Local Government
Bridge Scour Evaluation Study
Contract No. 95-42

Final Scour Evaluation Report for City of Peoria

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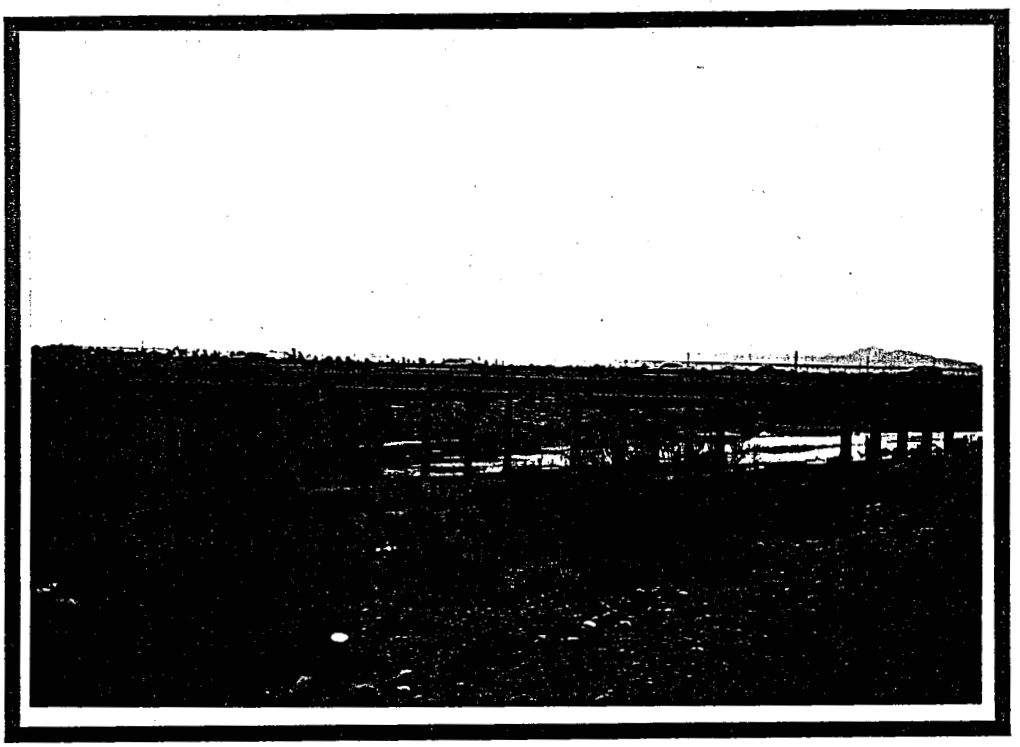
Structure No. 9684
THUNDERBIRD ROAD
OVER
NEW RIVER



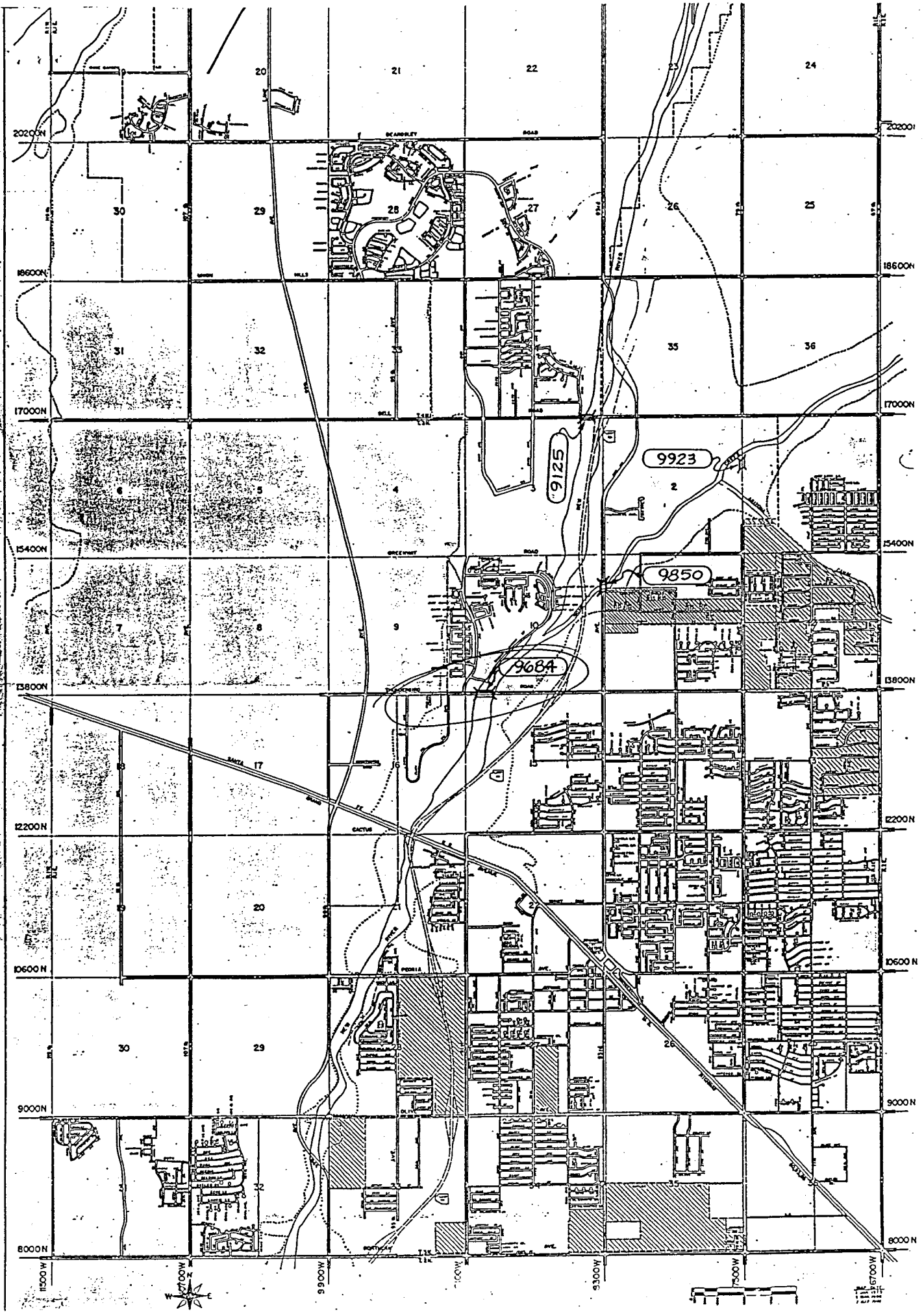
March 1996

Prepared for:

Arizona Department of Transportation

Prepared by:

Michael Baker Jr., Inc.



20200N
18600N
17000N
15400N
13800N
12200N
10600N
9000N
8000N
11500W
10700W
9900W
9300W
7500W
6700W
9923
9850
9684
9125

SCOUR EVALUATION REPORT FORM

NBI Structure Number: 9684
County: Maricopa
Roadway: Thunderbird Road

TRACS No.: S0358-27D
Owner: Peoria
Stream: New River

This bridge has been evaluated for scour and is classified as (circle one):

(Calculated Scour Stable)
Declared Scour Stable
Declared Unknown Foundation

Calculated Scour Critical
Declared Scour Critical

This report presents the background data, evaluation parameters, and appropriate calculations to determine the susceptibility of the subject bridge to foundation scour in accordance with the procedures recommended in the Local Government Bridge Scour Evaluation Study.

The following table summarizes the scour calculations at the critical substructure unit(s). This format is intended to provide the owner with concise information for formulating a plan of action and prioritizing the action relative to the other bridges under their jurisdiction.

SCOUR CALCULATION SUMMARY TABLE		
Flow Frequency & Magnitude	Q_{100} = 32,137 cfs	
Substructure unit (abut.#, pier #)	P1	
Calculated Local Pier Scour (ft.)	14.53	
Calculated Contraction Scour (ft.)	0.47	
Long-Term Degradation (ft.)	2.4	
Calculated Abutment Scour (ft.)	–	
Total Calculated Scour (ft.)	17.4	
Existing Length of Exposed Foundation (ft.)		
Existing Depth of Embedded Foundation (ft.)	47.1	

Registered Professional Engineer (Civil)
CERTIFICATE NO. 21674
ROBERT L. DAVIES
Date signed 2-26-97
ARIZONA, U.S.A.

(Seal)

Attach Data Summaries, Field Notes, and Calculations and file as part of the permanent bridge maintenance record.

Comments: CALCULATED SCOUR < TOTAL ALLOWABLE SCOUR. PASSED STRUCTURAL EVALUATION. SCOUR STABLE.

Figure 6

LOCAL GOVERNMENT BRIDGE SCOUR EVALUATION STUDY
DATA SUMMARY FORMS
(Items in Bold Print are Required for Quantitative Analyses)

I. SITE IDENTIFICATION

County MARICOPA Owner PEORIA NBI Struct. No. 9684
Route THUNDERBIRD RD Stream NEW RIVER TRACS No. SB358-27D
Original Project No. 55300 Year Built 1980
Rehab. Project No. _____ Year Rehab. _____
Date of Site Visit FEB 26, 1996 Survey Datum _____

Owner Representative Not available Engineer DAVIES / WONDERS

II. INFORMATION RESOURCES AVAILABLE

(Provide Names and Dates if Available)

- ☐ **Site Topography**
- ☐ **Cross Sections**
- ☐ **Roadway Profile Plan**
- ☐ As-Built Bridge Plans
- ☐ Other Agency Studies (FEMA, Corps, SRP, SCS)
- ☐ Hydraulic/Hydrologic Study Report
- ☑ Soils/Foundation Report/Borings
- ☑ Quad Maps
- ☑ Photos/Aerial Photography
- ☑ Bridge Inspection Report
- ☐ Gage Data (Distance to Site)

III. HYDROLOGIC/HYDRAULIC DATA

Drainage Area _____ sq. mi. Mean Annual Evaporation _____ in.
Mean Elev. of Watershed _____ ft. Ref. _____
USGS Hydrological Region _____

Historical Floods

Date	High Water Elev. (ft.)	Approx. Frequency (yrs.)	Approximate Discharge	Adjusted to Site

Ref. _____

Flood Frequency (yrs)	Q_{500}	Q_{OT}	Q_{100}	Q_{10}	Q___
Elevation (ft.)	___	___	1153.6	___	___
Discharge (cfs)	75,000	** 32,137	41,000 / 53,000* (AFTER SKUNK CREEK DAM)	13,500	___
Avg. Velocity (Q/A)	___	___	___	___	___

Ref.* Per design plans / FIS Report (Maricopa County 1995) / ** Calculated

Comments: _____

Figure 7

IV STRUCTURAL DATA

Bridge Length 302
No. of Spans 4
Thalweg Elevation 1136.1

Span Lengths 75
Underclearance (Thalweg to Low Beam) 18' +/-

NBI Struct No. 9684
TRACS No. 3B358-27D

Abut./Bent No.	A1	P1	P2	P3	A2					
Substructure Type	CONC	CONC	CONC	CONC	CONC					
Skew	26°	→	→	→	→					
Width	36"Ø	36"Ø	36"Ø	36"Ø	36"Ø					
Length										
Shape	RND	RND	RND	RND	RND					
Bottom Cap Elevation										
Foundation Type										
Bottom Footing Elevation	1133	→	→	→	→					
Minimum Spread Footing Embedment	45'	45'	45'	45'	45'					
Pile/Shaft Type	Drilled Shafts	→	→	→	→					
Length (Median)										
Size	42"Ø	42"Ø	42"Ø	42"Ø	42"Ø					
Tip Elevation	1089	→	→	→	→					
Unsupported Pile/Shaft Length										
Minimum Pile/Shaft Embedment										
Upstream Spur/Guide Bank										
Conc./Rip Rap Gabions Protection	✓				✓					

Comments: Data obtained from as-built plans

Figure 8

V. GEOMORPHIC DATA

NBI Struct. No. 9684
TRACS No. SB358-27D

Channel (Normal to Flow):

Type: (Straight) Meandering Braided Man-Made (Circle One)

At Crossing: (Straight) Curved (Circle One)

Est. Avg. Top Width 302 **Est. Avg. Depth** _____

Est. Max. Depth 17'

Crossing Width Compared to:

Upstream: Wider ___ Same ___ Narrower ✓

Downstream: Wider ___ Same ___ Narrower ✓

Bed Material Type ROCKY **Est. D_{50}, D_{100} Size** _____

Bank Material Type GABIONS AT & AROUND ABUT **Est. D_{50}, D_{100} Size** _____

Est. Manning's "n": Channel 0.026 **Overbank** _____

Bed Slope 0.00125 '/' per as-built plans GABION 4'

Date and Nature of Reported Site Scour Problems:

	Minor	Moderate	Severe
Left Bank			
Right Bank			
Left Spill Slope			
Right Spill Slope			
Pier			
Debris			
Channel Bed			
Other			

Any Sand and Gravel Mining Within 1 Mile Downstream or 2 Miles Upstream of Bridge?
Yes (No) If Yes, Describe: _____

Based on the Available Geomorphic Data, the Channel Stability Over the Lifetime of the Existing Structure Can Best Be Described as (check one):

- ☑ Relatively Stable with Little Expected Change
- ☐ Potential for Slow Change Over Time, Not Prone to a Major One-Event Change
- ☐ Unstable Subject to Rapid Change

Comments: _____

Figure 9

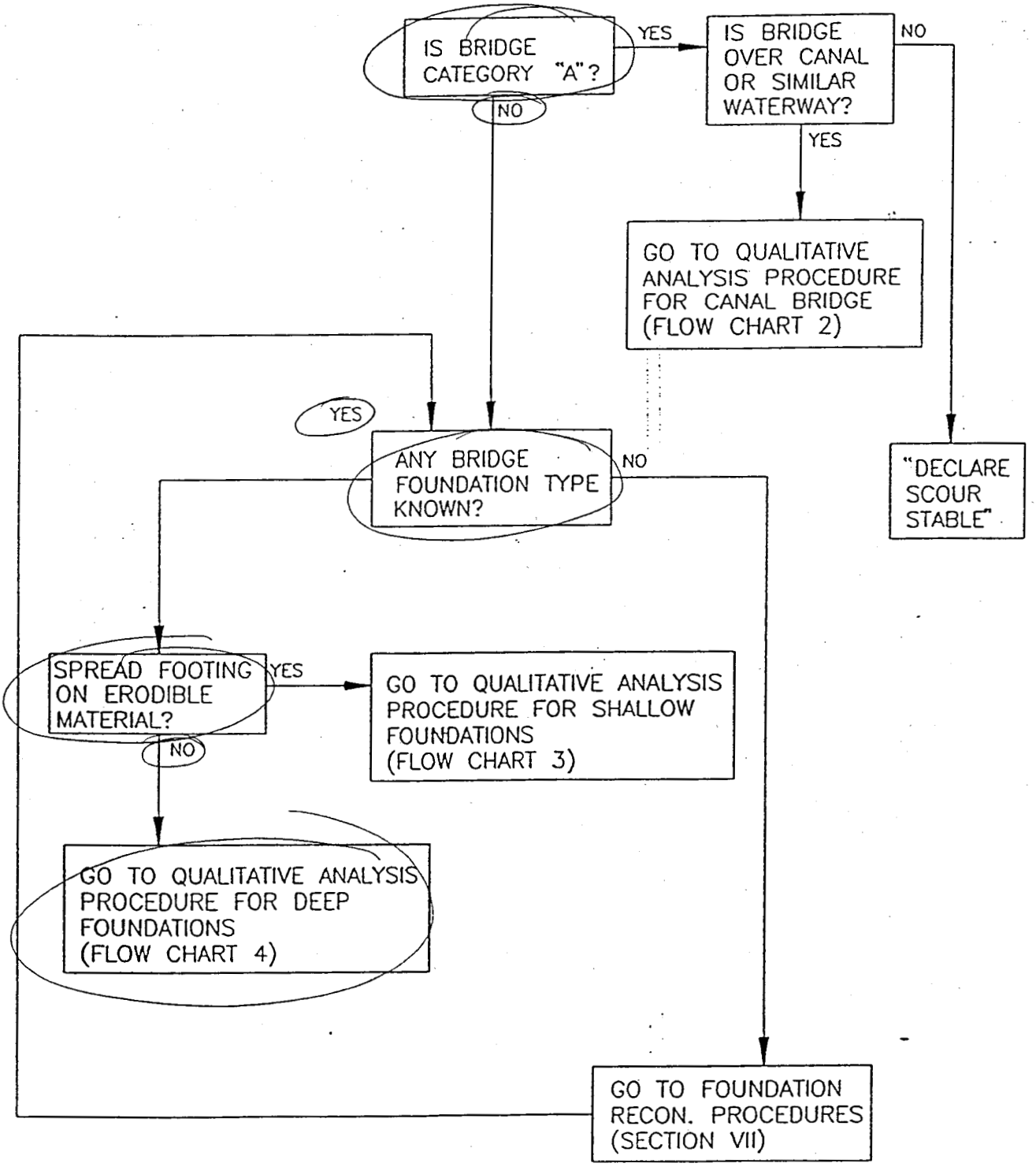
2/26/96
9684
New River
T- Bird
Peoria
Pic 19-24

Evid. of scour @ pier columns in channel
Gabion bank protection @ abuts
Veg - in channel
Rocky in channel / sandy
Slope to abuts - no obstruction

Str. No. 9684
Peoria

BRIDGE IDENTIFICATION PROCEDURE

(QUALITATIVE)

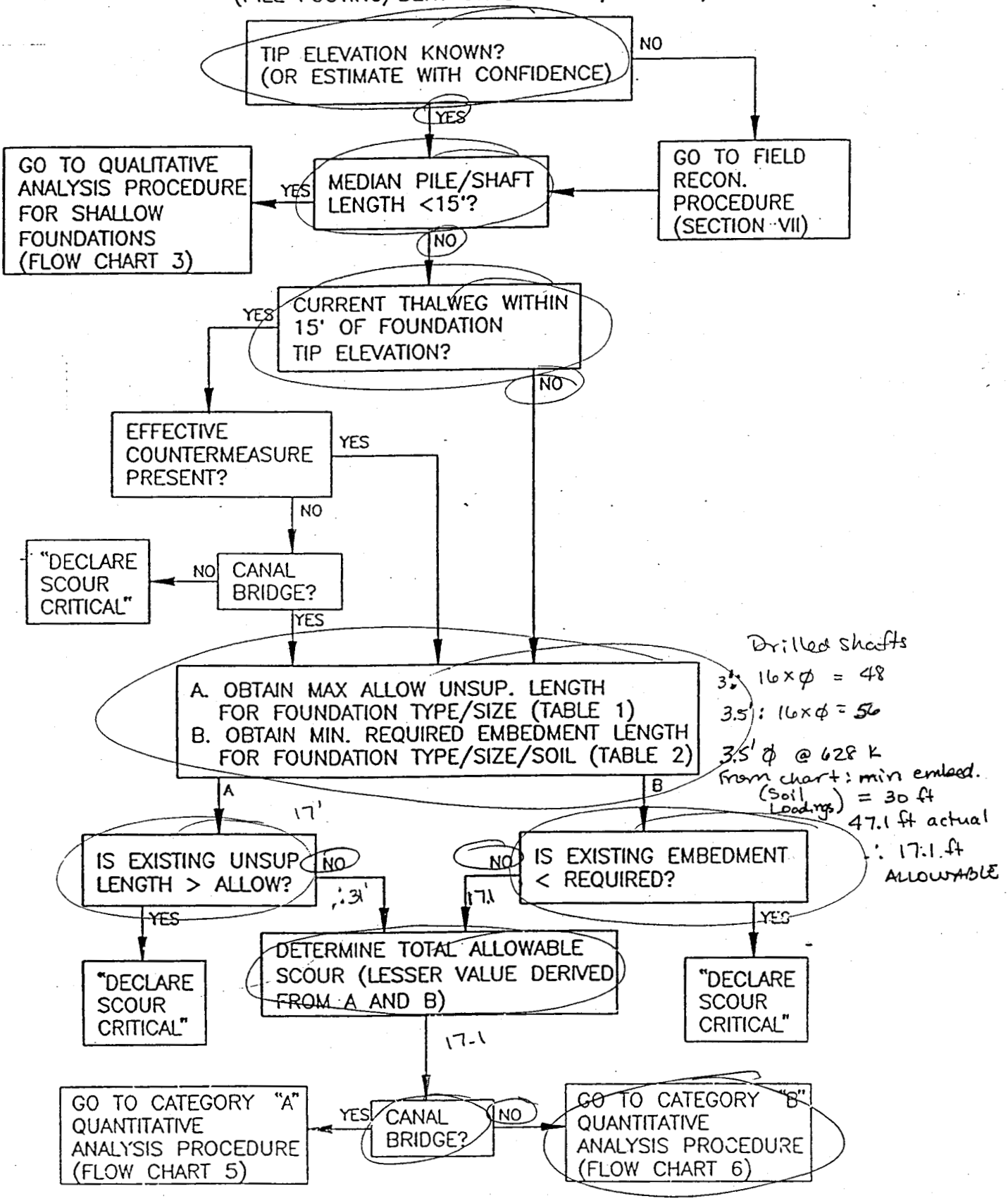


Flow Chart 1
Bridge Identification Procedure

Str. NO. 9684

QUALITATIVE ANALYSIS PROCEDURE

DEEP FOUNDATION
(PILE FOOTING/BENT OR D. SHAFT/CAISSON)



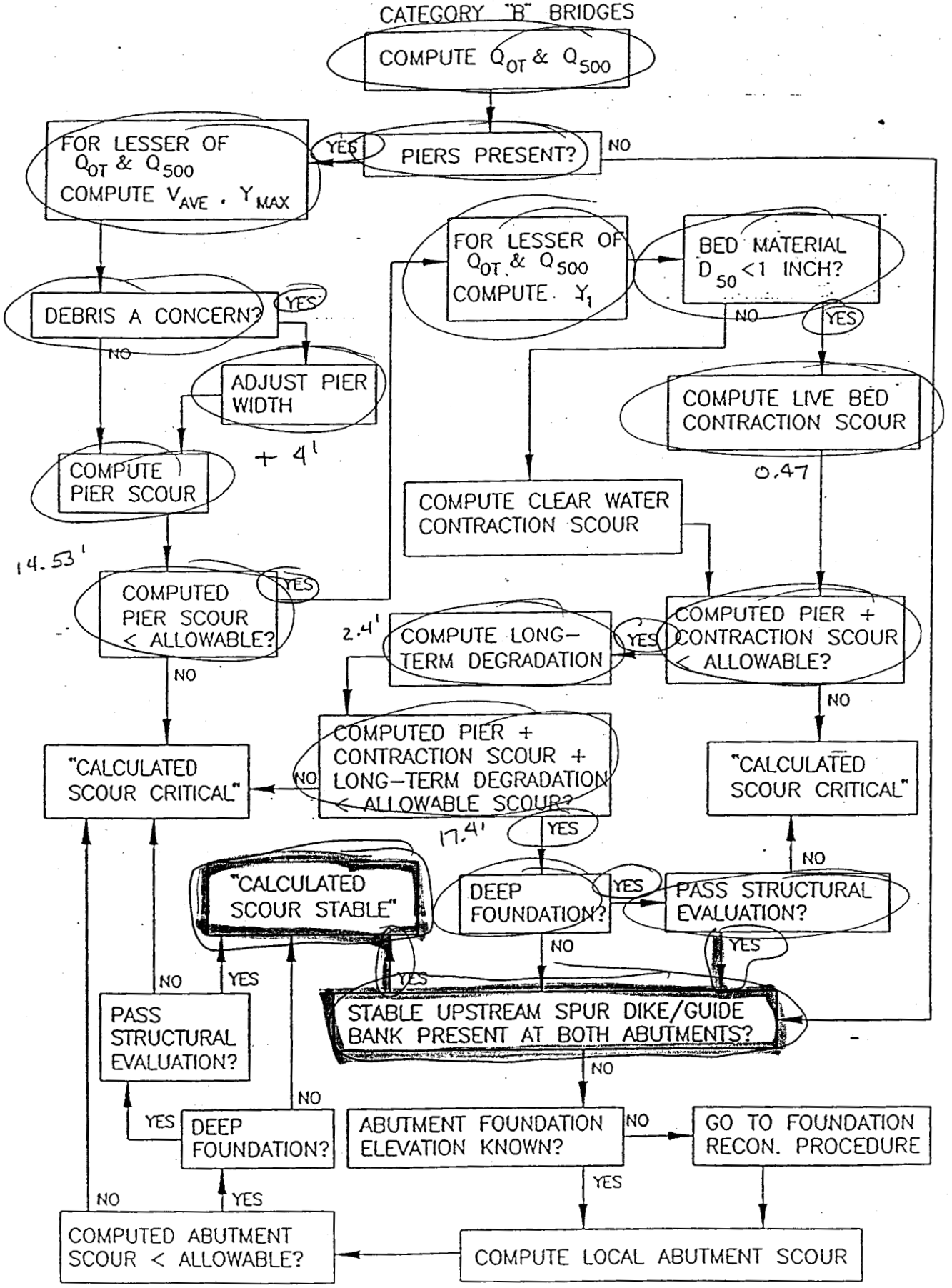
Flow Chart 4

Qualitative Analysis Procedure – Deep Foundation

Str. No. 9684

QUANTITATIVE ANALYSIS PROCEDURE

CATEGORY "B" BRIDGES



S.O. No. 21693-002-0000

Subject: Str. No. 9624 Peoria

New River

T-bird Rd.

Sheet No. 1 of 3

Drawing No.

Computed by KLW Checked By RLD Date 5/10/96

Baker

$Q_{100} = 41{,}000$ cfs
$Q_{500} = 75{,}000$ cfs
$Q_{10} = 13{,}500$ cfs
} FIS Report (Maricopa County - 1995)

$Elev_{Q_T} = 1156$

$Q_{Q_T} = 52{,}700$ cfs

$Q_{Q_T} < Q_{500}$

$\therefore Q_{Q_T}$ evaluation Discharge

$K_1 = 1{,}208{,}947$ cfs

$K_t = 1{,}659{,}785$ cfs

$m = 1 - K_1/K_t$

$= 1 - 1{,}208{,}947/1{,}659{,}785$

$m = 0.27$

$K = 0.3$

$S_e = K S_o = 0.3(0.00125\%)$

$S_e = 0.000375\%$

$Q_{eval} = K_t S_e^{1/2}$

$= 1{,}659{,}578\ (0.000375)^{1/2}$

$Q_{eval} = 32{,}137$ cfs

$y_{max} = 13.35$ ft
$V = 10.70$ fps
} HEC-RAS

S.O. No. 21693 - 002 - 0000

Subject: Str. No. 9684 Peoria

New River

T-bird Rd

Sheet No. 2 of 3

Drawing No.

Computed by KJW Checked By RLD Date 5/13/96

Baker

Compute Local Pier Scour

$y_s/y_1 = 2.0 K_1 K_2 K_3 (a/y_1)^{0.65} Fr_1^{0.43}$

$K_1 = 1.0$

$K_2 = 1.0 \rightarrow$ No skew

$K_3 = 1.1$

$a = 3' + 4' = 7'$ $L = 91'-10''$

$Fr_1 = V/(gy)^{1/2} = 10.70 / [(32.2)(13.35)]^{1/2}$

$Fr_1 = 0.516$

$y_s/13.35 = 2.0(1.0)(1.0)(1.1)(7/13.35)^{0.65}(0.516)^{0.43}$

$y_s = 14.53$ ft < 17.1 ft ALLOWABLE

Compute Contraction Scour

$y_1 = 11.40$ ft

$y_2/y_1 = (Q_2/Q_1)^{6/7} (W_1/W_2)^K$

$Q_2 = 32,137.0$ cfs

$Q_1 = 32,137.0$ cfs

$W_1 = 278.16$ ft

$W_2 = 261.05$ ft

$K = 0.64$

$y_2/11.40 = (32,137/32,137)^{6/7} (278.16/261.05)^{0.64}$

$y_2 = 11.87$ ft

$y_s = y_2 - y_1$

$= 11.87 - 11.40$

$y_s = 0.47$ ft

$y_{s\,TOT} = 14.53 + 0.47 = 15.0$ ft $< 17.1'$ ALLOWABLE

S.O. No. 21693-002-0000

Subject: Str. No. 9684 Peoria

New River

T-bird Rd

Sheet No. 3 of 3

Drawing No.

Computed by KJW Checked By RLD Date 6/4/96

Baker

Compute Long-Term Degradation

$V = 10.95\, y^{1/6} D_c^{1/3}$

$V = 7.89$ fps

$y = 7.72$ ft

$7.89 = 10.95\,(7.72)^{1/6} D_c^{1/3}$

$D_c = 0.135$ ft $\rightarrow$ 1.62 in $\rightarrow$ Max particle size > 1.62 in

$\therefore y_{lt} = 2\, D_c\, (1/p_c - 1)$

$= 2(0.135)(1/0.1 - 1)$

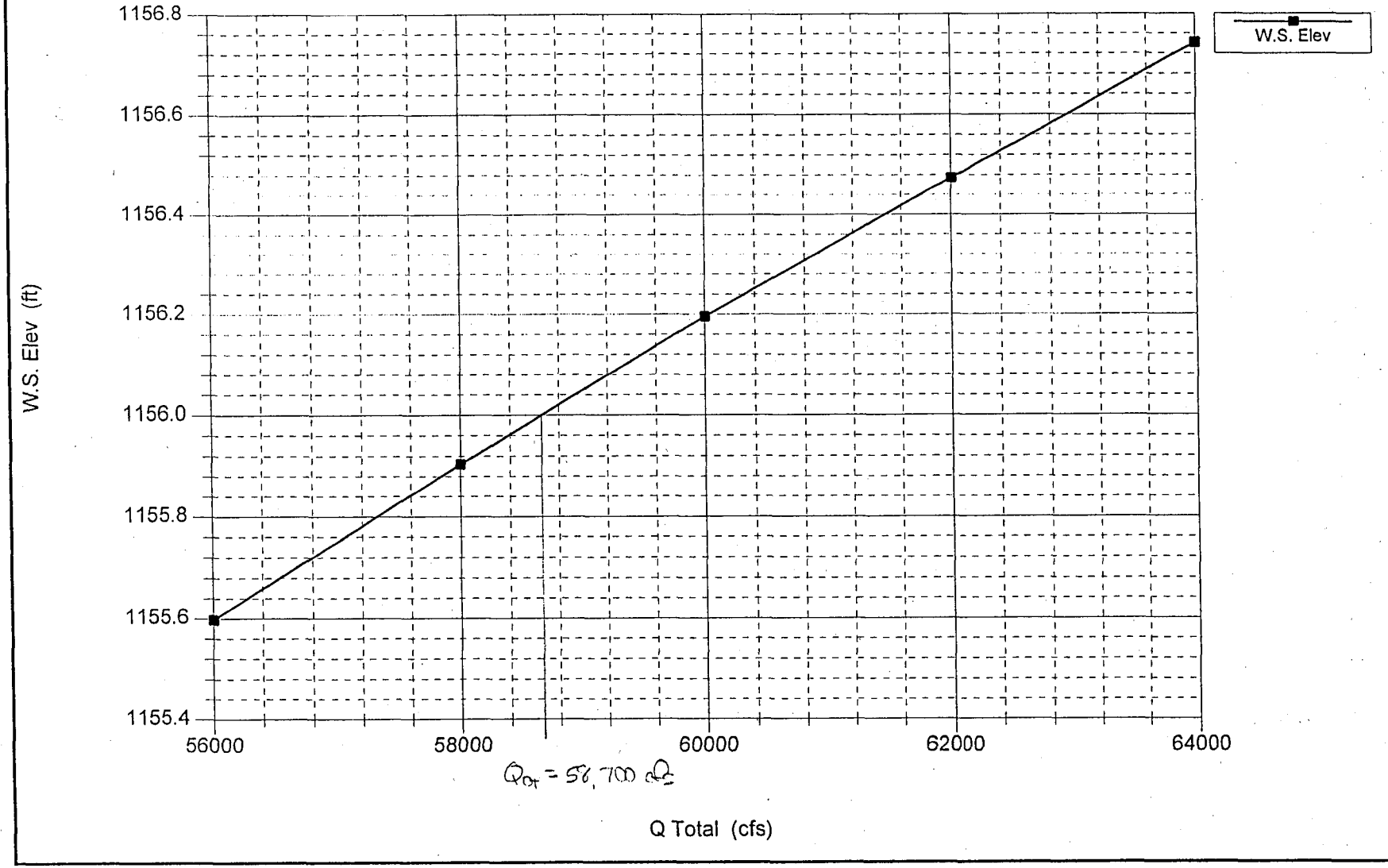
$y_{lt} = 2.4$ ft

$y_{STOT} = 14.53 + 0.47 + 2.4 = 17.4' \approx 17.1'$ ALLOWABLE

$\therefore$ Structural Evaluation Req'd - PASSED

CALCULATED SCOUR STABLE

9684 - NewR/T-bird/Peoria Plan: 1 - Overtop 5/13/96
Natural section



Q_{OT} = 58,700 cfs

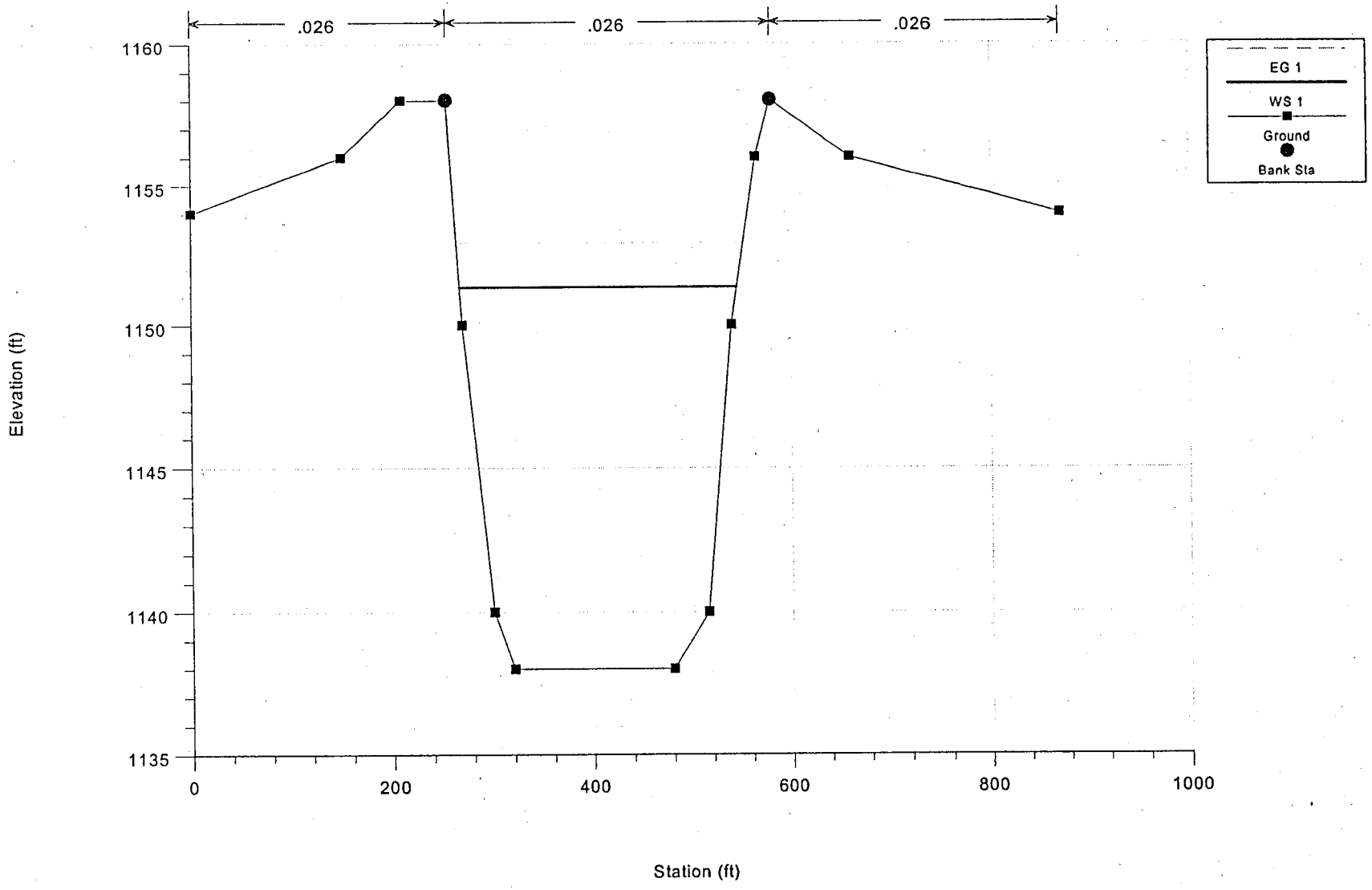
Plan: 2 - Natural Reach: 9684nat Riv Sta: 1 Profile: 1 7/22/96

W.S. Elev (ft)	1151.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.60	Wt. n-Val.		0.026	
E.G. Elev (ft)	1152.95	Reach Len. (ft)	1.00	1.00	1.00
E.G. Slope (ft/ft)	0.001251	Flow Area (sq ft)		3170.34	
Q Total (cfs)	32137.00	Flow (cfs)		32137.00	
Top Width (ft)	278.16	Top Width (ft)		278.16	
Vel Total (ft/s)	10.14	Avg. Vel. (ft/s)		10.14	
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)		11.40	
Crit W.S. (ft)		Wetted Per. (ft)		282.37	
Conv. Total (cfs)	908494.4	Conv. (cfs)		908494.4	

Plan: 2 - Natural Reach: 9684nat Riv Sta: 0 Profile: 1 7/22/96

W.S. Elev (ft)	1151.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.60	Wt. n-Val.		0.026	
E.G. Elev (ft)	1152.95	Reach Len. (ft)			
E.G. Slope (ft/ft)	0.001252	Flow Area (sq ft)		3170.00	
Q Total (cfs)	32137.00	Flow (cfs)		32137.00	
Top Width (ft)	278.16	Top Width (ft)		278.16	
Vel Total (ft/s)	10.14	Avg. Vel. (ft/s)		10.14	
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)		11.40	
Crit W.S. (ft)	1146.97	Wetted Per. (ft)		282.36	
Conv. Total (cfs)	908349.1	Conv. (cfs)		908349.1	

9684 - NewR/T-bird/Peoria Plan: 2 - Natural 7/22/96
Natural section



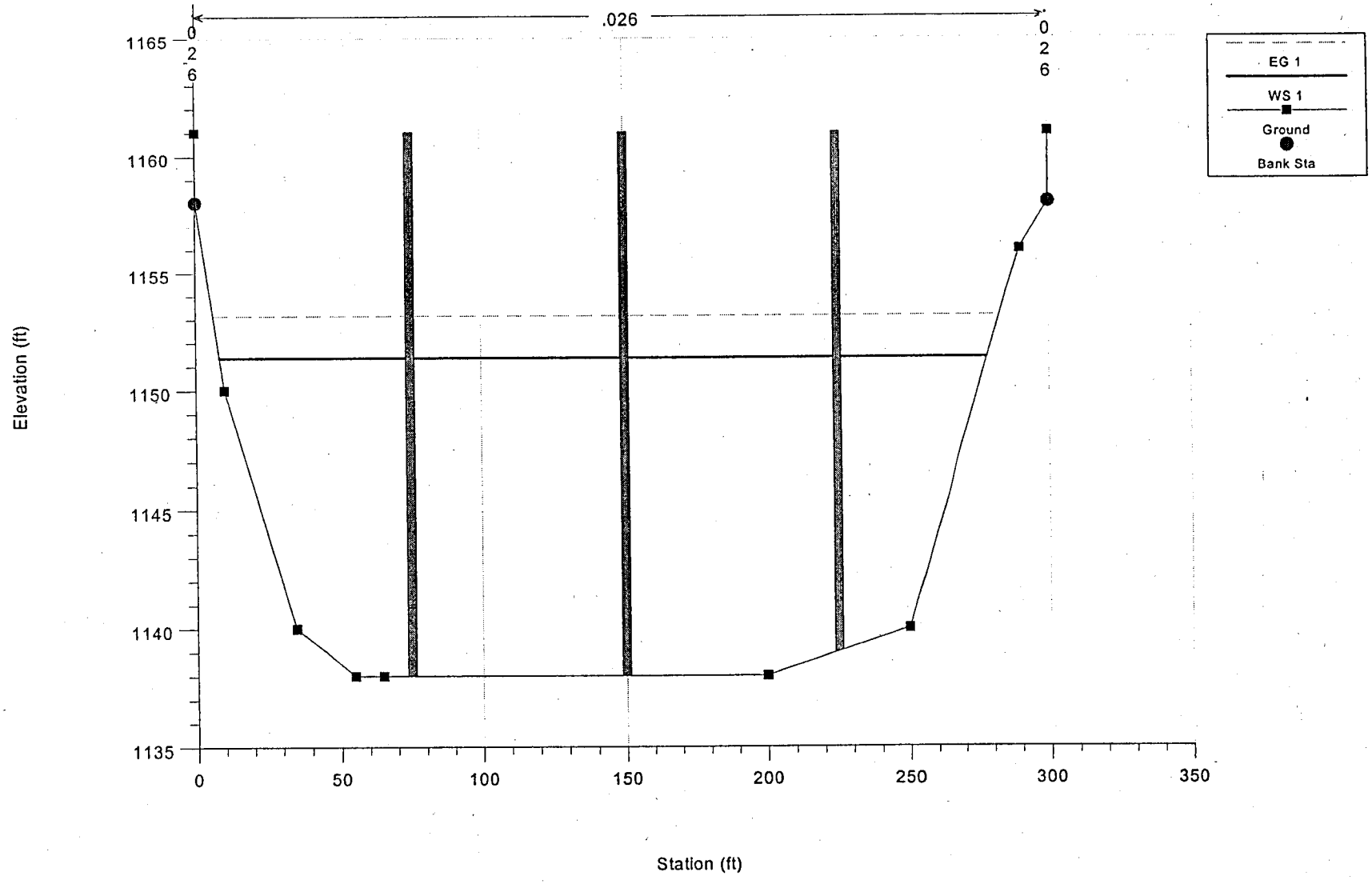
Plan: 3 - Bridge Reach: 9684br Riv Sta: 1 Profile: 1 7/22/96

W.S. Elev (ft)	1151.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.78	Wt. n-Val.		0.026	
E.G. Elev (ft)	1153.13	Reach Len. (ft)	1.00	1.00	1.00
E.G. Slope (ft/ft)	0.001947	Flow Area (sq ft)		3004.51	
Q Total (cfs)	32137.00	Flow (cfs)		32137.00	
Top Width (ft)	261.05	Top Width (ft)		261.05	
Vel Total (ft/s)	10.70	Avg. Vel. (ft/s)		10.70	
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)		11.51	
Crit W.S. (ft)		Wetted Per. (ft)		343.89	
Conv. Total (cfs)	728389.2	Conv. (cfs)		728389.2	

Plan: 3 - Bridge Reach: 9684br Riv Sta: 0 Profile: 1 7/22/96

W.S. Elev (ft)	1151.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.78	Wt. n-Val.		0.026	
E.G. Elev (ft)	1153.13	Reach Len. (ft)			
E.G. Slope (ft/ft)	0.001948	Flow Area (sq ft)		3004.00	
Q Total (cfs)	32137.00	Flow (cfs)		32137.00	
Top Width (ft)	261.05	Top Width (ft)		261.05	
Vel Total (ft/s)	10.70	Avg. Vel. (ft/s)		10.70	
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)		11.51	
Crit W.S. (ft)	1147.29	Wetted Per. (ft)		343.87	
Conv. Total (cfs)	728211.5	Conv. (cfs)		728211.5	

9684 - NewR/T-bird/Peoria Plan: 3 - Bridge 7/22/96
Bridge section



Plan: 4 - 10 yr Reach: 9684nat Riv Sta: 1 Profile: 1 7/22/96

W.S. Elev (ft)	1146.14	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.88	Wt. n-Val.		0.026	
E.G. Elev (ft)	1147.01	Reach Len. (ft)	1.00	1.00	1.00
E.G. Slope (ft/ft)	0.001252	Flow Area (sq ft)		1797.53	
Q Total (cfs)	13500.00	Flow (cfs)		13500.00	
Top Width (ft)	248.74	Top Width (ft)		248.74	
Vel Total (ft/s)	7.51	Avg. Vel. (ft/s)		7.51	
Max Chl Dpth (ft)	8.14	Hydr. Depth (ft)		7.23	
Crit W.S. (ft)		Wetted Per. (ft)		251.08	
Conv. Total (cfs)	381603.6	Conv. (cfs)		381603.6	

Plan: 4 - 10 yr Reach: 9684nat Riv Sta: 0 Profile: 1 7/22/96

W.S. Elev (ft)	1146.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.88	Wt. n-Val.		0.026	
E.G. Elev (ft)	1147.01	Reach Len. (ft)			
E.G. Slope (ft/ft)	0.001252	Flow Area (sq ft)		1797.23	
Q Total (cfs)	13500.00	Flow (cfs)		13500.00	
Top Width (ft)	248.74	Top Width (ft)		248.74	
Vel Total (ft/s)	7.51	Avg. Vel. (ft/s)		7.51	
Max Chl Dpth (ft)	8.13	Hydr. Depth (ft)		7.23	
Crit W.S. (ft)	1143.22	Wetted Per. (ft)		251.07	
Conv. Total (cfs)	381503.3	Conv. (cfs)		381503.3	

Date 091493

ARIZONA DEPARTMENT OF TRANSPORTATION
STRUCTURES SECTION
BRIDGE INSPECTION REPORT

8 Structure Number 09684 5 Principal Route 150050230
209 Structure Name NEW RIVER BRIDGE 11 Mile Post 000000
District 01 4 Place Peoria 00255
3 County Maricopa 013 203 ORG 4 Area
208 Inspection No. 08 210 Spec.Ins _ Next Insp.Due.Qtr 7 Yr 95
Inspected By Athalye - Cox 224 Crew 1

Registered Professional Engineer (Civil) CERTIFICATE NO. 23639 SUNIL E. ATHALYE Date Signed 9/19/95 ARIZONA, U.S.A.

P.E. SEAL

	DESCRIPTION	RTG	CONDITION	NOTE
DECK				
Deck/Wearing Surface	conc	7		1
Sidewalk,Curb,Median	conc. s.walk on each side	8		
Rail,Parapet,Barrier	conc barrier w/ped. fence	8		
Expansion Joints	sliding plates @ abutmnts	7	part filled w/dirt.	2
SUPERSTRUCTURE				
Main Members	conc PC,PS I girders	8	no significant change	
Secondary Members	conc diaphragms	8		
Bearing Devices	elastomeric pads	8		
SUBSTRUCTURE				
Abutments	conc	7	stained backwalls	
Piers	conc colmns w/cap beam	8	no significant change	
Slope Protection		N		
Wingwalls,Dadoes,Etc	conc	8		
WATERWAY				
Channel	rocky	8	no significant change	
Bank Protection	gabions at & around abuts	8		
ROADWAY/SAFETY				
Approaches	conc slabs & AC roadways	7	med long crks on slabs	
Fills		8		
Guardrail,Barrier	conc tapered barriers	8		
Signing	B/Y marker @ each corner	8		
Lighting		N		

CONDITION ITEM	RTG	APPRAISAL ITEM	RTG
58 Deck	7	67 Structural Evaluation	7
59 Superstructure	8	68 Deck Geometry	5
60 Substructure	7	69 Underclearances-Vert. & Horiz.	N
61 Waterway	8	71 Waterway Adequacy	8
		72 Approach Roadway Alignment	8
		113 Scour Critical Bridge	6
36 Traffic Safety Feature	1111	211 Posted Limit (Tons)	

NOTES,RECOMMENDATIONS 212 Repair Priority: 5

1 The top of deck exhibits random transverse cracks with scaling, minor popouts and surface spalls. The underside shows random transverse cracks with efflorescence.

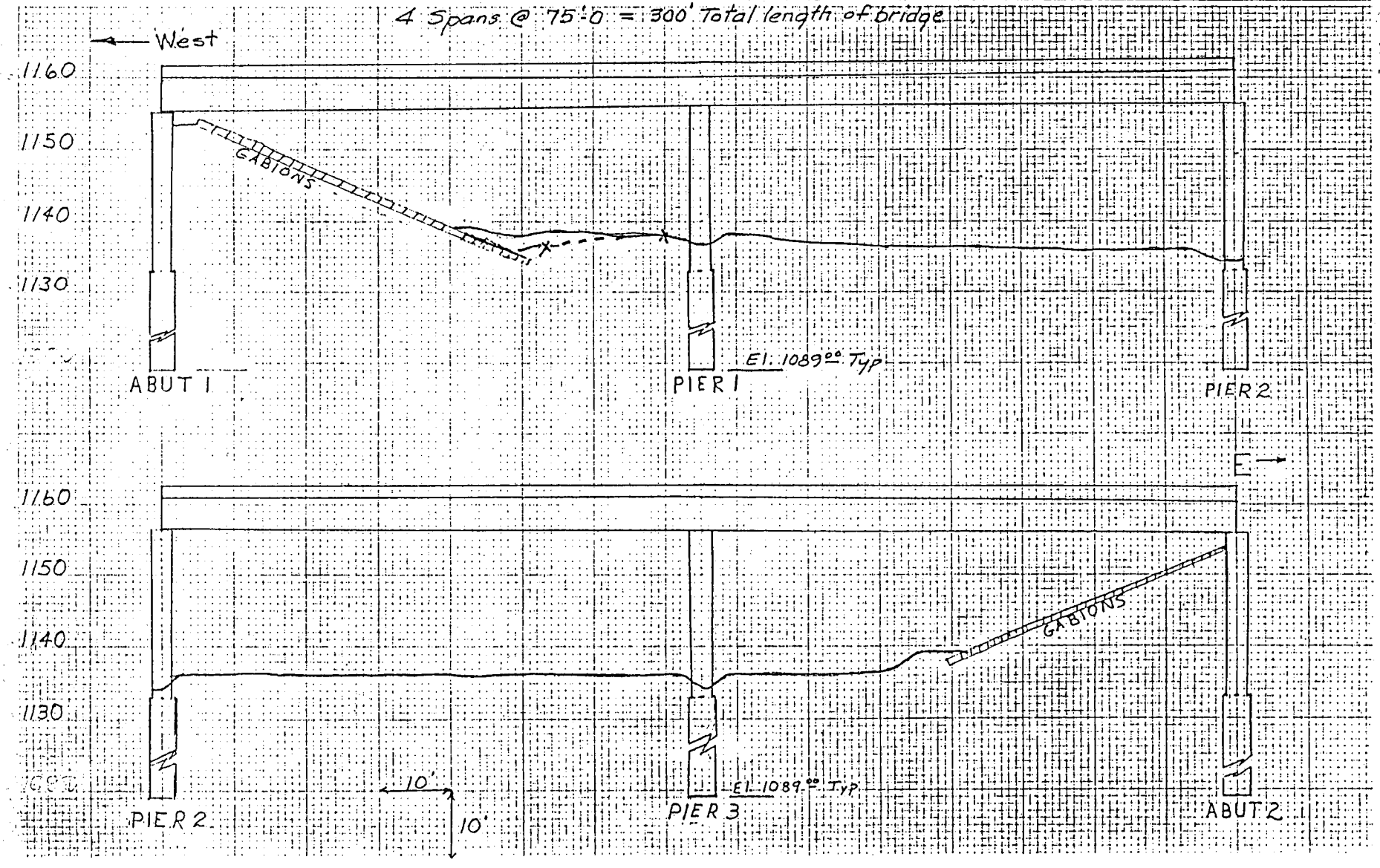
2 The joints appear to leak. The openings at 90 deg.F were as follws; A1(W)- 2 13/16", 2 3/4', 2 5/8"; A2(E)- 2 3/4", 2 9/16", 2 13/16" (N,C,S).

NAME OF STRUCTURE NEW RIVER BRIDGE

STRUCT NO. 9684

LOCATION Thunderbird Rd FAU 5023
ROUTE MILEPOST

INSPECTION NO.	7	8			
DATE	7-1-91	9/14/93			
INITIALS	GDH DCC	DCC SEA			
SYMBOL	——	X- - -X			
UPSTREAM	✓	✓			
D'STREAM					



ARIZONA DEPARTMENT OF TRANSPORTATION
STRUCTURES SECTION
SUPPLEMENTAL PAGE TO BRIDGE INSPECTION REPORT
CHANNEL PROFILE

S.O. No.	21693 - APA				
Subject:	Bridge Scour Evaluation Study				
Structural Bridge Evaluation				**Sheet No.**	
				Drawing No.	
Computed By	JGK	**Checked By**	AN/MMP	**Date**	Feb-97

Baker

Bridge # ***09684***

Summary:

Bridge structure number 09684 is *not* considered scour critical. This conclusion was reached by loading the bridge under scoured conditions. The loading was done in accordance with the 1996 version of AASHTO specifications. Additionally "The Final Scour Evaluation Report" provided the scoured conditions.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
28174
MARK
PILWALLIS
Date Signed 2/25/97
ARIZONA, U.S.A.

Bridge # ***09684***

Based on the initial hydraulic and geotechnical assessments a structural analysis of this bridge is required to determine the stability of the structure under scour conditions. Foundation capacities will be evaluated for three load cases using load factor design.

Load Cases,

I. D+SF+0.5W+B
II. D+L+SF
III. D+L+SF+.3*W+WL+LF+T

Bridge information:

Bridge Roadway Width =	68.00	ft.		
Span Lengths, L =	75.00	ft.		
Bridge Length =	300.00	ft.	# of 12' Lanes =	5
Pier Column Spacing =	21.35	ft.		
Bridge skew =	26.42	degrees		
Column Diameter 1,133.00 ft. =	3.00	ft.		
Shaft Diameter 1,089.00 ft. =	3.50	ft.		

Elevations:

Top of pier cap elev. =	1157.03	ft.
Bottom of pier cap elev. =	1153.28	ft.
Native ground elev. =	1136.10	ft.
Column/Shaft Diameter change =	1133.00	ft.
Shaft tip elev. =	1089.00	ft.
Length of 3.00 ft. dia. column =	20.28	ft. = 243.36 in.
Length of 3.50 ft. dia. shaft =	44.00	ft. = 528.00 in.

Scour Information:

High water elev. =	1156.00	ft.
Total scour depth =	17.10	ft.
Ground elev. after scour =	1119.00	ft.
Length of exposed column after scour =	34.28	ft. = 411.36 in.
Water Velocity, V_{avg} =	10.70	ft/s

Bridge # 09684

Dead Load,

Dimensions:			Loading:		
Bridge deck width =	83.50	ft.	Deck =	8.35	kips/ft.
Slab Thickness =	0.67	ft.			
F.W.S =	0.04	kips/ft^2	F.W.S =	2.38	kips/ft.
Parapet weight =	1.09	kips/ft.	Parapet =	1.09	kips/ft.

Girders

# of Girders =	10	
Girder area =	853	in.^{2}
Girder weight =	8.89	kips/ft.

Girder Loading = 8.89 kips/ft.

Super Dead loading = 20.70 kips/ft.

Loading on pier line = 1.143*Span length*Super Dead loading = 1774.58 kips

Pier Cap

Width =	3.25	ft.
Height =	3.75	ft.
Length =	91.83	ft.

Pier cap taken care of in STAAD model.

Pier Diaphram

Length =	73.50	ft.
Thickness =	2.33	ft.
Height =	4.63	ft.
Diaphram weight =	100.18	kips

Pier Diaphram loading = 100.18 kips

Bridge # ***09684***

# of columns = 5

Total Dead Loading = 1874.75 kips

Pier Line Dead Load = 20.41 kips/ft.
Total Dead Loading/Column = 374.95 kips

Live Load,

HS20-44 truck will be used for the Live Loading. Modeling a four span section the controlling live load can be in looked in up the AISC Manual from Moments, Shears, and Reactions for continuous highway bridges.

Span Lengths, L = 75.00 ft.

Max. Reaction at piers = 84.70 kips/lane
# of 12' Lanes = 5
Reduction factor = 0.75

# of columns = 5

Pier Line Live loading = 317.63 kips

Pier Line Live loading = 3.46 kips/ft.

Total Live Load loading/column = 63.53 kips

Bridge # *09684*

Buoyancy,

Length of 3 ft. dia. column under water =	20.28	ft.
Column Vol. =	143.35	ft^3
Length of 3.5 ft. dia. column under water =	14.00	ft.
Shaft Vol. =	134.70	ft^3
Submerged pier cap vol. =	936.70	ft^3
Buoyant force =	0.0624	$kips/ft^3$

Force per column = 29.04 kips

Stream Flow Pressure,

Column Pressure

Water Velocity, V_{avg} = 10.70 ft./s

Reference section 3.18.1.1.1 of AASHTO,

Constant for circular piers, K =	0.70	
Average Pressure, $P_{avg} = KV_{avg}^2$ =	0.080	$kips/ft.^2$
Max. Pressure, $P_{max} = 2P_{avg}$ =	0.16	$kips/ft.^2$
Column Diameter =	3.00	ft.

Force at column top = 0.48 kips

Force on column at scour bottom = 0.00 kips

Since the stream water elevation is above the top of column, assume the maximum pressure is uniformly distributed over the exposed area.
Reference section 3.18.1.1.2 of AASHTO

Bridge # ***09684***

Pier Cap Pressure

Pier Cap Width = 3.25 ft.
Exposed Area = 8.84 $ft.^2$

Water pressure parallel to pier cap = 1.42 kips

Wind Load,

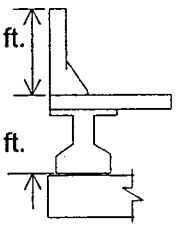
Superstructure wind,

Pressure		Direction
0.050	$kips/ft.^2$	Transverse to bridge
0.012	$kips/ft.^2$	Longitudinal to bridge

Reference section 3.15.2.1.3 of AASHTO,

All wind loads on structure apply simultaneously.

Superstructure depth exposed to wind = 7.96 ft.



Longitudinal wind,

W = 0.012 * 7.96 * 300 / 3 = 9.55 kips/pier

Horizontal wind on column top = 1.91 kips

Horizontal loading on column top,

Loading parallel to pier line = 0.85 kips
Loading perpendicular to pier line = 1.71 kips

Bridge # ***09684***

Transverse wind,

W = 0.05 * 7.96 * 75.00 = 29.84 kips/pier

Horizontal wind on column top = 5.97 kips/col.

Horizontal loading on column top,

Loading parallel to pier line = 5.35 kips

Loading perpendicular to pier line = 2.66 kips

Substructure wind,

Substructure wind apply pressure of .04 kips/ft.^{2} to each pier face.

Top of pier cap elev. = 1157.03 ft.
Water elevation = 1156.00 ft.
Long. pier cap length = 91.83 ft.
Exposed Pier cap height = 1.03 ft.

Perpendicular wind to pier line,

Longitudinal exposed pier cap area = 94.59 ft.^{2}

Pier cap wind loading = .04 * 94.59 / 5 = 0.76 kips/col.

Loading perpendicular to pier line = 0.76 kips

Parallel wind to pier line,

Wind loading on pier cap,

Projected pier length = 3.25 ft.
Exposed height = 1.03 ft.
Exposed Area = 3.35 ft.^{2}

Loading parallel to pier line = 0.04 * 3.35 / 5 = 0.03 kips

Bridge # *09684*

Wind on Live Load (WL),

The wind on live load is applied 6 feet above the deck.

Loading		Direction
0.10	kips/ft.	Transverse to bridge
0.04	kips/ft.	Longitudinal to bridge

Bridge Roadway Width = 68.00 ft.
# of contributing spans = 4
# of contributing piers = 3

Longitudinal force = 4.00 kips/pier
Transverse force = 10.00 kips/pier

WL_{perp} = 1.61 kips/col.
WL_{parll} = 2.15 kips/col.

Longitudinal Force,

Longitudinal force is 5% of Live Load. (AASHTO 3.9)

# of contributing piers = 3 Pier span lengths = 75.00 ft.
# of contributing spans = 4 # of columns = 5

Longitudinal force per pier, LF = 15.88 kips

Loading perpendicular to pier line = 14.22 kips => LF_{perp} = 2.84 kips/col.
Loading parallel to pier line = 7.07 kips => LF_{parll} = 1.41 kips/col.

Bridge # *09684*

Thermal Force,

Moderate climate temp. fall = 40 degree F
Coefficient of thermal expansion = 6.00E-06 / degree F

Displacement due to temp. change = 0.216 in.

Deflection perpendicular to pier line, Δ_{perp} = 0.193 in.

The equivalent horizontal forces produced from the thermal displacements are calculated in STAAD.

$Loading_{perp}$ = 3.90 kips

$Loading_{parll}$ = 1.94 kips

Bridge # ***09684***

Axial Loading Summary,

Dead Load = 374.95 kips

Live Load = 63.53 kips

Buoyancy = 29.04 kips

Horizontal Loading Summary,

Loading Type	Direction to pier line: Perpendicular		Parallel	
Stream Flow Pressure	0.00	kips	1.42	kips
		Top =	0.48	kips
		Bottom =	0.00	kips
Wind	5.12	kips	6.22	kips
Wind on Live Load	1.61	kips	2.15	kips
Longitudinal Force	2.84	kips	1.41	kips
Thermal Force	3.90	kips	1.94	kips

Bridge # *09684*

Design Loading:

Using the load factor design, the gamma value for case I, II and III is 1.25.

STAAD-III Output,

Parallel (to pier line) Loading,

Loading Combinations:	P (kips)	M (ft.-kips)	Lat Load (kips)
I. D+SF+0.5W+B	251.70	109.70	22.71
II. D+L+SF	855.24	0.00	23.74
III. D+L+SF+.3*W+WL+LF+T	797.17	423.62	31.54

Perpendicular (to pier line) Loading,

Loading Combinations:	P (kips)	M (ft.-kips)	Lat Load (kips)
I. D+SF+0.5W	251.70	361.27	3.20
II. D+L+SF	855.24	350.49	0.00
III. D+L+SF+.3*W+WL+LF+T	797.17	514.59	12.36

COM624P Input,

Loading Combinations:	P (lbs.)	M (in.-lbs.)	Lat Load (lbs.)
I. D+SF+0.5W	251700	4530697	22934
II. D+L+SF	855240	4205880	23740
III. D+L+SF+.3*W+WL+LF+T	797170	7998311	33875

Results:

The maximum axial service load is 633 kips.

The greatest calculated axial service load is 633 kips, and at the same time, the geotech report the allows a maximum of 600 kips. (Sergent, Hauskins & Beckwith) This produces an overstress of 5%. This temporary situation occurs concurrently when the maximum of both overloading and scour conditions occur. Because in fact this small overstress is temporary it passes the structural evaluation.

The results from PCACOL shows the column and shaft to be OK.

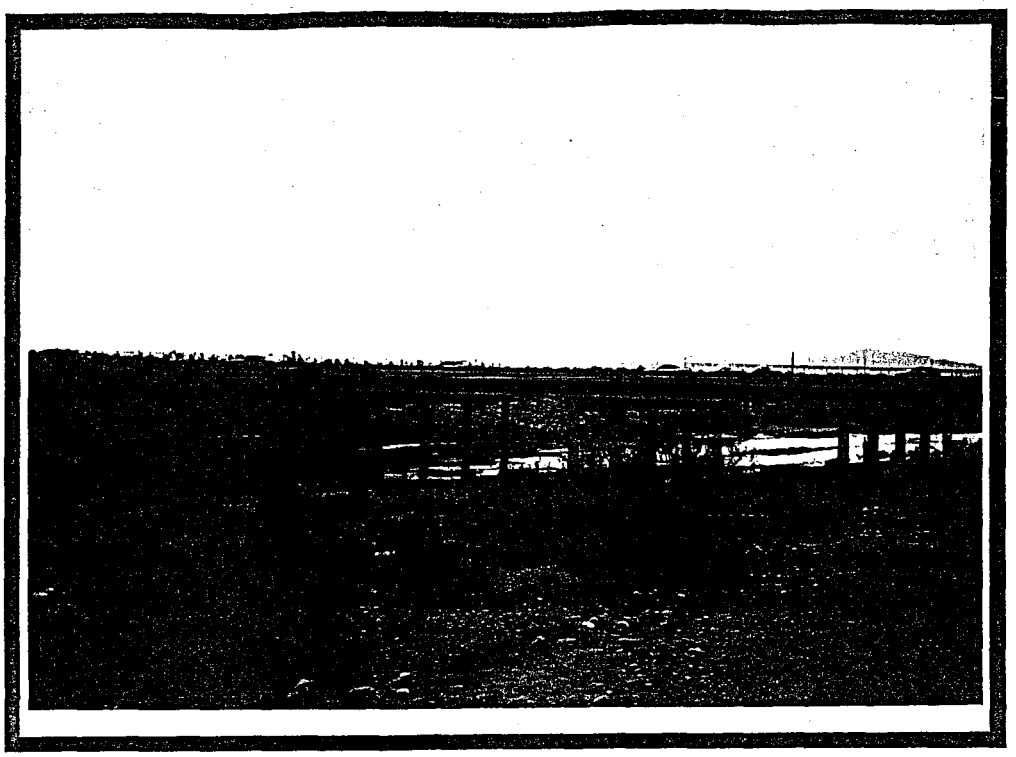


PHOTO 1 - New River - Thunderbird Road - Looking South (downstream) along channel at bridge

PHOTO 2 - New River - Thunderbird Road - Looking North (upstream) along main channel

PHOTO 3 - New River - Thunderbird Road - Looking North (upstream) along channel at bridge

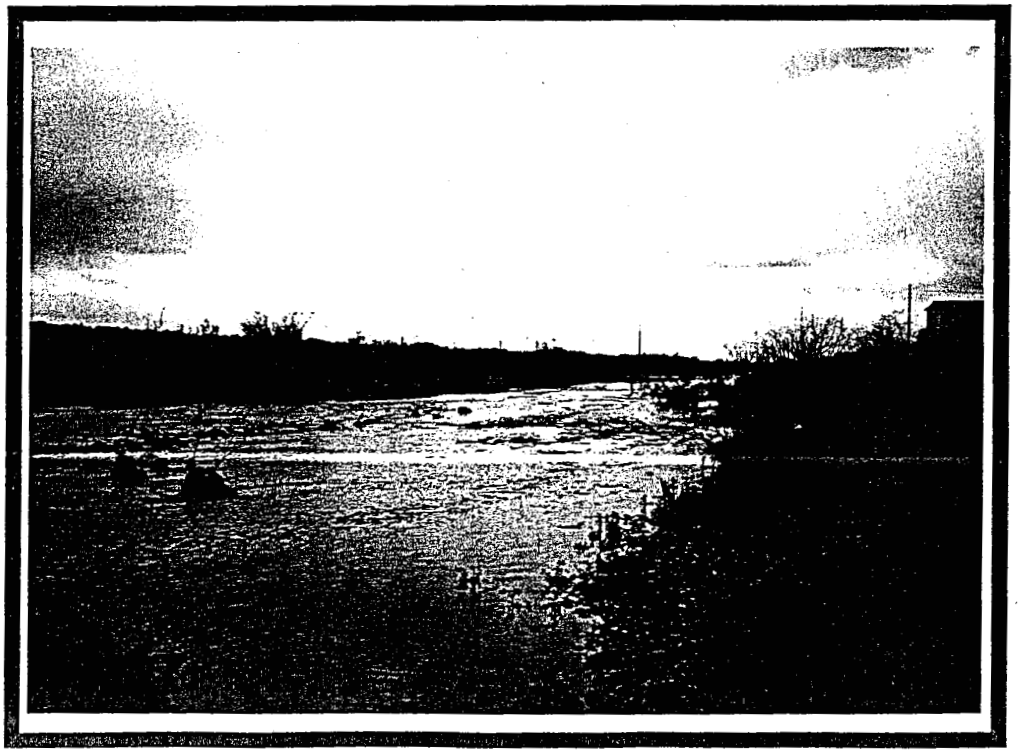


PHOTO 4 - New River - Thunderbird Road - Looking South (downstream) along main channel

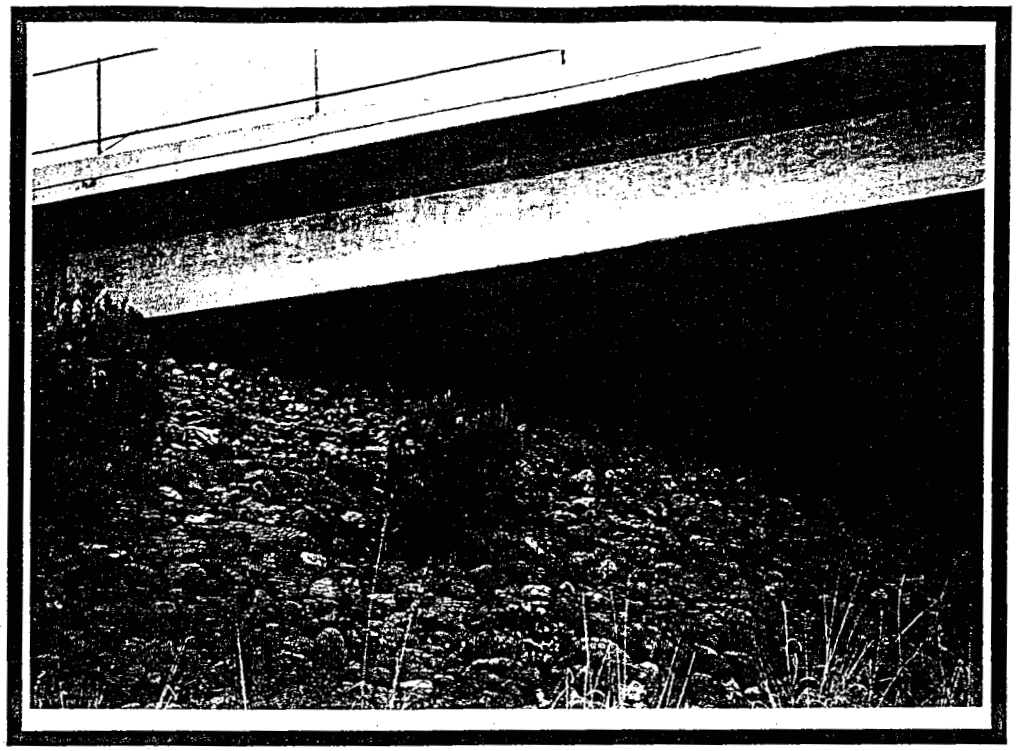


PHOTO 5 - New River - Thunderbird Road - View of West abutment

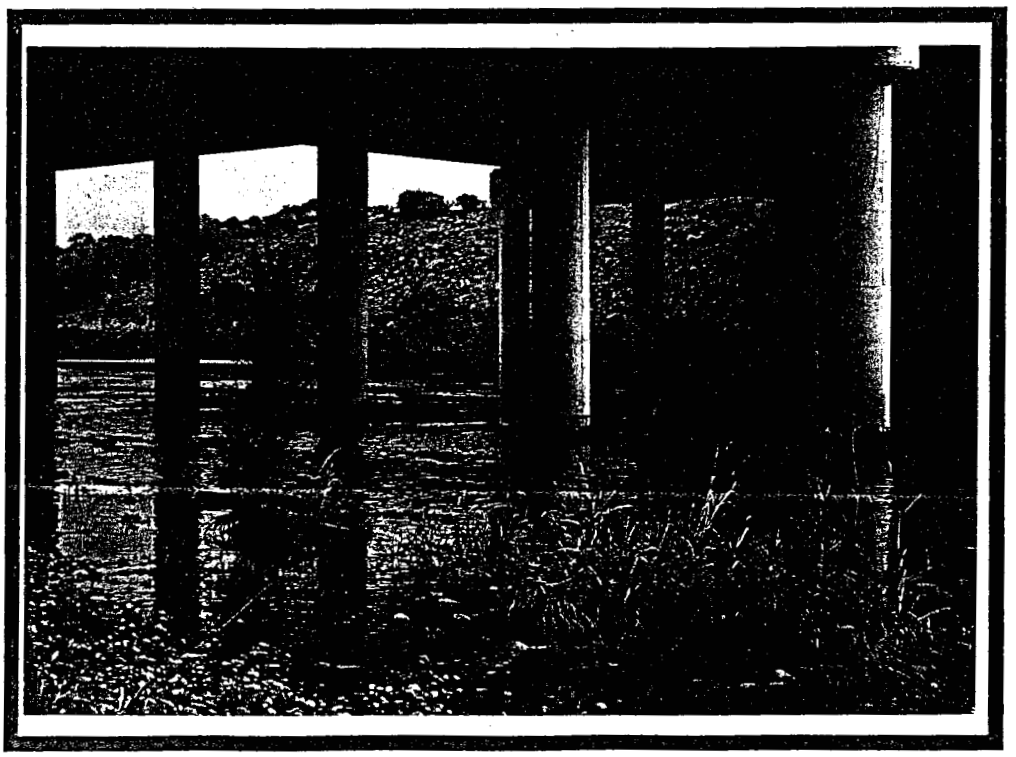


PHOTO 6 - New River - Thunderbird Road - View of pier columns

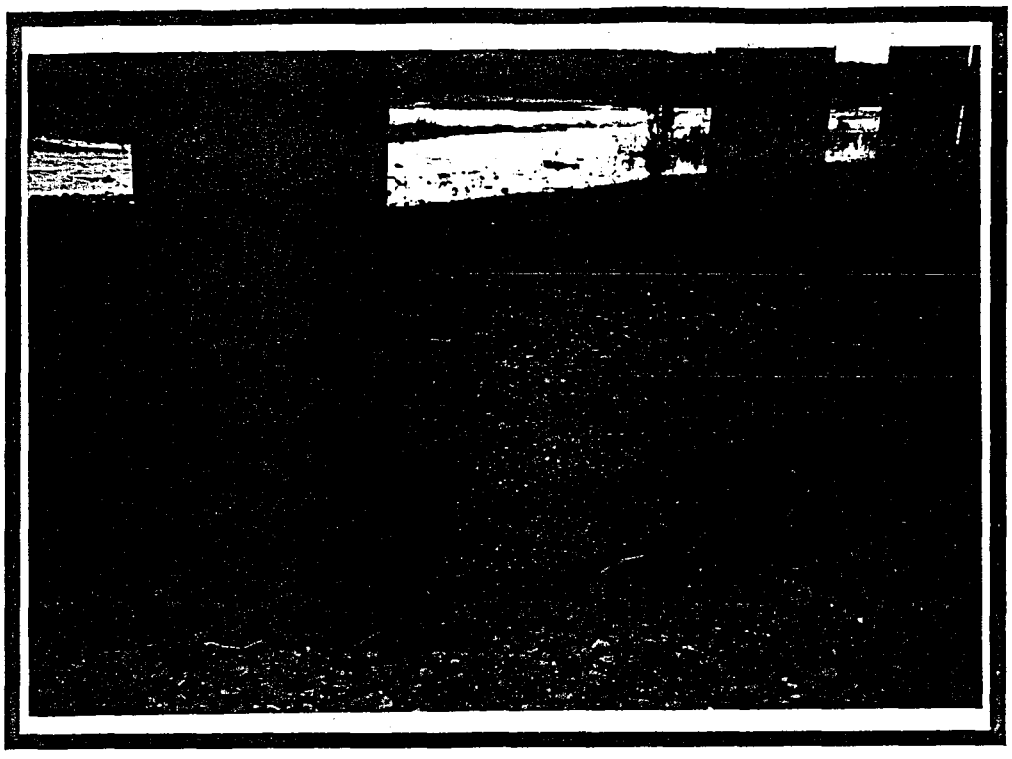


PHOTO 7 - New River - Thunderbird Road - View of scour at base of pier columns

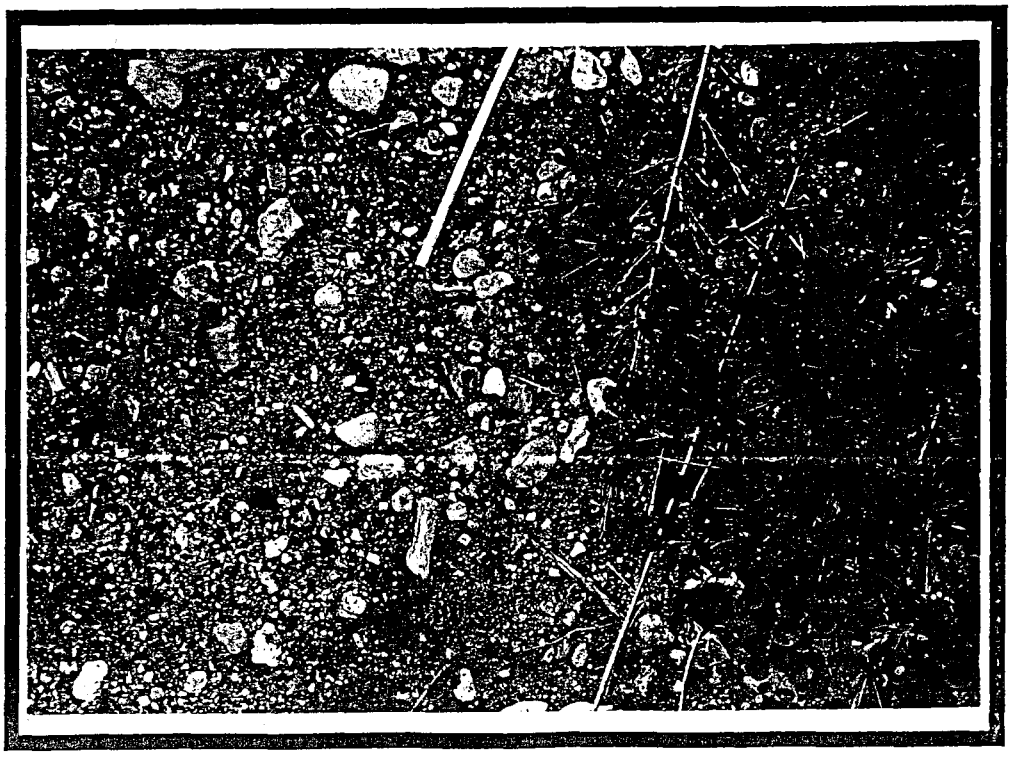


PHOTO 8 - New River - Thunderbird Road - View of bed material in main channel