Engineers
Planners
Economists
Scientists

August 23, 1991

PHX27815.AM

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2801 W. Durango
Phoenix, AZ 85009

Ms. Jan Opstein
Flood Control District of Maricopa County
3335 W. Durango Street
Phoenix, Arizona 85009

Dear Ms. Opstein:

Subject: Cave Creek/Carefree Flood Insurance Study

This letter follows our meeting of August 1, 1991 and presents the information and modifications to the project deliverables requested by the Federal Emergency Management Agency in their letter dated May 8, 1991. The following paragraphs summarize the requested information:

I. HYDROLOGY

The stream reaches referred to in the May 8, 1991 letter were modeled using discharges estimated by assuming a unit discharge for each subbasin as estimated using the HEC-1 model. The discharge per unit area was then used to estimate discharges for channel reaches in the watershed. The supporting calculations are shown in Table 1.

CH2M HILL Phoenix Office, 1620 West Fountainhead Parkway, Suite 550, P.O. Box 28440 Tempe, Arizona 85285-8440 602.966.8188

Table 1

Stream	Section	Subarea	Total Subarea (sq.mi.)	Partial Area (sq.mi.)	Fraction	Q(HEC-1)	Q(HEC-2)
WS	4.95	D2	0.32	0.16	0.50	420	210
			0.32	0.16	0.50	626	313
			0.32	0.16	0.50	724	362
			0.32	0.16	0.50	896	449
WST1 uses PC 32+0.58*		F1 from sec.	0.98 to 1.52				
WST1	0.98	PC 32	0.84			543	
			0.84			820	
			0.84			962	
			0.84			1,215	
		F1	0.82	0.48	0.58	525	848
			0.82	0.48	0.58	787	1,277
			0.82	0.48	0.58	921	1,497
			0.82	0.48	0.58	1,168	1,894
WST1	2.82	F1B	0.56	0.25	0.45	358	160
			0.56	0.25	0.45	537	240
			0.56	0.25	0.45	629	281
			0.56	0.25	0.45	794	354
WST2	1.31	F2B	0.43	0.22	0.50	511	256
			0.43	0.22	0.50	762	240
			0.43	0.22	0.50	891	281
			0.43	0.22	0.50	1,114	354
WST2A	0.52	F2A	0.29	0.19	0.67	345	231
			0.29	0.19	0.67	514	344
			0.29	0.19	0.67	601	403
			0.29	0.19	0.67	752	504
WST4	0.52	F2D	0.23	0.16	0.69	180	124
			0.23	0.16	0.69	271	187
			0.23	0.16	0.69	318	219
			0.23	0.16	0.69	402	277
WST4	0.98	F2D	0.23	0.10	0.42	180	76
			0.23	0.10	0.42	271	114
			0.23	0.10	0.42	318	134
			0.23	0.10	0.42	402	169
WST5	0.92	F3	0.89	0.42	0.47	352	165
			0.89	0.42	0.47	536	252
			0.89	0.42	0.47	631	297
			0.89	0.42	0.47	804	378

II. HYDRAULICS

A. Ocotillo Wash Foot Flow Analysis

The first concern listed by FEMA regards the "split flow."

1. FEMA's reviewer questioned whether the weir flow or the normal depth option for calculating the flow distribution at the two areas of channel bifurcation was most appropriate. Based on detailed field investigations by our staff as well as Flood Control District staff and evaluations of stereoscopic aerial photographs, it was our conclusion that the predominant flow direction was in the east or main braid at both split locations. As depth of flow increases to above the crest of the ridge separating the east and west braids, flow begins to leave the main channel into the west braid. The angle of this flow over the divide will vary depending on the depth, however, it was our conclusion that the component of velocity in that direction would be low. Using normal depth to estimate the magnitude of the split would therefore not be appropriate. It is our opinion that modeling the flow as a broad-crested weir with a relatively high weir coefficient more accurately represents the actual flow characteristics. Although arguments could be made for using either method, the field and photographic evidence appeared to indicate that the predominant flow direction was within the main or west braid and that the use of the normal depth option for estimating the flow split would underestimate the magnitude and severity of flooding in the main braid.

2. The second concern described in FEMA's letter regards the length of the reach modeled by the west braid HEC-2 model. On Ocotillo Wash two separate reaches of divided flow were investigated. The upstream split occurs between Section 3.09 and 3.17 at that location; a minor amount of flow is diverted from the main braid. This flow re-enters the main stream at approximately Section 2.65. Between cross-sections 2.72 and 3.17, the hydraulic characteristics of the diverted west braid were modeled by approximate methods as directed by FCDMC. Based on our conversations with FEMA and FCDMC, these calculations have been revised. New 100-year flood-prone areas have been estimated using Manning's equation for normal depth. These calculations and a portion of Sheet 13 showing the cross-section locations are attached.

Cross-sections 1.71 through 2.85 were used in the west braid model to evaluate the flooding conditions downstream of the lower flow split which occurs between cross-sections 2.72 and 2.78. Although the flow split model predicts that during large events relatively equal flow would occur in either braid, field investigations and examination of stereographic aerial photography led to the conclusion that the primary flow channel is indeed the eastern or main braid. This conclusion is supported by evidence of recent and historic scour, highwater marks, and anecdotal evidence. It was our conclusion that as this channel continues to scour, all flow could be contained in or diverted to the main braid. The channel banks are composed of unconsolidated alluvial fill materials and are subject to significant episodes of scour and deposition. Because of these conditions, we were directed by the Flood Control District to use a conservative assumption that represented the probable worse case for each braid. We therefore modeled the main stream assuming no flow diversion occurred at the split and modeled the west braid assuming that the portion of flow indicated by the split flow analysis was conveyed by the west braid.

B. Floodway Surcharges

The profiles and work maps for Cottonwood Creek and Ocotillo Wash sections referenced in the letter have been revised. The revised work products are attached.

C. Culvert Calculations for Willow Springs Wash Tributary 5

As we discussed, the hydraulic computations for these culverts have been revised. The 40-inch by 27-inch cmp arch culvert had been omitted from the original model. It has been added and new computations revised. Federal Highway Administration Model HY8 was used to revise the calculations and to estimate outlet velocities. The results were used to revise the HEC-2 model. Calculations and documentation are attached.

II. MAPPING

The sections of Ocotillo Wash referred to in the May 8th letter have been revised to address the discrepancies indicated. Revised HEC2 outputs, revised maps, and profiles are attached.

Jan, I believe these items will respond to each of FEMA's comments and allow for finalization of the above-referenced project. If you have any questions or comments, please call me.

Sincerely,

CH2M HILL

Steven R. Walker
Project Manager

Attachments

OCOTILLO WEST BRAID
HYDRAULIC COMPUTATION

Section 2.65 through 3.09

PHXC17.104.51

CROSS-SECTIONAL ANALYSIS

X-SECT.BAS/V.1

Preparer: D.STOUGH
Job#: PHX27815.AM
Date: 08-19-1991

ect: CAVE CREEK FIS
s Section Description: XS-1

	STA(ft)	ELEV(ft)	MANNINGS n (to Next #)
1	705.00	2349.50	.045
	755.00	2349.00	.04
	810.00	2345.00	.04
	850.00	2347.00	.04
5	878.00	2344.50	.04
	905.00	2345.50	.045
	935.00	2345.50	.04
8	950.00	2344.00	.04
	970.00	2345.50	.045
	985.00	2345.50	.04
	995.00	2344.00	.04
12	1010.00	2344.00	.04
	1030.00	2345.00	.045
	1125.00	2347.50	-

Channel Slope = 0.0276 ft./ft.

.E. = 2347.40 ft.
Depth = 3.40 ft.
Channel Slope = 0.0276 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
L BANK	777.0								
		0.040	206.59	128.27	10573.7	1756.63	8.50	1.18	128.0
RIGHT BANK	905.0								
		0.045	57.00	30.00	2895.0	480.95	8.44	1.08	30.0
	935.0								
		0.040	92.75	35.13	6599.3	1096.35	11.82	1.28	35.0
	970.0								
		0.045	28.50	15.00	1447.5	240.48	8.44	1.08	15.0
	985.0								
		0.040	135.50	45.14	10503.0	1744.89	12.88	1.31	45.0
	1030.0								
		0.045	109.43	91.23	4090.6	679.59	6.21	1.00	91.2
	1121.2								
			---	---	---	---	---	---	---
TALS:			629.76	344.76	36109.1	5998.89	9.53	1.24	344.2

W E. = 2347.10 ft.
D h = 3.10 ft.
C nnel Slope = 0.0276 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
LEFT BANK	781.1								
		0.040	168.83	124.13	7720.1	1282.56	7.60	1.15	123.9
RIGHT BANK	905.0								
		0.045	48.00	30.00	2174.4	361.24	7.53	1.05	30.0
	935.0								
		0.040	82.25	35.13	5402.4	897.52	10.91	1.25	35.0

	985.0								
		0.040	68.00	45.14	3328.4	552.96	8.13	1.17	45.0
	1030.0								
		0.045	15.39	34.21	299.1	49.69	3.23	0.85	34.2
	1064.2								
			---	---	---	---	---	---	---
LS:			190.56	232.66	7046.5	1170.66	6.14	1.20	232.2

E. = 2345.80 ft.
h = 1.80 ft.
Channel Slope = 0.0276 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
LEFT BANK	799.0								
		0.040	10.80	27.05	218.2	36.25	3.36	0.93	27.0
	826.0								
BANK	863.4								
		0.040	31.07	41.64	952.0	158.15	5.09	1.04	41.6
RIGHT BANK	905.0								
		0.045	9.00	30.00	133.6	22.19	2.47	0.79	30.0
	935.0								
		0.040	36.75	35.13	1410.8	234.38	6.38	1.10	35.0
	970.0								
		0.045	4.50	15.00	66.8	11.10	2.47	0.79	15.0
	985.0								
		0.040	63.50	45.14	2970.0	493.41	7.77	1.15	45.0
	1030.0								
		0.045	12.16	30.41	218.6	36.31	2.99	0.83	30.4
	1060.4								
			---	---	---	---	---	---	---
TALS:			167.79	224.37	5969.8	991.78	5.91	1.20	224.0

W.S.E. = 2345.87 ft.
Dth = 1.87 ft.
nnel Slope = 0.0276 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
T BANK	798.0								
		0.040	12.78	29.42	272.9	45.34	3.55	0.95	29.4
BK	827.4								
NK	862.7								
		0.040	34.01	42.42	1093.0	181.59	5.34	1.05	42.3
RHT BANK	905.0								
		0.045	11.10	30.00	189.5	31.49	2.84	0.82	30.0
	935.0								
		0.040	39.20	35.13	1571.2	261.02	6.66	1.11	35.0
	970.0								
		0.045	5.55	15.00	94.8	15.74	2.84	0.82	15.0
	985.0								
		0.040	66.66	45.14	3219.8	534.92	8.03	1.16	45.0
	1030.0								
		0.045	14.38	33.08	273.4	45.42	3.16	0.84	33.1
	1063.1								
			---	---	---	---	---	---	---
TALS:			183.68	230.19	6714.6	1115.51	6.07	1.20	229.8

CROSS-SECTIONAL ANALYSIS

X-SECT.BAS/V.1

Preparer: D.STOUGH
Job#: PHX27815.AM
Date: 08-19-1991

Project: CAVE CREEK FIS
Cross Section Description: XS-2

No.	STA(ft)	ELEV(ft)	MANNINGS n (to Next #)
1	925.00	2370.50	.055
2	940.00	2366.50	.055
3	980.00	2367.00	.035
4	1000.00	2364.00	.035
5	1010.00	2364.50	.035
6	1025.00	2368.00	.055
7	1040.00	2371.00	.055
8	1090.00	2372.00	-

Channel Slope = 0.0296 ft./ft.

RATING CURVE

WSE(ft)	D(ft)	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
2364.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.0
2364.50	0.50	3.33	13.38	56.2	9.66	2.90	1.02	13.3
2365.00	1.00	11.37	18.95	344.2	59.22	5.21	1.18	18.8
2365.50	1.50	22.14	24.53	880.6	151.50	6.84	1.26	24.3
2366.00	2.00	35.65	30.10	1699.4	292.38	8.20	1.32	29.8
2366.50	2.50	51.90	35.67	2837.6	488.20	9.41	1.37	35.2
2367.00	3.00	81.36	83.18	4443.4	764.48	9.40	1.67	82.6
2367.50	3.50	123.66	87.32	7131.9	1227.02	9.92	1.46	86.6
2368.00	4.00	167.97	91.46	10545.0	1814.22	10.80	1.40	90.6
2368.50	4.50	214.38	95.95	14931.6	2568.94	11.98	1.41	95.0
2369.00	5.00	262.97	100.44	19998.8	3440.72	13.08	1.42	99.4
2369.50	5.50	313.75	104.93	25732.4	4427.16	14.11	1.43	103.8
2370.00	6.00	366.72	109.42	32123.9	5526.81	15.07	1.44	108.1
2370.50	6.50	421.88	113.91	39168.8	6738.86	15.97	1.45	112.5

RATING CURVE

WSE(ft)	D(ft)	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
2367.00	3.00	81.36	83.18	4443.4	764.48	9.40	1.67	82.6
2367.05	3.05	85.51	83.60	4676.9	804.65	9.41	1.63	83.0
2367.10	3.10	89.67	84.01	4918.8	846.27	9.44	1.60	83.4
2367.15	3.15	93.83	84.42	5167.7	889.08	9.48	1.58	83.8
2367.20	3.20	98.04	84.84	5425.7	933.47	9.52	1.56	84.2
2367.25	3.25	102.26	85.25	5691.5	979.20	9.58	1.53	84.6
2367.30	3.30	106.50	85.67	5964.9	1026.25	9.64	1.52	85.0
2367.35	3.35	110.77	86.08	6246.0	1074.60	9.70	1.50	85.4
2367.40	3.40	115.03	86.49	6533.0	1123.99	9.77	1.49	85.8
2367.45	3.45	119.34	86.91	6828.8	1174.88	9.85	1.47	86.2
2367.50	3.50	123.66	87.32	7131.9	1227.02	9.92	1.46	86.6

W.S.E. = 2367.37 ft.
Depth = 3.37 ft.

Channel Slope = 0.0296 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
LEFT BANK	936.7								
		0.055	26.22	43.38	507.9	87.39	3.33	0.75	43.3
RIGHT BANK	980.0								
		0.035	86.26	42.87	5852.6	1006.91	11.67	1.44	42.3
	1022.3								
TOTALS:			112.48	86.25	6360.5	1094.30	9.73	1.50	85.6

CROSS-SECTIONAL ANALYSIS

X-SECT.BAS/V.1

Preparer: D.STOUGH
Job#: PHX27815.AM
Date: 08-19-1991

Project: CAVE CREEK FIS
Cross Section Description: XS-3

NO.	STA(ft)	ELEV(ft)	MANNINGS n (to Next #)
1	750.00	2395.00	.045
2	850.00	2392.00	.045
3	910.00	2392.00	.045
4	925.00	2392.00	.035
5	985.00	2388.00	.035
6	1005.00	2388.00	.035
7	1025.00	2390.50	.045
8	1050.00	2392.00	.045
9	1110.00	2395.00	-

Channel Slope = 0.0445 ft./ft.

RATING CURVE

SE(ft)	D(ft)	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
2388.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.0
2388.50	0.50	12.88	31.55	301.6	63.62	4.94	1.36	31.5
2389.00	1.00	31.50	43.10	1088.1	229.54	7.29	1.50	43.0
2389.50	1.50	55.88	54.64	2414.3	509.30	9.11	1.59	54.5
2390.00	2.00	86.00	66.19	4359.3	919.59	10.69	1.65	66.0
2390.50	2.50	121.88	77.74	7001.9	1477.06	12.12	1.70	77.5
2391.00	3.00	164.58	93.60	10662.1	2249.16	13.67	1.81	93.3
2391.50	3.50	215.21	109.47	15205.7	3207.65	14.90	1.87	109.2
2392.00	4.00	273.75	125.33	20735.1	4374.07	15.98	1.90	125.0

RATING CURVE

SE(ft)	D(ft)	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
2390.00	2.00	86.00	66.19	4359.3	919.59	10.69	1.65	66.0
2390.05	2.05	89.33	67.35	4591.1	968.50	10.84	1.66	67.2
2390.10	2.10	92.72	68.50	4830.0	1018.89	10.99	1.66	68.3
2390.15	2.15	96.15	69.65	5074.8	1070.54	11.13	1.67	69.4
2390.20	2.20	99.66	70.81	5328.1	1123.96	11.28	1.67	70.6
2390.25	2.25	103.22	71.96	5588.6	1178.91	11.42	1.68	71.8
2390.30	2.30	106.84	73.12	5856.5	1235.43	11.56	1.68	72.9
2390.35	2.35	110.52	74.28	6131.9	1293.52	11.70	1.69	74.1
2390.40	2.40	114.23	75.43	6413.3	1352.90	11.84	1.69	75.2
2390.45	2.45	118.03	76.58	6703.8	1414.17	11.98	1.70	76.3
2390.50	2.50	121.88	77.74	7001.9	1477.06	12.12	1.70	77.5

W.S.E. = 2390.19 ft.
Depth = 2.19 ft.
Channel Slope = 0.0445 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
LEFT BANK	952.2								
		0.035	98.95	70.58	5276.8	1113.15	11.25	1.67	70.4
RIGHT BANK	1022.5								
TOTALS:			98.95	70.58	5276.8	1113.15	11.25	1.67	70.4

CROSS-SECTIONAL ANALYSIS

X-SECT.BAS/V.1

Preparer: D.STOUGH
Job#: PHX27815.AM
Date: 08-19-1991

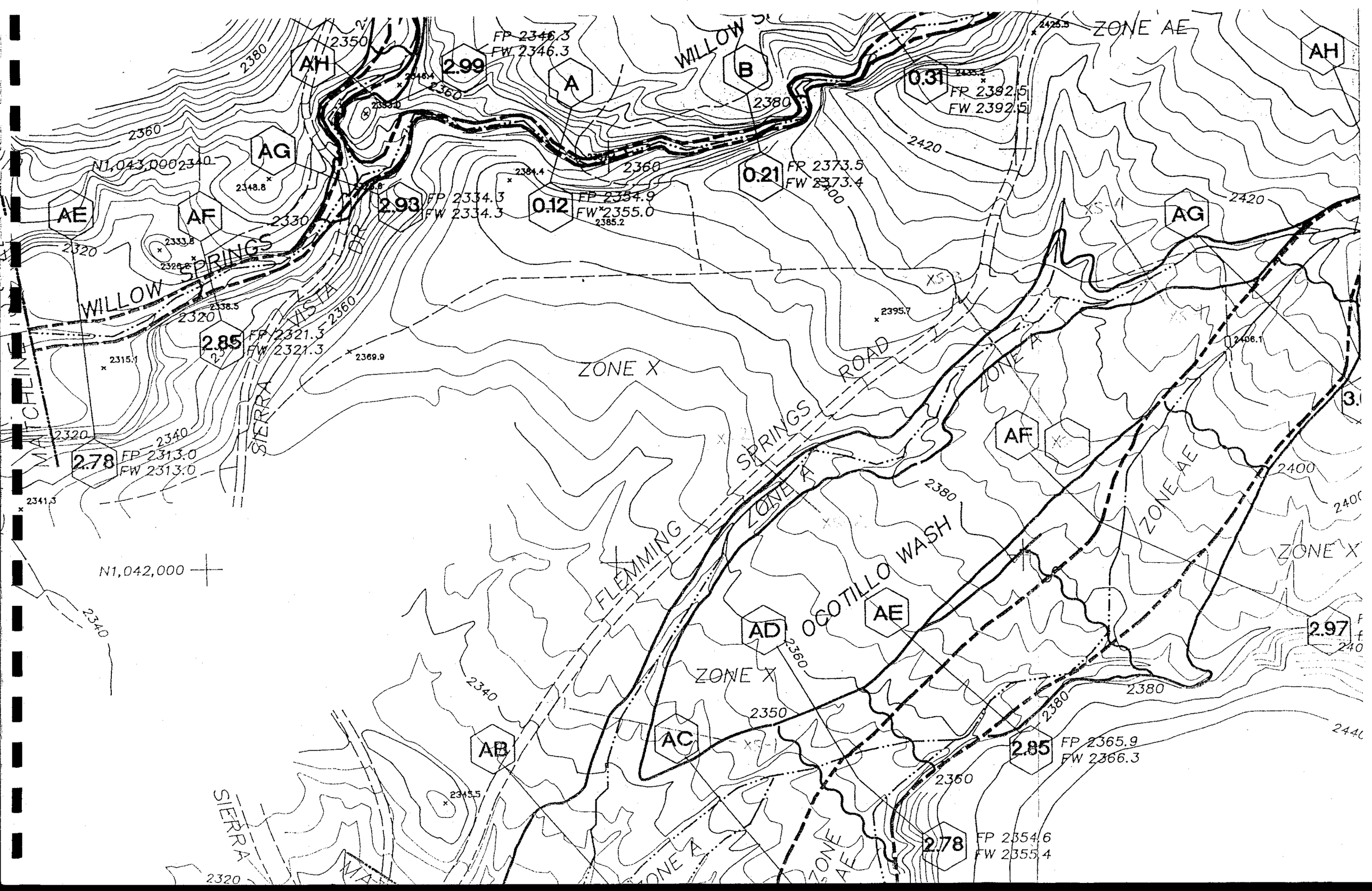
Project: CAVE CREEK FIS
Cross Section Description: XS-4

NO.	STA(ft)	ELEV(ft)	MANNINGS n (to Next #)
1	925.00	2407.00	.05
2	960.00	2406.50	.03
3	995.00	2404.00	.03
4	1005.00	2404.00	.03
5	1030.00	2409.00	.05
6	1070.00	2410.00	-

Channel Slope = 0.0410 ft./ft.

W.S.E. = 2406.50 ft.
Depth = 2.50 ft.
Channel Slope = 0.0410 ft./ft.

NOTES	STA-ft	MAN.n	AREA-sf	WT.P-ft	CONV(K)	Q-(cfs)	V-fps	Fr.#	TW(ft)
LEFT BANK	960.0								
		0.030	84.38	57.84	5390.4	1091.47	12.94	1.88	57.5
RIGHT BANK	1017.5								
TOTALS:			84.38	57.84	5390.4	1091.47	12.94	1.88	57.5


WILLOW SPRINGS
WILLOW SPRINGS ROAD
SIERRA VISTA DR
SIERRA
FLEMMING
OCOTILLO WASH
ZONE X
ZONE A
ZONE AE
AH
AG
AE
AF
A
B
AD
AC
AB
2.99
FP 2346.3
FW 2346.3
0.31
FR 2392.5
FW 2392.5
0.21
FR 2373.5
FW 2373.4
2.93
FP 2334.3
FW 2334.3
0.12
FP 2334.9
FW 2355.0
2.85
FP 2321.3
FW 2321.3
2.78
FP 2313.0
FW 2313.0
2.97
2.85
FP 2365.9
FW 2366.3
2.78
FP 2354.6
FW 2355.4
N1,043,000
N1,042,000
XS-1
XS-2
XS-3
XS-4

WILLOW SPRINGS TRIBUTARY 5
CULVERT COMPUTATION

CURRENT DATE: 06-17-1991
CURRENT TIME: 14:28:50

FILE DATE: 06-17-1991
FILE NAME: WST5

****
********** FHWA CULVERT ANALYSIS **********
********** HY-8, VERSION 3.2 **********
****

CULV #	SITE DATA: INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	2104.50	2102.10	50.06	3 CSP	3.50	3.50	.024	CONVENTIONAL
2	2104.50	2102.10	50.06	1 CMPA	3.50	2.42	.025	CONVENTIONAL
3								
4								
5								
6								

****

SUMMARY OF CULVERT FLOWS (CFS) FILE: WST5 DATE: 06-17-1991

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
2104.50	0	0	0	0	0	0	0	0	0
2106.60	100	76	24	0	0	0	0	0	4
2107.93	200	158	42	0	0	0	0	0	4
2109.55	300	244	56	0	0	0	0	0	4
2111.80	400	330	71	0	0	0	0	0	4
2114.69	500	413	86	0	0	0	0	0	4
2117.41	600	476	100	0	0	0	0	23	6
2117.61	631	481	100	0	0	0	0	50	4
2118.36	800	496	100	0	0	0	0	203	3
2118.71	900	502	100	0	0	0	0	297	3
2119.03	1000	500	100	0	0	0	0	398	3
2117.10	568	470	98	0	0	0	0	OVERTOPPING	

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SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: WST5 DATE: 06-17-1991

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
2104.50	0.00	0	0	0.00
2106.60	0.00	100	-0	-0.02
2107.93	0.00	200	-0	-0.01
2109.55	0.00	300	-0	-0.03
2111.80	0.01	400	-0	-0.08
2114.69	-0.00	500	0	0.02
2117.41	-0.01	600	1	0.16
2117.61	-0.00	631	1	0.12
2118.36	-0.00	800	1	0.10
2118.71	-0.00	900	1	0.15
2119.03	-0.00	1000	2	0.15

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<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

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CURRENT DATE: 06-17-1991 FILE DATE: 06-17-1991
CURRENT TIME: 14:28:50 FILE NAME: WST5

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********** CULVERT # 1 **********
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PERFORMANCE CURVE FOR 3 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	2104.50	2102.10	0.00	-2.40	0-NF	0.00	2104.50	0.00	0.00
76	2106.61	2102.30	2.11	0.39	6-FF	0.00	0.00	0.00	9.94
158	2107.93	2104.20	3.43	1.69	6-FF	0.00	0.00	0.00	11.41
244	2109.55	2104.60	5.05	3.62	6-FF	0.00	0.00	0.00	12.69
330	2111.79	2104.85	7.29	6.17	6-FF	0.00	0.00	0.00	14.08
413	2114.68	2105.00	10.18	9.33	4-FF	0.00	0.00	0.00	14.32
476	2117.41	2105.20	12.91	12.03	4-FF	0.00	0.00	0.00	16.50
481	2117.61	2105.60	13.11	12.22	4-FF	0.00	0.00	0.00	16.65
496	2118.36	2106.10	13.86	13.46	4-FF	0.00	0.00	0.00	17.19
502	2118.71	2106.60	14.12	14.21	4-FF	0.00	0.00	0.00	17.38
500	2119.05	2107.00	14.06	14.55	4-FF	0.00	0.00	0.00	17.33

El. inlet face invert 2104.50 ft El. outlet invert 2102.10 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION (FT)	690.00
INLET ELEVATION (FT)	2104.50
OUTLET STATION (FT)	740.00
OUTLET ELEVATION (FT)	2102.10
NUMBER OF BARRELS	3.00
SLOPE (V-FT/H-FT)	0.0480
CULVERT LENGTH ALONG SLOPE (FT)	50.06

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.50 FT
BARREL MATERIAL	CORRUGATED STEEL
BARREL MANNING'S N	0.024
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE WITH HEADWALL
INLET DEPRESSION	NONE

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********** CULVERT # 2 **********
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PERFORMANCE CURVE FOR 1 BARREL(S)

Q (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	2104.50	2102.10	0.00	-2.40	0-NF	0.00	2104.50	0.00	0.00
24	2106.60	2102.30	2.10	0.15	6-FF	0.00	0.00	0.00	9.30
42	2107.92	2104.20	3.42	1.84	6-FF	0.00	0.00	0.00	10.44
56	2109.55	2104.60	5.05	3.94	4-FF	0.00	0.00	0.00	8.28
71	2111.79	2104.85	7.29	6.48	4-FF	0.00	0.00	0.00	10.46
86	2114.69	2105.00	10.19	9.66	4-FF	0.00	0.00	0.00	12.79
100	2117.41	2105.20	12.91	12.91	4-FF	0.00	0.00	0.00	15.36
100	2117.86	2105.60	12.95	13.36	4-FF	0.00	0.00	0.00	15.38
100	2118.39	2106.10	12.97	13.89	4-FF	0.00	0.00	0.00	15.40
100	2118.86	2106.60	12.95	14.36	4-FF	0.00	0.00	0.00	15.39
100	2119.26	2107.00	12.95	14.76	4-FF	0.00	0.00	0.00	15.39

El. inlet face invert 2104.50 ft El. outlet invert 2102.10 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION (FT)	690.00
INLET ELEVATION (FT)	2104.50
OUTLET STATION (FT)	740.00
OUTLET ELEVATION (FT)	2102.10
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0480
CULVERT LENGTH ALONG SLOPE (FT)	50.06

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	PIPE ARCH
BARREL SPAN	42.00 FT
BARREL RISE	29.00 FT
BARREL MATERIAL	STEEL OR ALUMINUM
BARREL MANNING'S N	0.025
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	PROJECTING
INLET DEPRESSION	NONE

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CURRENT DATE: 06-17-1991 FILE DATE: 06-17-1991
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********** TAILWATER **********
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TAILWATER RATING CURVE

FLOW(CFS)	W.S.E.(FT)
0	2102.10
100	2102.30
200	2104.20
300	2104.60
400	2104.85
500	2105.00
600	2105.20
631	2105.60
800	2106.10
900	2106.60
1000	2107.00

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********** ROADWAY OVERTOPPING DATA **********
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ROADWAY SURFACE	GRAVEL
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	50.00
OVERTOPPING CREST ELEVATION (FT)	2117.10

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