment based on these calculations.

25-year and 100-year, 24 hour storm events.

Precipitation: (Miller, 1973)
25-year, 24 hour = 2.9 inches
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.

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CONVERTED BY TECH ENGINEERING INC.
VERSION 1.10 NOVEMBER 17,1983

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*
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* 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 ****

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*         DURING PEAK 24 HOUR PERIOD                                 *
*                                                                    *
*     ALL CONCENTRATIONS ARE IN ML/L.                                *
*                                                                    *
**********************************************************************
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WATERSHED IDENTIFICATION CODE

100-YR, 24-HR STORM EVENT

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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 ****

TRAIN LOADOUT AREA
STAGE VOLUME

G. TAYLOR
6-20-89

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

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

$CN = \frac{\text{CN FOR PAD (AC. OF PAD)} + \text{CN FOR UNDISTURBED GROUND (AC. OF AREA)}}{\text{TOTAL AC.}}$

$= \frac{90(8.46) + 64(3.92)}{12.56} = 80.60$

$= 81$

10 YR - 24 HR STORM

P = 2.43 IN. SECTION 2 PAGE 5 of 7, VOL. 5

$S = \frac{1000}{CN} - 10$ EQ 2.39 PAGE 81 APPLIED HYD. AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HAAN

$= \frac{1000}{81} - 10$

$= 2.35$

$Q = \frac{(P - .25)^2}{P + .85}$ EQ 2.38 PAGE 81

$= \frac{(2.43 - .2(2.35))^2}{2.43 + .8(2.35)}$

$= .89 \text{ IN} \div 12 \text{ IN/FT} = .07 \text{ FT.}$

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
100 YR - 24 HR - 3.50 IN
} SECTION 2 PAG 5 OF 7

PEAK FLOW

10 YR - 24 HR = 18.41 CFS
100 YR - 24 HR - 29.12 CFS
} SCS UNIT HYDROGRAPH METHOD NSH-4, 1972

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

$Q = C L H^{3/2}$

$Q = 28.27 H^{3/2}$

C = 3
L = 9.42

EQ 4.1
PAGE 23D
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS

ORIFICE FLOW

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

$Q = 39.04 \sqrt{H}$

C' = .60
a = 7.07

EQ 4.2
PAGE 23D
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA, OKLAHOMA TECHNICAL PRESS

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.

$$H' = H + 8.11 - .6(1.5)$$
$$= H + 7.21$$

$K_e = 1.0$
$K_b = .5$
$K_c = .0476$
$a = 1.77$
$L = 60$

$$Q = 1.77 [2g(H + 7.21)]^{1/2} / (1 + 1.0 + .5 + .0476(60))^{1/2}$$

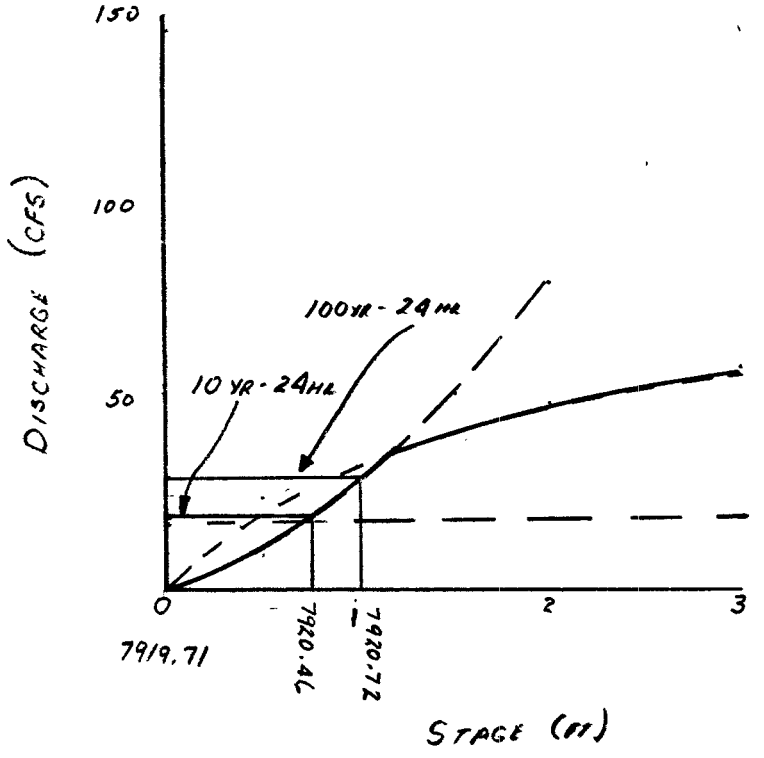
$$= 1.77 (64.4(H + 7.21))^{1/2} / 2.31$$

$$Q = 6.15 (H + 7.21)^{1/2}$$

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

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

$Q = CLH^{3/2}$ [1]

EQU. 5-10 PAGE 5-3 HANDBOOK OF HYDRAULICS FIFTH EDITION

H: HEAD = .4 FT

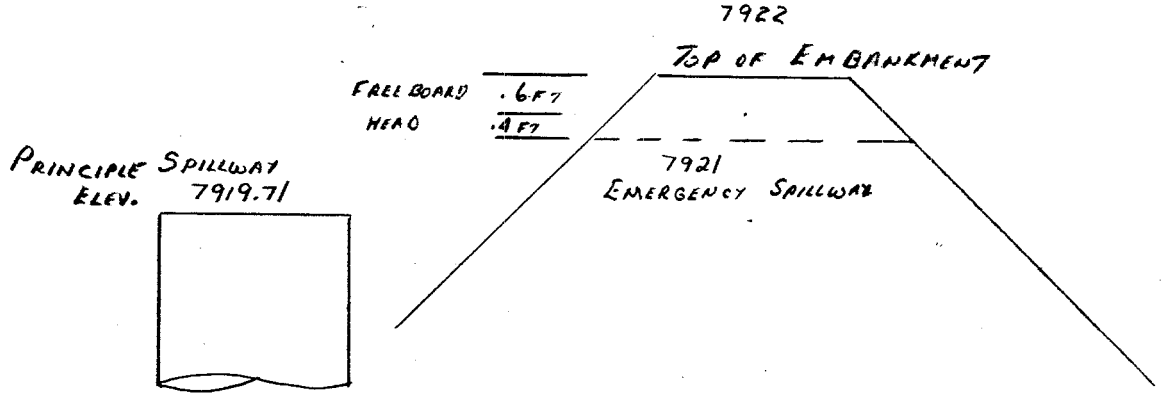
L: LENGTH OF WEIR = 10 FT

C: COEFFICIENT = 2.56

TABLE 5-3 PAGE 5-46 HANDBOOK OF HYDRAULICS FIFTH EDITION

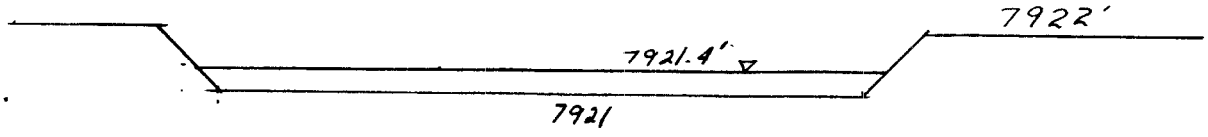
$Q = 2.56\ (10)\ (.4)^{1.5}$

$= 6.48$ CFS



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



FRONT VIEW

CALCULATE VELOCITY

A = 10 FT × 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

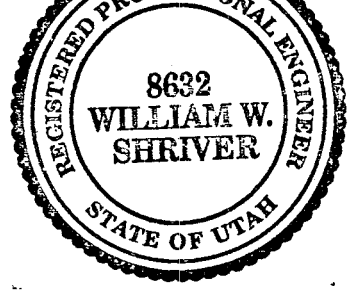
NOTE:

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 ELEVATIONAL 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.



Wm W. Shriver
7-18-91

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

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
1.20	.000	.000	*	1.30	.000	.000
1.40	.000	.000	*	1.50	.000	.000
1.60	.000	.000	*	1.70	.000	.000
1.80	.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
6.20	.000	.000	*	6.30	.000	.000
6.40	.000	.000	*	6.50	.000	.000
6.60	.000	.000	*	6.70	.000	.000
6.80	.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
7.80	.000	.000	*	7.90	.000	.000
8.00	.000	.000	*	8.10	.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
21.00	.263	.000	*	21.10	.263	.000
21.20	.264	.000	*	21.30	.264	.000

22.20	.265	.000	*	22.30	.265	.000
22.40	.265	.000	*	22.50	.266	.000
22.60	.266	.000	*	22.70	.266	.000
22.80	.266	.000	*	22.90	.266	.000
.00	.266	.000	*	23.10	.266	.000
.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 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	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	=	1.0000
BEND LOSS COEFFICIENT	=	.5000
WEIR COEFFICIENT	=	

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

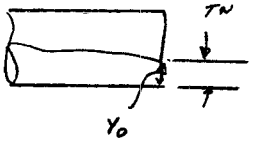
*** RUN COMPLETED ****

OUTLET PROTECTION AT LOADOUT SEDIMENTATION POND

ASSUME TAILWATER TW < ½ 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



$Q/D^{2.5} = 18.41/(1.5)^{2.5} = 6.68$

$\frac{TW}{D} = .6/1.5 = .40$

$Y_o/D = 1.00$

$Y_o = 1.00(1.5) = 1.5$ PIPE IS FLOWING FULL

DETERMINE AREA OF FLOW

$A = CD^2$ $Y_o = d$ $d/D = \frac{1.5}{1.5} = 1$

$C = .78$ TABLE 7.9 PAGE 539 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS.

$A = .78(1.5)^2$
$= 1.76 \text{ FT}^2$

CALCULATE EQUIVALENT DEPTH

$Y_E = (A/2)^{1/2} = (1.76/2)^{1/2} = .94$ FT.

SINCE TW = .6 < .5 D = .75 USE TABLE 7.6 PAGE 530

CALCULATE DEPTH OF SCOUR

$H_s = \alpha (Y_c)^{\beta} (Q/Y_c^{2.5})^{B} t^{\theta}$ EQ 7.5 PAGE 529

$= .82 (.94)^{.10} \times (18.41/(.94)^{2.5})^{.375} \cdot (30)^{.10}$
$= 3.42$ FT.

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

CALCULATE WIDTH OF SCOUR

$$W_s \propto (Y_e)^{\gamma} (Q/Y_e)^{2.5})^{\beta} t^{\theta}$$

$\alpha = .55$
$\beta = .915$
$\theta = .15$
$\gamma = 1$

$= .55 (.99)^1 (18.91/(.99)^{2.5})^{.915} (30)^{.15}$

$= 14.26$ FT.

CALCULATE LENGTH OF SCOUR

$$L_s = \alpha (Y_e)^{\gamma} (Q/Y_e^{2.5})^{\beta} t^{\theta}$$

$\alpha = 1.67$
$\beta = .71$
$\theta = .125$
$\gamma = 1.0$

$= 1.67 (.99)^1 (18.91/.99^{2.5})^{.71} (30)^{.125}$

$= 21.20$ FT.

CALCULATE VOLUME OF SCOUR

$$V_s = \alpha (Y_e)^{\gamma} (Q/Y_e^{2.5})^{\beta} t^{\theta}$$

$\alpha = .29$
$\beta = 2$
$\theta = .375$
$\gamma = 3$

$= .29 (.99)^3 (18.91/.99^{2.5})^2 (30)^{.375}$

$= 398.26$ FT^3

CALCULATE VELOCITY

$V = Q/A$

$Q = 18.91$ CFS
$A = 1.76$ FT. AREA OF FLOW

$= 18.19/1.76$

$= 10.31$ FPS

RIPRAP WILL BE NEEDED

CALCUATE FROUDE NUMBER

$Fr = V / (g Y_e)^{1/2} =$

EQ 3.10 PAGE 152 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA, OKLAHOMA TECHNICAL PRESS

$= 10.31/(32.2(.99)^{1/2}$

$= 1.87$

ASSUME d_{50} SUCH THAT $.25 < d_{50}/y_c < .45$

$d_{50}/y_c < .45$

so, $d_{50} < .45(.99) = .42$ FT

$d_{50}/y_c > .25$

so $d_{50} > .25(.99\text{ FT}) = .24$ FT

$.24\text{ FT} \leq d_{50}/y_c \leq .42$ FT

$h_s/y_c = 1.48$ FIG. 7.23 PAGE 537

$h_s = 1.48(.99) = \underline{1.39\text{ FT}}$

CHECK THAT $2 < h_s/d_{50} < 4$ OR USE d_{50} AVG. $= .33$ FT.

LENGTH OF ENERGY DISSIPATION POOL

$W_o = 1.5$ 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

$\text{MAX}\,[15\,h_s, 4\,W_o] = [15(1.39), 4(1.5)]$
$= [20.85\text{ FT}, 6.00]$
$= 20.85$ FT.

RIPRAP GRADATION

		Size in	%
$1.25\,D_{50}$	-	5	30
D_{50}	-	4	50
$.50\,D_{50}$	-	2	10
$.20\,D_{50}$	-	.80	10

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

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.

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

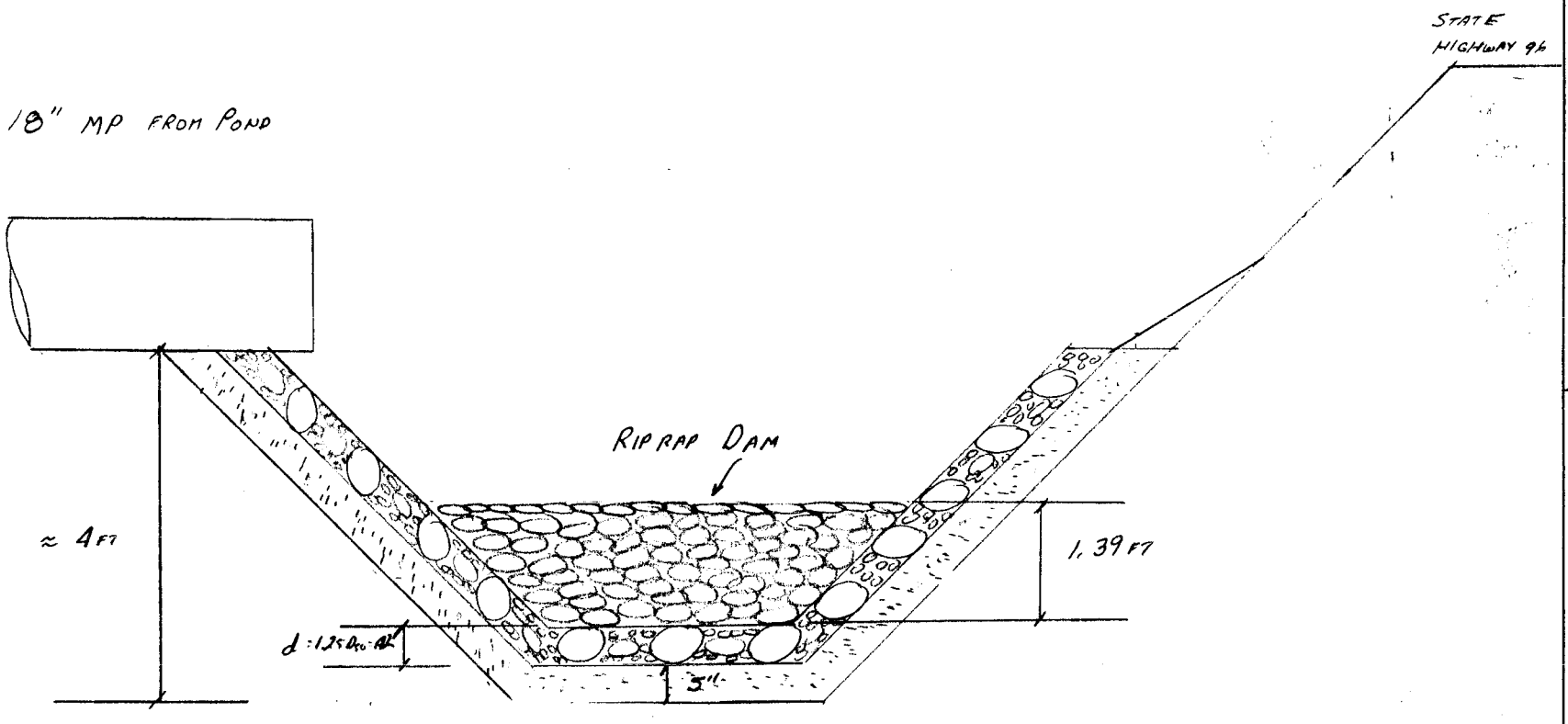
$.02\text{IN.} < D_{15}(\text{FILTER}) < .15$ MIN

$D_{50}(\text{FILTER}) > .10$ IN

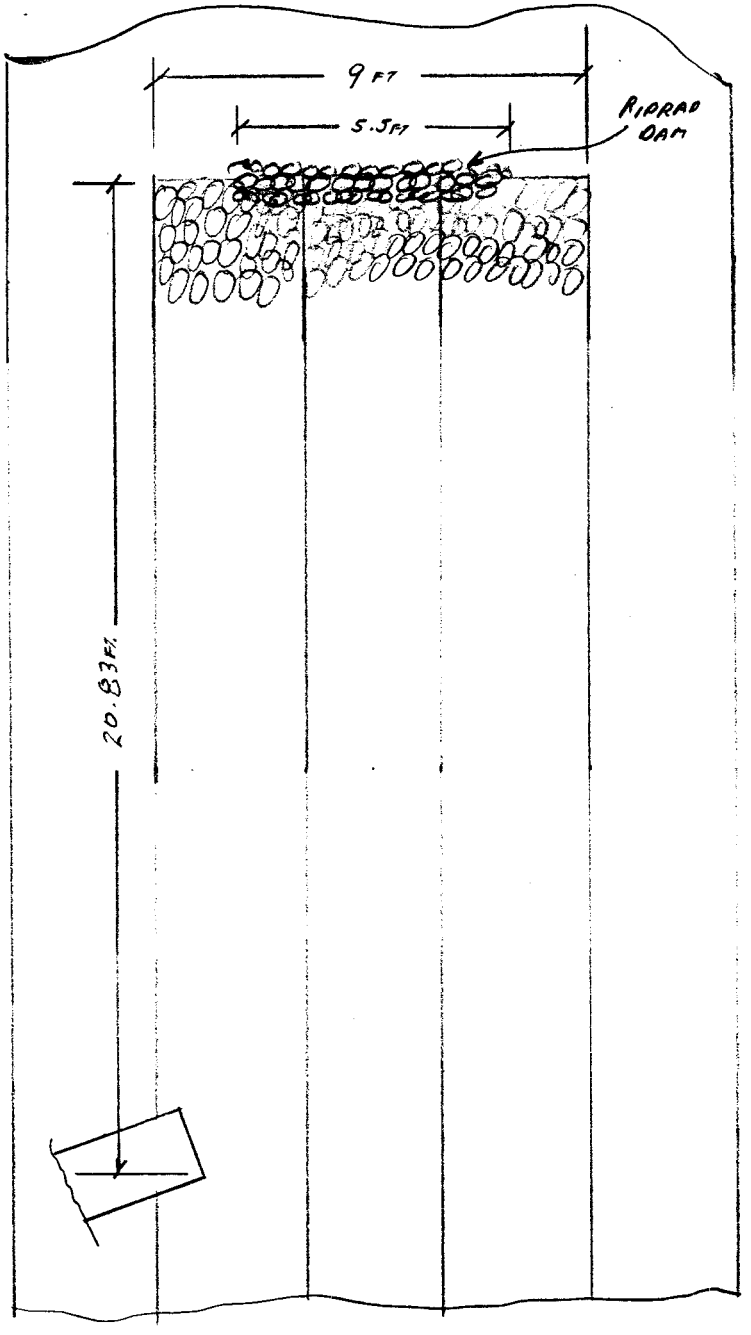
$D_{85}(\text{FILTER}) > .15$ MIN.

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



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



STATE HIGHWAY 96

SECTION 14

DRAINAGE CONTROL
WASTE ROCK DISPOSAL SITE

WASTE ROCK DISPOSAL SITE
CHANNEL DESIGN DU-5

G. Tatcan
6-30-89
REVISED 11-17-89

1. DRAINAGE BASIN CHARACTERISTICS

AREA - 283.07 ACRES - SEE MAP 3.2.8-3
HYDRAULIC LENGTH: 5053.64 FT.
Σ OF CONTOURS = 55,280.53 FT.
SLOPE - .3587
CN = 77 SOIL GROUP C - FOREST LAND POOR COVER
t_c HATHWAY METHOD = .5 HRS
P_{10-24} = 2.43 IN
P_{100-24} = 3.5 IN

T_c Kerts = 0.354
w/ T_c = 0.5
Q_p = 131
Q_p = 291 cfs

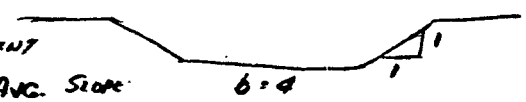
Q_{10-24} = 30.43 CFS 158.43

Q_{100-24} = 73.57 CFS

2. DRAINAGE DITCH DESIGN

a) DETERMINE DEPTH 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

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

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

$Q_1 = 4d + d^2 \times 1.486/.035 \times 4d + d^2/4 + 2d\sqrt{(1)^2+1} \times (.03)^{1/2}$

$73.57 = 4d + d^2 \times 42.46 \times (4d + d^2/4 + 2.83d)^{2/3} \times .17$

$10.19 = (4d + d^2)(4d + d^2/4 + 2.83d)^{2/3}$

TRAIL 4

d ft	Q
2	13.88
1.9	12.63
1.8	11.45
1.7	10.33

USE $d = 1.7$ FT

b) DETERMINE VELOCITY

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

$$R = bd + zd^2/6 + 2d\sqrt{z^2+1}$$

$$= 4(1.70) + (1)(1.70)^2/4 + 2(1.70)\sqrt{(1)^2+1}$$

$$= 6.80 + 2.89/4 + 4.81$$

$$= 1.10$$

$$V = \frac{1.486}{.035} \times (1.10)^{2/3} \times (.03)^{1/2}$$

$$= 42.46 \times 1.07 \times .17$$

$$= 7.69 \text{ FPS}$$

THE VELOCITY IS ABOVE 6 FPS, RIPRAP WILL BE NEEDED.

3. DESIGN RIPRAP SIZE

DESIGN FLOW - 73.57 CFS
CHANNEL SLOPE - .03

FROM FIG. 2 PAGE 11-2 (1)

$D_{50} = .75$ FT.

RIPRAP GRADATION

	Size	%
$1.25 D_{50}$	= 11.25 in	30
D_{50}	= 9. in	50
$.50 D_{50}$	= 4.5 in	10
$.20 D_{10}$	= 1.2 in	10

4. DESIGN FILTER BLANKET.

ASSUME BASE MATERIAL

D_{85} = .09 in
D_{50} = .029 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

$D_{15}(\text{FILTER})/D_{15}(\text{BASE}) > 5$

SO, $D_{15}(\text{FILTER}) > 5 \times .006 = .03\text{IN.}$

$.03\text{IN} < D_{15}(\text{FILTER}) < .45\text{IN}$

$D_{50}(\text{FILTER}) < .96\text{ IN}$

c) FILTER BLANKET WITH RESPECT TO RIPRAP

$D_{50}(\text{RIPRAP})/D_{50}(\text{FILTER}) < 40$

SO, $D_{50}(\text{FILTER}) > 9/40 = .23\text{ IN.}$

$D_{15}(\text{RIPRAP})/D_{15}(\text{FILTER}) < 40$

SO, $D_{15}(\text{FILTER}) > 1.69/40 = .04\text{ IN.}$

$D_{15}(\text{RIPRAP})/D_{85}(\text{FILTER}) < 5$

SO, $D_{85}(\text{FILTER}) > 1.69/5 = .34\text{ IN}$

$D_{15}(\text{RIPRAP})/D_{15}(\text{FILTER}) > 5$

SO, $D_{15}(\text{FILTER}) < 1.69/5 = .34\text{ IN.}$

$.04\text{IN} < D_{15}(\text{FILTER}) < .34\text{ IN.}$

$D_{50}(\text{FILTER}) > .23\text{ IN}$

$D_{85}(\text{FILTER}) > .34\text{ IN.}$

d) THICKNESS OF FILTER BLANKET

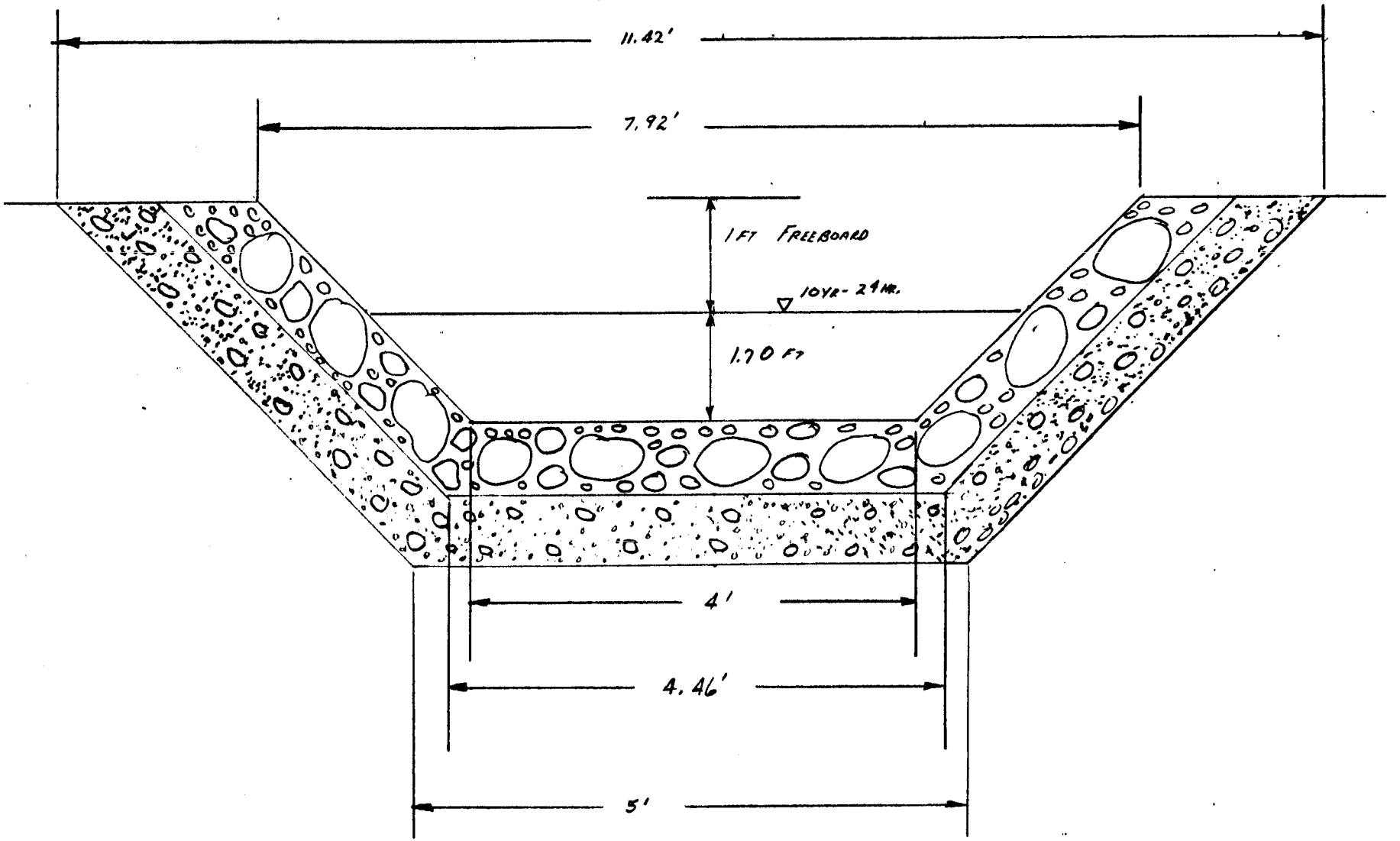
THICKNESS - MAX D_{50} = 9 IN.

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

C. TAYLOR
REVISED
11-9-94

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 - $t_c = L^{0.8}(S+1)^{0.7}/1900Y^{0.5}/0.6$ 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

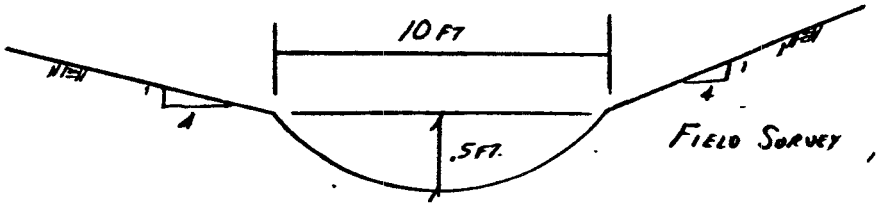
G. Tower
11-17-89

A. SW-10 MAP 3.2.8-1

PEAK FLOWS 10 YR - 24 HR - 30.43 CFS
100 YR - 24 HR - 73.57 CFS

USE MANNING FORMULA

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



FIELD SURVEY, NOV. 1989

$A = \frac{2}{3} dT$
$R = 2dT^2/3T^2 + 8d^2$
} 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

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

$$= \frac{2}{3} d\,10 \times 1.486/.014 \times (2d\,10^2/3\,10^2 + 8d^2)^{2/3} \times (.05)^{1/2}$$

$$= 6.67d \times 106.14 \times (200d/300 + 8d^2)^{2/3} \times .22$$

TRY $d = .47$ FT

$$Q = 6.67(.47) \times 106.14 \times (200(.47)/300 + 8(.47)^2)^{2/3} \times .22$$

$$= 33.51 \text{ CFS}$$

TRY $d = .44$

$$Q = 6.67(.44) \times 106.14 \times (200(.44)/300 + 8(.44)^2)^{2/3} \times .22$$

$$= 30.03 \text{ CFS}$$

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

TRY $d = .45$ FT

$$Q = 6.67(.45) \times 106.19 \times \left(200(.45)/300 + 8(.45)^2\right)^{4/3} \times .22$$

$$= 31.17$$

SWALE WILL WORK AS BUILT

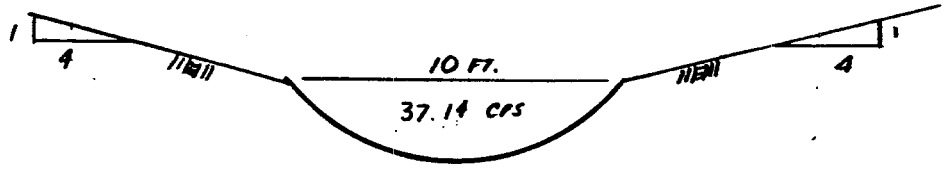
$Q_{100\text{-}24} = 73.57$ - FLOW OF SWALE 10 YR - 24 HR

WHEN SWALE 10 IS FULL

$$Q = 6.67(.5) \times 106.19 \times \left(200(.5)/300 + 8(.5)^2\right) \times .22 = 37.14$$

$$Q_{100\text{-}24} = 73.57 - 37.14$$
$$= 36.43$$

RECLAMATION SWALE SW-10



A TRAPEZOID FORMED WITH DIRT WILL ACT AS THE SWALE

$Z = 4$

$$A = bd + zd^2$$
$$R = bd + 2d^2 / b + 2d\sqrt{z^2+1}$$
$$n = .023 \text{ EARTH, UNIFORM SECTION}$$

$$Q = bd + zd^2 \times 1.49/n \times \left(bd + 2d^2/b + 2d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$

$$= 10d + 4d^2 \times 1.49/.023 \times \left(10d + 4d^2/10 + 2d\sqrt{4^2+1}\right)^{2/3} \times (.05)^{1/2}$$

$$= 10d + 4d^2 \times 64.61 \times \left(10d + 4d^2/10 + 8.25d\right)^{2/3} \times .22$$

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

TRY $d = .45$ FT.

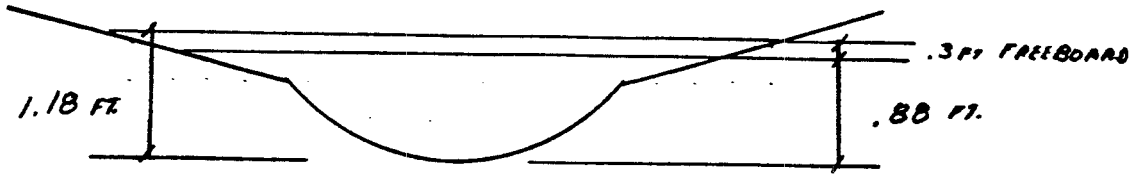
$$Q = 10(.45) + 4(.45)^2 \times 64.61 \times \left(\frac{10(.45) + 4(.45)^2}{10 + 8.25(.45)}\right)^{2/3} \times .22$$

TRY $d = .43$ FT.

$$Q = 10(.43) + 4(.43)^2 \times 64.61 \times \left(\frac{10(.43) + 4(.43)^2}{10 + 8.25(.43)}\right)^{2/3} \times .22$$

$$= 31.93$$

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



SWALES SW-A, SW-12, SW-13 AND SW-M WILL BE DESIGNED FOR THE 100YR-24HR AS THE FLOWS FOR THE ROAD AT 10YR-24HR 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

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

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

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

$n = .023$ EARTH, UNIFORM SECTION, GRAVELY SOIL

$S = .03$ FIELD SURVEY, NOV. 1999

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

$$= \left(33.33d^2/2 + 20d^2/2\right) \times 1.486/.023 \times \left(33.33d/4\sqrt{33.33^2+1} + 20d/4\sqrt{20^2+1}\right)^{2/3} \times (.03)^{1/2}$$

$$= 16.67d^2 + 10d^2 \times 64.61 \times (.25d + .25d)^{2/3} \times .17$$

$$= (26.67d^2) \times 64.61 \times (.50d)^{2/3} \times .17$$

TRY $d = .3$ FT

$$Q = 26.67(.3)^2 \times 64.61 \times (50(.3))^{2/3} \times .17$$

$$= 7.90 \text{ CFS.}$$

TRY $d = .46$

$Q = 26.67(.46)^2 \times 64.61 \times (.5(.46))^{2/3} \times .17$

$= 23.16$

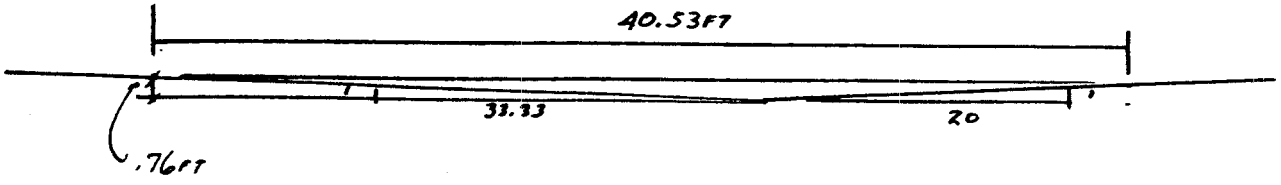
USE .46 FT

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

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

$A = 2d^2/2 + 2d^2/2$

$R = 2d/4\sqrt{2}d + 2d/4\sqrt{2}d$

$n = .023$

$S = .08$ FIELD SURVEY, NOV 1989

$$Q = \left(\frac{2d^2}{2} + \frac{2d^2}{2}\right) \times \frac{1.49}{n} \times \left(\frac{2d}{4\sqrt{2^2+1}} - \frac{2d}{4\sqrt{1^2+1}}\right)^{2/3} \times S^{1/2}$$

$$\left(\frac{25d^2}{2} + \frac{9.09d^2}{2}\right) \times \frac{1.49}{.023} \times \left(\frac{25d}{4\sqrt{25^2+1}} - \frac{9.09d}{4\sqrt{9.09^2+1}}\right)^{2/3} \times (.08)^{1/2}$$

$$= (12.50d^2 + 4.41d^2) \times 64.61 \times (.25d + .25d)^{2/3} \times .28$$

$$= (17.05d^2) \times 64.61 \times (.50d)^{2/3} \times .28$$

Try $d = .5$ ft

$$Q = (17.05(.5)^2) \times 64.61 (.50(.5)^{2/3} \times .28$$

$$= 30.96 \text{ cfs}$$

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.

$$Q = (17.05(.46)^2) \times 64.61 \times (.5(.46)^{2/3} \times .28$$

$$= 24.38 \text{ cfs}$$

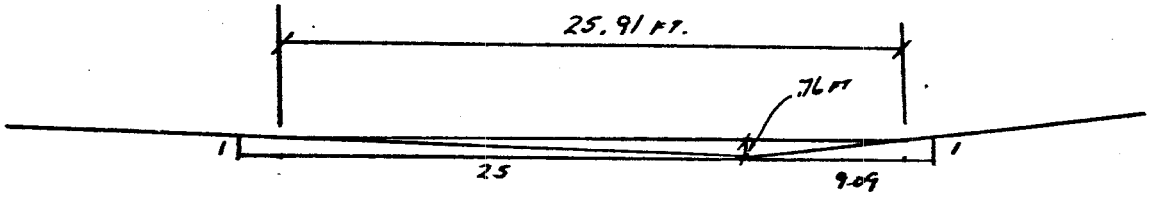
USE .46 ft

Swale Design

Total Depth = Depth of Flow + Freeboard

= .46 ft + .3 ft

= .76 ft.



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

D. SW - 13

TOTAL FLOW = OVERLAND + ROAD

= 22.73 CFS + .97 CFS

= 23.70 CFS

USE MANNING FORMULA TO DETERMINE DEPTH OF FLOW

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

$A = 2d^2/2 + 2d^2/2$

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

$n = .023$

$S = .03$

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

$= (25d^2/2 + 8.33d^2/2) \times 1.49/.023 \times (25d/4\sqrt{25^2+1} + 8.33d/4\sqrt{8.33^2+1})^{2/3} \times (.03)^{1/2}$

$= (12.5d^2 + 4.17d^2) \times 64.61 \times (.25d + .25d)^{2/3} \times .17$

$= (16.67\,d^2) \times 64.61 \times (.5d)^{2/3} \times .17$

TRY $d = .46$ FT.

$Q = (16.67(.46)^2) \times 64.61 \times 1.5(.46)^{2/3} \times .17$

$= 14.47$ CFS

TRY $d = .55$ FT.

$Q = (16.67(.55)^2) \times 64.61 \times (5(.55)^{2/3} \times .17$

$= 23.32$ CFS

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

Try $d = .56$

$Q = (16.67(56)^2) \times 64.61 \times (.56/.56)^{4/3} = .17$

$= 29.97$

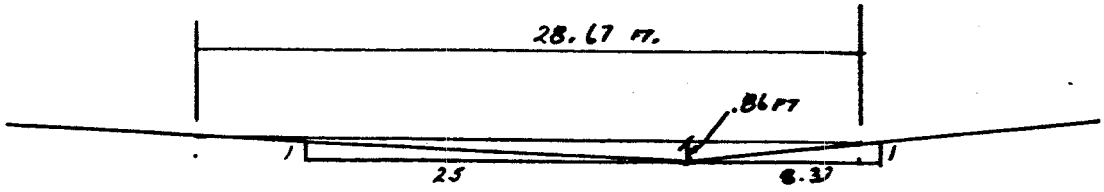
USE $d = .56$ FT

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

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

$$= \left(\frac{100d^{3/2}}{2} + \frac{14.14d^{3/2}}{2}\right) \times \frac{1.486}{.023} \times \left(\frac{100d}{\sqrt{10000+1}} \cdot \frac{14.14d}{\sqrt{200+1}}\right)^{2/3} \times (.02)^{1/2}$$

$$= (50d^2 + 7.15d^2) \times 64.61 \times (.25d + .22d)^{2/3} \times .28$$

$$= (57.12\,d^2) \times 64.61 \times (.50\,d)^{2/3} \times .28$$

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

$$Q = (57.12(.29)^2) \times 64.61 \times (.5(.29)^{2/3} \times .28$$

$$= 23.83$$

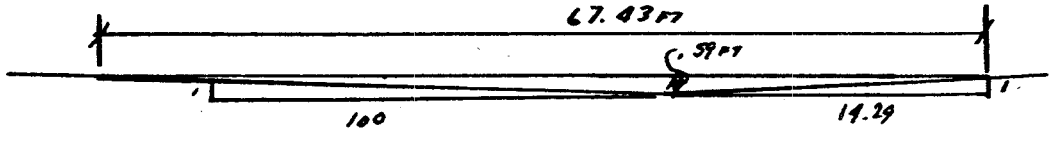
USE $d = .29$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$$= .29 \text{ FT} + .3 \text{ FT}$$

$$= .59 \text{ FT}$$

SWALE DESIGN



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

DITCH UDD-2 MAP 3.2.8-1

DETERMINE DEPTH OF FLOW FOR 10YR-24HR

USE MANNING FORMULA

PEAK FLOW $Q_{10-24} = 30.43$ CFS SECTION 14, VOL. 5

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

$n = .035$ STONY BED
$S = .13$

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

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

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

$= (2.5d^2/2 + d^2/2) \times 1.486/.035 \times (2.5d/4\sqrt{2.5^2+1} + d/4\sqrt{1^2+1})^{2/3} \times (.13)^{1/2}$

$30.43 = (.d^2 + .5d^2) \times 42.46 \times (.22d + .18d)^{2/3} \times .36$

TRAIL d

d	Q
1.4	30.47

VELOCITY

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

$V = 1.486/n \; (.22d + .18d)^2 \; S^{1/2}$

$V = 1.486/.035 \times [.22(1.4)^{2/3} + .18(1.4)^2] \times (.13)^{1/2}$

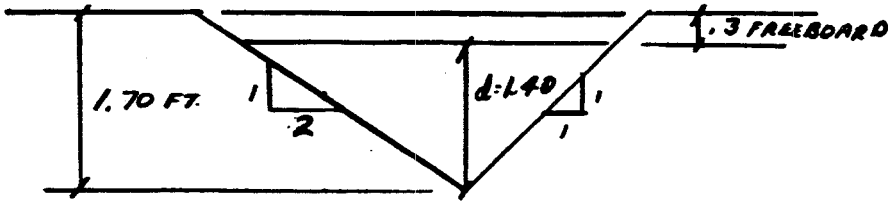
$= 42.46 \times (.56)^{2/3} \times .36$

$= 10.36$ FPS

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH WAS CONSTRUCTED IN ROCK.

G. TAYLOR
REVISED
11-9-89

DITCH DESIGN

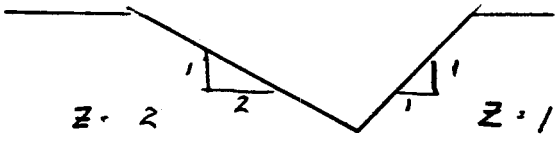


VDD-2 DITCH
DIMENSIONS
FOR 10YR-24HR EVENT

DETERMINE DEPTH OF FLOW FOR 100YR-24HR

USE MANNING FORMULA

PEAK FLOW $Q_{100-24} = 73.57$ CFS



$n = .035$ STONEY BED
$S = .13$

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

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

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

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

$$= \left(2d^2/2 + 1d^2/2\right) \times 1.486/.035 \times \left(2d/4\sqrt{2^2+1} + d/4\sqrt{(1)^2+1}\right)^{2/3} \times (.13)^{1/2}$$

$$73.57 = \left(d^2 + .5d^2\right) \times 42.46 \times (.22d + .18d) \times .36$$

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

TRAIL d

d FT	Q CFS
2.8	193.94
2.0	78.98
1.95	73.82

VELOCITY

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

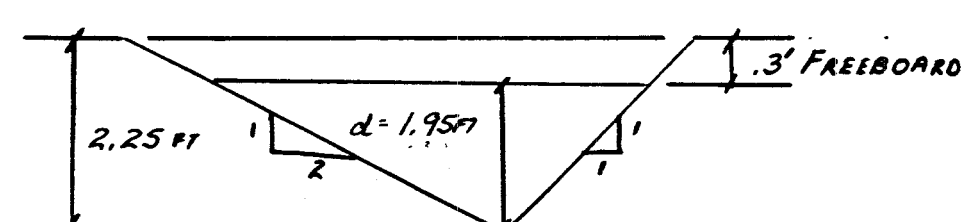
$$= 1.486/n \times (.22d + .18d)^{2/3} \times S^{1/2}$$

$$= 1.486/.035 \times (.22(1.95) + .18(1.95))^{2/3} \times (.13)^{1/2}$$

$$= 42.46 \times .85 \times .36$$

$$= 12.96 \text{ FPS}$$

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.

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 = 84.59 ACRES	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 HANN

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 HANN

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

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

DITCHS DO-12, DO-13, DO-14 AND DO-15 WILL BE DESIGNED FOR THE 100YR-24HR. THE OVERLAND FLOW TO THE DITCHES WILL BE EQUALLY DIVIDED BETWEEN THE FOUR DITCHES

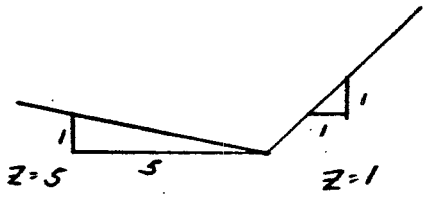
$Q_{100-24} = 90.9$ SECTION 14, VOL. 5

DITCH FLOW = $90.9/4 = 22.73$ CFS = Q

A. DO-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

$$A = 2d^2/2 + 2d^2/2$$
$$R = 2d/4\sqrt{2^2+1} + 2d/4\sqrt{2^2+1}$$

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

$$= (5d^2/2 + 1d^2/2) \times 1.486/.035 \times (5d/4\sqrt{5^2+1} + d/4\sqrt{1^2+1})^{2/3} \times (.12)^{1/2}$$

$$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d) \times .35$$

$$= (3d^2) \times 42.46 \times (.43d)^{2/3} \times .35$$

TRY $d = .5$ FT

$$Q = (3(.5)^2) \times 42.46 (.43(.5)^{2/3} \times .35$$

$= 3.90$ CFS

TRY $d = 1$ FT

$$Q = (3(1)^2) \times 42.46 \quad (.43(1))^{2/3} \times .35$$

$= 25.33$ CFS

TRY $d = .96$

$$Q = (3(.96)^2) \times 42.46 \times (.43(.96))^{2/3} \times .35$$

$= 22.71$ CFS

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

VELOCITY

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

$= 1.486/.035 \times (.41)^{2/3} \times (.12)^{1/2}$

$= 42.46 \quad (.55) \times .35$

$= 9.13$ FPS

$R = (.43)(.96) = .41$
$S = .12$
$n = .035$

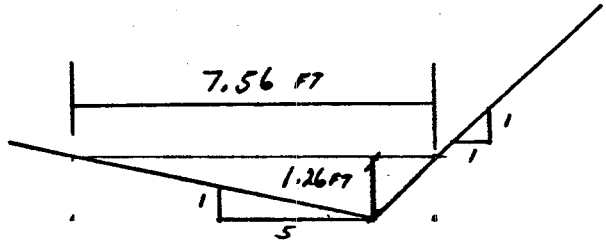
EVEN TROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

= .96 FT + .3 FT

= 1.26 FT.

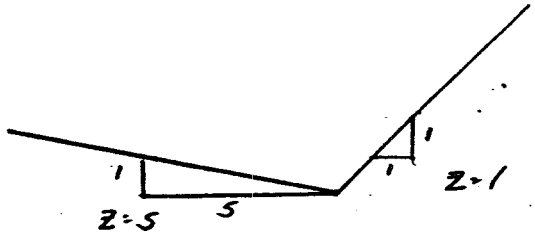
DITCH DESIGN



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

$A = 2d^2/2 + 2d^2/2$

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

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

$= (5d^2/2 + 1d^2/2) \times 1.49/.035 \times (5d/4\sqrt{5^2+1} + 1d/4\sqrt{1^2+1})^{2/3} \times (.11)^{1/2}$

$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d)^{2/3} \times .33$

$= 3d^2 \times 42.46 \times (.43d)^{2/3} \times .33$

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

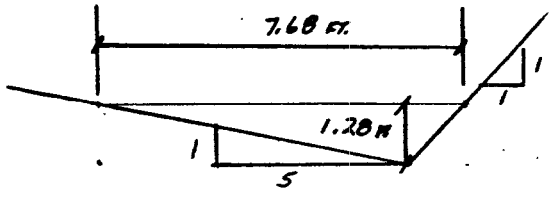
USE $d = .98$ FT

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= .98$ FT $+ .3$ FT

$= 1.28$ FT.

DITCH DESIGN



VELOCITY

$V = 1.49R^{2/3} \times S^{1/2}$

$= 1.49/.035 \times (.42)^{2/3} \times .33$

$= 7.87$ FPS

$R = (.43(.98) = .42$

$S = .11$

$n = .035$

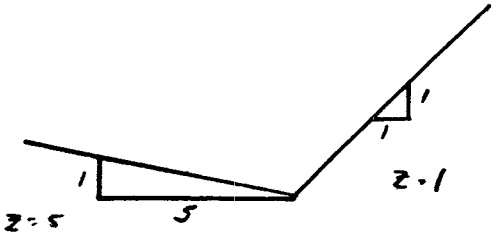
EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

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

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

$A = 2d^2/2 + 2d^2/2$
$R = 2d/4\sqrt{2^2+1} + 2d/4\sqrt{2^2+1}$

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

$= (5d^2/2 + 1d^2/2) \times 1.486/.035 \times (2d/4\sqrt{5}+1 + d/4\sqrt{1}+1)^{2/3} \times (.08)^{1/2}$

$= (2.5d^2 + .5d^2) \times 42.46 \times (.25d + .18d)^{2/3} \times .27$

$= 3d^2 \times 42.46 \times (.43d)^{2/3} \times .27$

TRY $d = 1.0$ FT

$Q = 3(1)^2 \times 42.46 (.43(1))^{2/3} \times .27$

$= 19.54$ CFS

TRY $d = 1.05$ FT

$Q = 3(1.05)^2 \times 42.46 \times (.43(1.05)^{2/3} \times .27$ 22.26

$= 22.26$ CFS

TRY $d = 1.06$ FT

$Q = 3(1.06)^2 \times 42.46 \times (.43(1.06))^{2/3} \times .27$

$= 22.83$ CFS

USE $d = 1.06$ FT.

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

VELOCITY

$V = 1.49/n \times R^{2/3} \times S^{1/2}$

$= 1.49/.035 \times (.96)^{2/3} \times (.08)^{1/2}$

$= 42.96 \times .59 \times .28$

$= 7.09$

$R = (.43)(1.06) = .96$
$S = .08$
$n = .035$

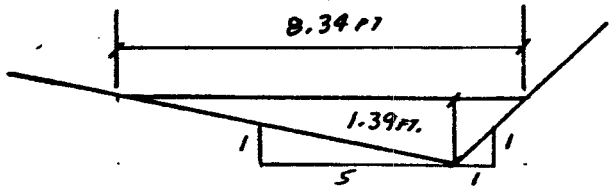
EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$= 1.06 \text{ ft.} + 1.3 \text{ ft}$

$= 1.39 \text{ ft}$

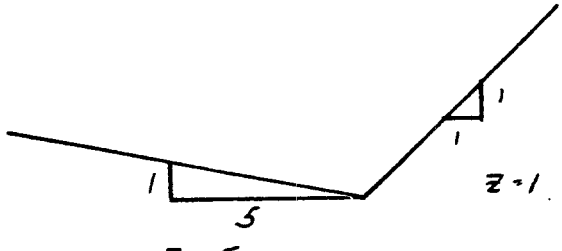
DITCH DESIGN



D. DD-15 DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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



$Z = 5$

$n = .035$
$S = .06$ MAP 3.2.8-1

$A = 2d^2/2 + 2d^2/2$

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

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

$$= 5d^{1/2} + 1d^{1/2} \times 1.49/.035 \times (5d/\sqrt{4} + d/\sqrt{4})^{4/3} \times (.06)^{1/2}$$

$$= 2.5d^1 + .5d^1 \times 42.46 \times (.25d + .18d)^{4/3} \times .24$$

$$= 3d^2 \times 42.46 \times (.43d)^{4/3} \times .24$$

Try $d = 1.1$ ft

$$Q = 3(1.1)^2 \times 42.46 \times (.43(1.1))^{4/3} \times .24$$

$$= 22.40 \text{ cfs}$$

Try $d = 1.11$ ft

$$Q = 3(1.11)^2 \times 42.46 \times (.43(1.11))^{4/3} \times .24$$

$$= 22.95 \text{ cfs}$$

use $d = 1.11$ ft

VELOCITY

$$V = 1.49/n \times R^{2/3} \times S^{1/2}$$

$$= 1.49/.035 \times (.48)^{2/3} \times .24$$

$$= 42.46 \times .61 \times .24$$

$$= 6.34 \text{ FPS}$$

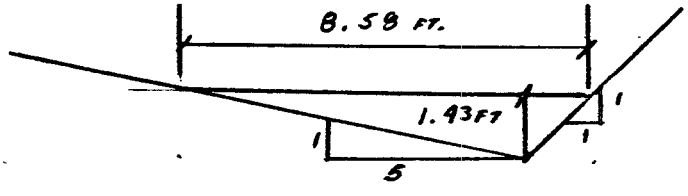
$R = .43(1.11) = .48$
$S = .06$
$n = .035$

EVEN THROUGH THE VELOCITY IS GREATER THAN 6 FPS THE DITCH IS CONSTRUCTED IN ROCK.

TOTAL DEPTH = DEPTH OF FLOW + FREEBOARD

$$= 1.11 + .3$$

$$= 1.43 \text{ ft}$$



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

SECTION 15

WASTE ROCK DISPOSAL
SEDIMENT POND

WASTE ROCK DISPOSAL
SEDIMENT POND

C. TAYLOR
6-30-89
REVISED 11-21-89

SIZING POND - DISPOSAL SITE - MAP 4.K.1-1B

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]	HYA 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	LL
MIDFORK FAMILY SOILS	7	B	LL

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

$$CN = \frac{.30(66) + .25(77) + .25(77) + .13(66) + .07(66)}{.3 + .25 + .25 + .13 + .7}$$

$$= 19.80 + 19.25 + 19.25 + 8.58 + 4.62$$

$$= 71.50 \quad \text{USE} \quad \underline{72}$$

$S = 1000/CN - 10 = 3.89$ EQ 2.39

$Q = (P - .25)^2 / P + 0.85$ EQ 2.38

} PAGE 81 APPLIED HYDROLOGY AND SEDIMETOLOGY FOR DISTURBED AREAS, BARFIELD AND HANN

$P_{10\text{-}24} = 2.45$ IN

$P_{25\text{-}24} = 2.85$ IN

} SECTION 2, VOL 5 PAGE 5

Q - 10 YR - 24 HR

$Q_{10\text{-}24} = [2.45\text{in} - .2(3.89)]^2 / 2.45 + .8(3.89)$

$= 2.80 / 5.56$

$= .50$ INCHES

Q = 25 YR - 24 HR

$Q_{25\text{-}24} = [2.85 - .2(3.89)]^2 / 2.85 + .8(3.89)$

$= 4.29 / 5.96$

$= .72$ INCHES

c) RUNOFF VOLUMES

10YR - 24HR

$RV = QA / 12\text{IN/FT}$

$= .50\text{IN} \times 1.57 \text{ ACRES} / 12\text{IN/FT} = .07$ ACRE-FT

2,850 CU.FT.

25 YR - 24 HR

$RV = .72\text{IN} \times 1.57 \text{ ACRES} / 12\text{IN/FT} = .09$ ACRE-FT

4,100 CU.FT.

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

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

$Q = (P - .2S)^2 / P + .8S$ 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

$RV = QP / 12 in/ft$

$= 1.41 in \times 2.09 Acres / 12 in/ft = .25$

10,697 cu. ft.

25 YR - 24 HR

RV = QA / 12 IN/FT

= 1.97 IN x 2.09 ACRE / 12 IN/FT = .329 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

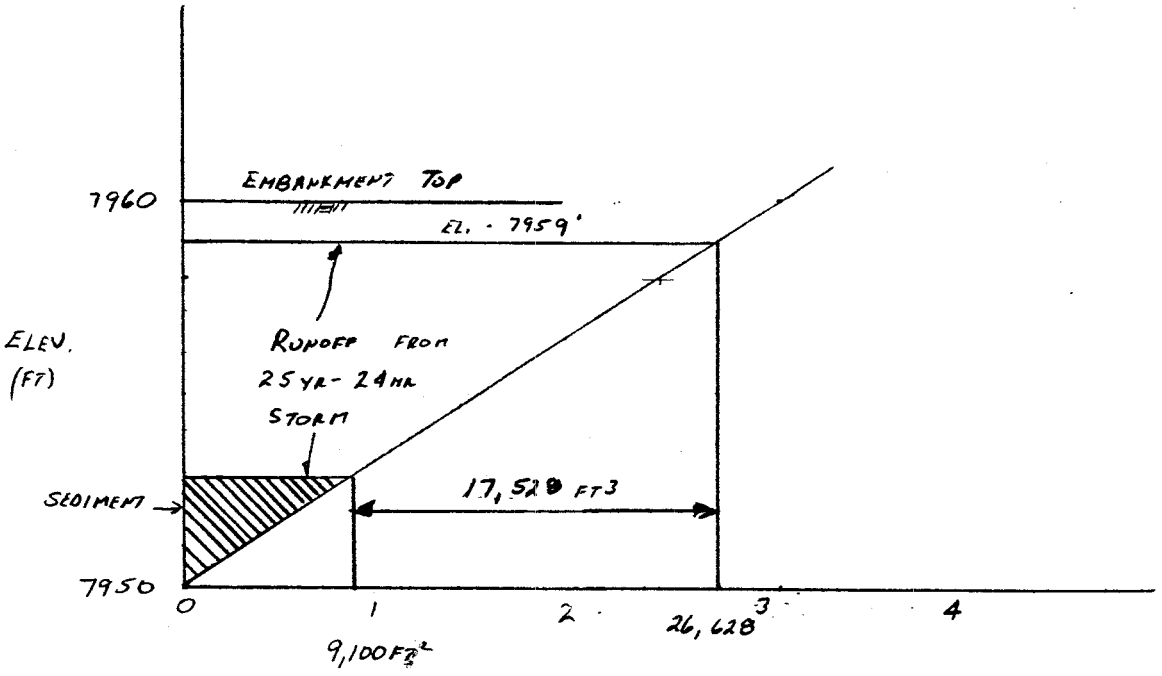
25 YR - 24 HR

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
BRYCAN 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 HANN

3) % SLOPE = Σ CONTOURS × CONTOUR INTERVALS / AREA

PEAK FLOW (CFS) (5)

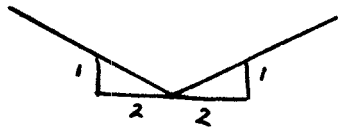
AREA NO.	t_c (4)	Q10-24	Q25-24	Q50-24	Q100-24
	.077 hr				3.68

4) KENT'S
$t_c = L^{.8} (S+1)^{.7} / 1900\ y^{.5} / .6$ EQ. = 2.60 PAGE 102
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HANN

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_{100-24}

USE MANNING FORMULA

$n = .023$ UNIFORM - NOT VEG.
$S = .027$

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

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

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

$= 2d^2 \times 1.486/.023 \times (2d/2\sqrt{4+1})^{2/3} \times (.027)^{1/2}$

$= 2d^2 \times 64.61 \times (.45d)^{2/3} \times .16$

TRY $d = .6$ FT

$Q = 2(.6)^2 \times 64.61 \times (.45(.6))^{2/3} \times .16$

$= 3.10$ CFS

TRY $d = .64$ FT

$Q = 2(.64)^2 \times 64.61 \times (.45(.64))^{2/3} \times .16$

$= 3.68$ CFS

USE $d = .64$ FT.

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

Velocity

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

$$= \frac{1.486}{.023} (29)^{2/3} \times (.027)^{1/2}$$

$$= 4.61 \text{ fps}$$

$R = .45(.64) = .29$
$S = .027$
$n = .023$

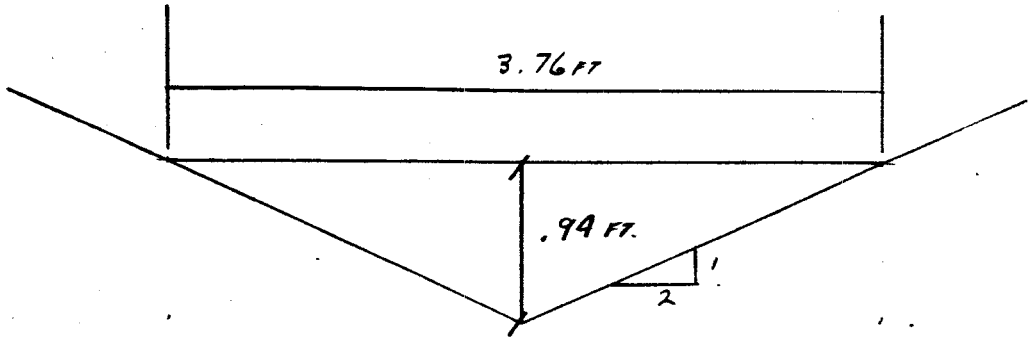
Total Depth = Depth of Flow + Free Board

= .64 ft + .3 ft

= .94

1.00

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 AT THE DISPOSAL SITE

Section 16

YEAR	VOLUME STORED YD³	
1984		
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

REVISED 9-18-89
G. TAYLOR

THE DISPOSAL AREA WAS DESIGNED TO HOLDS 131,000 YD^3 OF MATERIAL. AS OF 13 AUGUST 1987, 11,541 YD^3 HAS BEEN PLACED AT THE DISPOSAL SITE

YEAR	VOLUME STORED YD^3	ACC. VOL. YD^3
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 YD^3 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

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C. TAYLOR
6-30-89
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Sec 17

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

RECLAMATION EQUIPMENT LIST (1)

1) EQUIPMENT RATES

EQUIPMENT	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
D6D TRACK TYPE TRACTOR	6,005	2420		11.80
D8L " " "	12,665	4,350		28.50
631D WHEEL TRACTOR SCRAPER	17,665	6,005		49.60
146 MOTOR GRADER	5,980	2,030		18.65
245 BACKHOE	19,695	6,500		43.85
10T DUMP TRUCK	3,050	945		12.95
3/4T 4x4 PICKUP	550	170		2.00
410 B-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	.4.45/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

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

EQUIPMENT REMOVAL

1 DAYS TO REMOVE ANY PIECE OF EQUIPMENT

LABOR

FOREMAN - 1 x 8 HR x $33.65/HR = 269.20
OPERATOR - 1 x 8 HR x $31.00/HR = 248.00
LABORER - 4 x 8 HR x 23.65 HR = 756.00

EQUIPMENT

PICK-UP - 1 x 39 x 8.x 8.9 = 105.20
65 ton CRANE - 1,104 x 8 x 39.00 = 1808.00
2,787.2

	MONTH	WEEKLY	HR.
P&H 265	16,720	5,520	38.00

2,787.2 ÷ 20 TON = 139.36 USE $190/TON

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

Reclamation Cost Calculation

Description	Units	Unit Cost	Subtotal
Building and Equipment Removal	Tons		
Equipment Removal			
1,500 x 75%	Tons	$1.40/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

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

Parking Area	110 YD²	1.48/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 Foundation

	32,400 FT³	.22/FT³	7,130
Disposal	1,200 YD³	5.10/YD³	6,120

Concrete Removal - Loadout

Silo Sides	162,000 FT³	.22/FT³	35,640
Railcar Loadout	6,706 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 x 40 D' = 2,840 D'

N
66 x 40 D' = 2,640 D'

Section B-B' - Map 4.4.2-1B

51 x 40 D' = 2,040 D'

N
15 x 40 D' = 600 D'

11 x 40 D' = 440 D'

S
65 x 40 D' = 2,600 D'

Section C-C' Map 4.4.2-1B

19 x 40 D' = 760 D'

N
112 x 40 D' = 4,480 D'

S
52 x 40 D' = 2,080 D'

Cut Material

2,840 Section A-A'
2,040 Section B-B'
4,880 ÷ 2 = 2,440 D' x 270 Ft. = 658,800 cu. ft.

2,040 Section B-B'
760 Section C-C'
2,800 ÷ 2 = 1,400 D x 233 Ft. = 326,200 cu. ft.

760 D' ÷ 2 = 380 D x 230 Ft = 87,400 cu. ft

1,072,400 cu. ft. ÷ 27 = 39,719 yd^3

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

FILL MATERIAL

NORTH SIDE

2,640 SECTION A-A'
1,040 SECTION B-B'
3,680 ÷ 2 = 1,840 D' × 270 FT = 496,800 CU. FT

1,040 SECTION B-B'
4,480 SECTION C-C'
5,520 ÷ 2 = 2,760 D' × 233 FT = 643,080 CU. FT

4,480 D' ÷ 2 = 2,240 D' × 230 FT = 515,200 CU. FT.

1,655,080 CU. FT. ÷ 27 = 61,299 YD³

SOUTH SIDE

2,600 ÷ 2 = 1,300 D' × 270 FT = 351,000 CU. FT

2,600 SECTION B-B'
2,080 SECTION C-C'
4,680 ÷ 2 = 2,340 D' × 233 FT = 545,220 CU. FT.

2,080 ÷ 2 = 1,040 D' × 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 BEACH

CUT FILL

SECTION E-E MAP 4.4.2-1B

144 x 40 D' = 5,760 D'

SECTION F-F' MAP 4.4.2-1B

55 x 40 D': 2,200 D' 24 x 40 D': 960 D'

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

CUT MATERIAL

5,760 D' x 540 FT : 3,110,400 CU.FT

2,200 D' x 540 FT : 1,188,000 CU.FT

4,298,400 CU FT. ÷ 27 : 159,200 YD³

FILL MATERIAL

960 D' x 207 FT : 198,720 CU.FT ÷ 27 : 7,360 YD³

UPPER BENCH

CUT	FILL

WEST FORK

SECTION G-G' MAP - 4.4.2-18

73 x 40D' : 2,920 D'

N
121 x 40 D' = 4,840 D'

SECTION H-H' MAP - 4.4.2-18

30 x 40D = 1,200 D'

N
25 x 40D' = 1,000 D'

S
33 x 40D' = 1,320 D'

CUT MATERIAL

2,920 D' ÷ 2 = 1,460 D' x 455 FT = 664,300 cu.ft

2920
1,200
4,120 ÷ 2 = 2,060 D' x 268 FT = 552,080 cu.ft.

1,200 ÷ 2 = 600 D' x 70 FT = 42,000 cu.ft

1,258,380 cu.ft ÷ 27 = 46,607 yd³

FILL MATERIAL

NORTH SIDE

4,840 D' ÷ 2 = 2,420 D' x 135 FT = 326,700 cu.ft

4890
1000
5,840 ÷ 2 = 2,920 D' x 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 × 400 □' = 10,000 □'	198 × 400 □' = 7,920 □'

CUT MATERIAL

1,000 □ ÷ 2 = 500 □' × 846 FT = 423,000 cu.ft ÷ 27 = 15,667 YD³

FILL MATERIAL

7,9200' ÷ 2 = 3,960 × 355 FT = 1,405,800 cu.ft

7,9200 ÷ 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 x 60' = 2400'

SECTION B-B'

61 x 60' = 3660'

FILL

240
366
606 ÷2 = 3030' x 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 888

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

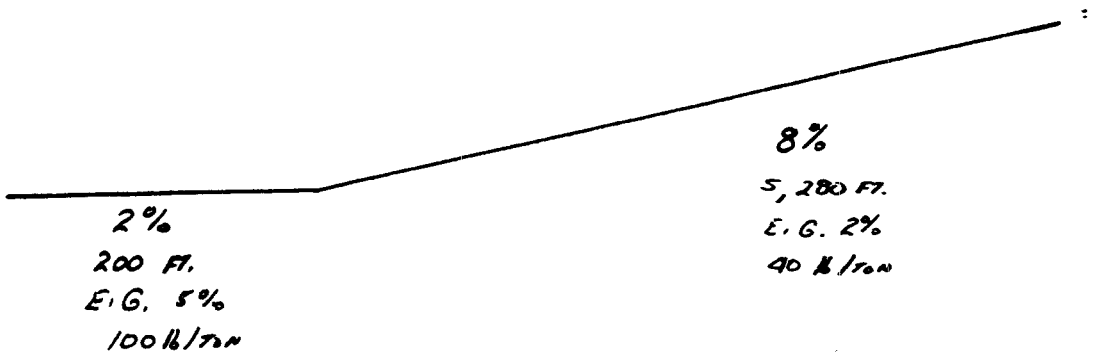
3 - 769C OFF HIGWAY TRUCK
1 - 988B WHEEL LOADER
1 - D8L TRACTOR

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 yd³ x .8 x 2840 = 69,977.6 lbs USE 70,000 lbs

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 x 138,000 lbs x .667 = 64,432

EMPTY (WEIGHT ON DRIVING WHEELS 50.4%)
.70 x 138,000 x .504 = 48,686

4. COMPARE TOTAL RESISTENCE TO TRACTIVE EFFORT ON HAUL

GRADE RESISTANCE

SEC. 1 20 lb/ton x 69 ton x 2 = 2,760

SEC 2 20 lb/ton x 69 ton x 8 = 11,040 lbs

ROLLING RESISTENCE

SEC. 1 100 lb/ton x 69 = 6,900 lbs

SEC 2 40 lb/ton x 69 = 2,760 lbs

TOTAL RESISTENCE

SEC 1 6,900 lbs + 2,760 = 9,660

SEC. 2 11,090 lbs + 2,760 = 13,800 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 x 34 tons x 2 = 1,360 lbs

SEC. 2 20 lb/ton x 39 x 8 = 5,990 lbs

ROLLING RESISTENCE

SEC. 1 100 lb x 39 tons = 3900 lbs

SEC 2 40 lbs x 39 tons = 1,360 lbs

TOTAL RESISTENCE

SEC. 1 3,900 lbs - 1,360 = 2090 lbs

SEC 2 1,360 - 5,990 = -4,060 lbs

TRAVEL TIME

SEC. 1 .2 min
SEC 2 3.70 min
3.90 min

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

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 YD^3/HR

1,683 YD^3 ÷ 276.16 YD^3/HR = 6.09 HRS

COST OF FILL AND GRADING

FILL

769 @	= ($22.65/HR × 6.09 + $95.503 × 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	= $24.60/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		48.94 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

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

WATER TANK TOPSOIL

TOPSOIL NEEDED

150 FT x 90 FT x 2.5FT = 33,750 FT³ ÷ 27 = 1250 YD³

1- 769 C OFF HIGHWAY TRUCK
1- 988 B WHEEL LOADER
1- 08L TRACTOR

HOURLY UNIT PRODUCTION

24.64 BCY x 4.50 CYCLE/HR = 110.88 BCY/HR

ADJUSTED PROD.

110.88 BCY/HR x .83 = 92.03 BCY/HR

1250 YD³ ÷ 92.03 BCY/HR = 13.58 HRS

COST

769 C @	13.58 HRS x (93.50 + 22.65)	=	1,577.32
988 B @	13.58 HRS x (170.00 + 42)	=	2,878.96
D8L @	13.58 HRS x (100 + 28.50)	=	1,853.67
PICK-UP @	13.58 HRS x (4.25 + 2.00)	=	84.88
OPERATOR @	$30.35/HR x 13.58 HR	=	412.15
TEAMSTER	$24.60/HR x 13.58 HR	=	334.07
FOREMAN	$33.65/HR x 13.58 HR	=	456.97
			7,598.02

USE = $7,600

RIPPING

TRACTOR @	.3HR x ($26.70/HR + 20.63)	=	8.20
OPERATOR @	$30.35/HR x .3HR	=	9.11
LABORER @	$23.65/HR x .3HR x 3		21.29
HAY	$200/ACRE .3	=	60.00
			98.60 ≈ $100.00

PORTAL BACKFILL

MINE SITE SILO 680 YD³

RAIL LOADOUT SILOS 6,000 YD³

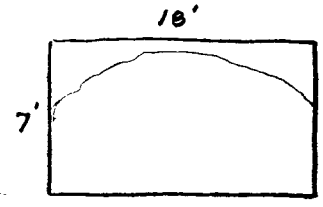
6,680 YD³

TOTAL ENTRIES TO BACKFILL - 10

6,680 YD³ ÷ 10 = 668 YD³/ENTER SWELL FACTOR OF 20%

USE 915 LHD TO BACK FILL PORTALS

DESCRIPTION - CONCRETE
LOAD FACTOR - .80



≈ 80% OF THE ENTRY CAN BE FILLED

7' × 18' = 126 FT² ÷ 9 FT/YD² = 14 YD³

668 YD³ × 1.2 = 801.6 YD³ ÷ 14 YD² = 57.26 YD × 3 = 171.77

≈ THE 172 FT OF EACH PORTAL WOULD BE FILLED

NUMBER OF TRIPS

7 YD³ × .8 = 5.6 YD³

801.6 ÷ 5.6 = 143.14 TRIPS/ENTRY

TRAVEL TIME

3.5 MILES/HR × 5,280 FT/MILES × .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
CABLE 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 × 1203 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 @ 89.85 / hr × 50.64 hrs × 2 = 9,100
OPERATOR @ 30.35 / hr × 50.64 hrs × 2 = 3,073.85
FOREMAN @ 33.65 / hr × 50.64 hrs × 1 = 1,704.04
13,877.89 = 13,800 / 12 = 6,900

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 08L 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 = 190% LOAD TIME + .25 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

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

2 FILLING AND GRADING COST

USE THE WEEKLY RATE FOR THE EQUIPMENT

631 @ $6,005/wk × 2 wks × 3 + 49.60 × 79.5 hrs × 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 + 99.60 × 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 6,038.29 EQUALY BETWEEN BACKFILLING AND GRADING

C. UPPER BENCH

1. PRODUCTION RATE

134,544 YD^3 ÷ 1,299.99 YD^3/HR = 103.5 HRS

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

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	= 697.30
	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

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 x 270 FT = 189,000 FT² x 2.5 FT = 472,500 CU.FT ÷ 27 = 17,500

SOUTH SIDE

700 FT. x 170 FT = 119,000 FT² x 2.0 FT. = 238,000 CU.FT ÷ 27 = 8,814.81

MIDDLE BENCH

NORTH SIDE

600 FT x 480 FT x 2.5 FT = 720,000 CU.FT. ÷ 27 = 26,666.67

SOUTH SIDE

260 FT x 160 FT x 2 FT = 83,200 CU.FT. ÷ 27 = 3,081.48

UPPER BENCH

NORTH SIDE

1000 FT x 400 FT x 2.5 FT = 1,000,000 CU.FT. ÷ 27 = 37,040

SOUTH SIDE

1300 FT x 300 FT x 2 FT = 1,008,800 CU.FT. ÷ 27 = 37,360

2. SPREAD TOPSOIL

a) USE SCRAPERS

CAT 631 21 YD³ (STRUCK) + 31 YD³ (HEAPED)/2 = 26 YD³ AVG. CAPACITY

A DBL DOZER WILL ASSIST THE SCRAPERS IN LOADING

DESCRIPTION OF SCRAPER ROUTE % GRADE THIS WOULD BE TYPICAL FOR THE MINE SITE

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

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 m = 8.77 CYCLES/HR

HOURLY PRODUCTION

26 YD^3 × 8.77 CYCLES/HR = 228.07 YD^3/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 YD^3/HR × 5 = 1,140.35

26,310 YD^3 ÷ 1,140.35 YD^3/HR = 23.07 HRS

COST

631 @	(150.13 + 49.60) 23.07 × 5	= 23,038.86
D8 @	(108.75 + 28.50) 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

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	=	163.82
MULCHER 2.50 × 23.07	=	57.68
HAY $200/AC × 9.8	=	1960.00
		4,924.69
		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	=	26,054.78
DB @ (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	=	1,810.65
OPERATOR $30.35/HR. 26.09	=	791.83
		2,602.48

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

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 = 65.29 hrs

Cost

Use the weekly rate

631 @ [6,005 × 1.63 + (49.60)(5.29)] 5		=	65,082.65
D8 @	4,350 × 1.63 + (28.50) 65.20	=	8,949.84
Operator	30.35 × 65.29 × 6	=	11,880.20
			85,917.69

Foreman	33.65 × 65.29	=	2,195.33
Pick-up	170 × 1.63 + 2 × 65.29	=	407.58
			2,602.91

88,520.60
88,520

Ripping

AG @	2,030 × 1.63 + 18.65 × 65.20	=	4,525.63
Operator	30.65 hr × 65.20	=	1,999.61
			6,525.24

Tractor @	825 × 1.63 + 6.70 × 65.29	=	1,781.86
Operator	30.35 × 65.20	=	1,980.03
Laborer	23.65 × 65.29 × 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

Reference: Caterpillar Preformance Handbook, Edition 19

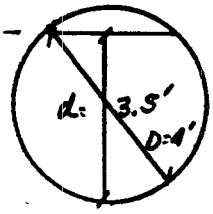
Drainage Reconstruction

1. Upper Bench

A. Backfill - 48" ∅ CMP

Stream A - 580
Stream B - 588 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' × 1168 ft = 8,981.92 cu. ft. ÷ 27 = 332.66 yd³

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 = $786.84

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

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 = 33,558.5 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

18.05 cycles/hr × 2.87 yd³ = 51.80 yd³/hr

1,242.89 m³ ÷ 51.80 yd³/hr = 23.99 hr

2. STREAM B

FILTER BLANKET

34.83 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	-	8,481.92	
EQUIPMENT	-	277.22	
LABOR	-	786.84	
		9,546.98	$9,550

STREAM A

MATERIAL	-	24,293.22	$24,290

STREA B

MATERIA	-	25,291.38	$25,290

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

EQUIPMENT STATION A-B

245 TOTAL HOURS 77.47

USE WEEKLY RATE

6,500 /WK × 1.94 WK × 93.95 × 77.47 HRS = 15,993.68 $16,000

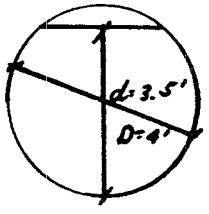
LABOR

OPERATOR $30.35/HR × 77.47 = 2,351.21
LABORER $23.65/HR × 77.47 × 3 = 5,496.50
7,847.71 2,850
82,900

2. MIDDLE BENCH

A. BACK FILL - CMP

48" Ø CMP



CIRCLE 7 1/2 FULL

AREA = $D^2/8 (2\pi - \pi\theta/180 + \sin\theta)$

$\theta = 4 \cos^{-1}\sqrt{d/D} = 4 \cos^{-1}\sqrt{3.5/4} = 82.82$

$A = (4)^2/8 (2\pi - \pi(82.82)/180 + \sin 82.82)$
$= 7.69$ SQ. FT.

7.69 SQ.FT × 410 FT = 3,152.90 CU.FT ÷ 27 = 116.77 YD^3

COST

MATERIAL

116.77 YD^3 × $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

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

RIPRAP

TOTAL SQUARE FT. OF RIPRAP IS 101.40 ONLY 20% OF THAT TOTAL WILL HAVE TO BE PURCHASED BECAUSE LARGER SIZE MATERIAL WILL BE FOUND ON THE SITE!

$101.40\ FT^2 \times .2 = 20.28\ FT^2$

$20.28\ FT^2 \times 540 = 10,951.20\ FT^3 \div 27 = 405.60\ YD^3$

$405.60\ YD^3 \times \$11.50\ YD^3 = 4,664.90$

FILTER BLANKET - EQUIPMENT HR

$2,332.20\ YD^3 \div 76.71\ YD^3/HR = 30.40\ HRS$

RIPRAP - EQUIPMENT

$405.60\ YD^3 \div 51.80\ YD^3/HR = 7.83\ HR$

LARGE RIPRAP

$101.40\ FT^2 \times .3 = 30\ FT^3 \times 540 = 16,200\ FT^3 \div 27 = 600\ YD^3$

LOAD BUCKET	.24 MIN.
SWING LOADED	.07 MIN
DUMP BUCKET	1.00 MIN
SPEED, MANEUVER	1.50 MIN.
SWING EMPTY	.07 MIN
	2.88 MIN

$50\ MIN/HR \div 2.88\ MIN/CYCL = 17.36\ CYCLES/HR$

$17.36\ CYCLES/HR \times 2.87\ YD^3 = 49.83\ YD^3/HR$

$600\ YD^3 \div 49.83\ YD^3/HR = 12.04\ HRS$

3. TRANSITION FROM STREAM B TO STREAM D

FILTER BLANKET

$93\ FT^2 \times 92\ FT = 8,556\ FT^3 \div 27 = 316.89\ YD^3$

$316.89\ YD^3 \times \$9.50/YD^3 = \$3,010.46$

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

RIPRIP

TOTAL SQUARE FT. OF RIPRAP IS 90 SQ.FT. ONLY 20% OF THIS TOTAL WILL HAVE TO BE PURCHASED BECAUSE LARGER SIZE MATERIAL WILL BE FOUND ON THE SITE.

90 SQ.FT × 2 = 18 FT²

18 FT² × 1.92 FT = 1,656 FT³ ÷ 27 = 61.33 YD³

61.33 YD³ × $11.50 = 705.33

LARGE RIPRAP

90 FT² × .3 = 27 FT² × 1.92 FT = 2,488 FT³ ÷ 27 = 92 YD³

FILTER BLANKET - EQUIPMENT HRS

613.08 YD³ ÷ 76.71 YD³/HR = 7.99 HRS

RIPRAP

61.32 YD³ ÷ 51.81 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 LAGREA 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

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

LARGE RIPRAP

$46.37\ FT^2 \times .3 = 13.91\ FT^2 \times 35\ FT = 486.89\ FT^3 \div 27\ YD^3 = 18.03\ YD^3$

FILTER BLANKET - EQUIP. HRS

$74.41\ YD^3 \div 76.71\ YD^3/HR = .97\ HRS$

RIPRAP

$12.02\ YD^3 \div 51.81\ YD^3/HR = .23\ HRS$

$18.03\ YD^3 \div 49.83\ YD^3/HR = .36\ HRS$

$.59$

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	20,930.80	20,930

STREAM D

- MATERIA	26,820.30	26,820

TRANSITION B TO D

MATERIAL	3,715.77	3,720

TRANSITION C TO D

MATERIAL	845.10	850

EQUIPMENT HOURS FOR STREAM C + D, TANSITIONS B to D + C to D

245 TOTAL HOURS 94.31 MPS

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 FT² ÷ 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

295 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

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

Loadout Site Material Balance

Cut

Section A - A' Map - 4.4.2-1D

75 x 40 Ft² = 3,000 Ft²

2,340 Ft² x 280 Ft = 655,200 Ft³ ÷ 27 = 24,267 YD³

Section B - B' Map 4.4.2 - 1D

42 x 40 Ft² = 1,680 Ft²

2200 Ft² x 500 Ft = 1,100,000 Ft³ ÷ 27 = 40,741 YD³

Section C - C' Map 4.4.2 - 1D

68 x 40 Ft² = 2,720 Ft²

1660 Ft² x 500 Ft = 830,000 Ft² ÷ 27 = 30,741 YD³

Section D - D' Map 4.4.2 - 1D

15 x 40 Ft² = 600 Ft²

96,149 YD³

Fill

Section C - C' Map 4.4.2 - 1D

90 x 40 Ft² = 3600 Ft²

3,060 Ft² x 500 = 1,530,000 ÷ 27 = 56,667

Section D - D' Map 4.4.2-1D

63 x 40 Ft² = 2,520 Ft²

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

$2,300 FT^2 \times 420 FT = 966,000 FT^3 \div 27 =$ 35,778 YD^3

SECTION E-E' MAP 4.4.2-1D

$52 \times 40 FT^2 =$ 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

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 1.25 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

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

FILLING AND GRADING COST

USE THE WEEKLY RATE FOR THE EQUIPMENT

631 @ (6,005/hr × 2.22 + 49.60 × 88.75) 3	=	53, 199.30
D8 @ 4,350/hr × 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 - 17 CH/hr × 2.22 + 2.00 × 8.875	=	554.90
		3, 541.34
		94, 714.33

DIVIDE 94,710 EQUALLY BETWEEN BACKFILLING AND GRADING

TOPSOIL BALANCE
LOADOUT SITE

	YD^3	
TOPSOIL STOCKPILE		35,589 YD^3
WASTE DISPOSAL SITE	3,480	
LOADOUT SITE	32,109	

13,105

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

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 & 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
MANEOUVER TIME	- .7 MIN
RETURN TRIP TIM	1.1 MIN
	3.60 MIN

CYCLES/HOUR = WORK FACTOR HOURS = 50 MIN/HR ÷ 3.60 MIN = 13.89 CYCLES/HR

HOURLY PRODUCTION

$26 YD^3$ x 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 x 3 = $1,083.33 YD^3$/HR

$32,109 YD^3$ ÷ $1,083.33 YD^3$/HR = 29.64 HRS

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

TOPSOIL ADDITION

631 @	(6,005 × .74 + 49.60 × 29.69) × 3	=	17,741.41
DB	4,350 × .74 + 28.50 × 29.69	=	4,063.74
OPERATORS	$30.35/HR × 29.69 × 4	=	3,598.80
			25,403.95
FOREMAN	$33.65/HR × 29.69	=	999.39
PICK-UP	170 × .74 + 200 × 29.69	=	185.08
			1182.47
			26,586.42
		USE	26,590.00

RIPPING

140 GRADER

140 @	5,980 × .75 ÷ 18.65 × 29.69	=	4977.99
OPERATOR	30.35/HR × 29.69	=	899.57
			5,877.56
TRACTOR @	(20.63 + 6.70) 29.69	=	810.06
OPERATOR	30.35 × 29.69	=	899.57
LABORERS	23.65 × 29.69 × 3	=	2102.96
MULCHER	2.50 × 29.69	=	74.10
HAY	$200/AC × 8.7	=	1790.00
			5,626.69
			11,504.25
		USE	11,500

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

SEDIMENTATION POND #1
AT LOADOUT BACKFILL

1. BACKFILL

USE 245 EXCAVATOR

BUCKET SIZE - 4.25 YD^3

PRODUCTION RATE

LOAD BUCKET	-	.24 MIN
SWING LOADED	-	.12 MIN
DUMP BUCKET	-	.05 MIN
SPREAD MATERIAL	-	1.00 MIN
COMPACT	-	4.00 MIN
SWING EMPTY	-	.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 × 43.85 × 103.72	= 21,389.48
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	

G. Taylor
Revised
11-17-99

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 - 3,480.76 Acres - Map 3.2.8-3

Hydraulic Length - 18,150. ft. from the culvert to South Eccles canyon drainage.

ECI : 46,218,000 Section 12, Vol 5

Slope : 30.90 %. Section 12, Vol. 5

CN: 65 Section 12, Vol. 5

Hathway Coeff. = 0.7

		P(in)	Q cfs
Section 2	Soft 10-24	2.43	212.3
	50-24	3.10	529.2
	100-24	3.5	768.5

Determine the size of the arch culvert

Use Manning Formula

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

Try an arch that spans - 8'-7" and has a rise of 5'-11"

$A = 40 \text{ ft}^2$

$n = .024$

$S = .03$

Surface Mining Water Diversion Design Manual United States Dept of Interior, Office of Surface Mining.

$$R = \frac{2d^2}{\frac{1}{2}\sqrt{16d^2 + T^2}} + \frac{T}{2d}\sin^{-1}\frac{2d}{T}$$

$$= \frac{40}{\frac{1}{2}\sqrt{16(5.92)^2 + (8.57)^2}} + \frac{(8.57)}{8(5.92)}\sin^{-1}\frac{4(5.92)}{8.57}$$

$$= 2.87$$

$Q = 40 \times 1.486/.024 \times (2.87)^{2/3} \times (.03)^{1/2}$

$= 40 \times 61.92 \times .203 \times .17$

$= 854.74$ 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 HANDBOOK OF DRAINAGE AND CONSTRUCTION PRODUCTS 1958 EDITION
GAGE SELECTED	-	No. 10

USE A STANDARD - 8'-7" x 5'-11" No. 10 PIPE-ARCH

DETERMINE VELOCITY

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

$= 1.486/.024 \times (2.87)^{2/3} \times (.03)^{1/2}$

$= 12.73$ FPS

RIPRAP WILL BE NEEDED

DETERMINE DEPTH OF FLOW

USE MANNING FORMULA

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

$A = .67 dT$

$R = .67 dT / .5 \sqrt{16 d^2 + T^2} + \frac{T^2}{8d} \sin^{-1} \frac{4d}{T}$

$n = .017$

$S = .03$

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

$$Q = \tfrac{2}{3} dT \times 1.486/n \times \left(\tfrac{2}{3} dT / \tfrac{1}{2}\sqrt{16d^2 + T^2} + \tfrac{T^2}{8d} \sinh^{-1}\tfrac{4d}{T} \right)^{2/3} \times S^{1/2}$$

$$820.58 = \tfrac{2}{3} dT \times 1.486/.017 \times \left(5.71d / \tfrac{1}{2}\sqrt{16d^2 + (8.57)^2} + \tfrac{(8.57)^2}{8d} \sinh^{-1}\tfrac{4d}{8.57} \right)^{2/3} \times (.07)^{1/2}$$

$$820.58 = 5.71d \times 87.41 \times \left(5.71d / \tfrac{1}{2}\sqrt{16d^2 + 73.44} + \tfrac{73.44}{8d} \sinh^{-1}\tfrac{4d}{8.57} \right)^{2/3} \times .17$$

$$55.22 = 5.71d \times \left(5.71d / \tfrac{1}{2}\sqrt{16d^2 + 73.44} + \tfrac{73.44}{8d} \sinh^{-1}\tfrac{4d}{8.57} \right)^{2/3}$$

11.81   2.77   1.169

TRIAL 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

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

$$= 1.486/.017 \times \left(5.71d / \tfrac{1}{2}\sqrt{16d^2 + 73.44} + \tfrac{73.44}{8d} \sinh^{-1}\tfrac{4d}{8.57} \right)^{2/3} \times (.03)^{1/2}$$

19.76   2.77   1.69

$$= 87.41 \times (2.17)^{2/3} \times (.03)^{1/2}$$

$$= 87.41 \times 1.68 \times .17$$

$$= 24.94$$

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
$.50_{50}$	1.13	10
$.20_{50}$	.45	10

FILTER BLANKET DESIGN

ASSUME BASE MATERIAL

$D_{85} = .09$ in

$D_{50} = .029$ in

$D_{15} = .006$ in

RIPRAP PROPERTIES

$D_{85} = 20.66$ in

$D_{50} = 27$ in

$D_{15} = 5.06$ in

FILTER BLANKET WITH RESPECT TO BASE MATERIAL

$D_{50(FILTER)}/D_{50(BASE)} < 40$

so, $D_{50(FILTER)} < 40 \times .029 = .96$ in

$D_{15(FILTER)}/D_{15(BASE)} < 40$

so, $D_{15(FILTER)} < 40 \times .006 = .24$ in

$D_{15(FILTER)}/D_{85(BASE)} < 5$

so $D_{15(FILTER)} < 5 \times .09 = .45$ in

$D_{15(FILTER)}/D_{15(BASE)} > 5$

so $D_{15(FILTER)} > 5 \times .006 = .03$ in.

$.03 < D_{15(FILTER)} < .24$ in.

$D_{50(FILTER)} < .96$ in.

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

FILTER BLANKET WITH RESPECT TO 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

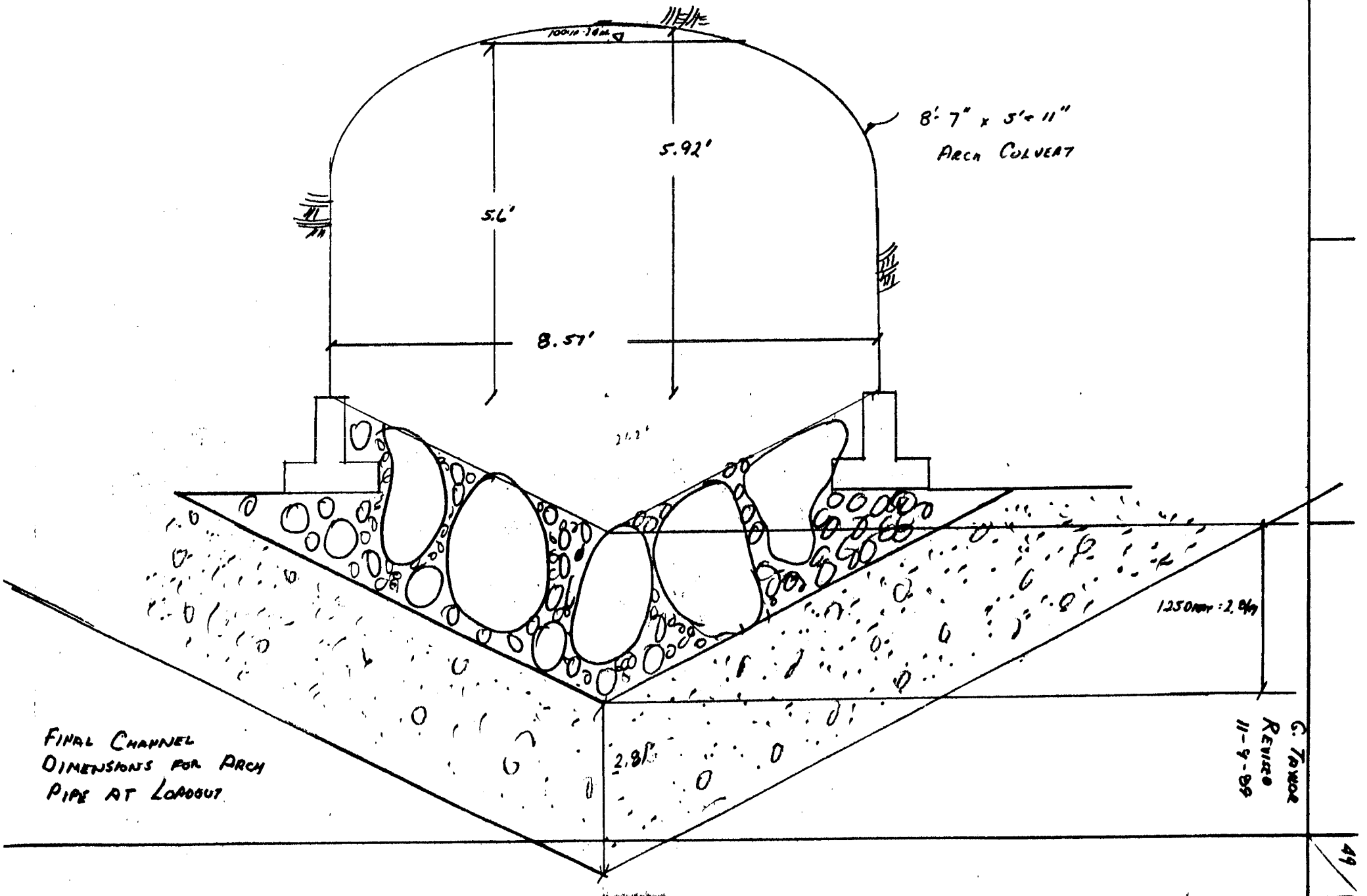
D_{50} (FILTER) > .68 IN

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

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



Final Channel Dimensions for Arch Pipe at Loadout

G. Taylor
Revised
11-9-89

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

RECLAMATION COST

COST OF MATERIALS

FILTER BLANKET

$20.14 FT \times 2 = 40.28 FT^2 \times 160 FT = 6,449.27 CU.FT \div 27 = 238.68 YD^3$

$238.68 YD^3 \times \$9.50 = \underline{\$2,267.93}$

RIPRAP

$40.28 FT^2$ OF THIS TOTAL ONLY 20% OF WILL HAVE TO BE PURCHASED.

$40.28 FT^2 \times .2 = 8.06 FT^2$

$8.06 FT^2 \times 160 FT = 1,288.96 FT^3 \div 27 = 47.74 YD^3$

$47.74 YD^3 \times \$11.50/YD = \$549.00$

CONCRETE

$2.50 FT^2 \times 160 FT = 400 FT^2 \div 27 = 14.81 YD^3$

$14.81 YD^3 \times \$400/YD = 5,925.93$

ARCH - PIPE

$160 FT \times \$30/FT = \$4,800$

$\$13,542.36$

USE

13,540

EXCAVATION

USE 245

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

$4.25 YD^3$ BUCKET SIZE $\times .95 = 4.04 YD^3$

50 MIN/HR ÷ .36 MIN/CYCLE = 138.86 CYCLE/HR

138.86 CYCLE/HR × 9.09 YD³ = 561.11 YD³/HR

AMOUNT OF MATERIAL TO MOVE

10 FT (DEPTH) × 20 FT (WIDTH) × 160 FT (LENGTH) ÷ 3,3000 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	= 64.09
		$499.49 USE $500

INSTALL FILTER BLANKET AND RIPRAP

238.68 YD³ ÷ 76.71 YD³/HR = 3.11 HR

47.79 YD³ ÷ 51.81 YD³/HR = .92 HR

190.93 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
		2,418.13 USE 2420

ARCH PIPE INSTALL + BACK FILL

30 FT/DAY

160 FT ÷ 30FT/DAY = 5.33 DAYS

5.33 DAYS × 8 HR/DAY = 42.67 HRS

245	6,500 × 457 WKS + 43.85 × 62.67	= 2,953.00
OPERATOR	30.35 × 62.67	= 1,902.03
LABORER	23.65 × 62.67 × 4	= 5,482.15
		16,337.26 USE 16,340

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

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

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

<u>Use 54,710 Cu.Ft</u>

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

$CN = 86(.80) + 79(.20) / .8 + .2$

$= 68.80 + 15.80 / 1$

$= 84.60$ use <u>85</u>

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-B

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

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

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	

$CN = 719.10 \times 455.88 + 250.88 / 20.24$

$= 70.45$ 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

$Q = (P - 0.25)^2 / P + 0.85$

$(2.13 - .2(4.08))^2 / 2.13 + .8(4.08)$

$= .46$ IN ÷ 12 IN/FT = .04 FT.

EQ. 2-38 PAGE 81 APPLIED HYDROLOGY SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HAAN

20.24 ACRES × 43,560 FT²/AC × .04 FT = 33,612.96 CU.FT

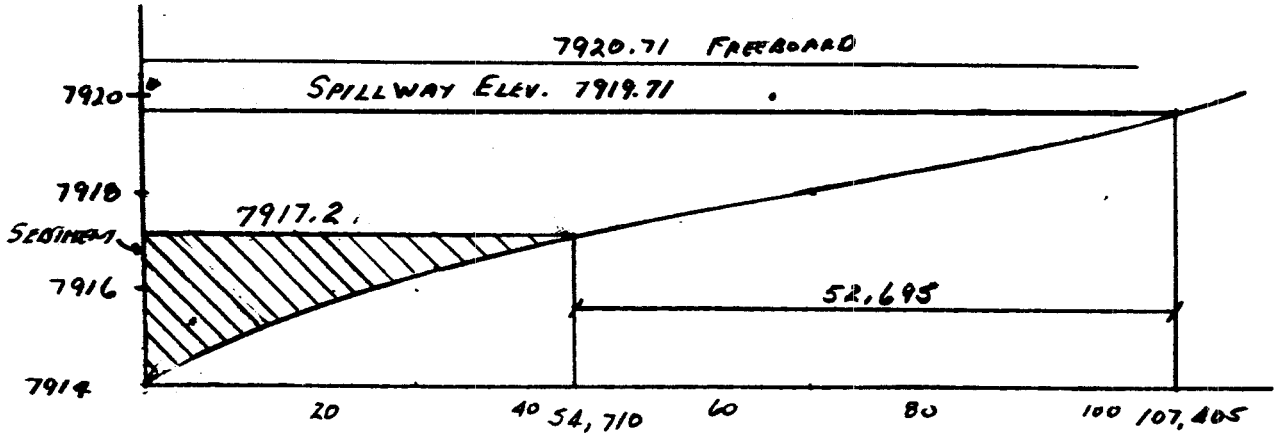
USE 33,610 CU.FT.

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

$$V_T = 54,710 + 33,616 = 88,320 \text{ cu. ft.}$$

3. POND CAPACITY (MAP 4.1.2-1C)

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

OU-6 WILL INTERCEPT FROM THE RECLAIM SITE AND LS-1

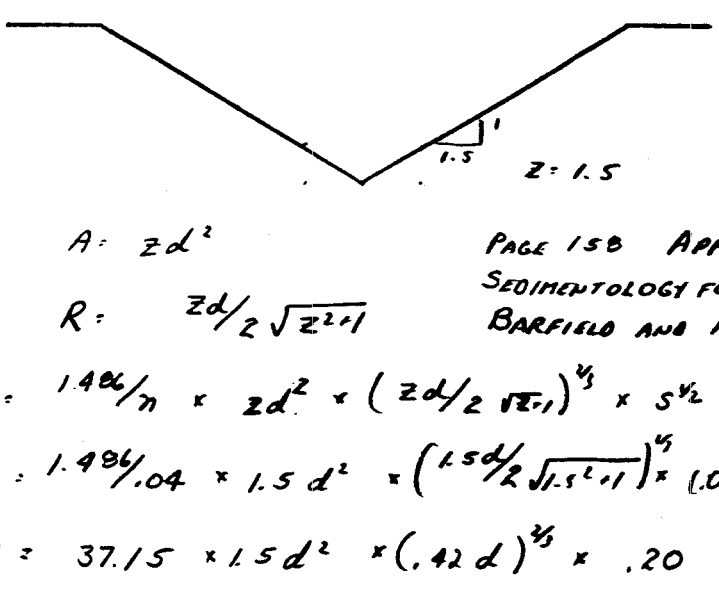
LS-1	Q_{10-24}	=	.23 CFS
LOADOUT	Q_{10-24}	=	18.41 CFS
			18.64 CFS

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.

$18.64 = 37.15 \times 1.5(1.51)^2 \times (.42(1.51))^{2/3} \times .20$

$= 37.15 \times 3.42 \times .79 \times .20$

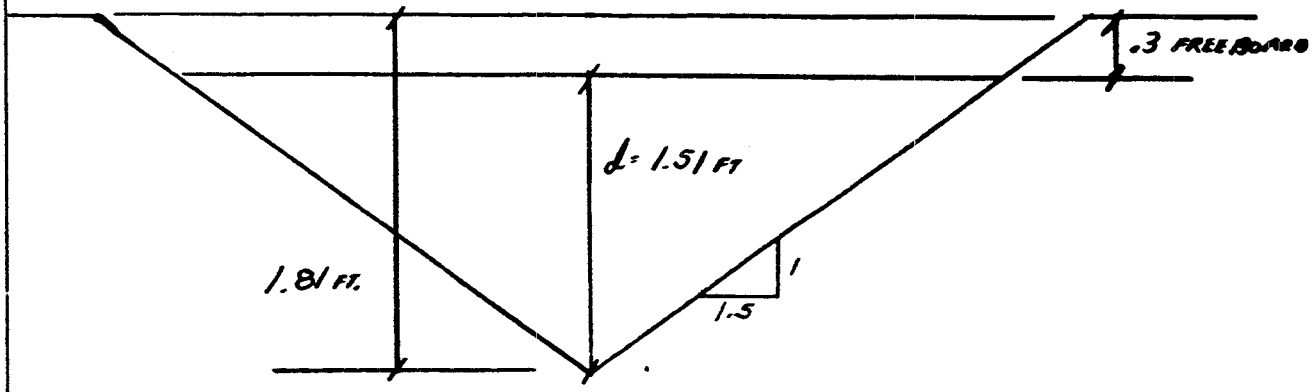
$= 18.73$ CFS

B. Ditch Design

Depth of Ditch = Flow Depth + Free Board

= 1.51 + .3

= 1.81 ft.



C. Velocity

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

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

$$= \frac{1.486}{.04} \left(\frac{1.5(1.51)}{2\sqrt{1.5^2+1}} \right)^{2/3} (.04)^{1/2}$$

$$= 37.15 \times .73 \times .20$$

$$= 5.42 \text{ FPS}$$

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	.5MIN
DUMP	1.2 min
	32.9 min

CYCLE /HR

50 min/hr ÷ 32.9 min = 1.52 cycle/hr

PRODUCTION RATE

8.70 yd^3 x .58 = 5.05 yd^3

5.05 yd^3 x 1.52 cycle /hr = 7.68 yd^3/hr/unit

7.68 yd^3 /hr /unit x 3 units = 23.05 yd^3/hr

4,000 yd^3 ÷ 23.05 yd^3 /hr = 173.54 hr

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

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 + 42.40 × 173.54	= 25,798.78
14G	- 2,030 × 4.34 + 18.65 × 173.54	= 12,046.72
Operator	- 30.35 × 173.54 × 2	= 10,533.86
Teamster	- 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
		74,458.36
		use
		74,460

Ripping

14G	- (50.75 + 18.65) 2.3	- 138.40
Tractor	- (20.63 + 6.20) 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	- 14.38
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 = 2,814.81 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.

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

245 EXCAVATOR

2,130 YD^3

CYCLE TIME

LOAD BUCKET	-	.12 MIN
SWING LOADED	-	.12 MIN
DUMP BUCKET	-	.05 MIN
SWING EMPTY	-	.10 MIN
		.39 MIN

CATERPILLAR PERFORMANCE HANDBOOK EDITION 19

50 MIN/HR ÷ .39 MIN = 128.21 CYCLE/HR

PRODUCTION RATE

4.25 YD^3 x .95 LOAD FACTOR = 4.04 YD^3

4.04 YD^3 x 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 x 12.95) 25.17 HRS	-	920.72
988B LOADER	(170.00 x 42.00) 25.17 HRS	-	5,338.04
D6D TRACTOR	(60.50 x 11.80) 29.28 HRS	-	2,116.94
245 EXCAVATOR	(162.50 x 18.65) 4.11 HRS	-	749.53
OPERATOR	30.65 x 25.17 x	-	771.96
OPERATOR	30.65 x 29.28	-	897.43
OPERATOR	30.65 x 4.11	-	125.97
TEAMSTER	24.60 x 25.17 x 2	-	1,238.36
FOREMAN	30.65 x 29.28	-	985.27
PICK-UP	(4.11 x 2) 29.28	-	183.00
			13,370.02
			USE
			13,320

22-141 30 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

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
PICK-UP	-	170 x 1.49 + 2 x 59.76	- 372.82
			19,204.41
			USE
			19,200

MULCHER	-	2 x 2.56	= 5.00	
LABORER	-	23.65 x 2 x 3	= 141.90	
FOREMAN	-	33.65 x 2	= 67.30	
PICK-UP	-	(4.25 12)L	= 12.50	
HAY	-	200 lbs x .96	= 192.00	
			418.70	420

19,620

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

RESTORE ROAD

8 FT × 3 FT × 12,000 FT = 28,800 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
		3.22 MIN

PRODUCTION RATE

50 MIN ÷ 3.22 MIN = 15.39 CYCLES/HR

15.39 CYCLE/HR × 4.09 YD³/CYCLE = 61.96 YD³/HR

1,066.67 YD³ ÷ 61.96 YD³/HR = 17.21 HRS

COST

245	(162.50 + 18.65) 17.21	= 3,118.42
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/HR = $20,000

SECTION 18

RECLAIMED CHANNEL DESIGNS

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

G. Taylor
Revised 11-24-69

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Transition Stream C to D	66-70

Sec 19

G. TAMOA
6-30-89

RECLAM CHANNEL DESIGN
STREAM A

ELEV. 8693' - 8669'

MAP. 3.2.4-2
STREAM SLOPE = .028 MAP 4.4.2-181

DESIGN FLOOD PLAIN FOR THE Q_{100-24} = SB + UD-4 - SUMMER FLOW

148.32 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

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

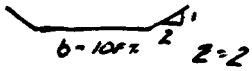
I. DETERMINE PERMISSIBLE VELOCITY

$V = 1.49/n \times R^{2/3} S^{1/2}$

R = HYDRAULIC RADIUS
S = SLOPE
n = .032 EARTH BOTTOM, RUBBLE SIDES
S = .0369. MAP 4.4.2-181

a) DETERMINE DEPTH OF FLOW

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



$A = bd + zd^2$
$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$
$Q = 111$ CFS

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

$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times (.0369)^{1/2}$

$Q = 10d \times 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .19$

$111.0 \text{ cfs} = 8.82 \times (10d \times 2d^2) \times (10d + 2d^2/10 + 4.47d)^{2/3}$

$12.59 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRAIL d

d	Q
1.1	12.59

$d = 1.1$

b) DETERMINE VELOCITY

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

$R = (bd + zd^2 / b + 2d\sqrt{z^2+1})$ $\quad d = 1.1$

$= 10d + 2d^2 / 10 + 2d\sqrt{z^2+1})$ $\quad b = 10$ FT

$= (10(1.1) + 2(1.1)^2 / 10 + 2(1.1)\sqrt{2^2+1})$ $\quad z = 2$

$= 13.42 / 14.92$ $\quad S = .0369$

$= .90$

$V = 1.486/.035 \times (.90)^{2/3} \times (.0369)^{1/2}$

$= 46.49 \times .93 \times .19$

$= 8.31$ FPS

THE STREAM WILL NEED TO BE RIPRAPED.

c, DETERMINE RIPRAP SIZE AND FILTER BLANKET

1) RIPRAP SIZE - MILO SLOPE

a. ASSUME $K_m = 6$ IN. $\quad K_m = D_{50}$

$n = 0.0395 \, D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 0.0395 \, (6/12)^{1/6}$

$= .035$

b. CHARTS IN APPENDIX C PAGE C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q(n)$

$= .111 \quad (.035)$

$= 3.89$ 3 ON A 4% SLOPE

$V_n = .27$

$V = V_n / n$

$V = .27 / .035 =$

$V = 7.71$ FPS

$d = 1.1$ FT.

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

THEREFORE

$$R = \frac{10(1.4) + 2(1.0)^2}{10 + 2(1.0\sqrt{2})^{1/2}}$$

$$= .90$$

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

$Q_n = Q_n$

$= 149.51\ (.038)$

$= 5.629$ ON A 27% SLOPE

$V_n = .27$

$V = V_n/n$

$= .27/.038$

$= 7.10$ FPS @ $d = 1.1$ FT

f. $V^2/R^{.33} = (7.10)^2/(6.90)^{.3} = 5L\ 19$

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

$F_R = V/\sqrt{gL}$ $L = 1.1$ EQ 4.6 PAGE 4.15 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 7.10/\sqrt{32.2(1.1}$

$= 1.15 < 1$

g) RIPRAS SIZE - STEEP SLOPE
DESIGN - 111 CFS SLOPE - .029 BOTTOM 10 FT

USE FIG 5.5 PAGE 5.18 SINCE THERE IS NO S=.029 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

RIPRAG GRADATION

$1.25\ D_{50}$	= .99 FT	30%
D_{50}	= .75 FT	50%
$.5\ D_{50}$	= .39 FT	10%
$.2\ D_{50}$	= 15 FT	10%

2. FILTER BLANKET DESIGN
ASSUMED 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.

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

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

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

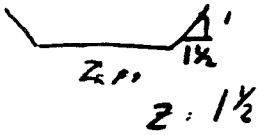
IV Summer Flow Ditch Design

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



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

$A = bd + zd^2$
$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$
$n = .032$
$S = .0369$

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

$$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2(d) + 1.5d^2/2 + 2d\sqrt{1.5^2+1})^{2/3} \times (.0369)^{1/2}$$

$$38.51 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + .361d)^{2/3} \times (.19)$$

$$38.51 = 8.92\,(2d + 1.5d^2) \times (2d + 1.5d^2/2 + 361d)^{2/3}$$

$$4.32 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 361d)^{2/3}$$

Table d

d	Q
1.31	4.37

B Determine Velocity

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

$$V = 1.486/.032 \; (.77)^{2/3} \; (.0369)^{1/2}$$

$$= 46.44 \times .84 \times .19$$

$$= 7.30 \text{ FPS}$$

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

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 Mining Water Diversion Design Manual

$= 0.0395\ (3/12)^{1/6}$

$= .031$

b) Charts in Appendix C C-5

$Q_n = Q_n$

$= 38.81\ (.031)$ Surface Mining Water Diversion Design Manual

$= 1.207$

$V_n = .13$

$V = V_n/n$

$= .13/.031$

$= 4.194$ @ $d = 12$ FT

c) $V^2/R^{33} = (4.199)^2/(.77)^3 = 19.17$

Table 6.4 page 6.39 does not go below 20 FPS Surface Mining Water Diversion Design Manual

Assume 6 in will work

d) Check Froude Number

$F_R = V/\sqrt{gL}$ L - 1.4 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
$.50\ D_{50}$	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

$D_{15}(\text{RIPRAP}) / D_{85}(\text{BASE}) < 5$

$1.8/.09 = 20 < 5$

$D_{15}(\text{RIPRAP}) / D_{15}(\text{BASE}) < 40$

$1.8/.006 = 300 < 40$

FILTER CRITERIA ARE EXCEEDED, A FILTER LAYER IS REQUIRED.

2. 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 $D_{15}(\text{FILTER}) < 40 \times .006 = .24$

$D_{15}(\text{FILTER}) / D_{85}(\text{BASE}) < 5$

SO $D_{15} < 5 \times .09 > .45$ IN

D_{15} (FILTER) / D_{15} (BASE) > 5

so D_{15} (FILTER) > 5 × .006 = .03 in

.03in < D_{15} (FILTER) < .45in

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) > 1.13in/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

.03in < D_{15} (FILTER) < .23 in

D_{50} (FILTER) > .15 in

D_{85} (FILTER) > .23 in

4. THICKNESS OF FILTER BLANKET [2]

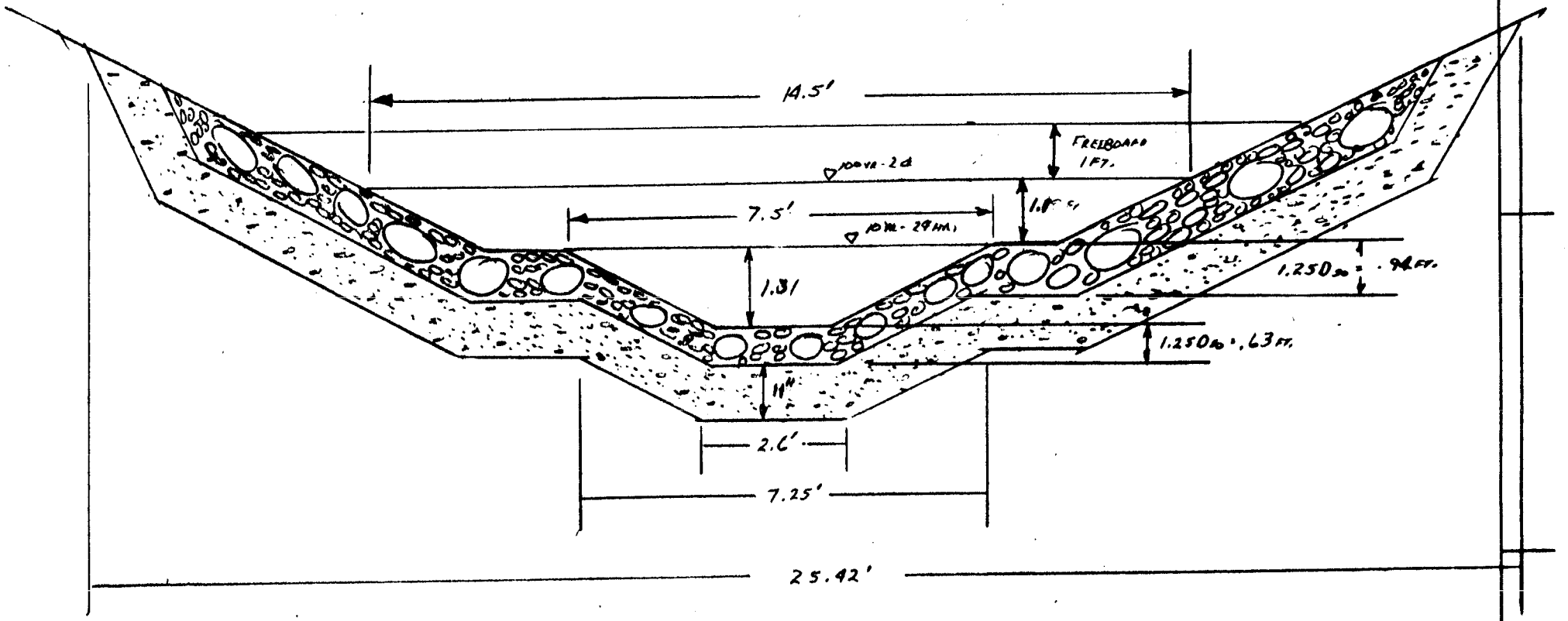
THICKNESS = MAX D_{50} = .94 FT.

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

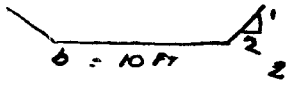
$Q = 125.75 + 3.30 + .85 - 34.64 = 95.26$ CFS
SECTION 2, VOL. 5 PAGE 7

DESIGN CHANNEL TO BE A TRAPEZOID

I DETERMINE DEPTH OF FLOW

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

n = .032 EARTH BOTTOM WITH RUBBLE SIDES
S = .0452 - DESIGN SLOPE MAP 4.9.2-181



$A = bd + Zd^2$
$R = bd + Zd^2 / b + 2d\sqrt{Z^2+1}$
$Q = 95.26$ CFS

$Q = bd + 2d^2 \times 1.49/n \times \left(bd + 2d^2/b + 2d\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$
$= 10d + 2d^2 \times 1.49/.032 \times \left(10d + 2d^2/10 + 2d\sqrt{2^2+1}\right)^{2/3} \times (.0452)^{1/2}$
$= 10d + 2d^2 \times 46.44 \times \left(10d + 2d^2/10 + d(4.47)\right)^{2/3} \times (.21)$

$95.26 = 9.87 (10d + 2d^2)\left(10d + 2d^2/10 + d(4.47)\right)^{2/3}$

$9.65 = (10d + 2d^2)\left(10d + 2d^2/10 + d(4.47)\right)^{2/3}$

TRAIL d

d (FT)	Q CFS
.9	8.82
.95	9.68

USE d = .95 FT.

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 DETERMINE VELOCITY

$b = 10$ FT
$d = .95$ FT
$n = .032$
$S = .0452$

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

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

$= 10(.95) + 2(.95)^2/10 + 2(.95)\sqrt{(2)^2+1}$

$= 11.31/14.25$

$= .79$

$V = 1.486/.032 \times (.79)^{2/3} \times (.0452)^{1/2}$

$= 46.44 \times .86 \times .21$

$= 8.49$ 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 $D_{50} = K_m$

$n = 0.0395\ D_{50}^{1/6}$ Eq 4.18 PAGE 4.10 SURFACE
$= 0.0395\ (9/12)^{1/6}$ MINING WATER DIVERSION
$= .038$ 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

$V_n = .31$

$V = V_n/n$

$V = .31/.038$

$V = 8.36$ FPS

$d = .95$ FT

3. $V^2/R^{.33} = (8.16)^2/(.79)^{.33} = 11.97$

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

$= 8.16/\sqrt{32.2(.95)}$

$= 1.48$ 71

5. RIPRAP SIZE - STEEP SLOPE

DESIGN - 95.26 cfs SLOPE = .045 BOTTOM 10 FT

USE FIG. 5.5 PAGE 5.18 SINCE THERE IS NO CURVE FOR S=.045 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 %
$.20 D_{50}$	.15 FT	10 %

6. DESIGN FILTER BLANKET

ASSUME BASE MATERIAL

$D_{85} = .091$ 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

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

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 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 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_{85} (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 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) > 1.7/40 = .04 IN

$D_{15}(\text{RIPRAP}) / D_{85}(\text{FILTER}) < 5$

so $D_{85}(\text{FILTER}) < 1.7/5 = .34$ in

$D_{15}(\text{RIPRAP}) / D_{15}(\text{FILTER}) > 5$

so $D_{15}(\text{FILTER}) < 27/5 = .39$ in

$.04 < D_{15}(\text{FILTER}) < .34$ in

$D_{50}(\text{FILTER}) > .23$ in

$D_{85}(\text{FILTER}) > .39$ 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

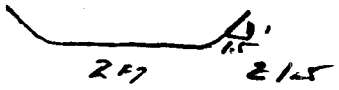
II Summer Flow Ditch Design

Design Flow Q_{10-20} = MB + UDA-2 + UDA-3 + SMB

Q = 33.09 + 1.31 + .24 = 34.64 cfs

Section 7, 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

$A = bd + Zd^2$
$R = bd + Zd^2/b + 2d\sqrt{Z^2+1}$

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

$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 2d^2/2 + 2d\sqrt{2^2+1})^{2/3} \times (.0452)^{1/2}$

$34.64 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + 2d\sqrt{(1.5)^2+1})^{2/3} \times .21$

$39.64 = 9.81\,(2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$3.51 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

Trial 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 - MILO SLOPE

a) ASSUME K_M = 6 in $K_M = D_{50}$

$n = .0395\ D_{50}^{1/6}$ EQ 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= .0395\ (6/12)^{1/6}$

$= .035$

b) CHARTS IN APPENDIX C C-5 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q\,n$

$= 34.64\ (.035)$

$= 1.22$ CFS

$V_n = .25$

$V_1 = V_n/n$

$V = .25/.035 = 7.14$ @ 1.19' DEEP

c) $V^2/R^{.33} = (7.14)^2/(.71)^{.33} = 37.13$

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 1.19 EQ 4.6 PAGE 4.14 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
$.20\ D_{50}$	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

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

$D_{15}(\text{RIPRAP}) / D_{85}(\text{BASE}) < 5$

$1.13/.09 = 20 < 5$

$D_{15}(\text{RIPRAP}) / D_{15}(\text{BASE}) < 40$

$1.13/.006 = 300 < 40$

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

$D_{50}(\text{FILTER}) / D_{50}\ \text{BASE} < 40$

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 $D_{85}(\text{FILTER}) < 5 \times .09 = .45$ 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 5.11 Surface Mining Water Diversion Design Manual
D_{50} (Riprap) / D_{50} (Filter) < 40

so D_{50} (Filter) > 4/40 = .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 2) < 5

so D_{15} (Filter) < 1.13/5 = .23 in.

.03 in < D_{15} (Filter) < .22 in

D_{50} (Filter) > .15 in

D_{85} (Filter) > .22 in.

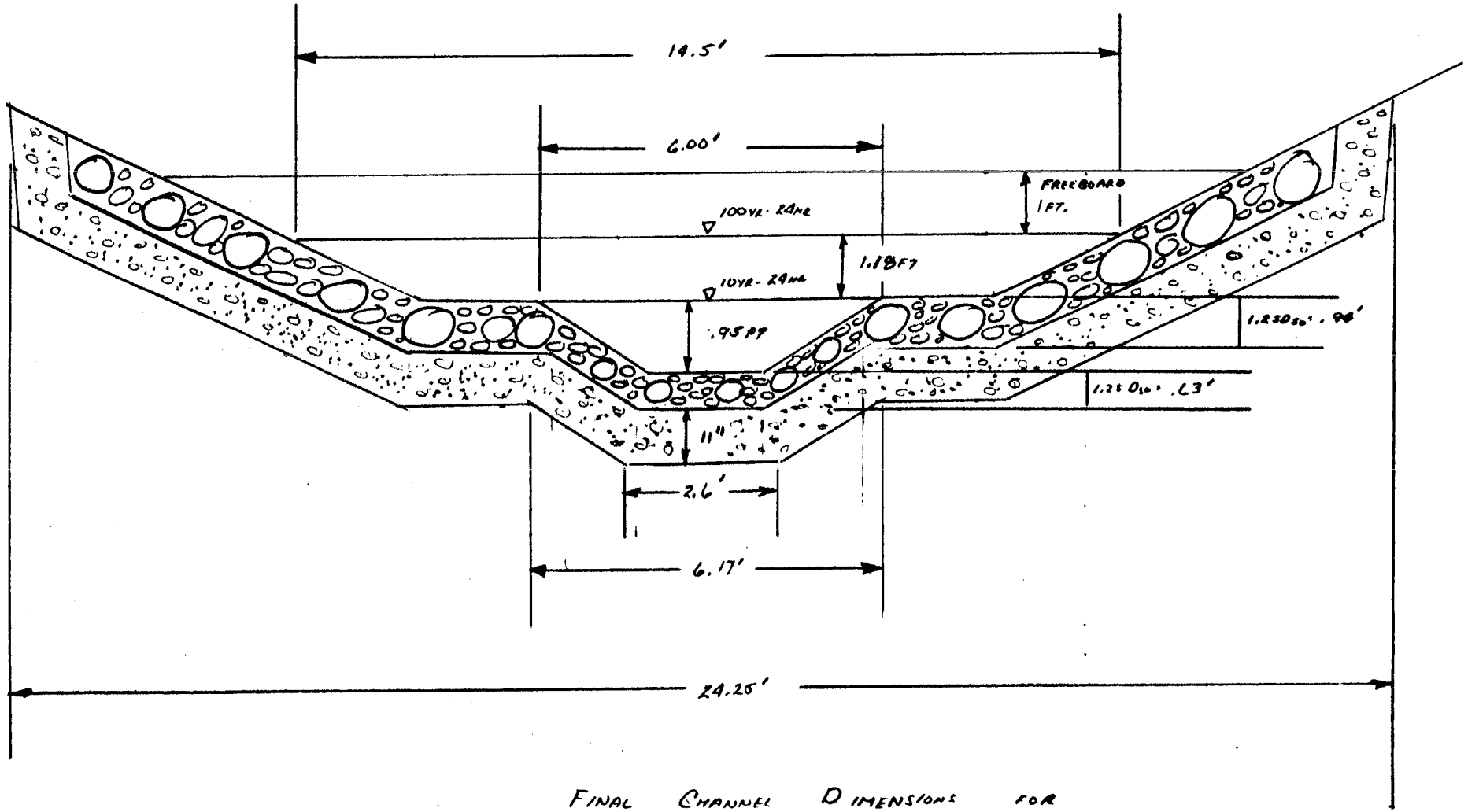
4. Thickness of Filter Blanket.[2]
Thickness = Max D_{50} = .94

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 1/10 TO 3/10

RECLAIM CHANNEL DESIGN
STREAM C

MAP 32.4-2

INITIAL SLOPE = .0643

DESIGN FLOOD PLAIN FOR THE Q_{100-24} = NB + UDA-1 - SUMMED FLOW

$Q = 127.80 + 12.76 - 52.86 = 87.40$ CFS

SECTION 2, VOL. 5 PAGE 7

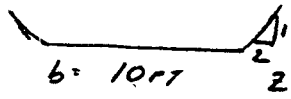
DESIGN CHANNEL TO BE A TRAPEZOID

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



$A = bd + Zd^2$

$R = bd + Zd^2 / b + 2d\sqrt{Z^2+1}$

$Q = 87.40$

$Q = bd + Zd^2 \times 1.986/n \times \left(bd + 2d^2/b + 2d\sqrt{Z^2+1}\right)^{2/3} \times S^{1/2}$

$Q_1 = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{2^2+1})^{2/3} \times (.0643)^{1/2}$

$Q = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .25$

$87.4 = 11.6 (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

$7.43 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRAIL d

d	Q
.8	7.19
.82	7.50

USE $d = .82$ FT.

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

II Determine Velocity

$V = 1.49 R^{2/3} S^{1/2} / n$

$b = 10$ ft
$d = .82$
$n = .032$
$S = .0143$

$R = bd + 2d^2/b + 2d\sqrt{2^2+1}$
$= 10(.82) + 2(.82)^2/10 + 2(.82)\sqrt{2^2+1}$
$= 9.54 / 13.67$
$= .70$

$V = 1.49/.032 \times (.70)^{2/3} \times (.0143)^{1/2}$

$= 46.44 \times (.79) \times .25$

$= 9.26$ fps

Stream will need riprap

III Determine Riprap Size and Filter Blanket

a) Riprap Size - Mild Slope

1 Assume $K_M = 9$ in $K_M = D_{50}$

$n = .0395 D_{50}^{1/6}$ Eq 4.18 page 4-10 Surface Mining Water Diversion Design Manual
$= .0395 (9/12)^{1/6}$
$= .038$

2. Charts in Appendix C page C-5 Surface Mining Water Diversion Design Manual

$Q_n = Q_n$
$= (87.40)(.039)$
$= 3.32$

$V_n = .18$

$V = V_n/n$

$= .70/.038$

$= 2.63$ fps

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

3. $V^2/R^{.33} = \frac{(9.26)^2}{(.70)^{.33}} = 96.46$

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 L, $K_m = 10$. SURFACE MINING WATER DIVERSION DESIGN MANUAL

4. CHECK FROUDE NUMBER

$Fr = V/\sqrt{gL}$ L = 97' EQ 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 9.26/\sqrt{(32.3)(1.97)}$

$= 1.0071$

RIPRAP GRADATION

	SIZE	%
$1.25\ D_{50}$	22.5" IN	30
D_{50}	18 IN	50
$.5\ D_{50}$	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.

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

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} (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.

.03IN < 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} > 18/40 = .45 IN

D_{15} (RIPRAP)/D_{15} (FILTER) < 40

SO, D_{15} (FILTER) > 33/40 = .08 IN

D_{15} (RIPRAP)/D_{85} (FILTER) < 5

SO, D_{85} (FILTER) > 3.3/5 = .66 IN

D_{15} (RIPRAP)/D_{15} (FILTER) > 5

D_{15} < 3.3/5 = .66 IN.

.08 < D_{15} (FILTER) < .66 IN

D_{50} (FILTER) > .45 IN

D_{85} > .66 IN.

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

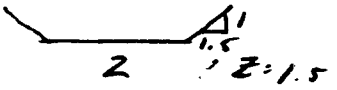
II Summer Flow Ditch Design

Design Flow Q_{10-2} = NB + UDA-1

$Q = 47.98 + 4.88 = 52.86$

Section 2, Vol. 5 Page 7

A. Determine Depth of Flow



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

$A = bd + Zd^2$

$R = bd + 2d^2/b + 2d\sqrt{Z^2+1}$

$S = .0143$

$n = .032$

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

$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 1.5d^2/2 + 2d\sqrt{1.5^2+1})^{2/3} \times (.0143)^{1/2}$

$52.86 = 2d + 1.5d^2 \times 46.44 \times 2d + 1.5d^2/2 + 3.61d)^{2/3} \times .25$

$52.86 = 11.61 (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$4.55 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

d (ft)	Trial d Q
1.33	4.50

B Determine Velocity

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

$$= 1.486/.032 \times (.78)^{2/3} \times (.0143)^{1/2}$$

$$= 46.44 \times .85 \times .25$$

$$= 9.96 \text{ FPS}$$

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

C. DETERMINE RIPRAP SIZE

1. RIPRAP SIZE - MILO SLOPE

a) ASSUME $K_m = 6$ in $K_m = D_{50}$

$n = .0395\ D_{50}^{1/6}$
$= .0395\ (6/12)^{1/6}$
$= .035$

Eq 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL

b) CHARTS IN APPENDIX C C-1 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$Q_n = Q\ n$
$= (52.86)(.035)$
$= 1.86$ cfs

$V_n = .34$

$V = V_n / n$
$= .34 / .035$
$= 9.14$ fps

$C = V^2 / R^{.33} = (9.92)^2 / (.72)^{.33} = 108.11$

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

$= 9.92 / 2.33$

$= 1.58 > 1$

$D_{50} = 6$ 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

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} = 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 × .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) < .45 IN

D_{50} (FILTER) < .96 IN.

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

3) FILTER BLANKET WITH RESPECT TO RIPRAP MATERIAL
EQ 5.1 PAGE 5.11 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) > $^{1.8}/_{40}$ = .05 in.

D_{15} (RIPRAP) / D_{85} (FILTER) < 5

so, D_{85} (FILTER) > $^{1.8}/_{5}$ = .36 in.

D_{15} (RIPRAP) / D_{15} (FILTER) > 5

so D_{15} (FILTER) < $^{1.8}/_{5}$ = .36 in

.05 in < D_{15} (FILTER) < .36 in.

D_{50} (FILTER) > .23 in

D_{85} > .36 in.

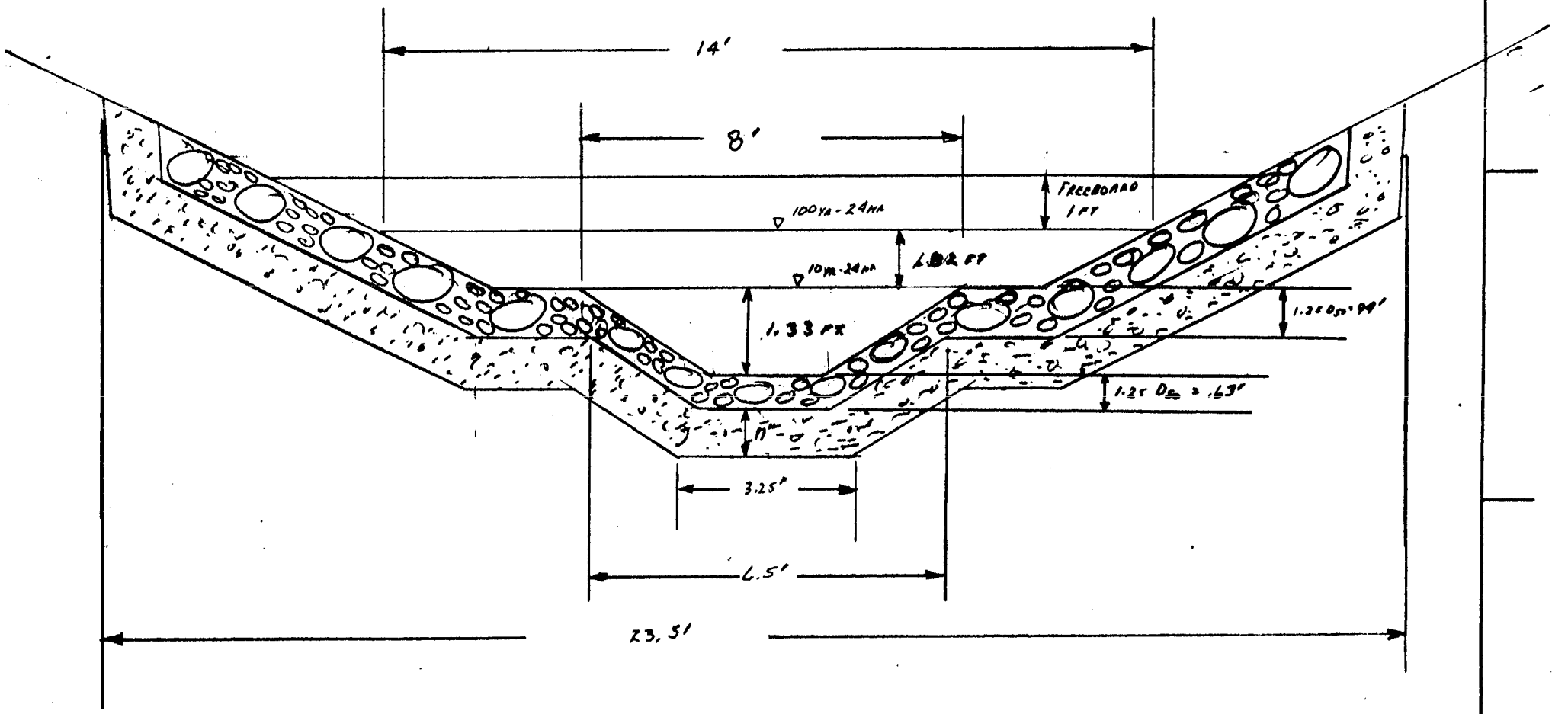
4 THICKNESS OF FILTER BLANKET. [6]
THICKNESS = MAX D_{50} = .94 ft

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 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 + UDAT - SUMMER FLOW

$Q = 127.80 + 12.46 - 52.86 = 87.40$ CFS

DESIGN CHANNEL TO BE A TRAPEZOID

I DETERMINE DEPTH OF FLOW

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

$n = .032$ EARTH BOTTOM WITH RUBBLE SIDE
$S = .1506$ MAP 4.9.2-181

$A = bd + zd^2$
$R = bd + zd^2 / b + 2d\sqrt{z^2+1}$ PAGE 158

$b = 10$ FT $z = 2$

APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HARN

$Q = 87.40$

$Q = bd + zd^2 \times \frac{1.486}{n} \times (bd + 2d^2/b + 2d\sqrt{z^2+1})^{2/3} \times S^{1/2}$
$= 10d + 2d^2 \times \frac{1.486}{.032} \times (10d + 2d^2/10 + 2d\sqrt{2^2+1})^{2/3} \times (.1506)^{1/2}$
$87.40 = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .39$

$4.85 = 10d + 2d^2 \times (10d + 2d^2/10 + 4.47d)^{2/3}$

TRAIL d

d	Q
.6	4.39
.64	4.90

USE $d = .64$

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

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

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

b) 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_{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 512 (SURFACE MINING WATER DIVERSION DESIGN MANUAL - U. S. DEPT. OF THE INTERIOR - OFFICE OF SURFACE MINING)

$D_{50}(\text{FILTER}) / D_{50}(\text{BASE}) < 40$

SO, $D_{50}(\text{FILTER}) < 40 \times .029\text{IN} = .96\text{IN}$

$D_{15}(\text{FILTER}) / D_{15}(\text{BASE}) < 40$

SO, $D_{15}(\text{FILTER}) < 40 \times .006\text{IN} = .24\text{IN}.$

$D_{15}(\text{FILTER}) / D_{85}(\text{BASE}) < 5$

SO, $D_{15}(\text{FILTER}) < 5 \times .09 = .45\text{IN}$

$D_{15}(\text{FILTER}) / D_{15}(\text{BASE}) > 5$

SO $D_{15}(\text{FILTER}) > 5 \times .006 = .03\text{IN}.$

$.03\text{IN} < D_{15}(\text{FILTER}) < .45\text{IN}.$

$D_{50} < .96\text{IN}.$

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

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.

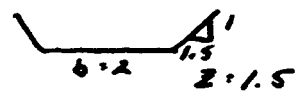
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

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 158 Applied $S = .1506$

$R = bd + zd^2/b + 2d\sqrt{z^2+1}$ Hydrology and Sedimentology $n = .032$ Earth Bottom for Disturbed Area - Barrier Wall 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 116 — 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 (FT)	%
$1.25 D_{50}$	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} = .629 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 5.11)

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) < .45 in

D_{50} (Filter) < .96 in

3) Filter Blanket with Respect to Riprap (Eq 5.2 page 5.11 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.

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

1) THICKNESS OF FILTER BLANKET
THICKNESS MAX D_{50} × 1.75

REFERENCE

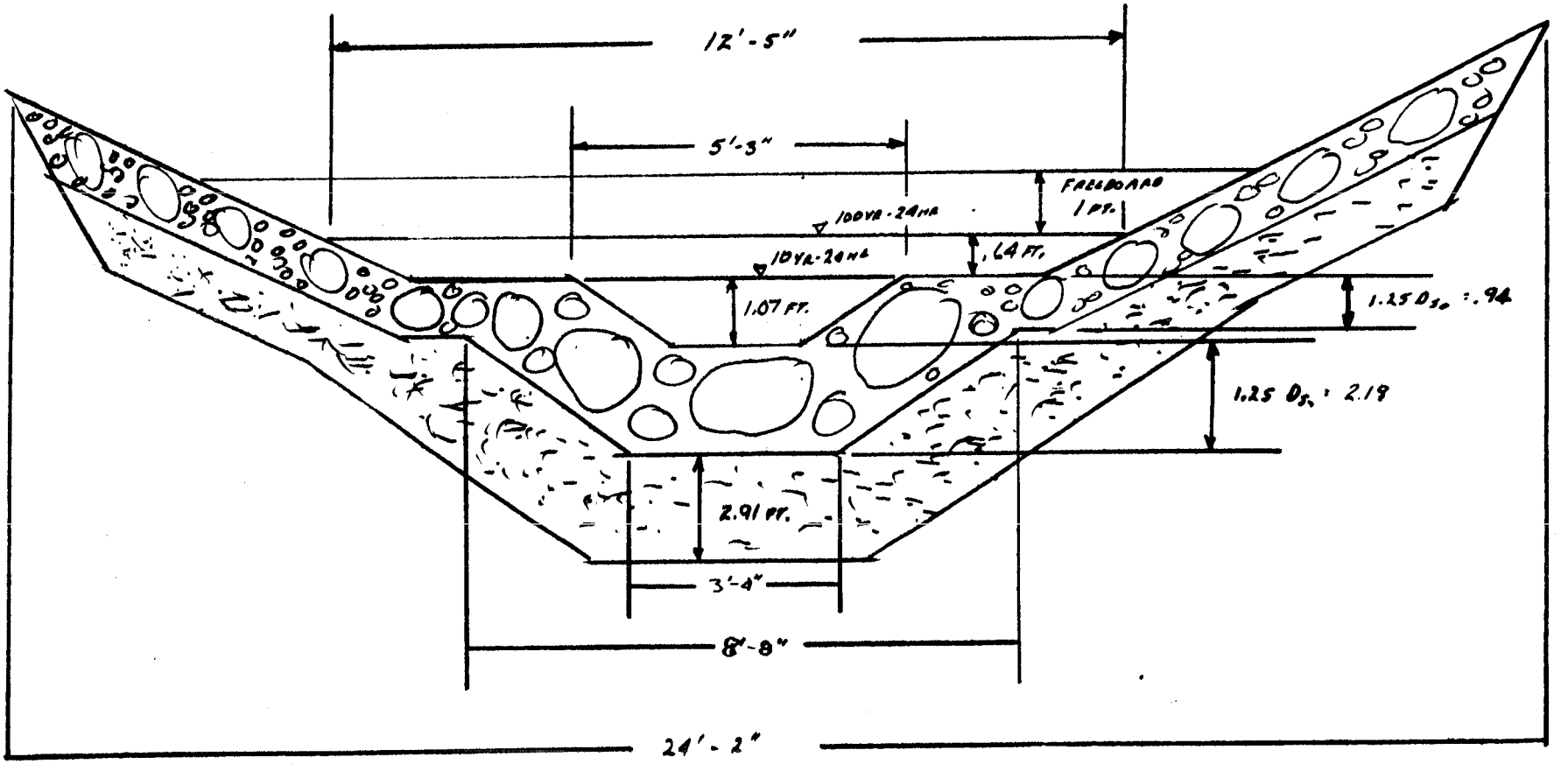
1) SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPT. OF THE INTERIOR
OFFICE OF SURFACE MINING

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_{100-24} = NB + MB + SB - Summed Flow

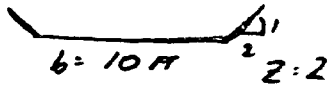
$Q = 149.51 + 129.90 + 140.62 - 126.01 = 294.02$

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN SECTION 1B, VOL. 5

DESIGN CHANNEL TO BE A TRAPEZOID

A. DETERMINE DEPTH FLOW

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



$A = bd + zd^2$

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

$Q = 294.02$ CFS

$n = .032$ EARTH BOTTOM

$S = .1667$ MAP 4.9.2-181

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

$Q = 10d + 2d^2 \times 1.486/.032 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times (.1667)^{1/2}$

$Q = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 2d\sqrt{(2)^2+1})^{2/3} \times .41$

$294.02 = 18.96 \times (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

$15.51 = (10d + 2d^2)(10d + 2d^2/10 + 4.47d)^{2/3}$

TRIAL d

d	Q	
1.2	14.56	.10
1.25	15.65	

USE $d = 1.25$ FT

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

B DETERMINE VELOCITY

$V = 1.49/n \times R^{2/3} S^{1/2}$

$n = .032$
$S = .1667$
$b = 10$ FT
$d = 1.25$ FT
$z = 2$

$R = bd + zd^2/b + 2d\sqrt{z^2+1}$
$= 10(1.25) + 2(1.25)^2/10 + 2(1.25)\sqrt{(2)^2+1}$
$= 15.62/15.58$
$= 1.00$

$V = 1.49/.032 \times (1.00)^{2/3} \times (.1667)^{1/2}$

$= 46.44 \times 1.00 \times .41$

$= 19.04$ 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

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

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

$D_{50}(\text{FILTER})/D_{50}(\text{BASE}) < 40$

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

$.03\text{in} < D_{15}(\text{FILTER}) < .24\text{in}$

$D_{50}(\text{FILTER}) < .96\text{in}$

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

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

.15IN < 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

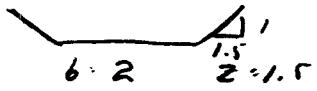
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

II Summer Flow Ditch Design

Design flow $Q_{10-24} = NB + MB + SB$

$Q = 34.64 + 38.51 + 52.86 = 126.01$

Q values determined from previous calculations in Section 17, Vol. 5



A. Determine depth of flow

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

$S_o = .1667$ MN 4.4.2-181

$n = .032$ earth bottom

$A = bd + zd^2$

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

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

$Q = 2d + 1.5d^2 \times 1.486/.032 \times (2d + 1.5d^2/2 + 2d\sqrt{1.5^2+1})^{2/3} \times (.1667)^{1/2}$

$126.01 = 2d + 1.5d^2 \times 46.44 \times (2d + 1.5d^2/2 + 3.61d)^{2/3} \times .41$

$126.01 = 18.96\,(2d + 1.5d^2)\,(2d + 1.5d^2/2 + 3.61d)^{2/3}$

$6.65 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$

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

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

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
$.8\ D_{50}$	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

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

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 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) < .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.

$.15 \text{ in} < D_{15} \text{ (Filter)} < 1.20$

$D_{50} \text{ (Filter)} > .81 \text{ in}$

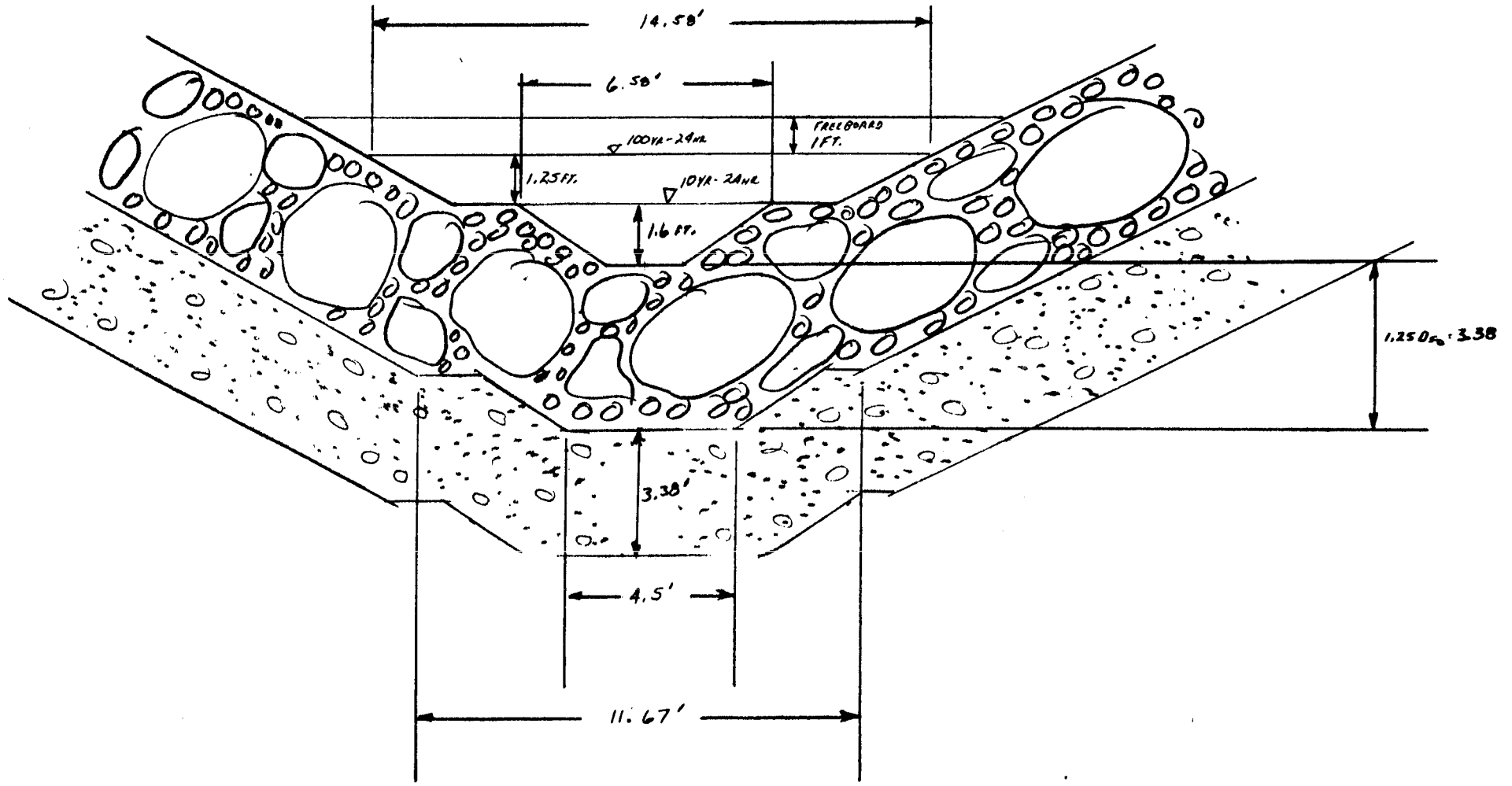
$D_{85} \text{ (Filter)} > 1.20 \text{ in}$

4) Thickness of Filter Blanket.[2]
Thickness = Max D_{50} · 3.30 ft

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

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



FINAL CHANNEL DIMENSION FOR
STREAM O

RECLAIM CHANNEL DESIGN
STREAM E

INITIAL SLOPE = .0396 (MAP

I. DESIGN FLOOD PLAIN FOR Q_{100-24} = NB + MB + SB

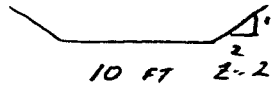
Q = 149.51 + 129.90 + 140.62 = 420.03 cfs - 126.01 (SUMMER FLOW)
= 294.02

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN THIS SECTION. IB, VOL. 5

DESIGN CHANNEL TO BE A TRAPEZOID

A. DETERMINE DEPTH OF FLOW

DRAWING NOTE



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

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

$n = .032$
$S = .0396$ MAP 4A.2-181

$$Q = bd + zd^2 \times \frac{1.486}{n} \times \left(bd + 2d^2/b + 2d\sqrt{z^2+1}\right)^{2/3} \times S^{1/2}$$
$$Q = 10d + 2d^2 \times \frac{1.486}{.032} \times \left(10d + 2d^2/10 + 2d\sqrt{(2)^2+1}\right) \times (.0396)^{1/2}$$
$$294.02 = 10d + 2d^2 \times 46.44 \times (10d + 2d^2/10 + 4.47d)^{2/3} \times .20$$
$$294.02 = 9.24\,(10d + 2d^2)(10d + 2d^2/10 + 9.47d)^{2/3}$$

$$31.82 = (10d + 2d^2)(10d + 2d^2/10 + 9.47d)^{2/3}$$

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

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

B. Determine Velocity

$R = 1.39$
$S = .0396$
$n = .032$

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

$= 1.486/.032 \times (1.39)^{2/3} \times (.0396)^{1/2}$

$= 46.44 \times 1.247 \times .199$

$= 11.52$ 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. $V^2/R^{.33}$ (1) $= (9.62)^2/(1.89)^{.33} = 83.02$ $R = 1.39$

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

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

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 $D_{50} = 18\text{ in} = 1.5\text{ Ft.}$

$n = .0395\, D_{50}^{1/6}$

$= .0395\,(1.5)^{.17}$

$= .042$

2) CHECK FOR STABILITY

$\tau = \gamma d s$

$\gamma = 62.4$

$d = 2.6$

$s = .0396$

$\tau = 62.4\,(1.86)(.0396)$

$= 4.59\text{ lb/ft}^2$

$\eta_b = 2.1\,\tau/\gamma(S.G-1)\,D_{50}$ EQ 3.33 PAGE 198 (2) APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS BARFIELD AND HANN

$= 21(4.59)/62.4(2.36-1)\,1.5$ S.G 2.36

$= .76$

$SF = \cos\theta \tan\phi / \sin\theta * \eta_b \tan\phi$ EQ 3.28 PAGE 186

ϕ ANGLE OF RESPONSE FIGURE 3.14 PAGE 197 RIPRAP ROUND AND ANGULAR APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HANN

$\phi = 38°$

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 RESPOSE (DEG)	DEBT OF FLOW	TRACTIVE FORCE T	STABILITY FACTOR η_6	S.F.
1.5	.042	38	1.86	4.59	.76	1.23

USE 1.5FT = D_{50}

RIPRAP GRADATION

	SIZE (FT)	%
$2\,D_{50}$ =	3.0	30
D_{50} =	1.5	50
$.5\,D_{50}$ =	.75	10
$.2\,D_{50}$ =	.3	10

C) FILTER BLANKET DESIGN

ASSUME BASE MATERIAL (SCREEN ANALYSIS DONE)

D_{85} = .091N

D_{50} = .029IN

D_{15} = .006 N

RIPAR PROPERTIES

D_{85}	30.6 IN
D_{50}	18 IN
D_{15}	5.41 IN

a) BASED ON PASSED 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

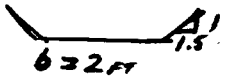
II SUMMER FLOW DITCH DESIGN

DESIGN FLOW Q_{10-24} = NB + MB + SB

$Q = 34.64 + 38.51 + 52.86 = 126.01$ CFS

Q VALUES DETERMINED FROM PREVIOUS CALCULATIONS IN SECTION 18, VOL. 5

A. DETERMINE DEPTH OF FLOW



$n = .032$
$S = .0396$

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

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

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

$$Q = 2d + 1.5d^2 \times \frac{1.486}{.032} \times \left(2d + 1.5d^2/2 + 2d\sqrt{1.5^2+1}\right)^{2/3} \times (.0396)^{1/2}$$

$$126.01 = 2d + 1.5d \times 46.44 \times 2d + 1.5d^2/2 + 3.61d)^{2/3} \times .20$$

$$126.01 = 9.24\,(2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$$

$$13.64 = (2d + 1.5d^2)(2d + 1.5d^2/2 + 3.61d)^{2/3}$$

TRIAL d

d	Q
2.2	12.97
2.3	14.30
2.25	13.63

USE $d = 2.25$ FT.

B. DETERMINE VELOCITY

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

$R = 1.20$
$S = .0396$
$n = .032$

$$= \frac{1.486}{.032} \times (1.20)^{2/3} \times (.0396)^{1/2}$$

$$= 46.44 \times 1.13 \times .20$$

$$= 10.49 \text{ FPS}$$

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
$= 4.98$

$V_m = .30$

$V = V_m/n$ (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
$= .0395\,(9/12)^{1/6}$ DIVERSION DESIGN MANUAL
$= .038$

b) CHARTS IN APPENDIX C PAGE C-1

SURFACE MINING WATER
$Q_n = Q_n$ DIVERSION DESIGN MANUAL
$= 126.01\,(.038)$
$= 4.79$

$V_m = .30$

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

$V = V_a / n$

$= .30 / .038$

$= 7.90$ 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 4.6 PAGE 4.19 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$= 7.90/\sqrt{(2.25)(32.2)}$

$= .92 < 1$

$D_{50} = 9$IN.

RIPRAR 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

$D_{BE} = .09$ IN

$D_{50} = .024$ IN

$D_{15} = .006$ 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

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

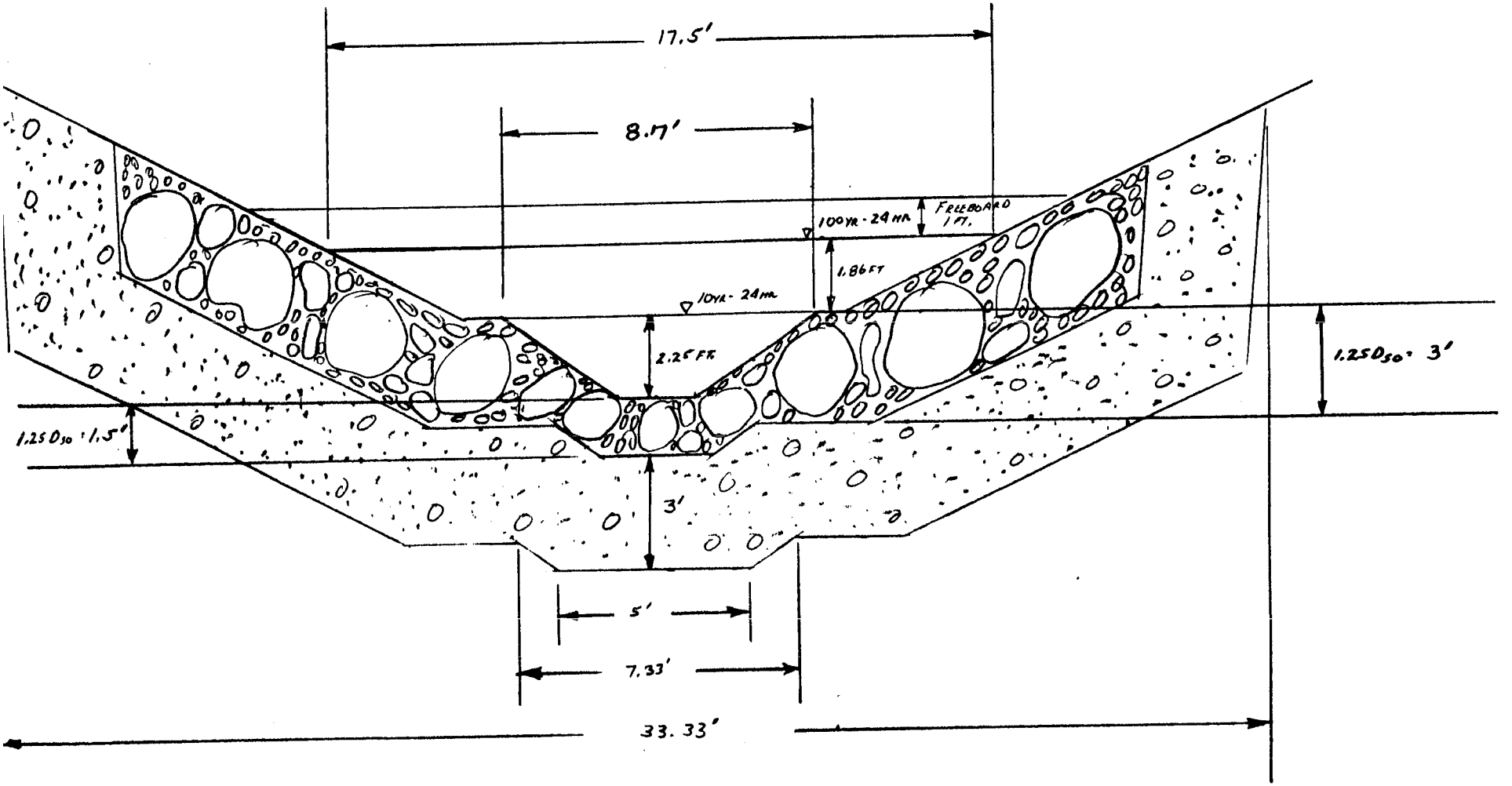
THICKNESS : MAY D_{50} = 3 FT,

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. HAAN, APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS, OKLAHOMA TECHNICAL PRESS, STILLWATER, OK

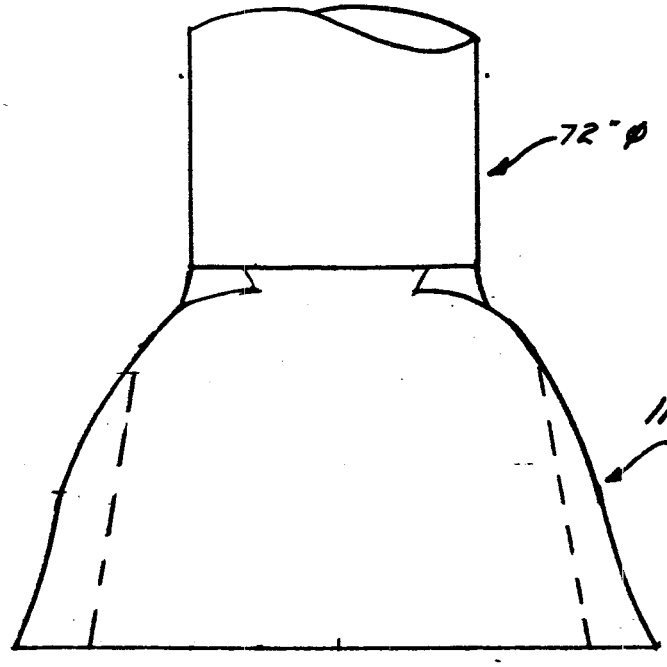
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

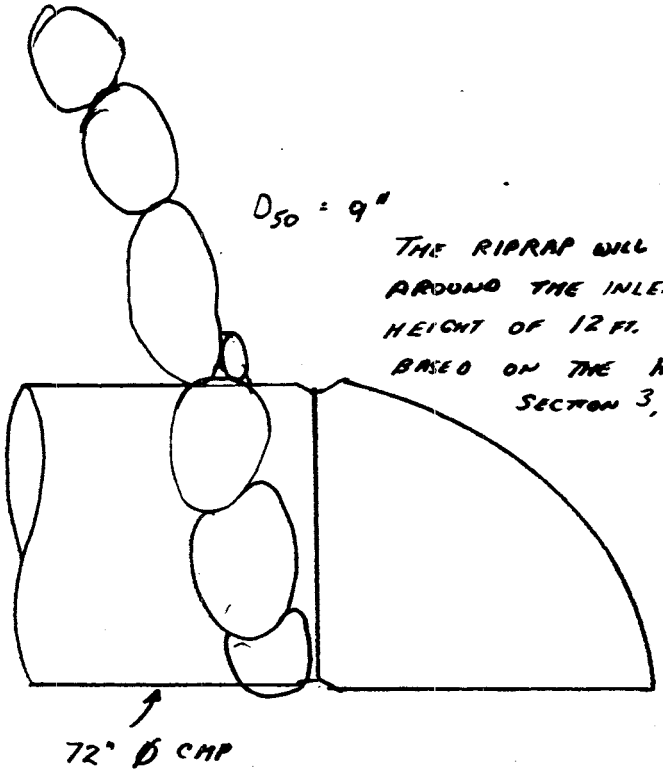
AMPAD
22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



FINAL CHANNEL DIMENSION FOR
STREAM E

72" Ø CMP Inlet Structure





THE RIPRAP WILL PLACED AROUND THE INLET FOR A HEIGHT OF 12 FT. THIS IS BASED ON THE HW IN SECTION 3, VOL. 5 PAGE 4

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	DOWNSTREAM CHANNEL
RIPRAP LINED	RIPRAP LINED
D_{50} = .75 FT.	D_{50} = 2.70
S = .045 MAP 4.4.2-181	S = .167 MAP 4.4.2-181
BASE WIDTH = 10 FT.	BASE WIDTH = 10 FT.

Q = 95.26 CFS

1) EVALUATE UPSTREAM CHANNEL SECTION PROPERTIES

$n = .0395\ D_{50}^{1/6}$
$= .0395\ (.75)^{.17}$ Eq. 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL
$= .0376$

$Q_n = Q\,n$
$= 95.26\ (.0376)$
$= 3.58$

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

$n = .0395\ D_{50}^{1/6}$
$= .0395\ (2.7)^{.17}$ Eq 4.18 PAGE 4.10 SURFACE MINING WATER DIVERSION DESIGN MANUAL
$= .0548$

$Q_n = Q\,n$
$= 95.26\ (.0548)$
$= 5.22$

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

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

3) COMPUTE CHANGE IN WATER SURFACE PROFILES

$\Delta W.S. = 1.15\ \Delta h$

$V_2 = 8.99$ FPS
$V_1 = 1.12$ FPS

$\Delta h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$

$= 1.15 \left(\frac{(8.99)^2}{2g} - \frac{(1.12)^2}{2g} \right)$

$= 1.15 (1.29 - .50)$

$= .76$ FT

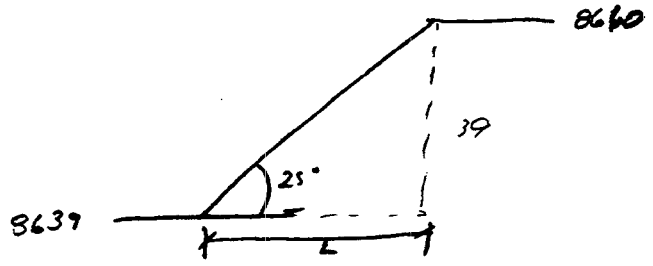
4) COMPUTE NECESSARY CHANGE

$\Delta B.E. = d_1 - d_2 + \Delta W.S.$

$= 1.13 - .95 + .76$

$= .94$ FT.

5.) COMPUTE LENGTH OF TRANSITION



$\text{TAN}\,\theta = \frac{8660 - 8639}{L}$

$\text{TAN}\,25° = \frac{21}{L}$

$= 98.07$ 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

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

$D_{MAX} = 1.25\ D_{50} = 1.25(2.5) = 3.13$ 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
$D_{50} = .024$ 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. 5.8 PAGE 5.12 SURFACE MINING WATER DIVERSION DESIGN MANUAL

$D_{50}(\text{FILTER})/D_{50}(\text{BASE}) < 40$

SO, $D_{50}(\text{FILTER}) < 40 \times .029 = .96$ 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 $D_{15}(\text{FILTER}) > 5 \times .006 = .03$

$.03\text{IN} < D_{15}(\text{FILTER}) < .45\text{IN}$,

$D_{50}(\text{FILTER}) < .96$ 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

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

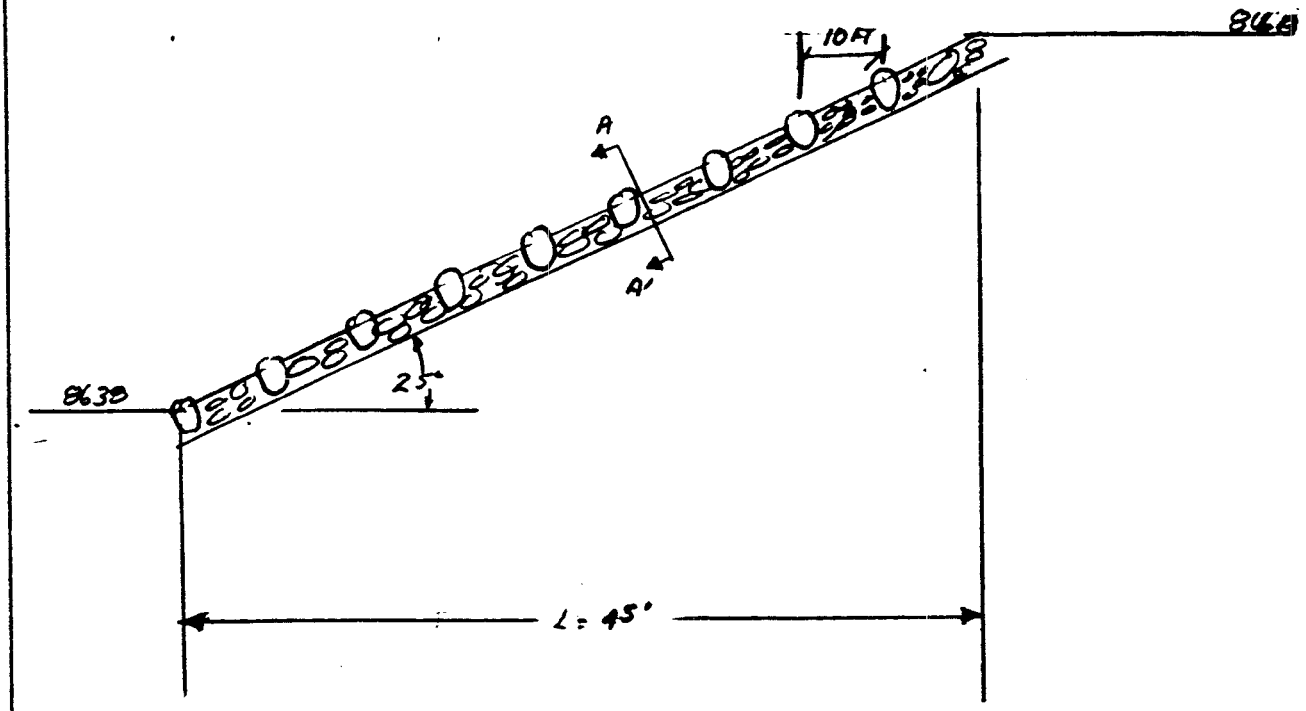
D_{85} (FILTER) > 1.12 IN.

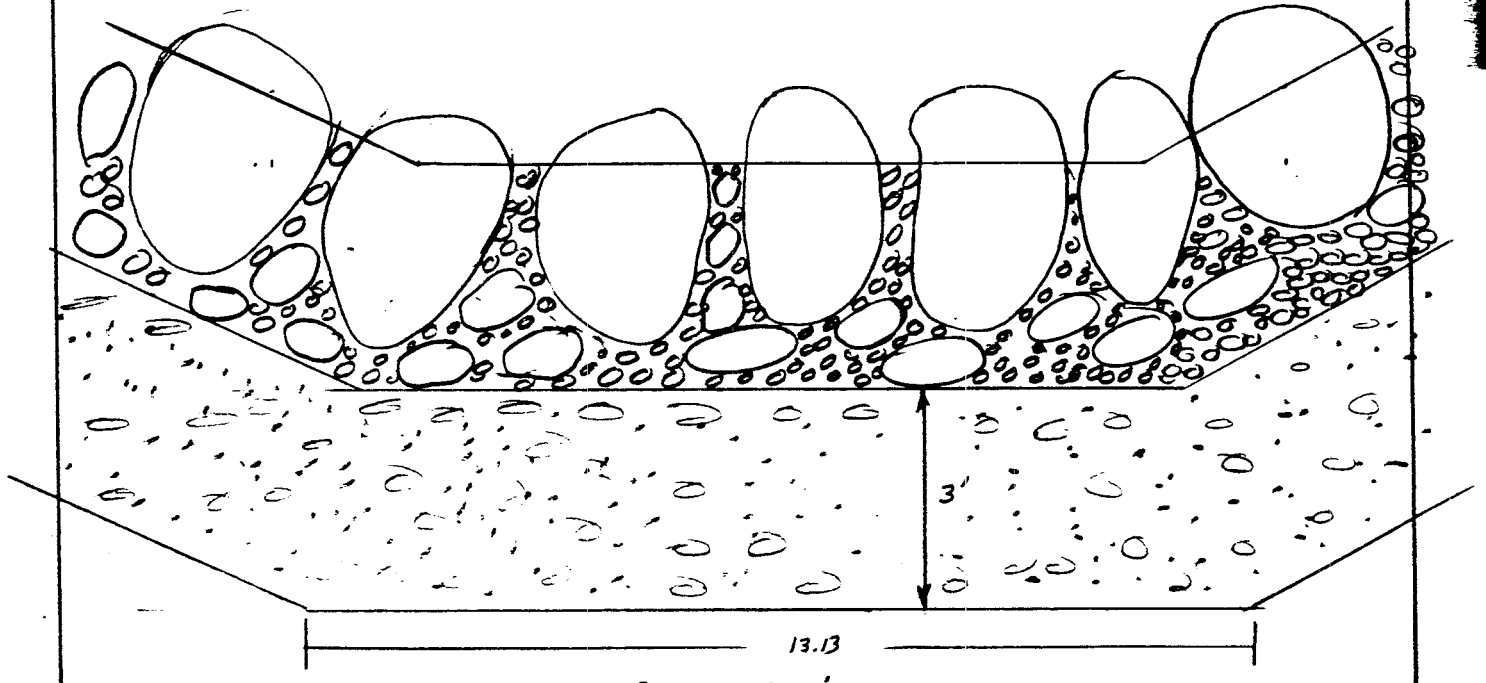
c) THICKNESS OF THE FILTER BLANKET.

THICKNESS = MAX D_{50} = 3.13'

REFERENCE: SURFACE MINING WATER DIVERSION DESIGN MANUAL UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF SURFACE MINING.

G. Taylor
Revised
11-9-89





Section A-A'

Final Channel Dimensions
For Transition Middle
'Branch to Stream'

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

TRANSITION DESIGN FOR NORTH BRANCH TO MAIN STREAM.

UPSTREAM CHANNEL	DOWNSTREAM CHANNEL
RIPRAP LINED	RIPRAP LINED
D_{50} = .75 FT	D_{50} = 2.7
S = .01 - MAP 4.4.2-181	S = .1667 MAP 4.4.2-181
BASE WIDTH = 10FT	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

$\Delta S.\omega = 1.15\,\Delta h \qquad \Delta h = V_2^2/2g - V_1^2/2g$

$= 1.15\left(V_2^2/2g - V_1^2/2g\right)$

$= 1.15\left[(12.37)^2/2g - (6.58)^2/2g\right]$

$= 1.15\,(2.38 - .67)$

$= 1.15\,(1.71)$

$= 1.96$ ft.

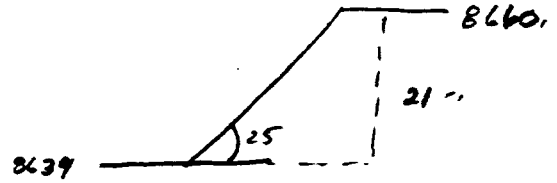
4) Compute necessary change

Δ B.E. $= d_2 - d_1 + \Delta$ W.S.

$= 1.07 - .85 + 1.96$

$= 2.18$ ft.

5) Compute length of transitation



$\tan\theta = \frac{8660 - 8639}{L}$

$\tan 25 = \frac{21}{L}$

$L = 45$ ft.

6) Design Ripap 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

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

$D_{MAX} = 1.25\ D_{50} = (1.25)(2.25) = 2.81$ FT

RIPRAP GRADATION

	SIZE (FT)	%
$1.25\ D_{50}$	2.81	30
D_{50}	2.25	50
$.5 D_{50}$	1.13	10
$.20_{50}$	.45	10

2) DESIGN FILTER BLANKET

ASSUME BASE MATERIAL

$D_{85} = .09$ IN
$D_{50} = .024$ IN
$D_{15} = .006$ IN

RIPRAP PROPERTIES

$D_{85} = 28.66$ IN
$D_{50} = 27$ IN
$D_{15} = 5.6$ 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 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) < .45 IN

D_{50} (FILTER) < .96 IN.

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

b) FILTER BLANKET WITH RESPECT TO RIPRAP
Eq X.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) 7.68 in

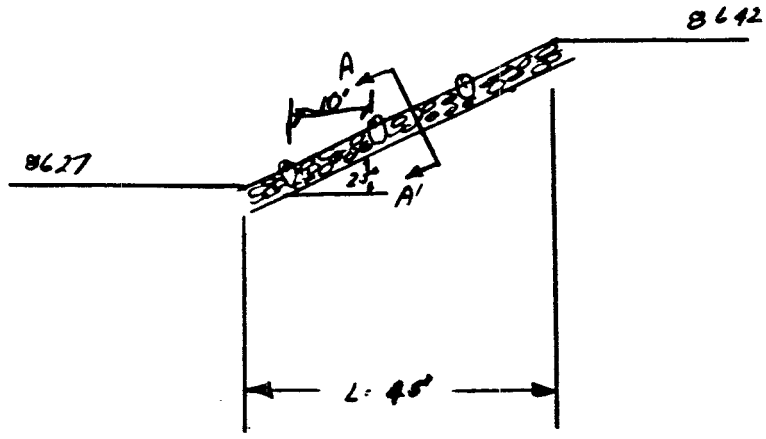
D_{85} (FILTER) > 1.01 in.

C) THICKNESS OF THE FILTER BLANKET
THICKNESS = MAX D_{50} = 2.81 c.

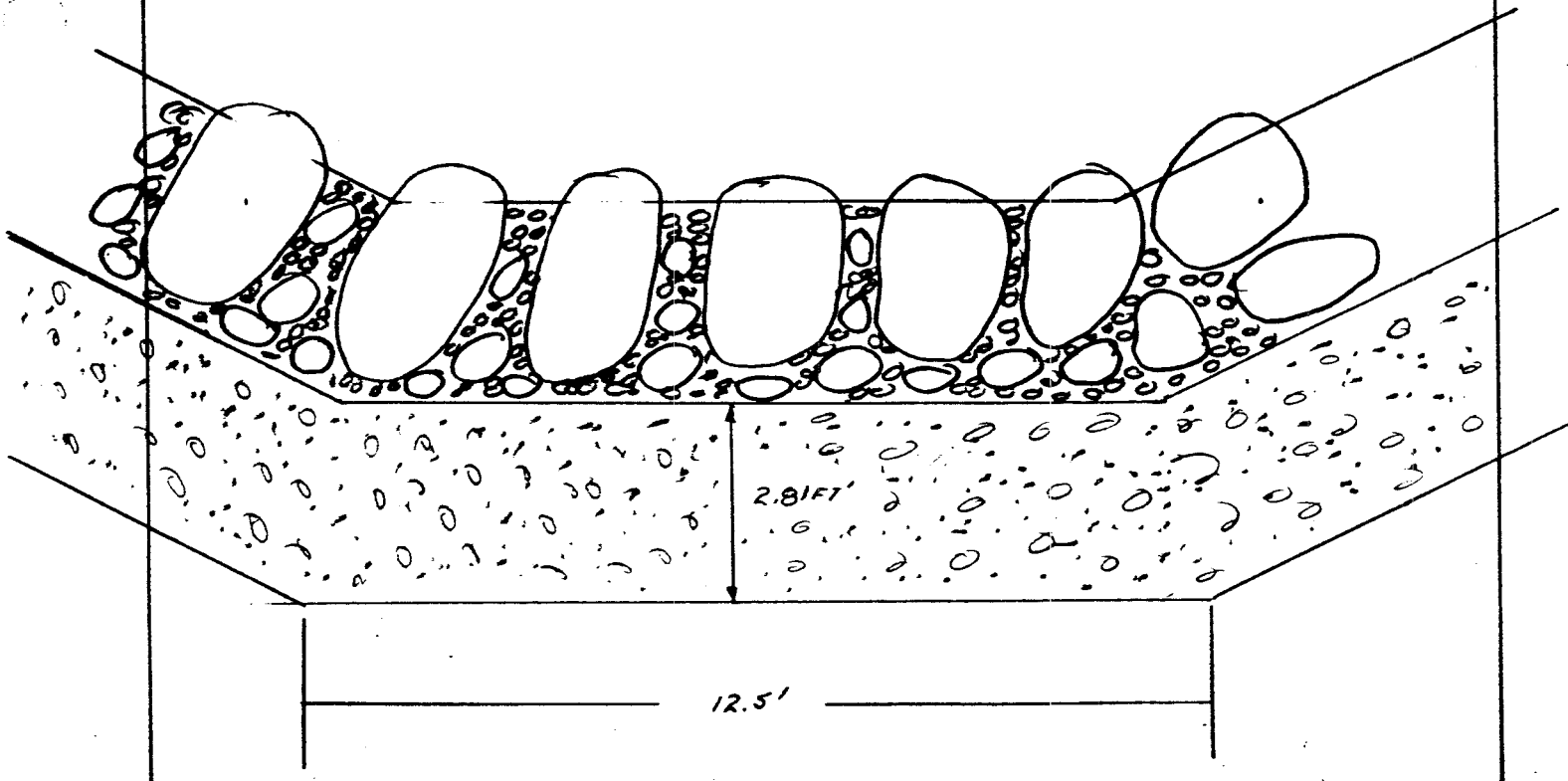
REFERENCE: · SURFACE MINING WATER DIVERSION DESIGN MANUAL
UNITED STATES DEPT. OF THE INTERIOR, OFFICE OF
SURFACE MINING.

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

G. TAYLOR
REVISED
11-9-89



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



SECTION A-A'

FINAL CHANNEL DIMENSIONS
FOR TRANSITION NORTH
BRANCH TO STREAM D

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	3) 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 HAAM
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 57

$S = 1000/CN - 10$ Eq. 2.39 PAGE 81 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HAAM

$= 1000/57 - 10$

$= 7.54$

AREA OF THE WATER SHED

PLANIMETER READING = 3,228

$443 \times .0199 \text{ in}^2 = 6.60 \text{ in}^2 \times 22.96 \text{ acre/in}^2 = 151.55 \text{ ACRES}$

$151.55 \text{ acres} \times 43,560 \text{ ft}^2/\text{acre} = \underline{6,601,609.26 \text{ ft}^2}$

151 acres

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

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

$t_c = 0.476$

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	-	3,720
1,400	-	8,800
2,300	-	8,280
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 MAAP

$18. = .6 (t_c)$

$t_c = 0.494$ HRS

PEAK FLOW USING SCS CURVE METHOD

EVENT	PEAK FLOW
2YR - 24 HR	71 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

2.64 of Tc = 0.494 hr w/ fronts 37°C ave 57 speed = 151

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

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 = 3FT
$= 1,500 lb/ft^2 \times 3/2$
$= 1,500 lb/ft^2 \times 1.5 ft$
$= 2,250 lb/ft$

4 ALLOWABLE WALL STRESS
FIG 3-6 $f_c = 22,500 lb/in^2$ PAGE 105 - HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS
FOR $2\frac{2}{3} \times \frac{1}{2}$ IN. CORROGATION

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 PAGE 107 HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCT

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 CFS USE 1 CFS 2 YR - 24 HR

SIZE OF CULVERT - FLAT SLOPE

$Q = 2.58\ D^{2.5}$

$D = (Q/2.58)^{1/2.5}$

$= (1\ CFS/2.58)^{.4}$

$= .684\ FT \times 12\ IN/FT$

$= 8.21\ IN.$

NEED A 12 IN CULVERT

USE A 18 IN. DIA. CULVERT

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

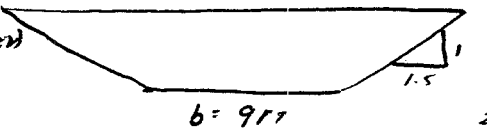
Channel Reconstruction

Trapezoidal Type Channel Design

$Q = 39.1$ cfs

$S = .143$ ft/ft (Field Survey)

$n = .04$



$Z = \frac{1.5}{1} = 1.5$

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

$$= \frac{1.49}{n} \left[\frac{bd + zd^2}{b + 2d\sqrt{z^2+1}}\right]^{2/3} S^{1/2} (bd + zd^2)$$

$$39.1 = \frac{1.49}{.04} \left[\frac{9d + 1.5d^2}{9 + 3.61d}\right]^{2/3} (.143)^{.5} (9d + 1.5d^2)$$

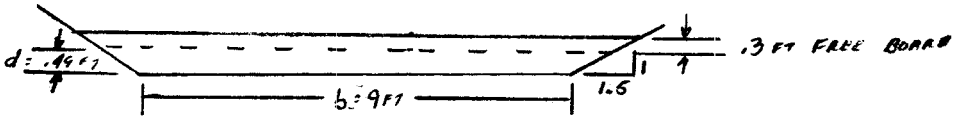
$$2.78 = \left[\frac{9d + 1.5d^2}{9 + 3.61d}\right]^{2/3} (9d + 1.5d^2)$$

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.



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

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

$R = \frac{bd + 2d^2}{b + 2d\sqrt{Z^2+1}} = \frac{9(.99) + 1.5(.99)^2}{9 + (.99)(2)\sqrt{1.5^2+1}} = \frac{9.77}{10.767} = .443$

$V = \frac{1.49}{.04} (.443)^{.66} (.143)^{.5}$

$= (37.25)(.568)(.38)$

$= 8.27$ FT/SEC.

STONE $D_{50} = 7.5in = .625$ FT.

CHECK n VALUE

$n = .0395\ D_{50}^{.17}$ Eq. 3.34 page 188 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA BARFIELD AND HAAN.

$= .0395 (.625)$

$= .036$

CHECK FOR STABILITY

$d = .49$ FT $S = 14.3$ $\gamma = 62.4$

$\tau = \gamma d s$

$= (62.4)(.49)(.143) = 4.372$ 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 HAAN

$n_b = \frac{21(4.372)}{(62.4)(2.36-1)(.63)}$

$= \frac{91.812}{53.464}$

$= 1.72$

SF MUST BE > 1

ϕ = 42° ANGULAR RIPRAP

14.3 % SLOPE

θ = 8°

$$SF_b = \frac{\cos\theta \tan\phi}{\sin\theta + n_b \tan\phi}$$

EQ 3.26 PAGE 186 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARRIERS AND HARP.

$$= \frac{(\cos 8°)(\tan 42°)}{(\sin 8°) + (1.72)(\tan 42°)}$$

$$= \frac{(.990)(.904)}{(.139) + 1.549}$$

$$= \frac{.896}{1.688}$$

= .529 UNDER DESIGNED RESIGN STREAM CHANNEL

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	.529
1.26	.041	42°	.49	4.372	.859	.982
1.6	.043	42°	.49	4.372	.676	1.192

D_{50} = 1.6 FT.

DETERMINE RIPRAP FOR BANK SF = 1.2

D_{50} = 1.6 FT , n_s = .043 , θ = 8°, d = .49 FT.

ASSUME

$\tau_{MAX} = .76\,\gamma\,d\,S$

$= .76\,(62.4)(.49)(.143) = 3.323\ lb/FT^2$

$n = (21)(\tau_{max}) / \gamma\,(SG-1)\,D_{50}$ EQ 3.37 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HANN

$= (21)(3.326) / 62.4\,(2.36-1)\,1.6$

$= 69.783 / 135.782$

$= .514$

ASSUME UNIFORM FLOW

$\lambda = \theta = 8°$

SIDE SLOPE

$\alpha = \tan^{-1} 1/1.5$

$= 33.69°$

$\beta = \tan^{-1}\left[\cos\lambda / \frac{2\sin\alpha}{n\tan\beta} + \sin\lambda\right]$ EQ 3.36 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HANN

$= \tan^{-1}\left[.990 / 2(.555)/.514\,(.900) + .139\right]$

$= \tan^{-1}(.390)$

$= 21.32°$

$n' = n\left[\frac{1+\sin(\lambda+\beta)}{2}\right]$ EQ. 3.38 PAGE 190 APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREA - BARFIELD AND HANN

$= .514\left[\frac{1+\sin(8+21.32)}{2}\right]$

$= .514\left[1.819/2\right]$

$= .383$

Eq 3.35 page 190
Applied Hydrology and Sedimentology for Disturbed Area - Barfield and Hann

$$SF = \cos\alpha \tan\phi / n' \tan\phi + \sin\alpha \cos\beta$$

$$= \cos 33.69 \tan 42 / (.383)(\tan 42) + (\sin 33.69)(\cos 21.32)$$

$$= (.832)(.900) / .345 + (.555)(.932)$$

$$= .749 / .862$$

$$= .869$$

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
$2D_{50}$	3.2	100
$1D_{50}$	1.6	50
$.5D_{50}$	.8	20
$.2D_{50}$	.32	0

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

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 > $487.68/40$: 12.19 mm

(2) D_{15} (RIPRAP) / D_{15} FILTER > 5

D_{15} (FILTER) < $73.15\ mm/5$: 14.63 mm

PAGE 195 - APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS - BARFIELD AND HAAN

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

$39.1 = \frac{1.49}{.024} \left(\frac{.5765\,D}{1.9576}\right)^{.66} (.143) \frac{\pi D^2}{4}$

$39.1 = 62.09\,(.295\,D)^{.66}\,(143)(.785\,D^2)$

$39.1 = 9.877\,(.295D)^{.66}\,(.785\,D^2)$

$4.404 = (.295\,D)^{.66}\,(785\,D^2)$

D	Q
1 FT	.351
2 FT	2.317
3 FT	6.519
2.5 FT	4.01
2.6 FT	4.45

$D = 2.6$ FT $= TW$

CALCULATE APRON WIDTH

$W_A = D + La \quad (TW < .5D)$

$W_A = D + .4\,La \quad (TW \geq .5D)$

$TW = 2.6 > .5D = 1.50$

$Q = 39.1$ CFS $\quad D = 3$ FT $\quad d_{50} = .33$ FT. $\quad LA = 10$ FT

$W_A = D + .4\,LA$

$= 3\text{ FT} + .4\,(10)$

$= 3\text{ FT} + 4\text{ FT}$

$= 7\text{ FT}$

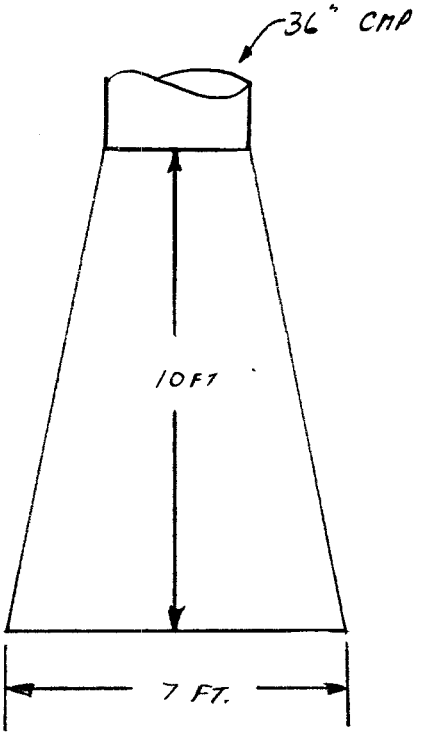
$d_{MAX} = 1.5 \times D_{50}$

$= 1.5 \times .33$

$= .50$ FT $= 6''$

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

ENERGY DISSIPATION



d_{50} = 9 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

CLIMATOLOGICAL DATA SUMMARY

YEAR 1984	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMPERATURE -F												
-MAX							79	78	73	60	52	45
-MIN							40	41	17	2	-5	-10
-AVE HIGH							72.0	70.6	60.8	41.6	36.2	28.6
-AVE LOW							46.0	44.9	33.9	20.8	14.5	9.1
PRECIPITATION												
-TOTAL							1.76	1.60	1.60	5.02	3.14	3.86
-NO DAYS 1 IN +							16	12	10	15	10	14
SNOW COVER												
-MAX DEPTH							0	0	2	14	24	43

YEAR 1985	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMPERATURE -F												
-MAX	43	46	48	63	68	79	85	81	77	63	57	45
-MIN	-24	-26	-13	5	20	29	38	31	19	21	-2	-16
-AVE HIGH	29.6	27.5	35.0	47.9	57.1	67.5	73.3	70.2	57.4	50.0	34.0	33.7
-AVE LOW	5.8	3.8	11.4	23.8	32.7	39.9	49.7	43.5	34.1	27.0	16.5	8.4
PRECIPITATION												
-TOTAL	1.20	1.35	2.85	1.91	1.34	1.27	4.53	0.00	2.55	2.54	5.63	1.82
-NO DAYS 1 IN +	9	12	14	8	8	5	14	0	7	8	16	8
SNOW COVER												
-MAX DEPTH	41	51	57	47	4	0	0	0	0	4	38	888

YEAR 1986	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TEMPERATURE -F												
-MAX	51	52	57	59	71	81	80	80	74	62	59	44
-MIN	-7	-14	10	6	13	22	39	40	19	12	0	-8
-AVE HIGH	40.4	34.1	44.8	44.3	53.6	72.1	71.8	71.9	59.9	51.2	40.4	35.0
-AVE LOW	13.2	13.9	21.8	23.2	28.1	39.3	43.6	46.7	33.4	25.5	19.3	11.7
PRECIPITATION												
-TOTAL	1.65	8.73	2.88	2.56	2.77	0.15	0.92	1.29	2.38	1.62	1.71	0.32
-NO DAYS 1 IN +	6	15	12	12	9	3	10	6	11	9	11	4
SNOW COVER												
-MAX DEPTH	38	79	57	31	4	0	0	0	5	4	13	6

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1
SAMPLE DATE	05/12/81	06/28/81	07/30/81	08/20/81	09/25/81	11/21/81	06/30/82	07/22/82	08/20/82	09/14/82
LOCATION	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.
LOCATION										
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	11	21.5	24	14	13	2	15	15	18	6
FLOW (CFS)	0.61	0.34	0.20	0.20	0.15	0.23	2.37	0.75	0.32	0.32
WATER TEMPERATURE (C)	5	11	13	9	7	0	8	8	9	3
SPEC. COND. (UMHOS/CM) FIELD	182	350	360	380	380	450	300	410	395	490
PH FIELD	8.0	7.9	8.3	7.4	7.9	8.0	8.2	8.3	8.4	8.6
TURBIDITY (NTU) FIELD							13	5.9	9.2	16
TOTAL SUSP. SOLIDS							10.0	2.0	10.0	1.0
TOTAL DISS. SOLIDS MEAS.							188	272	326	335
OXYGEN (O) DISS									8.2	
COMMON IONS										
CALCIUM (CA)							53.50	73.60	80.00	82.40
MAGNESIUM (MG)							9.10	13.44	27.36	28.32
SODIUM (NA)							1.9	13.0	2.6	3.0
POTASSIUM (K)							0.62	0.65	1.49	1.87
ACIDITY AS CACO3									4.00	
ALKALINITY AS CACO3 (LAB)								233	250	
BICARBONATE (HCO3) (LAB)							176	284	306	314
SULFATE (SO4)							28.0	30.0	39.0	60.0
CHLORIDE (CL)							0.60	5.10	19.20	5.60
FLUORIDE (F)									0.15	
NUTRIENTS										
NITRATE (NO3-N)									0.09	
AMMONIA (NH3 AS N)							0.23		0.33	
TOTAL PHOSPHATE (PO4)							0.050		0.050	
TRACE ELEMENTS										
BARIUM (BA) TOTAL									0.035	
BORON (B) TOTAL									0.025	
COPPER (CU) TOTAL									0.010	
IRON (FE) TOTAL							0.300	0.070	0.110	0.080
LEAD (PB) TOTAL									0.002	
MANGANESE (MN) TOTAL							0.010	0.005	0.010	0.010
ZINC (ZN) TOTAL									0.005	
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)									11.7	
PHENOLS							0.004		0.004	
OTHER PARAMETERS										
OIL AND GREASE							0.8		1.4	
CYANIDE (CN) TOTAL									0.008	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1	CS-1
SAMPLE DATE	06/30/83	07/20/83	08/25/83	09/29/83	10/27/83	11/11/83	06/28/84	07/30/84	08/27/84	09/18/84
LOCATION	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	7	14	14	11	0	3	20	3	21	10
FLOW (CFS)	3.85	1.22	0.47	0.38	0.14	0.18	1.69	0.93	0.42	0.31
WATER TEMPERATURE (C)	4	8	10	5	1	1	8	11	13	7
SPEC. COND. (UMHOS/CM) FIELD	313	440	551	578	559	529	327	572	704	622
PH FIELD	7.7	8.2	8.0	8.1	7.8	7.6	7.5	7.8	8.1	8.0
TURBIDITY (NTU) FIELD	13	8.0	3.3	8.5	11	13	22	24	15	20
TOTAL SUSP. SOLIDS	13.0	7.0	13.0	13.0	11.0	11.0	7.0	14.0	11.0	9.0
TOTAL DISS. SOLIDS MEAS.	204	268	295	290	340	380	360	480	475	422
OXYGEN (O) DISS			7.2						8.0	
COMMON IONS										
CALCIUM (CA)	52.00	66.40	64.00	75.00	76.80	81.60	84.00	83.20	92.00	94.00
MAGNESIUM (MG)	10.08	16.32	21.60	22.56	24.48	25.92	26.40	22.30	22.60	33.60
SODIUM (NA)	16.1	10.0	15.0	2.50	12.00	2.70	2.20	7.50	55.00	2.90
POTASSIUM (K)	0.74	1.1	0.8	1.6	1.2	1.6	1.0	3.00	2.45	2.47
ACIDITY AS CACO3			23.00						4.00	
ALKALINITY AS CACO3 (LAB)			210						250	
BICARBONATE (HCO3) (LAB)	217	254	256	266	271	288	219.6	298.9	305.0	311.1
SULFATE (SO4)	22.0	40	62	60	79	65	134	74	109	106
CHLORIDE (CL)	6.0	6.0	2.0	4.00	6.00	6.00	1.7	0.8	50.0	9.0
FLUORIDE (F)			0.09						0.27	
NUTRIENTS										
NITRATE (NO3-N)			<0.02						0.11	
AMMONIA (NH3 AS N)	<0.1		0.80		0.50		0.22		0.01	
TOTAL PHOSPHATE (PO4)	0.16		0.005		0.06		0.02		0.02	
TRACE ELEMENTS										
BARIUM (BA) TOTAL			0.032						0.04	
BORON (B) TOTAL			0.010						0.107	
COPPER (CU) TOTAL			<0.001						0.018	
IRON (FE) TOTAL	0.350	0.130	0.335	0.060	0.150	0.060	0.31	0.33	0.30	0.20
LEAD (PB) TOTAL			<0.001						<0.001	
MANGANESE (MN) TOTAL	0.013	0.012	0.010	0.010	0.015	0.010	0.02	0.12	0.02	0.01
ZINC (ZN) TOTAL			0.20							
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)			2.50						2.10	
PHENOLS	0.171		<0.001		0.110		<0.001		<0.001	
OTHER PARAMETERS										
OIL AND GREASE	1.4		<0.2		<0.2		0.8		<0.1	
CYANIDE (CN)			<0.001						<0.001	

All quantities in milligrams per liter unless otherwise noted. BlanK line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-1	CS-1
SAMPLE DATE	10/17/85	06/19/86
LOCATION	UPR S. FORK ECCLES CR.	UPR S. FORK ECCLES CR.
LOCATION		
PHYSICAL PARAMETERS		
AIR TEMPERATURE (C)	-2	18
FLOW (CFS)	0.27	3.61
WATER TEMPERATURE (C)	0.5	8
SPEC. COND. (UMHOS/CM) FIELD	609	383
PH FIELD	8.3	7.4
TURBIDITY (NTU) FIELD	3.1	4.8
TOTAL SUSP. SOLIDS	7.0	13.0
TOTAL DISS. SOLIDS MEAS.	370	212
COMMON IONS		
CALCIUM (CA)	88.80	56.00
MAGNESIUM (MG)	28.60	13.90
SODIUM (NA)	1.80	3.00
POTASSIUM (K)	2.28	0.66
BICARBONATE (HCO3) (LAB)	298.9	178.1
SULFATE (SO4)	98	24
CHLORIDE (CL)	3.1	1.8
NUTRIENTS		
AMMONIA (NH3 AS N)	<0.01	0.46
TOTAL PHOSPHATE (PO4)	0.06	0.25
TRACE ELEMENTS		
IRON (FE) TOTAL	<0.01	0.29
MANGANESE (MN) TOTAL	<0.01	<0.01
ORGANIC PARAMETERS		
PHENOLS	<0.001	<0.001
OTHER PARAMETERS		
OIL AND GREASE	0.4	1.6

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	01/27/81	03/11/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/23/81	11/11/81
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	-3	4	5	17	26	21	20	17	3	1
WATER TEMPERATURE (C)	2	2	1	5.2	8.5	9	9	8	5	5
SPEC. COND. (UMHOS/CM) FIELD	275	272	284	320	380	400	480	450	490	490
PH FIELD	7.8	7.7	7.6	8.3	7.8	7.8	7.6	7.9	7.4	7.2
TURBIDITY (NTU) FIELD				6.00			1.00			0.70
TOTAL SUSP. SOLIDS	7.0	52.0	1348	40.0	4.0	1.0	2.0	10.0	11.2	2.0
TOTAL DISS. SOLIDS MEAS.	295	290	290	212	250	265	310	296	320	319
OXYGEN (O) DISS				9.5	10.0	10.6	9.6	9.5	10.8	10.6
COMMON IONS										
TOTAL HARDNESS AS CACO3				188						
CALCIUM (CA)	86.40	74.40	79.20	68.00	71.20	23.20	82.40	78.40	19.20	83.50
MAGNESIUM (MG)	18.24	10.56	15.36	4.32	15.84	31.20	21.12	15.84	22.09	20.50
SODIUM (NA)	5.90	27.00	10.00	9.10	3.00	35.00	3.90	11.00	76.00	6.80
POTASSIUM (K)	1.60	1.38	1.53	1.01	1.29	1.39	1.51	1.30	2.54	2.25
ACIDITY AS CACO3				<0.01			9.00			6.00
ALKALINITY AS CACO3 (LAB)				196			258		289	252
BICARBONATE (HCO3) (LAB)	358.68	334.28	310	237	268	303	315	329	352	308
CARBONATE AS CO3 (LAB)				1.20						
SULFATE (SO4)	6.0	9.0	18.00	9.0	22.0	18.0	24.0	15.0	15.0	44.0
CHLORIDE (CL)	3.92	6.38	12.00	4.50	3.83	5.14	4.97	4.04	5.10	7.30
FLUORIDE (F)				0.19			0.19			0.18
NUTRIENTS										
NITRATE (NO3-N)				0.57			0.48			0.47
NITRITE (NO2-N)				0.01						
AMMONIA (NH3 AS N)	<0.01	<0.01	<0.01	<0.01	<0.01	0.20	<0.01	0.04	0.05	0.55
TOTAL PHOSPHATE (PO4)	0.080	0.060	1.200	0.290		0.150	0.180	0.882	0.830	0.290
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL				<0.001						
ARSENIC (AS) TOTAL				<0.001			<0.001			<0.001
ARSENIC (AS) DISS				<0.001			<0.001			<0.001
BARIUM (BA) TOTAL				0.026			0.050			0.050
BARIUM (BA) DISS				0.20			0.025			0.040
BORON (B) TOTAL				0.013			0.022			0.029
BORON (B) DISS				0.10						0.025
CADMIUM (CD) TOTAL				<0.001			<0.001			<0.001
CADMIUM (CD) DISS				<0.001			<0.001			<0.001
CHROMIUM (CR) TOTAL				<0.001			<0.001			0.002
CHROMIUM (CR) DISS				<0.001			<0.001			<0.001
COPPER (CU) TOTAL				<0.001			0.010			<0.001
COPPER (CU) DISS				<0.001			0.010			<0.001
IRON (FE) TOTAL	0.310	0.190	0.288	0.720	0.130	0.650	0.070	0.069	0.250	0.220

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	01/27/81	03/11/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/23/81	11/11/81
TRACE ELEMENTS										
LEAD (PB) TOTAL				0.002			<0.001			0.003
LEAD (PB) DISS				<0.001			<0.001			0.002
MANGANESE (MN) TOTAL	0.095	0.050	0.090	0.110	0.090	0.124	0.030	0.035	0.030	0.060
MERCURY (HG) TOTAL				<0.0002			<0.0002			<0.0002
MOLYBDENUM (MO) TOTAL				<0.001						
NICKEL (NI) TOTAL				<0.001						
SELENIUM (SE) TOTAL				<0.001			<0.001			<0.001
SELENIUM (SE) DISS				<0.001			<0.001			<0.001
SILVER (AG) TOTAL				<0.001			<0.001			<0.001
SILVER (AG) DISS				<0.001			<0.001			<0.001
ZINC (ZN) TOTAL				0.15			0.012			0.010
ZINC (ZN) DISS				0.008			0.006			0.007
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)							13.0			<2.0
TOTAL COLIFORM (NO./100ML)							330			33.0
5 - DAY BOD							2.4			3.6
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)				2.20			1.00			21.00
PHENOLS	<0.001	0.130	0.004	0.007	0.022	0.003	0.110	<0.001	<0.001	<0.001
OTHER PARAMETERS										
OIL AND GREASE				1.40			9.40			0.20
CYANIDE (CN)				<0.001			0.002			<0.001

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	12/09/81	01/21/82	02/18/82	04/15/82	05/20/82	06/30/82	07/21/82	08/19/82	09/15/82	10/14/82
LOCATION	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY	ECCLES CR. USFS BNDRY
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	7	-6	11	6	13	17	22	18	6	2
FLOW (CFS)								0.62	0.51	0.56
WATER TEMPERATURE (C)	3	1	1	2	3	9	11	11	5	3
SPEC. COND. (UMHOS/CM) FIELD	500	480	500	465	224	390	416	371	367	430
PH FIELD	7.6	8.0	7.5	7.2	7.8	8.0	7.6	8.1	8.1	7.7
TURBIDITY (NTU) FIELD				100+	100+	34	39	4.6	35	54
TOTAL SUSP. SOLIDS	1.0	25.0	25.0	133	378	23.0	27.0	36.0	38.0	119
TOTAL DISS. SOLIDS MEAS.	320	310	320	256	156	236	235	318	295	235
OXYGEN (O) DISS								9.3		
COMMON IONS										
CALCIUM (CA)	89.00	80.10	80.00	60.00	48.00	67.50	62.40	75.20	77.60	77.60
MAGNESIUM (MG)	21.00	20.10	21.50	14.00	8.70	12.30	15.36	16.80	18.24	18.24
SODIUM (NA)	3.95	30.00	7.50	5.80	2.4	38.0	4.5	13.0	5.7	4.0
POTASSIUM (K)	1.95	2.80	1.68	5.40	4.80	0.97	1.10	1.72	1.86	1.70
ACIDITY AS CACO3								<0.01		
ALKALINITY AS CACO3 (LAB)	278	256	263	181	140		204	257		
BICARBONATE (HCO3) (LAB)	338	312	321	221	171	211	249	314	302	291
SULFATE (SO4)	32.0	12.0	38.0	36.0	20.0	9.0	19.0	<3.0	26.0	30.0
CHLORIDE (CL)	5.40	9.23	1.40	7.30	1.80	4.50	2.10	24.70	4.90	7.90
FLUORIDE (F)								0.17		
NUTRIENTS										
NITRATE (NO3-N)								0.59		
AMMONIA (NH3 AS N)	0.52	2.68	0.05			0.28		0.31		0.28
TOTAL PHOSPHATE (PO4)	0.370	0.170	0.220			0.070		0.130		0.010
TRACE ELEMENTS										
BARIUM (BA) TOTAL								0.045		
BORON (B) TOTAL								0.025		
COPPER (CU) TOTAL								0.010		
IRON (FE) TOTAL	0.080	0.550	0.200	1.950	4.750	1.100	0.860	0.980	0.730	0.970
LEAD (PB) TOTAL								0.004		
MANGANESE (MN) TOTAL	0.052	0.009	0.040	0.170	0.113	0.050	0.050	0.090	0.260	0.250
ZINC (ZN) TOTAL								0.012		
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)								10.0		
PHENOLS	0.046	0.033	0.010			0.013		0.025		<0.001
OTHER PARAMETERS										
OIL AND GREASE						1.8		0.8		0.8
CYANIDE (CN)								0.007		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	11/09/82	12/14/82	01/19/83	02/15/83	03/31/83	04/21/83	05/25/83	06/30/83	07/20/83	08/25/83
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	0	-8	3	-2	4	7	17	13	15	13
FLOW (CFS)							10.3	3.62	1.08	0.80
WATER TEMPERATURE (C)	2	0.5	1	1	3	3	4	6	11	10
SPEC. COND. (UMHOS/CM) FIELD	550	457	554	562	560	634	324	353	364	565
PH FIELD	7.7	7.0	7.6	8.1	7.7	7.2	7.7	8.1	7.6	7.6
TURBIDITY (NTU) FIELD	66	16	7.2	18.5	89	100+	100+	24	33	13
TOTAL SUSP. SOLIDS	100	7.0	<0.1	6.0	72.0	72.0	924	13.0	8.0	31.0
TOTAL DISS. SOLIDS MEAS.	295	298	320	344	351	322	198	228	300	318
TOTAL SETTLEABLE SOLIDS							0.5			
OXYGEN (O) DISS										7.9
COMMON IONS										
CALCIUM (CA)	79.20	79.20	80.80	75.20	68.80	71.20	48.80	57.60	75.20	80.00
MAGNESIUM (MG)	16.32	19.68	20.64	23.04	16.32	15.84	11.52	10.56	13.44	19.20
SODIUM (NA)	4.8	5.1	6.0	21.0	28.0	23.0	4.8	7.5	19.0	14.0
POTASSIUM (K)	1.67	1.73	1.99	1.76	1.97	1.85	1.41	1.06	1.6	1.1
ACIDITY AS CACO3										33.00
ALKALINITY AS CACO3 (LAB)										270
BICARBONATE (HCO3) (LAB)	302	312	333	336	297	273	193	220	295	329
SULFATE (SO4)	21.0	26.0	15.0	30.0	38.0	36.0	21.0	18.0	36	37
CHLORIDE (CL)	4.90	4.20	8.50	20.40	19.20	27.60	4.00	2.0	8.0	4.0
FLUORIDE (F)										0.15
NUTRIENTS										
NITRATE (NO3-N)										<0.02
AMMONIA (NH3 AS N)								<0.1		<0.01
TOTAL PHOSPHATE (PO4)								0.18		0.10
TRACE ELEMENTS										
BARIUM (BA) TOTAL										0.042
BORON (B) TOTAL										0.012
COPPER (CU) TOTAL										0.010
IRON (FE) TOTAL	1.150	0.950	0.370	0.350	1.480	3.270	11.000	0.600	0.180	0.580
LEAD (PB) TOTAL										<0.001
MANGANESE (MN) TOTAL	0.200	0.300	0.350	0.300	0.140	0.175	0.315	0.082	0.190	0.385
ZINC (ZN) TOTAL										0.015
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)										1.80
PHENOLS								<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE								1.4		<0.2
CYANIDE (CN)										<0.001

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	09/28/83	10/26/83	11/11/83	01/18/84	02/22/84	03/22/84	04/26/84	05/17/84	06/28/84	07/27/84
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	11	9	3	-25	-11	-4	-5	11	18	16
FLOW (CFS)	0.45	0.28	0.42					23.9	6.02	0.91
WATER TEMPERATURE (C)	9	6	4	2	1	2	2	6	14	9
SPEC. COND. (UMHOS/CM) FIELD	320	542	479	578	600	546	436	315	396	475
PH FIELD	7.7	7.5	7.7	7.1	7.6	7.5	7.7	7.3	7.7	7.5
TURBIDITY (NTU) FIELD	37	18	30	5.7	8.8	16	46	100+	37	35
TOTAL SUSP. SOLIDS	21.0	30.0	29.0	15.0	5.0	11.0	65	1828	9.0	13.0
TOTAL DISS. SOLIDS MEAS.	286	320	320	328	360	400	376	440	295	490
COMMON IONS										
CALCIUM (CA)	88.80	80.00	79.20	86.40	96.80	94.80	92.40	80.00	72.00	88.00
MAGNESIUM (MG)	14.88	21.12	24.48	22.56	22.80	18.00	28.56	48.00	24.00	11.30
SODIUM (NA)	4.70	12.00	4.60	7.70	30.00	9.70	3.90	3.10	3.80	4.10
POTASSIUM (K)	1.8	1.2	1.7	1.8	2.1	1.8	1.3	3.2	1.6	1.37
BICARBONATE (HCO3) (LAB)	295	310	320	329	329	336	308.6	122.0	256.2	284.3
SULFATE (SO4)	40	79	34	47	72	37	82	286	68	34
CHLORIDE (CL)	6.00	8.00	8.00	8.0	50.0	19.0	9.0	3.6	3.3	3.3
NUTRIENTS										
AMMONIA (NH3 AS N)		<0.01							0.10	
TOTAL PHOSPHATE (PO4)		0.06							<0.01	
TRACE ELEMENTS										
IRON (FE) TOTAL	0.860	0.176	0.540	0.55	0.34	0.30	0.85	31.20	0.40	0.65
MANGANESE (MN) TOTAL	0.252	0.160	0.220	0.64	0.42	0.49	0.18	1.13	24.00	0.21
ORGANIC PARAMETERS										
PHENOLS		0.110							<0.001	
OTHER PARAMETERS										
OIL AND GREASE		<0.2							0.6	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-2	CS-2	CS-2	CS-2	CS-2	CS-2
SAMPLE DATE	08/24/84	09/18/84	10/16/85	04/17/86	05/28/86	06/25/86
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY	USFS BNDRY
PHYSICAL PARAMETERS						
AIR TEMPERATURE (C)	16	13	8	-4	18	15
FLOW (CFS)	0.78	1.07	1.16		16.6	3.33
WATER TEMPERATURE (C)	9	10	6	3	5	9
SPEC. COND. (UMHOS/CM) FIELD	610	499	577	509	245	468
PH FIELD	7.9	7.7	7.3	7.9	7.5	7.7
TURBIDITY (NTU) FIELD	21	48	16	19	62	7.58
TOTAL SUSP. SOLIDS	11.0	53.0	14.0	27.0	142	27.0
TOTAL DISS. SOLIDS MEAS.	310	344	356	330	172	260
OXYGEN (O) DISS	7.8					
COMMON IONS						
CALCIUM (CA)	66.00	80.00	93.60	84.40	44.40	71.20
MAGNESIUM (MG)	32.40	30.00	21.60	17.50	8.40	15.40
SODIUM (NA)	16.00	6.30	7.70	5.30	5.67	5.01
POTASSIUM (K)	1.89	3.45	3.29	1.82	0.79	1.83
ACIDITY AS CACO3	6.00					
ALKALINITY AS CACO3 (LAB)	270					
BICARBONATE (HCO3) (LAB)	329.4	366.0	309.9	256.0	148.0	214.7
SULFATE (SO4)	26	29	78	7	29	65
CHLORIDE (CL)	12.0	11.0	8.1	50.0	2.1	3.2
FLUORIDE (F)	0.23					
NUTRIENTS						
NITRATE (NO3-N)	0.29					
AMMONIA (NH3 AS N)	0.03		<0.01			0.13
TOTAL PHOSPHATE (PO4)	<0.01		0.02			0.02
TRACE ELEMENTS						
BARIUM (BA) TOTAL	0.05					
BORON (B) TOTAL	0.061					
COPPER (CU) TOTAL	0.020					
IRON (FE) TOTAL	0.68	0.79	0.21	0.16	1.15	1.18
LEAD (PB) TOTAL	<0.001					
MANGANESE (MN) TOTAL	0.20	0.14	0.10	0.09	0.10	0.08
ORGANIC PARAMETERS						
ORGANIC CARBON (TOTAL)	11.80					
PHENOLS	<0.001		<0.001			<0.001
OTHER PARAMETERS						
OIL AND GREASE	<0.1		0.2			0.6
CYANIDE (CN)	<0.001					

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	12/09/81	05/20/82	06/30/82
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FRK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	16	26	22	18	15	15	0	1	13	18
FLOW (CFS)	2.2	0.4	0.1	0.07	0.03	0.04	0.04		2.7%	0.82
WATER TEMPERATURE (C)	6.9	16	14	14	8	1	0	0	2	7
SPEC. COND. (UMHOS/CM) FIELD	285	340	300	380	360	450	430	450	198	280
PH FIELD	8.4	8.3	8.2	8.0	8.0	7.2	7.4	8.0	7.9	8.3
TURBIDITY (NTU) FIELD	0.62			0.26			0.30		16	3.6
TOTAL SUSP. SOLIDS	6.0	3.0	1.0	2.0	33.0	26.0	4.0	1.0	6.40	1.0
TOTAL DISS. SOLIDS MEAS.	186	220	198	245	236	300	278	289	130	184
OXYGEN (O) DISS	10.6	9.2	8.3	9.6	9.8	10.4	12.1			
COMMON IONS										
TOTAL HARDNESS AS CACO3	174									
CALCIUM (CA)	60.00	63.2	40.00	72.00	67.20	30.40	76.80	82.50	44.00	60.50
MAGNESIUM (MG)	5.76	11.52	24.00	12.00	12.48	23.04	16.50	16.50	5.80	9.20
SODIUM (NA)	2.50	2.50	2.90	3.20	3.40	55.00	3.30	3.40	1.6	2.6
POTASSIUM (K)	0.96	1.07	1.14	1.25	1.20	4.20	1.25	1.35	6.10	0.81
ACIDITY AS CACO3	<0.01			<0.01			<0.01			
ALKALINITY AS CACO3 (LAB)	158			206		289	255	261	129	
BICARBONATE (HCO3) (LAB)	193	215	229	242	259	352	292	319	157	208
CARBONATE AS CO3 (LAB)	0.60									
SULFATE (SO4)	13.0	29.0	9.0	30.0	15.0	6.0	20.0	18.0	12.0	20.0
CHLORIDE (CL)	3.50	2.68	3.95	3.48	2.81	3.70	3.60	3.20	0.80	1.20
FLUORIDE (F)	0.17			0.20			0.15			
NUTRIENTS										
NITRATE (NO3-N)	0.96			0.50			0.53			
NITRITE (NO2-N)	0.01									
AMMONIA (NH3 AS N)	<0.01	<0.01	<0.01	<0.01	0.08	0.02	0.39	0.13		0.12
TOTAL PHOSPHATE (PO4)	0.150		1.150	0.160	0.710	0.665	0.320	0.390		0.050
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	0.010									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.019			0.028			0.030			
BARIUM (BA) DISS	0.010			0.025			0.020			
BORON (B) TOTAL	0.018			0.022			0.028			
BORON (B) DISS	0.010			0.020			0.020			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	0.010			0.013			<0.001			
COPPER (CU) DISS	<0.001			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	12/09/81	05/20/82	06/30/82
TRACE ELEMENTS										
IRON (FE) TOTAL	0.010	0.080	0.200	0.080	0.095	0.089	0.150	0.100	0.350	0.050
IRON (FE) TOTAL	0.190									
LEAD (PB) TOTAL	0.003			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	0.010	0.10	0.016	0.010	0.014	0.015	0.020	0.018	0.120	0.005
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.020			0.010			0.010			
ZINC (ZN) DISS	0.007			0.008			0.005			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				33.0			5.0			
TOTAL COLIFORM (NO./100ML)				1400			33.0			
5 - DAY BOD				1.9			4.1			
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	3.10			5.00			12.20			
PHENOLS	0.003	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	0.080		<0.001
OTHER PARAMETERS										
OIL AND GREASE	3.80			1.2			0.20			0.4
CYANIDE (CN)	<0.001			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3
SAMPLE DATE	07/21/82	08/19/82	09/15/82	10/14/82	11/09/82	06/29/83	07/20/83	08/25/83	09/28/83	10/26/83
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR MID FRK	UPR MID FRK	UPR MID FRK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	19	24	6	0	0	17	15	11	11	7
FLOW (CFS)	0.09	0.11	0.11			1.49	0.44	0.27	0.18	0.14
WATER TEMPERATURE (C)	11	11	5	1	0	6	8	9	8	3
SPEC. COND. (UMHOS/CM) FIELD	356	356	345	320	540	330	369	492	506	497
PH FIELD	8.1	8.4	8.4	7.7	7.9	8.2	7.8	7.8	7.7	7.7
TURBIDITY (NTU) FIELD	3.4	5.7	62	2.8	2.5	14	20	6.8	11	12
TOTAL SUSP. SOLIDS	3.0	5.0	1.0	31.0	27.0	5.0	6.0	16.0	14.0	16.0
TOTAL DISS. SOLIDS MEAS.	255	289	245	304	260	212	286	282	248	285
OXYGEN (O) DISS		8.3						6.2		
COMMON IONS										
CALCIUM (CA)	68.00	74.40	73.60	82.40	76.00	56.00	74.40	72.80	83.20	79.20
MAGNESIUM (MG)	9.12	12.96	15.36	8.64	13.44	10.08	10.08	14.88	11.52	14.88
SODIUM (NA)	17.0	14.0	2.8	23.3	2.7	4.4	18.0	14.1	2.80	7.0
POTASSIUM (K)	0.90	1.14	1.25	1.20	1.20	0.85	1.2	0.9	1.4	1.3
ACIDITY AS CACO3		<0.01						30.00		
ALKALINITY AS CACO3 (LAB)	243	248						252		
BICARBONATE (HCO3) (LAB)	297	303	297	333	299	220	288	307	281	288
SULFATE (SO4)	3.0	<3.0	<0.1	18.0	2.0	6.0	28	24	25	30
CHLORIDE (CL)	2.20	18.60	5.10	2.20	2.90	6.0	6.0	2.0	2.00	4.00
FLUORIDE (F)		0.17						0.14		
NUTRIENTS										
NITRATE (NO3-N)		0.85						<0.02		
AMMONIA (NH3 AS N)		0.37		0.27		<0.1		<0.10		<0.01
TOTAL PHOSPHATE (PO4)		0.080		0.030		0.10		0.02		0.04
TRACE ELEMENTS										
BARIUM (BA) TOTAL		0.025						0.20		
BORON (B) TOTAL		0.020						0.011		
COPPER (CU) TOTAL		0.010						0.002		
IRON (FE) TOTAL	0.080	0.090	0.090	0.050	0.050	0.290	0.220	0.300	0.830	0.250
LEAD (PB) TOTAL		0.002						0.003		
MANGANESE (MN) TOTAL	0.015	0.140	0.008	0.010	0.007	0.026	0.125	0.200	0.171	0.130
ZINC (ZN) TOTAL		0.005						0.018		
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)		10.20						2.10		
PHENOLS		0.021		<0.001		0.008		<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE		0.6		<0.1		<0.2		<0.2		<0.2
CYANIDE (CN)		<0.001						0.016		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3	CS-3
SAMPLE DATE	11/11/83	02/22/84	03/22/84	04/25/84	05/17/84	06/27/84	07/26/84	08/28/84	09/17/84	10/16/85
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK	UPR MID FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	3	-8	-5	-5	10	22	18	13	17	4
FLOW (CFS)	0.13				7.33	0.44	0.21	0.30	0.16	0.13
WATER TEMPERATURE (C)	2	0.5	0.5	1	5	10	13	10	12	1
SPEC. COND. (UMHOS/CM) FIELD	440	456	437	364	264	536	431	530	440	438
PH FIELD	7.8	8.0	7.9	7.6	7.4	7.7	7.6	8.1	8.0	7.7
TURBIDITY (NTU) FIELD	19	100+	15	53	90	17	22	12	12	4.3
TOTAL SUSP. SOLIDS	19.0	9.0	2.0	79	233	2.0	3.0	11.0	8.0	4.0
TOTAL DISS. SOLIDS MEAS.	285	240	320	470	460	330	200	288	292	254
OXYGEN (O) DISS								9.0		
COMMON IONS										
CALCIUM (CA)	76.80	88.00	81.60	88.00	80.00	80.00	81.60	76.00	80.00	90.40
MAGNESIUM (MG)	16.32	18.00	17.52	50.40	60.00	9.60	10.80	9.60	20.40	7.40
SODIUM (NA)	2.90	2.70	2.70	2.40	1.90	33.00	2.80	36.00	3.00	1.90
POTASSIUM (K)	1.2	1.2	1.2	1.0	1.0	1.3	1.10	1.12	1.28	1.30
ACIDITY AS CACO3								8.00		
ALKALINITY AS CACO3 (LAB)								260		
BICARBONATE (HCO3) (LAB)	295	301	322	278.2	122.0	353.8	278.2	317.2	298.9	301.3
SULFATE (SO4)	15	34	14	182	310	20	20	18	28	16
CHLORIDE (CL)	4.00	9.0	9.0	5.0	16.9	5.6	1.8	1.0	10.0	3.1
FLUORIDE (F)								0.24		
NUTRIENTS										
NITRATE (NO3-N)								0.70		
AMMONIA (NH3 AS N)						0.15		0.04		<0.01
TOTAL PHOSPHATE (PO4)						0.03		0.03		0.06
TRACE ELEMENTS										
BARIUM (BA) TOTAL								0.02		
BORON (B) TOTAL								0.035		
COPPER (CU) TOTAL								0.013		
IRON (FE) TOTAL	0.260	2.01	0.39	1.03	2.77	0.33	0.30	0.33	0.26	0.08
LEAD (PB) TOTAL								0.003		
MANGANESE (MN) TOTAL	0.110	0.28	0.12	0.10	0.15	0.18	0.05	0.07	0.06	0.03
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)								0.20		
PHENOLS						<0.001		<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE						<0.01		<0.01		<0.1
CYANIDE (CN)								<0.001		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-3	CS-3
SAMPLE DATE	05/28/86	06/25/86
LOCATION	ECCLES CR.	ECCLES CR.
LOCATION	UPR MID FK	UPR MID FK
PHYSICAL PARAMETERS		
AIR TEMPERATURE (C)	10	18
FLOW (CFS)	5.22	0.78
WATER TEMPERATURE (C)	4	7
SPEC. COND. (UMHOS/CM) FIELD	221	367
PH FIELD	7.6	7.7
TURBIDITY (NTU) FIELD	23	1.77
TOTAL SUSP. SOLIDS	44.0	1.0
TOTAL DISS. SOLIDS MEAS.	150	210
COMMON IONS		
CALCIUM (CA)	41.20	62.40
MAGNESIUM (MG)	1.00	9.10
SODIUM (NA)	5.90	2.40
POTASSIUM (K)	<0.01	0.86
BICARBONATE (HCO3) (LAB)	139.0	222.0
SULFATE (SO4)	7	9
CHLORIDE (CL)	1.7	2.0
NUTRIENTS		
AMMONIA (NH3 AS N)		0.11
TOTAL PHOSPHATE (PO4)		<0.01
TRACE ELEMENTS		
IRON (FE) TOTAL	0.46	0.60
MANGANESE (MN) TOTAL	0.03	0.02
ORGANIC PARAMETERS		
PHENOLS		<0.001
OTHER PARAMETERS		
OIL AND GREASE		1.4

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	12/08/81	06/29/82	07/21/82
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	16	22	27	19	15	14	8	0	19	21
FLOW (CFS)		0.25	0.03	0.02			0.01		0.57	0.19
WATER TEMPERATURE (C)	3.6	12.5	15.5	13	9	2	0	0	7	10
SPEC. COND. (UMHOS/CM) FIELD	225	260	360	380	360	430	380	450	295	301
PH FIELD	8.3	8.2	8.5	8.2	8.4	7.2	7.7	7.9	8.1	7.8
TURBIDITY (NTU) FIELD	0.53			0.42			0.28		5.4	100+
TOTAL SUSP. SOLIDS	60.0	6.0	1.0	4.0	7.0	5.5	12.0	103	4.0	747
TOTAL DISS. SOLIDS MEAS.	235	169	215	245	233	280	245	286	195	189
OXYGEN (O) DISS	11.0	10.4		9.4	10.8	9.7	10.2			
COMMON IONS										
TOTAL HARDNESS AS CACO3	132									
CALCIUM (CA)	43.2	55.2	61.6	75.20	71.20	72.00	73.60	82.50	58.50	52.80
MAGNESIUM (MG)	5.76	7.20	13.44	10.56	12.48	10.56	12.00	12.50	5.90	7.68
SODIUM (NA)	9.80	1.80	2.10	2.40	2.50	21.00	2.40	2.90	2.0	9.0
POTASSIUM (K)	1.68	0.62	0.69	0.71	0.90	0.95	0.92	1.10	0.56	0.50
ACIDITY AS CACO3	<0.01			<0.01			<0.01			
ALKALINITY AS CACO3 (LAB)	144			206		262	215	224		184
BICARBONATE (HCO3) (LAB)	176	193		237	264	320	237	224	149	224
CARBONATE AS CO3 (LAB)	0.60									
SULFATE (SO4)	13.5	9.0	29.0	36.0	13.0	6.0	37.0	70.0	49.0	3.0
CHLORIDE (CL)	2.80	2.25	2.46	2.70	2.22	3.70	3.20	3.00	0.30	0.30
FLUORIDE (F)	0.14			0.15			0.12			
NUTRIENTS										
NITRATE (NO3-N)	0.05			<0.01			0.13			
NITRITE (NO2-N)	<0.01									
AMMONIA (NH3 AS N)	<0.01	<0.01	<0.01	<0.01	0.04	0.02	0.49	0.06	0.22	
TOTAL PHOSPHATE (PO4)	0.200		0.300	0.110	0.620	1.522	0.280	0.590	0.060	
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	0.020									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.020			0.027			0.025			
BARIUM (BA) DISS	0.010			0.015			0.015			
BORON (B) TOTAL	0.005			0.018			0.016			
BORON (B) DISS	<0.001			0.011			0.010			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	<0.001			0.010			<0.001			
COPPER (CU) DISS	<0.001			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	12/08/81	06/29/82	07/21/82
TRACE ELEMENTS										
IRON (FE) TOTAL	0.010	0.070	0.125	0.150	0.350	0.335	0.280	0.250	0.100	13.500
IRON (FE) TOTAL	0.120									
LEAD (PB) TOTAL	0.002			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	<0.001	<0.001	0.002	0.020	0.035	0.037	0.010	0.015	0.008	0.245
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.007			0.025			0.007			
ZINC (ZN) DISS	0.007			0.020			0.005			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				23.0			<2.0			
TOTAL COLIFORM (NO./100ML)				790			23.0			
5 - DAY BOD				1.1			4.6			
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	2.60			2.50			11.30			
PHENOLS	<0.001	<0.001	0.009	<0.001	<0.001	<0.001	0.007	0.026	<0.001	
OTHER PARAMETERS										
OIL AND GREASE	6.60			4.0			0.20		1.6	
CYANIDE (CN)	<0.001			<0.001			0.006			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4
SAMPLE DATE	08/19/82	09/14/82	10/14/82	06/29/83	07/20/83	08/24/83	09/28/83	10/26/83	11/11/83	05/24/84
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	24	5	-2	17	16	17	14	14	2	17
FLOW (CFS)	0.10	0.08	0.05	0.72	0.27	0.09	0.06	0.05	0.04	7.12
WATER TEMPERATURE (C)	10	3	1	8	8	9	8	6	1	6
SPEC. COND. (UMHOS/CM) FIELD	310	360	305	237	331	399	408	403	358	219
PH FIELD	8.3	8.5	7.5	8.0	7.6	7.8	8.1	7.8	7.8	7.4
TURBIDITY (NTU) FIELD	100+	91	50	9.2	25	71	41	8.9	35	39
TOTAL SUSP. SOLIDS	300	28.0	115	3.0	6.0	131	10.0	14.0	53.0	44.0
TOTAL DISS. SOLIDS MEAS.	239	225	269	154	198	245	10.0	240	230	140
OXYGEN (O) DISS	6.4					5.8				
COMMON IONS										
CALCIUM (CA)	68.80	68.00	75.20	40.80	55.20	64.00	68.80	69.60	68.00	24.00
MAGNESIUM (MG)	8.16	9.60	7.68	7.20	6.24	11.04	10.56	10.08	12.00	21.60
SODIUM (NA)	14.0	2.2	17.0	3.2	12.0	13.0	2.0	11.00	2.00	1.10
POTASSIUM (K)	0.90	0.84	0.95	0.61	0.6	0.7	0.9	0.8	0.8	0.6
ACIDITY AS CACO3	<0.01					26.00				
ALKALINITY AS CACO3 (LAB)	211					216				
BICARBONATE (HCO3) (LAB)	257	256	271	156	205	264	244	251	254	176.9
SULFATE (SO4)	<3.0	<0.1	30.0	4.0	22	20	15	25	10	7
CHLORIDE (CL)	21.30	2.70	3.70	8.0	2.0	<0.1	4.00	6.00	2.00	<0.1
FLUORIDE (F)	0.16					0.10				
NUTRIENTS										
NITRATE (NO3-N)	0.11					<0.02				
AMMONIA (NH3 AS N)	0.35		0.34	0.1		<0.10		<0.01		
TOTAL PHOSPHATE (PO4)	0.510		0.080	0.10		0.07		0.05		
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.040					0.020				
BORON (B) TOTAL	0.010					0.014				
COPPER (CU) TOTAL	0.010					0.020				
IRON (FE) TOTAL	6.700	5.000	0.800	0.140	0.180	0.150	0.410	0.160	0.420	0.92
LEAD (PB) TOTAL	0.003					0.003				
MANGANESE (MN) TOTAL	0.160	0.075	0.070	0.010	0.012	0.060	0.040	0.018	0.050	0.04
ZINC (ZN) TOTAL	0.075					0.020				
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	11.00					2.20				
PHENOLS	<0.001		<0.001	0.008		<0.001		<0.001		
OTHER PARAMETERS										
OIL AND GREASE	0.2		<0.1	<0.2		<0.2		<0.2		
CYANIDE (CN)	0.007					<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4	CS-4
SAMPLE DATE	06/27/84	07/26/84	08/27/84	09/17/84	10/16/85	05/28/86	06/25/86
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK	UPR L FRK
PHYSICAL PARAMETERS							
AIR TEMPERATURE (C)	24	19	21	17	1	10	11
FLOW (CFS)	0.64	0.02	0.07	0.05	0.04	2.89	0.40
WATER TEMPERATURE (C)	7	10	11	9	1.5	3	6
SPEC. COND. (UMHOS/CM) FIELD	312	316	431	361	371	166	273
PH FIELD	7.3	7.5	8.0	7.8	7.6	7.6	7.8
TURBIDITY (NTU) FIELD	7.7	21	32	11	4.4	17	2.58
TOTAL SUSP. SOLIDS	1.0	11.0	3.0	12.0	4.0	40.0	1.0
TOTAL DISS. SOLIDS MEAS.	185	199	346	238	204	130	150
OXYGEN (O) DISS			8.2				
COMMON IONS							
CALCIUM (CA)	48.00	57.60	66.0	70.00	69.60	35.20	45.60
MAGNESIUM (MG)	9.60	10.10	39.60	16.80	10.00	3.80	5.30
SODIUM (NA)	1.70	1.70	5.00	2.20	6.50	5.36	1.59
POTASSIUM (K)	0.6	0.59	0.69	0.80	1.09	0.08	0.68
ACIDITY AS CACO3			4.00				
ALKALINITY AS CACO3 (LAB)			205				
BICARBONATE (HCO3) (LAB)	170.8	194.0	253.8	268.4	270.8	113.0	161.0
SULFATE (SO4)	18	24	114	16	8	17	5
CHLORIDE (CL)	1.1	0.8	<1.0	7.0	2.0	1.3	1.2
FLUORIDE (F)			0.21				
NUTRIENTS							
NITRATE (NO3-N)			0.11				
AMMONIA (NH3 AS N)	0.22		<0.01		<0.01		0.56
TOTAL PHOSPHATE (PO4)	0.05		0.04		<0.01		0.03
TRACE ELEMENTS							
BARIUM (BA) TOTAL			0.02				
BORON (B) TOTAL			0.040				
COPPER (CU) TOTAL			0.019				
IRON (FE) TOTAL	0.14	0.24	0.20	0.20	<0.01	0.49	0.44
LEAD (PB) TOTAL			<0.001				
MANGANESE (MN) TOTAL	0.01	0.01	0.02	0.01	<0.01	0.03	0.03
ORGANIC PARAMETERS							
ORGANIC CARBON (TOTAL)			0.50				
PHENOLS	<0.001		<0.001		<0.001		<0.001
OTHER PARAMETERS							
OIL AND GREASE	<0.1		<0.1		0.6		0.8
CYANIDE (CN)			<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	01/27/81	02/25/81	03/11/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/24/81	10/23/81
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	-1	10	0	4	17	27	28	10	22	3
FLOW (CFS)	2.8		2.4	3						
WATER TEMPERATURE (C)	1	3	3	5	10.5	12.5	15	8	12	2
SPEC. COND. (UMHOS/CM) FIELD	279	410	280	325	360	390	490	500	430	650
PH FIELD	7.8	8.1	7.9	8.1	8.3	8.1	8.1	8.0	8.4	7.3
TURBIDITY (NTU) FIELD					0.64			4.40		
TOTAL SUSP. SOLIDS	7.0	41.0	23.0	150	60	34	50	12	10.0	4.0
TOTAL DISS. SOLIDS MEAS.	294	270	558	300	235	250	315	328	283	420
OXYGEN (O) DISS					9.8	9.1	10.9	9.9	8.9	11.0
COMMON IONS										
TOTAL HARDNESS AS CACO3					214					316
CALCIUM (CA)	76.80	43.60	72.00	72.80	63.20	42.40	64.00	73.68	60.00	64.00
MAGNESIUM (MG)	24.00	37.80	22.08	24.96	13.44	33.12	26.88	30.24	28.32	24.00
SODIUM (NA)	6.00	6.40	123	7.30	9.80	3.60	4.40	4.90	5.00	41.00
POTASSIUM (K)	1.50	2.27	2.15	1.46	1.68	2.08	2.23	2.30	1.30	1.40
ACIDITY AS CACO3					<0.01			<0.01		
ALKALINITY AS CACO3 (LAB)					212			250		
BICARBONATE (HCO3) (LAB)	339.16	263.52	641.72	283.04	259	249	144	300	307	386
CARBONATE AS CO3 (LAB)					0.60					
SULFATE (SO4)	18.0	44.0	12.0	43.0	13.5	35.0	145	58.0	24.0	27.0
CHLORIDE (CL)	5.87	12.00	8.51	16.00	8.80	6.85	7.77	8.20	4.96	6.00
FLUORIDE (F)					0.19			0.21		
NUTRIENTS										
NITRATE (NO3-N)					0.05			<0.01		
NITRITE (NO2-N)					<0.01					
AMMONIA (NH3 AS N)	<0.01	<0.01	<0.01	0.15	<0.01	<0.01	0.15	<0.01	0.15	<0.01
TOTAL PHOSPHATE (PO4)	0.120	0.030	0.080	0.020	0.200		0.220	0.300	0.520	0.520
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL					0.020					
ARSENIC (AS) TOTAL					<0.001			<0.001		
ARSENIC (AS) DISS					<0.001			<0.001		
BARIUM (BA) TOTAL					0.050			0.050		
BARIUM (BA) DISS					0.040			0.045		
BORON (B) TOTAL					0.016			0.035		
BORON (B) DISS					0.010			0.030		
CADMIUM (CD) TOTAL					<0.001			<0.001		
CADMIUM (CD) DISS					<0.001			<0.001		
CHROMIUM (CR) TOTAL					<0.001			<0.001		
CHROMIUM (CR) DISS					<0.001			<0.001		
COPPER (CU) TOTAL					0.010			0.012		
COPPER (CU) DISS					<0.001			<0.001		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	01/27/81	02/25/81	03/11/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/24/81	10/23/81
TRACE ELEMENTS										
IRON (FE) TOTAL	1.110	1.370	0.740	1.420	0.960	0.500	0.860	1.530	1.835	1.635
LEAD (PB) TOTAL					0.003			<0.001		
LEAD (PB) DISS					<0.001			<0.001		
MANGANESE (MN) TOTAL	0.090	0.110	0.100	0.086	0.060	0.060	0.050	0.160	0.210	0.200
MERCURY (HG) TOTAL					<0.0002			<0.0002		
MOLYBDENUM (MO) TOTAL					<0.001					
NICKEL (NI) TOTAL					<0.001					
SELENIUM (SE) TOTAL					<0.001			<0.001		
SELENIUM (SE) DISS					<0.001			<0.001		
SILVER (AG) TOTAL					<0.001			<0.001		
SILVER (AG) DISS					<0.001			<0.001		
ZINC (ZN) TOTAL					0.020			0.018		
ZINC (ZN) DISS					0.008			0.012		
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)								49		
TOTAL COLIFORM (NO./100ML)								1300		
5 - DAY BOD								2.0		
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)					1.80			7.10		
PHENOLS	0.144	0.012	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	<0.001
OTHER PARAMETERS										
OIL AND GREASE					6.60			0.80		
CYANIDE (CN)					<0.001			<0.001		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	11/11/81	12/09/81	01/21/82	02/18/82	03/31/82	04/15/82	05/20/82	06/30/82	07/22/82	08/19/82
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	8	8	-6	11	0	5	14	18	14	25
FLOW (CFS)								7.87	2.85	2.44
WATER TEMPERATURE (C)	4	3	2	3	2	5	7	11	9	12
SPEC. COND. (UMHOS/CM) FIELD	500	540	460	700	628	602	324	400	420	420
PH FIELD	8.0	7.9	8.2	8.1	7.4	7.7	8.0	8.3	8.3	8.0
TURBIDITY (NTU) FIELD	0.54				45	100+	100+	55	11	78
TOTAL SUSP. SOLIDS	16.0	23.0	166	33.0	44.0	347	331	38.0	76.0	168
TOTAL DISS. SOLIDS MEAS.	350	349	299	450	405	338	198	258	275	321
OXYGEN (O) DISS	10.4									9.9
COMMON IONS										
CALCIUM (CA)		79.50	72.50	90.00	87.50	80.00	53.60	66.00	50.40	72.00
MAGNESIUM (MG)	29.00	28.00	22.80	27.00	27.50	23.00	12.80	16.50	25.92	24.96
SODIUM (NA)	5.10	4.40	7.80	6.54	15.0	4.9	1.5	4.3	20.0	9.0
POTASSIUM (K)	2.50	2.50	2.10	2.09	2.25	4.85	5.20	1.69	1.30	2.54
ACIDITY AS CACO3	<0.01									<0.01
ALKALINITY AS CACO3 (LAB)	278	275	262	258	247	239	178		275	262
BICARBONATE (HCO3) (LAB)	320	287	320	315	301	292	218	218	236	319
CARBONATE AS CO3 (LAB)	9.60									
SULFATE (SO4)	21.0	79.0	21.0	73.0	102	36.0	12.0	56.0	3.0	<3.0
CHLORIDE (CL)	5.90	5.20	9.81	10.20	13.00	24.40	3.90	3.20	3.20	33.40
FLUORIDE (F)	0.18									0.21
NUTRIENTS										
NITRATE (NO3-N)	0.05									0.18
AMMONIA (NH3 AS N)	3.50	0.51	2.65	<0.02				0.06		0.36
TOTAL PHOSPHATE (PO4)	0.260	0.360	0.760	0.210				0.110		0.290
TRACE ELEMENTS										
ARSENIC (AS) TOTAL	<0.001									
ARSENIC (AS) DISS	<0.001									0.065
BARIUM (BA) TOTAL	0.175									
BARIUM (BA) DISS	0.145									0.035
BORON (B) TOTAL	0.065									
BORON (B) DISS	0.025									
CADMIUM (CD) TOTAL	<0.001									
CADMIUM (CD) DISS	<0.001									
CHROMIUM (CR) TOTAL	<0.001									
CHROMIUM (CR) DISS	<0.001									0.010
COPPER (CU) TOTAL	0.011									
COPPER (CU) DISS	0.010									
IRON (FE) TOTAL	0.350	0.760	0.140	0.990	2.000	4.600	3.600	1.400	0.520	2.430
IRON (FE) TOTAL	1.975									
LEAD (PB) TOTAL	<0.001									0.003

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	11/11/81	12/09/81	01/21/82	02/18/82	03/31/82	04/15/82	05/20/82	06/30/82	07/22/82	08/19/82
TRACE ELEMENTS										
LEAD (PB) DISS	<0.001									
MANGANESE (MN) TOTAL	0.180	0.128	0.134	0.110	0.190	0.230	0.115	0.065	0.075	0.125
MERCURY (HG) TOTAL	<0.0002									
SELENIUM (SE) TOTAL	<0.001									
SELENIUM (SE) DISS	<0.001									
SILVER (AG) TOTAL	<0.001									
SILVER (AG) DISS	<0.001									
ZINC (ZN) TOTAL	0.020									0.015
ZINC (ZN) DISS	0.015									
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)	<2.0									
TOTAL COLIFORM (NO./100ML)	700									
5 - DAY BOD	4.0									
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	4.70									8.80
PHENOLS	0.002	0.036	0.093	0.010				<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE	0.20							0.4		0.8
CYANIDE (CN)	0.044									<0.001

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	09/14/82	10/14/82	11/10/82	12/14/82	01/19/83	02/15/83	03/31/83	04/21/83	05/25/83	06/30/83
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	7	13	-1	-8	-5	-1	0	8	18	11
FLOW (CFS)		2.57	1.33						20.1	11.75
WATER TEMPERATURE (C)	6	4	1	0	1.5	0.5	3	5	7	8
SPEC. COND. (UMHOS/CM) FIELD	395	540	643	420	583	570	642	781	342	405
PH FIELD	8.5	8.6	7.9	7.5	7.8	8.1	7.9	7.7	8.1	8.0
TURBIDITY (NTU) FIELD	87	62	35	23	28	44	81	100+	100+	30
TOTAL SUSP. SOLIDS	97	161	50.0	9.0	13.0	41.0	427	688	3190	22.0
TOTAL DISS. SOLIDS MEAS.	313	318	322	320	338	378	404	414	234	256
TOTAL SETTLEABLE SOLIDS									1.2	
COMMON IONS										
CALCIUM (CA)	73.60	77.60	80.00	69.60	77.60	79.20	74.40	80.00	51.20	59.20
MAGNESIUM (MG)	25.44	27.36	23.52	30.72	27.84	19.20	24.96	24.00	11.04	15.84
SODIUM (NA)	4.8	1.2	4.5	7.5	9.1	35.0	31.0	20.0	6.0	6.0
POTASSIUM (K)	2.19	2.20	2.04	2.20	2.38	2.19	2.48	2.95	1.64	1.45
BICARBONATE (HCO3) (LAB)	309	317	315	326	329	326	312	281	190	229
SULFATE (SO4)	30.0	42.0	37.0	37.0	37.0	60.0	64.0	60.0	28.0	32.0
CHLORIDE (CL)	10.30	7.00	7.10	7.40	15.00	21.50	31.90	43.40	4.00	6.0
NUTRIENTS										
AMMONIA (NH3 AS N)		0.30								<0.1
TOTAL PHOSPHATE (PO4)		0.060								0.24
TRACE ELEMENTS										
IRON (FE) TOTAL	2.250	1.350	1.050	2.550	1.220	1.030	2.400	9.800	24.500	0.700
MANGANESE (MN) TOTAL	0.140	0.145	0.130	0.163	0.135	0.140	0.175	0.495	0.740	0.060
ORGANIC PARAMETERS										
PHENOLS		<0.001								0.004
OTHER PARAMETERS										
OIL AND GREASE		<0.1								<0.2

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	07/20/83	08/25/83	09/29/83	10/26/83	11/11/83	01/18/84	02/22/84	03/22/84	04/26/84	05/17/84
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	15	17	11	16	1	-23	-4	-3	-5	16
FLOW (CFS)	5.64	3.10	3.50	1.87	2.22				.	71.2
WATER TEMPERATURE (C)	11	13	9	5	2	0	0.5	1	3	9
SPEC. COND. (UMHOS/CM) FIELD	528	580	300	576	522	606	617	634	1786	367
PH FIELD	8.0	7.6	7.7	7.7	7.2	7.9	8.0	8.0	8.2	7.7
TURBIDITY (NTU) FIELD	25	7.9	34	16	23	13	22	27	100+	100+
TOTAL SUSP. SOLIDS	28.0	43.0	12.0	16.0	23.0	20.0	5.0	17.0	237	1102
TOTAL DISS. SOLIDS MEAS.	284	320	330	350	330	395	380	420	1000	275
OXYGEN (O) DISS		5.4								
COMMON IONS										
CALCIUM (CA)	69.60	68.00	76.00	79.20	73.60	40.80	86.00	82.00	72.80	88.00
MAGNESIUM (MG)	21.60	24.00	23.52	25.92	28.32	25.44	28.80	33.12	30.72	<0.10
SODIUM (NA)	4.7	15.0	6.30	3.50	8.30	56.0	14.40	21.60	262	4.30
POTASSIUM (K)	2.3	1.5	2.8	2.5	2.6	2.2	2.4	2.3	2.4	2.6
ACIDITY AS CACO3		27.00								
ALKALINITY AS CACO3 (LAB)		236								
BICARBONATE (HCO3) (LAB)	290	288	256	285	300	315	306	320	328.2	207.4
SULFATE (SO4)	26	62	68	58	53	57	64	52	5	45
CHLORIDE (CL)	10.0	6.0	14.00	12.00	12.00	18.0	38.0	51.0	428	6.8
FLUORIDE (F)		0.14								
NUTRIENTS										
NITRATE (NO3-N)		<0.02								
AMMONIA (NH3 AS N)		<0.10		<0.01						
TOTAL PHOSPHATE (PO4)		0.03		0.04						
TRACE ELEMENTS										
BARIUM (BA) TOTAL		0.050								
BORON (B) TOTAL		0.015								
COPPER (CU) TOTAL		0.020								
IRON (FE) TOTAL	0.340	0.650	0.630	0.350	0.540	0.62	0.67	0.78	3.53	19.20
LEAD (PB) TOTAL		0.002								
MANGANESE (MN) TOTAL	0.097	0.120	0.113	0.100	0.120	0.18	0.17	0.19	0.23	0.70
ZINC (ZN) TOTAL		0.025								
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)		2.50								
PHENOLS		<0.001		<0.001						
OTHER PARAMETERS										
OIL AND GREASE		<0.2		<0.2						
CYANIDE (CN)		<0.001								

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6	CS-6
SAMPLE DATE	06/29/84	07/27/84	08/28/84	09/18/84	10/16/85	03/20/86	04/17/86	05/28/86	06/25/86
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.	GAGING STA.
PHYSICAL PARAMETERS									
AIR TEMPERATURE (C)	22	14	15	11	10	5	-2	21	16
FLOW (CFS)	13.9	6.08	3.12	2.78	2.86			46.5	9.11
WATER TEMPERATURE (C)	9	11	11	8	4	2	3	9	13
SPEC. COND. (UMHOS/CM) FIELD	501	558	660	535	606	719	2240	286	516
PH FIELD	8.3	7.8	8.1	7.9	8.0	7.9	8.0	7.8	7.7
TURBIDITY (NTU) FIELD	25	42	22	35	6.5	7.8	93	83	43.55
TOTAL SUSP. SOLIDS	8.0	63.0	11.0	38.0	12.0	39.0	238	385	71.0
TOTAL DISS. SOLIDS MEAS.	280	380	320	348	368	426	1282	208	302
OXYGEN (O) DISS			8.8						
COMMON IONS									
CALCIUM (CA)	72.00	59.20		76.00	82.80	91.60	86.00	48.40	60.00
MAGNESIUM (MG)	22.80	37.00	28.80	31.20	24.70	28.10	22.10	10.30	21.60
SODIUM (NA)	4.70	5.50	12.00	6.20	8.80	25.60	358.00	6.68	5.70
POTASSIUM (K)	1.8	2.12	2.48	2.84	2.46	2.71	2.35	0.92	2.33
ACIDITY AS CACO3			5.00						
ALKALINITY AS CACO3 (LAB)			225						
BICARBONATE (HCO3) (LAB)	298.9	287.9	274.5	260.0	268.0	303.0	265.0	170.0	205.0
SULFATE (SO4)	33	60	81	95	82	38	60	28	69
CHLORIDE (CL)	6.3	9.11		12.0	14.9	82.3	58.4	4.1	7.7
FLUORIDE (F)			1.17						
NUTRIENTS									
NITRATE (NO3-N)			0.04						
AMMONIA (NH3 AS N)	0.16		0.12		<0.01				0.11
TOTAL PHOSPHATE (PO4)	0.02		<0.01		<0.01				0.04
TRACE ELEMENTS									
BARIUM (BA) TOTAL			0.06						
BORON (B) TOTAL			0.026						
COPPER (CU) TOTAL			0.026						
IRON (FE) TOTAL	0.45	1.13	1.20	0.86	0.34	0.50	2.39	2.22	2.50
LEAD (PB) TOTAL			<0.001						
MANGANESE (MN) TOTAL	0.08	0.12	0.09	0.11	0.09	0.10	0.27	0.18	0.25
ORGANIC PARAMETERS									
ORGANIC CARBON (TOTAL)			0.40						
PHENOLS	0.015		<0.001		<0.001				<0.001
OTHER PARAMETERS									
OIL AND GREASE	<0.1		<0.1		0.4				0.8
CYANIDE (CN)			<0.001						

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/25/81	10/22/81	11/10/81	12/08/81	06/28/82	07/21/82
LOCATION	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	11	20	23	14	15	9	6	10	23	21
FLOW (CFS)	0.59	0.39	0.29	0.28	0.11	0.30	0.28		4.69	1.28
WATER TEMPERATURE (C)	11	19	9.5	10	6	0	0	0	12	12
SPEC. COND. (UMHOS/CM) FIELD	270	270	320	340	300	450	440	310	475	307
PH FIELD	8.5	8.3	8.2	8.0	8.1	7.1	7.9	8.0	8.3	8.2
TURBIDITY (NTU) FIELD	0.65			0.80			0.66		5.5	6.0
TOTAL SUSP. SOLIDS	11.0	6.0	4.0	2.0	7.0	6.5	1.0	5.0		
TOTAL DISS. SOLIDS MEAS.	176	177	210	220	198	300	298	200		
OXYGEN (O) DISS	10.0			9.9			13.0			
COMMON IONS										
TOTAL HARDNESS AS CACO3	172									
CALCIUM (CA)	60.00	50.40	60.00	60.00	49.60	70.40	63.50	70.50		
MAGNESIUM (MG)	5.28	10.56	11.52	15.84	15.84	9.60	10.50	11.00		
SODIUM (NA)	2.20	2.10	2.20	2.30	2.50	36.00	31.00	2.50		
POTASSIUM (K)	0.74	0.75	0.70	0.78	0.60	0.55	0.46	0.90		
ACIDITY AS CACO3	<0.01			<0.01			<0.01			
ALKALINITY AS CACO3 (LAB)	170			194		283	192	213		
BICARBONATE (HCO3) (LAB)	198	185	210	232	227	345	220	211		
CARBONATE AS CO3 (LAB)	4.80									
SULFATE (SO4)	4.5	16.0	24.0	22.0	6.0	9.0	79.0	46.0		
CHLORIDE (CL)	3.40	2.80	3.00	3.13	2.28	3.90	3.00	2.60		
FLUORIDE (F)	0.16			0.15			0.12			
NUTRIENTS										
NITRATE (NO3-N)	0.36	<0.01	0.10	0.48	0.02	0.05	0.40	1.35		
NITRITE (NO2-N)	0.01									
AMMONIA (NH3 AS N)	<0.01	<0.001	0.002	<0.01	<0.001	<0.001	2.70	0.023		
TOTAL PHOSPHATE (PO4)	0.140		0.130	0.280	9.000	4.450	0.300	0.380		
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	<0.001									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.030			0.030			0.040			
BARIUM (BA) DISS	0.015			0.025			0.020			
BORON (B) TOTAL	0.004			0.012			0.019			
BORON (B) DISS	<0.001			0.010			0.010			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	0.010			0.010			<0.001			
COPPER (CU) DISS	<0.001			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/25/81	10/22/81	11/10/81	12/08/81	06/28/82	07/21/82
TRACE ELEMENTS										
IRON (FE) TOTAL	0.010	0.180	0.190	0.250	0.288	0.235	0.230	0.330		
IRON (FE) TOTAL	0.160									
LEAD (PB) TOTAL	0.003			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	0.010	0.010	0.013	0.020	0.019	0.015	0.016	0.014		
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.005			0.020			0.021			
ZINC (ZN) DISS	0.003			0.010			0.011			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				130			8.0			
TOTAL COLIFORM (NO./100ML)				330			110			
5 - DAY BOD				1.5						
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	4.10			24.00			11.80			
PHENOLS	0.006			<0.001			11.800			
OTHER PARAMETERS										
OIL AND GREASE	<0.01	9.2	8.9	15.00	9.8	11.6	0.20			
CYANIDE (CN)	<0.001			<0.001			0.011			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7	CS-7
SAMPLE DATE	08/17/82	09/15/82	10/12/82	06/28/83	07/19/83	08/24/83	09/27/83	10/20/83	06/28/84	07/31/84
LOCATION	BURNOUT CR. ABV	BURNOUT CR. HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR	BURNOUT CR. ABV	HUNT CR
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	20	10	11	16	19	16	13	9	18	16
FLOW (CFS)	0.58	0.57	0.49	10.24	1.79	0.65	0.56	0.48	9.1	2.24
WATER TEMPERATURE (C)	12	7	3	10	14	9	9	4	11	10
SPEC. COND. (UMHOS/CM) FIELD	368	302	347	263	332	394	369	378	284	379
PH FIELD	8.6	8.4	6.6	8.1	7.8	8.0	7.4	7.7	7.6	7.6
TURBIDITY (NTU) FIELD	5.0	8.4	3.0	13	8	2.1	4.3	7.2	19	8.1
TOTAL SUSP. SOLIDS	20.0					17.0				
TOTAL DISS. SOLIDS MEAS.	228					210				
OXYGEN (O) DISS	8.4					5.0				
COMMON IONS										
CALCIUM (CA)	55.26					60.40				
MAGNESIUM (MG)	14.88					10.08				
SODIUM (NA)	8.0					9.0				
POTASSIUM (K)	0.71					4.5				
ACIDITY AS CACO3	<0.01					22.00				
ALKALINITY AS CACO3 (LAB)	193					208				
BICARBONATE (HCO3) (LAB)	235					254				
SULFATE (SO4)	<3.0					<3				
CHLORIDE (CL)	20.10					2.0				
FLUORIDE (F)	0.15					0.11				
NUTRIENTS										
NITRATE (NO3-N)	0.62					<0.02				
AMMONIA (NH3 AS N)	0.64					0.30				
TOTAL PHOSPHATE (PO4)	0.070					0.02				
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.020					0.021				
BORON (B) TOTAL	0.010					0.020				
COPPER (CU) TOTAL	0.010					<0.001				
IRON (FE) TOTAL	0.200					0.510				
LEAD (PB) TOTAL	0.002					<0.001				
MANGANESE (MN) TOTAL	0.025					0.017				
ZINC (ZN) TOTAL	0.002					0.035				
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	11.30					2.60				
PHENOLS	<0.001					<0.001				
OTHER PARAMETERS										
OIL AND GREASE	<0.1					<0.2				
CYANIDE (CN)	<0.001					<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-7	CS-7	CS-7	CS-7
SAMPLE DATE	08/24/84	09/26/84	10/15/85	06/24/86
LOCATION	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR	BURNOUT CR. ABV HUNT CR
PHYSICAL PARAMETERS				
AIR TEMPERATURE (C)	14	10	10	22
FLOW (CFS)	1.22	0.68	0.40	0.30
WATER TEMPERATURE (C)	8	6	6	11
SPEC. COND. (UMHOS/CM) FIELD	434	371	361	323
PH FIELD	7.9	7.9	7.8	7.4
TURBIDITY (NTU) FIELD	11	4.5	4.8	
TOTAL SUSP. SOLIDS	10.0			
TOTAL DISS. SOLIDS MEAS.	266			
OXYGEN (O) DISS	8.8			
COMMON IONS				
CALCIUM (CA)	68.00			
MAGNESIUM (MG)	9.60			
SODIUM (NA)	26.00			
POTASSIUM (K)	0.67			
ACIDITY AS CACO3	7.50			
ALKALINITY AS CACO3 (LAB)	215			
BICARBONATE (HCO3) (LAB)	262.3			
SULFATE (SO4)	12			
CHLORIDE (CL)	10.0			
FLUORIDE (F)	0.09			
NUTRIENTS				
NITRATE (NO3-N)	0.47			
AMMONIA (NH3 AS N)	0.07			
TOTAL PHOSPHATE (PO4)	<0.01			
TRACE ELEMENTS				
BARIUM (BA) TOTAL	0.02			
BORON (B) TOTAL	0.020			
COPPER (CU) TOTAL	0.016			
IRON (FE) TOTAL	0.70			
LEAD (PB) TOTAL	0.002			
MANGANESE (MN) TOTAL	0.02			
ZINC (ZN) TOTAL	0.036			
ORGANIC PARAMETERS				
ORGANIC CARBON (TOTAL)	<0.01			
PHENOLS	<0.001			
OTHER PARAMETERS				
OIL AND GREASE	<0.1			
CYANIDE (CN)	<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/24/81	10/22/81	11/10/81	12/08/81	06/28/82	07/21/82
LOCATION	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK	HNT CR R FK
LOCATION	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK	ABV L FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	17	27	21	11	20	4	8	10	28	22
FLOW (CFS)	2.02	0.48	0.32	0.32	0.29	0.38	0.60	0.40	1.79	0.48
WATER TEMPERATURE (C)	10	13	9.5	8	10	1	4	1	9	9
SPEC. COND. (UMHOS/CM) FIELD	115	170	290	325	320	300	340	285	302	281
PH FIELD	8.2	8.2	8.4	8.1	8.3	7.4	7.9	8.0	7.2	7.9
TURBIDITY (NTU) FIELD	5.60			1.00			0.48		9.9	6.9
TOTAL SUSP. SOLIDS	4.0	6.0	1.0	4.0	3.0	2.6	2.0	1.0		
TOTAL DISS. SOLIDS MEAS.	75	110	189	211	210	198	220	185		
OXYGEN (O) DISS	9.5	10.2	10.8	10.4	10.0	11.0	12.5			
COMMON IONS										
TOTAL HARDNESS AS CACO3	60									
CALCIUM (CA)	20.0	32.0	56.80	64.00	52.00	52.00	52.00	51.50		
MAGNESIUM (MG)	2.40	5.28	10.08	8.64	16.80	5.76	8.50	9.00		
SODIUM (NA)	5.9	2.0	2.20	2.40	2.50	20.00	19.60	2.45		
POTASSIUM (K)	0.50	0.56	0.69	0.74	0.50	0.50	0.55	0.85		
ACIDITY AS CACO3	3.64			<0.01			6.00			
ALKALINITY AS CACO3 (LAB)	60			162		184	146	150		
BICARBONATE (HCO3) (LAB)	73.2	102	188	193	207	225	178	183		
CARBONATE AS CO3 (LAB)	<0.01									
SULFATE (SO4)	9.0	16.0	27.0	35.0	28.0	9.0	50.0	18.0		
CHLORIDE (CL)	4.00	2.58	2.74	2.56	2.24	3.70	3.00	2.70		
FLUORIDE (F)	0.09			0.14			0.10			
NUTRIENTS										
NITRATE (NO3-N)	0.20			0.48			0.17			
NITRITE (NO2-N)	0.01									
AMMONIA (NH3 AS N)	<0.01	<0.01	0.10	<0.01	0.02	0.05	<0.01	0.52		
TOTAL PHOSPHATE (PO4)	0.130		0.100	0.270	6.300	3.880	0.330	0.310		
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	0.080									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.018			0.029			0.025			
BARIUM (BA) DISS	0.010			0.025			0.025			
BORON (B) TOTAL	<0.001			0.016			0.017			
BORON (B) DISS	<0.001			0.010			0.010			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	<0.001			0.009			<0.001			
COPPER (CU) DISS	<0.001			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/24/81	10/22/81	11/10/81	12/08/81	06/28/82	07/21/82
TRACE ELEMENTS										
IRON (FE) TOTAL	0.080	0.220	0.365	0.210	0.200	0.160	0.225	0.240		
IRON (FE) TOTAL	0.380									
LEAD (PB) TOTAL	0.003			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	0.010	0.010	0.012	0.020	0.026	0.018	0.019	0.015		
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.010						0.014			
ZINC (ZN) DISS	0.008			0.005			0.003			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				5.0			2.0			
TOTAL COLIFORM (NO./100ML)				700			130			
5 - DAY BOD				1.2						
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	2.90			4.00			8.80			
PHENOLS	0.019	<0.001	0.011	<0.001	<0.001	<0.001	11.80	0.013		
OTHER PARAMETERS										
OIL AND GREASE	4.00			1.20			<0.001			
CYANIDE (CN)	<0.001			<0.001			0.002			
SULFIDE	1.80			0.010						

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8
SAMPLE DATE	08/18/82	09/15/82	10/15/82	06/28/83	07/19/83	08/24/83	09/27/83	10/20/83	05/24/84	06/26/84
LOCATION	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV	HNT CR R FK ABV
LOCATION	L FK	L FK	L FK	L FK	L FK	L FK	L FK	L FK	L FK	L FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	21	11	8	16	22	14	11	9	13	14
FLOW (CFS)	0.25	0.27	0.62	4.80	1.11	0.63	0.18	0.33	60.7	3.16
WATER TEMPERATURE (C)	9	6	3	13	13	7	9	6	8	4
SPEC. COND. (UMHOS/CM) FIELD	202	234	225	122	205	293	270	284	109	169
PH FIELD	8.4	7.9	7.7	7.6	7.5	7.4	6.0	7.3	7.2	6.4
TURBIDITY (NTU) FIELD	13	50	9	18	21	76	53	29	45	26
TOTAL SUSP. SOLIDS	10.0					87.0				
TOTAL DISS. SOLIDS MEAS.	195					152				
OXYGEN (O) DISS	8.2					7.6				
COMMON IONS										
CALCIUM (CA)	48.00					43.20				
MAGNESIUM (MG)	11.04					9.60				
SODIUM (NA)	7.5					4.5				
POTASSIUM (K)	0.69					3.6				
ACIDITY AS CACO3	0.50					16.00				
ALKALINITY AS CACO3 (LAB)	161					146				
BICARBONATE (HCO3) (LAB)	196					178				
SULFATE (SO4)	<3.0					15				
CHLORIDE (CL)	17.30					<0.10				
FLUORIDE (F)	0.12					0.08				
NUTRIENTS										
NITRATE (NO3-N)	0.42					<0.02				
AMMONIA (NH3 AS N)	0.35					0.45				
TOTAL PHOSPHATE (PO4)	0.070					0.10				
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.013					0.020				
BORON (B) TOTAL	0.010					0.055				
COPPER (CU) TOTAL	<0.001					0.020				
IRON (FE) TOTAL	0.300					0.465				
LEAD (PB) TOTAL	0.004					0.003				
MANGANESE (MN) TOTAL	0.020					0.135				
ZINC (ZN) TOTAL	0.003					0.030				
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	7.70					1.90				
PHENOLS	0.008					<0.001				
OTHER PARAMETERS										
OIL AND GREASE	<0.1					<0.2				
CYANIDE (CN)	<0.001					<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-8	CS-8	CS-8	CS-8	CS-8	CS-8
SAMPLE DATE	07/31/84	08/24/84	09/27/84	10/15/85	05/27/86	06/19/86
LOCATION	HNT CR R FK ABV L FK	HNT CR R FK ABV L FK	HNT CR R FK ABV L FK	HNT CR R FK ABV L FK	HNT CR R FK ABV L FK	HNT CR R FK ABV L FK
PHYSICAL PARAMETERS						
AIR TEMPERATURE (C)	20	9	6	11	15	19
FLOW (CFS)	0.65	0.36	0.21	0.34	20.7	3.11
WATER TEMPERATURE (C)	10	7	4	8	6	12
SPEC. COND. (UMHOS/CM) FIELD	243	328	305	292	68	149
PH FIELD	7.2	7.3	7.6	7.3	7.0	7.5
TURBIDITY (NTU) FIELD	25	15	8.1	9.3	33	
TOTAL SUSP. SOLIDS		4.0				
TOTAL DISS. SOLIDS MEAS.		200				
OXYGEN (O) DISS		8.2				
COMMON IONS						
CALCIUM (CA)		52.00				
MAGNESIUM (MG)		8.40				
SODIUM (NA)		17.00				
POTASSIUM (K)		0.72				
ACIDITY AS CACO3		5.20				
ALKALINITY AS CACO3 (LAB)		150				
BICARBONATE (HCO3) (LAB)		183.0				
SULFATE (SO4)		<10				
CHLORIDE (CL)		20.0				
FLUORIDE (F)		0.16				
NUTRIENTS						
NITRATE (NO3-N)		0.18				
AMMONIA (NH3 AS N)		0.08				
TOTAL PHOSPHATE (PO4)		0.02				
TRACE ELEMENTS						
BARIUM (BA) TOTAL		0.02				
BORON (B) TOTAL		0.035				
COPPER (CU) TOTAL		0.013				
IRON (FE) TOTAL		6.20				
LEAD (PB) TOTAL		0.007				
MANGANESE (MN) TOTAL		0.07				
ZINC (ZN) TOTAL		0.041				
ORGANIC PARAMETERS						
ORGANIC CARBON (TOTAL)		<0.01				
PHENOLS		<0.001				
OTHER PARAMETERS						
OIL AND GREASE		<0.10				
CYANIDE (CN)		<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9
SAMPLE DATE	01/27/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/23/81	11/10/81	12/09/81
LOCATION	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	-2	5	16	26	22	24	13	2	2	9
FLOW (CFS)			0.05	0.01	0.01	0.003	0.01	0.01	0.01	0.19
WATER TEMPERATURE (C)	1	3	9	16	17	13	9	1	0	2
SPEC. COND. (UMHOS/CM) FIELD	283	202	440	410	380	500	450	520	500	500
PH FIELD	7.8	8.0	8.4	8.3	8.4	8.1	8.1	7.6	8.0	8.1
TURBIDITY (NTU) FIELD			0.34			0.28			0.28	
TOTAL SUSP. SOLIDS	11.0	6.0	11.0	11.0	1.0	2.0	16.0	15.0	10.0	5.0
TOTAL DISS. SOLIDS MEAS.	302	300	285	270	250	325	288	340	330	335
OXYGEN (O) DISS			10.0	9.0	7.9	8.8	9.2	10.2	10.5	
COMMON IONS										
TOTAL HARDNESS AS CACO3			170							
CALCIUM (CA)	89.60	83.20	60.00	44.80	68.80	80.80	74.40	48.00	86.40	88.50
MAGNESIUM (MG)	17.76	18.72	4.80	14.88	13.44	24.00	10.08	27.36	20.50	20.00
SODIUM (NA)	5.20	5.20	47.00	36.00	8.00	5.20	17.00	49.00	5.40	5.50
POTASSIUM (K)	1.30	1.33	1.48	1.93	1.32	1.28	1.35	1.84	1.35	1.35
ACIDITY AS CACO3			<0.01			<0.01			<0.01	
ALKALINITY AS CACO3 (LAB)			236			242		314	261	270
BICARBONATE (HCO3) (LAB)	336.72	295.24	273	268	254	276	293	383	294	290
CARBONATE AS CO3 (LAB)			7.20							
SULFATE (SO4)	19.0	41.0	16.5	30.0	27.0	68.0	21.0	21.0	59.0	67.0
CHLORIDE (CL)	8.01	8.00	15.20	7.47	9.02	8.31	6.43	5.50	5.80	5.20
FLUORIDE (F)			0.23			0.22			0.19	
NUTRIENTS										
NITRATE (NO3-N)			1.90			1.80			1.75	
NITRITE (NO2-N)			0.02							
AMMONIA (NH3 AS N)		0.20	<0.01	<0.01	0.10	<0.01	0.01	0.02	0.91	0.64
TOTAL PHOSPHATE (PO4)	0.090	<0.001	0.150		0.200	0.160	7.500	3.500	0.340	0.510
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL			<0.001							
ARSENIC (AS) TOTAL			<0.001			<0.001			<0.001	
ARSENIC (AS) DISS			<0.001			<0.001			<0.001	
BARIUM (BA) TOTAL			0.020			0.030			0.018	
BARIUM (BA) DISS			0.015			0.020			0.015	
BORON (B) TOTAL			0.016			0.025			0.025	
BORON (B) DISS			0.010			0.020			0.020	
CADMIUM (CD) TOTAL			<0.001			<0.001			<0.001	
CADMIUM (CD) DISS			<0.001			<0.001			<0.001	
CHROMIUM (CR) TOTAL			<0.001			<0.001			<0.001	
CHROMIUM (CR) DISS			<0.001			<0.001			<0.001	
COPPER (CU) TOTAL			0.140			0.011			<0.001	
COPPER (CU) DISS			<0.001			<0.001			<0.001	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9
SAMPLE DATE	01/27/81	04/08/81	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/23/81	11/10/81	12/09/81
TRACE ELEMENTS										
IRON (FE) TOTAL	0.250	0.260	0.070	0.120	0.085	0.080	0.076	0.220	0.120	0.140
LEAD (PB) TOTAL			<0.001			<0.001			<0.001	
LEAD (PB) DISS			<0.001			<0.001			<0.001	
MANGANESE (MN) TOTAL	0.015	0.010	<0.001	0.010	0.002	0.020	0.010	0.019	0.020	0.018
MERCURY (HG) TOTAL			<0.0002			<0.0002			<0.0002	
MOLYBDENUM (MO) TOTAL			<0.001							
NICKEL (NI) TOTAL			<0.001							
SELENIUM (SE) TOTAL			<0.001			<0.001			<0.001	
SELENIUM (SE) DISS			<0.001			<0.001			<0.001	
SILVER (AG) TOTAL			<0.001			<0.001			<0.001	
SILVER (AG) DISS			<0.001			<0.001			<0.001	
ZINC (ZN) TOTAL			0.007			0.012			0.010	
ZINC (ZN) DISS			0.007			0.010			0.010	
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)						23.0			7.0	
TOTAL COLIFORM (NO./100ML)						1300			94.0	
5 - DAY BOD						1.9			4.0	
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)			3.40			4.60			4.30	
PHENOLS		0.007	0.017	<0.001	0.004	<0.001	<0.001	<0.001	0.003	0.013
OTHER PARAMETERS										
OIL AND GREASE			0.60			1.00			0.20	
CYANIDE (CN)			<0.001			<0.001			<0.001	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9
SAMPLE DATE	05/20/82	06/30/82	07/21/82	08/19/82	09/15/82	10/14/82	11/09/82	06/30/83	07/20/83	08/25/83
LOCATION	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.	RIGHT FORK ECCLES CR.
LOCATION										
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	13	15	23	26	7	5	0	16	16	12
FLOW (CFS)	0.94	0.19	0.17	0.15	0.15	0.12	0.17	0.29	0.08	0.06
WATER TEMPERATURE (C)	5	10	11	13	5	4	1	10	9	10
SPEC. COND. (UMHOS/CM) FIELD	321	500	470	413	394	472	560	472	514	572
PH FIELD	7.8	8.3	7.7	7.4	8.3	8.0	8.1	8.2	7.9	8.0
TURBIDITY (NTU) FIELD	5.7		3.4	20	11	6.2	10.6	14	12	6.6
TOTAL SUSP. SOLIDS	40.0	1.0	26.0	1.0	11.0	30.0	16.0	10.0	1.0	19.0
TOTAL DISS. SOLIDS MEAS.	218	310	269	310	325	322	325	294	318	332
OXYGEN (O) DISS				9.3						5.8
COMMON IONS										
CALCIUM (CA)	64.80	92.50	74.40	78.40	90.40	88.00	91.20	77.60	83.20	88.00
MAGNESIUM (MG)	9.50	13.00	15.36	20.16	18.24	15.36	14.40	11.52	12.96	16.80
SODIUM (NA)	2.0	4.7	8.5	9.0	5.2	11.9	5.4	8.0	28.0	7.5
POTASSIUM (K)	4.20	1.22	1.18	1.46	1.79	1.80	1.47	16.00	1.2	12.5
ACIDITY AS CACO3				3.0						33.00
ALKALINITY AS CACO3 (LAB)	189		261	265						264
BICARBONATE (HCO3) (LAB)	231	257	318	324	317	329	316	273	342	322
SULFATE (SO4)	18.0	70.0	3.0	<3.0	41.0	30.0	29.0	36.0	36	45
CHLORIDE (CL)	3.00	6.60	6.10	26.20	6.70	7.60	6.50	10.0	8.0	6.0
FLUORIDE (F)				0.21						0.17
NUTRIENTS										
NITRATE (NO3-N)				2.45						<0.02
AMMONIA (NH3 AS N)		0.25		0.05		0.32		<0.1		<0.10
TOTAL PHOSPHATE (PO4)		0.070		0.070		0.080		0.44		0.05
TRACE ELEMENTS										
BARIUM (BA) TOTAL				0.020						0.016
BORON (B) TOTAL				0.025						0.014
COPPER (CU) TOTAL				0.010						<0.001
IRON (FE) TOTAL	0.750	0.170	0.070	0.080	0.300	0.080	0.140	0.450	0.090	0.750
LEAD (PB) TOTAL				0.001						<0.001
MANGANESE (MN) TOTAL	0.085	0.030	0.007	0.010	0.027	0.025	0.012	0.150	0.015	0.030
ZINC (ZN) TOTAL				0.002						0.025
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)				8.20						2.30
PHENOLS		<0.001		<0.001		<0.001		<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE		0.4		0.6		0.8		<0.2		<0.2
CYANIDE (CN)				<0.001						<0.001

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9	CS-9
SAMPLE DATE	09/28/83	10/26/83	11/11/83	04/25/84	05/17/84	06/27/84	07/26/84	08/28/84	09/17/84	10/16/85
LOCATION	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK	RIGHT FORK
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	13	13	3	-6	6	23	14	15	16	6
FLOW (CFS)	0.04	0.03	0.03		8.8	2.7	0.14	0.07	0.06	0.08
WATER TEMPERATURE (C)	9	7	2	0.5	5	11	13	8	15	5
SPEC. COND. (UMHOS/CM) FIELD	570	565	488	441	371	443	528	629	517	545
PH FIELD	7.4	7.6	7.4	7.7	7.7	7.9	7.7	8.0	7.7	7.5
TURBIDITY (NTU) FIELD	13	14	32	39	100+	17	22	20	20	8.5
TOTAL SUSP. SOLIDS	8.0	14.0	25.0	83	3580	8.0	8.0	22.0	15.0	25.0
TOTAL DISS. SOLIDS MEAS.	304	320	320	260	220	298	310	339	336	276
OXYGEN (O) DISS								7.8		
COMMON IONS										
CALCIUM (CA)	83.20	90.40	85.60	36.00	80.00	80.00	79.20	82.00	90.00	88.4
MAGNESIUM (MG)	17.76	17.28	18.72	40.80	<0.10	14.40	19.20	25.00	19.20	14.60
SODIUM (NA)	5.40	5.50	5.10	4.20	4.10	2.60	5.00	16.00	6.40	20.00
POTASSIUM (K)	1.3	1.1	1.2	1.2	4.4	1.0	1.48	1.34	1.56	0.85
ACIDITY AS CACO3								8.0		
ALKALINITY AS CACO3 (LAB)								265		
BICARBONATE (HCO3) (LAB)	285	307	305	297.7	231.8	231.8	300.1	323.3	317.2	348.9
SULFATE (SO4)	47	39	38	4	10	54	30	42	35	32
CHLORIDE (CL)	6.00	10.00	8.00	13.0	6.2	9.8	6.6	4.0	14.0	7.3
FLUORIDE (F)								0.34		
NUTRIENTS										
NITRATE (NO3-N)								2.38		
AMMONIA (NH3 AS N)		<0.01				0.12		0.03		<0.01
TOTAL PHOSPHATE (PO4)		0.10				0.04		0.05		0.12
TRACE ELEMENTS										
BARIUM (BA) TOTAL								0.02		
BORON (B) TOTAL								0.033		
COPPER (CU) TOTAL								0.017		
IRON (FE) TOTAL	0.240	0.095	0.270	0.80	45.10	0.36	0.46	0.50	0.65	0.12
LEAD (PB) TOTAL								<0.001		
MANGANESE (MN) TOTAL	0.027	0.017	0.030	0.08	2.00	0.04	0.50	0.62	0.46	0.16
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)								0.25		
PHENOLS		<0.001				<0.001		<0.001		<0.001
OTHER PARAMETERS										
OIL AND GREASE		<0.2				<0.1		<0.1		0.6
CYANIDE (CN)								<0.001		

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-9	CS-9
SAMPLE DATE	05/28/86	06/24/86
LOCATION	RIGHT FORK	RIGHT FORK
LOCATION	ECCLES CR.	ECCLES CR.
PHYSICAL PARAMETERS		
AIR TEMPERATURE (C)	18	20
FLOW (CFS)	1.78	0.21
WATER TEMPERATURE (C)	8	10.5
SPEC. COND. (UMHOS/CM) FIELD	365	480
PH FIELD	7.7	7.6
TURBIDITY (NTU) FIELD	34	1.77
TOTAL SUSP. SOLIDS	142	13.6
TOTAL DISS. SOLIDS MEAS.	232	270
COMMON IONS		
CALCIUM (CA)	60.40	73.60
MAGNESIUM (MG)	7.90	13.00
SODIUM (NA)	6.69	5.05
POTASSIUM (K)	1.15	1.15
BICARBONATE (HCO3) (LAB)	194.0	251.3
SULFATE (SO4)	29	30
CHLORIDE (CL)	4.3	6.2
NUTRIENTS		
AMMONIA (NH3 AS N)		0.19
TOTAL PHOSPHATE (PO4)		0.05
TRACE ELEMENTS		
IRON (FE) TOTAL	1.09	1.10
MANGANESE (MN) TOTAL	0.08	0.10
ORGANIC PARAMETERS		
PHENOLS		<0.001
OTHER PARAMETERS		
OIL AND GREASE		<0.01

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/24/81	10/22/81	11/10/81	12/08/81	06/30/82	07/21/82
LOCATION	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.
LOCATION	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	17	27	21	10	21	4	9	10	27	21
FLOW (CFS)	4.9	1.13	0.41	0.41	0.40	0.68	0.60		7.9	2.2
WATER TEMPERATURE (C)	11	15	12	10	13	1	2	0	10	9
SPEC. COND. (UMHOS/CM) FIELD	115	170	225	240	330	240	200	230	273	267
PH FIELD	8.2	8.2	8.1	8.1	8.3	7.2	7.9	8.0	7.4	7.7
TURBIDITY (NTU) FIELD	5.60			4.40			4.00		10.5	9.0
TOTAL SUSP. SOLIDS	15.0	<0.1	1.0	6.0	10.0	6.5	1.0	3.0		
TOTAL DISS. SOLIDS MEAS.	75			160			135			
TDS MEAS. @ 180 DEG. C		112	145		213	155		150		
OXYGEN (O) DISS	9.8	10.0	8.8	9.9	10.2	11.5	13.2			
COMMON IONS										
TOTAL HARDNESS AS CACO3	66									
CALCIUM (CA)	21.60	32.80	44.80	45.60	44.00	40.00	40.50	43.00		
MAGNESIUM (MG)	2.88	3.84	5.76	8.16	8.16	4.80	4.50	5.00		
SODIUM (NA)	1.90	3.10	1.80	2.00	1.90	13.00	1.80	1.60		
POTASSIUM (K)	0.51	0.50	0.74	0.86	0.80	1.20	0.85	0.95		
ACIDITY AS CACO3	2.73			3.60			4.00			
ALKALINITY AS CACO3 (LAB)	54			134		126	92	94		
BICARBONATE (HCO3) (LAB)	66	107	132	163	134	154	112	115		
CARBONATE AS CO3 (LAB)	<0.01									
SULFATE (SO4)	9.5	15.0	24.0	13.5	32.0	18.0	25.8	31.0		
CHLORIDE (CL)	4.00	2.11	3.29	2.65	2.26	3.60	3.00	2.60		
FLUORIDE (F)	0.08			0.12			0.07			
NUTRIENTS										
NITRATE (NO3-N)	0.20			0.03			0.10			
NITRITE (NO2-N)	0.02									
AMMONIA (NH3 AS N)	<0.01	<0.01	0.10	<0.01	0.02	<0.01	0.20	0.65		
TOTAL PHOSPHATE (PO4)	0.130		0.180	0.180	6.200	2.500	0.330	1.400		
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	0.020									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.024			0.050			0.030			
BARIUM (BA) DISS	0.020			0.030			0.025			
BORON (B) TOTAL	0.005			0.19			0.015			
BORON (B) DISS	<0.001			0.010			0.010			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	<0.001			0.15			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10
SAMPLE DATE	05/13/81	06/23/81	07/30/81	08/21/81	09/24/81	10/22/81	11/10/81	12/08/81	06/30/82	07/21/82
TRACE ELEMENTS										
COPPER (CU) DISS	<0.001			<0.001			<0.001			
IRON (FE) TOTAL	0.140	0.530	0.850	0.900	0.840	0.920	0.860	0.520		
IRON (FE) TOTAL	0.790									
LEAD (PB) TOTAL	0.001			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	0.030	0.020	0.026	0.050	0.046	0.063	0.060	0.049		
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.010			0.014			0.020			
ZINC (ZN) DISS	0.005			0.011			0.020			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				17.0			<2.0			
TOTAL COLIFORM (NO./100ML)				330			130			
5 - DAY BOD				1.2						
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	2.90			1.00			6.50			
PHENOLS	0.002	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	0.023		
OTHER PARAMETERS										
OIL AND GREASE	<0.01			2.40			0.40			
CYANIDE (CN)	<0.001			<0.001			<0.001			
SULFIDE	<0.01									

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10
SAMPLE DATE	08/18/82	09/15/82	10/15/82	06/28/83	07/19/83	08/24/83	09/27/83	10/20/83	05/24/84	06/26/84
LOCATION	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.
LOCATION	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	21	10	8	16	21	11	15	9	13	14
FLOW (CFS)	0.82	1.10	3.70	13.67	5.25	1.31	2.43	1.00		7.4
WATER TEMPERATURE (C)	11	6	2	12	15	9	9	5	7	10
SPEC. COND. (UMHOS/CM) FIELD	213	210	198	125	152	250	224	232	111	170
PH FIELD	8.3	8.6	8.0	7.8	7.6	6.8	6.4	7.2	7.1	6.3
TURBIDITY (NTU) FIELD	18	11	19	30	18	18	72	19	100+	22
TOTAL SUSP. SOLIDS	5.0					16.0				
TOTAL DISS. SOLIDS MEAS.	160					136				
OXYGEN (O) DISS	8.2									
COMMON IONS										
CALCIUM (CA)	41.60				39.20					
MAGNESIUM (MG)	8.64				5.28					
SODIUM (NA)	1.8				1.6					
POTASSIUM (K)	0.61				1.5					
ACIDITY AS CACO3	2.0				16.00					
ALKALINITY AS CACO3 (LAB)	107					114				
BICARBONATE (HCO3) (LAB)	130					139				
SULFATE (SO4)	14.0					10				
CHLORIDE (CL)	14.70				2.0					
FLUORIDE (F)	0.09				0.06					
NUTRIENTS										
NITRATE (NO3-N)	0.11					<0.02				
AMMONIA (NH3 AS N)	0.14					<0.10				
TOTAL PHOSPHATE (PO4)	0.050					0.04				
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.030				0.021					
BORON (B) TOTAL	0.010				0.013					
COPPER (CU) TOTAL	0.010				0.010					
IRON (FE) TOTAL	1.050				0.855					
LEAD (PB) TOTAL	0.003				0.002					
MANGANESE (MN) TOTAL	0.050				0.085					
ZINC (ZN) TOTAL	0.005				0.020					
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	8.10					1.80				
PHENOLS	0.008					<0.001				
OTHER PARAMETERS										
OIL AND GREASE	0.6					<0.2				
CYANIDE (CN)	<0.001				<0.001					

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-10	CS-10	CS-10	CS-10	CS-10	CS-10
SAMPLE DATE	07/31/84	08/24/84	09/27/84	10/15/85	05/27/86	06/19/86
LOCATION	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.	HUNT.CR.L.
LOCATION	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK	FK ABV R FK
PHYSICAL PARAMETERS						
AIR TEMPERATURE (C)	20	9	6	11	15	19
FLOW (CFS)	2.13	1.11	1.05	0.77		9.23
WATER TEMPERATURE (C)	12	9	9	6	7	13
SPEC. COND. (UMHOS/CM) FIELD	221	117	245	232	74	147
PH FIELD	6.9	6.8	7.2	7.1	6.9	7.6
TURBIDITY (NTU) FIELD	36	23	12.0	8.8	36	
TOTAL SUSP. SOLIDS		13.0				
TOTAL DISS. SOLIDS MEAS.		190				
OXYGEN (O) DISS		8.4				
COMMON IONS						
CALCIUM (CA)		48.00				
MAGNESIUM (MG)		8.40				
SODIUM (NA)		24.00				
POTASSIUM (K)		0.61				
ACIDITY AS CACO3		6.70				
ALKALINITY AS CACO3 (LAB)		150				
BICARBONATE (HCO3) (LAB)		183.0				
SULFATE (SO4)		<10				
CHLORIDE (CL)		20.0				
FLUORIDE (F)		0.13				
NUTRIENTS						
NITRATE (NO3-N)		0.06				
AMMONIA (NH3 AS N)		0.04				
TOTAL PHOSPHATE (PO4)		<0.01				
TRACE ELEMENTS						
BARIUM (BA) TOTAL		0.03				
BORON (B) TOTAL		0.028				
COPPER (CU) TOTAL		0.017				
IRON (FE) TOTAL		2.50				
LEAD (PB) TOTAL		0.041				
MANGANESE (MN) TOTAL		0.11				
ZINC (ZN) TOTAL		0.033				
ORGANIC PARAMETERS						
ORGANIC CARBON (TOTAL)		<0.01				
PHENOLS		<0.001				
OTHER PARAMETERS						
OIL AND GREASE		<0.1				
CYANIDE (CN)		<0.001				

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	05/20/82	06/30/82	07/21/82
LOCATION	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE
LOCATION										
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	15	22	25	17	15	15	0	13	17	22
FLOW (CFS)									1.20	0.11
WATER TEMPERATURE (C)	2.5	11	13	12	9	0	0	2	7	10
SPEC. COND. (UMHOS/CM) FIELD	250	290	300	370	350	450	470	205	270	296
PH FIELD	8.4	8.5	8.5	8.2	8.3	7.6	8.1	7.7	8.2	7.9
TURBIDITY (NTU) FIELD	0.82			4.0			8.50	100+	4.0	58
TOTAL SUSP. SOLIDS	7.0	10.0	4.0	4.0	41.0	30.0	91.0	380	1.0	51.0
TOTAL DISS. SOLIDS MEAS.	165	190	197	240	230	280	304	150	179	235
OXYGEN (O) DISS	11.5	9.6	8.7	9.4		11.0	11.5			
COMMON IONS										
TOTAL HARDNESS AS CACO3	166									
CALCIUM (CA)	51.20	47.20	60.80	65.60	69.60	36.80	73.00	42.40	52.50	56.00
MAGNESIUM (MG)	9.12	16.32	9.60	14.88	12.48	6.72	15.50	6.50	8.20	16.32
SODIUM (NA)	2.30	2.20	2.40	2.80	2.30	67.00	2.50	1.6	2.5	14.0
POTASSIUM (K)	0.72	0.74	0.91	0.96	0.58	3.69	3.80	6.30	0.60	0.70
ACIDITY AS CACO3	<0.01			<0.01			<0.01			
ALKALINITY AS CACO3 (LAB)	154			198		267	229	123		235
BICARBONATE (HCO3) (LAB)	178	265	207	224	251	325	255	150	177	287
CARBONATE AS CO3 (LAB)	4.80									
SULFATE (SO4)	7.5	19.5	20.0	38.0	18.0	3.0	38.9	17.0	20.0	3.0
CHLORIDE (CL)	6.00	3.00	3.77	3.56	2.87	3.60	3.60	1.20	0.80	2.80
FLUORIDE (F)	0.13			0.17			0.12			
NUTRIENTS										
NITRATE (NO3-N)	0.23			<0.01			0.14			
NITRITE (NO2-N)	0.02									
AMMONIA (NH3 AS N)	<0.01	<0.01	<0.01	<0.01		0.04	0.10		0.25	
TOTAL PHOSPHATE (PO4)	0.110		0.210	0.170	0.540	0.420	0.660		0.080	
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL	<0.001									
ARSENIC (AS) TOTAL	<0.001			<0.001			<0.001			
ARSENIC (AS) DISS	<0.001			<0.001			<0.001			
BARIUM (BA) TOTAL	0.030			0.025			0.28			
BARIUM (BA) DISS	0.015			0.020			0.015			
BORON (B) TOTAL	0.015			0.015			0.020			
BORON (B) DISS	0.010			0.010			0.015			
CADMIUM (CD) TOTAL	<0.001			<0.001			<0.001			
CADMIUM (CD) DISS	<0.001			<0.001			<0.001			
CHROMIUM (CR) TOTAL	<0.001			<0.001			<0.001			
CHROMIUM (CR) DISS	<0.001			<0.001			<0.001			
COPPER (CU) TOTAL	0.010			0.017			<0.001			
COPPER (CU) DISS	0.010			<0.001			<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11
SAMPLE DATE	05/12/81	06/23/81	07/29/81	08/20/81	09/25/81	10/22/81	11/11/81	05/20/82	06/30/82	07/21/82
TRACE ELEMENTS										
IRON (FE) TOTAL	0.020	0.150	0.115	0.330	0.159	0.133	0.165	5.150	0.100	1.280
IRON (FE) TOTAL	0.110									
LEAD (PB) TOTAL	0.002			<0.001			<0.001			
LEAD (PB) DISS	<0.001			<0.001			<0.001			
MANGANESE (MN) TOTAL	0.010	0.010	0.015	0.030	0.021	0.020	0.025	0.077	0.002	0.020
MERCURY (HG) TOTAL	<0.0002			<0.0002			<0.0002			
MOLYBDENUM (MO) TOTAL	<0.001									
NICKEL (NI) TOTAL	<0.001									
SELENIUM (SE) TOTAL	<0.001			<0.001			<0.001			
SELENIUM (SE) DISS	<0.001			<0.001			<0.001			
SILVER (AG) TOTAL	<0.001			<0.001			<0.001			
SILVER (AG) DISS	<0.001			<0.001			<0.001			
ZINC (ZN) TOTAL	0.007			0.014			0.024			
ZINC (ZN) DISS	0.007			0.010			0.016			
BACTERIOLOGICAL PARAMETERS										
FECAL COLIFORM (NO./100ML)				79.0			<2.0			
TOTAL COLIFORM (NO./100ML)				220			330			
5 - DAY BOD				1.4						
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	2.40			9.70			11.50			
PHENOLS	0.010	<0.001	0.009	0.164		0.028	10.220		<0.001	
OTHER PARAMETERS										
OIL AND GREASE	<0.01			1.20			<0.01		0.2	
CYANIDE (CN)	<0.001			<0.001			0.002			
SULFIDE	0.92									

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987
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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11
SAMPLE DATE	08/19/82	09/15/82	10/14/82	11/09/82	06/29/83	07/20/83	08/25/83	09/28/83	10/26/83	11/11/83
LOCATION	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE	ECCLES CR. ABV MINE
LOCATION										
PHYSICAL PARAMETERS										
AIR TEMPERATURE (C)	22	6	-2	0	16	16	8	14	7	2
FLOW (CFS)	0.04	0.15	0.14		2.03	0.52	0.38	0.14	0.11	0.11
WATER TEMPERATURE (C)	10	3	1	0	9	8	7	7	3	1
SPEC. COND. (UMHOS/CM) FIELD	380	320	309	478	282	375	454	459	443	403
PH FIELD	8.5	8.4	7.8	8.0	8.1	7.9	8.0	7.9	7.9	7.9
TURBIDITY (NTU) FIELD	100+	56	84	69	61	22	23	42	11	42
TOTAL SUSP. SOLIDS	297	84.0	218	137	55.0	1.0	27.0	22.0	29.0	26.0
TOTAL DISS. SOLIDS MEAS.	268	245	250	270	184	240	248	230	300	260
OXYGEN (O) DISS	10.7						5.0			
COMMON IONS										
CALCIUM (CA)	69.60	72.00	74.40	75.20	48.80	62.40	70.40	72.00	73.60	73.60
MAGNESIUM (MG)	14.88	11.04	12.48	14.40	6.72	8.16	12.00	13.92	14.40	15.84
SODIUM (NA)	13.0	3.5	4.0	2.9	11.0	20.0	7.5	2.50	21.00	2.50
POTASSIUM (K)	1.00	1.27	1.30	1.13	0.64	0.8	0.6	1.1	0.9	0.9
ACIDITY AS CACO3	<0.01						33.00			
ALKALINITY AS CACO3 (LAB)	239						230			
BICARBONATE (HCO3) (LAB)	292	279	277	269	185	249	281	256	268	281
SULFATE (SO4)	<3.0	<0.1	18.0	27.0	12.0	28	10	27	58	16
CHLORIDE (CL)	19.80	5.90	2.50	3.00	8.0	4.0	2.0	2.00	4.00	4.00
FLUORIDE (F)	0.17						0.10			
NUTRIENTS										
NITRATE (NO3-N)	0.20						<0.02			
AMMONIA (NH3 AS N)	0.17		0.30		<0.1		1.5		<0.01	
TOTAL PHOSPHATE (PO4)	0.270		0.150		0.30		0.10		0.05	
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.030						0.011			
BORON (B) TOTAL	0.015						0.011			
COPPER (CU) TOTAL	<0.001						0.010			
IRON (FE) TOTAL	3.330	1.550	1.870	1.520	0.900	0.210	0.850	1.070	0.230	0.480
LEAD (PB) TOTAL	0.004						0.003			
MANGANESE (MN) TOTAL	0.125	0.095	0.090	0.100	0.022	0.025	0.060	0.088	0.029	0.070
ZINC (ZN) TOTAL	0.055						0.016			
ORGANIC PARAMETERS										
ORGANIC CARBON (TOTAL)	21.00						1.70			
PHENOLS	<0.001		<0.001		<0.001		<0.001		<0.001	
OTHER PARAMETERS										
OIL AND GREASE	0.6		<0.1		<0.2		<0.1		<0.2	
CYANIDE (CN)	<0.001						<0.001			

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested. Output Date: 02-09-1987

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SUMMARY OF WATER QUALITY ANALYSIS - UTAH FUEL CO.

SITE NAME	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11	CS-11
SAMPLE DATE	05/24/84	06/27/84	07/26/84	08/28/84	09/17/84	10/16/85	05/28/86	06/25/86
LOCATION	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.	ECCLES CR.
LOCATION	ABV MINE	ABV MINE	ABV MINE	ABV MINE	ABV MINE	ABV MINE	ABV MINE	ABV MINE
PHYSICAL PARAMETERS								
AIR TEMPERATURE (C)	17	24	18	13	17	0	8	14
FLOW (CFS)		2.2	0.40	0.37	0.07			0.97
WATER TEMPERATURE (C)	6	11	13	8	11	1	3	7
SPEC. COND. (UMHOS/CM) FIELD	250	340	362	504	401	417	194	335
PH FIELD	7.4	7.5	7.6	8.2	8.2	7.6	7.6	7.6
TURBIDITY (NTU) FIELD	100+	38	100+	30	24	15	47	2.90
TOTAL SUSP. SOLIDS	201	18.0	236	19.0	20.0	15.0	142	2.0
TOTAL DISS. SOLIDS MEAS.	160	280	230	310	262	250	128	172
OXYGEN (O) DISS				8.0				
COMMON IONS								
CALCIUM (CA)	24.00	76.00	85.60	74.00	78.00	97.60	39.60	53.60
MAGNESIUM (MG)	25.20	14.50	<0.01	20.40	13.20	4.80	5.50	7.20
SODIUM (NA)	1.50	2.10	2.50	11.00	8.10	1.70	5.36	1.98
POTASSIUM (K)	0.7	0.7	1.28	0.81	1.00	0.86	0.35	0.68
ACIDITY AS CACO3				6.00				
ALKALINITY AS CACO3 (LAB)				240				
BICARBONATE (HCO3) (LAB)	170.8	146.4	230.6	292.3	298.9	298.9	133.0	185.4
SULFATE (SO4)	24	118	24	26	21	16	0.18	12
CHLORIDE (CL)	<0.1	1.9	1.5	4.0	4.0	2.8	1.9	1.7
FLUORIDE (F)				0.27				
NUTRIENTS								
NITRATE (NO3-N)				0.18				
ORTHO-PHOSPHATE (PO4-P)				26				
AMMONIA (NH3 AS N)		0.21		0.03		<0.01		0.30
TOTAL PHOSPHATE (PO4)		0.05		0.02		0.08		<0.01
TRACE ELEMENTS								
BARIUM (BA) TOTAL				0.03				
BORON (B) TOTAL				0.041				
COPPER (CU) TOTAL				0.021				
IRON (FE) TOTAL	3.52	0.69	8.50	9.10	0.40	0.10	0.99	1.05
LEAD (PB) TOTAL				0.002				
MANGANESE (MN) TOTAL	0.12	0.03	0.27	0.06	0.05	0.04	0.07	0.05
ORGANIC PARAMETERS								
ORGANIC CARBON (TOTAL)				0.30				
PHENOLS		<0.001		<0.001		<0.001		<0.001
OTHER PARAMETERS								
OIL AND GREASE		<0.1		<0.1		0.8		<0.1
CYANIDE (CN)				<0.001				

All quantities in milligrams per liter unless otherwise noted. BlanK line indicates parameter not tested.

Output Date: 02-09-1987
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