



US Army Corps of Engineers
Los Angeles District

**Santa Cruz River, Paseo de las Iglesias
Pima County, Arizona**

Feasibility Study Draft Report

Appendix B Hydraulic Investigation

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TABLE OF CONTENTS

I Introduction

II Descriptions of Current Hydraulic Studies

- 1.1 Flood Insurance Study
- 1.2 Master Drainage Study, San Xavier District
- 1.3 Los Reales Improvement District LOMR
- 1.4 Midvale Park Master Drainage Report
- 1.5 Old West Branch of the Santa Cruz River LOMR

III Hydraulic Investigation of With Project Conditions

- 1.1 Introduction
 - 1.1.1 Purpose
 - 1.1.2 Study Area Description
- 1.2 Methodology
 - 1.2.1 Guidance
 - 1.2.2 Analysis Tools
 - 1.2.3 Hydrology and Design Discharges
 - 1.2.4 Topographic Mapping and Vertical Datum
- 1.3 Hydraulic
 - 1.3.1 Previous Models and Data
 - 1.3.2 With Project Conditions Analysis
 - 1.3.3 Model Alteration
 - 1.3.4 Results
 - 1.3.5 Sediment Budget Analysis
 - 1.3.6 Bank Erosion

IV References

LIST OF FIGURES

Figure 1: Map of Paseo de Las Iglesias Study Area showing the Hydraulic Study Areas and Major Washes

Figure 2: Paseo de Las Iglesias Study Area

LIST OF APPENDICES

Appendix 1: Flood Insurance Study: HEC-2 input files (Disk) for the Santa Cruz River and Old West Branch of the Santa Cruz River, Old West Branch of the Santa Cruz River work maps (5) and printout of HEC-2 Input Data (duplicate of file contents)

- Appendix 2: Master Drainage Study, Tohono O'odham Nation-San Xavier District Phase 1- Panhandle Area Existing Conditions: study boundaries, hydraulic analysis, HEC-RAS output printout, and maps (2) of HEC-RAS cross section locations
- Appendix 3: Request for a Letter of Map Revision for the Los Reales Improvement District Located in Pima County, Arizona, and the City of Tucson, Arizona: study boundaries, HEC-2 input and output printout for the West Branch of the Santa Cruz River from Valencia Road to the Reservation Boundary, HEC-2 input and output printout for the South Channel
- Appendix 4: Midvale Park Master Drainage Report: study boundaries, West Branch Channel typical cross sections

I INTRODUCTION

The Paseo de Las Iglesias Study Area is traversed by several watercourses including the Santa Cruz River (SCR) and the West Branch of the Santa Cruz River (WBSCR). The study area is located between the Los Reales Road alignment and Congress Street within Township 14, Range 13, Sections 14, 22-24, 25-27, 34 and 35, as well as Township 15, Range 13, Sections 2-3, 10-11, 14, and 15 (Figure 1). Five separate studies contain hydraulic data for the watercourses traversing and immediately adjacent to this reach. This report summarizes the available hydraulic information, including HEC-2 analyses, work maps, and hydraulic information for bridges and culverts within and adjacent to the study area. Much of the information cited is available within the attached appendices.

II DESCRIPTION OF CURRENT HYDRAULIC STUDIES

1.1 The most recent SCR **Flood Insurance Study** (FIS) that includes the Paseo de Las Iglesias study area was performed on March 26th, 1990, by CMG Drainage Engineering Inc. The CMG Drainage Engineering study area covers the reach of the SCR downstream of the I-19 bridge (south of the study area) north past Congress Street through Tucson (Figure 1). The FIS was issued by the Federal Emergency Management Agency (FEMA) on February 8, 1999. The peak discharges of the SCR at both Drexel Road and Congress Street are reported to be 16800, 41000, 60000, and 93000 cfs for the 10-, 50-, 100-, and 500-year flood events, respectively. The drainage areas at Drexel Road and Congress Street are 2101 and 2222 square miles, respectively. The cross section elevations were determined using the 1984, 1"=200' aerial topography maps with a 2' contour interval based on the North American Vertical Datum (NAVD) 1929. The complete set of mylars of these orthophoto-topographic maps with floodplain delineations is available through the Pima County Department of Transportation, Mapping and Records Division. The FIS document is available through the FEMA Publication Center. Although no formal written report was prepared, CMG Drainage Engineering Inc. provided the input files for the HEC-2 analyses. A diskette containing the HEC-2 model input files for the 10-, 50-, 100-, and 500-year floodplain (PC25uf5.DAT) and the floodway (PC25ux5.DAT) for the Santa Cruz River from the I-19 bridge to Camino Del Cerro are available in Appendix 1.

1.2 **Master Drainage Study, Tohono O'odham Nation-San Xavier District Phase 1- Panhandle Area Existing Conditions** was prepared by McGovern, MacVittie, Lodge, and Associates, Inc. (MMLA) on July 31, 2001. The area studied is immediately adjacent to the south and west of the Paseo de Las Iglesias study area (Figure 1). Hydraulic information contained in this report includes details regarding four culvert crossings on Valencia Road, the Los Reales Improvement District collector and conveyance channels, and floodplain analysis utilizing HEC-RAS.

The culvert under Valencia Road at Valencia Wash (west of the Master Drainage Study area) is a seven-cell, 10' x 6' RCBC, with a design capacity (Q_{Design}) of 5257 cfs, which

will fully contain 100-year flood discharge (Q_{100}) of 3680 cfs. A single-cell 10' x 4' RCBC culvert at the southwest corner of Mission Road and Valencia Road conveys flows under Valencia Road into a concrete lined channel that conveys flows into the WBSCR. The Q_{Design} of 360 cfs is sufficient to pass the Q_{100} of 251 cfs, assuming all flow will concentrate at the headwall of the culvert. A three-cell, 71" x 47" CMPA is located in the historic alignment of the WBSCR at Valencia and Mission Road, 900' west of the WBSCR channel realignment. The Q_{Design} of 512 cfs conveys low flows under Valencia Road. The final culvert documented in this MMLA report conveys the flows from the relocated WBSCR under Valencia Road, east of Mission Road. It is a ten-cell 12' x 8' RCBC with upstream channel improvements. The Q_{Design} of 8000 cfs could pass the Q_{100} of 6900 cfs, as determined in this MMLA Master Drainage Study, under Valencia road without breakout, except earthen berms near the relocated WBSCR prevent some runoff from entering the channel, contributing to a wide floodplain in the area. This relocated WBSCR culvert design was also analyzed in the Midvale Park Master Drainage Report, which is presented in Section 1.4 (below).

Collector and conveyance channels information described in the MMLA Master Drainage Study are based on information more completely documented in the Arroyo Engineering Inc. report described in section 1.3 (below). HEC-RAS analyses of the floodplains in the Panhandle Study Area were performed based on discharges obtained from Manning Equation calculations. Topographic mapping based on aerial topography taken November 15, 1992 was completed by Kucera International Inc., with a horizontal scale of 1"=200' and a vertical contour interval of 2', based on NAVD 1929. A summing of hydrographs was done to obtain the 100-year discharge of 6809 cfs for Mission Wash upstream of Valencia Road. The HEC-RAS output files, as well as maps showing cross section locations are included in Appendix 2.

1.3 The Request for a Letter of Map Revision for the Los Reales Improvement District Located in Pima County, Arizona, and the City of Tucson, Arizona report was completed by Arroyo Engineering Inc. in December of 1994. This Letter of Map Revision (LOMR) was approved by FEMA prior to the issuance of the February 8, 1999 FIS, so the information contained in the current FIS reflects this LOMR. The Los Reales Improvement District (LRID) is located south of Valencia Road, entirely within Section 15 of Township 15 South, Range 13 East (Figure 1). The report contains detailed hydraulic analysis based on existing conditions including a new floodwall and associated drainage channels. The ground-profile data for the eastern portion of the report was based on 1984 Cooper Aerial Survey Co. aerial topographic maps, and the western portion was based on the 1986, McLain Aerial Surveys aerial topography maps. Both map sets have a horizontal scale of 1"=200' and a 2' contour interval based on NAVD 1929. Two HEC-2 models were assembled. The first detailed the depth of ponding against the floodwall, determined flood depths south of Valencia Road along the WBSCR, and performed split flow analysis to differentiate water flowing into the South Channel or westward into the SCR. The second HEC-2 model and split flow analysis was used to predict water surface elevations in the South Channel, and quantify the amount of floodwater that will either flow northward along Indian Agency Road, or eastward in the South Channel.

Ground profile data used to represent the improved portions of the South Channel were taken from field survey data and approved constructions plans. In evaluating breakout flows, a value of 2.6 was assigned to the weir-loss coefficient “C” to represent the flow over the roadways and channel levees. Areas of ineffective flow downstream of channel expansions were assigned specific cross sections, and an expansion ratio of 4:1 was used to delineate these areas. A 100-year peak discharge of 7638 cfs (determined by Buck Lewis and Associates, Inc., 1982) was used to establish flood heights for the WBSCR.

Based on the split flow calculations, output data predicted that 3131 cfs will flow northward in the “West Branch Channel” (WBSCR) during a 100-year flood, 3308 cfs will flow northward from the Reservation into the South Channel, and 1199 cfs will flow directly eastward into the SCR. A split flow calculation performed on the 3131 cfs flowing northward in the WBSCR predicted that approximately 219 cfs and 123 cfs will breakout at two locations and sheet flow to the east. This 342 cfs of break-out flow will concentrate south of Valencia Road, then be conveyed under the road by a 2-cell, 10’x 4’ RCBC, into a 30’ wide flood control channel that trends northwesterly and feeds back into the WBSCR. A separate split flow calculation predicted that the 3308 cfs that flows in the South Channel during the 100-year flood would be entirely contained within the South Channel. Full printouts of the input and output files, the plotted hydraulic cross sections, and river profiles for the HEC-2 model of the SCR are contained in Appendix 3. Printouts contain a summary of the split flow calculations.

1.4 The **Midvale Park Master Drainage Report** was completed in July of 1983 by Dooley-Jones & Associates, Inc. This study covers an irregular area south of Irvington Road and west of the SCR, within Township 15 South, Range 13 East, Sections 3, 10, and 15 (Figure 1). The report described the general design of numerous hydraulic structures. Tables and graphs for roadway capacities were provided, but were not tied to specific locations. Numerous generalized typical, as well as some alternative, cross sections and plans are provided for roadways, drainage channels, detentions basins, spillways, etc., but no specific location information was provided for this hydraulic information. The typical cross sections for the West Branch Channel are included in Appendix 4.

1.5 The **Old West Branch of the Santa Cruz River Letter of Map Revision Study** was completed in 1994 by McGovern, MacVittie, Lodge, and Associates, Inc. No project report document was prepared. The Letter of Map Revision was approved by FEMA on July 24, 2000. The area studied includes the historic WBSCR north of Irvington Road to its confluence with the SCR (Figure 1). The cross section elevations were based on 1983, 1”=200’ Cooper Aerial Survey Co. aerial topography maps with a 2’ contour interval based on the NAVD 1929. The discharges used in the models were based on the Tucson Stormwater Management Study. Copies of the applicable work maps, and a diskette with the WBSCR HEC-2 input files are located in Appendix 1.

III. HYDRAULIC INVESTIGATION OF WITH PROJECT CONDITIONS

1.1 INTRODUCTION

1.1.1 PURPOSE

The purpose of this section is to document the hydraulic analysis completed in support of the Alternative Formulation Briefing (AFB) milestone for the Santa Cruz River, Paseo de las Iglesias Feasibility Study. This hydraulic analysis has been conducted to determine the “With Project” hydraulic conditions on the Santa Cruz River for the final array of alternatives. With Project hydraulic analysis was not performed on the Old West Branch and Los Reales tributaries, because no flood damage reduction or ecosystem restoration measures are being proposed for these reaches.

1.1.2 STUDY AREA DESCRIPTION

The Santa Cruz River has its headwaters in the San Rafael Valley in southeastern Arizona. From there, the river flows south into Mexico. After a 35-mile loop through Mexico, it turns to flow northward and reenters Arizona about six miles east of Nogales. The river continues northward to Tucson then northwest to its confluence with the Gila River 12 miles southwest of Phoenix. The river runs approximately 43 miles north of the US-Mexico border before entering the study area. Throughout this reach, flow occurs only because of effluent discharges or following major storms.

The Paseo de las Iglesias study area (see Figure 2) encompasses approximately 5005 acres and consists of a 7.5 river mile reach of the Santa Cruz River and its tributary washes. Beginning where Congress Street crosses the river in downtown Tucson the study area extends upstream to the south along the river to the boundary of the San Xavier District of the Tohono O’Odham Nation. The eastern study boundary is represented by Interstates 10 and 19. The western study area boundary is represented by Mission Road and the San Xavier District of the Tohono O’Odham Nation. Soil cement bank protection exists on both channel banks between Irvington Road and Ajo Way; near Valencia Road; and on both banks of the river between Silver Lake Road (29th Street) and Congress Street. All other portions of the river are unprotected with near vertical eroded banks. Bridges in the study area include Valencia Road, Irvington Road, Ajo Way, Silverlake Road, 22nd Street, and Congress Street.

The main channel of the Santa Cruz River flows in a relatively straight northerly direction from the southern to the northern borders of the study area. The West Branch tributary of the Santa Cruz River currently extends from the southern border of the study area to the north approximately 3.5 river miles to where it joins the mainstem of the Santa Cruz River, just north of Irvington Road. The portion of this channel just north of Irvington Road, the New West Branch, has been re-routed. The former channel (before it was re-routed) extends from just north of Irvington to just south of 22nd Street where it joins the mainstem of the Santa Cruz River.

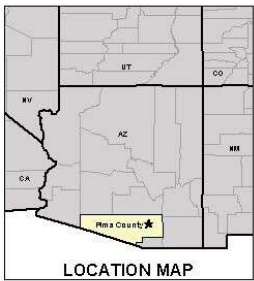
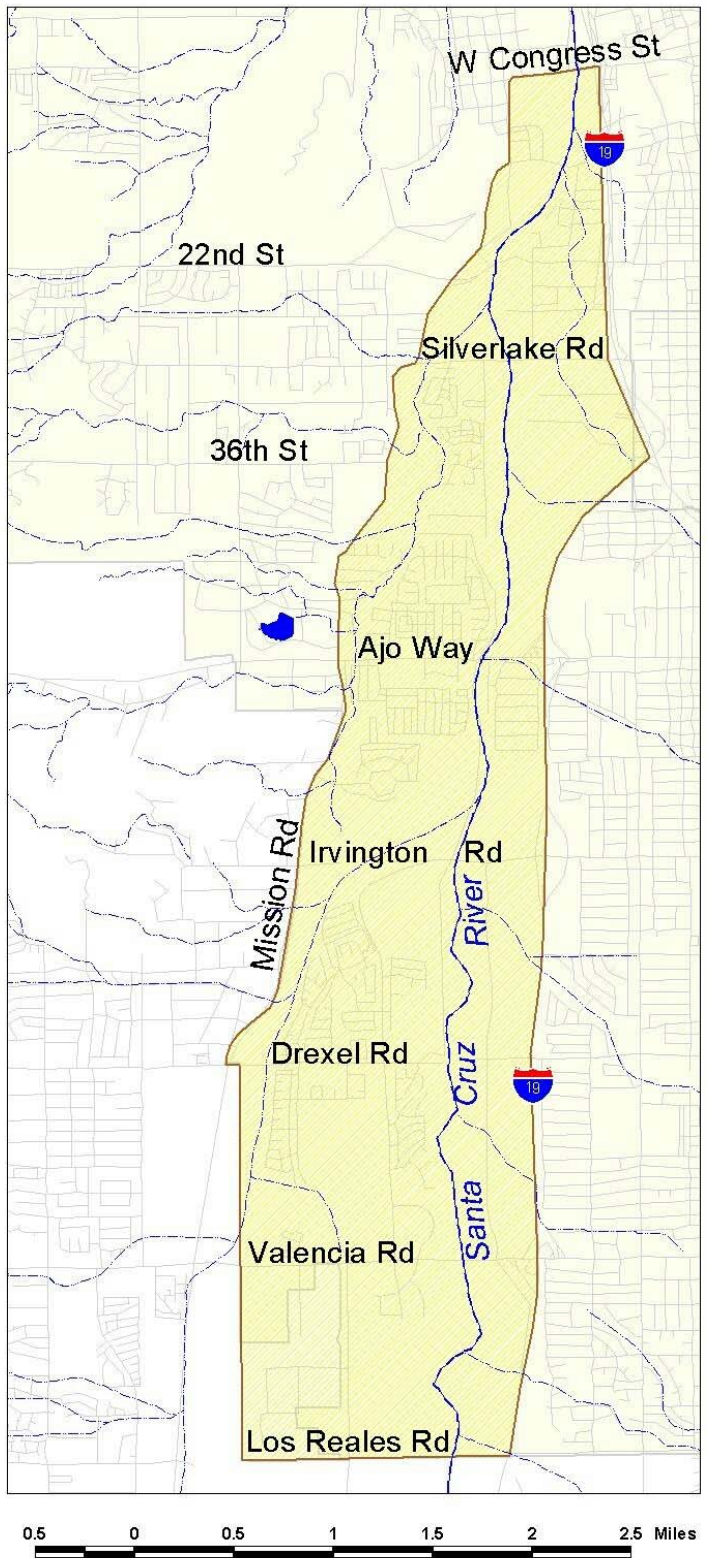
The reach investigated for this hydraulic analysis includes approximately seven and one-half (7.5) river miles of stream channel and historic floodplain areas and is characterized by an incised, partially bank protected river with a narrow 100-year floodplain. Between Ajo Way and Irvington Road, the New West Branch tributary joins the Santa Cruz River at a confluence marked by a large concrete drop structure and energy dissipater.

1.1.2.1 Major Tributaries




Old West Branch: The Old West Branch of the Santa Cruz River is an entrenched natural channel that extends from Irvington Road to 22nd Street where it joins the river. The average base width is 20 ft and the average bank height is 10 ft. There is a significant amount of vegetation (e.g., mesquite) growing along the banks and some vegetation growing in the channel bed. There is a large concrete drop structure at the confluence of the New West Branch and the Santa Cruz River. Vehicular bridges exist at the Silverlake Road and Ajo Way crossings.

Los Reales Improvement District: The Pima County Department of Transportation and Flood Control District (FCD) formed the Los Reales Improvement District in 1987 in order to construct a flood-control levee and associated drainage ways. The District is located at the upstream end of the New West Branch, between Los Reales and Valencia Roads. The purpose of this project was to divert flows around the development and dispose of these flood flows either into the Santa Cruz River or into the New West Branch channel. Along the south boundary of this Improvement District, there is a 4 ft high, 1400 ft long floodwall, which extends between the Tohono O’odham Indian Reservation Boundary and Indian Agency Road. On the west end of this floodwall, a partially lined concrete channel diverts a portion of the flood flows northward into the New West Branch channel. A partially lined concrete channel exists along the south edge of the development and diverts all remainder flood flows into the Santa Cruz River approximately opposite Hughes Wash.

New West Branch: The New West Branch diversion is an entrenched partially bank protected trapezoidal channel that extends 3.5 miles from Los Reales road to Irvington Road where it joins the river. The channel has a natural bottom with 3 on 1 concrete lined sideslopes. The base width varies from 100 to 120 ft. The average bank height is 8 ft. There is a large concrete drop structure at the confluence of the New West Branch and the Santa Cruz River. Vehicular bridges exist at Irvington and Valencia Roads and one (1) a pedestrian bridge exists south of Drexel Road.



LEGEND

-  Study Area Boundary
-  City of Tucson Municipal Boundary
-  Washes

**Paseo de las Iglesias
Pima County, Arizona
Feasibility Study**



Figure 2: Paseo de las Iglesias Study Area

1.2 METHODOLOGY

1.2.1 GUIDANCE

The hydraulic analysis was prepared in accordance with EM 1110-2-1601, “Hydraulic Design of Flood Control Channels”, USACE 1994. EM 1110-2-1418, “Channel Stability Assessment for Flood Control Projects” (USACE, 1994), and EM 1110-2-1619, “Risk-Based Analysis for Flood Damage Reduction Studies” (USACE, 1996) provided additional guidance.

1.2.2 ANALYSIS TOOLS

HEC-RAS (USACE 2001) was used for the Santa Cruz River with project conditions model(s). The ArcView (ESRI 1999) extension HEC-GeoRAS (HEC 2000) was used as a pre and post processor for HEC-RAS.

1.2.3 HYDROLOGY AND DESIGN DISCHARGES

Table 1 below summarizes the peak discharges that were used for the with project hydraulic analysis. Hydrologic methodologies and assumptions were used to develop the respective discharges are documented in Appendix A, Hydrology.

**Table 1: Santa Cruz River (Drainage Area = 2,222 Sq. mi.)
Discharge – Frequency Relationships**

<u>Frequency (Year)</u>	<u>Discharge (cfs)</u>
2	4,900
5	9,500
10	14,000
20	20,000
50	35,000
100	55,000
200	75,000
500	120,000

1.2.4 TOPOGRAPHIC MAPPING AND VERTICAL DATUM

The information used for this study is based on two vertical datums. The original Flood Insurance Study (FIS) models and workmaps that were based on the National Geodetic Vertical Datum of 1929 (NGVD 1929). The datum used for the current topography is the North American Vertical Datum of 1988 (NAVD 1988). The difference between these datums varies as a function of location.

However, within the study reach, a constant difference was determined to be appropriate and reasonable. The following equations were used to convert between the datums:

$$\begin{aligned}Elev(NAVD) &= Elev(NGVD) + \blacktriangleup Elev \\Elev(NGVD) &= Elev(NAVD) - \blacktriangleup Elev\end{aligned}$$

where: Elev(NAVD) = elevation in NAVD 1988 datum;
Elev(NGVD) = elevation in NGVD 1929 datum.
 $\blacktriangleup Elev = 2.2$ ft.

The Pima County Flood Control District provided digital orthophotos (1998), digital terrain model (DTM) breakline data, DTM mass points, ArcInfo coverage of the existing mapped floodplains, and digital GIS layers for the County. Additional field survey data was provided by Pima County for the New West Branch diversion. Triangulated Irregular Networks (TIN) were then developed to obtain cross section data for the models. All topography provided by Pima County was based on NAVD 1988 datum.

1.2.4.1 New West Branch Survey Information

Field survey information for the New West Branch channel was provided by Pima County on 18 June 2003. The survey information consisted of a spreadsheet containing northing, easting, elevation data and an AutoCAD image of the points and breaklines. The data is on the same coordinate system as the topography that was used in the original hydraulic model. Pima County also provided some field drawing showing structure locations (e.g., bike paths, concrete channel locations, pipes).

1.3. HYDRAULIC ANALYSES

1.3.1 PREVIOUS MODELS AND DATA

The Pima County Department of Transportation and Flood Control District assembled a continuous HEC-2 water surface profile model for the Santa Cruz River that extended through Pima County, from the Santa Cruz County line to the Pinal County line. The original model was adapted from previously coded HEC-2 flood insurance study and County engineering study models.

In September 1998, the Corps of Engineers (USACE) converted the original Pima County HEC-2 model into a HEC-RAS model for the Gila River, Santa Cruz River Watershed, Pima County, Arizona, Final Feasibility Study, dated August 2001. Within Pima County, the Santa Cruz River was modeled under six contiguous reaches, which provided the modelers an efficient method to characterize the hydraulic differences along the river. The geometric data contained in the USACE model was updated at several locations along the Santa Cruz River from cross-section data provided by Pima County that was generated from detailed topography provided to the County by the U.S. Bureau of Reclamation.

The Paseo de las Iglesias study area is contained in the Tucson Urban reach, known as Reach 4 in the USACE Santa Cruz River Watershed Feasibility Study. The original cross-section geometric data within the stream valley in Reach 4 was not updated from the Bureau of Reclamation topography; however, some of the overbank areas (also known as the Historic Floodplain) have been updated using the GEO-RAS software program. The distinction for the age of the geometric data indicates that the station versus elevation data used to define the in-channel cross-sections (low flow area) is older than the historic floodplain (upland areas that receive flow only during major flood events) data, which was more recently updated with accurate topography. In short, the model's accuracy for predicting floodwater surface elevations is somewhat diminished "inside" the channel, whereas flood elevations "outside" the channel are more accurate.

Starting Water Surface Elevations

The starting water surface elevations were determined for each model based on stage-discharge curves from the FIS model at the downstream end of the Santa Cruz River model.

Bridge Modeling

All bridges on the Santa Cruz River were modeled using detailed bridge geometry developed for the Santa Cruz River Watershed Study (USACE 2001) HEC-RAS model. Contraction and expansion loss coefficients were set at 0.30 and 0.50, respectively in the cross sections upstream and downstream of bridges. Standard bridge pier loading was used.

Manning's Roughness Coefficients

Manning's roughness coefficients contained in the Pima County FIS model were used initially. These roughness coefficients were subsequently field checked and found to be reasonable. In general, roughness coefficients assigned to the channel, overbanks, and ineffective flow areas were 0.025 – 0.035, 0.035 – 0.070, and 1.00 respectively.

For with project conditions, the roughness coefficients will be increased to reflect the proposed establishment of vegetation along the channel where it does not currently exist.

1.3.1.1 Revised New West Branch Model

At the request of the non-federal sponsor, additional hydraulic analysis was performed subsequent to the Without Project investigation. Based on suspicions that the New West Branch Channel actually has a higher conveyance capacity, field survey data described in Section 2.4.1 was provided by the non-federal sponsor. The Without Project HEC-RAS model was then updated using this new survey information. However, there were two limitations with the new data: 1) the survey locations did not correspond with the original HEC-RAS cross-sections, and were subsequently incorporated into the original model as additional cross-sections; and 2) the new survey only included channel geometric information, i.e. there was no overbank information. Once the original HEC-RAS model was updated with new geometric information, another channel capacity-split flow analysis was performed to determine the amount of water overtopping the left bank. Finally, the left overbank was modeled separately using the flows determined from the split flow analysis to compute the more representative water surface elevations.

1.3.1.1.1 Revised New West Branch Model Results

1. The 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year flood events were simulated for the New West Branch channel reach. There are no breakouts for the 50-year flood event. The New West Branch was determined to have a flood conveyance capacity of between a 50- and 100-year flood event within the channel system. The 100-, 200-, and 500-year flood events would overtop the channel banks, primarily the left overbank looking downstream.
2. For the 100-year flood event, approximately 1,120 cfs overtops the left bank. The breakout over the weir (left levee) extends approximately 760 ft with a depth of 1-2 ft. The overbank breakout flow then quickly spreads out onto the overbank where flood depths of approximately one foot are experienced.
3. The 200- and 500-year flood events would overtop the channel similar to the original HEC-RAS model results.
4. Plate 15 in the Without Project Hydraulics Appendix was updated to reflect the changes described above. Specifically, the 50-year floodplain was removed from the left overbank. The 100-year floodplain was redrawn, while the 200- and 500-year floodplains remained the same.
5. Conclusions: The revised without-project overflow analysis for the New West Branch of the Santa Cruz River indicated that the existing channel capacity and

amount of overflow is different from the original hydraulic model results. Applicable hydraulic data tables, overflow maps, and equivalent annual damage estimates were updated based on the results of this analysis.

1.3.2 SANTA CRUZ RIVER WITH PROJECT CONDITIONS ANALYSIS

As part of the project, ecosystem restoration measures are being proposed within the active channel, on the channel banks and the historic overbank floodplain. The predominant method for ecosystem restoration is the establishment of native vegetation species in areas that do not receive high frequency flows. These areas exist within the main channel but are located on terraces that are above low flow channel or 2-year recurrent event water surface elevation.

Stream banks along the Santa Cruz River are highly unstable and nearly vertical cliffs composed of weakly cemented sands, which are highly susceptible to instability from shear stresses during flood events, desiccation and wind erosion from the lack of vegetative cover that would normally provide stability from these erosive forces. Modifications to the present channel geometry important to the ability to construct, re-vegetate and sustain a restored riparian ecosystem include lowering the gradient of the steep channel banks, reducing instability from water and wind erosion. By altering the station versus elevation data on specific River Station cross-sections, the available flow area within the channel can be increased which would result in a lower water surface elevation.

The hydraulic investigation of the potential impacts of the proposed actions for the project can be analyzed by modeling the proposed conditions and comparing the results to the existing conditions. The two major changes to the existing model, adding vegetation for an increased Manning's roughness coefficient and decreasing the steepness of the channel banks through the alteration of station versus elevation data, will allow for the comparison of existing and proposed conditions.

1.3.3 SANTA CRUZ RIVER MODEL ALTERATION

The existing USACE Santa Cruz River Watershed Study HEC-RAS model was used to determine the hydraulic effects of proposed channel alterations on portions of the study area. The limits of the HEC-RAS model for the Santa Cruz River study are located upstream at River Station 40.11 (Los Reales Road) and downstream at River Station 32.62 (Congress Street bridge). River Stations within the model are defined and measured as river miles starting at zero at the mouth of the Santa Cruz and increasing in an upstream direction. There are 73 HEC-RAS River Station (RS) cross-sections and five bridge crossings within the study area model. Areas along the project reach that lacked soil cement bank protection and had sufficient width of adjacent vacant land were identified for the establishment of vegetation and laying back the over steep banks. Areas along the channel that are currently protected by soil cement or areas where development exists in close proximity to the historic floodplain were not altered in the model. Based on these parameters, two main reaches of the model were identified for channel alterations as shown in Table 2:

Table 2: Reach Alteration River Station Limits

Reach	Upstream RS in Reach	Downstream RS in Reach	No. of RS Altered
Upstream	RS 39.16 (Valencia Rd)	RS 36.93 (Irvington Rd)	23
Downstream	RS 35.66 (Ajo Way)	RS 34.34 (Silverlake Rd)	15

The cross-section geometric data for each River Station in these two reaches was examined to determine the existing slopes of the channel banks and the location and value of the Manning’s roughness coefficient. Within the station versus elevation data that define the cross-sectional shape of the channel at that River Station, the channel banks that were steeper than a five-on-one vertical to horizontal (5:1 V:H) slope were altered to achieve a 5:1 slope. The station versus elevation data pairs that defined the steep slopes within the cross-section were replaced by proposed station versus elevation data pairs that were set on a 5:1 slope.

Alteration to the existing station versus elevation data pairs was limited to only those data pairs that define the channel geometry at elevations above the 2-year recurrent storm water surface elevation. By preserving geometric data pairs near the invert of the channel, the channel-forming discharge (also known as the bankfull discharge) was left in tact to prevent further instability within the low flow boundaries of the channel.

The location and value of the Manning’s roughness coefficient was reviewed and altered for each of the River Stations identified in Table 2. The roughness coefficient is applied to each cross-section by indicating the location and value in the model. The overbank areas, either left overbank or right overbank, usually have higher roughness values than in the channel, which is attributed to the fact that larger vegetation and/or development (resulting in higher roughness values) is more readily able to grow in less flooded areas on the overbanks. Likewise, the channel roughness values are lower because frequent discharges presumably reduce the ability for vegetation to persist.

Manning’s roughness values for floodplain (or overbank) areas in the project were set at 0.05, corresponding to the existing scattered brush and trees in the project area. The roughness values for channel areas in the project were set at 0.025; the appropriate value for the existing clean, straight, full stage channel, with no rifts or deep pools. The roughness values (0.05 in the floodplain and 0.025 in the channel) set for the project were unchanged in value, however, the location of where the roughness values were applied was changed in each of the 38 altered River Stations. The left overbank and right overbank areas (roughness set at 0.05) were expanded toward the centerline of the channel to account for the proposed establishment of vegetation on the banks and in the terraces. Likewise, the channel roughness value (set at 0.025) was applied to the reduced lateral extent of the 2-year recurrent storm water surface elevation, where dense vegetation typically does not exist, due to the higher frequency of flow.

1.3.4 SANTA CRUZ RIVER MODEL RESULTS

There was an increase in the 100-year recurrent floodwater surface elevation in 19 of the 38 altered cross-sections due to the change in roughness values within the channel (decreasing

horizontal range of 0.025 to only include 2-year event discharges). A rise is defined in this investigation as any increase exceeding 0.1 feet in vertical elevation. The largest rise was 1.53 feet at River Station 37.4, which is located on a meander bend approximately halfway between Irvington Road bridge crossing and Drexel Road. The proposed 100-year recurrent flood event water surface elevation at this, and all other locations showing increases remains within the Santa Cruz River valley banks and would not induce flooding conditions in the historic floodplain.

Thirteen (13) altered cross-section River Stations showed a reduction in the 100-year recurrent flood water surface elevation due primarily to added available flow area from laying back the steep banks to a uniform 5:1 slope. A reduction is defined in this investigation as any decrease in water surface elevation greater than 0.09-feet. River Station 35.66, located immediately downstream from the Ajo Way bridge crossing, exhibited the largest reduction in water surface flood elevation at a minus 2.03 feet. The remaining six cross-section River Stations either exhibited no change in water surface elevation, exhibited an increase between 0 and 0.1 feet, or exhibited a reduction in water surface elevation between 0 and 0.1 feet.

These results are expected and would typically be observed in this type of project where both the roughness and channel geometry are altered for the purpose of ecosystem restoration and bank stability efforts. Table 3 provides a comparison of With and Without Project model results. River stations are measured from the confluence of the Santa Cruz River and Gila River, 35 miles downstream of the study area. Overflow maps are provided in Figures 2a and 2b following Table 3.

Table 3: Santa Cruz River Comparison – With Project

River Station	Profile	Q Total (cfs)	Without Project Water Surface Elevation (ft)	With Project Water Surface Elevation (ft)	Change in Water Surface Elevation (Pro - Ex)ft
40.11	2YR	4900	2469.23	2469.23	0
40.11	100YR	55000	2475.79	2475.79	0
40.01	2YR	4900	2468.45	2468.45	0
40.01	100YR	55000	2472.89	2472.89	0
39.92	2YR	4900	2466.88	2466.88	0
39.92	100YR	55000	2470.83	2470.86	0.03
39.82	2YR	4900	2461.68	2461.68	0
39.82	100YR	55000	2470.64	2470.67	0.03
39.73	2YR	4900	2461.48	2461.48	0
39.73	100YR	55000	2469.91	2469.95	0.04

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
39.63	2YR	4900	2459.64	2459.65	0.01
39.63	100YR	55000	2466.77	2466.5	-0.27
39.54	2YR	4900	2452.28	2452.28	0
39.54	100YR	55000	2468.56	2468.44	-0.12
39.44	2YR	4900	2452.26	2452.25	-0.01
39.44	100YR	55000	2468.32	2468.19	-0.13
39.35	2YR	4900	2452.24	2452.24	0
39.35	100YR	55000	2468.33	2468.2	-0.13
39.25	2YR	4900	2452.24	2452.24	0
39.25	100YR	55000	2468.31	2468.18	-0.13
39.16	2YR	4900	2451.19	2451.19	0
39.16	100YR	55000	2461.3	2461.34	0.04
39.06	2YR	4900	2448.34	2448.36	0.02
39.06	100YR	55000	2460.92	2459.64	-1.28
38.97	2YR	4900	2445.32	2445.32	0
38.97	100YR	55000	2462.12	2461.85	-0.27
38.965	Bridge at Valencia Road				
38.96	2YR	4900	2444.58	2444.58	0
38.96	100YR	55000	2461.85	2461.56	-0.29
38.82	2YR	4900	2444.11	2444.11	0
38.82	100YR	55000	2461.97	2461.64	-0.33
38.73	2YR	4900	2443.98	2443.98	0
38.73	100YR	55000	2461.84	2461.42	-0.42
38.63	2YR	4900	2443.68	2443.68	0
38.63	100YR	55000	2461.52	2460.85	-0.67
38.54	2YR	4900	2441.46	2441.46	0
38.54	100YR	55000	2454.84	2454.7	-0.14
38.44	2YR	4900	2437.64	2437.64	0
38.44	100YR	55000	2448.7	2448.88	0.18
38.35	2YR	4900	2435.89	2435.89	0
38.35	100YR	55000	2449.1	2449.69	0.59

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
38.25	2YR	4900	2435.22	2435.23	0.01
38.25	100YR	55000	2449.04	2449.59	0.55
38.16	2YR	4900	2433.42	2433.42	0
38.16	100YR	55000	2443.53	2443.84	0.31
38.06	2YR	4900	2430.62	2430.61	-0.01
38.06	100YR	55000	2438.59	2439.12	0.53
37.97	2YR	4900	2429.4	2429.29	-0.11
37.97	100YR	55000	2438.19	2438.63	0.44
37.87	2YR	4900	2428.44	2428.34	-0.1
37.87	100YR	55000	2437.85	2438.17	0.32
37.78	2YR	4900	2427.53	2427.54	0.01
37.78	100YR	55000	2435.48	2436.56	1.08
37.69	2YR	4900	2425.24	2425.22	-0.02
37.69	100YR	55000	2432.52	2433.24	0.72
37.59	2YR	4900	2422.32	2422.43	0.11
37.59	100YR	55000	2431.07	2431.52	0.45
37.5	2YR	4900	2420.07	2420.06	-0.01
37.5	100YR	55000	2430.66	2430.6	-0.06
37.4	2YR	4900	2418.3	2418.25	-0.05
37.4	100YR	55000	2428.37	2429.9	1.53
37.31	2YR	4900	2416.32	2416.44	0.12
37.31	100YR	55000	2427.15	2426.74	-0.41
37.21	2YR	4900	2414.97	2415	0.03
37.21	100YR	55000	2426.71	2426.68	-0.03
37.12	2YR	4900	2413.64	2413.62	-0.02
37.12	100YR	55000	2426.35	2426.66	0.31
37.02	2YR	4900	2412.55	2412.53	-0.02
37.02	100YR	55000	2426.06	2426.58	0.52
36.93	2YR	4900	2409.84	2409.85	0.01
36.93	100YR	55000	2425.66	2424.93	-0.73

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
36.83	2YR	4900	2406.66	2406.66	0
36.83	100YR	55000	2425.72	2425.72	0
36.825	Bridge at Irvington				
36.82	2YR	4900	2405.23	2405.23	0
36.82	100YR	55000	2415.19	2415.19	0
36.72	2YR	4900	2403.34	2403.34	0
36.72	100YR	55000	2412.15	2412.15	0
36.63	2YR	4900	2400.53	2400.53	0
36.63	100YR	55000	2412.33	2412.33	0
36.54	2YR	4900	2399.42	2399.42	0
36.54	100YR	55000	2413.18	2413.18	0
36.44	2YR	4900	2398.23	2398.23	0
36.44	100YR	55000	2409.92	2409.92	0
36.35	2YR	4900	2396.84	2396.84	0
36.35	100YR	55000	2408.79	2408.79	0
36.25	2YR	4900	2395.84	2395.84	0
36.25	100YR	55000	2408.43	2408.43	0
36.16	2YR	4900	2394.47	2394.47	0
36.16	100YR	55000	2407.2	2407.2	0
36.06	2YR	4900	2392.93	2392.93	0
36.06	100YR	55000	2405.5	2405.5	0
35.97	2YR	4900	2390.12	2390.12	0
35.97	100YR	55000	2403.03	2403.04	0.01
35.87	2YR	4900	2389.79	2389.79	0
35.87	100YR	55000	2403.1	2403.11	0.01
35.78	2YR	4900	2388.67	2388.67	0
35.78	100YR	55000	2401.88	2401.88	0
35.775	Bridge at Ajo Way				
35.77	2YR	4900	2387.62	2387.62	0
35.77	100YR	55000	2398.6	2398.6	0

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
35.66	2YR	4900	2383.58	2383.58	0
35.66	100YR	55000	2395.78	2393.75	-2.03
35.57	2YR	4900	2382.74	2382.72	-0.02
35.57	100YR	55000	2391.2	2391.22	0.02
35.47	2YR	4900	2381.1	2381.09	-0.01
35.47	100YR	55000	2389.48	2389.98	0.5
35.38	2YR	4900	2379.67	2379.67	0
35.38	100YR	55000	2388.91	2389.75	0.84
35.29	2YR	4900	2377.91	2377.91	0
35.29	100YR	55000	2385.5	2385.78	0.28
35.19	2YR	4900	2376.5	2376.5	0
35.19	100YR	55000	2386.02	2386.06	0.04
35.1	2YR	4900	2375.33	2375.35	0.02
35.1	100YR	55000	2384.83	2384.02	-0.81
35	2YR	4900	2374.06	2373.85	-0.21
35	100YR	55000	2381.4	2381.41	0.01
34.91	2YR	4900	2372.47	2372.56	0.09
34.91	100YR	55000	2382.4	2382.9	0.5
34.81	2YR	4900	2369.62	2369.61	-0.01
34.81	100YR	55000	2379.88	2379.06	-0.82
34.72	2YR	4900	2367.01	2367.05	0.04
34.72	100YR	55000	2379.7	2378.3	-1.4
34.62	2YR	4900	2366.41	2366.45	0.04
34.62	100YR	55000	2377.82	2377.95	0.13
34.53	2YR	4900	2365.24	2365.24	0
34.53	100YR	55000	2378.49	2378.34	-0.15
34.43	2YR	4900	2362.4	2362.4	0
34.43	100YR	55000	2378.3	2377.98	-0.32
34.34	2YR	4900	2359.3	2359.31	0.01
34.34	100YR	55000	2377.32	2376.87	-0.45
34.25	2YR	4900	2357.34	2357.34	0

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
34.25	100YR	55000	2376.17	2376.17	0
34.245	Bridge at Silverlake				
34.24	2YR	4900	2356.23	2356.23	0
34.24	100YR	55000	2367.77	2367.77	0
34.14	2YR	4900	2352.86	2352.86	0
34.14	100YR	55000	2365.45	2365.45	0
34.05	2YR	4900	2350.55	2350.55	0
34.05	100YR	55000	2363.73	2363.73	0
33.95	2YR	4900	2350.35	2350.35	0
33.95	100YR	55000	2365.62	2365.62	0
33.86	2YR	4900	2349.38	2349.38	0
33.86	100YR	55000	2362.38	2362.38	0
33.76	2YR	4900	2348.08	2348.08	0
33.76	100YR	55000	2361.08	2361.08	0
33.755	Bridge at 22nd Street				
33.75	2YR	4900	2346.96	2346.96	0
33.75	100YR	55000	2359.02	2359.02	0
33.66	2YR	4900	2343.92	2343.92	0
33.66	100YR	55000	2359.21	2359.21	0
33.57	2YR	4900	2343	2343	0
33.57	100YR	55000	2359.18	2359.18	0
33.47	2YR	4900	2342.02	2342.02	0
33.47	100YR	55000	2356.6	2356.6	0
33.38	2YR	4900	2340.92	2340.92	0
33.38	100YR	55000	2354.7	2354.7	0
33.28	2YR	4900	2339.79	2339.79	0
33.28	100YR	55000	2352.68	2352.68	0
33.19	2YR	4900	2338.64	2338.64	0
33.19	100YR	55000	2350.77	2350.77	0
33.09	2YR	4900	2338.19	2338.19	0

River Station	Profile	Q Total (cfs)	Without Project	With Project	Change in
			Water Surface Elevation (ft)	Water Surface Elevation (ft)	Water Surface Elevation (Pro - Ex)ft
33.09	100YR	55000	2352.45	2352.45	0
33	2YR	4900	2337.02	2337.02	0
33	100YR	55000	2351.65	2351.65	0
32.9	2YR	4900	2334.77	2334.77	0
32.9	100YR	55000	2350.15	2350.15	0
32.81	2YR	4900	2333.55	2333.55	0
32.81	100YR	55000	2350.13	2350.13	0
32.72	2YR	4900	2332.9	2332.9	0
32.72	100YR	55000	2350.07	2350.07	0
32.62	2YR	4900	2331.85	2331.85	0
32.62	100YR	55000	2347.46	2347.46	0
32.615	Bridge at Congress Street				
32.61	2YR	4900	2331.48	2331.48	0
32.61	100YR	55000	2343.46	2343.46	0
32.53	2YR	4900	2330.8	2330.8	0
32.53	100YR	55000	2343.5	2343.5	0
32.44	2YR	4900	2328.25	2328.25	0
32.44	100YR	55000	2340.82	2340.82	0
32.34	2YR	4900	2325.37	2325.37	0
32.34	100YR	55000	2341.27	2341.27	0
32.25	2YR	4900	2323	2323	0
32.25	100YR	55000	2340.48	2340.48	0
32.15	2YR	4900	2321.94	2321.94	0
32.15	100YR	55000	2341.06	2341.06	0
32.06	2YR	4900	2320.98	2320.98	0
32.06	100YR	55000	2340.87	2340.87	0
31.96	2YR	4900	2319.87	2319.87	0
31.96	100YR	55000	2339.73	2339.73	0
31.955	Bridge at St. Marys				
31.95	2YR	4900	2318.71	2318.71	0

River Station	Profile	Q Total (cfs)	Without Project Water Surface Elevation (ft)	With Project Water Surface Elevation (ft)	Change in Water Surface Elevation (Pro - Ex)ft
31.95	100YR	55000	2332.88	2332.88	0
31.82	2YR	4900	2315.83	2315.83	0
31.82	100YR	55000	2328.3	2328.3	0
31.73	2YR	4900	2314.02	2314.02	0
31.73	100YR	55000	2328.03	2328.03	0
31.63	2YR	4900	2311.68	2311.68	0
31.63	100YR	55000	2327.63	2327.63	0
31.54	2YR	4900	2310.72	2310.72	0
31.54	100YR	55000	2328.56	2328.56	0
31.53	Bridge at Speedway				
31.52	2YR	4900	2310.13	2310.13	0
31.52	100YR	55000	2323.43	2323.43	0

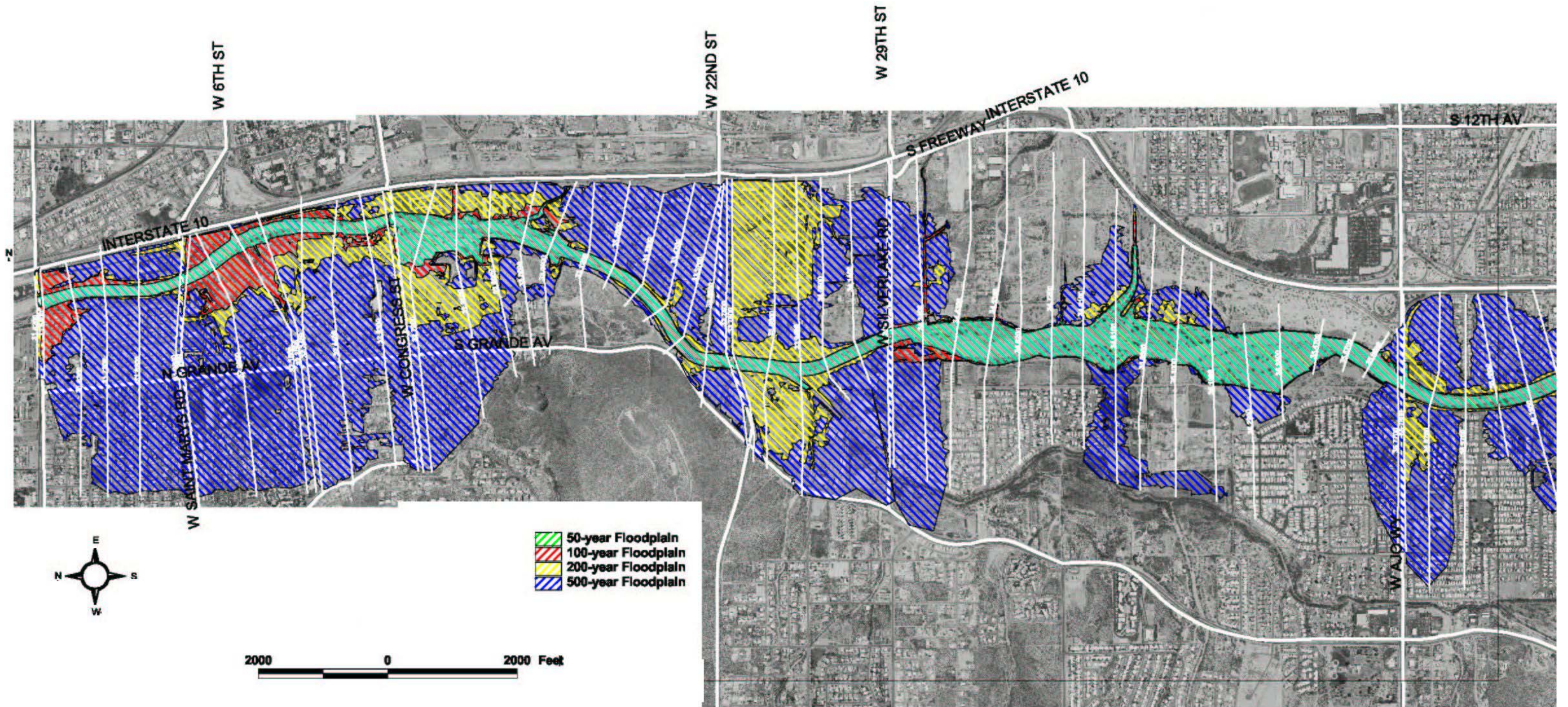


Figure 3 Santa Cruz River With Project Floodplain
Northern Portion of Study Area

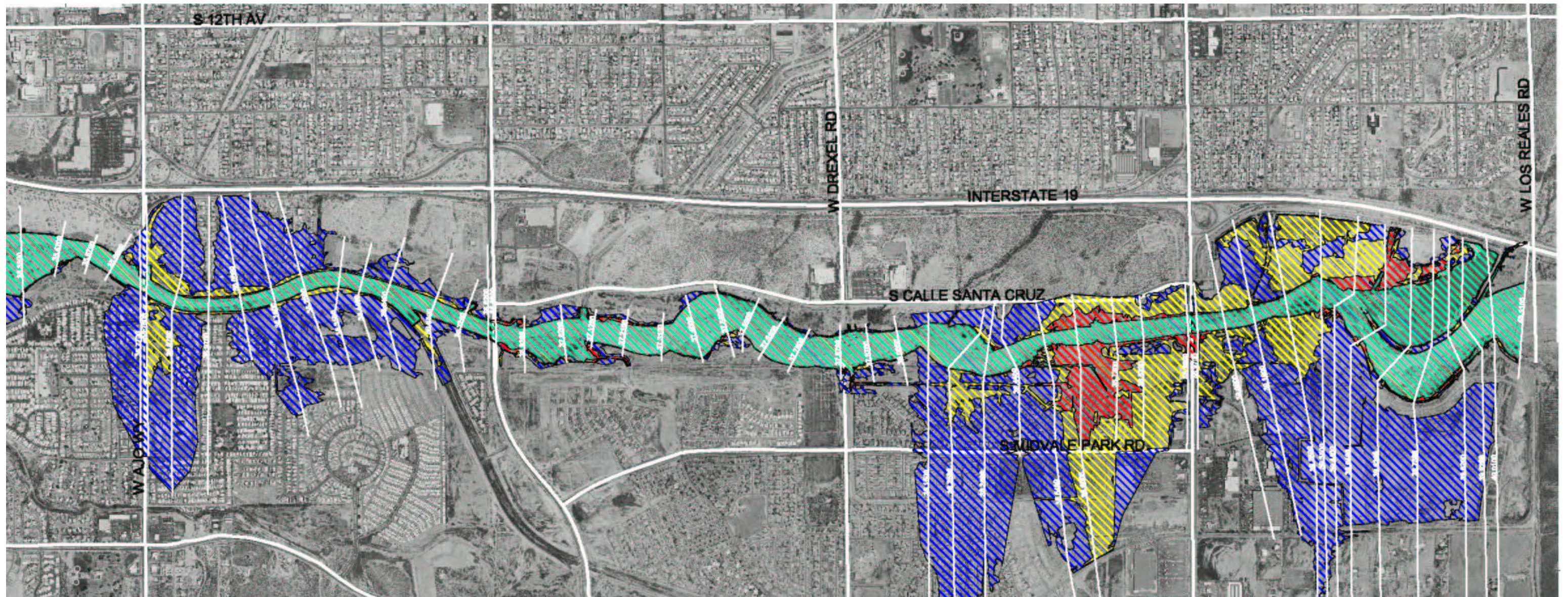


Figure 4 Santa Cruz River With Project Floodplain
Southern Portion of Study Area

1.3.5 SEDIMENT BUDGET ANALYSIS

To date, a sediment budget level of analysis was undertaken for the Without Project Condition only. The computer program SAM (WES, 1997) was used for the sediment budget analysis. More detailed analysis (e.g., HEC-6, HEC, 1993) program model approach will be utilized once a recommend plan is identified for design purposes.

In general, the previous analysis results indicate that there would be significant to moderate degradation at both the extreme upstream and downstream reaches and to a lesser extent within the middle reaches. In other words, almost all of the entire study reach was found to be subject to some overall degradation. However, a full comprehension of the results especially at the upstream and downstream limit of the study reach needs to be expanded upon. In the case of the upstream reach, the deep scour phenomenon may be the result of the equilibrium conditions that were assumed for this reach. Whereas, for the downstream reach, the obvious effects of the existing grade control structure downstream of Congress Street could not be incorporated in the sediment budget model. Hence, the application of a sediment budget analysis inherently suffers several notable shortcomings as a penalty for the simple and expedient nature of the calculations. Specifically, the analysis does not properly restrict the deposition of the wash load from the supply reach; it does not revise the hydraulic characteristics of the stream to reflect the changes in bed slope caused by scour and deposition; it does not account for the effect of changes in the bed material composition on the computed sediment transport capacities; and it does not account for armoring of the streambed that would limit degradation. Because of these simplifications, a sediment budget analysis typically overestimates aggradation and degradation. This overestimation is evident in the results for the upstream reach of the Santa Cruz River. In addition, a sediment budget analysis is extremely sensitive to the selection of subreaches and representative cross sections. Relatively minor differences in average hydraulic characteristics, particularly velocity, can translate into large differences in computed average bed changes. For these reasons, firm conclusions as to the stability of the study reach could not be drawn from the limited sedimentation computations. However, the reach did appear to exhibit a progression toward quasi-equilibrium by a lessening in the erosion rate.

Because of the inadequacies of the sediment budget analysis, the historical behavior of the existing stream was reviewed to add additional clarity in assessing the stability of this reach of the Santa Cruz River. The following excerpt was extracted from the Santa Cruz River Management Study (SLA, 1986):

“USGS data suggest that there may have been vertical stability during the early to mid 19th century, but that this reach has been degrading since the 1950’s. There have been multiple references to degradation along specific reaches of the Santa Cruz River during the late 1950’s to the mid 1960’s. Ajo Way to Grant Road experienced 10 to 15 feet of degradation, while 6 to 8 feet of degradation occurred between Speedway Boulevard and Valencia Road. This change may be partially due to the extensive use of materials from the Santa Cruz River streambed during the construction of the I-10 highway during the late 1950’s/early 1960’s. While subsequent bed profiles show a slight recovery, the overall profile of the streambed has still degraded by one to four feet through the Tucson Urban Reach since

1947. *Historic lateral changes are not easily identified through this reach of the river due to extensive fill and channelization. There is general agreement that this reach is well defined and incised; however, any documentation of the lateral changes may suffer due to the intensive channel work performed in the metropolitan area.*

The floods of 1983 were a significant test of lateral and channel stability. During this event, the unstabilized embankments along two reach locations—one reach located just upstream of and within the southern end (i.e., between I-19 and Ajo Way), and the other reach located at the northern end of the Tucson Urban Reach (i.e., just downstream of Grant Road to the Silverbell Golf Course)—experienced significant erosion/lateral migration (i.e., from 200 feet to 500 feet)."

1.3.6 BANK EROSION

1.3.6.1 Background

The bank erosion study was limited to the Santa Cruz River. The New West Branch was not studied since its banks are lined with concrete/soil cement. This was the same case for the Los Reales Improvement District area. The Old West Branch was not studied due to plan formulation constrains that preclude structural channel modifications.

1.3.6.2 Geomorphic Relationships

Since there is no official guidance on determining bank erosion, several widely acceptable technical approaches within the hydraulic community were used in the study. The processes and methodologies were found in the following references:

- a. EM 1110-2-1418, "Channel Stability Assessment for Flood Control Channels" (US Army Corps of Engineers, 1994). The section titled "Channel Evolution and Geomorphic Thresholds" has guidance on distinguishing braided from non-braided channels. The channel slope of the study area is approximately 0.003. In natural streams the channel-forming discharge can often be taken as equivalent to the bank-full discharge. In terms of flood frequency, a return period of around 2 years appears to be common in the eastern half of the United States. However, in the western United States area, a return period between 5 and 10 years is more appropriate (the latter for urban and channelized streams). The channel forming discharge is between 4900 cfs (2-year flood event) and 14000 cfs (10-year flood event). This range of data was plotted on Figure 2-24. The Leopold & Wolman 1957 braided vs. meandering separation line was used to distinguish between braided and meandering channels. According to this figure, this reach of the Santa Cruz River is of the braided type.
- b. Rosgen Classification System (Rosgen, 1996). This reach of the Santa Cruz River has a slope of 0.003, sinuosity less than 1.2, has multiple channels, and consists of sands and

gravels. According to the Rosgen Classification System, it can be classified as a D4 or D5 channel. Rosgen describes a D5 channel as follows: “The D5 stream types are multiple channel systems described as braided streams... The braided channel system is characterized by high bank erosion rates, excessive deposition occurring as both longitudinal and transverse bars, and annual shifts of the bed location. A combination of adverse conditions are responsible for channel braiding, including high sediment supply, high bank erodibility, moderately steep gradients, and very flashy runoff conditions which can vary rapidly from a base flow to an over-bank flow on a frequent basis (Rosgen, 1996).”

- c. Restoring Streams in Cities (Riley, 1998). According to the book: “A braided stream channel is typically wide and shallow and contains a number of separated channels that flow in and around mid-channel sediment bars and islands. Braided channels usually indicate that a stream is supplied with more sediment than it can carry. Other conditions that can lead to braiding are steep slopes, coarse materials with low erosion resistance, sediments deposited at grade changes, and aggradation that allows the channel to shift course...A braided stream is unstable, changes its alignment rapidly, carries large amounts of sediment, is wide and shallow even at flood flows, and is in general unpredictable.” This reach of the Santa Cruz River certainly fits this description.
- d. USGS Water Supply Paper 2429, Channel Change on the Santa Cruz River, Pima County, Arizona, 1936-86 (USGS, 1995). This paper contained some historical and geomorphic information.

1.3.6.3 Existing Bank Protection

In response to historical flooding and lateral bank erosion, Pima Count and the City of Tucson initiated a program of bank stabilization. Many areas in the study reach were channelized and the banks lined with soil cement revetments. Soil cement grade control structures were also installed to prevent scour at selected bridges. Currently, the following areas of the Santa Cruz River are completely bank protected with soil cement and were excluded from this analysis:

- Upstream and downstream of the Valencia Road Bridge,
- Irvington Road to Ajo Way, and
- Silverlake Road to Congress Street.

There are three (3) remaining gaps that are currently unprotected:

- Los Reales Road to south of Valencia Road,
- North of Valencia Road to Irvington Road, and
- Ajo Way to Silverlake Road.

1.3.6.4 Historical Bank Erosion Information

The following excerpts from USGS Water Supply Paper 2429 (1995) pertain to this study reach:

“The Tucson reach has shown the least lateral instability during the period. Either much of the apparent stability is artificial—because of bank armoring, which has prevented channel change, or of artificial filling, which has obscured the record of change occurring between 1936 and 1986. Parts of the reach underwent about 15 ft of degradation between the 1950’s and 1976.”

“Arroyo change along other reaches of the Santa Cruz River is difficult to evaluate because the Tucson and Sahuarita reaches have been subject to extensive human alteration and much of the apparent lateral stability of the reaches is artificial. For example, according to bridge specifications prepared in 1916, the channel at Congress Street in the Tucson reach widened to 375 ft during the floods of 1914-15, but subsequent artificial filling reduced width at that location to less than 200 ft. Two motels now stand on landfill above the site of the migrating meander that destroyed the Congress Street bridge in 1915. In contrast to the San Xavier reach, most arroyo widening of the upper Tucson reach took place in the 1950’s, and little widening occurred thereafter except locally as a result of the flood of 1983. Some of the arroyo widening that took place between Silverlake Road and Congress Street in the 1950’s may have been associated with construction activity that is visible in aerial photographs of 1960...The most pronounced arroyo widening occurred from Silverlake Road to Grant Road during 1953-60 before degradation had begun at most locations in the Tucson reach. Between Silverlake Road and Congress Street, the rate of arroyo widening was constant from 1953 to 1971. From Congress Street to Grant Road, however, no significant arroyo widening occurred between 1960 and 1978 even though this was a period of maximum incision and subsequent vertical fluctuation. After the flood of 1983, only the part of the Tucson reach from Congress Street to Speedway Boulevard showed a significant increase in mean arroyo width.”

“Between 1915 and 1929, extensive arroyo widening occurred during 1914-15 floods throughout the reach and the Congress Street bridge was destroyed. Between 1930 and 1959, extensive widening occurred between Speedway Boulevard and Grant Road and channel degradation begins during the later years. Between 1960 and 1986, the arroyo widths were generally stable. There was apparent narrowing at some locations caused by channelization and landfill operations. As much as 15 ft of arroyo incision occurred. There was substantial arroyo wall retreat along unprotected segments of the reach as a result of 1983 flood.”

Table 4 summarizes the amount of bank movement between 1941 and 2002. Within the study reach, there was major arroyo widening throughout the study period. There was considerable degradation in the 1950’s and 1960’s. Artificial changes include extensive channelization and armoring; and landfill operations. There was sand-gravel mining at Valencia Road. There were some armoring, highway fill, and landfill at other locations.

At some locations, the banks generally did not move. This is expected in geologically confined reaches and reaches with bank protection. At other locations, the banks moved as much as 900 ft within the past 60 years. In addition, the migration rate per year for each bank

was determined by dividing the migration amount by the number of years between the photographs, i.e. the migration rate was linearized from the historical data.

Table 4: Bank Erosion Between 1941-2002

Year	Bank Width	Lt. Bank Erosion	Rt. Bank Erosion	Lt. Bank Erosion Rate Per Year	Rt Bank Erosion Rate Per Year
Station 34.43					
1941	180				
1960	130	40	60	2	3
2002	650	350	170	8	4
Station 35.66					
1941	220				
1960	250	420	380	22	20
2002	330	380	460	9	11
Station 37.50					
1941	610				
1960	360	340	680	18	36
2002	890	380	850	9	20

1.3.6.5 Erosion Hazard Boundary Mapping

Erosion hazard boundary maps from the Santa Cruz River Management Study (SLA, 1986) were also considered in this study. The subject report developed a map identifying potential erosion-hazard areas based on lateral-migration measurements and a time-sequence series of historical photographs. They present the “worst-case” estimates of the potential bank erosion limits of the Santa Cruz River. The erosion limits within the study area were manually digitized and is illustrated in Plate 19.

The Pima County Flood Control District provided digitized historical aerial photographs of the Santa Cruz River study reach dated 1941 and 1969. The digitized photographs were not georeferenced or orthorectified. Using an ArcView extension, the photographs were georeferenced only. They were not orthorectified since this is a more involved process. The left and right banks were then digitized. Given the original conditions of the photographs, the historical bank locations are not exact but were determined to be adequate for this level of study.

Recent geologic banks were determined from reviewing the historical aerial photographs and viewing the shape of the topographic lines along the Santa Cruz River study reach. The boundaries were initially set to include all areas where abandoned meander features were found as well as extending to the areas where the contour lines changed direction from following the regional slopes to being perpendicular to the river channel. This coverage should be fairly close to the maximum historical meander belt for the river in this reach. It varies from approximately 0.5 mile in width at 22nd Street to approximately 1.5 miles in width at Valencia Road. Lateral migration would not be expected to exceed these limits.

1.3.6.6 Conclusions

The purpose of this erosion investigation was to determine the maximum bank erosion as well as the average annual bank erosion along the study reach of the Santa Cruz River. The references cited in this section contained numerous historical material for the Santa Cruz River and geomorphic relationships for natural streams. However, there was no information or guidance to calculate average annual bank erosion for braided type streams. To complicate matters, there were several artificial features that affected the bank stability of the study reach, i.e. bridge abutment fill, bank armoring, gravel mining, etc.

For the reasons stated above, it was determined that a simplified methodology would be used to determine the maximum bank erosion; it would be inappropriate at this time to determine an average annual erosion rate given all the uncertainties. Using a combination of all the methods and historical information described above, a maximum bank erosion set of limits was developed and is illustrated on Plate 19.

It is anticipated that the With Project Conditions bank erosion analysis will not significantly change from the Without Project analysis. The flattening of unprotected banks and introduction of vegetative habitat may prevent bank erosion and lateral head cutting during frequent storm events, however these measures are unlikely to provide sufficient bank stability infrequent (e.g., 50 to 500-year) storm events.

1.4 NEW WEST BRANCH WITH PROJECT CONDITIONS

1.4.1 ALTERNATIVES ANALYSES

The revised without project conditions HEC-RAS model for the New West Branch was modified to determine the impacts of two proposed alternatives. These alternatives are NWB-1 (Channel Invert Excavation), NWB-2 (raise Existing Levees), and NWB-3 (Floodwalls).

1.4.1.1 Alternative NWB-1 (Channel Dredging)

The without project hydraulic model was modified to determine the impacts of channel dredging. The following impacts or concerns were identified:

- a) Excavation can increase the conveyance of the New West Branch up to the 100-yr flood event only. Up to two (2) ft of excavation is necessary.
- b) Excavation alone would not contain the 200- and 500-yr flood events.
- c) The existing grade control structure at Station 6.0 would need to be modified (i.e., lowered or reconstructed) as well as the key-in to the existing bank protection.
- d) The existing footbridge upstream of Drexel Road would need to be removed or replaced.

- e) Excavation may result in undermining of the existing soil cement bank protection. The toe down depth(s) of the existing soil cement bank protection is unknown and cannot be verified. Additional field exploration will be required to determine structural integrity, toe-down depths, and subsurface conditions behind and under the soil cement.

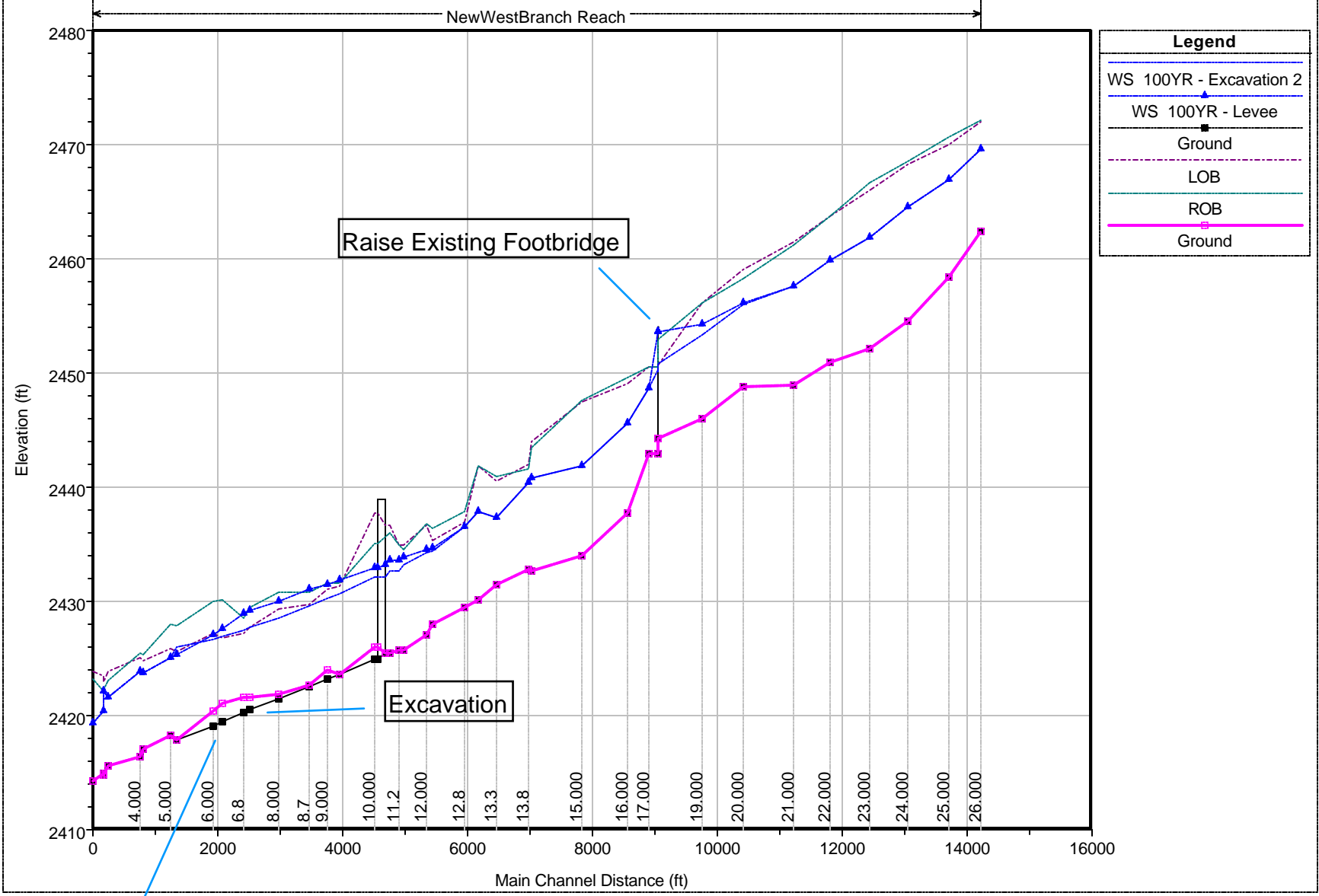
The results of this evaluation are presented in Figures 5 and 6 and Table 5.

1.4.1.2 Alternative NWB-2 and NWB-3

Low levees currently exist along both channel banks, however they do not contain the 100, 200, and 500-year flows. An alternative analysis was performed to determine effects of raising the existing levees to protect for the 100 through 500-year flood events. As built drawings for the existing levees and bank protection are not available therefore, for engineering design and cost estimating purposes, the existing levees were assumed to be structurally inadequate, therefore new engineered levees are assumed. Due to the high velocities and possibility of run-up at the curve, rigid armoring (i.e., soil cement) is recommended for the inside slopes of the levees.

The results of the evaluation and required levee heights for each respective design storm are presented in Table 6.

FIGURE 5 Paseo de las Iglesias - New West Branch Plan: 1) Excavation 2 12/3/2003 2) Levee 12/3/2003
 Geom: Excavation Alternative 2 Flow: Excavation Alternative 2

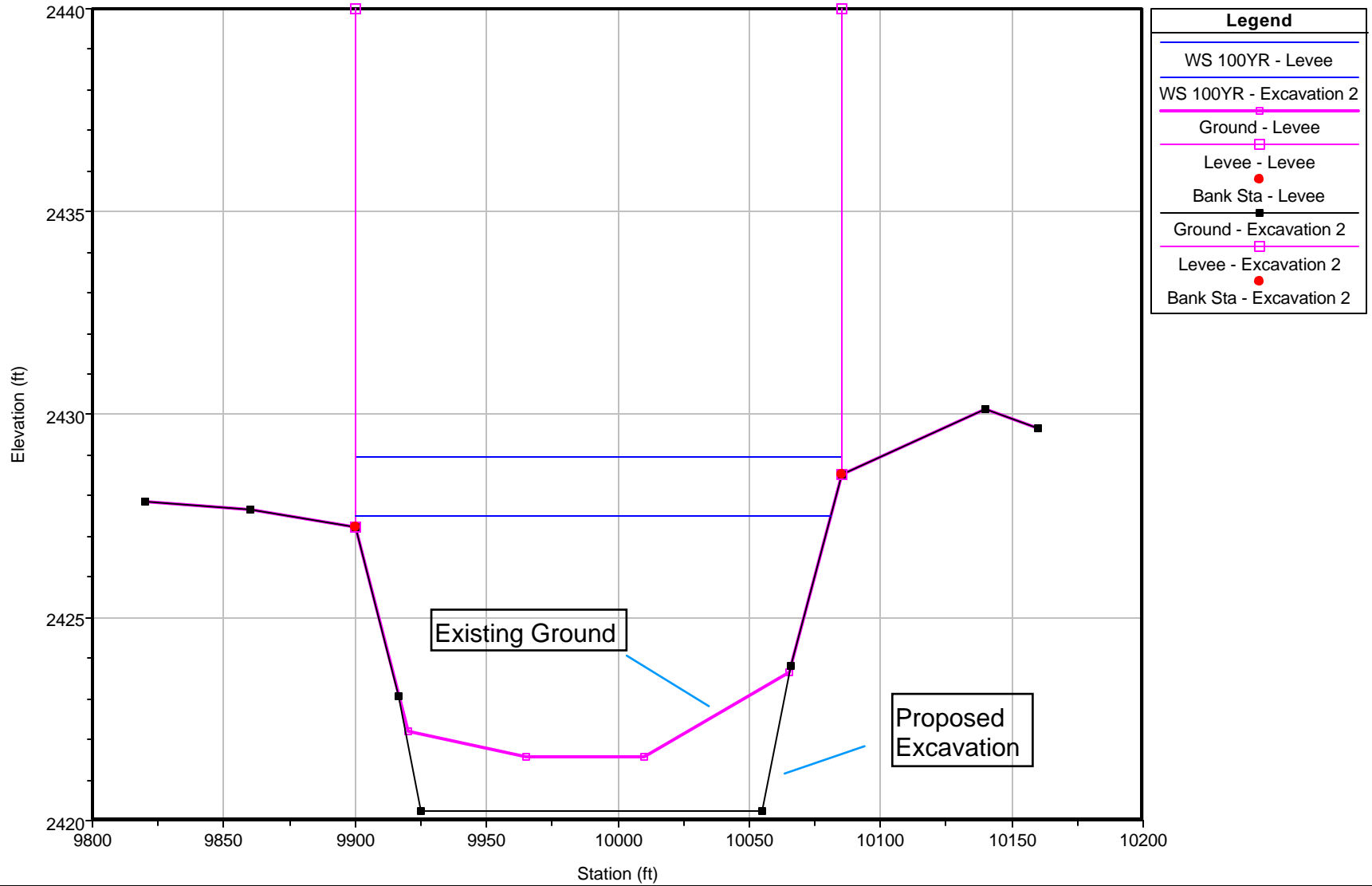


Legend	
WS 100YR - Excavation 2	▲
WS 100YR - Levee	■
Ground	- - -
LOB	—
ROB	—
Ground	■

Modify Grade Control Structure

HEC-RAS Profile Plot

FIGURE 6 Paseo de las Iglesias - New West Branch Plan: 1) Excavation 2 2) Levee
 Geom: Excavation Alternative 2 Flow: Excavation Alternative 2
 River = NewWestBranch Reach = Reach RS = 6.8



1

Typical Cross-Section

TABLE 5 HEC-RAS Plan: Excavation 2 River: NewWestBranch Reach: Reach Profile: 100YR

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach	1.000	100YR	9908.00	2414.25	2419.37	2419.37	2421.76	0.005646	12.42	797.89	165.90	1.00
Reach	1.9	100YR	9908.00	2415.00	2420.44	2420.44	2422.76	0.005491	12.24	809.58	173.32	1.00
Reach	2.000	100YR	9908.00	2414.78	2422.13	2420.63	2422.99	0.002886	7.43	1334.23	375.13	0.69
Reach	3.000	100YR	9908.00	2415.55	2421.54	2421.22	2423.58	0.004423	11.47	863.44	172.99	0.91
Reach	4.000	100YR	9908.00	2416.43	2423.87	2422.19	2425.14	0.002102	9.05	1095.26	179.15	0.64
Reach	4.2	100YR	9908.00	2417.00	2423.76	2422.80	2425.37	0.003119	10.19	972.70	179.52	0.77
Reach	5.000	100YR	9908.00	2418.25	2425.11	2423.96	2426.65	0.002776	9.96	994.70	173.40	0.73
Reach	5.2	100YR	9908.00	2417.80	2425.95	2423.17	2426.89	0.001285	7.80	1270.47	178.32	0.51
Reach	6.000	100YR	9908.00	2419.13	2426.71	2424.46	2427.77	0.001579	8.25	1201.48	181.41	0.56
Reach	6.3	100YR	9908.00	2419.46	2426.87	2424.86	2428.06	0.001803	8.73	1134.46	173.47	0.60
Reach	6.8	100YR	9908.00	2420.25	2427.51	2425.70	2428.73	0.001984	8.85	1119.35	180.83	0.63
Reach	7.000	100YR	9908.00	2420.47	2427.74	2425.87	2428.93	0.001920	8.75	1132.23	181.65	0.62
Reach	8.000	100YR	9908.00	2421.47	2428.57	2426.87	2429.84	0.002103	9.07	1092.72	177.93	0.64
Reach	8.7	100YR	9908.00	2422.59	2429.62	2428.01	2430.92	0.002189	9.14	1083.69	179.72	0.66
Reach	9.000	100YR	9908.00	2423.25	2430.28	2428.63	2431.57	0.002176	9.09	1089.89	181.53	0.65
Reach	9.2	100YR	9908.00	2423.57	2430.70	2429.14	2432.03	0.002275	9.23	1073.62	182.32	0.67
Reach	10.000	100YR	9908.00	2424.94	2432.07	2430.19	2433.17	0.001826	8.40	1178.98	193.51	0.60
Reach	10.5		Bridge									
Reach	11.000	100YR	9908.00	2425.48	2432.71	2430.83	2433.93	0.001926	8.86	1118.66	176.34	0.62
Reach	11.2	100YR	9908.00	2425.77	2432.63	2432.01	2434.52	0.003689	11.03	898.16	166.47	0.84
Reach	11.3	100YR	9908.00	2425.70	2433.16	2432.15	2434.78	0.003038	10.23	968.72	174.06	0.76
Reach	12.000	100YR	9908.00	2427.04	2434.22	2433.27	2435.94	0.003105	10.51	942.36	164.96	0.78
Reach	12.2	100YR	9908.00	2428.00	2434.39	2433.89	2436.37	0.004013	11.30	877.01	167.11	0.87
Reach	12.8	100YR	9908.00	2429.50	2436.56	2435.19	2437.98	0.002463	9.56	1036.35	175.69	0.69
Reach	13.000	100YR	9908.00	2430.08	2437.84	2435.69	2438.45	0.001304	6.24	1588.68	318.09	0.49
Reach	13.3	100YR	9908.00	2431.52	2437.35	2437.35	2439.86	0.005442	12.69	780.73	156.75	1.00
Reach	13.8	100YR	9908.00	2432.76	2440.45	2438.31	2441.27	0.001420	7.27	1362.91	229.94	0.53
Reach	14.000	100YR	9908.00	2432.60	2440.80	2437.68	2441.36	0.000842	6.04	1639.74	246.62	0.41
Reach	15.000	100YR	9908.00	2434.04	2441.82	2441.82	2444.26	0.005392	12.53	790.67	160.29	0.99
Reach	16.000	100YR	9908.00	2437.70	2445.60	2445.18	2447.75	0.004193	11.76	842.55	155.97	0.89
Reach	17.000	100YR	9908.00	2442.96	2448.67	2448.67	2451.07	0.005484	12.43	797.12	164.41	0.99
Reach	17.5		Bridge									
Reach	18.000	100YR	9908.00	2444.29	2450.86	2450.06	2452.71	0.003608	10.93	906.18	165.90	0.82
Reach	19.000	100YR	9908.00	2446.01	2453.32	2452.51	2455.22	0.003423	11.06	895.89	156.02	0.81
Reach	20.000	100YR	9908.00	2448.79	2456.03	2454.62	2457.06	0.002229	8.16	1213.53	242.86	0.64
Reach	21.000	100YR	9908.00	2448.97	2457.62	2456.96	2459.62	0.003657	11.34	874.07	154.39	0.84
Reach	22.000	100YR	9908.00	2450.92	2459.81	2458.95	2461.68	0.003281	10.97	903.34	154.56	0.80
Reach	23.000	100YR	9908.00	2452.07	2461.86	2461.64	2464.28	0.004654	12.48	793.62	144.70	0.94
Reach	24.000	100YR	9908.00	2454.54	2464.56	2463.77	2466.74	0.003502	11.84	837.13	133.33	0.83
Reach	25.000	100YR	9908.00	2458.40	2466.90	2466.65	2469.54	0.004559	13.04	759.86	127.70	0.94
Reach	26.000	100YR	9908.00	2462.46	2469.55	2469.48	2471.98	0.005118	12.53	790.64	154.60	0.98

HEC-RAS Standard Output Table for Proposed Excavation Alternative

Table 6. New West Branch of the Santa Cruz River Required Levee Elevations

Station ¹	WSEL ² (ft)			Existing Top of Levee (ft)		Minimum Top of Levee ³ (ft)			Minimum Required Levee Raising ⁴ (ft)					
									100-yr		200-yr		500-yr	
	100-yr	200-yr	500-yr	Left Levee	Right Levee	100-yr	200-yr	500-yr	Left Levee	Right Levee	Left Levee	Right Levee	Left Levee	Right Levee
1	2419.4	2420.0	2420.6	2423.8	2423.2	2421.4	2422.0	2422.6	-2.5	-1.8	-1.8	-1.2	-1.2	-0.6
1.9	2420.4	2421.1	2421.7	2423.5	2422.1	2422.4	2423.1	2423.7	-1.0	0.3	-0.3	1.0	0.3	1.6
2	2422.1	2423.3	2424.2	2423.0	2422.2	2424.1	2425.3	2426.2	1.2	1.9	2.3	3.1	3.2	4.0
3	2421.5	2422.4	2423.2	2423.9	2423.1	2423.5	2424.4	2425.2	-0.4	0.5	0.5	1.3	1.3	2.1
4	2423.9	2424.6	2425.3	2425.1	2425.4	2425.9	2426.6	2427.3	0.8	0.4	1.5	1.2	2.3	1.9
4.2	2423.8	2424.5	2425.2	2424.8	2425.3	2425.8	2426.5	2427.2	1.0	0.5	1.7	1.2	2.4	2.0
5	2425.1	2425.8	2426.5	2425.9	2428.1	2427.1	2427.8	2428.5	1.2	-0.9	1.9	-0.2	2.5	0.4
5.2	2425.3	2426.1	2426.7	2425.6	2427.9	2427.3	2428.1	2428.7	1.8	-0.6	2.5	0.2	3.1	0.8
6	2427.1	2427.9	2428.5	2427.3	2430.0	2429.1	2429.9	2430.5	1.9	-0.9	2.6	-0.1	3.3	0.5
6.3	2427.6	2428.3	2429.0	2426.8	2430.1	2429.6	2430.3	2431.0	2.8	-0.5	3.5	0.2	4.1	0.8
6.8	2429.0	2429.8	2430.5	2427.2	2428.5	2431.0	2431.8	2432.5	3.8	2.4	4.5	3.2	5.2	3.9
7	2429.3	2430.1	2430.8	2427.7	2429.5	2431.3	2432.1	2432.8	3.5	1.7	4.4	2.6	5.1	3.3
8	2430.0	2430.8	2431.5	2429.4	2430.8	2432.0	2432.8	2433.5	2.6	1.2	3.5	2.1	4.2	2.8
8.7	2431.1	2432.0	2432.7	2429.8	2430.8	2433.1	2434.0	2434.7	3.3	2.3	4.2	3.2	4.9	3.9
9	2431.5	2432.4	2433.1	2431.0	2431.6	2433.5	2434.4	2435.1	2.5	1.8	3.3	2.7	4.1	3.4
9.2	2431.9	2432.7	2433.4	2431.3	2431.7	2433.9	2434.7	2435.4	2.6	2.3	3.4	3.1	4.1	3.8
10	2432.9	2433.7	2434.5	2437.7	2435.0	2434.9	2435.7	2436.5	-2.8	-0.1	-2.0	0.7	-1.2	1.5
11	2433.6	2434.4	2435.3	2436.7	2436.0	2435.6	2436.4	2437.3	-1.1	-0.5	-0.2	0.4	0.6	1.3
11.2	2433.6	2434.5	2435.3	2435.0	2435.0	2435.6	2436.5	2437.3	0.6	0.6	1.4	1.4	2.3	2.3
11.3	2433.8	2434.7	2435.5	2435.0	2434.6	2435.8	2436.7	2437.5	0.8	1.2	1.7	2.1	2.5	2.9
12	2434.5	2435.3	2436.1	2436.7	2436.8	2436.5	2437.3	2438.1	-0.2	-0.3	0.6	0.6	1.4	1.3
12.2	2434.7	2435.5	2436.2	2435.3	2436.4	2436.7	2437.5	2438.2	1.3	0.3	2.1	1.1	2.9	1.9
12.8	2436.5	2437.3	2437.9	2436.9	2437.9	2438.5	2439.3	2439.9	1.6	0.6	2.4	1.3	3.1	2.0
13	2437.8	2438.8	2439.6	2441.9	2441.9	2439.8	2440.8	2441.6	-2.1	-2.1	-1.2	-1.2	-0.3	-0.3
13.3	2437.4	2438.1	2438.7	2440.6	2440.9	2439.4	2440.1	2440.7	-1.2	-1.6	-0.5	-0.8	0.1	-0.2
13.8	2440.5	2441.3	2442.1	2442.0	2441.7	2442.5	2443.3	2444.1	0.4	0.8	1.3	1.7	2.1	2.5
14	2440.8	2441.7	2442.5	2444.0	2443.5	2442.8	2443.7	2444.5	-1.2	-0.7	-0.4	0.2	0.4	1.0
15	2441.8	2442.5	2443.1	2447.5	2447.6	2443.8	2444.5	2445.1	-3.6	-3.8	-2.9	-3.1	-2.3	-2.5
16	2445.6	2446.3	2446.8	2449.1	2449.6	2447.6	2448.3	2448.8	-1.5	-2.0	-0.8	-1.3	-0.2	-0.8
17	2448.7	2449.4	2450.0	2450.5	2450.5	2450.7	2451.4	2452.0	0.2	0.2	0.9	0.8	1.5	1.5
18	2453.7	2453.9	2454.1	2450.7	2453.0	2455.7	2455.9	2456.1	4.9	2.7	5.2	3.0	5.4	3.2
19	2454.3	2454.8	2454.9	2456.1	2456.1	2456.3	2456.8	2456.9	0.2	0.2	0.7	0.6	0.8	0.8
20	2456.1	2456.9	2457.7	2459.1	2458.3	2458.1	2458.9	2459.7	-1.0	-0.2	-0.1	0.7	0.7	1.5
21	2457.6	2458.2	2458.7	2461.4	2461.2	2459.6	2460.2	2460.7	-1.8	-1.6	-1.2	-1.0	-0.7	-0.5
22	2459.8	2460.7	2461.4	2463.8	2463.7	2461.8	2462.7	2463.4	-2.0	-1.9	-1.1	-1.0	-0.4	-0.3
23	2461.9	2462.6	2463.2	2466.1	2466.6	2463.9	2464.6	2465.2	-2.2	-2.8	-1.5	-2.0	-0.8	-1.4
24	2464.6	2465.3	2466.0	2468.3	2468.5	2466.6	2467.3	2468.0	-1.7	-1.9	-0.9	-1.1	-0.3	-0.5
25	2466.9	2467.7	2468.5	2470.0	2470.7	2468.9	2469.7	2470.5	-1.1	-1.8	-0.3	-1.0	0.4	-0.2
26	2469.6	2470.5	2471.3	2472.1	2472.2	2471.6	2472.5	2473.3	-0.5	-0.6	0.4	0.3	1.2	1.1

Notes:

1. Station numbers with decimals are from additional Pima County survey data.
2. HEC-RAS computed water surface elevations.
3. 95% confidence levee elevation (computed water surface elevation + 2.0 ft).
4. Negative numbers indicate locations where levee raising is not necessary.

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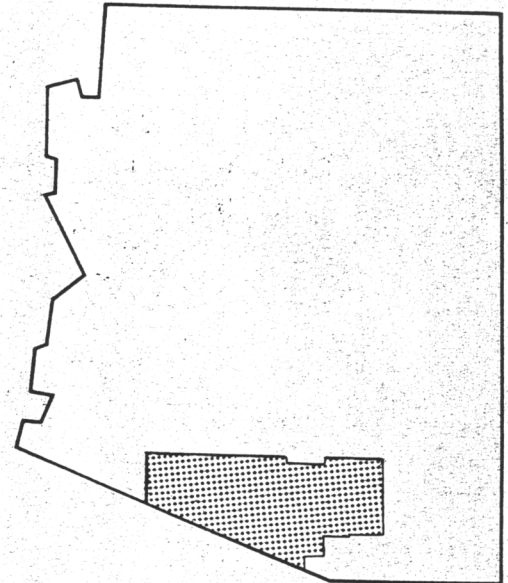
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FLOOD INSURANCE STUDY



PIMA COUNTY, ARIZONA AND INCORPORATED AREAS VOLUME 1 OF 3

COMMUNITY NAME	COMMUNITY NUMBER
MARANA, TOWN OF	040118
ORO VALLEY, TOWN OF	040109
PIMA COUNTY, UNINCORPORATED AREAS	040073
SAHUARITA, TOWN OF	040137
SOUTH TUCSON, TOWN OF	040075
TUCSON, CITY OF	040076



REVISED: FEBRUARY 8, 1999



Federal Emergency Management Agency

Table 2. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
Ruelas Canyon					
Downstream of confluence with Unnamed Canyon	56.6	-- ¹	-- ¹	6,562	-- ¹
At Apex	3.58	1,800	4,460	5,990	10,470
Sabino Creek					
Above confluence with Tanque Verde Creek	66.4	4,900	12,000	18,000	36,000
Above confluence with Bear Creek	36.8	3,750	8,500	12,500	25,000
Sahuara Wash					
At Pima Street	0.4	-- ¹	-- ¹	622	-- ¹
San Juan Wash					
At confluence with West Branch Santa Cruz River	1.2	-- ¹	-- ¹	2,165	-- ¹
1,300 feet upstream of Mission Road	1.1	-- ¹	-- ¹	2,420	-- ¹
At Greasewood Road	0.4	-- ¹	-- ¹	1,125	-- ¹
Santa Clara Wash					
At Interstate Highway 19	0.3	-- ¹	-- ¹	705	-- ¹
Santa Cruz River					
At Cortaro Road	3,503	21,800	48,000	70,000	107,400
Above confluence with Canada del Oro Wash	3,232	21,800	48,000	70,000	107,400
At Cortaro Farms Road	3,053	21,800	48,000	70,000	107,400
Above confluence with Rillito Creek	2,282	16,800	41,000	60,000	93,000
At Congress Street	2,222	16,800	41,000	60,000	93,000
At Drexel Road	2,101	16,800	41,000	60,000	93,000
At Continental Road	1,662	-- ¹	-- ¹	45,000	-- ¹

See LOMR 7-24-00

48

¹Data not computed

T1 EMW-94-C-4542 (MMLA Job No. 92145-03)										
T2 City of Tucson FIS (FEMA '94)										
T3 West Branch SCR 100-yr Floodplain										
J1	0	2	0	0	0.011	0	0.0	6621.0		
J2	-1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
J6	1	0	0.0							
NC 0.045	0.045	0.035	0.1	0.3						
X1	0.5	9	67.5	117.5	0.0	0.0	0.0	1.0	0.0	
GR2366.0	0.0	2366.0	50.0	2365.5	60.0	2365.0	67.5	2347.5	84.0	
GR2347.5	101.0	2365.0	117.5	2365.5	125.0	2370.0	130.0			
NC 0.055	0.055	0.035	0.1	0.3						
X1	1	9	140.0	180.0	505.0	505.0	1.0	0.0		
GR2370.0	0.0	2370.0	125.0	2360.0	140.0	2353.0	155.0	2353.0	165.0	
GR2360.0	180.0	2370.0	190.0	2372.0	240.0	2374.0	300.0			
NC 0.055	0.055	0.035	0.1	0.3						
X1	2	10	168.0	200.0	520.0	520.0	1.0	0.0		
GR2372.0	0.0	2370.0	130.0	2360.0	168.0	2356.0	180.0	2356.0	190.0	
GR2360.0	200.0	2370.0	220.0	2372.0	225.0	2374.0	270.0	2376.0	315.0	
NC 0.055	0.055	0.035	0.1	0.3						
X1	3	10	245.0	330.0	400.0	400.0	1.0	0.0		
GR2373.0	0.0	2372.0	190.0	2370.0	245.0	2360.0	275.0	2358.0	285.0	
GR2358.0	300.0	2360.0	305.0	2370.0	330.0	2374.0	335.0	2376.0	660.0	
NC 0.055	0.055	0.035	0.3	0.5						
QT	1	6220.0								
X1	4	7	220.0	273.0	345.0	345.0	345.0	1.0	0.0	
X3	0	0.0	0.0	220.0	2376.0	273.0	2376.0	0.0	0.0	
GR2376.0	0.0	2374.0	150.0	2372.8	220.0	2360.4	221.0	2360.4	272.0	
GR2372.8	273.0	2376.0	550.0							
NC 0.055	0.055	0.035	0.3	0.5						
SC 4.012	0.4	3.0	100.0	12.0	12.0	90.0	10.1	2360.8	2360.4	
X1	4.1	7	220.0	273.0	100.0	100.0	1.0	0.0		
X2	0.0	0.0	2	0.0	2373.3	0.0	0	0.0	0.0	
X3	0	0.0	0.0	220.0	2376.0	273.0	2376.0	0.0	0.0	
GR2376.0	0.0	2374.0	150.0	2372.8	220.0	2360.8	221.0	2360.8	272.0	
GR2372.8	273.0	2376.0	550.0							
NC 0.055	0.065	0.035	0.1	0.3						
X1	5	15	620.0	685.0	440.0	620.0	510.0	1.0	0.0	
GR2380.0	0.0	2378.0	50.0	2376.0	620.0	2370.0	640.0	2364.0	645.0	
GR2364.0	655.0	2370.0	665.0	2376.0	685.0	2377.0	705.0	2377.0	1030.0	
GR2376.0	1031.0	2376.0	1055.0	2377.0	1060.0	2377.0	1560.0	2378.5	1580.0	
NC 0.055	0.065	0.035	0.1	0.3						
X1	6	12	455.0	495.0	670.0	370.0	590.0	1.0	0.0	
GR2380.0	0.0	2378.0	330.0	2376.0	440.0	2372.0	455.0	2366.0	470.0	
GR2366.0	482.0	2372.0	495.0	2378.0	512.0	2380.0	600.0	2378.0	750.0	
GR2378.0	1600.0	2379.5	1660.0							
NC 0.055	0.06	0.035	0.1	0.3						
QT	1	5722.0								
X1	7	8	185.0	240.0	580.0	460.0	560.0	1.0	0.0	
GR2382.0	0.0	2380.0	80.0	2380.0	185.0	2369.0	205.0	2369.0	225.0	
GR2380.0	240.0	2380.0	1160.0	2381.5	1210.0					
NC 0.055	0.065	0.035	0.1	0.3						
X1	8	11	747.0	770.0	550.0	650.0	680.0	1.0	0.0	
GR2384.0	0.0	2382.0	120.0	2380.0	220.0	2380.0	747.0	2372.0	750.0	
GR2372.0	760.0	2380.0	770.0	2382.0	780.0	2382.0	1230.0	2383.2	1620.0	
GR2383.5	1955.0									
NC 0.055	0.065	0.035	0.1	0.3						
X1	9	12	1035.0	1080.0	400.0	500.0	470.0	1.0	0.0	

GR2384.0	0.0	2383.5	130.0	2382.0	660.0	2382.0	1035.0	2380.0	1045.0
GR2373.5	1050.0	2373.5	1070.0	2380.0	1080.0	2382.0	1100.0	2382.0	1155.0
GR2383.0	1390.0	2384.0	1760.0						
NC 0.055	0.06	0.035	0.1	0.3					
X1 10	9	1090.0	1130.0	470.0	470.0	480.0	1.0	0.0	
GR2386.0	0.0	2384.0	400.0	2383.5	805.0	2382.0	1090.0	2378.0	1110.0
GR2378.0	1120.0	2382.0	1130.0	2384.0	1220.0	2386.0	1700.0		
NC 0.055	0.06	0.035	0.1	0.3					
NH 3	0.05	410.0	0.035	455.0	0.05	1080.0			
X1 11	10	410.0	455.0	600.0	650.0	800.0	1.0	0.0	
GR2388.0	0.0	2386.0	370.0	2384.0	410.0	2380.0	425.0	2380.0	450.0
GR2384.0	455.0	2386.0	475.0	2385.5	700.0	2386.0	950.0	2388.0	1080.0
NC 0.05	0.05	0.035	0.1	0.3					
X1 12	13	410.0	470.0	520.0	620.0	695.0	1.0	0.0	
GR2392.0	0.0	2390.0	165.0	2390.0	360.0	2388.0	410.0	2384.0	440.0
GR2384.0	460.0	2390.0	470.0	2390.0	560.0	2388.0	710.0	2387.5	800.0
GR2388.0	890.0	2390.0	900.0	2391.0	950.0				
NC 0.055	0.055	0.035	0.1	0.3					
QT 1	3614.0								
X1 13	10	300.0	350.0	475.0	475.0	475.0	1.0	0.0	
GR2392.5	0.0	2391.0	190.0	2390.0	300.0	2385.5	320.0	2385.5	335.0
GR2390.0	350.0	2391.5	355.0	2390.0	600.0	2390.0	770.0	2393.0	800.0
NC 0.055	0.055	0.035	0.1	0.3					
X1 13.5	11	280.0	335.0	270.0	360.0	310.0	1.0	0.0	
GR2394.0	0.0	2392.0	220.0	2390.0	280.0	2387.0	290.0	2387.0	330.0
GR2390.0	335.0	2392.0	340.0	2392.0	550.0	2391.5	600.0	2392.0	670.0
GR2394.0	680.0								
NC 0.055	0.055	0.035	0.1	0.3					
NH 4	0.055	160.0	0.035	220.0	0.045	310.0	0.06	910.0	
X1 14	9	170.0	210.0	450.0	560.0	480.0	1.0	0.0	
GR2396.0	0.0	2394.0	130.0	2392.0	160.0	2389.0	170.0	2389.0	210.0
GR2394.0	220.0	2394.0	310.0	2394.0	460.0	2395.5	910.0		
NC 0.0	0.0	0.0	0.1	0.3					
NH 4	0.055	110.0	0.035	160.0	0.04	230.0	0.07	620.0	
X1 14.5	10	110.0	140.0	390.0	390.0	390.0	1.0	0.0	
X3 0	0.0	0.0	0.0	0.0	280.0	2396.5	0.0	0.0	
GR2398.0	0.0	2396.0	63.0	2392.0	85.0	2390.0	110.0	2390.0	140.0
GR2396.0	160.0	2396.0	230.0	2396.5	280.0	2396.0	340.0	2398.0	620.0
NC 0.055	0.055	0.035	0.1	0.3					
X1 15	9	130.0	180.0	360.0	405.0	380.0	1.0	0.0	
GR2400.0	0.0	2398.0	60.0	2396.0	100.0	2394.0	130.0	2390.7	135.0
GR2390.7	162.0	2396.0	180.0	2398.0	235.0	2400.0	350.0		
NC 0.055	0.055	0.035	0.1	0.3					
NH 3	0.05	65.0	0.035	135.0	0.055	300.0			
X1 15.5	8	65.0	135.0	375.0	375.0	375.0	1.0	0.0	
GR2402.0	0.0	2400.0	40.0	2398.0	65.0	2391.5	75.0	2391.5	90.0
GR2398.0	135.0	2400.0	215.0	2401.0	300.0				
NC 0.055	0.05	0.035	0.1	0.3					
X1 16	7	70.0	120.0	580.0	580.0	580.0	1.0	0.0	
X3 0	0.0	0.0	0.0	0.0	190.0	0.0	0.0	0.0	
GR2404.0	0.0	2402.0	70.0	2394.5	80.0	2394.5	110.0	2402.0	120.0
GR2403.0	190.0	2404.0	240.0						
NC 0.055	0.055	0.035	0.1	0.3					
X1 17	11	57.0	100.0	445.0	445.0	445.0	1.0	0.0	
X3 0	0.0	0.0	0.0	0.0	190.0	2405.5	0.0	0.0	
GR2406.0	0.0	2404.0	30.0	2402.0	40.0	2400.0	55.0	2398.0	57.0
GR2395.0	70.0	2395.0	95.0	2398.0	100.0	2400.0	115.0	2404.0	130.0

GR2405.5	435.0									
NC 0.04	0.065	0.035	0.1	0.3						
X1 17.5	8	30.0	140.0	570.0	570.0	570.0	1.0	0.0		
GR2410.0	0.0	2410.0	30.0	2396.5	75.0	2396.5	100.0	2400.0	110.0	
GR2402.0	122.0	2408.0	140.0	2408.5	200.0					
NC 0.055	0.055	0.035	0.3	0.5						
X1 18	8	370.0	430.0	415.0	415.0	415.0	1.0	0.0		
X3 0	0.0	0.0	370.0	2415.0	430.0	2415.0	0.0	0.0		
GR2418.0	0.0	2414.0	190.0	2412.0	230.0	2411.0	370.0	2399.0	381.0	
GR2399.0	419.0	2410.5	430.0	2411.0	1200.0					
NC 0.055	0.055	0.035	0.3	0.5						
SC 3.012	0.4	3.0	90.0	10.0	12.0	77.0	8.1	2399.2	2399.0	
X1 18.1	8	370.0	430.0	80.0	80.0	80.0	1.0	0.0		
X2 0.0	0.0	2	0.0	2411.0	0.0	0	0.0	0.0		
X3 0	0.0	0.0	370.0	2415.0	430.0	2415.0	0.0	0.0		
GR2418.0	0.0	2414.0	190.0	2412.0	230.0	2411.0	370.0	2399.2	381.0	
GR2399.2	419.0	2410.5	430.0	2411.0	1200.0					
NC 0.040	0.060	0.035	0.1	0.3						
X1 18.5	12	420.0	465.0	265.0	265.0	265.0	1.0	0.0		
GR2418.0	0.0	2416.0	95.0	2414.0	145.0	2414.0	245.0	2412.0	340.0	
GR2410.0	417.0	2408.0	420.0	2400.0	430.0	2400.0	460.0	2408.0	465.0	
GR2410.0	473.0	2412.0	520.0							
NC 0.050	0.075	0.035	0.1	0.3						
X1 19	8	390.0	425.0	280.0	305.0	315.0	1.0	0.0		
GR2414.0	0.0	2412.0	280.0	2410.0	390.0	2400.5	405.0	2400.5	420.0	
GR2410.0	425.0	2412.0	525.0	2413.5	570.0					
NC 0.045	0.06	0.035	0.1	0.3						
QT 1	1657.0									
X1 19.5	9	310.0	335.0	185.0	230.0	210.0	1.0	0.0		
GR2416.0	0.0	2414.0	170.0	2412.0	295.0	2410.0	310.0	2401.0	315.0	
GR2401.0	325.0	2410.0	335.0	2412.0	360.0	2414.0	430.0			
NC 0.05	0.05	0.035	0.1	0.3						
X1 20	10	280.0	310.0	395.0	380.0	395.0	1.0	0.0		
GR2416.0	0.0	2414.0	220.0	2412.0	270.0	2410.0	280.0	2401.7	290.0	
GR2401.7	300.0	2410.0	310.0	2412.0	327.0	2414.0	330.0	2414.5	390.0	
NC 0.04	0.045	0.035	0.1	0.3						
X1 20.5	9	275.0	315.0	330.0	390.0	390.0	1.0	0.0		
GR2416.0	0.0	2414.0	250.0	2412.0	254.0	2410.0	275.0	2402.5	287.0	
GR2402.5	297.0	2410.0	315.0	2414.5	327.0	2416.0	427.0			
NC 0.055	0.055	0.035	0.1	0.3						
X1 21	10	200.0	228.0	330.0	330.0	330.0	1.0	0.0		
GR2416.0	0.0	2414.0	190.0	2408.0	200.0	2404.0	210.0	2404.0	220.0	
GR2408.0	228.0	2410.0	240.0	2414.0	250.0	2416.0	265.0	2417.5	400.0	
NC 0.055	0.055	0.035	0.1	0.3						
X1 21.5	10	75.0	100.0	380.0	510.0	510.0	1.0	0.0		
GR2418.0	0.0	2416.0	55.0	2410.0	75.0	2406.0	78.0	2406.0	95.0	
GR2410.0	100.0	2412.0	110.0	2414.0	127.0	2416.0	133.0	2418.0	250.0	
NC 0.055	0.055	0.035	0.1	0.3						
X1 22	13	89.0	105.0	370.0	370.0	370.0	1.0	0.0		
GR2420.0	0.0	2418.0	50.0	2414.0	60.0	2412.0	75.0	2410.0	89.0	
GR2408.0	90.0	2408.0	100.0	2410.0	105.0	2412.0	110.0	2414.0	137.0	
GR2416.0	160.0	2416.0	190.0	2417.0	400.0					
NC 0.055	0.055	0.035	0.1	0.3						
X1 23	11	70.0	95.0	580.0	580.0	580.0	1.0	0.0		
GR2420.0	0.0	2418.0	60.0	2416.0	65.0	2414.0	70.0	2410.5	75.0	
GR2410.5	95.0	2414.0	98.0	2416.0	104.0	2418.0	140.0	2419.0	250.0	
GR2420.0	380.0									

NC 0.055	0.055	0.035	0.3	0.5						
X1 24	6	150.0	220.0	215.0	215.0	215.0	1.0	0.0		
X3 0	0.0	0.0	150.0	2422.0	220.0	2422.0	0.0	0.0		
GR2422.0	0.0	2421.5	150.0	2411.7	184.0	2411.7	216.0	2421.5	220.0	
GR2422.0	500.0									
NC 0.055	0.055	0.035	0.3	0.5						
SC 3.012	0.4	3.0	50.0	7.0	10.0	50.0	10.1	2412.0	2411.75	
X1 24.1	6	170.0	240.0	75.0	75.0	75.0	1.0	0.0		
X2 0.0	0.0	2	0.0	2421.5	0.0	0	0.0	0.0		
X3 0	0.0	0.0	170.0	2422.0	240.0	2422.0	0.0	0.0		
GR2422.0	0.0	2421.5	170.0	2412.0	184.0	2412.0	216.0	2421.5	240.0	
GR2422.0	500.0									
NC 0.055	0.055	0.035	0.1	0.3						
QT 1	768.0									
X1 25	10	157.0	181.0	325.0	325.0	325.0	1.0	0.0		
GR2421.0	0.0	2420.0	145.0	2414.0	157.0	2412.5	160.0	2412.5	170.0	
GR2414.0	181.0	2416.0	183.0	2418.0	200.0	2420.0	290.0	2421.0	350.0	
NC 0.055	0.055	0.035	0.1	0.3						
X1 26	9	40.0	57.0	490.0	500.0	490.0	1.0	0.0		
GR2422.0	0.0	2420.0	27.0	2416.0	37.0	2415.0	40.0	2415.0	53.0	
GR2416.0	57.0	2418.0	110.0	2420.0	120.0	2422.0	150.0			
NC 0.055	0.055	0.035	0.1	0.3						
X1 27	10	65.0	95.0	500.0	500.0	500.0	1.0	0.0		
GR2424.0	0.0	2422.0	45.0	2420.0	50.0	2418.0	65.0	2416.0	70.0	
GR2416.0	85.0	2418.0	95.0	2420.0	120.0	2422.0	150.0	2424.0	185.0	
NC 0.055	0.055	0.035	0.1	0.3						
X1 28	9	40.0	65.0	425.0	475.0	435.0	1.0	0.0		
GR2424.0	0.0	2422.0	29.0	2420.0	40.0	2418.0	50.0	2418.0	65.0	
GR2420.0	65.0	2421.0	145.0	2422.0	220.0	2424.0	240.0			
NC 0.055	0.055	0.035	0.1	0.3						
X1 29	10	90.0	140.0	350	350	350	1.0	0.0		
GR2426.0	0.0	2424.0	85.0	2421.5	100.0	2421.5	120.0	2424.0	125.0	
GR2426.0	150.0	2426.0	210.0	2425.0	240.0	2425.0	420.0	2426.0	480.0	

EJ

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Appendix 2

Master Drainage Study, Tohono O’Odham Nation-San Xavier District Phase 1- Pan-handle Area Existing Conditions: study boundaries, hydraulic analysis, HEC-RAS output printout, and maps (2) of HEC-RAS cross section locations

**MASTER DRAINAGE STUDY
TOHONO O'ODHAM NATION - SAN XAVIER DISTRICT
PHASE I - PANHANDLE AREA
EXISTING CONDITIONS**

Location:

The study area is located in portions of
Section 9, 16, 21&22, Township 15 South, Range 13 East

Prepared for:

Pima County Flood Control District
201 N. Stone Avenue
Tucson, Arizona 85701

July 31, 2001

Prepared by:

MMLA Inc.
800 E. Wetmore Road, Suite 110
Tucson, AZ 85719

MMLA 99024-04-45



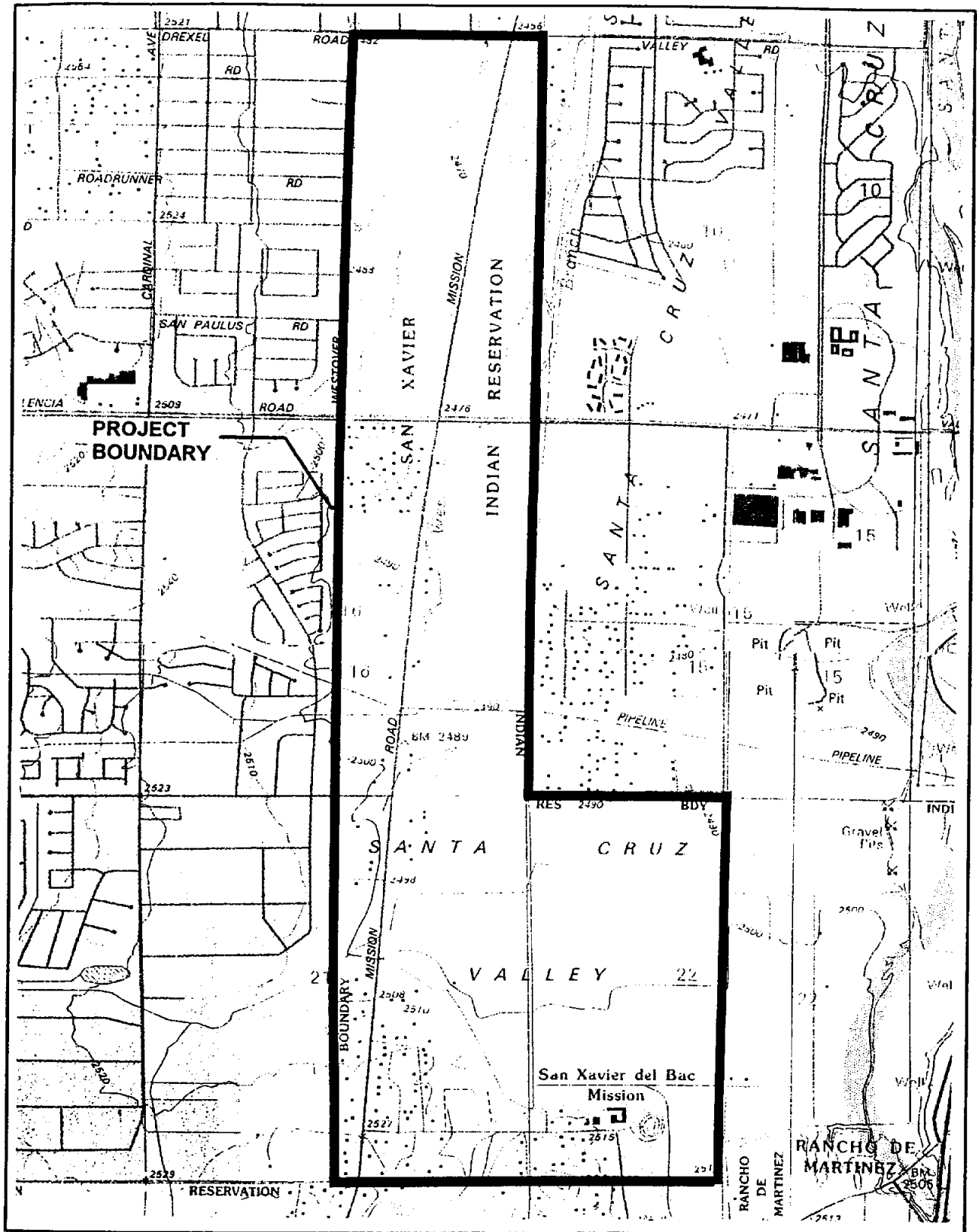


FIGURE 1
 STUDY BOUNDARY MAP
 Township 15S, Range 13E,
 Portions of Sections 9, 16, 21 & 22



MMLA

McGovern MacVittie Lodge & Associates, Inc.
 MMLA Job No. 98013-05-45

3.3.3 Split Flow Analysis

In order to better quantify the peak discharges in Cemetery Wash at San Xavier Mission Road, a split flow analysis was completed on Black Mountain Wash (Watershed 21) using the HEC-2 split flow option. The analysis utilized the HEC-1 peak discharge calculated at Concentration Point (C.P.) 21, and it was assumed that breakout over Mission Road behaves as weir flow. The results of the split flow analysis were entered back into the HEC-1 model as a flow diversion.

Under existing conditions, conveyance in Black Mountain Wash is limited to approximately 1630 cfs upstream of Go:k Ka:wulk Wo:g. Excess flow breaks over Mission Road and enters Watershed 17. Downstream of Go:k Ka:wulk Wo:g, most of the remaining flow crosses Mission Road and enters the Cemetery Wash watershed. Flow that does not cross Mission Road, enters the Mission Wash watershed and causes problematic flooding along Su:dagi Wo:g, a local dirt road. A detailed analysis of this second flow split was not completed due to the lack of adequate topography, and all of the runoff downstream of Go:k Ka:wulk Wo:g was assumed to contribute to Cemetery Wash. A copy of the split flow output and a cross-section location map are provided in Appendix 8.8.

4.0 HYDRAULIC ANALYSIS

4.1 EXISTING DRAINAGE IMPROVEMENTS

4.1.1 CULVERT CROSSINGS

There are currently four culvert crossings that affect the study area, all of which are located along Valencia Road. The details and design capacities of the culverts were determined from as-built drawings obtained from Pima County Mapping and Records. The first crossing consists of a 7 cell, 10' x 6' RCBC which conveys flow in Valencia Wash under Valencia Road. The upstream channel and culvert have a design capacity of 5257 cfs, which will pass the calculated 100-year peak discharge without breakout over Valencia Road. The second crossing is located at the southwest corner of Mission Road and Valencia Road and consists of a single 10' x 4' RCBC. The crossing conveys flow at C.P. 5 (Figure 4a) under Valencia Road and into a concrete lined channel which conveys flow to WBCSR. The design capacity of the culvert is 360 cfs, which will pass the 100-year discharge if all flow can concentrate at the headwall of the culvert. The third crossing consists of a 3 cell, 71" x 47" CMPA which is located in the historic alignment of the WBCSR, approximately 900 feet west of the channel realignment. The design capacity of the crossing is 512 cfs and conveys low flows in the historic channel under Valencia Road. The final crossing consists of a 10 cell, 12' x 8' RCBC and upstream channel improvements that convey flow from the relocated WBCSR under Valencia Road. The upstream channel and culvert crossing have a design capacity of 8000 cfs, which assuming all flow is contained in the channel, could pass the calculated 100-year discharge without breakout over Valencia Road. However, the earthen berms near the improved WBCSR prevent runoff from entering the channel, contributing to the wide floodplain across the panhandle area and Co-op Farm. Table 2 provides a summary of culvert crossing details.



**TABLE 2
SUMMARY OF CULVERT CROSSING DETAILS**

LOCATION	TYPE	Q _{design} (cfs)	Q ₁₀₀ [*] (cfs)
Valencia Wash @ Valencia Road	10-12' x 8 RCBC	5257	3680
Mission Road @ Valencia Road	1-10' x 4' RCBC	360	251
900 ft. west of WBSCR	3-71" x 47" CMPA	512	N/A
WBSCR @ Valencia Road	7-10' x 6' RCBC	8000	6900

*As determined by this study

4.1.2 LOS REALES IMPROVEMENT DISTRICT

In order to mitigate flooding caused from Mission Wash, Cemetery Wash and the unnamed drainage located just east of San Xavier Mission, the residents of the Los Reales subdivision formed an improvement district with Pima County in 1986. The formation of the Los Reales Improvement District (LRID) resulted in the construction of collector and conveyance channels on the west and south boundaries of the subdivision. The channel on the west boundary ties into an existing channel improvement which was associated with the construction of the 10-12'x 8' RCBC under Valencia Road. The extent of the west LRID channel is shown on Figure 5 (Sheet 2). Along the southern boundary, a floodwall was constructed which diverts flow to the head of the southern conveyance channel. The floodwall extends approximately 1500' feet east from the southwest corner of the subdivision, and has a height of four feet. The southern channel conveys flow directly to the Santa Cruz River as shown on Figure 5 (Sheet 4).

Record drawings for the LRID were obtained from Pima County to estimate the conveyance capacity of the channels. The western channel consists of two distinct channel reaches. The first reach is fully lined with concrete and extends north from Los Reales Road for a distance of approximately 1100 feet. It has 1:1 side slopes, a depth that varies from 4.5 to 6 feet, and a bottom width of 34 feet with a slope of 0.32%. The channel then transitions into Reach 2 geometry, which extends north for a distance of approximately 1500 feet. The channel has a 26' bottom width with a slope of 0.35%. The sides are concrete lined with a 1:1 slope, and the channel depth ranges from 5.5 to 7.5 feet.

The southern channel consists of three distinct reaches, the first of which begins at the end of the flood wall. This reach extends approximately 2100' east and has a 30' to 40' bottom width, 1:1 concrete lined side slopes, and a depth ranging from 6 to 9 feet. The slope of the earthen bottom is 0.25%. The channel then transitions into Reach 2 geometry which extends approximately 2000 feet to the east. Reach 2 has an unlined bottom with a width of 15' to 30' feet and slope of 0.25%. The northern side of the channel is earthen with a 3:1 slope. The southern side of the channel is concrete lined with a 1:1 slope. The last segment of the channel (Reach 3) extends approximately 630 east where it discharges to the Santa Cruz River. The channel is completely unlined with 3:1 side slopes, a depth of 15 to 19 feet, and a 15' bottom width with a 1.2% slope.



A minimum and maximum capacity for each reach of the west and south channels was calculated using Manning's equation. A field inspection of channel integrity and more detailed backwater analysis may be completed on both channels as part of the Phase II study. Hydraulic calculation sheets and typical cross-sections for the channels taken from the record drawings are provided in Appendix 8.8. The approximate beginning and end for each channel reach is shown on Figure 5 (Sheets 2 & 4). The minimum full flow discharge for each segment is summarized in Table 3 below. The variances in full flow capacity are the results of both varying channel depth and bottom slope. As shown in the table, it does not appear the LRID channels were designed to convey the 100-year discharge. The capacity values calculated as part of this study correlate well with those presented in the *Letter of Map Revision for the Los Reales Improvement District*, completed by Arroyo Engineering in December 1994. The analysis presented in that document is the basis for the current FEMA floodplain mapping in the area of the collector channels.

**TABLE 3
SUMMARY OF MANNING'S CALCULATIONS
LOS REALES IMPROVEMENT DISTRICT CONVEYANCE CHANNELS**

CHANNEL	SEGMENT	ESTIMATED CAPACITY (cfs)		INFLOW (cfs)		
		Min.	Max.	Q ₂	Q ₁₀	Q ₁₀₀
West	1	1938	2858	2241	4215	6901
West	2	1578	2389	2241	4215	6901
South	1	2723	2829	1056	2355	5128
South	2	3559	4498	1056	2355	5128
South	3	17010	18500	1056	2355	5128

Based on field observations and available topographic mapping, the channels are not effectively receiving the flows they were intended to convey. The presence of earthen berms, as shown on Figure 5 (Sheets 2 & 4), is severely impeding conveyance into both the western and southern channels. Consequently, the channels are not providing any appreciable level of flood control or mitigation for the Nation. The presence of the berms is shown on the record drawings. However, it is unknown whether they were present prior to construction, or placed as part of construction.

4.2 FLOODPLAIN ANALYSIS

The purpose of the floodplain analysis was to delineate the 100-year floodplains impacting the study area, and determine the 100-year water surface elevations for planning of future improvements. Floodplain delineation was completed using Manning's equation, the HEC-RAS computer program, as well as the results of aerial photograph analysis and field reconnaissance in areas where computational methods were considered inappropriate due to topography and limited conveyance. Floodplain mapping was completed on 1"= 200', 2' contour interval aerial topography dated November 15, 1994 (Figure 5). The topography was supplied to Pima County Flood Control District by the Natural Resource Conservation Service (NRCS), Phoenix office, and is based on the North American Vertical Datum of 1929. An attempt was made in a memorandum dated April 16, 1999, to obtain the more recent



topography (April 1998) which is to be distributed by Pima Association of Governments. However, it was determined that this topography was not readily available at the time of this report, and that it did not extend far enough into the study area. Manning's calculation sheets and HEC-RAS output files are provided in Appendix 8.10.

The 100-year discharge of 6809 cfs used upstream of Valencia Road represents the hydrograph summation of the Mission Wash and Cemetery Wash watersheds. An additional 2440 cfs is contributed from the smaller watersheds to the west. However, this discharge was not added to the 6809 cfs due to the large difference in the time to peak discharge between the those smaller watersheds to the west, and the Cemetery Wash and Mission Wash watersheds which contribute the largest amount of flow. Mission Wash was modeled assuming an approximate 4:1 expansion from the point where flow crosses Mission Road. This approach was taken to ensure that water surface elevations on the west side of the floodplain were not underestimated as a result of the expansion of flows into the agricultural area east of Mission Road (see Figure 5, Sheet 3). The results of the floodplain analysis yielded the following conclusions:

- The agricultural area south of Valencia Road is **completely inundated** during the 100-year event because of flat topography and poor conveyance into the existing Los Reales Improvement District southern channel. Most existing residences in the panhandle area south of Valencia Road are not in the 100-year floodplain.
- Flow from Watershed 17 which enters the study area east of San Xavier Mission is conveyed east to the Santa Cruz River, either directly, or by way of the Los Reales Improvement District southern conveyance channel. This assumption is based on existing topography and the presence of a berm on both sides of Cemetery Wash that tends to promote conveyance to the east.
- For the purposes of future development, the entire panhandle area north of Valencia Road is considered as **completely inundated** during the 100-year event. This assumption is based on the results of the hydrologic analysis, and review of the existing topography which indicates flows in the various poorly defined drainages converge prior to reaching Mission Road creating large ponded areas. In addition, the actual location of discharge points across Westover Avenue is unpredictable due to poorly defined dip sections and periodic grading of the shoulder. Any "islands" which do exist in the panhandle area during the 100-year event would be inaccessible due to flooding in the surrounding areas.
- The 100-year discharge in the Santa Cruz River is contained within the existing channel banks as per FIRM Panel C2830K, dated February 8, 1999.



HEC-RAS September 1998 Version 2.2
 U.S. Army Corp of Engineers
 Hydrologic Engineering Center
 609 Second Street, Suite D
 Davis, California 95616-4687
 (916) 756-1104

```

X  X  XXXXXX  XXXX  XXXX  XX  XXXX
X  X  X      X  X      X  X  X  X  X
X  X  X      X      X  X  X  X  X
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X  X  X      X      X  X  X  X  X
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```

PROJECT DATA

Project Title: San Xavier District Master Drainage Study
 Project File : FSPNIR.prj
 Run Date and Time: 11/22/99 2:21:08 PM

Project in English units

Project Description:
 100-year Floodplain Mission Wash, Mission Road to Valencia Road

PLAN DATA

Plan Title: Plan 06
 Plan File : e:\mike\98013-05\FSPNIR.p06

Geometry Title: Mission Wash - South of Valencia
 Geometry File : e:\mike\98013-05\FSPNIR.g02

Flow Title : Mission Wash
 Flow File : e:\mike\98013-05\FSPNIR.f04

Plan Summary Information:

Number of: Cross Sections = 11 Multiple Openings = 0
 Culverts = 0 Inline Weirs = 0
 Bridges = 0

Computational Information

Water surface calculation tolerance = 0.01
 Critical depth calculation tolerance = 0.01
 Maximum number of iterations = 20
 Maximum difference tolerance = 0.3
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary
 Conveyance Calculation Method: At breaks in n values only
 Friction Slope Method: Average Conveyance
 Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Mission Wash
 Flow File : e:\mike\98013-05\FSPNIR.f04

Flow Data (cfs)

River	Reach	RS	PF#1
Mission Wash	1	11	6901

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Mission Wash	1	PF#1		Normal S = .003

GEOMETRY DATA

Geometry Title: Mission Wash - South of Valencia
 Geometry File : e:\mike\98013-05\FSPNIR.g02

CROSS SECTION RIVER: Mission Wash

Sta	n Val	Sta	n Val	Sta	n Val						
0	.035	0	.035	1850	.035						

Bank Sta: Left Right Lengths: Left Channel Right
 0 1850 500 500 500
 Coeff Contr. Expan.
 .1 .3

CROSS SECTION RIVER: Mission Wash
 REACH: 1 RS: 6

INPUT

Description:

Station	Elevation	Data	num=	14							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2492	25	2492	165	2490	400	2488	585	2488.3		
1340	2488	1760	2486	1772	2484	1800	2486	1810	2488		
1815	2490.5	1825	2481.2	1855	2481.2	1865	2491				

Manning's n Values	num=	3									
Sta	n Val	Sta	n Val	Sta	n Val						
0	.035	0	.035	1815	.025						

Bank Sta: Left Right Lengths: Left Channel Right
 0 1815 800 800 800
 Coeff Contr. Expan.
 .1 .3

Ineffective Flow num= 1
 Sta L Sta R Elev
 1815 1865 2490.5

CROSS SECTION RIVER: Mission Wash
 REACH: 1 RS: 5

INPUT

Description:

Station	Elevation	Data	num=	18							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2488	60	2488	180	2487	220	2486	260	2486		
620	2485.3	1045	2485.4	1255	2485.3	1625	2484	1720	2482		
1740	2481	1750	2482	1760	2484	1765	2486	1770	2488		
1780	2479.5	1810	2479.5	1820	2489						

Manning's n Values	num=	3									
Sta	n Val	Sta	n Val	Sta	n Val						
0	.035	0	.035	1770	.025						

Bank Sta: Left Right Lengths: Left Channel Right
 0 1770 800 800 800
 Coeff Contr. Expan.
 .1 .3

Ineffective Flow num= 1
 Sta L Sta R Elev
 1770 1820 2488

CROSS SECTION RIVER: Mission Wash
 REACH: 1 RS: 4

INPUT

Description:

Station	Elevation	Data	num=	18							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2486	35	2486	100	2484	260	2482	750	2481		
1050	2480.2	1404	2481.4	1535	2480	1650	2478	1660	2476		
1670	2474	1680	2478	1690	2480	1700	2478	1710	2483		
1720	2475	1750	2475	1760	2484						

Manning's n Values	num=	3									
Sta	n Val	Sta	n Val	Sta	n Val						
0	.035	0	.035	1710	.035						

Bank Sta: Left Right Lengths: Left Channel Right
 0 1710 800 800 800
 Coeff Contr. Expan.
 .1 .3

Ineffective Flow num= 1
 Sta L Sta R Elev
 1710 1760 2484

CROSS SECTION RIVER: Mission Wash
 REACH: 1 RS: 3

INPUT

Description:

Station	Elevation	Data	num=	19							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2486	20	2485	40	2486	75	2484	120	2482		
179	2482	300	2483	370	2482	410	2480	900	2479.5		
1250	2479.7	1560	2478	1575	2477	1590	2478	1615	2480		
1630	2480	1645	2472	1665	2472	1675	2481				

Manning's n Values	num=	3									
Sta	n Val	Sta	n Val	Sta	n Val						
0	.035	0	.035	1675	.035						

Bank Sta: Left Right Lengths: Left Channel Right
 0 1675 780 780 780
 Coeff Contr. Expan.
 .1 .3

Ineffective Flow num= 1
 Sta L Sta R Elev
 1630 1675 2482

CROSS SECTION RIVER: Mission Wash
 REACH: 1 RS: 2

INPUT

Description:

Station Elevation Data		num= 12							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2481	20	2480	150	2478	430	2477.6	700	2478
1220	2478	1330	2477.6	1490	2478	1580	2480	1615	2467.5
1635	2467.5	1645	2481						

Manning's n Values

num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.035	1645	.035

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff Contr.	Expan.
	0	1645		800	800	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev
1580	1645	2480

CROSS SECTION

RIVER: Mission Wash

REACH: 1

RS: 1

INPUT

Description:

Station Elevation Data		num= 27							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	2479	50	2478.5	70	2478	130	2476	145	2476
160	2476	320	2474	505	2472	560	2472	650	2474
1150	2474	1312	2474	1370	2474	1440	2472	1460	2474
1471	2476	1485	2478	1500	2478	1508	2476	1512	2474
1520	2470	1530	2468	1550	2466	1580	2464	1590	2463
1600	2464	1630	2470						

Manning's n Values

num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.035	0	.035	1630	.035

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff Contr.	Expan.
	0	1630		800	800	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev
1485	1630	2478

SUMMARY OF REACH LENGTHS

River: Mission Wash

Reach	River Sta.	Left	Channel	Right
1	11	720	720	720
1	10	640	640	640
1	9	600	600	600
1	8	460	460	460
1	7	500	500	500
1	6	800	800	800
1	5	800	800	800
1	4	800	800	800
1	3	780	780	780
1	2	800	800	800
1	1	800	800	800

Profile Output Table - Standard Table 1

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
Froude # Chl		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
1	11	6901.00	2498.00	2502.75		2502.97	0.002764	3.77	1830.75	834.10
0.45										
1	10	6901.00	2494.20	2500.85	2499.53	2501.09	0.002462	3.92	1761.19	2604.05
0.43										
1	9	6901.00	2491.30	2497.54	2497.26	2498.22	0.010125	6.62	1043.21	2031.29
0.84										
1	8	6901.00	2490.00	2493.52	2492.81	2493.92	0.005165	5.08	1357.99	1581.78
0.61										
1	7	6901.00	2488.90	2490.97		2491.20	0.006484	3.81	1809.73	1536.06
0.62										
1	6	6901.00	2484.00	2489.53	2488.58	2489.63	0.001777	2.55	2708.14	1640.44
0.34										
1	5	6901.00	2481.00	2485.87	2485.87	2486.31	0.018049	5.33	1295.82	1479.79
0.99										
1	4	6901.00	2474.00	2482.68	2481.44	2482.77	0.001369	2.41	2863.17	1551.81
0.31										
1	3	6901.00	2472.00	2481.52	2480.40	2481.63	0.001474	2.65	2599.29	1295.44
0.32										
1	2	6901.00	2467.50	2479.05	2478.80	2479.33	0.008439	4.22	1636.64	1516.79
0.70										
1	1	6901.00	2463.00	2475.36	2474.63	2475.53	0.003002	3.28	2103.99	1376.97
0.45										

Profile Output Table - Standard Table 2

Reach	River Sta	S.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
1	11	2502.97	2502.75	0.22	1.87	0.00		6901.00		834.10
1	10	2501.09	2500.85	0.24	2.83	0.04		6901.00		2604.05
1	9	2498.22	2497.54	0.68	4.22	0.08		6901.00		2031.29
1	8	2493.92	2493.52	0.40	2.67	0.05		6901.00		1581.78
1	7	2491.20	2490.97	0.23	1.53	0.04		6901.00		1536.06
1	6	2489.63	2489.53	0.10	3.29	0.03		6901.00		1640.14
1	5	2486.31	2485.87	0.44	2.69	0.11		6901.00		1479.79
1	4	2482.77	2482.68	0.09	1.14	0.00		6901.00		1551.81
1	3	2481.63	2481.52	0.11	2.29	0.02		6901.00		1295.44
1	2	2479.33	2479.05	0.28	3.77	0.03		6901.00		1516.79
1	1	2475.53	2475.36	0.17				6901.00		1376.97

Appendix 3

Request for a Letter of Map Revision for the Los Reales Improvement District Located in Pima County, Arizona, and the City of Tucson, Arizona: study boundaries, HEC-2 input and output printout for the West Branch of the Santa Cruz River from Valencia Road to the Reservation Boundary, HEC-2 input and output printout for the South Channel

**REQUEST FOR A
LETTER OF MAP REVISION FOR THE
LOS REALES IMPROVEMENT DISTRICT
LOCATED IN PIMA COUNTY, ARIZONA,
AND IN THE CITY OF TUCSON, ARIZONA**

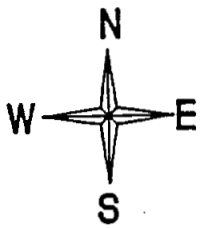
Submitted to:
PIMA COUNTY DEPARTMENT OF TRANSPORTATION
AND FLOOD CONTROL DISTRICT
Floodplain Planning Section
Fourth Floor, Public Works Building
201 North Stone Avenue
Tucson, Arizona 85701-1207
(602) 740-6350

and to:
CITY OF TUCSON DEPARTMENT OF TRANSPORTATION
Engineering Division, Floodplain Section
P.O. Box 27210
Tucson, Arizona 85726-7210
(602) 791-4914

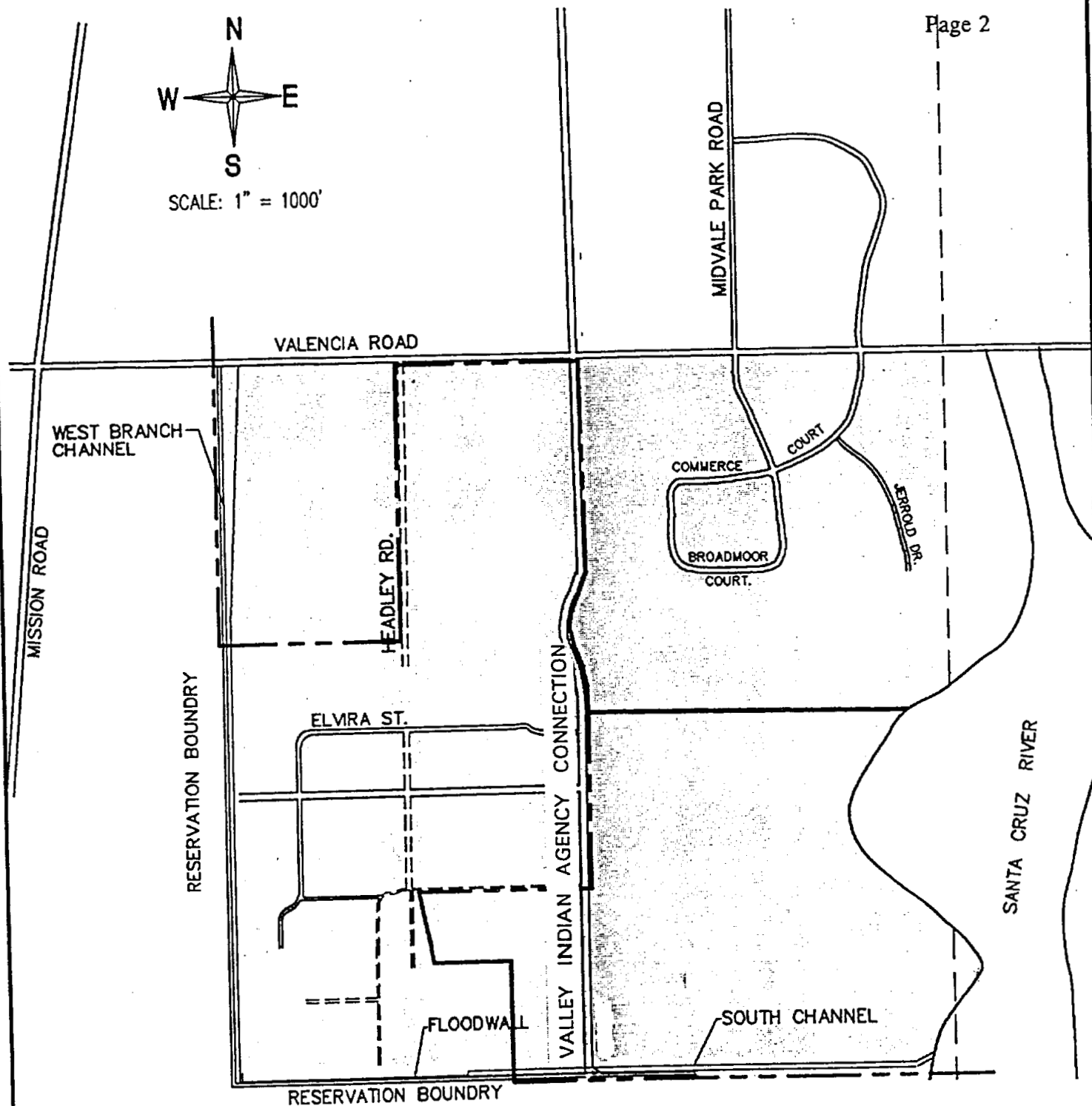
Prepared By:
ARROYO ENGINEERING, INC.
P.O. Box 2668
Tucson, Arizona 85702
(602) 882-0206

December, 1994





SCALE: 1" = 1000'



----- CITY LIMITS
[] LOS REALES IMPROVEMENT DISTRICT

FIGURE 1
PROJECT LOCATION MAP

Appendix C

**HEC-2 Input and Output Files for the
West Branch of the Santa Cruz River from
Valencia Rd to the Reservation Boundary**

SF Splitflow Analysis of the Los Reales Floodwall and Diversion Channels
 JC Splitflow Analysis

JP	0	0	100	0	0					
TN	Normal depth split flow - Sections 11 to 12									
NS	2	11	12	-1	0.06	0.004				
NG	0	2477.2	200	2478.0						
TN	Normal depth split flow - Sections 12 to 13									
NS	2	12	13	-1	0.06	0.004				
NG	0	2478.0	200	2478.5						
TN	Normal depth split flow - Section 13 to 14									
NS	2	13	14	-1	0.06	0.004				
NG	0	2478.5	112	2478.6						
TN	Normal depth split flow - Sections 14 to 15									
NS	2	14	15	-1	0.06	0.004				
NG	0	2478.6	100	2479.5						
TN	Normal depth split flow - Sections 21 to 22									
NS	2	21	22	-1	0.06	0.003				
NG	0	2484.3	44	2484.4						
TN	Normal depth split flow - Sections 22 to 23									
NS	2	22	23	-1	0.06	0.003				
NG	0	2484.4	231	2484.5						
TC	Rating curve outflow data set for Splitflow into South Diversion Channel									
CS	3	28	28.1	-1						
CR	3250	2489.90	3300	2489.93	3350	2489.97				
TW	Splitflow #28 to #28.1 (Splitflow goes directly into the Santa Cruz River)									
WS	9	28	28.1	-1	2.6					
WC6750.0	2491.3	6760.0	2488.3	6950.0	2489.1	7150.0	2489.2	7350.0	2490.0	
WC7550.0	2491.6	7750.0	2491.8	7850.0	2492.5	7950.0	2494.1			

EE
 T1 Los Reales Improvement District, Letter of Map Revision
 T2 Arroyo Job #PDOT01.1, HEC2 File: WEST.H2I
 T3 West Branch Santa Cruz River
 T4 West Branch Santa Cruz River, from Valencia Rd. to Los Reales Rd.

J1	0	2	0	0	0	0	0	0	2466.7	
J2	1	0	-1	0	0	0	0	0	0	
J3	38	43	13	14	15	1	2	3	8	53
J3	4	54	61		150					
NC	.030	.030	.0275	0.1	0.3					
QT	1	7638								

X1	1	15	1390	2002	0	0	0			
* X-Sec	1: Same as Sta 448+00 on West Branch Bank Protection Plan 4BVALE									
GR	2474	1300	2474	1390	2472	1520	2470	1695	2468	1780
GR	2466	1810	2465	1836	2463.7	1861.5	2463	1864	2463	1995
GR	2470	2002	2470.3	2022	2470	2172	2472	2860	2472	3020

X1	2	23	1800	2002	100	100	100			
* X-Sec	2: Same as Sta 447+00 on West Branch Bank Protection Plan 4BVALE									
GR	2475	1250	2474	1430	2472	1560	2470	1710	2470	1778
GR	2472	1785	2472	1794	2474	1800	2472	1805	2470	1810
GR	2468	1825	2466	1835.5	2464.9	1841	2465.2	1852	2464	1864
GR2463.5	1865.5	2463.5	1995	2470.5	2002	2470.8	2022	2471.4	2024	
GR2471.7	2074	2472	2164	2472	3050					

X1	3	18	1820	2002	200	200	200			
* X-Sec	3: Same as Sta 445+00 on West Branch Bank Protection Plan 4BVALE									
GR2475.5	1200	2474	1470	2472	1565	2470	1650	2472	1680	
GR	2472	1750	2472	1790	2476	1805	2476	1820	2471.5	1836.5
GR2465.8	1858	2464.5	1878	2464.3	1879.5	2464.4	1995	2471.2	2002	
GR2471.5	2022	2471.8	2023	2473	3050					

X1	4	16	1838	2002	200	200	200			
* X-Sec	4: Same as Sta 443+00 on West Branch Bank Protection Plan 4BVALE									
GR	2476	1260	2474	1515	2472	1600	2472	1660	2474	1820
GR	2476	1830	2479	1838	2474	1848	2466.8	1873	2464.7	1939
GR	2465	1945.5	2465	1995	2472	2002	2472.3	2022	2472.5	2023
GR2473.5	3100									

X1	5	15	1841	2002	200	200	200			
* X-Sec	5: Same as Sta 441+00 on West Branch Bank Protection Plan 4BVALE									
X3	0	0	0	0	0	3090				
GR2476.0	1250	2476	1530	2474	1790	2474	1820	2476	1830	
GR2479.5	1841	2465.5	1901	2464.8	1918	2465.6	1925.5	2465.6	1995	
GR2472.6	2002	2473	2022	2473.8	2023	2472	2720	2472.5	3100	

X1	6	15	1868	2002	200	200	200			
* X-Sec	6: Same as Sta 439+00 on West Branch Bank Protection Plan 4BVALE									
X3	0	0	0	0	0	3040				
GR	2476	1300	2476	1840	2480	1850	2480	1868	2474	1879
GR	2467	1913	2465	1913	2466.5	1965.5	2466.5	1995	2473.5	2002

GR	2480	1920	2478	1927	2476	1932	2476	1940	2478	1948
GR	2480	1960	2482	1967	2482	1993	2480.3	2000	2473.11	2007
GR2473.1	2033	2480.5	2040	2478.5	2160	2480.0	2590	2481.5	3350	
X1	17	14	1995	2040	250	250	250	0		
* X-Sec 17:	Same	as Sta	46+66 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2620				
GR	2484	490	2482	1190	2480	1740	2481	1900	2480	1940
GR	2482	1970	2482	1995	2480.7	2000	2474.02	2007	2474.02	2033
GR2481.1	2040	2480.5	2250	2481.0	2900	2481.8	3300			
X1	18	18	1990	2040	250	250	250	0	2000	
* X-Sec 18:	Same	as Sta	44+16 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2550				
GR	486	450	484	580	482	1300	481.6	1530	482	1740
GR	482.2	1830	482	1910	480	1950	477	1970	480	1980
GR	483	1990	481.1	2000	474.92	2007	474.92	2033	481.7	2040
GR	481.5	2480	482	3300	482.2	3450				
X1	19	17	1995	2040	250	250	250	0	2000	
* X-Sec 19:	Same	as Sta	41+66 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2480				
GR	488	500	486	520	484	830	482.2	1500	482	1940
GR	480	1960	479	1980	480	1990	487	1995	481.6	2000
GR475.80	2007	475.80	2033	482.3	2040	481.8	2250	482	2500	
GR	482	3000	483	3680						
X1	20	18	1995	2040	250	250	250	0	2000	
* X-Sec 20:	Same	as Sta	39+16 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2420				
GR	488	445	486	695	484	810	482.9	1065	482.2	1860
GR	478	1950	480	1960	482	1970	484	1980	486	1990
GR	487	1995	482.3	2000	476.67	2007	476.67	2033	483.0	2040
GR	482.2	2280	483	2930	484	3310				
NC	.030	.060	.020							
X1	21	16	1990	2048	197	197	197	0	2000	
* X-Sec 21:	Same	as Sta	37+19 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2375				
GR	488	410	486	670	484	1060	484	1930	482	1949
GR	482	1962	484	1972	486	1980	487	1990	483.0	2000
GR477.37	2015	477.37	2041	484.0	2048	483.3	2300	484	2595	
GR	484.3	3330								
X1	22	19	1990	2046	44	44	44	0	2000	
* X-Sec 22:	Same	as Sta	36+75 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2365				
GR	488	390	488	650	486	720	484	780	484	1600
GR	482	1660	482	1910	482	1965	484	1975	486	1982
GR	487	1990	483.2	2000	478.87	2006	478.87	2040	484.2	2046
GR	484	2080	483.4	2300	484	2640	484.4	3335		
X1	23	15	1980	2046	231	231	231	0	2000	
* X-Sec 23:	Same	as Sta	34+44 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2310				
GR	490	450	488	470	486	1230	484.3	1800	484	1910
GR	482	1935	481.5	1940	487	1980	484.2	2000	479.6	2006
GR	479.6	2040	485.2	2046	484.1	2140	484.5	3000	484.5	3400
X1	24	13	1985	2046	231	231	231	0	2000	
* X-Sec 24:	Same	as Sta	32+13 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2250				
GR	488	370	487.4	820	486	1380	484	1950	482.2	1960
GR	488	1985	486	1995	485.8	2000	480.4	2006	480.4	2040
GR	485.4	2046	485.5	2400	486	3150				
X1	25	15	2000	2046	300	300	300	0	2000	
* X-Sec 25:	Same	as Sta	29+13 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2170				
GR	488	410	486	1850	484	1950	483.5	1955	484	1970
GR	486	1982	488	1995	488.3	2000	481.3	2006	481.3	2040
GR	488.3	2046	486.5	2430	487	3040	486.2	3450	487.5	4100
X1	26	13	2000	2046	235	235	235	0	2000	
* X-Sec 26:	Same	as Sta	26+78 on	Los Reales	Improvement	District	Plan ID-101			
X3	0	0	0	0	0	2100				
GR	490	420	488	650	487	1200	486	1940	485	1950
GR	486	1975	488	1990	488.5	2000	482.1	2006	482.1	2040
GR	488.5	2046	487	2500	488	3400				
X1	27	16	2000	2046	234	234	234	0		

* X-Sec 2444 Located at u/s end of channel

GR2494.0	50	2492.0	200	2490.0	490	2488.0	1900	2487.4	1931.5
GR2485.6	1957.5	2488.5	1961.5	2488.8	1967.5	2488.2	1975.5	2489.1	1984.5
GR2488.8	1998.9	2488.8	2000	2482.8	2006	2482.8	2040	2488.8	2045.5
GR2493.4	2046.0								

NC 0.030 0.060 0.022 .1 .3
 X1 28 44 2000 3340 52 52 52 0

* X-Sec 2392 Located at u/s end of channel and 31 ft u/s from Floodwall

* Ground-profile data along upstream side of floodwall were determined by field survey (NGVD-1929 datum).

GR2494.0	0	2492.0	150	2491.0	400	2489.5	650	2489.5	800
GR2490.0	1000	2490.0	1200	2490.0	1400	2490.0	1600	2490.0	1746.5
GR2490.3	1800	2490.2	1846.5	2490.0	1889.5	2488.6	1903	2488.6	1912.5
GR2487.4	1931.5	2485.6	1957.5	2488.5	1961.5	2488.8	1967.5	2488.2	1975.5
GR2489.1	1984.5	2488.8	1998.9	2488.7	2000.0	2488.9	2042.3	2489.4	2046.4
GR2488.7	2046.5	2489.3	2260.0	2489.2	2520.0	2489.0	2770.0	2489.2	3020.0
GR2489.3	3340.0	2488.9	3470	2488.9	3546.5	2488.2	4046.5	2488.7	4346.5
GR2487.9	4546.5	2489.5	4633.5	2489.5	4650	2489.5	5200	2488.7	5500
GR2488.6	5800.5	2488.7	6100	2488.3	6400	2491.3	6750		

NC 0.030 0.060 0.022 .1 .3
 X1 28.1 52 2000 3340 2 2 2 0

* X-Sec 2390 Located at u/s end of channel and 33 ft u/s from Floodwall

* Ground-profile data along upstream side of floodwall were determined by field survey (NGVD-1929 datum).

GR2494.0	0	2492.0	150	2491.0	400	2489.5	650	2489.5	800
GR2490.0	1000	2490.0	1200	2490.0	1400	2490.0	1600	2490.0	1746.5
GR2490.3	1800	2490.2	1846.5	2490.0	1889.5	2488.6	1903	2488.6	1912.5
GR2487.4	1931.5	2485.6	1957.5	2488.5	1961.5	2488.8	1967.5	2488.2	1975.5
GR2489.1	1984.5	2488.8	1998.9	2488.7	2000.0	2488.9	2042.3	2489.4	2046.4
GR2488.7	2046.5	2489.3	2260.0	2489.2	2520.0	2489.0	2770.0	2489.2	3020.0
GR2489.3	3340.0	2488.9	3470	2488.9	3546.5	2488.2	4046.5	2488.7	4346.5
GR2487.9	4546.5	2489.5	4633.5	2489.5	4650	2489.5	5200	2488.7	5500
GR2488.6	5800.5	2488.7	6100	2488.3	6400	2491.3	6750	2488.3	6760
GR2489.1	6950	2489.2	7150	2490	7350	2491.6	7550	2491.8	7750
GR2492.5	7850	2494.1	7950						

EJ
 ER


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*****
* HEC-2 WATER SURFACE PROFILES *
*                               *
* Version  4.6.2:  May 1991    *
*                               *
* RUN DATE  30NOV94  TIME  11:37:31 *
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* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET, SUITE D    *
* DAVIS, CALIFORNIA 95616-4687 *
* (916) 756-1104              *
*****

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X   X  XXXXXXX  XXXXX      XXXXX
X   X  X       X   X      X   X
X   X  X       X           X   X
XXXXXXXX XXXX  X           XXXXX
X   X  X       X           X   X
X   X  X       X   X      X   X
X   X  XXXXXXX  XXXXX      XXXXXXX

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WEST BRANCH SANTA CRUZ RIVER
 EXISTING CONDITIONS
 REVISED 12-1-94
 INCLUDES SPLIT FLOWS TO EAST

 HEC-2 WATER SURFACE PROFILES
 Version 4.6.2; May 1991

SPLIT FLOW BEING PERFORMED

SF Splitflow Analysis of the Los Reales Floodwall and Diversion Channels

JC Splitflow Analysis

JP 0 0 100 0 0

TN Normal depth split flow - Sections 11 to 12

NS 2 11 12 -1 0.06 0.004
 NG 0 2477.2 200 2478.0

TN Normal depth split flow - Sections 12 to 13

NS 2 12 13 -1 0.06 0.004
 NG 0 2478.0 200 2478.5

TN Normal depth split flow - Section 13 to 14

NS 2 13 14 -1 0.06 0.004
 NG 0 2478.5 112 2478.6

TN Normal depth split flow - Sections 14 to 15

NS 2 14 15 -1 0.06 0.004
 NG 0 2478.6 100 2479.5

TN Normal depth split flow - Sections 21 to 22

NS 2 21 22 -1 0.06 0.003
 NG 0 2484.3 44 2484.4

TN Normal depth split flow - Sections 22 to 23

NS 2 22 23 -1 0.06 0.003
 NG 0 2484.4 231 2484.5

TC Rating curve outflow data set for Splitflow into South Diversion Channel

CS 3 28 28.1 -1
 CR 3250 2489.90 3300 2489.93 3350 2489.97

TW Splitflow #28 to #28.1 (Splitflow goes directly into the Santa Cruz River)

WS 9 28 28.1 -1 2.6
 WC6750.0 2491.3 6760.0 2488.3 6950.0 2489.1 7150.0 2489.2 7350.0 2490.0
 WC7550.0 2491.6 7750.0 2491.8 7850.0 2492.5 7950.0 2494.1

X1	5	15	1841	2002	200	200	200	200			
X3	0	0	0	0	0	0	3090				
GR	2476.0	1250	2476	1530	2474	1790	2474	1820	2476	1830	
GR	2479.5	1841	2465.5	1901	2464.8	1918	2465.6	1925.5	2465.6	1995	
GR	2472.6	2002	2473	2022	2473.8	2023	2472	2720	2472.5	3100	
X1 6: Same as Sta 441+00 on West Branch Bank Protection Plan 4BVALE											
X1	6	15	1868	2002	200	200	200				
X3	0	0	0	0	0	0	3040				
GR	2476	1300	2476	1840	2480	1850	2480	1868	2474	1879	
GR	2467	1913	2465	1913	2466.5	1965.5	2466.5	1995	2473.5	2002	
GR	2473.7	2026.5	2474	2028	2472	2100	2473	2800	2474.0	3100	
X1 6: Same as Sta 439+00 on West Branch Bank Protection Plan 4BVALE											
X1	7	14	1886	2002	200	200	200				
X3	0	0	0	0	0	0	3000				
GR	2477	1300	2476	1870	2478	1875	2480	1880	2481	1886	
GR	2475.3	1894	2469.5	1922	2466.7	1930	2467.1	1982.5	2467.1	1995	
GR	2474	2002	2474.4	2022	2472.5	2400	2474	3000			
X1 7: Same as Sta 437+00 on West Branch Bank Protection Plan 4BVALE											
X1	8	12	1880	2000	200	200	200				
X3	0	0	0	0	0	0	2970				
GR	2477	1300	2478	1880	2480	1890	2480.0	1895	2476.5	1905	
GR	2470	1930	2467	1948	2468	1992	2474.8	2000	2475	2020	
GR	2474	2400	2475.5	3150							
X1 8: Same as Sta 435+00 on West Branch Bank Protection Plan 4BVALE											
X1	9	17	1920	1998	164	164	164				
X3	0	0	0	0	0	0	2930				
GR	2478	1500	2478	1900	2480	1905	2480	1920	2476.8	1934	
GR	2467.7	1953	2467.5	1978	2469	1982.6	2469	1991.3	2475.5	1998	
GR	2475.6	2018	2476	2019	2476	2043.5	2474.5	2230.0	2475.0	2550	
GR	2476.0	2900	2476	3150							
X1 9: Same as Sta 433+36 on West Branch Bank Protection Plan 4BVALE											
NC	.030	.030	.029	0.1	0.3						
X1	10	18	1946	2004.5	136	136	136				
X3	0	0	0	0	0	0	2920				
GR	2482	400	2480	420	2478	540	2478	780	2478	1730	
GR	2477	1850	2478.0	1920	2480	1940	2482.8	1946	2477.5	1955	
GR	2469.5	1977	2469	1980	2469	1998	2475.9	2004.5	2476.1	2064	
GR	2475	2300	2476.0	2700	2476.5	3200					
X1 10: Same as Sta 432+00 on West Branch Bank Protection Plan 4BVALE											

NC	0.030	0.060	0.022	.1	.3					
X1	28	44	2000	3340	52	52	52	0		
X-Sec 2392 Located at u/s end of channel and 31 ft u/s from Floodwall										
Ground-profile data along upstream side of floodwall were determined by field survey (NGVD-1929 datum).										
GR	2494.0	0	2492.0	150	2491.0	400	2489.5	650	2489.5	800
GR	2490.0	1000	2490.0	1200	2490.0	1400	2490.0	1600	2490.0	1746.5
GR	2490.3	1800	2490.2	1846.5	2490.0	1889.5	2488.6	1903	2488.6	1912.5
GR	2487.4	1931.5	2485.6	1957.5	2488.5	1961.5	2488.8	1967.5	2488.2	1975.5
GR	2489.1	1984.5	2488.8	1998.9	2488.7	2000.0	2488.9	2042.3	2489.4	2046.4
GR	2488.7	2046.5	2489.3	2260.0	2489.2	2520.0	2489.0	2770.0	2489.2	3020.0
GR	2489.3	3340.0	2488.9	3470	2488.9	3546.5	2488.2	4046.5	2488.7	4346.5
GR	2487.9	4546.5	2489.5	4633.5	2489.5	4650	2489.5	5200	2488.7	5500
GR	2488.6	5800.5	2488.7	6100	2488.3	6400	2491.3	6750		

NC	0.030	0.060	0.022	.1	.3					
X1	28.1	52	2000	3340	2	2	2	0		
X-Sec 2390 Located at u/s end of channel and 33 ft u/s from Floodwall										
Ground-profile data along upstream side of floodwall were determined by field survey (NGVD-1929 datum).										
GR	2494.0	0	2492.0	150	2491.0	400	2489.5	650	2489.5	800
GR	2490.0	1000	2490.0	1200	2490.0	1400	2490.0	1600	2490.0	1746.5
GR	2490.3	1800	2490.2	1846.5	2490.0	1889.5	2488.6	1903	2488.6	1912.5
GR	2487.4	1931.5	2485.6	1957.5	2488.5	1961.5	2488.8	1967.5	2488.2	1975.5
GR	2489.1	1984.5	2488.8	1998.9	2488.7	2000.0	2488.9	2042.3	2489.4	2046.4
GR	2488.7	2046.5	2489.3	2260.0	2489.2	2520.0	2489.0	2770.0	2489.2	3020.0
GR	2489.3	3340.0	2488.9	3470	2488.9	3546.5	2488.2	4046.5	2488.7	4346.5
GR	2487.9	4546.5	2489.5	4633.5	2489.5	4650	2489.5	5200	2488.7	5500
GR	2488.6	5800.5	2488.7	6100	2488.3	6400	2491.3	6750	2488.3	6760
GR	2489.1	6950	2489.2	7150	2490	7350	2491.6	7550	2491.8	7750
GR	2492.5	7850	2494.1	7950						

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1
0

CCHV= .100 CEHV= .300

*SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
1.000	3.70	2466.70	.00	2466.70	2467.04	.34	.00	.00	2474.00
2786.7	.0	2786.7	.0	.0	594.7	.0	.0	.0	2470.00
.00	.00	4.69	.00	.000	.027	.000	.000	2463.00	1799.50
.001769	0.	0.	0.	0	0	0	.00	199.20	1998.70

*SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
2.000	3.31	2466.81	.00	.00	2467.30	.49	.21	.05	2474.00
2786.7	.0	2786.7	.0	.0	494.0	.0	1.2	.4	2470.50
.00	.00	5.64	.00	.000	.027	.000	.000	2463.50	1831.24
.002603	100.	100.	100.	2	0	0	.00	167.07	1998.31

*SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
3.000	2.99	2467.29	.00	.00	2468.06	.77	.68	.08	2476.00
2786.7	.0	2786.7	.0	.0	395.3	.0	3.3	1.1	2471.20
.01	.00	7.05	.00	.000	.027	.000	.000	2464.30	1852.38
.004552	200.	200.	200.	2	0	0	.00	145.60	1997.98

*SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
4.000	3.47	2468.17	.00	.00	2469.18	1.00	1.05	.07	2479.00
2786.7	.0	2786.7	.0	.0	346.4	.0	5.0	1.8	2472.00
.02	.00	8.04	.00	.000	.027	.000	.000	2464.70	1868.25
.006089	200.	200.	200.	3	0	0	.00	129.92	1998.17

*SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
5.000	4.51	2469.31	.00	.00	2470.07	.77	.87	.02	2479.50
2786.7	.0	2786.7	.0	.0	397.0	.0	6.7	2.3	2472.60
.03	.00	7.02	.00	.000	.027	.000	.000	2464.80	1884.69
.003274	200.	200.	200.	3	0	0	.00	114.02	1998.71

*SECNO 6.000

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRISW	WSELK	EG	HV	HL	QLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3470 ENCROACHMENT STATIONS=	.0	3040.0	TYPE=	1	TARGET=	3039.999			
6.000	4.89	2469.89	.00	.00	2470.91	1.02	.77	.08	2480.00
2786.7	.0	2786.7	.0	.0	343.5	.0	8.4	2.8	2473.50
.03	.00	8.11	.00	.000	.027	.000	.000	2465.00	1898.96
.004534	200.	200.	200.	3	0	0	.00	99.43	1998.39

*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	3000.0	TYPE=	1	TARGET=	2999.999			
7.000	3.92	2470.62	2470.62	.00	2472.29	1.66	1.17	.19	2481.00
2786.7	.0	2786.7	.0	.0	269.1	.0	9.8	3.2	2474.00
.04	.00	10.35	.00	.000	.027	.000	.000	2466.70	1916.57
.007778	200.	200.	200.	3	15	0	.00	82.00	1998.58

*SECNO 8.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2970.0	TYPE=	1	TARGET=	2969.999			
8.000	5.17	2472.17	.00	.00	2473.59	1.42	1.28	.02	2478.00
2786.7	.0	2786.7	.0	.0	291.6	.0	11.1	3.6	2474.80
.05	.00	9.56	.00	.000	.027	.000	.000	2467.00	1921.61
.005332	200.	200.	200.	3	0	0	.00	75.31	1996.92

*SECNO 9.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2930.0	TYPE=	1	TARGET=	2929.999			
9.000	5.59	2473.09	2473.09	.00	2475.29	2.21	1.02	.24	2480.00
2786.7	.0	2786.7	.0	.0	233.8	.0	12.1	3.8	2475.50
.05	.00	11.92	.00	.000	.027	.000	.000	2467.50	1941.75
.007384	164.	164.	164.	20	8	0	.00	53.76	1995.51

SECNO	DEPTH	CWSEL	CRISW	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

CCHV= .100 CEHV= .300
 *SECNO 10.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2920.0	TYPE=	1	TARGET=	2919.999			
10.000	7.35	2476.35	2476.35	.00	2476.79	.44	.49	.18	2482.80
2786.7	.0	1647.8	1138.9	.0	243.4	600.5	13.8	5.4	2475.90
.06	.00	6.77	1.90	.000	.029	.030	.000	2469.00	1958.17
.002148	136.	136.	136.	20	12	0	.00	961.83	2920.00

CCHV= .100 CEHV= .300
 *SECNO 11.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2860.0	TYPE=	1	TARGET=	2859.999			
11.000	7.53	2477.13	2477.13	.00	2477.67	.54	.48	.03	2480.00
2786.7	.2	1549.3	1237.3	.5	198.6	914.3	18.3	9.7	2476.60
.07	.41	7.80	1.35	.030	.029	.060	.000	2469.60	1874.80
.002642	200.	200.	200.	20	9	0	.00	895.58	2860.00

*SECNO 12.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2810.0	TYPE=	1	TARGET=	2809.999			
12.000	7.54	2477.84	2477.84	.00	2478.46	.61	.58	.02	2483.10
2786.7	5.1	1647.0	1134.6	5.9	203.6	764.9	23.1	13.5	2478.40
.08	.86	8.09	1.48	.030	.029	.060	.000	2470.30	1882.82
.003187	200.	200.	200.	20	5	0	.00	777.78	2810.00

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	GLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 13.000

3265 DIVIDED FLOW

3280 CROSS SECTION 13.00 EXTENDED .35 FEET

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2765.0	TYPE=	1	TARGET=	2764.999			
13.000	7.85	2478.85	2478.85	.00	2479.28	.43	.54	.02	2484.00
2798.7	374.6	1538.9	885.3	240.4	219.8	746.9	28.1	18.3	2478.50
.09	1.56	7.00	1.19	.030	.029	.060	.000	2471.00	1428.52
.002295	200.	200.	200.	20	9	0	.00	1295.70	2765.00

CCHV= .100 CEHV= .300
 *SECNO 14.000

3265 DIVIDED FLOW

3280 CROSS SECTION 14.00 EXTENDED .74 FEET

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2740.0	TYPE=	1	TARGET=	2739.999			
14.000	7.44	2479.34	2479.34	.00	2479.77	.43	.16	.00	2480.00
2863.0	403.1	1631.8	828.1	372.5	237.1	912.2	31.6	22.1	2479.20
.10	1.08	6.88	.91	.030	.020	.060	.000	2471.90	1063.48
.000965	112.	112.	112.	20	9	0	.00	1655.57	2740.00

CCHV= .100 CEHV= .300
 *SECNO 15.000

3280 CROSS SECTION 15.00 EXTENDED .23 FEET

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. KRATIO = 1.64

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3470 ENCROACHMENT STATIONS= .0 2765.0 TYPE= 1 TARGET= 2764.999

15.000	7.53	2479.73	.00	.00	2479.85	.12	.06	.03	2478.80
2910.1	1534.3	952.3	423.5	624.2	251.9	807.6	35.2	25.4	2479.70
.11	2.46	3.78	.52	.030	.023	.060	.000	2472.20	1525.00
.000369	100.	100.	100.	2	0	0	.00	1240.00	2765.00

*SECNO 16.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= .0 2680.0 TYPE= 1 TARGET= 2679.999

16.000	7.19	2480.29	2480.29	.00	2480.80	.51	.17	.12	2482.00
2910.1	648.1	1728.1	534.0	344.7	236.4	562.5	43.4	32.9	2480.50
.12	1.88	7.31	.95	.030	.023	.060	.000	2473.10	1248.73
.001503	250.	250.	250.	20	9	0	.00	1379.59	2680.00

*SECNO 17.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= .0 2620.0 TYPE= 1 TARGET= 2619.999

17.000	7.44	2481.46	2481.46	.00	2481.94	.48	.36	.00	2482.00
2910.1	804.7	1766.3	339.1	498.5	250.4	438.7	50.1	40.5	2481.10
.14	1.61	7.05	.77	.030	.023	.060	.000	2474.02	1339.65
.001400	250.	250.	250.	20	9	0	.00	1245.09	2620.00

*SECNO 18.000

3265 DIVIDED FLOW

7185 MINIMUM SPECIFIC ENERGY

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	GLOSS	L-BANK	ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK	ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA	
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST	

3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2550.0	TYPE=	1	TARGET=	2549.999			
18.000	7.36	2482.28	2482.28	.00	2482.75	.46	.35	.00	2483.00
2910.1	907.9	1743.4	258.9	431.5	252.8	353.8	56.4	47.9	2481.70
.15	2.10	6.90	.73	.030	.023	.060	.000	2474.92	1198.13
.001422	250.	250.	250.	3	6	0	.00	1345.70	2550.00

*SECNO 19.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL.CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2480.0	TYPE=	1	TARGET=	2479.999			
19.000	6.92	2482.72	2482.72	.00	2483.23	.50	.37	.01	2487.00
2910.1	934.1	1707.9	268.1	459.4	234.5	332.8	62.4	55.1	2482.30
.17	2.03	7.28	.81	.030	.023	.060	.000	2475.80	1304.99
.001520	250.	250.	250.	20	9	0	.00	1168.00	2480.00

*SECNO 20.000

3265 DIVIDED FLOW

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE. KRATIO = 1.57

3470 ENCROACHMENT STATIONS=	.0	2420.0	TYPE=	1	TARGET=	2419.999			
20.000	6.69	2483.36	.00	.00	2483.50	.14	.23	.04	2487.00
2910.1	1691.2	1028.6	190.4	1035.4	226.4	333.3	69.9	62.6	2483.00
.19	1.63	4.54	.57	.030	.023	.060	.000	2476.67	957.99
.000616	250.	250.	250.	2	0	0	.00	1439.95	2420.00

*SECNO 21.000

3265 DIVIDED FLOW

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRISW	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2375.0	TYPE=	1	TARGET=	2374.999			
21.000	7.21	2484.58	2484.58	.00	2485.05	.47	.15	.10	2487.00
2910.1	747.2	1917.0	245.9	617.0	283.7	323.5	76.3	69.0	2484.00
.20	1.21	6.76	.76	.030	.020	.060	.000	2477.37	946.98
.000948	197.	197.	197.	20	9	0	.00	1406.29	2375.00

*SECNO 22.000

3265 DIVIDED FLOW

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.39

3470 ENCROACHMENT STATIONS=	.0	2365.0	TYPE=	1	TARGET=	2364.999			
22.000	6.20	2485.07	.00	.00	2485.11	.04	.01	.04	2487.00
2927.5	2036.2	713.8	177.5	1990.5	261.3	442.5	78.2	70.5	2484.20
.21	1.02	2.73	.40	.030	.020	.060	.000	2478.87	747.59
.000168	44.	44.	44.	2	0	0	.00	1601.14	2365.00

*SECNO 23.000

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=	.0	2310.0	TYPE=	1	TARGET=	2309.999			
23.000	5.76	2485.36	2485.36	.00	2485.92	.56	.09	.16	2487.00
3129.9	1007.9	1833.4	288.7	454.4	239.3	275.1	88.0	77.0	2485.20
.22	2.22	7.66	1.05	.030	.020	.060	.000	2479.60	1443.49
.001612	231.	231.	231.	20	10	0	.00	842.91	2310.00

30NOV94 11:37:31

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	QLOSS	L-BANK	ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK	ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA	
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST	

*SECNO 24.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=			.0	2250.0	TYPE=	1	TARGET=	2249.999		
24.000	5.65	2486.05	2486.05	.00	2486.52	.48	.35	.01	2488.00	
3129.9	1364.6	1679.4	86.0	657.9	229.3	125.9	93.2	81.6	2485.40	
.24	2.07	7.33	.68	.030	.020	.060	.000	2480.40	1361.64	
.001453	231.	231.	231.	20	6	0	.00	870.17	2250.00	

*SECNO 25.000

3265 DIVIDED FLOW

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=			.0	2170.0	TYPE=	1	TARGET=	2169.999		
25.000	5.67	2486.97	2486.97	.00	2487.56	.59	.45	.03	2488.30	
3129.9	1366.4	1763.5	.0	627.6	220.4	.0	99.6	87.6	2488.30	
.25	2.18	8.00	.00	.030	.020	.000	.000	2481.30	1150.92	
.001560	300.	300.	300.	20	5	0	.00	881.11	2044.86	

*SECNO 26.000

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=			.0	2100.0	TYPE=	1	TARGET=	2099.999		
26.000	5.42	2487.52	.00	.00	2487.91	.40	.33	.02	2488.50	
3129.9	1631.4	1498.6	.0	912.5	212.0	.0	104.9	93.0	2488.50	
.27	1.79	7.07	.00	.030	.020	.000	.000	2482.10	911.98	
.001280	235.	235.	235.	3	0	0	.00	1118.62	2045.08	

30NOV94 11:37:31

PAGE 16

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 27.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

27.000	6.45	2489.25	2489.25	.00	2489.87	.62	.30	.07	2488.80
3129.9	1111.0	2019.0	.0	695.7	258.8	.0	110.5	98.7	2493.40
.28	1.60	7.80	.00	.030	.020	.000	.000	2482.80	1021.68
.001267	234.	234.	234.	20	12	0	.00	1023.87	2045.55

CCHV= .100 CEHV= .300

*SECNO 28.000

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.15

28.000	4.35	2489.95	.00	.00	2489.96	.01	.03	.06	2488.70
3129.9	343.6	1052.1	1734.3	331.3	1084.8	3660.8	114.1	102.4	2489.30
.30	1.04	.97	.47	.030	.022	.060	.000	2485.60	575.13
.000273	52.	52.	52.	3	0	0	.00	5106.97	6592.40

CCHV= .100 CEHV= .300

*SECNO 28.100

3265 DIVIDED FLOW

28.100	4.32	2489.92	.00	.00	2489.97	.05	.00	.01	2488.70
7638.0	798.0	2394.2	4445.8	318.5	1051.1	4036.4	114.4	102.7	2489.30
.30	2.51	2.28	1.10	.030	.022	.060	.000	2485.60	579.32
.001573	2.	2.	2.	2	0	0	.00	5665.98	7331.02

TN Normal depth split flow - Sections 11 to 12

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.0	.00	.00	.00	200.0	.0	.00	.00	.00	.00	.00	.00	10	2477.130	2477.844	11.000	12.000

TN Normal depth split flow - Sections 12 to 13

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
24.4	.49	.35	.18	200.0	138.5	12.00	11.99	.10	12.00	11.99	.10	10	2477.844	2478.852	12.000	13.000

TN Normal depth split flow - Section 13 to 14

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
61.2	1.05	.74	.55	112.0	112.0	64.27	64.11	.25	76.27	76.10	.22	10	2478.852	2479.341	13.000	14.000

TN Normal depth split flow - Sections 14 to 15

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
48.6	.97	.74	.49	100.0	100.0	47.12	47.03	.19	123.39	123.13	.21	10	2479.341	2479.730	14.000	15.000

TN Normal depth split flow - Sections 21 to 22

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
20.9	.83	.67	.48	44.0	44.0	17.34	17.29	.32	140.73	140.42	.22	10	2484.580	2485.071	21.000	22.000

TN Normal depth split flow - Sections 22 to 23

TOTAL AREA	AVG VELOCITY	MAX DEPTH	AVG DEPTH	TOF WIDTH	TOP WIDTH	ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
177.3	1.14	.86	.77	231.0	231.0	202.49	201.53	.48	343.23	341.95	.37	10	2485.071	2485.363	22.000	23.000

TC Rating curve outflow data set for Splitflow into South Diversion Channel

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
3308.07	3308.22	.00	3651.30	3650.17	.03	10	2489.949	2489.924	28.000	28.100

TW Splitflow #28 to #28.1 (Splitflow goes directly into the Santa Cruz River)

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
1199.98	1197.65	.19	4851.28	4847.82	.07	10	2489.949	2489.924	28.000	28.100

THIS RUN EXECUTED 30NOV94 11:41:02

 HEC-2 WATER SURFACE PROFILES
 Version 4.6.2; May 1991

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

West Branch Santa Cruz

SUMMARY PRINTOUT

SECNO	Q	QLOB	QCH	QROB	CWSEL	CRISW	EG	DEPTH	SSTA	TOPWID	ENDST	DIFEG
1.000	2786.72	.00	2786.72	.00	2466.70	.00	2467.04	3.70	1799.50	199.20	1998.70	.00
2.000	2786.72	.00	2786.72	.00	2466.81	.00	2467.30	3.31	1831.24	167.07	1998.31	.00
3.000	2786.72	.00	2786.72	.00	2467.29	.00	2468.06	2.99	1852.38	145.60	1997.98	.00
4.000	2786.72	.00	2786.72	.00	2468.17	.00	2469.18	3.47	1868.25	129.92	1998.17	.00
5.000	2786.72	.00	2786.72	.00	2469.31	.00	2470.07	4.51	1884.69	114.02	1998.71	.00
6.000	2786.72	.00	2786.72	.00	2469.89	.00	2470.91	4.89	1898.96	99.43	1998.39	.00
* 7.000	2786.72	.00	2786.72	.00	2470.62	2470.62	2472.29	3.92	1916.57	82.00	1998.58	.00
8.000	2786.72	.00	2786.72	.00	2472.17	.00	2473.59	5.17	1921.61	75.31	1996.92	.00
* 9.000	2786.72	.00	2786.72	.00	2473.09	2473.09	2475.29	5.59	1941.75	53.76	1995.51	.00
* 10.000	2786.72	.00	1647.79	1138.94	2476.35	2476.35	2476.79	7.35	1958.17	961.83	2920.00	.00
* 11.000	2786.72	.20	1549.26	1237.26	2477.13	2477.13	2477.67	7.53	1874.80	895.58	2860.00	.00
* 12.000	2786.72	5.10	1646.98	1134.64	2477.84	2477.84	2478.46	7.54	1882.82	777.78	2810.00	.00
* 13.000	2798.72	374.61	1538.86	885.25	2478.85	2478.85	2479.28	7.85	1428.52	1295.70	2765.00	.00
* 14.000	2862.99	403.09	1631.77	828.13	2479.34	2479.34	2479.77	7.44	1063.48	1655.57	2740.00	.00
* 15.000	2910.11	1534.34	952.28	423.49	2479.73	.00	2479.85	7.53	1525.00	1240.00	2765.00	.00
* 16.000	2910.11	648.07	1728.09	533.95	2480.29	2480.29	2480.80	7.19	1248.73	1379.59	2680.00	.00
* 17.000	2910.11	804.66	1766.34	339.11	2481.46	2481.46	2481.94	7.44	1339.65	1245.09	2620.00	.00

	SECNO	Q	QLOB	QCH	QROB	CWSEL	CRWS	EG	DEPTH	SSTA	TOPWID	ENDST	DIFEG
*	18.000	2910.11	907.86	1743.38	258.88	2482.28	2482.28	2482.75	7.36	1198.13	1345.70	2550.00	.00
*	19.000	2910.11	934.13	1707.91	268.07	2482.72	2482.72	2483.23	6.92	1304.99	1168.00	2480.00	.00
*	20.000	2910.11	1691.17	1028.56	190.38	2483.36	.00	2483.50	6.69	957.99	1439.95	2420.00	.00
*	21.000	2910.11	747.23	1916.99	245.89	2484.58	2484.58	2485.05	7.21	946.98	1406.29	2375.00	.00
*	22.000	2927.46	2036.17	713.84	177.45	2485.07	.00	2485.11	6.20	747.59	1601.14	2365.00	.00
*	23.000	3129.95	1007.85	1833.37	288.72	2485.36	2485.36	2485.92	5.76	1443.49	842.91	2310.00	.00
*	24.000	3129.95	1364.55	1679.39	86.00	2486.05	2486.05	2486.52	5.65	1361.64	870.17	2250.00	.00
*	25.000	3129.95	1366.44	1763.51	.00	2486.97	2486.97	2487.56	5.67	1150.92	881.11	2044.86	.00
	26.000	3129.95	1631.36	1498.59	.00	2487.52	.00	2487.91	5.42	911.98	1118.62	2045.08	.00
*	27.000	3129.95	1110.97	2018.97	.00	2489.25	2489.25	2489.87	6.45	1021.68	1023.87	2045.55	.00
*	28.000	3129.95	343.55	1052.07	1734.33	2489.95	.00	2489.96	4.35	575.13	5106.97	6592.40	.00
	28.100	7638.00	797.98	2394.20	4445.82	2489.92	.00	2489.97	4.32	579.32	5665.98	7331.02	.00

West Branch Santa Cruz

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRISWS	EG	10*KS	VCH	AREA	.01K
1.000	.00	.00	.00	2463.00	2786.72	2466.70	.00	2467.04	17.69	4.69	594.71	662.55
2.000	100.00	.00	.00	2463.50	2786.72	2466.81	.00	2467.30	26.03	5.64	493.97	546.18
3.000	200.00	.00	.00	2464.30	2786.72	2467.29	.00	2468.06	45.52	7.05	395.31	413.05
4.000	200.00	.00	.00	2464.70	2786.72	2468.17	.00	2469.18	60.89	8.04	346.42	357.13
5.000	200.00	.00	.00	2464.80	2786.72	2469.31	.00	2470.07	32.74	7.02	396.99	487.04
6.000	200.00	.00	.00	2465.00	2786.72	2469.89	.00	2470.91	45.34	8.11	343.47	413.87
* 7.000	200.00	.00	.00	2466.70	2786.72	2470.62	2470.62	2472.29	77.78	10.35	269.14	315.99
8.000	200.00	.00	.00	2467.00	2786.72	2472.17	.00	2473.59	53.32	9.56	291.63	381.65
* 9.000	164.00	.00	.00	2467.50	2786.72	2473.09	2473.09	2475.29	73.84	11.92	233.84	324.31
* 10.000	136.00	.00	.00	2469.00	2786.72	2476.35	2476.35	2476.79	21.48	6.77	843.87	601.30
* 11.000	200.00	.00	.00	2469.60	2786.72	2477.13	2477.13	2477.67	26.42	7.80	1113.41	542.18
* 12.000	200.00	.00	.00	2470.30	2786.72	2477.84	2477.84	2478.46	31.87	8.09	974.42	493.60
* 13.000	200.00	.00	.00	2471.00	2798.72	2478.85	2478.85	2479.28	22.95	7.00	1207.04	584.25
* 14.000	112.00	.00	.00	2471.90	2862.99	2479.34	2479.34	2479.77	9.65	6.88	1521.86	921.51
* 15.000	100.00	.00	.00	2472.20	2910.11	2479.73	.00	2479.85	3.69	3.78	1683.71	1514.73
* 16.000	250.00	.00	.00	2473.10	2910.11	2480.29	2480.29	2480.80	15.03	7.31	1143.65	750.67
* 17.000	250.00	.00	.00	2474.02	2910.11	2481.46	2481.46	2481.94	14.00	7.05	1187.54	777.70
* 18.000	250.00	.00	.00	2474.92	2910.11	2482.28	2482.28	2482.75	14.22	6.90	1038.16	771.77
* 19.000	250.00	.00	.00	2475.80	2910.11	2482.72	2482.72	2483.23	15.20	7.28	1026.78	746.48
* 20.000	250.00	.00	.00	2476.67	2910.11	2483.36	.00	2483.50	6.16	4.54	1595.12	1172.58
* 21.000	197.00	.00	.00	2477.37	2910.11	2484.58	2484.58	2485.05	9.48	6.76	1224.30	945.13
* 22.000	44.00	.00	.00	2478.87	2927.46	2485.07	.00	2485.11	1.68	2.73	2694.39	2258.57
* 23.000	231.00	.00	.00	2479.60	3129.95	2485.36	2485.36	2485.92	16.12	7.66	968.81	779.68
* 24.000	231.00	.00	.00	2480.40	3129.95	2486.05	2486.05	2486.52	14.53	7.33	1013.08	821.05

30NOV94 11:37:31

PAGE 22

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	25.000	300.00	.00	.00	2481.30	3129.95	2486.97	2486.97	2487.56	15.60	8.00	847.99	792.52
	26.000	235.00	.00	.00	2482.10	3129.95	2487.52	.00	2487.91	12.80	7.07	1124.46	874.98
*	27.000	234.00	.00	.00	2482.80	3129.95	2489.25	2489.25	2489.87	12.67	7.80	954.45	879.46
*	28.000	52.00	.00	.00	2485.60	3129.95	2489.95	.00	2489.96	2.73	.97	5076.90	1892.93
	28.100	2.00	.00	.00	2485.60	7638.00	2489.92	.00	2489.97	15.73	2.28	5406.00	1925.84

West Branch Santa Cruz

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
1.000	2786.72	2466.70	.00	.00	.00	199.20	.00
2.000	2786.72	2466.81	.00	.11	.00	167.07	100.00
3.000	2786.72	2467.29	.00	.48	.00	145.60	200.00
4.000	2786.72	2468.17	.00	.88	.00	129.92	200.00
5.000	2786.72	2469.31	.00	1.14	.00	114.02	200.00
6.000	2786.72	2469.89	.00	.59	.00	99.43	200.00
* 7.000	2786.72	2470.62	.00	.73	.00	82.00	200.00
8.000	2786.72	2472.17	.00	1.55	.00	75.31	200.00
* 9.000	2786.72	2473.09	.00	.91	.00	53.76	164.00
* 10.000	2786.72	2476.35	.00	3.26	.00	961.83	136.00
* 11.000	2786.72	2477.13	.00	.78	.00	895.58	200.00
* 12.000	2786.72	2477.84	.00	.71	.00	777.78	200.00
* 13.000	2798.72	2478.85	.00	1.01	.00	1295.70	200.00
* 14.000	2862.99	2479.34	.00	.49	.00	1655.57	112.00
* 15.000	2910.11	2479.73	.00	.39	.00	1240.00	100.00
* 16.000	2910.11	2480.29	.00	.56	.00	1379.59	250.00
* 17.000	2910.11	2481.46	.00	1.16	.00	1245.09	250.00
* 18.000	2910.11	2482.28	.00	.83	.00	1345.70	250.00
* 19.000	2910.11	2482.72	.00	.44	.00	1168.00	250.00
* 20.000	2910.11	2483.36	.00	.63	.00	1439.95	250.00
* 21.000	2910.11	2484.58	.00	1.22	.00	1406.29	197.00
* 22.000	2927.46	2485.07	.00	.49	.00	1601.14	44.00
* 23.000	3129.95	2485.36	.00	.29	.00	842.91	231.00
* 24.000	3129.95	2486.05	.00	.68	.00	870.17	231.00

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PAGE 24

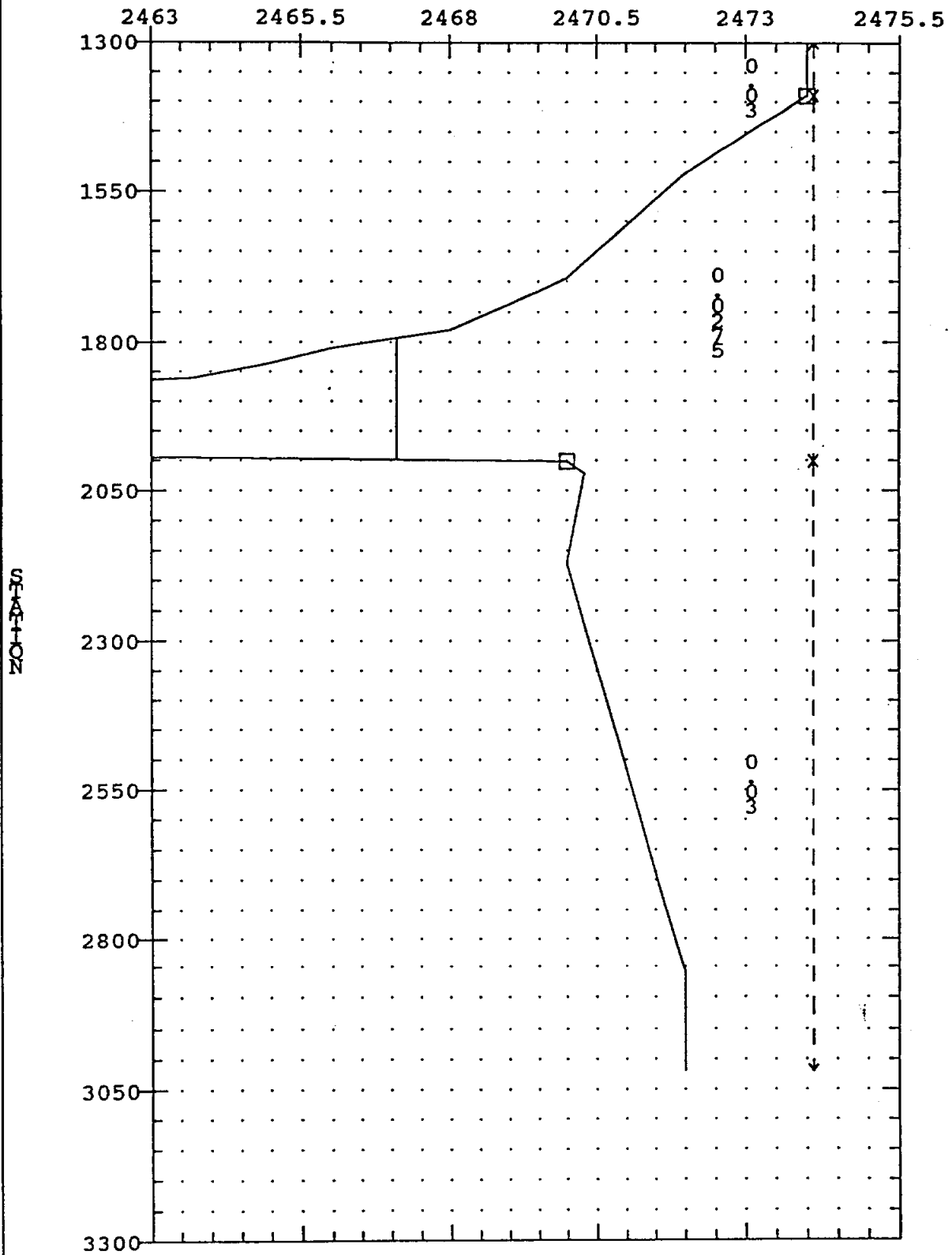
	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	25.000	3129.95	2486.97	.00	.93	.00	881.11	300.00
	26.000	3129.95	2487.52	.00	.55	.00	1118.62	235.00
*	27.000	3129.95	2489.25	.00	1.73	.00	1023.87	234.00
*	28.000	3129.95	2489.95	.00	.70	.00	5106.97	52.00
	28.100	7638.00	2489.92	.00	-.02	.00	5665.98	2.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO=	7.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	7.000	PROFILE=	1	MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	9.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	9.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	9.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	10.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	10.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	10.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	11.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	11.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	11.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	12.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	12.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	12.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	13.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	13.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	13.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	14.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	14.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	14.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	15.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	16.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	16.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	16.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	17.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	17.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	17.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	18.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	18.000	PROFILE=	1	MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	19.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	19.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	19.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	20.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	21.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	21.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	21.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	22.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

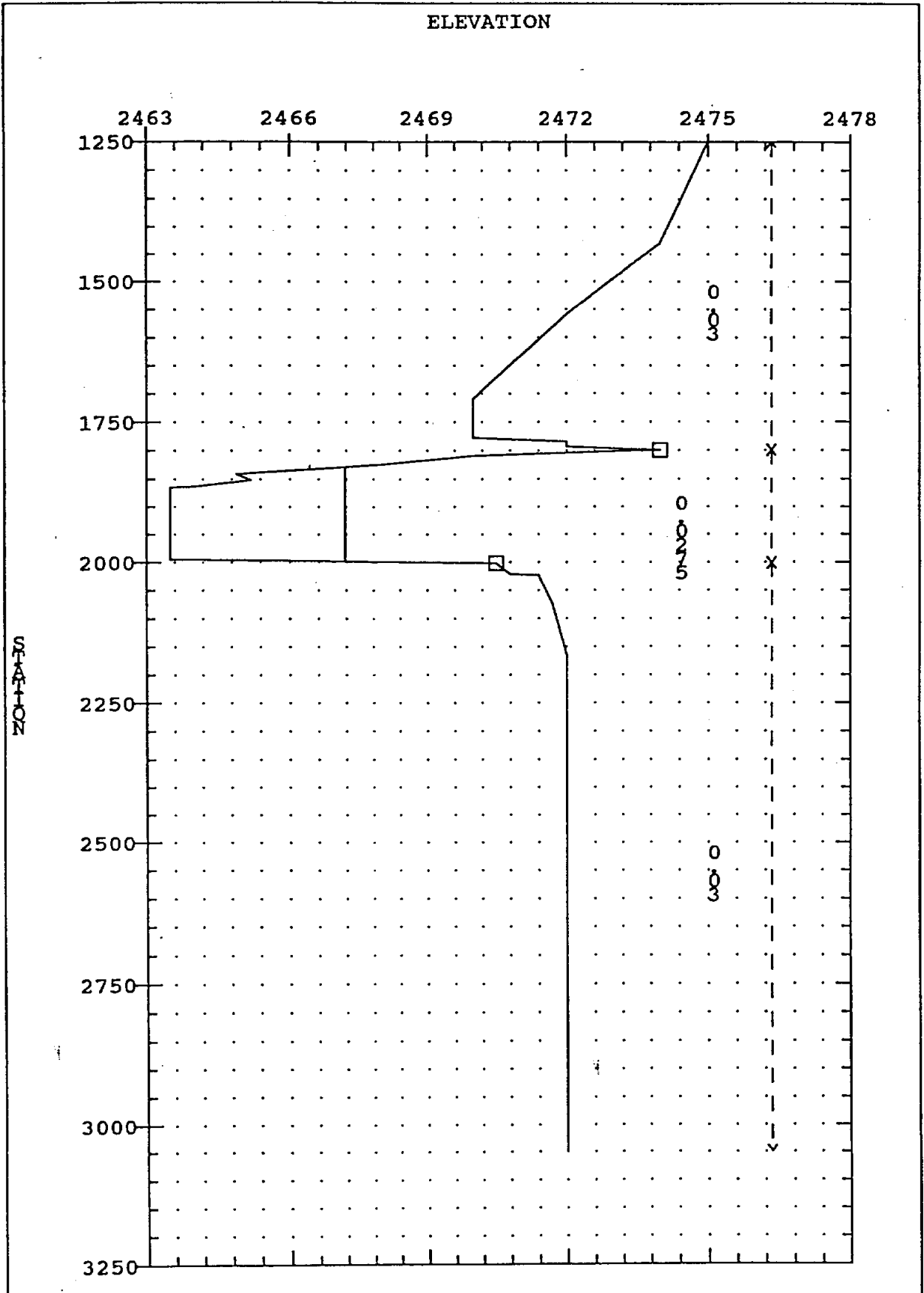
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CAUTION SECNO=	24.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	24.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	24.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	25.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	25.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	25.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	27.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	27.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	27.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	28.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

ELEVATION



SECTION : 1

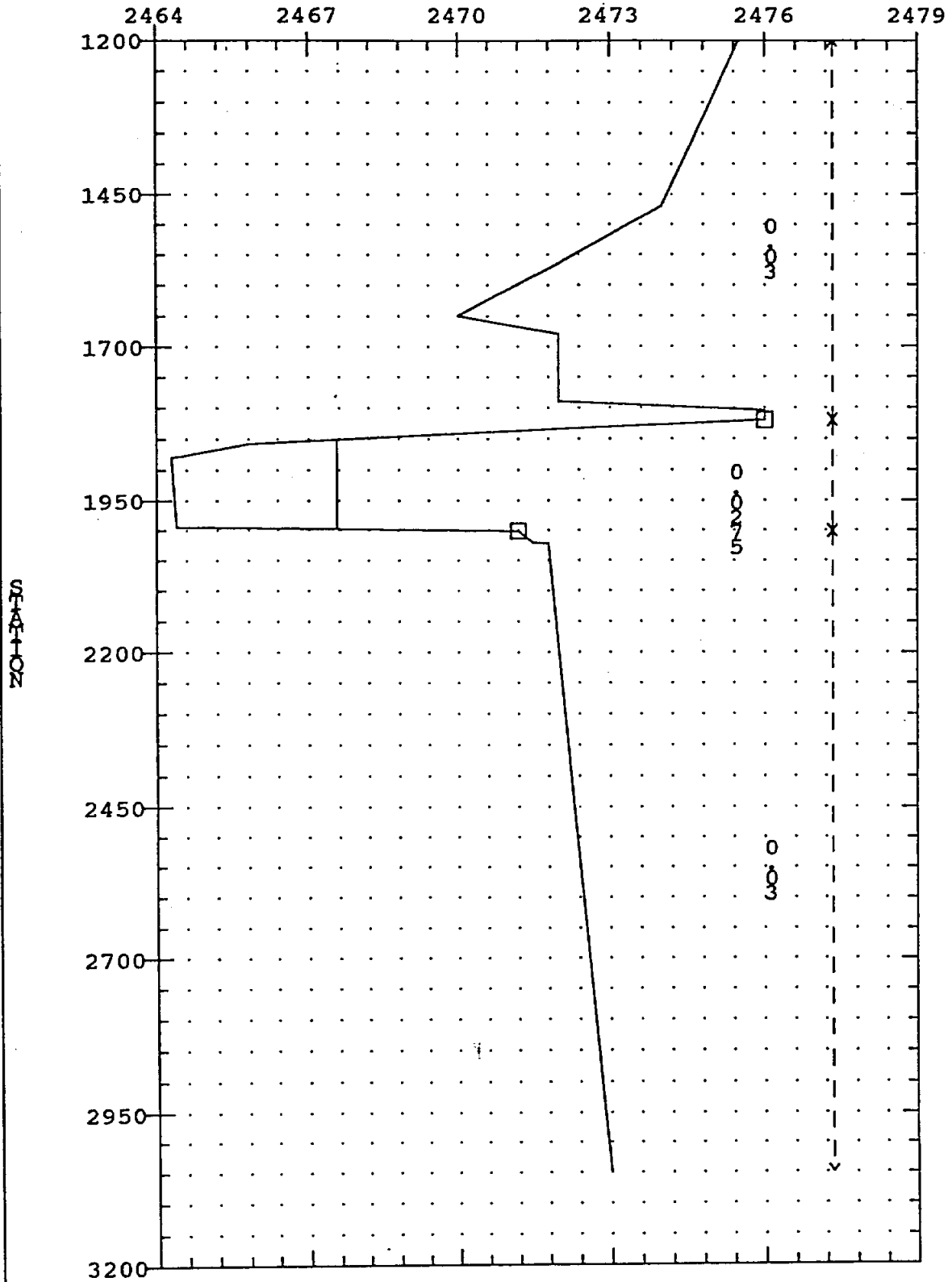
West Branch Santa Cruz River



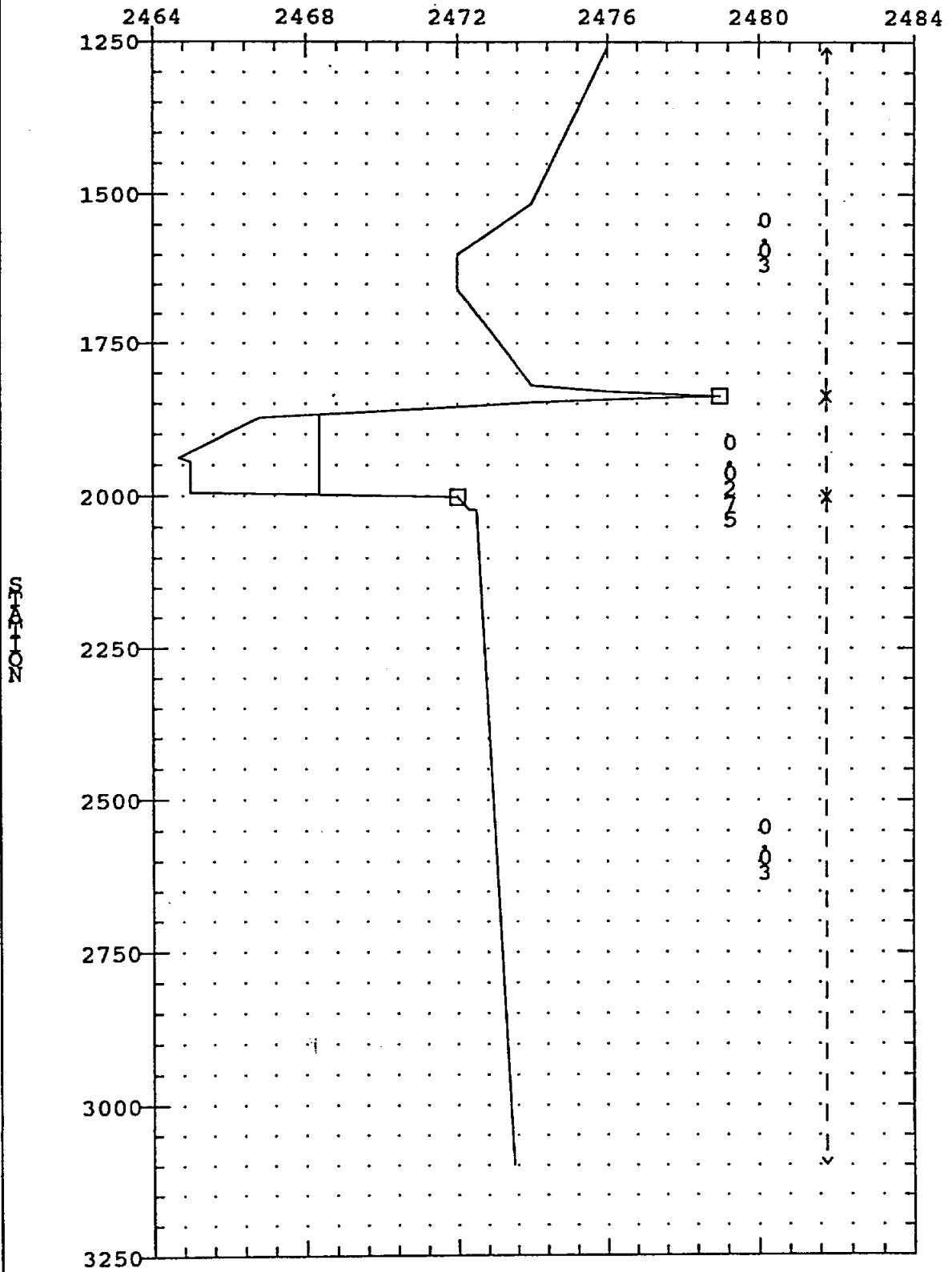
SECTION : 2

West Branch Santa Cruz River

ELEVATION



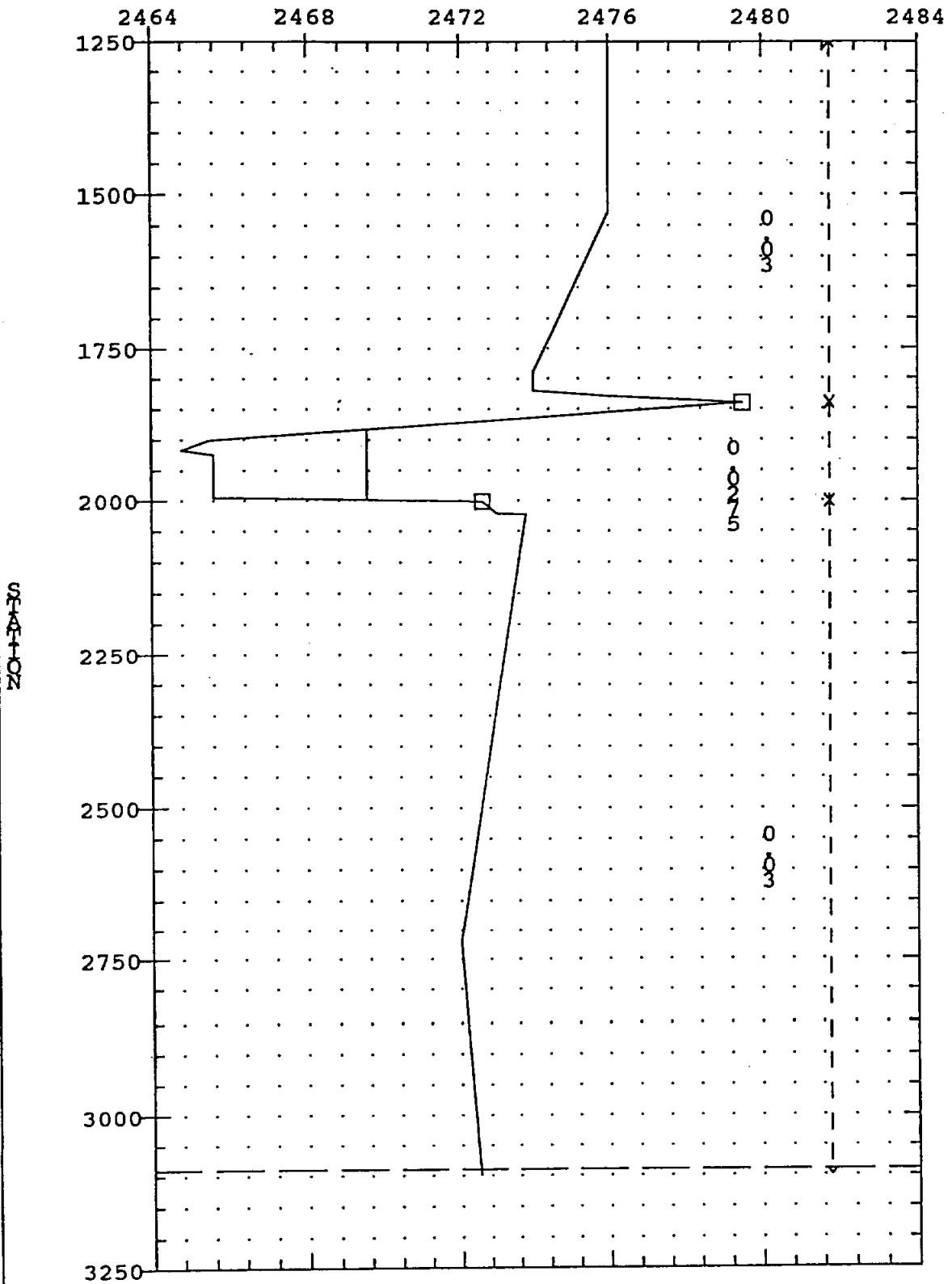
ELEVATION



SECTION : 4

West Branch Santa Cruz River

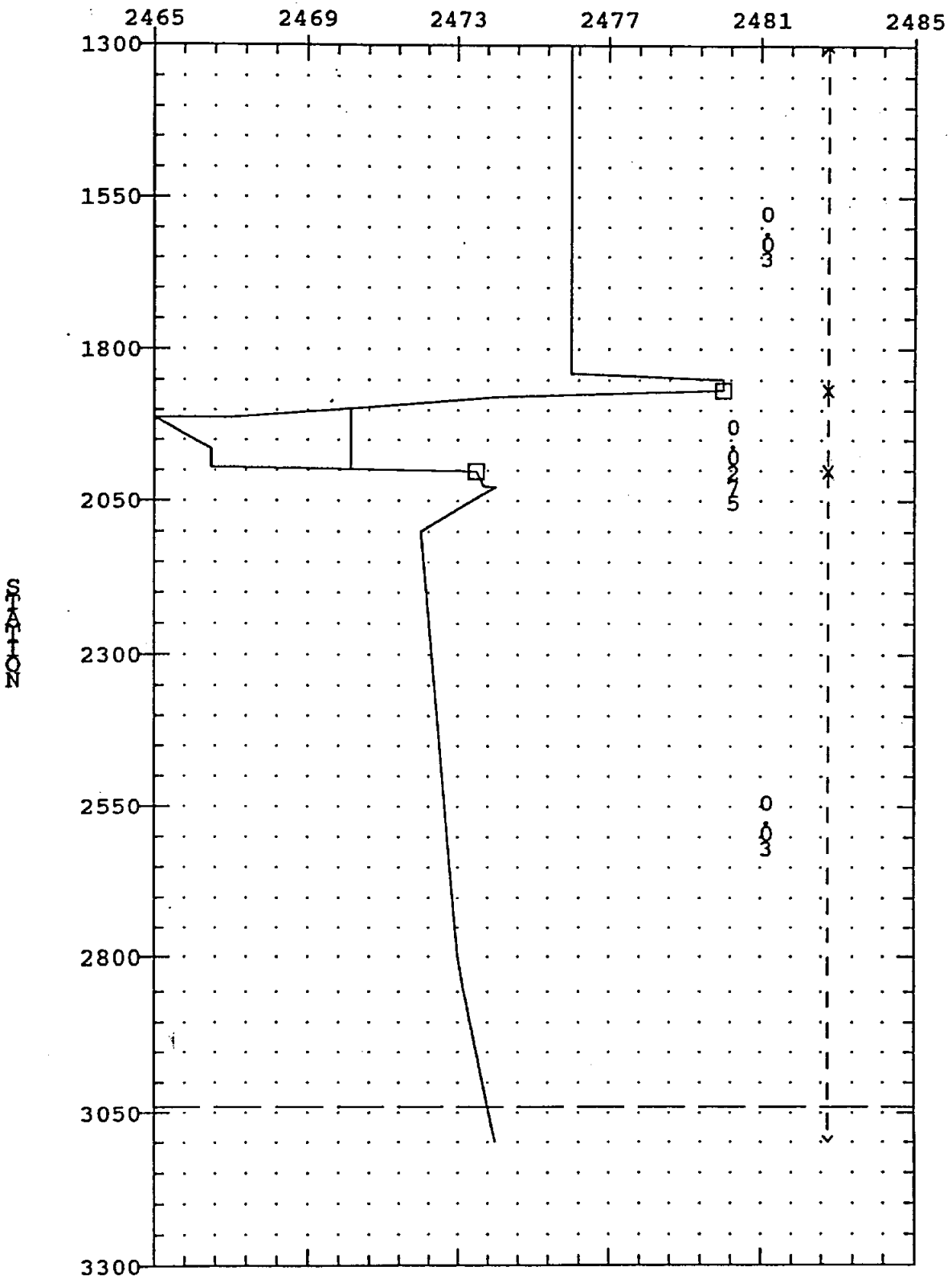
ELEVATION



SECTION : 5

West Branch Santa Cruz River

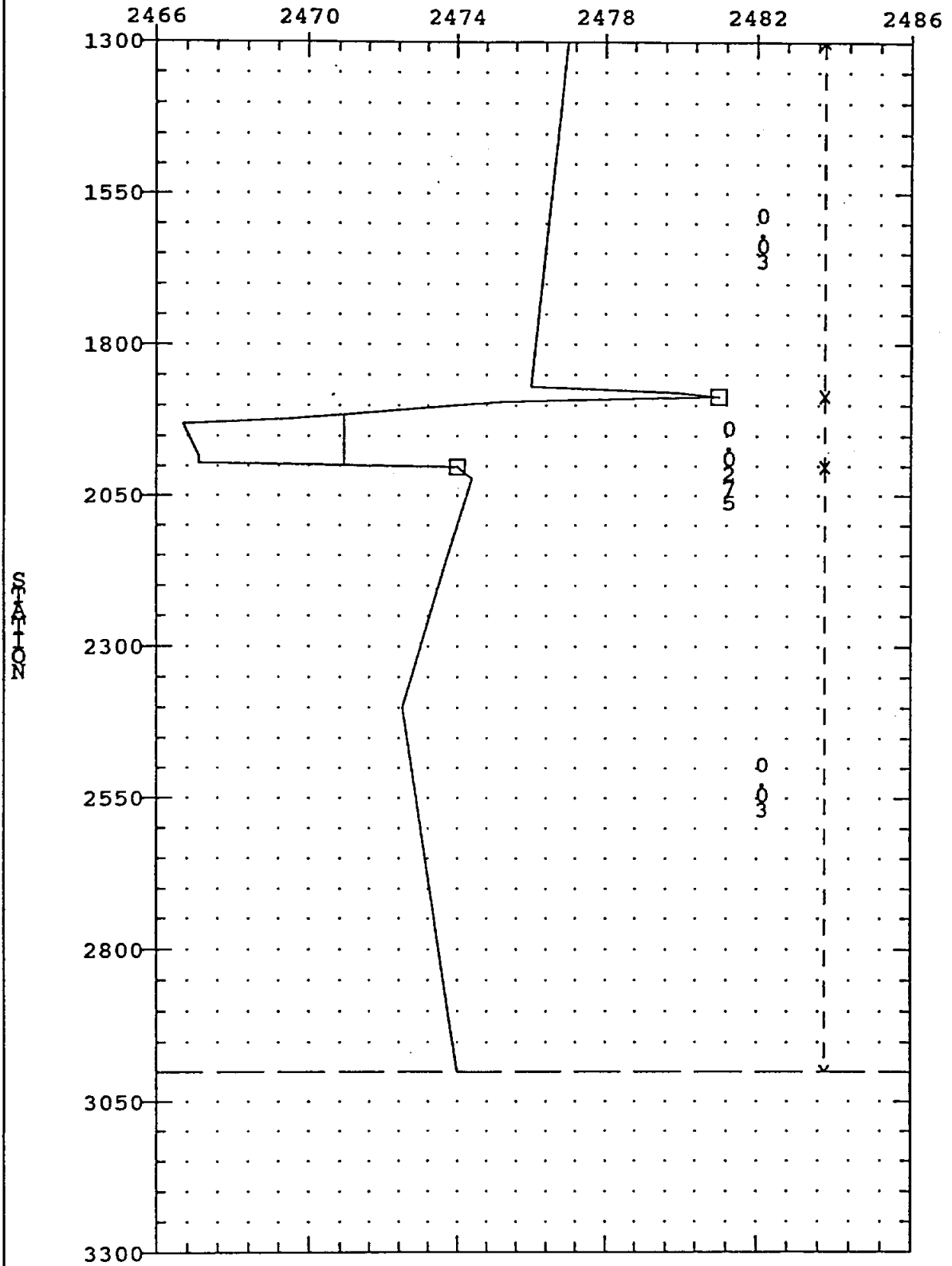
ELEVATION



SECTION : 6

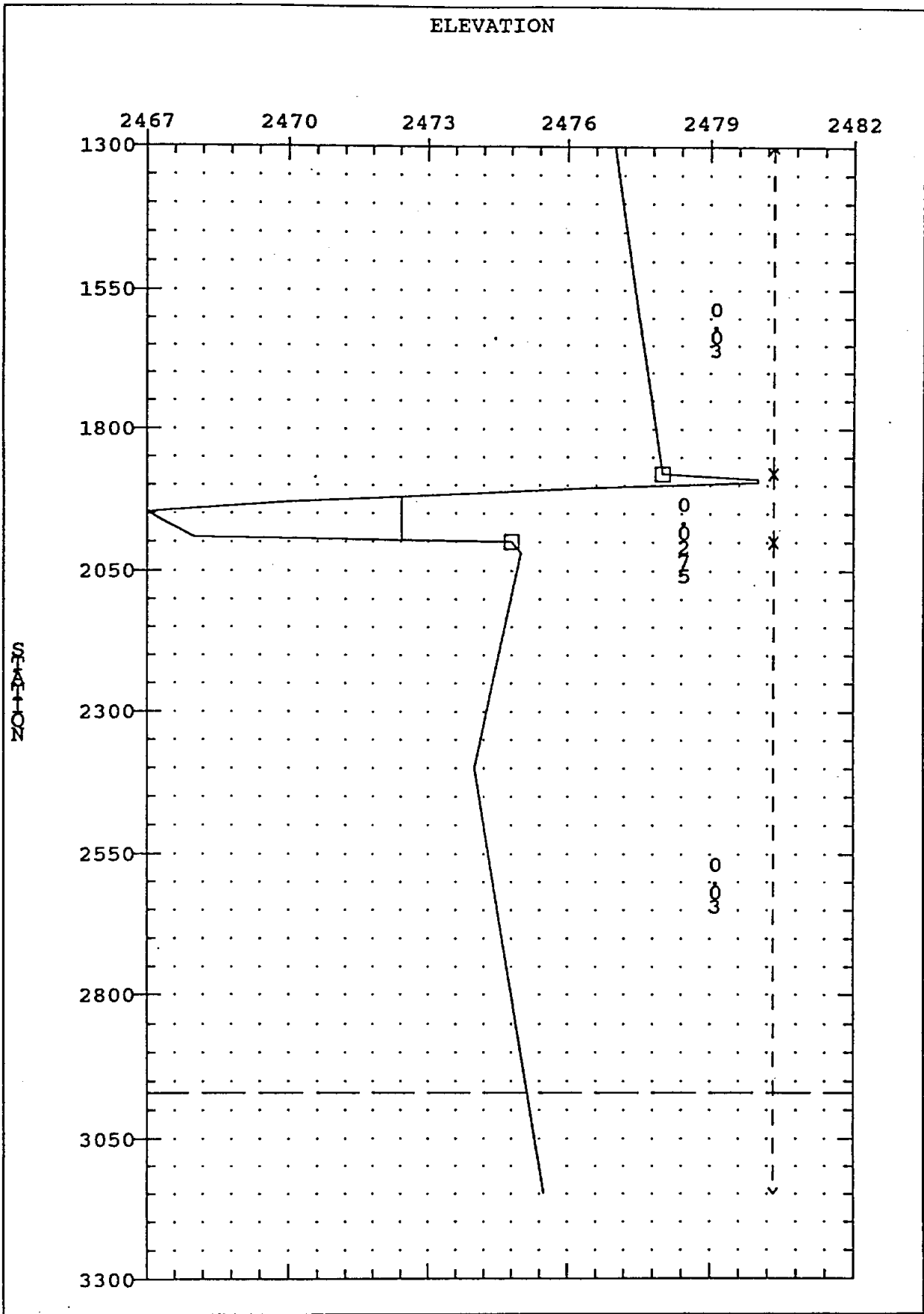
West Branch Santa Cruz River

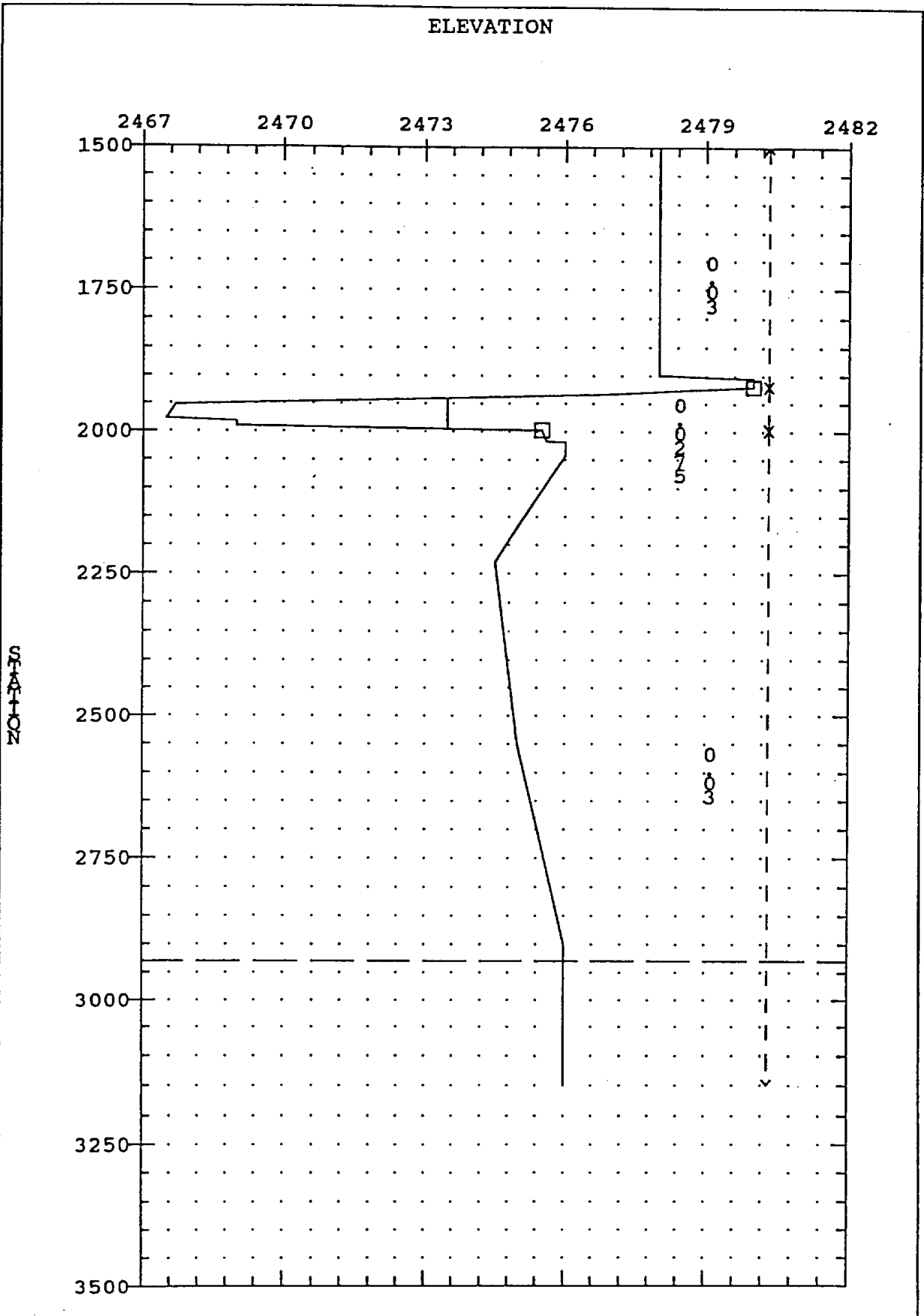
ELEVATION



SECTION : 7

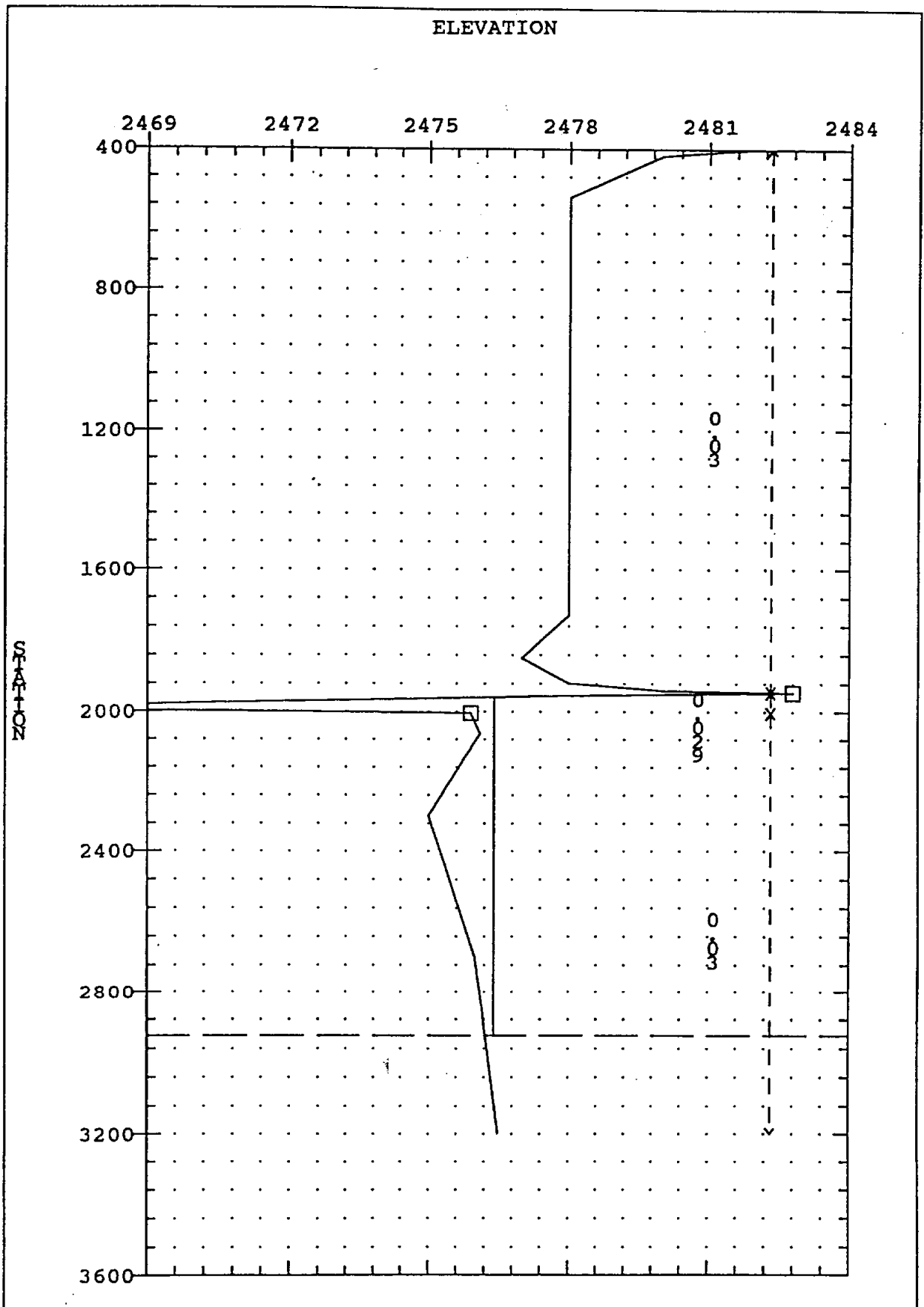
West Branch Santa Cruz River





SECTION : 9

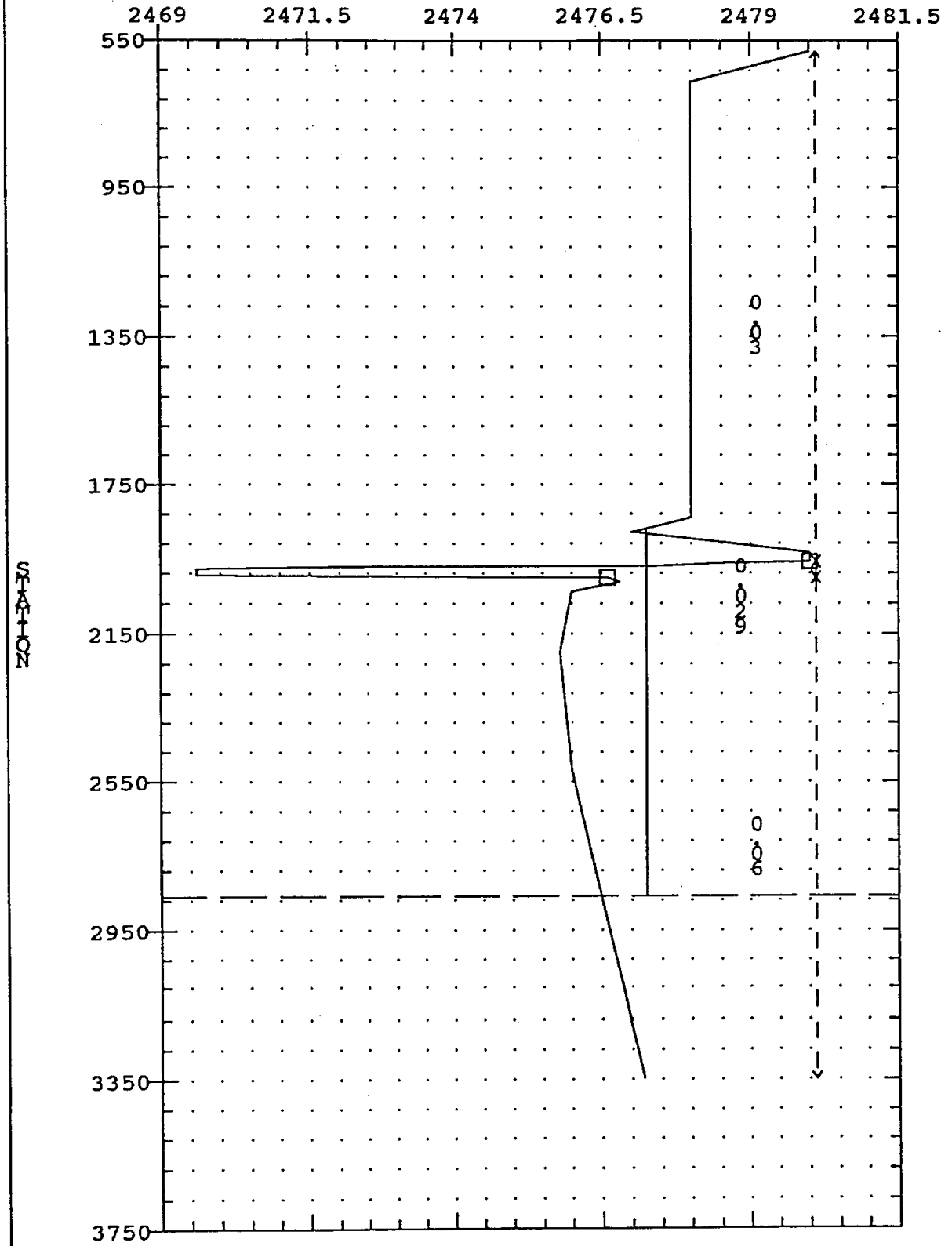
West Branch Santa Cruz River



SECTION : 10

West Branch Santa Cruz River

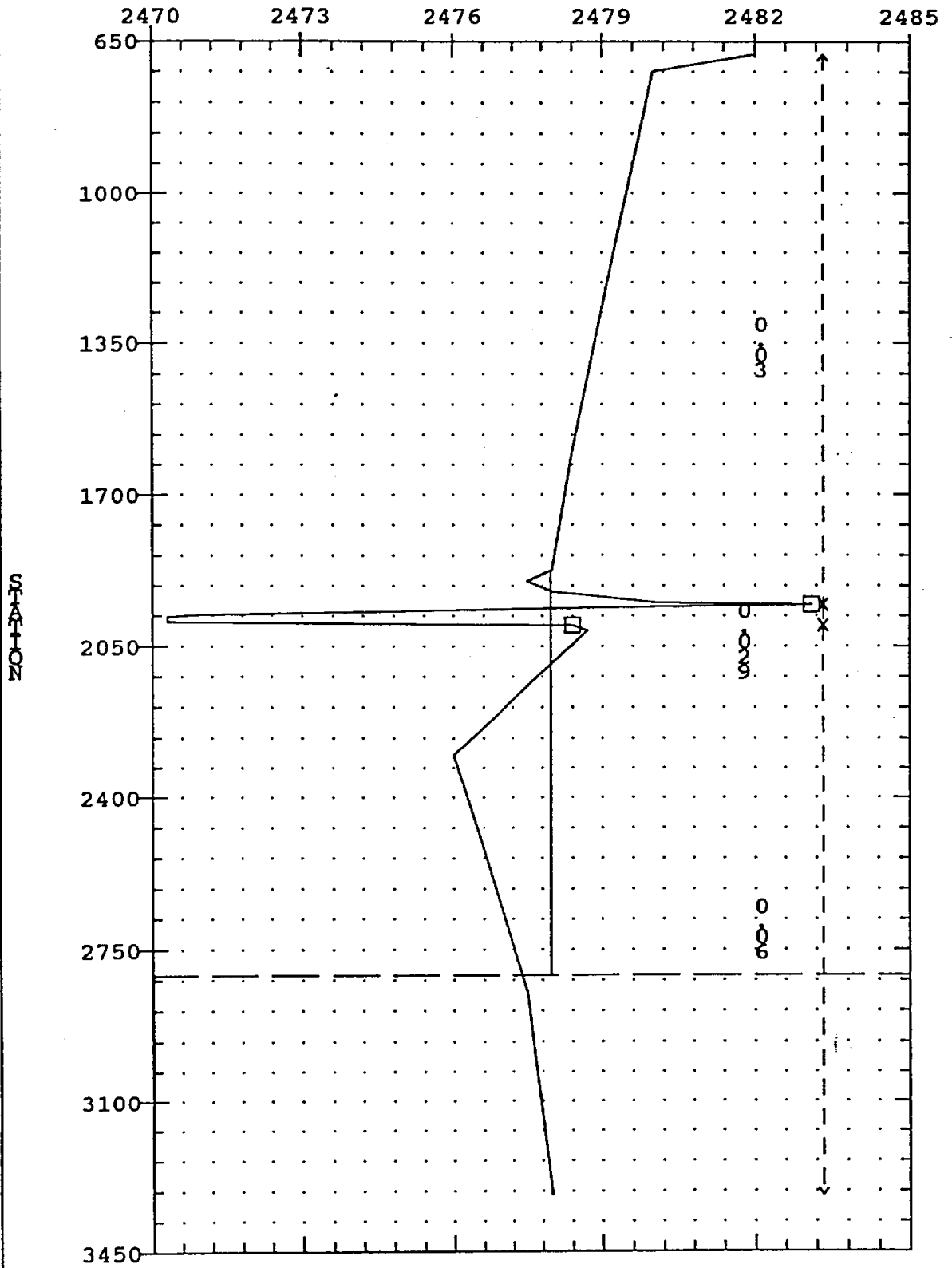
ELEVATION



SECTION : 11

West Branch Santa Cruz River

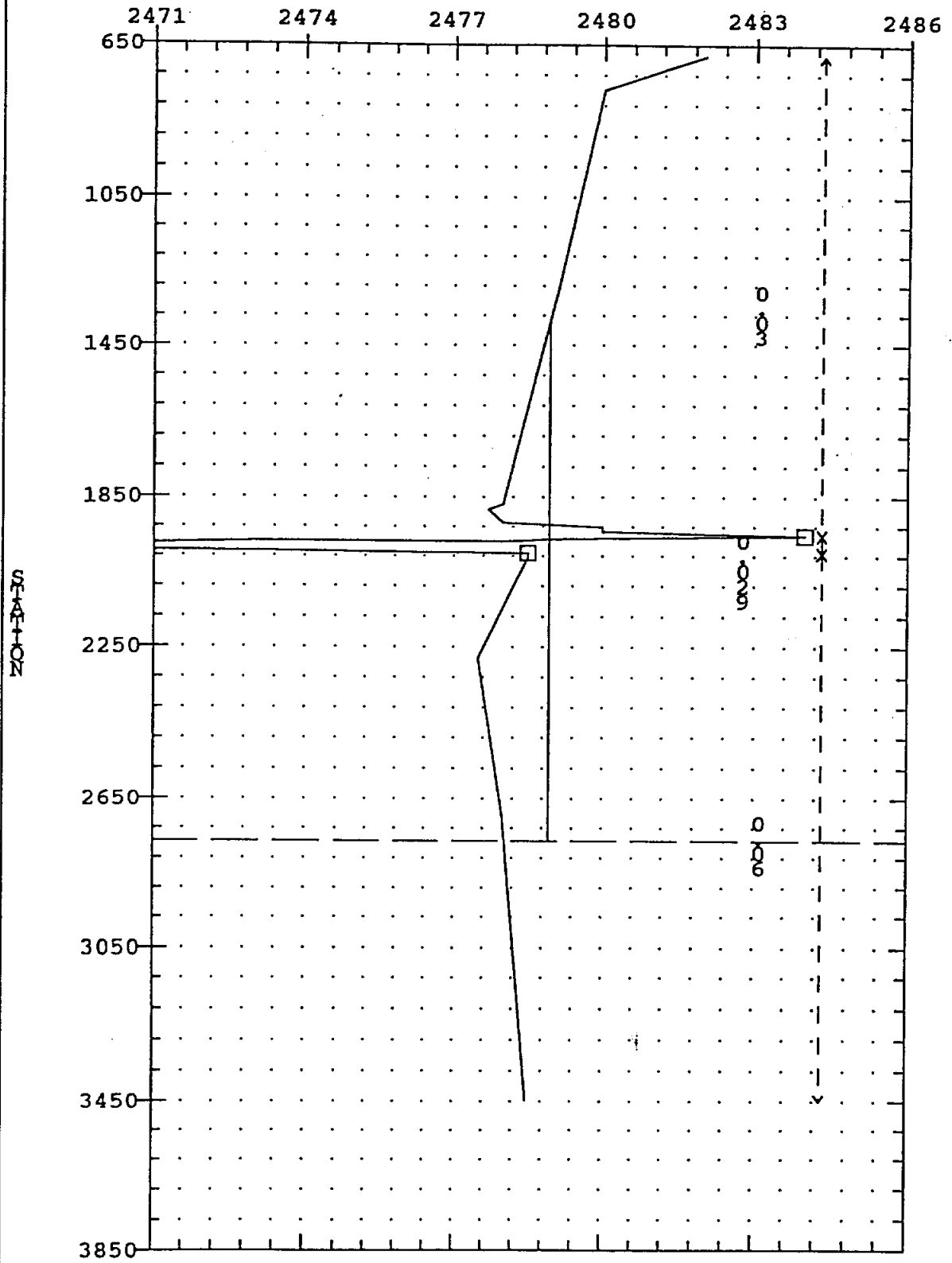
ELEVATION



SECTION : 12

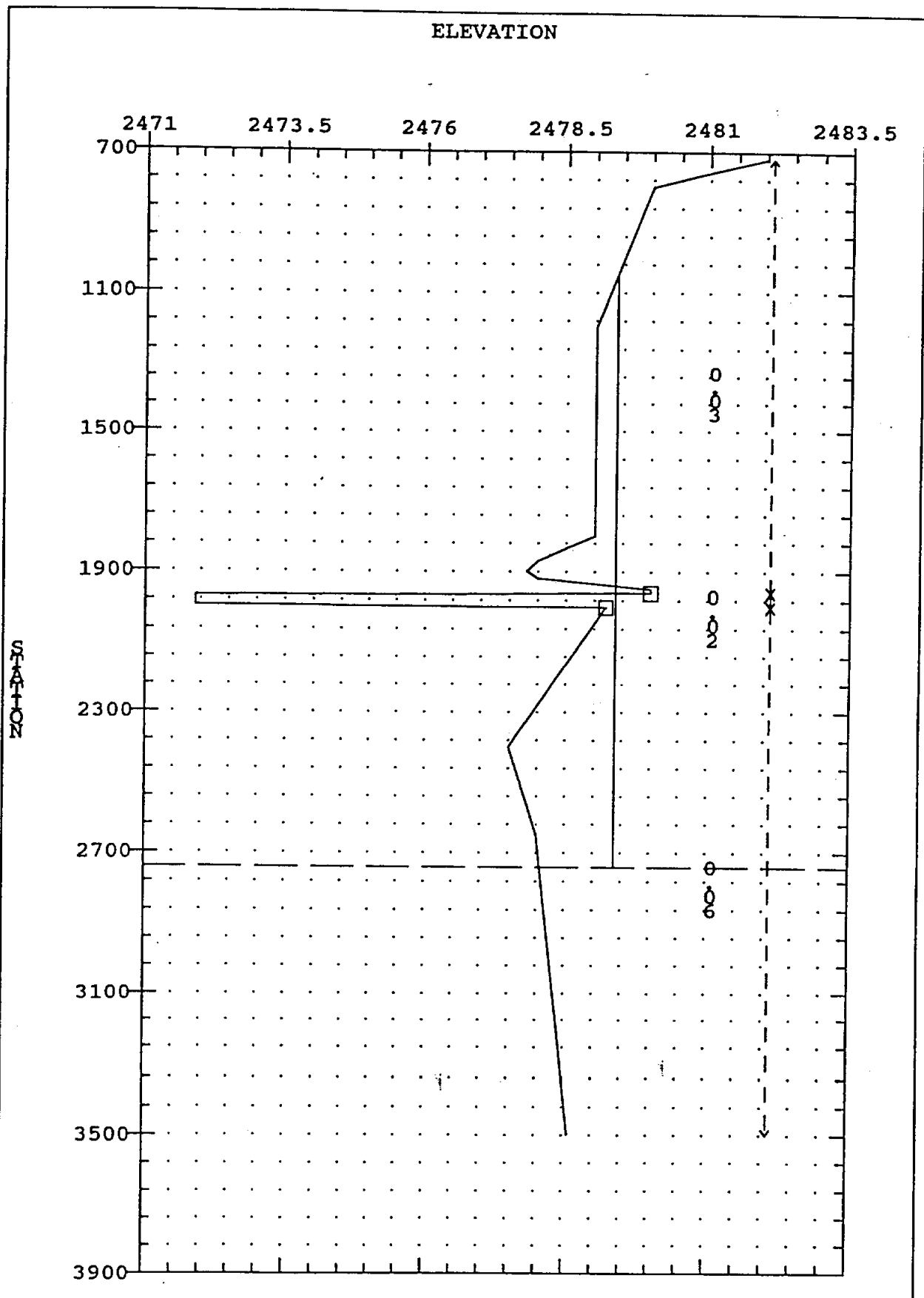
West Branch Santa Cruz River

ELEVATION



SECTION : 13

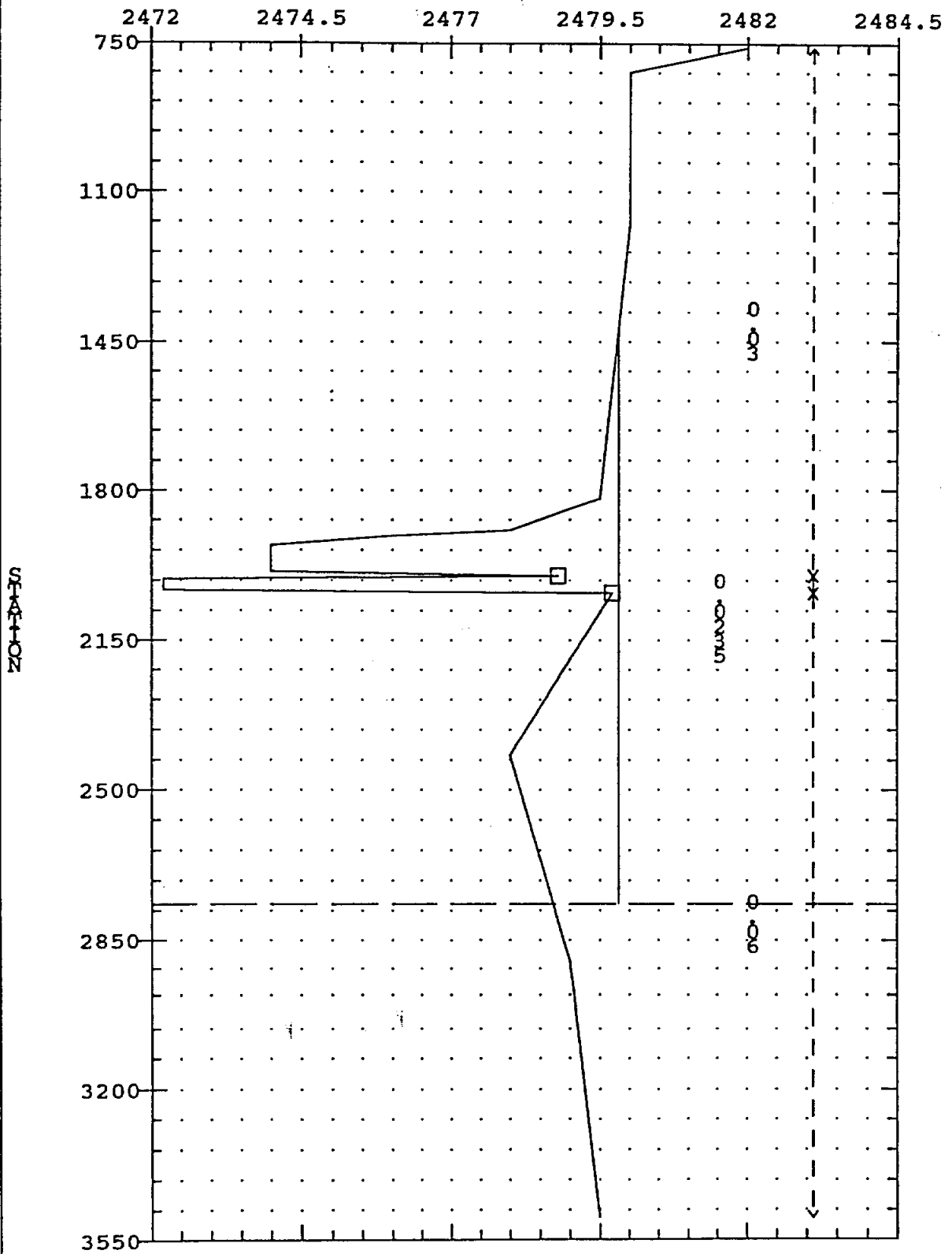
West Branch Santa Cruz River



SECTION : 14

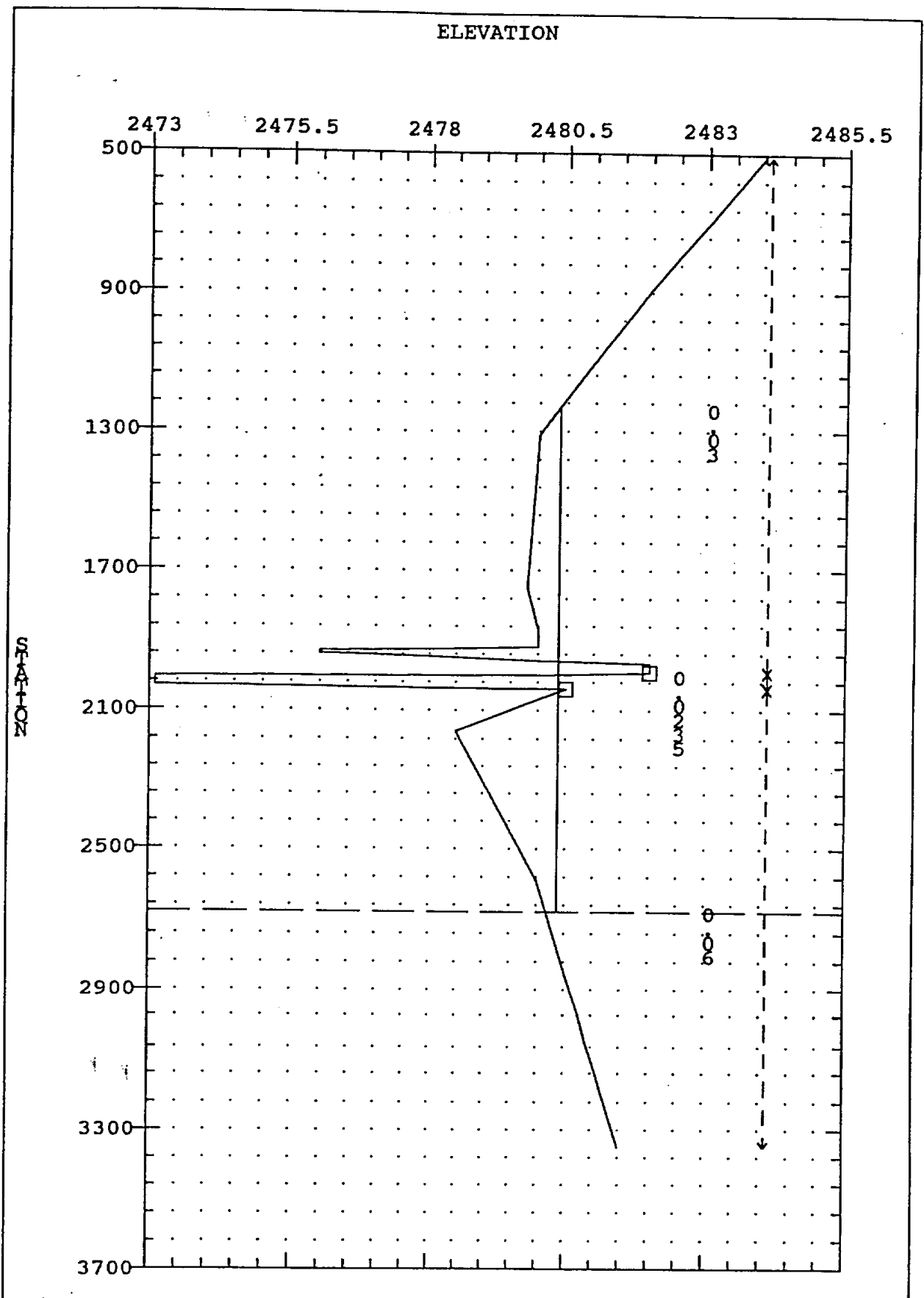
West Branch Santa Cruz River

ELEVATION



SECTION : 15

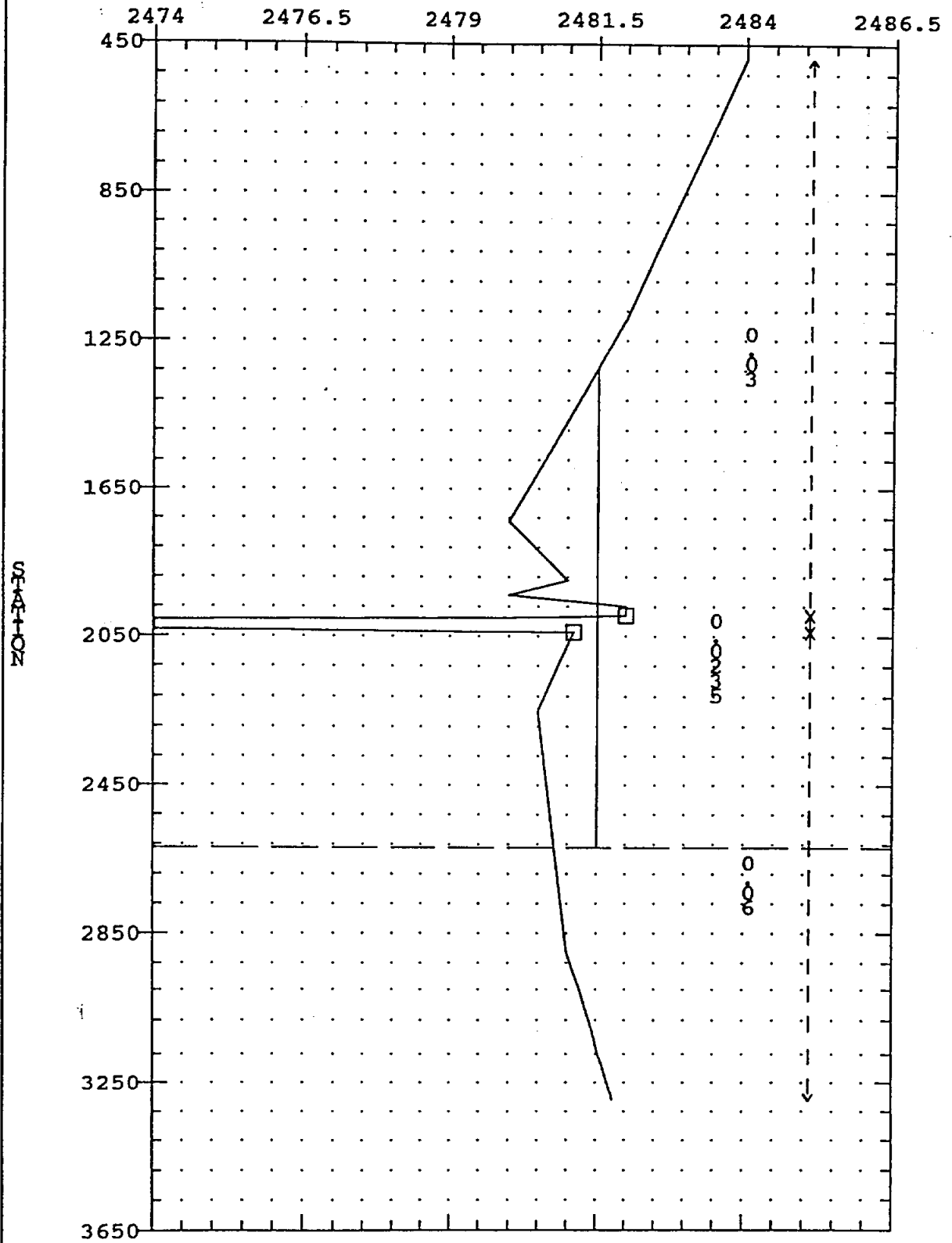
West Branch Santa Cruz River



SECTION : 16

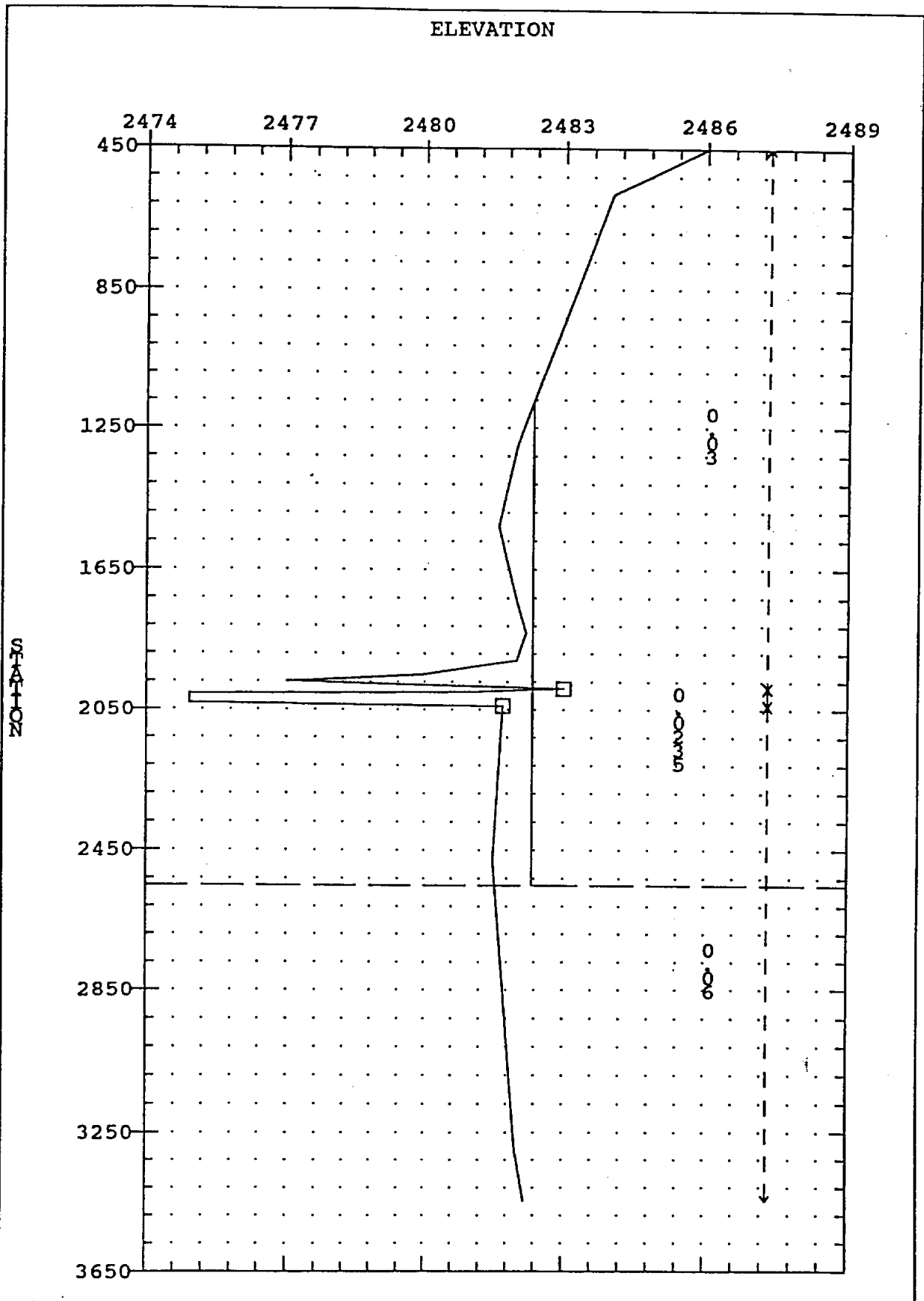
West Branch Santa Cruz River

ELEVATION



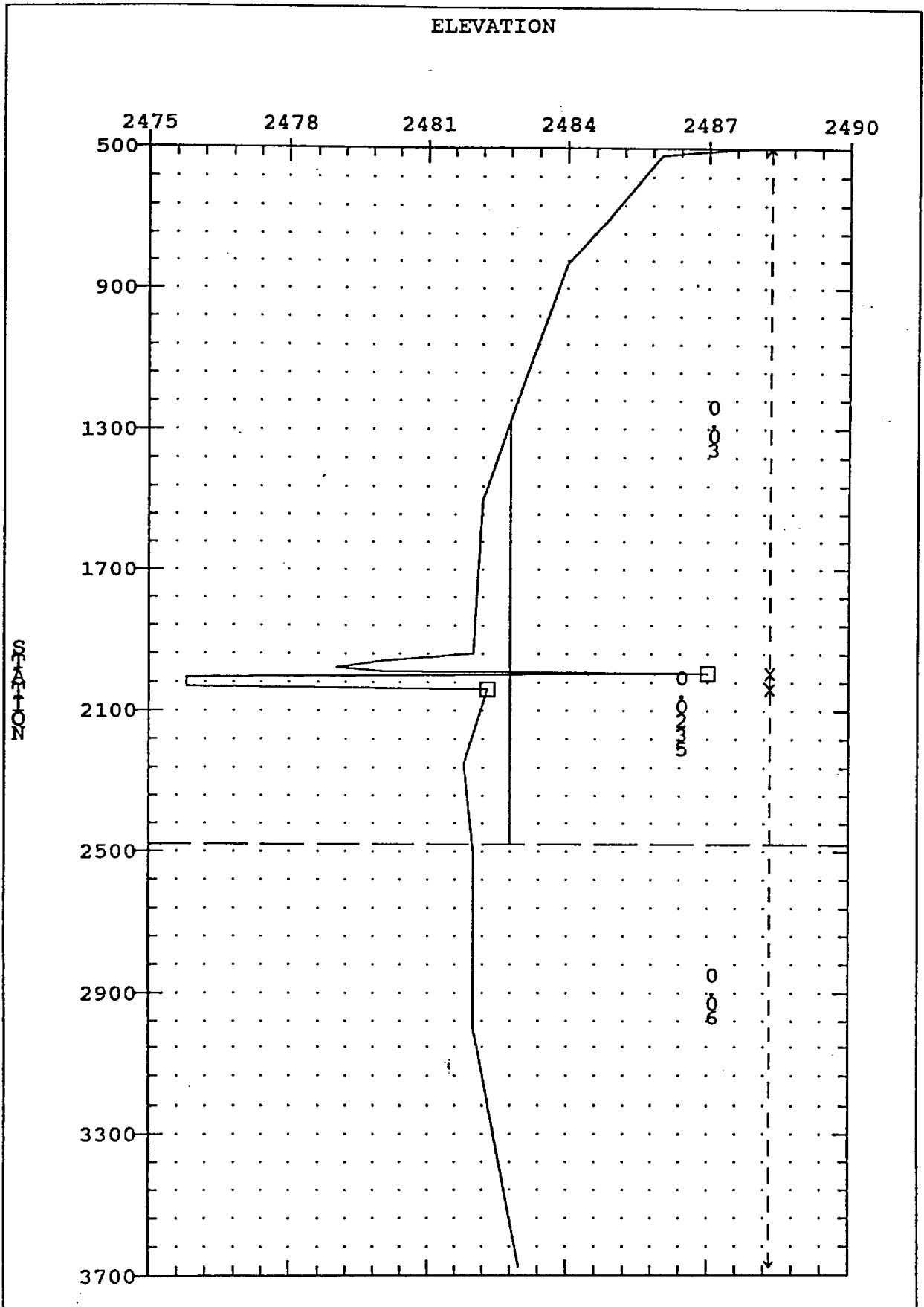
SECTION : 17

West Branch Santa Cruz River



SECTION : 18

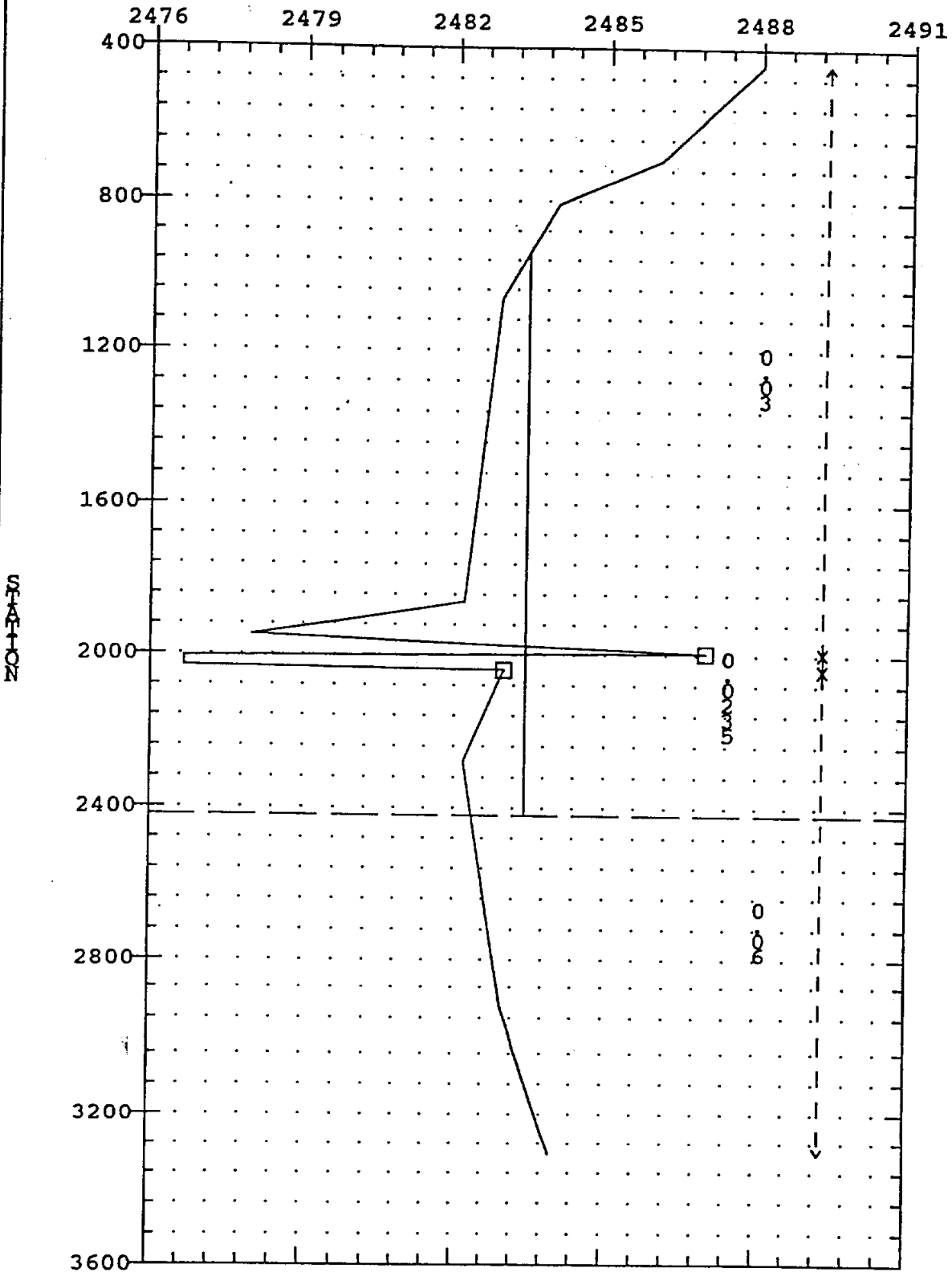
West Branch Santa Cruz River



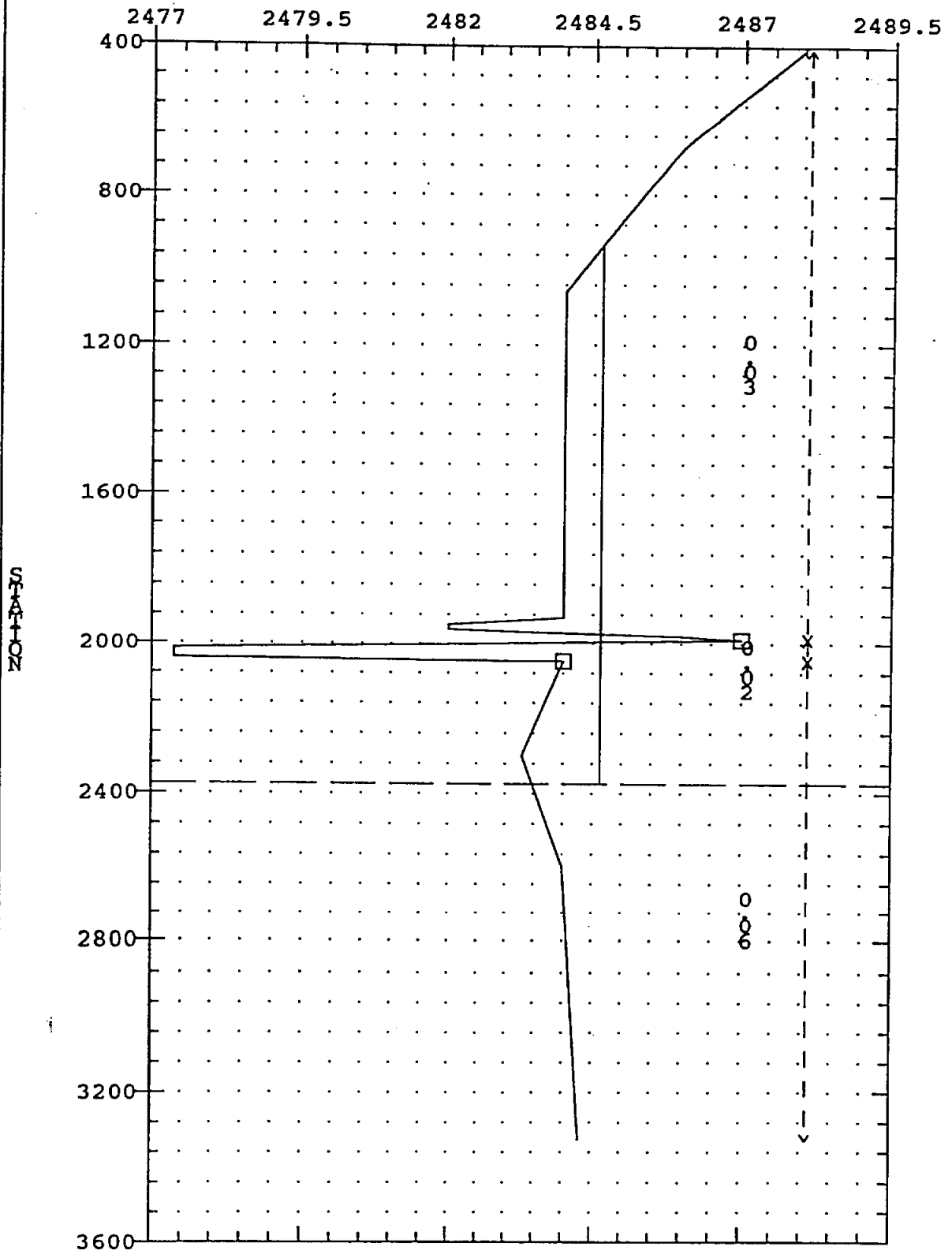
SECTION : 19

West Branch Santa Cruz River

ELEVATION



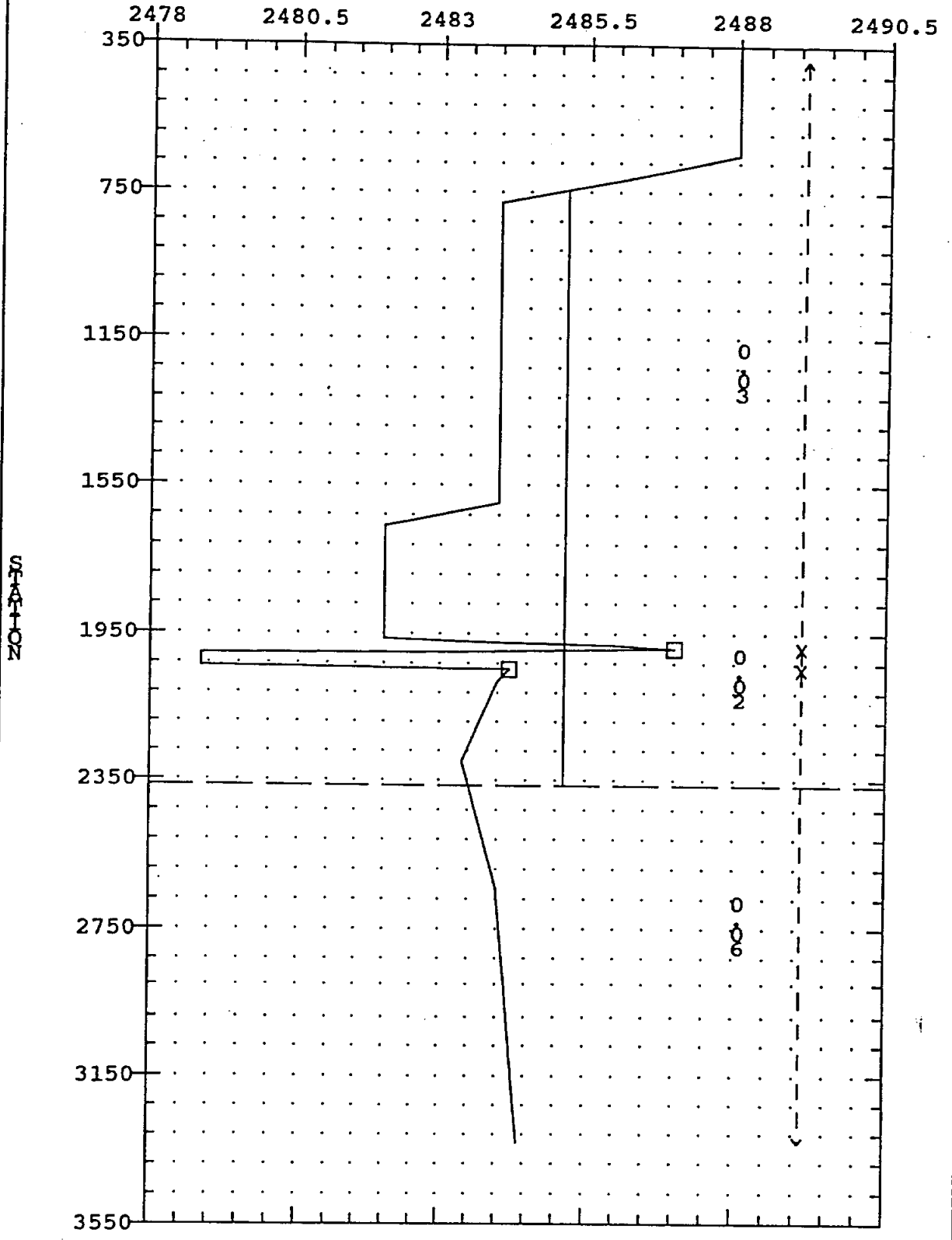
ELEVATION



SECTION : 21

West Branch Santa Cruz River

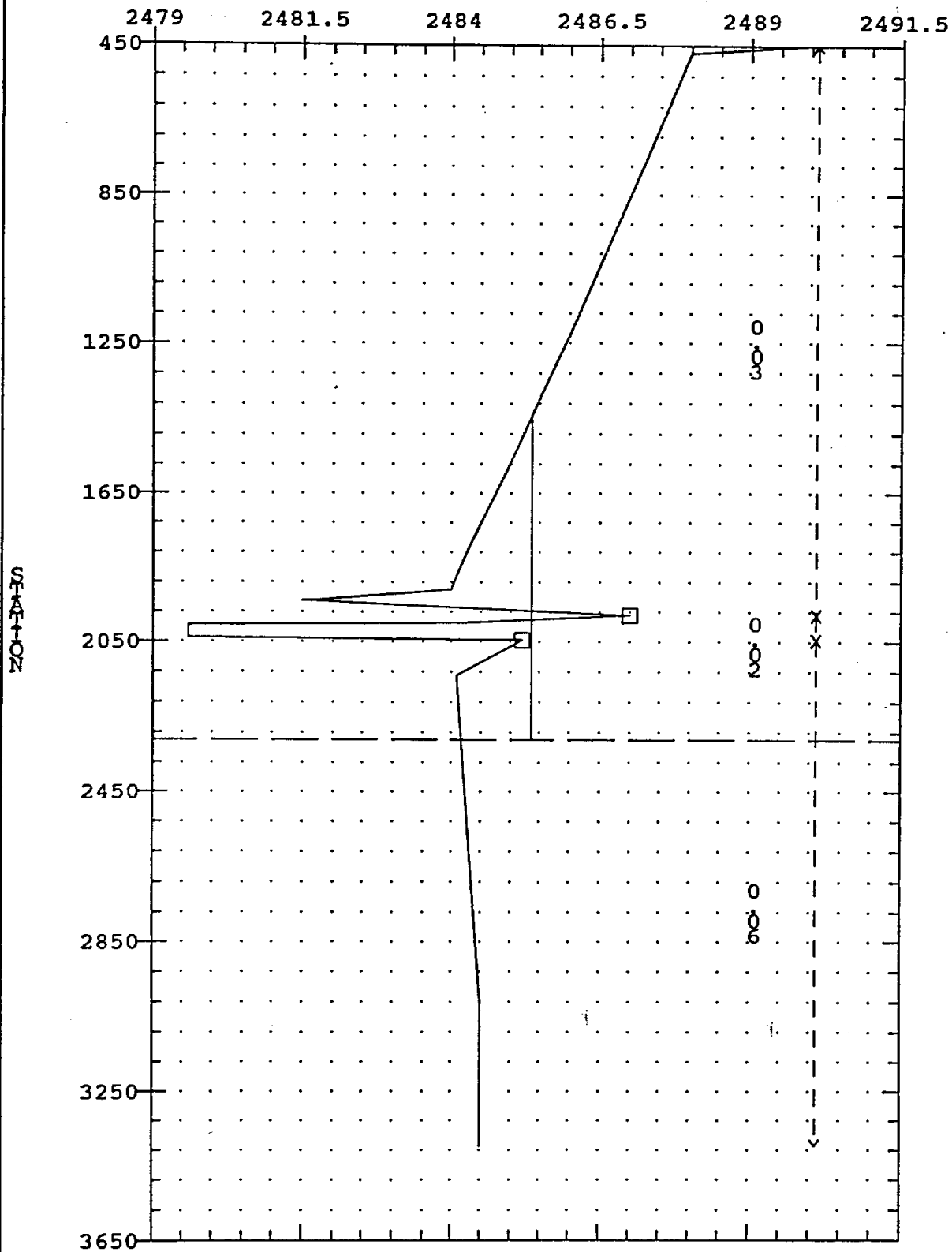
ELEVATION



SECTION : 22

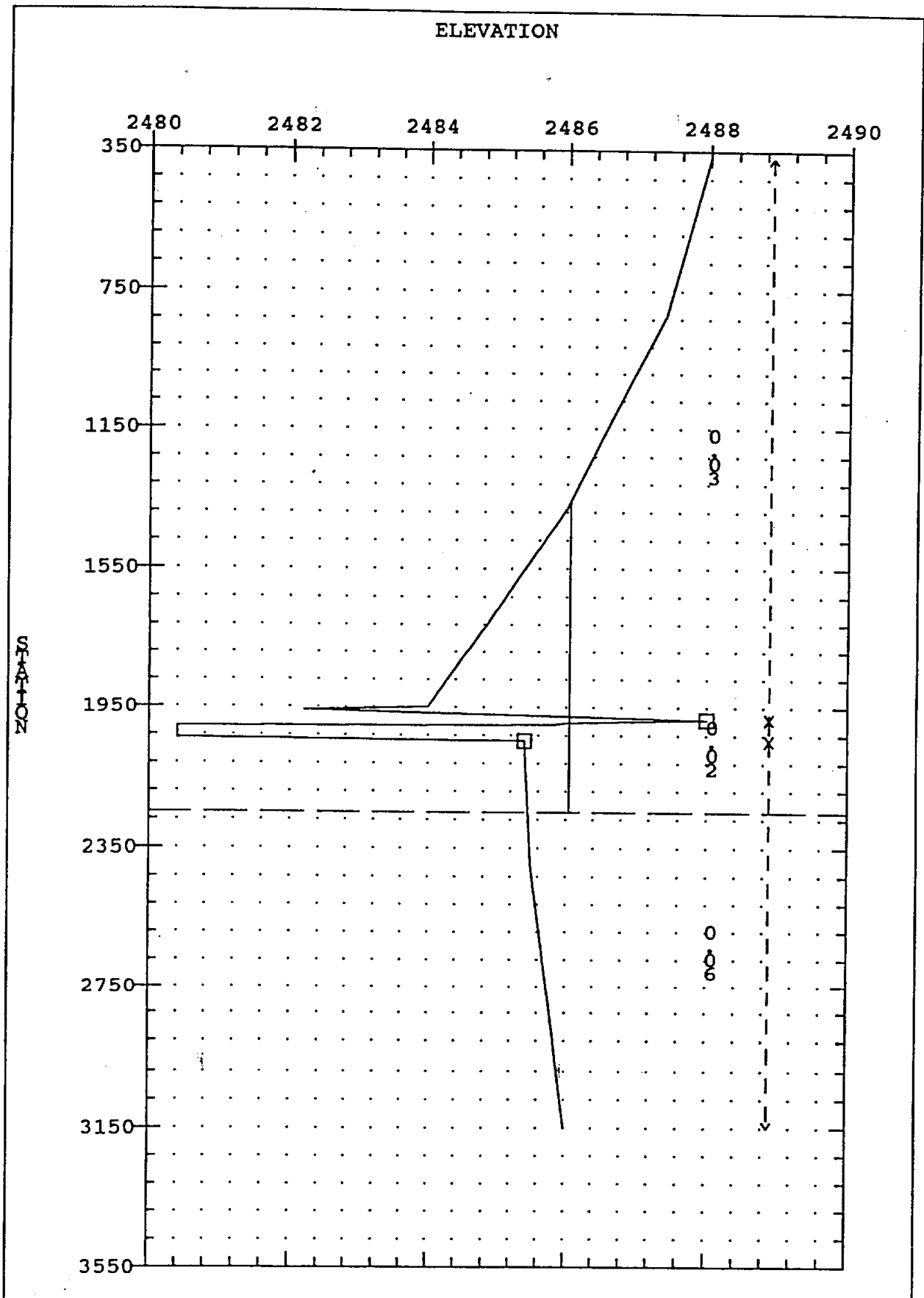
West Branch Santa Cruz River

ELEVATION



SECTION : 23

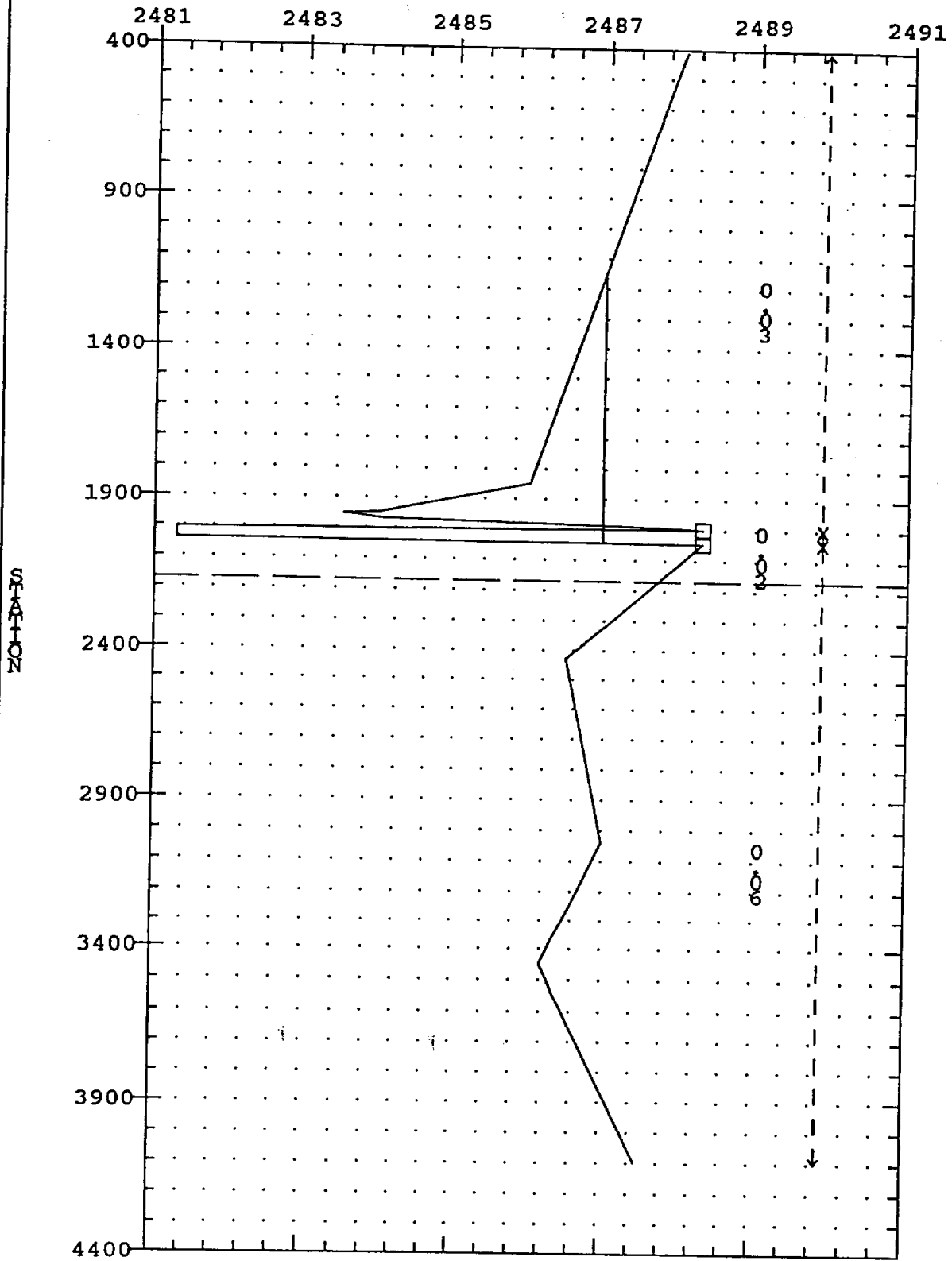
West Branch Santa Cruz River



SECTION : 24

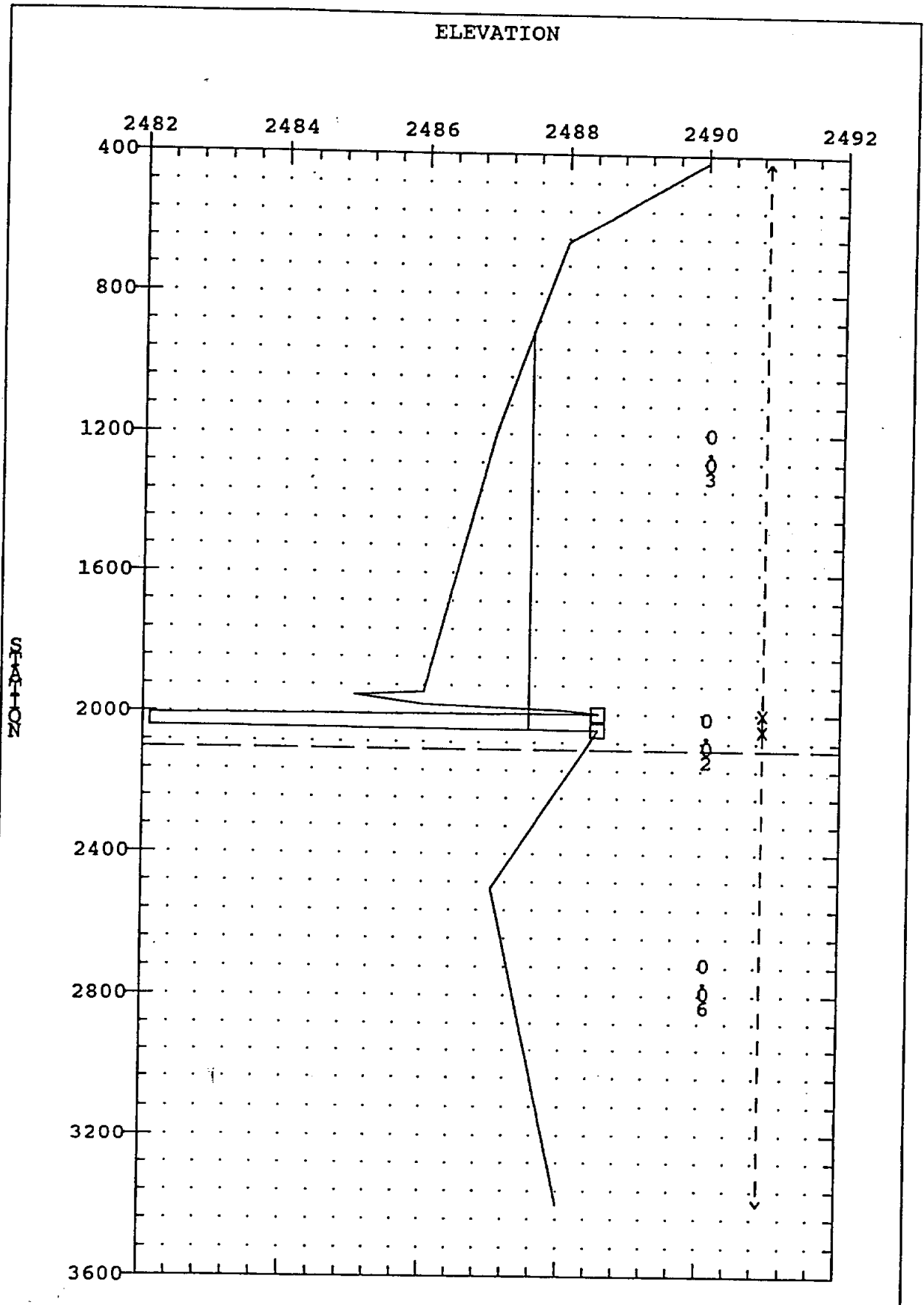
West Branch Santa Cruz River

ELEVATION



SECTION : 25

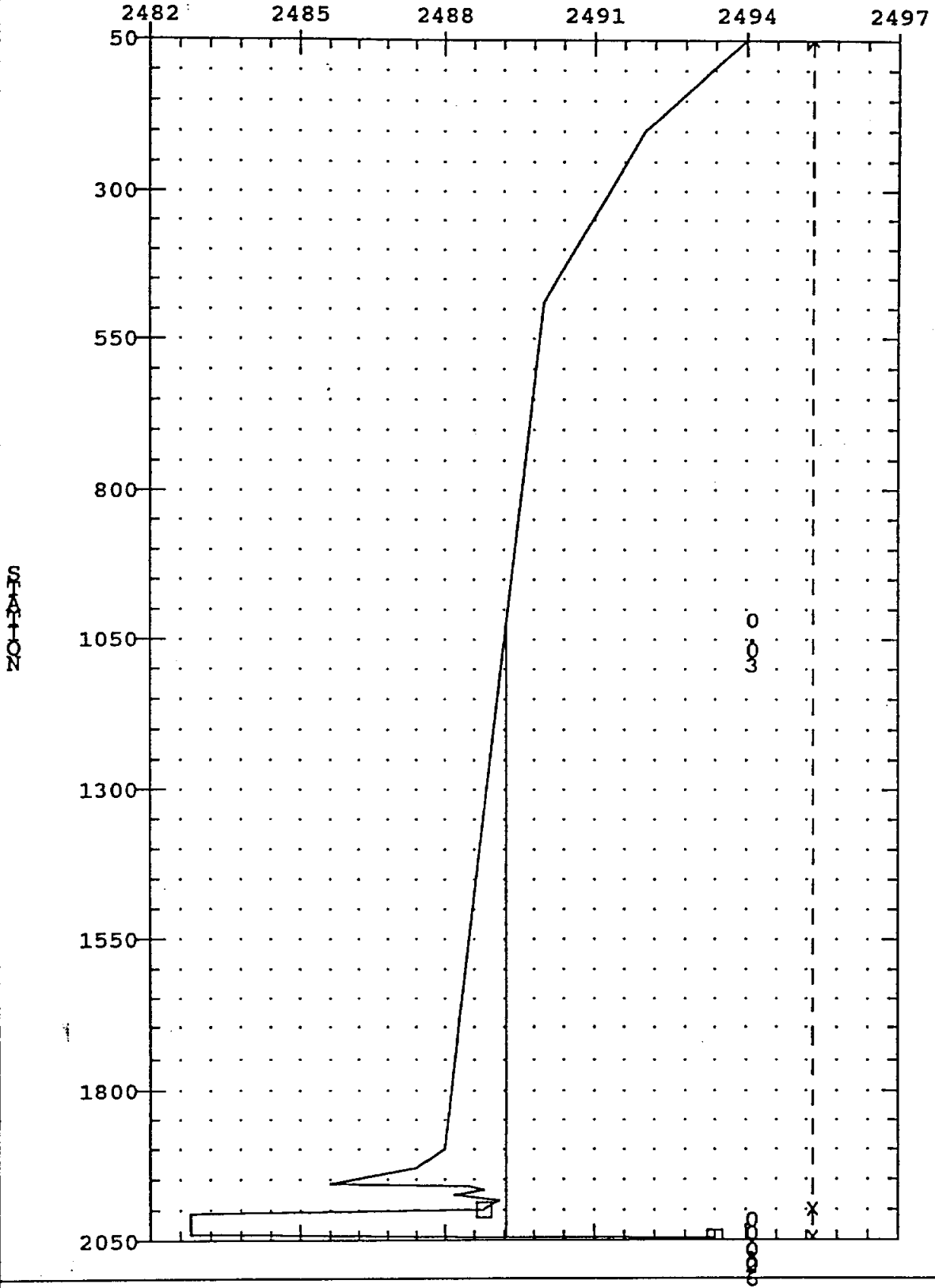
West Branch Santa Cruz River



SECTION : 26

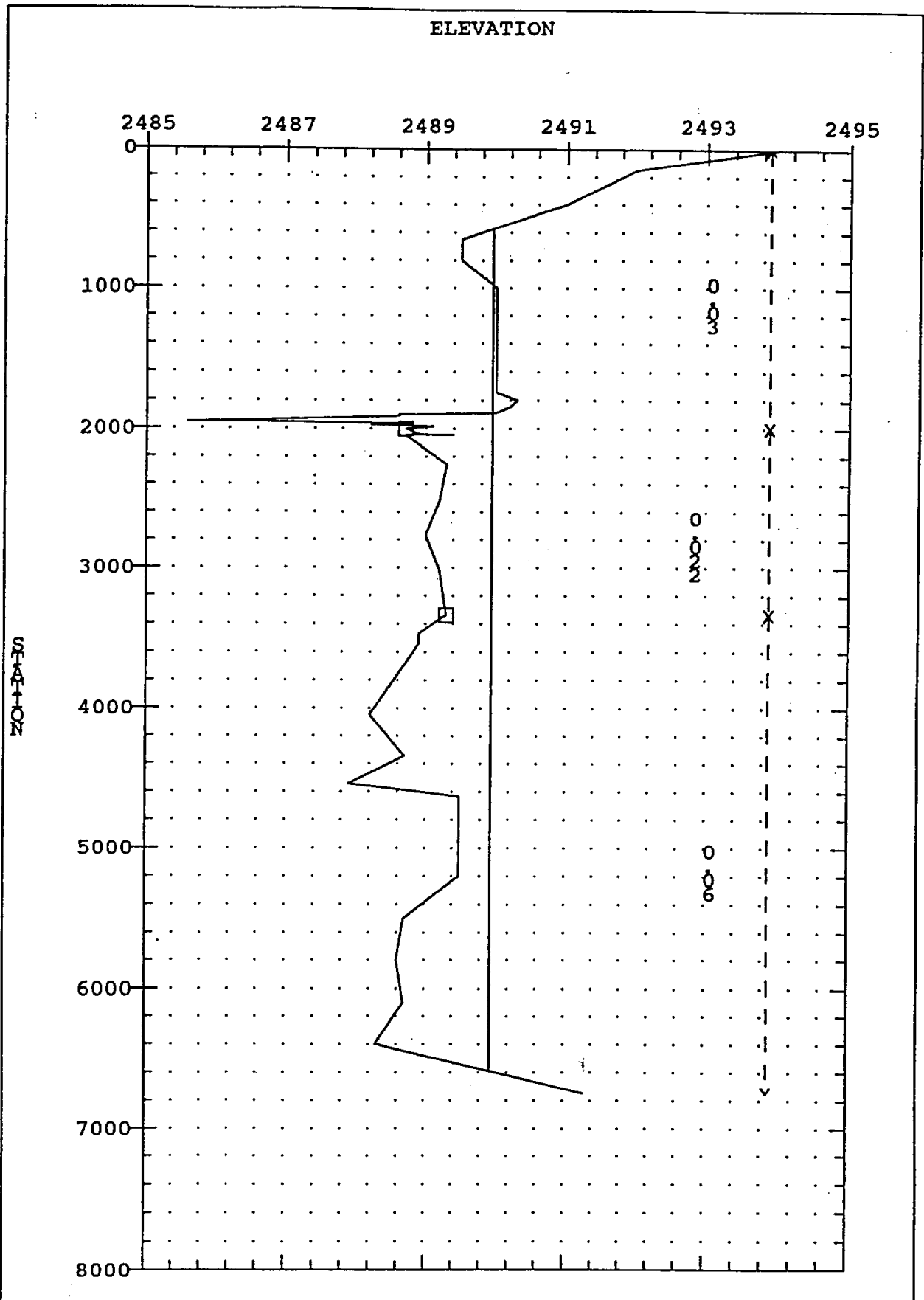
West Branch Santa Cruz River

ELEVATION



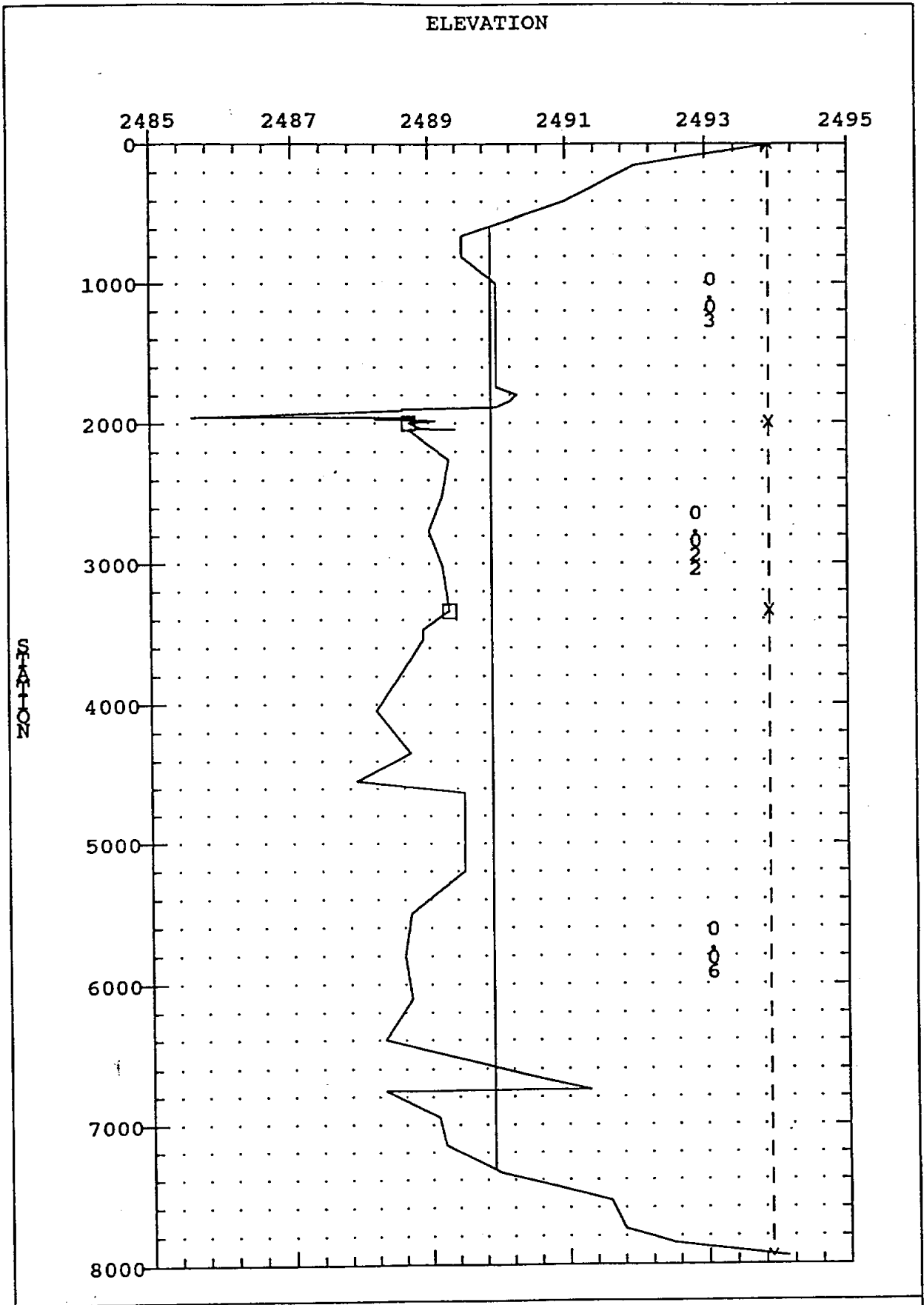
SECTION : 27

West Branch Santa Cruz River



SECTION : 28

West Branch Santa Cruz River



SECTION : 28.1

West Branch Santa Cruz River

Appendix D

**HEC-2 Input And Output Files For The
South Channel Of The Los Reales Improvement District**

SF Splitflow Analysis of the South Channel

TW Splitflow #9 to #10, Weir flow across Los Reales Rd. on No.Side of So.Channel

WS	7	9	10	-1	2.6					
WC	0	2493.1	1	2489.8	530	2489.4	730	2489.7	1080	2492.5
WC	1280	2492.5	1450	2492.5						

EE

T1 Los Reales Improvement District, Letter of Map Revision

T2 Arroyo Job #PDOT01.1, HEC2 File: South.H21

T3 South Channel

J1	0	2	0	0	-1	0	0	0	2472	
J2	1	0	-1	0	0	0	0	0	0	
J3	38	43	13	14	15	1	2	3	8	53
J3	4	54	61		150					
NC	.025	.025	.025	0.1	0.3					
QT	3	3250	3300	3350						

- * Note that 3 flood discharges were used in this multi-profile run. These
- * discharges were used to develop the stage-discharge curve for use in the
- * HEC-2 model of the West Branch (see TC cards in HEC-2 file WEST.H21), as well
- * as to predict water-surface elevations within and along the South Channel.
- * In addition, the water-surface elevation given in field J1.9 is equal to the
- * 10-year water-surface elevation within the Santa Cruz River at the channel outlet.

* Cross Section #62+50 from Sheet 12 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	1	4	0	128	0	0	0		
GR	2486.6	0	2468.9	57	2468.9	73	2486.4	128	

* Cross Section #60+00 from Sheet 12 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	2	4	0	112	250	250	250		
GR	2487.4	0	2471.8	48	2471.8	64	2487.6	112	

* Cross Section #57+00 from Sheet 11 of 15 of Los Reales Improvement District

* Job No. 85-074

NC	.024	.024	.024	0.1	0.3					
X1	3	6	0	86.9	300	300	300	0	2400	
GR	87.78	0	75.20	27.1	75.20	56.0	88.19	66.5	91.31	75.9
GR	91.31	86.9								

* Cross Section #54+00 from Sheet 11 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	4	6	0	86.9	300	300	300	0	2400	
GR	87.95	0	75.67	27.1	75.67	56.0	88.15	66.5	91.51	75.9
GR	91.51	86.9								

* Cross Section #51+00 from Sheet 11 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	5	6	0	86.9	300	300	300	0	2400	
GR	88.11	0	76.64	27.1	76.64	56.0	88.35	66.5	91.59	75.9
GR	91.59	86.9								

* Cross Section #48+00 from Sheet 10 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	6	6	0	86.9	300	300	300	0	2400	
GR	87.47	0	77.44	27.1	77.44	56.0	88.30	66.5	92.2	75.9
GR	92.2	86.9								

* Cross Section #45+00 from Sheet 10 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	7	6	0	86.9	300	300	300	0	2400	
GR	87.99	0	78.16	27.1	78.16	56.0	88.50	66.5	92.03	75.9
GR	92.03	86.9								

* Cross Section #42+00 from sheet 10 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	8	6	0	86.9	300	300	300	0	2400	
GR	88.28	0	78.70	27.1	78.70	56.0	88.71	66.5	92.55	75.9
GR	92.55	86.9								

* Cross Section #39+20 from sheet 9 of 15 of Los Reales Improvement District

* Job No. 85-074

NC	.022	.022	.022	0.1	0.3				
X1	9	4	0	67	280	280	280	0	2400
GR	88.0	0	79.4	28	79.4	57	89.0	67	

* Cross Section runs along south top of bank protection between sta.

* #24+70 and #39+20 from sheets 8 & 9 of 15 of Los Reales Improvement District

* Job No. 85-074

X1	10	7	0	730	1450	720	1085	0	2400	
GR	93.1	0	89.8	1	88.6	530	88.9	730	88.0	1130
GR	89.3	1310	92.5	1450						

EJ

T1 Los Reales Improvement District, Letter of Map Revision

T2 Arroyo Job #PDOT01.1, HEC2 File: South.H2I

T3 South Channel

J1	0	3	0	0	-1	0	0	0	2472
J2	2	0	-1	0	0	0	0	0	0

T1 Los Reales Improvement District, Letter of Map Revision

T2 Arroyo Job #PDOT01.1, HEC2 File: South.H2I

T3 South Channel

J1	0	4	0	0	-1	0	0	0	2472
J2	3	0	-1	0	0	0	0	0	0

ER

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*****
* HEC-2 WATER SURFACE PROFILES *
* *
* Version 4.6.2; May 1991 *
* *
* RUN DATE 03OCT94 TIME 15:32:21 *
*****

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*****
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET, SUITE D *
* DAVIS, CALIFORNIA 95616-4687 *
* (916) 756-1104 *
*****

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X X XXXXXXX XXXXX XXXXX
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THIS RUN EXECUTED 03OCT94 15:32:21

HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991

SPLIT FLOW BEING PERFORMED

SF Splitflow Analysis of the South Channel

TW Splitflow #9 to #10, Weir flow across Los Reales Rd. on No.Side of So.Channel

WS	7	9	10	-1	2.6						
WC	0	2493.1	1	2489.8	530	2489.4	730	2489.7	1080	2492.5	
WC	1280	2492.5	1450	2492.5							

T1 Los Reales Improvement District, Letter of Map Revision
 T2 Arroyo Job #PDOT01.1, HEC2 File: South.H2I
 T3 South Channel

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	-1	0	0	0	2472	
J2	NPROF	IPLT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	-1	0	0	0	0	0	0	

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38	43	13	14	15	1	2	3	8	53
4	54	61		150					
NC	.025	.025	.025	0.1	0.3				
QT	3	3250	3300	3350					

Note that 3 flood discharges were used in this multi-profile run. These discharges were used to develop the stage-discharge curve for use in the HEC-2 model of the West Branch (see TC cards in HEC-2 file WEST.H2I), as well as to predict water-surface elevations within and along the South Channel. In addition, the water-surface elevation given in field J1.9 is equal to the 10-year water-surface elevation within the Santa Cruz River at the channel ou

Cross Section #62+50 from Sheet 12 of 15 of Los Reales Improvement District
 Job No. 85-074

X1	1	4	0	128	0	0	0		
GR	2486.6	0	2468.9	57	2468.9	73	2486.4	128	

Cross Section #60+00 from Sheet 12 of 15 of Los Reales Improvement District
 Job No. 85-074

X1	2	4	0	112	250	250	250		
GR	2487.4	0	2471.8	48	2471.8	64	2487.6	112	

Cross Section #57+00 from Sheet 11 of 15 of Los Reales Improvement District
 Job No. 85-074

NC	.024	.024	.024	0.1	0.3				
X1	3	6	0	86.9	300	300	300	0	2400
GR	87.78	0	75.20	27.1	75.20	56.0	88.19	66.5	91.31
GR	91.31	86.9							75.9

Cross Section #54+00 from Sheet 11 of 15 of Los Reales Improvement District
 Job No. 85-074

X1	4	6	0	86.9	300	300	300	0	2400	
GR	87.95	0	75.67	27.1	75.67	56.0	88.15	66.5	91.51	75.9
GR	91.51	86.9								

Cross Section #51+00 from Sheet 11 of 15 of Los Reales Improvement District
Job No. 85-074

X1	5	6	0	86.9	300	300	300	0	2400	
GR	88.11	0	76.64	27.1	76.64	56.0	88.35	66.5	91.59	75.9
GR	91.59	86.9								

Cross Section #48+00 from Sheet 10 of 15 of Los Reales Improvement District
Job No. 85-074

X1	6	6	0	86.9	300	300	300	0	2400	
GR	87.47	0	77.44	27.1	77.44	56.0	88.30	66.5	92.2	75.9
GR	92.2	86.9								

Cross Section #45+00 from Sheet 10 of 15 of Los Reales Improvement District
Job No. 85-074

X1	7	6	0	86.9	300	300	300	0	2400	
GR	87.99	0	78.16	27.1	78.16	56.0	88.50	66.5	92.03	75.9
GR	92.03	86.9								

Cross Section #42+00 from sheet 10 of 15 of Los Reales Improvement District
Job No. 85-074

X1	8	6	0	86.9	300	300	300	0	2400	
GR	88.28	0	78.70	27.1	78.70	56.0	88.71	66.5	92.55	75.9
GR	92.55	86.9								

Cross Section #39+20 from sheet 9 of 15 of Los Reales Improvement District
Job No. 85-074

NC	.022	.022	.022	0.1	0.3					
X1	9	4	0	67	280	280	280	0	2400	
GR	88.0	0	79.4	28	79.4	57	89.0	67		

Cross Section runs along south top of bank protection between sta.
#24+70 and #39+20 from sheets 8 & 9 of 15 of Los Reales Improvement District
Job No. 85-074

X1	10	7	0	730	1450	720	1085	0	2400	
GR	93.1	0	89.8	1	88.6	530	88.9	730	88.0	1130
GR	89.3	1310	92.5	1450						

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	GLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CCHV= .100 CEHV= .300

*SECNO 1.000

3720 CRITICAL DEPTH ASSUMED

1.000	7.03	2475.93	2475.93	2472.00	2478.18	2.26	.00	.00	2486.60
3250.0	.0	3250.0	.0	.0	269.7	.0	.0	.0	2486.40
.00	.00	12.05	.00	.000	.025	.000	.000	2468.90	34.36
.005899	0.	0.	0.	0	16	0	.00	60.73	95.09

*SECNO 2.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

2.000	7.12	2478.92	2478.92	.00	2481.19	2.27	1.46	.00	2487.40
3250.0	.0	3250.0	.0	.0	269.0	.0	1.5	.3	2487.60
.01	.00	12.08	.00	.000	.025	.000	.000	2471.80	26.09
.005818	250.	250.	250.	20	5	0	.00	59.54	85.63

CCHV= .100 CEHV= .300

*SECNO 3.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

3.000	6.48	2481.68	2481.68	.00	2484.32	2.63	1.70	.11	2487.78
3250.0	.0	3250.0	.0	.0	249.7	.0	3.3	.7	2491.31
.01	.00	13.02	.00	.000	.024	.000	.000	2475.20	13.13
.005544	300.	300.	300.	20	11	0	.00	48.11	61.24

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.61

4.000	8.42	2484.09	.00	.00	2485.42	1.33	.97	.13	2487.95
3250.0	.0	3250.0	.0	.0	351.3	.0	5.4	1.1	2491.51
.02	.00	9.25	.00	.000	.024	.000	.000	2475.67	8.52
.002130	300.	300.	300.	4	0	0	.00	54.56	63.08

SECNO	DEPTH	CWSEL	CRIS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 5.000									
5.000	8.06	2484.70	.00	.00	2486.13	1.43	.68	.03	2488.11
3250.0	.0	3250.0	.0	.0	338.7	.0	7.8	1.4	2491.59
.03	.00	9.59	.00	.000	.024	.000	.000	2476.64	8.06
.002410	300.	300.	300.	3	0	0	.00	55.17	63.23
*SECNO 6.000									
6.000	8.08	2485.52	.00	.00	2486.84	1.31	.70	.01	2487.47
3250.0	.0	3250.0	.0	.0	353.3	.0	10.2	1.8	2492.20
.04	.00	9.20	.00	.000	.024	.000	.000	2477.44	5.27
.002234	300.	300.	300.	2	0	0	.00	58.55	63.81
*SECNO 7.000									
7.000	8.04	2486.20	.00	.00	2487.51	1.31	.67	.00	2487.99
3250.0	.0	3250.0	.0	.0	354.4	.0	12.6	2.2	2492.03
.05	.00	9.17	.00	.000	.024	.000	.000	2478.16	4.93
.002237	300.	300.	300.	2	0	0	.00	59.24	64.17
*SECNO 8.000									
8.000	8.26	2486.96	.00	.00	2488.15	1.19	.63	.01	2488.28
3250.0	.0	3250.0	.0	.0	371.2	.0	15.1	2.7	2492.55
.06	.00	8.76	.00	.000	.024	.000	.000	2478.70	3.73
.001986	300.	300.	300.	2	0	0	.00	60.94	64.67
CCHV=	.100	CEHV=	.300						
*SECNO 9.000									
9.000	8.11	2487.51	.00	.00	2488.66	1.16	.51	.00	2488.00
3250.0	.0	3250.0	.0	.0	376.4	.0	17.5	3.1	2489.00
.07	.00	8.63	.00	.000	.022	.000	.000	2479.40	1.60
.001679	280.	280.	280.	2	0	0	.00	63.85	65.45
*SECNO 10.000									
3301 HV CHANGED MORE THAN HVINS									
10.000	1.90	2489.90	.00	.00	2489.99	.09	1.22	.11	2493.10
3250.0	.0	1116.4	2133.6	.0	600.2	812.8	36.4	17.9	2488.90
.18	.00	1.86	2.62	.000	.022	.022	.000	2488.00	.97
.000983	1450.	1085.	720.	6	0	0	.00	1335.27	1336.24

TW Splitflow #9 to #10, Weir flow across Los Reales Rd. on No.Side of So.Channel

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	2	2487.507	2489.900	9.000	10.000

T1 Los Reales Improvement District, Letter of Map Revision
T2 Arroyo Job #PDOT01.1, HEC2 File: South.H21
T3 South Channel

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	-1	0	0	0	2472	
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	0	-1	0	0	0	0	0	0	

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	GLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CCHV= .100 CEHV= .300

*SECNO 1.000

3720 CRITICAL DEPTH ASSUMED

1.000	7.09	2475.99	2475.99	2472.00	2478.25	2.27	.00	.00	2486.60
3300.0	.0	3300.0	.0	.0	273.2	.0	.0	.0	2486.40
.00	.00	12.08	.00	.000	.025	.000	.000	2468.90	34.18
.005873	0.	0.	0.	0	16	0	.00	61.10	95.27

*SECNO 2.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

2.000	7.17	2478.97	2478.97	.00	2481.26	2.28	1.46	.01	2487.40
3300.0	.0	3300.0	.0	.0	272.1	.0	1.6	.3	2487.60
.01	.00	12.13	.00	.000	.025	.000	.000	2471.80	25.93
.005811	250.	250.	250.	20	5	0	.00	59.87	85.79

CCHV= .100 CEHV= .300

*SECNO 3.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

3.000	6.54	2481.74	2481.74	.00	2484.40	2.65	1.70	.11	2487.78
3300.0	.0	3300.0	.0	.0	252.6	.0	3.4	.7	2491.31
.01	.00	13.07	.00	.000	.024	.000	.000	2475.20	13.00
.005532	300.	300.	300.	20	11	0	.00	48.29	61.29

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.61

4.000	8.49	2484.16	.00	.00	2485.50	1.34	.97	.13	2487.95
3300.0	.0	3300.0	.0	.0	355.0	.0	5.5	1.1	2491.51
.02	.00	9.30	.00	.000	.024	.000	.000	2475.67	8.37
.002132	300.	300.	300.	4	0	0	.00	54.76	63.14

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 5.000

5.000	8.13	2484.77	.00	.00	2486.21	1.44	.68	.03	2488.11
3300.0	.0	3300.0	.0	.0	342.5	.0	7.9	1.5	2491.59
.03	.00	9.63	.00	.000	.024	.000	.000	2476.64	7.90
.002408	300.	300.	300.	3	0	0	.00	55.39	63.29

*SECNO 6.000

6.000	8.15	2485.59	.00	.00	2486.92	1.32	.69	.01	2487.47
3300.0	.0	3300.0	.0	.0	357.5	.0	10.3	1.8	2492.20
.04	.00	9.23	.00	.000	.024	.000	.000	2477.44	5.07
.002230	300.	300.	300.	2	0	0	.00	58.81	63.88

*SECNO 7.000

7.000	8.11	2486.27	.00	.00	2487.59	1.32	.67	.00	2487.99
3300.0	.0	3300.0	.0	.0	358.5	.0	12.7	2.3	2492.03
.05	.00	9.21	.00	.000	.024	.000	.000	2478.16	4.74
.002233	300.	300.	300.	2	0	0	.00	59.50	64.24

*SECNO 8.000

8.000	8.33	2487.03	.00	.00	2488.23	1.20	.63	.01	2488.28
3300.0	.0	3300.0	.0	.0	375.4	.0	15.3	2.7	2492.55
.06	.00	8.79	.00	.000	.024	.000	.000	2478.70	3.53
.001984	300.	300.	300.	2	0	0	.00	61.21	64.74

CCHV= .100 CEHV= .300

*SECNO 9.000

9.000	8.18	2487.58	.00	.00	2488.74	1.17	.51	.00	2488.00
3300.0	.0	3300.0	.0	.0	380.7	.0	17.7	3.1	2489.00
.07	.00	8.67	.00	.000	.022	.000	.000	2479.40	1.38
.001677	280.	280.	280.	2	0	0	.00	64.13	65.52

*SECNO 10.000

3301 HV CHANGED MORE THAN HVINS

10.000	1.93	2489.93	.00	.00	2490.02	.09	1.17	.11	2493.10
3300.0	.0	1153.9	2146.1	.0	625.5	833.9	37.1	18.0	2488.90
.18	.00	1.84	2.57	.000	.022	.022	.000	2488.00	.96
.000915	1450.	1085.	720.	6	0	0	.00	1336.80	1337.76

TW Splitflow #9 to #10, Weir flow across Los Reales Rd. on No.Side of So.Channel

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	2	2487.575	2489.935	9.000	10.000

T1 Los Reales Improvement District, Letter of Map Revision
T2 Arroyo Job #PDOT01.1, HEC2 File: South.H2I
T3 South Channel

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	-1	0	0	0	2472	
J2	NPROF	IPLT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	0	-1	0	0	0	0	0	0	

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	LOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XLN	XNCH	XNR	WTH	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 3

CCHV= .100 CEHV= .300

*SECNO 1.000

3720 CRITICAL DEPTH ASSUMED

1.000	7.14	2476.04	2476.04	2472.00	2478.32	2.28	.00	.00	2486.60
3350.0	.0	3350.0	.0	.0	276.6	.0	.0	.0	2486.40
.00	.00	12.11	.00	.000	.025	.000	.000	2468.90	34.00
.005855	0.	0.	0.	0	16	0	.00	61.45	95.45

*SECNO 2.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

2.000	7.23	2479.03	2479.03	.00	2481.33	2.30	1.46	.01	2487.40
3350.0	.0	3350.0	.0	.0	275.3	.0	1.6	.3	2487.60
.01	.00	12.17	.00	.000	.025	.000	.000	2471.80	25.76
.005802	250.	250.	250.	20	5	0	.00	60.19	85.96

CCHV= .100 CEHV= .300

*SECNO 3.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

3.000	6.60	2481.80	2481.80	.00	2484.47	2.67	1.70	.11	2487.78
3350.0	.0	3350.0	.0	.0	255.3	.0	3.4	.7	2491.31
.01	.00	13.12	.00	.000	.024	.000	.000	2475.20	12.88
.005528	300.	300.	300.	20	11	0	.00	48.46	61.34

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.61

4.000	8.56	2484.23	.00	.00	2485.58	1.35	.97	.13	2487.95
3350.0	.0	3350.0	.0	.0	358.7	.0	5.5	1.1	2491.51
.02	.00	9.34	.00	.000	.024	.000	.000	2475.67	8.22
.002134	300.	300.	300.	4	0	0	.00	54.97	63.20

SECNO	DEPTH	CWSEL	CRISW	WSELK	EG	HV	HL	GLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 5.000

5.000	8.20	2484.84	.00	.00	2486.29	1.45	.68	.03	2488.11
3350.0	.0	3350.0	.0	.0	346.3	.0	8.0	1.5	2491.59
.03	.00	9.67	.00	.000	.024	.000	.000	2476.64	7.74
.002406	300.	300.	300.	3	0	0	.00	55.61	63.35

*SECNO 6.000

6.000	8.22	2485.66	.00	.00	2487.00	1.33	.69	.01	2487.47
3350.0	.0	3350.0	.0	.0	361.6	.0	10.4	1.9	2492.20
.04	.00	9.26	.00	.000	.024	.000	.000	2477.44	4.88
.002225	300.	300.	300.	2	0	0	.00	59.06	63.95

*SECNO 7.000

7.000	8.18	2486.34	.00	.00	2487.66	1.33	.67	.00	2487.99
3350.0	.0	3350.0	.0	.0	362.5	.0	12.9	2.3	2492.03
.05	.00	9.24	.00	.000	.024	.000	.000	2478.16	4.55
.002231	300.	300.	300.	2	0	0	.00	59.75	64.30

*SECNO 8.000

8.000	8.40	2487.10	.00	.00	2488.31	1.21	.63	.01	2488.28
3350.0	.0	3350.0	.0	.0	379.5	.0	15.4	2.7	2492.55
.06	.00	8.83	.00	.000	.024	.000	.000	2478.70	3.34
.001984	300.	300.	300.	2	0	0	.00	61.47	64.81

CCHV= .100 CEHV= .300

*SECNO 9.000

9.000	8.25	2487.65	.00	.00	2488.82	1.17	.51	.00	2488.00
3350.0	.0	3350.0	.0	.0	385.3	.0	17.9	3.1	2489.00
.07	.00	8.70	.00	.000	.022	.000	.000	2479.40	1.15
.001673	280.	280.	280.	2	0	0	.00	64.44	65.59

*SECNO 10.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.40

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	GLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
10.000	1.97	2489.97	.00	.00	2490.05	.08	1.12	.11	2493.10
3350.0	.0	1191.2	2158.8	.0	651.1	855.3	37.9	18.0	2488.90
.18	.00	1.83	2.52	.000	.022	.022	.000	2488.00	.95
.000853	1450.	1085.	720.	6	0	0	.00	1338.35	1339.30

TW Splitflow #9 to #10, Weir flow across Los Reales Rd. on No.Side of So.Channel

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
.00	.00	.00	.00	.00	.00	2	2487.645	2489.970	9.000	10.000

THIS RUN EXECUTED 03OCT94 15:34:10

HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

South Channel

SUMMARY PRINTOUT

SECNO	Q	QLOB	QCH	QROB	CWSEL	CRIWS	EG	DEPTH	SSTA	TOPWID	ENDST	DIFEG	
*	1.000	3250.00	.00	3250.00	.00	2475.93	2475.93	2478.18	7.03	34.36	60.73	95.09	.00
*	1.000	3300.00	.00	3300.00	.00	2475.99	2475.99	2478.25	7.09	34.18	61.10	95.27	.07
*	1.000	3350.00	.00	3350.00	.00	2476.04	2476.04	2478.32	7.14	34.00	61.45	95.45	.14
*	2.000	3250.00	.00	3250.00	.00	2478.92	2478.92	2481.19	7.12	26.09	59.54	85.63	.00
*	2.000	3300.00	.00	3300.00	.00	2478.97	2478.97	2481.26	7.17	25.93	59.87	85.79	.07
*	2.000	3350.00	.00	3350.00	.00	2479.03	2479.03	2481.33	7.23	25.76	60.19	85.96	.14
*	3.000	3250.00	.00	3250.00	.00	2481.68	2481.68	2484.32	6.48	13.13	48.11	61.24	.00
*	3.000	3300.00	.00	3300.00	.00	2481.74	2481.74	2484.40	6.54	13.00	48.29	61.29	.08
*	3.000	3350.00	.00	3350.00	.00	2481.80	2481.80	2484.47	6.60	12.88	48.46	61.34	.16
*	4.000	3250.00	.00	3250.00	.00	2484.09	.00	2485.42	8.42	8.52	54.56	63.08	.00
*	4.000	3300.00	.00	3300.00	.00	2484.16	.00	2485.50	8.49	8.37	54.76	63.14	.08
*	4.000	3350.00	.00	3350.00	.00	2484.23	.00	2485.58	8.56	8.22	54.97	63.20	.16
	5.000	3250.00	.00	3250.00	.00	2484.70	.00	2486.13	8.06	8.06	55.17	63.23	.00
	5.000	3300.00	.00	3300.00	.00	2484.77	.00	2486.21	8.13	7.90	55.39	63.29	.08
	5.000	3350.00	.00	3350.00	.00	2484.84	.00	2486.29	8.20	7.74	55.61	63.35	.16
	6.000	3250.00	.00	3250.00	.00	2485.52	.00	2486.84	8.08	5.27	58.55	63.81	.00
	6.000	3300.00	.00	3300.00	.00	2485.59	.00	2486.92	8.15	5.07	58.81	63.88	.08
	6.000	3350.00	.00	3350.00	.00	2485.66	.00	2487.00	8.22	4.88	59.06	63.95	.16
	7.000	3250.00	.00	3250.00	.00	2486.20	.00	2487.51	8.04	4.93	59.24	64.17	.00
	7.000	3300.00	.00	3300.00	.00	2486.27	.00	2487.59	8.11	4.74	59.50	64.24	.08
	7.000	3350.00	.00	3350.00	.00	2486.34	.00	2487.66	8.18	4.55	59.75	64.30	.16
	8.000	3250.00	.00	3250.00	.00	2486.96	.00	2488.15	8.26	3.73	60.94	64.67	.00
	8.000	3300.00	.00	3300.00	.00	2487.03	.00	2488.23	8.33	3.53	61.21	64.74	.08
	8.000	3350.00	.00	3350.00	.00	2487.10	.00	2488.31	8.40	3.34	61.47	64.81	.16

SECNO	Q	QLOB	QCH	QROB	CWSEL	CRWS	EG	DEPTH	SSTA	TOPWID	ENDST	DIFEG
9.000	3250.00	.00	3250.00	.00	2487.51	.00	2488.66	8.11	1.60	63.85	65.45	.00
9.000	3300.00	.00	3300.00	.00	2487.58	.00	2488.74	8.18	1.38	64.13	65.52	.08
9.000	3350.00	.00	3350.00	.00	2487.65	.00	2488.82	8.25	1.15	64.44	65.59	.15
10.000	3250.00	.00	1116.35	2133.65	2489.90	.00	2489.99	1.90	.97	1335.27	1336.24	.00
10.000	3300.00	.00	1153.94	2146.06	2489.93	.00	2490.02	1.93	.96	1336.80	1337.76	.03
* 10.000	3350.00	.00	1191.23	2158.77	2489.97	.00	2490.05	1.97	.95	1338.35	1339.30	.06

South Channel

SUMMARY PRINTOUT TABLE 150

SECH0	XLCH	ELTRD	ELLC	ELHIN	Q	CWSEL	CRWS	EG	10*KS	VCH	AREA	.01K	
*	1.000	.00	.00	.00	2468.90	3250.00	2475.93	2475.93	2478.18	58.99	12.05	269.69	423.15
*	1.000	.00	.00	.00	2468.90	3300.00	2475.99	2475.99	2478.25	58.73	12.08	273.20	430.61
*	1.000	.00	.00	.00	2468.90	3350.00	2476.04	2476.04	2478.32	58.55	12.11	276.56	437.80
*	2.000	250.00	.00	.00	2471.80	3250.00	2478.92	2478.92	2481.19	58.18	12.08	268.95	426.10
*	2.000	250.00	.00	.00	2471.80	3300.00	2478.97	2478.97	2481.26	58.11	12.13	272.12	432.89
*	2.000	250.00	.00	.00	2471.80	3350.00	2479.03	2479.03	2481.33	58.02	12.17	275.32	439.82
*	3.000	300.00	.00	.00	2475.20	3250.00	2481.68	2481.68	2484.32	55.44	13.02	249.69	436.48
*	3.000	300.00	.00	.00	2475.20	3300.00	2481.74	2481.74	2484.40	55.32	13.07	252.58	443.69
*	3.000	300.00	.00	.00	2475.20	3350.00	2481.80	2481.80	2484.47	55.28	13.12	255.33	450.59
*	4.000	300.00	.00	.00	2475.67	3250.00	2484.09	.00	2485.42	21.30	9.25	351.27	704.21
*	4.000	300.00	.00	.00	2475.67	3300.00	2484.16	.00	2485.50	21.32	9.30	354.96	714.62
*	4.000	300.00	.00	.00	2475.67	3350.00	2484.23	.00	2485.58	21.34	9.34	358.69	725.14
	5.000	300.00	.00	.00	2476.64	3250.00	2484.70	.00	2486.13	24.10	9.59	338.72	662.05
	5.000	300.00	.00	.00	2476.64	3300.00	2484.77	.00	2486.21	24.08	9.63	342.52	672.46
	5.000	300.00	.00	.00	2476.64	3350.00	2484.84	.00	2486.29	24.06	9.67	346.34	682.99
	6.000	300.00	.00	.00	2477.44	3250.00	2485.52	.00	2486.84	22.34	9.20	353.35	687.60
	6.000	300.00	.00	.00	2477.44	3300.00	2485.59	.00	2486.92	22.30	9.23	357.49	698.87
	6.000	300.00	.00	.00	2477.44	3350.00	2485.66	.00	2487.00	22.25	9.26	361.63	710.19
	7.000	300.00	.00	.00	2478.16	3250.00	2486.20	.00	2487.51	22.37	9.17	354.37	687.17
	7.000	300.00	.00	.00	2478.16	3300.00	2486.27	.00	2487.59	22.33	9.21	358.50	698.36
	7.000	300.00	.00	.00	2478.16	3350.00	2486.34	.00	2487.66	22.31	9.24	362.49	709.22
	8.000	300.00	.00	.00	2478.70	3250.00	2486.96	.00	2488.15	19.86	8.76	371.16	729.26
	8.000	300.00	.00	.00	2478.70	3300.00	2487.03	.00	2488.23	19.84	8.79	375.38	740.82
	8.000	300.00	.00	.00	2478.70	3350.00	2487.10	.00	2488.31	19.84	8.83	379.49	752.10
	9.000	280.00	.00	.00	2479.40	3250.00	2487.51	.00	2488.66	16.79	8.63	376.43	793.18
	9.000	280.00	.00	.00	2479.40	3300.00	2487.58	.00	2488.74	16.77	8.67	380.73	805.76
	9.000	280.00	.00	.00	2479.40	3350.00	2487.65	.00	2488.82	16.73	8.70	385.26	819.11
	10.000	1085.00	.00	.00	2488.00	3250.00	2489.90	.00	2489.99	9.83	1.86	1413.02	1036.65
	10.000	1085.00	.00	.00	2488.00	3300.00	2489.93	.00	2490.02	9.15	1.84	1459.34	1090.75
*	10.000	1085.00	.00	.00	2488.00	3350.00	2489.97	.00	2490.05	8.53	1.83	1506.36	1146.82

South Channel

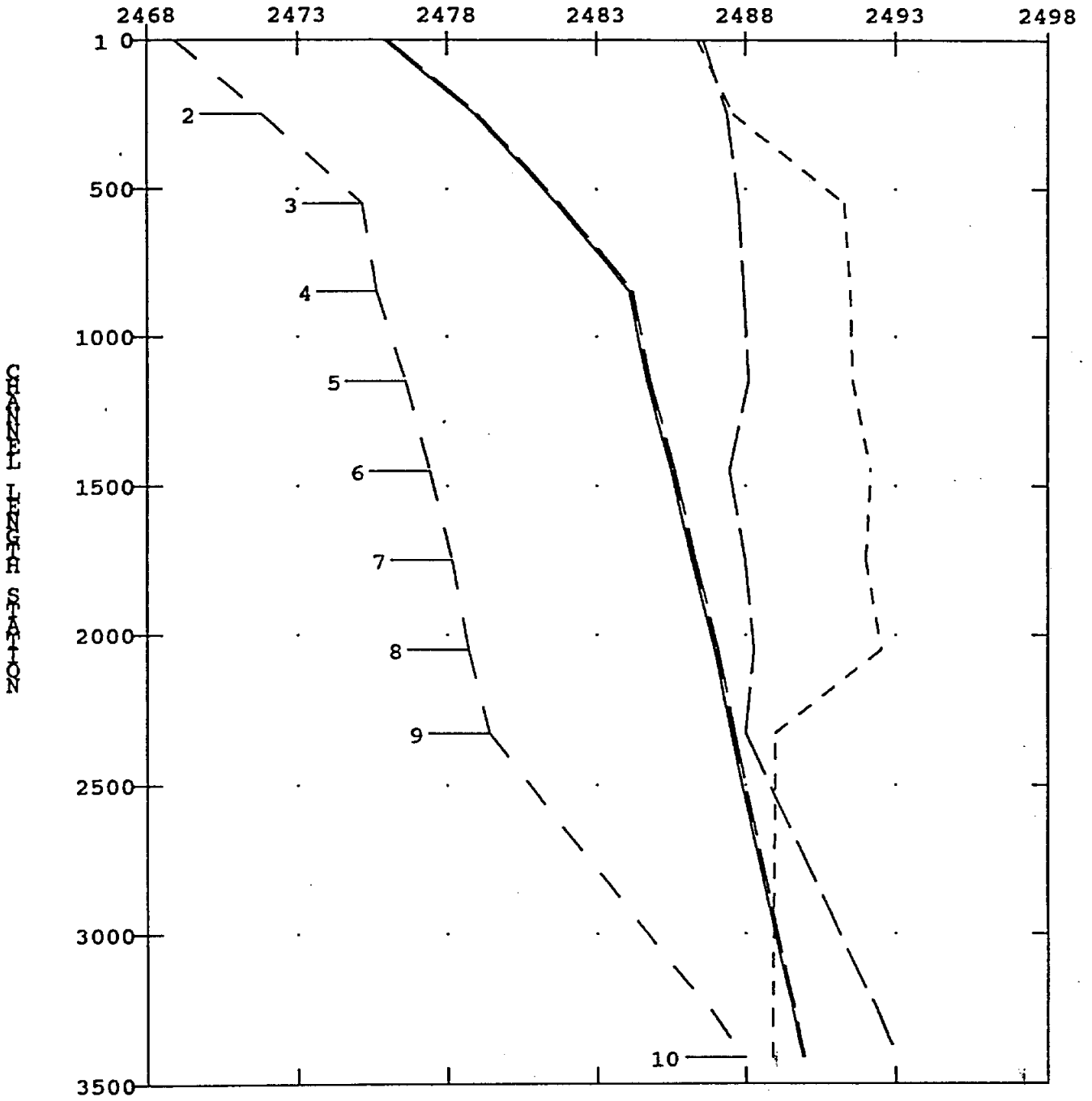
SUMMARY PRINTOUT TABLE 150

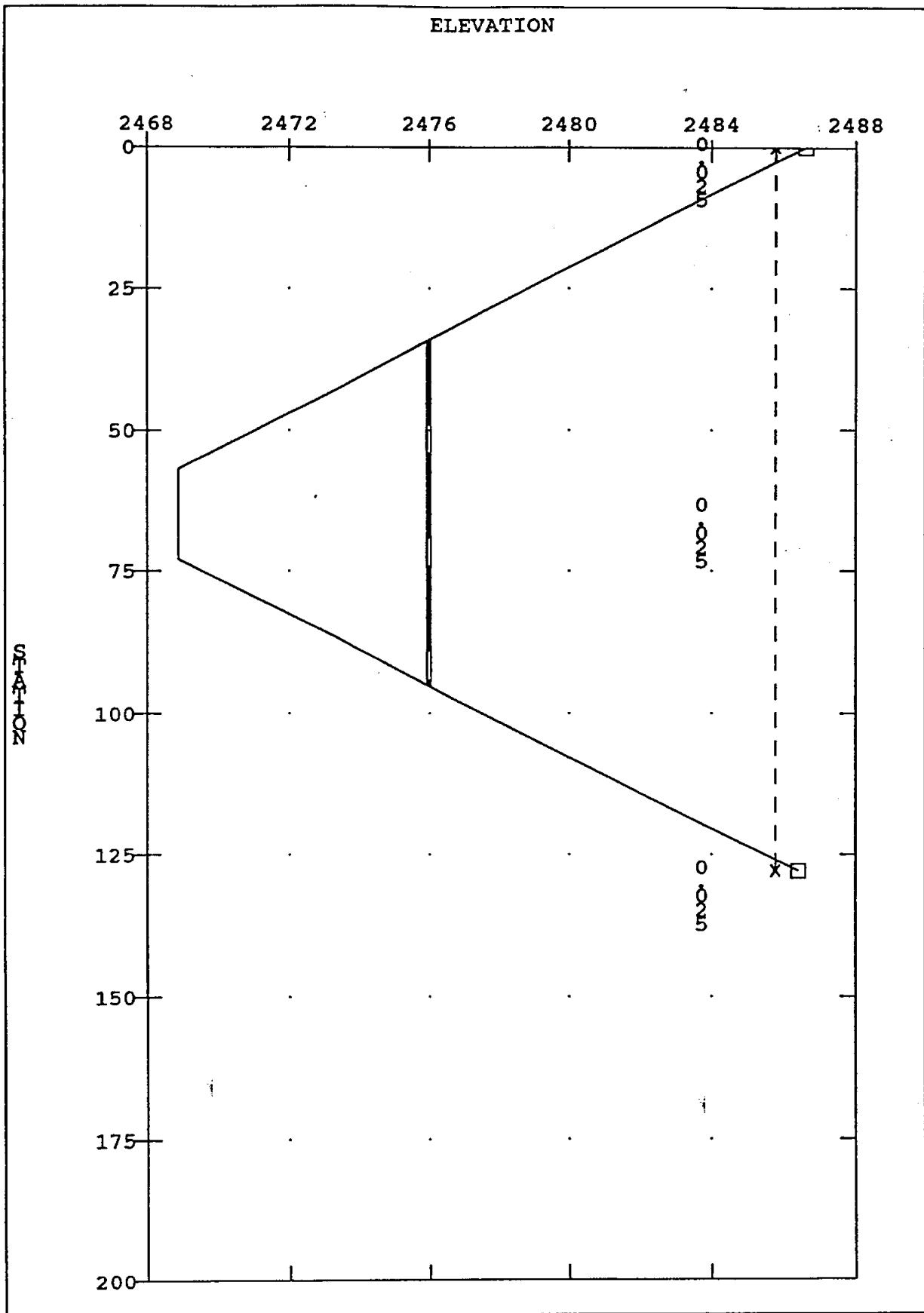
	SECNO	Q	CNSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	1.000	3250.00	2475.93	.00	.00	3.93	60.73	.00
*	1.000	3300.00	2475.99	.06	.00	3.99	61.10	.00
*	1.000	3350.00	2476.04	.05	.00	4.04	61.45	.00
*	2.000	3250.00	2478.92	.00	2.99	.00	59.54	250.00
*	2.000	3300.00	2478.97	.05	2.99	.00	59.87	250.00
*	2.000	3350.00	2479.03	.05	2.99	.00	60.19	250.00
*	3.000	3250.00	2481.68	.00	2.76	.00	48.11	300.00
*	3.000	3300.00	2481.74	.06	2.77	.00	48.29	300.00
*	3.000	3350.00	2481.80	.06	2.77	.00	48.46	300.00
*	4.000	3250.00	2484.09	.00	2.41	.00	54.56	300.00
*	4.000	3300.00	2484.16	.07	2.41	.00	54.76	300.00
*	4.000	3350.00	2484.23	.07	2.42	.00	54.97	300.00
	5.000	3250.00	2484.70	.00	.61	.00	55.17	300.00
	5.000	3300.00	2484.77	.07	.61	.00	55.39	300.00
	5.000	3350.00	2484.84	.07	.61	.00	55.61	300.00
	6.000	3250.00	2485.52	.00	.82	.00	58.55	300.00
	6.000	3300.00	2485.59	.07	.82	.00	58.81	300.00
	6.000	3350.00	2485.66	.07	.83	.00	59.06	300.00
	7.000	3250.00	2486.20	.00	.68	.00	59.24	300.00
	7.000	3300.00	2486.27	.07	.68	.00	59.50	300.00
	7.000	3350.00	2486.34	.07	.68	.00	59.75	300.00
	8.000	3250.00	2486.96	.00	.76	.00	60.94	300.00
	8.000	3300.00	2487.03	.07	.76	.00	61.21	300.00
	8.000	3350.00	2487.10	.07	.76	.00	61.47	300.00
	9.000	3250.00	2487.51	.00	.55	.00	63.85	280.00
	9.000	3300.00	2487.58	.07	.55	.00	64.13	280.00
	9.000	3350.00	2487.65	.07	.55	.00	64.44	280.00
	10.000	3250.00	2489.90	.00	2.39	.00	1335.27	1085.00
	10.000	3300.00	2489.93	.03	2.36	.00	1336.80	1085.00
*	10.000	3350.00	2489.97	.04	2.32	.00	1338.35	1085.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO=	1.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	1.000	PROFILE=	2	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	1.000	PROFILE=	3	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	2.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	2.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	2.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	2.000	PROFILE=	2	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	2.000	PROFILE=	2	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	2.000	PROFILE=	2	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	2.000	PROFILE=	3	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	2.000	PROFILE=	3	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	2.000	PROFILE=	3	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	3.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	3.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
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CAUTION SECNO=	3.000	PROFILE=	2	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	3.000	PROFILE=	3	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	3.000	PROFILE=	3	PROBABLE MINIMUM SPECIFIC ENERGY
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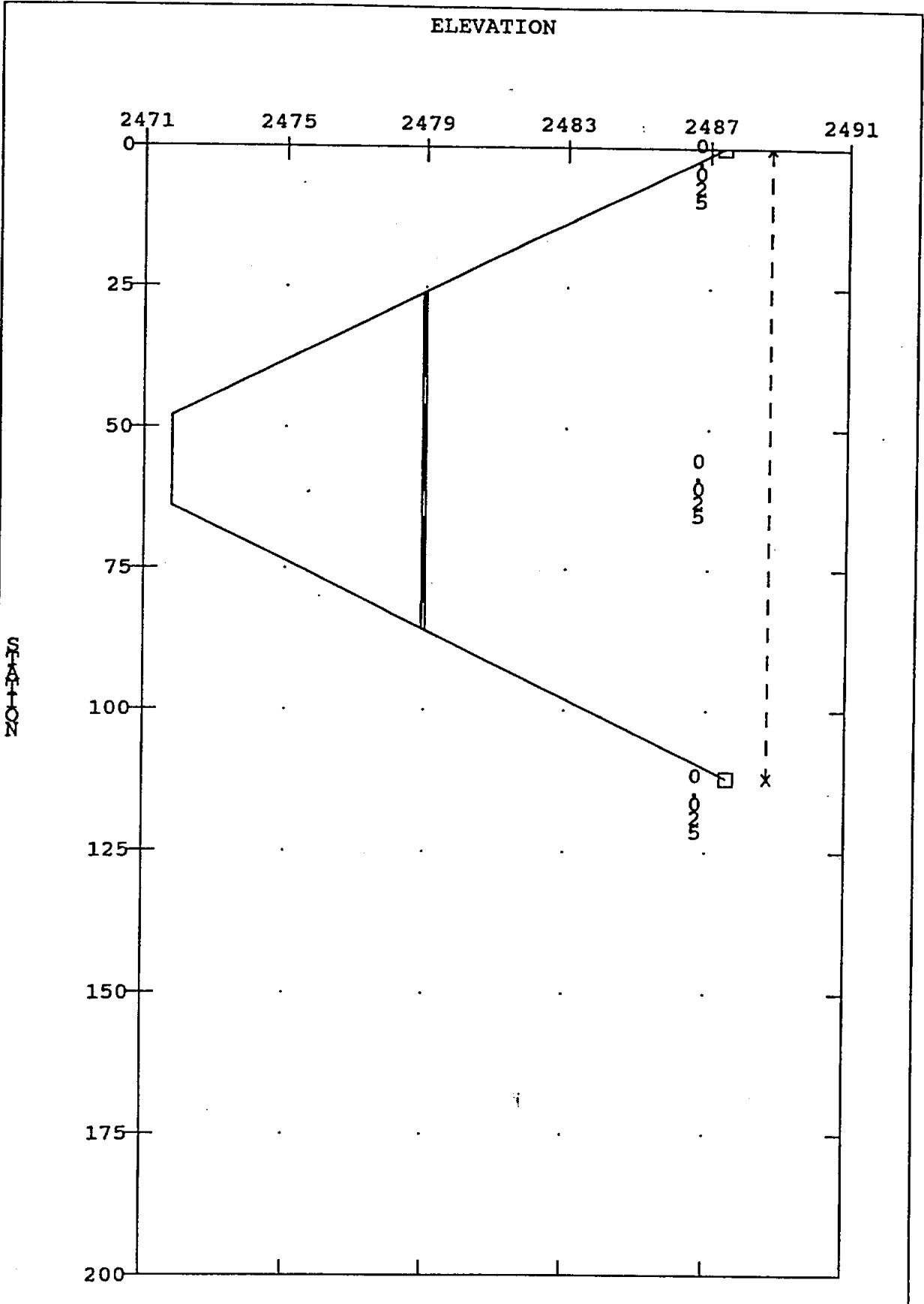
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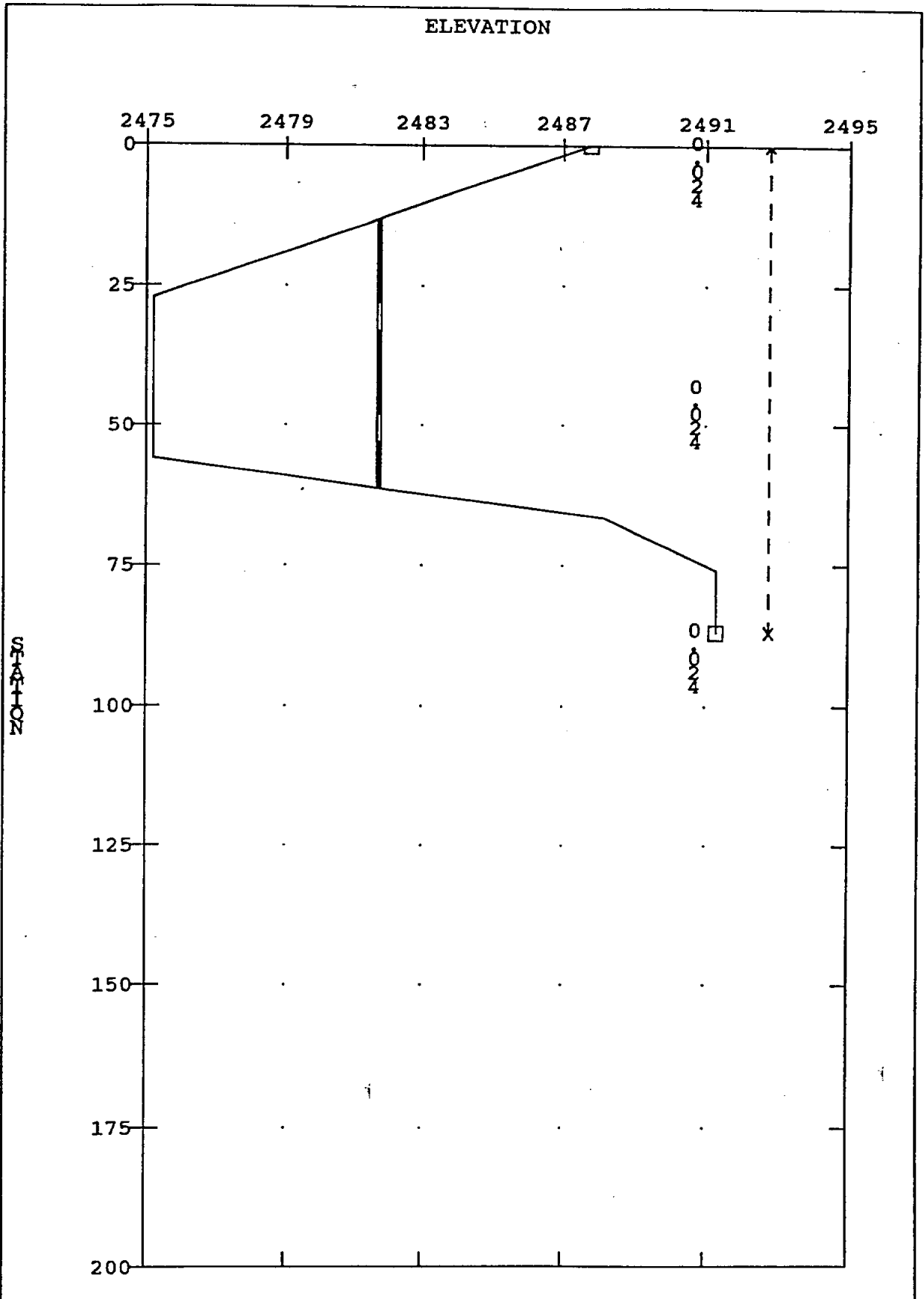
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South Channel



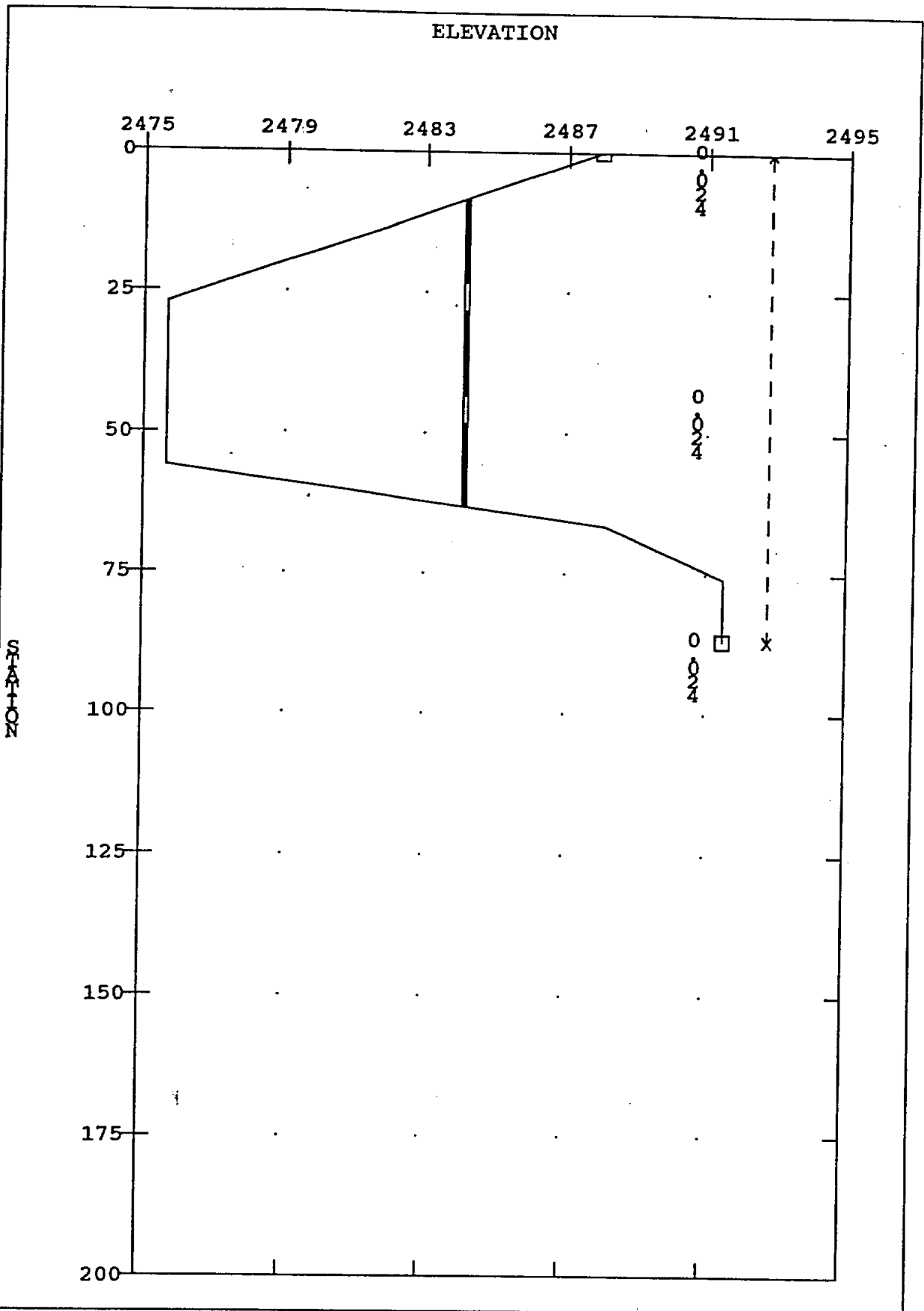
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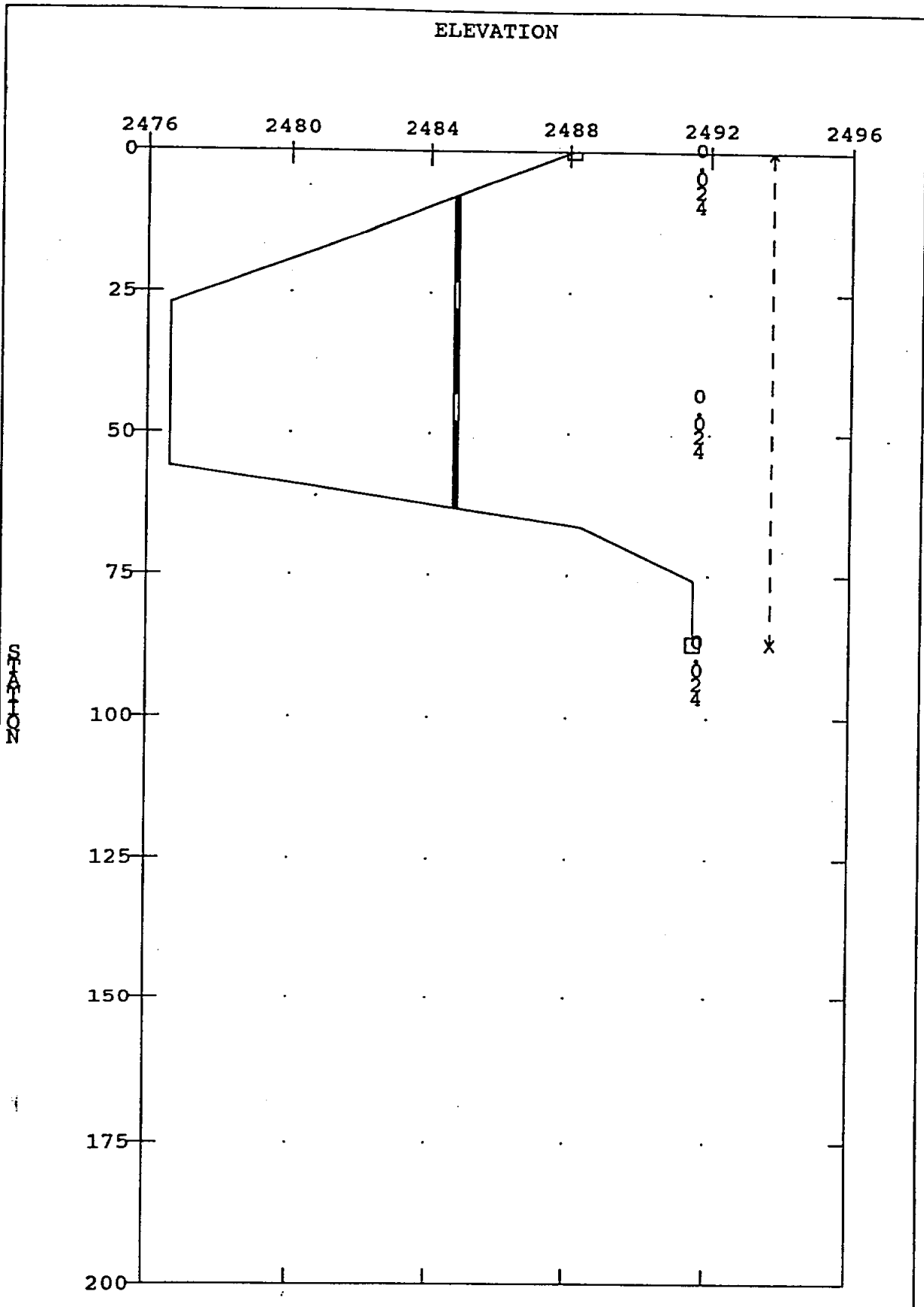
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South Channel



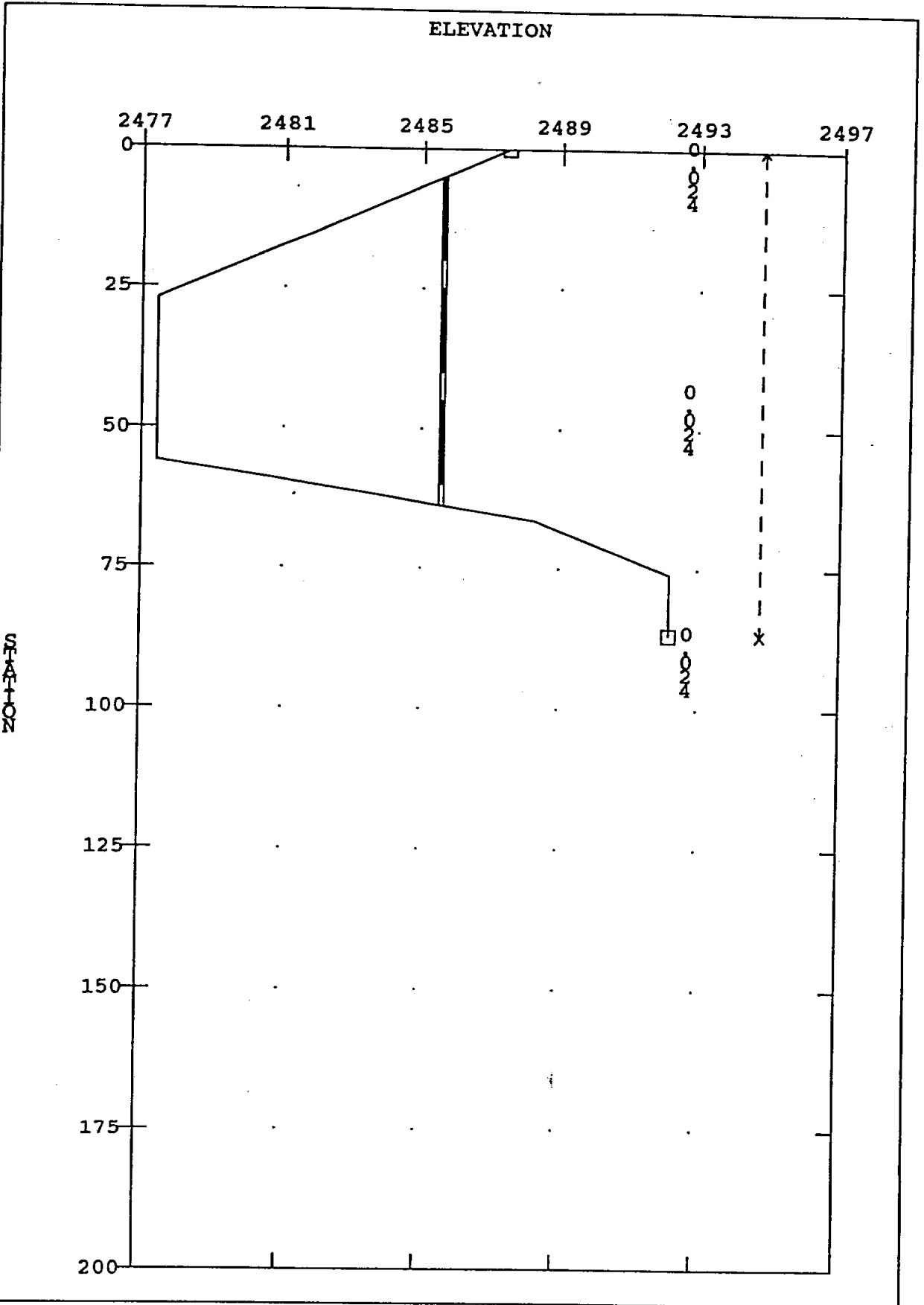
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South Channel



SECTION : 5

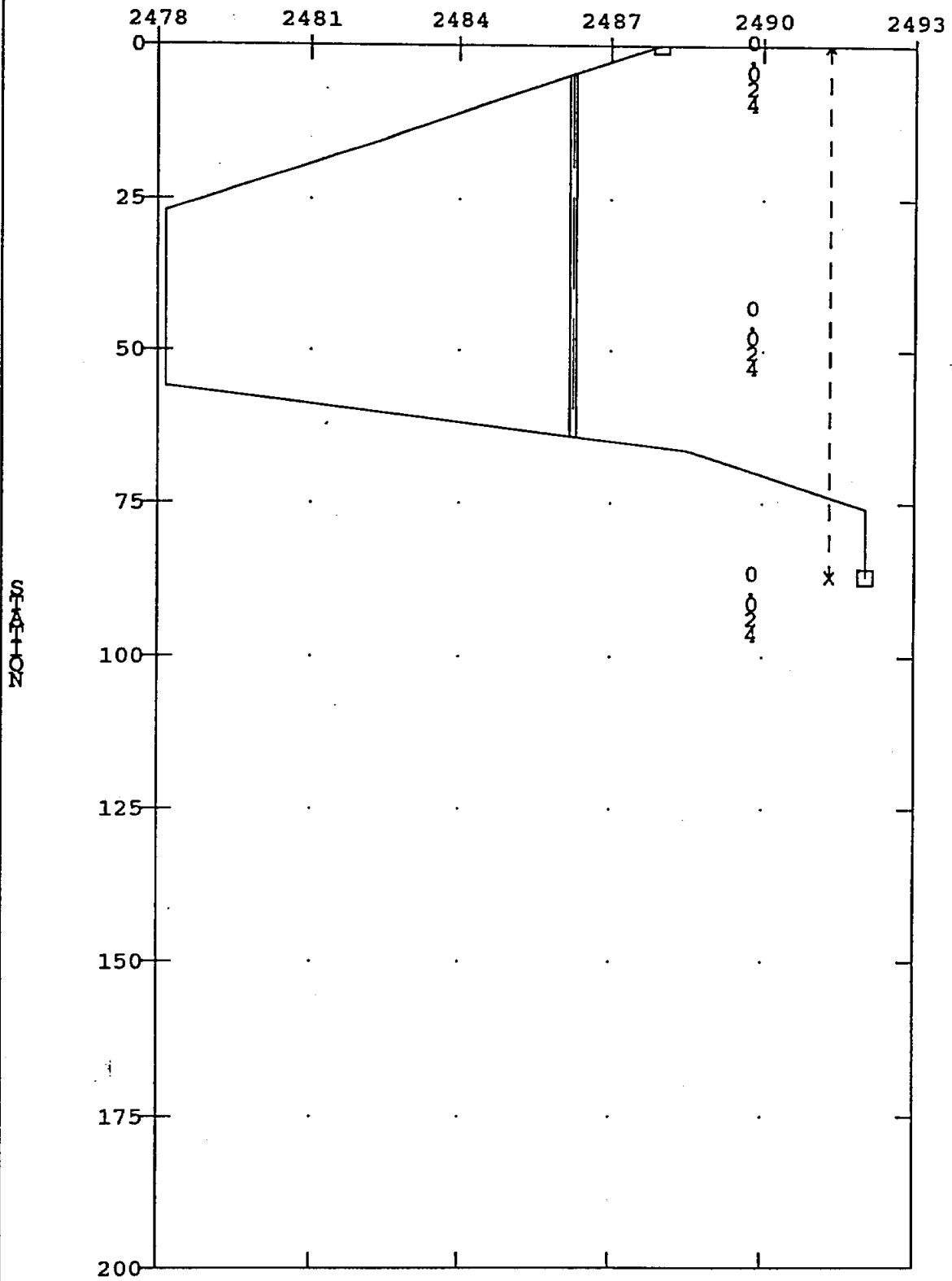
South Channel



SECTION : 6

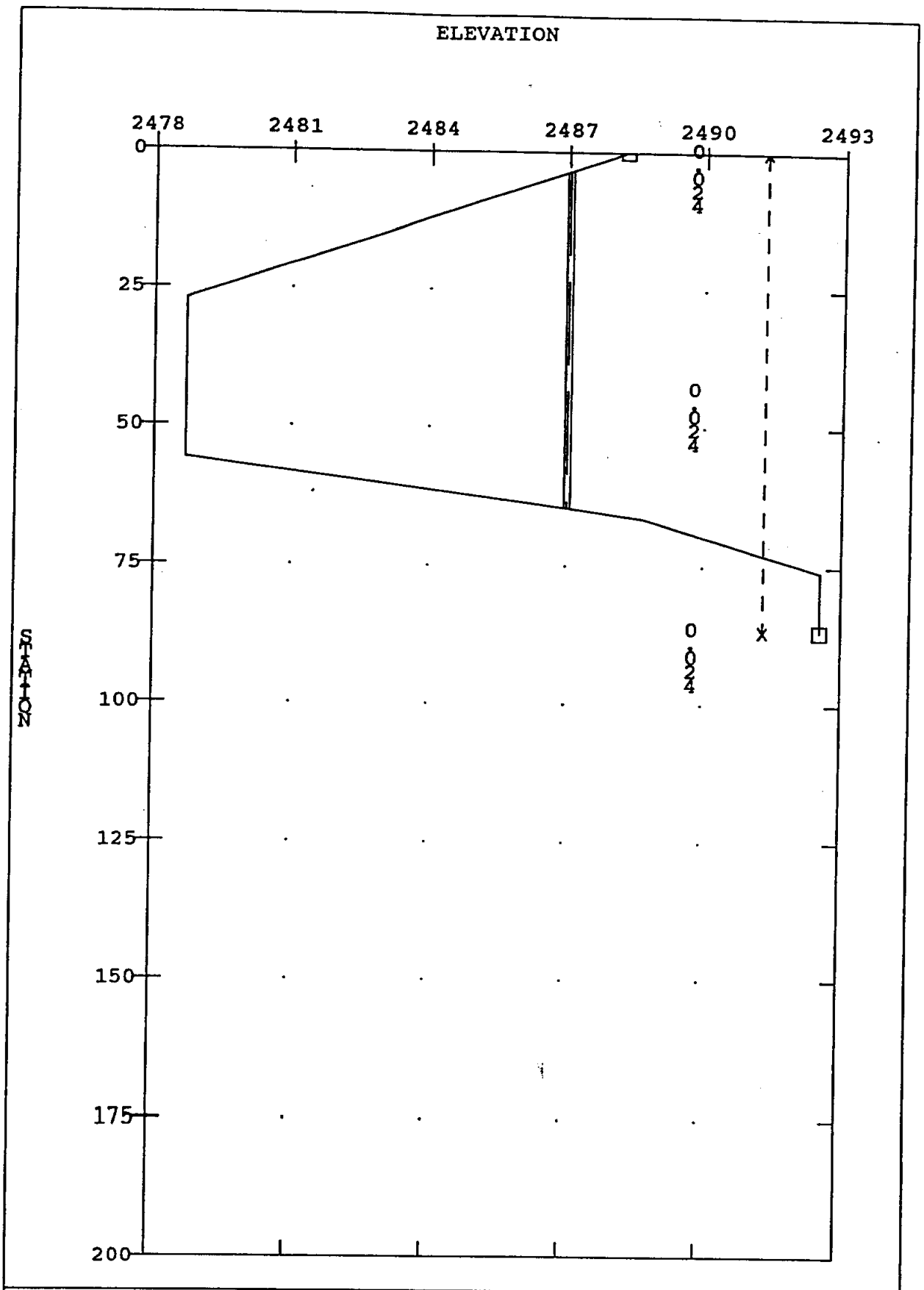
South Channel

ELEVATION



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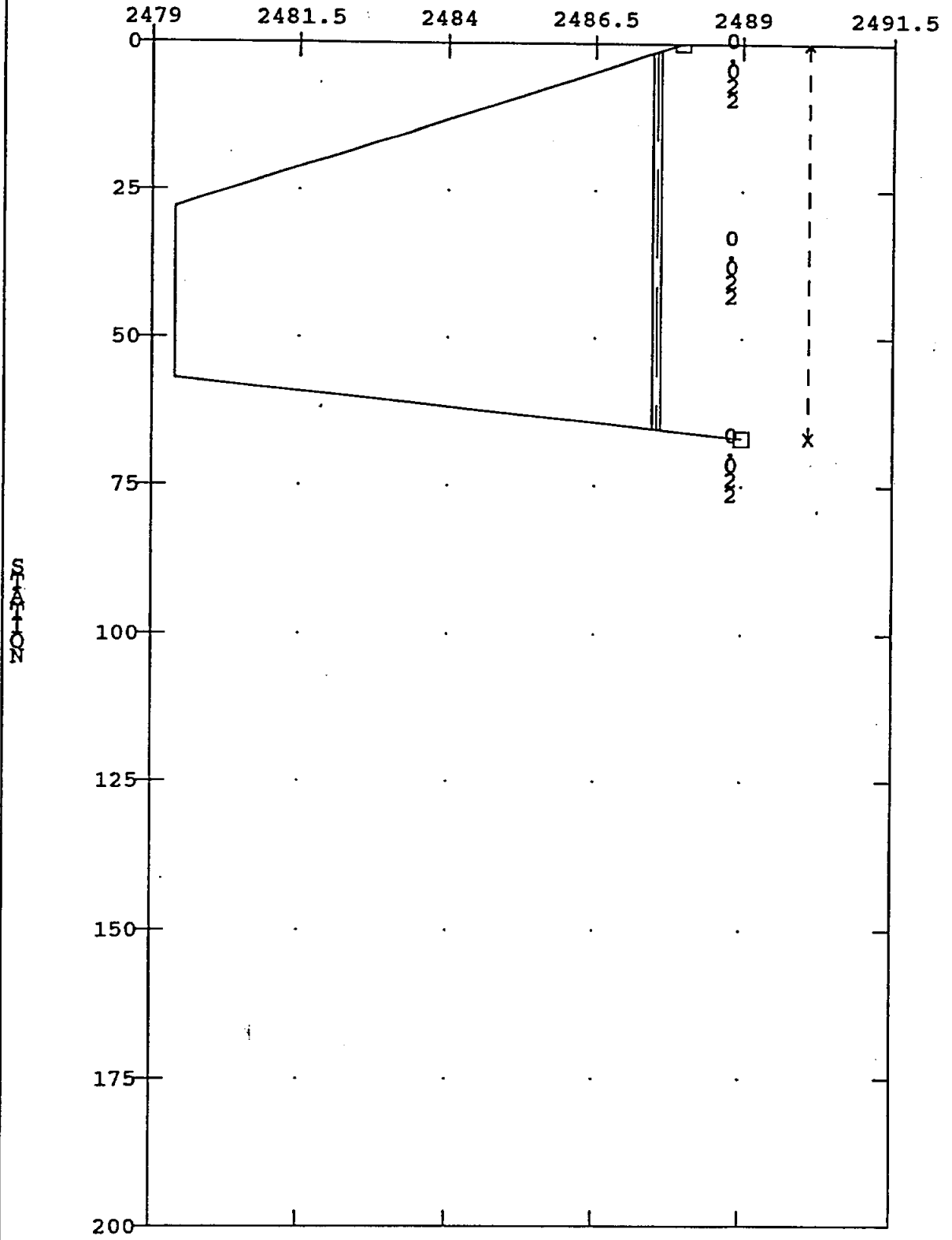
South Channel



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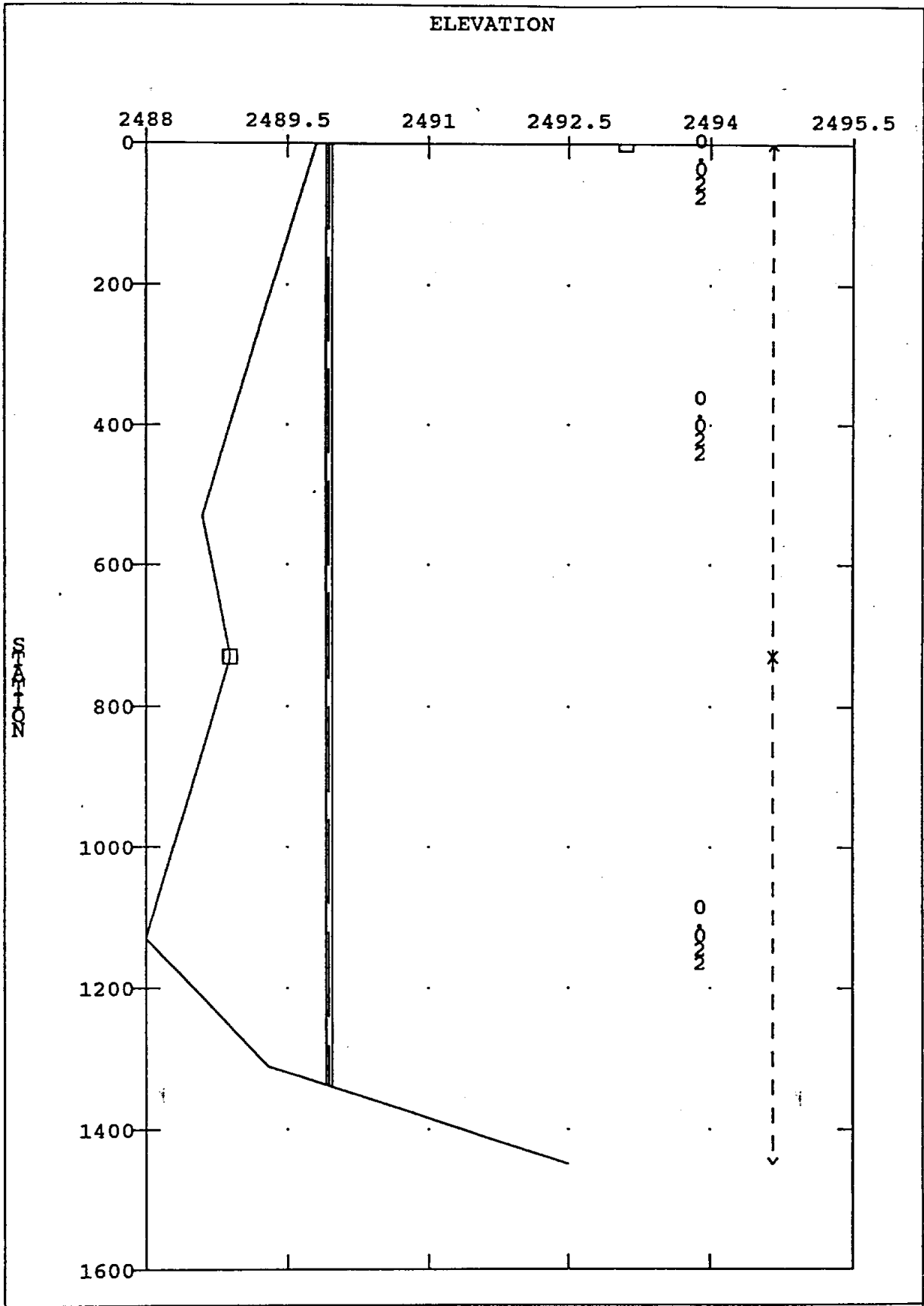
South Channel

ELEVATION



SECTION : 9

South Channel

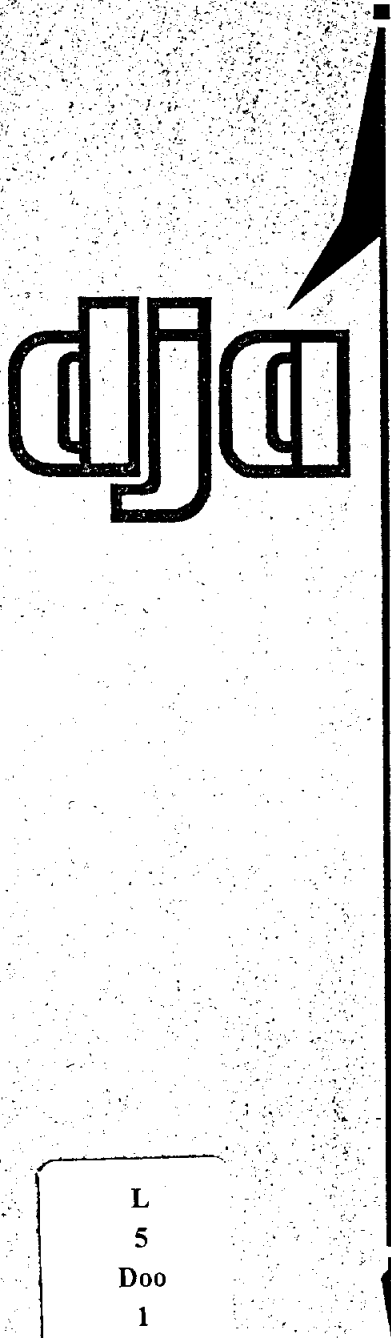


SECTION : 10

South Channel

Appendix 4

Midvale Park Master Drainage Report: study boundaries, West Branch Channel typical cross sections



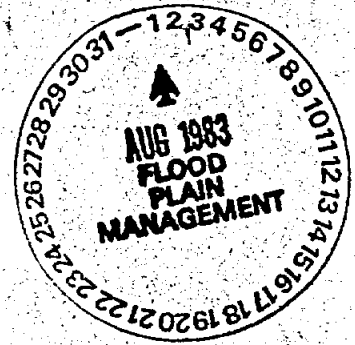
Dooley-Jones & Associates, Inc.

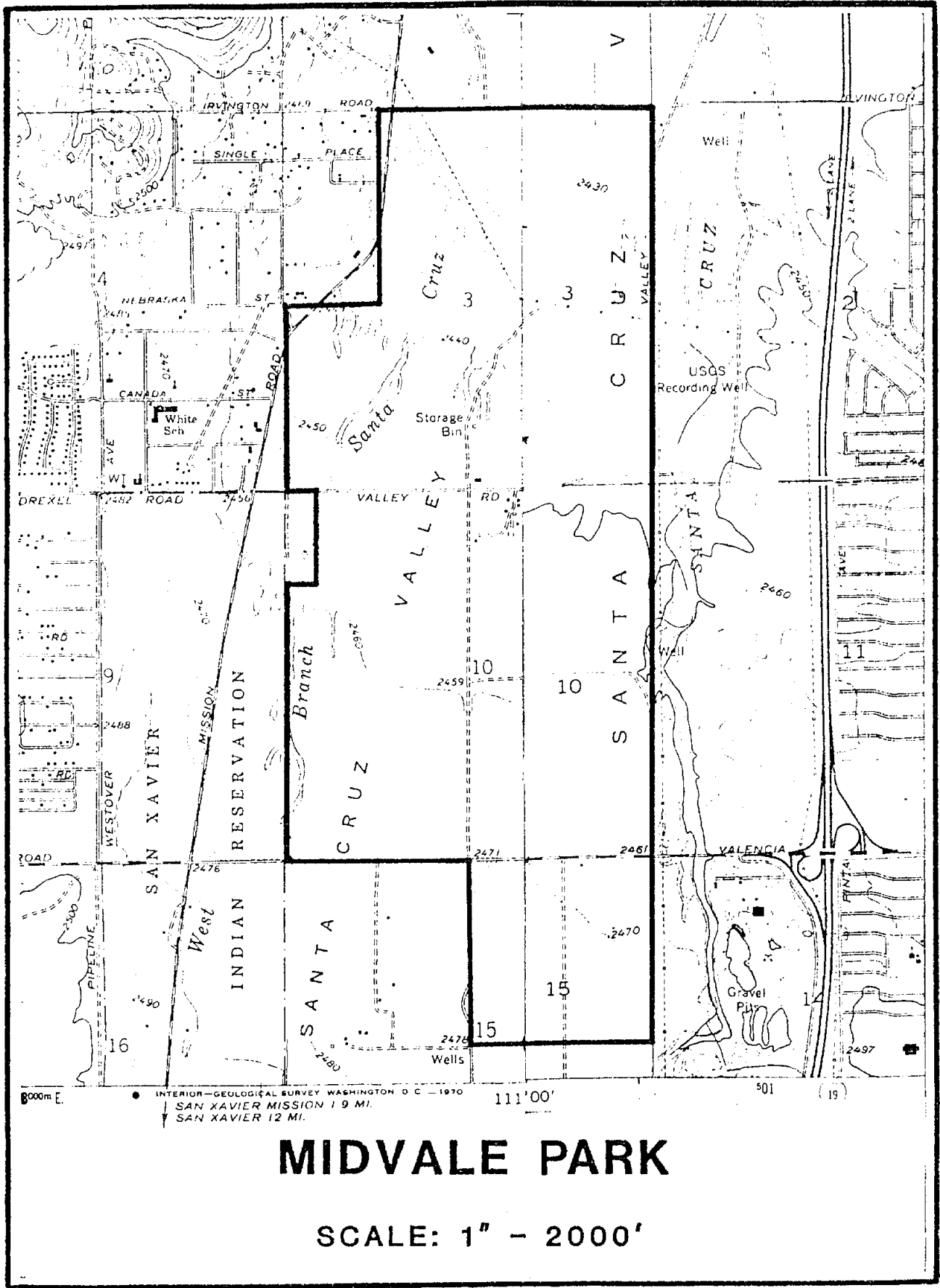
CONSULTING ENGINEERS / PLANNERS

MIDVALE PARK
MASTER DRAINAGE REPORT

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Pima County
Flood Control District Library
740-6350





MIDVALE PARK

SCALE: 1" - 2000'

LOCATION PLAN

FIGURE 1