Final

Drainage Report

Sediment Transport Analysis For Salt River North-Bank Levee

Pima Freeway to Alma School Road

SALT RIVER PIMA – MARICOPA INDIAN COMMUNITY

October 1998

Prepared for:

Dibble and Associates
2633 E. Indian School Road, Suite 401
Phoenix, AZ 85016

Prepared by:

Premier Engineering Corporation
1600 W. Broadway Road, Suite 165
Tempe, Arizona 85282

Premier Project No. 9803

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
23170
JEFFREY J.
HOLZMEISTER
Date Signed 11/2/98
ARIZONA, U.S.A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
23170
JEFFREY J.
HOLZMEISTER
Date Signed 11/2/96
ARIZONA, U.S.A.

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
23170
JEFFREY J.
HOLZMEISTER
Date Signed 11/24/98
ARIZONA, U.S.A.

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
23170
JEFFREY J.
HOLZMEISTER
Date Signed 11/4/98
ARIZONA, U.S.A.

EXECUTIVE SUMMARY

The purpose of this report is to document the engineering assumptions and methodologies utilized in the hydrologic, hydraulic and sediment transport analyses of the Salt River. Results of these analyses were applied to design the geometric layout, toe-down and top of levee elevations of the bank protection along the north bank of the Salt River from the Pima Freeway/Red Mountain Freeway T.I. to Alma School Road. In accordance with Flood Control District of Maricopa County (FCDMC) criteria, hydraulic models (HEC-2) were prepared for the subject reach of the Salt River using pre-Roosevelt Dam renovation 100-year discharge value (220,000 cfs).

The toe-down elevation of the hardbank was established from the calculation of actual scour depth (plus a safety factor) or a minimum value of ten feet below the river thalwag. The top of the levee was established as three feet above the worst case 100-year water surface elevation. The total height of the levee was approximately 40-50 feet for the entire length of the project.

Review of Project History

Two engineering reports were prepared for the Arizona Department of Transportation (ADOT) for the south bank protection of the Salt River adjacent to the subject project. The analyses are published in the following documents:

> **Sediment transport Analysis, Salt River, Red Mountain Freeway, McKellips Road to Dobson Road**, September 15, 1995.
>
> **Sediment Transport Analysis, Salt river,** Red Mountain Freeway, Supplement No. 1, McKellips Road to Country Club Drive, October 3, 1996.

Engineering assumptions and methodologies utilized in these studies were used in the following report. Specifically, design parameters stated in agreements between the SRPMIC, ADOT, CoE, and FCDMC regarding mining restrictions, 404 jurisdictional boundaries, long-term maintenance, etc. were incorporated into the analyses.

A engineering report entitled **Sediment Transport Analysis for Salt River North-Bank Levee, Pima Freeway to Alma School Road Salt River Pima Maricopa Indian Community**, Preliminary Draft, July 31, 1998 was prepared and submitted to the FCDMC for their review and comment. The FCDMC provided comments regarding the preliminary report to the design team in their September 2, 1998 letter. The comments are included in Appendix D. The comments were addressed by the design team and approved by the FCDMC in their October 8, 1998 letter. The response to FCDMC comments and FCDMC approval letter are included in Appendix D.

Based on results of the geotechnical report, the hardbank alignment may be modified by Dibble & Associates, Inc. Specifically, the side slope of the hardbank may be increased from 1:1 H:V to 11/2:1 H:V (It should be noted that the south hardbank was constructed with a 1:1 H:V side slope). This may cause a shift in the hardbank alignment of approximately 20 feet. This shift would not have a significant impact on the hydraulic operation of the Salt River.

1 INTRODUCTION

The purpose of this report is to present the results of a hydraulic, sediment transport, and scour analysis that was performed to provide data for the design of a bank protection system for a proposed levee along the north-bank of the Salt River, between the Pima Freeway Bridge and Alma School Road. This levee system will be located on land owned by the Salt River Pima Maricopa Indian Community (SRPMIC). The study reach is shown in Figure 1.1.

At the present time, the proposed levee will extend along the north side of the Salt River for approximately 8,700 L.F. upstream from the north spur dike at the Pima Freeway Bridge. The levee will terminate about 3,000-feet downstream of the Alma School Road Bridge.

The proposed levee system will include a cement-stabilized alluvium (CSA) bank-lining material to prevent an erosion failure resulting from flow in the Salt River.

Specific objectives of this study are to:

1. provide recommended toe-down elevations for the CSA bank protection system.
2. provide recommended top-of-bank elevations that will prevent the CSA system from being overtopped during the 100-year, 10-day flow event in the Salt River.

To be consistent with the previously approved sediment transport and scour analysis that was prepared by Robert L. Ward, P.E. Consulting Engineer for the Red Mountain Freeway bank stabilization system along the south bank of the river, the same engineering methodologies and technical approach have been adopted for this north-bank study. The Ward study is published in the following two documents:

1. **Sediment Transport Analysis, Salt River, Red Mountain Freeway, McKellips Road to Dobson Road**, September 15, 1995.
2. **Sediment Transport Analysis, Salt River, Red Mountain Freeway, Supplement No. 1, McKellips Road to Country Club Drive**, October 3, 1996

The following sections of this report present a technical discussion of the engineering assumptions and methodologies that were used in the sediment transport and scour analysis for the proposed levee. The text for this report follows the same format and is, for the most part, identical to the same text from the 1995-1996 Ward reports. Changes to the text of these previous reports have only been made to reflect specific features associated with the north-bank levee.

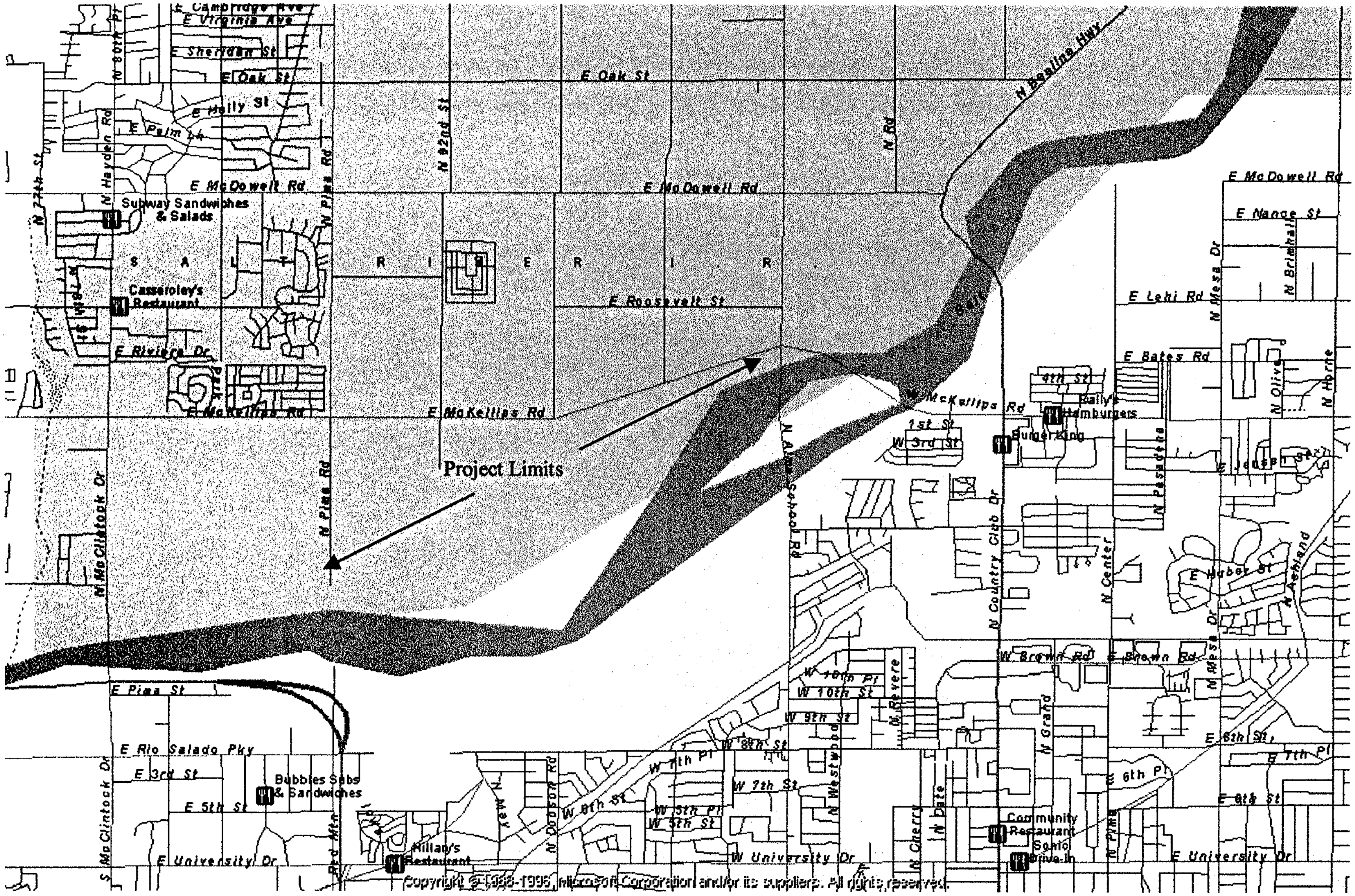


Figure 1.1
Project Location Map

Section 4 of this report presents calculation summaries and design recommendations for the proposed levee.

2 HYDRAULIC MODELS (HEC-2)

The HEC-2 models used in this study were based in-part on previous models developed by *Michael Baker, Jr., Inc.* (MBJ), *Simons, Li & Associates, Inc.* (SLA) and new data developed in July 1998 by R. Ward. The MBJ and SLA HEC-2 models were provided to the author of this report by *Wood, Patel & Associates, Inc.* (WPA) for use in the previously referenced 1995-1996 reports for the Red Mountain Freeway. The original HEC-2 modeling was performed by *Michael Baker, Jr., Inc.* (MBJ) in 1994 as part of a floodplain study. SLA reportedly made changes to the MBJ cross-sections downstream of the Pima Freeway bridge (see page 8, April 1994 report referenced below).

Certain revisions were also made to the MBJ files by WPA. WPA indicated that these revised files have been approved by the Arizona Department of Transportation (ADOT) and by the Flood Control District of Maricopa County (FCDMC) for use in this sediment transport and scour analysis. Specific HEC-2 modeling sources used in this current study are identified as follows:

1. McClintock Road (Grade Control No. 5) to upstream side of Pima Freeway bridge uses SLA model BASE.DAT (XSECs 20.5 through 42.1 (see **Hydraulic And Sediment Transport Analysis Report, Salt River Bank Protection Design, South Bank Upstream Of Pima Freeway, Bank STA. 33+00 To 73+00**, SLA, April 1994).

2. Upstream side of Pima Freeway bridge to Alma School Road uses new cross-sectional geometry developed by R. Ward during July 1998. XSECs 224.33 through 226.32 were manually coded from April 1998 topographic mapping provided by SRPMIC. Cross-sectional geometry for XSECs 226.43 through 226.66 were electronically coded from February 1997 topographic maps provided by *Kimley-Horn & Associates, Inc. (KHA).*

3. All modeling data upstream of the Alma School Road bridge was taken from the MBJ models, with minor modifications as outlined in the previous 1995-1996 Red Mountain Freeway studies.

Topographic maps showing the original WPA/MBJ cross-section locations referenced in this report are included as Plates 1, 2, and 3. Plates 4 and 5 show the updated 1998 cross-sections used for this study, as well as the proposed SRPMIC north-bank levee control-line. Plate 6 shows a portion of the 1997 Kimley-Horn and Associates topography that was used to code the cross-sectional geometry for XSECs 226.43 through 226.66. The levee alignment shown on Plates 4 and 5 was provided by Premier Engineering Corporation.

To date, efforts to retrieve copies of the topographic mapping (and HEC-2 cross-section locations) used in the April 1994 SLA study have been unsuccessful. However, Figure 1 of the April 1994 SLA report does show HEC-2 cross-section locations superimposed onto an aerial photograph of the Salt River. The cross-section numbers on this Figure appear to match those in the SLA HEC-2 model (BASE.DAT). Figure 1 from the SLA report is enclosed in this report as Plate 7.

Using the 1997-1998 topographic mapping, two HEC-2 models were created for use in this report. The first model, SRP2HC2, reflects the actual cross-sectional geometry coded from the topographic maps, and, includes minor filling of dry gravel pit excavations at XSECs 225.66, 225.75, 225.94, and 226.03. The reason for filling these pits is discussed in Section 3.3 of this report. Model SRP2HC2 was used for the existing condition, 100-year water surface profile presented in this report.

The second HEC-2 model, SLAEQHC2, is the same as model SRP2HC2 between XSECs 224.33 through 226.03. However, this second model uses a projected long-term, equilibrium slope invert profile from XSECs 226.13 through 226.66. This long-term profile is based on the assumed, continued propagation of a gravel mining headcut from XSEC 226.13 to the Alma School Road Bridge. A discussion of modeling details for SLAEQHC2 is presented in Sections 3.1.1 and 3.2.2 of this report.

3 SEDIMENT TRANSPORT & SCOUR ANALYSIS

A sediment transport analysis was conducted for the proposed levee in order to examine the potential for sediment deposition impacts to the design water surface profile and for potential undercutting of the bank-lining by scour processes. The following sections address the mechanics of both short-term, single-event bed scour and long-term bed-slope adjustments. Section 3.3 discusses the issue of gravel pits being located adjacent to the levee, while water surface profile fluctuations, associated with moveable-bed geometry, are addressed in Section 4.3.

3.1 Scour Analysis (Non-Gravel Pit Environment)

The design of an erosion resistant bank protection system must consider the potential for scour of the channel bed, if the bed is to be left in a natural condition. Failure to do so could lead to the toe of the bank protection material being undercut by scour processes that will be induced by flowing water. Should this situation occur, the bank-lining material may collapse into the scour hole, thus exposing the bank to erosive velocities and possible lateral movement.

Vertical incisement of the channel bed can occur in response to the following six processes:

$$Z_{tot} = Z_{deg} + Z_{ls} + Z_{gs} + Z_{bs} + Z_{i} + Z_{bf} \quad \text{(Equation 3.1)}$$

where Z_{tot} = total vertical adjustment in bed elevation

Z_{deg} = vertical change due to long-term degradation
Z_{ls} = vertical change due to local scour
Z_{gs} = vertical change due to general scour
Z_{bs} = vertical change due to bend scour
Z_{i} = vertical change due to low-flow incisement
Z_{bf} = vertical change due to bed-form troughs

A brief discussion of each of these phenomena, and its applicability to this project, is presented in the following sub-sections.

3.1.1 Long-Term Degradation

Sediment transport analyses need to distinguish between short-term and long-term changes. Short-term changes are event-specific and occur to some extent during each flood hydrograph. Referring to Equation 3.1, examples of short-term changes would be local scour, general scour, bend scour, bedform troughs, and to some extent, low-flow incisement. With the exception of low-flow incisement, any visible signs of these processes may be difficult to detect after the flow has subsided.

Long-term degradation occurs over a long period of time in response to an imbalance between the sediment transport capacity of the channel and the dominant sediment supply to the channel. When such imbalances occur, the channel will naturally adjust its slope to restore equilibrium between the transport capacity and incoming supply of sediment. If the transport capacity of the channel exceeds the sediment supply, the channel will flatten its slope (degrade). However, should the sediment supply exceed the transport capacity of the channel, the channel slope will increase (aggrade) in order to generate higher velocities that are capable of moving the sediment inflows.

Long-term degradation is very difficult to quantify because of the many complex variables that drive this process. Accordingly, numerous assumptions have to be made on the basis of engineering judgment.

Long-term degradation (and/or aggradation) are normally evaluated with an equilibrium slope analysis. Such an analysis requires that a known or assumed scenario of river or watershed changes will occur and be in existence for an adequate time frame for the river system to re-establish equilibrium with such changes.

Since this reach of the Salt River is undergoing active gravel mining, there is no way that a constant set of river system changes can be assumed for conducting an equilibrium slope analysis, i.e., the equilibrium target is changing on a daily basis, and will probably continue to do so for many years to come. Accordingly, an equilibrium slope analysis is not considered practical for this reach of the Salt River.

As a matter of technical interest, the 1994 SLA report did conduct an equilibrium slope and armoring analysis for that reach of the Salt River between McClintock Drive and Alma School Road. This reach includes the SRPMIC north-bank levee alignment being addressed in this current study.

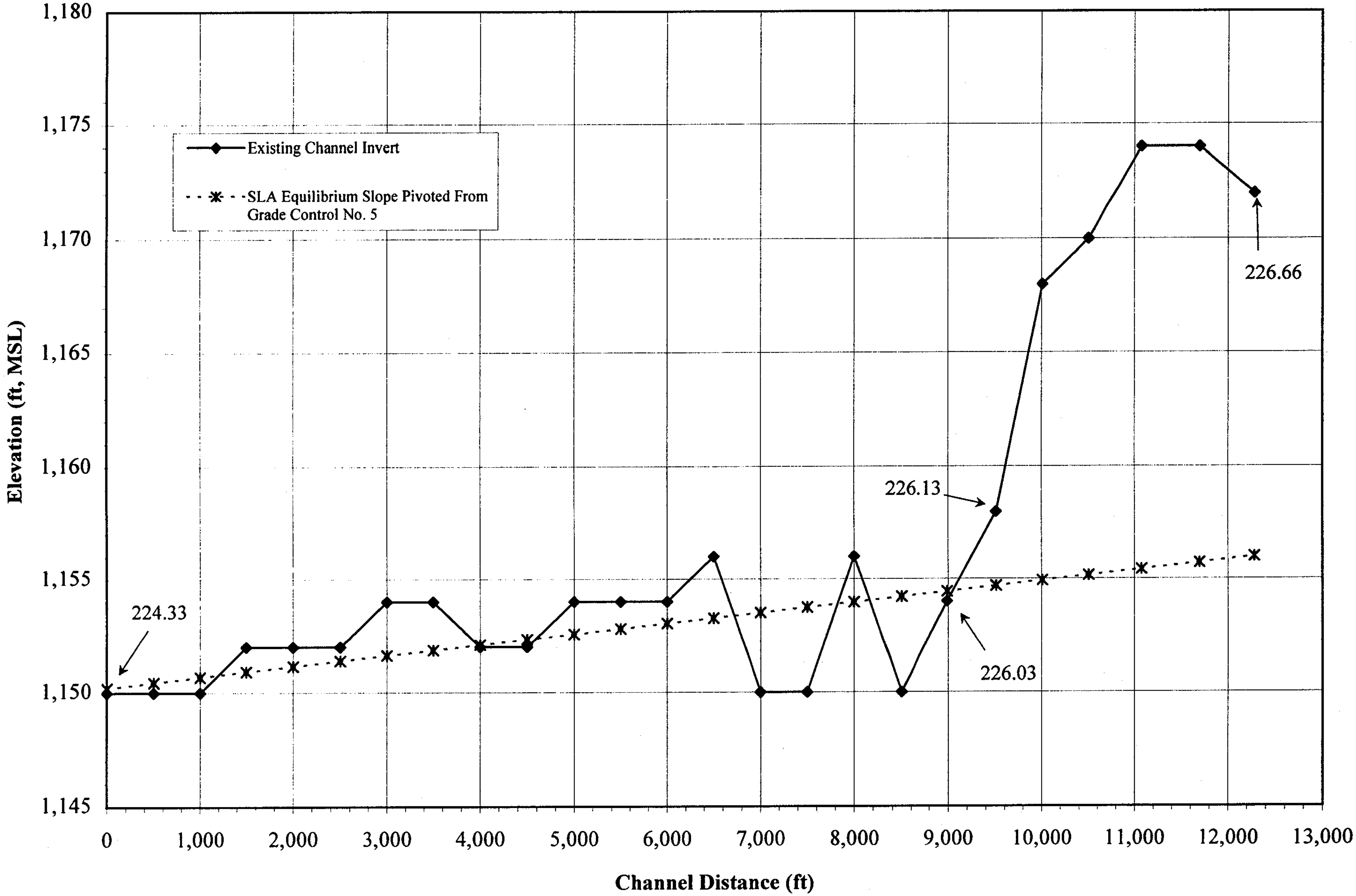
The SLA study published an equilibrium slope of 0.00047 ft/ft, which was pivoted about Grade Control #5, which is located just downstream of McClintock Drive. The SLA report also listed a computed armoring size of 24-mm (0.94"), and an associated armoring depth of 0.3-feet, for the 10-year peak discharge of 95,800 cfs. SLA compared this armoring depth to the theoretical equilibrium slope depth and used the lesser of these two depths to determine the long-term degradation component in Equation 3.1.

For the purpose of continuity with the approved SLA report, the published equilibrium slope of 0.00047 ft/ft, and the Q_{10} armoring depth of 0.3-feet, will also be compared in this report for a prediction of long-term degradation through the current study reach. However, due to the headcut that is presently located at XSEC 226.13, an alternate long-term degradation profile will be applied between XSECs 226.13 and 226.66 (Alma School Road Bridge).

This alternate degradation profile is based on the assumption that the existing headcut will continue to propagate upstream to the Alma School Road Bridge, where presumably, it will be halted by proposed improvements to the existing grade control structure at the bridge. It is further assumed that the riverbed will stabilize at the predicted SLA equilibrium slope of 0.00047 ft/ft, after passage of the headcut.

Figure 3.1 illustrates the long-term degradation profile that is being used in this study. The SLA equilibrium slope that is shown in Figure 3.1 is projected from Grade Control #5. This grade control was used as the projection point because there are no other

Figure 3.1
Long-Term Degradation Profile
SRPMIC North Bank Levee



riverbed "hard-points" between McClintock Drive and Alma School Road that could be used as the pivot point for projecting the equilibrium slope to Alma School Road.

It can be seen from Figure 3.1 that the existing riverbed is essentially at the projected equilibrium slope between XSECs 224.33 and 226.03 (see Plates 4, 5, and 6 for XSEC locations). However, there is a dramatic increase in bed-slope and bed elevation upstream of XSEC 226.03. This discontinuity in the bed-profile is the result of in-stream mining excavations that have occurred downstream of XSEC 226.03. The upstream edge of the headcut created by these mining activities is located at XSEC 226.13. The headcutting activity created by these mining operations will continue to move upstream between XSECs 226.13 and 226.66. The final bed-profile will be assumed to match the 0.00047 ft/ft equilibrium slope projection that extends from XSEC 226.03 through 226.66.

Until the headcut moves completely through this upstream area, any future levee toe-down construction would require nearly 20-feet of excavation just to reach the projected long-term bed profile. Since this headcut is located at the upstream end of the north-bank levee construction proposed in this report, this long-term profile has an insignificant impact on the current levee design; however, it could have a significant impact on any future levee construction that would extend from XSEC 226.13 to the Alma School Road Bridge.

Based on the above discussion, all recommended levee toe-down elevations presented in subsequent sections of this report will be based on the following long-term degradation profile:

1. XSEC 224.33 through 226.03 - Use projected SLA equilibrium slope elevation or Q_{10} armoring elevation, whichever yields the higher elevation. This assumes that the equilibrium slope degradation will be halted by armoring at a depth no greater that 0.3-feet below the existing bed elevation.

2. XSECs 226.13 through 226.66 - Use the projected equilibrium slope elevation shown in Figure 3.1.

3.1.2 Local Scour

Local scour will occur in response to objects being placed in the path of flowing water. The most common form of local scour is that occurring at bridge piers and protruding bridge abutments or spur dikes. This process would be applicable to bridge piers at the Alma School Road crossing of the Salt River. However, since the SRPMIC north-bank levee will terminate downstream of this bridge, the north-bank levee will not be in the pier scour envelope. Accordingly, local scour calculations were not required for this study.

3.1.3 General Scour

This scour process occurs in response to changes in river geometry and/or bed-slope from one reach of a river to the next. As the river cross-section contracts and expands, its flow velocity (and thus sediment transport capacity) will change. General scour will occur when a channel contracts (in the downstream direction) and causes an increase in velocity through the contracted section. The increase in sediment transport capacity through the contracted reach will begin to remove more sediment from the bed of the contracted reach than is being delivered to the contraction by the wider, upstream reach. The result is a lowering (general scour) of the channel bed through the contracted reach. When the channel geometry expands in the downstream direction, the opposite effect can occur, i.e., sediment deposition will take place in the wider channel section. However, sediment deposition can also take place if an artificially constricted channel is subjected to larger sediment inflows than it can transport.

General scour, and/or sediment deposition, is usually quantified with a mobile-boundary sediment routing model, such as HEC-6. Such models are capable of predicting scour and deposition patterns as a function of bed-material size, channel geometry, bed-slope, and changes in discharge that occur during passage of a specific flood hydrograph. Section 3.2 of this report provides a detailed discussion on the sediment routing model that was created to quantify the general scour contribution to the total scour depth for the bank-lining design.

3.1.4 Bend Scour

As the name implies, this process only occurs in the vicinity of channel curvature. For this study, the magnitude of bend scour was completed with the following equation (ADWR, 1985):

$$Z_{bs} = \frac{0.0685 Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right] \text{.............. (Equation 3.2)}$$

where Z_{bs} = depth of bend scour (ft)

V = mean velocity of upstream flow (fps)

Y = maximum depth of upstream flow (ft)

Y_h = hydraulic depth of upstream flow (ft)

S_e = upstream energy slope (ft/ft)

alpha = 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)

Depth and velocity data for the bend scour calculations were taken from HEC-2 File SLAEQHC2. Curvature angles were measured from the MBJ topographic mapping and are listed in the scour calculation table in Section 4.2.

Engineering judgment was used to taper-off the bend scour depths through the downstream end of the channel curvature near XSEC 226.03. The length of bend scour decay beyond this cross-section was computed as 1,050-feet. This would place the end of the bend scour component between XSECs 225.75 and 225.85. Accordingly, the bend scour angle of curvature was decreased through these two XSECs to force a gradual reduction in bend scour from 7.52-feet at XSEC 226.03 to 0-feet at XSEC 225.75.

The approximate downstream limit of the bend scour component was computed with Equation 3.3 (ADWR, 1985):

$$X=2.3\left(\frac{C}{\sqrt{g}}\right)Y \text{ . . . . (Equation 3.3)}$$

where X = distance from the end of channel curvature (point of tangency) to the downstream point at which secondary currents have dissipated (ft)

C = Chezy coefficient

Y = maximum depth of flow within the bend (ft)

g = 32.2 feet/second^2

3.1.5 Low-Flow Incisement

Man-made channels with large width to depth ratios are very vulnerable to the formation of low-flow channels. When trapezoidal channels, designed to carry large events such as the 100-year flood, are exposed to smaller, more frequent flows (2- to 5-year floods), the wide channel bottomwidths may cause a shallow sheetflow condition to exist. Rather than transporting small flows in this manner, nature will incise a low-flow section (similar to manmade pilot channels in wide trapezoidal sections) that provides a more hydraulically efficient conveyance for small discharges.

Low-flow channels will meander across the bottom of the larger, parent channel, thus randomly coming into contact with the channel banks. Accordingly, it is important to acknowledge low-flow incisement when computing the total scour depth for bank-lining design.

That reach of the Salt River extending for approximately 1.6 miles upstream from the Pima Freeway bridge has recently been graded to a relatively level bottom. Accordingly, there is potential for low-flow incisement to occur within this reach. This potential has been acknowledged in the scour calculations by including a 1.5-foot low-flow incisement depth in the cross-sections that are located within this region (XSECs 224.33 through 225.85).

Areas upstream of this reach exhibit effects of gravel mining and head-cutting. Accordingly, no practical low-flow incisement depth could be assigned to these areas. It is assumed that the existing and projected head-cutting (long-term degradation) through this upstream region will satisfactorily account for minor low-flow incisement.

3.1.6 Bed-Form Troughs

Sand and gravel-bed channels are prone to the development of transitory bedforms, such as dunes and antidunes. Such bedforms create troughs, or depressions, below the natural bed of the channel during the flow event. In order to account for the possibility of these troughs forming adjacent to the toe of the bank, it is prudent to include bedform troughs in the estimate of total scour. Although this reach of the Salt River has a very cobbly bottom, which may tend to inhibit the full development of bed-forms, calculations were performed in order to include this scour component in the toe-down design for the proposed levee embankment.

Based on laboratory flume studies, the maximum depth of antidune troughs (below the existing channel bed) is approximately equal to $\underline{0.0135V^2}$ or one-half the depth of flow, whichever value is less (ADWR 1985).

For lower regime flow, dune heights can be estimated from the following relationship (Simons & Senturk, 1977):

$$\log d = 0.8271 \log A + 0.8901 \quad \text{(Equation 3.4)}$$

where d = mean flow depth (meters)
A = dune height, from trough to crest (meters)

Table 4.1 (in Section 4.2 of this report) presents a quantitative summary of the preceding scour processes and recommended scour depths that should be applied to the bank-lining toe-down design. It should be noted that the total scour depths include a safety factor of 1.5. A minimum scour depth criteria of 10-feet is also applied to all locations.

3.2 Sediment Routing Model (HEC-6)

As discussed in Section 3.1.3, the general scour and sediment deposition process is an event-specific analysis that is most accurately performed with a mobile-boundary sediment routing model. Accordingly, the Corps of Engineers HEC-6 Program, Version 4.1.00, October 1993, was used to analyze the sediment transport performance of this reach of the Salt River.

Due to the split-flow condition in the vicinity of Alma School Road, separate HEC-6 models were created for the main channel and the smaller channel that flows around the south side of the island between McKellips Road and Alma School Road. The model for the south channel was used for the Red Mountain Freeway analysis, but was not used for the proposed north-bank levee, which is the focus of this study.

In addition to cross-sectional geometry, required input data for HEC-6 consists of a flood hydrograph, a sediment supply rating curve, a bed-material gradation, and the selection of a sediment transport equation. HEC-6 uses this information to compute hydraulic data and sediment transport rates for discrete intervals of time throughout the inflow hydrograph. The incoming sediment load is also computed for each hydrograph interval and introduced to the model at the most upstream cross-section.

The difference in sediment inflow and sediment transport is computed for the upstream control section and any imbalance between the two quantities is converted to a sediment volume and distributed within a *"control reach length"* that is a function of adjacent cross-section spacing. If the sediment inflow exceeds the channel transport rate, then sediment deposition occurs and the channel bed is adjusted upward to reflect the excess volume of material. If the reverse condition occurs, then scour will result in a lowering of the bed elevation.

The difference between actual sediment transport rate and incoming sediment load at the first control section becomes the sediment supply to the next downstream control section. This process is repeated until the downstream end of the model is reached. The next interval of the hydrograph is then introduced and the entire calculation sequence is repeated.

The Meyer-Peter and Muller (MPM, 1948) sediment transport equation was used for this study. This equation is recommended for streams with relatively coarse bed-material and very little suspended bed-material load. The cobbly bottom of the Salt River and the sediment trap efficiency of upstream SRP dams would seem to support these assumptions for the study reach addressed in this report. The MPM equation was also used in the sediment routing model prepared by SLA for the adjacent downstream reach of the Salt River, although it was integrated with Einstein's procedure for suspended bed-material load. Einstein's procedure is not an available option in HEC-6.

The following sub-sections discuss specific elements of the input data developed for the HEC-6 models presented in this report.

3.2.1 Flood Hydrograph

The hydrograph used for the sediment routing model was identical to that used in the previously referenced 1994 SLA report. The hydrograph coordinates, which were provided to Wood-Patel by SLA, reflect a 100-year, 10-day flood with a peak discharge of 220,000 cfs for the main channel of the Salt River.

The split-flow hydrograph for the south channel (around the Alma School Road island), was created by reducing all the main channel hydrograph ordinates by a ratio of 0.3295. This reduction constant is based on the ratio of the peak south channel discharge to the peak main channel discharge, i.e., 72,500/220,000. The peak south channel discharge was identified from a split-flow analysis performed by Wood-Patel.

Figure 3.2 presents a plot of the main channel and south channel hydrographs that were used with the HEC-6 model. The peak discharges used for the main channel hydrograph were reduced between XSECs 226.13 through 226.89 to reflect the loss of flow through the south channel.

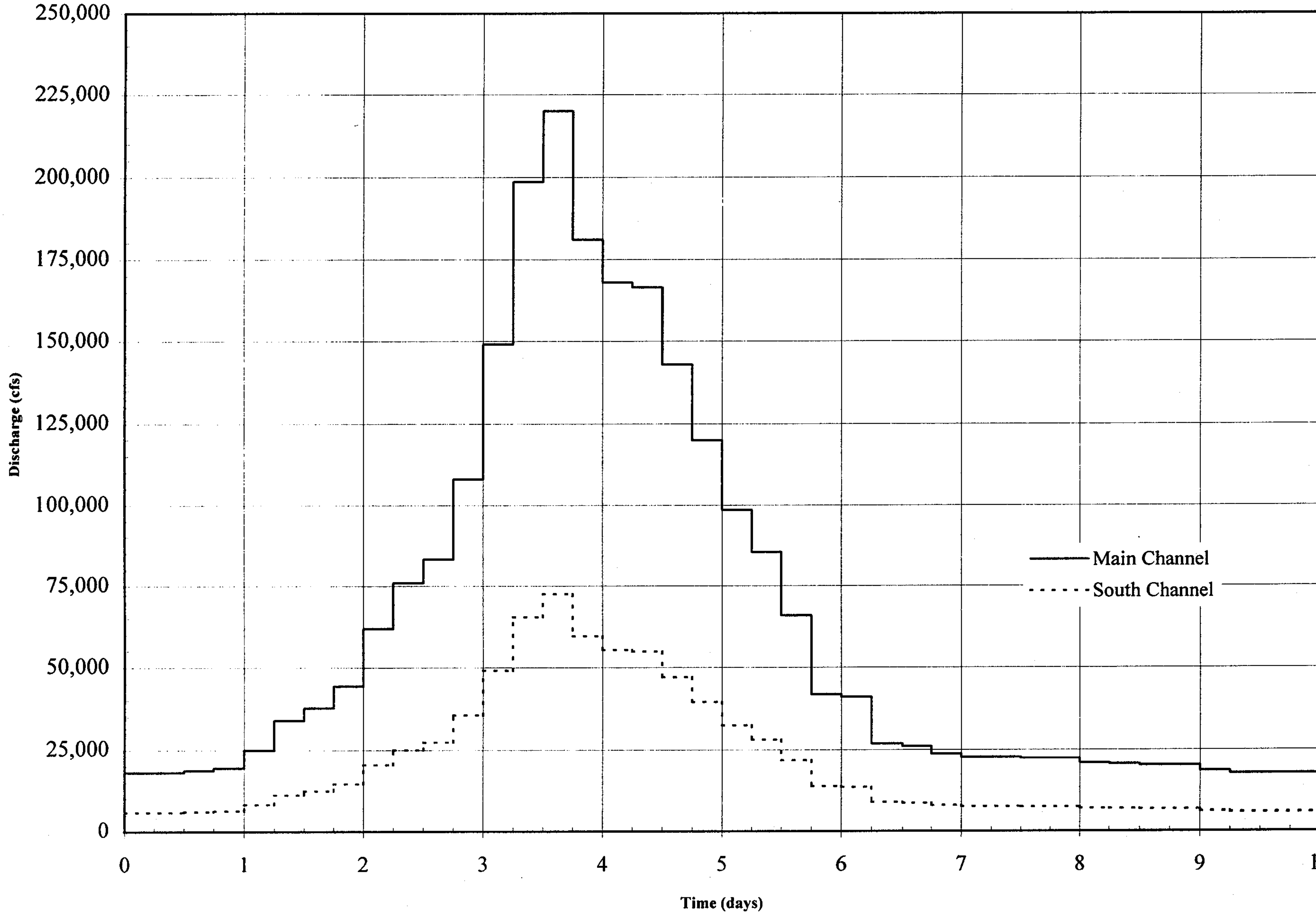
The main channel starting water surface elevations for each interval of the discretized hydrograph were taken from HEC-2 file WSL2 at XSEC 224.33, which is the downstream end of the HEC-6 models prepared for this study. File WSL2 is HEC-2 file SRP2HC2 with all cross-sections eliminated upstream of XSEC 224.33. Multiple profile runs were made for discharges ranging from 17,000 to 237,000 cfs, at 20,000 cfs intervals. The resulting water surface elevations were used to input an elevation/discharge relationship to the HEC-6 model.

3.2.2 Cross-Section Data

HEC-2 file SRP2HC2, previously referenced in Section 2.1 of this report, was used to provide the initial river geometry for the HEC-6 model. However, the HEC-6 version of the river geometry did not include any fill for the dry gravel pits at XSECs 225.66, 225.75, 225.94, and 226.03.

As discussed in Section 3.1.1, the long-term degradation profile used in this study assumes that an existing headcut (presently located at XSEC 226.13) will continue to propagate to the Alma School Road Bridge. The HEC-6 (and HEC-2) models that were created for the post-headcut riverbed profile use invert elevations (from XSECs 226.13 through 226.66) that match the SLA equilibrium slope profile that is projected from Grade Control No.5.

Figure 3.2
100-Year Discretized Hydrograph
Salt River - Country Club Drive to Pima Freeway Bridge



The post-headcut channel geometry that will exist through this reach was simulated as a 4-point trapezoidal section with a bottomwidth of 835-feet and 2:1 side-slopes. This cross-sectional geometry was used for XSECs 226.13 through 226.66. The 835-foot bottomwidth for these sections was based on the average river bottomwidth that presently exists through this reach of the river.

The GR data and encroachment stations from this model were visually reviewed with the PLOT2 subroutine in HEC-2 in order to verify that overbank gravel pit areas were not being used in the hydraulic calculations.

In addition to specifying effective flow boundaries for hydraulic calculations, HEC-6 also provides the capability to specify the horizontal limits of the moveable-bed geometry. This is an important feature which allows the user to exclude overbank areas which would not reasonably be expected to contribute to the scour or deposition process in a river.

For this study, moveable-bed limits were based on a visual review of PLOT2 cross-sections. Using this visual illustration of the river geometry, the moveable-bed width was generally set to coincide with the toe of the slope of the main channel bank-lines.

The allowable depth of scour within the moveable-bed width was set at 10-feet, except at grade control structures, which were modeled with a hard bottom.

In addition to cross-sectional geometry, cross-section spacing is also an important parameter in sediment routing calculations. The length of the control volume that HEC-6 uses for sediment transport calculations is defined as the distance between a point located halfway between the current cross-section and the adjacent upstream cross-section and the adjacent downstream cross-section. Irregular cross-section spacing will cause this control section length to vary along the length of the river. Such irregular spacing will result in errors in the bed-level changes that HEC-6 computes for each hydrograph interval. For example, bed-material may be scoured from a control section that is 800-feet long and transported to an adjacent control section that is only 200-feet long. Assuming equal bed-widths and hydraulic parameters within each section, the transported material from the 800-foot section will have a much smaller downstream surface area available for the distribution of any excess sediment. This would result in a larger depth of sediment deposition than would occur if the downstream control section were also 800-feet long.

The cross-section spacing in the MBJ HEC-2 models, provided by Wood-Patel, was found to be fairly uniform in the 500- to 600-foot range. Although there was some irregularity in the cross-section spacing, it was not considered severe enough to cause any major calculation errors. The new cross-sectional geometries coded by R.Ward (for that region downstream of Alma School Road) were spaced at about 500-feet apart.

It should be noted that the bridge cross-sections at Alma School Road were eliminated from the HEC-6 model. These sections were eliminated because of the short cross-section spacing and because HEC-6 cannot accept bridge routines used in HEC-2. XSEC 226.66 was added just downstream of the Alma School Bridge location (north channel only) in order to promote uniform cross-section spacing to MBJ XSEC 226.61, which is located just upstream of the Alma School Road bridge.

3.2.3 Bed-Material Gradation

The bed-material gradation used for the HEC-6 model was the same as that used by SLA for the sediment routing model through the adjacent downstream reach of the Salt River. No additional sampling information was available which was considered to be anymore reliable than that used in the 1994 SLA report.

Although *AGRA Earth & Environmental, Inc.* did perform bed-material sampling at four locations within the study reach, the sampling was limited to the existing surface armor layer and was not representative of material below the armor layer. Accordingly, this information was not considered suitable for use in the HEC-6 model.

Table 3.1 summarizes the sediment gradation data taken from the 1994 SLA report. The data in Table 3.1 is plotted in Figure 3.3.

3.2.4 Sediment Supply

A required input parameter for a sediment routing model is an estimate of the sediment load being supplied to the upstream end of the model.

The sediment load table for the main channel was developed through an iteration process that assumes a cross-section at the upstream end of the model is being supplied sediment at a rate that is in equilibrium with the theoretical transport rate of the cross-section. Using an initial guess of the inflowing sediment load for a specific water discharge, HEC-6 will compute the sediment load, in tons/day, for each size fraction in the given bed-material gradation. This information is then used to compute an updated sediment transport potential for each size fraction. This updated size fraction data is entered on the

Table 3.1 Sediment Gradation For HEC-6 Modeling Country Club Drive to Evergreen Road Salt River	
Particle Size (mm)	Cumulative Percent Passing (%)
0.15	5.00
0.30	10.00
0.60	18.00
1.18	25.00
2.36	30.00
4.75	36.00
12.50	46.00
25.00	62.00
50.00	70.00
75.00	78.00
152.40	88.00
228.60	96.00
304.80	100.00

LF record and the model is re-run. This iteration process is continued until the computed fraction of the total sediment load for each grain size matches that which is input to the model.

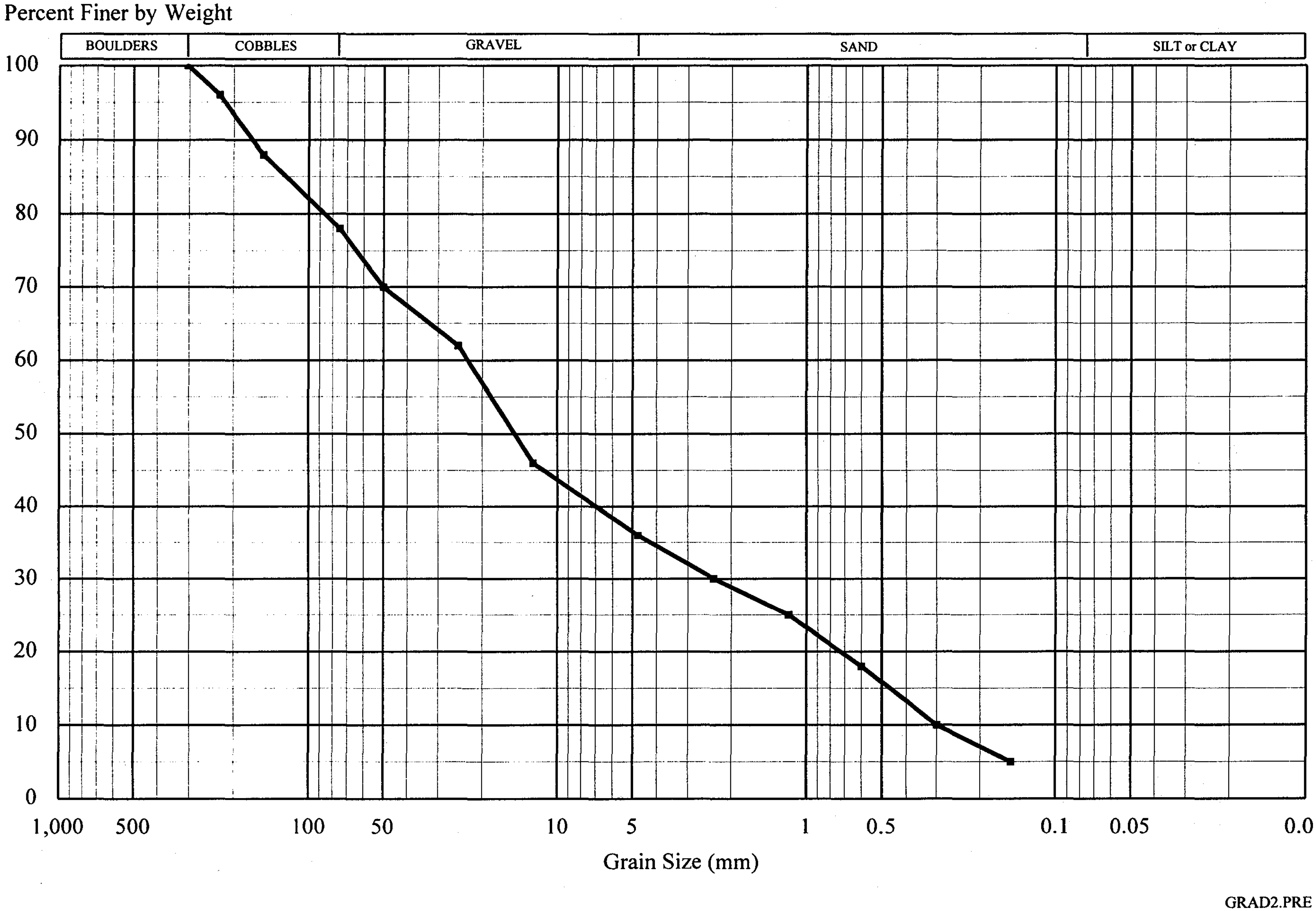
The first step in this iterative process identifies the fraction (or percentage) of each grain size contributing to the total sediment load for a given discharge, e.g., for Q = 25,000 cfs, 2.8% of the total sediment load might be composed of fine gravel (4-8mm), 4.5% of coarse gravel (16-32mm), etc.

Once the transport potential for each sediment size fraction has been determined for a range of water discharges, the total sediment load curve is developed to relate water discharge (cfs) to total sediment discharge (tons/day). In order to estimate the total sediment load curve, different sediment loads (tons/day) were input to the model until a load rate was found which produced very little vertical bed movement (at the upstream end of the model) over a 10-day flow period. The load rate that produced this minimal bed movement was assumed to be in equilibrium with the transport rate at the upstream

Figure 3.3

Sediment Gradation For Salt River Bed-Material

SRPMIC North Levee - Pima Freeway Bridge to Alma School Road



end of the model. This process was repeated for each water discharge used to define the sediment load curve.

Figure 3.4 illustrates the sediment load relationship that was developed using this procedure. This figure also shows a power regression curve that was fit to the actual data points in an effort to provide a more uniform sediment load relationship at the upper end of the flood hydrograph. Experimental runs with the HEC-6 model indicated that there was very little difference in bed level changes when changing the sediment load table from the actual data points to the regression curve values. Accordingly, the actual computed sediment load data points were used for the final HEC-6 runs, rather than the predicted regression curve values.

Any errors in the upstream sediment load curve are "washed out" within a few cross-sections, as the model becomes controlled by the actual sediment transport rates and sediment movement through the downstream control sections.

It should be noted that the sediment load curve that was developed for the original September 15, 1995 Red Mountain Freeway scour analysis was updated in 1996 as part of the supplemental study **Sediment Transport Analysis, Salt River, Red Mountain Freeway, Supplement No. 1, McKellips Road to Country Club Drive**, Robert L. Ward, P.E., October 3, 1996. This updated sediment load curve was used for the SRPMIC north-bank levee analysis.

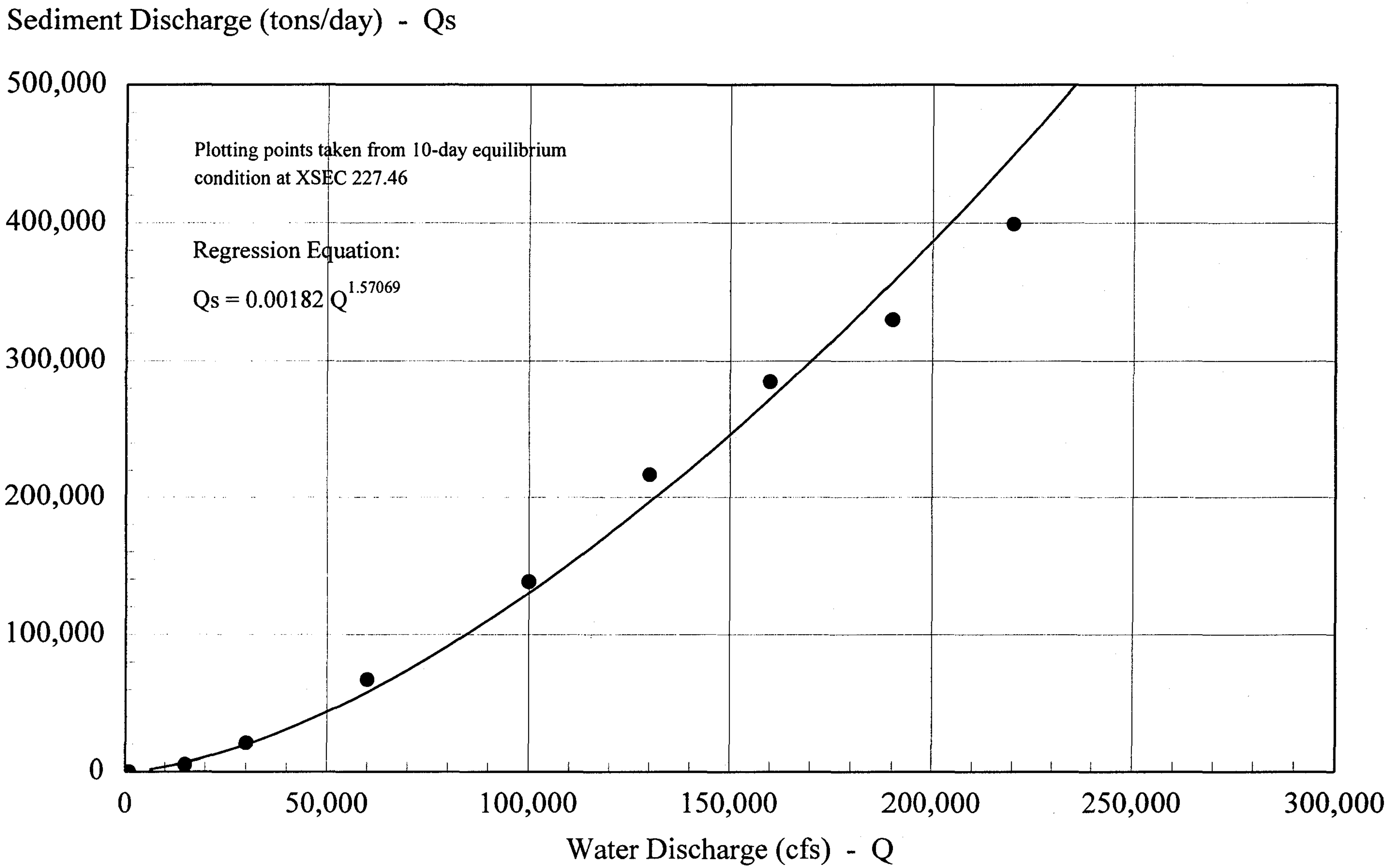
The only change that was made to the original 1995 HEC-6 parameters, in preparing the 1996 supplemental study, was a revision to the sediment supply data that is input at the upstream end of the model. The total sediment load versus water discharge relationship (LT record) was not changed from the previous 1995 study. However, the sediment transport potential for each bed-material grain size (LF records) that would be in transport during various stages of the 100-year, 10-day hydrograph was changed. The LF records tell the HEC-6 model what percentage of the total inflowing sediment load to allocate to each grain size classification.

The calculations for establishing grain size transport potential are dependent on the cross-sectional geometry and hydraulics of the river section that is used for the upstream sediment supply calculation. The September 15, 1995 study used data associated with XSECs 227.46 and 227.56, which are located immediately downstream of the Country Club Drive Bridge. With the easterly extension of the Red Mountain Freeway, the HEC-6 model was extended to Mesa Drive. Accordingly, calculations for grain size transport potential were updated to reflect the geometry and hydraulics of XSECs 229.12 and 229.21, which are located immediately downstream of Mesa Drive. Since this new location exhibits different hydraulic characteristics than that below Country Club Drive, the distribution of sediment sizes within the total inflowing sediment load will change. Accordingly, the LF records were updated to reflect this change.

Figure 3.4

SRPMIC North Levee Along Salt River

Upstream Sediment Load Curve



File: QQS2.PRE

Consideration was also given (in 1996) to updating the total sediment load versus water discharge relationship (LT record) to reflect this new upstream location. However, the initial runs of the model with the original LT record, and the updated LF records, revealed a very stable bottom profile at the upstream end of the model during passage of the 100-year, 10-day hydrograph, e.g., less than 4-inches of vertical bed movement occurred at XSECs 229.12 and 229.21 during the flood. These near-equilibrium starting conditions are justification for accepting the original LT record for this extended HEC-6 analysis.

Since HEC-6 is not capable of processing bridge routines used in the HEC-2 model, the 1996 supplemental report also removed bridge cross-sections at Country Club Drive, i.e., XSECs 227.61, 227.62, 227.63, and 227.64 were deleted from the HEC-6 model.

Except for updating the cross-sectional geometry between the Pima Freeway and Alma School Road bridges, no other changes were made to the HEC-6 input data that was presented in the October 3, 1996 report for the Red Mountain Freeway.

As stated previously, a separate HEC-6 model was created (as part of the 1995 Red Mountain Freeway report) to evaluate that portion of the south channel located between Alma School Road and McKellips Road. It is difficult to identify with any certainty how much of the main channel sediment load would be diverted into the south channel. Accordingly, two scenarios were created in order to examine a probable sediment load envelope for this split-flow location.

As a worst-case condition, the first scenario assumed none of the main channel sediment would enter the south channel. This would create a "clear-water" inflow condition which would be expected to induce the maximum scour profile through the south channel.

The second condition assumed that the sediment <u>concentration</u> in the south channel would be the same as that in the main channel. Under this scenario, the sediment size fractions for the south channel are assumed to be transported in the same <u>ratios</u> (for a given water discharge) as used in the main channel. However, the inflowing sediment <u>load</u> (tons/day) from the main channel to the south channel was reduced by the ratio of the peak discharge in the south channel to that in the main channel, i.e., 72,500/220,000 = 0.3295.

The following section provides a more in-depth discussion of how sediment diversions were handled around the Alma School Road "island".

3.2.5 Special Considerations Near Alma School Road

The sediment routing analysis in the vicinity of the Alma School Road bridge is complicated by the following factors:

1. A large gravel pit is located immediately downstream of the Alma School Road bridge over the south channel (not applicable to SRPMIC north-bank analysis).

2. A split-flow condition occurs around an island at Alma School Road.

3. Concrete grade control structures have been built at both the north and south bridge crossings on Alma School Road to halt headcutting that has occurred in response to downstream gravel mining operations.

Some engineering judgment was required in order to configure the HEC-6 model to address these features without causing unreasonable fluctuations in the hydraulic calculations. These modeling techniques are discussed in the following sub-sections.

3.2.5.1 Split-Flow Analysis

No attempt was made to apply HEC-6 to the large gravel pit that captures the outflow from the south channel. However, the existence of this pit was used to justify an assumption that no sediment flows will enter the main channel from the south channel. This gravel pit is assumed to provide 100-percent trap efficiency for any sediments transported into the pit by flows diverted through the south channel.

This split-flow condition is simulated in the HEC-6 model for the main channel by adding a local inflow point just upstream of XSEC 226.03 and a local diversion point at XSEC 226.89. For the main channel model, the water flow between these two cross-sections is reduced by the amount of water flowing through the south channel. The sediment flow diverted from the main channel at McKellips Road is computed by HEC-6 on the basis of the diverted water discharge and on an assumption of equal sediment concentrations existing in the main channel flow and diverted flow. This diverted sediment load is not allowed to re-enter the model at XSEC 226.03, i.e., it is trapped in the gravel pit. However, the diverted water discharge is returned to the model at XSEC 226.03.

3.2.5.2 Main Channel Headcut

As a result of in-stream gravel mining that was initiated downstream of Alma School Road in the mid-1980s, a large headcut has moved up the river-bed and lowered the main channel-bed through the Alma School Road Bridge. A concrete grade-control structure has been built at the bridge to prevent any further channel degradation that might jeopardize the stability of the bridge piers.

This grade-control structure creates an abrupt vertical drop in the riverbed profile at the downstream side of the bridge. In accordance with instructions from ADOT (as part of the 1995 **Red Mountain Freeway** sediment transport analysis), this grade-control structure was assumed to remain intact during the 100-year, 10-day flow event being analyzed in this report.

Since HEC-6 does not have a bridge analysis routine, the Alma School Road HEC-2 bridge coding was not included in the HEC-6 model. An additional cross-section (XSEC 226.66) was inserted in the HEC-6 model, just downstream of the grade control structure, to promote uniform cross-section spacing through the bridge. In order to simulate the effect of the concrete grade control structure on the upstream channel bed-profile, XSEC 226.61 was coded as a "hard bottom" so that no scour could occur at this location. All sections upstream of XSEC 226.61 were left with soft bottoms.

As previously discussed in Sections 3.1.1 and 3.2.2, a long-term equilibrium slope profile has been inserted in the HEC-6 model to simulate the continued movement of this headcut towards the Alma School Road Bridge.

3.3 Gravel Pit Analysis

Numerous remnants of recent in-stream gravel mining are visible through that reach of the Salt River that extends from the Pima Freeway Bridge to Alma School Road. The April 1998 topographic mapping shows several lakes in the riverbed which are assumed to be water-filled gravel pits. This mapping also shows several dry depressions in the riverbed, which would indicate that excavation has previously taken place.

Design criteria for evaluating in-stream gravel pits was previously published in a July 29, 1992 letter from Simons, Li & Associates, Inc. (SLA) to Daniel, Mann, Johnson & Mendenhall (DMJM). The criteria in this letter was approved by the Flood Control District of Maricopa County (FCDMC) via letter dated August 11, 1992 from Donald J. Rerick, to Thomas M. Monchak, DMJM. Both of these letters were included in Appendix IV to the previously referenced 1994 SLA report.

The 1992 letter indicated that scour dimensions associated with in-stream mining would be estimated from relationships published in **"Investigation of Gravel Mining Effects, Salt River Channelization Project At Sky Harbor International Airport"**, Colorado State University (CSU), December 1980.

The three design conditions outlined in the 1992 letter are summarized as follows:

1. If gravel pits are located within 150-feet of the bank, fill will be required and the total scour depth will be the sum of the normal scour depth plus a lateral migration depth component. The toe-down depth will be extended at least 3-feet below the point where the fill meets the existing channel invert.

2. If gravel pits are located between 150 and 300-feet of the bank, no fill will be required and the total scour depth will be the sum of the normal scour depth plus a lateral migration component.

3. If gravel pits are located beyond 300-feet from the bank, the total scour depth will be computed as the normal scour depth. This scenario assumes the bank is not within the scour envelope associated with the gravel pit.

Without knowing the depth of the existing water-filled pits, it is impossible to accurately apply the above criteria to an analysis of the proposed north-bank levee. This issue was discussed with representatives from SRPMIC on July 28, 1998. In order to isolate the proposed levee system from any increased scour potential associated with these pits, SRPMIC agreed to fill the pits to elevations to be specified in this report. The total scour depths in Table 4.1 of this report would then be referenced to the filled elevations of these pits.

Table 3.2 is a summary of the pre- and post-fill elevations for each XSEC through the study reach. The pre-fill elevations are referenced to the 1997-1998 mapping discussed in Section 2 of this report. These pre-fill elevations represent the low point in each cross-section, as read from the topographic mapping. In the case of the water-filled pits, the low-point is equal to the water surface elevation in each pit. In the case of dry pits, the low point is the actual bottom of the pit.

For the water-filled pits, the post-fill elevation is simply equal to the pre-fill elevation of the pit's water surface. In these cases, the pre- and post-fill elevations used in the HEC-2 and HEC-6 models are identical.

Post-fill elevation adjustments were only required at XSECs 225.66, 225.75, 225.94, and 226.03 for the dry pits. The pits at these four locations are small to moderate in size and have no significant impact on the river system hydraulics. The amount of fill recommended at these four locations ranges from 2 to 6-feet. Gradation data for this proposed fill is being developed by Premier Engineering Corporation.

4 CALCULATION SUMMARY & RECOMMENDATIONS

The preceding sections of this report present discussions of the technical procedures and assumptions that were used to perform the scour analysis for the proposed SRPMIC north-bank levee that will extend from the Pima Freeway Bridge to just west of the Alma School Road Bridge. This final section of the report presents both tabular and graphical summaries of the calculation results and recommendations for the bank-lining toe-down and top of CSA embankment elevations for the levee design.

Table 3.2
Summary of Recommended Fill Elevations For Existing Gravel Pits
Proposed SRPMIC North-Bank Levee
Pima Freeway to Alma School Road

Levee Station In Feet	Applicable HEC-2/HEC-6 XSEC	Pre-Fill Thalweg Elevations (ft, MSL)	Post-Fill Thalweg Elevations (ft, MSL)	Difference (ft)	Comments
1,161	224.33	1150	1150	0	Water-filled pit, actual depth unknown
1,670	224.42	1150	1150	0	Water-filled pit, actual depth unknown
2,169	224.52	1150	1150	0	Water-filled pit, actual depth unknown
2,669	224.61	1152	1152	0	Water-filled pit, actual depth unknown
3,169	224.71	1152	1152	0	Water-filled pit, actual depth unknown
3,670	224.80	1152	1152	0	Water-filled pit, actual depth unknown
4,169	224.90	1154	1154	0	No pit
4,630	224.99	1154	1154	0	No pit
4,919	225.09	1152	1152	0	No pit
5,400	225.18	1152	1152	0	No pit
5,879	225.28	1154	1154	0	Water-filled pit, actual depth unknown
6,310	225.37	1154	1154	0	Water-filled pit, actual depth unknown
6,654	225.47	1154	1154	0	Water-filled pit, actual depth unknown
7,130	225.56	1156	1156	0	No pit
7,603	225.66	1150	1152	2	Small depression
8,090	225.75	1150	1152	2	Moderate depression
8,570	225.85	1156	1156	0	Water-filled pit, actual depth unknown
8,910	225.94	1150	1156	6	Moderate depression
9,194	226.03	1154	1156	2	Moderate depression
9,832	226.13	1158	1158	0	Begin headcut
10,350	226.23	1168	1168	0	No pit
10,865	226.32	1170	1170	0	No pit
11,708	226.43	1174	1174	0	No pit
12,360	226.54	1174	1174	0	No pit
13,043	226.66	1172	1172	0	No pit

Note: Pre-fill & post-fill elevations for water-filled pits are based on existing water-level elevations shown on topographic maps.
Levee stations have been updated for 10/98 levee alignment.

File: Gravel Pit Fill Summary.xls

4.1 Results of HEC-6 Modeling

The HEC-6 output generates a summary of bed-profile and water surface profile changes for each time step at each cross-section. For the 34 time steps and 25 cross-sections used between the Pima Freeway and Alma School Road Bridges, 850 data sets were produced by the HEC-6 model for the 100-year, 10-day flood. Each of these data-sets had to be examined to find maximum and minimum bed profile and water surface profile fluctuations for each cross-section during each of the 34 time steps. This examination process was expedited by importing the HEC-6 output files into an EXCEL spreadsheet, where electronic data scans were performed to find maximum and minimum data points.

A copy of this spreadsheet is enclosed in Appendix A, which is composed of two data sets which show the scour or deposition dimension (feet) at each time step, as well as the adjusted bed profile elevation (feet MSL) for each time step. Summary columns are provided at the end of each data set to summarize the maximum and minimum conditions that occurred at each cross-section during the 10-day flow event. It should be emphasized that the scour and deposition elevations in Appendix A do not reflect the proposed minor filling of dry gravel pits at XSECs 225.66, 225.75, 225.94, and 226.03. It should also be emphasized that the initial bed profile elevations listed in this Appendix reflect the SLA equilibrium slope shown in Figure 3.1.

Figure 4.1 graphically illustrates the data in Appendix A in the form of bed-profile plots. This Figure shows the initial (pre-flood) bed profile, the maximum scour and deposition profiles that occur during the 10-day flood, and the bed-profile that occurs during the peak discharge of the 100-year, 10-day flood. The "X-axis" in Figure 4.1 reflects an extension of the HEC-6 XSECs into the proposed north-bank levee alignment. As a result, the HEC-6 XSECs are plotted as a function of their intersection points with the north-bank levee stationing. Several of the HEC-6 XSEC points are labeled in Figure 4.1. These XSEC locations are plotted on Plates 4, 5, and 6.

Figure 4.2, which is a companion plot to Figure 4.1, shows the actual general scour and deposition depths which were generated by HEC-6. This Figure provides a clear picture of the magnitude and location of vertical bed movement predicted by HEC-6 during the 100-year, 10-day flood. The large deposition region that develops between XSECs 226.23 and 226.66 is in response to the relatively flat, long-term bed-slope that exists immediately downstream of the Alma School Road Bridge The average slope immediately upstream of the bridge is nearly 16-times steeper (0.0077 ft/ft vs 0.00047 ft/ft) than the assumed long-term equilibrium slope downstream of the bridge. This difference in slope translates into much higher sediment transport rates upstream of the bridge than exist downstream of the bridge. Accordingly, there is a major amount of sediment deposition occurring within the first half-mile below the Alma School Road Bridge. Once this initial deposition occurs, the remaining length of the study reach (to the Pima Freeway Bridge), which is already at, or near, the long-term equilibrium slope, has sediment transport rates that are generally in

Figure 4.1
Salt River Bed Profile From HEC-6 Analysis
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood

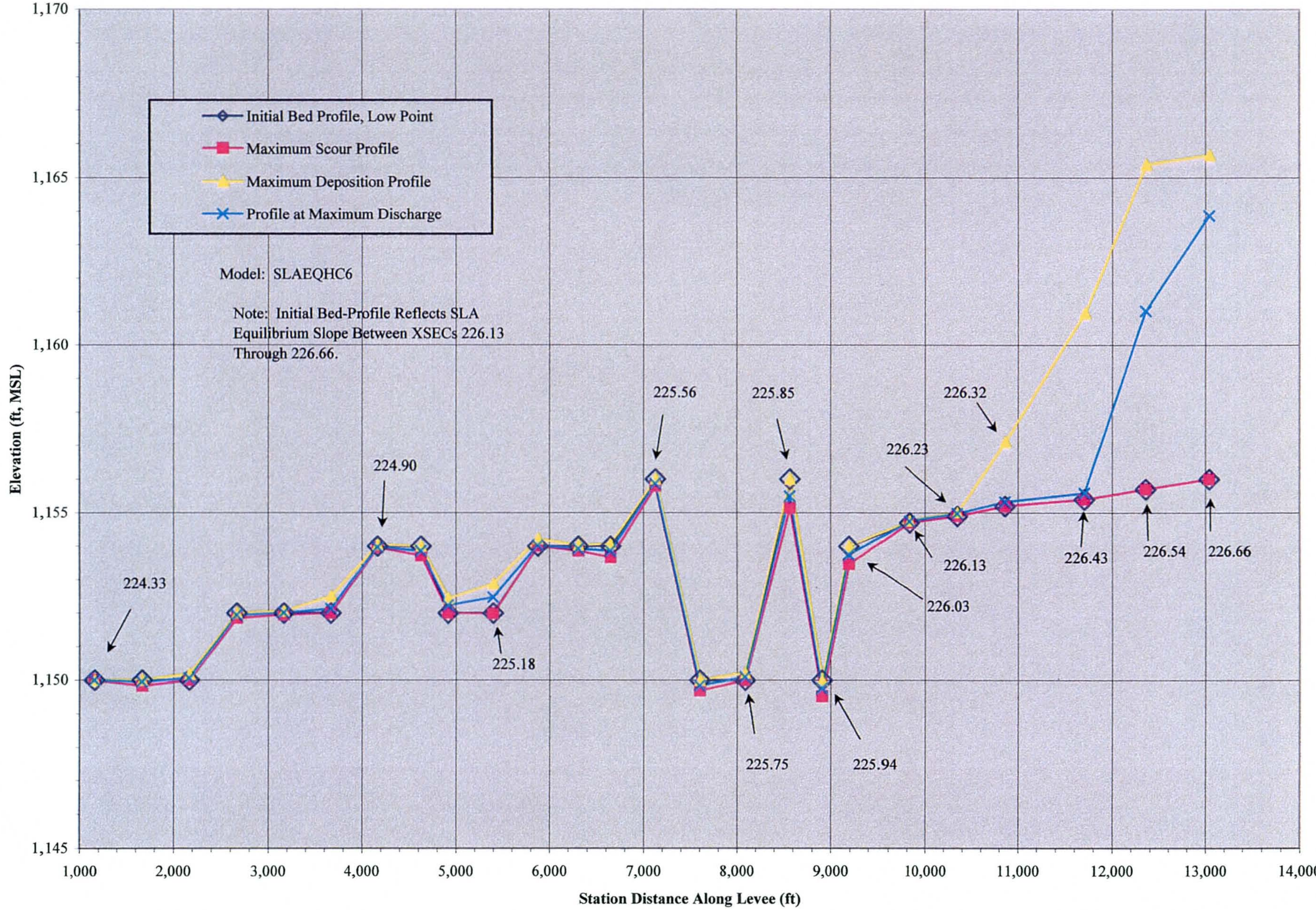
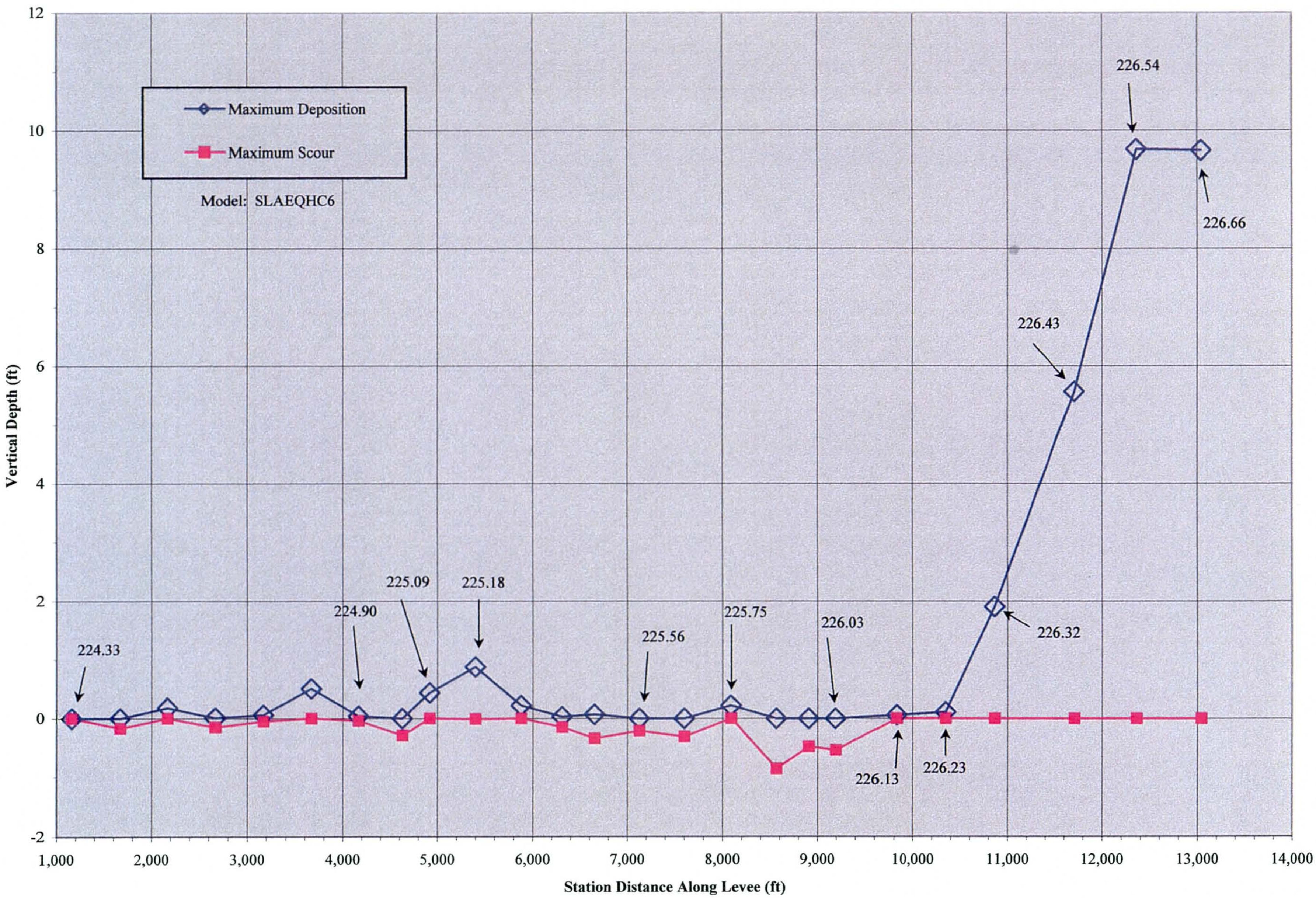


Figure 4.2
Scour & Deposition Profiles
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood



balance with those between XSECs 226.23 through 226.66. Accordingly, very little bed movement occurs downstream of XSEC 226.23.

Figure 4.3 presents the channel velocity profile between the Alma School Road Bridge and the Pima Freeway Bridge. The slightly higher velocities downstream of XSEC 226.23 correlate well with the scour and deposition profile in Figure 4.2, i.e., the higher velocities at these downstream XSECs generate sediment transport rates that are capable of moving any sediment that is transported beyond the large deposition region upstream of XSEC 226.23.

The velocity profile for the existing bed profile is also plotted in Figure 4.3. This information is included to provide insight into the interim condition that will exist until the headcut at XSEC 226.13 has propagated all the way to Alma School Road. The large velocity spike at XSEC 226.23 is caused by the abrupt slope change over the edge of the existing headcut.

It should be emphasized that the HEC-6 bed-profiles shown in Figures 4.1 and 4.2 only reflect the general scour/depostion component in Equation 3.1. The remaining scour components in Equation 3.1 must be added to these profiles in order to arrive at the total scour depth.

4.2 Total Scour Summary

Table 4.1 provides a quantitative summary of all applicable scour components for that section of the main channel of the Salt River that lies adjacent to the proposed SRPMIC north-bank levee.

All elevation data listed in Table 4.1 is referenced to the respective topographic mapping that was used for the HEC-2 models described in Section 2 of this report.

The following comments are provided to assist the reader in following the calculation sequence in Table 4.1. A sample calculation sequence is provided in Appendix C.

- All hydraulic data required for calculation of scour components in Table 4.1, other than general scour, were taken from HEC-2 Model SLAEQHC2.
- Between XSECs 224.33 through 226.03, the long-term degradation component was based on the smaller of the equilibrium slope depth or the Q_{10} armoring depth. This is consistent with the 1994 SLA report. Equilibrium slope depths of "zero" indicate that the projected equilibrium slope elevation is at or above the low-point of a particular XSEC.

Figure 4.3
Velocity Profile For Peak 100-Year Discharge
Proposed SRPMIC Levee Along North Bank oOf Salt River
100-Year, 10-Day Flood

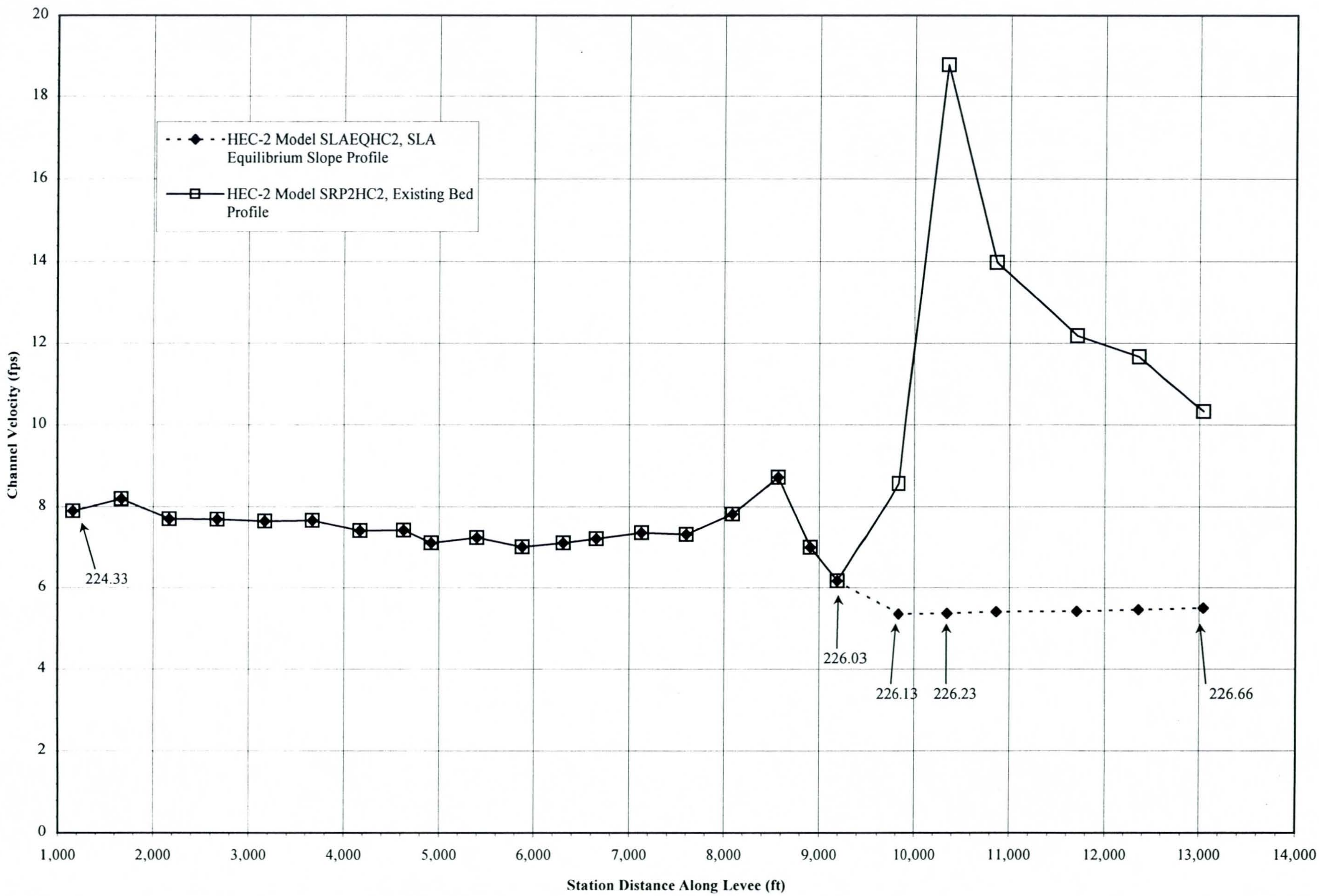


Table 4.1
Summary of Scour Analysis Calculations - Main Channel
Salt River Pima Maricopa Indian Community
North-Bank Levee Analysis - Salt River
Pima Freeway to Alma School Road

100-Year, 10-Day Flood

XSEC	Minimum Thalweg From SLAEQHC2 Model (ft, MSL)	Maximum Flow Depth Between Encroachments (ft)	Channel Velocity (fps)	Water Surface Topwidth Between Effective Flow Boundaries (ft)	Wetted Area (sf)	Hydraulic Depth (ft)	Energy Slope ft/ft)	North Bank Angle of Curvature (alpha) (degrees)	Long-Term Degradation: Based On Equil. Slope (ft)	Long-Term Degradation: Based On Q_{10} Armor Depth (ft)	Maximum General Scour (ft)	Bend Scour (ft)	Dune Troughs (ft)	Anti-dune Troughs (ft)	Low-Flow Incisement (ft)	Total Computed Scour Depth (ft)	Factor of Safety	Maximum Scour Depth With Safety Factor (ft)	Minimum Allowable Scour Depth (ft)	Recommended Toe-Down Elevation (ft, MSL)
224.33	1150.00	30.74	7.90	993.00	27,856	28.05	0.000419	0	0.00	0.3	0.00	0.00	2.06	0.84	1.50	3.56	1.50	5.34	10.00	1140.00
224.42	1150.00	30.91	8.20	987.00	26,827	27.18	0.000473	0	0.00	0.3	0.17	0.00	2.07	0.91	1.50	3.74	1.50	5.62	10.00	1140.00
224.52	1150.00	31.26	7.70	1012.00	28,588	28.25	0.000396	0	0.00	0.3	0.00	0.00	2.10	0.80	1.50	3.60	1.50	5.40	10.00	1140.00
224.61	1152.00	29.46	7.69	1040.39	28,604	27.49	0.000409	0	1.08	0.3	0.15	0.00	1.96	0.80	1.50	3.91	1.50	5.86	10.00	1142.00
224.71	1152.00	29.68	7.64	1058.51	28,778	27.19	0.000410	0	0.85	0.3	0.05	0.00	1.97	0.79	1.50	3.82	1.50	5.74	10.00	1142.00
224.80	1152.00	29.89	7.66	1080.91	28,717	26.57	0.000424	0	0.61	0.3	0.00	0.00	1.99	0.79	1.50	3.79	1.50	5.69	10.00	1142.00
224.90	1154.00	28.15	7.41	1106.00	29,675	26.83	0.000392	0	2.38	0.3	0.04	0.00	1.85	0.74	1.50	3.69	1.50	5.54	10.00	1144.00
224.99	1154.00	28.35	7.42	1109.54	29,666	26.74	0.000393	0	2.14	0.3	0.29	0.00	1.87	0.74	1.50	3.96	1.50	5.94	10.00	1144.00
225.09	1152.00	30.61	7.11	1163.24	30,932	26.59	0.000364	0	0.00	0.3	0.00	0.00	2.05	0.68	1.50	3.55	1.50	5.32	10.00	1142.00
225.18	1152.00	30.79	7.24	1192.49	30,392	25.49	0.000398	0	0.00	0.3	0.01	0.00	2.06	0.71	1.50	3.57	1.50	5.36	10.00	1142.00
225.28	1154.00	29.03	7.01	1190.60	31,373	26.35	0.000358	0	1.44	0.3	0.00	0.00	1.92	0.66	1.50	3.72	1.50	5.58	10.00	1144.00
225.37	1154.00	29.20	7.11	1188.80	30,961	26.04	0.000374	0	1.20	0.3	0.15	0.00	1.94	0.68	1.50	3.89	1.50	5.83	10.00	1144.00
225.47	1154.00	29.38	7.21	1256.80	30,512	24.28	0.000425	0	0.97	0.3	0.34	0.00	1.95	0.70	1.50	4.09	1.50	6.14	10.00	1144.00
225.56	1156.00	27.58	7.36	1276.58	29,898	23.42	0.000464	0	2.73	0.3	0.21	0.00	1.81	0.73	1.50	3.82	1.50	5.73	10.00	1146.00
225.66	1152.00	31.82	7.32	1262.62	30,063	23.81	0.000451	0	0.00	0.3	0.31	0.00	2.15	0.72	1.50	3.96	1.50	5.94	10.00	1142.00
225.75	1152.00	31.97	7.82	1113.84	28,128	25.25	0.000476	0	0.00	0.3	0.00	0.00	2.16	0.83	1.50	3.66	1.50	5.49	10.00	1142.00
225.85	1156.00	28.09	8.72	1145.33	25,232	22.03	0.000703	22	2.03	0.3	0.86	2.76	1.85	1.03	1.50	7.27	1.50	10.91	10.00	1145.09
225.94	1156.00	28.81	7.00	1273.19	31,448	24.70	0.000383	25	1.79	0.3	0.48	4.43	1.91	0.66	0.00	7.12	1.50	10.68	10.00	1145.32
226.03	1156.00	29.17	6.17	1611.23	35,673	22.14	0.000346	31	1.56	0.3	0.54	7.52	1.93	0.51	0.00	10.30	1.50	15.44	10.00	1140.56
226.13	1154.70	30.77	5.35	958.08	27,587	28.79	0.000183	31	Minimum thalweg		0.00	7.71	2.06	0.39	0.00	9.78	1.50	14.67	10.00	1140.03
226.23	1154.90	30.66	5.37	957.64	27,481	28.70	0.000186	31	elevation reflects		0.00	7.68	2.05	0.39	0.00	9.74	1.50	14.61	10.00	1140.29
226.32	1155.20	30.45	5.41	956.81	27,282	28.51	0.000190	31	equilibrium slope		0.00	7.65	2.04	0.40	0.00	9.68	1.50	14.53	10.00	1140.67
226.43	1155.40	30.36	5.42	956.42	27,190	28.43	0.000192	31	between XSECs		0.00	7.62	2.03	0.40	0.00	9.65	1.50	14.48	10.00	1140.92
226.54	1155.70	30.17	5.46	955.69	27,016	28.27	0.000196	18	226.13 thru 226.66		0.00	0.27	2.01	0.40	0.00	2.29	1.50	3.43	10.00	1145.70
226.66	1156.00	29.98	5.50	954.94	26,835	28.10	0.000200	18			0.00	0.27	2.00	0.41	0.00	2.27	1.50	3.41	10.00	1146.00

Note: All hydraulic data taken from HEC-2 File SLAEQHC2

General Scour depths taken from HEC-6 File SLAEQHC6

Equilibrium slope of 0.00047 ft/ft & Q10 armor depth of 0.3-ft taken from 1994 SLA report.

Equilibrium pivot point is at Grade-Control #5 (XSEC 20.5), invert elevation =1147.00-ft, MSL

The total scour depth is measured from the low point of the pre-flood channel-bed elevation within the effective flow area of each cross-section.
The thalweg elevations in column 2 of this table reflect the proposed fill to be placed in existing gravel pits. See Section 3.3 of this report for details.

File: SRPMIC North Levee Scour Summary, 1998 Topo, SLA Eq Slope.xls

- Between XSECs 226.13 through 226.66, the long-term degradation component was based on the SLA equilibrium slope elevation that is derived by projecting a 0.00047 ft/ft slope from Grade Control No. 5.

- The general scour dimensions in Table 4.1 were taken from HEC-6 model SLAEQHC6.

- The "Total Computed Scour Depth" is based on Equation 3.1. Local scour is not included because the north-bank levee is not within a scour envelope of bridge piers or spur dikes. Once the proposed north-bank levee is in-place, the existing spur dike at the northeast side of the Pima Road Bridge will no longer create a flow contraction that would warrant a local scour analysis.

- A safety factor of 1.50 is applied to the total scour depth to arrive at the "Maximum Scour Depth". This safety factor is based on FCDMC requirements. To provide consistency with the 1994 SLA report, a minimum scour depth of 10-feet is used at all cross-sections.

- The "Recommended Toe-Down Elevation" is computed by subtracting the larger of the "Maximum Scour Depth", or 10-feet, from the listed thalweg elevations. The listed thalweg elevations represent "filled" gravel pit conditions as discussed in Section 3.3 of this report, and, the SLA equilibrium slope profile between XSECs 226.13 through 226.66.

4.3 Water Surface Profile Summary

In addition to the scour analysis, the HEC-6 model was also used to examine fluctuations in the water surface profile that would occur during the 100-year, 10-day flow event. Appendix B presents a summary of the HEC-6 water surface elevation changes that occur in the main channel during the 100-year, 10-day event. These water surface profile changes reflect both discharge variations and bed-profile movements that are occurring during the flood.

In order to find the maximum water surface profile for the top of the bank-lining design, the maximum HEC-6 profile was compared to two fixed-bed HEC-2 profiles, as well as to the profile obtained from routing the 100-year peak discharge through a fixed-bed HEC-6 model, adjusted to the post-flood bed-profile. This latter condition, which was analyzed in order to be consistent with the 1994 SLA study, was simulated by applying a vertical elevation adjustment to the GR records. This elevation adjustment was taken as the cumulative, vertical bed-change dimension from the last hydrograph time step (#34) in the moveable-bed HEC-6 model.

The two HEC-2 profiles that were used in this analysis reflect existing, interim riverbed condition, as shown on the 1997-1998 topographic mapping, as well as the ultimate condition that will exist after the headcut has propagated all the way to the Alma School Road Bridge.

This latter condition, which will reflect the SLA equilibrium slope profile, creates a substantial lowering of both the riverbed and water surface elevations between XSECs 226.13 through 226.66. As a conservative design approach, any levee construction that might be pursued prior to the equilibrium slope being attained through XSECs 226.13 through 226.66, should be based on the existing riverbed water surface profile model (SRP2HC2).

Table 4.2 summarizes the computed water surface elevations for each of these four conditions. All water surface elevations in Table 4.2 include an allowance for superelevation along the north channel bank between XSECs 225.85 through 226.66. Table 4.3 presents a summary of the superelevation calculations that were used in this report.

Superelevation was computed from the following equation (ADWR, 1985).

$$\Delta y_{se} = \frac{V^2}{2g}\frac{W}{r_c}\left[\frac{1}{1-\left(\frac{W}{2r_c}\right)^2}\right] \text{..............................(Equation 4.1}$$

where delta y_{se} = height of superelevation (ft)

V = mean channel velocity (fps)

W = channel width at water surface (ft)

r_c = radius of channel centerline (ft)

g = acceleration of gravity, 32.2 ft/sec^2

Channel widths and velocities were taken from the HEC-2 and HEC-6 output summaries listed at the top of Table 4.3. The radius of curvature of the channel centerline was measured from 1" = 400' topographic mapping as 2,770-feet.

Figure 4.4 graphically compares the water surface profiles in Table 4.2. Notes on each of these figures identify the model file names that are being plotted.

The maximum water surface elevation (in Table 4.2) that occurred at each XSEC along the north-bank levee was used for the design recommendations presented in the following section. A freeboard elevation of 3.0-feet was added to these maximum water surface elevations in order to establish the recommended top-of-bank elevations. Freeboard is not reflected in the water surface elevations listed in Table 4.2.

Table 4.2
Summary of Water Surface Profiles
Salt River
100-Year, 10-Day Flood
Proposed SRPMIC North-Bank Levee

Station Distance Along Levee (ft)	Discharge (cfs)	HEC-2 XSEC	Water Surface Profile Elevations (ft, MSL): (Existing) HEC-2	(Post-Headcut) HEC-2	(Post-Headcut) HEC-6	Post-Flood, Fixed-Bed HEC-6 For Peak Discharge	Maximum Water Surface Elevation (ft, MSL)
1,161	220,000	224.33	1180.74	1180.74	1181.06	1181.06	1181.06
1,670	220,000	224.42	1180.91	1180.91	1181.61	1181.61	1181.61
2,169	220,000	224.52	1181.26	1181.26	1181.82	1181.81	1181.82
2,669	220,000	224.61	1181.46	1181.46	1181.85	1181.85	1181.85
3,169	220,000	224.71	1181.68	1181.68	1182.14	1182.13	1182.14
3,670	220,000	224.80	1181.89	1181.89	1182.26	1182.24	1182.26
4,169	220,000	224.90	1182.15	1182.15	1182.27	1182.26	1182.27
4,630	220,000	224.99	1182.35	1182.35	1182.30	1182.30	1182.35
4,919	220,000	225.09	1182.61	1182.61	1182.75	1182.73	1182.75
5,400	220,000	225.18	1182.79	1182.79	1182.81	1182.79	1182.81
5,879	220,000	225.28	1183.03	1183.03	1182.76	1182.75	1183.03
6,310	220,000	225.37	1183.20	1183.20	1182.88	1182.88	1183.20
6,654	220,000	225.47	1183.38	1183.38	1183.08	1183.09	1183.38
7,130	220,000	225.56	1183.58	1183.58	1183.42	1183.41	1183.58
7,603	220,000	225.66	1183.82	1183.82	1183.56	1183.55	1183.82
8,090	220,000	225.75	1183.97	1183.97	1183.69	1183.67	1183.97
8,570	220,000	225.85	1184.60	1184.60	1184.33	1184.34	1184.60
8,910	220,000	225.94	1185.18	1185.18	1184.77	1184.73	1185.18
9,194	220,000	226.03	1185.55	1185.55	1185.11	1185.06	1185.55
9,832	147,500	226.13	1185.38	1185.63	1185.14	1185.08	1185.63
10,350	147,500	226.23	1185.29	1185.72	1185.25	1185.18	1185.72
10,865	147,500	226.32	1190.28	1185.81	1185.36	1185.26	1190.28
11,708	147,500	226.43	1192.62	1185.92	1185.54	1185.37	1192.62
12,360	147,500	226.54	1194.27	1186.03	1185.62	1185.61	1194.27
13,043	147,500	226.66	1195.72	1186.15	1185.75	1185.91	1195.72
Model			SRP2HC2	SLAEQHC2	SLAEQHC6	SLAEQH6P	

All water surface elevations in this table include superelevation between XSECs 225.85 through 226.66.

File: Sht 4, CWSEL SUMMARY SLA Eq Slope, 1998 Topo.xls

Table 4.3
Summary of Superelevation Calculations
Salt River
100-Year, 10-Day Flood
Proposed SRPMIC North Levee

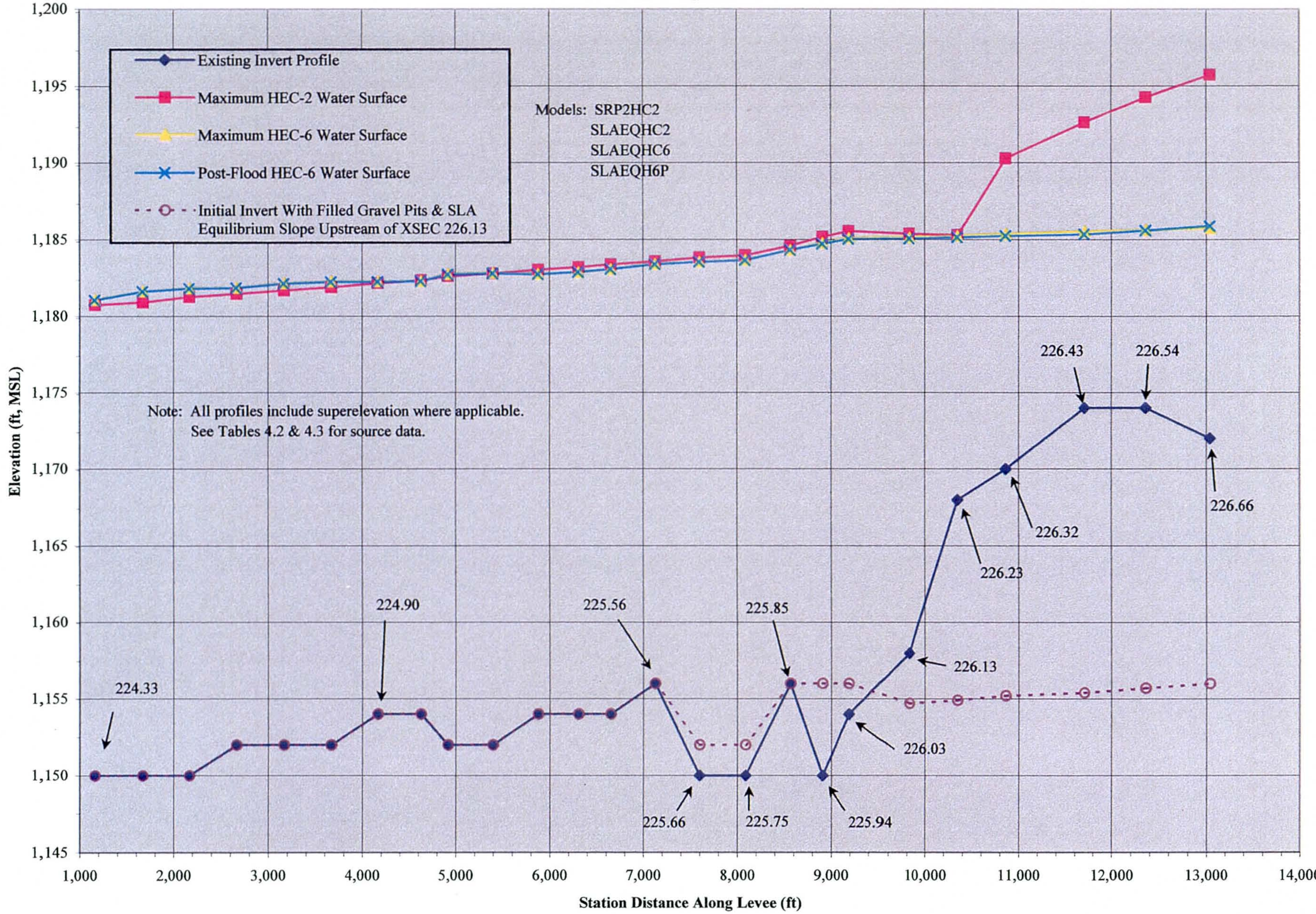
Station Distance Along Levee (ft)	Discharge (cfs)	HEC-2 XSEC	HEC-2 File SRP2HC2			HEC-2 File SLAEQHC2			HEC-6 File SLAEQH6P		
			Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)	Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)	Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)
1,161	220,000	224.33			n/a			n/a			n/a
1,670	220,000	224.42			n/a			n/a			n/a
2,169	220,000	224.52			n/a			n/a			n/a
2,669	220,000	224.61			n/a			n/a			n/a
3,169	220,000	224.71			n/a			n/a			n/a
3,670	220,000	224.80			n/a			n/a			n/a
4,169	220,000	224.90			n/a			n/a			n/a
4,630	220,000	224.99			n/a			n/a			n/a
4,919	220,000	225.09			n/a			n/a			n/a
5,400	220,000	225.18			n/a			n/a			n/a
5,879	220,000	225.28			n/a			n/a			n/a
6,310	220,000	225.37			n/a			n/a			n/a
6,654	220,000	225.47			n/a			n/a			n/a
7,130	220,000	225.56			n/a			n/a			n/a
7,603	220,000	225.66			n/a			n/a			n/a
8,090	220,000	225.75			n/a			n/a			n/a
8,570	220,000	225.85	8.72	1,145.33	0.51	8.72	1,145.33	0.51	7.90	1,254.01	0.46
8,910	220,000	225.94	7.00	1,273.19	0.37	7.00	1,273.19	0.37	6.80	1,293.51	0.35
9,194	220,000	226.03	6.17	1,611.23	0.38	6.17	1,611.23	0.38	6.13	1,611.29	0.37
9,832	147,500	226.13	8.57	830.47	0.35	5.35	958.08	0.16	5.46	955.63	0.16
10,350	147,500	226.23	18.78	733.11	1.48	5.37	957.64	0.16	5.49	955.08	0.17
10,865	147,500	226.32	13.98	879.12	0.99	5.41	956.81	0.16	5.91	947.00	0.19
11,708	147,500	226.43	12.18	882.64	0.75	5.42	956.42	0.16	6.90	931.83	0.26
12,360	147,500	226.54	11.67	905.60	0.71	5.46	955.69	0.16	7.42	925.32	0.29
13,043	147,500	226.66	10.33	932.38	0.57	5.50	954.94	0.17	7.65	922.72	0.31

Note: Radius of curvature = 2,770 feet.

Note: Superelevation data from HEC-6 file SLAEQH6P is also used for HEC-6 file SLAEQHC6.

File: CWSEL SUMMARY SLA Eq Slope, 1998 Topo.xls

Figure 4.4
Water Surface Profile Comparison
Proposed SRPMIC North Bank Levee
100-Year, 10-Day Flood



4.4 Recommended Elevations For SRPMIC North-Bank Levee Design

The scour and water surface profile data presented in Sections 4.2 and 4.3 have been condensed into summary tables for listing design recommendations for the CSA bank-lining. Table 4.4 summarizes these recommendations.

Design elevations are referenced to HEC-2 cross-section numbers, as well as to the levee control-line stationing. The levee control-line stationing was provided by Premier Engineering Corporation.

The top-of-bank and toe-down elevations from Table 4.4 are plotted in Figure 4.5. The top-of-bank profile in this Figure includes freeboard and superelevation (where applicable).

A magnetic disk is enclosed with all HEC-2 and HEC-6 files that were used as the basis for the calculations and recommendations contained in this report.

In preparing this study, it has been assumed that the general river characteristics have not changed in a way (since the preparation of the referenced topographic mapping listed in Section 2 of this report) that would cause any significant alteration to the recommended water surface and scour profiles presented in this report. However, continuation of un-regulated in-stream gravel mining could induce changes to the river system equilibrium that could void the recommendations presented in this report.

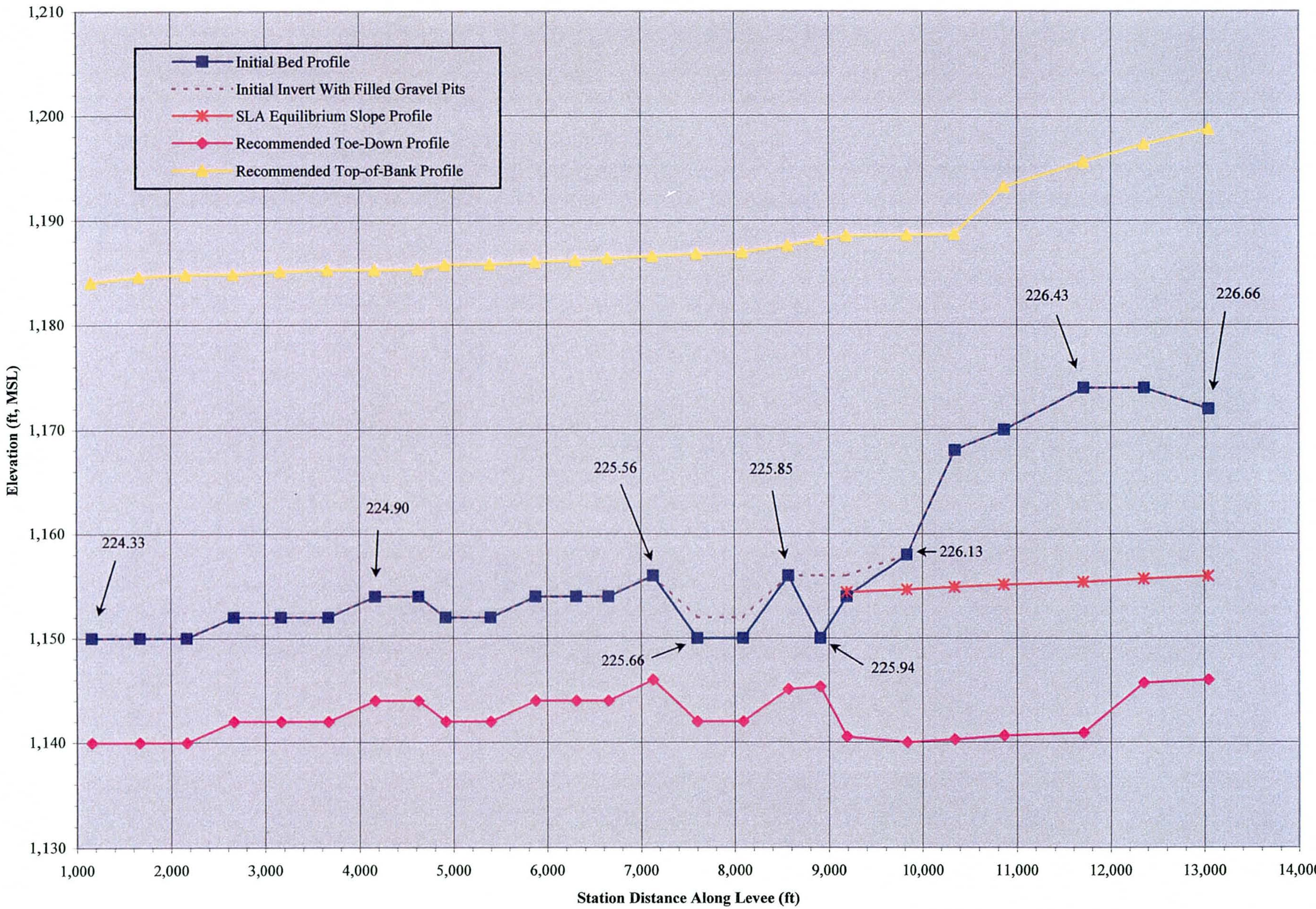
Table 4.4
Summary of Recommended Elevations for CSA Bank-Lining Design
Salt River Maricopa Pima Indian Community
North-Bank Levee Analysis Along Salt River, Pima Freeway Bridge to Alma School Road

100-Year, 10-Day Flood

		Top-of-Bank Design					Toe-Down Design	
Levee Station In Feet	Applicable HEC-2/HEC-6 XSEC	Maximum 100-Yr Water Surface (ft, MSL)	Data Source	Superelevation (ft)	Freeboard (ft)	Recommended Design Elevation (ft, MSL)	Data Source	Recommended Design Elevation (ft, MSL)
1,161	224.33	1181.06	Table 4.2	n/a	3.00	1184.06	Table 4.1	1140.00
1,670	224.42	1181.61		n/a	3.00	1184.61		1140.00
2,169	224.52	1181.82		n/a	3.00	1184.82		1140.00
2,669	224.61	1181.85		n/a	3.00	1184.85		1142.00
3,169	224.71	1182.14		n/a	3.00	1185.14		1142.00
3,670	224.80	1182.26		n/a	3.00	1185.26		1142.00
4,169	224.90	1182.27		n/a	3.00	1185.27		1144.00
4,630	224.99	1182.35		n/a	3.00	1185.35		1144.00
4,919	225.09	1182.75		n/a	3.00	1185.75		1142.00
5,400	225.18	1182.81		n/a	3.00	1185.81		1142.00
5,879	225.28	1183.03		n/a	3.00	1186.03		1144.00
6,310	225.37	1183.20		n/a	3.00	1186.20		1144.00
6,654	225.47	1183.38		n/a	3.00	1186.38		1144.00
7,130	225.56	1183.58		n/a	3.00	1186.58		1146.00
7,603	225.66	1183.82		n/a	3.00	1186.82		1142.00
8,090	225.75	1183.97		n/a	3.00	1186.97		1142.00
8,570	225.85	1184.60		(included)	3.00	1187.60		1145.09
8,910	225.94	1185.18		(included)	3.00	1188.18		1145.32
9,194	226.03	1185.55		(included)	3.00	1188.55		1140.56
9,832	226.13	1185.63		(included)	3.00	1188.63		1140.03
10,350	226.23	1185.72		(included)	3.00	1188.72		1140.29
10,865	226.32	1190.28		(included)	3.00	1193.28		1140.67
11,708	226.43	1192.62		(included)	3.00	1195.62		1140.92
12,360	226.54	1194.27		(included)	3.00	1197.27		1145.70
13,043	226.66	1195.72		(included)	3.00	1198.72		1146.00

File: SRPMIC LEVEE RECOM. 1998 TOPO.xls

Figure 4.5
Recommended Design Profiles For CSA Bank Lining
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood



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APPENDIX A

HEC-6 General Scour Summary
100-Year, 10-Day Flood
Model SLAEQHC6

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

Table A1
Summary of HEC-6 Bed Profile Data
Model SLAEQHC6
100-Year, 10-Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River XSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
224.33	0	1150.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224.42	500	1150.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.04	-0.05	-0.05	-0.06	-0.07	-0.07	-0.08
224.52	1000	1150.00	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.09	0.09	0.07	0.06	0.05	0.04	0.04	0.04
224.61	1500	1152.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.05	-0.05	-0.06	-0.07	-0.09	-0.10
224.71	2000	1152.00	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.04	0.02	0.00	-0.01	-0.02	-0.03
224.80	2500	1152.00	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.09	0.10	0.10	0.12	0.14	0.17	0.20	0.23	0.27
224.90	3000	1154.00	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.00	-0.01	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04
224.99	3500	1154.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.06	-0.07	-0.09	-0.10	-0.11	-0.13	-0.14	-0.16	-0.17	-0.19	-0.20
225.09	4000	1152.00	0.04	0.06	0.08	0.09	0.11	0.14	0.16	0.19	0.21	0.24	0.26	0.27	0.26	0.24	0.23	0.23	0.22	0.22
225.18	4500	1152.00	-0.01	-0.01	-0.01	-0.01	0.00	0.01	0.02	0.04	0.06	0.09	0.15	0.24	0.35	0.48	0.56	0.63	0.70	0.75
225.28	5000	1154.00	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.03	0.04	0.05	0.05	0.02	0.01	0.02	0.04	0.06	0.07	0.09
225.37	5500	1154.00	0.03	0.02	0.01	0.01	0.00	0.01	0.01	0.02	0.00	-0.02	-0.06	-0.07	-0.07	-0.08	-0.09	-0.10	-0.11	-0.12
225.47	6000	1154.00	0.07	0.07	0.06	0.05	0.03	0.01	-0.01	-0.06	-0.08	-0.09	-0.10	-0.11	-0.13	-0.14	-0.15	-0.17	-0.19	-0.21
225.56	6500	1156.00	-0.14	-0.16	-0.17	-0.18	-0.18	-0.19	-0.19	-0.19	-0.19	-0.19	-0.18	-0.16	-0.14	-0.13	-0.13	-0.12	-0.12	-0.11
225.66	7000	1150.00	-0.03	-0.05	-0.06	-0.08	-0.09	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12	-0.13	-0.15	-0.16	-0.16	-0.17	-0.17	-0.17
225.75	7500	1150.00	0.12	0.15	0.16	0.17	0.20	0.19	0.19	0.21	0.22	0.22	0.21	0.17	0.13	0.10	0.07	0.05	0.03	0.02
225.85	8000	1156.00	-0.13	-0.16	-0.18	-0.19	-0.24	-0.26	-0.29	-0.35	-0.39	-0.41	-0.44	-0.46	-0.48	-0.50	-0.52	-0.55	-0.57	-0.59
225.94	8500	1150.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.09	-0.11	-0.13	-0.15	-0.17	-0.20	-0.24	-0.27	-0.29	-0.32	-0.34
226.03	8990	1154.00	-0.06	-0.07	-0.08	-0.10	-0.12	-0.13	-0.15	-0.17	-0.20	-0.21	-0.23	-0.24	-0.25	-0.25	-0.27	-0.28	-0.30	-0.31
226.13	9510	1154.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.05	0.06	0.06	0.06
226.23	10010	1154.90	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.06	0.08	0.09	0.10	0.11	0.11
226.32	10510	1155.20	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.08	0.13	0.16	0.18	0.20	0.24
226.43	11077	1155.40	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.06	0.11	0.19	0.32	0.55	0.86	1.28
226.54	11696	1155.70	0.15	0.19	0.23	0.28	0.38	0.49	0.64	0.88	1.20	1.56	2.04	2.75	3.82	5.33	6.57	8.17	9.19	9.63
226.66	12280	1156.00	0.67	0.85	1.03	1.24	1.50	1.80	2.10	2.49	2.87	3.17	3.64	4.87	6.68	7.88	9.67	9.07	8.48	8.19

River XSEC	Time Step																Maximum Deposition (ft)	Maximum Scour (ft)
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
224.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
224.42	-0.1	-0.11	-0.11	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.17	-0.17	0.00	-0.17
224.52	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.1	0.11	0.12	0.13	0.14	0.15	0.18	0.18	0.00
224.61	-0.11	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.15	-0.15	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	0.01	-0.15
224.71	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	0.06	-0.05
224.80	0.30	0.33	0.36	0.38	0.40	0.41	0.42	0.44	0.44	0.46	0.48	0.48	0.49	0.50	0.50	0.51	0.51	0.00
224.90	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.04	-0.04
224.99	-0.21	-0.23	-0.24	-0.24	-0.25	-0.25	-0.25	-0.26	-0.26	-0.26	-0.27	-0.27	-0.27	-0.28	-0.28	-0.29	0.00	-0.29
225.09	0.22	0.22	0.22	0.23	0.24	0.25	0.27	0.29	0.30	0.33	0.36	0.37	0.38	0.40	0.41	0.44	0.44	0.00
225.18	0.80	0.84	0.86	0.88	0.88	0.88	0.86	0.84	0.82	0.79	0.76	0.75	0.74	0.71	0.70	0.67	0.88	-0.01
225.28	0.10	0.12	0.14	0.16	0.17	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.00
225.37	-0.12	-0.13	-0.13	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12	-0.13	-0.12	-0.13	-0.13	-0.15	-0.15	-0.15	0.03	-0.15
225.47	-0.23	-0.24	-0.26	-0.27	-0.28	-0.31	-0.31	-0.31	-0.31	-0.31	-0.33	-0.33	-0.34	-0.34	-0.34	-0.34	0.07	-0.34
225.56	-0.11	-0.12	-0.12	-0.13	-0.14	-0.14	-0.15	-0.15	-0.16	-0.16	-0.17	-0.18	-0.18	-0.19	-0.20	-0.21	0.00	-0.21
225.66	-0.18	-0.19	-0.19	-0.20	-0.21	-0.22	-0.23	-0.24	-0.25	-0.27	-0.28	-0.29	-0.29	-0.30	-0.30	-0.31	0.00	-0.31
225.75	0.02	0.03	0.04	0.05	0.07	0.08	0.11	0.13	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.22	0.22	0.00
225.85	-0.62	-0.64	-0.66	-0.68	-0.70	-0.71	-0.74	-0.76	-0.77	-0.78	-0.80	-0.81	-0.82	-0.84	-0.85	-0.86	0.00	-0.86
225.94	-0.37	-0.39	-0.40	-0.42	-0.43	-0.44	-0.45	-0.46	-0.46	-0.47	-0.47	-0.47	-0.47	-0.48	-0.48	-0.48	0.00	-0.48
226.03	-0.33	-0.34	-0.36	-0.38	-0.40	-0.41	-0.43	-0.44	-0.45	-0.47	-0.48	-0.49	-0.50	-0.52	-0.53	-0.54	0.00	-0.54
226.13	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.00
226.23	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.11	0.00
226.32	0.29	0.34	0.40	0.46	0.52	0.59	0.67	0.75	0.84	1.02	1.21	1.31	1.40	1.58	1.67	1.91	1.91	0.00
226.43	1.80	2.39	2.98	3.61	4.53	4.82	5.15	5.30	5.40	5.53	5.56	5.57	5.57	5.57	5.55	5.53	5.57	0.00
226.54	9.69	9.50	9.23	8.82	8.03	7.86	7.58	7.45	7.36	7.22	7.15	7.13	7.10	7.08	7.07	7.05	9.69	0.00
226.66	8.01	7.93	7.88	7.86	7.86	7.81	7.79	7.76	7.74	7.71	7.70	7.69	7.69	7.69	7.69	7.69	9.67	0.00

File: HEC6 OUT FOR SLAEQHC6.XLS

Table A2
Summary of HEC-6 Bed Profile Data
Model SLAEQHC6
100-Year, 10-Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River XSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
224.33	0	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00
224.42	500	1150.00	1149.99	1149.99	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.96	1149.95	1149.95	1149.94	1149.93	1149.93
224.52	1000	1150.00	1150.02	1150.03	1150.03	1150.04	1150.05	1150.06	1150.07	1150.08	1150.08	1150.09	1150.09	1150.09	1150.07	1150.06	1150.05	1150.04	1150.04
224.61	1500	1152.00	1152.00	1152.01	1152.01	1152.01	1152.01	1152.01	1152.00	1152.00	1151.99	1151.99	1151.98	1151.97	1151.95	1151.95	1151.94	1151.93	1151.91
224.71	2000	1152.00	1152.02	1152.02	1152.03	1152.04	1152.05	1152.05	1152.06	1152.06	1152.06	1152.06	1152.06	1152.05	1152.04	1152.02	1152.00	1151.99	1151.98
224.80	2500	1152.00	1152.01	1152.02	1152.02	1152.03	1152.04	1152.05	1152.06	1152.07	1152.09	1152.09	1152.10	1152.10	1152.12	1152.14	1152.17	1152.20	1152.23
224.90	3000	1154.00	1154.02	1154.03	1154.04	1154.04	1154.04	1154.04	1154.04	1154.03	1154.03	1154.02	1154.00	1153.99	1153.97	1153.97	1153.96	1153.96	1153.96
224.99	3500	1154.00	1153.99	1153.99	1153.98	1153.98	1153.97	1153.97	1153.96	1153.94	1153.93	1153.91	1153.90	1153.89	1153.87	1153.86	1153.84	1153.83	1153.81
225.09	4000	1152.00	1152.04	1152.06	1152.08	1152.09	1152.11	1152.14	1152.16	1152.19	1152.21	1152.24	1152.26	1152.27	1152.26	1152.24	1152.23	1152.23	1152.22
225.18	4500	1152.00	1151.99	1151.99	1151.99	1151.99	1152.00	1152.01	1152.02	1152.04	1152.06	1152.09	1152.15	1152.24	1152.35	1152.48	1152.56	1152.63	1152.70
225.28	5000	1154.00	1154.01	1154.02	1154.02	1154.02	1154.02	1154.01	1154.01	1154.03	1154.04	1154.05	1154.05	1154.02	1154.01	1154.02	1154.04	1154.06	1154.07
225.37	5500	1154.00	1154.03	1154.02	1154.01	1154.01	1154.00	1154.01	1154.01	1154.02	1154.00	1153.98	1153.94	1153.93	1153.93	1153.92	1153.91	1153.90	1153.89
225.47	6000	1154.00	1154.07	1154.07	1154.06	1154.05	1154.03	1154.01	1153.99	1153.94	1153.92	1153.91	1153.90	1153.89	1153.87	1153.86	1153.85	1153.83	1153.81
225.56	6500	1156.00	1155.86	1155.84	1155.83	1155.82	1155.82	1155.81	1155.81	1155.81	1155.81	1155.81	1155.82	1155.84	1155.86	1155.87	1155.87	1155.88	1155.88
225.66	7000	1150.00	1149.97	1149.95	1149.94	1149.92	1149.91	1149.89	1149.89	1149.88	1149.88	1149.88	1149.88	1149.87	1149.85	1149.84	1149.84	1149.83	1149.83
225.75	7500	1150.00	1150.12	1150.15	1150.16	1150.17	1150.20	1150.19	1150.19	1150.21	1150.22	1150.22	1150.21	1150.17	1150.13	1150.10	1150.07	1150.05	1150.03
225.85	8000	1156.00	1155.87	1155.84	1155.82	1155.81	1155.76	1155.74	1155.71	1155.65	1155.61	1155.59	1155.56	1155.54	1155.52	1155.50	1155.48	1155.45	1155.43
225.94	8500	1150.00	1149.99	1149.98	1149.97	1149.96	1149.95	1149.94	1149.93	1149.91	1149.89	1149.87	1149.85	1149.83	1149.80	1149.76	1149.73	1149.71	1149.68
226.03	8990	1154.00	1153.94	1153.93	1153.92	1153.90	1153.88	1153.87	1153.85	1153.83	1153.80	1153.79	1153.77	1153.76	1153.75	1153.75	1153.73	1153.72	1153.70
226.13	9510	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.70	1154.71	1154.72	1154.73	1154.75	1154.75	1154.76	1154.76
226.23	10010	1154.90	1154.90	1154.90	1154.90	1154.90	1154.90	1154.91	1154.91	1154.91	1154.91	1154.92	1154.93	1154.94	1154.96	1154.98	1154.99	1155.00	1155.01
226.32	10510	1155.20	1155.20	1155.20	1155.20	1155.20	1155.21	1155.21	1155.21	1155.21	1155.22	1155.22	1155.23	1155.25	1155.28	1155.33	1155.36	1155.38	1155.40
226.43	11077	1155.40	1155.41	1155.41	1155.41	1155.41	1155.41	1155.41	1155.41	1155.41	1155.42	1155.42	1155.44	1155.46	1155.51	1155.59	1155.72	1155.95	1156.26
226.54	11696	1155.70	1155.85	1155.89	1155.93	1155.98	1156.08	1156.19	1156.34	1156.58	1156.90	1157.26	1157.74	1158.45	1159.52	1161.03	1162.27	1163.87	1164.89
226.66	12280	1156.00	1156.67	1156.85	1157.03	1157.24	1157.50	1157.80	1158.10	1158.49	1158.87	1159.17	1159.64	1160.87	1162.68	1163.88	1165.67	1165.07	1164.48

River XSEC	Time Step 18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Maximum Deposition Elevation (ft, MSL)	Maximum Scour Elevation (ft, MSL)
224.33	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00
224.42	1149.92	1149.90	1149.89	1149.89	1149.88	1149.87	1149.87	1149.86	1149.86	1149.85	1149.85	1149.85	1149.84	1149.84	1149.84	1149.83	1149.83	1150.00	1149.83
224.52	1150.04	1150.04	1150.04	1150.05	1150.05	1150.06	1150.06	1150.07	1150.08	1150.08	1150.10	1150.11	1150.12	1150.13	1150.14	1150.15	1150.18	1150.18	1150.00
224.61	1151.90	1151.89	1151.88	1151.87	1151.86	1151.86	1151.85	1151.85	1151.85	1151.85	1151.86	1151.86	1151.86	1151.86	1151.86	1151.86	1151.86	1152.01	1151.85
224.71	1151.97	1151.97	1151.96	1151.96	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.95	1151.96	1152.06	1151.95
224.80	1152.27	1152.30	1152.33	1152.36	1152.38	1152.40	1152.41	1152.42	1152.44	1152.44	1152.46	1152.48	1152.48	1152.49	1152.50	1152.50	1152.51	1152.51	1152.00
224.90	1153.96	1153.96	1153.96	1153.97	1153.97	1153.97	1153.98	1153.98	1153.98	1153.98	1153.99	1153.99	1153.99	1153.99	1153.99	1153.99	1153.99	1154.04	1153.96
224.99	1153.80	1153.79	1153.77	1153.76	1153.76	1153.75	1153.75	1153.75	1153.74	1153.74	1153.74	1153.73	1153.73	1153.73	1153.72	1153.72	1153.71	1154.00	1153.71
225.09	1152.22	1152.22	1152.22	1152.22	1152.23	1152.24	1152.25	1152.27	1152.29	1152.30	1152.33	1152.36	1152.37	1152.38	1152.40	1152.41	1152.44	1152.44	1152.00
225.18	1152.75	1152.80	1152.84	1152.86	1152.88	1152.88	1152.88	1152.86	1152.84	1152.82	1152.79	1152.76	1152.75	1152.74	1152.71	1152.70	1152.67	1152.88	1151.99
225.28	1154.09	1154.10	1154.12	1154.14	1154.16	1154.17	1154.19	1154.19	1154.20	1154.20	1154.20	1154.21	1154.21	1154.21	1154.22	1154.22	1154.22	1154.22	1154.00
225.37	1153.88	1153.88	1153.87	1153.87	1153.87	1153.87	1153.88	1153.88	1153.88	1153.88	1153.87	1153.88	1153.87	1153.87	1153.85	1153.85	1153.85	1154.03	1153.85
225.47	1153.79	1153.77	1153.76	1153.74	1153.73	1153.72	1153.69	1153.69	1153.69	1153.69	1153.69	1153.67	1153.67	1153.66	1153.66	1153.66	1153.66	1154.07	1153.66
225.56	1155.89	1155.89	1155.88	1155.88	1155.87	1155.86	1155.86	1155.85	1155.85	1155.84	1155.84	1155.83	1155.82	1155.82	1155.81	1155.80	1155.79	1156.00	1155.79
225.66	1149.83	1149.82	1149.81	1149.81	1149.80	1149.79	1149.78	1149.77	1149.76	1149.75	1149.73	1149.72	1149.71	1149.71	1149.70	1149.70	1149.69	1150.00	1149.69
225.75	1150.02	1150.02	1150.03	1150.04	1150.05	1150.07	1150.08	1150.11	1150.13	1150.14	1150.15	1150.16	1150.17	1150.18	1150.20	1150.21	1150.22	1150.22	1150.00
225.85	1155.41	1155.38	1155.36	1155.34	1155.32	1155.30	1155.29	1155.26	1155.24	1155.23	1155.22	1155.20	1155.19	1155.18	1155.16	1155.15	1155.14	1156.00	1155.14
225.94	1149.66	1149.63	1149.61	1149.60	1149.58	1149.57	1149.56	1149.55	1149.54	1149.54	1149.53	1149.53	1149.53	1149.53	1149.52	1149.52	1149.52	1150.00	1149.52
226.03	1153.69	1153.67	1153.66	1153.64	1153.62	1153.60	1153.59	1153.57	1153.56	1153.55	1153.53	1153.52	1153.51	1153.50	1153.48	1153.47	1153.46	1154.00	1153.46
226.13	1154.76	1154.75	1154.75	1154.74	1154.74	1154.74	1154.74	1154.73	1154.73	1154.73	1154.73	1154.73	1154.73	1154.73	1154.73	1154.73	1154.73	1154.76	1154.70
226.23	1155.01	1155.00	1155.00	1154.99	1154.99	1154.98	1154.98	1154.98	1154.98	1154.98	1154.97	1154.97	1154.98	1154.98	1154.98	1154.98	1154.99	1155.01	1154.90
226.32	1155.44	1155.49	1155.54	1155.60	1155.66	1155.72	1155.79	1155.87	1155.95	1156.04	1156.22	1156.41	1156.51	1156.60	1156.78	1156.87	1157.11	1157.11	1155.20
226.43	1156.68	1157.20	1157.79	1158.38	1159.01	1159.93	1160.22	1160.55	1160.70	1160.80	1160.93	1160.96	1160.97	1160.97	1160.97	1160.95	1160.93	1160.97	1155.40
226.54	1165.33	1165.39	1165.20	1164.93	1164.52	1163.73	1163.56	1163.28	1163.15	1163.06	1162.92	1162.85	1162.83	1162.80	1162.78	1162.77	1162.75	1165.39	1155.70
226.66	1164.19	1164.01	1163.93	1163.88	1163.86	1163.86	1163.81	1163.79	1163.76	1163.74	1163.71	1163.70	1163.69	1163.69	1163.69	1163.69	1163.69	1165.67	1156.00

File: HEC6 OUT FOR SLAEQHC6.XLS

APPENDIX B

HEC-6 Water Surface Profile Summary
100-Year, 10-Day Flood
Model SLAEQHC6

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

Table B1
Summary of Maximum Water Surface Profile From HEC-6 Analysis
Model SLAEQHC6
100-Year, 10 Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River XSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
224.33	0	1150.00	1159.23	1159.34	1159.48	1160.48	1162.11	1162.77	1163.72	1166.12	1167.85	1168.66	1171.32	1175.22	1179.40	1181.06	1177.97	1176.87	1176.74	1174.66
224.42	500	1150.00	1159.38	1159.49	1159.64	1160.66	1162.31	1162.98	1163.94	1166.38	1168.14	1168.97	1171.68	1175.66	1179.91	1181.61	1178.46	1177.34	1177.21	1175.08
224.52	1000	1150.00	1159.52	1159.63	1159.78	1160.81	1162.46	1163.13	1164.10	1166.55	1168.32	1169.15	1171.86	1175.85	1180.12	1181.82	1178.66	1177.54	1177.40	1175.27
224.61	1500	1152.00	1159.60	1159.71	1159.87	1160.89	1162.54	1163.21	1164.18	1166.63	1168.39	1169.22	1171.92	1175.90	1180.16	1181.85	1178.70	1177.58	1177.45	1175.33
224.71	2000	1152.00	1159.75	1159.87	1160.02	1161.05	1162.70	1163.37	1164.34	1166.81	1168.58	1169.41	1172.13	1176.14	1180.43	1182.14	1178.96	1177.84	1177.70	1175.56
224.80	2500	1152.00	1159.90	1160.01	1160.17	1161.19	1162.82	1163.48	1164.46	1166.92	1168.68	1169.52	1172.24	1176.26	1180.55	1182.26	1179.08	1177.95	1177.81	1175.67
224.90	3000	1154.00	1160.07	1160.19	1160.34	1161.34	1162.95	1163.61	1164.57	1167.01	1168.77	1169.60	1172.30	1176.30	1180.57	1182.27	1179.11	1177.98	1177.85	1175.72
224.99	3500	1154.00	1160.26	1160.38	1160.53	1161.52	1163.10	1163.75	1164.71	1167.12	1168.87	1169.69	1172.39	1176.35	1180.61	1182.30	1179.15	1178.03	1177.90	1175.78
225.09	4000	1152.00	1160.56	1160.67	1160.83	1161.80	1163.37	1164.01	1164.98	1167.41	1169.17	1170.00	1172.72	1176.73	1181.04	1182.75	1179.56	1178.43	1178.29	1176.14
225.18	4500	1152.00	1160.85	1160.96	1161.11	1162.03	1163.55	1164.18	1165.13	1167.54	1169.28	1170.11	1172.81	1176.81	1181.10	1182.81	1179.63	1178.49	1178.35	1176.21
225.28	5000	1154.00	1161.21	1161.31	1161.45	1162.33	1163.78	1164.38	1165.31	1167.66	1169.38	1170.20	1172.86	1176.81	1181.06	1182.76	1179.61	1178.49	1178.36	1176.25
225.37	5500	1154.00	1161.50	1161.61	1161.75	1162.62	1164.05	1164.64	1165.56	1167.88	1169.58	1170.39	1173.04	1176.97	1181.19	1182.88	1179.75	1178.64	1178.50	1176.40
225.47	6000	1154.00	1161.82	1161.93	1162.08	1162.95	1164.36	1164.93	1165.84	1168.13	1169.83	1170.63	1173.25	1177.17	1181.39	1183.08	1179.94	1178.83	1178.70	1176.60
225.56	6500	1156.00	1162.29	1162.40	1162.55	1163.40	1164.77	1165.34	1166.24	1168.49	1170.16	1170.96	1173.57	1177.49	1181.72	1183.42	1180.27	1179.16	1179.02	1176.92
225.66	7000	1150.00	1162.99	1163.04	1163.17	1163.98	1165.29	1165.83	1166.68	1168.84	1170.46	1171.24	1173.81	1177.68	1181.88	1183.56	1180.44	1179.33	1179.20	1177.12
225.75	7500	1150.00	1163.29	1163.35	1163.49	1164.33	1165.65	1166.18	1167.03	1169.14	1170.74	1171.51	1174.05	1177.87	1182.02	1183.69	1180.60	1179.51	1179.37	1177.32
225.85	8000	1156.00	1163.39	1163.47	1163.61	1164.47	1165.84	1166.39	1167.23	1169.35	1170.94	1171.71	1174.25	1178.06	1182.21	1183.87	1180.78	1179.69	1179.55	1177.50
225.94	8500	1150.00	1163.99	1164.06	1164.20	1165.11	1166.51	1167.05	1167.89	1170.00	1171.57	1172.33	1174.85	1178.64	1182.76	1184.42	1181.34	1180.25	1180.11	1178.07
226.03	8990	1154.00	1164.18	1164.25	1164.39	1165.30	1166.71	1167.25	1168.10	1170.23	1171.80	1172.56	1175.09	1178.91	1183.07	1184.74	1181.63	1180.53	1180.39	1178.33
226.13	9510	1154.70	1164.37	1164.45	1164.60	1165.55	1167.00	1167.55	1168.43	1170.59	1172.16	1172.91	1175.41	1179.20	1183.32	1184.98	1181.90	1180.80	1180.66	1178.62
226.23	10010	1154.90	1164.40	1164.48	1164.63	1165.59	1167.05	1167.60	1168.48	1170.65	1172.23	1172.99	1175.50	1179.29	1183.42	1185.08	1181.99	1180.90	1180.75	1178.71
226.32	10510	1155.20	1164.43	1164.51	1164.67	1165.63	1167.10	1167.66	1168.54	1170.72	1172.30	1173.06	1175.58	1179.38	1183.51	1185.17	1182.08	1180.99	1180.84	1178.80
226.43	11077	1155.40	1164.47	1164.56	1164.71	1165.68	1167.16	1167.72	1168.61	1170.80	1172.39	1173.16	1175.68	1179.48	1183.62	1185.28	1182.19	1181.10	1180.95	1178.90
226.54	11696	1155.70	1164.52	1164.60	1164.76	1165.74	1167.23	1167.79	1168.69	1170.89	1172.48	1173.25	1175.77	1179.57	1183.69	1185.33	1182.20	1181.07	1180.85	1178.74
226.66	12280	1156.00	1164.57	1164.66	1164.82	1165.80	1167.30	1167.87	1168.77	1170.98	1172.58	1173.36	1175.89	1179.69	1183.81	1185.44	1182.37	1181.27	1181.27	1179.47

River XSEC	Time Step 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Maximum CWSEL Elevation (ft, MSL)	Minimum CWSEL Elevation (ft, MSL)
224.33	1172.50	1170.35	1168.90	1166.60	1163.35	1163.24	1160.82	1160.68	1160.26	1160.08	1160.01	1159.74	1159.70	1159.61	1159.31	1159.16	1181.06	1159.16
224.42	1172.89	1170.69	1169.22	1166.88	1163.57	1163.45	1161.00	1160.86	1160.43	1160.24	1160.18	1159.90	1159.85	1159.76	1159.45	1159.30	1181.61	1159.30
224.52	1173.07	1170.87	1169.39	1167.04	1163.72	1163.60	1161.15	1161.00	1160.58	1160.38	1160.32	1160.04	1159.99	1159.90	1159.59	1159.43	1181.82	1159.43
224.61	1173.13	1170.93	1169.46	1167.12	1163.80	1163.68	1161.24	1161.09	1160.66	1160.47	1160.41	1160.13	1160.08	1159.99	1159.67	1159.52	1181.85	1159.52
224.71	1173.35	1171.13	1169.65	1167.30	1163.96	1163.84	1161.39	1161.23	1160.81	1160.61	1160.55	1160.27	1160.22	1160.13	1159.82	1159.66	1182.14	1159.66
224.80	1173.45	1171.23	1169.76	1167.40	1164.07	1163.95	1161.52	1161.36	1160.95	1160.75	1160.69	1160.42	1160.37	1160.27	1159.97	1159.81	1182.26	1159.81
224.90	1173.51	1171.31	1169.84	1167.50	1164.21	1164.08	1161.70	1161.55	1161.14	1160.95	1160.90	1160.63	1160.58	1160.49	1160.19	1160.03	1182.27	1160.03
224.99	1173.59	1171.40	1169.94	1167.61	1164.34	1164.22	1161.86	1161.71	1161.31	1161.11	1161.06	1160.80	1160.75	1160.66	1160.37	1160.20	1182.30	1160.20
225.09	1173.92	1171.71	1170.24	1167.89	1164.59	1164.47	1162.12	1161.96	1161.57	1161.38	1161.33	1161.06	1161.01	1160.93	1160.64	1160.47	1182.75	1160.47
225.18	1174.00	1171.80	1170.33	1168.00	1164.76	1164.64	1162.39	1162.25	1161.89	1161.71	1161.67	1161.42	1161.38	1161.31	1161.05	1160.91	1182.81	1160.85
225.28	1174.06	1171.90	1170.46	1168.18	1165.04	1164.92	1162.84	1162.69	1162.37	1162.19	1162.14	1161.91	1161.86	1161.80	1161.55	1161.42	1182.76	1161.21
225.37	1174.24	1172.08	1170.66	1168.40	1165.29	1165.17	1163.12	1162.97	1162.65	1162.47	1162.42	1162.18	1162.13	1162.08	1161.81	1161.68	1182.88	1161.50
225.47	1174.44	1172.30	1170.88	1168.64	1165.56	1165.44	1163.39	1163.24	1162.92	1162.73	1162.68	1162.44	1162.39	1162.33	1162.06	1161.93	1183.08	1161.82
225.56	1174.75	1172.60	1171.19	1168.96	1165.92	1165.79	1163.75	1163.60	1163.27	1163.09	1163.04	1162.79	1162.74	1162.69	1162.40	1162.28	1183.42	1162.28
225.66	1174.98	1172.87	1171.48	1169.30	1166.39	1166.26	1164.30	1164.16	1163.84	1163.66	1163.60	1163.36	1163.31	1163.26	1162.97	1162.85	1183.56	1162.85
225.75	1175.20	1173.11	1171.74	1169.59	1166.72	1166.59	1164.63	1164.47	1164.14	1163.96	1163.90	1163.65	1163.60	1163.55	1163.24	1163.12	1183.69	1163.12
225.85	1175.39	1173.30	1171.93	1169.79	1166.92	1166.80	1164.80	1164.64	1164.30	1164.12	1164.06	1163.80	1163.75	1163.70	1163.39	1163.26	1183.87	1163.26
225.94	1175.97	1173.88	1172.52	1170.38	1167.49	1167.36	1165.32	1165.16	1164.80	1164.60	1164.54	1164.27	1164.21	1164.15	1163.82	1163.68	1184.42	1163.68
226.03	1176.20	1174.11	1172.73	1170.59	1167.67	1167.54	1165.49	1165.32	1164.96	1164.76	1164.70	1164.43	1164.37	1164.31	1163.99	1163.84	1184.74	1163.84
226.13	1176.51	1174.43	1173.07	1170.93	1167.97	1167.84	1165.73	1165.56	1165.18	1164.97	1164.92	1164.63	1164.57	1164.50	1164.17	1164.01	1184.98	1164.01
226.23	1176.59	1174.51	1173.15	1171.00	1168.03	1167.89	1165.77	1165.60	1165.22	1165.01	1164.96	1164.67	1164.61	1164.54	1164.21	1164.05	1185.08	1164.05
226.32	1176.68	1174.59	1173.22	1171.07	1168.08	1167.95	1165.81	1165.64	1165.27	1165.05	1165.00	1164.71	1164.65	1164.58	1164.24	1164.08	1185.17	1164.08
226.43	1176.77	1174.68	1173.30	1171.14	1168.15	1168.00	1165.86	1165.68	1165.30	1165.09	1165.04	1164.76	1164.71	1164.64	1164.32	1164.17	1185.28	1164.17
226.54	1176.58	1174.49	1173.17	1171.08	1168.18	1168.41	1166.66	1166.63	1166.42	1166.30	1166.29	1166.14	1166.07	1166.03	1165.83	1165.72	1185.33	1164.52
226.66	1177.61	1175.79	1174.59	1172.78	1170.64	1170.01	1168.65	1168.34	1168.07	1167.91	1167.76	1167.60	1167.53	1167.47	1167.25	1167.17	1185.44	1164.57

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APPENDIX C

Sample Calculations for Scour Analysis
100-Year, 10-Day Flood

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

ROBERT L. WARD, P.E. Consulting Engineer

Client: Premier Engineering | Page: 1/3
Project No.: PE-41 | Date: 7/31/98
Project Name: SRPMIC North-Bank Levee | Computed By: RLW

Revised: 10/24/98
JH
10/26/98

Sample Calculations For Scour Analysis

Use XSEC 225.85 From Table 4.1

1. Equilibrium Slope (.00047 ft/ft from SLA report)

Distance from Grade Control No. 5 = 14,840 ft
Elevation of Grade Control No. 5 = 1147.00 ft MSL

Project equilibrium slope @ XSEC 225.85:

$$(14{,}840)(.00047) + 1147.00 = 1153.97 \text{ ft MSL}$$

Thalweg elevation @ XSEC 225.85 = 1156.00 ft MSL

∴ Equilibrium slope is (1156 − 1153.97) = 2.03 ft below existing thalweg.

Q_{10} armor depth = 0.3-ft from SLA report.

Since 0.3-ft < 2.03-ft, use 0.3-ft as long-term degradation component.

2. Maximum General Scour

A value of -0.86-ft is read from Table A1 (Appendix A) under the "Maximum Scour" column

3. Bend Scour

$$Z_{bs} = \frac{0.0685\, Y V^{0.8}}{Y_h^{0.4}\, S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right]$$

$Y = 28.09'$
$V = 8.72$ fps
$Y_h = 22.03'$
$S_e = .000703$ ft/ft
$\alpha = 22°$

$$Z_{bs} = \frac{(.0685)(28.08)(8.72)^{0.8}}{(22.03)^{0.4}(.000703)^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{22°}{2}}{\cos 22°} \right)^{0.2} - 1 \right]$$

$Z_{bs} = (27.8746)(0.09907)$

$Z_{bs} = \underline{2.76 \text{ ft}}$

4. Dune Troughs

$\log d = 0.8271 \log A + 0.8901$

d = flow depth (meters) = (28.09)(.305) = 8.5675 meters

$\log(8.5675) = 0.8271 \log A + 0.8901$

$\log A = 0.051691 5888$

$A = 1.1264$ meters $= 3.69$-ft

Since "A" is the dune height from trough to crest, 1/2 of this value is the depth below the river-bed.

$\therefore \frac{1}{2} A = \frac{1}{2}(3.69) = \underline{1.85\text{-ft}}$

5. Anti-Dune Troughs

$$Z_{bf} = 0.0135\, V^2$$

$$V = 8.72 \text{ fps}$$

$$\therefore Z_{bf} = (0.0135)(8.72)^2$$

$Z_{bf} =$ 1.03', which is < ½ the flow depth

The anti-dune trough depth is less than the dune trough depth. Therefore, the dune trough depth of 1.85' will be used in the total scour calculation.

6. Low-Flow Incisement

For this cross-section, 1.5-ft of low-flow incisement was judgementally selected.

7. Total Computed Scour Depth

0.3	Long-term degradation
0	Local scour
0.86	General scour
2.76	Bend scour
1.85	Bed-form troughs
1.50	Low-flow incisement
Total: 7.27	
× 1.5	Safety Factor
10.91'	Maximum Total Scour Depth

Since 10.91' > 10.00' minimum criteria, use 10.91' of scour.

Scour elevation = 1156.00 − 10.91 = 1145.09-ft MSL.

APPENDIX D

FCDMC Correspondence

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5897

September 2, 1998

Mr. Jeff Holzmeister
Premier Engineering Corp.
4020 N. 20th Street, Suite 304
Phoenix, AZ 85016

Subject: **Review of the Sediment Transport Analysis and Geotechnical Report for the Salt River North-Bank Levee**

Dear Mr. Holzmeister:

The Flood Control District has reviewed the subject reports and provides the following comments:

Sediment Transport Analysis; July 31, 1998

1. **Page 6, 3rd Paragraph and Page 28, Table 4.1** – The Q10 armoring depth referenced from the SLA report may not be applicable upstream of XSEC 226.13. The channel velocities and energy slopes for the reaches upstream of this point are significantly higher values than those used in the SLA calculations, and it is clear in the SLA report that the armoring depth estimates were applicable only to that project reach (approximately XSEC 41.10 to XSEC 225.00). I suspect that re-calculation of the armoring depth will yield substantially larger critical particle diameter sizes and larger armoring depths. It appears (and is referenced in other reports for this area) that head-cutting along this particular reach exists due to past mining activities in the area. Given these two scenarios, it is recommended that the consultant re-evaluate the long term degradation value used for these reaches.

2. **Page 21, 1st full paragraph** – Please provide a discussion specifying the type of material that shall be used for backfill in the existing pit areas. This should be provided in this report to satisfy the sediment transport assumptions and analysis.

Geotechnical Report; April 3, 1998

I have reviewed AGRA's report for this project and have found it to be acceptable. I have the following comments:

1. A de-watering permit should be applied for well in advance of construction.

2. It should be pointed out to the bidders that in order to meet the gradation requirements for the CSA, some blending of stockpiled materials may be required.

3. The recommended gradation for the CSA aggregate should be discussed in a VE meeting. It may be found that in light of the high cost of cement, tighter gradation and PI requirements could result in a lower overall cost for the CSA.

Please refer questions regarding the sediment transport analysis review and the geotechnical report review to W. Scott Ogden (506-4071) and Warren Rosebraugh (506-4720), respectively, and general questions to me at 506-4771.

Sincerely,

C. Scott Vogel

C. Scott Vogel
Project Manager

Cc: Brian Fry, Dibble & Associates

PREMIER
ENGINEERING CORPORATION

September 16, 1998

C. Scott Vogel
Flood Control District of Maricopa County
2801 W. Durango Street
Phoenix, Arizona 85009-6399

RE: Review of Sediment Transport Analysis and Geotechnical Report for the Salt River North-Bank Levee

Dear Mr. Vogel:

The purpose of this letter is to respond to your comments (9/2/98) for the subject project.

<u>Comment No. 1</u> –

Page 6, 3rd Paragraph and page 28, Table 4.1 –

The Q10 armoring depth referenced from the SLA report may not be applicable upstream of XSEC 226.13. The channel velocities and energy slopes for the reaches upstream of this point are significantly higher than those used in the SLA calculations, and it is clear in the SLA report that the armoring depth estimates were applicable only to that project reach (approximately XSEC 41.10 to XSEC 225.00). I suspect that re-calculation of the armoring depth will yield substantially larger critical particle diameter sizes and larger armoring depths. It appears (and is referenced in other reports for this area) that head-cutting along this particular reach exists due to past mining activities in the area. Given these two scenarios, it is recommended that the consultant re-evaluate the long term degradation used for these reaches.

Response No. 1 –

The District's comment focuses on the fact that the channel velocities and energy slopes for this upstream reach of the Salt River were significantly higher than those used by SLA in developing the equilibrium slope profile through downstream reaches of the Salt River. As a result of the disparity, the District requested that a separate long-term degradation analyses be performed for this upstream reach of the Salt River.

The higher velocities through this upstream reach of the river occur in response to a localized bed-slope increase that appears to be a remnant of previous gravel mining operations. This bed-slope increase occurs in the vicinity of XSEC 226.13. As noted in Table 3.2 of the draft report, this bed-slope increase is considered to be the upstream end of an old head-cut. Over time, this head-cut will probably continue to propagate upstream toward the Alma School Road Bridge drop structure.

During this propagation sequence, the hydraulic characteristics of this reach of the river will continually change as the bed-slope becomes flatter. Under these circumstances, an armoring analysis may not be the most appropriate method to predict the long-term degradation profile that may develop. Armoring calculations were performed (using existing bed-profile data) for the six cross-sections located within its upstream reach of the river. As expected, the high velocities and energy slopes produces armoring depths that ranged from 1 foot to infinity. The lower depths were associated with the lower velocities that exist near Alma School Road Bridge.

A more appropriate form of analysis may be to project the SLA equilibrium slope (0.00047 ft/ft) through the study reach and use the invert profile associated with that slope as an existing thalwag elevation to which short term scour depths would be referenced. Accordingly, the SLA equilibrium slope was projected upstream from grade control No. 5 to the Alma School Bridge. This projected equilibrium slope follows the existing bed elevations very closely between XSEC's 224.33 and 226.03. In fact, it is within 0.2 feet of the existing invert elevation at XSEC 224.33. It is substantially below the existing bed elevations from XSEC 226.13 to 226.66.

Using the new equilibrium slope invert elevations between XSEC 266.13 and 266.66, a 4-point trapezoidal cross-section with a bottom width of 835 feet and 2:1 side slopes was created. This new geometry was based on the average bottom width of this reach of the Salt River, as measured from current topographic mapping.

The existing cross-sectional data for XSEC 226.13 through 226.66 was replaced with new data. New HEC-2 and HEC-6 models were then created with this new data in place. Cross-section data from XSEC 224.33 through 226.03 was not changed from that previously used in the analysis.

Results of the revised models were used to generate new scour estimates for the entire study reach that extends from the Pima Freeway/Red Mountain Freeway T.I. to the Alma School Road Bridge. The scour depths for XSEC 224.33 to 226.03 were referenced to the same existing invert elevations that were previously listed in Table 4.1 of the report. However, scour depths for XSEC's 226.13 through 226.66 were referenced to the new equilibrium slope inverts that resulted from projecting the SLA equilibrium slope upstream from Grade Control No. 5. The HEC-2 and HEC-6 models are on the attached floppy disk.

All scour calculations in the revised analysis were computed in the identical manner as previously presented in the report. The use of the SLA equilibrium slope through the upstream reach of the river eliminated the high velocities and energy slopes that were associated with the head-cut that currently exists at XSEC 226.13.

Table 4.1 summaries the results of the scour calculations with the SLA equilibrium slope projection. Table 4.2 presents a summary of the water surface profile that accompanied the revised analysis.

Figure 1 is a plot of the existing thalwag profile versus the SLA equilibrium slope projection (the SLA equilibrium slope invert elevations were only used between XSEC's 226.13 and 226.66).

Figure 2 is a plot of recommended toe-down profiles which compares the original profile to the revised profile resulting from this updated analysis. Figure 4.3 is a plot of the velocity profile associated with the revised analysis.

Since our proposed levee stops short of the existing head-cut, it is insignificantly affected by this revised analysis. However, the revised analysis should be considered for any future levee construction that might extend from the upstream end of the levee to the Alma School Road Bridge.

Comment No. 2

Page 21, 1st full paragraph

> *Please provide a discussion specifying the type of material that shall be used for backfill in the existing pit areas. This should be provided in this report to satisfy the sediment transport assumptions and analysis.*

The backfill material will consist of material that is comparable with native material or courser. The fill material will not increase the predicted scour depth of the river. Specifications for the material will be written and submitted to the FCDMC as part of the construction documents.

Comments 3 through 5

The CSA specification will be coordinated with ADOT, FCDMC, and SRSR to ensure that a stable and cost effective product is constructed.

Once the FCDMC has approved the revised analysis a final report will be prepared.

PREMIER
ENGINEERING CORPORATION

If you have any questions or need additional information please call me at 604-9500.

Sincerely,

Premier Engineering Corporation

Jeff Holzmeister, P.E.

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5897

October 8, 1998

Mr. Jeff Holzmeister
Premier Engineering Corp.
4020 N. 20th Street, Suite 304
Phoenix, AZ 85016

Subject: Review of the Sediment Transport Analysis and Geotechnical Report for the Salt River North-Bank Levee

Dear Mr. Holzmeister:

As I indicated in our recent phone conversation, the Flood Control District has reviewed your responses to our comments on the subject reports and finds them acceptable.

As you know, there is considerable study and design along the Salt River in the vicinity of the proposed improvements. The Alma School Bridge (north) grade control structure is being improved, and design of the McKellips Road Bridge is starting. At this time, the ultimate configuration of the river is under investigation, to determine if the split flow at Alma School should remain, or if the entire design flow (220,000 cfs) should be channelized in the north portion of the bridge, allowing for the southern Alma School Road Bridge to be closed as a design flow path. MCDOT, SRPMIC, and FCD are coordinating to come to a conclusion on this matter, which will affect the scenarios that require investigation for the subject improvements.

To discuss this matter further, I may be reached at 506-4771 (e-mail: csv@mail.maricopa.gov).

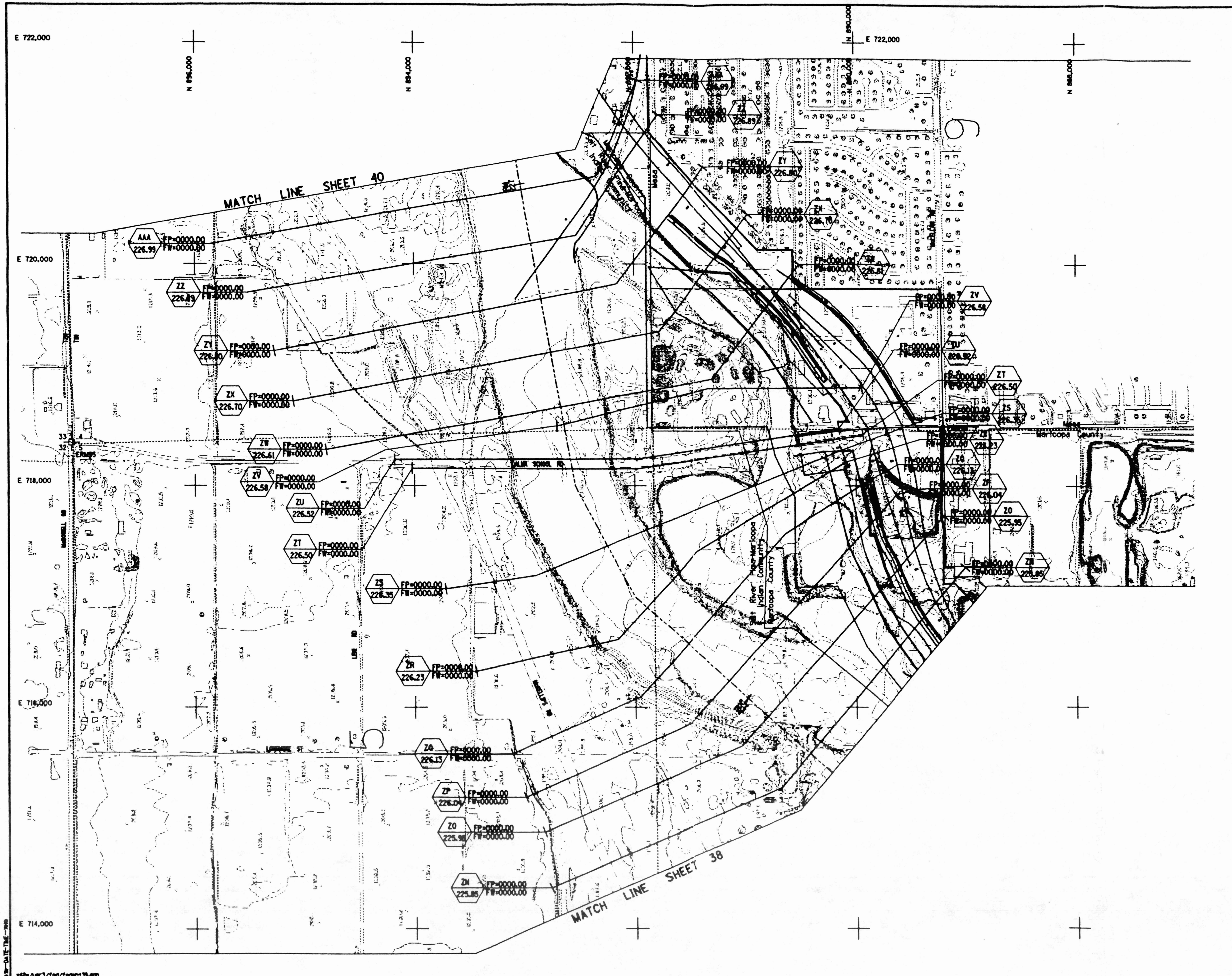
Sincerely,

C. Scott Vogel
Project Manager

cc: Brian Fry, Dibble & Associates
Ron Martinez, SRPMIC
Andrzej Wojakiewicz, MCDOT

PLATES

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road



AERIAL MAPPING COMPANY, MCLAUGHLIN KMETZ 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
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
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
MAIN CHANNEL LIMITS

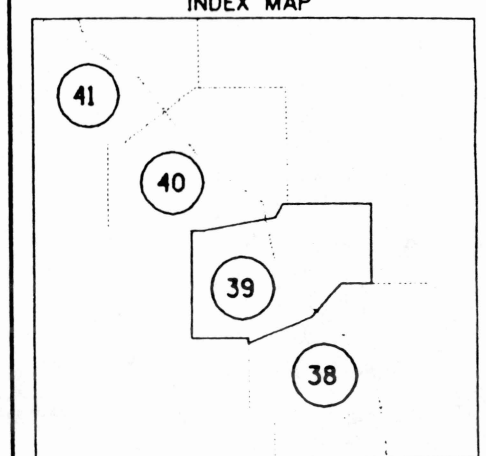
ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1983

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
94	1204.35	A BC in a HH in the intersection of McLellan Rd. and Alma School Rd. This point is the one quarter corner between Sec. 8 and 9 of T 1 N, R 5 E of the G&SRB&M Maricopa County, Arizona.
95	1218.72	A BC in a HH in the intersection of Alma School Rd. and McDowell Rd. This point is the SE corner of Sec. 32, T 2 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.

PRELIMINARY FOR INTERNAL USE ONLY

INDEX MAP



400 0' 400 800
SCALE: 1"= 400'
CONTOUR INTERVAL = 4 FEET

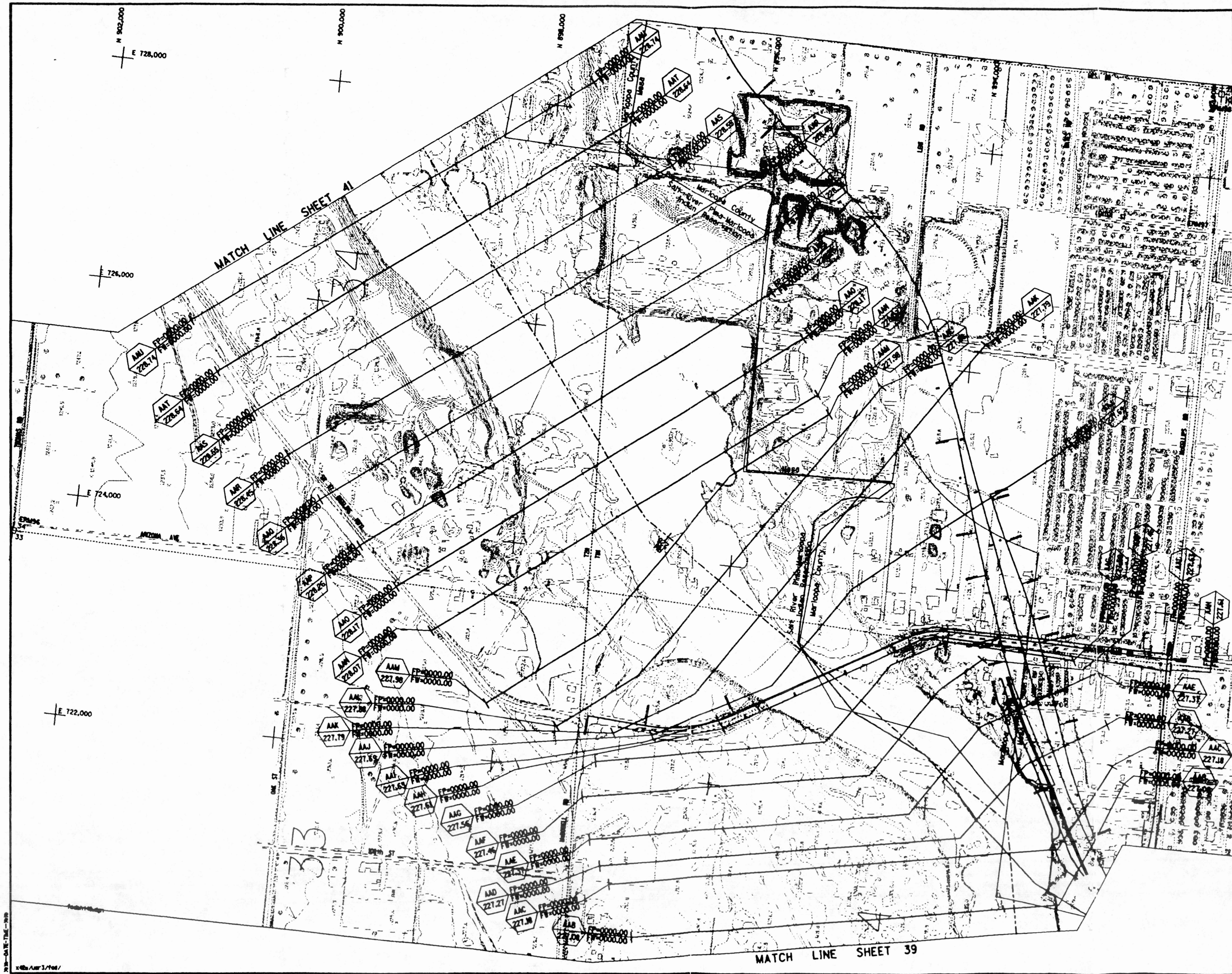
MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	RLD	-
DESIGN CHK.	TEX	-
PLANS	SSO	-
PLANS CHK.	RLD/TEX	-
SUBMITTED BY:		

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SHEET 39 OF 46

PLATE 1



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	
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
MAIN CHANNEL LIMITS	

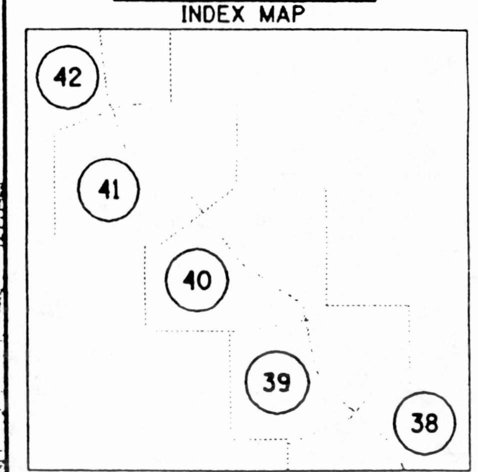
ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1983

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
96	1244.28	A BC in a HH in the intersection of Thomas Rd. and Arizona Ave. This point is the NE corner of Sec. 33, T 2 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.
97	1219.19	A BC in a HH in the intersection of Center St. and McKellips Rd. This point is the N quarter corner of Sec. 10, T 1 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.
98	1224.71	A BC in a HH in the intersection of Mesa Dr. and McKellips Rd. This point is the NE corner of Sec. 10, T 1 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.

PRELIMINARY FOR INTERNAL USE ONLY

INDEX MAP



400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4 FEET

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	RLD	-
DESIGN CHK.	TEK	-
PLANS	SSO	-
PLANS CHK.	RLD/TEK	-

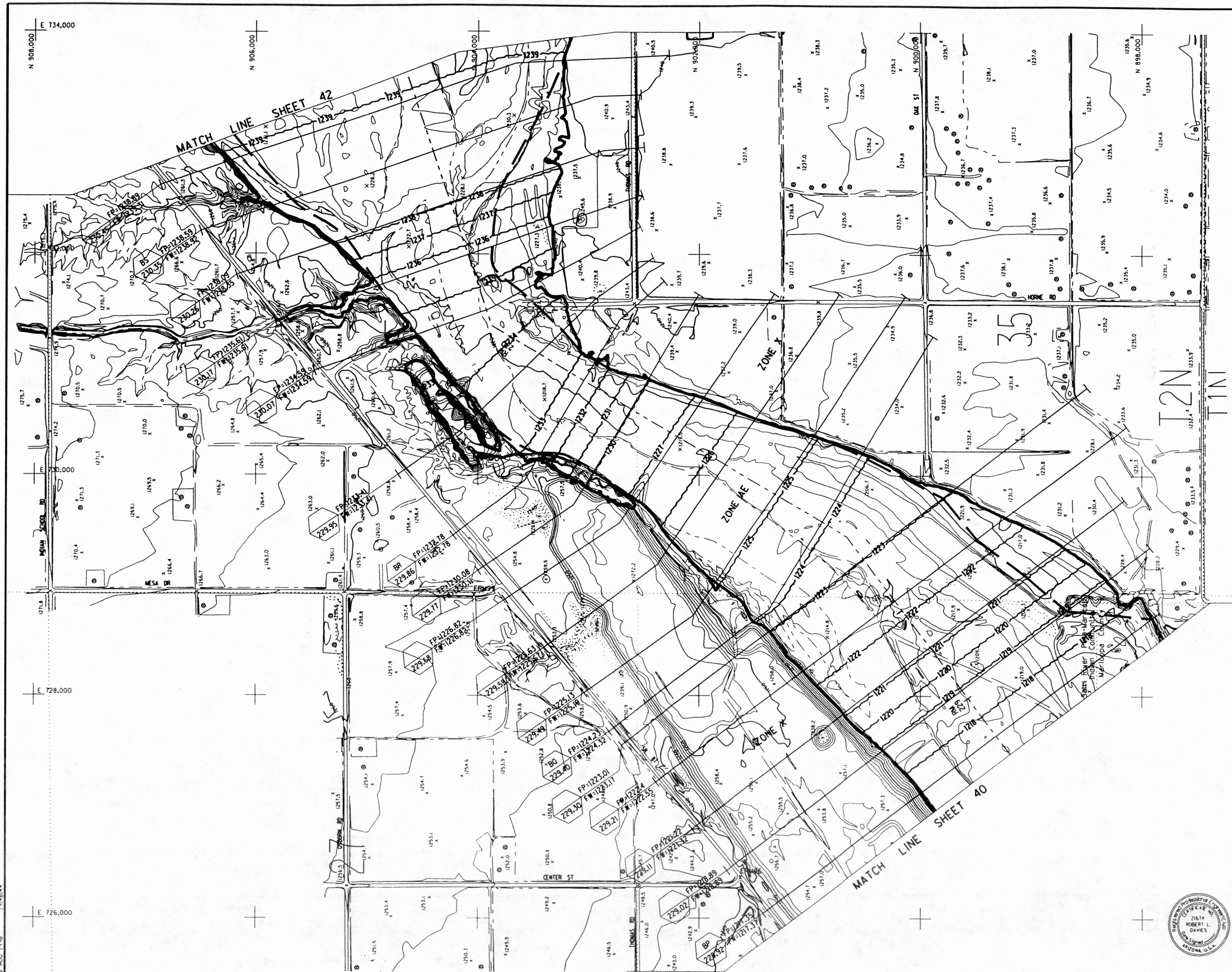
SUBMITTED BY: DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DATE

APPROVED BY: DATE

SHEET 40 of 46



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	FP=100 Yr WSE, FW=Floodway WSE
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
CONTROL POINT	144 △
APPROXIMATE SECTION CORNER	20 21 / 29 28
GUTTER ZONE	

ELEVATION REFERENCE MARKS

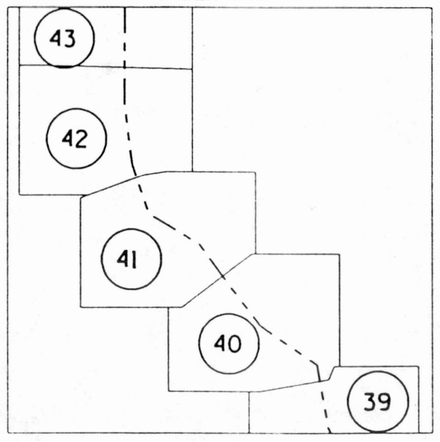
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
96	1244.28	A BC in a HH in the intersection of Thomas Rd. and Arizona Ave. This point is the NE corner of Sec. 33, T 2 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.
99	1261.69	A BC in a HH in the intersection of Mesa Dr. and Osborn Road. This point is the E quarter corner of Sec. 27, T 2 N, R 5 E 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



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 41 OF 46

REV. DEC. 10, 1991

ROBERT L. DAVIES 21674 — Registered Professional Engineer, ARIZONA, U.S.A.

v:\fcd\cadd\fcsht41.dgn

20 AUG 1998 19:46:44

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

AERIAL MAPPING COMPANY: MCLAIN, HARBORS CO., INC.
RIVER CHANNEL ONLY: SHTS 10-21A, 23-26A, & 40-44 ONLY.
FLIGHT DATE: APR. 1993.

AERIAL MAPPING COMPANY: MICHAEL BAKER JR., INC.
RIVER CHANNEL ONLY: SHTS 33-40 ONLY.
FLIGHT DATE: FEB. 1997.

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

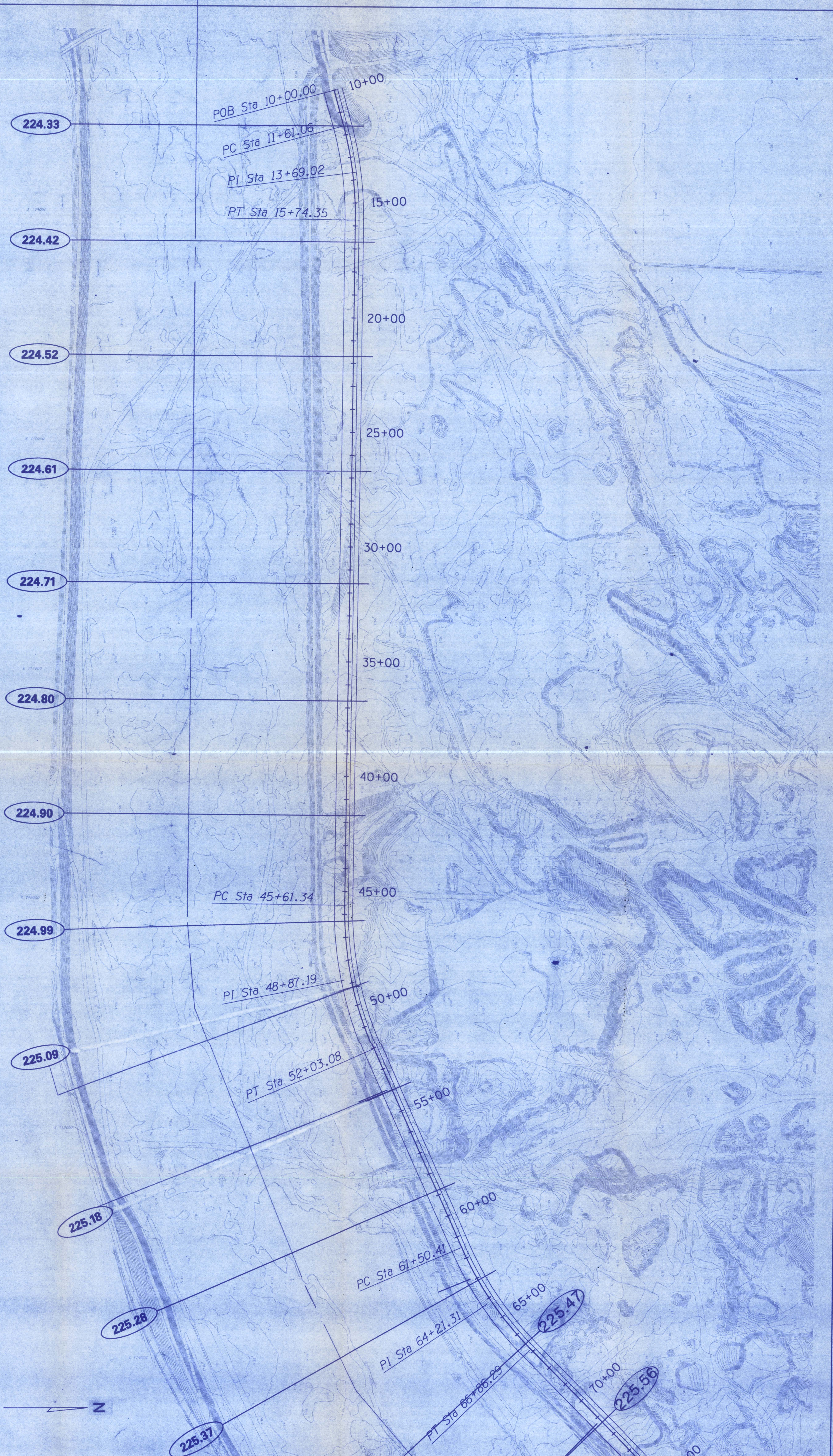
SEE COVER SHEET FOR INDIVIDUAL DISCIPLINES' CERTIFICATION

PRELIMINARY

PLATE 3

SURVEY NO.	FINISHED PLANS	REVISIONS	LOCATION	DATE

21 OCT 98



	NAME	DATE
DESIGN	K. ALLEN	10/98
DRAWN	M. ROSS	10/98
CHECKED	J. HOLLMEISTER	10/98

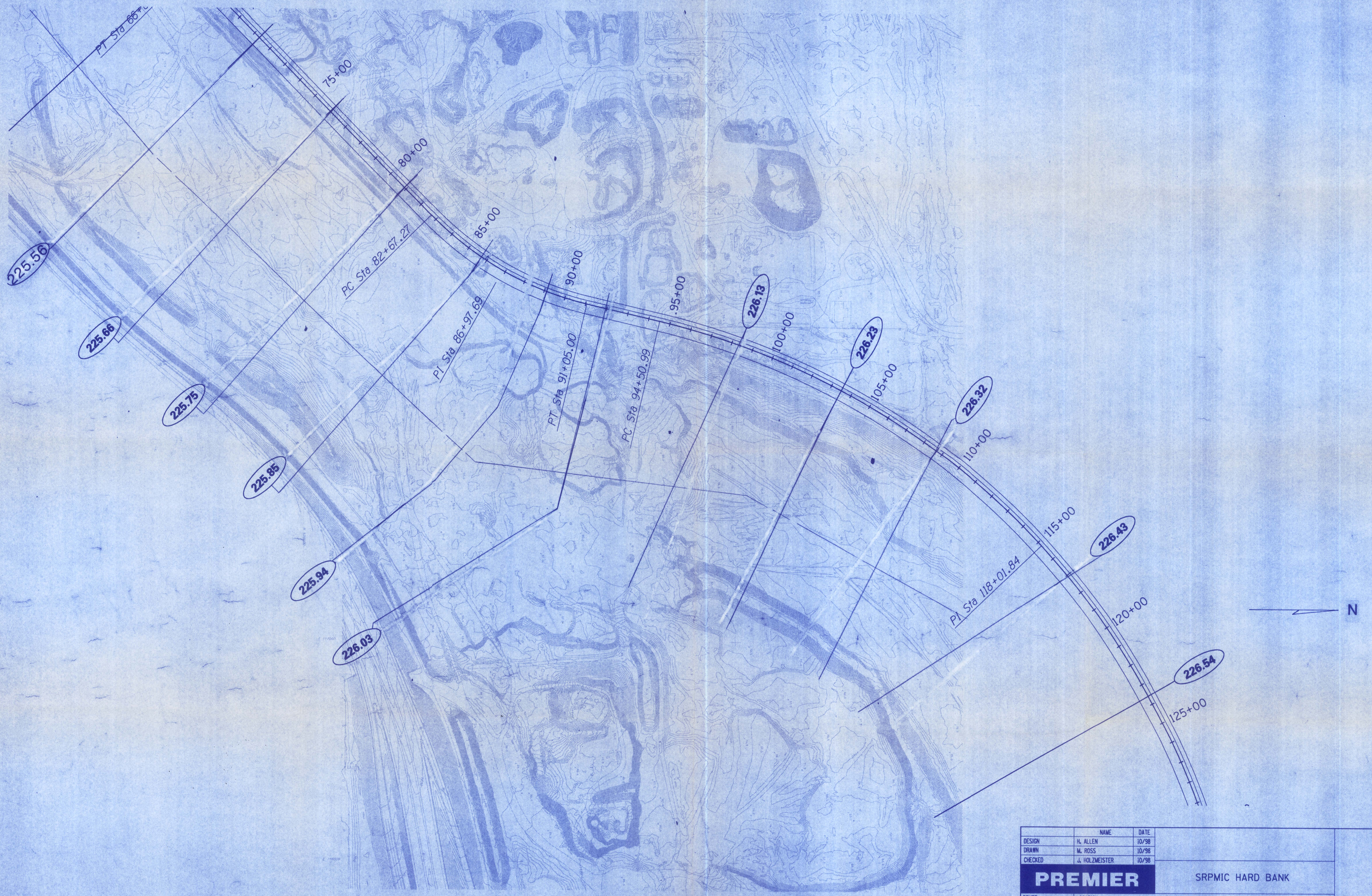
PREMIER

ROUTE | LOCATION

SRPMIC HARD BANK

SHEET __ OF __

PLATE 4



SURVEY NO.	FINISHED PLANS	REVISIONS	LOCATION	DATE

w:\9803\cadd\plan02.dgn
Plotted By: MGR 21 OCT 98 16:10:23

	NAME	DATE
DESIGN	H. ALLEN	10/98
DRAWN	M. ROSS	10/98
CHECKED	J. HOLZMEISTER	10/98

PREMIER

SRPMIC HARD BANK

ROUTE

LOCATION

SHEET OF

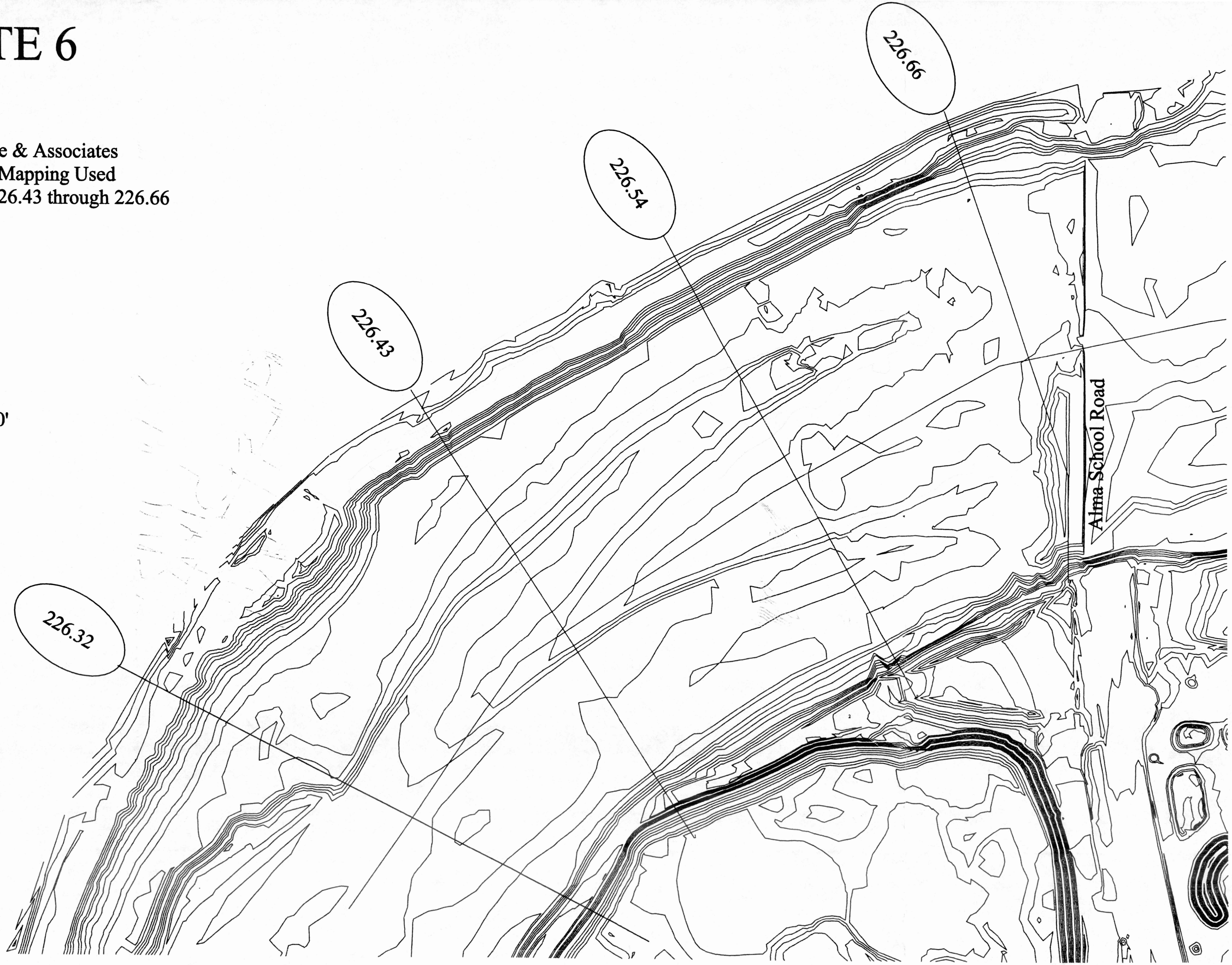
___ OF ___

PLATE 5

PLATE 6

Kimley-Horne & Associates
Topographic Mapping Used
For XSECs 226.43 through 226.66

1" = 200'



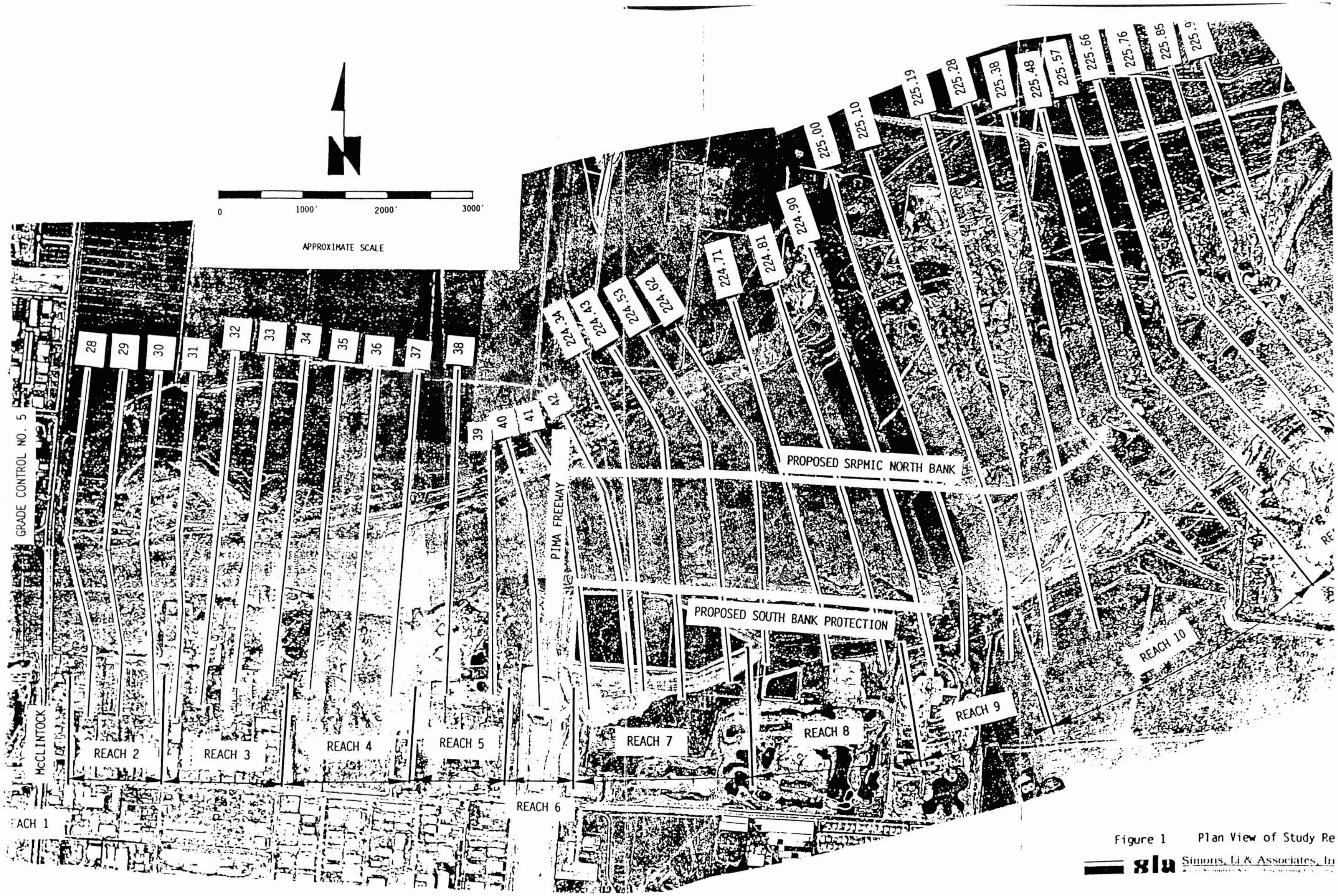


Figure 1 Plan View of Study Re

Simons, Li & Associates, In

PLATE 7