

ADDENDUM NO. 1 TO:
PRELIMINARY HYDRAULIC ANALYSIS
OF THE SALT RIVER FOR
THE EAST PAPAGO FREEWAY
AND RED MOUNTAIN INTERCHANGE

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OF THE SALT RIVER FOR
THE EAST PAPAGO FREEWAY
AND RED MOUNTAIN INTERCHANGE

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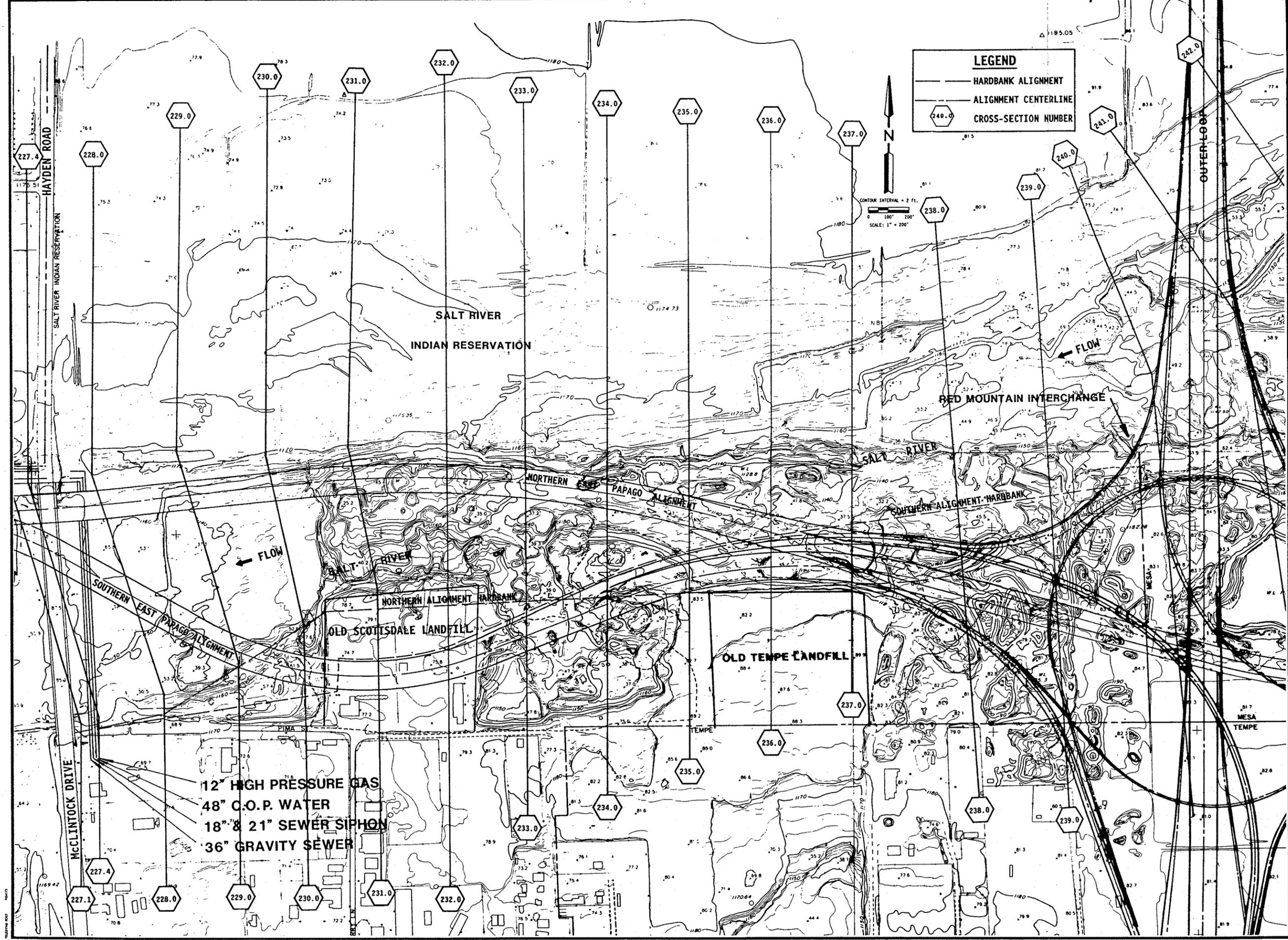
PREFACE

The results presented in this report are based on state-of-the-art techniques for river mechanics and scour analysis. However, the state-of-the-art of river mechanics is such that flow depths on the order of those which exist within the Salt River cannot realistically be predicted more accurately than plus or minus 10%. In addition, the state-of-the-art for scour analysis is such that predictions may vary by as much as 50% to 100%. The results obtained depend on the data base used, assumptions made, engineering computer models utilized, engineering judgement exercised, etc. Some of the assumptions made in conjunction with this study effort include: 1) hydrology (flood peaks) for the Salt River is correct; 2) the 1986 topographic mapping is sufficient to accurately depict topographic conditions; 3) sediment sampling adequately represents the existing sediment distributions in the stream bed; and 4) one-dimensional hydraulic modeling is appropriate to apply to the study reach. Consequently, the results obtained by different investigators could vary widely. Because the results presented within this report are considered to be conservative, based on the assumptions made, they can be used to give a relative measure of the maximum impacts associated with the proposed project. However, the results are only preliminary and not to be used for final design.

I. INTRODUCTION

This addendum to the report titled "Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange," September 1989, presents the results of a preliminary hydraulic analysis for an alternate alignment of Section 6 of the East Papago Freeway. The initial report summarized the preliminary hydraulic and sediment-transport analysis of the Salt River for a proposed alignment of the East Papago Freeway which would cross over the existing Hayden Road Bridge and the Salt River on a southeasterly skew. After crossing Hayden Road and the Salt River on structure, the proposed alignment would basically follow along the south bank of the Salt River. In doing so, it would cross the Old Scottsdale Landfill on fill, skirt the northern boundary of the Old Tempe Landfill on fill, and then tie into the Red Mountain Interchange. In this addendum, the above described alignment will be termed the southern alignment.

The alternate alignment evaluated in this addendum is for a northern alignment of Section 6 of the East Papago Freeway which would be entirely on structure east of Hayden Road. This proposed alignment would cross the existing Hayden Road Bridge at approximately a 90 degree angle, then follow the north bank of the river to a point north of the Old Tempe Landfill, where the alignment would turn southeasterly and cross the Salt River in order to tie into the Red Mountain Interchange. Figure 1 shows the general location of both the proposed northern alignment and the proposed southern alignment.



LEGEND

- HARDBANK ALIGNMENT
- ALIGNMENT CENTERLINE
- CROSS-SECTION NUMBER

sla Simons, Li & Associates, Inc.
 NEWPORT BEACH, CA., FORT COLLINS, CO.,
 TUCSON, AZ., PHOENIX, AZ.

**EAST PAPAGO FREEWAY - SECTION 6
 ALTERNATE ALIGNMENTS**

Project No. AZ-DNJM-03
Date: 11/7/89
Design:
Drawn: JRM
Check:
Revisions:

FIGURE 1

II. HYDRAULIC ANALYSIS FOR PROPOSED NORTHERN ALIGNMENT

2.1 General

The analyses procedures and data base used for the analysis of the proposed northern alignment were the same as those used for the analysis of the proposed southern alignment, and are described in the initial report (1). For concept conditions of the proposed northern alignment, bridge routines were not used to analyze the East Papago crossing of the Salt River. Instead, the piers were modeled as obstructions in the flow field, thus removing the pier area from the effective flow area of the channel. This modeling procedure was used due to the alignment of the structure with respect to flow.

A baseline condition, with the effects of gravel pits removed, was used to analyze impacts resulting from the project. This is the same approach as was used in the analysis for the proposed southern alignment, and was done to provide an estimate of water-surface elevations that would result if the gravel pits were filled in with water and/or sediment during flood events. This condition provided a conservative estimate of water-surface elevations.

The baseline condition used for this study was identical to that used in the initial study, except for an adjustment made to cross-section 234.00. It was found that cross-section 234.00 contained an obstruction, unique to the location of the cross-section, which produced irregular results. Therefore, the baseline condition presented in this addendum incorporates an adjustment to cross-section 234.00.

2.2 Concept Analysis - Proposed Northern Alignment

Concept conditions for the proposed northern alignment are a result of both the best estimate of conditions resulting from this alignment of the East Papago Freeway, which is entirely on structure, and a best estimate of the Outer Loop bridge configuration. The effects of gravel pits were removed from the concept conditions for the northern alignment, as in the baseline conditions, in order to provide a conservative estimate of impacts resulting from the project and to permit comparison with the concept conditions for the proposed southern alignment presented in the initial report (1).

In addition to removing the effects of gravel pits, concept conditions for the proposed northern alignment include bank protection along the south bank of

the river from Hayden Road to upstream of the Outer Loop. The bank protection will be located adjacent to the Old Scottsdale Landfill and the Old Tempe Landfill in an effort to minimize disturbance to the sites, and yet maximize conveyance in the Salt River channel. No bank protection or other improvements have been included for the north bank of the river. Figure 1 shows the approximate location of the East Papago Freeway for both the proposed northern alignment and the proposed southern alignment.

The concept condition for the proposed northern alignment of the East Papago Freeway assumed a structure consisting of 135-foot spans with 7-foot diameter columns, 2 columns per structure. Each column of the East Papago structure will be exposed to flow. The Outer Loop crossing of the Salt River is identical to that used for the concept conditions for the proposed southern alignment. The effective length of the mainline and ramps of the Outer Loop crossing was approximately 1900 feet. The Outer Loop crossing was analyzed assuming 130-foot spans with 6-foot diameter columns, 3 columns per structure. As a result of the small angle to which the structures are skewed to the flow, it was assumed that the piers for the Outer Loop crossing would be aligned to flow.

Water-surface profiles for the proposed northern alignment were computed for the 100-year peak discharge for both baseline conditions and concept conditions. For concept conditions, two cases were analyzed. The first case did not consider debris buildup on the piers. The second case considered debris buildup, and assumed that the effective pier diameter would be double the actual pier diameter. The hydraulic results are presented in Table 1 for the case without debris buildup, and in Table 2 for the case with debris buildup. The case with debris buildup provides a more conservative estimate of water-surface elevations. Figure 2 provides plots of the water-surface profiles for the 100-year event. Computed differences between concept conditions for the proposed northern alignment, with debris buildup, and baseline conditions for both water-surface elevations and average velocities are presented in Table 3 for the 100-year event.

The results of the concept conditions for the proposed northern alignment show a maximum increase in water-surface elevation of 2.1 feet, which occurs at the upstream face of the Hayden Road bridge. This increase is due to the East Papago freeway encroachment on the Salt River downstream of Hayden Road, and the

TABLE 1. Hydraulic Information -- Baseline and Concept Conditions for Proposed Northern Alignment, Without Debris Buildup, 100-Year Event

PROJECT STATION (ft)	CROSS-SECTION NUMBER	----- BASELINE CONDITION -----				----- CONCEPT CONDITION -----				PHYSICAL FEATURE	
		CALCULATED		HYDRAULIC DEPTH (ft)	CHANNEL VELOCITY (fps)	TOPWIDTH (ft)	CALCULATED		CHANNEL VELOCITY (fps)		TOPWIDTH (ft)
		WATER SURFACE ELEV. (ft)					WATER SURFACE ELEV. (ft)	HYDRAULIC DEPTH (ft)			
36263	225.00	1170.5	17.6	10.6	2180	1170.7	17.8	11.2	1231		
36660	226.00	1171.3	17.6	10.7	2252	1171.4	17.8	11.8	1277		
37027	227.10	1171.8	17.1	11.0	1571	1173.2	21.4	8.7	1806	Hayden Road Bridge	
37116	227.40	1171.8	14.2	13.2	1496	1173.9	22.1	8.4	1889		
37436	228.00	1173.8	18.7	10.5	2426	1174.7	22.3	7.0	2376		
37836	229.00	1174.9	22.7	7.7	2430	1174.7	19.5	8.6	2229		
38236	230.00	1175.0	22.6	8.7	2655	1175.0	17.4	9.9	2481		
38635	231.00	1175.0	21.3	12.8	2059	1175.4	17.6	10.5	2336	Old Scottsdale Landfill	
39042	232.00	1175.4	22.8	13.0	2093	1176.2	19.4	10.0	2502		
39444	233.00	1177.3	15.4	9.1	2311	1176.8	20.5	10.1	2032		
39840	234.00	1177.7	24.6	8.4	1987	1177.4	22.2	9.6	1814		
40246	235.00	1177.7	22.3	10.8	1603	1177.9	24.4	9.9	1579		
40647	236.00	1178.6	24.6	9.1	1875	1178.5	24.1	9.2	1813	Old Tempe Landfill	
41043	237.00	1179.1	24.6	8.6	1472	1178.9	24.0	9.0	1415		
41553	238.00	1179.6	25.2	7.8	1456	1179.8	28.9	7.4	1462		
42018	239.00	1179.8	16.5	8.9	1438	1180.0	28.0	7.8	1455		
42568	240.00	1180.4	25.0	8.0	1461	1180.8	20.5	5.7	1882	Outer Loop Highway	
43073	241.00	1181.0	22.9	6.8	1826	1181.0	20.7	5.7	1882		
43588	242.00	1181.5	25.0	5.1	2324	1181.3	24.8	5.3	2130		
44058	243.00	1181.7	25.7	4.0	2482	1181.5	25.7	4.2	2244		
44528	244.00	1181.8	19.2	4.5	2532	1181.6	19.1	5.0	2284		
45078	245.00	1181.9	16.1	4.8	2868	1181.8	16.0	5.3	2581		
45693	246.00	1182.2	16.9	4.2	3146	1182.2	16.9	4.2	3143	Evergreen Road	
46197	247.00	1182.2	13.6	6.9	2354	1182.2	13.5	6.8	2377		
46736	248.00	1183.0	17.0	4.1	3177	1182.9	17.1	4.1	3173		
47237	249.00	1183.1	19.5	4.4	2579	1183.1	19.8	4.3	2576		
47757	250.00	1183.2	17.7	5.1	2450	1183.1	17.6	5.1	2449		
48364	251.00	1183.2	13.0	9.1	1861	1183.1	13.0	9.1	1861		
48862	252.00	1183.9	15.1	9.4	1558	1183.9	15.0	9.4	1558	Dobson Road	
49506	253.00	1185.3	11.8	8.8	2121	1185.3	11.8	8.8	2121		
49980	254.00	1185.5	9.5	15.0	1545	1185.5	9.5	15.0	1545		
50487	255.00	1189.7	12.8	11.1	1541	1189.7	12.8	11.1	1542		
50957	256.00	1191.5	18.4	7.5	1586	1191.5	18.4	7.5	1586		
51491	257.00	1191.5	13.2	11.2	1496	1191.5	13.2	11.2	1496		
51910	258.00	1192.6	17.3	11.0	1162	1192.6	17.3	11.0	1162		
52496	259.00	1194.3	15.5	9.1	1565	1194.3	15.5	9.1	1565		
53001	260.00	1195.3	17.8	8.0	1662	1195.3	17.8	8.0	1662		
53445	261.00	1195.9	20.9	6.9	2069	1195.9	20.9	6.9	2069		
53954	262.00	1195.9	17.2	11.7	1820	1195.9	17.2	11.7	1820		
54478	263.00	1196.9	13.1	11.7	2145	1196.9	13.1	11.7	2145		
55034	264.00	1198.2	12.2	12.2	1871	1198.2	12.2	12.2	1871		
55471	265.00	1199.6	13.4	11.0	2008	1199.6	13.4	11.0	2008	Alma School Road	

TABLE 2. Hydraulic Information -- Baseline and Concept Conditions for Proposed Northern Alignment, With Debris Buildup, 100-Year Event

PROJECT STATION (ft)	CROSS-SECTION NUMBER	----- BASELINE CONDITION -----				----- CONCEPT CONDITION -----				PHYSICAL FEATURE
		CALCULATED WATER SURFACE ELEV. (ft)	HYDRAULIC DEPTH (ft)	CHANNEL VELOCITY (fps)	TOPWIDTH (ft)	CALCULATED WATER SURFACE ELEV. (ft)	HYDRAULIC DEPTH (ft)	CHANNEL VELOCITY (fps)	TOPWIDTH (ft)	
36263	225.00	1170.5	17.6	10.6	2180	1170.7	17.8	11.2	1231	
36660	226.00	1171.3	17.6	10.7	2252	1171.4	17.8	11.9	1261	
37027	227.10	1171.8	17.1	11.0	1571	1173.2	21.4	8.7	1813	Hayden Road Bridge
37116	227.40	1171.8	14.2	13.2	1496	1173.9	22.2	8.4	1895	
37436	228.00	1173.8	18.7	10.5	2426	1174.7	21.8	7.1	2356	
37836	229.00	1174.9	22.7	7.7	2430	1174.8	19.0	8.8	2206	
38236	230.00	1175.0	22.6	8.7	2655	1175.0	16.9	10.1	2454	
38635	231.00	1175.0	21.3	12.8	2059	1175.5	17.0	10.8	2335	Old Scottsdale Landfill
39042	232.00	1175.4	22.8	13.0	2093	1176.4	18.8	10.2	2477	
39444	233.00	1177.3	15.4	9.1	2311	1177.0	19.9	10.3	2094	
39840	234.00	1177.7	24.6	8.4	1987	1177.7	21.6	9.8	1827	
40246	235.00	1177.7	22.3	10.8	1603	1178.1	23.7	10.1	1628	
40647	236.00	1178.6	24.6	9.1	1875	1178.8	23.5	9.4	1930	Old Tempe Landfill
41043	237.00	1179.1	24.6	8.6	1472	1179.2	23.4	9.2	1391	
41553	238.00	1179.6	25.2	7.8	1456	1180.2	29.3	7.3	1496	
42018	239.00	1179.8	16.5	8.9	1438	1180.4	28.4	7.7	1458	
42568	240.00	1180.4	25.0	8.0	1461	1181.1	20.9	5.6	1883	Outer Loop Highway
43073	241.00	1181.0	22.9	6.8	1826	1181.4	21.0	5.6	1884	
43588	242.00	1181.5	25.0	5.1	2324	1181.6	25.1	5.2	2131	
44058	243.00	1181.7	25.7	4.0	2482	1181.9	26.0	4.1	2244	
44528	244.00	1181.8	19.2	4.5	2532	1181.9	19.4	5.0	2285	
45078	245.00	1181.9	16.1	4.8	2868	1182.1	16.3	5.2	2582	
45693	246.00	1182.2	16.9	4.2	3146	1182.5	17.2	4.1	3145	Evergreen Road
46197	247.00	1182.2	13.6	6.9	2354	1182.5	13.8	6.7	2390	
46736	248.00	1183.0	17.0	4.1	3177	1183.2	17.3	4.0	3179	
47237	249.00	1183.1	19.5	4.4	2579	1183.3	20.0	4.3	2578	
47757	250.00	1183.2	17.7	5.1	2450	1183.4	17.9	5.0	2454	
48364	251.00	1183.2	13.0	9.1	1861	1183.4	13.3	8.9	1862	
48862	252.00	1183.9	15.1	9.4	1558	1184.1	15.2	9.3	1559	Dobson Road
49506	253.00	1185.3	11.8	8.8	2121	1185.5	11.9	8.7	2122	
49980	254.00	1185.5	9.5	15.0	1545	1185.6	9.6	14.9	1547	
50487	255.00	1189.7	12.8	11.1	1541	1189.7	12.8	11.1	1541	
50957	256.00	1191.5	18.4	7.5	1586	1191.5	18.4	7.5	1586	
51491	257.00	1191.5	13.2	11.2	1496	1191.5	13.2	11.2	1496	
51910	258.00	1192.6	17.3	11.0	1162	1192.6	17.3	11.0	1162	
52496	259.00	1194.3	15.5	9.1	1565	1194.3	15.5	9.1	1565	
53001	260.00	1195.3	17.8	8.0	1662	1195.3	17.8	8.0	1662	
53445	261.00	1195.9	20.9	6.9	2069	1195.9	20.9	6.9	2069	
53954	262.00	1195.9	17.2	11.7	1820	1195.9	17.2	11.7	1820	
54478	263.00	1196.9	13.1	11.7	2145	1196.9	13.1	11.7	2145	
55034	264.00	1198.2	12.2	12.2	1871	1198.2	12.2	12.2	1871	
55471	265.00	1199.6	13.4	11.0	2008	1199.6	13.4	11.0	2008	Alma School Road

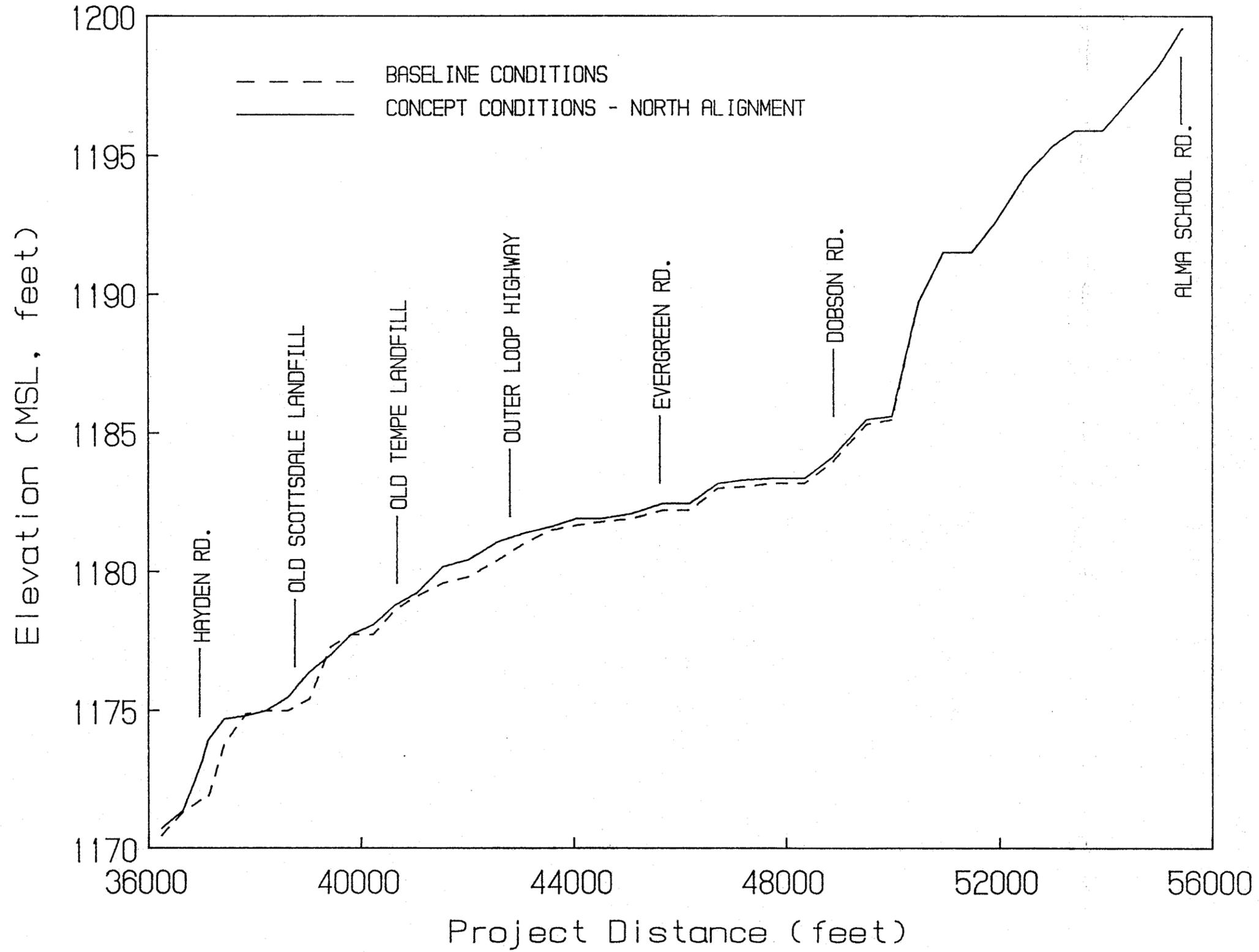


Figure 2. Water-Surface Profiles for Baseline and Concept Conditions for Proposed Northern Alignment, With Debris Buildup, 100-Year Event

TABLE 3. Water-Surface Elevations and Velocity Comparisons--Concept Conditions for Proposed Northern Alignment Minus Baseline Conditions, 100-Year Event With Debris Buildup

PROJECT STATION (feet)	CROSS-SECTION NUMBER	WATER SURFACE ELEVATION (feet)	CHANNEL VELOCITY (ft/sec)	PHYSICAL FEATURE
36263	225.00	0.2	0.6	
36660	226.00	0.2	1.2	
37027	227.10	1.4	-2.3	Hayden Road Bridge
37116	227.40	2.1	-4.8	
37436	228.00	1.0	-3.4	
37836	229.00	-0.1	1.1	
38236	230.00	0.0	1.4	
38635	231.00	0.5	-2.0	Old Scottsdale Landfill
39042	232.00	1.0	-2.8	
39444	233.00	-0.3	1.2	
39840	234.00	-0.1	1.4	
40246	235.00	0.4	-0.7	
40647	236.00	0.2	0.2	Old Tempe Landfill
41043	237.00	0.1	0.6	
41553	238.00	0.6	-0.5	
42018	239.00	0.6	-1.2	
42568	240.00	0.8	-2.4	Outer Loop Highway
43073	241.00	0.4	-1.2	
43588	242.00	0.1	0.2	
44058	243.00	0.1	0.1	
44528	244.00	0.1	0.4	
45078	245.00	0.2	0.5	
45693	246.00	0.3	-0.1	Evergreen Road
46197	247.00	0.3	-0.2	
46736	248.00	0.2	-0.1	
47237	249.00	0.2	-0.1	
47757	250.00	0.2	-0.1	
48364	251.00	0.2	-0.2	
48862	252.00	0.2	-0.1	Dobson Road
49506	253.00	0.1	-0.1	
49980	254.00	0.1	-0.1	
50487	255.00	0.0	0.0	
50957	256.00	0.0	0.0	
51491	257.00	0.0	0.0	
51910	258.00	0.0	0.0	
52496	259.00	0.0	0.0	
53001	260.00	0.0	0.0	
53445	261.00	0.0	0.0	
53954	262.00	0.0	0.0	
54478	263.00	0.0	0.0	
55034	264.00	0.0	0.0	
55471	265.00	0.0	0.0	Alma School Road

assumed configuration of the East Papago freeway crossing. Above this point, the maximum increase is 1.0 foot, and is in the vicinity of the Old Scottsdale Landfill (cross-section 232.00). The maximum increase in average velocity is 1.4 feet per second, which occurs at cross-section 234.00.

Since baseline conditions in this addendum are different than the baseline conditions presented in the initial report, a comparison of baseline conditions to concept conditions for the southern alignment is included in this addendum. This difference in baseline conditions is due to the adjustment that was made in cross-section 234.00. Table 4 presents the hydraulic results of the baseline conditions, as presented in this addendum, and the concept conditions for the proposed southern alignment. Table 5 presents the computed differences between concept conditions for the proposed southern alignment and baseline conditions, as presented in this addendum, for both water-surface elevations and average velocities for the 100-year event.

TABLE 4. Hydraulic Information -- Baseline and Concept Conditions for Proposed Southern Alignment, Without Debris Buildup, 100-Year Event

PROJECT STATION (ft)	CROSS-SECTION NUMBER	----- BASELINE CONDITION -----				----- CONCEPT CONDITION -----				PHYSICAL FEATURE
		CALCULATED		CHANNEL VELOCITY (fps)	TOPWIDTH (ft)	CALCULATED		CHANNEL VELOCITY (fps)	TOPWIDTH (ft)	
		WATER SURFACE ELEV. (ft)	HYDRAULIC DEPTH (ft)			WATER SURFACE ELEV. (ft)	HYDRAULIC DEPTH (ft)			
36263	225.00	1170.5	17.6	10.6	2180	1170.7	17.8	11.2	1231	
36660	226.00	1171.3	17.6	10.7	2252	1171.5	17.9	11.3	1318	
37027	227.10	1171.8	17.1	11.0	1571	1173.0	21.2	8.8	1784	Hayden Road Bridge
37116	227.40	1171.8	14.2	13.2	1496	1173.7	21.9	8.4	1871	
37436	228.00	1173.8	18.7	10.5	2426	1173.8	22.8	8.3	1135	
37836	229.00	1174.9	22.7	7.7	2430	1175.0	24.0	7.7	1170	
38236	230.00	1175.0	22.6	8.7	2655	1175.5	22.4	7.4	2745	
38635	231.00	1175.0	21.3	12.8	2059	1175.7	24.9	8.0	2652	Old Scottsdale Landfill
39042	232.00	1175.4	22.8	13.0	2093	1175.9	24.7	8.0	2688	
39444	233.00	1177.3	15.4	9.1	2311	1175.9	23.9	9.7	1600	
39840	234.00	1177.7	24.6	8.4	1987	1176.0	22.4	11.7	1471	
40246	235.00	1177.7	22.3	10.8	1603	1176.2	23.1	13.9	1390	
40647	236.00	1178.6	24.6	9.1	1875	1177.0	22.0	14.3	1231	Old Tempe Landfill
41043	237.00	1179.1	24.6	8.6	1472	1178.4	22.8	13.1	1163	
41553	238.00	1179.6	25.2	7.8	1456	1180.7	28.4	7.5	1487	
42018	239.00	1179.8	16.5	8.9	1438	1181.0	23.2	7.4	1512	
42568	240.00	1180.4	25.0	8.0	1461	1181.7	21.4	5.5	1885	Outer Loop Highway
43073	241.00	1181.0	22.9	6.8	1826	1181.9	21.5	5.4	1886	
43588	242.00	1181.5	25.0	5.1	2324	1182.1	25.6	5.1	2133	
44058	243.00	1181.7	25.7	4.0	2482	1182.4	26.5	4.0	2245	
44528	244.00	1181.8	19.2	4.5	2532	1182.4	19.9	4.8	2286	
45078	245.00	1181.9	16.1	4.8	2868	1182.6	16.7	5.1	2584	
45693	246.00	1182.2	16.9	4.2	3146	1182.9	17.6	4.0	3149	Evergreen Road
46197	247.00	1182.2	13.6	6.9	2354	1182.9	14.1	6.5	2410	
46736	248.00	1183.0	17.0	4.1	3177	1183.6	17.7	3.9	3184	
47237	249.00	1183.1	19.5	4.4	2579	1183.7	20.4	4.2	2581	
47757	250.00	1183.2	17.7	5.1	2450	1183.8	18.2	4.9	2460	
48364	251.00	1183.2	13.0	9.1	1861	1183.8	13.6	8.7	1864	
48862	252.00	1183.9	15.1	9.4	1558	1184.4	15.5	9.1	1561	Dobson Road
49506	253.00	1185.3	11.8	8.8	2121	1185.7	12.1	8.6	2123	
49980	254.00	1185.5	9.5	15.0	1545	1185.8	9.7	14.6	1555	
50487	255.00	1189.7	12.8	11.1	1541	1189.7	12.8	11.1	1541	
50957	256.00	1191.5	18.4	7.5	1586	1191.5	18.4	7.5	1586	
51491	257.00	1191.5	13.2	11.2	1496	1191.5	13.2	11.2	1496	
51910	258.00	1192.6	17.3	11.0	1162	1192.6	17.2	11.0	1162	
52496	259.00	1194.3	15.5	9.1	1565	1194.3	15.5	9.1	1565	
53001	260.00	1195.3	17.8	8.0	1662	1195.3	17.8	8.0	1662	
53445	261.00	1195.9	20.9	6.9	2069	1195.9	20.9	6.9	2069	
53954	262.00	1195.9	17.2	11.7	1820	1195.9	17.2	11.7	1820	
54478	263.00	1196.9	13.1	11.7	2145	1196.9	13.1	11.7	2144	
55034	264.00	1198.2	12.2	12.2	1871	1198.2	12.2	12.2	1871	
55471	265.00	1199.6	13.4	11.0	2008	1199.6	13.4	11.0	2008	Alma School Road

TABLE 5. Water-Surface Elevations and Velocity Comparisons -- Concept Conditions for Proposed Southern Alignment, 100-Year Event Without Debris Buildup

PROJECT STATION (feet)	CROSS-SECTION NUMBER	WATER SURFACE ELEVATION (feet)	CHANNEL VELOCITY (ft/sec)	PHYSICAL FEATURE
36263	225.00	0.2	0.6	
36660	226.00	0.2	0.6	
37027	227.10	1.2	-2.2	Hayden Road Bridge
37116	227.40	1.9	-4.8	
37436	228.00	0.0	-2.2	
37836	229.00	0.1	0.0	
38236	230.00	0.5	-1.3	
38635	231.00	0.7	-4.8	Old Scottsdale Landfill
39042	232.00	0.5	-5.0	
39444	233.00	-1.4	0.6	
39840	234.00	-1.7	3.3	
40246	235.00	-1.5	3.1	
40647	236.00	-1.6	5.2	Old Tempe Landfill
41043	237.00	-0.7	4.5	
41553	238.00	1.1	-0.3	
42018	239.00	1.2	-1.5	
42568	240.00	1.3	-2.5	Outer Loop Highway
43073	241.00	0.9	-1.4	
43588	242.00	0.6	0.0	
44058	243.00	0.7	0.0	
44528	244.00	0.6	0.3	
45078	245.00	0.7	0.3	
45693	246.00	0.7	-0.2	Evergreen Road
46197	247.00	0.7	-0.4	
46736	248.00	0.6	-0.2	
47237	249.00	0.6	-0.2	
47757	250.00	0.6	-0.2	
48364	251.00	0.6	-0.4	
48862	252.00	0.5	-0.3	Dobson Road
49506	253.00	0.4	-0.2	
49980	254.00	0.3	-0.4	
50487	255.00	0.0	0.0	
50957	256.00	0.0	0.0	
51491	257.00	0.0	0.0	
51910	258.00	0.0	0.0	
52496	259.00	0.0	0.0	
53001	260.00	0.0	0.0	
53445	261.00	0.0	0.0	
53954	262.00	0.0	0.0	
54478	263.00	0.0	0.0	
55034	264.00	0.0	0.0	
55471	265.00	0.0	0.0	Alma School Road

III. LOCAL SCOUR

Local scour, due to the presence of structures and debris in the flow field, was computed for the 100-year design flood under concept conditions for the proposed northern alignment. Due to the proximity of the freeway to the north bank of the Salt River, pier scour and its resulting zone of influence could potentially undermine the north bank, in the absence of bank stabilization, and create bank instability problems for the section of the freeway located parallel to the north bank of the Salt River.

The zone of influence for local scour is the distance that the local scour extends from the face of the pier. This zone of influence can be approximately determined by assuming that the bottom of the scour hole extends horizontally one pier diameter away from the face of the pier in a radial direction, and then slopes upward to the bed of the channel on a 1.75 to 1 (horizontal to vertical) side-slope, which is approximately equal to the natural angle of repose of the streambed sediments. For example, the zone of influence for a 7-foot diameter pier with 16 feet of local scour would be 35 feet (7 feet plus 1.75 times 16 feet).

Local scour can be deeper if scour holes overlap. The mechanisms of this phenomenon are not well understood, but a conservative estimate of local scour can be obtained by considering the local-scour components to be additive at a given location. Consequently, if the predicted local scour for an individual 7-foot diameter pier column is 16 feet, the total (additive) local scour for 7-foot columns spaced on 40-foot centers would be 21.1 feet due to the overlapping of the scour holes. During the passage of the design flood, this 21.1-foot-deep scour hole could migrate against the face of either pier. In addition, the zone of influence of this increased local scour, due to the overlapping of the scour holes, would expand to approximately 44 feet (7 feet plus 1.75 times 21.1 feet). This example demonstrates the need to carefully evaluate the size and location of piers in relation to each other when considering local scour.

As was stated in the initial report, the total-scour depth at any given point along the reach of the Salt River under investigation is the sum of the general scour; bedform-trough depths; local scour; and long-term degradation. General scour and long-term channel response were discussed in the initial report. Table 6 presents a summary of the total-scour depths at piers for

concept conditions of the proposed northern alignment. The pier scour included in Table 6 is for an East Papago structure with 130-foot spans with 7-foot diameter columns and 7-feet of additional pier width included for debris buildup, and an Outer Loop crossing with 130-foot spans with 6-foot diameter columns and 6-feet of additional pier width included for debris buildup.

The local-scour depths included in Table 6 are believed to be conservative. The depths included in the table include the potential for overlap of the scour holes, and assume that no bedrock is encountered within the scour zone. A safety factor equal to 30 percent of the sum of the above scour components is included to account for the non-uniform flow distribution that is typical of alluvial channels, except where scour holes overlap. It is felt that the conservative approach of simply adding depths for overlapping scour holes already incorporates an adequate safety factor for local scour at these locations.

Local scour in the areas where gravel pits are present were computed by Shen's Equation and the C.S.U. Equation (2). These equations were used since flow velocities within the pit areas are small, and these equations account for flow velocities by including the Froude number as a parameter. The two equations predicted similar local-scour depths, and the mean value computed with these two equations was used for this study. The local-scour computations at all other locations were based on several pier-scour equations reported in the literature, and the most conservative result was adopted.

A conservative approach for computing local scour within gravel pits was taken, since there is nothing in the literature which addresses the determination of local scour at piers subjected to such unique flow conditions. It is possible a more precise estimate of local scour for these conditions could be developed with the aid of a physical model, should a more definitive estimate of local scour be desired.

TABLE 6. Summary of Total-Scour Depths at Piers

Project Station (ft)	Cross-Section Number	General Scour (ft)	Bed-Form Scour (ft)	Pier ¹ Scour (ft)	Long-term ² Degradation (ft)	Safety Factor (ft)	Total Scour at Piers (ft)	Minimum ³ Predicted Invert Elevation (ft)	Physical Feature
36660	226.00	1.9	2.0	41.0	6.5	3.1	54.5	1093.5	
37027	227.10	1.6	2.0	41.0	6.5	3.0	54.1	1095.9	Hayden Road Bridge
37116	227.40	0.0	2.0	41.0	6.5	2.6	52.1	1097.9	
37436	228.00	0.0	2.0	41.0	6.5	2.6	52.1	1097.9	
37836	229.00	0.0	2.0	41.0	6.5	2.6	52.1	1097.9	
38236	230.00	0.0	2.0	41.0	6.5	2.6	52.1	1097.9	
38635	231.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
39042	232.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
39444	233.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
39840	234.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
40246	235.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
40647	236.00	NA	NA	21.0	40.0	NA	61.0	1089.0	Old Tempe Landfill
41043	237.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
41553	238.00	NA	NA	21.0	40.0	NA	61.0	1089.0	
42018	239.00	NA	NA	26.0	20.0	7.8	53.8	1096.2	
42568	240.00	NA	NA	26.0	20.0	7.8	53.8	1097.2	Outer Loop Highway
43073	241.00	NA	NA	26.0	20.0	7.8	53.8	1097.7	
43588	242.00	NA	NA	26.0	20.0	7.8	53.8	1098.2	

NOTES:

- 1 Includes consideration for debris buildup and the overlap of scour holes, where applicable.
 - 2 Represents armoring, mining, or headcut component, whichever is the controlling process.
 - 3 Based upon ADOT 1986 topographic mapping.
- NA Scour component is not applicable at this cross-section.

IV. COMPARISON OF ALTERNATIVES

The initial report (1), "Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" presented the results of a preliminary hydraulic and sediment-transport analyses for a proposed southern alignment of Section 6 of the East Papago Freeway. This addendum has presented the results of a preliminary hydraulic analysis for a proposed northern alignment.

Table 7 is a tabulation of water-surface elevations for baseline conditions, as presented in this addendum; for concept conditions for the proposed northern alignment; and for concept conditions for the proposed southern alignment. The water-surface elevations presented for the proposed northern alignment are for the case with debris buildup on the piers, which provides a conservative estimate of water-surface elevations. A comparison of the water-surface elevations for the proposed northern alignment versus the proposed southern alignment shows that the proposed northern alignment will result in higher water-surface elevations in the reach between the Old Scottsdale Landfill (cross-section 232.00) and the Old Tempe Landfill (cross-section 237.00); and that the maximum increase over baseline conditions is 1.0 foot, which occurs at cross-section 232.00. Table 8 is a tabulation of average velocities for baseline conditions, as presented in this addendum; for concept conditions for the proposed northern alignment; and for concept conditions for the proposed southern alignment.

One of the major hydraulic disadvantages to a proposed southern alignment is that, north of the Old Tempe Landfill, average velocities increase significantly over baseline conditions. This increase in average velocities creates the potential for increased sediment transport and bank instability in this reach of the Salt River. This is due to the proposed encroachment of the freeway into the Salt River, resulting in a flow constriction.

In the vicinity of the Old Tempe Landfill, the average velocities are significantly less for the concept conditions of the proposed northern alignment than for the concept conditions of the proposed southern alignment. This is due, in part, to not having to encroach on the river with fill embankment. In the vicinity of the Old Scottsdale Landfill, the average velocities are greater for

TABLE 7. Water-Surface Elevations, 100-Year Event

PROJECT STATION (feet)	CROSS-SECTION NUMBER	BASELINE CONDITION (feet)	NORTHERN ¹ ALIGNMENT (feet)	SOUTHERN ALIGNMENT (feet)	NORTHERN-SOUTHERN (feet)	PHYSICAL FEATURE
36263	225.00	1170.5	1170.7	1170.7	0.0	
36660	226.00	1171.3	1171.4	1171.5	-0.1	
37027	227.10	1171.8	1173.2	1173.0	0.2	Hayden Road Bridge
37116	227.40	1171.8	1173.9	1173.7	0.2	
37436	228.00	1173.8	1174.7	1173.8	0.9	
37836	229.00	1174.9	1174.8	1175.0	-0.2	
38236	230.00	1175.0	1175.0	1175.5	-0.5	
38635	231.00	1175.0	1175.5	1175.7	-0.2	Old Scottsdale Landfill
39042	232.00	1175.4	1176.4	1175.9	0.5	
39444	233.00	1177.3	1177.0	1175.9	1.1	
39840	234.00	1177.7	1177.7	1176.0	1.7	
40246	235.00	1177.7	1178.1	1176.2	1.9	
40647	236.00	1178.6	1178.8	1177.0	1.8	Old Tempe Landfill
41043	237.00	1179.1	1179.2	1178.4	0.8	
41553	238.00	1179.6	1180.2	1180.7	-0.5	
42018	239.00	1179.8	1180.4	1181.0	-0.6	
42568	240.00	1180.4	1181.1	1181.7	-0.6	Outer Loop Highway
43073	241.00	1181.0	1181.4	1181.9	-0.5	
43588	242.00	1181.5	1181.6	1182.1	-0.5	
44058	243.00	1181.7	1181.9	1182.4	-0.5	
44528	244.00	1181.8	1181.9	1182.4	-0.5	
45078	245.00	1181.9	1182.1	1182.6	-0.5	
45693	246.00	1182.2	1182.5	1182.9	-0.4	Evergreen Road
46197	247.00	1182.2	1182.5	1182.9	-0.4	
46736	248.00	1183.0	1183.2	1183.6	-0.4	
47237	249.00	1183.1	1183.3	1183.7	-0.4	
47757	250.00	1183.2	1183.4	1183.8	-0.4	
48364	251.00	1183.2	1183.4	1183.8	-0.4	
48862	252.00	1183.9	1184.1	1184.4	-0.3	Dobson Road
49506	253.00	1185.3	1185.5	1185.7	-0.2	
49980	254.00	1185.5	1185.6	1185.8	-0.2	
50487	255.00	1189.7	1189.7	1189.7	0.0	
50957	256.00	1191.5	1191.5	1191.5	0.0	
51491	257.00	1191.5	1191.5	1191.5	0.0	
51910	258.00	1192.6	1192.6	1192.6	0.0	
52496	259.00	1194.3	1194.3	1194.3	0.0	
53001	260.00	1195.3	1195.3	1195.3	0.0	
53445	261.00	1195.9	1195.9	1195.9	0.0	
53954	262.00	1195.9	1195.9	1195.9	0.0	
54478	263.00	1196.9	1196.9	1196.9	0.0	
55034	264.00	1198.2	1198.2	1198.2	0.0	
55471	265.00	1199.6	1199.6	1199.6	0.0	Alma School Road

¹ With Debris Buildup

TABLE 8. Average Velocities, 100-Year Event

PROJECT STATION (feet)	CROSS-SECTION NUMBER	BASELINE CONDITION (ft/sec)	NORTHERN ¹ ALIGNMENT (ft/sec)	SOUTHERN ALIGNMENT (ft/sec)	NORTHERN-SOUTHERN (ft/sec)	PHYSICAL FEATURE
36263	225.00	10.6	11.2	11.2	0.0	
36660	226.00	10.7	11.9	11.3	0.6	
37027	227.10	11.0	8.7	8.8	-0.1	Hayden Road Bridge
37116	227.40	13.2	8.4	8.4	0.0	
37436	228.00	10.5	7.1	8.3	-1.2	
37836	229.00	7.7	8.8	7.7	1.1	
38236	230.00	8.7	10.1	7.4	2.7	
38635	231.00	12.8	10.8	8.0	2.8	Old Scottsdale Landfill
39042	232.00	13.0	10.2	8.0	2.2	
39444	233.00	9.1	10.3	9.7	0.6	
39840	234.00	8.4	9.8	11.7	-1.9	
40246	235.00	10.8	10.1	13.9	-3.8	
40647	236.00	9.1	9.4	14.3	-4.9	Old Tempe Landfill
41043	237.00	8.6	9.2	13.1	-3.9	
41553	238.00	7.8	7.3	7.5	-0.2	
42018	239.00	8.9	7.7	7.4	0.3	
42568	240.00	8.0	5.6	5.5	0.1	Outer Loop Highway
43073	241.00	6.8	5.6	5.4	0.2	
43588	242.00	5.1	5.2	5.1	0.1	
44058	243.00	4.0	4.1	4.0	0.1	
44528	244.00	4.5	5.0	4.8	0.2	
45078	245.00	4.8	5.2	5.1	0.1	
45693	246.00	4.2	4.1	4.0	0.1	Evergreen Road
46197	247.00	6.9	6.7	6.5	0.2	
46736	248.00	4.1	4.0	3.9	0.1	
47237	249.00	4.4	4.3	4.2	0.1	
47757	250.00	5.1	5.0	4.9	0.1	
48364	251.00	9.1	8.9	8.7	0.2	
48862	252.00	9.4	9.3	9.1	0.2	Dobson Road
49506	253.00	8.8	8.7	8.6	0.1	
49980	254.00	15.0	14.9	14.6	0.3	
50487	255.00	11.1	11.1	11.1	0.0	
50957	256.00	7.5	7.5	7.5	0.0	
51491	257.00	11.2	11.2	11.2	0.0	
51910	258.00	11.0	11.0	11.0	0.0	
52496	259.00	9.1	9.1	9.1	0.0	
53001	260.00	8.0	8.0	8.0	0.0	
53445	261.00	6.9	6.9	6.9	0.0	
53954	262.00	11.7	11.7	11.7	0.0	
54478	263.00	11.7	11.7	11.7	0.0	
55034	264.00	12.2	12.2	12.2	0.0	
55471	265.00	11.0	11.0	11.0	0.0	Alma School Road

¹ With Debris Buildup

conditions of the proposed southern alignment. However, the average velocities are less than baseline conditions at cross-section 231.00 and cross-section 232.00.

In addition to minimizing the increase in average velocities, the proposed northern alignment offers the potential for minimizing the impact on existing utilities located immediately upstream of the Hayden Road Bridge. As noted previously, one disadvantage to the proposed northern alignment is that pier scour, and its resulting zone of influence, could potentially undermine the north bank, in the absence of bank stabilization, and create bank stability problems for the section of the freeway located parallel to the north bank of the Salt River. In addition, if gravel mining is allowed to continue in this reach of the river, the depth of bridge foundations required for the proposed northern alignment will be significant.

V. SUMMARY

Preliminary results of the hydraulic and local scour analysis of the reach of the Salt River from immediately downstream of Hayden Road to upstream of the Outer Loop Highway crossing have been presented in this report. Water-surface profiles were computed for 1) baseline conditions, and 2) concept conditions for a proposed northern alignment of Section 6 of the East Papago Freeway. The results presented as concept conditions are for the best estimate of conditions resulting from the proposed northern alignment, which is entirely on structure from Hayden Road to the Red Mountain Interchange. Concept conditions for the proposed northern alignment were analyzed both with and without debris buildup on the piers. Preliminary estimates of local scour at bridge piers have been performed, based on preliminary bridge configurations. General scour and long-term channel degradation were addressed in the initial report.

From a hydrologic, hydraulic, and erosion standpoint; the advantages/disadvantages of the proposed northern alignment and of the proposed southern alignment are as follows:

PROPOSED NORTHERN ALIGNMENT

Advantages

- Lower average velocities.
- Less impact on existing utilities.
- Less erosion potential.
- Less impact on landfill sites.

Disadvantages

- Higher water-surface elevations.
- Greater problems due to debris.
- Greater impact from gravel mining.

PROPOSED SOUTHERN ALIGNMENT

Advantages

- Lower water-surface elevations.
- Less potential for debris problems.
- Less impact from gravel mining.

Disadvantages

- Higher average-velocities.
- Greater erosion potential.
- Greater impact on existing utilities.
- Greater disturbance of landfill sites.

In summary, the results presented in this addendum show that the proposed northern alignment will produce less severe increases in average velocities through the subject reach of the Salt River than will the proposed southern alignment. Water-surface elevations tend to be higher for the proposed northern alignment, but the changes are not substantially greater than for baseline conditions.

VI. REFERENCES

1. Simons, Li & Associates, Inc., "Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange". Submitted to Daniel, Mann, Johnson, & Mendenhall. September, 1989.
2. Jones, J.S., "Comparison of Prediction Equations for Bridge Pier and Abutment Scour", Transportation Research Record 950, Second Bridge Engineering Conference, Volume 2, September, 1984.