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CENTENNIAL WASH BASIN

100-YEAR FLOOD STUDY

MAY 1976

Charlie A. Maish

Louis Y. Ehrlich

≈ 16,000 c.f.s. @ syphon

04.0-01-1-05/76

Design Flood

The design 100-year flood for Centennial Wash Siphon has a peak discharge of 7,345 ft^3/s, occurring on the 13th hour from the beginning of the design storm. The routed outflow from Tiger Detention Basin, 1,140 ft^3/s, is additional to that flow and enters Centennial Wash immediately above the siphon crossing. The design flood is the combination of the routed 100-year outflow from Narrows Dam and the runoff from the intervening drainage between Narrows Dam and the siphon crossing.

Prior Study

A prior study, prepared by the E&R Center in 1966, recommended a 100-year design value of 19,000 ft^3/s. This study was for 258 square miles of drainage area below Narrows Dam. The major portion of the study area, 166 square miles, will be controlled by Tiger Detention Basin. It was assumed that storage behind Narrows Dam and upper basin storage developments of the Bureau of Land Management would control flood events including a 100-year flood. ?

The upstream storage development, constructed in 1956, consists of seven major dikes plus several smaller spreader dikes. Dike No. 7, the upstream structure, was constructed to 3410 acre feet capacity and was designed to contain a 50-year flood. The other six dikes had lesser capacities.

Failure of Upstream Dams

In July 1975, the entire upper basin storage system failed during a local thunderstorm and the resulting runoff filled the reservoir behind Narrows Dam, some 31 miles downstream, causing the spillway to discharge.

The reservoir behind Dike No. 7 was about half full at the time of failure, and the sudden release of water destroyed the six downstream dikes. Precipitation estimates for the storm are 1.78 inches at Aguilla gage, 6.00 inches at Wenden, and 3.00 inches at Urea Farm.

Failure of Dike No. 7 occurred at several locations, and subsidence is indicated as the major contributing cause. The area has experienced 68 feet of water table decline since the project construction.

Future effects of the upstream storage system are not incorporated in this study, since failure remains potential. The system is scheduled for repair and reconstruction but future water table decline and resultant subsidence are probable due to accelerated agricultural development.

Drainage Area

Total drainage above the siphon crossing is 835 square miles, exclusive of the drainage above Tiger Detention Basin. The drainage is divided by Narrows Dam into upper and lower basins. Ravines in the mountainous boundaries of the basins become a network of braided channels in the higher alluvial fans. The channels progressively diminish in the alluvial fans, indicating sheet runoff for significant flood events.

The watershed above Narrows Dam, containing about 745 square miles, heads in the Date Creek Mountains in the northeast and the Vulture Mountains in the southeast. The basin is bounded to the north, south, and west by the Harcuvar Mountains, Harquahala Mountains, and Granite Wash Mountains, respectively. The mean effective slope of the stream channel is 19 feet per mile. Centroid of the drainage is about 30 miles above Narrows Dam.

The basin below Narrows Dam contains about 90 square miles exclusive of the drainage above Tiger Detention Basin. The basin heads in the Harquahala Mountains to the north and in the Little Harquahala Mountains to the northwest and is bounded to the east by Tiger Detention Basin and the south by the proposed siphon crossing. Mean effective slope of the stream channel is 26 feet per mile. The centroid of the area is about eight miles above the siphon crossing.

Runoff curve numbers were assigned according to the surface geology by visual inspection of the drainage areas. These are summarized as follows:

Material	Percent of Area Upper Basin	Percent of Area Lower Basin	Runoff Curve No.
Qs, sand, silt and gravel	36.0	38.0	50
Cropland	6.0	4.0	35
QTs, sand, silt, gravel, and Conglomerate	34.0	31.0	65
Gn, Granite Gneiss	13.0	9.0	95
Mgr E-Lgr Granite and related intrusive crystalline rocks	4.5	3.5	85
gr, Granite and related crystalline rocks	2.5	-	88
Ms, Shale, sandstone, conglomerate, and limestone, locally metamorphosed	0.5	-	90
PMu, Shale, limestone, quartzite and sandstone	-	11.0	95
Sch, Schist	1.0	3.0	85
KTv, Kofa Volcanics	1.5	-	88
Ka, Andesite	0.5	0.5	98
Qb, Basalt	0.5	-	90
Weighted Runoff Curve Number	64	66	

BUTLER VALLEY
HARCUVAR MOUNTAINS
MOUNTAINS
Gn
Ka
TKs
QTs
Qs
Qb
gr
Lgr
mgr
ms
msCh
KTv
Sch
PMu
Narrows Dam
Siphon Crossing
ROUAHALA MOUNTAINS
VULTURE MOUNTAINS
BLACK BUTTE
HORN MOUNTAINS
BIG HORN PEAK
LITTLE HARQUAHALA
AGUILA VALLEY
Hermans Ranch
Manzanita
Cullins Wash
Hutchinson Wash
Ranch house

Explanation

gn	Granite gneiss
gr	Granite and related crystalline rocks
Ka	Andesite
Kr	Rhyolite
Ki	Dikes and plugs Rhyolitic to andesitic in composition
Ktv	Kofa volcanics
Mgr	Granite and related crystalline intrusive rocks
Ms	Shale, sandstone, conglomerate, and limestone, locally metamorphosed
Ps	Limestone, shale, sandstone, and quartzite
Qs	Sand, silt, and gravel
QTs	Sand, silt, gravel, and conglomerate
Qb	Basalt
Sch	Schist

Lag Time

Lag time was estimated to be 11.5 hours for the area above Narrows Dam and 4.1 hours for the area below Narrows Dam using the relationship:

$$Lg = 24\ n\ \left(\frac{L x Lca}{S^{\frac{1}{2}}}\right)^{0.38}$$

	Upper Basin	Lower Basin
n, Channel friction, Manning	0.05	0.05
L, Channel length to headwaters, miles	55	16
Lca, Channel length to centroid, miles	30	8
S, Channel slope, ft/mile	19	26
Lg, Lag time, hours	11.5	4.1

Unit Hydrograph

A one-hour unit hydrograph was prepared for each drainage using the Paradise Valley dimensionless graph (Table 1.). The unit hydrograph values for the upper and lower basins are presented in Tables 2 and 3.

Design Storm

A general type 6-hour storm was used for each drainage. 100-year point precipitation, obtained from Precipitation Charts for Arizona, Weather Bureau, 1967, was found to be 3.36 inches at Narrows Dam and 3.35 inches at siphon crossing, the low points of the upper and lower basins. An orographic increase of one-inch per 1000 feet was applied resulting in weighted values of 3.42 and 3.39 inches. The point precipitation was reduced to area precipitation and distributed in hourly increments as follows:

			Upper Basin	Lower Basin
Point Precipitation, inches			3.42	3.39
Drainage Area, sq. mi.			745	90
Area Reduction Factor			0.67	0.90
Area Precipitation, inches			2.29	3.05
Hourly Distribution,	Hr.	%		
	1	11	0.25	0.34
	2	25	0.57	0.76
	3	40	0.92	1.22
	4	70	1.60	2.14
	5	88	2.02	2.68
	6	100	2.29	3.05

Runoff Computation

Excess precipitation was calculated from the relationship: $Q = \frac{(P-0.2S)^2}{P+0.8S}$

where

Q is total runoff in inches

P is total precipitation in inches

S is potential infiltration calculated as

(1000 ÷ Runoff Curve No.)- 10. S was found to be 5.62 inches and 5.15 inches for the upper and lower basins. Incremental runoff was calculated each basin as follows:

Hour	Upper Basin			Lower Basin		
	P	Q	q	P	Q	q
1	0.25	0.00	0.00	0.34	0.00	0.00
2	0.57	0.00	0.00	0.76	0.00	0.00
3	0.92	0.00	0.00	1.22	0.01	0.01
4	1.60	0.04	0.04	2.14	0.20	0.19
5	2.02	0.12	0.08	2.68	0.40	0.20
6	2.29	0.20	0.08	3.05	0.57	0.17

Incremental precipitation excess, q, was applied to the unit hydrographs for the respective basins to obtain storm runoff. Results are presented in Tables 4 and 5. Peak values found were 6,376 ft^3/s on the 11th hour for the upper basin and 5,074 ft^3/s on the 7th hour for the lower basin.

Flood Routing

The 100-year flood for the upper basin was routed through Narrows Dam using the Puls method. Routing began with the reservoir filled to spillway level. An outflow table was developed from the combined discharges for the drop inlet, orifice, main spillway and emergency spillway using one-half foot increments. A new area curve for the reservoir was drawn, reflecting reservoir sedimentation equivalent to approximately one-half the original capacity. Available capacity was calculated from the new area curve and the results incorporated into the storage-outflow values for the routing study as shown in Table 6. The flood routing is presented in Table 7. Combined discharge of Narrows Dam and runoff of the lower basin are presented in Table 8.

Table 1.

Paradise Valley Dimensionless Graph

%	0	1	2	3	4	5	6	7	8	9
0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	1.1	1.4	1.7	2.0	2.3	2.7	3.1	3.5	3.9	4.3
20	4.8	5.3	5.7	6.1	6.5	7.0	7.5	8.1	8.7	9.3
30	9.9	10.5	11.0	11.5	12.0	12.5	12.9	13.3	13.7	14.2
40	14.7	15.2	15.7	16.2	16.7	17.1	17.4	17.7	18.0	18.3
50	18.5	18.7	18.9	19.1	19.2	19.3	19.3	19.4	19.4	19.4
60	19.4	19.4	19.3	19.3	19.2	19.1	18.9	18.7	18.5	18.3
70	18.1	17.9	17.7	17.6	17.4	17.2	17.0	16.9	16.7	16.6
80	16.4	16.3	16.1	16.0	15.8	15.6	15.5	15.3	15.2	15.0
90	14.9	14.8	14.6	14.5	14.3	14.2	14.1	13.9	13.8	13.6
100	13.5	13.4	13.3	13.1	13.0	12.9	12.8	12.7	12.5	12.4
110	12.3	12.2	12.1	11.9	11.8	11.7	11.6	11.5	11.3	11.2
120	11.1	11.0	10.9	10.7	10.6	10.5	10.4	10.3	10.3	10.2
130	10.1	10.0	9.9	9.8	9.7	9.6	9.5	9.4	9.4	9.3
140	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.5	8.4
150	8.3	8.2	8.1	8.1	8.0	7.9	7.8	7.7	7.7	7.6
160	7.5	7.4	7.4	7.3	7.3	7.2	7.1	7.0	7.0	6.9
170	6.8	6.7	6.6	6.6	6.5	6.4	6.3	6.3	6.2	6.2
180	6.1	6.0	5.9	5.9	5.8	5.7	5.6	5.6	5.5	5.5
190	5.4	5.3	5.3	5.2	5.1	5.1	5.0	4.9	4.8	4.8
200	4.7	4.7	4.6	4.6	4.5	4.5	4.4	4.4	4.3	4.3
210	4.2	4.2	4.1	4.1	4.0	4.0	3.9	3.9	3.8	3.8
220	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.3
230	3.3	3.3	3.2	3.2	3.1	3.1	3.1	3.0	3.0	2.9
240	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.5
250	2.5	2.5	2.5	2.4	2.4	2.4	2.3	2.3	2.3	2.2
260	2.2	2.2	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.9
270	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7
280	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4
290	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1
300	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9
310	0.9	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7
320	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5
330	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
340	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
350	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
360	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
370	0.0									

Adjusted to total $24 (L_g + D/2)$

L. Ehrlich Apr. 1973

Table 2.

Centennial Wash Above Narrows Dam

Hour	% (Lag + D/2)	q (Lag + D/2) / daf	q cfs / inch
1	8.3	0.8	1348.0
2	16.7	3.4	5729.0
3	25.0	7.0	11795.0
4	33.0	11.6	19546.0
5	41.7	15.6	26286.0
6	50.0	18.5	31172.5
7	58.3	19.4	32689.0
8	66.7	18.8	31678.0
9	75.0	17.2	28982.0
10	83.3	16.0	26960.0
11	91.7	14.7	24769.5
12	100.0	13.5	22747.5
13	108.3	12.5	21062.5
14	116.7	11.5	19377.5
15	125.0	10.5	17692.5
16	133.3	9.8	16513.0
17	141.7	9.0	15165.0
18	150.0	8.3	13985.5
19	158.3	7.7	12974.5
20	166.7	7.0	11795.0
21	175.0	6.4	10784.0
22	183.3	5.9	9941.5
23	191.7	5.3	8930.5
24	200.0	4.7	7919.5
25	208.3	4.3	7245.5
26	216.7	3.9	6571.5
27	225.0	3.5	5897.5
28	233.3	3.2	5392.0
29	241.7	2.8	4718.0
30	250.0	2.5	4212.5
31	258.3	2.3	3875.5
32	266.7	2.0	3370.0
33	275.0	1.8	3033.0
34	283.3	1.6	2696.0
35	291.7	1.3	2190.5
36	300.0	1.1	1853.5
37	308.3	0.9	1516.5
38	316.7	0.7	1179.5
39	325.0	0.5	842.5
40	333.3	0.4	674.0
41	341.7	0.2	337.0
42	350.0	0.1	168.5
43	358.3	0.1	168.5
44	366.7	0.0	0

Table 3.

Centennial Wash Below Narrows Dam

Hour	% (Lag + D/2)	q (Lag + D/2) / dsf	q cfs / inch
1	21.7	5.6	2946.16
2	43.5	16.4	8628.04
3	65.2	19.1	10048.51
4	87.0	15.3	8049.33
5	108.7	12.4	6523.64
6	130.4	10.1	5313.61
7	152.2	8.1	4261.41
8	173.9	6.5	3419.65
9	195.7	5.0	2630.50
10	217.4	3.9	2051.79
11	239.1	2.9	1525.69
12	260.9	2.2	1157.42
13	282.6	1.6	841.76
14	304.3	1.0	526.10
15	326.1	0.5	263.05
16	347.8	0.2	105.22
17	369.6	0	0

Table 4.

Runoff from Upper Centennial Basin
100-year flood

TIME HOUR	UNIT HYDROGRAPH CFS/INCH	PRECIPITATION EXCESS INCHES	DISCHARGE CFS
1.00	1348.00	0.000	0.00
2.00	5729.00	0.000	0.00
3.00	11795.00	0.000	0.00
4.00	19546.00	.040	53.92
5.00	26286.00	.080	337.00
6.00	31173.00	.080	1037.96
7.00	32689.00	0.000	2183.76
8.00	31678.00	0.000	3558.72
9.00	28982.00	0.000	4913.48
10.00	26960.00	0.000	5904.28
11.00	24770.00	0.000	6376.08
12.00	22748.00	0.000	6308.64
13.00	21063.00	0.000	5931.20
14.00	19378.00	0.000	5466.16
15.00	17693.00	0.000	5048.32
16.00	16513.00	0.000	4643.96
17.00	15165.00	0.000	4280.00
18.00	13986.00	0.000	3943.00
19.00	12975.00	0.000	3626.20
20.00	11795.00	0.000	3343.08
21.00	10784.00	0.000	3093.68
22.00	9942.00	0.000	2851.08
23.00	8931.00	0.000	2628.68
24.00	7920.00	0.000	2412.96
25.00	7246.00	0.000	2204.00
26.00	6572.00	0.000	2015.32
27.00	5898.00	0.000	1826.64
28.00	5392.00	0.000	1637.92
29.00	4718.00	0.000	1476.16
30.00	4213.00	0.000	1341.36
31.00	3876.00	0.000	1213.28
32.00	3370.00	0.000	1091.92
33.00	3033.00	0.000	977.32
34.00	2696.00	0.000	869.52
35.00	2191.00	0.000	781.92
36.00	1854.00	0.000	701.00
37.00	1517.00	0.000	620.08
38.00	1180.00	0.000	545.96
39.00	843.00	0.000	465.12
40.00	674.00	0.000	384.28
41.00	337.00	0.000	316.88
42.00	169.00	0.000	249.48
43.00	169.00	0.000	188.80
44.00	0.00	0.000	134.84

Table 4. (cont.)

TIME HOUR	UNIT HYDROGRAPH CFS/INCH	PRECIPITATION EXCESS INCHES	DISCHARGE CFS
46.00	0.00	0.000	47.24
47.00	0.00	0.000	27.04
48.00	0.00	0.000	13.52
49.00	0.00	0.000	0.00
50.00	0.00	0.000	0.00
51.00	0.00	0.000	0.00
52.00	0.00	0.000	0.00
53.00	0.00	0.000	0.00
54.00	0.00	0.000	0.00
55.00	0.00	0.000	0.00
56.00	0.00	0.000	0.00
57.00	0.00	0.000	0.00
58.00	0.00	0.000	0.00
59.00	0.00	0.000	0.00
60.00	0.00	0.000	0.00
61.00	0.00	0.000	0.00
62.00	0.00	0.000	0.00
63.00	0.00	0.000	0.00
64.00	0.00	0.000	0.00
65.00	0.00	0.000	0.00
66.00	0.00	0.000	0.00
67.00	0.00	0.000	0.00
68.00	0.00	0.000	0.00
69.00	0.00	0.000	0.00
70.00	0.00	0.000	0.00
71.00	0.00	0.000	0.00
72.00	0.00	0.000	0.00
73.00	0.00	0.000	0.00
74.00	0.00	0.000	0.00
75.00	0.00	0.000	0.00
76.00	0.00	0.000	0.00
77.00	0.00	0.000	0.00
78.00	0.00	0.000	0.00
79.00	0.00	0.000	0.00
80.00	0.00	0.000	0.00
81.00	0.00	0.000	0.00
82.00	0.00	0.000	0.00
83.00	0.00	0.000	0.00
84.00	0.00	0.000	0.00
85.00	0.00	0.000	0.00
86.00	0.00	0.000	0.00
87.00	0.00	0.000	0.00
TOTAL	485797.00	.200	97159.40

Table 5. Runoff from Lower Centennial Basin
100-year flood

TIME HOUR	UNIT HYDROGRAPH CFS/INCH	PRECIPITATION EXCESS INCHES	DISCHARGE CFS
1.00	2946.00	0.000	0.00
2.00	8628.00	0.000	0.00
3.00	10049.00	.008	23.57
4.00	8049.00	.188	622.87
5.00	6524.00	.204	2303.43
6.00	5314.00	.169	4211.58
7.00	4261.00	0.000	5073.53
8.00	3420.00	0.000	4609.30
9.00	2631.00	0.000	3724.30
10.00	2052.00	0.000	3015.05
11.00	1526.00	0.000	2431.32
12.00	1157.00	0.000	1928.84
13.00	842.00	0.000	1512.69
14.00	526.00	0.000	1159.40
15.00	263.00	0.000	882.35
16.00	105.00	0.000	656.43
17.00	0.00	0.000	468.29
18.00	0.00	0.000	299.88
19.00	0.00	0.000	162.28
20.00	0.00	0.000	65.87
21.00	0.00	0.000	17.75
22.00	0.00	0.000	0.00
23.00	0.00	0.000	0.00
24.00	0.00	0.000	0.00
25.00	0.00	0.000	0.00
26.00	0.00	0.000	0.00
27.00	0.00	0.000	0.00
28.00	0.00	0.000	0.00
29.00	0.00	0.000	0.00
30.00	0.00	0.000	0.00
31.00	0.00	0.000	0.00
TOTAL	58293.00	.569	33168.73

Table 6.

ELEVATION (FEET)	AREA (ACRES)	CAPACITY (ACRE-FEET)	STORAGE (CFS-HRS)	HEAD (FEET)	OUTFLOW (CFS)	S - O/2	S + O/2
246.00	160.	875.	10588.	0.0	586.	10295.	10881.
246.50	172.	958.	11592.	0.0	837.	11173.	12010.
247.00	184.	1047.	12669.	0.0	1284.	12027.	13311.
247.50	195.	1141.	13806.	0.0	1979.	12817.	14796.
248.00	209.	1242.	15028.	0.0	2876.	13590.	16466.
248.50	225.	1351.	16347.	0.0	3927.	14384.	18311.
249.00	240.	1467.	17751.	0.0	5108.	15197.	20305.
249.50	257.	1591.	19251.	0.0	6408.	16047.	22455.
250.00	273.	1724.	20860.	0.0	7816.	16952.	24768.
250.50	291.	1865.	22567.	0.0	9323.	17905.	27228.
251.00	309.	2015.	24382.	0.0	10924.	18920.	29844.
251.50	331.	2175.	26318.	0.0	12611.	20012.	32623.
252.00	360.	2348.	28411.	0.0	14382.	21220.	35602.

Table :

0

54

196

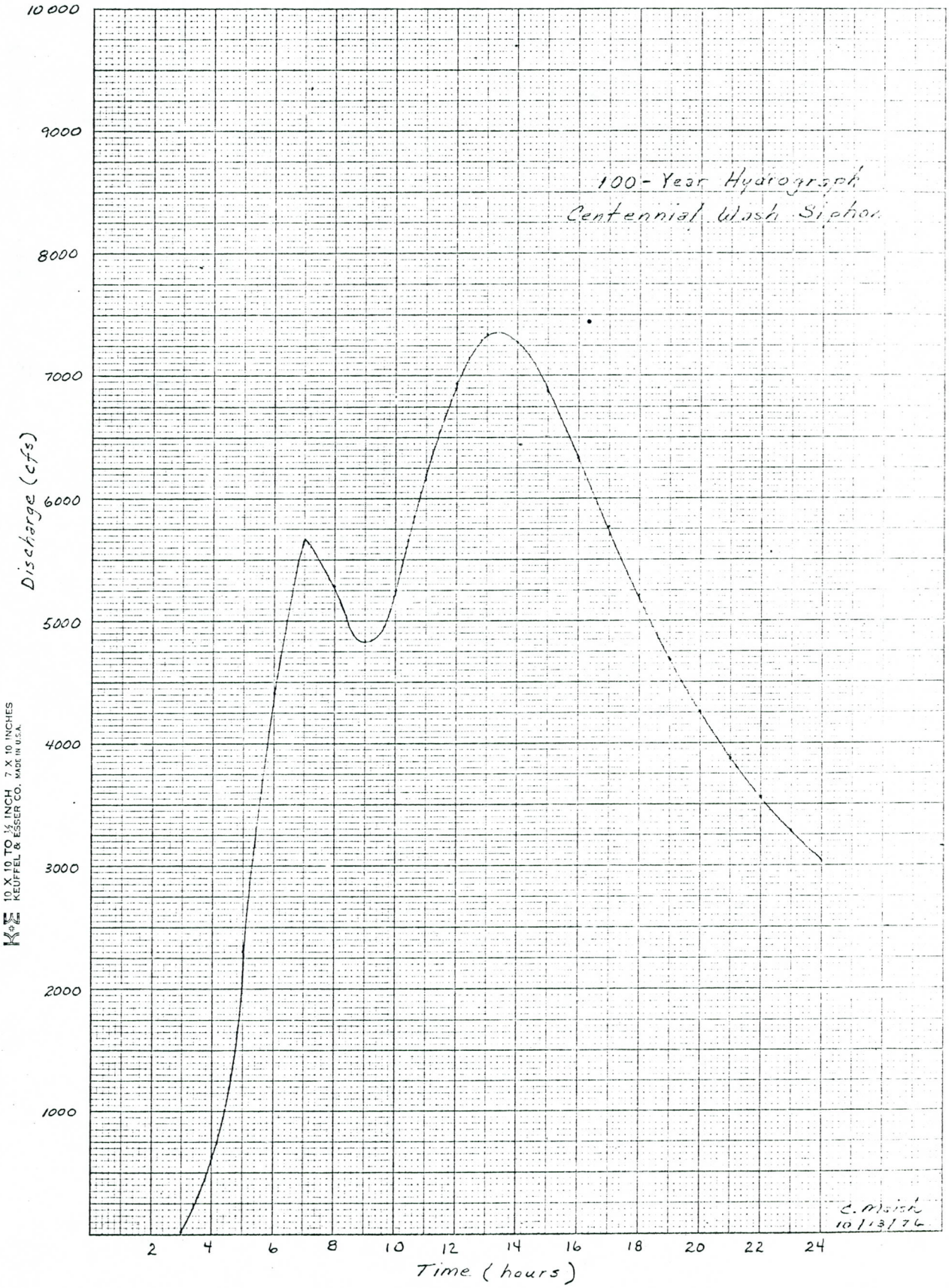
337

586

TIME (HRS)	INFLOW (CFS-HRS)	S - O/2	S + O/2	STORAGE (CFS-HRS)	STORAGE (AF)	OUTFLOW (CFS)	W.S. ELEVATION (FT)
0		10295.	10881.	10588.	875.	586.	246.00
	1038.						
1		10646.	11333.	10989.	908.	686.	246.40
	2184.						
2		11711.	12830.	12271.	1014.	1119.	247.13
	3559.						
3		13036.	15270.	14153.	1170.	2234.	247.78
	4913.						
4		14228.	17949.	16089.	1330.	3721.	248.80
	5904.						
5		15126.	20132.	17629.	1457.	5006.	249.41
	6376.						
6		15670.	21502.	18586.	1536.	5832.	249.56
	6309.						
7		15859.	21979.	18919.	1564.	6120.	249.78
	5931.						
8		15784.	21790.	18787.	1553.	6006.	249.69
	5466.						
9		15571.	21250.	18410.	1522.	5680.	249.44
	5048.						
10		15321.	20619.	17970.	1485.	5298.	249.15
	4644.						
11		15058.	19965.	17511.	1447.	4907.	249.33
	4280.						
12		14803.	19338.	17070.	1411.	4536.	249.02
	3943.						
13		14561.	18746.	16653.	1376.	4185.	248.72
	3626.						
14		14330.	18187.	16259.	1344.	3857.	248.93
	3343.						
15		14110.	17673.	15891.	1313.	3564.	248.65
	3094.						
16		13907.	17204.	15555.	1286.	3296.	248.40
	2851.						
17		13716.	16758.	15237.	1259.	3042.	248.16
	2629.						
18		13534.	16345.	14939.	1235.	2811.	248.43
	2413.						
19		13350.	15947.	14648.	1211.	2597.	248.19
	2204.						
20		13168.	15554.	14361.	1187.	2386.	247.95
	2015.						
21		12996.	15183.	14089.	1164.	2187.	247.73
	1827.						
22		12829.	14823.	13826.	1143.	1994.	247.52
	1638.						
23		12642.	14467.	13555.	1120.	1825.	247.78
	1476.						
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	1663	247.54

Table 8.
Combined Discharge of Centennial Wash at Siphon Crossing for 100-yr. Flood

Hour of Storm	Local Drainage	Upper Drainage	Total
1	0		0
2	0		0
3	24		24
4	623		623
5	2303	0	2303
6	4212	196	4408
7	5074	586	5660
8	4609	686	5295
9	3724	1119	4843
10	3015	2234	5249
11	2431	3721	6152
12	1929	5006	6935
13	1513	5832	7345
14	1159	6120	7279
15	882	6006	6888
16	656	5680	6336
17	468	5298	5766
18	300	4907	5207
19	162	4536	4698
20	66	4185	4251
21	18	3857	3875
22	0	3564	3564
23	0	3296	3296
[illegible]		[illegible]	[illegible]


100-Year Hydrograph
Centennial Wash Siphon
Discharge (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
2
4
6
8
10
12
14
16
18
20
22
24
Time (hours)
C. Moish
10/13/76
K&E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

CENTENNIAL WASH SIPHON CROSSING

BACKWATER STUDY

MAY 1976

Charlie A. Maish

Louis Y. Ehrlich

Backwater Profiles

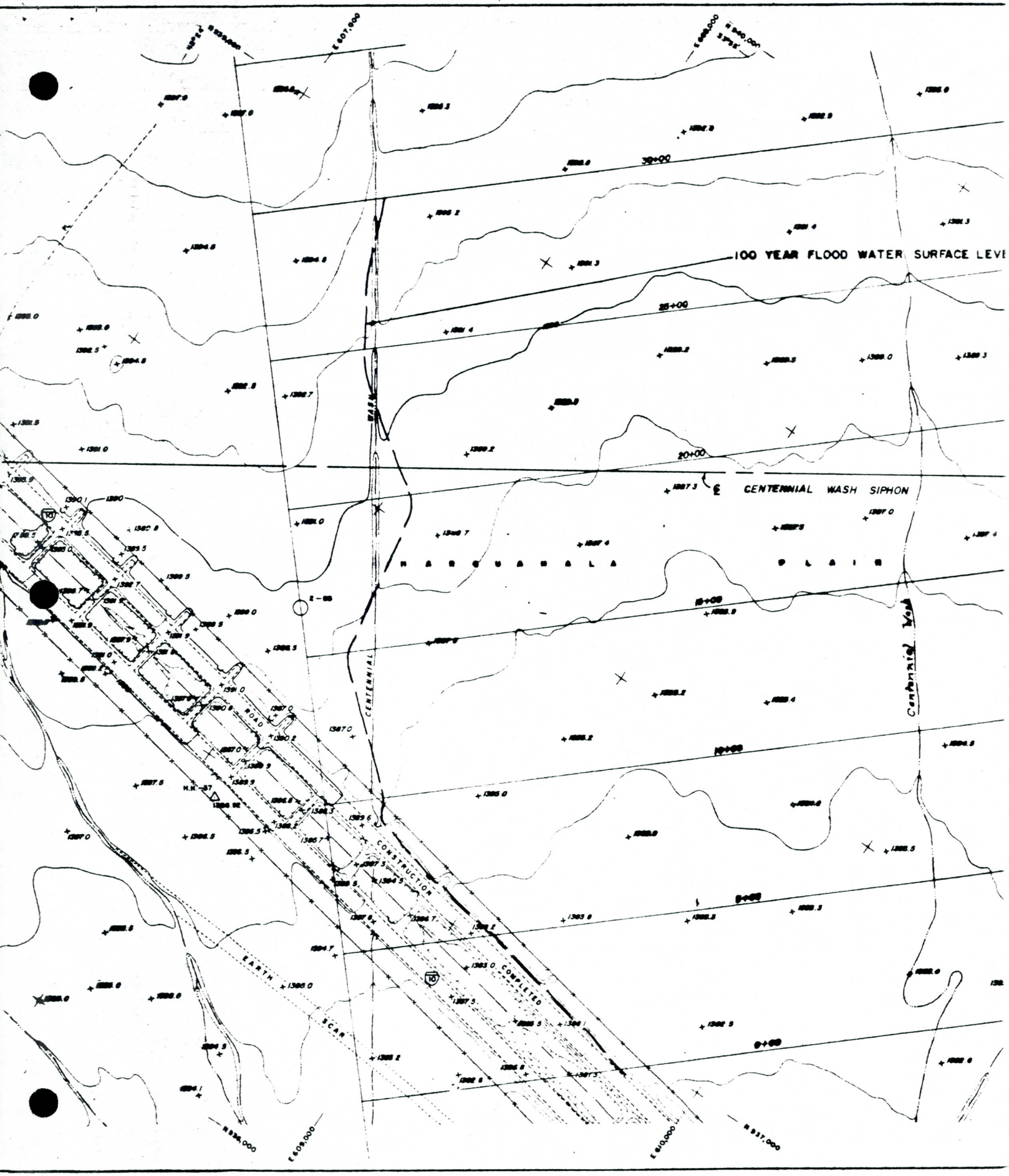
Water surface elevations for the 100-year flood were computed for seven cross sections of Centennial Wash at intervals of 500 feet beginning with station 0+00 being located at station 3544 of Interstate Highway 10. Cross sections were obtained from 1:2400 scale topography and a channel friction (Manning) of 0.045 was used throughout.

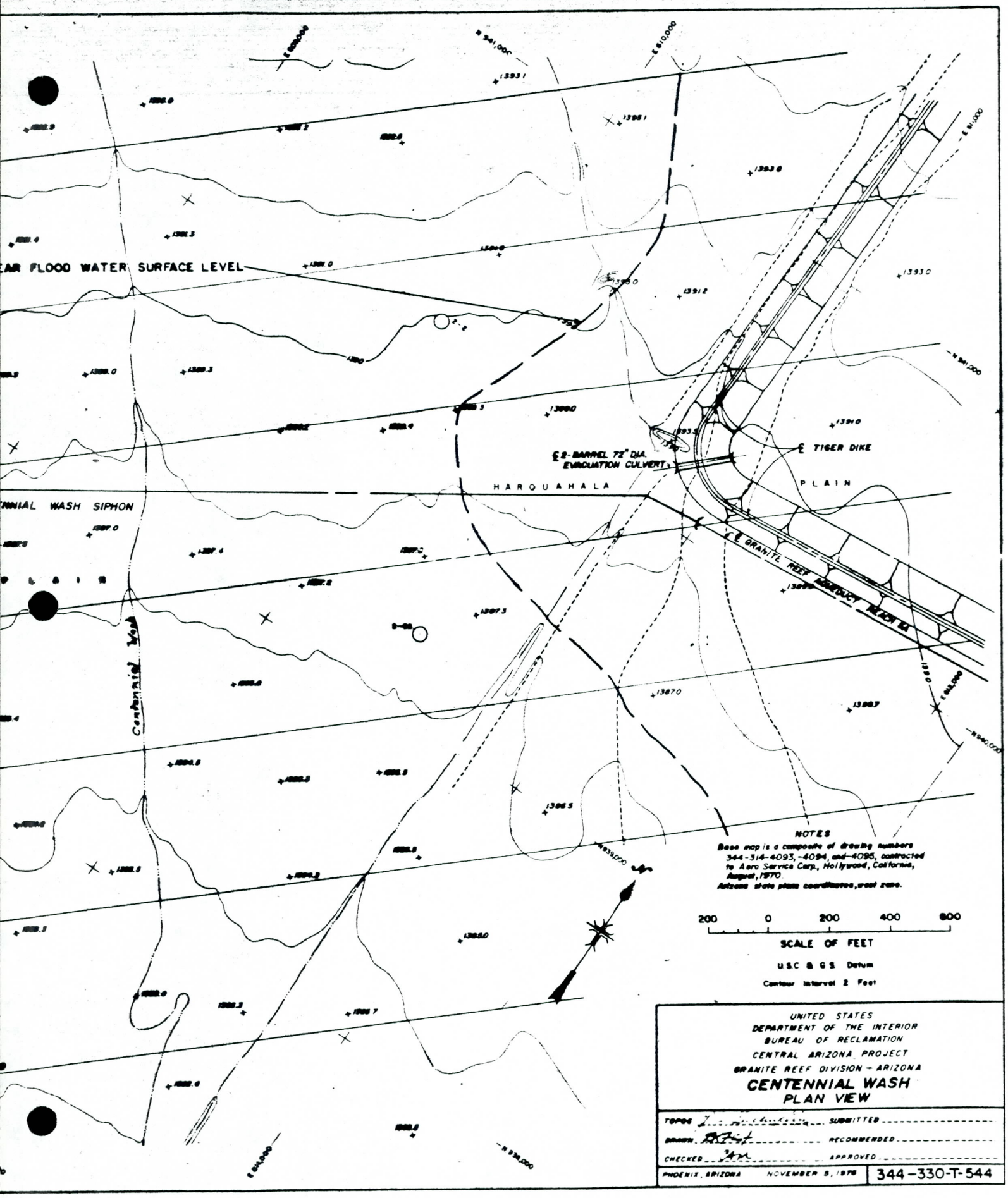
The beginning water surface elevation for the 100-year flood at station 0+00 is estimated to be 1387.05 feet. Highway I-10 which crosses Centennial Wash at about 50° right skew from the direction of flow provides the control for the beginning water surface. In addition, outflow from Tiger Detention Basin, 1140 ft^3/s, will enter Centennial Wash about station 17+30.

Trial backwater computations were made, accounting for known inflows and outflows. From the trial computations, the beginning water surface elevation for station 0+00 and the following flow apportionments were established:

Station	Increment, ft^3/s	Q, ft^3/s
	100-year Flood above I-10 station 3460	7,345
	22 each CMPA	-616

Station	Increment, ft^3/s	Q, ft^3/s
30+00	I-10 station 3515+60	6,729
	2 each CMPA	-56
25+00	I-10 station 3522+00	6,673
	3 each CMPA	-84
20+00	I-10 station 3528+40	6,589
	2 each CMPA	1,140
	Outflow of Tiger Detention Basin	-56
15+00	I-10 station 3534+80	7,673
	3 each CMPA	-84
10+00	I-10 station 3541+20	7,589
	2 each CMPA	-56
5+00	I-10 station 3547+60	7,533
	1 each CMPA	-28
0+00	I-10 station 3544	7,505
	1 each CMPA	-28
	10 each Triple Box Culverts	7,477
	Discharge below I-10 station 3605	0


100 YEAR FLOOD WATER SURFACE LEVE
30+00
25+00
20+00
15+00
10+00
5+00
0+00
℄ CENTENNIAL WASH SIPHON
H A R Q U A H A L A P L A I N
CENTENNIAL WASH
CONSTRUCTION ROAD
COMPLETED EARTH SCAR
Centennial Wash
E 607,000
E 609,000
E 610,000
N 936,000
N 937,000


EAR FLOOD WATER SURFACE LEVEL
TENNIAL WASH SIPHON
PLAIN
HARQUAHALA
PLAIN
℄ 2-BARREL 72" DIA. EVACUATION CULVERT
℄ TIGER DIKE
℄ GRANITE REEF AQUEDUCT
Centennial Wash
NOTES
Base map is a composite of drawing numbers 344-314-4093, -4094, and -4095, contracted to Aero Service Corp., Hollywood, California, August, 1970.
Arizona state plane coordinates, west zone.
200 0 200 400 800
SCALE OF FEET
U.S.C. & G.S. Datum
Contour Interval 2 Feet
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION – ARIZONA
CENTENNIAL WASH
PLAN VIEW
TRACED
SUBMITTED
DRAWN
RECOMMENDED
CHECKED
APPROVED
PHOENIX, ARIZONA
NOVEMBER 5, 1970
344-330-T-544

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 0 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1382.2 THALWEG SLOPE 0.0000

THIS IS A CONTROL SECTION -COMPUTATION LINE NOT REQD

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
0	10287	3468	3.0	-.04500	701272	.73	7505
SUM OR AVG	10287	3468			701272	.73	7505

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
THIS SECTION IS AN INITIAL CONTPOL -- FLOW IS SUB-CRITICAL - COMPUTED SLOPE = .00011 W.S. ELEV.= 1387.05

STATION	0.	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
		1	0.0	0.0	0.

NUMBER OF COORDINATE PAIRS = 13
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT-MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6760.	-.045	0.

X COORDINATES	2790.0	2840.0	2885.0	2905.0	3000.0	3450.0	3800.0	4000.0	4600.0	4750.0
Y COORDINATES	1386.0	1388.0	1386.0	1384.0	1382.2	1382.2	1382.5	1382.9	1383.7	1384.0

X COORDINATES	5800.0	6280.0	6760.0
Y COORDINATES	1386.0	1387.0	1388.0

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 5 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1383.3 THALWEG SLOPE .0022

COMPUTATION LINE HF1 = .06 HV1 = .01 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	8552	3422	2.5	-.04500	520218	.88	7533
SUM OR AVG	8552	3422			520218	.88	7533

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= .10 HV2= .01 SF= .00016 TOTAL HEAD= .08 CRIT. FLOW= 76689 W.S. ELEV.= 1387.13

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
500.	1	0.0	0.0	28.

NUMBER OF COORDINATE PAIRS = 14
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6350.	-.045	500.

X COORDINATES	2415.0	2460.0	2505.0	2525.0	2535.0	2750.0	3800.0	4200.0	4400.0	4850.0
Y COORDINATES	1388.0	1388.2	1388.0	1386.0	1384.0	1383.8	1383.3	1384.0	1384.3	1385.3
X COORDINATES	5200.0	5300.0	5400.0	6350.0						
Y COORDINATES	1386.0	1386.1	1386.0	1388.0						

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 10 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1384.1 THALWEG SLOPE .0016

COMPUTATION LINE HF1 = .11 HV1 = .01 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	6964	3474	2.0	-.04500	365737	1.09	7561
SUM OR AVG	6964	3474			365737	1.09	7561

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= .21 HV2= .02 SF= .00032 TOTAL HEAD= .16 CRIT. FLOW= 55934 W.S. ELEV.= 1387.29

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
1000.	1	0.0	0.0	56.

NUMBER OF COORDINATE PAIRS = 22
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6540.	-.045	500.

X COORDINATES	2020.0	2055.0	2120.0	2170.0	2230.0	2530.0	3100.0	3550.0	3850.0	4150.0
Y COORDINATES	1390.0	1390.0	1388.0	1387.0	1388.0	1385.1	1384.1	1384.8	1384.4	1384.7
X COORDINATES	4950.0	5040.0	5120.0	5160.0	5220.0	5260.0	5290.0	5450.0	5600.0	5900.0
Y COORDINATES	1386.0	1386.2	1386.0	1385.7	1385.9	1385.7	1386.0	1386.8	1386.6	1388.0
X COORDINATES	6520.0	6540.0								
Y COORDINATES	1389.7	1394.3								

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 15 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. - 1385.9 THALWEG SLOPE .0036

COMPUTATION LINE HF1 = .22 HV1 = .02 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	4094	3304	1.2	-.04500	155982	1.85	7589
SUM OR AVG	4094	3304			155982	1.85	7589

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= 1.18 HV2= .05 SF= .00140 TOTAL HEAD= .68 CRIT. FLOW= 25851 W.S. ELEV.= 1387.97

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
1500.	1	0.0	0.0	84.

NUMBER OF COORDINATE PAIRS = 19
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
5880.	-.045	500.

X COORDINATES	1660.0	1710.0	1720.0	1800.0	2000.0	2100.0	2430.0	2730.0	3350.0	3680.0
Y COORDINATES	1391.3	1390.0	1388.1	1388.0	1388.2	1388.0	1387.3	1386.0	1385.9	1386.0
X COORDINATES	3960.0	4020.0	4040.0	4060.0	4600.0	5000.0	5500.0	5860.0	5880.0	
Y COORDINATES	1386.2	1386.0	1385.9	1386.0	1387.2	1387.8	1388.0	1388.4	1394.4	

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 20 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1387.4 THALWEG SLOPE .0030

COMPUTATION LINE HF1 = .85 HV1 = .04 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	3091	3260	.9	-.04500	98544	2.08	6421
SUM OR AVG	3091	3260			98544	2.08	6421

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= 2.12 HV2= .07 SF= .00297 TOTAL HEAD= 1.47 CRIT. FLOW= 17078 W.S. ELEV.= 1389.44

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
2000.	1	0.0	0.0	-1084.

NUMBER OF COORDINATE PAIRS = 24
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6060.	-.045	500.

X COORDINATES	1270.0	1320.0	1420.0	1590.0	2000.0	2270.0	2290.0	2310.0	2320.0	2600.0
Y COORDINATES	1393.5	1390.0	1387.9	1390.0	1391.4	1390.0	1388.0	1387.4	1388.0	1389.0
X COORDINATES	2820.0	2960.0	3070.0	3250.0	3440.0	3650.0	3930.0	4050.0	4100.0	4600.0
Y COORDINATES	1388.0	1388.3	1388.0	1387.6	1388.0	1388.2	1387.9	1388.1	1387.9	1389.2
X COORDINATES	5200.0	5900.0	6040.0	6060.0						
Y COORDINATES	1389.3	1390.0	1390.0	1396.7						

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 25 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1389.6 THALWEG SLOPE .0044

COMPUTATION LINE HF1 = 2.97 HV1 = .09 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	3933	3353	1.2	-.04500	144459	1.93	7589
SUM OR AVG	3933	3353			144459	1.93	7589

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= 1.38 HV2= .06 SF= .00435 TOTAL HEAD= 2.21 CRIT. FLOW= 24161 W.S. ELEV.= 1391.65

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
2500.	1	0.0	0.0	84.

NUMBER OF COORDINATE PAIRS = 20
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6510.	-.045	500.

X COORDINATES	870.0	900.0	940.0	1370.0	2000.0	2270.0	2360.0	2610.0	2960.0	3400.0
Y COORDINATES	1394.9	1394.9	1392.0	1392.0	1393.3	1392.0	1390.0	1391.4	1390.0	1389.6
X COORDINATES	3660.0	4220.0	4730.0	5350.0	5750.0	5950.0	6050.0	6200.0	6490.0	6510.0
Y COORDINATES	1390.0	1390.0	1391.0	1391.0	1391.9	1391.8	1392.0	1392.5	1392.0	1398.7

CENTENNIAL WASH BACKWATER -- SIPHON CROSSING AT CENTENNIAL WASH
REACH 4 - CENTRAL ARIZONA PROJECT -- MAY 1976

STATION 30 + 0 ENGLISH SYSTEM ASSUMED ELEV. 0.00 THALWEG ELEV. 1392.0 THALWEG SLOPE .0048

COMPUTATION LINE HF1 = 1.37 HV1 = .06 AVG OVERBANK REACHES - (NO OVERBANK SEGMENTS ARE INDICATED)

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES
500	3189	3577	.9	-.04500	97550	2.37	7561
SUM OR AVG	3189	3577			97550	2.37	7561

THIS SECTION HAS 1 ROUGHNESS SEGMENT OR SEGMENTS. 1 SEGMENT OR SEGMENTS USED FOR THIS DISCHARGE
COMPUTATION LINE HF2= 3.00 HV2= .09 SF= .00437 TOTAL HEAD= 2.17 CRIT. FLOW= 17081 W.S. ELEV.= 1393.82

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
3000.	1	0.0	0.0	56.

NUMBER OF COORDINATE PAIRS = 24
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

RIGHT MOST COORDINATE	ROUGHNESS COEFFCIENT	REACH LENGTH OF CENTROID
6920.	-.045	500.

X COORDINATES	470.0	520.0	600.0	700.0	870.0	1050.0	1380.0	2000.0	2100.0	2390.0
Y COORDINATES	1397.9	1396.0	1394.5	1394.0	1394.0	1394.3	1394.0	1395.8	1396.0	1394.0
X COORDINATES	2420.0	2460.0	3080.0	3300.0	4100.0	4160.0	4200.0	4720.0	5100.0	5450.0
Y COORDINATES	1392.4	1393.5	1392.8	1392.4	1392.4	1392.0	1392.8	1393.2	1393.0	1393.1
X COORDINATES	6100.0	6800.0	6900.0	6920.0						
Y COORDINATES	1394.0	1395.0	1395.2	1401.8						

CENTENNIAL WASH SIPHON CROSSING

CHANNEL SCOUR STUDY

July 1976

Charlie A. Maish

The Granite Reef Aqueduct will cross under Centennial Wash in a 21-foot siphon, 5495.5 feet in overall length.

On the basis of the estimates made in this study, it is recommended that 4.0 feet of vertical scour be considered at the proposed siphon crossing.

Data

Eleven auger holes were located along the siphon alignment. Field logs and gradations are included with the supporting data. Gradations results indicate that the bed material is primarily composed of sands and fines with varying amounts of gravel. The material size generally increases with depth.

Auger Hole	Depth (ft)	d_m Mean Size (mm.)	Weighted Mean Size (mm.)
AP-101	0.0-10.0	0.55	0.55
AP-102	0.0- 9.0	0.67	0.67
	9.0-16.0	5.38*	
AP-103	0.0- 6.0	0.78**	0.78
	6.0-15.0	4.61*	
AP-104	0.0- 7.0	0.45**	0.45
AP-105	0.0- 6.0	0.60**	0.60
	6.0-14.0	5.33*	
AP-106	0.0-13.0	0.48	0.48
AP-107	0.0-17.0	1.88	1.88
AP-108	0.0-13.0	0.99	0.99
AP-109	0.0-14.0	2.37	2.37
AP-110	0.0-10.0	1.56	1.56
AP-111	0.0-12.0	2.22	2.22

*Omitted

Average weighted mean size = 1.14 mm.

**Average weighted mean size = 0.61 mm.

Hydraulic data was obtained from a previous computed backwater study for a 100-year design flood using the "Water Surface Computer Program". Cross sections for this study began at 15+00, because previous sections were influenced by highway presence. Pertinent data is as follows:

	SECTIONS				
	15+00	20+00	25+00	30+00	Ave.
Discharge (cfs)	7589	6421	7589	7561	7290
Channel width (ft)	3304	3260	3353	3577	3374
Area (ft^2)	4094	3091	3933	3189	3577
Average depth (ft)	1.2	0.9	1.2	0.9	1.05
Water surface elev. (ft)	1387.97	1389.44	1391.65	1393.82	1390.72
Thalweg elev. (ft)	1385.90	1387.40	1389.60	1392.00	1388.73
Mannings "N"	.045	.045	.045	.045	.045
Velocity (ft/sec)	1.85	2.08	1.93	2.37	2.06

Scour

The recommended minimum cover for Centennial Wash Siphon is 4.0 feet. This value was influenced by Centennial Wash being an aggrading vegetated flat channel affected by upstream agriculture development and some storage effects which have reduced peaks below those which have occurred in natural state.

Depth of scour was estimated using Lacey's method, the Navajo Indian Irrigation Project Scour Study and by incorporating Blench's equation with the Navajo Indian Irrigation Project Study. Lacey's method resulted in a scour depth of 6.2 feet. This was computed using data for material to 7.0 feet depth. This result is not considered directly applicable since conditions found in Centennial Wash are substantially different from the relatively uniform canals which were used in the development of Lacey's theory. The Navajo Indian Irrigation Project Study was used since it took into account the important influence of sediment load in arroyos, which are similar in nature to Centennial Wash. Empirical curves for scour derived in the Study resulted in an average depth of 3.4 feet. The applicability of Blench's regime equations to sand bed arroyos which can potentially move very large quantites of sediment is also questionable. To compensate for this a unit discharge was also found using curves from the Navajo Indian Irrigation Project Study and used in Blench's equation to obtain a scour depth of 4.9 feet.

The backwater study indicated the flow of water would not reach the abutment at the outlet of Centennial Wash Siphon. Scour recommended for the outflow from Tiger Detention Basin at the beginning of Reach 5A was 6 feet, measured from the lowest elevation in Centennial Wash.

Degradation limited by armoring was considered but was found to be ineffective since there is insufficient material larger than 7.5 millimeter, the size necessary for armor at the computed velocity in Centennial Wash at the Siphon Crossing.

Lacey

d_m = 0.61 mm.

Q = 7290 cfs

$f = 1.76\ (d_m)^{\frac{1}{2}} = 1.37$

$D = 0.47\ (Q/f)^{\frac{1}{3}} = 8.2$

$d_s = 0.75\ D = 6.2$

Navajo Indian Irrigation Project

Scour from empirical curve for mean depth = 3.6

Scour from empirical curve for unit discharge = 3.1

Application of Navajo Indian Irrigation Project with

Blench

Bed slope = .0044

K = 4.4

W = 360

Q = 7290

q = 20.25

d_m = 0.61 mm. = .002 ft.

F_{bo} = 1.5

$D = q^{\frac{2}{3}} / F_{bo}^{\frac{1}{3}} = 6.5$

$d_s = 0.75\ D = 4.9$

Lacey

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Q = 7290 cfs

$f = 1.76\ (d_m)^{\frac{1}{2}} = 1.37$

$D = 0.47\ (Q/f)^{\frac{1}{3}} = 8.2$

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$d_s = 0.75\ D = 4.9$

Stop

384 mi²

Upper 9,100 c.f.s.

194 mi²

NARROWS 6,850 c.f.s.

2 blocks

BLM District Office

Indian School & Clarendon

2929 W Indian School Rd

Ray Evans Chief of Operations

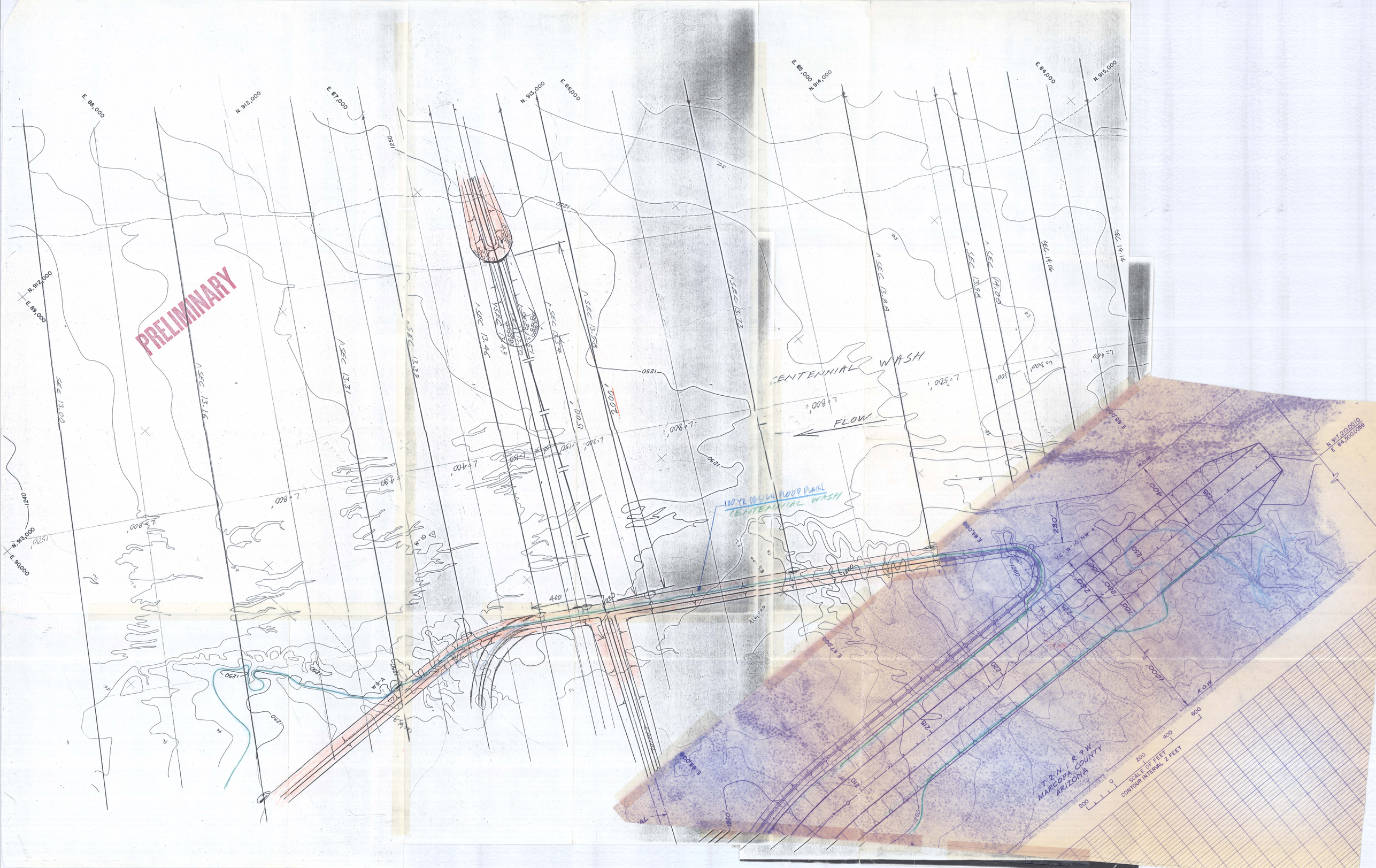
241-2501

241-2920

Joe Lowe

Mc-Whittier

SM 5.1


PRELIMINARY
CENTENNIAL WASH
FLOW
100 YR DESIGN FLOOD PLAIN
CENTENNIAL WASH
T.2.N., R.9.W.
MARICOPA COUNTY
ARIZONA
SCALE OF FEET
CONTOUR INTERVAL 2 FEET
N. 912,000
E. 89,000
N. 913,000
E. 88,000
N. 914,000
E. 85,000
N. 915,000
E. 84,000
N. 917,000.10
E. 84,500.0599
SEC. 13.00
SEC. 13.16
SEC. 13.31
SEC. 13.46
SEC. 13.61
SEC. 13.76
SEC. 13.88
SEC. 13.99
SEC. 14.06
SEC. 14.16
W-10
W-5-A
VG-W-10 NW-4
R.O.W.