Bridge Scour Investigation
and Design of Corrective Measures

Work Order No. 80407
Maricopa County Department of Transportation

June 29, 1998
23048-APA

FINAL REPORT

Structure Number 8485
Tuthill Road Bridge over the Gila River

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Submitted to
Maricopa County Department of Transportation

Submitted by

Baker

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Registered Professional Engineer (Civil)
CERTIFICATE NO. 21674
ROBERT L. DAVIES
Date Signed 6-30-98
ARIZONA, U.S.A.

BRIDGE SCOUR INVESTIGATION AND DESIGN OF CORRECTIVE MEASURES

Work Order No. 80407
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FINAL REPORT

Structure Number 8584
Tuthill Road Bridge over the Gila River

Introduction

Maricopa County Department of Transportation (MCDOT) has completed an initial scour investigation of all Maricopa County bridges. Of the bridges studied, ten scour critical bridges are being considered for countermeasure design. The Baker team is investigating and performing the final design required to retrofit five of these bridges. Existing data/reports were reviewed, site investigations made, countermeasure alternative reports developed, and PS&E packages will be completed for each structure.

Bridge Location and Description

The bridge is a 15 simple span ASHTO I-girder type. The bridge length is 1770 feet long. The piers and abutments are hammer-head shafts supported by a pile cap on driven steel piles. The bridge was built in 1981 under Maricopa County Project Work Order No. 07100. The bridge is located about 24 miles west of downtown Phoenix at the Tuthill Road crossing of the Gila River.

Report Review

Parsons Brinckerhoff (PB) evaluated this bridge for scour risk under a previous contract with MCDOT. PB's report, completed in February 1997, has been reviewed and the following comments are made.

1. Page 19: The contraction scour is the same for both Q100 and Q500. Should there be a difference?

2. Page 22: There is some discussion of reliance on the existing bank protection. The grouted riprap had damage during the 1993 flood, and should not be relied upon for future floods.

3. The report was silent on the new repair work at the south abutment, although the work was completed before the consultant filed the report.

4. The Hydrology in the PB report was based on the older values for Q100 and Q500 in the Gila River. The work at the Roosevelt Dam has been completed for some time and the new values, based on a completed dam, need to be used. The lower revised discharges are effective now and have been posted in the federal register.

5. The analysis in the PB report shows that the bridge is scour critical for both the 100- and the 500-year floods at the South Abutment. The South Abutment failed in stability evaluation, however, the stability calculations did not take into account the protection system constructed on the South Abutment as a result of the 1993 flooding.

Site Inspection

The site inspection was made on June 24, 1997 with the following present: Bob Davies, John Misik, Anthony Pisano, and Richard Bruesch of Baker; Ken Ricker of Ricker, Atkinson, McBee & Associates, Mark Larson of Larson & Company; and Tom Sonnemann of MCDOT.

Observations from the site visit and subsequent report review:

1. There is a section of grouted riprap remaining at the south abutment. This should be replaced since any slumping of the wire-tied riprap directly under it would leave a gap for erosion and undercutting to occur. The grouted riprap failed during the 1993 flood, a flow well below the Q_{500}.

2. The newer south spur dike, built by the County after the 1993 flood, should be evaluated for length and effectiveness in view of the bend erosion at the south bank and for the Q_{500} flow.

3. The area over the new wire-tied floor at the south end of the bridge is depressed creating a pond. There is a small flow through many ponds on the south bank.

4. The water table is likely to be high and nearly at the free water pond surface.

5. The effects of long term degradation needs to be determined. The 1993 flow, the first major flood since construction of the bridge, caused about 8 feet of degradation at the south end of the bridge and in some braided channels in the middle of the bridge.

6. There are no visible gravel mining activities in the area around the bridge site or immediately downstream. The degradation caused by the 1993 flow may be a natural process.

7. Additional hydraulic modeling is warranted, considering the magnitude of the countermeasures needed to overcome the scour-related deficiencies of the bridge.

8. The Tuthill Road bridge is located within the wide floodplain of the Gila River. This segment of the Gila River supports a small permanent flow in the low flow channel near the south bank. Sources of this water include irrigation return flow and effluent from the 91st Avenue Wastewater Treatment Plant. The permanent water supports a vital riparian community of vegtation and wildlife.

9. The land surrounding the bridge is in use for agriculture and open space. There is some recreational use of the river by fishermen, waterfowl hunters, and birders.

10. Vegetation in the vicinity of the bridge includes willows, cattails, bulrushes, salt cedar, and dense grasses surrounding the permanent water, and stands of willow, cottonwood, and salt cedar in other portions of the river channel. Several small willows and cottonwoods are growing dircetly under the bridge near piers.

11. The low flow channel with its surface water provides habitat for a wide variety of water and land birds, bullfrogs, carp, bluegill, and tilapia, and most probably, several mammal species such as coyote, beaver, muskrat, and cottontail rabbit. Many of the birds inhabiting the area are riparian obligates; that is they are entirely dependent on the presence of surface water and the vegetation it supports. Among these species are snowy egret, green heron, song sparrow, common yellowthroat, least bittern, and double-crested cormorant. An unusually large (+200 nesting pairs) population of cliff swallows uses the bridge to support its mud nests. In addition to these breeding season species, several species of migratory waterfowl use the area in the winter.

12. Special note should be made of the potential for Yuma clapper rails in this vicinity. This federally listed species has been found nesting in numerous locations along the Gila River. The habitat near the bridge may be suitable for this species. What's more, the dense willow habitat for the Southwest willow flycatcher, another federally-listed species.

13. The south side of the channel received scour protection several years ago. (This is the location of the low-flow channel and its permanent water.) A rock-filled wire mat was placed under the first three piers at a depth of 20'-3" and approximately 85' on either side of the centerline. The current concept for scour protection of the rest of the bridge would be to extend this mat across the rest of the river channel. As with all study bridges, any construction may be limited to periods when higher flows are not likely. Material to be excavated consists of fines, gravels, and cobbles with a low organic content. The willows and cottonwoods growing directly under the bridge would be lost to construction.

14. The river bed contains sandy silt-silty sand, silty sand with clay lenses, sand and gravel, and silty sands with various amounts of gravel. These soils are generally loose at the surface, medium dense to dense below and typically extend to a depth approximately 30' below grade (elevation 840 feet). Below these depths, the soils are composed of clayey sand with some gravel.

15. The following parameters may be used in the design of the corrective measures. The existing

subsurface data is sufficient for design of these measures.

Cut Slopes*:

Dry Soils 1 ½ H:1V

Submerged 3H:1V

- Dewatering will affect cut slopes in that dewatering from sumps within the excavation may require flatter slopes. Dewatering using external well-points may result in steeper slopes.

Fill Slopes:

Site soils 2H: 1V or flatter with slope protection.

16. The following guidelines should be used for spur dike foundation preparation and fill placement. The area directly below and 5 feet either side of the spur dike or bank protection should be medium dense granular soils. Therefore, all sandy silt or loose silty fine sands should be removed from this area and recompacted. All fill dikes or banks should be placed and compacted at moisture contents in the range of 3 percent above to 3 percent below optimum and to densities of at least 95 percent of the ASTM D698 maximum dry density.

17. Material reuse considerations. The excavated material will probably be silty sands with various amounts of gravel. These materials may be used as the primary constituent of soil cement. The soil cement will probably require about 11 percent cement. The deeper sand, gravel and cobble deposit could be used to make cement stabilized alluvium. These deeper soils, if properly graded and sorted by screening, could be used to make roller compacted concrete by employing a batch plant. Once the scour protection is installed, the excavated material may be used as cover to bring the area back to design channel grades. The existing channel material may be used to construct spur dike and bank protection. However, material to be used as rip-rap, wire mesh covered bank protection and fill for gabions is not available on-site.

18. Groundwater levels within the Gila River are controlled by various dams on the Salt and Gila River Systems. However, downstream from these facilities, additional water is discharged from the City of Phoenix wastewater treatment plant and by irrigation tail water. The depth of groundwater in the area is directly related to all these facilities. During and for some time after heavy rains or flows in the river, groundwater will be near the surface. Typically, the groundwater conditions are high, and dewatering of the excavation will be required. Due to the clean, sandy nature of soils and the relatively large size of the excavation, dewatering by internal sump may not be possible, especially if groundwater levels are near the surface. An external well point or large diameter well system may be required. The design of the dewatering system should be accomplished by an experienced dewatering firm. The discharge from the dewatering may have to meet some water quality standards.

19. Due to the sandy nature of the near-surface soils, access to the site may require track equipment or the use of gravel or cement to stabilize the surface materials so that rubber-tired vehicles can readily service the construction activities.

Hydrology and Hydraulics

The 100- and 500-year discharges (245,000 and 350,000 cfs) used in the PB report were the effective regulatory discharges based on conditions prior to the raising of Roosevelt Dam. The *Water Control Manual Modified Roosevelt Dam Salt and Gila Rivers, Arizona* is now final and new hydrology has been released by the USACOE. The new discharges at Tuthill Rd. for the 100- and 500-year flows are 227,000 and 285,000 cfs. MCDOT has approved the use of the new regulatory discharges.

Baker is performing a Flood Insurance Restudy of Salt and Gila Rivers from SR85 to Granite Reef Dam for the Flood Control District of Maricopa County. The study is nearing completion. Excerpts from the technical data notebook for this study are included below.

Split Flow:

The are breaks in the northern floodplain boundary just upstream of the Tuthill Road Bridge. The breaks occur at cross section 190.05 and at 189.77 (See topo sheets included in Appendix A for cross-section locations) and are approximately 720 and 250 feet long respectively. In these locations, the floodwater spills over the canal. It does not seem reasonable to assume that the water surface elevation on the landward side of the canal will be the same as the water surface elevation in the floodplain. The depth of flow over the canal is less than ½ foot for the 100-year storm. Based on the weir equation using a coefficient of 2.6, the spill at this location would be 900 cfs maximum. This spill is only 0.4% of the total flow in the Gila River (227,000 cfs) at this location. This amount of flow will spill over the canal and flow to the west along the canal. As the discharge increases above this amount, the weir length will lengthen, the head will rise and flow in the north overbank will spread out.

There would be no measurable effect on the water surface elevations in the Gila River if this discharge was removed from the total flow. Since it is conservative not to subtract this split flow from the flow in the river, a standard split flow type of approach was not taken. The floodplain delineation did not account for this difference in flow.

The critical flow for use in the scour analysis is normally the lesser of the 500-year flood and the flow that just reaches the low chord elevation of the bridge. This bridge has an approach road north that is overtopped at a much smaller discharge than either the 500-year flood or the low chord elevation discharge. The overtopping discharge controls for this bridge and is used for this scour evaluation.

Hydraulic and Scour Analysis

Table 1 summarizes the total revised scour predicted at each pier and abutment for the 100-year

and $Q_{overtopping}$ flood event. Scour computations are included in Appendix A.

Table 1 – Scour Results (100-year)

100 – Year Flood Existing Conditions	South Abutment (feet)	Pier (feet)	North Abutment (feet)
Degradation	0	0	0
Bend Scour	18.7	0	0
Local Scour	19.5	22.4	22.2
Contraction Scour	8.1	8.1	8.1
Total Scour	**46.3**	**30.5**	**30.3**
Remaining Pile Depth	24.7	40.5	40.7

** This depth assumes a minimum pile tip elevation of 788' as shown in the bridge plans and a plan bed elevation of 859'.

Note: Bend scour is included at the South Abutment even though there is a wire-tied system in place. The existing spur dike is inadequate.

As discussed above the evaluation discharge for this bridge is the overtopping discharge which is about equal to the 100-year discharge. The 500-year is used as the evaluation criteria since the low points in the north bank protection upstream could easily be closed at some future time.

Table 2 – Scour Results (500-year)

Q500 – Year Flood Existing Conditions	South Abutment	Pier	North Abutment
Degradation	0	0	0
Bend Scour	20.4	0	0
Local Scour	22.6	23.9	25.6
Contraction Scour	6.8	6.8	6.8
Total Scour	**49.8**	**30.7**	**32.4**
Remaining Pile Depth	21.2	40.3	38.6

** This depth assumes a minimum pile tip elevation of 788' as shown in the bridge plans and a plan bed elevation of 859'.

Note: Bend scour is included at the South Abutment even though there is a wire-tied system in place. The existing spur dike is inadequate.

Long-Term Scour

Baker concurs with the PB results for long-term scour assessment. There are no control points such as grade control structures, dams, or bedrock nearby to readily facilitate evaluating the equilibrium/stable slope conditions. A detailed sediment transport study to accurately assess long-term scour is beyond the scope of this contract. Based on review of the available data such as topography mapping, bridge inspection cross-sections, field surveys, and field investigation no long-term scour is anticipated.

Presently there is a breach in Gillespie Dam which has changed the geomorphology of the river for several miles upstream. It has degraded the channel. This degradation will continue as flooding events occur. The existing degraded channel stretches for several miles upstream of the dam. Tuthill Bridge is still several miles upstream of where the degraded channel ends. When and if the dam will be reconstructed is uncertain.

Since Tuthill Road Bridge is built on a bend significant flow events tend to scour the south bank area. Flow accelerates on the outside of the bend. Over time these scoured areas tend to aggrade back to the pre-scour condition. The bend scour is assessed in the scour evaluation.

Bridge Deficiencies

As discussed previously the 500-year flood is included. Tables 1 & 2 show the remaining pile depth for both the 100-year and 500-year floods, respectively. The South Abutment and the first three spans to the north are now protected by a wire tied riprap system which will limit the calculated scour to maximum scour elevation of 853 feet. The lack of an adequate spur dike on the South Abutment makes it very vulnerable to scour. The grouted riprap protection at the existing top half of the South Abutment is inadequate. The interface between the wire-tied system and grouted riprap to the top of the abutment is vulnerable. Erosion at the interface and cracking in the grouted riprap section is present. In a significant event, the grouted riprap section will likely fail. The North Abutment also has a poor scour protection with a similar grouted riprap section facing.

The new scour analyses performed with the hydrology from the Water Control Manual Modified Roosevelt Dam Salt and Gila Rivers, Arizona show that the scour decreases in the 100 & 500-year flood condition for the abutments and piers. The pier scour decreases from 46.0' calculated by PB to 31.1' shown in Table1 (worst case is the 100 year flood). Therefore the remaining pile depth increases from 25.0' to 39.9'. The increase in remaining pile depth, however, does not appear to warrant changing the conclusion that the pier foundations are scour critical. The

applied vertical load per pile calculated by PB is 212 kip. Per the pile capacity design chart (see Appendix B) used by PB, the capacity of an HP 12X53 pile with 39.9' of embedment depth is approximately 215 kip. Because the science of scour analysis is not exact, this resulting change in capacity is considered to be inadequate to justify not constructing the pier protection system.

Scour Countermeasure Alternatives

There are two countermeasure alternatives proposed for the protection of the piers and abutments at this structure. Both of the alternatives integrate existing wire-tied riprap protection system constructed previously. Also, both proposed alternatives have two common items on the South Abutment – a new wire-tied spur dike extension and removing and replacing existing grouted riprap section with wire-tied riprap slope protection.

Both alternatives also include transverse (deflector) dikes used to train the flow of the Gila River back into the main channel. Recent migration of the river to the south, if left unchecked, will eventually migrate far enough to wash out the approach roadway and erode the protection at the South Abutment from behind. Stabilizing the channel may be beyond the scope of this project.

Alternative No. 1- Wire Tied Riprap

This alternative requires the construction of a wire-tied riprap section for pier protection similar to the existing section previously constructed for the south side of the bridge. The new pier protection will tie into the existing system on the south and then tie into the new wire-tied spur dike on the north (see below).

The existing grouted riprap spur dike on the north side of the bridge will be removed and replaced with wire-tied riprap on 2:1 slopes and a horizontal wire-tied riprap apron at the toe of the slope. The existing section of grouted riprap on the South Spur Dike will be replaced with wire-tied riprap. Additionally, the existing wire-tied protection on the spur dike will be extended to wrap around the South Abutment until it terminates perpendicular to the bridge. The two deflector dikes will be constructed similar to the new North Spur Dike with wire-tied riprap on 2:1 slopes and a horizontal wire-tied riprap apron at the toe of the slope. The horizontal aprons on both the North Spur Dike and deflector dikes are designed per the commonly used standard of horizontal length equal to 1.5 to 2 times the scour depth minus cover. One major advantage of the wire-tied system is that it can be placed in a limited amount of standing water.

The estimated cost for this alternative is $9,675,000.

Alternative No. 2 - Soil Cement

This alternative is the same concept as Alternative 1, except that a soil cement layer is used in place of the wire-tied riprap for pier protection and dike slopes. The pier protection consists of a 4' thick horizontal layer of soil cement with soil cement on 2:1 slopes on both sides. The top of the horizontal layer is set to the same elevation as the wire-tied system in Alternative #1. This will require some of the pier pile caps to be embedded in the soil cement. The new pier protection will tie into the bottom of the existing wire-tied riprap system on the south and then

tie into the new spur dike on the north (see below).

The existing grouted riprap spur dike on the north side of the bridge will be removed and replaced with soil cement on 1:1 slopes and a horizontal wire-tied riprap apron at the toe of the slope. The two deflector dikes will be constructed similar to the new North Spur Dike with soil cement on 1:1 slopes and a horizontal wire-tied riprap apron at the toe of the slope. The horizontal aprons on both the North Spur Dike and deflector dikes are designed per the commonly used standard of horizontal equal to 1.5 to 2 times the scour depth minus cover.

The estimated cost for this alternative is $8,800,000.

Recommended Alternative

Alternative No. 1 is the recommended alternative. Because of the high water table and permanent flow through parts of the channel, soil cement layers may be difficult to construct and a more complete dewatering effort will be required verses the wire-tied construction. Also, the new wire-tied system will better match the existing wire-tied riprap. Although Alternative No. 2 is less expensive, fewer problems during construction are anticipated using the wire-tied system over the soil cement.

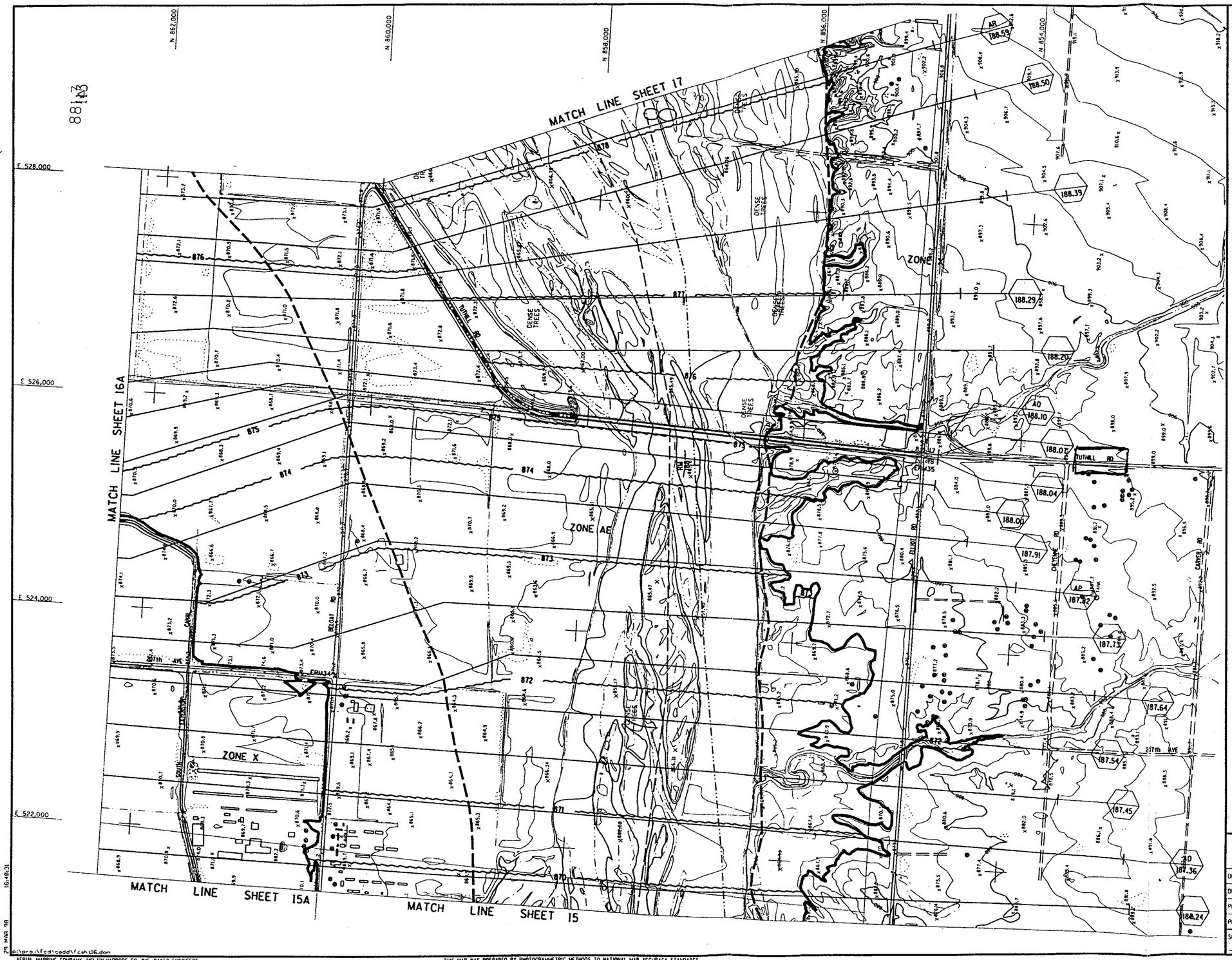
Based on the calcs provided, the training dikes will cause an approximate 1.2' increase in the 100yr floodplain.

This may or may not impact existing structures, but should be investigated and certainly evaluated as part of the feasibility study.

Please provide a paragraph within report addressing this issue ~~and~~ with a general summary of the impacts of the training dikes to the FP

APPENDIX A

Hydraulics and Scour Calculations



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SALT - GILA RIVERS

F.C.D. CONTRACT NO. 90-59 & 92-01

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	RM 12.0 — RM 13.0
STATION 200+00	
CROSS SECTION	A 16.1.1 — FP=100 Yr WSE / FW=floodway WSE — A 16.1.1
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
BENCH MARK LOCATION	BM 144 △
APPROXIMATE SECTION CORNER	20 21 / 29 28
GUTTER ZONE	

ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

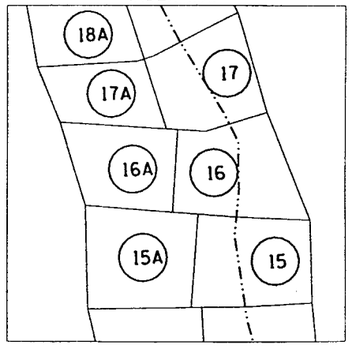
I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
34	868.82	A BC in a HH in the intersection of Beloat Rd. and Tuthill Rd. This point is the S quarter corner of Sec. 6, T 1 S, R 2 W of the G&SRB&M, Maricopa County, Arizona.
35	885.99	A BC in a HH in the intersection of Tuthill Rd. and Elliot Rd. This point is the [illegible] of Sec. 18, T 1 S, R 2 W of the [illegible] County, Arizona.

Registered Professional Engineer (Civil) CERTIFICATE NO. 21874 ROBERT L. DAVIES Date Signed 3-30-92 ARIZONA, U.S.A.

GENERAL NOTES

1. ALL AREAS DESIGNATED AS ZONE X ARE SHADED ZONE X.
2. THE AVERAGE CONVERSION FACTOR FROM NGVD 29 TO NAVD 88 IS +1.8044ft.

INDEX MAP



N

400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4 FEET

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	AGP	-
DESIGN CHK.	RLD	-
PLANS	SSO	-
PLANS CHK.	CWR/BAC	-
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 16 OF 46

ADM.MRB REV. DEC. 10, 1991

AERIAL MAPPING COMPANY, MCLAIN/HARBORS CO. INC. BAKER ENGINEERS.
SURVEYING COMPANY, JAYKIM ENGINEERS & GREINER ENGINEERS.
FLIGHT DATES 13 DEC. 1991 ; 13 JAN. 1992 ; 23 JAN. 1992

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"=400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
USING NAD 83 HORIZONTAL DATUM. DATA PROVIDED BY JAYKIM ENGINEERS & GREINER ENGINEERS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SALT - GILA RIVERS

F.C.D. CONTRACT NO. 90-59 & 92-01

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	RM 12.0 — RM 13.0
STATION 200+00	
CROSS SECTION	EP=100 Yr WSE; FP=Floodway WSE
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
BENCH MARK LOCATION	BM 144
APPROXIMATE SECTION CORNER	20 21 / 29 28
GUTTER ZONE	

ELEVATION REFERENCE MARKS

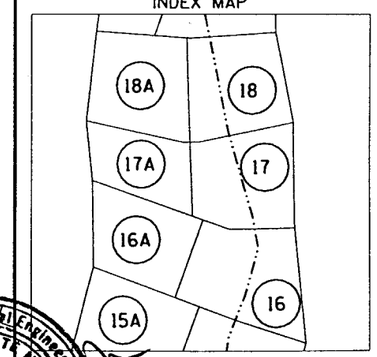
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
36	917.07	A BC in a HH in the intersection of Elliot Rd. and Rainbow Valley Rd. This point is the NE corner of Sec. 17, T 1 S, R 2 W of the G&SRB&M, Maricopa County, Arizona.

GENERAL NOTES

1. ALL AREAS DESIGNATED AS ZONE X, ARE SHADED ZONE X.
2. THE AVERAGE CONVERSION FACTOR FROM NGVD 29 TO NAVD 88 IS +1.804ft.

INDEX MAP



400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 21674 ROBERT L. DAVIES Date Signed 2-7-92 ARIZONA, U.S.A.

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	AOP	-
DESIGN CHK.	RLD	-
PLANS	SSO	-
PLANS CHK.	CWR/BAC	-
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

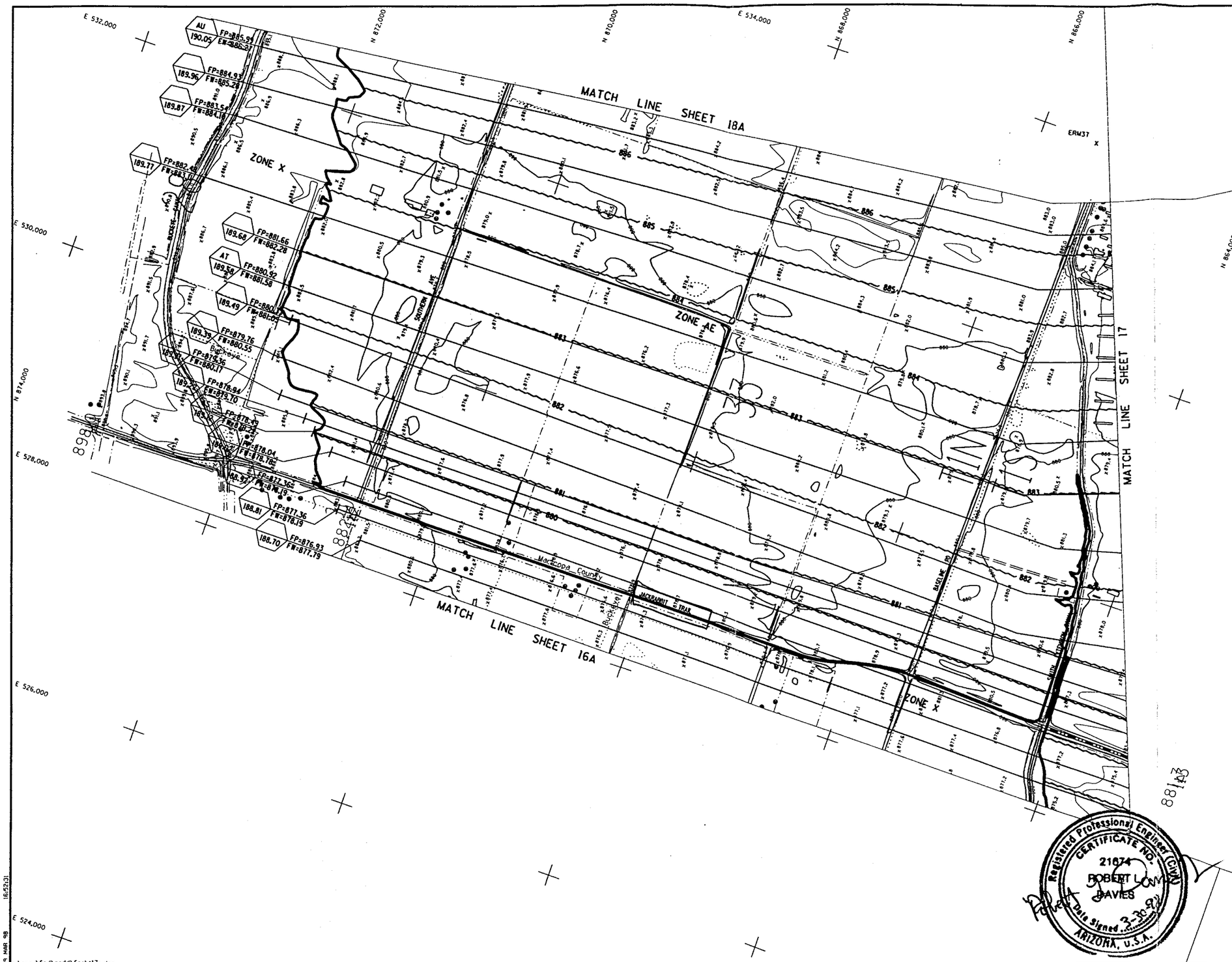
SHEET 17 OF 46

29 MAR 98 18:04:28 d:\proj\fcd\cadd\fcsht17.dgn

ADM,MRB REV. DEC. 10, 1991

AERIAL MAPPING COMPANY, MCLAINHARBORS CO. INC. BAKER ENGINEERS. SURVEYING COMPANY, JAYKIM ENGINEERS & GREINER ENGINEERS. FLIGHT DATES 13 DEC. 1991 ; 13 JAN. 1992 ; 23 JAN. 1992

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS 1"=400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY USING NAD 83 HORIZONTAL DATUM. DATA PROVIDED BY JAYKIM ENGINEERS & GREINER ENGINEERS



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SALT - GILA RIVERS

F.C.D. CONTRACT NO. 90-59 & 92-01

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	RM 12.0 — RM 13.0
STATION 200+00	
CROSS SECTION	A (161.1) FP=100 Yr WSE FW=floodway WSE A (161.1)
ELEVATION REFERENCE MARK	ERM3 X
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ZONE DESIGNATIONS	ZONE AE
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GUTTER ZONE	

ELEVATION REFERENCE MARKS

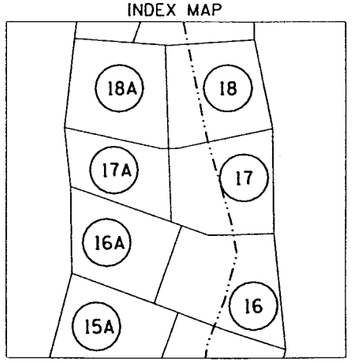
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. *	ELEV (FT)	DESCRIPTION/LOCATION
36	917.07	A BC in a HH in the intersection of Elliot Rd. and Rainbow Valley Rd. This point is the NE corner of Sec. 17, T 1 S, R 2 W of the G&SRB&M, Maricopa County, Arizona. (LOCATED ON SHEET 17)
37	887.63	An ADOT BC in the center of an irrigation structure headwall, approximately 36 feet southerly of the centerline of SR 85, and 25 feet easterly of the centerline of Perryville Rd. This point is located in the proximity of the SE corner of Sec. 33, T 1 N, R 2 W of the G&SRB&M, Maricopa County, Arizona. (LOCATED ON SHEET 18A)

GENERAL NOTES

1. ALL AREAS DESIGNATED AS ZONE X, ARE SHADED ZONE X.
2. THE AVERAGE CONVERSION FACTOR FROM NGVD 29 TO NAVD 88 IS +1.804ft.

INDEX MAP



400 0' 400 800

SCALE: 1" = 400'

CONTOUR INTERVAL = 4 FEET

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	AGP	-
DESIGN CHK.	RLD	-
PLANS	SSO	-
PLANS CHK.	CWR/BAC	-
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 17A OF 46

ADM,MRB REV. DEC. 10, 1991

24 MAR 98 16:52:31

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AERIAL MAPPING COMPANY, MCLAIN,HARBORS CO. INC. BAKER ENGINEERS.
SURVEYING COMPANY, JAYKIM ENGINEERS & CREIMER ENGINEERS.
FLIGHT DATES 15 DEC. 1991 ; 13 JAN. 1992 ; 23 JAN. 1992

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS 1"=400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY USING NAD 83 HORIZONTAL DATUM. DATA PROVIDED BY JAYKIM ENGINEERS & CREIMER ENGINEERS

SCOUR VARIABLES + OUTPUT TUT SCOUR TUTSUBIT Q100

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	0.91	14.96	3.92
	Approach Velocity (ft/s):	0.15	4.27	1.03
	Br Average Depth (ft):		17.15	
	BR Opening Flow (cfs):	24.53	226975.50	
	BR Top WD (ft):		1755.41	
	Grain Size D50 (ft):	0.0164	0.0164	0.0164
	Approach Flow (cfs):	1771.94	225228.05	
	Approach Top WD (ft):	3.15	2305.44	7302.73
	K1 Coefficient:	0.590	0.590	0.590
Results				
	Scour Depth Ys (ft):		8.14	
	Critical Velocity (ft/s):		4.38	
	Equation:		Clear	

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	8.00
	Grain Size D50 (ft):	0.01640
	Depth Upstream (ft):	19.93
	Velocity Upstream (ft/s):	7.60
	K1 Nose Shape:	1.00
	Pier Angle:	16.00
	Pier Length (ft):	33.00
	K2 Angle Coef:	1.55
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (ft):	0.10000
	K4 Armouring Coef:	1.00
	Set K1 value to 1.0 because angle > 5 degrees	
Results		
	Scour Depth Ys (ft):	22.37
	Froude #:	0.30
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	19130.00	20841.00
	Toe Sta at appr (ft):	19150.00	20840.00
	Abutment Length (ft):	904.00	654.00
	Depth at Toe (ft):	17.19	11.77
	K1 Shape Coef:	0.55 - Spill-through abutment	
	Degree of Skew (degrees):	16.00	164.00
	K2 Skew Coef:	0.80	1.08
	Projected Length L' (ft):	249.18	180.27
	Avg Depth Obstructed Ya (ft):	12.39	9.08
	Flow Obstructed Qe (cfs):	11534.00	23045.00
	Area Obstructed Ae (sq ft):	11822.00	9865.00
Results			
	Scour Depth Ys (ft):	19.52	22.22

Qe/Ae = Ve:		0.98	2.34
Froude #:	0.05	0.14	
Equation:	Froehlich	Froehlich	

Combined Scour Depths

Pier Scour + Contraction Scour (ft):		
	Channel:	30.51
Left abutment scour + contraction scour (ft):	27.66	
Right abutment scour + contraction scour (ft):	30.36	

Q100

HYDRAULIC OUTPUT FROM HECRAS
@ FIRST CROSS-SECTION JUST UPSTREAM OF BRIDGE

Plan: Main w M4 FW River: RIVER-1 Reach:Reach-1 Riv Sta: 188.1 Profile: PF#1

W.S. Elev (ft)	878.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.72	Wt. n-Val.	0.025	0.025	
E.G. Elev (ft)	878.82	Reach Len. (ft)	0.00	0.00	0.00
Crit W.S. (ft)	868.75	Flow Area (sq ft)	179.00	33346.65	
E.G. Slope (ft/ft)	0.000315	Area (sq ft)	179.00	33346.65	32195.56
Q Total (cfs)	227000.00	Flow (cfs)	171.96	226828.05	
Top Width (ft)	9044.29	Top Width (ft)	205.77	2030.88	6807.64
Vel Total (ft/s)	6.77	Avg. Vel. (ft/s)	0.96	6.80	
Max Chl Dpth (ft)	22.30	Hydr. Depth (ft)	0.87	16.42	
Conv. Total (cfs)	12790329.0	Conv. (cfs)	9689.0	12780640.0	
Length Wtd. (ft)	0.00	Wetted Per. (ft)	205.97	2036.50	
Min Ch El (ft)	855.80	Shear (lb/sq ft)	0.02	0.32	
Alpha	1.01	Stream Power (lb/ft s)	0.02	2.19	
Frctn Loss (ft)		Cum Volume (acre-ft)	309.74	37274.82	11090.05
C & E Loss (ft)		Cum SA (acres)	437.66	4073.02	1940.32

Q100

FLOW DISTRIBUTION OUTPUT FROM HECRAS
@ FIRST CROSS-SECTION JUST UPSTREAM OF BRIDGE.

Plan: Main w M4 FW River: RIVER-1 Reach:Reach-1 Riv Sta: 188.1 Profile: PF#1

Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	% Conv.	Hydr D. (ft)	Velocity (ft/s)
18671.29	18770.57	1.82	3.15	7.28	0.00	0.44	0.58
18770.57	18869.84	119.58	110.14	99.31	0.05	1.11	1.09
18869.84	18969.12	50.55	65.72	99.38	0.02	0.66	0.77
18969.12 LB	19104.51	4945.84	1150.85	135.99	2.18	8.50	4.30
19104.51	19239.90	15760.69	2303.86	135.55	6.94	17.02	6.84
19239.90	19375.29	15504.69	2280.25	135.39	6.83	16.84	6.80
19375.29	19510.69	15437.23	2274.30	135.39	6.80	16.80	6.79
19510.69	19646.08	20498.50	2697.91	135.62	9.03	19.93	7.60
19646.08	19781.47	18733.81	2557.27	135.78	8.25	18.89	7.33
19781.47	19916.86	14755.74	2215.68	135.73	6.50	16.36	6.66
19916.86	20052.26	12564.15	2020.49	137.17	5.53	14.92	6.22
20052.26	20187.65	19886.74	2655.06	136.36	8.76	19.61	7.49
20187.65	20323.04	19796.83	2641.21	135.50	8.72	19.51	7.50
20323.04	20458.43	15831.71	2311.26	135.73	6.97	17.07	6.85
20458.43	20593.82	16628.22	2378.05	135.40	7.33	17.56	6.99
20593.82	20729.22	16023.73	2325.76	135.39	7.06	17.18	6.89
20729.22	20864.61	12587.21	2016.11	136.06	5.55	14.89	6.24
20864.61	21000.00 RB	7872.93	1518.59	135.43	3.47	11.22	5.18

Q100

HYDRAULIC OUTPUT FROM HECRAS
@ APPROACH CROSS-SECTION

Plan: Main w M4 FW River: RIVER-1 Reach:Reach-1 Riv Sta: 188.39 Profile: PF#1

W.S. Elev (ft)	879.22	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.28	Wt. n-Val.	0.150	0.039	0.065
E.G. Elev (ft)	879.50	Reach Len. (ft)	705.00	536.34	280.00
Crit W.S. (ft)	868.98	Flow Area (sq ft)	2.88	52954.82	648.15
E.G. Slope (ft/ft)	0.000329	Area (sq ft)	2.88	52954.82	28988.47
Q Total (cfs)	227000.00	Flow (cfs)	0.44	226332.02	667.55
Top Width (ft)	10845.89	Top Width (ft)	3.15	3540.01	7302.73
Vel Total (ft/s)	4.23	Avg. Vel. (ft/s)	0.15	4.27	1.03
Max Chl Dpth (ft)	18.52	Hydr. Depth (ft)	0.91	14.96	3.92
Conv. Total (cfs)	12509321.0	Conv. (cfs)	24.4	12472510.0	36786.9
Length Wtd. (ft)	535.96	Wetted Per. (ft)	3.64	3545.06	165.68
Min Ch El (ft)	860.70	Shear (lb/sq ft)	0.02	0.31	0.08
Alpha	1.02	Stream Power (lb/ft s)	0.00	1.31	0.08
Frctn Loss (ft)	0.16	Cum Volume (acre-ft)	838.15	38845.41	11512.53
C & E Loss (ft)	0.01	Cum SA (acres)	442.03	4175.33	2031.15

Q100

FLOW DISTRIBUTION OUTPUT FROM HECRAS @ APPROACH CROSS-SECTION

Plan: Main w M4 FW River: RIVER-1 Reach:Reach-1 Riv Sta: 188.39 Profile: PF#1

Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	% Conv.	Hydr D. (ft)	Velocity (ft/s)
18215.06	18217.52	0.01	0.14	0.79	0.00	0.20	0.05
18217.52	18219.99	0.44	2.75	2.85	0.00	1.11	0.16
18219.99 LB	18455.99	3182.13	3166.61	238.25	1.40	13.42	1.00
18455.99	18691.99	2964.76	3023.73	236.05	1.31	12.81	0.98
18691.99	18927.99	2454.15	2700.12	236.17	1.08	11.44	0.91
18927.99	19163.99	3117.86	3116.60	236.07	1.37	13.21	1.00
19163.99	19399.99	13533.58	3389.48	236.43	5.96	14.36	3.99
19399.99	19635.99	30350.08	4265.21	236.00	13.37	18.07	7.12
19635.99	19871.99	31317.76	4346.29	236.00	13.80	18.42	7.21
19871.99	20108.00	30659.50	4291.26	236.00	13.51	18.18	7.14
20108.00	20344.00	30119.08	4245.76	236.01	13.27	17.99	7.09
20344.00	20580.00	28472.27	4104.88	236.00	12.54	17.39	6.94
20580.00	20816.00	19565.99	3487.98	236.93	8.62	14.78	5.61
20816.00	21052.00	8621.73	3473.99	236.09	3.80	14.72	2.48
21052.00	21288.00	9049.02	3578.18	236.40	3.99	15.16	2.53
21288.00	21524.00	8625.86	3474.69	236.04	3.80	14.72	2.48
21524.00	21760.00 RB	4298.27	2290.02	236.62	1.89	9.70	1.88
21760.00	22462.47	667.55	648.15	165.68	0.29	3.92	1.03

Q500

SCOUR VARIABLES + OUTPUT

Pg. 1/2

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	1.53	16.75	5.04
	Approach Velocity (ft/s):	0.27	4.79	1.34
	Br Average Depth (ft):		18.66	
	BR Opening Flow (cfs):	27.75	284972.25	
	BR Top WD (ft):		1753.47	
	Grain Size D50 (ft):	0.0164	0.0164	0.0164
	Approach Flow (cfs):	3.16	283691.31	1305.53
	Approach Top WD (ft):	7.62	3540.01	10025.37
	K1 Coefficient:		0.590	
Results				
	Scour Depth Ys (ft):		6.79	
	Critical Velocity (ft/s):		4.46	
	Equation:		Live	

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	8.00
	Grain Size D50 (ft):	0.01640
	Depth Upstream (ft):	21.50
	Velocity Upstream (ft/s):	8.62
	K1 Nose Shape:	1.00
	Pier Angle:	16.00
	Pier Length (ft):	33.00
	K2 Angle Coef:	1.55
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (ft):	
	K4 Armouring Coef:	1.00
	Set K1 value to 1.0 because angle > 5 degrees	
Results		
	Scour Depth Ys (ft):	23.86
	Froude #:	0.33
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	19130.00	20841.00
	Toe Sta at appr (ft):	19150.00	20840.00
	Abutment Length (ft):	920.00	721.00
	Depth at Toe (ft):	19.50	14.08
	K1 Shape Coef:	0.55 - Spill-through abutment	
	Degree of Skew (degrees):	16	164
	K2 Skew Coef:	0.80	1.08
	Projected Length L' (ft):	253.59	198.74
	Avg Depth Obstructed Ya (ft):	14.46	10.28
	Flow Obstructed Qe (cfs):	15201.00	30038.62
	Area Obstructed Ae (sq ft):	13547.00	11282.00
Results			
	Scour Depth Ys (ft):	22.61	25.62

SCOUR VARIABLES + OUTPUT

Qe/Ae = Ve:		1.12	2.66
Froude #:	0.05	0.15	
Equation:	Froehlich	Froehlich	

Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Channel:	30.65

Left abutment scour + contraction scour (ft):	29.40
Right abutment scour + contraction scour (ft):	32.41

Q500

HYDRAULIC OUTPUT FROM HECRAS
@ FIRST CROSS-SECTION UPSTREAM OF BRIDGE

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.1 Profile: PF#2

W.S. Elev (ft)	879.67	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.93	Wt. n-Val.	0.025	0.025	
E.G. Elev (ft)	880.61	Reach Len. (ft)	0.00	0.00	0.00
Crit W.S. (ft)	869.95	Flow Area (sq ft)	703.38	36534.28	
E.G. Slope (ft/ft)	0.000364	Area (sq ft)	703.38	36534.28	44942.96
Q Total (cfs)	285000.00	Flow (cfs)	1072.32	283927.69	
Top Width (ft)	12921.80	Top Width (ft)	451.02	2030.88	10439.90
Vel Total (ft/s)	7.65	Avg. Vel. (ft/s)	1.52	7.77	
Max Chl Dpth (ft)	23.87	Hydr. Depth (ft)	1.56	17.99	
Conv. Total (cfs)	14937240.0	Conv. (cfs)	56201.8	14881038.0	
Length Wtd. (ft)	0.00	Wetted Per. (ft)	451.27	2036.50	
Min Ch El (ft)	855.80	Shear (lb/sq ft)	0.04	0.41	
Alpha	1.03	Stream Power (lb/ft s)	0.05	3.17	
Frctn Loss (ft)		Cum Volume (acre-ft)	2484.98	43404.88	13972.36
C & E Loss (ft)		Cum SA (acres)	470.09	4124.39	1994.51

Q500

FLOW DISTRIBUTION OUTPUT FROM HECRAS
@ FIRST CROSS-SECTION UPSTREAM OF BRIDGE

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.1 Profile: PF#2

Left Sta	Right Sta	Flow	Area	W.P.	% Conv.	Hydr D.	Velocity
(ft)	(ft)	(cfs)	(sq ft)	(ft)		(ft)	(ft/s)
18472.75	18572.02	12.99	23.23	53.93	0.00	0.43	0.56
18572.02	18671.29	81.49	89.22	99.27	0.03	0.90	0.91
18671.29	18770.57	104.18	103.43	99.36	0.04	1.04	1.01
18770.57	18869.84	502.94	265.95	99.31	0.18	2.68	1.89
18869.84	18969.12	370.72	221.54	99.38	0.13	2.23	1.67
18969.12 LB	19104.51	7074.86	1363.36	135.99	2.48	10.07	5.19
19104.51	19239.90	19690.82	2516.36	135.55	6.91	18.59	7.83
19239.90	19375.29	19399.25	2492.76	135.39	6.81	18.41	7.78
19375.29	19510.69	19322.03	2486.81	135.39	6.78	18.37	7.77
19510.69	19646.08	25085.80	2910.42	135.62	8.80	21.50	8.62
19646.08	19781.47	23079.79	2769.78	135.78	8.10	20.46	8.33
19781.47	19916.86	18538.68	2428.19	135.73	6.50	17.93	7.63
19916.86	20052.26	16008.30	2233.00	137.17	5.62	16.49	7.17
20052.26	20187.65	24384.95	2867.57	136.36	8.56	21.18	8.50
20187.65	20323.04	24290.39	2853.71	135.50	8.52	21.08	8.51
20323.04	20458.43	19770.67	2523.77	135.73	6.94	18.64	7.83
20458.43	20593.82	20683.58	2590.56	135.40	7.26	19.13	7.98
20593.82	20729.22	19992.97	2538.27	135.39	7.02	18.75	7.88
20729.22	20864.61	16043.17	2228.61	136.06	5.63	16.46	7.20
20864.61	21000.00 RB	10562.44	1731.10	135.43	3.71	12.79	6.10

Q500

HYDRAULIC OUTPUT FROM HECRAS

@ APPROACH CROSS-SECTION

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.39 Profile: PF#2

W.S. Elev (ft)	881.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.35	Wt. n-Val.	0.150	0.039	0.064
E.G. Elev (ft)	881.36	Reach Len. (ft)	705.00	536.34	280.00
Crit W.S. (ft)	869.88	Flow Area (sq ft)	11.67	59277.52	974.77
E.G. Slope (ft/ft)	0.000367	Area (sq ft)	11.67	59277.52	45086.44
Q Total (cfs)	285000.00	Flow (cfs)	3.16	283691.31	1305.53
Top Width (ft)	13572.99	Top Width (ft)	7.62	3540.01	10025.37
Vel Total (ft/s)	4.73	Avg. Vel. (ft/s)	0.27	4.79	1.34
Max Chl Dpth (ft)	20.30	Hydr. Depth (ft)	1.53	16.75	5.04
Conv. Total (cfs)	14873198.0	Conv. (cfs)	165.0	14804902.0	68131.5
Length Wtd. (ft)	535.76	Wetted Per. (ft)	8.50	3545.06	193.75
Min Ch El (ft)	860.70	Shear (lb/sq ft)	0.03	0.38	0.12
Alpha	1.02	Stream Power (lb/ft s)	0.01	1.83	0.15
Frctn Loss (ft)	0.17	Cum Volume (acre-ft)	2526.65	45162.18	14713.54
C & E Loss (ft)	0.01	Cum SA (acres)	477.48	4226.70	2167.67

Q500

FLOW DISTRIBUTION OUTPUT FROM HECRAS @ APPROACH CROSS-SECTION

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 189.39 Profile: PF#2

Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	% Conv.	Hydr D. (ft)	Velocity (ft/s)
18328.50	18334.20	0.79	1.36	3.44	0.00	0.41	0.58
18334.20	18339.90	11.88	8.58	5.86	0.00	1.50	1.38
18339.90	18345.60	35.24	16.47	5.87	0.01	2.89	2.14
18345.60	18351.30	67.65	24.36	5.86	0.02	4.27	2.78
18351.30	18357.00	108.02	32.26	5.87	0.04	5.66	3.35
18357.00	18362.70	155.52	40.14	5.86	0.05	7.04	3.87
18362.70	18368.40	209.74	48.03	5.86	0.07	8.43	4.37
18368.40	18374.10	270.35	55.94	5.87	0.09	9.81	4.83
18374.10	18379.80	302.39	60.07	5.93	0.11	10.54	5.03
18379.80	18385.50	231.44	51.28	5.96	0.08	8.99	4.51
18385.50	18391.20	161.82	41.37	5.96	0.06	7.26	3.91
18391.20 LB	18669.12	11314.72	2298.53	277.95	3.97	8.27	4.92
18669.12	18947.04	10074.47	2143.79	277.92	3.53	7.71	4.70
18947.04	19224.96	6959.16	1664.06	277.98	2.44	5.99	4.18
19224.96	19502.88	19269.40	2857.88	278.16	6.76	10.28	6.74
19502.88	19780.80	19975.85	2919.75	278.03	7.01	10.51	6.84
19780.80	20058.72	35857.99	4147.14	277.96	12.58	14.92	8.65
20058.72	20336.64	39045.11	4364.31	277.92	13.70	15.70	8.95
20336.64	20614.56	40567.71	4465.69	277.93	14.23	16.07	9.08
20614.56	20892.48	13884.37	3558.59	278.36	4.87	12.80	3.90
20892.48	21170.40	12493.42	3733.22	278.19	4.38	13.43	3.35
21170.40	21448.32	14951.47	4156.95	278.02	5.25	14.96	3.60
21448.32	21726.24	15874.13	4308.43	277.92	5.57	15.50	3.68
21726.24	22004.16	15184.39	4195.11	277.92	5.33	15.09	3.62
22004.16	22282.08	12630.70	3756.77	278.01	4.43	13.52	3.36
22282.08	22560.00 RB	15362.28	4314.98	293.04	5.39	15.53	3.56

TUTHILL ROAD BRIDGE OVER THE GILA RIVER

BEND SCOUR	SEE NOTE	100-YEAR	500-YEAR
Y-MAX DEPTH OF UPSTREAM FLOW		22.3	23.87
Yh - HYDRAULIC DEPTH OF UPSTREAM FLOW (FT)		16.42	17.99
V - MEAN VELOCITY OF UPSTREAM FLOW (FPS)		6.77	7.65
Se - UPSTREAM ENERGY SLOPE (FT/FT)		0.000315	0.000364
[(0.0685)(Y)(V)^.8]/[(Yh^.4)(Se^.3)]		25.87	28.19
ALPHA (a) - ANGLE FORMED BY CHANNEL CENTERLINE AND A TANGENT POINT ON OUTER BANK	1	55	55
SIN^2(a/2)		0.2132118	0.21321178
COS(a)		0.5735764	0.57357644
2.1{[(SIN^2)(A/2)/COS(A)]^.2}-1		0.7229127	0.72291271
Zbs=[(0.0685)(Y)(V)^.8]/[(Yh^0.4)(sE^.3)]*2.1{[(sin^2)((a/2)/cosA)]^.2}-1		18.70	20.38

NOTES:
1. ALPHA (a) IS THE ANGLE FORMED BY THE PROJECTION OF THE CHANNEL CENTERLINE FROM THE POINT OF CURVATURE TO A POINT WHICH MEETS A LINE TANGENT TO THE OUTER BANK OF THE CHANNEL (DEGREES).

S.O. No. 23048-000-0000

Subject: TUTHILL BRIDGE

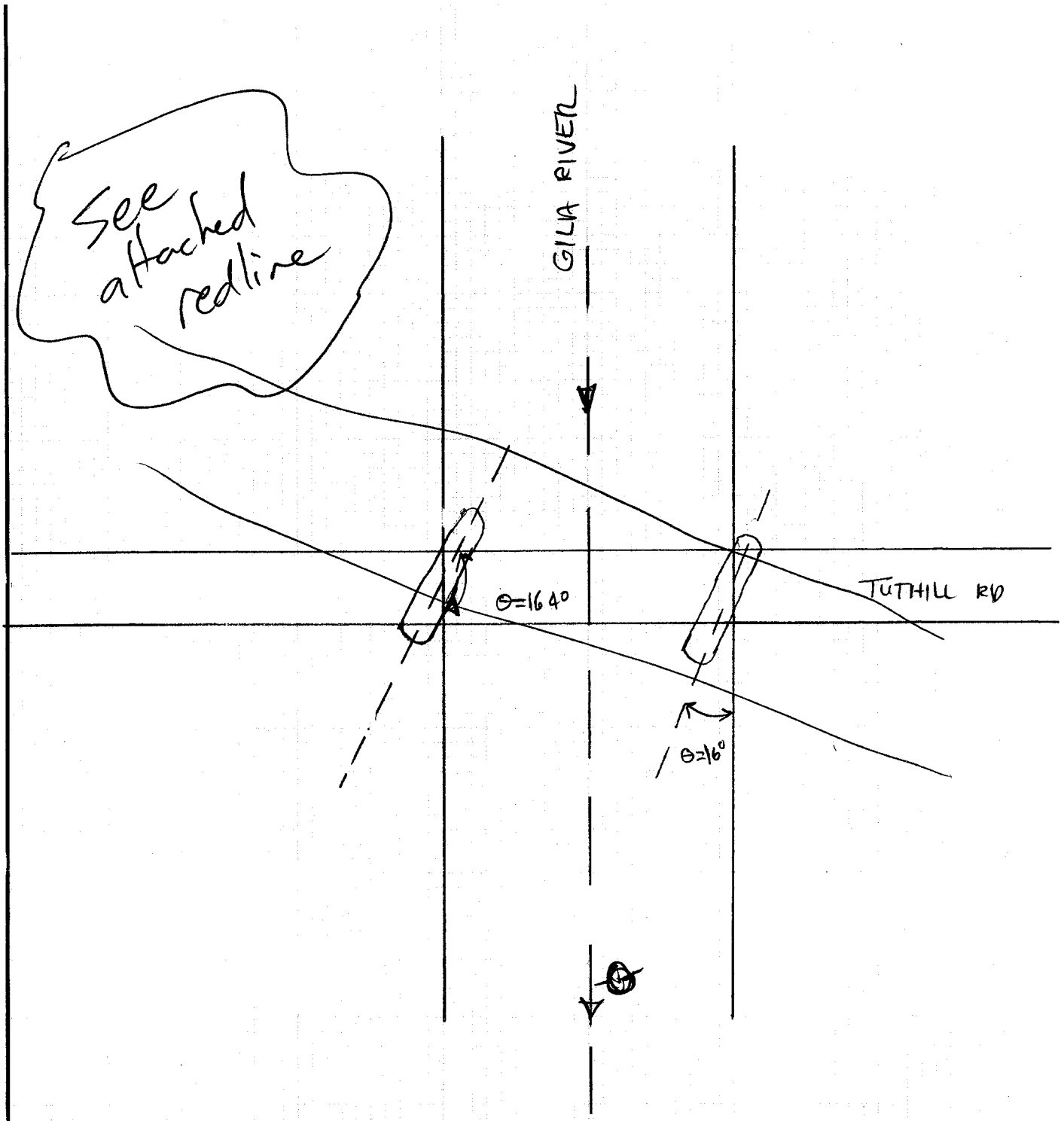
ABUTMENT SKEW ANGLE

Sheet No. ____ of ____

Drawing No. ____

Computed by RLN Checked By ____ Date 6-26-98

Baker



FROM HEC-18

$$\frac{y_s}{y_1} = 4\ Fr^{0.33}\ \frac{K_1}{0.55} \qquad (29)$$

where:

y_s = Scour depth, m
y_1 = Depth of flow at the abutment on the overbank or in the main channel, m
Fr = Froude Number based on the velocity and depth adjacent to and upstream of the abutment
K_1 = Abutment shape coefficient (from table 6)

To correct equation 29 for abutments skewed to the stream, use figure 16.[13]

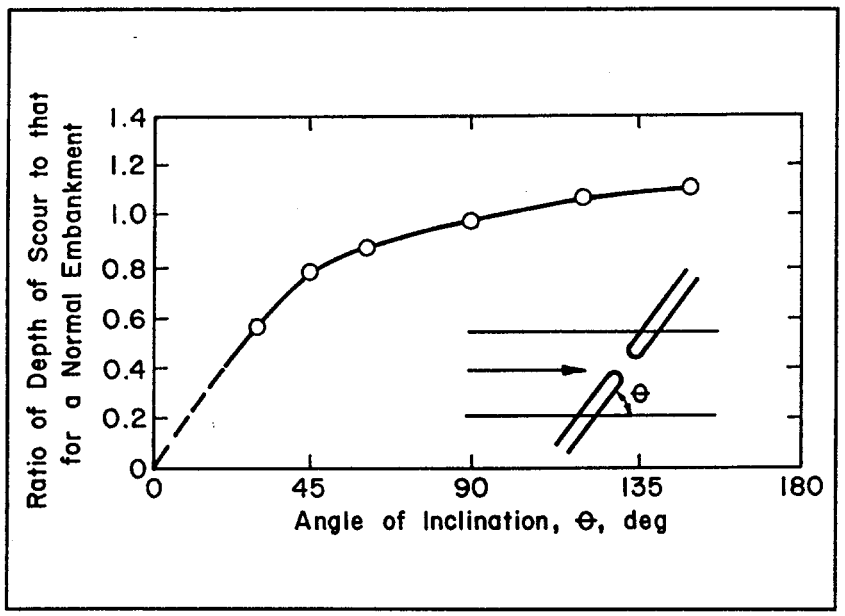


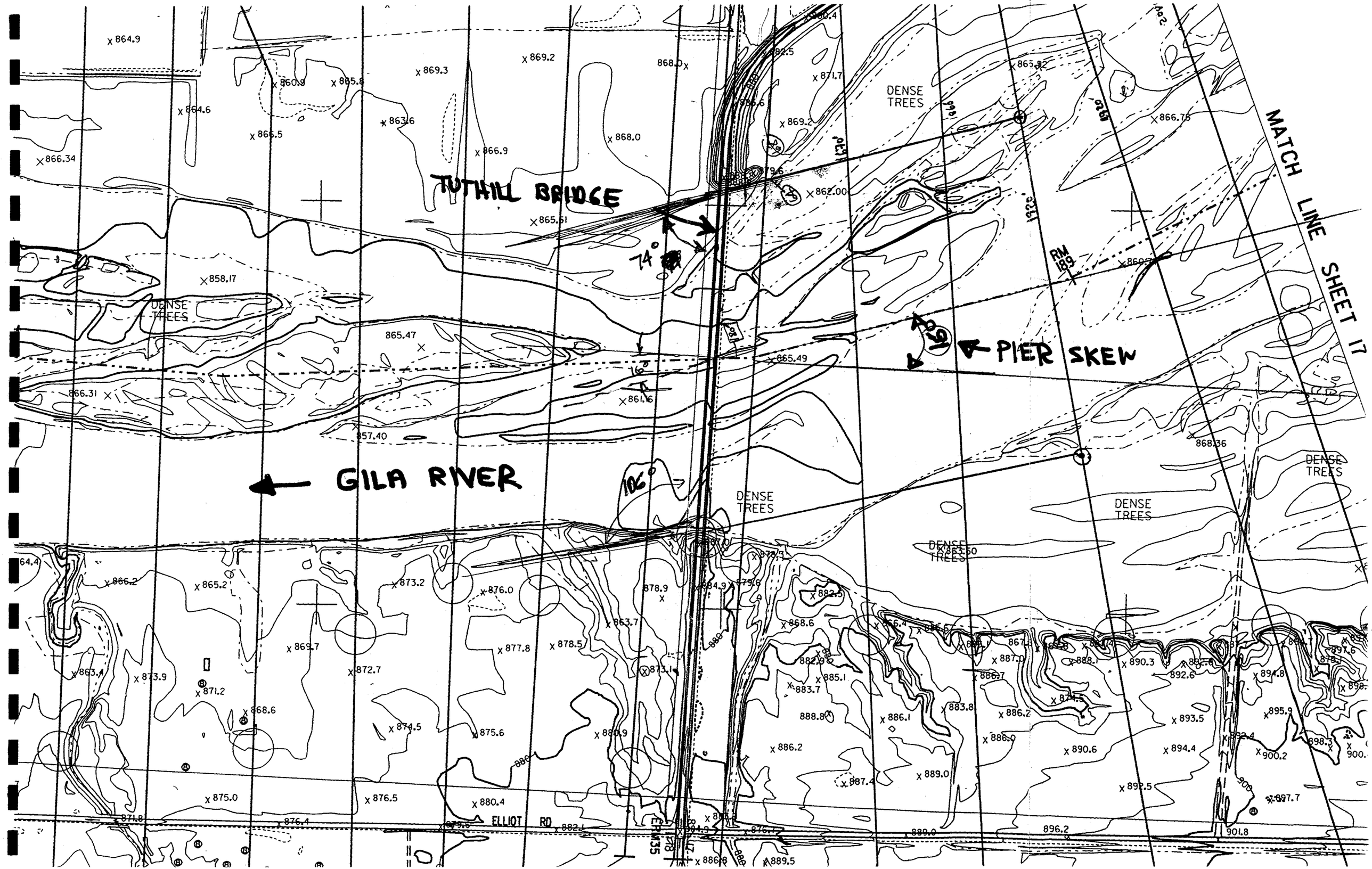
Figure 16. Adjustment of abutment scour estimate for skew.

Clear-Water Scour at an Abutment. Use equations 28 or 29 for live-bed scour because clear-water scour equations potentially decrease scour at abutments due to the presence of coarser material. This decrease is unsubstantiated by field data.

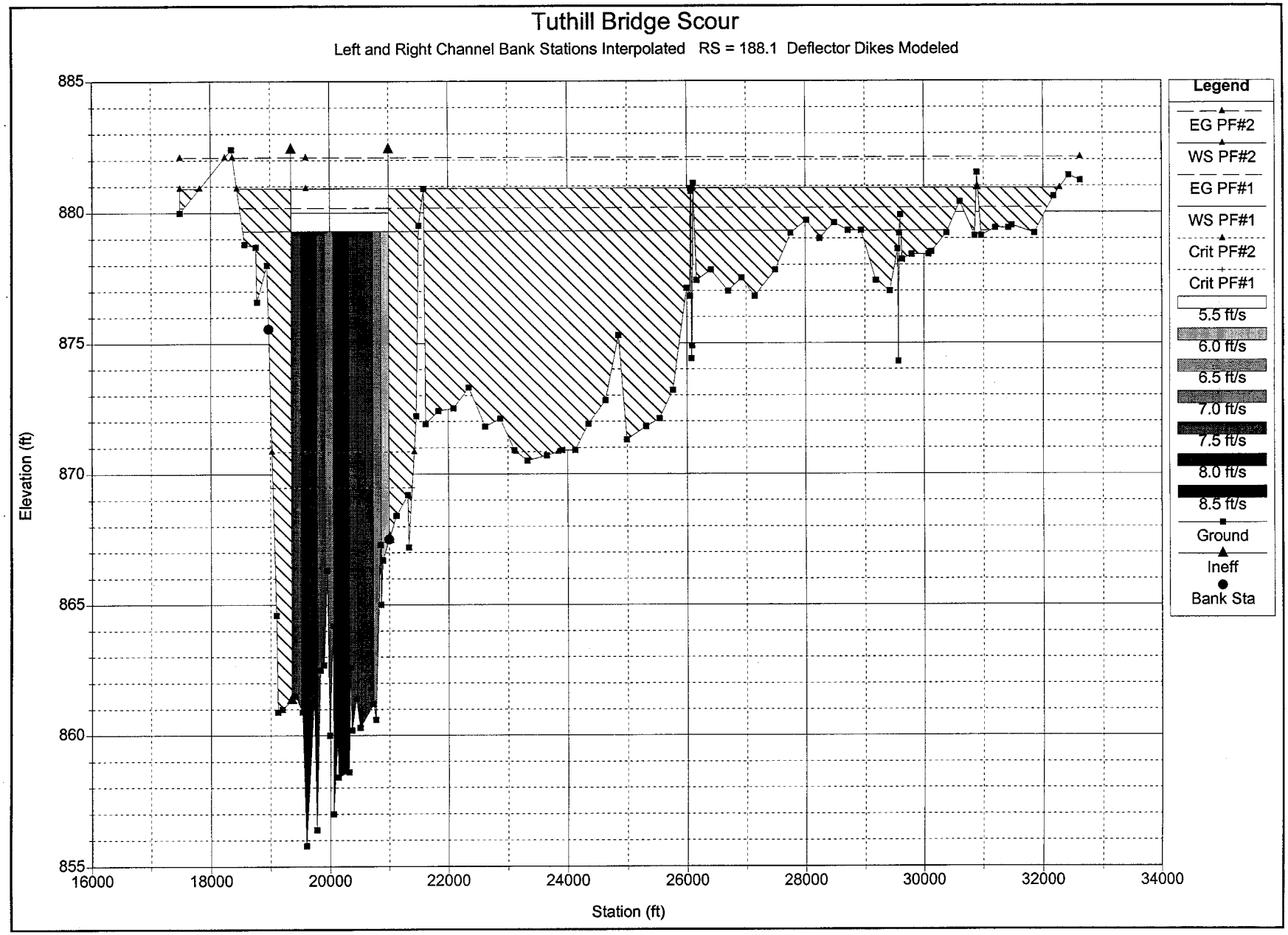
4.3.7 Step 7: Plot Total Scour Depths and Evaluate Design

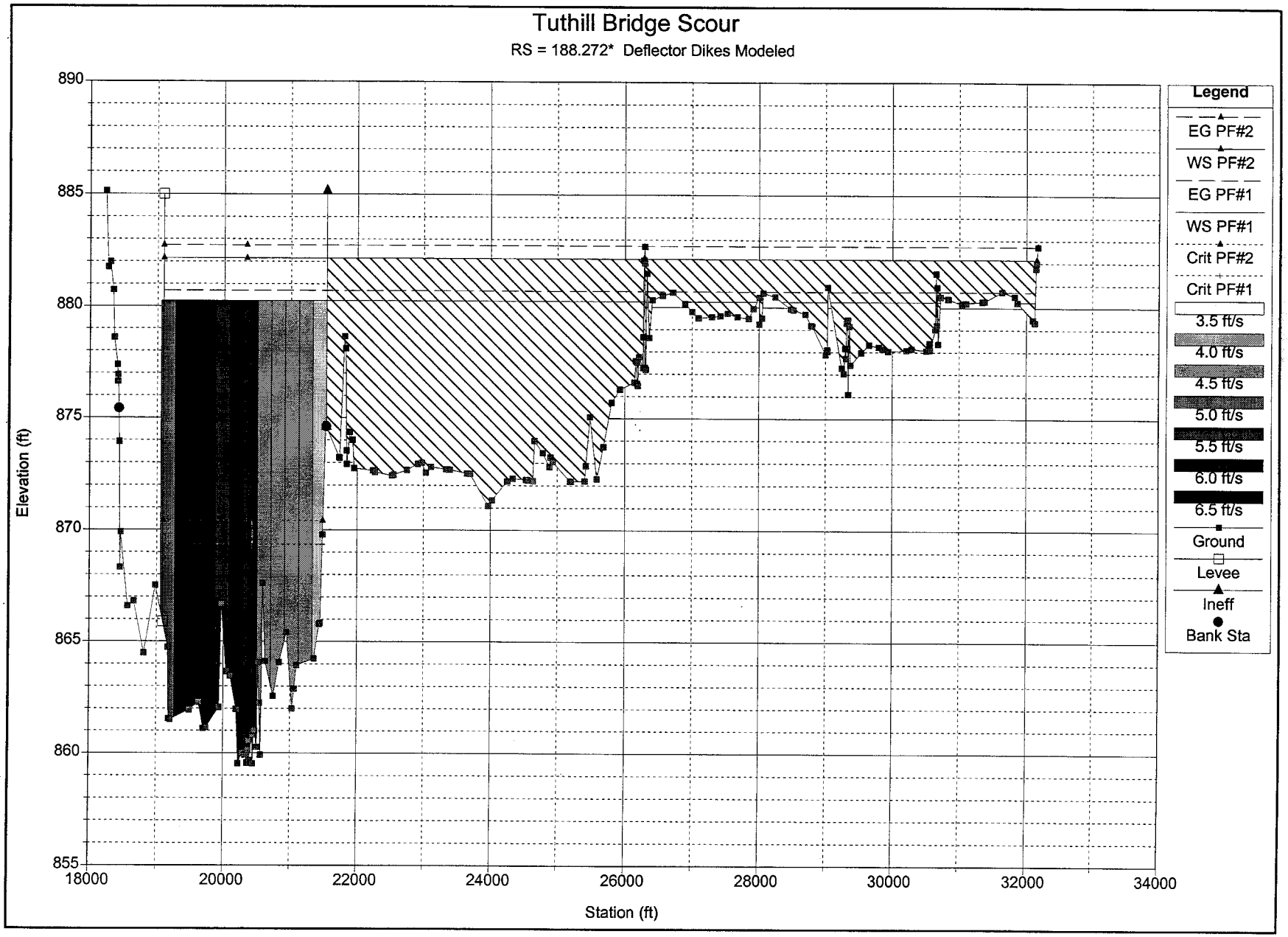
Plot the Total Scour Depths. On the cross section of the stream channel and floodplain at the bridge crossing, plot the estimate of long-term bed elevation change, contraction scour, and local scour at the piers and abutments. Use a distorted scale so that the scour determinations will be easy to evaluate. Make a sketch of any planform changes (lateral stream channel movement due to meander migration, etc.) that might be reasonably expected to occur.

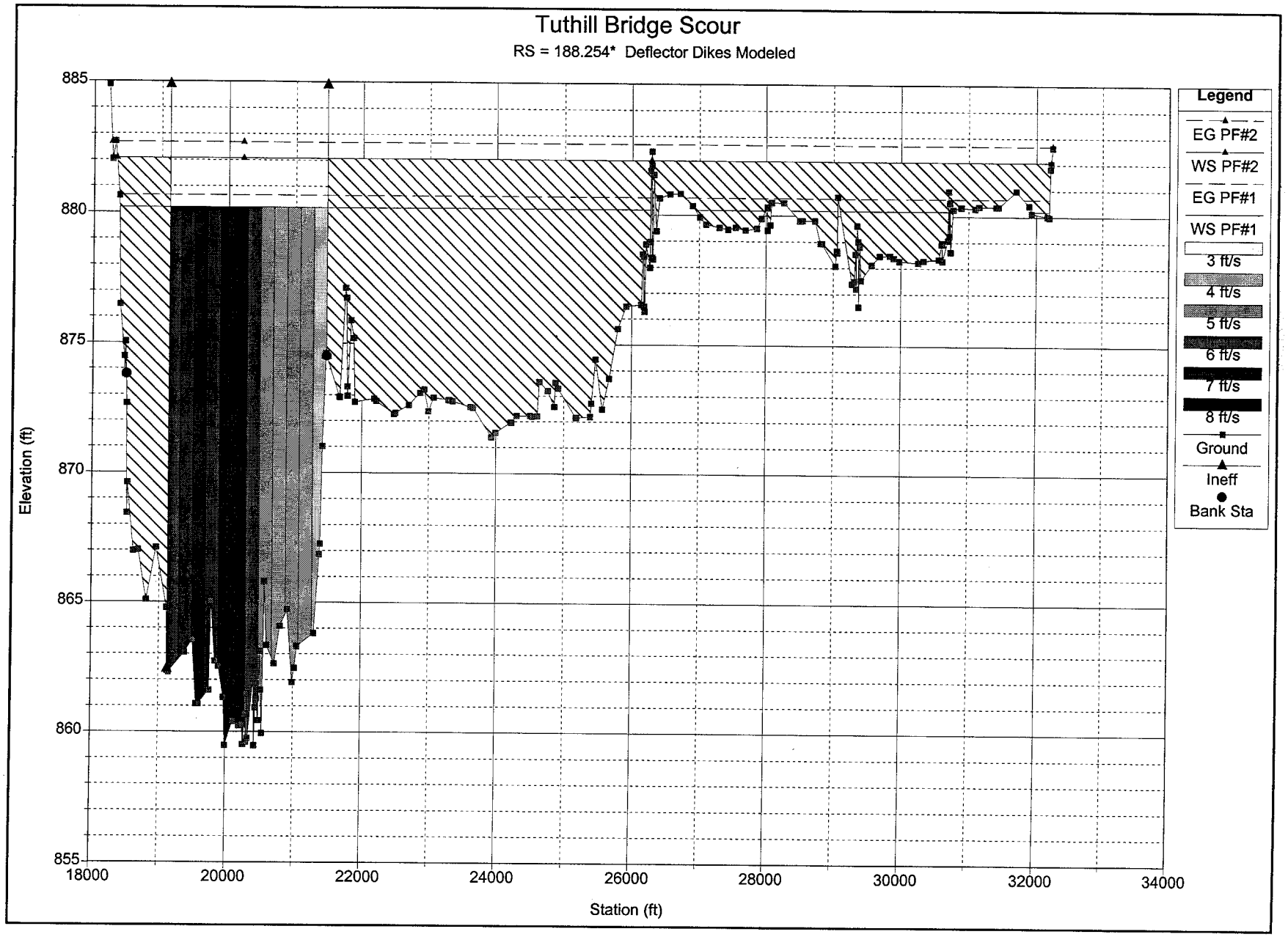
1. Long-term elevation changes may be either aggradation or degradation. However, only degradation is considered in scour computations.

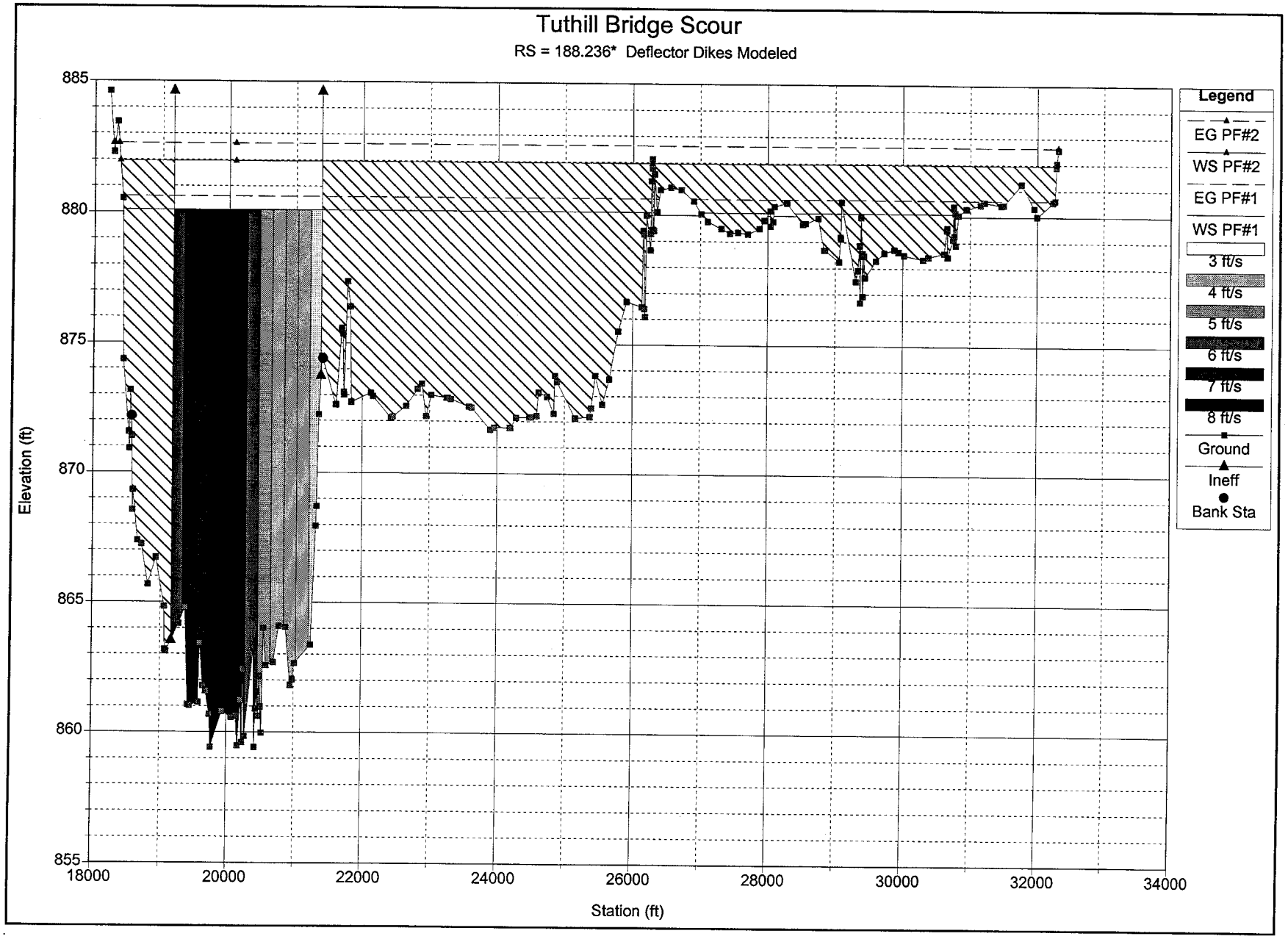


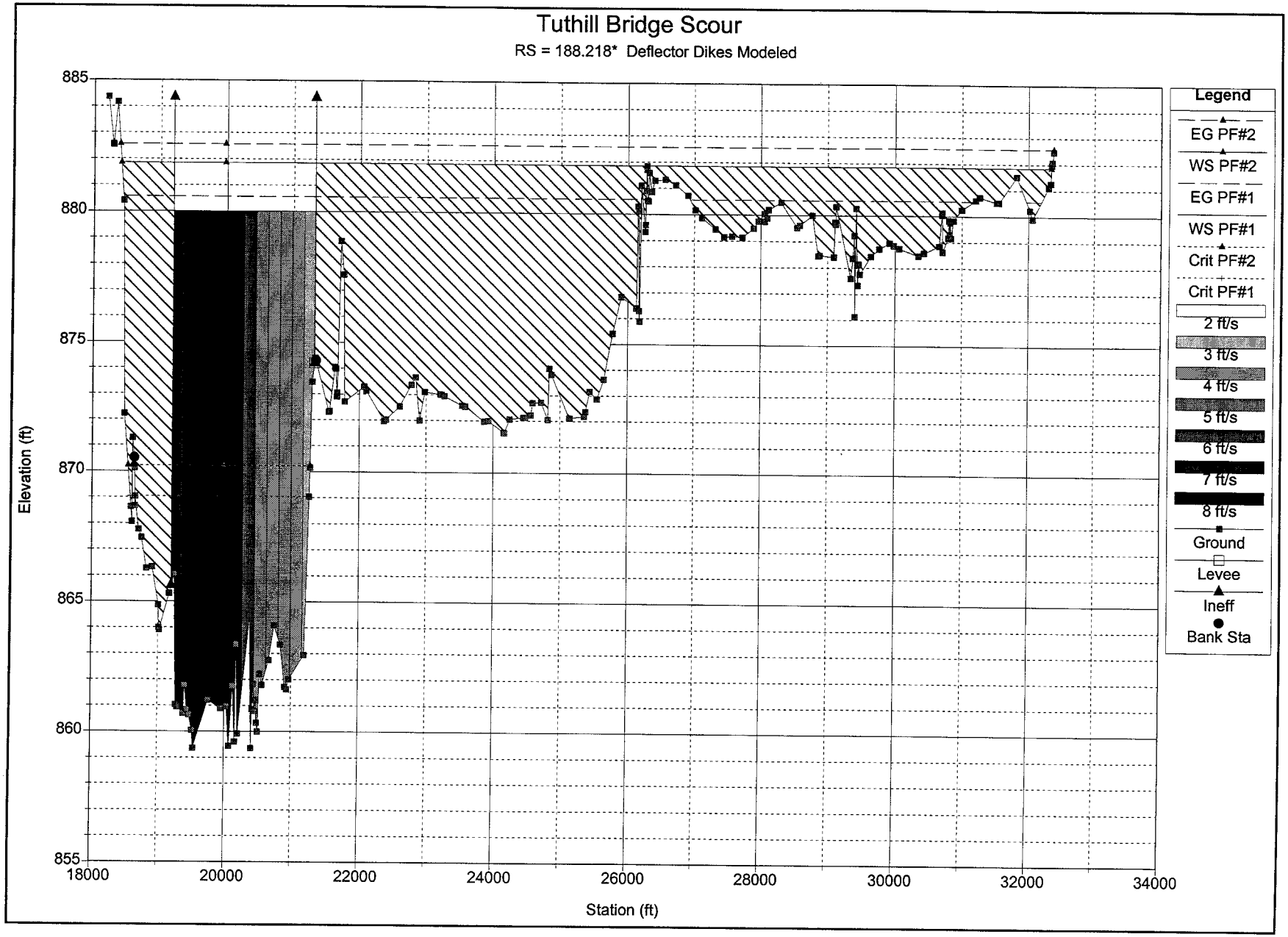
TUTHILL BRIDGE
74°
PIER SKEW
GILA RIVER
106°
DENSE TREES
MATCH LINE SHEET 17
RM 189
ELLIOT RD

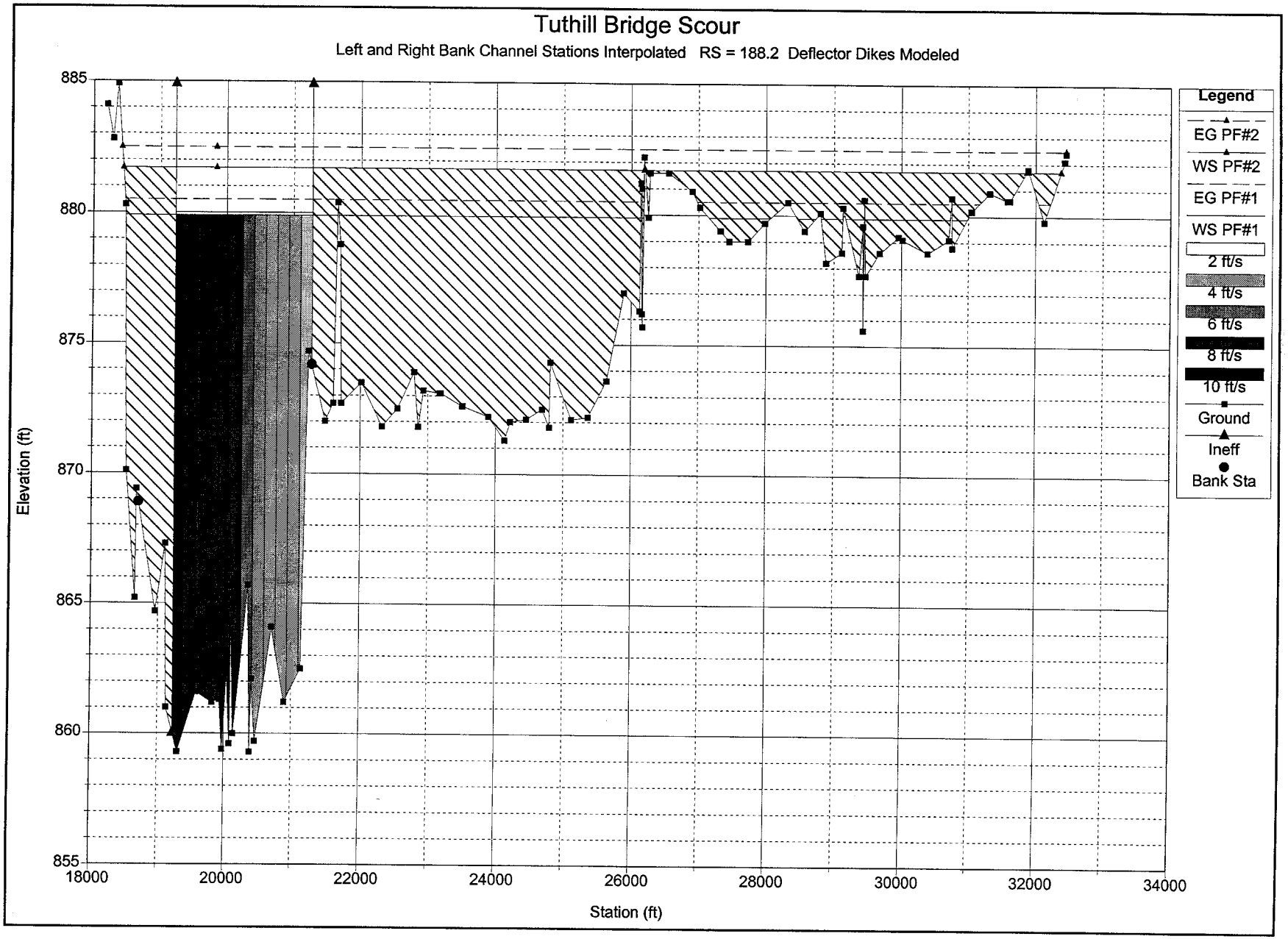

Tuthill Bridge Scour
Left and Right Channel Bank Stations Interpolated RS = 188.1 Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
16000
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
Crit PF#2
Crit PF#1
5.5 ft/s
6.0 ft/s
6.5 ft/s
7.0 ft/s
7.5 ft/s
8.0 ft/s
8.5 ft/s
Ground
Ineff
Bank Sta

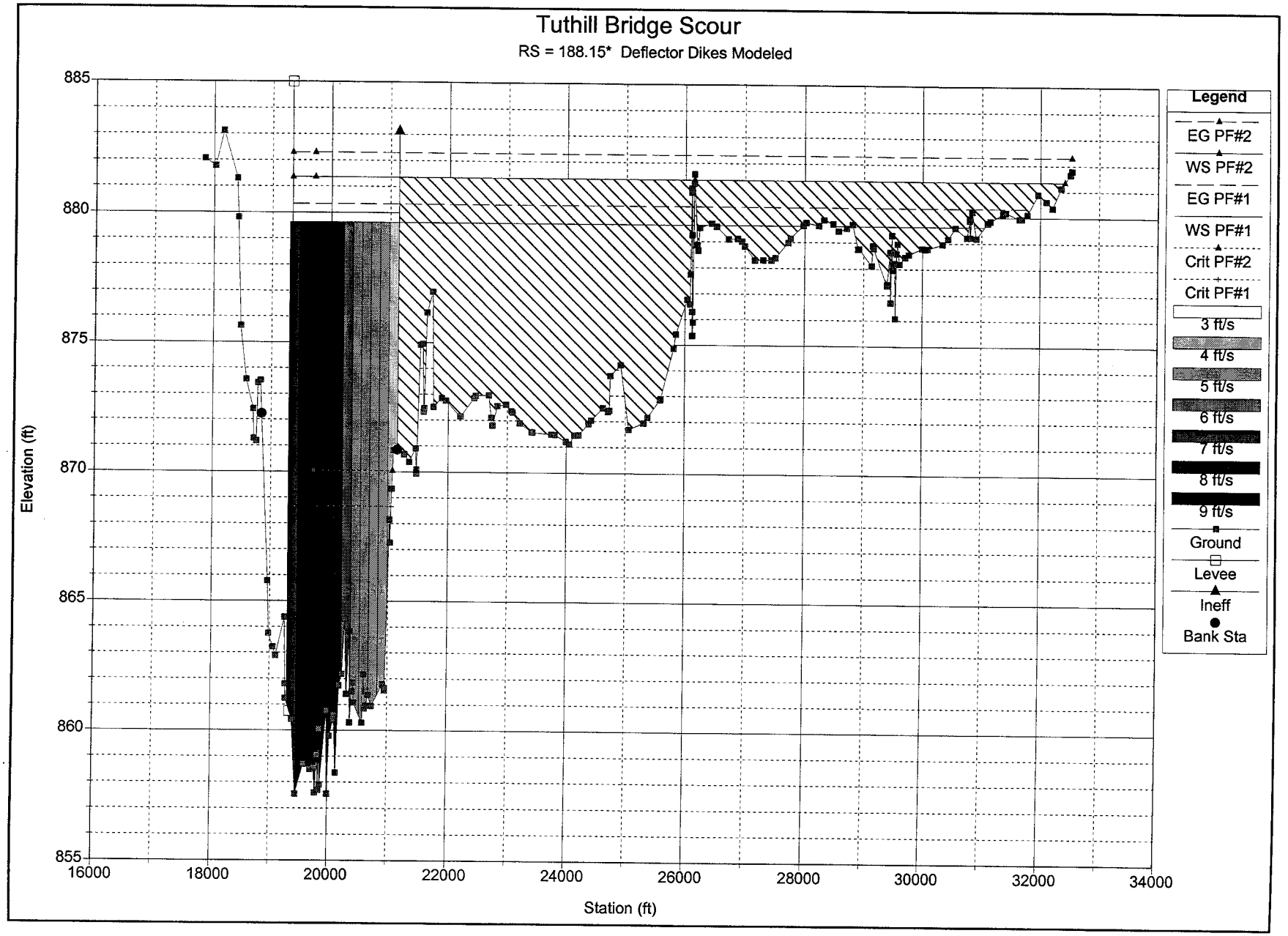

Tuthill Bridge Scour
RS = 188.272* Deflector Dikes Modeled
Elevation (ft)
890
885
880
875
870
865
860
855
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
Crit PF#2
Crit PF#1
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
5.5 ft/s
6.0 ft/s
6.5 ft/s
Ground
Levee
Ineff
Bank Sta


Tuthill Bridge Scour
RS = 188.254* Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Ineff
Bank Sta


Tuthill Bridge Scour
RS = 188.236* Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Ineff
Bank Sta


Tuthill Bridge Scour
RS = 188.218* Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
Crit PF#2
Crit PF#1
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Levee
Ineff
Bank Sta


Tuthill Bridge Scour
Left and Right Bank Channel Stations Interpolated RS = 188.2 Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta


Tuthill Bridge Scour
RS = 188.15* Deflector Dikes Modeled
Elevation (ft)
885
880
875
870
865
860
855
16000
18000
20000
22000
24000
26000
28000
30000
32000
34000
Station (ft)
Legend
EG PF#2
WS PF#2
EG PF#1
WS PF#1
Crit PF#2
Crit PF#1
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Levee
Ineff
Bank Sta

HYDRAULIC OUTPUT FROM Q_{100} HECRAS
@ TRANSVERSE DIKE #1

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.15* Profile: PF#1

W.S. Elev (ft)	879.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.71	Wt. n-Val.		0.032	
E.G. Elev (ft)	880.34	Reach Len. (ft)	310.00	262.53	170.00
Crit W.S. (ft)	868.66	Flow Area (sq ft)		33497.10	
E.G. Slope (ft/ft)	0.000435	Area (sq ft)		33497.10	38081.68
Q Total (cfs)	227000.00	Flow (cfs)		227000.00	
Top Width (ft)	10818.38	Top Width (ft)		1800.00	9018.38
Vel Total (ft/s)	6.78	Avg. Vel. (ft/s)		6.78	
Max Chl Dpth (ft)	22.07	Hydr. Depth (ft)		18.61	
Conv. Total (cfs)	10878715.0	Conv. (cfs)		10878715.0	
Length Wtd. (ft)	262.53	Wetted Per. (ft)		1821.66	
Min Ch El (ft)	857.55	Shear (lb/sq ft)		0.50	
Alpha	1.00	Stream Power (lb/ft s)		3.39	
Frctn Loss (ft)	0.10	Cum Volume (acre-ft)	811.65	37484.54	11244.82
C & E Loss (ft)	0.05	Cum SA (acres)	439.19	4084.56	1974.78

Q500

HYDRAULIC OUTPUT FROM HECRAS
@ TRANSVERSE DIKE #1

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.15* Profile: PF#2

W.S. Elev (ft)	881.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.94	Wt. n-Val.		0.032	
E.G. Elev (ft)	882.29	Reach Len. (ft)	310.00	262.53	170.00
Crit W.S. (ft)	870.03	Flow Area (sq ft)		36604.91	
E.G. Slope (ft/ft)	0.000515	Area (sq ft)		36604.91	56441.79
Q Total (cfs)	285000.00	Flow (cfs)		285000.00	
Top Width (ft)	13064.45	Top Width (ft)		1800.00	11264.45
Vel Total (ft/s)	7.79	Avg. Vel. (ft/s)		7.79	
Max Chl Dpth (ft)	23.80	Hydr. Depth (ft)		20.34	
Conv. Total (cfs)	12556739.0	Conv. (cfs)		12556739.0	
Length Wtd. (ft)	262.53	Wetted Per. (ft)		1823.39	
Min Ch El (ft)	857.55	Shear (lb/sq ft)		0.65	
Alpha	1.00	Stream Power (lb/ft s)		5.03	
Frctn Loss (ft)	0.12	Cum Volume (acre-ft)	2490.20	43634.00	14196.73
C & E Loss (ft)	0.07	Cum SA (acres)	473.15	4135.93	2038.43

Q100

HYDRAULIC OUTPUT FROM HECRAS
@ TRANSVERSE DIKE #2

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.272* Profile: PF#1

W.S. Elev (ft)	880.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.45	Wt. n-Val.		0.031	
E.G. Elev (ft)	880.70	Reach Len. (ft)	101.00	98.51	62.00
Crit W.S. (ft)	869.35	Flow Area (sq ft)		42039.98	
E.G. Slope (ft/ft)	0.000278	Area (sq ft)		42039.98	38295.49
Q Total (cfs)	227000.00	Flow (cfs)		227000.00	
Top Width (ft)	11308.87	Top Width (ft)		2446.00	8862.87
Vel Total (ft/s)	5.40	Avg. Vel. (ft/s)		5.40	
Max Chl Dpth (ft)	20.71	Hydr. Depth (ft)		17.19	
Conv. Total (cfs)	13612134.0	Conv. (cfs)		13612134.0	
Length Wtd. (ft)	98.51	Wetted Per. (ft)		2464.15	
Min Ch El (ft)	859.54	Shear (lb/sq ft)		0.30	
Alpha	1.00	Stream Power (lb/ft s)		1.60	
Frctn Loss (ft)	0.03	Cum Volume (acre-ft)	330.18	38138.83	11601.56
C & E Loss (ft)	0.01	Cum SA (acres)	441.27	4122.71	2056.53

Q500

HYDRAULIC OUTPUT FROM HECRAS
@ TRANSVERSE DIKE #2

Plan: DDike Scour River: RIVER-1 Reach:Reach-1 Riv Sta: 188.272* Profile: PF#2

W.S. Elev (ft)	882.15	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.58	Wt. n-Val.		0.031	
E.G. Elev (ft)	882.73	Reach Len. (ft)	101.00	98.51	62.00
Crit W.S. (ft)	870.41	Flow Area (sq ft)		46696.25	
E.G. Slope (ft/ft)	0.000311	Area (sq ft)		46696.25	58051.77
Q Total (cfs)	285000.00	Flow (cfs)		285000.00	
Top Width (ft)	13049.07	Top Width (ft)		2446.00	10603.07
Vel Total (ft/s)	6.10	Avg. Vel. (ft/s)		6.10	
Max Chl Dpth (ft)	22.61	Hydr. Depth (ft)		19.09	
Conv. Total (cfs)	16170317.0	Conv. (cfs)		16170317.0	
Length Wtd. (ft)	98.51	Wetted Per. (ft)		2466.06	
Min Ch El (ft)	859.54	Shear (lb/sq ft)		0.37	
Alpha	1.00	Stream Power (lb/ft s)		2.24	
Frctn Loss (ft)	0.03	Cum Volume (acre-ft)	2512.90	44358.20	14731.05
C & E Loss (ft)	0.01	Cum SA (acres)	475.72	4174.08	2143.77

DEFLECTOR DIKES NOT MODELED

Profile Output Table - Standard Table 1
HEC-RAS Plan: Method 1 FW River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 182
Plans = 1
Profiles = 2

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	194.18	227000.00	895.00	908.04	903.82	909.44	0.001562	9.47	23959.93	2139.10	0.50
Reach-1	194.18	285000.00	895.00	909.35	904.96	911.11	0.001709	10.66	26747.51	2139.09	0.53
Reach-1	194.09	227000.00	891.90	906.70		908.32	0.002740	10.21	22229.52	2607.01	0.62
Reach-1	194.09	285000.00	891.90	908.13		910.00	0.002584	10.98	25948.74	2607.10	0.61
Reach-1	194.01	227000.00	894.10	905.96		907.04	0.001807	8.32	27280.84	3061.61	0.49
Reach-1	194.01	285000.00	894.10	907.50		908.73	0.001689	8.91	31986.68	3061.61	0.49
Reach-1	193.93	227000.00	894.10	905.61		906.35	0.001084	6.89	32952.70	3463.54	0.39
Reach-1	193.93	285000.00	894.10	907.19		908.05	0.001035	7.41	38445.24	3463.54	0.39
Reach-1	193.86	227000.00	892.00	905.19		905.93	0.001081	6.87	33058.03	3482.68	0.39
Reach-1	193.86	285000.00	892.00	906.80		907.65	0.001024	7.37	38660.20	3482.68	0.39
Reach-1	193.78	227000.00	892.20	904.82		905.43	0.000948	6.28	36129.46	3564.35	0.35
Reach-1	193.78	285000.00	892.20	906.45		907.17	0.000922	6.80	41938.27	3564.35	0.35
Reach-1	193.71	227000.00	891.30	904.37		905.06	0.001133	6.65	34139.64	3430.95	0.37
Reach-1	193.71	285000.00	891.30	906.00		906.80	0.001092	7.17	39732.52	3430.94	0.37
Reach-1	193.65	227000.00	890.00	903.86		904.61	0.001206	6.97	32590.59	3240.77	0.39
Reach-1	193.65	285000.00	890.00	905.49		906.37	0.001169	7.53	37860.20	3240.77	0.39
Reach-1	193.54	227000.00	889.80	902.97		903.86	0.001361	7.56	30109.16	3274.27	0.43
Reach-1	193.54	285000.00	889.80	904.63		905.64	0.001287	8.08	35256.90	3175.60	0.43
Reach-1	193.45	227000.00	888.90	902.29		903.14	0.001593	7.40	30690.74	3334.02	0.43
Reach-1	193.45	285000.00	888.90	904.01		904.97	0.001442	7.82	36426.80	3334.03	0.42
Reach-1	193.36	227000.00	888.70	901.66		902.44	0.001143	7.13	32341.33	3835.59	0.42
Reach-1	193.36	285000.00	888.70	903.45		904.33	0.001035	7.53	37844.21	3540.33	0.41
Reach-1	193.24	227000.00	888.00	900.78		901.61	0.001610	7.34	31315.95	4111.63	0.45
Reach-1	193.24	285000.00	888.00	902.76		903.62	0.001284	7.46	38216.51	3761.13	0.41
Reach-1	193.16	227000.00	884.80	899.89		900.82	0.001967	7.75	29590.25	4156.17	0.50
Reach-1	193.16	285000.00	884.80	902.19		903.05	0.001342	7.47	38157.93	3900.87	0.42
Reach-1	193.07	227000.00	883.90	899.51		900.11	0.000884	6.21	37123.36	4346.34	0.36
Reach-1	193.07	285000.00	883.90	901.92		902.52	0.000698	6.23	45772.93	3913.60	0.32
Reach-1	192.97	227000.00	883.00	899.11		899.65	0.000787	5.93	39256.76	4389.78	0.32
Reach-1	192.97	285000.00	883.00	901.56		902.16	0.000675	6.23	45764.28	3573.10	0.31
Reach-1	192.88	227000.00	883.70	898.62		899.23	0.000895	6.36	37505.79	5154.21	0.35
Reach-1	192.88	285000.00	883.70	901.08		901.79	0.000791	6.77	42113.69	3281.20	0.33
Reach-1	192.78	227000.00	883.30	898.24		898.82	0.000682	6.32	39472.74	5363.61	0.33
Reach-1	192.78	285000.00	883.30	900.58		901.40	0.000736	7.28	39294.82	2925.31	0.35
Reach-1	192.69	227000.00	882.70	897.92		898.49	0.000645	6.42	40582.71	5979.48	0.33
Reach-1	192.69	285000.00	882.70	900.18		901.05	0.000721	7.54	38351.19	2877.20	0.35
Reach-1	192.6	227000.00	883.70	897.63		898.11	0.000753	5.93	41525.72	5476.95	0.31
Reach-1	192.6	285000.00	883.70	899.71		900.63	0.000946	7.43	37298.17	2907.20	0.35
Reach-1	192.51	227000.00	883.30	897.05		897.69	0.000881	7.00	37509.82	5228.00	0.38
Reach-1	192.51	285000.00	883.30	899.13		900.14	0.001001	8.33	35873.75	3015.40	0.41
Reach-1	192.42	227000.00	883.20	896.60		897.23	0.001088	6.92	37407.64	5028.00	0.38
Reach-1	192.42	285000.00	883.20	898.66		899.61	0.001229	8.20	37294.84	3218.00	0.41
Reach-1	192.33	227000.00	884.20	895.87		896.64	0.001234	7.70	35036.52	5185.89	0.44
Reach-1	192.33	285000.00	884.20	897.81		898.95	0.001350	9.01	35286.41	3444.11	0.47
Reach-1	192.23	227000.00	883.70	895.01		895.93	0.001574	7.68	29609.59	3385.92	0.44
Reach-1	192.23	285000.00	883.70	897.36		898.25	0.001140	7.52	37548.39	3385.90	0.39
Reach-1	192.13	227000.00	883.10	894.54		895.05	0.001298	5.61	39816.27	5996.18	0.34
Reach-1	192.13	285000.00	883.10	896.74		897.56	0.001445	6.82	39958.48	3946.17	0.37
Reach-1	192.04	227000.00	882.00	894.09		894.54	0.000818	5.58	42523.29	6377.35	0.34
Reach-1	192.04	285000.00	882.00	896.25		896.98	0.000919	6.78	41683.52	4167.90	0.37
Reach-1	191.94	227000.00	881.40	893.72		894.10	0.000791	5.06	45703.25	6358.57	0.30
Reach-1	191.94	285000.00	881.40	895.87		896.47	0.000897	6.10	46023.70	4348.56	0.32
Reach-1	191.84	227000.00	880.80	893.26		893.66	0.000901	5.24	45417.14	7855.21	0.32
Reach-1	191.84	285000.00	880.80	895.41		895.98	0.000934	6.05	46855.90	4551.00	0.33
Reach-1	191.75	227000.00	880.40	892.89		893.22	0.000784	4.79	50234.98	8670.64	0.29
Reach-1	191.75	285000.00	880.40	895.01		895.52	0.000862	5.72	49687.86	4729.00	0.31
Reach-1	191.65	227000.00	879.10	892.54		892.84	0.000596	4.55	53559.77	8486.20	0.27
Reach-1	191.65	285000.00	879.10	894.66		895.10	0.000629	5.28	54115.32	4967.30	0.28
Reach-1	191.55	227000.00	876.50	892.26		892.53	0.000664	4.36	55071.15	8650.09	0.26
Reach-1	191.55	285000.00	876.50	894.36		894.77	0.000710	5.09	56011.95	5172.90	0.27
Reach-1	191.46	227000.00	879.00	891.93		892.21	0.000642	4.31	54206.29	8106.14	0.26
Reach-1	191.46	285000.00	879.00	894.05		894.43	0.000645	4.92	57947.39	5559.00	0.27
Reach-1	191.36	227000.00	879.20	891.59		891.86	0.000726	4.12	55214.62	7623.90	0.26
Reach-1	191.36	285000.00	879.20	893.70		894.06	0.000771	4.85	58747.45	5797.70	0.27
Reach-1	191.27	227000.00	879.00	891.30		891.53	0.000555	3.78	59623.61	7679.93	0.22
Reach-1	191.27	285000.00	879.00	893.39		893.71	0.000605	4.48	63455.91	5871.80	0.24

Reach-1	191.17	227000.00	879.30	891.01		891.25	0.000537	3.92	58564.59	7458.90	0.23
Reach-1	191.17	285000.00	879.30	893.04		893.39	0.000624	4.78	61294.40	5728.16	0.25
Reach-1	191.08	227000.00	877.30	890.74		890.98	0.000518	4.03	58268.11	7441.21	0.23
Reach-1	191.08	285000.00	877.30	892.70		893.08	0.000620	4.99	59878.96	5681.12	0.26
Reach-1	190.99	227000.00	876.80	890.50		890.74	0.000452	4.15	58477.98	7300.72	0.23
Reach-1	190.99	285000.00	876.80	892.44		892.80	0.000511	4.92	60619.36	5426.40	0.25
Reach-1	190.89	227000.00	876.20	890.28		890.51	0.000468	3.98	59464.47	7238.17	0.21
Reach-1	190.89	285000.00	876.20	892.16		892.53	0.000589	4.94	60144.91	5355.00	0.24
Reach-1	190.8	227000.00	875.80	890.09		890.30	0.000430	3.85	61227.23	7319.22	0.21
Reach-1	190.8	285000.00	875.80	891.89		892.25	0.000594	4.92	59951.81	5224.00	0.24
Reach-1	190.71	227000.00	875.30	889.88		890.10	0.000437	3.80	61918.69	7088.43	0.20
Reach-1	190.71	285000.00	875.30	891.60		891.96	0.000616	4.89	60053.86	5160.00	0.24
Reach-1	190.62	227000.00	872.20	889.63		889.87	0.000453	3.91	58609.31	5742.11	0.20
Reach-1	190.62	285000.00	872.20	891.36		891.67	0.000510	4.47	63780.78	5230.00	0.21
Reach-1	190.53	227000.00	874.10	889.34		889.61	0.000659	4.16	55120.98	5214.09	0.21
Reach-1	190.53	285000.00	874.10	891.08		891.40	0.000648	4.45	62839.57	5050.30	0.21
Reach-1	190.43	227000.00	874.20	888.98		889.27	0.000719	4.41	55646.00	5130.50	0.23
Reach-1	190.43	285000.00	874.20	890.71		891.06	0.000733	4.81	64249.26	5028.90	0.23
Reach-1	190.34	227000.00	873.00	888.53		888.82	0.001171	4.32	52985.48	5016.95	0.23
Reach-1	190.34	285000.00	873.00	890.26		890.60	0.001174	4.69	60806.67	4779.70	0.23
Reach-1	190.24	227000.00	873.00	888.03		888.33	0.000814	4.38	52672.33	5103.44	0.23
Reach-1	190.24	285000.00	873.00	889.74		890.09	0.000860	4.81	59310.36	4604.80	0.24
Reach-1	190.15	227000.00	873.80	887.29		887.74	0.001811	5.44	42778.36	5184.56	0.32
Reach-1	190.15	285000.00	873.80	888.95		889.49	0.001798	5.92	48157.68	4508.40	0.32
Reach-1	190.05	227000.00	873.80	886.42		886.93	0.001418	5.75	40172.34	5390.58	0.35
Reach-1	190.05	285000.00	873.80	888.07		888.69	0.001376	6.29	45097.11	4524.70	0.35
Reach-1	189.96	227000.00	873.70	885.63		886.16	0.001828	5.78	39010.73	4908.53	0.35
Reach-1	189.96	285000.00	873.70	887.32		887.96	0.001683	6.33	44615.51	4406.60	0.35
Reach-1	189.87	227000.00	872.50	884.72		885.27	0.001791	5.95	38282.09	4673.04	0.36
Reach-1	189.87	285000.00	872.50	886.57		887.18	0.001499	6.25	45619.55	4392.34	0.34
Reach-1	189.77	227000.00	869.90	884.03		884.43	0.001294	5.11	44751.14	4569.88	0.29
Reach-1	189.77	285000.00	869.90	885.99		886.44	0.001164	5.43	52482.54	4452.50	0.28
Reach-1	189.68	227000.00	864.60	883.47		883.85	0.000977	4.95	45915.52	4637.21	0.28
Reach-1	189.68	285000.00	864.60	885.52		885.93	0.000829	5.15	55333.30	4616.30	0.26
Reach-1	189.58	227000.00	867.70	882.98		883.37	0.000944	4.96	45813.97	4530.27	0.27
Reach-1	189.58	285000.00	867.70	885.10		885.52	0.000814	5.15	55310.08	4501.20	0.26
Reach-1	189.49	227000.00	863.40	882.59		882.95	0.000740	4.79	47370.75	4344.59	0.26
Reach-1	189.49	285000.00	863.40	884.76		885.15	0.000656	5.02	56766.18	4337.80	0.24
Reach-1	189.39	227000.00	866.80	882.20		882.58	0.000715	4.93	46141.69	4222.21	0.26
Reach-1	189.39	285000.00	866.80	884.41		884.83	0.000617	5.18	55062.21	4168.80	0.25
Reach-1	189.31	227000.00	865.80	881.89		882.26	0.000715	4.85	46838.90	4158.13	0.25
Reach-1	189.31	285000.00	865.80	884.15		884.54	0.000627	5.07	56199.01	4154.65	0.24
Reach-1	189.22	227000.00	864.70	881.54		881.90	0.000741	4.83	47015.19	4153.77	0.25
Reach-1	189.22	285000.00	864.70	883.84		884.23	0.000646	5.04	56562.57	4152.18	0.24
Reach-1	189.12	227000.00	863.10	881.18		881.53	0.000692	4.75	47825.78	4197.00	0.25
Reach-1	189.12	285000.00	863.10	883.53		883.91	0.000601	4.94	57681.69	4195.60	0.23
Reach-1	189.02	227000.00	863.40	880.88		881.20	0.000566	4.54	49985.23	4481.60	0.24
Reach-1	189.02	285000.00	863.40	883.28		883.62	0.000492	4.69	60725.32	4481.60	0.22
Reach-1	188.92	227000.00	863.30	880.65		880.93	0.000409	4.21	53872.16	4560.94	0.22
Reach-1	188.92	285000.00	863.30	883.08		883.38	0.000360	4.39	64929.12	4555.81	0.20
Reach-1	188.81	227000.00	863.50	880.47		880.71	0.000349	3.93	57720.59	4571.80	0.19
Reach-1	188.81	285000.00	863.50	882.92		883.18	0.000314	4.14	68836.66	4549.78	0.19
Reach-1	188.7	227000.00	863.30	880.16		880.45	0.000514	4.28	53100.30	4351.21	0.22
Reach-1	188.7	285000.00	863.30	882.64		882.95	0.000454	4.47	63827.75	4336.36	0.21
Reach-1	188.59	227000.00	861.40	879.91		880.18	0.000448	4.18	54251.80	4186.79	0.20
Reach-1	188.59	285000.00	861.40	882.41		882.71	0.000410	4.41	64679.40	4174.86	0.20
Reach-1	188.5	227000.00	860.50	879.68		879.96	0.000462	4.26	53350.48	3851.60	0.20
Reach-1	188.5	285000.00	860.50	882.19		882.50	0.000433	4.52	62988.07	3844.01	0.20
Reach-1	188.39	227000.00	860.70	879.46	868.98	879.74	0.000313	4.20	54521.44	11654.68	0.19
Reach-1	188.39	285000.00	860.70	881.97	869.87	882.29	0.000313	4.55	62703.45	3540.01	0.19
Reach-1	188.29	227000.00	859.60	879.25		879.58	0.000250	4.65	48875.96	3239.29	0.21
Reach-1	188.29	285000.00	859.60	881.75		882.14	0.000242	5.00	56945.79	3229.26	0.21
DD #2 → Reach-1	188.272*	227000.00	859.54	878.97	869.35	879.49	0.000358	5.83	38903.51	8894.18	0.26
Reach-1	188.272*	285000.00	859.54	881.41	870.43	882.04	0.000354	6.35	44888.03	13028.10	0.26
Reach-1	188.254*	227000.00	859.48	879.01		879.39	0.000294	4.95	46254.65	9657.71	0.22
Reach-1	188.254*	285000.00	859.48	881.47		881.92	0.000285	5.35	53869.07	13832.71	0.22
Reach-1	188.236*	227000.00	859.42	878.95		879.35	0.000328	5.11	45134.97	9498.82	0.23
Reach-1	188.236*	285000.00	859.42	881.40		881.88	0.000320	5.54	52430.92	13862.01	0.23
Reach-1	188.218*	227000.00	859.36	878.88	868.86	879.31	0.000382	5.28	44197.88	9300.56	0.23
Reach-1	188.218*	285000.00	859.36	881.33	869.88	881.83	0.000376	5.74	51249.04	13778.57	0.24
Reach-1	188.2	227000.00	859.30	878.78		879.25	0.000560	5.51	41164.18	8564.37	0.24
Reach-1	188.2	285000.00	859.30	881.21		881.77	0.000565	6.01	47445.69	2580.00	0.25
DD#1 → Reach-1	188.15*	227000.00	857.55	878.15	868.66	878.99	0.000568	7.36	30842.91	7013.71	0.31
Reach-1	188.15*	285000.00	857.55	880.45	870.03	881.48	0.000597	8.15	34980.14	12521.94	0.33
Reach-1	188.1	227000.00	855.80	878.10	868.75	878.82	0.000315	6.80	33525.65	9044.29	0.30
Reach-1	188.1	285000.00	855.80	880.41	869.95	881.29	0.000324	7.49	38042.07	2030.88	0.31

w/out dikes

Reach-1	188.055	Bridge									
Reach-1	188.04	227000.00	855.00	875.32	866.18	876.24	0.000646	7.72	29399.94	5742.38	0.33
Reach-1	188.04	285000.00	855.00	877.37	867.74	878.53	0.000696	8.64	32989.08	1751.40	0.35

DEFLECTOR DIKES MODELED

Profile Output Table - Standard Table 1
HEC-RAS Plan: DDike Scour River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 182
Plans = 1
Profiles = 2

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	194.18	227000.00	895.00	908.04	903.82	909.44	0.001562	9.47	23959.93	2139.10	0.50
Reach-1	194.18	285000.00	895.00	909.30	904.96	911.07	0.001728	10.70	26654.40	2150.81	0.53
Reach-1	194.09	227000.00	891.90	906.70		908.32	0.002740	10.21	22229.52	2607.01	0.62
Reach-1	194.09	285000.00	891.90	908.02		909.93	0.002681	11.11	25665.46	2611.48	0.62
Reach-1	194.01	227000.00	894.10	905.96		907.04	0.001807	8.32	27281.21	3061.61	0.49
Reach-1	194.01	285000.00	894.10	907.35		908.62	0.001768	9.04	31539.58	3066.00	0.50
Reach-1	193.93	227000.00	894.10	905.61		906.35	0.001084	6.89	32953.13	3463.55	0.39
Reach-1	193.93	285000.00	894.10	907.03		907.91	0.001086	7.53	37878.27	3475.44	0.40
Reach-1	193.86	227000.00	892.00	905.19		905.93	0.001081	6.87	33058.45	3482.68	0.39
Reach-1	193.86	285000.00	892.00	906.61		907.49	0.001082	7.50	38010.16	3490.55	0.40
Reach-1	193.78	227000.00	892.20	904.82		905.43	0.000948	6.28	36129.89	3564.35	0.35
Reach-1	193.78	285000.00	892.20	906.24		906.98	0.000977	6.92	41192.67	3575.63	0.36
Reach-1	193.71	227000.00	891.30	904.37		905.06	0.001133	6.65	34140.06	3430.95	0.37
Reach-1	193.71	285000.00	891.30	905.76		906.59	0.001169	7.33	38904.29	3445.42	0.38
Reach-1	193.65	227000.00	890.00	903.86		904.61	0.001206	6.97	32590.78	3240.77	0.39
Reach-1	193.65	285000.00	890.00	905.20		906.12	0.001267	7.72	36922.48	3242.62	0.40
Reach-1	193.54	227000.00	889.80	902.97		903.86	0.001361	7.56	30109.56	3274.28	0.43
Reach-1	193.54	285000.00	889.80	904.24		905.32	0.001433	8.36	34280.82	3333.87	0.45
Reach-1	193.45	227000.00	888.90	902.29		903.14	0.001593	7.40	30691.15	3334.03	0.43
Reach-1	193.45	285000.00	888.90	903.53		904.57	0.001669	8.19	34834.16	3375.38	0.45
Reach-1	193.36	227000.00	888.70	901.66		902.44	0.001143	7.13	32341.80	3835.59	0.42
Reach-1	193.36	285000.00	888.70	902.88		903.82	0.001200	7.86	37046.95	3924.45	0.44
Reach-1	193.24	227000.00	888.00	900.78		901.61	0.001610	7.34	31316.95	4111.63	0.45
Reach-1	193.24	285000.00	888.00	902.00		902.98	0.001613	7.98	36490.54	4523.63	0.46
Reach-1	193.16	227000.00	884.80	899.89		900.82	0.001967	7.75	29591.52	4156.21	0.50
Reach-1	193.16	285000.00	884.80	901.14		902.20	0.001893	8.30	34913.29	4426.21	0.50
Reach-1	193.07	227000.00	883.90	899.51		900.11	0.000884	6.21	37125.22	4346.48	0.36
Reach-1	193.07	285000.00	883.90	900.76		901.47	0.000942	6.83	42750.79	4716.46	0.37
Reach-1	192.97	227000.00	883.00	899.11		899.65	0.000786	5.93	39258.90	4389.78	0.32
Reach-1	192.97	285000.00	883.00	900.33		900.98	0.000841	6.55	44603.80	4394.08	0.34
Reach-1	192.88	227000.00	883.70	898.62		899.23	0.000895	6.36	37508.94	5154.27	0.35
Reach-1	192.88	285000.00	883.70	899.83		900.54	0.000931	6.92	43835.32	5297.74	0.36
Reach-1	192.78	227000.00	883.30	898.24		898.82	0.000682	6.32	39476.66	5363.63	0.33
Reach-1	192.78	285000.00	883.30	899.45		900.10	0.000712	6.82	45938.61	5388.38	0.34
Reach-1	192.69	227000.00	882.70	897.92		898.49	0.000645	6.42	40587.46	5979.72	0.33
Reach-1	192.69	285000.00	882.70	899.13		899.75	0.000649	6.83	47809.91	6010.74	0.33
Reach-1	192.6	227000.00	883.70	897.63		898.11	0.000753	5.93	41530.73	5476.96	0.31
Reach-1	192.6	285000.00	883.70	898.82		899.38	0.000744	6.30	48049.18	5477.70	0.31
Reach-1	192.51	227000.00	883.30	897.05		897.69	0.000880	7.00	37516.21	5228.00	0.38
Reach-1	192.51	285000.00	883.30	898.25		898.96	0.000870	7.42	43757.32	5228.00	0.38
Reach-1	192.42	227000.00	883.20	896.60		897.23	0.001087	6.92	37415.01	5028.00	0.38
Reach-1	192.42	285000.00	883.20	897.79		898.50	0.001079	7.36	43386.38	5028.00	0.38
Reach-1	192.33	227000.00	884.20	895.87		896.64	0.001233	7.70	35047.91	5185.92	0.44
Reach-1	192.33	285000.00	884.20	897.09		897.93	0.001181	8.10	41380.36	5192.30	0.43
Reach-1	192.23	227000.00	883.70	895.02		895.93	0.001573	7.67	29619.71	3385.95	0.44
Reach-1	192.23	285000.00	883.70	896.03		897.19	0.001729	8.59	33088.13	3415.00	0.47
Reach-1	192.13	227000.00	883.10	894.54		895.05	0.001295	5.61	39841.53	5996.20	0.34
Reach-1	192.13	285000.00	883.10	895.66		896.25	0.001219	5.87	46540.54	5998.10	0.33
Reach-1	192.04	227000.00	882.00	894.09		894.54	0.000816	5.58	42557.93	6377.38	0.34
Reach-1	192.04	285000.00	882.00	895.26		895.76	0.000771	5.85	49962.72	6378.30	0.34
Reach-1	191.94	227000.00	881.40	893.73		894.11	0.000788	5.05	45744.78	6358.59	0.30
Reach-1	191.94	285000.00	881.40	894.90		895.35	0.000763	5.34	53241.53	6360.10	0.30
Reach-1	191.84	227000.00	880.80	893.27		893.67	0.000897	5.23	45484.28	7857.83	0.32
Reach-1	191.84	285000.00	880.80	894.51		894.93	0.000829	5.42	55385.87	8142.57	0.31
Reach-1	191.75	227000.00	880.40	892.90		893.23	0.000780	4.78	50326.02	8674.31	0.29
Reach-1	191.75	285000.00	880.40	894.19		894.53	0.000676	4.83	61650.96	8880.94	0.27
Reach-1	191.65	227000.00	879.10	892.55		892.85	0.000593	4.54	53666.46	8486.20	0.27
Reach-1	191.65	285000.00	879.10	893.88		894.19	0.000529	4.64	64954.29	8486.20	0.25
Reach-1	191.55	227000.00	876.50	892.27		892.55	0.000660	4.35	55196.28	8650.36	0.26
Reach-1	191.55	285000.00	876.50	893.64		893.93	0.000577	4.41	67038.70	8676.49	0.24
Reach-1	191.46	227000.00	879.00	891.95		892.22	0.000638	4.30	54343.34	8106.20	0.26
Reach-1	191.46	285000.00	879.00	893.35		893.64	0.000561	4.41	65669.87	8110.34	0.25
Reach-1	191.36	227000.00	879.20	891.61		891.87	0.000720	4.11	55364.93	7624.20	0.26
Reach-1	191.36	285000.00	879.20	893.04		893.33	0.000642	4.26	66285.22	7646.41	0.24
Reach-1	191.27	227000.00	879.00	891.32		891.55	0.000550	3.76	59795.18	7680.52	0.22
Reach-1	191.27	285000.00	879.00	892.79		893.04	0.000497	3.92	71041.81	7698.38	0.22

MCDOT Bridge Scour			
Tuthill Road Bridge over Gila River			
Comparison of FP elevations with or without training dikes			
River Mile	FP Elev w/o training dikes	FP Elev w/ training dikes	Difference
190.34	888.53	888.59	0.06
189.87	884.72	885.01	0.29
189.49	882.59	883.16	0.57
189.22	881.54	882.29	0.75
188.81	880.47	881.45	0.98
188.59	879.91	881.01	1.1
188.29	879.25	880.49	1.24
188.2	878.78	879.89	1.11
188.1	878.1	879.29	1.19

Reach-1	191.17	227000.00	879.30	891.04		891.27	0.000531	3.90	58753.54	7459.55	0.23	
Reach-1	191.17	285000.00	879.30	892.53		892.79	0.000482	4.08	69899.02	7497.86	0.22	
Reach-1	191.08	227000.00	877.30	890.77		891.00	0.000512	4.01	58480.21	7441.32	0.23	
Reach-1	191.08	285000.00	877.30	892.29		892.55	0.000458	4.19	69785.96	7447.03	0.22	
Reach-1	190.99	227000.00	876.80	890.53		890.77	0.000447	4.14	58707.93	7302.56	0.22	
Reach-1	190.99	285000.00	876.80	892.07		892.34	0.000409	4.32	69988.98	7317.45	0.22	
Reach-1	190.89	227000.00	876.20	890.32		890.54	0.000462	3.97	59712.79	7240.29	0.21	
Reach-1	190.89	285000.00	876.20	891.88		892.13	0.000424	4.13	71089.84	7336.59	0.21	
Reach-1	190.8	227000.00	875.80	890.12		890.34	0.000424	3.83	61497.95	7319.50	0.20	
Reach-1	190.8	285000.00	875.80	891.70		891.94	0.000392	3.97	73051.61	7331.27	0.20	
Reach-1	190.71	227000.00	875.30	889.92		890.13	0.000431	3.78	62200.79	7088.89	0.20	
Reach-1	190.71	285000.00	875.30	891.51		891.75	0.000402	3.94	73480.67	7101.69	0.19	
Reach-1	190.62	227000.00	872.20	889.67		889.91	0.000447	3.89	58854.64	5742.46	0.20	
Reach-1	190.62	285000.00	872.20	891.25		891.53	0.000449	4.18	67910.77	5750.19	0.20	
Reach-1	190.53	227000.00	874.10	889.38		889.65	0.000650	4.14	55364.13	5214.65	0.21	
Reach-1	190.53	285000.00	874.10	890.95		891.27	0.000664	4.48	63528.14	5233.64	0.22	
Reach-1	190.43	227000.00	874.20	889.03		889.32	0.000709	4.39	55911.29	5133.03	0.22	
Reach-1	190.43	285000.00	874.20	890.57		890.92	0.000758	4.87	63864.65	5205.00	0.23	
Reach-1	190.34	227000.00	873.00	888.59		888.87	0.001152	4.29	53280.13	5019.58	0.23	
Reach-1	190.34	285000.00	873.00	890.10		890.45	0.001215	4.74	60925.40	5076.72	0.24	
Reach-1	190.24	227000.00	873.00	888.10		888.39	0.000799	4.35	53019.46	5107.55	0.23	
Reach-1	190.24	285000.00	873.00	889.58		889.93	0.000864	4.79	60639.73	5197.04	0.24	
Reach-1	190.15	227000.00	873.80	887.38		887.82	0.001755	5.38	43231.20	5184.99	0.31	
Reach-1	190.15	285000.00	873.80	888.83		889.34	0.001705	5.74	50821.96	5216.38	0.31	
Reach-1	190.05	227000.00	873.80	886.55		887.04	0.001344	5.65	40872.91	5392.04	0.34	
Reach-1	190.05	285000.00	873.80	888.09		888.63	0.001184	5.85	49177.76	5404.08	0.32	
Reach-1	189.96	227000.00	873.70	885.82		886.32	0.001686	5.64	39926.05	4909.25	0.33	
Reach-1	189.96	285000.00	873.70	887.45		888.01	0.001406	5.84	47950.43	4915.62	0.32	
Reach-1	189.87	227000.00	872.50	885.01		885.52	0.001597	5.75	39601.32	4673.73	0.34	
Reach-1	189.87	285000.00	872.50	886.79		887.34	0.001320	5.95	47923.98	4678.06	0.32	
Reach-1	189.77	227000.00	869.90	884.39		884.77	0.001149	4.93	46417.66	4571.16	0.27	
Reach-1	189.77	285000.00	869.90	886.26		886.68	0.001045	5.23	54954.69	4586.38	0.27	
Reach-1	189.68	227000.00	864.60	883.91		884.26	0.000848	4.74	47944.02	4639.85	0.26	
Reach-1	189.68	285000.00	864.60	885.82		886.21	0.000762	5.02	56845.96	4651.40	0.25	
Reach-1	189.58	227000.00	867.70	883.49		883.84	0.000809	4.72	48114.10	4535.22	0.25	
Reach-1	189.58	285000.00	867.70	885.45		885.84	0.000744	5.01	57006.37	4588.82	0.25	
Reach-1	189.49	227000.00	863.40	883.16		883.48	0.000631	4.56	49833.30	4346.07	0.24	
Reach-1	189.49	285000.00	863.40	885.13		885.50	0.000599	4.88	58411.70	4351.24	0.23	
Reach-1	189.39	227000.00	866.80	882.84		883.17	0.000593	4.66	48806.39	4224.80	0.24	
Reach-1	189.39	285000.00	866.80	884.83		885.21	0.000550	4.99	57220.31	4233.00	0.24	
Reach-1	189.31	227000.00	865.80	882.58		882.90	0.000592	4.57	49694.21	4160.81	0.23	
Reach-1	189.31	285000.00	865.80	884.58		884.96	0.000566	4.91	58041.98	4168.65	0.23	
Reach-1	189.22	227000.00	864.70	882.29		882.61	0.000604	4.53	50139.07	4154.96	0.23	
Reach-1	189.22	285000.00	864.70	884.31		884.68	0.000579	4.87	58524.21	4158.13	0.23	
Reach-1	189.12	227000.00	863.10	882.01		882.31	0.000555	4.43	51281.83	4197.97	0.22	
Reach-1	189.12	285000.00	863.10	884.04		884.39	0.000535	4.77	59806.02	4200.37	0.22	
Reach-1	189.02	227000.00	863.40	881.77		882.05	0.000448	4.21	53966.81	4481.60	0.21	
Reach-1	189.02	285000.00	863.40	883.81		884.13	0.000437	4.52	63120.39	4481.60	0.21	
Reach-1	188.92	227000.00	863.30	881.59		881.83	0.000323	3.90	58155.50	4564.37	0.19	
Reach-1	188.92	285000.00	863.30	883.64		883.91	0.000319	4.22	67507.49	4571.83	0.19	
Reach-1	188.81	227000.00	863.50	881.45		881.65	0.000276	3.65	62203.96	4590.17	0.17	
Reach-1	188.81	285000.00	863.50	883.49		883.74	0.000278	3.99	71608.81	4595.19	0.18	
Reach-1	188.7	227000.00	863.30	881.21		881.45	0.000398	3.94	57650.90	4355.71	0.19	
Reach-1	188.7	285000.00	863.30	883.25		883.54	0.000398	4.29	66544.92	4357.75	0.19	
Reach-1	188.59	227000.00	861.40	881.01		881.24	0.000349	3.86	58869.48	4191.38	0.18	
Reach-1	188.59	285000.00	861.40	883.05		883.33	0.000361	4.23	67409.66	4199.30	0.19	
Reach-1	188.5	227000.00	860.50	880.83		881.07	0.000360	3.93	57792.04	3855.50	0.18	
Reach-1	188.5	285000.00	860.50	882.85		883.14	0.000381	4.35	65584.08	3859.79	0.19	
Reach-1	188.39	227000.00	860.70	880.66	868.98	880.90	0.000248	3.89	58986.42	13289.19	0.17	
Reach-1	188.39	285000.00	860.70	882.66	869.87	882.96	0.000274	4.35	66486.74	13779.59	0.18	
Reach-1	188.29	227000.00	859.60	880.49		880.77	0.000194	4.29	52899.16	3258.03	0.19	
Reach-1	188.29	285000.00	859.60	882.46		882.82	0.000213	4.81	59446.29	3339.12	0.20	w/ dikes
DD# 2→ Reach-1	188.272*	227000.00	859.54	880.25	869.35	880.70	0.000278	5.40	42039.98	11308.87	0.23	
Reach-1	188.272*	285000.00	859.54	882.15	870.41	882.73	0.000311	6.10	46696.25	13049.07	0.25	
Reach-1	188.254*	227000.00	859.48	880.18		880.66	0.000334	5.55	40881.16	11687.35	0.23	
Reach-1	188.254*	285000.00	859.48	882.07		882.69	0.000376	6.29	45306.80	13878.85	0.25	
Reach-1	188.236*	227000.00	859.42	880.10		880.62	0.000386	5.78	39287.16	11389.60	0.24	
Reach-1	188.236*	285000.00	859.42	881.96		882.63	0.000439	6.56	43428.69	13902.95	0.26	
Reach-1	188.218*	227000.00	859.36	880.01	869.04	880.57	0.000455	5.97	38025.31	11273.86	0.25	
Reach-1	188.218*	285000.00	859.36	881.85	870.22	882.57	0.000521	6.79	41943.40	13933.09	0.27	
Reach-1	188.2	227000.00	859.30	879.89		880.50	0.000565	6.26	36275.52	10957.77	0.26	
Reach-1	188.2	285000.00	859.30	881.70		882.49	0.000648	7.13	39985.64	13875.44	0.28	
DD# 1→ Reach-1	188.15*	227000.00	857.55	879.62	868.66	880.34	0.000435	6.78	33497.10	10818.38	0.28	
Reach-1	188.15*	285000.00	857.55	881.35	870.03	882.29	0.000515	7.79	36604.91	13064.45	0.30	
Reach-1	188.1	227000.00	855.80	879.29	869.48	880.18	0.000340	7.57	30000.75	11098.53	0.31	
Reach-1	188.1	285000.00	855.80	880.92	870.85	882.10	0.000403	8.72	32682.41	14137.60	0.35	

Reach-1	188.055	Bridge									
Reach-1	188.04	227000.00	855.00	875.32	866.18	876.24	0.000646	7.72	29399.94	5742.38	0.33
Reach-1	188.04	285000.00	855.00	876.82	867.74	878.05	0.000765	8.90	32040.85	5754.45	0.37

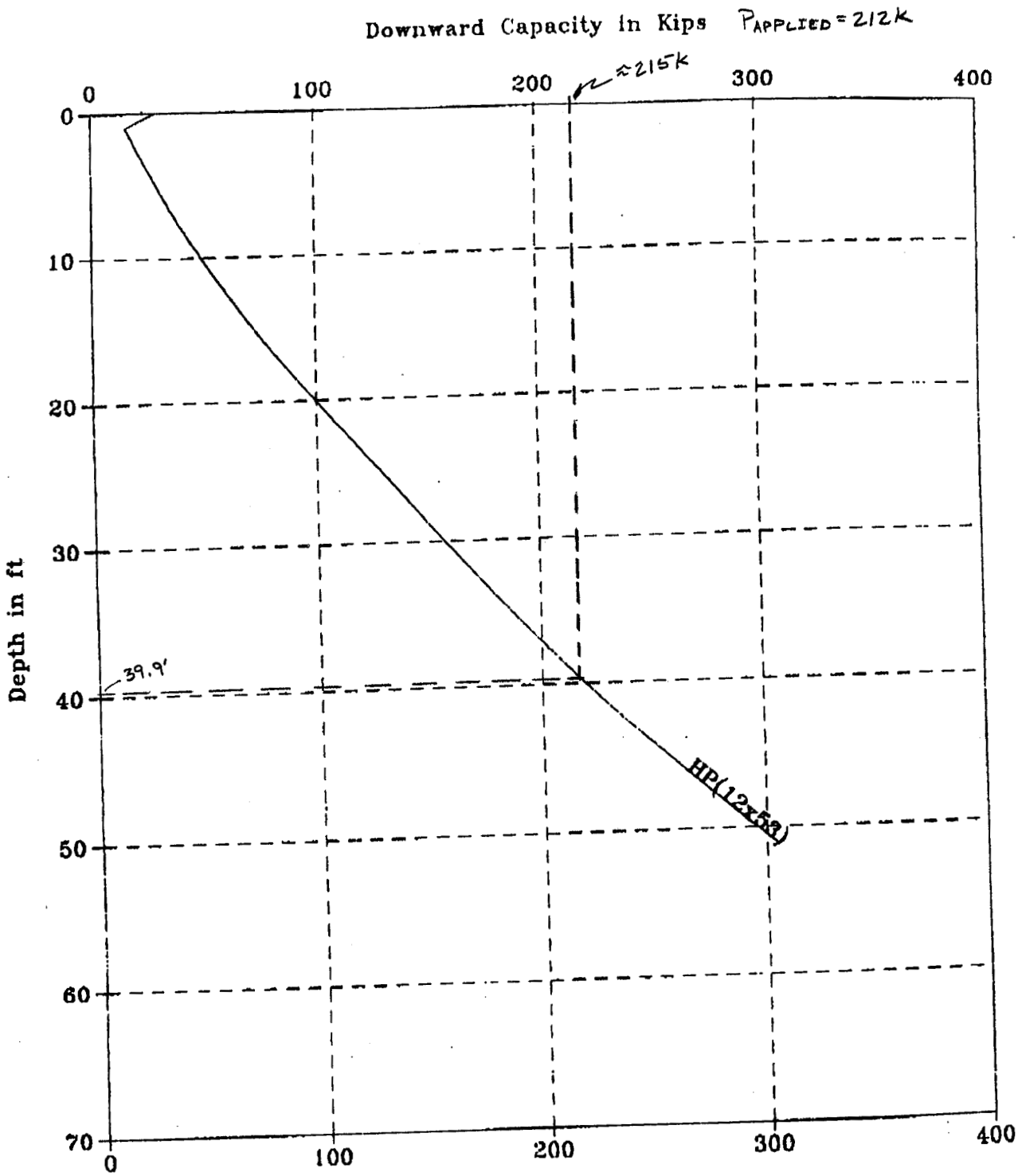
APPENDIX B

Design Chart 1 – Ultimate Capacity of Straight Driven H- Piles

Project Bridge Scour Analysis Job No. E95-56

DESIGN CHART 1

ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRIVEN H-PILES



AGRA
Earth & Environmental, Inc.

APPENDIX C

List of Figures:

Alternative 1

Alternative 2

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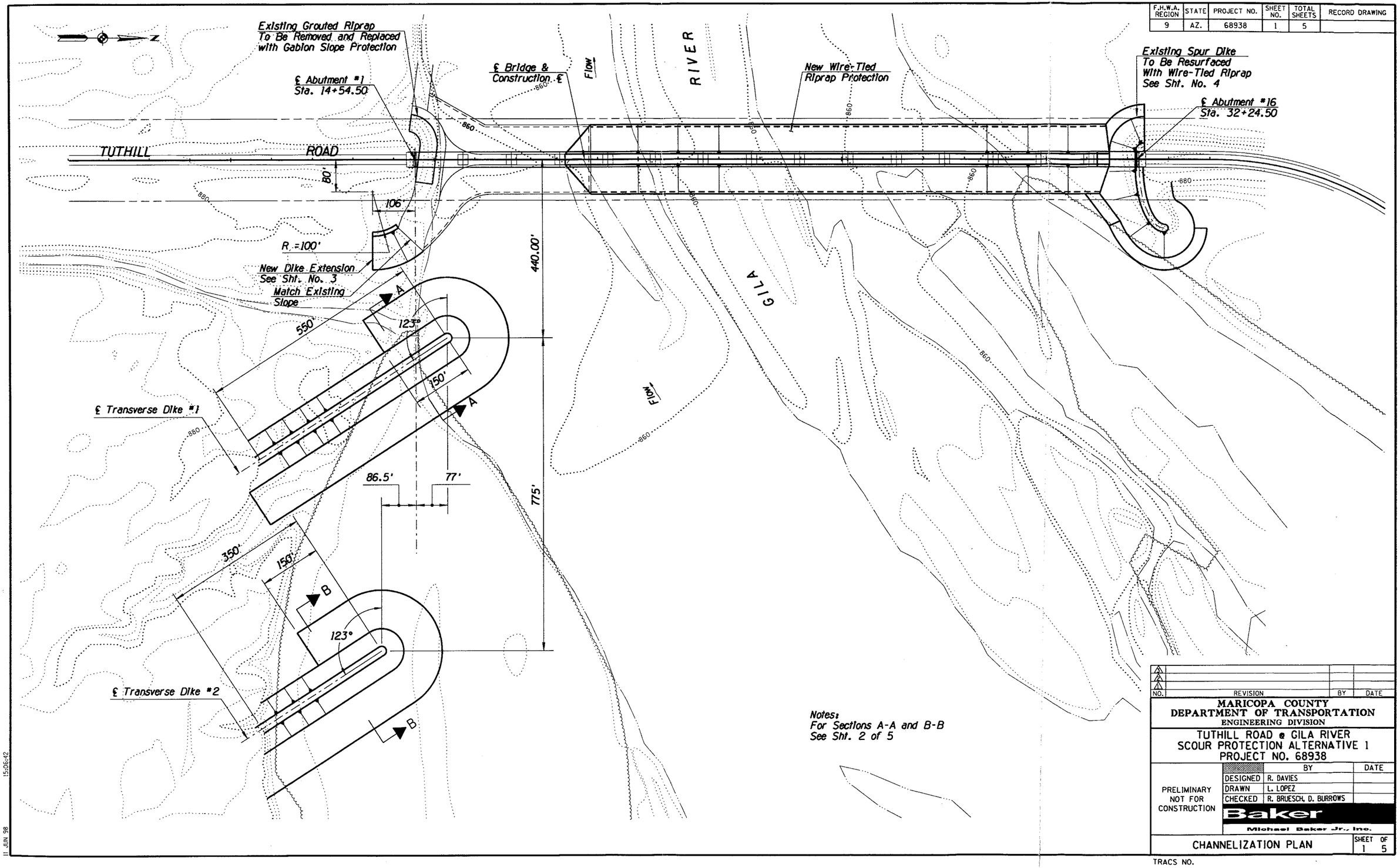

Notes:
For Sections A-A and B-B
See Sht. 2 of 5

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 1
PROJECT NO. 68938

PRELIMINARY
NOT FOR
CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

CHANNELIZATION PLAN

SHEET 1 OF 5

TRACS NO.

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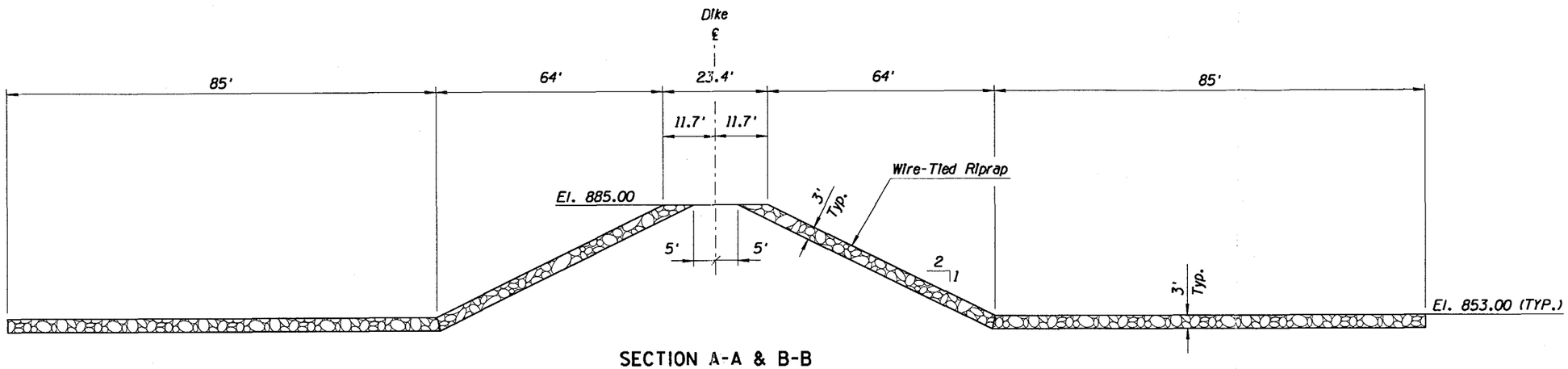

SECTION A-A & B-B
TRANSVERSE DIKES #1 & #2
N.T.S.

NO.	REVISION	BY	DATE
3			
2			
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MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 1
PROJECT NO. 68938

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

TRANSVERSE DIKES

SHEET 2 OF 5

TRACS NO.

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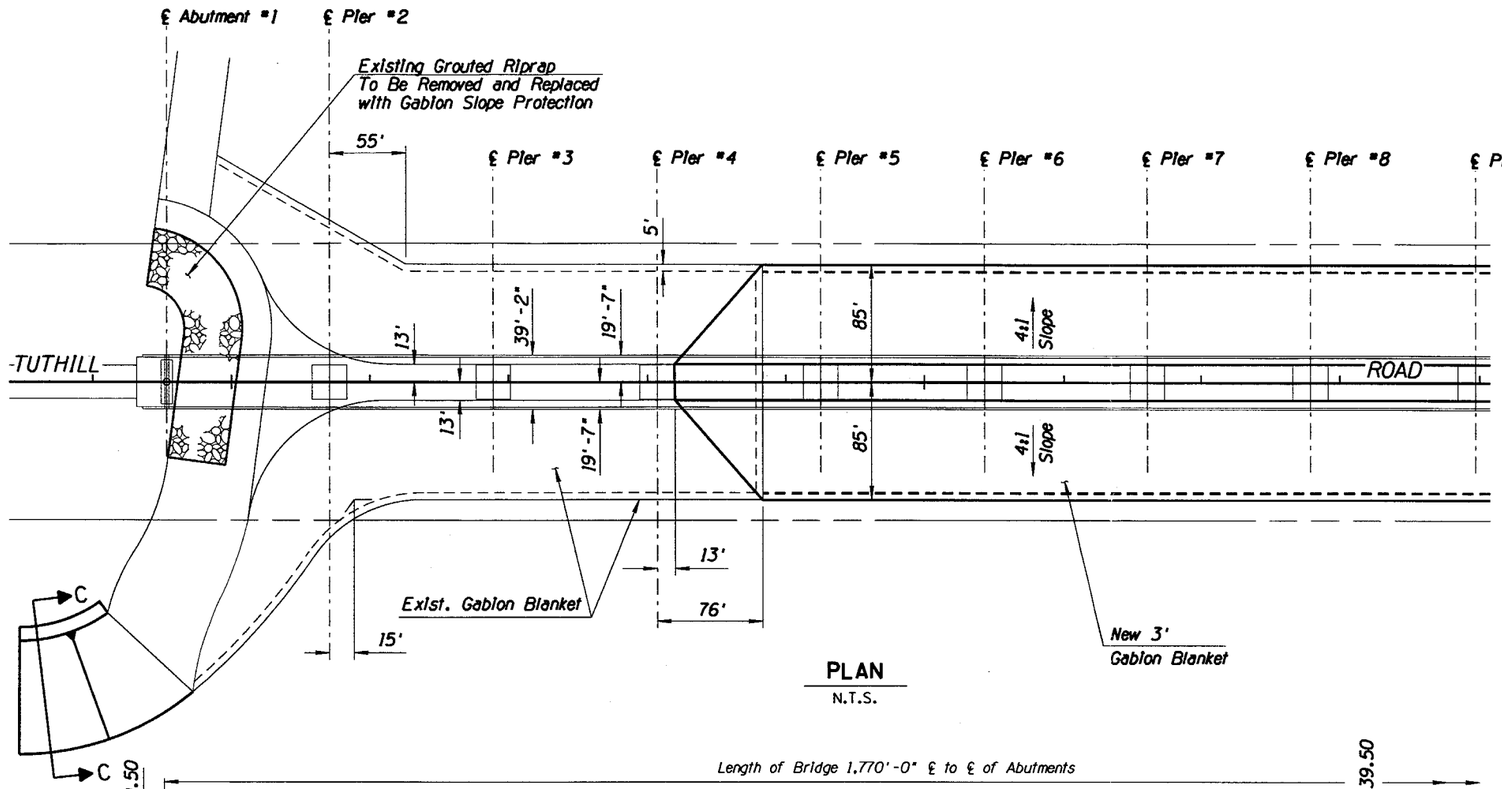

PLAN
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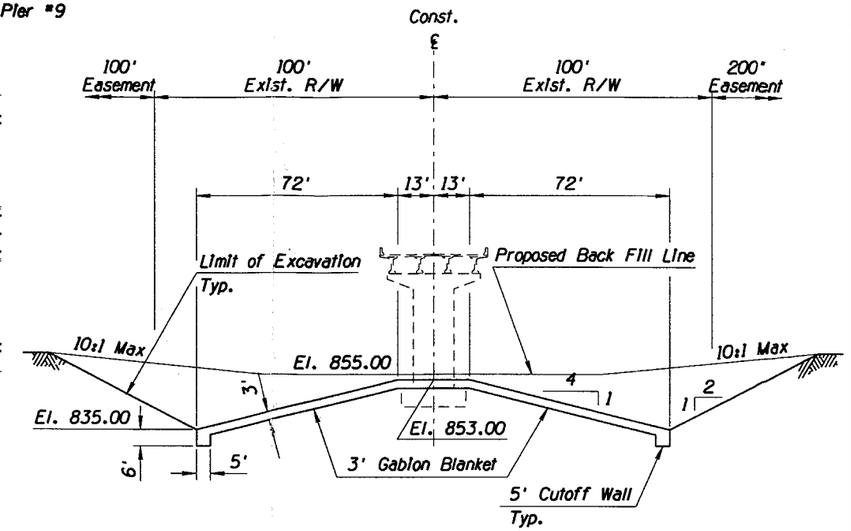

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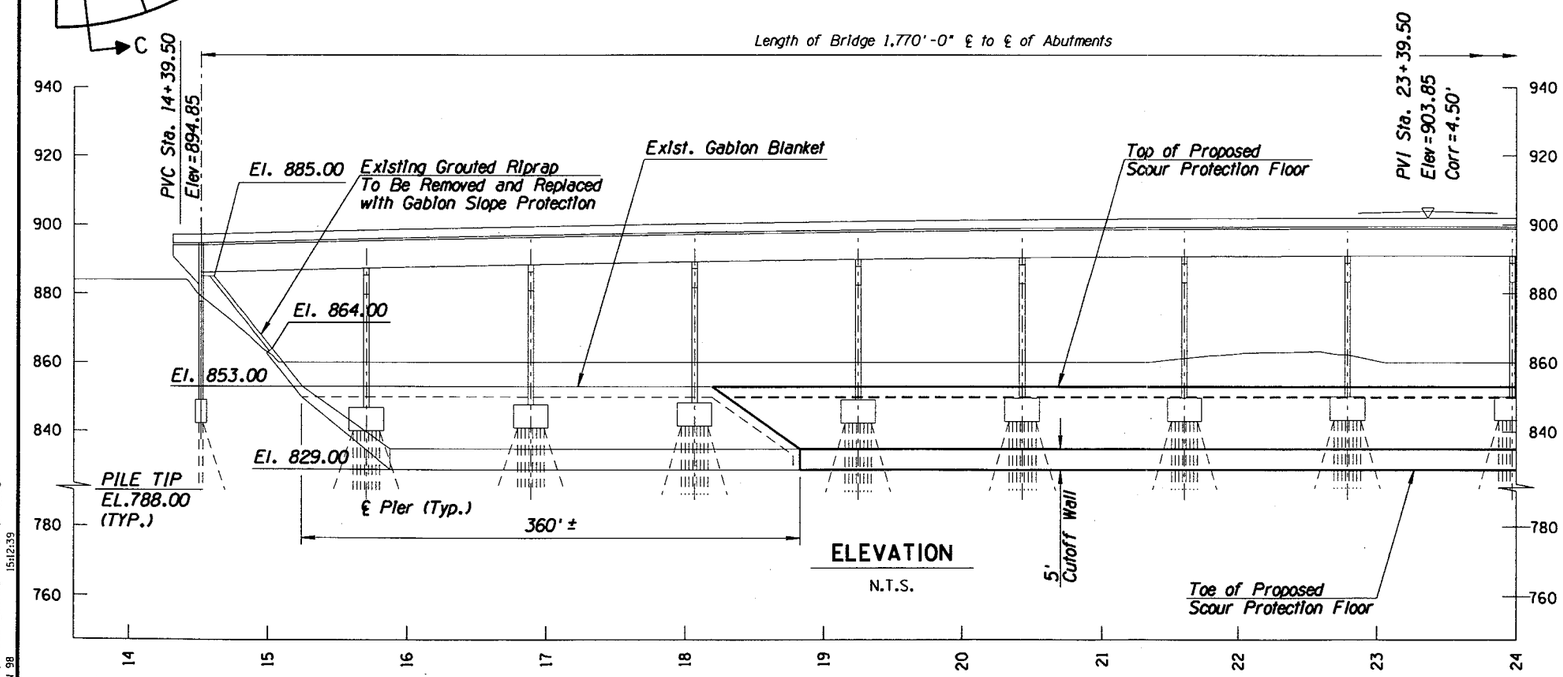

ELEVATION
N.T.S.

GENERAL NOTES

1. Construction - Maricopa Assn. of Govts. Uniform Standard Specs for Public Works Constr., 1992 and Current Supplements.
2. Design - AASHTO Std. Specs. for Highway Bridges, 1996 Edition and Interims to Date.
3. Loading - AASHTO HS20 or as Applicable.
4. For Section C-C, See Sht. 5 of 5.

NO.	REVISION	BY	DATE
3			
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MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 1
PROJECT NO. 68938

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

GENERAL PLAN

SHEET 3 OF 5

TRACS NO.

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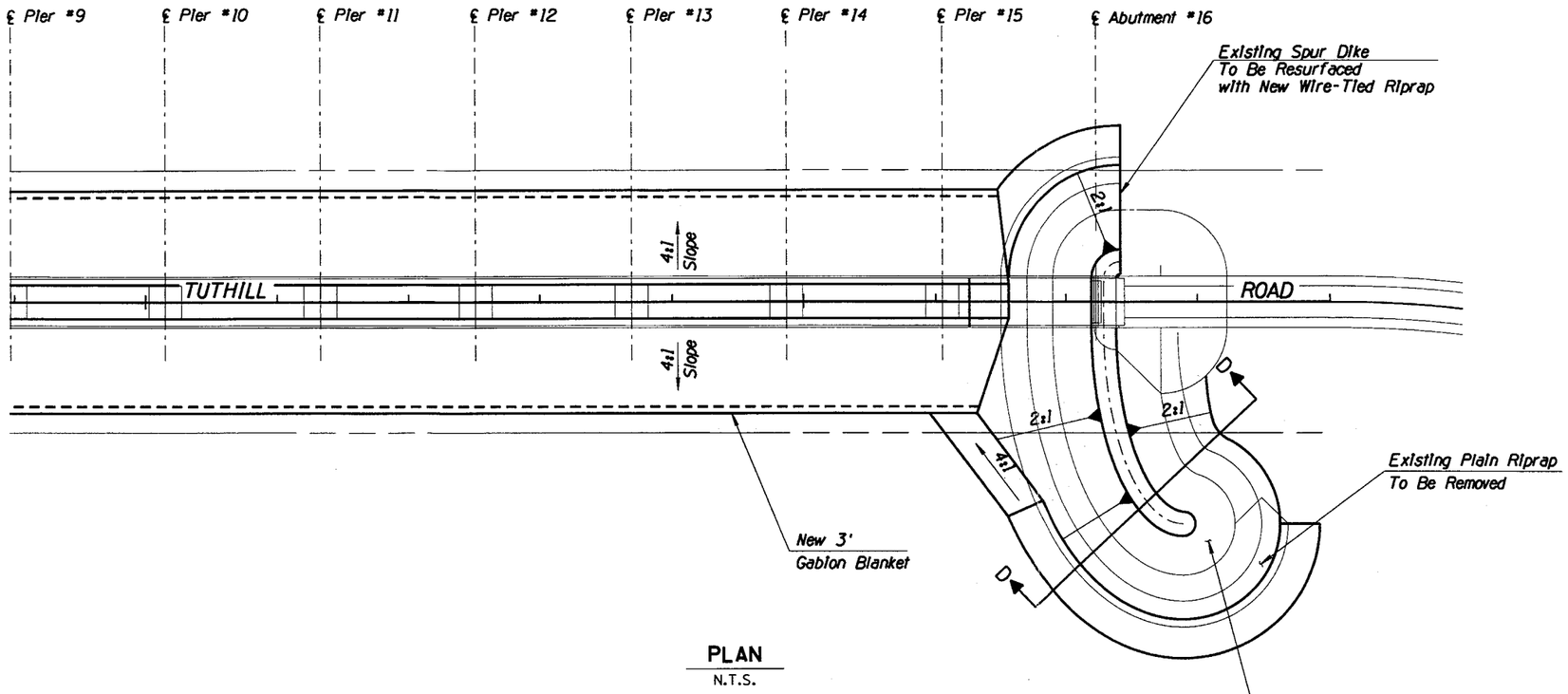

PLAN
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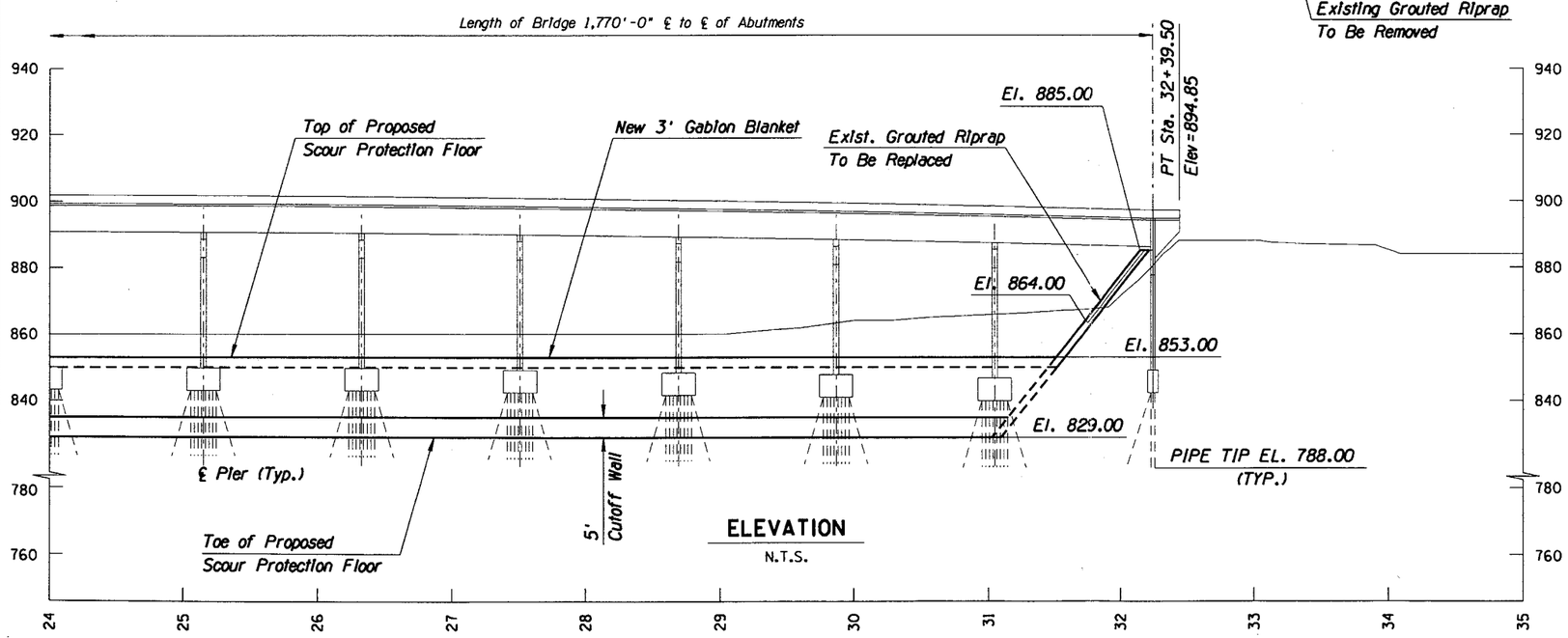

ELEVATION
N.T.S.

Notes:
For Sections D-D See Sht. 5 of 5

NO.	REVISION	BY	DATE
3			
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MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 1
PROJECT NO. 68938

		BY	DATE
PRELIMINARY NOT FOR CONSTRUCTION	DESIGNED	R. DAVIES	
	DRAWN	L. LOPEZ	
	CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

GENERAL PLAN

SHEET 4 OF 5

TRACS NO.

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
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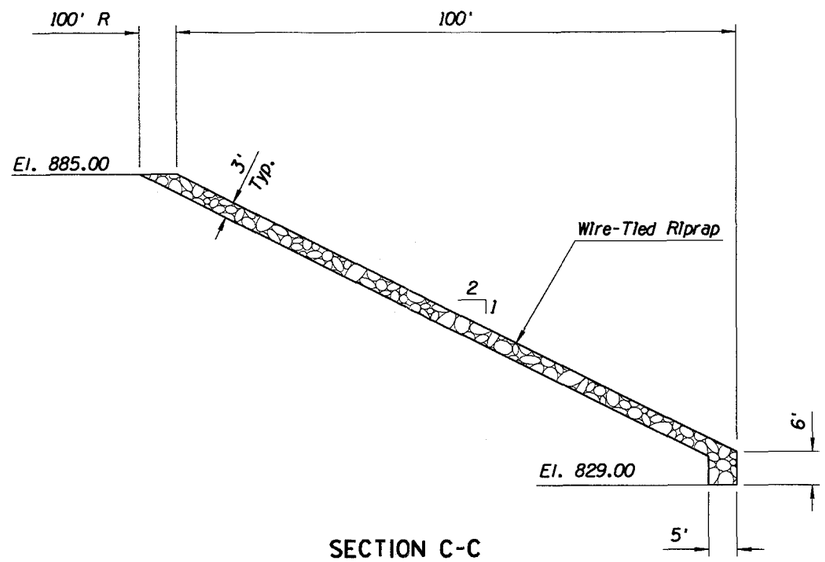
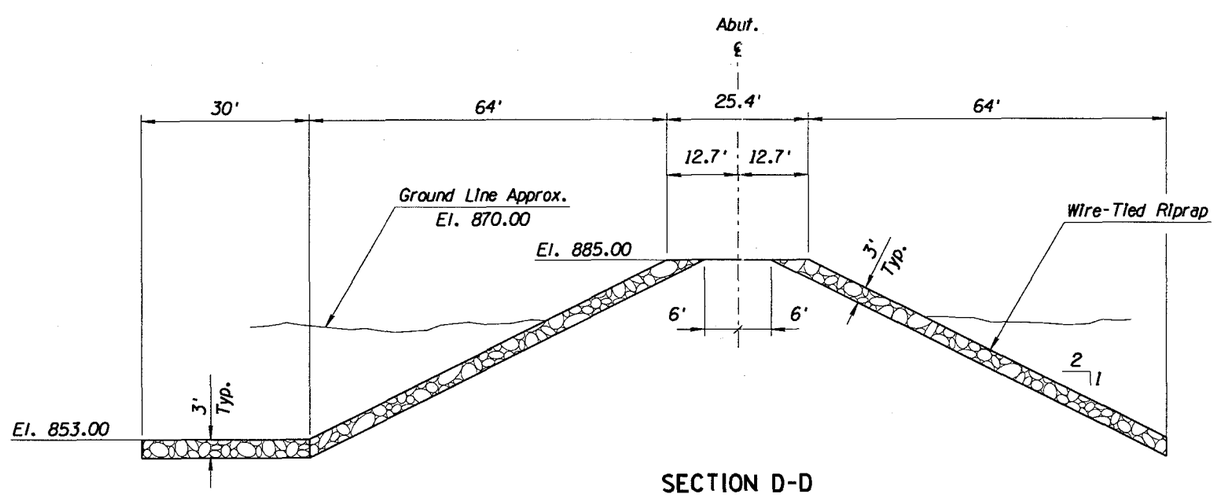


SECTION C-C
SOUTH SPUR DIKE
N.T.S.



SECTION D-D
NORTH SPUR DIKE
N.T.S.

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 1
PROJECT NO. 68938

PRELIMINARY
NOT FOR
CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

SPUR DIKE DETAILS

SHEET 5 OF 5

TRACS NO.

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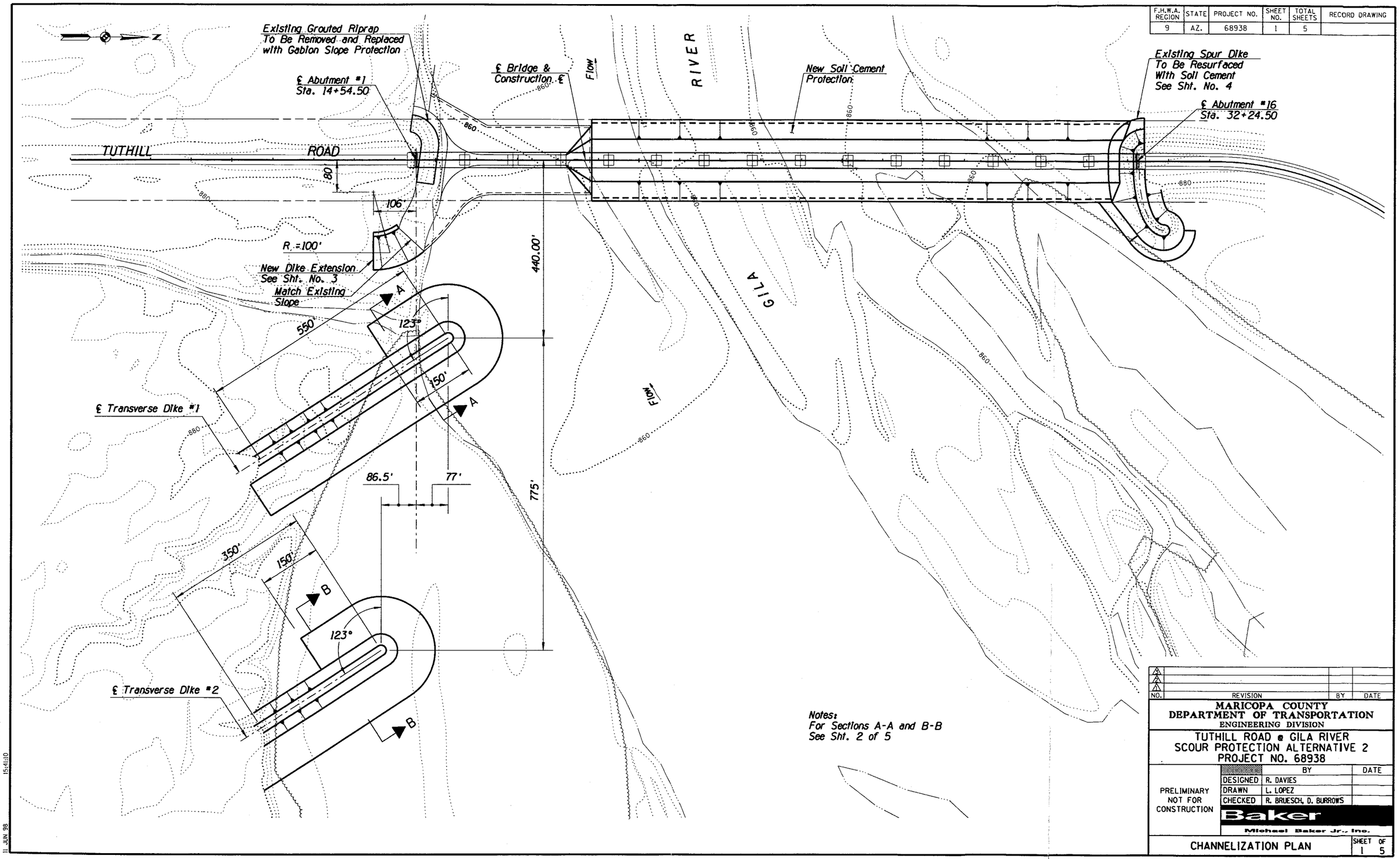
F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
9	AZ.	68938	1	5	



Notes:
For Sections A-A and B-B
See Sht. 2 of 5

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 2
PROJECT NO. 68938

PRELIMINARY
NOT FOR
CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

CHANNELIZATION PLAN

SHEET 1 OF 5

TRACS NO.

p:\proj\mcdot\cadd\tuthill\thpln06.dgn
11 JUN 98 15:41:10

...\mcdot\cadd\tuthill\thpln06.dgn Jun. 11, 1998 15:41:10 Michael Baker Jr., Inc.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
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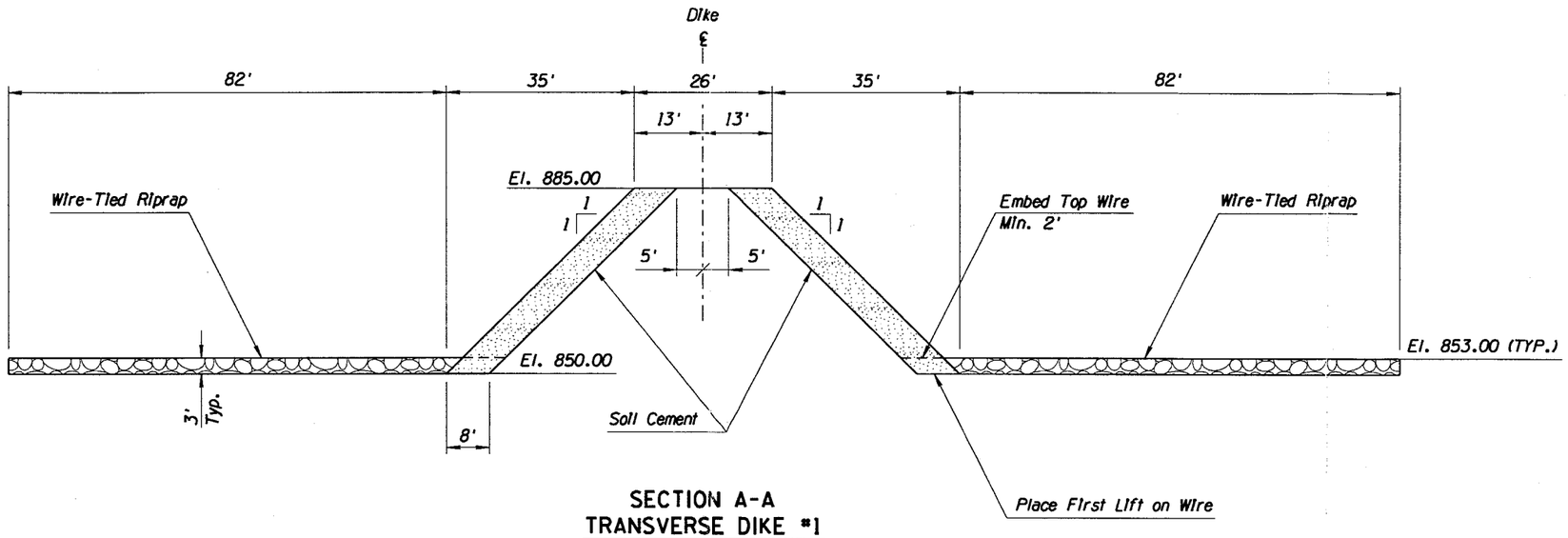

SECTION A-A
TRANSVERSE DIKE #1
N.T.S.

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 2
PROJECT NO. 68938

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

TRANSVERSE DIKES

SHEET 2 OF 5

TRACS NO.

p:\proj\mcdot\cadd\tuthill\det02.dgn
29 MAY 98 14:03:13

\mcdot\cadd\tuthill\det02.dgn May 29, 1998 14:03:13 Michael Baker Jr., Inc.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
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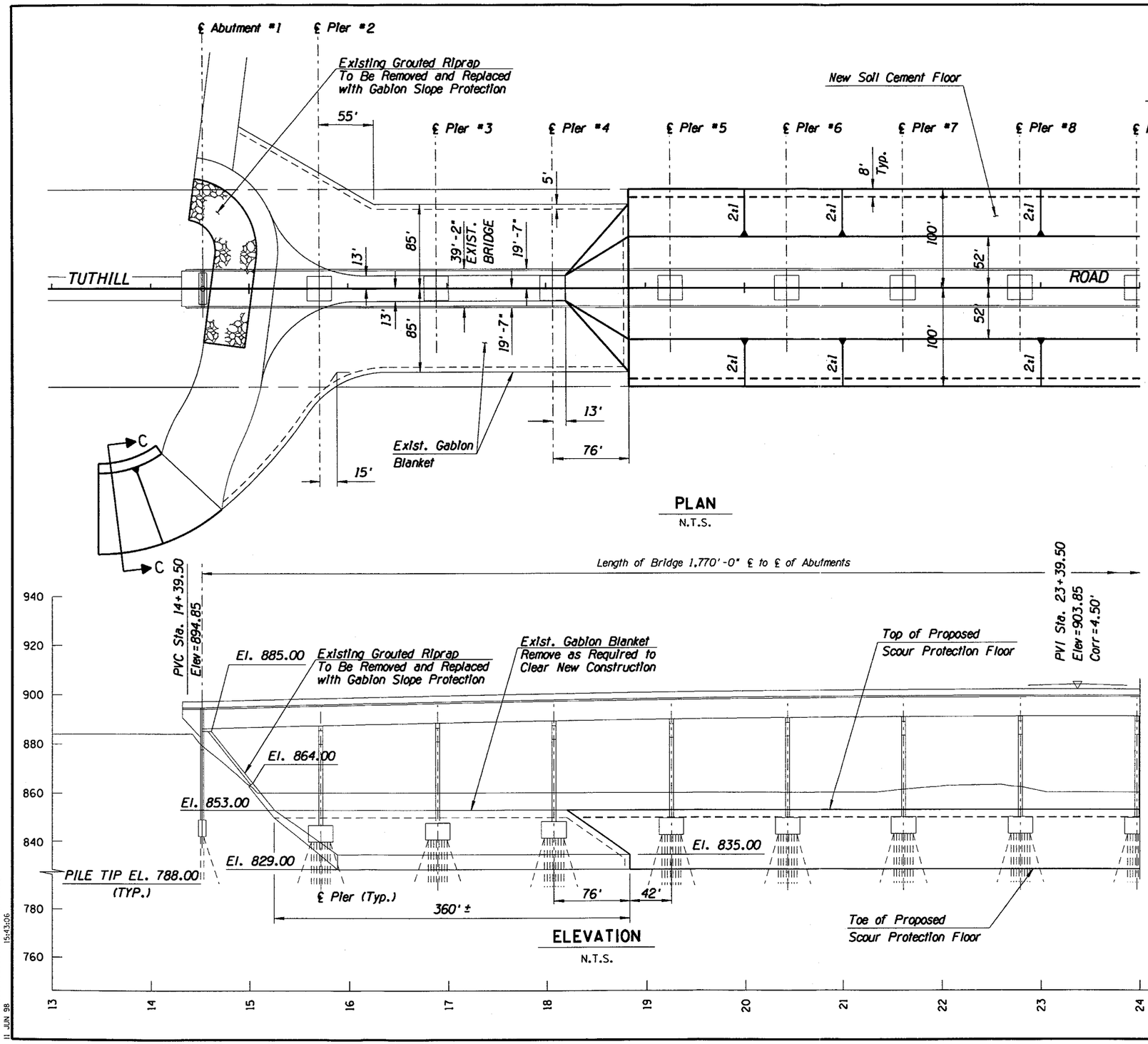
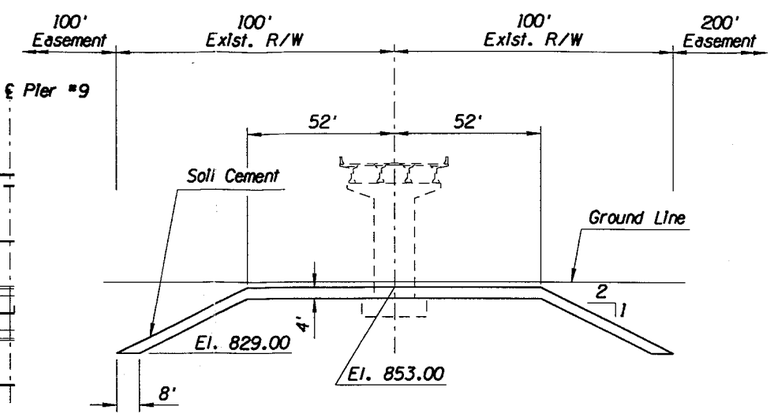


PLAN
N.T.S.

ELEVATION
N.T.S.



TYPICAL SECTION
N.T.S.

GENERAL NOTES

1. Construction - Maricopa Assn. of Govts. Uniform Standard Specs for Public Works Constr., 1992 and Current Supplements.
2. Design - AASHTO Std. Specs. for Highway Bridges, 1996 Edition and Interims to Date.
3. Loading - AASHTO HS20 or as Applicable.
4. For Section C-C, See Sht. 5 of 5.

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 2
PROJECT NO. 68938

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

GENERAL PLAN

SHEET 3 OF 5

TRACS NO.

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
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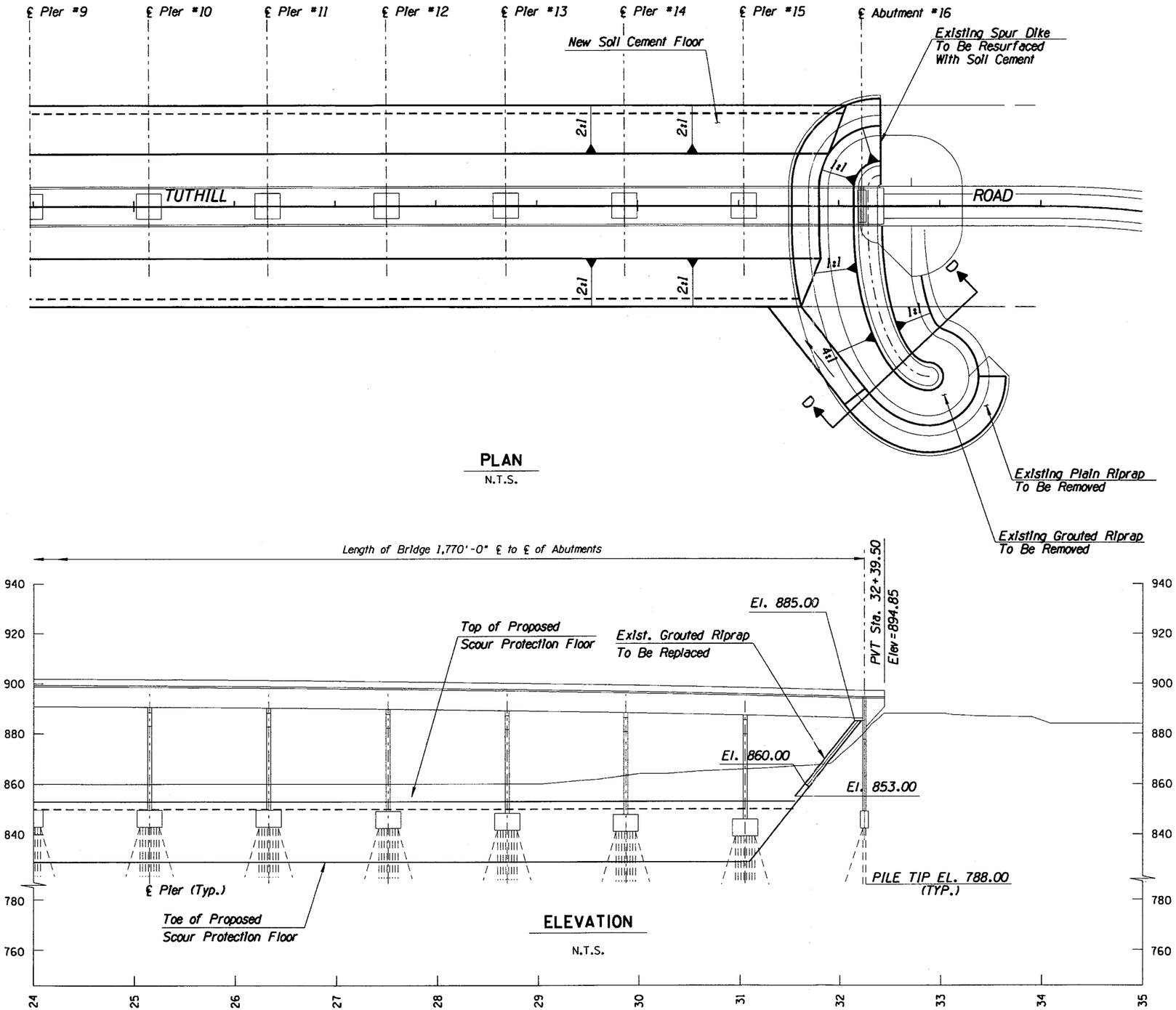

Notes:
For Section D-D See Sht. 5 of 5

NO.	REVISION	BY	DATE
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MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 2
PROJECT NO. 68938

PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

GENERAL PLAN

SHEET 4 OF 5

TRACS NO.

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	RECORD DRAWING
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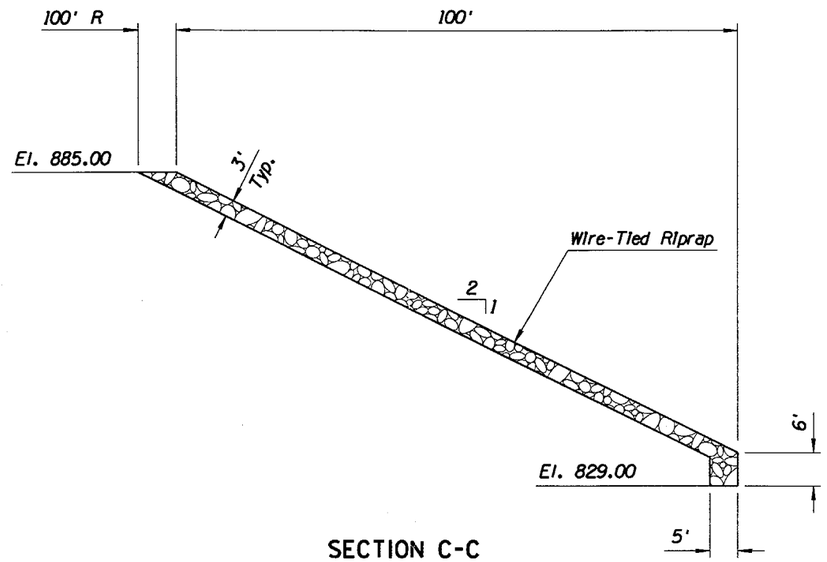
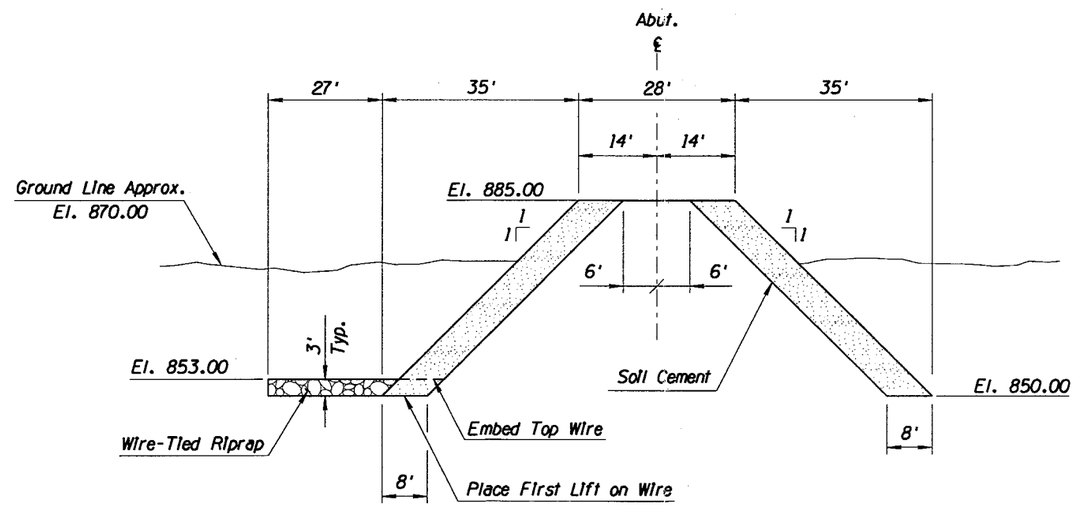


SECTION C-C
SOUTH SPUR DIKE
N.T.S.



SECTION D-D
NORTH SPUR DIKE
N.T.S.

NO.	REVISION	BY	DATE
3			
2			
1			

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION

TUTHILL ROAD @ GILA RIVER
SCOUR PROTECTION ALTERNATIVE 2
PROJECT NO. 68938

PRELIMINARY
NOT FOR
CONSTRUCTION

	BY	DATE
DESIGNED	R. DAVIES	
DRAWN	L. LOPEZ	
CHECKED	R. BRUESCH, D. BURROWS	

Baker
Michael Baker Jr., Inc.

SPUR DIKE DETAILS

SHEET 5 OF 5

TRACS NO.

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29 MAY 98 13:27:44

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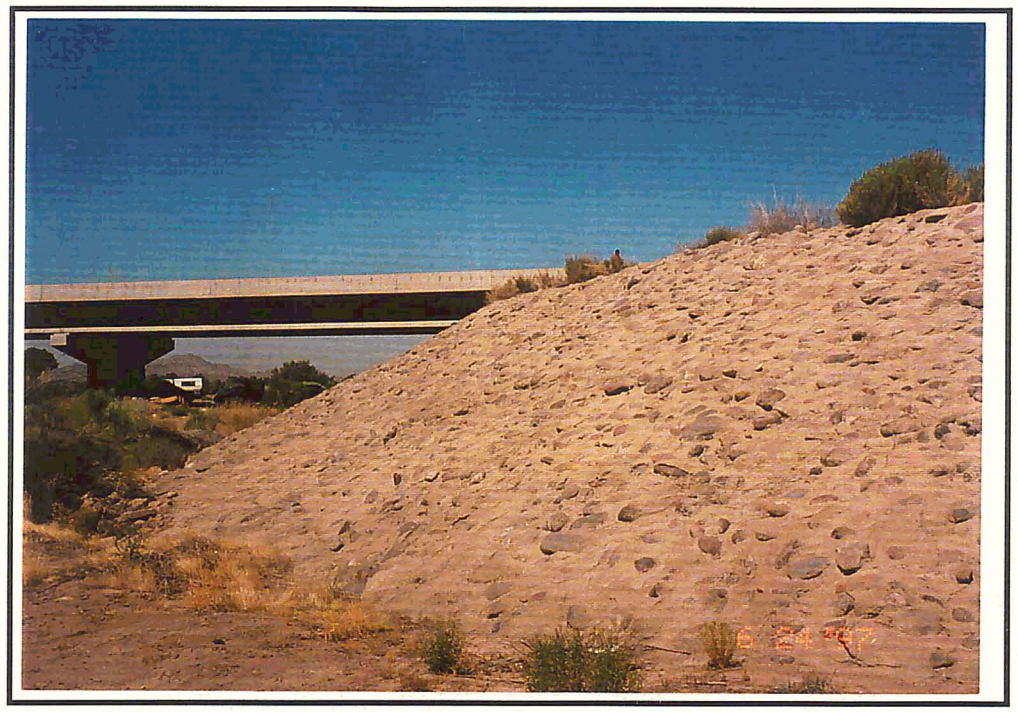
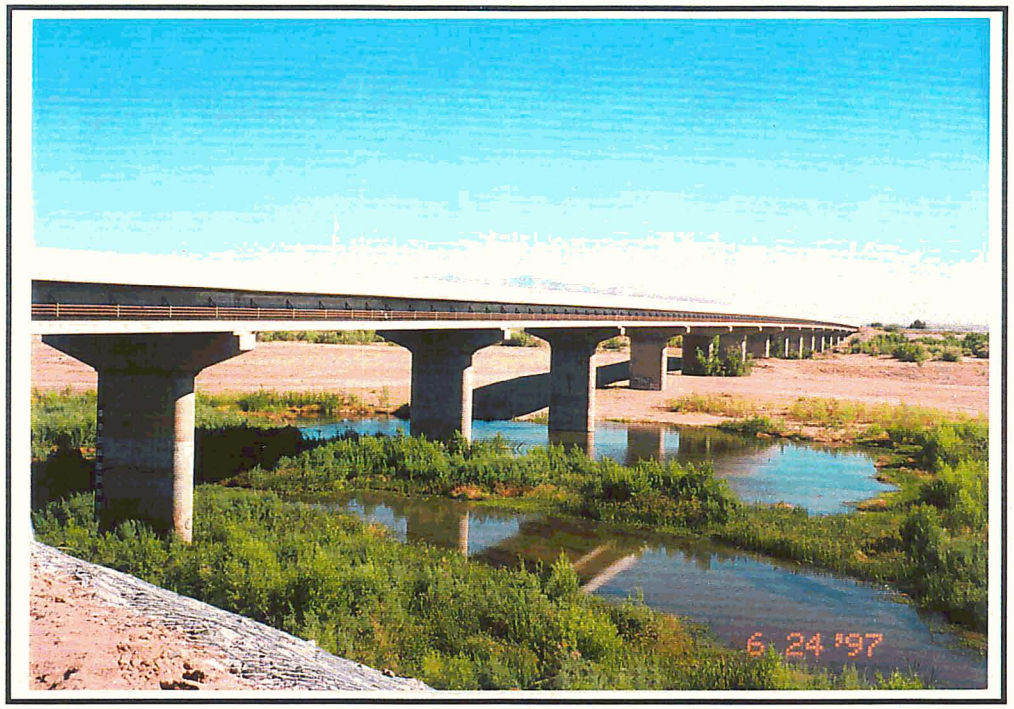
FIELD PHOTOS

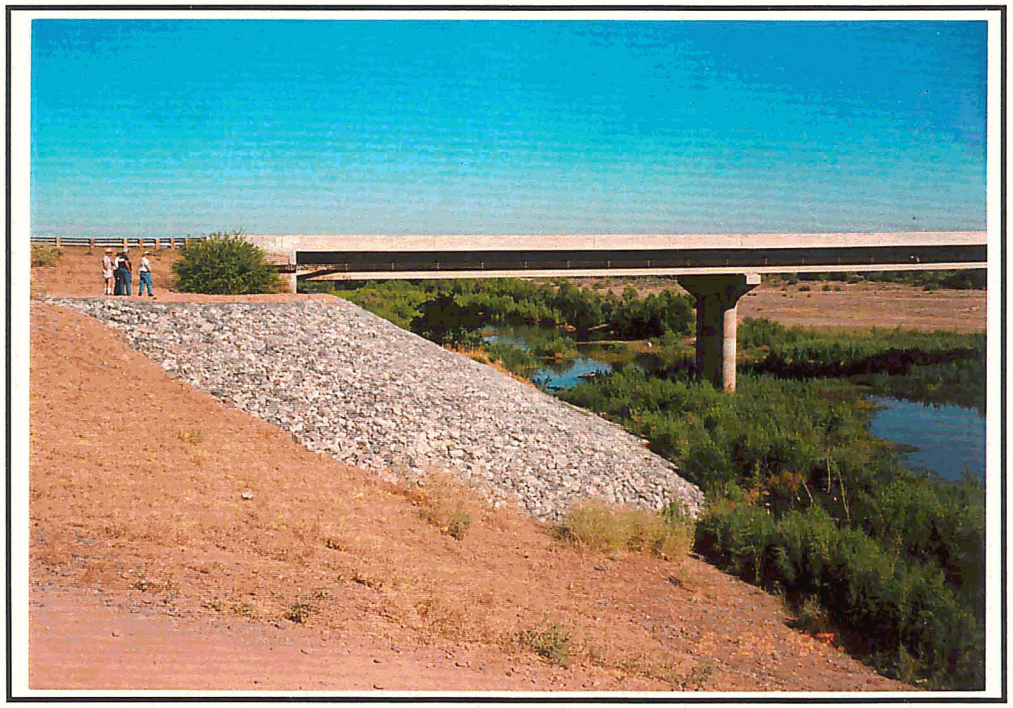


At the base of the North Spur Dike looking west.

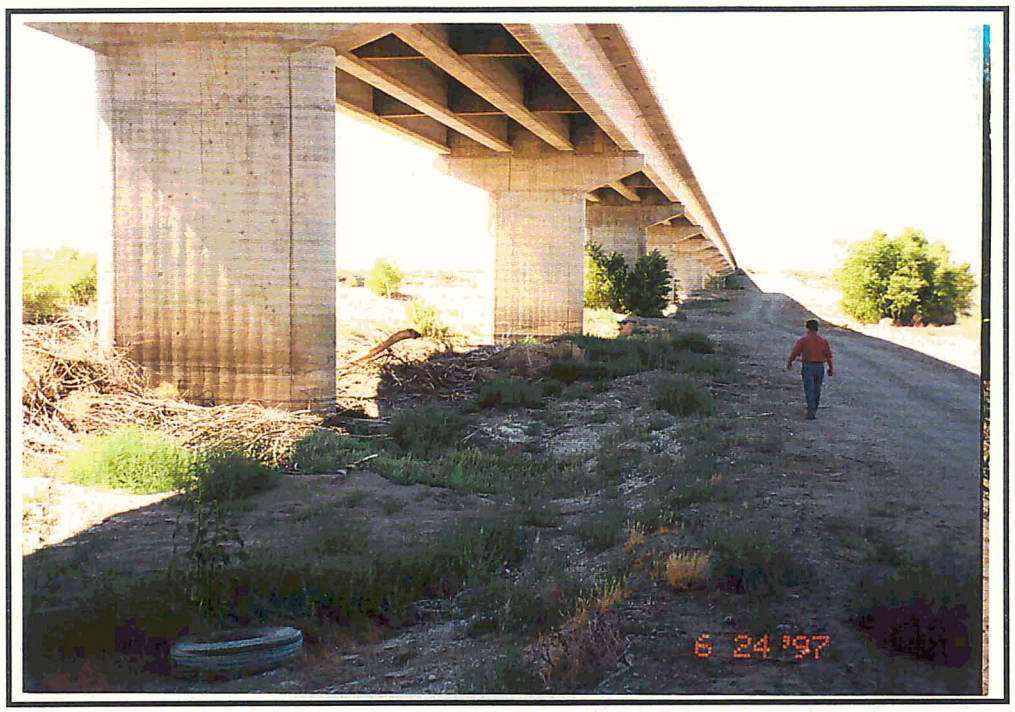
Looking east from the top of the North Spur Dike.



Looking to the northwest from the South Spur Dike. Riparian area in the foreground.



Looking downstream (west). South Spur Dike.



Looking south from the road on the west side of the bridge. Photo taken near the north side of the bridge.

Grouted riprap adjacent to wire-tied riprap on the South Spur Dike.