INSPECTION REPORT

Sedimentation Structure

TPF-D

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure TPF-D is a partially incised structure with an earthen embankment, designed and constructed in 1984 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Kayenta Mine. The location of Structure TPF-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure TPF-D. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure TPF-D was inspected on September 5, 1985 by an interdisciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the TPF-D project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure TPF-D has a 267.1-acre tributary drainage area and is located near Yellow Water Canyon at the Kayenta Mine. The watershed is classified as 96% Pinion/Juniper and 4% disturbed.

EMBANKMENT

Structure TPF-D is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure TPF-D

Embankment	Residual Sandstone Soils/Sandstone
Foundation	Sandstone
Right Abutment	Residual Sandstone Soils/Sandstone
Left Abutment	Residual Sandstone Soils/Sandstone
Height	19.9 ft
Crest Width	42 ft
Upstream Slope	2.1 H : 1 V
Downstream Slope	4.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section TPF-D, A-A'.

ANALYSES

STABILITY

Structure TPF-D is a category A-5 embankment. A standard category A-5 embankment has static and seismic factors of safety equal to or greater than 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 30 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 4.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The TPF-D embankment is lower in height and has flatter slopes than the category standard; therefore, the embankment has factors of safety greater than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure TPF-D is located upstream from Structure TPF-A and downstream from proposed Structure TPF-E. TPF-E and TPF-D have a combined storage capacity that is greater than 20 acre-feet. Therefore, the spillway for TPF-D was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure TPF-D was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

		10-Year, 24-hour Storm	100-year, 6-hour Storm	
1.	Water Course length, L	0.97	0.97	mi
2.	Elevation Difference, H	626	626	ft
3.	Time of Concentration, T_c . . .	0.210	0.210	h
4.	Lag time, $0.6T_c$	0.126	0.126	h
5.	SCS Curve Number	83	84	
6.	Rainfall Depth	2.1	2.4	in.
7.	Drainage Area	267.1	330.6	acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. The 10-year, 24-hour storm was routed through Structure TPF-E and into TPF-D. The 100-year storm was analyzed without TPF-E. The initial conditions and results of the analysis are summarized in the following table.

TPF-D HYDRAULICS

	Units	10-year 24-hour Storm	100-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	283	748
Volume	acre-ft	16.69	27.27
Storage			
Peak Stage	ft	6716.15	--
Spillway Elevation . .	ft	6719.91	--
Peak Storage	acre-ft	16.69	--
Incised Storage Capacity	acre-ft	2.19	--
Active Storage Capacity	acre-ft	18.41	--
Total Storage Capacity	acre-ft	20.60	--
Outflow			
Peak Flow	cfs	0	630
Embankment Crest Elevation	ft	—	6726.88
Peak Stage	ft	--	6723.90
Freeboard	ft	--	2.98
Spillway Channel			
Flow Depth	ft	--	3.99
Critical Velocity. . .	fps	—	7.8
Manning's "n"		—	0.040
Outflow Channel			
Slope	%	--	21
Normal Velocity. . . .	fps	--	17.1
Normal Depth	ft	--	1.11
Manning's "n"		--	0.040

Spillway Channel

The existing spillway for TPF-D has a trapezoidal channel with the following dimensions:

Channel depth	12 ft
Channel width	30 ft
Channel length	70 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	0 percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for TPF-D has a trapezoidal channel with the following dimensions:

Channel width	30 ft
Channel length	250 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	21 percent

Rock provides some, however inadequate erosion protection within the channel. The outflow channel also has a stilling basin which needs to be enlarged.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and

1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, TPF-D.

The calculations for the sediment load entering Structure TPF-D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.14
3. Slope Factor, LS 18.70
4. Cover Factor, C 0.174
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of TPF-D and the results of the sediment inflow analysis are summarized in the following table.

TPF-D STORAGE

Total Storage Capacity	20.60	acre-ft
10-year, 24-hour Storm Inflow	16.69	acre-ft
Available Sediment Storage Capacity . .	3.91	acre-ft
Sediment Inflow Rate	2.14	acre-ft/yr
Sediment Storage Life	2	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure TPF-D indicated that the only geotechnical problems consist of rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway channel and the left abutments. Some sloughing was noted on the right abutment. Correction of erosion and sloughing is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure TPF-D are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. A trapezoidal outflow channel and a stilling basin should be constructed along the alignment B-B' shown in Plate 1. The channel and stilling basin profile is shown in Plate 4 and the required dimensions are shown in Plate 5 and Plate 6. The spillway, outflow channel and stilling basin should be protected against erosion using geotextile and riprap as shown in Plate 5.

* * *

The following plates and appendix are attached and complete this inspection report.

Plate 1 - Site Plan TPF-D

Plate 2 - Existing Maximum Cross Section TPF-D, A-A'

Plate 3 - Volume-Elevation Curve TPF-D

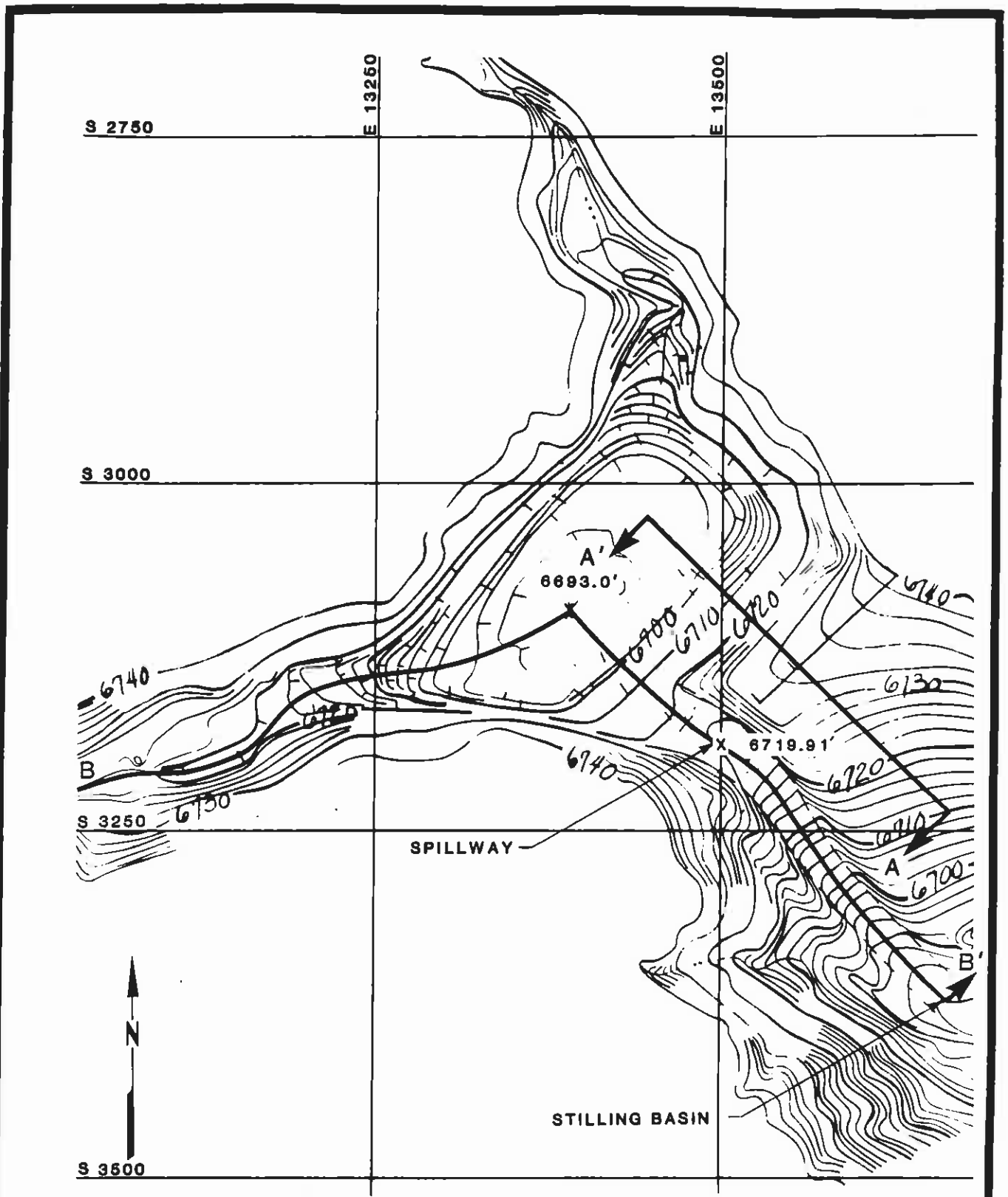
Plate 4 - Channel Profile TPF-D, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section TPF-D

Plate 6 - Spillway Stilling Basin Plan TPF-D

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



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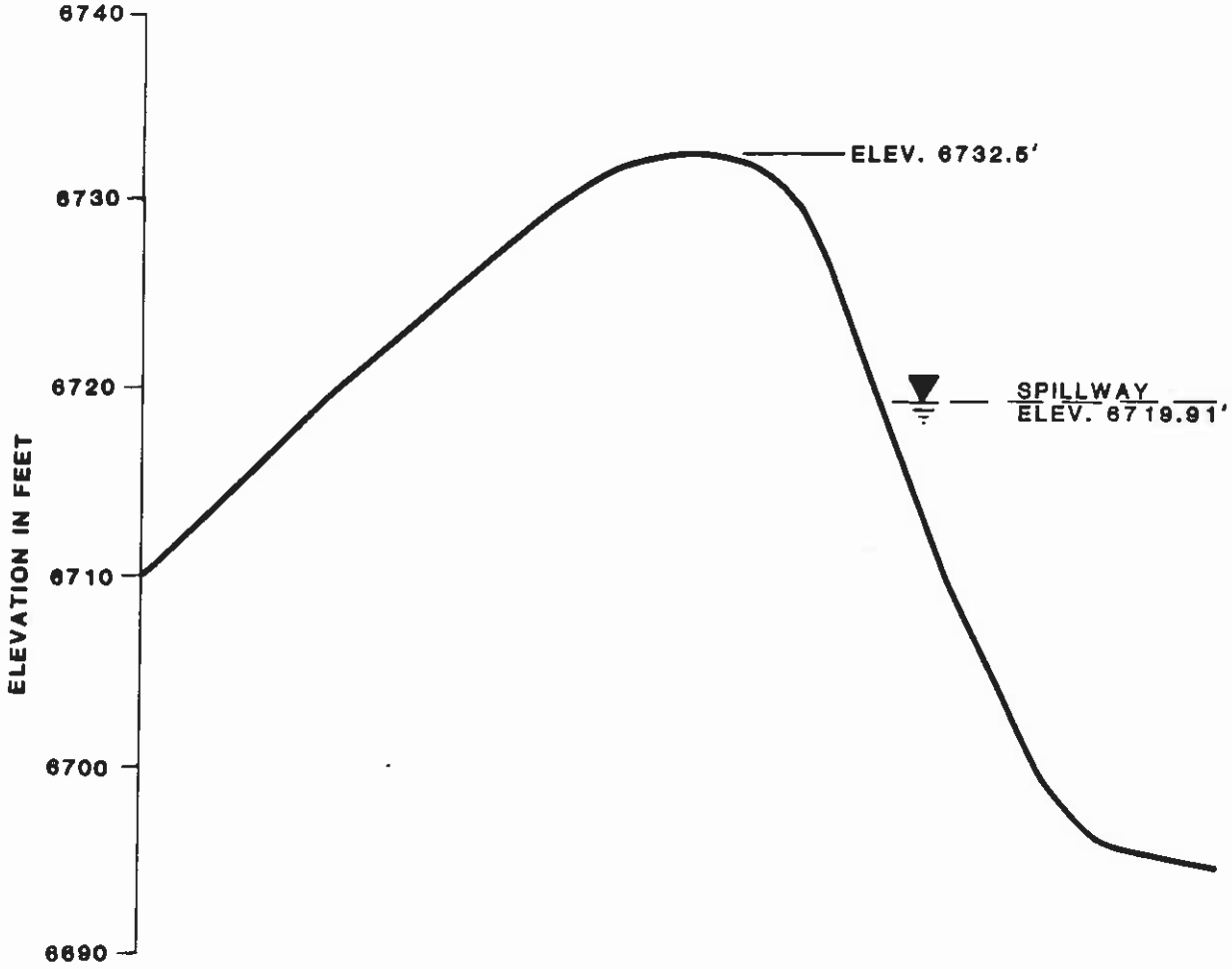
FEET

SITE PLAN
TPF-D

BY **Dames & Moore** Plate 1



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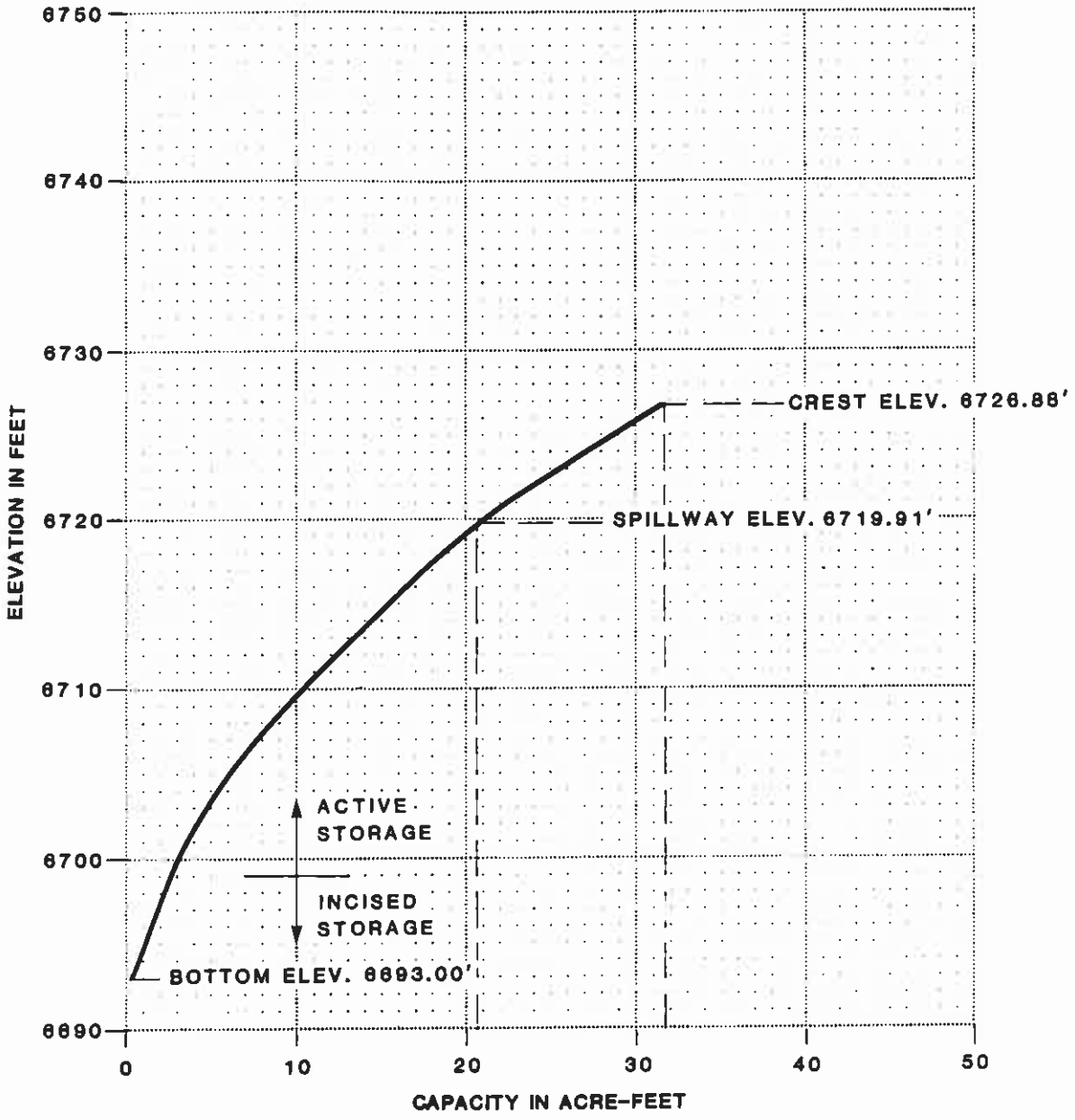
EXISTING MAXIMUM CROSS-SECTION A-A' TPF-D

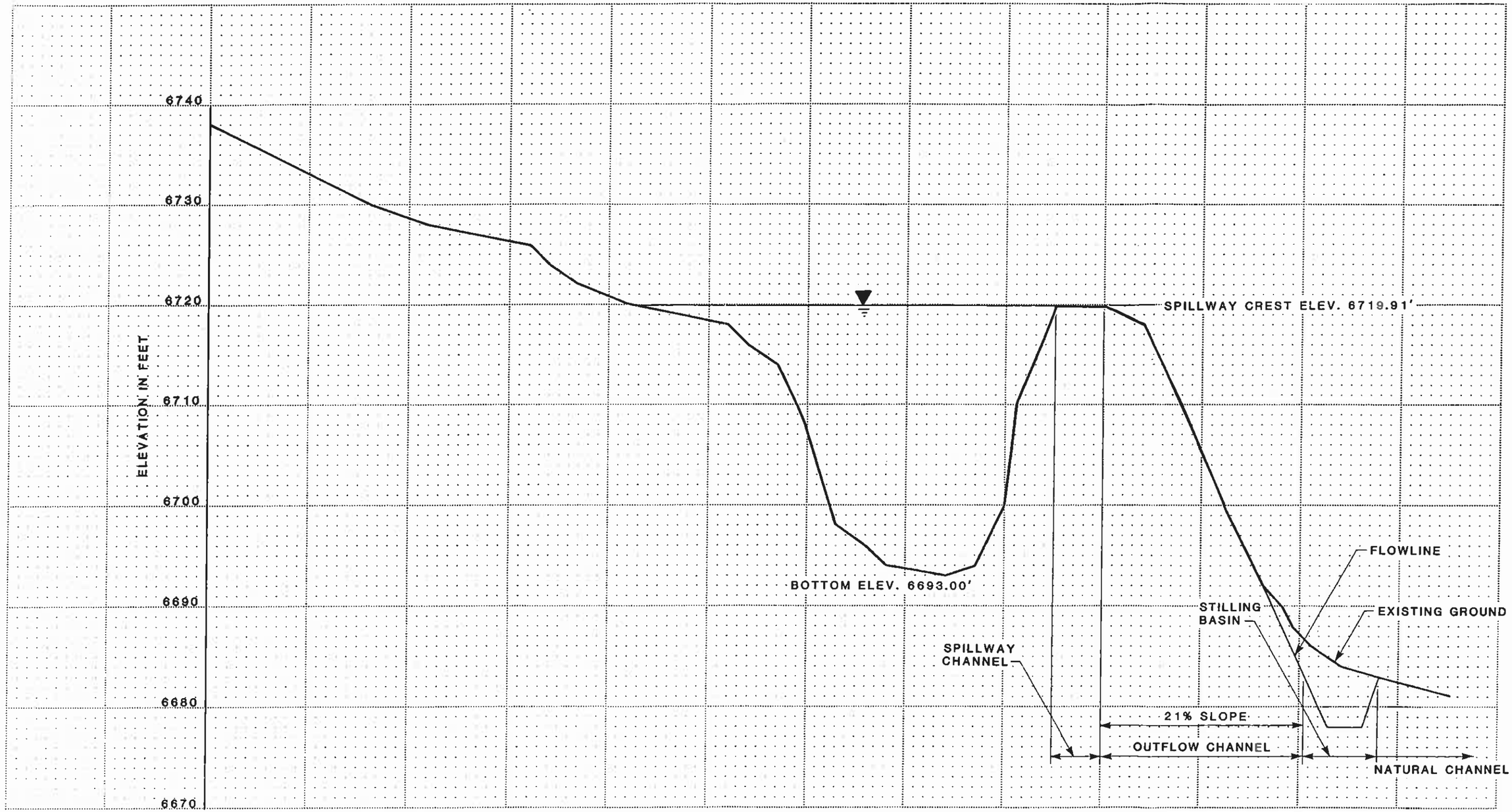
FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE TPF-D

BY **Dames & Moore** Plate 3



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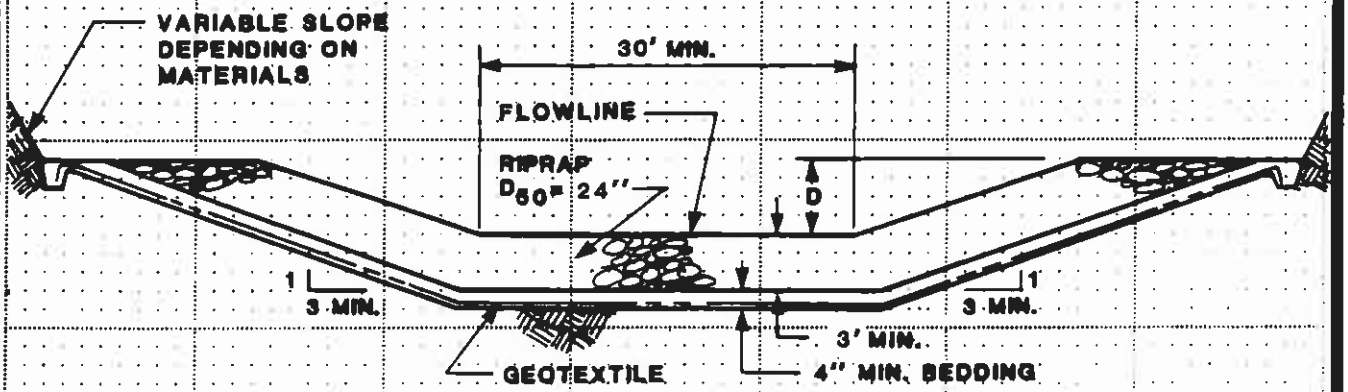
CHANNEL PROFILE B-B'
TPF-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 6.0'

LENGTH = 50'

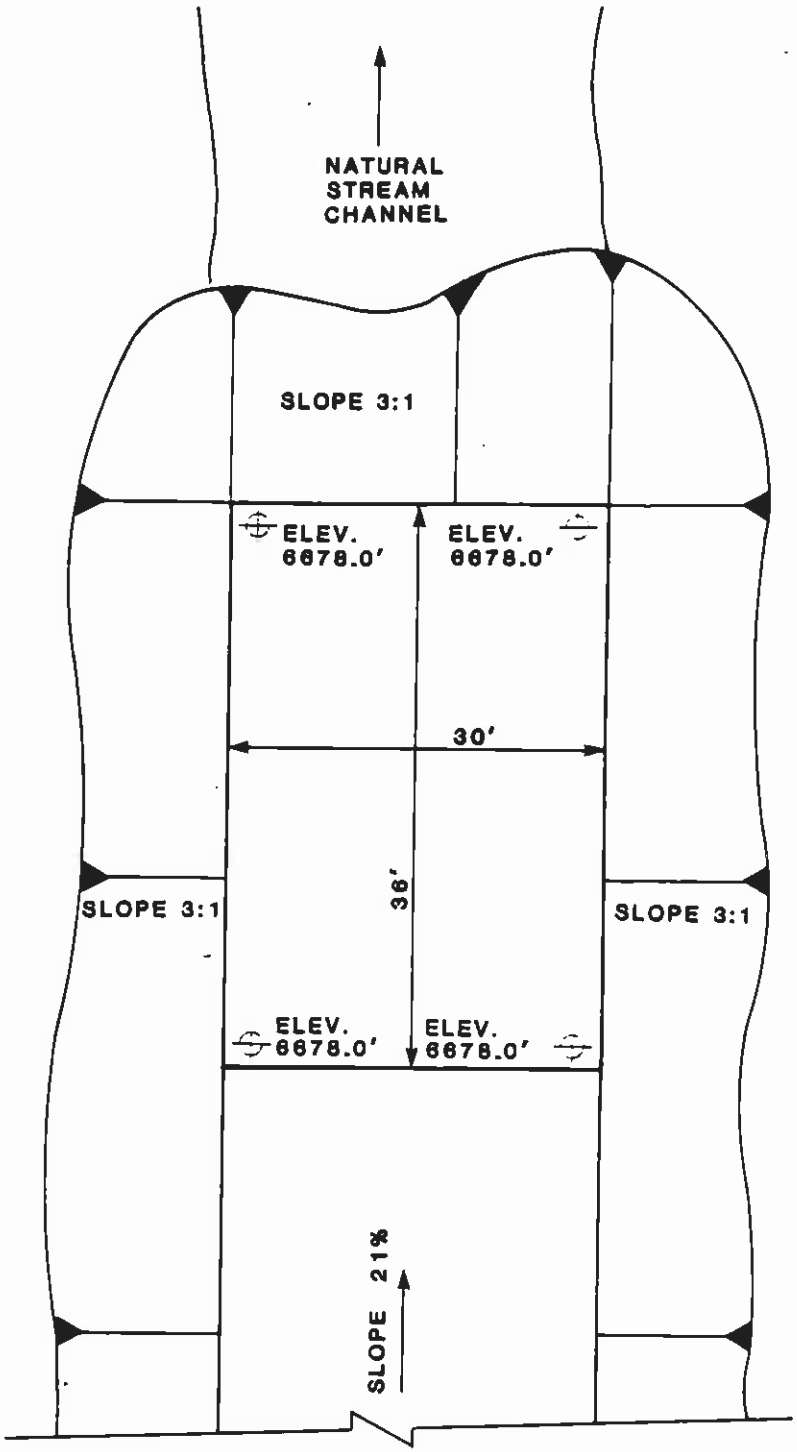
FLOWLINE ELEV.= 6719.91'

OUTFLOW CHANNEL

D = 2.5'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION TPF-D

BY **Dames & Moore** Plate 5



MINIMUM HEIGHT OF RIPRAP ALONG SIDEWALLS ABOVE THE BASIN FLOOR = 9.7'

MINIMUM DEPTH OF BASIN FLOOR BELOW NATURAL STREAMBED = 5.7'

SPILLWAY STILLING BASIN PLAN TPF-D

BY **Dames & Moore** Plate 6

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			slightly rounded 42' W
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			26°
a. Adequate grass cover?		X	
b. Any erosion?	X		Gullys & Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?		X	
g. Any stone deterioration?			NA
h. Visual depressions or bulges?	X		slope racked (construction)
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			12°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?			NA
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Fill above natural Rock
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		
b. Visual differential movement?	X		Slough &/or erosion in to spillway
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brown Mt

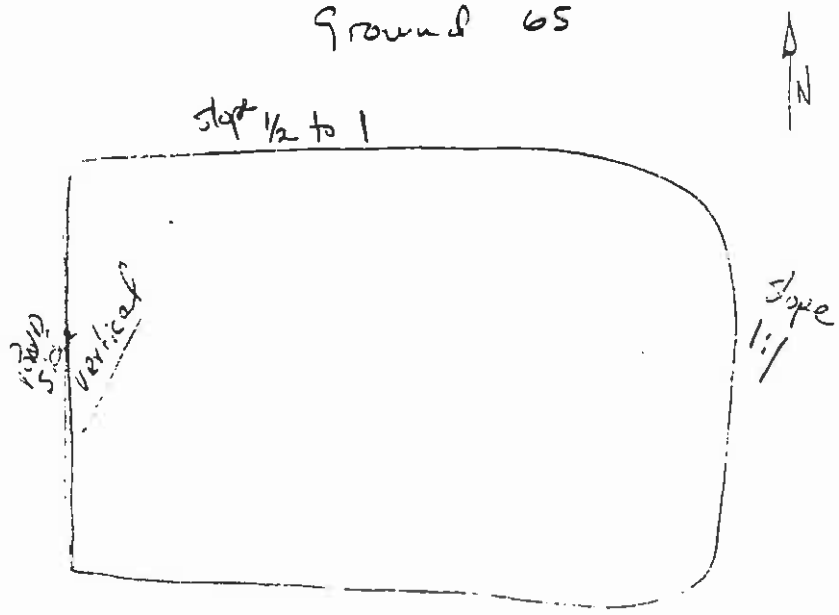
ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Toward R.A.
b. Approach Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		30'W 70'L 12' below crest
Are side slopes eroding?	X		Rills & gullies
Are side slopes sloughing?	X		R.A. slope
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		12° 30'W trapezoidal
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		Rock 9" D-50
e. Weir:		X	
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?	X		(Elev.) feet
c. Siltation?	X		Suspected
d. Watershed matches soil map?	X		

9. GENERAL COMMENTS

Need vegetating, flatten F.A. slope

CANOPY 75
Ground 65



APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO. 10139-011-27
SUBJECT SEDIMENT POND HYDROLOGY
BY TPF-D SHEET ___ OF ___
11 NOV 1985

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 7346 − 6720 = 626 ft.

WATER COURSE LENGTH = 12.8(400) = 5120 ft. = 0.97 mi.

$T_c = \left(\frac{11.9(0.97)^3}{626}\right)^{0.385} = 0.21$ hr. ≈ same

LAG TIME = $0.6 T_c$ = 0.126 hr. "

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
~~191.9~~ 255.7	P-J	average	D	83(~~94~~).96
3.50	DISTURBED (CONVEYOR)		D	94(~~98~~).01
7.89	PAVED ROAD		D	.93(~~98~~) .02
				~~83.42~~ 82.5

EH #30 100%

USE ~~84.0~~ 83

add 63.8 acres of PJ

DRAINAGE BASIN AREA

~~203.5~~ 267.1 ACRES ~~.318~~ .417 SQ. MILES

REVISIONS BY DATE TO ED BY DATE TO ED BY DATE

BY DATE CHECKED BY COPY TO ED

Dames & Moore

FILE PEABODY COAL CO 1039-011-22
SUBJECT SEDIMENT INFLOW
TPF-D SHEET ___ OF ___
7 NOV 1985

UNIVERSAL SOIL LOSS EQUATION

REVISIONS BY ___ DATE ___ TO EO ___ BY ___ DATE ___ TO EO ___

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EM #30

K = .14

SLOPE FACTOR

off sheet *

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
800	150	18.8	10.4 (.15)
800	320	40	22.5 (.23)
500	270	54	20 (.15)
700	290	41.4	21.0 (.15)
450	160	36	20 (.18)
700	130	18.6	9.8 (.06)
400	250	62.5	20 (.08)

18.7

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
4%	disturbed	—	—	.04 (1.0)
96%	P-J	40	25	.96 (.14)

C = .174

EROSION CONTROL FACTOR

P = 1.0

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

SEDIMENT INFLOW

$A = 40(.14)(18.7)(.174)(1.0) = 18.22$ ton/acre/year

$A = 18.22\left(\frac{1}{2047}\right)(267.1)(.9) = 2.14$ acre-feet/year

Dames & Moore

TPF-D & TPF-E
COMBINED
FOR 100-YR STORM
TPF-D SPILLWAY DESIGN

FILE PEABODY COAL CO. 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
TPF-D SHEET ___ OF ___

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 7346 - 6720 = 626'

WATER COURSE LENGTH = 12.8 (400') - 5120' = 0.970 mi

$T_c = \left(\frac{11.9\,(0.970)^3}{626}\right)^{0.385} = 0.210$ hr. ck

LAG TIME = $0.6\,T_c$ = 0.126 hr. ck

REVISIONS
BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
TPF-D	191.9	P-J	ave.	D	83 (0.58) = 48.14
	3.5	DIST.		D	94 (0.01) = 0.94
	7.89	Paved Road		D	93 (0.03) = 2.79
TPF-E	119.8	P-J	ave	D	83 (0.36) = 29.88
	7.5	DIST.		D	94 (0.02) = 1.88
					83.6

USGS 84

DRAINAGE BASIN AREA

330.6 ACRES 0.517 SQ. MILES EAST ~~WEST~~

TPF-D 203.3 OLD (NOW INCLUDES TPF-E
TPF-G 127.3 = 63.5 (WEST) + 63.8 (EAST)
330.6

BY S. DOLAN DATE 11-7-85
CHECKED BY G. Dewitt DATE 10/4/85
COPY TO EO ___