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ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

SUPPLEMENTAL HYDROLOGIC INFORMATION FOR THE SEDIMENTATION PONDS AT HIAWATHA AND MOHRLAND, UTAH

FOR

UNITED STATES FUEL COMPANY

MAY 1979

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GENERAL

This report presents modifications to the hydrologic report submitted by Vaughn Hansen Associates (VHA) to the United States Fuel Company entitled "Surface Hydrologic and Culvert Adequacy of the Hiawatha and Mohrland, Utah Areas" dated August, 1978.

The basic hydrologic data prepared by VHA are assumed correct and are used in this report. Changes presented herein to the VHA report pertain to recent modifications of the regulations, different assumptions, and different analysis methodology. The following sections will discuss details of the changes as they pertain to required sediment storage capacity, peak flows for spillway design and water storage capacity of the sedimentation ponds.

SEDIMENT STORAGE

The Federal Register, Vol. 44, No. 50 dated March 13, 1979 states that the required sediment storage is to be 0.1 acre feet for each acre of disturbed area instead of 0.2 acres feet as previously required. Sediment storage volumes as given in the VHA report were therefore cut in half.

PEAK FLOWS FOR SPILLWAY DESIGN

Peak flows were estimated using the composite triangular hydrograph method oulined in "Design of Small Dams" (Water Resources Technical Publication dated 1973 by the U.S. Bureau of Reclamation).

The peak flow was figured for a 25-year return period, 6-hour storm. Curve numbers (CN) were estimated as a composite using 70 for undisturbed areas and 90 for disturbed areas. The composite CN for a watershed was estimated as an area weighted CN.

STORM VOLUME

Storm volume used to design 24-hour retention times for the required 10-year storm return period were also modified using the less conservative curve numbers estimated as explained in the previous section.

PRESENTATION OF RESULTS

The composite curve numbers are calculated in Table 1.

Hydrologic characteristics of the various watershed are shown in Table 2. The basic hydrologic data in the table came from the VHA report. Calculated characteristics were derived using the curve numbers from Table 1.

A summary of the sedimentation pond storage requirements and design spillway flows are shown in Table 4.

The design rainfall presented in Table 3 for the 25-year, 6-hour storm was calculated according to procedures in "Design of Small Dams" using the rainfall amount in the VHA report. Typical hydrographs for the peak flows are shown in Figures 1-3. Because the small watersheds studied have such short peaking times (T_p) with respect to the component periods (D), Figures 2 and 3 show that the component hydrograph peaks are not additive, therefore, most of the peaks are taken from Table 5-12, instead of from hydrographs.

TABLE 1

Calculation of Composite CN's for Selected Watersheds
Near Hiawatha, Utah

Site	Disturbed Area Acres 2	CN 3	Natural Watershed Acres 4	CN 5	Total Area Acres 6	CN* 7	S 8
Hiawatha Man Yard	30.0	90	40	70	70.0	79	2.73
Slurry Ponds 3 & 4	8.3	90	-	-	8.3	90	1.11
Slurry Pond 5-South	6.8	90	-	-	6.8	90	1.11
Slurry Pond 5-North	12.1	90	-	-	12.1	90	1.11
Hiawatha Refuse Pile	4.4	90	-	-	4.4	90	1.11
Upper Coal Storage Yard	6.0	90	8	70	14.0	79	2.73
Middle Fork Yard	4.8	90	18.2	70	23.0	74	3.48
South Fork Yard	7.6	90	83.4	70	91.0	72	3.95
Lower Mohrland Yard	6.9	90	3.1	70	10.0	84	1.93
Upper Mohrland yard-upper	1.4	90	4.0	70	5.4	75	3.30
Upper Mohrland yard-lower	0.8	90	59.2	70	60.0	70	4.23
Upper Mohrland yard-combined	2.2	90	62.80	70	65.0	71	4.15

Col. 2, 4 and 6 from Vaughn Hansen Associates (August 1978)

$$\text{Composite CN} = \frac{\text{Col 2} \times \text{Col 3} + \text{Col 4} \times \text{Col 5}}{\text{Col 2} + \text{Col 4}}$$

$$S = \frac{1000}{\text{Col 7}} - 10$$

Middle Fork Yard

Scale

U.M. → .0011 v.u. = ~~26.5~~ 10.02 ac

L.M → 0019 v.u. = 17.31

U.S.Y. → 0009 v.u. = 8.2

MF → 0014 v.u. = 12.75

Hiawatha # 5a

Scale 1" = 200; 1 v.u. = .01 ac

1359 v.u. = 13.59 ac.

Hiawatha # 5b

Scale 1" = 200'; 1 v.u. = .01 ac

1207 v.u. = 12.07 ac.

Hiawatha 3 & 4

Scale 1" = 200'; 1 v.u. = 0.01 ac

1040 v.u. = 10.40 ac

Hiawatha # 1

Scale 1" = 100' 1 V.U. = 100 sq ft

1773 v.u. = 4.07 ac

Lower Mohrland Yard

Scale 1" = 200'; 1 v.u. = 0.01 ac

3627 v.u. = 36.27 ac

Upper Coal Storage yard

Scale 1" = 200'; 1 v.u. = 0.01 ac

2226 v.u. = 22.26 ac

Middle Fork yard

Scale 2.65"/mi =

0118 v.u. = 107 ac

Upper Mohrland yard

Scale 2.65"/mi =

0112 v.u. = 102 ac

TABLE 2

Hydrologic Characteristics of Selected Watersheds
Near Hiawatha, Utah

Site	Area	Length of Water Course	Elevation Difference	CN	S	Tc	Tp	qp
	Acres	Ft	Ft			Hrs	Hrs	Cfs
	2	3	4	5	6	7	8	9
Hiawatha Main Yard	70.0	4860	670	79	2.73	.19	.37	145
Slurry Pond 3 & 4	8.3	1390	279	90	1.11	.06	.29	22
Slurry Pond 5-South	6.8	1210	333	90	1.11	.05	.28	18
Slurry Pond 5-North	12.1	1910	265	90	1.11	.09	.31	30
Hiawatha Refuse Pile	4.4	640	65	90	1.11	.05	.28	12
Upper Coal Storage Yard	14.0	1650	322	79	2.73	.07	.29	36
Middlefork Yard	23.0	1400	626	74	3.48	.05	.28	63
South Fork Yard	91.0	3300	1998	72	3.95	.08	.30	231
Lower Mohrland Yard	10.0	1360	482	84	1.93	.05	.28	27
Upper Mohrland Yard-Upper	5.4	1200	966	75	3.30	.03	.27	15
Upper Mohrland Yard-Lower	60.0	3000	2020	70	4.23	.07	.29	155
Upper Mohrland Yard-Combined	65.0	3000	1992	71	4.15	.07	.29	167

Col. 2, 3 and 4 from Vaughn Hansen Associates (1978)

Col. 5 and 6 from Table 1.

$$\text{Col. 7} = \left[\frac{11.9}{\text{Col 4}} \times \left(\frac{\text{Col 3}}{5280}\right)^{3}\right]^{0.385}$$

$$\text{Col. 8} = \frac{0.50}{2} + 0.6 \times \text{Col 7}$$

$$\text{Col. 9} = \frac{484 \times \text{Col 2} \times 1}{640 \times \text{Col 8}}$$

(Col 9 is the peak discharge for 1 inch of runoff)

TABLE 3

DESIGN RAINFALL ANALYSIS
25 YEAR 6 HOUR EVENT

Item	Duration, Hour 1	2	3	4	5	6
Duration variation for 6 one-hour ratio in %	30	48	63	77	89	100
Accumulative rainfall in inches	0.51	0.81	1.06	1.30	1.50	1.69
Incremental rainfall in inches	0.51	0.30	0.25	0.24	0.20	0.19
Incremental rainfall rearranged for design storm in inches	0.19	0.24	0.30	0.51	0.25	0.20
Accumulative design rainfall in inches	0.19	0.43	0.73	1.24	1.49	1.69

Rainfall Amount from Table 1 Vaughn Hansen Associates Report.

Procedures outlined in "Design of Small Dams"

TABLE 4

Summary of Storage Requirements and Design Spillway Flows
For Sedimentary Ponds of U.S. Fuels at Hiawatha, Utah

Site	Areas		S	Storage Requirements			Design flow for spillway 25 year 6 hr Event CFS
	Total Acres	Disturbed Acres		Storm Water 10 year 24 hour Event. AF	Sediment AF	Combined AF	
1	2	3	4	5	6	7	8
Hiawatha Main Yard	70.0	30.0	2.73	3.82	3.00	6.82	11.2
Slurry Pond 3 & 4	8.3	8.3	1.11	0.91	0.83	1.74	3.6
Slurry Pond 5-South	6.8	6.8	1.11	0.74	0.68	1.42	3.0
Slurry Pond 5-North	12.1	12.1	1.11	1.32	1.21	2.53	4.9
Hiawatha Refuse Pile	4.4	4.4	1.11	0.48	0.44	0.92	2.0
Upper Coal Storage yard	14.0	6.0	2.73	0.76	0.60	1.36	2.3
Middlefork Yard	23.0	4.8	3.48	0.92	0.48	1.40	2.3
South Fork	91.0	7.6	3.95	2.99	0.76	3.75	7.3
Lower Mohrland	10.0	6.9	1.93	0.76	0.69	1.45	2.8
Upper Mohrland-Upper	5.4	1.4	3.30	0.23	0.14	0.37	0.7
Upper Mohrland-Lower	60.0	0.8	4.23	1.75	0.08	1.83	4.3
Upper Mohrland-Combined	65.0	22.0	4.15	1.96	0.22	2.18	4.8

Col 8 from Figure 1, 2 and 3 and from Tables 5 to 17.

TABLE 5

SLURRY POND 3 & 4
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.29	1.77
1.5		.03	.02	.36	1.5	1.79	2.27
2.0	.43	.03	.02	.36	2.0	2.29	2.77
2.5		.16	.06	1.39	2.5	2.79	3.27
3.0	.73	.16	.06	1.39	3.0	3.29	3.77
3.5		.49	.16	3.60	3.5	3.79	4.27
4.0	1.24	.49	.16	3.60	4.0	4.29	4.77
4.5		.68	.09	2.08	4.5	4.79	5.27
5.0	1.49	.68	.09	2.08	5.0	5.29	5.77
5.5		.84	.08	1.76	5.5	5.79	6.27
6.0	1.69	.84	.08	1.76	6.0	6.29	6.77

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 6

SLURRY POND 5 - SOUTH
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.28	1.75
1.5		.03	.02	0.30	1.5	1.78	2.25
2.0	.43	.03	.02	0.30	2.0	2.28	2.75
2.5		.16	.06	1.14	2.5	2.78	3.25
3.0	.73	.16	.06	1.14	3.0	3.28	3.75
3.5		.49	.16	2.95	3.5	3.78	4.25
4.0	1.24	.49	.16	2.95	4.0	4.28	4.75
4.5		.68	.09	1.70	4.5	4.78	5.25
5.0	1.49	.68	.09	1.70	5.0	5.28	5.75
5.5		.84	.08	1.44	5.5	5.78	6.25
6.0	1.69	.84	.08	1.44	6.0	6.28	6.75

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 7

SLURRY POND 5 - NORTH
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.31	1.83
1.5		.03	.02	.49	1.5	1.81	2.31
2.0	.43	.03	.02	.49	2.0	2.31	2.83
2.5		.16	.06	1.90	2.5	2.81	3.31
3.0	.73	.16	.06	1.90	3.0	3.31	3.83
3.5		.49	.16	4.91	3.5	3.81	4.31
4.0	1.24	.49	.16	4.91	4.0	4.31	4.83
4.5		.68	.09	2.84	4.5	4.81	5.31
5.0	1.49	.68	.09	2.84	5.0	5.31	5.83
5.5		.84	.08	2.40	5.5	5.81	6.31
6.0	1.69	.84	.08	2.40	6.0	6.31	6.83

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 8

UPPER COAL STORAGE YARD
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental Runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.29	1.77
1.5		0	0	0	1.5	1.79	2.27
2.0	.43	0	0	0	2.0	2.29	2.77
2.5		.01	.01	.21	2.5	2.79	3.27
3.0	.73	.01	.01	.21	3.0	3.29	3.77
3.5		.14	.06	2.32	3.5	3.79	4.27
4.0	1.24	.14	.06	2.32	4.0	4.29	4.77
4.5		.24	.05	1.83	4.5	4.79	5.27
5.0	1.49	.24	.05	1.83	5.0	5.29	5.77
5.5		.34	.05	1.71	5.5	5.79	6.27
6.0	1.69	.34	.05	1.71	6.0	6.29	6.77

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 9

MIDDLE FORK YARD
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.28	1.75
1.5		0	0	0	1.5	1.78	2.25
2.0	.43	0	0	0	2.0	2.28	2.75
2.5		3.3×10^{-4}	1.6×10^{-4}	3.31	2.5	2.78	3.25
3.0	.73	3.3×10^{-4}	1.6×10^{-4}	.01	3.0	3.28	3.75
3.5		.07	.04	2.31	3.5	3.78	4.25
4.0	1.24	.07	.04	2.31	4.0	4.28	4.75
4.5		.15	.04	2.33	4.5	4.78	5.25
5.0	1.49	.15	.04	2.33	5.0	5.28	5.75
5.5		.22	.04	2.31	5.5	5.78	6.25
6.0	1.69	.33	.04	2.31	6.0	6.28	6.75

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 10

SOUTH FORK YARD
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.3	1.8
1.5		0	0	0	1.5	1.8	2.3
2.0	.43	0	0	0	2.0	2.3	2.8
2.5		0	0	0	2.5	2.8	3.3
3.0	.73	0	0	0	3.0	3.3	3.8
3.5		.05	.02	5.66	3.5	3.8	4.3
4.0	1.24	.05	.02	5.66	4.0	4.3	4.8
4.5		.11	.03	7.06	4.5	4.8	5.3
5.0	1.49	.11	.03	7.06	5.0	5.3	5.8
5.5		.17	.03	7.28	5.5	5.8	6.3
6.0	1.69	.17	.03	7.28	6.0	6.3	6.8

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 11

LOWER MOHRLAND YARD
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.28	1.75
1.5		9.8×10^{-4}	4.9×10^{-4}	.01	1.5	1.78	2.25
2.0	.43	9.8×10^{-4}	4.9×10^{-4}	.01	2.0	2.28	2.75
2.5		.05	.03	.69	2.5	2.78	3.25
3.0	.73	.05	.03	.69	3.0	3.28	3.75
3.5		.26	.10	2.83	3.5	3.78	4.25
4.0	1.24	.26	.10	2.83	4.0	4.28	4.75
4.5		.40	.07	1.89	4.5	4.78	5.25
5.0	1.49	.40	.07	1.89	5.0	5.28	5.75
5.5		.53	.06	1.68	5.5	5.78	6.25
6.0	1.69	.53	.06	1.68	6.0	6.28	6.75

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

TABLE 12

UPPER MOHRLAND YARD
RUNOFF FLOW CALCULATIONS FOR 25 YEAR FLOOD HYDROGRAPH

Time Ending (hours)	Accum-ulative Rainfall (inches)	Direct Runoff Accumulative (inches)	Direct Runoff Incremental (inches)	Qp Incremental Runoff (CFS)	Time along the Hydrograph in hrs. Begin	Peak	End
1	2	3	4	5	6	7	8
1.0	.19	0	0	0	1.0	1.27	1.72
1.5		0	0	0	1.5	1.77	2.22
2.0	.43	0	0	0	2.0	2.27	2.72
2.5		1.45×10^{-3}	7.27×10^{-4}	.01	2.5	2.77	3.22
3.0	.73	1.45×10^{-3}	7.27×10^{-4}	.01	3.0	3.27	3.72
3.5		.09	.04	.64	3.5	3.77	4.22
4.0	1.24	.09	.04	.64	4.0	4.27	4.72
4.5		.17	.04	.60	4.5	4.77	5.22
5.0	1.49	.17	.04	.60	5.0	5.27	5.72
5.5		.25	.04	.59	5.5	5.77	6.22
6.0	1.69	.25	.04	.59	6.0	6.27	6.72

$$\text{Col. 3} = \frac{(\text{Col 2} - 0.25)^2}{\text{Col 2} + 0.85}$$

Col. 4: Since D = 0.5 hrs. Hourly excesses are divided by 2
Col. 5 = Col 4 x qp
Col. 7 = Col 6 + Tp
Col. 8 = 2.67 x Tp + Col 6

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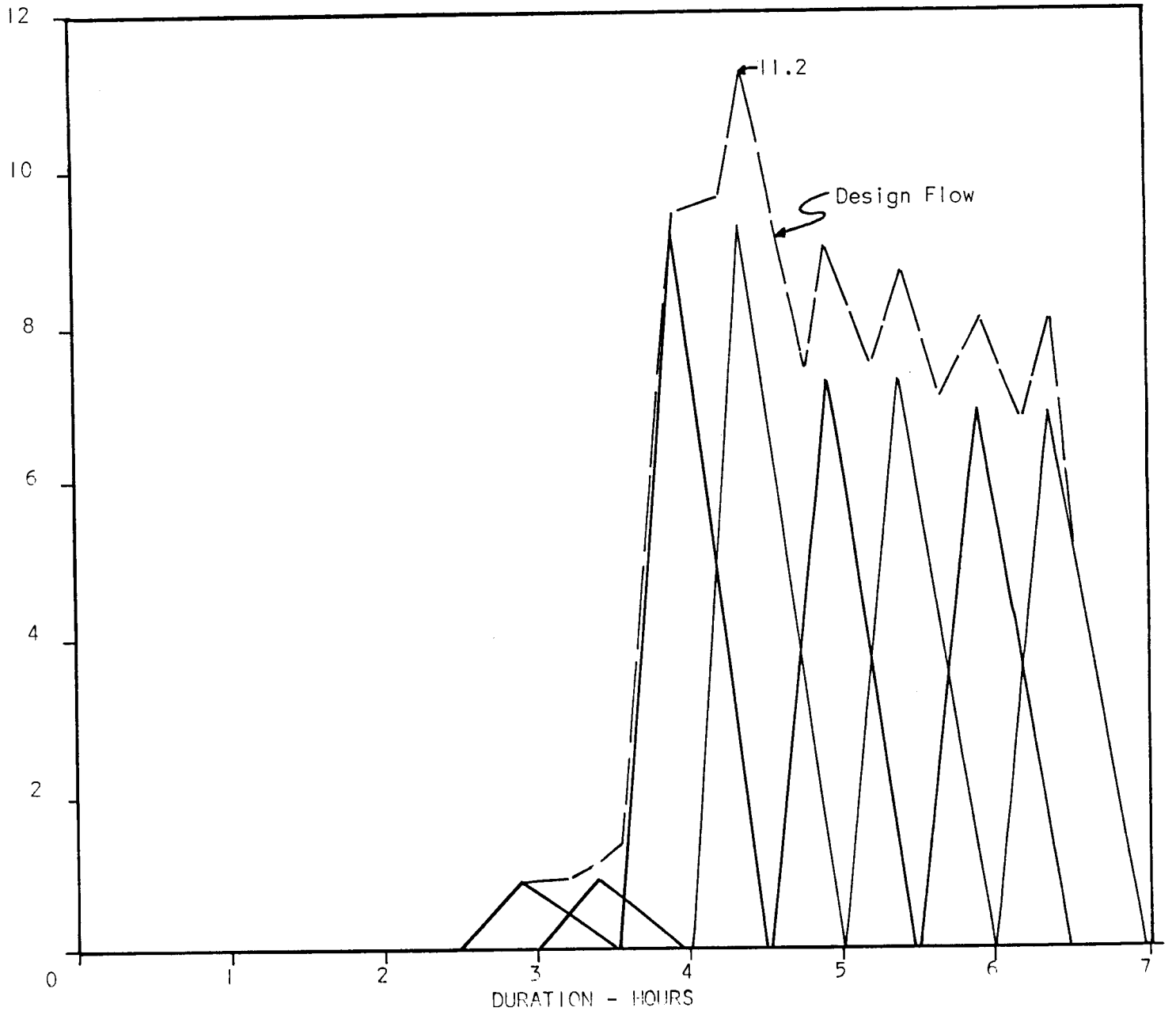

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Design Flow Hydrograph of 25 Year, 6 Hour Storm for Hiawatha Main Yard

Figure No. 1

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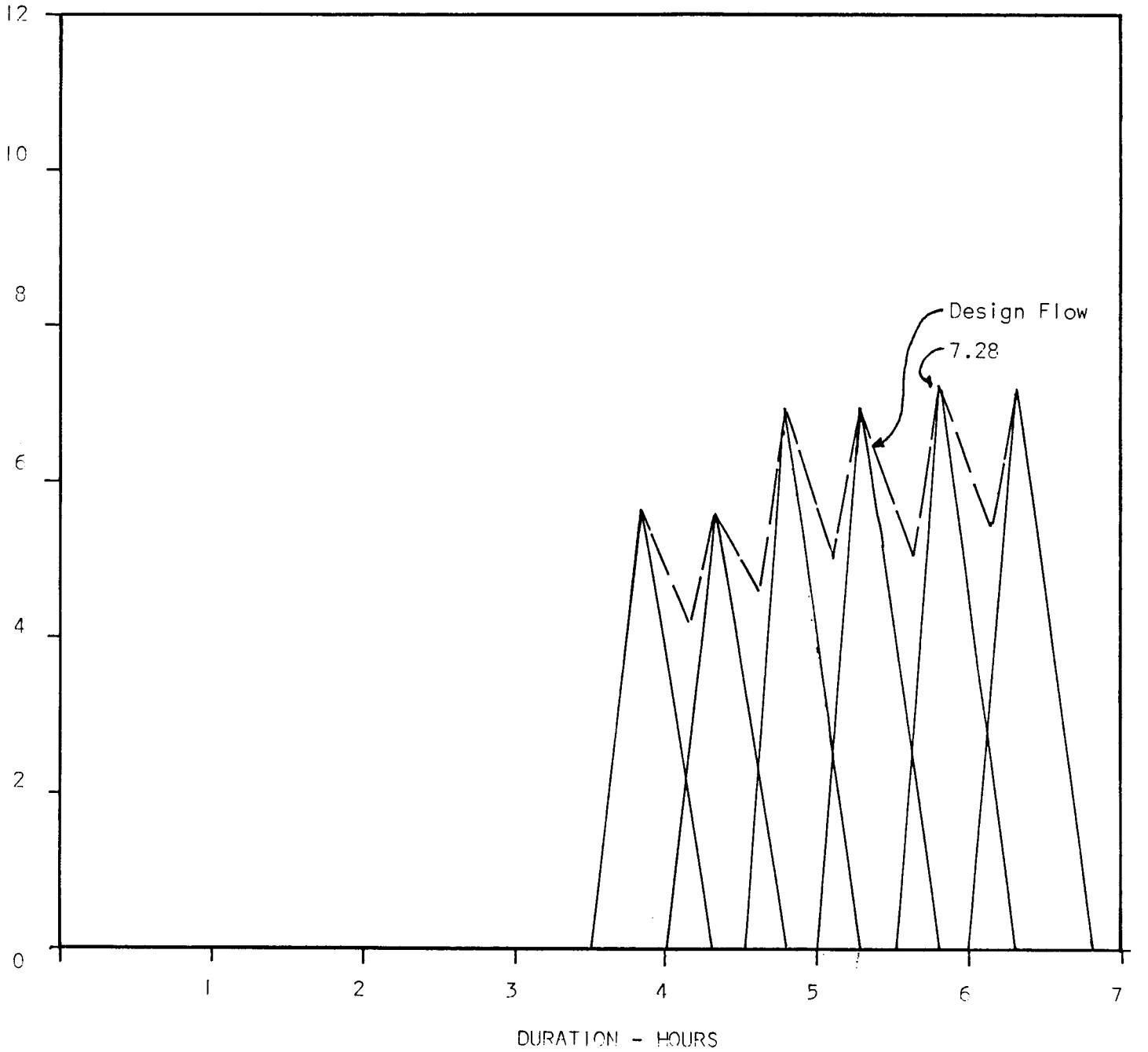

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Design Flow Hydrograph of 25 Year, 6 Hour Storm For South Fork Yard

Figure No. 2

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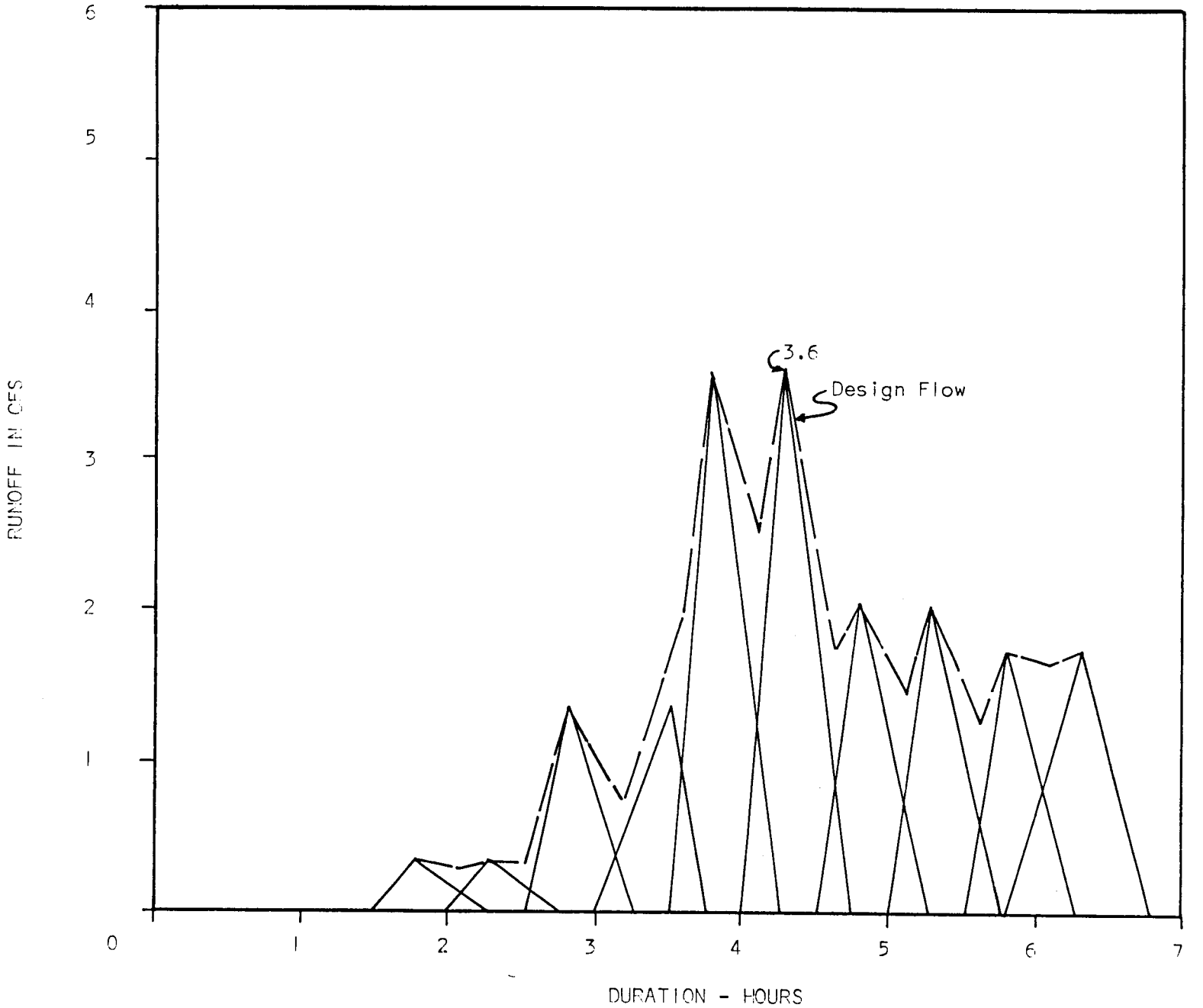

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Design Flow Hydrograph of 25 Year, 6 Hour Storm For Slurry Ponds No. 3 and No. 4

Figure No. 3