TECHNICAL DATA NOTEBOOK

Volume IV
Hydraulic Analysis

for

SWEAT CANYON WASH
FLOOD INSURANCE STUDY

January,1999

Prepared for:

Federal Emergency Management Agency
Risk Studies Division
Federal Insurance Administration
500 C Street, SW Room 422
Washington, DC 20472

Submitted by:

David Evans and Associates, Inc.
7878 North 16th Street, Suite 250
Phoenix, Arizona 85020
(602) 678-5151

on behalf of:
Maricopa County Flood Control District
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501

TECHNICAL DATA NOTEBOOK

Volume IV
Hydraulic Analysis

for

SWEAT CANYON WASH
FLOOD INSURANCE STUDY

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

September, 1998

Prepared for:

Federal Emergency Management Agency
Risk Studies Division
Federal Insurance Administration
500 C Street, SW Room 422
Washington, DC 20472

Submitted by:

David Evans and Associates, Inc.
7878 North 16th Street, Suite 250
Phoenix, Arizona 85020
(602) 678-5151

on behalf of:
Maricopa County Flood Control District
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501

Registered Professional Engineer (Civil)
CERTIFICATE NO. 30013
TERI S. MINTZ
Date Signed 5/26/99
ARIZONA, U.S.A.

TABLE OF CONTENTS

SECTION 1: INTRODUCTION.....(VOLUME I) 1

1.1 Purpose of study 1

1.2 Authority for study 1

1.3 Location of study reach 2

1.4 Methodology 2

1.5 Acknowledgment 3

1.6 Study Results 3

SECTION 2: ADWR/FEMA FORMS....(VOLUME I) 1

Section 2.1 Study Documentation Abstract for FEMA Submittals 1

Section 2.2 FEMA 2

SECTION 3: SURVEY AND MAPPING INFORMATION.....(VOLUME II) 1

3.1 Field Survey Information 1

3.2 Mapping 2

SECTION 4: HYDROLOGIC ANALYSIS.....(VOLUME III) 1

4.1 Method description 1

4.2 Parameter estimation 1

4.3 Problems encountered during the study 19

4.4 Calibration 20

4.5 Final results 20

SECTION 5: HYDRAULIC ANALYSIS.....(VOLUME IV) 1

5.1 Method description 1

5.2 Work study maps 2

5.3 Parameter estimation 16

5.4 Cross-section descriptions 19

5.5 Modeling considerations 19

5.6 Floodway modeling 20

Registered Professional Engineer (Civil)
CERTIFICATE NO. 30016
TERRI S. MINTZ
Date Signed 5/24/99
ARIZONA, U.S.A.

5.7 Special problems encountered during the study 21

5.8 Calibration 22

5.9 References 23

5.10 Final Results 24

SECTION 7: DRAFT FIS DATA.....(VOLUME V) 1

7.1 Summary of Discharges 1

7.2 Floodway Data 2

7.3 Annotated Flood Insurance Rate Maps 7

7.4 Flood Profiles 12

FIGURES	TITLE	SECTION NO.	PAGE NO.
1	Location Map	1	4
2	Vicinity Map	1	5
3	Watershed Map	4	2
4	Schematic Routing Map	4	3
5	Grid Elevation Figure for Estimating Flood	4	22
6	FIS Overview Map	5	3
7	Work Study Maps - Reduced	5	4-15

TABLES	TITLE	SECTION NO.	PAGE NO.
4.2.6.1	Sub-basin Characteristics	4	5
4.2.6.2	Sub-basin Soil Types	4	7-13
4.2.6.3	Routing Characteristics	4	14-15
4.2.6.4	Time Step Calculations for HEC-1	4	16
4.2.6.5	Transmission Losses	4	17
4.5.1.1	Summary of Peak Runoff	4	20
5.1.1	Peak 100-year, 24-hour Discharges	5	2

EXHIBITS	TITLE	LOCATION
A	Watershed Map	Back Pocket Section 4
B	Soils Map	Back Pocket Section 4
C	Land Use Map	Back Pocket Section 4
D	Working Watershed Map	Back Pocket Section 4

APPENDIX	TITLE	SECTION NO.
A	References	4
B	General Documentation and Correspondence	4
C	Survey Field Notes	3
D	Hydrologic Analysis Supporting Documentation	4
E	Hydraulic Analysis Supporting Documentation	5

Registered Professional Engineer (Civil)
CERTIFICATE NO.
30013
TERI S.
MINTZ
Date Signed 5/26/99
ARIZONA, U.S.A.

SECTION 5: HYDRAULIC ANALYSIS

5.1 Method description

Sweat Canyon Wash is located in north central Maricopa County, Arizona. The total watershed encompasses approximately 15.5 square miles and generally flows in a south/southwesterly direction. The floodplain delineation covers Sections 19, 20, 29, 30, 31, and 32 of Township 7 North, Range 2 East, Sections 5, 6, 7, 8, 18, and 19 of Township 6 North, Range 2 East, and Section 24 of Township 6 North, Range 1 East as shown on 1:24000 scale Biscuit Flat and New River Quadrangle maps. A portion of the Sweat Canyon Wash was delineated as part of the *New River From New River Dam to Rock Springs Maricopa County, Arizona* Flood Insurance Study (FIS) prepared in 1987. Approximately three and a half miles of the Sweat Canyon Wash were delineated upstream of the confluence with New River. The Sweat Canyon Wash Flood Insurance Study incorporates thirteen additional miles of study area.

The lower reach of Sweat Canyon Wash has an average slope of 0.005 ft/ft increasing to 0.013 ft/ft in the upper reaches. The wash bottoms are gravely to cobbly with sparse vegetation. The embankments contain medium to thick amounts of vegetation, especially in months of substantial precipitation as was the condition in the spring of 1998. The vegetation is typical Sonoran Desert, lush with creosote bush, saguaro, cholla, prickly pear cactus, palo verde and mesquite trees, and native grasses. Much of the watershed has been used for rangeland. The degree of stream meandering was determined to be minor to negligible for most of the study area and an adjustment factor of 1.0 was applied. Several portions of the reaches had appreciable meandering and an adjustment factor of 1.5 was used.

The floodplain analysis was modeled as a subcritical flow regime. The resulting water surface elevations revealed that approximately 25% of the cross sections defaulted to critical depth. Most of the cross sections that defaulted were isolated, showing some instability in flow. Cross sections were added in an attempt to stabilize the model. In most cases, the model continued to default to critical, showing that a hydraulic drop and subsequent jump occurs. Of the cross-sections that defaulted to critical, approximately 63% have Froude Numbers ranging from 0.8 to 1, indicating critical or supercritical flow.

The HEC-RAS (River System Analysis System), Version 2.2, dated Septemeber 1998, by Haested Methods was used to develop the Water Surface Profile for Sweat Canyon Wash Topographic Mapping and Floodplain Delineation Study. The starting water surface elevation was selected from the existing Flood Insurance Study (New River Floodplain Delineation, from New River Dam Reservoir to Rock Springs, Coe & Van Loo, 1988). The first three (3) cross-sections (3.873-4.129) of this study were taken from the New River Floodplain Delineation Study (Ref. 3). The starting water surface elevation for the study was selected as 1703.84' MSL at cross-section 3.873. However, the HEC-RAS program defaulted to critical giving a starting water surface elevation of 1704.11' MSL. This cross-section is beyond the mapping limits and is not shown on the Work Study Maps. The 100-year, 24-hour storm for this study produces a discharge of 13,677 cfs, which is greater than that (12,400 cfs) used for the New River Floodplain Delineation Study. However, the use of the new 100-year, 24-hour discharge from this study results in insignificant increases (less than 0.5') of computed water surface elevation at cross-section 4.019-4.129. Additionally, the differences in floodplain widths for the same cross-sections were also determined to be less than 10% of the effective FIRM map scale of 1"=1000'. Starting

water surface elevations for tributary washes were based on the normal depth method as directed by FEMA.

Representative 100 year 24 hour storm discharges at key locations within the study area are listed in Table 5.1.1.

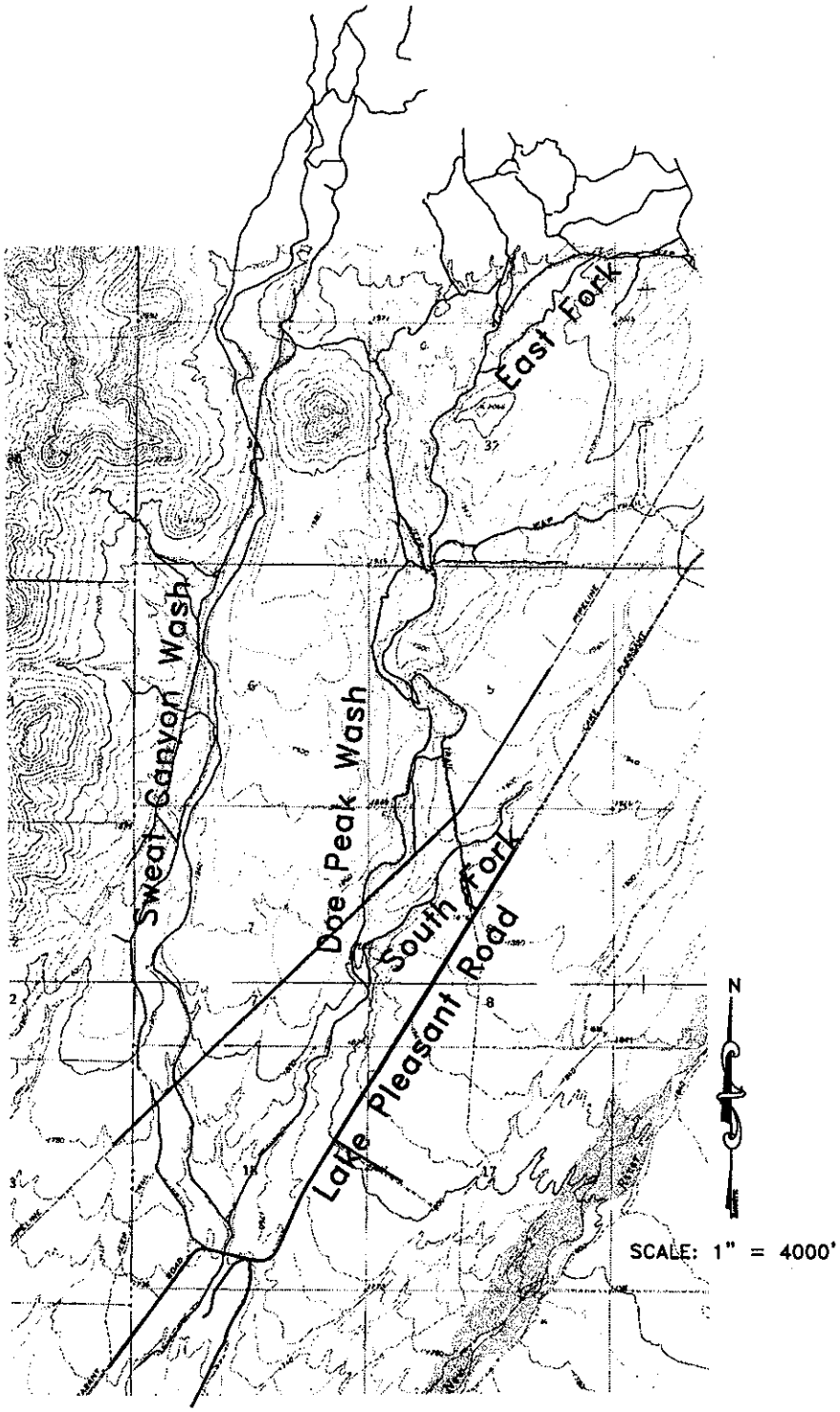
Peak 100 year-24 hour Discharges
Table 5.1.1

X-section to X-section	$Q_{100\ yrs\ 24\ hrs}$ (cfs)	X-section to X-section	$Q_{100\ yrs\ 24\ hrs}$ (cfs)
3.878 to 4.019	12,400	10.371 to 10.465	3,977
4.129 to 4.867	13,677	10.560 to 10.623	3,574
5.134 to 6.590	7,174	0.018 to 1.231 (Doe Peak)	7,335
6.684 to 7.442	6,481	1.343 to 2.734 (Doe Peak)	5,677
7.554 to 7.631	6,035	2.859 to 3.707 (Doe Peak)	3,715
7.726 to 8.105	5,718	3.804 to 4.138 (Doe Peak)	3,719
8.200 to 8.926	5,811	4.185 to 4.696 (Doe Peak)	1,392
9.010 to 9.518	5,396	0.102 to 0.984 (South Fork)	1,890
9.613 to 9.992	5,172	1.040 (South Fork)	1,639
10.087 to 10.276	4,375	0.094 to 0.661 (East Fork)	1,458

5.2 Work study maps

This flood insurance study includes topographic mapping and floodplain delineation of the Sweat Canyon Wash and its main tributary, Doe Peak Wash. Two additional tributaries, South Fork Doe Peak Wash and East Fork Doe Peak Wash, collect flood waters from the contributing drainage area and confluence with the Doe Peak Wash. The 100 year 24 hour discharges from South Fork Doe Peak Wash is approximately 2,000 cfs, while East Fork Doe Peak Wash contributes approximately 1,500 cfs to the main stream of Doe Peak Wash. A general overview map of the study area (Figure 6) is shown on the following page.

Figure 7 (Sheets 1 through 12) shows the location of the cross-sections, floodplain/floodway boundaries, and the computed water surface elevations for the Sweat Canyon Wash Topographic Mapping and Floodplain Delineation Study. The full size (24" X 36") work study maps are located in the map pockets of this notebook.



FIS OVERVIEW MAP

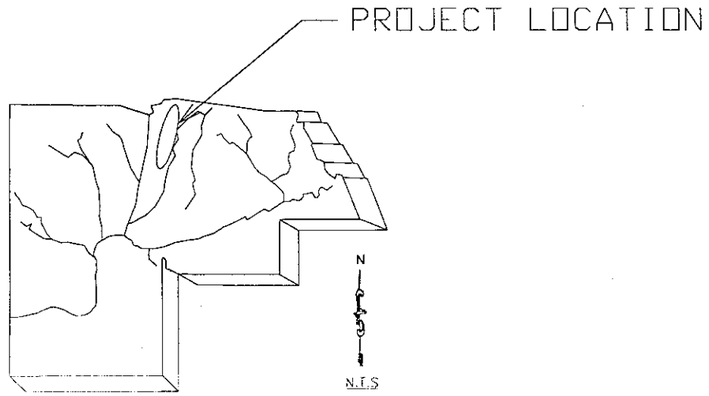
FIGURE 6

MARIO tjcl 09/16/98 10:51:29 tjcl M29fig6

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
SWEAT CANYON WASH

FLOOD DELINEATION STUDY

F.C.D. CONTRACT NO. 97-12



LOCATION MAP

DATUM

All elevations are based on National Geodetic Vertical Datum of 1929.

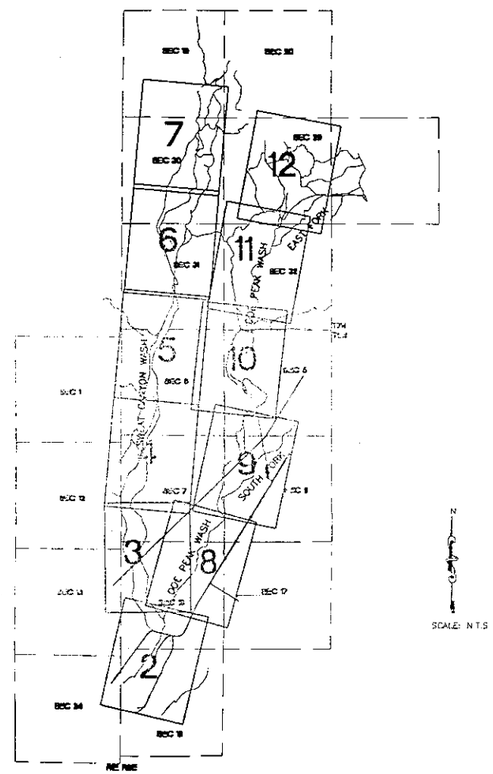
STATEMENTS BY PROFESSIONAL REGISTRANTS

The ground control survey was prepared under my direct supervision:

The following statements apply to the individual seals affixed to each of the maps following this cover sheet.

The photogrammerty and topographic mapping were prepared under direct supervision:

The floodplain and floodway delineation were prepared under my direct supervision:



STUDY AREA MAP
AND SHEET INDEX

SHEET INDEX

Sheet 2-12 Flood Delineation Study

AERIAL MAPPING

Aerial Mapping Company, Inc.
3141 W. Clarendon Ave.
Phoenix, AZ 85017 (602) 263-5728

Flight Date: 9/23/97 and 11/7/97
Contour Interval: 2 Feet

GROUND CONTROL

David Evans and Associates, Inc.
7878 N. 16th St., Ste. 250
Phoenix, AZ 85320 (602) 678-5151

ADDITIONAL SURVEY

David Evans and Associates, Inc.
7878 N. 16th St., Ste. 250
Phoenix, AZ 85320 (602) 678-5151

HYDROLOGY

David Evans and Associates, Inc.
7878 N. 16th St., Ste. 250
Phoenix, AZ 85320 (602) 678-5151

HYDRAULICS

David Evans and Associates, Inc.
7878 N. 16th St., Ste. 250
Phoenix, AZ 85320 (602) 678-5151

LEGEND

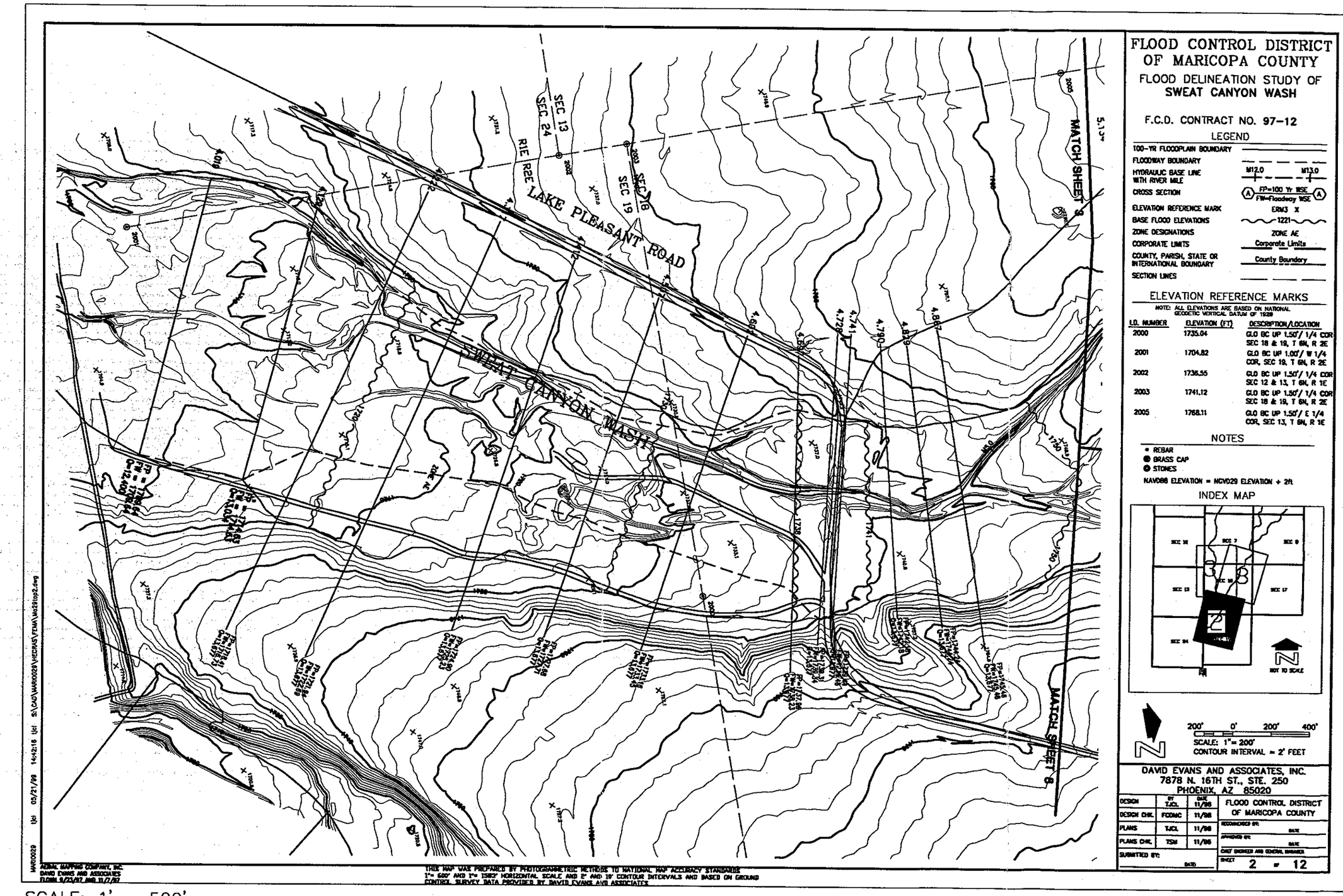
Section Label
Sheet Limits
Sheet Number 8
Study Wash
Section Line

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	
PLANS	TJCL	11/98	RECOMMENDED BY: DATE
PLANS CHK.	TSM	11/98	APPROVED BY: DATE
SUBMITTED BY: DATE			CHIEF ENGINEER AND GENERAL MANAGER
			SHEET 1 OF 12

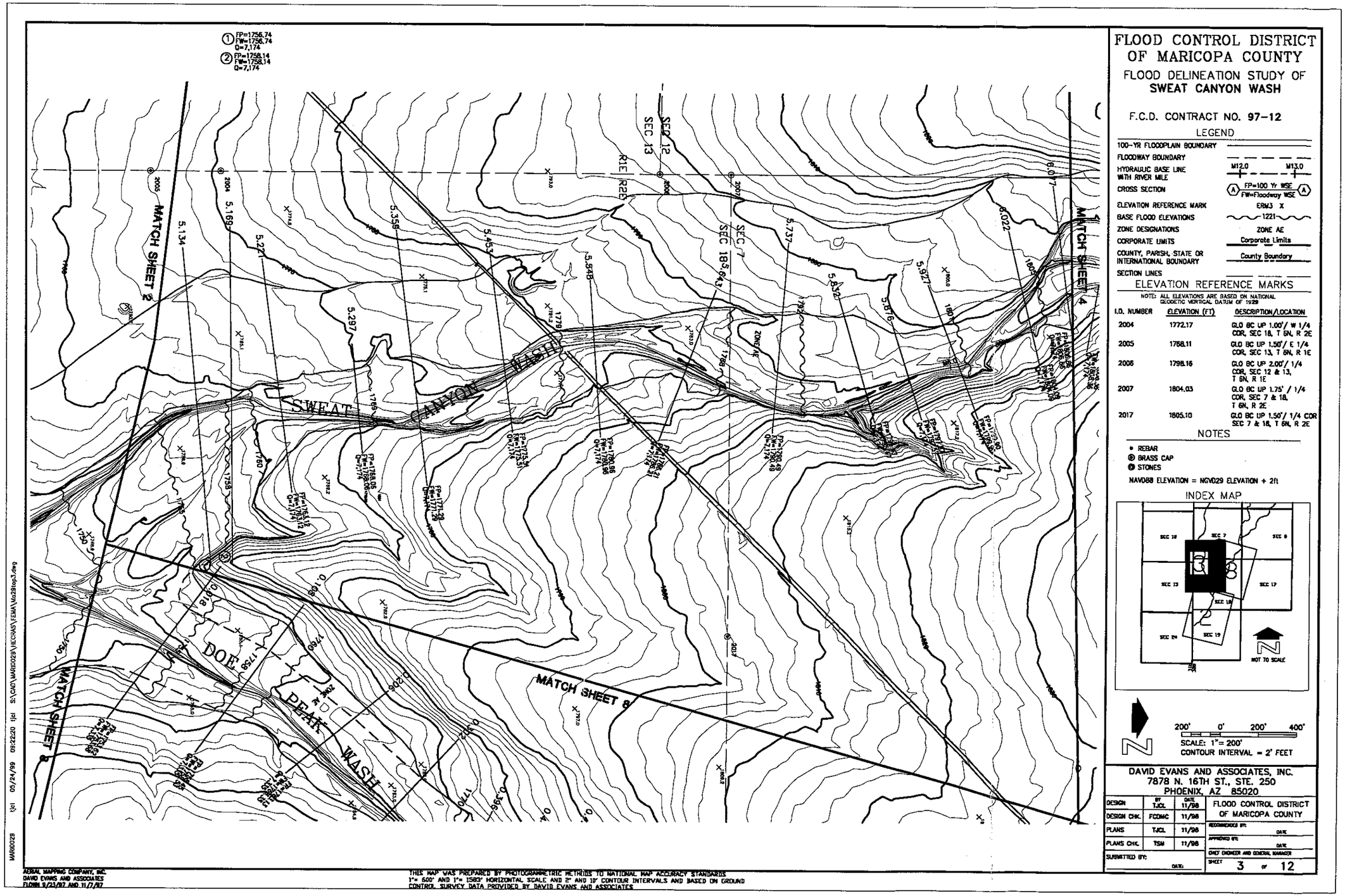
MARIOO29 tjcl 01/04/99 14:15:34 tjcl S:\CAD\MARIOO29\HECRAS\Wu29sect1.dwg

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 1 OF 12



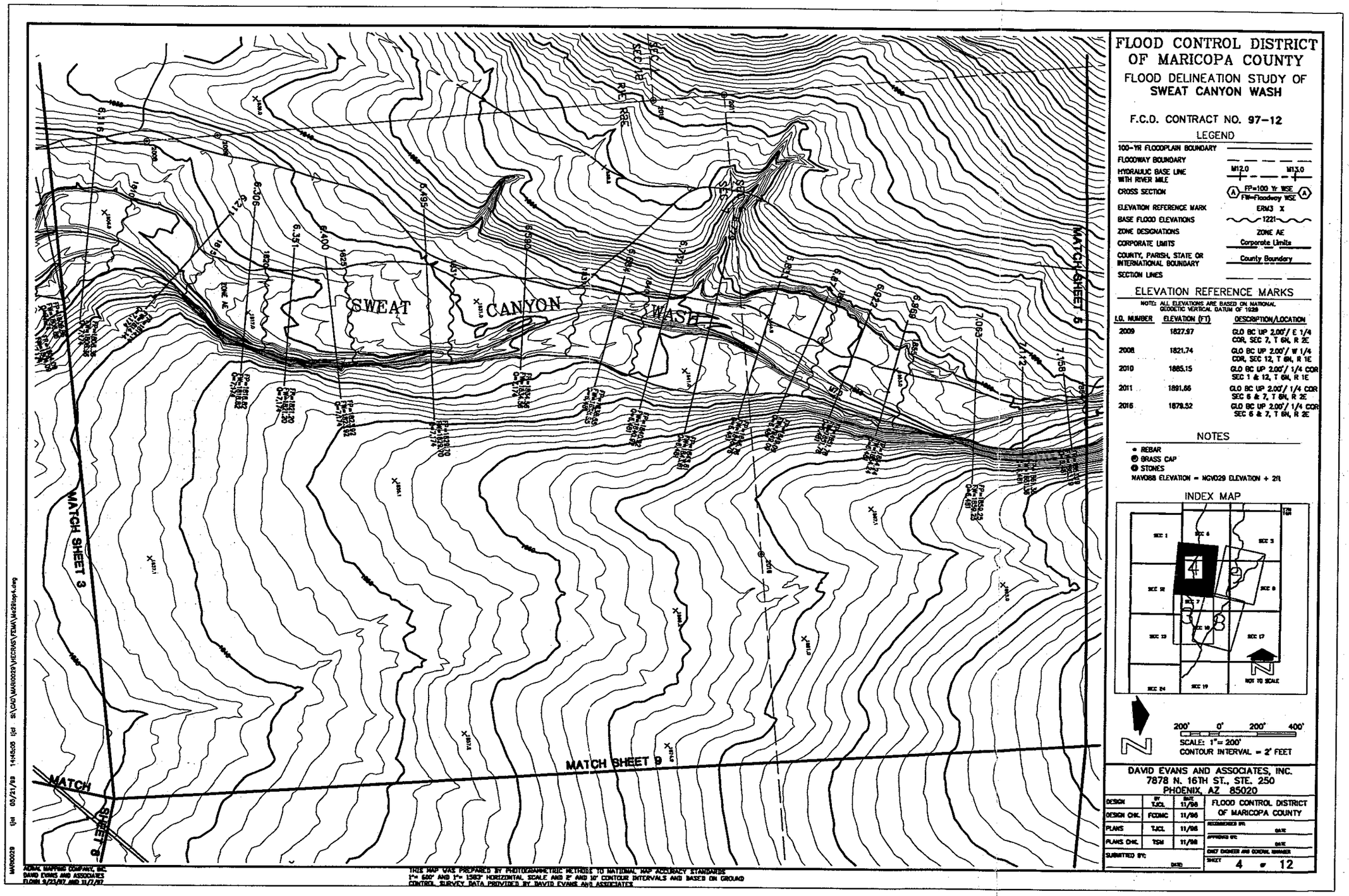
SCALE: 1' = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 2 OF 12



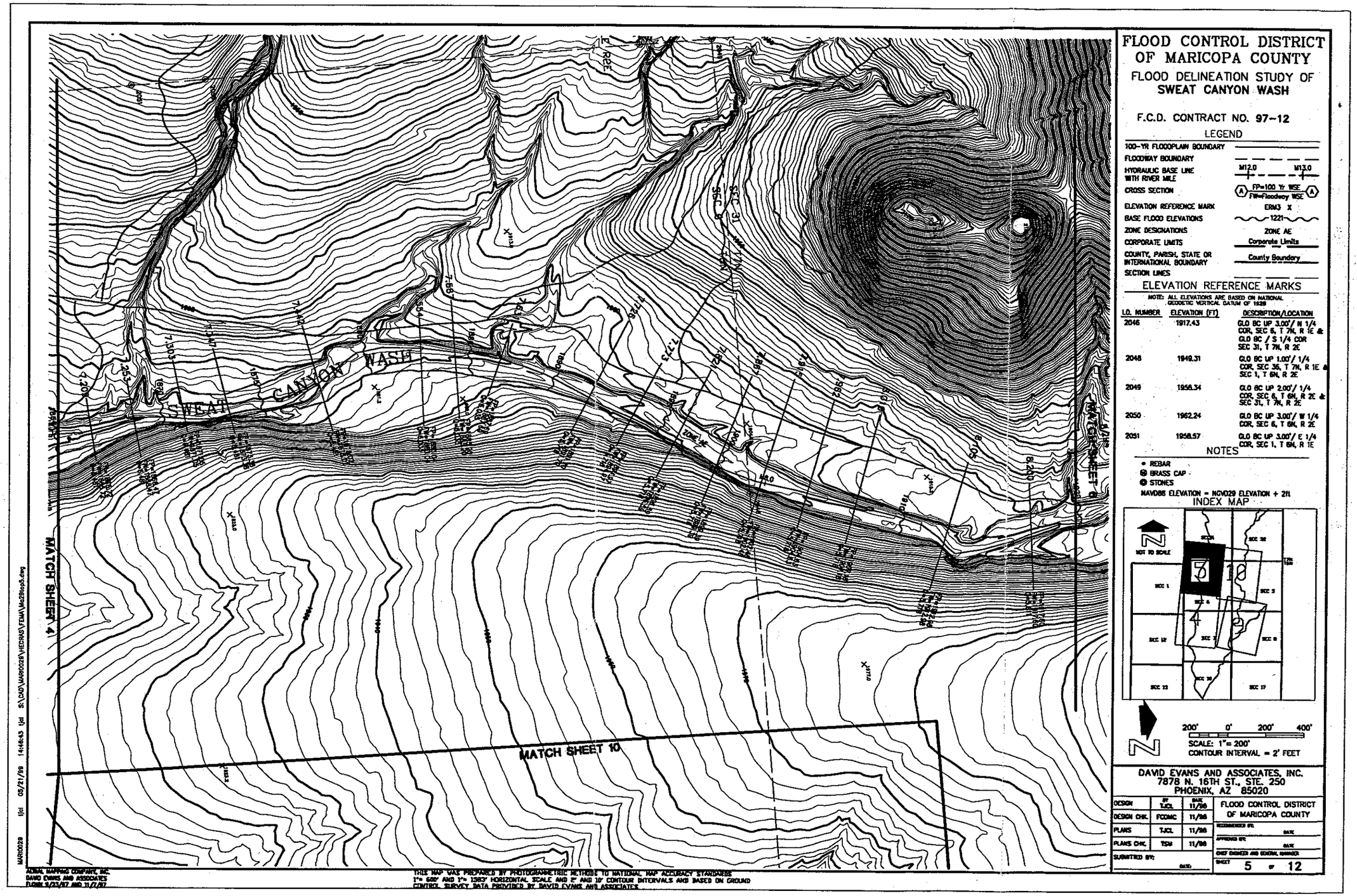
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 3 OF 12



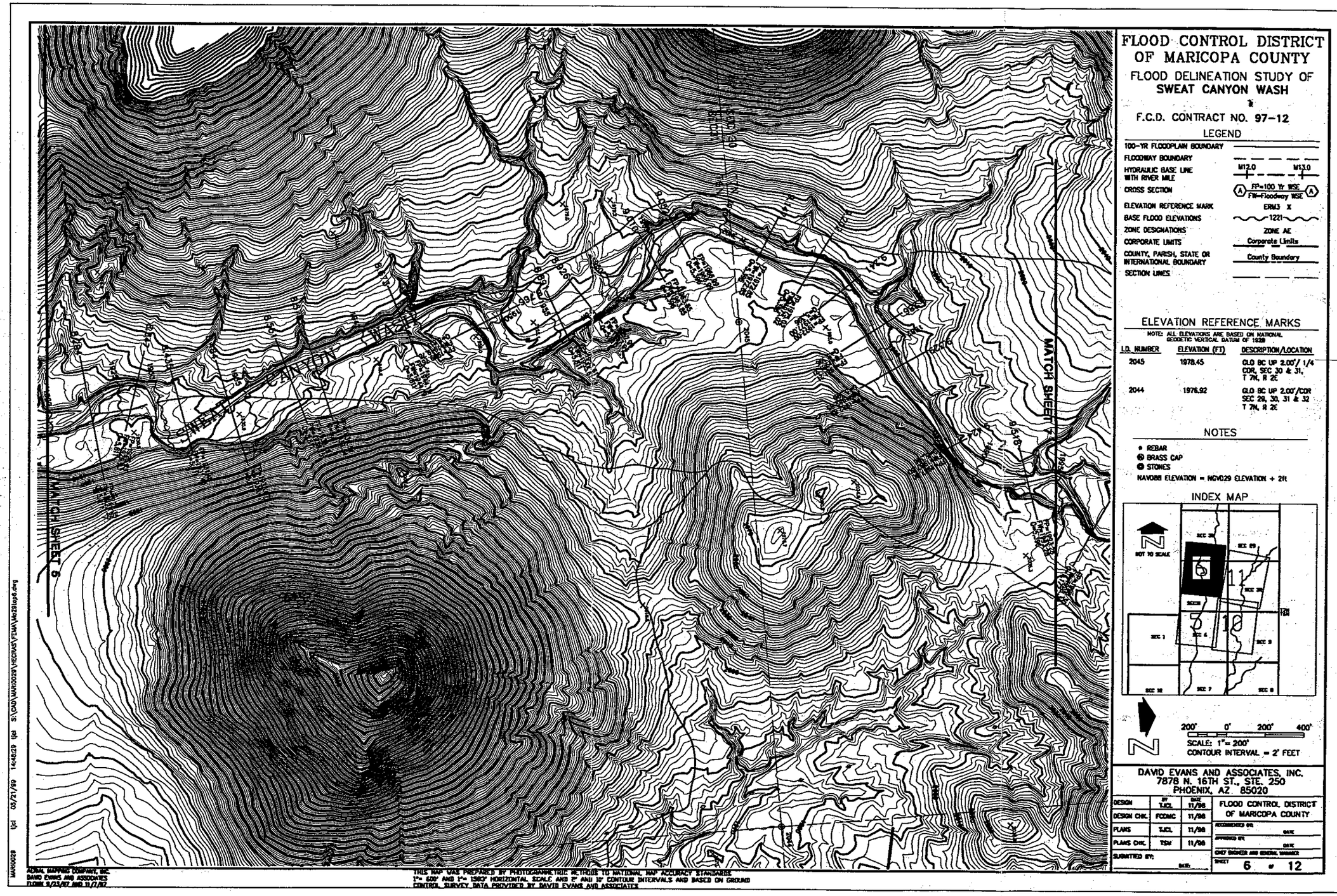
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 4 OF 12



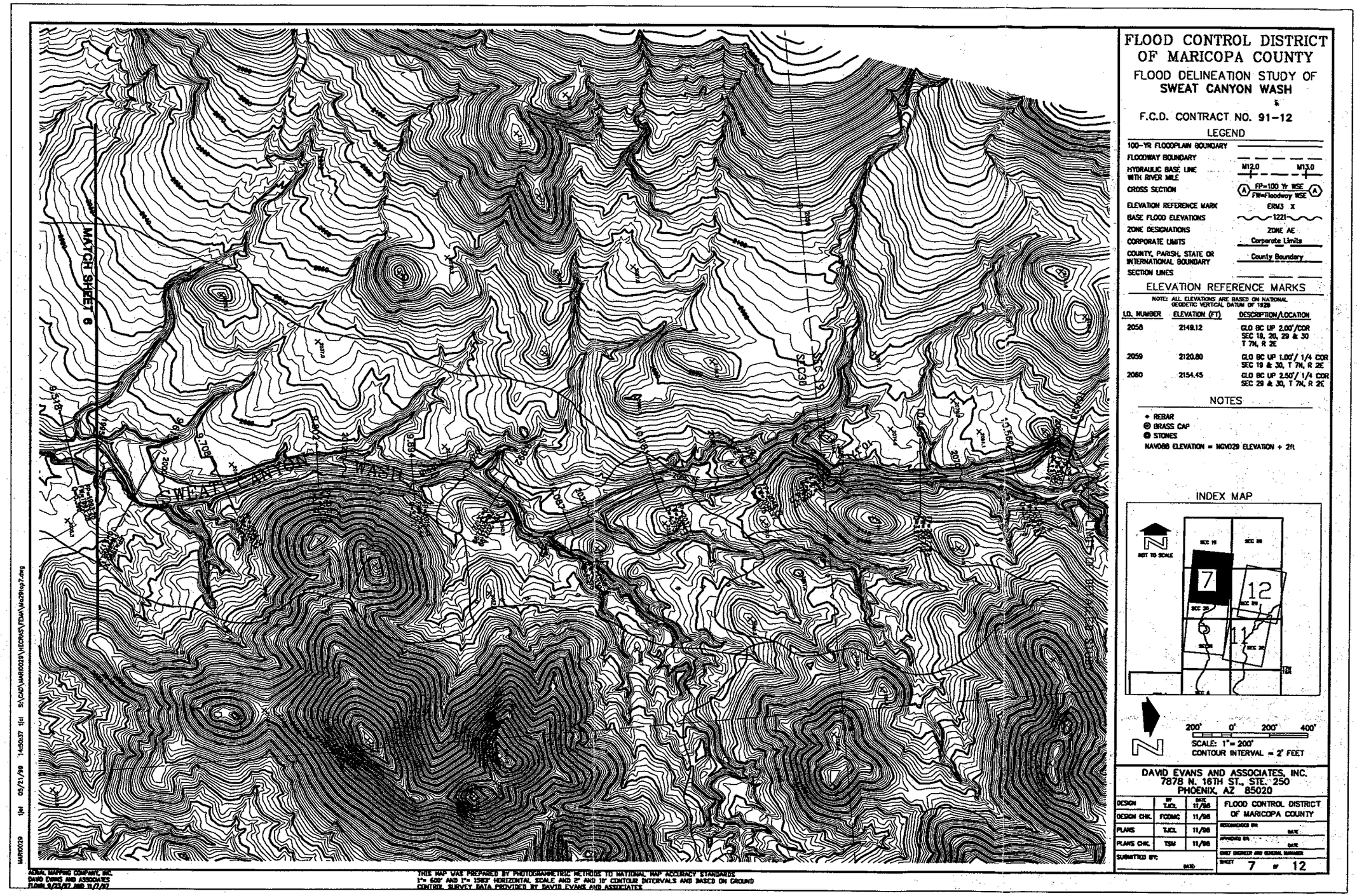
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 5 OF 12



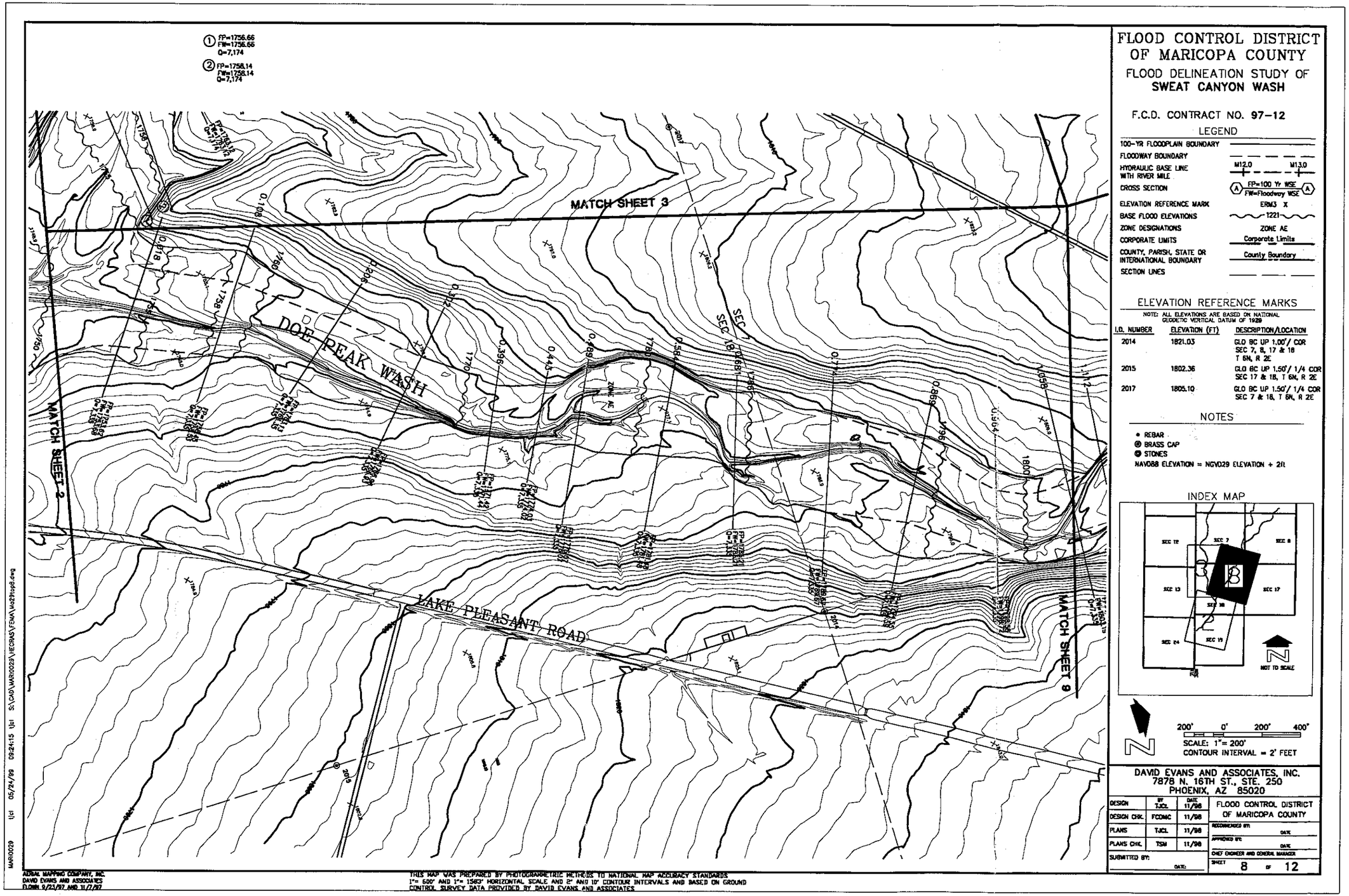
SCALE: 1' = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 6 OF 12



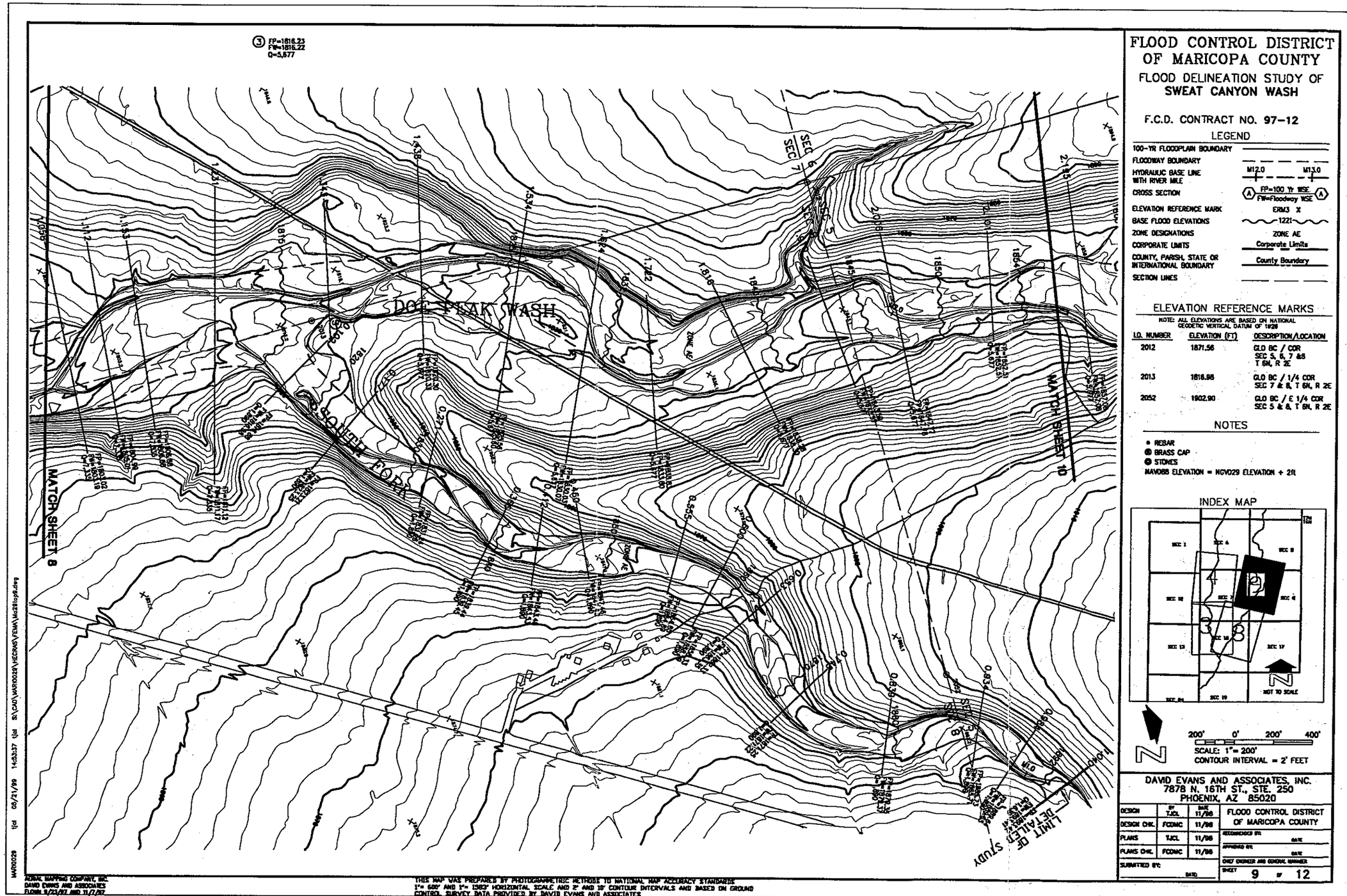
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 7 OF 12



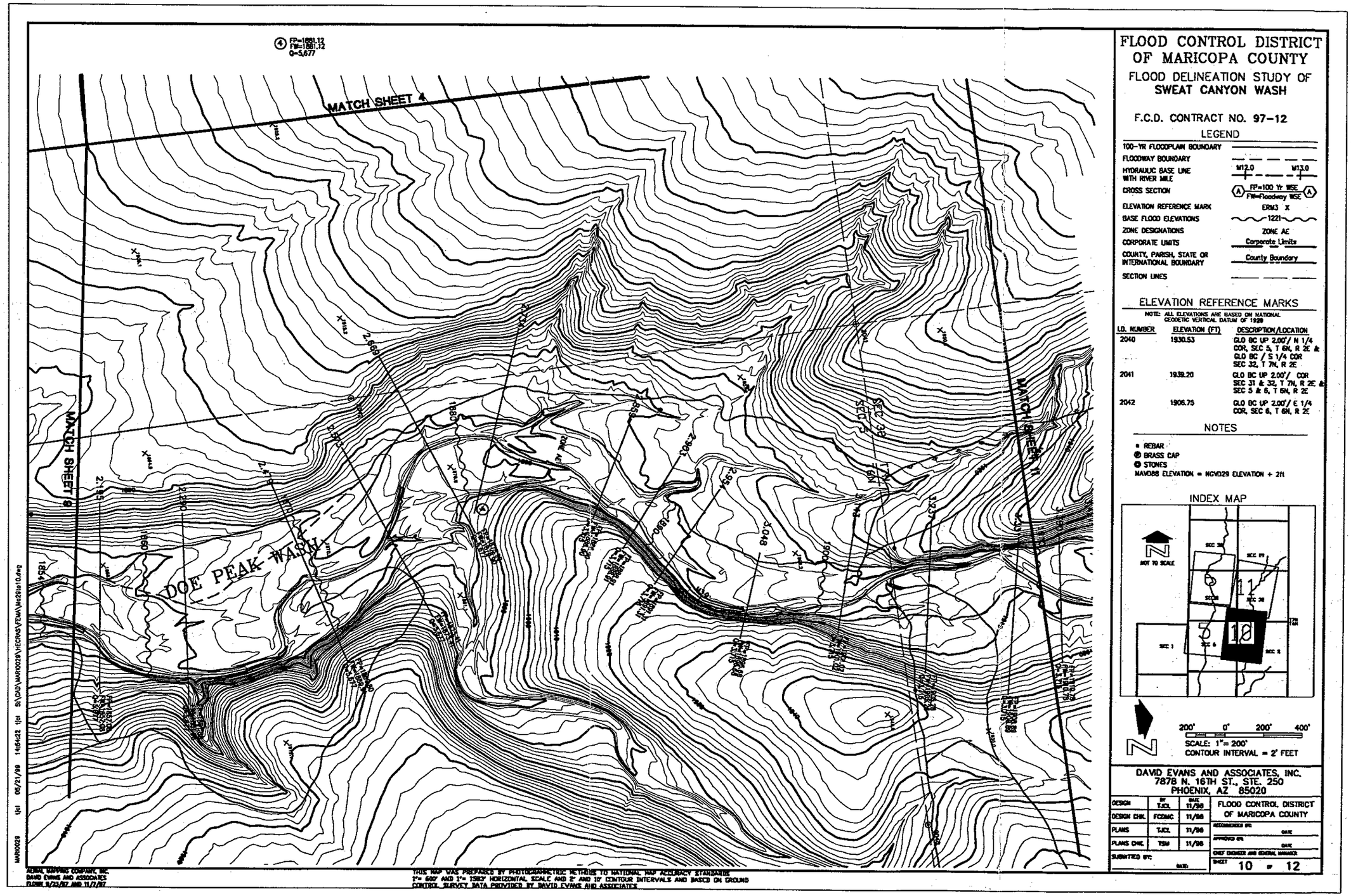
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 8 OF 12



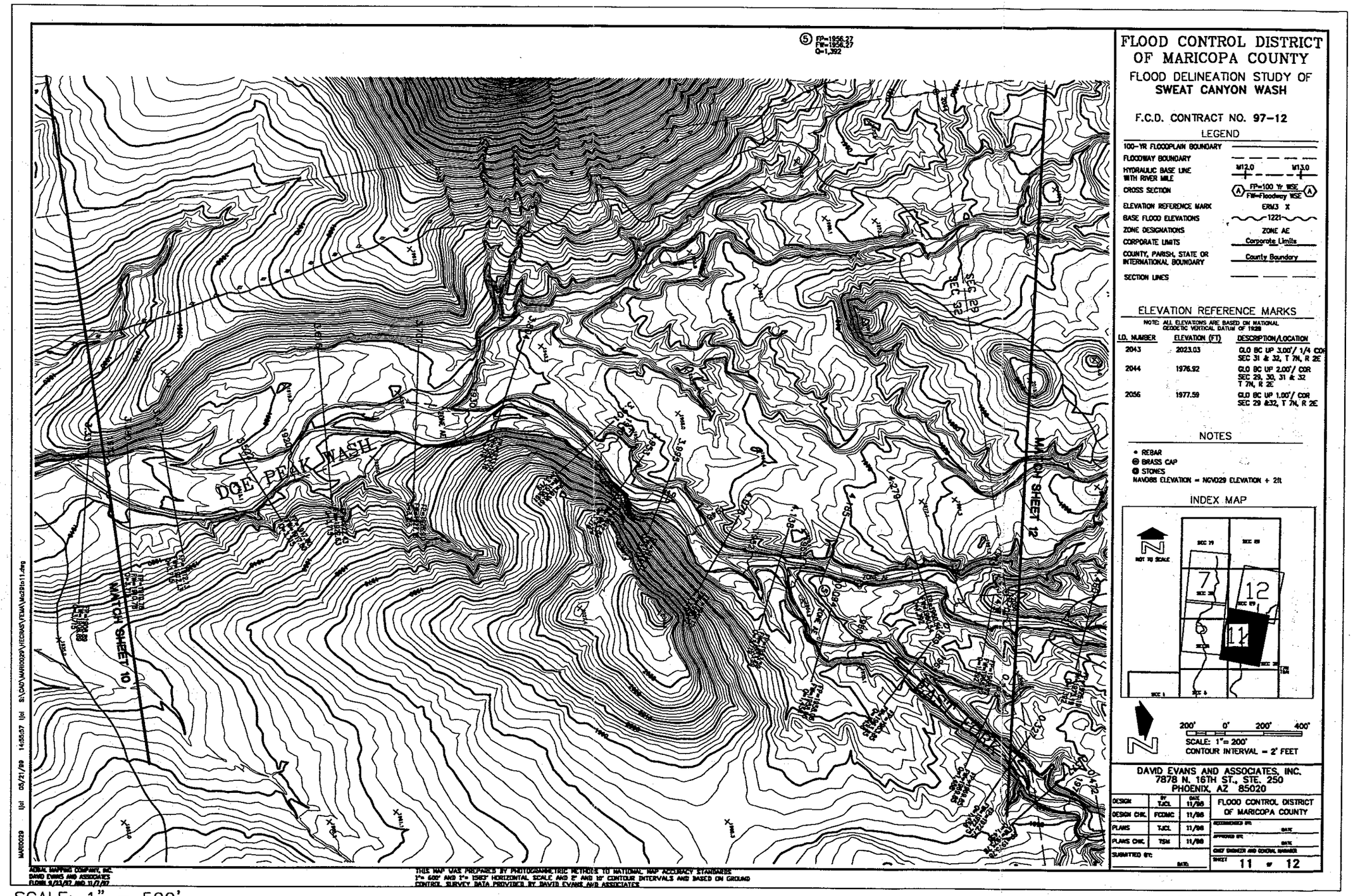
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 9 OF 12



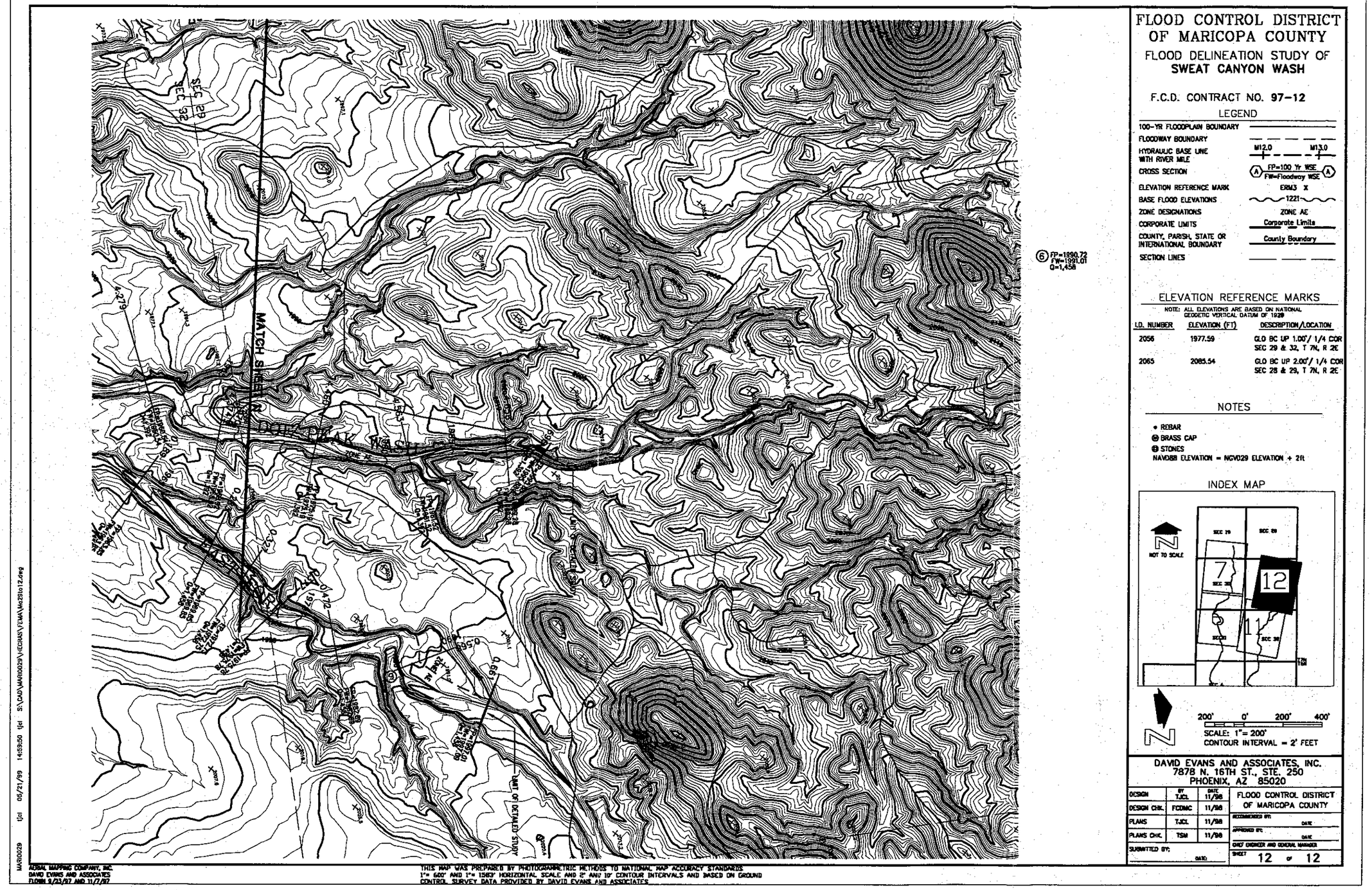
SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 10 OF 12



SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 11 OF 12



SCALE: 1" = 500'

FIGURE 7
WORK STUDY MAP – REDUCED
SHEET 12 OF 12

5.3 Parameter estimation

5.3.1 Roughness Coefficients

Manning's equation, also known as the slope-area computation, is a method of determining the depth of flow for open channel flow. The equation relates the area of flow, wetted perimeter, slope, and roughness coefficient to its velocity or flow rate. The main deficiency of this equation is the difficulty of determining a roughness coefficient, n, for a channel.

The coefficient may vary depending on the bed material, vegetation type and size, depth of flow, channel meandering, and flow velocity. Additionally, the roughness coefficient will vary across the cross-section of a natural channel. Therefore, careful consideration must be given to the effects that a channel's characteristics will have on the roughness coefficient.

Hydraulic modeling of channels using HEC-RAS, requires three (3) values of the roughness coefficients. These values are for the main channel and the left and right overbanks. The coefficient values are determined for the time of peak flow through the cross-section.

N values are usually calculated by establishing a base value for a typical channel and adjusting this value for channel characteristics. The base value can be determined by a comparison with typical values established through channel studies that are available in widely accepted references.

The USGS published reference, *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, (Ref. 2), was one source used determining the base values in this study. Another source was *Comparison of Verified Roughness Coefficients for Gravel-Bed Stream, Blodgett (1986)* (Ref. 1). This method utilizes the hydraulic radius and the d_{50} of the base material. A sensitivity analysis was also performed to establish the base n values. Several field investigations were conducted to determine channel characteristics for the study reach. Notes and photographs were taken to document the characteristics.

Adjustments to the base value were made based on the equation presented in the USGS text as follows:

$$n = m\,(nb + n1 + n2 + n3 + n4)$$

Where:
n = equivalent roughness coefficient
m = correction factor for channel meandering
nb = base value for straight uniform channel
n1 = correction for surface irregularities
n2 = variations in channel shape and size
n3 = corrections for obstructions
n4 = correction for vegetation

The values for each of the correction factors were determined using guidelines presented in *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona, 1998* (Ref. 4). The equivalent value was rounded to the nearest 5/1000th for inclusion in the HEC-RAS model.

Surface Irregularities

Surface irregularities are obstructions to flow in the channel that cause an energy loss in the flow. Irregularities are seen as sloughed, jagged, or eroded banks or side slopes. The adjustment factor ranges from .001 to .005 for slight irregularities, and from .011 to .020 for severe irregularities.

Channel Shape Variations

As flows travel in a channel through its watercourse, the channel may change shape and size as it is influenced by soil type, obstructions, tributary flow, and slope modifications. The degree or rapidity with which the channel changes size from large to small, or with which it shifts flow from one side to the other may cause an energy loss in the flow. The adjustment factor for channel variation ranges from .001 to .005 for occasionally alternating cross-sections, and from .010 to .015 for frequently alternating cross-sections.

Obstructions to Flow

Obstructions to flow may act as energy dissipators. Large boulders, exposed roots or stumps of established vegetation, or permanently resting logs or piers can act as obstructions to flow. In addition, anything that may act to hold debris or impede the natural flow will require an adjustment factor. The percentage of area influenced by obstructions and the spacing of the obstructions will influence the value of the adjustment factor.

The adjustment factor for obstructions ranges from .000 to .004 for nearly negligible obstructions affecting less than 5% of the flow area. Minor obstructions occupying from 5 to 15% of the cross-sectional area have an adjustment factor ranging from .005 to .015. The adjustment for appreciable obstructions, from 15 to 50% of the cross-sectional area or with spacing close enough for several obstructions to share a sphere of influence, ranges from .020 to .030. For closely spaced obstructions that create turbulence across the entire cross-section or for obstructions occupying more than 50% of a cross-sectional area, the adjustment ranges from .040 to .060.

Correction for Vegetation

Vegetation exerts the most influence on flows having a depth that is less than or only slightly greater than the height of the vegetation. Vegetation with deep roots or that is well established will not become dislodged or uprooted in shallow flows. Deeper flows that submerge trees or large bushes should also have an adjustment for vegetation.

The adjustment factor for vegetation ranges from .002 to .010 for weeds and grasses in shallow flows twice the height of the vegetation. For weeds, grasses, and dense bushes in shallow flows less than twice the height of the vegetation, the adjustment ranges from .010 to .025. For weeds or grasses in shallow flows roughly equal to the vegetation height, or for small bushy trees intergrown with weeds and brush, the adjustment ranges from .025 to .050. For flow depths less than the vegetation height for weeds or grasses, or for small bushy trees with dense undergrowth, the adjustment ranges from .050 to .100.

Channel Meandering

Channel meandering, the variation from a straight channel to one with multiple curves and an elongated watercourse, will have the greatest impact on the adjustment factor for the n-value. A meandering channel magnifies all adjustment factors.

The degree of meandering may be computed by calculating the ratio of the existing watercourse length to the minimum watercourse length. For meandering channels with a ratio of less than 1.2, the degree is minor and negligible. Appreciable meandering is seen in channels with a ratio of from 1.2 to 1.5 and an adjustment factor of 1.15 is applied. For channels with a ratio higher than 1.5, the effect is severe and an adjustment factor of 1.3 is applied.

Determination of Adjustment Factors

Determination of the degree of influence and the related values for the adjustment factors relies on experience and judgment. The process is aided by adequate assessment of the site. On-site inspection of the watercourse and selection of typical cross-sections aid in determining the values for the adjustment factors.

Several field visits were made to Sweat Canyon Wash to determine base n-values and adjustment factors. Typical cross-sections were located and the conditions documented with photographs and field notes. Topographic data was gathered and reviewed as well to determine meandering and channel geometry variations.

Cross-section locations, photographs of typical cross-sections, a map of the photograph locations, and the calculated n-values with adjustment factors are included in the Appendix E.1. The photographic documentation includes a view of the main channel soil sample, a view of the cross-section, and the vegetation found on the left and right overbanks. Each page represents a reach containing similar cross-sections. The location for each set of photographs taken is shown on a drawing located in Appendix E.1.

5.3.2 Expansion and Contraction Coefficients

The expansion and contraction coefficients used throughout the study reach were 0.3 and 0.1, respectively. There were no bridges or culverts in the entire reach. Generally, the washes consisted of gradual transitions with no major irregularities.

5.4 Cross-section descriptions

Cross sections were generally placed 500 feet apart for the initial hydraulic run. Additional cross sections were added if warning messages resulted, warning that the energy equation was not solved in 40 attempts. Many of the warnings were removed by doing this, however, several cross sections continue to give warnings of conveyance ratio outside of range and energy loss greater than 1 foot. The orientations of several of the cross sections were changed after the initial run which showed the general flow direction. In several areas within the study, it became clear that substantial overbank flow was present, thus the changes in orientation.

The cross section labeling represents the distance upstream of the mouth of New River (Sweat Canyon Wash) or, as the case is with the tributaries, the distance upstream of the convergence with Sweat Canyon Wash. The HEC-RAS results were examined to determine that the sections were representative of the reach and to remove non-effective flow areas.

HEC-RAS requires that the cross sections created to depict a junction located upstream and downstream of the junction, unlike HEC-2 that requires one to be located at the junction. Therefore, two cross sections (where Sweat Canyon and Doe Peak join) that were originally spaced 500 feet apart, were removed. These two cross sections contained two thalwegs and HEC-RAS only recognizes one thalweg per cross section. The HEC-RAS program placed the junction at the Sweat Canyon thalweg, which is not an accurate representation of the junction. In addition, the floodway analysis could not accurately be represented with these two cross sections included in the model.

An attempt was made to include separate cross sections along each of the two washes but vertical extension warnings resulted. The normal solution to this warning is to widen the conveyance area. However, doing so resulted in cross section lines overlapping which does not properly represent the junction. Once the cross sections were removed, the floodplain and the floodway boundaries were portrayed correctly.

The majority of the cross sections were generated using AutoCad Softdesk (Ref 5). The resulting cross sections were checked and points added or deleted if warranted. A few cross sections were determined based off topographic contours.

5.5 Modeling considerations

5.5.1 Hydraulic Jump and Drop Analysis

The floodplain analysis was modeled as a subcritical flow regime. The resulting water surface elevations revealed that approximately 25% of the cross sections defaulted to critical depth. Most of the cross sections that defaulted were isolated, showing some instability in flow. Cross sections were added in an attempt to stabilize the model. In most cases, the model continued to default to critical, showing that a hydraulic drop and subsequent jump does occur. When these portions of the wash are developed or improved, special precautions will need to be taken to protect against erosion and flood protection.

5.5.2 Bridge or Culverts

There were no bridges or culverts along the studied reaches.

5.5.3 Levees and Dikes

There were no levees or dikes along the studied reaches.

5.5.4 Islands and Flow Splits

Islands, which show up as divided flow, were evident in approximately 19 of the 171 cross sections. The 'islands' were not handled in any special way because of their impact on the total floodplain width. Because the islands were comparatively small, they were not removed from the total floodplain. The top width shown on the HEC-RAS output depicts the total flow spread minus the 'islands', not the floodplain width as shown on the drawings.

5.5.5 Ineffective Flow Areas

Cross-section 8.578 of Sweat Canyon Wash required the ineffective flow option. The block obstruction option was implemented for cross-sections 5.359 and 7.631 of Sweat Canyon Wash. This was to provide surface information extending the 100 year flood plain limit while limiting the conveyance area to the main wash and preventing flow in adjacent tributaries.

5.5.6 Supercritical Flow

Cross sections that indicated supercritical flow were sporadic in their location. Any flood insurance study should be modeled as subcritical and this study gave no indication to be modeled differently. Therefore, the water surface elevations at cross sections defaulting to critical depth were used to delineate the floodplain.

5.6 Floodway modeling

Encroachment on floodplains, such as artificial fill, reduces the flood carrying capacity, increases water surface elevations, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from development within a floodplain against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain area that are void of any encroachment in order that the 100-year flood can be conveyed without substantial increase in water surface elevations. Minimum federal standards limit such increases in water surface elevations to 1.0 foot, provided that hazardous velocities are not produced.

The encroachment method utilized to define the floodway was Encroachment Method 4. This method determines stations that result in an equal loss of conveyance at each overbank. Target increases in water surface elevations of 0. 9', 1.0', and 1.1' were used for the first attempt. Encroachment Method 1 was used for the final analysis. In addition to the maximum one (1) foot water surface elevation increase as required by FEMA, velocities and main channel Froude numbers were taken into consideration when choosing encroachment stations. The goal was to prevent velocities from increasing to erosive levels, approximately 10 ft/sec. In general, no encroachments were made for cross sections in which the velocity was 10 ft/sec or greater naturally. Main channel Froude numbers were considered for cross section defaulting to critical. In general, no encroachments were made for cross sections that defaulted to critical depth and with main channel Froude numbers greater than 0.8.

Other considerations when choosing encroachment stations included overbank depths, overbank velocities and upstream effects due to encroachment. In general, no encroachment was made if the depth of water in the overbank was greater then 3 feet and if the product of the velocity and the depth in the overbank was greater than 10. No encroachment was made if, by doing so, it caused problems for upstream cross sections such as a surcharge of more than one foot, a decrease in water surface upstream to less than zero (0), and/or increase of upstream velocities to erosive levels.

5.7 Special problems encountered during the study

5.7.1 Special Problems and Solutions

The selection of roughness coefficients for this project involved several experts. David Evans and Associates, with advise from their consultant, Primatech Engineers and Consultants, proposed the first set of n values. These values were used in the initial HEC-RAS run that resulted in approximately 62% of the cross sections defaulting to critical depth.

The Flood Control District of Maricopa County (FCD) questioned whether Sweat Canyon Wash and its tributaries were truly mixed flow watercourses. FCD specifically questioned the base values used in the analysis. Another expert with the FCD reviewed the n value report and suggested raising the values 0.002 to 0.005 across the board. The FCD also provided another consultant with the information and the response from West Consultants, Inc. was to add 0.005 to each value. West Consultants further recommended an equation for determining the base n value that is based on D_{50} and the hydraulic radius. Excerpts of the technical book are included in Section E.1 of this manual. As a result, the n values used in this FIS are a consensus of several experts. The revised n-values resulted in the HEC-RAS defaulting to critical depth in approximately 25% of the cross sections.

A comparison was made of the average depths and velocities between the hydrology and the hydraulic models. The method used to derive average depths from the HEC-1 was to examine the stage-storage-discharge tables generated for each routing. Based on the value of flow routed through a particular reach, an elevation was determined. These values were compared to a Manning's analysis that used the routed flows and the 8-point cross section used in the HEC-1 model. The results were very similar.

Another comparison was made between the average depth determined from the HEC-RAS model and a Manning's analysis. The HEC-RAS depths were based off peak discharges at any given concentration point - not the lower routed discharge which HEC-1 used. The Manning's analysis used the 8-point cross section used in the HEC-1 model. Again the depths were comparable.

The same method was used to compare the velocities between the HEC-1 and the HEC-RAS models. The method used to determine the velocity from the HEC-1 model was to calculate the conveyance area from the interpolated storage determined from the stage-storage-discharge tables and divide by the routed reach length. Then the continuity equation Q=VA was used to determine the average velocity. Again, the velocities were similar. The calculations are included in Section E.5 of this notebook.

The Flood Profile data were taken directly from the HEC-RAS model. Scaling was a problem when inserting the HEC-RAS output into the AutoCAD drawings. Some manipulation was required to bring the HEC-RAS data in at the correct scale.

5.7.2 Modeling warning and error messages

A list of warnings indicated the need for additional cross sections. When a cross section was added midway between cross sections placed 500 feet apart, the messages remained with minor or no change in water surface elevations. Due to the length of the study, an average of 500 feet between cross sections was maintained with a few exceptions. These exceptions include: changes in roughness coefficient, more detail required to correctly delineate floodplain and floodway boundaries, indication of supercritical flow, etc.

5.8 Calibration

5.9 References

1. *Comparaision of Verified Roughness Coefficients for Gravel-Bed Streams.* Blodgett. 1986.
2. *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in the Maricopa County, Arizona.* U.S. Geological Survey. April 1991.
3. *New River Floodplain Delineation Study.* Coe & Van Loo. 1988.
4. *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona.* U.S. Geological Survey. 1998.
5. AutoCAD Softdesk, Version 8
6. New River Quadrangle 1:24000 United States Department of the Interior Geological Survey
7. Biscuit Flat Quadrangle 1:24000 United States Department of the Interior Geological Survey

5.10 Final Results

5.10.1 Hydraulic analysis results

HEC-RAS OUTPUT

SWEAT CANYON FIS

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
South Fork	0.102	1890	1817.38		9988.08	10246.67	258.59	1816.64	1817.63	4.80	1328.79	556.40	4.47	4.28	0.48
South Fork	0.102	1890	1817.44	0.06	9988.08	10200.00	211.92	1816.72	1817.74	5.63	1459.95	424.43	4.81	4.34	0.52
South Fork	0.177	1890	1823.21		9978.23	10185.79	207.56	1823.21	1824.05	4.57	1615.46	269.97	7.89	5.61	0.75
South Fork	0.177	1890	1823.25	0.04	9978.23	10185.79	207.56	1823.25	1824.05	4.89	1600.46	284.65	7.73	5.65	0.73
South Fork	0.271	1890	1831.24		9852.00	10021.66	169.66	1831.24	1832.08	553.67	1334.99	1.34	8.45	5.74	0.79
South Fork	0.271	1890	1831.26	0.02	9852.00	10021.66	169.66	1831.26	1832.08	559.47	1329.09	1.44	8.37	5.76	0.78
South Fork	0.366	1890	1839.44		9987.07	10158.22	171.16	1839.14	1840.01	13.67	844.84	1031.49	7.42	3.54	0.79
South Fork	0.366	1890	1839.45	0.01	9987.07	10145.00	157.93	1839.16	1840.06	14.39	872.21	1003.40	7.62	3.55	0.81
South Fork	0.412	1890	1843.48		9921.07	10076.85	155.78	1843.38	1844.28	708.19	904.31	277.50	8.94	4.38	0.87
South Fork	0.412	1890	1843.53	0.04	9921.07	10076.85	155.78	1843.38	1844.28	710.99	895.00	284.01	8.73	4.43	0.84
South Fork	0.460	1890	1847.46		9827.79	10030.37	202.58	1847.32	1848.07	913.86	936.27	39.87	8.06	4.36	0.74
South Fork	0.460	1890	1847.42	-0.03	9828.05	10030.23	202.18	1847.32	1848.06	904.40	946.12	39.48	8.22	4.32	0.76
South Fork	0.555	1890	1854.85		9864.10	10019.77	155.67	1854.69	1855.62	1003.67	846.63	39.70	8.99	4.65	0.86
South Fork	0.555	1890	1854.89	0.04	9864.10	10019.77	155.67	1854.70	1855.62	1010.45	838.78	40.76	8.81	4.69	0.84
South Fork	0.600	1890	1858.33		9881.46	10026.70	145.24	1857.97	1859.00	691.77	1144.00	54.24	7.72	5.13	0.69
South Fork	0.600	1890	1858.29	-0.04	9882.96	10026.56	143.60	1857.96	1858.99	687.92	1148.86	53.22	7.83	5.09	0.70
South Fork	0.653	1890	1862.33		9908.70	10077.50	168.81	1861.85	1862.89	130.14	1408.32	351.54	6.53	4.23	0.67
South Fork	0.653	1890	1862.35	0.02	9908.70	10077.50	168.80	1861.85	1862.90	133.06	1403.72	353.22	6.47	4.25	0.66

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
South Fork	0.745	1890	1871.25		9875.44	10060.20	184.76	1870.98	1871.80	1150.31	737.48	2.21	5.89	4.25	0.78
South Fork	0.745	1890	1871.22	-0.02	9875.60	10059.84	184.24	1870.98	1871.79	1151.19	736.86	1.94	5.97	4.22	0.80
South Fork	0.839	1890	1879.35		9895.03	10060.72	165.70	1878.71	1879.82	450.27	1340.65	99.08	5.96	4.75	0.61
South Fork	0.839	1890	1879.37	0.02	9895.03	10060.72	165.69	1878.71	1879.84	451.63	1337.28	101.10	5.91	4.77	0.60
South Fork	0.934	1890	1885.73		9923.36	10046.99	123.63	1885.29	1886.45	146.73	1742.98	0.30	7.04	4.93	0.72
South Fork	0.934	1890	1885.71	-0.02	9923.66	10046.88	123.23	1885.29	1886.45	144.75	1744.99	0.26	7.10	4.91	0.72
South Fork	0.984	1890	1889.64		9978.12	10126.13	148.01	1888.67	1890.24	31.16	1210.70	648.14	7.06	4.74	0.66
South Fork	0.984	1890	1889.65	0.01	9978.12	10126.13	148.01	1888.67	1890.25	31.37	1208.79	649.84	7.03	4.75	0.66
South Fork	1.035	1639	1893.30		9865.69	10020.87	155.17	1893.02	1893.91	491.52	1114.26	33.23	7.12	3.80	0.69
South Fork	1.035	1639	1893.30	-0.01	9865.88	10020.82	154.94	1893.02	1893.91	489.69	1116.23	33.09	7.15	3.80	0.69
East Fork	0.094	1458	1958.74		9956.46	10168.29	211.83	1957.94	1958.98	158.90	486.11	812.99	5.70	4.94	0.54
East Fork	0.094	1458	1958.74	0.00	9956.46	10168.29	211.83	1957.94	1958.98	158.89	486.15	812.96	5.70	4.94	0.54
East Fork	0.189	1458	1963.48		9968.57	10058.54	89.97	1963.48	1964.64	42.44	960.97	454.59	10.07	3.98	1.00
East Fork	0.189	1458	1963.47	-0.01	9968.63	10053.00	84.38	1963.47	1964.61	41.68	950.57	465.76	10.00	3.97	1.00
East Fork	0.283	1458	1970.11		9956.50	10011.44	54.94	1969.85	1971.43	27.04	1425.78	5.18	9.31	5.21	0.86
East Fork	0.283	1458	1970.10	-0.01	9956.54	10011.39	54.85	1969.85	1971.43	26.81	1426.11	5.07	9.34	5.20	0.87
East Fork	0.327	1458	1972.65		9963.70	10036.23	72.53	1971.29	1973.20	17.60	1229.37	211.03	6.32	5.75	0.52
East Fork	0.327	1458	1972.65	0.00	9963.70	10036.23	72.53	1971.29	1973.20	17.67	1229.14	211.19	6.32	5.75	0.52
East Fork	0.377	1458	1975.78		9974.35	10056.09	81.73	1975.78	1976.91	258.19	691.79	508.02	10.78	4.38	0.98
East Fork	0.377	1458	1975.78	0.00	9974.35	10056.09	81.73	1975.78	1976.91	258.19	691.79	508.02	10.78	4.38	0.98

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
East Fork	0.472	1458	1982.89		9957.21	10101.63	144.42	1982.84	1983.66	76.66	897.19	484.15	8.45	4.69	0.82
East Fork	0.472	1458	1982.89	0.00	9957.21	10101.63	144.42	1982.87	1983.66	76.69	897.06	484.24	8.45	4.69	0.82
East Fork	0.568	1458	1990.72		9992.48	10249.82	240.80	1990.72	1991.53	3.83	877.73	576.44	8.95	5.62	0.81
East Fork	0.568	1458	1991.01	0.28	9992.48	10100.00	107.52	1991.01	1991.95	5.10	965.46	487.44	9.16	5.91	0.80
East Fork	0.661	1458	1997.01		9923.75	10032.50	108.75	1996.96	1997.87	405.56	1052.44		8.38	4.31	0.83
East Fork	0.661	1458	1997.09	0.08	9923.75	10032.50	108.75	1996.96	1997.88	420.21	1037.79		8.06	4.39	0.79
Doe Peak Wash	0.018	7335	1754.06		9720.07	10376.21	656.14	1753.28	1754.66	1088.83	4845.30	1400.87	7.40	9.06	0.52
Doe Peak Wash	0.018	7335	1754.11	0.05	9800.00	10230.00	430.00	1753.31	1754.77	1255.40	5002.21	1077.38	7.58	9.11	0.53
Doe Peak Wash	0.108	7335	1758.45		9851.18	10410.83	559.65	1758.45	1759.48	241.41	6044.73	1048.87	8.88	7.55	0.73
Doe Peak Wash	0.108	7335	1758.53	0.07	9851.18	10250.00	398.82	1758.53	1759.77	280.81	6525.02	529.17	9.44	7.63	0.76
Doe Peak Wash	0.206	7335	1763.13		9863.61	10329.10	465.50	1762.39	1763.99	948.75	5024.34	1361.91	8.72	10.03	0.59
Doe Peak Wash	0.206	7335	1763.36	0.23	9863.61	10245.00	381.39	1762.28	1764.17	1054.73	4996.75	1283.53	8.39	10.26	0.56
Doe Peak Wash	0.302	7335	1766.96		9921.53	10239.15	317.63	1765.88	1767.99	93.22	6705.79	535.99	8.49	7.66	0.65
Doe Peak Wash	0.302	7335	1766.93	-0.03	9922.25	10233.48	311.23	1765.88	1767.98	90.81	6710.32	533.88	8.55	7.63	0.65
Doe Peak Wash	0.396	7335	1771.42		9976.01	10244.56	268.55	1770.64	1772.70	2.70	6953.03	379.27	9.30	10.42	0.70
Doe Peak Wash	0.396	7335	1771.44	0.02	9976.01	10244.56	268.55	1770.60	1772.71	2.77	6945.25	386.97	9.26	10.44	0.69
Doe Peak Wash	0.443	7335	1774.03		9863.08	10240.21	355.29	1772.25	1774.71	362.78	2753.22	4219.00	9.25	10.23	0.53
Doe Peak Wash	0.443	7335	1774.02	-0.01	9863.25	10240.17	353.49	1772.25	1774.70	364.00	2754.25	4216.75	9.26	10.22	0.53

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Doe Peak Wash	0.489	7335	1776.07		9843.45	10249.85	363.33	1775.44	1776.97	87.89	3671.57	3575.54	9.35	8.27	0.72
Doe Peak Wash	0.489	7335	1776.07	0.00	9843.46	10249.85	363.30	1775.43	1776.97	87.84	3671.71	3575.45	9.35	8.27	0.72
Doe Peak Wash	0.584	7335	1781.48		9692.85	10165.35	472.51	1780.18	1782.06	1617.51	4288.86	1428.63	7.43	6.88	0.56
Doe Peak Wash	0.584	7335	1781.48	0.00	9692.85	10165.35	472.50	1780.18	1782.06	1617.51	4288.85	1428.64	7.43	6.88	0.56
Doe Peak Wash	0.681	7335	1785.21		9916.04	10362.56	446.52	1784.15	1785.69	1009.96	2305.33	4019.71	8.05	8.11	0.53
Doe Peak Wash	0.681	7335	1785.21	0.00	9916.04	10362.55	446.51	1784.15	1785.69	1009.99	2305.31	4019.70	8.05	8.11	0.53
Doe Peak Wash	0.774	7335	1789.67		9674.07	10192.03	485.59	1789.30	1790.36	2999.23	3817.76	518.01	7.99	8.47	0.75
Doe Peak Wash	0.774	7335	1789.67	0.00	9674.08	10192.03	485.58	1789.30	1790.36	2999.18	3817.84	517.98	7.99	8.47	0.75
Doe Peak Wash	0.869	7335	1794.55		9605.61	10241.17	635.56	1793.73	1795.14	803.13	4963.31	1568.56	7.11	7.05	0.57
Doe Peak Wash	0.869	7335	1794.59	0.04	9780.00	10200.00	420.00	1793.70	1795.24	776.13	5116.06	1442.81	7.27	7.09	0.58
Doe Peak Wash	0.964	7335	1798.58		9868.12	10322.67	454.54	1798.45	1799.57	518.93	4600.42	2215.66	9.59	8.68	0.72
Doe Peak Wash	0.964	7335	1798.72	0.14	9868.12	10210.00	341.88	1798.52	1799.86	617.67	4910.21	1807.12	10.00	8.82	0.74
Doe Peak Wash	1.058	7335	1803.02		9740.04	10217.65	477.61	1801.57	1803.50	3162.98	3814.92	357.10	6.52	7.62	0.49
Doe Peak Wash	1.058	7335	1803.19	0.17	9740.04	10150.00	409.96	1801.58	1803.64	3243.24	3806.79	284.97	6.31	7.79	0.46
Doe Peak Wash	1.112	7335	1804.99		9521.37	10011.87	490.50	1803.89	1805.39	4883.41	2451.59		6.30	6.89	0.56
Doe Peak Wash	1.112	7335	1805.01	0.02	9555.00	10011.87	456.87	1803.88	1805.42	4893.95	2441.05		6.25	6.91	0.56
Doe Peak Wash	1.153	7335	1806.88		9473.93	10066.89	592.96	1806.22	1807.39	3832.89	3502.11		7.07	7.58	0.66
Doe Peak Wash	1.153	7335	1806.88	0.01	9555.00	10066.89	511.89	1806.21	1807.44	3759.43	3575.57		7.21	7.58	0.68
Doe Peak Wash	1.231	7335	1811.12		9517.41	10079.14	561.74	1810.84	1811.83	2719.65	4615.35		8.04	6.92	0.69
Doe Peak Wash	1.231	7335	1811.17	0.05	9610.00	10079.14	469.14	1810.78	1811.89	2688.47	4646.53		8.00	6.97	0.68

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Doe Peak Wash	1.343	5677	1816.23		9908.27	10222.44	314.17	1815.75	1817.10	1046.86	3523.54	1106.60	8.73	8.13	0.65
Doe Peak Wash	1.343	5677	1816.22	0.00	9908.28	10180.00	271.72	1815.69	1817.12	1051.39	3539.54	1086.07	8.77	8.12	0.65
Doe Peak Wash	1.438	5677	1820.30		9761.24	10067.91	306.67	1820.00	1821.29	1772.66	3822.47	81.87	9.11	7.70	0.74
Doe Peak Wash	1.438	5677	1820.33	0.03	9810.00	10067.91	257.91	1819.96	1821.37	1698.46	3891.10	87.44	9.22	7.73	0.75
Doe Peak Wash	1.534	5677	1825.56		9615.16	10053.66	367.31	1825.56	1826.72	760.27	4916.73		9.16	7.76	0.78
Doe Peak Wash	1.534	5677	1825.60	0.04	9790.00	10053.66	263.66	1825.51	1826.80	677.40	4999.60		9.24	7.80	0.78
Doe Peak Wash	1.624	5677	1830.03		9811.46	10231.36	419.90	1829.40	1830.65	163.71	3920.83	1592.46	7.17	5.53	0.59
Doe Peak Wash	1.624	5677	1830.07	0.03	9811.46	10231.36	419.90	1829.40	1830.67	173.76	3898.26	1604.98	7.07	5.57	0.58
Doe Peak Wash	1.722	5677	1833.83		9948.10	10372.75	424.65	1833.24	1834.32	123.30	2552.99	3000.72	6.72	6.13	0.60
Doe Peak Wash	1.722	5677	1833.80	-0.02	9948.20	10372.65	424.46	1833.24	1834.31	121.36	2563.73	2991.91	6.79	6.10	0.61
Doe Peak Wash	1.816	5677	1838.28		9842.05	10242.40	364.48	1838.22	1839.28	839.27	3388.36	1449.38	9.62	6.78	0.79
Doe Peak Wash	1.816	5677	1838.30	0.02	9842.05	10242.40	365.42	1838.22	1839.28	850.02	3373.43	1453.54	9.54	6.80	0.78
Doe Peak Wash	1.910	5677	1843.59		9703.00	10065.42	362.43	1843.43	1844.51	1572.90	4085.86	18.24	8.63	7.79	0.73
Doe Peak Wash	1.910	5677	1843.57	-0.02	9703.23	10065.14	361.91	1843.43	1844.50	1559.92	4099.65	17.42	8.69	7.77	0.74
Doe Peak Wash	2.006	5677	1847.77		9823.62	10224.32	400.70	1846.65	1848.15	1457.75	1365.97	2853.28	5.99	5.67	0.50
Doe Peak Wash	2.006	5677	1847.78	0.01	9823.62	10224.32	400.70	1846.65	1848.16	1460.85	1363.24	2852.91	5.96	5.68	0.50
Doe Peak Wash	2.101	5677	1852.51		9870.06	10170.72	300.66	1852.51	1853.67	592.47	2480.20	2604.33	11.04	6.31	0.86
Doe Peak Wash	2.101	5677	1852.51	0.00	9870.06	10170.72	300.66	1852.51	1853.67	592.47	2480.20	2604.33	11.04	6.31	0.86

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Doe Peak Wash	2.195	5677	1857.08		9967.85	10355.75	387.90	1855.91	1857.47		2316.74	3360.26	6.16	5.98	0.52
Doe Peak Wash	2.195	5677	1857.08	0.00	9967.85	10355.75	387.90	1855.91	1857.47		2316.56	3360.44	6.16	5.98	0.52
Doe Peak Wash	2.290	5677	1861.88		9984.35	10674.57	472.26	1861.88	1862.76	0.37	2352.27	3324.36	9.96	6.48	0.88
Doe Peak Wash	2.290	5677	1861.96	0.08	9984.35	10365.00	380.65	1861.96	1862.87	0.56	2396.43	3280.02	9.96	6.56	0.87
Doe Peak Wash	2.479	5677	1869.80		9709.66	10360.22	650.56	1868.50	1870.12	3135.91	2013.77	527.32	4.78	6.00	0.44
Doe Peak Wash	2.479	5677	1869.91	0.11	9709.66	10230.00	520.34	1868.53	1870.28	3363.80	2140.92	172.27	4.93	6.11	0.45
Doe Peak Wash	2.573	5677	1873.41		9841.53	10306.96	298.30	1873.41	1874.67	2954.58	2313.15	409.27	10.52	5.71	0.94
Doe Peak Wash	2.573	5677	1873.43	0.02	9841.53	10306.96	300.07	1873.43	1874.67	2957.12	2304.98	414.90	10.42	5.73	0.93
Doe Peak Wash	2.669	5677	1878.90		9677.18	10092.63	415.45	1877.92	1879.29	3737.48	1935.66	3.86	5.72	6.20	0.53
Doe Peak Wash	2.669	5677	1878.89	-0.01	9677.27	10092.46	415.19	1877.92	1879.28	3736.06	1937.19	3.75	5.74	6.19	0.53
Doe Peak Wash	2.734	5677	1881.12		9690.03	10100.28	410.25	1880.39	1881.72	3329.06	1534.10	813.84	7.98	5.72	0.72
Doe Peak Wash	2.734	5677	1881.12	0.00	9690.03	10100.28	410.25	1880.39	1881.72	3330.92	1532.28	813.80	7.96	5.72	0.72
Doe Peak Wash	2.859	3715	1886.90		9957.98	10224.95	266.97	1886.24	1887.44	52.72	1618.90	2043.38	7.45	5.80	0.62
Doe Peak Wash	2.859	3715	1886.89	0.00	9957.99	10224.91	266.92	1886.24	1887.44	52.60	1619.51	2042.90	7.46	5.79	0.63
Doe Peak Wash	2.903	3715	1888.91		9940.89	10194.09	253.20	1888.13	1889.43	1.22	1963.57	1750.20	6.48	3.91	0.64
Doe Peak Wash	2.903	3715	1888.92	0.00	9940.89	10194.09	253.20	1888.13	1889.43	1.23	1963.08	1750.69	6.48	3.92	0.64
Doe Peak Wash	2.954	3715	1891.31		9975.32	10210.28	234.96	1891.15	1892.19	45.71	1971.28	1698.01	9.14	4.61	0.83
Doe Peak Wash	2.954	3715	1891.31	0.00	9975.32	10210.28	234.96	1891.14	1892.19	45.73	1970.78	1698.49	9.13	4.61	0.83
Doe Peak Wash	3.048	3715	1896.68		9977.89	10259.51	281.62	1896.23	1897.27	0.06	1764.78	1950.16	7.58	6.58	0.67
Doe Peak Wash	3.048	3715	1896.68	0.00	9977.89	10259.51	281.62	1896.23	1897.27	0.06	1764.54	1950.40	7.58	6.58	0.67

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Doe Peak Wash	3.143	3715	1901.02		9916.69	10204.71	288.02	1900.90	1901.86	533.56	2377.58	803.86	8.74	6.52	0.72
Doe Peak Wash	3.143	3715	1901.02	0.00	9916.69	10204.71	288.01	1900.91	1901.86	533.55	2377.65	803.80	8.74	6.52	0.72
Doe Peak Wash	3.237	3715	1905.26		9746.24	10028.99	282.75	1904.57	1905.81	1969.42	1736.36	9.21	7.52	6.16	0.62
Doe Peak Wash	3.237	3715	1905.26	0.00	9746.24	10028.99	282.75	1904.57	1905.81	1969.92	1735.85	9.23	7.52	6.16	0.62
Doe Peak Wash	3.331	3715	1908.89		9900.91	10119.30	218.40	1908.28	1909.61	311.22	2816.07	587.71	7.42	5.39	0.66
Doe Peak Wash	3.331	3715	1908.89	0.00	9900.91	10119.30	218.39	1908.28	1909.61	311.20	2816.09	587.71	7.42	5.39	0.66
Doe Peak Wash	3.380	3715	1910.78		9868.46	10266.24	397.78	1909.59	1911.06	61.09	2193.76	1460.15	4.71	5.68	0.45
Doe Peak Wash	3.380	3715	1910.78	0.00	9868.46	10266.24	397.78	1909.59	1911.06	61.11	2193.73	1460.16	4.71	5.68	0.45
Doe Peak Wash	3.427	3715	1912.13		9940.95	10351.55	384.79	1911.83	1912.66	33.52	1504.24	2177.24	7.35	4.73	0.75
Doe Peak Wash	3.427	3715	1912.13	0.00	9940.95	10351.55	384.85	1911.83	1912.66	33.74	1503.25	2178.01	7.34	4.73	0.75
Doe Peak Wash	3.522	3715	1917.80		9983.27	10207.96	224.69	1917.67	1918.74		2769.88	945.12	8.61	5.60	0.81
Doe Peak Wash	3.522	3715	1917.80	0.00	9983.28	10207.94	224.66	1917.67	1918.74		2770.74	944.26	8.62	5.60	0.81
Doe Peak Wash	3.616	3715	1922.43		9643.19	10091.68	439.39	1921.74	1922.83	1498.56	1857.59	358.85	6.53	5.63	0.56
Doe Peak Wash	3.616	3715	1922.63	0.21	9800.00	10091.68	291.68	1922.08	1923.19	1096.98	2148.42	469.60	7.21	5.83	0.60
Doe Peak Wash	3.707	3715	1926.91		9992.81	10270.75	277.94	1926.91	1927.81		2061.55	1653.45	9.06	5.31	0.92
Doe Peak Wash	3.707	3715	1927.16	0.26	9992.81	10200.00	207.19	1927.16	1928.24		2342.33	1372.67	9.49	5.56	0.93
Doe Peak Wash	3.804	3719	1933.04		9864.96	10029.54	164.58	1932.14	1933.74		3719.00		6.71	6.34	0.64
Doe Peak Wash	3.804	3719	1933.16	0.11	9864.96	10029.54	164.58	1932.13	1933.81		3719.00		6.49	6.46	0.61

River	River Sta	Q Total	W.S. Elev	Prof Delta WS	Sta W.S. Lft	Sta W.S. Rgt	Top Width	Crit W.S.	E.G. Elev	Q Left	Q Channel	Q Right	Vel Chnl	Max Chl Dpth	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)	(ft)	
Doe Peak Wash	3.901	3719	1938.61		9950.48	10051.86	101.38	1938.61	1940.44	18.38	3659.26	41.37	10.94	6.81	0.99
Doe Peak Wash	3.901	3719	1938.65	0.04	9950.48	10051.86	101.38	1938.65	1940.44	19.13	3657.00	42.87	10.82	6.85	0.97
Doe Peak Wash	3.953	3719	1942.84		9979.21	10144.08	163.58	1941.64	1943.58		3663.99	55.01	6.97	6.94	0.62
Doe Peak Wash	3.953	3719	1942.81	-0.02	9979.24	10143.95	162.91	1941.64	1943.57		3665.55	53.45	7.01	6.91	0.62
Doe Peak Wash	3.995	3719	1944.77		9924.23	10050.95	126.71	1944.39	1946.01		3719.00		8.94	6.07	0.87
Doe Peak Wash	3.995	3719	1944.77	0.01	9924.23	10050.95	126.72	1944.38	1946.01		3719.00		8.92	6.07	0.87
Doe Peak Wash	4.076	3719	1950.12		9896.48	10060.04	163.56	1949.76	1951.36	294.26	3400.09	24.65	9.28	7.32	0.77
Doe Peak Wash	4.076	3719	1950.11	-0.01	9896.64	10060.01	163.37	1949.78	1951.36	293.00	3401.48	24.51	9.30	7.31	0.77
Doe Peak Wash	4.138	3719	1953.59		9920.54	10027.66	107.12	1952.92	1954.86	51.74	3654.41	12.84	9.10	7.39	0.76
Doe Peak Wash	4.138	3719	1953.59	0.00	9920.56	10027.66	107.09	1952.92	1954.86	51.64	3654.54	12.82	9.11	7.39	0.76
Doe Peak Wash	4.185	1392	1956.27		9982.07	10077.34	95.26	1954.23	1956.58	33.16	1001.65	357.19	5.01	6.27	0.38
Doe Peak Wash	4.185	1392	1956.27	0.00	9982.07	10077.34	95.27	1954.23	1956.58	33.17	1001.61	357.22	5.00	6.27	0.38
Doe Peak Wash	4.279	1392	1960.54		9958.63	10025.15	66.52	1960.54	1961.81	16.17	1375.11	0.72	9.07	4.14	0.97
Doe Peak Wash	4.279	1392	1960.54	0.00	9958.63	10025.15	66.52	1960.54	1961.81	16.17	1375.11	0.72	9.07	4.14	0.97
Doe Peak Wash	4.374	1392	1968.92		9946.07	10032.84	86.77	1968.06	1969.48	1.19	1388.85	1.96	6.03	4.42	0.61
Doe Peak Wash	4.374	1392	1968.92	0.00	9946.07	10032.84	86.77	1968.06	1969.48	1.19	1388.85	1.96	6.03	4.42	0.61
Doe Peak Wash	4.460	1392	1975.19		9941.48	10011.52	70.04	1974.42	1975.90	2.32	1388.53	1.15	6.75	5.29	0.67
Doe Peak Wash	4.460	1392	1975.19	0.00	9941.48	10011.52	70.04	1974.42	1975.90	2.32	1388.53	1.15	6.75	5.29	0.67
Doe Peak Wash	4.563	1392	1981.52		9971.95	10028.92	56.97	1980.36	1982.24		1392.00		6.80	5.82	0.63
Doe Peak Wash	4.563	1392	1981.52	0.00	9971.95	10028.92	56.97	1980.36	1982.24		1392.00		6.80	5.82	0.63

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Doe Peak Wash	4.656	1392	1989.28		9969.86	10009.35	39.49	1988.95	1990.73		1392.00		9.66	5.58	0.89
Doe Peak Wash	4.656	1392	1989.28	0.00	9969.86	10009.35	39.49	1988.95	1990.73		1392.00		9.66	5.58	0.89
Doe Peak Wash	4.696	1392	1995.88		9981.83	10012.92	31.08	1995.88	1997.86		1392.00		11.30	7.88	1.00
Doe Peak Wash	4.696	1392	1995.88	0.00	9981.83	10012.92	31.08	1995.88	1997.86		1392.00		11.30	7.88	1.00
Sweat Canyon	3.873	12400	1703.84		8947.09	10015.49	1068.39	1703.82	1704.67	8801.33	3598.67		11.37	8.64	0.84
Sweat Canyon	3.873	12400	1703.89	0.05	8947.09	10015.49	1068.40	1703.89	1704.66	8879.50	3520.50		11.03	8.69	0.81
Sweat Canyon	4.019	12400	1709.52		8624.56	10085.25	1460.69	1709.32	1710.18	8964.92	3312.80	122.28	11.13	6.72	0.87
Sweat Canyon	4.019	12400	1709.50	-0.02	8633.16	10084.79	1451.64	1709.30	1710.18	8949.89	3329.48	120.63	11.22	6.70	0.88
Sweat Canyon	4.129	13034	1714.33		8624.50	10105.66	1473.70	1714.33	1715.04	8657.31	4033.00	343.69	10.73	8.73	0.75
Sweat Canyon	4.129	13034	1714.33	0.00	8624.50	10105.66	1473.70	1714.33	1715.04	8657.31	4033.00	343.69	10.73	8.73	0.75
Sweat Canyon	4.222	13034	1717.79		8680.14	10087.05	1362.62	1717.29	1718.19	10946.90	1958.08	129.01	8.14	5.19	0.76
Sweat Canyon	4.222	13034	1717.93	0.14	9075.00	10032.20	938.36	1717.67	1718.67	10428.29	2605.71		10.42	5.33	0.96
Sweat Canyon	4.317	13034	1722.10		8813.12	10156.32	1343.20	1720.54	1722.30	10766.35	1887.01	380.64	4.96	8.10	0.46
Sweat Canyon	4.317	13034	1722.94	0.83	9266.36	10054.80	788.44	1720.91	1723.21	10552.26	2481.74		5.32	8.94	0.44
Sweat Canyon	4.412	13034	1724.71		9089.15	10030.08	940.93	1722.41	1724.99	10940.53	2089.75	3.73	5.68	9.21	0.50
Sweat Canyon	4.412	13034	1725.09	0.38	9400.00	10030.38	630.38	1722.49	1725.39	10945.42	2081.67	6.91	5.18	9.59	0.43
Sweat Canyon	4.507	13034	1727.57		9261.25	10130.25	869.00	1725.08	1727.86	11654.75	1364.37	14.88	4.63	7.37	0.47
Sweat Canyon	4.507	13034	1727.57	0.00	9510.00	10068.40	558.40	1725.00	1727.99	11602.85	1431.15		4.85	7.37	0.50

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	4.602	13034	1733.13		9178.12	10170.50	953.40	1733.13	1734.14	5639.35	6971.01	423.64	10.50	10.33	0.72
Sweat Canyon	4.602	13034	1733.32	0.19	9490.00	10140.00	612.87	1733.32	1734.69	4556.29	7899.24	578.47	11.56	10.52	0.78
Sweat Canyon	4.697	13034	1737.84		9319.48	10479.33	1159.85	1737.47	1738.40	3414.88	6120.15	3498.97	7.63	10.34	0.58
Sweat Canyon	4.697	13034	1738.14	0.30	9470.00	10430.00	960.00	1737.54	1738.61	3550.69	5826.29	3657.03	6.88	10.64	0.51
Sweat Canyon	4.728	13034	1739.26		9327.82	10382.66	1054.85	1739.19	1740.00	3604.46	6852.39	2577.15	8.35	10.66	0.72
Sweat Canyon	4.728	13034	1739.26	0.00	9327.70	10382.68	1054.98	1739.19	1740.00	3607.77	6847.85	2578.38	8.34	10.66	0.72
Sweat Canyon	4.741	13034	1739.39		9355.36	10369.41	1005.92	1739.25	1740.36	1173.03	10246.13	1614.84	8.71	9.99	0.64
Sweat Canyon	4.741	13034	1739.40	0.00	9355.34	10369.42	1006.06	1739.25	1740.36	1174.78	10243.36	1615.86	8.71	10.00	0.64
Sweat Canyon	4.790	13677	1742.18		9518.50	10402.71	884.21	1742.18	1743.35	1883.93	8073.90	3719.16	10.92	11.38	0.73
Sweat Canyon	4.790	13677	1742.18	0.00	9518.50	10402.71	884.21	1742.18	1743.35	1883.93	8073.90	3719.16	10.92	11.38	0.73
Sweat Canyon	4.829	13677	1744.24		9545.10	10435.98	890.88	1743.49	1744.94	1740.13	8546.82	3390.05	8.23	10.74	0.55
Sweat Canyon	4.829	13677	1744.24	0.00	9545.10	10435.98	890.88	1743.49	1744.94	1740.13	8546.82	3390.05	8.23	10.74	0.55
Sweat Canyon	4.867	13677	1745.46		9407.02	10370.21	963.20	1745.46	1746.66	2039.10	10320.41	1317.50	10.01	8.76	0.71
Sweat Canyon	4.867	13677	1745.46	0.00	9407.02	10370.21	963.20	1745.46	1746.66	2039.10	10320.41	1317.50	10.01	8.76	0.71
Sweat Canyon	5.215	7174	1756.66		9223.35	10022.65	637.32	1755.11	1756.90	6230.83	942.47	0.70	4.89	6.26	0.44
Sweat Canyon	5.215	7174	1756.66	0.00	9223.35	10022.65	637.32	1755.11	1756.90	6230.83	942.47	0.70	4.89	6.26	0.44
Sweat Canyon	5.250	7174	1758.14		9274.85	10011.32	645.34	1758.14	1758.81	5418.24	1755.76		8.71	6.34	0.91
Sweat Canyon	5.250	7174	1758.14	0.00	9274.85	10011.32	645.34	1758.14	1758.81	5418.24	1755.76		8.71	6.34	0.91
Sweat Canyon	5.302	7174	1763.12		9780.65	10156.24	375.59	1763.12	1764.43	411.29	5751.86	1010.85	9.97	6.32	0.82
Sweat Canyon	5.302	7174	1763.12	0.00	9780.65	10156.24	375.59	1763.12	1764.43	411.29	5751.86	1010.85	9.97	6.32	0.82

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	5.378	7174	1768.06		9953.18	10259.52	306.34	1767.85	1769.30	111.00	4293.07	2769.92	10.94	8.96	0.72
Sweat Canyon	5.378	7174	1768.06	0.00	9953.18	10259.52	306.34	1767.85	1769.30	111.00	4293.07	2769.92	10.94	8.96	0.72
Sweat Canyon	5.440	7174	1771.29		9932.80	10310.57	377.77	1770.56	1772.11	1188.66	4705.75	1279.59	8.30	10.39	0.60
Sweat Canyon	5.440	7174	1771.29	0.00	9932.80	10310.57	377.77	1770.56	1772.11	1188.66	4705.75	1279.59	8.30	10.39	0.60
Sweat Canyon	5.534	7174	1775.51		9773.87	10060.91	287.04	1774.99	1776.53	1296.83	5858.63	18.55	8.74	8.41	0.70
Sweat Canyon	5.534	7174	1775.51	0.00	9773.87	10060.91	287.04	1774.99	1776.53	1296.83	5858.63	18.55	8.74	8.41	0.70
Sweat Canyon	5.629	7174	1780.96		9760.82	10078.77	317.94	1780.70	1782.06	1312.22	5861.03	0.75	9.10	7.86	0.73
Sweat Canyon	5.629	7174	1780.96	0.00	9760.82	10078.77	317.94	1780.70	1782.06	1312.22	5861.03	0.75	9.10	7.86	0.73
Sweat Canyon	5.724	7174	1786.21		9938.02	10326.18	388.16	1785.26	1786.94	266.05	2594.73	4313.22	9.55	8.11	0.61
Sweat Canyon	5.724	7174	1786.21	0.00	9938.02	10326.18	388.16	1785.26	1786.94	266.05	2594.73	4313.22	9.55	8.11	0.61
Sweat Canyon	5.818	7174	1790.49		9991.82	10476.03	217.19	1789.42	1791.63	17.08	4899.39	2257.53	9.63	9.29	0.69
Sweat Canyon	5.818	7174	1790.49	0.00	9991.82	10476.03	217.19	1789.42	1791.63	17.08	4899.39	2257.53	9.63	9.29	0.69
Sweat Canyon	5.913	7174	1795.47		9935.33	10445.35	510.02	1793.97	1796.35	228.07	3532.98	3412.96	9.95	7.77	0.68
Sweat Canyon	5.913	7174	1795.47	0.00	9935.33	10445.35	510.02	1793.97	1796.35	228.07	3532.98	3412.96	9.95	7.77	0.68
Sweat Canyon	5.957	7174	1797.57		9935.79	10249.87	314.08	1796.90	1798.68	279.74	4373.30	2520.97	10.22	8.87	0.70
Sweat Canyon	5.957	7174	1797.57	0.00	9935.79	10249.87	314.08	1796.90	1798.68	279.74	4373.30	2520.97	10.22	8.87	0.70
Sweat Canyon	6.008	7174	1799.90		9949.09	10229.03	279.95	1798.88	1800.82	231.91	5291.84	1650.25	8.70	9.10	0.59
Sweat Canyon	6.008	7174	1799.90	0.00	9949.09	10229.03	279.95	1798.88	1800.82	231.91	5291.84	1650.25	8.70	9.10	0.59

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	6.103	7174	1804.09		9826.31	10062.22	235.91	1803.05	1804.99	3353.61	3820.30	0.09	8.48	7.29	0.68
Sweat Canyon	6.103	7174	1804.09	0.00	9826.31	10062.22	235.91	1803.05	1804.99	3353.61	3820.30	0.09	8.48	7.29	0.68
Sweat Canyon	6.158	7174	1806.86		9644.75	10140.74	495.99	1805.39	1807.25	2745.36	2764.39	1664.25	6.28	7.16	0.52
Sweat Canyon	6.158	7174	1806.86	0.00	9644.75	10140.74	495.99	1805.39	1807.25	2745.36	2764.39	1664.25	6.28	7.16	0.52
Sweat Canyon	6.197	7174	1808.36		9754.37	10217.71	463.34	1808.13	1809.20	2717.54	3107.62	1348.84	9.38	6.96	0.80
Sweat Canyon	6.197	7174	1808.36	0.00	9754.37	10217.71	463.34	1808.13	1809.20	2717.54	3107.62	1348.84	9.38	6.96	0.80
Sweat Canyon	6.292	7174	1814.14		9941.40	10203.57	262.17	1813.75	1815.43	47.60	5799.84	1326.56	9.90	8.34	0.71
Sweat Canyon	6.292	7174	1814.14	0.00	9941.40	10203.57	262.17	1813.75	1815.43	47.60	5799.84	1326.56	9.90	8.34	0.71
Sweat Canyon	6.387	7174	1818.82		9967.43	10361.14	393.71	1818.17	1819.60	8.43	4486.51	2679.06	8.56	9.52	0.58
Sweat Canyon	6.387	7174	1818.82	0.00	9967.43	10361.14	393.71	1818.17	1819.60	8.43	4486.51	2679.06	8.56	9.52	0.58
Sweat Canyon	6.432	7174	1821.20		9962.90	10430.94	468.04	1821.20	1822.29	36.85	4821.05	2316.10	9.95	9.20	0.71
Sweat Canyon	6.432	7174	1821.20	0.00	9962.90	10430.94	468.04	1821.20	1822.29	36.85	4821.05	2316.10	9.95	9.20	0.71
Sweat Canyon	6.481	7174	1823.92		9961.98	10475.22	513.25	1823.45	1824.68		5145.46	2028.54	8.08	9.72	0.61
Sweat Canyon	6.481	7174	1823.92	0.00	9961.98	10475.22	513.25	1823.45	1824.68		5145.46	2028.54	8.08	9.72	0.61
Sweat Canyon	6.576	7174	1829.70		9946.70	10459.89	513.19	1829.70	1830.80		5544.20	1629.80	9.45	10.10	0.68
Sweat Canyon	6.576	7174	1829.70	0.00	9946.70	10459.89	513.19	1829.70	1830.80		5544.20	1629.80	9.45	10.10	0.68
Sweat Canyon	6.671	7174	1834.56		9857.16	10275.27	418.11	1833.58	1835.47	1751.58	3826.65	1595.77	9.62	8.16	0.67
Sweat Canyon	6.671	7174	1834.56	0.00	9857.16	10275.27	418.11	1833.58	1835.47	1751.58	3826.65	1595.77	9.62	8.16	0.67
Sweat Canyon	6.765	6481	1838.55		9721.87	10104.84	382.98	1838.49	1839.65	2036.81	4119.69	324.50	10.07	7.35	0.77
Sweat Canyon	6.765	6481	1838.55	0.00	9721.87	10104.84	382.98	1838.49	1839.65	2036.81	4119.69	324.50	10.07	7.35	0.77

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	6.813	6481	1840.92		9693.36	10155.66	462.30	1840.92	1841.96	1201.51	4496.21	783.28	9.40	7.92	0.85
Sweat Canyon	6.813	6481	1840.92	0.00	9693.36	10155.66	462.30	1840.92	1841.96	1201.51	4496.21	783.28	9.40	7.92	0.85
Sweat Canyon	6.860	6481	1843.81		9667.56	10201.74	534.19	1843.81	1844.70	1428.99	3782.45	1269.56	9.35	7.41	0.80
Sweat Canyon	6.860	6481	1843.81	0.00	9667.56	10201.74	534.19	1843.81	1844.70	1428.99	3782.45	1269.56	9.35	7.41	0.80
Sweat Canyon	6.914	6481	1846.76		9779.77	10356.10	576.33	1846.76	1847.59	862.87	3137.18	2480.95	9.61	6.46	0.82
Sweat Canyon	6.914	6481	1846.76	0.00	9779.77	10356.10	576.33	1846.76	1847.59	862.87	3137.18	2480.95	9.61	6.46	0.82
Sweat Canyon	6.955	6481	1849.09		9907.63	10432.76	525.13	1849.09	1849.99	95.34	2647.04	3738.62	10.52	6.39	0.87
Sweat Canyon	6.955	6481	1849.09	0.00	9907.63	10432.76	525.13	1849.09	1849.99	95.34	2647.04	3738.62	10.52	6.39	0.87
Sweat Canyon	7.003	6481	1851.78		9953.36	10414.65	461.29	1851.78	1852.77	98.49	4083.20	2299.31	9.55	6.08	0.75
Sweat Canyon	7.003	6481	1851.78	0.00	9953.36	10414.65	461.29	1851.78	1852.77	98.49	4083.20	2299.31	9.55	6.08	0.75
Sweat Canyon	7.050	6481	1854.24		9922.48	10336.60	414.12	1854.24	1855.36	64.22	5161.21	1255.56	9.36	6.44	0.74
Sweat Canyon	7.050	6481	1854.24	0.00	9922.48	10336.60	414.12	1854.24	1855.36	64.22	5161.21	1255.56	9.36	6.44	0.74
Sweat Canyon	7.144	6481	1859.25		9938.90	10247.79	308.90	1859.25	1860.62	0.00	5764.68	716.32	9.91	7.55	0.79
Sweat Canyon	7.144	6481	1859.25	0.00	9938.90	10247.79	308.90	1859.25	1860.62	0.00	5764.68	716.32	9.91	7.55	0.79
Sweat Canyon	7.193	6481	1861.36		9828.20	10082.47	254.27	1861.22	1862.86	801.73	5505.09	174.18	10.52	6.96	0.79
Sweat Canyon	7.193	6481	1861.36	0.00	9828.20	10082.47	254.27	1861.22	1862.86	801.73	5505.09	174.18	10.52	6.96	0.79
Sweat Canyon	7.239	6481	1863.19		9868.03	10044.77	176.73	1862.99	1865.15	755.64	5459.47	265.89	12.06	7.09	0.86
Sweat Canyon	7.239	6481	1863.19	0.00	9868.03	10044.77	176.73	1862.99	1865.15	755.64	5459.47	265.89	12.06	7.09	0.86

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	7.290	6481	1865.72		9919.69	10068.35	148.66	1865.58	1867.90	1001.66	4936.12	543.22	13.15	7.62	0.90
Sweat Canyon	7.290	6481	1865.72	0.00	9919.69	10068.35	148.66	1865.58	1867.90	1001.66	4936.12	543.22	13.15	7.62	0.90
Sweat Canyon	7.334	6481	1868.47		9928.82	10076.04	147.22	1866.85	1869.60	79.82	5165.56	1235.62	9.06	9.27	0.62
Sweat Canyon	7.334	6481	1868.47	0.00	9928.82	10076.04	147.22	1866.85	1869.60	79.82	5165.56	1235.62	9.06	9.27	0.62
Sweat Canyon	7.384	6481	1871.05		9981.48	10163.68	182.21	1871.05	1873.08	1.05	6364.86	115.09	11.52	7.95	0.88
Sweat Canyon	7.384	6481	1871.05	0.00	9981.48	10163.68	182.21	1871.05	1873.08	1.05	6364.86	115.09	11.52	7.95	0.88
Sweat Canyon	7.428	6481	1873.38		9976.61	10106.16	129.55	1873.14	1875.55	23.92	6252.14	204.94	12.01	9.18	0.87
Sweat Canyon	7.428	6481	1873.38	0.00	9976.61	10106.16	129.55	1873.14	1875.55	23.92	6252.14	204.94	12.01	9.18	0.87
Sweat Canyon	7.523	6481	1878.02		9900.02	10105.58	205.56	1876.46	1878.97	105.94	6360.42	14.63	7.86	7.92	0.59
Sweat Canyon	7.523	6481	1878.02	0.00	9900.02	10105.58	205.56	1876.46	1878.97	105.94	6360.42	14.63	7.86	7.92	0.59
Sweat Canyon	7.635	6035	1883.04		9879.82	10039.27	159.45	1883.04	1885.16	194.92	5776.56	63.52	11.92	7.14	0.90
Sweat Canyon	7.635	6035	1883.04	0.00	9879.82	10039.27	159.45	1883.04	1885.16	194.92	5776.56	63.52	11.92	7.14	0.90
Sweat Canyon	7.668	6035	1885.20		9889.50	10057.91	168.40	1884.77	1886.89	187.63	5695.02	152.35	10.73	7.40	0.80
Sweat Canyon	7.668	6035	1885.20	0.00	9889.50	10057.91	168.40	1884.77	1886.89	187.63	5695.02	152.35	10.73	7.40	0.80
Sweat Canyon	7.712	6035	1887.69		9878.09	10115.62	237.53	1886.28	1888.46	33.53	5948.46	53.02	7.10	9.29	0.58
Sweat Canyon	7.712	6035	1887.69	0.00	9878.09	10115.62	237.53	1886.28	1888.46	33.53	5948.46	53.02	7.10	9.29	0.58
Sweat Canyon	7.807	5718	1891.70		9960.95	10086.93	125.98	1891.70	1893.70		5718.00		11.35	6.10	1.00
Sweat Canyon	7.807	5718	1891.70	0.00	9960.95	10086.93	125.98	1891.70	1893.70		5718.00		11.35	6.10	1.00
Sweat Canyon	7.854	5718	1894.97		9965.26	10126.36	161.10	1893.73	1895.98	6.66	5707.30	4.04	8.07	7.87	0.65
Sweat Canyon	7.854	5718	1894.97	0.00	9965.26	10126.36	161.10	1893.73	1895.98	6.66	5707.30	4.04	8.07	7.87	0.65

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	7.902	5718	1896.59		9987.09	10132.25	145.16	1895.95	1897.94		5718.00		9.34	7.39	0.80
Sweat Canyon	7.902	5718	1896.59	0.00	9987.09	10132.25	145.16	1895.95	1897.94		5718.00		9.34	7.39	0.80
Sweat Canyon	7.948	5718	1899.39		9984.79	10125.72	140.93	1898.65	1900.72		5718.00		9.27	6.09	0.78
Sweat Canyon	7.948	5718	1899.39	0.00	9984.79	10125.72	140.93	1898.65	1900.72		5718.00		9.27	6.09	0.78
Sweat Canyon	7.996	5718	1902.48		9956.54	10103.65	147.12	1900.98	1903.44		5718.00		7.85	6.38	0.62
Sweat Canyon	7.996	5718	1902.48	0.00	9956.54	10103.65	147.12	1900.98	1903.44		5718.00		7.85	6.38	0.62
Sweat Canyon	8.043	5718	1904.63		9917.19	10062.78	145.60	1903.36	1905.68		5718.00		8.22	7.33	0.66
Sweat Canyon	8.043	5718	1904.63	0.00	9917.19	10062.78	145.60	1903.36	1905.68		5718.00		8.22	7.33	0.66
Sweat Canyon	8.091	5718	1907.18		9916.78	10039.41	122.63	1906.27	1908.60		5718.00		9.59	7.88	0.77
Sweat Canyon	8.091	5718	1907.18	0.00	9916.78	10039.41	122.63	1906.27	1908.60		5718.00		9.59	7.88	0.77
Sweat Canyon	8.186	5718	1912.98		9977.14	10095.42	118.27	1911.57	1914.21		5718.00		8.88	7.38	0.67
Sweat Canyon	8.186	5718	1912.98	0.00	9977.14	10095.42	118.27	1911.57	1914.21		5718.00		8.88	7.38	0.67
Sweat Canyon	8.281	5811	1917.60		9885.59	10107.21	190.66	1915.70	1918.39	142.25	5668.75		7.18	8.70	0.57
Sweat Canyon	8.281	5811	1917.60	0.00	9885.59	10107.21	190.66	1915.70	1918.39	142.25	5668.75		7.18	8.70	0.57
Sweat Canyon	8.375	5811	1922.35		9919.19	10052.31	133.13	1921.97	1924.01		5811.00		10.35	7.25	0.89
Sweat Canyon	8.375	5811	1922.35	0.00	9919.19	10052.31	133.13	1921.97	1924.01		5811.00		10.35	7.25	0.89
Sweat Canyon	8.428	5811	1926.93		9834.90	10022.32	187.42	1925.76	1927.87	187.53	5594.80	28.67	7.92	7.83	0.63
Sweat Canyon	8.428	5811	1926.93	0.00	9834.90	10022.32	187.42	1925.76	1927.87	187.53	5594.80	28.67	7.92	7.83	0.63

River	River Sta	Q Total	W.S. Elev	Prof Delta WS	Sta W.S. Lft	Sta W.S. Rgt	Top Width	Crit W.S.	E.G. Elev	Q Left	Q Channel	Q Right	Vel Chnl	Max Chl Dpth	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)	(ft)	
Sweat Canyon	8.516	5811	1931.40		9921.07	10276.43	355.36	1930.27	1931.86	285.80	2801.12	2724.08	6.79	7.00	0.52
Sweat Canyon	8.516	5811	1931.40	0.00	9921.07	10276.43	355.36	1930.27	1931.86	285.80	2801.12	2724.08	6.79	7.00	0.52
Sweat Canyon	8.565	5811	1933.67		9826.59	10038.90	212.32	1933.67	1935.27	1316.90	4494.10		11.28	7.07	0.90
Sweat Canyon	8.565	5811	1933.67	0.00	9826.59	10038.90	212.32	1933.67	1935.27	1316.90	4494.10		11.28	7.07	0.90
Sweat Canyon	8.632	5811	1938.15		9807.76	10021.94	214.19	1937.30	1939.42	263.37	5537.41	10.22	9.26	8.15	0.70
Sweat Canyon	8.632	5811	1938.15	0.00	9807.76	10021.94	214.19	1937.30	1939.42	263.37	5537.41	10.22	9.26	8.15	0.70
Sweat Canyon	8.659	5811	1939.34		9838.74	10043.36	140.59	1938.11	1940.67		5811.00		9.24	8.34	0.71
Sweat Canyon	8.659	5811	1939.34	0.00	9838.74	10043.36	140.59	1938.11	1940.67		5811.00		9.24	8.34	0.71
Sweat Canyon	8.754	5811	1944.19		9905.15	10039.25	134.09	1943.66	1945.81	26.21	5765.75	19.04	10.25	6.69	0.82
Sweat Canyon	8.754	5811	1944.19	0.00	9905.15	10039.25	134.09	1943.66	1945.81	26.21	5765.75	19.04	10.25	6.69	0.82
Sweat Canyon	8.847	5811	1949.76		9934.75	10083.19	148.43	1948.13	1950.85	87.48	5233.02	490.50	8.75	8.76	0.59
Sweat Canyon	8.847	5811	1949.76	0.00	9934.75	10083.19	148.43	1948.13	1950.85	87.48	5233.02	490.50	8.75	8.76	0.59
Sweat Canyon	8.972	5811	1955.61		9973.72	10122.17	148.45	1955.28	1957.50	78.57	5458.15	274.28	11.34	7.41	0.84
Sweat Canyon	8.972	5811	1955.61	0.00	9973.72	10122.17	148.45	1955.28	1957.50	78.57	5458.15	274.28	11.34	7.41	0.84
Sweat Canyon	9.007	5811	1957.94		9984.37	10139.00	154.63	1957.94	1960.20	44.59	4724.02	1042.38	13.15	8.04	0.92
Sweat Canyon	9.007	5811	1957.94	0.00	9984.37	10139.00	154.63	1957.94	1960.20	44.59	4724.02	1042.38	13.15	8.04	0.92
Sweat Canyon	9.091	5396	1963.74		9903.86	10056.56	152.71	1962.93	1965.03	692.56	4596.01	107.43	9.71	7.24	0.71
Sweat Canyon	9.091	5396	1963.74	0.00	9903.86	10056.56	152.71	1962.93	1965.03	692.56	4596.01	107.43	9.71	7.24	0.71
Sweat Canyon	9.133	5396	1966.99		9914.65	10027.51	112.86	1966.99	1969.32	939.33	4433.07	23.60	13.25	8.39	0.90
Sweat Canyon	9.133	5396	1966.99	0.00	9914.65	10027.51	112.86	1966.99	1969.32	939.33	4433.07	23.60	13.25	8.39	0.90

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	9.228	5396	1972.85		9959.55	10063.67	104.12	1971.44	1974.28	14.95	5351.73	29.32	9.63	8.15	0.67
Sweat Canyon	9.228	5396	1972.85	0.00	9959.55	10063.67	104.12	1971.44	1974.28	14.95	5351.73	29.32	9.63	8.15	0.67
Sweat Canyon	9.283	5396	1975.02		9907.24	10033.30	126.05	1974.58	1976.93	687.78	4649.34	58.88	11.86	7.72	0.80
Sweat Canyon	9.283	5396	1975.02	0.00	9907.24	10033.30	126.05	1974.58	1976.93	687.78	4649.34	58.88	11.86	7.72	0.80
Sweat Canyon	9.322	5396	1977.00		9942.41	10035.58	93.17	1977.00	1979.77	27.70	5207.87	160.43	13.57	8.00	0.94
Sweat Canyon	9.322	5396	1977.00	0.00	9942.41	10035.58	93.17	1977.00	1979.77	27.70	5207.87	160.43	13.57	8.00	0.94
Sweat Canyon	9.367	5396	1981.21		9956.56	10083.15	126.59	1979.73	1982.46	26.98	5276.06	92.96	9.05	8.91	0.64
Sweat Canyon	9.367	5396	1981.21	0.00	9956.56	10083.15	126.59	1979.73	1982.46	26.98	5276.06	92.96	9.05	8.91	0.64
Sweat Canyon	9.417	5396	1983.15		9963.62	10067.18	103.55	1981.91	1984.64		5396.00		9.80	8.85	0.75
Sweat Canyon	9.417	5396	1983.15	0.00	9963.62	10067.18	103.55	1981.91	1984.64		5396.00		9.80	8.85	0.75
Sweat Canyon	9.512	5396	1987.68		9976.98	10057.47	80.48	1986.81	1989.85	7.51	5338.71	49.78	11.91	9.38	0.80
Sweat Canyon	9.512	5396	1987.68	0.00	9976.98	10057.47	80.48	1986.81	1989.85	7.51	5338.71	49.78	11.91	9.38	0.80
Sweat Canyon	9.606	5396	1993.33		9938.75	10063.43	124.68	1992.25	1994.69	4.17	5388.97	2.86	9.36	7.13	0.72
Sweat Canyon	9.606	5396	1993.33	0.00	9938.75	10063.43	124.68	1992.25	1994.69	4.17	5388.97	2.86	9.36	7.13	0.72
Sweat Canyon	9.701	5172	1998.30		9991.28	10187.43	196.16	1998.30	2000.01	7.71	4355.56	808.74	11.33	8.60	0.77
Sweat Canyon	9.701	5172	1998.30	0.00	9991.28	10187.43	196.16	1998.30	2000.01	7.71	4355.56	808.74	11.33	8.60	0.77
Sweat Canyon	9.796	5172	2004.34		9966.28	10054.79	88.51	2004.18	2006.60		5172.00		12.05	7.84	0.96
Sweat Canyon	9.796	5172	2004.34	0.00	9966.28	10054.79	88.51	2004.18	2006.60		5172.00		12.05	7.84	0.96

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Prof Delta WS (ft)	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)	Top Width (ft)	Crit W.S. (ft)	E.G. Elev (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	Froude # Chl
Sweat Canyon	9.890	5172	2010.59		9953.08	10058.04	104.96	2008.71	2011.86	6.69	5165.31		9.05	10.29	0.65
Sweat Canyon	9.890	5172	2010.59	0.00	9953.08	10058.04	104.96	2008.71	2011.86	6.69	5165.31		9.05	10.29	0.65
Sweat Canyon	9.982	5172	2015.44		9947.66	10063.55	115.88	2015.44	2017.67	500.46	4623.98	47.56	12.54	7.94	0.94
Sweat Canyon	9.982	5172	2015.44	0.00	9947.66	10063.55	115.88	2015.44	2017.67	500.46	4623.98	47.56	12.54	7.94	0.94
Sweat Canyon	10.080	5172	2022.99		9946.61	10028.93	82.32	2022.67	2025.23		5172.00		12.02	8.89	0.93
Sweat Canyon	10.080	5172	2022.99	0.00	9946.61	10028.93	82.32	2022.67	2025.23		5172.00		12.02	8.89	0.93
Sweat Canyon	10.175	4375	2030.36		9971.10	10061.28	90.18	2029.47	2031.90		4375.00		9.95	8.96	0.79
Sweat Canyon	10.175	4375	2030.36	0.00	9971.10	10061.28	90.18	2029.47	2031.90		4375.00		9.95	8.96	0.79
Sweat Canyon	10.269	4375	2037.27		9948.96	10035.34	86.38	2037.27	2039.42		4375.00		11.78	7.67	1.00
Sweat Canyon	10.269	4375	2037.27	0.00	9948.96	10035.34	86.38	2037.27	2039.42		4375.00		11.78	7.67	1.00
Sweat Canyon	10.364	4375	2048.77		9972.77	10044.95	72.18	2048.77	2051.20		4375.00		12.51	8.67	1.00
Sweat Canyon	10.364	4375	2048.77	0.00	9972.77	10044.95	72.18	2048.77	2051.20		4375.00		12.51	8.67	1.00
Sweat Canyon	10.459	3977	2058.27		9976.29	10037.28	60.99	2058.13	2060.88		3972.79	4.21	12.95	9.77	0.96
Sweat Canyon	10.459	3977	2058.27	0.00	9976.29	10037.28	60.99	2058.13	2060.88		3972.79	4.21	12.95	9.77	0.96
Sweat Canyon	10.553	3977	2067.19		9972.34	10028.26	55.92	2066.73	2069.56		3977.00		12.34	10.59	0.91
Sweat Canyon	10.553	3977	2067.19	0.00	9972.34	10028.26	55.92	2066.73	2069.56		3977.00		12.34	10.59	0.91
Sweat Canyon	10.648	3574	2073.83		9971.53	10041.45	69.92	2072.98	2075.44		3574.00		10.17	7.53	0.80
Sweat Canyon	10.648	3574	2073.83	0.00	9971.53	10041.45	69.92	2072.98	2075.44		3574.00		10.17	7.53	0.80
Sweat Canyon	10.711	3574	2082.13		9978.51	10034.98	56.47	2082.13	2084.64		3574.00		12.70	10.43	1.00
Sweat Canyon	10.711	3574	2082.13	0.00	9978.51	10034.98	56.47	2082.13	2084.64		3574.00		12.70	10.43	1.00

Sweat Canyon Wash - n Value Determination

[1]n = m(nb +n1 + n2 + n3 + n4)

where:

n = roughness coefficient
m = meandering factor
[2]nb = base n value
n1 = surface irregularities factor
n2 = variation in shape and size factor
n3 = obstructions factor
[3]n4 = vegitation factor = 0.0008B - 0.0007
B = % of flow blocked by vegetation

	Section	nb	n1	n2	n3	B	n4	m	*n*	*rounded n*
Main Channel	4.222 - 4.602	0.029	0.008	0.000	0.000	15	0.0113	1	0.048	0.050
LB		0.025	0.001	0.000	0.000	50	0.0393	1	0.065	0.065
RB		0.025	0.001	0.000	0.000	50	0.0393	1	0.065	0.065
Main Channel	4.602 - 4.728	0.040	0.003	0.000	0.000	10	0.0073	1	0.050	0.050
LB		0.025	0.001	0.000	0.000	20	0.0153	1	0.041	0.040
RB		0.025	0.001	0.000	0.000	30	0.0233	1	0.049	0.050
Main Channel	4.728 - 4.741	0.025	0.001	0.000	0.000	1	0.0001	1	0.026	0.025
LB		0.025	0.001	0.000	0.000	1	0.0001	1	0.026	0.025
RB		0.025	0.001	0.000	0.000	1	0.0001	1	0.026	0.025
Main Channel	4.741 - 4.790	0.035	0.007	0.000	0.000	10	0.0073	1	0.049	0.050
LB		0.025	0.003	0.000	0.000	50	0.0393	1	0.067	0.070
RB		0.025	0.003	0.000	0.000	50	0.0393	1	0.067	0.070
Main Channel	4.790 - 4.867	0.035	0.005	0.000	0.000	15	0.0113	1	0.051	0.050
LB		0.027	0.002	0.000	0.000	50	0.0393	1	0.068	0.070
RB		0.027	0.002	0.000	0.000	60	0.0473	1	0.076	0.075
Main Channel	4.867 - 5.548	0.040	0.003	0.000	0.000	10	0.0073	1	0.050	0.050
LB		0.031	0.002	0.000	0.000	30	0.0233	1	0.056	0.055
RB		0.025	0.002	0.000	0.000	40	0.0313	1	0.058	0.060
Main Channel	5.584 - 5.643	0.040	0.002	0.003	0.000	10	0.0073	1	0.052	0.055
LB		0.031	0.002	0.003	0.000	30	0.0233	1	0.059	0.060
RB		0.025	0.002	0.003	0.000	40	0.0313	1	0.061	0.060
Main Channel	5.643 - 6.211	0.040	0.002	0.000	0.000	10	0.0073	1	0.049	0.050
LB		0.031	0.002	0.000	0.000	30	0.0233	1	0.056	0.055
RB		0.025	0.002	0.000	0.000	40	0.0313	1	0.058	0.060
Main Channel	6.211 - 6.590	0.033	0.005	0.005	0.000	10	0.0073	1	0.050	0.050
LB		0.031	0.001	0.005	0.000	30	0.0233	1	0.060	0.060
RB		0.029	0.001	0.005	0.000	30	0.0233	1	0.058	0.060
Main Channel	6.590 - 6.684	0.029	0.002	0.003	0.000	10	0.0073	1	0.041	0.040
LB		0.027	0.000	0.003	0.000	25	0.0193	1	0.049	0.050
RB		0.027	0.000	0.003	0.000	20	0.0153	1	0.045	0.045
Main Channel	6.684 - 6.833	0.024	0.002	0.000	0.000	10	0.0073	1	0.033	0.035
LB		0.027	0.000	0.000	0.000	25	0.0193	1	0.046	0.045
RB		0.027	0.000	0.000	0.000	20	0.0153	1	0.042	0.045
Main Channel	6.833 - 6.874	0.024	0.002	0.003	0.000	10	0.0073	1	0.036	0.035
LB		0.027	0.001	0.003	0.000	25	0.0193	1	0.050	0.050
RB		0.027	0.000	0.003	0.000	20	0.0153	1	0.045	0.045
Main Channel	6.874 - 7.821	0.029	0.002	0.000	0.000	10	0.0073	1	0.038	0.040
LB		0.027	0.001	0.000	0.000	25	0.0193	1	0.047	0.050
RB		0.027	0.001	0.000	0.000	20	0.0153	1	0.043	0.045
Main Channel	7.821 - 8.294	0.035	0.004	0.003	0.000	10	0.0073	1	0.049	0.050
LB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
RB		0.033	0.004	0.003	0.000	40	0.0313	1	0.071	0.070
Main Channel	8.294 - 8.435	0.035	0.004	0.000	0.000	10	0.0073	1.15	0.053	0.055
LB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
RB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
Main Channel	8.435 - 8.484	0.035	0.004	0.003	0.000	10	0.0073	1	0.049	0.050
LB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
RB		0.033	0.004	0.003	0.000	40	0.0313	1	0.071	0.070
Main Channel	8.484 - 8.673	0.035	0.004	0.000	0.000	10	0.0073	1	0.046	0.045
LB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
RB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070

Sweat Canyon Wash - n Value Determination

	Section	nb	n1	n2	n3	B	n4	m	*n*	*rounded n*
Main Channel	8.673 - 8.891	0.035	0.004	0.000	0.000	10	0.0073	1.15	0.053	0.055
LB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
RB		0.033	0.004	0.000	0.000	40	0.0313	1	0.068	0.070
Main Channel	8.891 - 9.147	0.035	0.002	0.000	0.000	10	0.0073	1	0.044	0.045
LB		0.030	0.000	0.000	0.000	40	0.0313	1	0.061	0.060
RB		0.030	0.000	0.000	0.000	40	0.0313	1	0.061	0.060
Main Channel	9.147 - 9.424	0.037	0.002	0.000	0.000	10	0.0073	1	0.046	0.045
LB		0.037	0.000	0.000	0.000	50	0.0393	1	0.076	0.075
RB		0.033	0.000	0.000	0.000	60	0.0473	1	0.080	0.080
Main Channel	9.424 - 9.894	0.035	0.001	0.000	0.000	10	0.0073	1	0.043	0.045
LB		0.025	0.000	0.000	0.000	50	0.0393	1	0.064	0.065
RB		0.027	0.000	0.000	0.000	50	0.0393	1	0.066	0.065
Main Channel	9.894 - 10.276	0.030	0.002	0.000	0.000	15	0.0113	1	0.043	0.045
LB		0.031	0.000	0.000	0.000	50	0.0393	1	0.070	0.070
RB		0.029	0.000	0.000	0.000	50	0.0393	1	0.068	0.070
Main Channel	10.276 - 10.371	0.030	0.002	0.000	0.000	15	0.0113	1.15	0.050	0.050
LB		0.031	0.000	0.000	0.000	50	0.0393	1	0.070	0.070
RB		0.029	0.000	0.000	0.000	50	0.0393	1	0.068	0.070
Main Channel	10.371 - 10.465	0.030	0.002	0.000	0.000	15	0.0113	1	0.043	0.045
LB		0.031	0.000	0.000	0.000	50	0.0393	1	0.070	0.070
RB		0.029	0.000	0.000	0.000	50	0.0393	1	0.068	0.070
Main Channel	10.465 - 10.623	0.033	0.000	0.000	0.000	10	0.0073	1	0.040	0.040
LB		0.029	0.000	0.000	0.000	35	0.0273	1	0.056	0.055
RB		0.029	0.000	0.000	0.000	30	0.0233	1	0.052	0.055

[1]Equation (9) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

[2]Table 1. Base values of Manning's n for stable channels from *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, USGS, 1991.

uation (14) from *Verification of Roughness Coefficients for Selected Natural Constructed Stream Channels in Arizona*, USGS, 1998.

Doe Peak Wash - n Value Determination

[1] $n = m(nb + n1 + n2 + n3 + n4)$

where:

n = roughness coefficient
m = meandering factor
[2] nb = base n value
n1 = surface irregularities factor
n2 = variation in shape and size factor
n3 = obstructions factor
[3] n4 = vegitation factor = 0.0008B - 0.0007
B = % of flow blocked by vegetation

	Section	nb	n1	n2	n3	B	n4	m	n	*rounded n*
Main Channel	0.018 - 0.396	0.040	0.001	0	0	10	0.0073	1	0.048	0.050
LB		0.025	0	0	0	40	0.0313	1	0.056	0.055
RB		0.025	0	0	0	40	0.0313	1	0.056	0.055
Main Channel	0.396 - 0.681	0.042	0.003	0	0	10	0.0073	1	0.052	0.055
LB		0.027	0.001	0	0	50	0.0393	1	0.067	0.070
RB		0.029	0.001	0	0	50	0.0393	1	0.069	0.070
Main Channel	0.681 - 0.964	0.042	0.002	0	0	10	0.0073	1	0.051	0.050
LB		0.029	0	0	0	40	0.0313	1	0.060	0.060
RB		0.029	0	0	0	40	0.0313	1	0.060	0.060
Main Channel	0.964 - 1.058	0.042	0	0	0	10	0.0073	1.15	0.057	0.055
LB		0.029	0	0	0	40	0.0313	1	0.060	0.060
RB		0.029	0	0	0	40	0.0313	1	0.060	0.060
Main Channel	1.058 - 1.231	0.042	0	0	0	10	0.0073	1	0.049	0.050
LB		0.029	0	0	0	40	0.0313	1	0.060	0.060
RB		0.029	0	0	0	40	0.0313	1	0.060	0.060
Main Channel	1.231 - 1.438	0.035	0	0.003	0	10	0.0073	1	0.045	0.045
LB		0.029	0	0.003	0	20	0.0153	1	0.047	0.050
RB		0.029	0	0.003	0	25	0.0193	1	0.051	0.050
Main Channel	1.438 - 1.624	0.035	0	0	0	10	0.0073	1	0.042	0.045
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	1.624 - 1.722	0.035	0	0	0	10	0.0073	1.15	0.049	0.050
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	1.722 - 1.910	0.035	0	0	0	10	0.0073	1	0.042	0.045
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	1.910 - 2.006	0.035	0	0	0	10	0.0073	1.15	0.049	0.050
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	2.006 - 2.290	0.035	0	0	0	10	0.0073	1	0.042	0.045
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	2.290 - 2.479	0.035	0	0	0	10	0.0073	1.15	0.049	0.050
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	2.479 - 2.859	0.035	0	0	0	10	0.0073	1	0.042	0.045
LB		0.029	0	0	0	20	0.0153	1	0.044	0.045
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	2.859 - 3.804	0.035	0.004	0	0	10	0.0073	1	0.046	0.045
LB		0.027	0	0	0	30	0.0233	1	0.050	0.050
RB		0.029	0	0	0	25	0.0193	1	0.048	0.050
Main Channel	3.804 - 4.279	0.033	0.004	0	0	10	0.0073	1	0.044	0.045
LB		0.033	0	0	0	30	0.0233	1	0.056	0.055
RB		0.033	0	0	0	30	0.0233	1	0.056	0.055

Doe Peak Wash - n Value Determination

	Section	nb	n1	n2	n3	B	n4	m	n	*rounded n*
Main Channel	4.279 - 4.696	0.035	0.01	0	0	10	0.0073	1	0.052	0.055
LB		0.033	0	0	0	40	0.0313	1	0.064	0.065
RB		0.033	0	0	0	50	0.0393	1	0.072	0.075

[1]Equation (9) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

[2]Table 1. Base values of Manning's n for stable channels from *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, USGS, 1991.

[3]Equation (14) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

South Fork Doe Peak Wash
n Value Determination

[1] $n = m(nb + n1 + n2 + n3 + n4)$

where:

n = roughness coefficient
m = meandering factor
[2] nb = base n value
n1 = surface irregularities factor
n2 = variation in shape and size factor
n3 = obstructions factor
[3] n4 = vegitation factor = 0.0008B - 0.0007
B = % of flow blocked by vegetation

	Section	nb	n1	n2	n3	B	n4	m	*n*	*rounded n*
Main Channel	0.102 - 0.271	0.040	0	0	0	15	0.0113	1	0.051	0.050
LB		0.035	0	0	0	30	0.0233	1	0.058	0.060
RB		0.030	0	0	0	35	0.0273	1	0.057	0.060
Main Channel	0.271 - 0.555	0.040	0	0	0	15	0.0113	1	0.051	0.050
LB		0.035	0	0	0	30	0.0233	1	0.058	0.060
RB		0.035	0	0	0	30	0.0233	1	0.058	0.060
Main Channel	0.555 - 0.745	0.040	0	0	0	20	0.0153	1	0.055	0.055
LB		0.030	0	0	0	30	0.0233	1	0.053	0.055
RB		0.030	0	0	0	30	0.0233	1	0.053	0.055
Main Channel	0.745 - 1.040	0.040	0	0	0	20	0.0153	1	0.055	0.055
LB		0.029	0	0	0	30	0.0233	1	0.052	0.055
RB		0.029	0	0	0	30	0.0233	1	0.052	0.055

[1]Equation (9) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

[2]Table 1. Base values of Manning's n for stable channels from *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, USGS, 1991.

[3]Equation (14) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

East Fork Doe Peak Wash
n Value Determination

[1] $n = m(nb + n1 + n2 + n3 + n4)$

where:

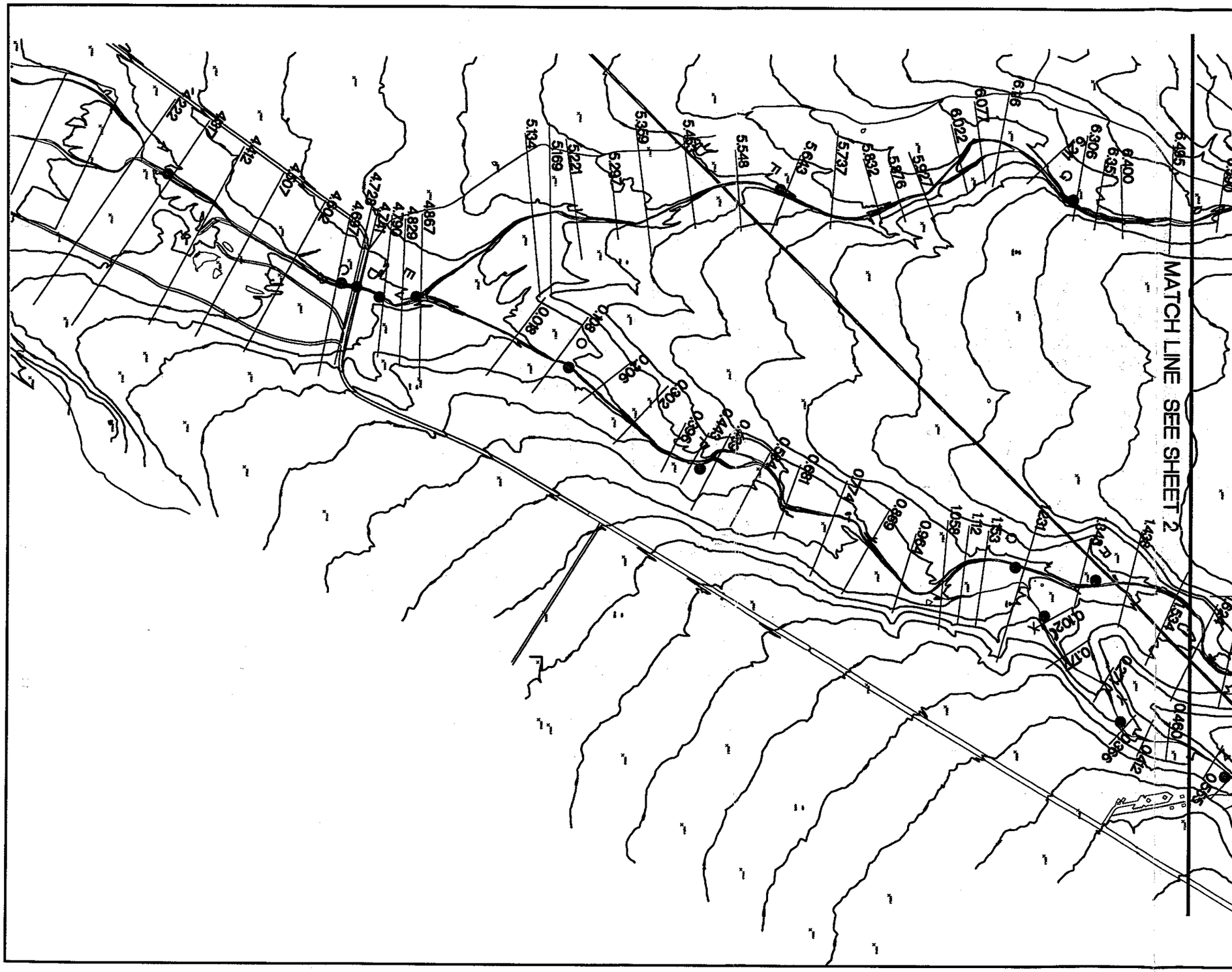
n = roughness coefficient
m = meandering factor
[2] nb = base n value
n1 = surface irregularities factor
n2 = variation in shape and size factor
n3 = obstructions factor
[3] n4 = vegitation factor = 0.0008B - 0.0007
B = % of flow blocked by vegetation

	Section	nb	n1	n2	n3	B	n4	m	*n*	*rounded n*
Main Channel	0.094 - 0.283	0.033	0	0	0	10	0.0073	1	0.040	0.040
LB		0.033	0	0	0	35	0.0273	1	0.060	0.060
RB		0.033	0	0	0	35	0.0273	1	0.060	0.060
Main Channel	0.283 - 0.661	0.033	0.004	0	0	10	0.0073	1	0.044	0.045
LB		0.033	0	0	0	30	0.0233	1	0.056	0.055
RB		0.033	0	0	0	30	0.0233	1	0.056	0.055

[1]Equation (9) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.

[2]Table 1. Base values of Manning's n for stable channels from *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, USGS, 1991.

[3]Equation (14) from *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*, USGS, 1998.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

PHOTO LOCATION PONT

CROSS SECTION IDENTIFIER 3707

N

1000 0 500 1000

1 inch =1000 ft.
CONTOUR INTERVAL = 10'FEET

DAVID EVANS AND ASSOCIATES, INC.
2929 E. CAMELBACK RD., STE. 240
PHOENIX, AZ 85016

	BY	DATE
DESIGN	–	–
DESIGN CHK.	–	–
PLANS	–	–
PLANS CHK.	–	–
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

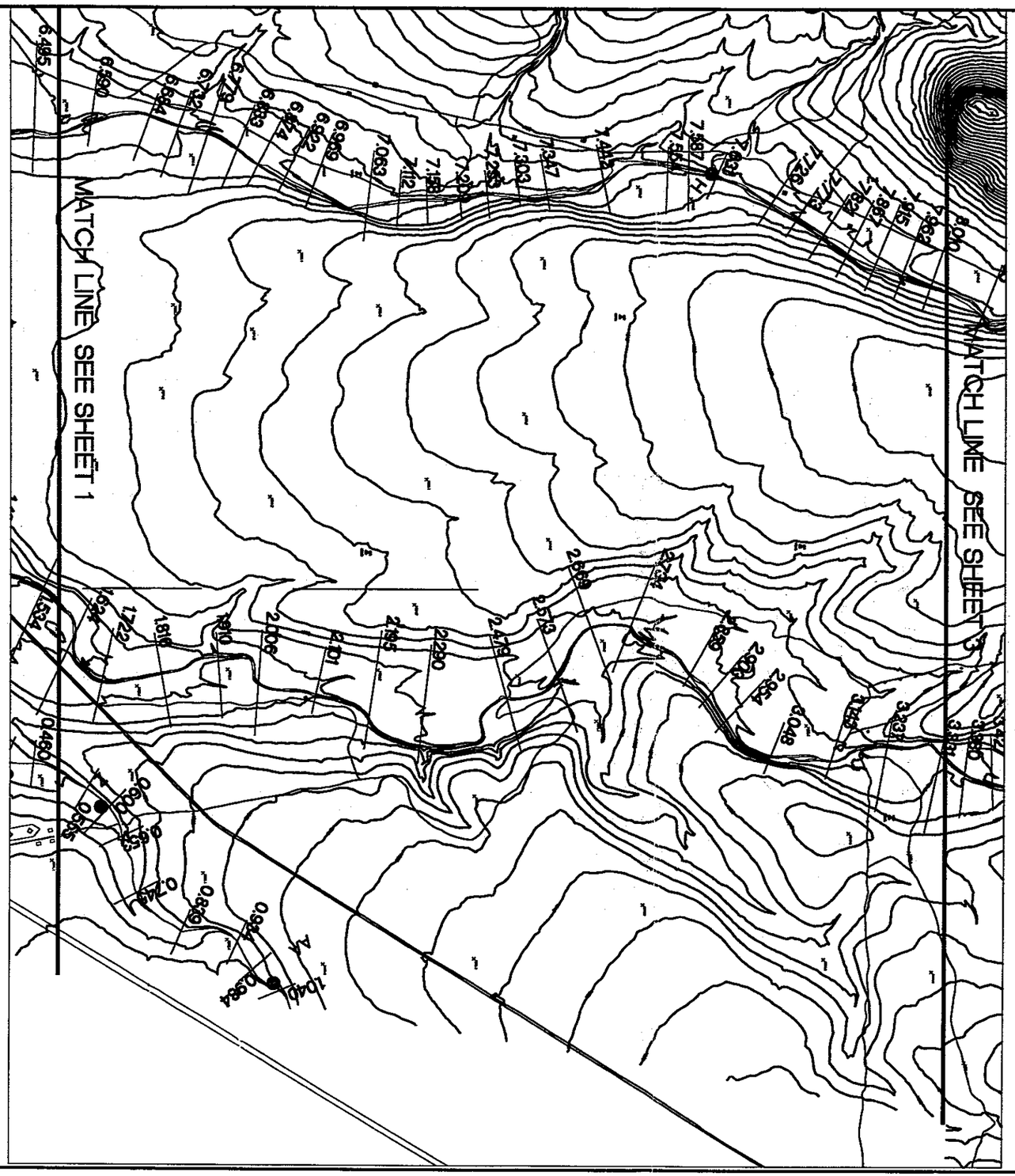
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3

MARI0029 tjel 05/20/99 14:43:45 tjel S:\CAD\MARI0029\HECRAS\FEMA\Mo29pho1.dwg



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF
SWEAT CANYON WASH

F.C.D. CONTRACT NO. **97-12**

LEGEND

PHOTO LOCATION PONT

CROSS SECTION IDENTIFIER 3.707

N

1000 0 500 1000

1 inch =1000 ft.
CONTOUR INTERVAL = 10 FEET

DAVID EVANS AND ASSOCIATES, INC.
2929 E. CAMELBACK RD., STE. 240
PHOENIX, AZ 85016

	BY	DATE
DESIGN	-	-
DESIGN CHK.	-	-
PLANS	-	-
PLANS CHK.	-	-
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

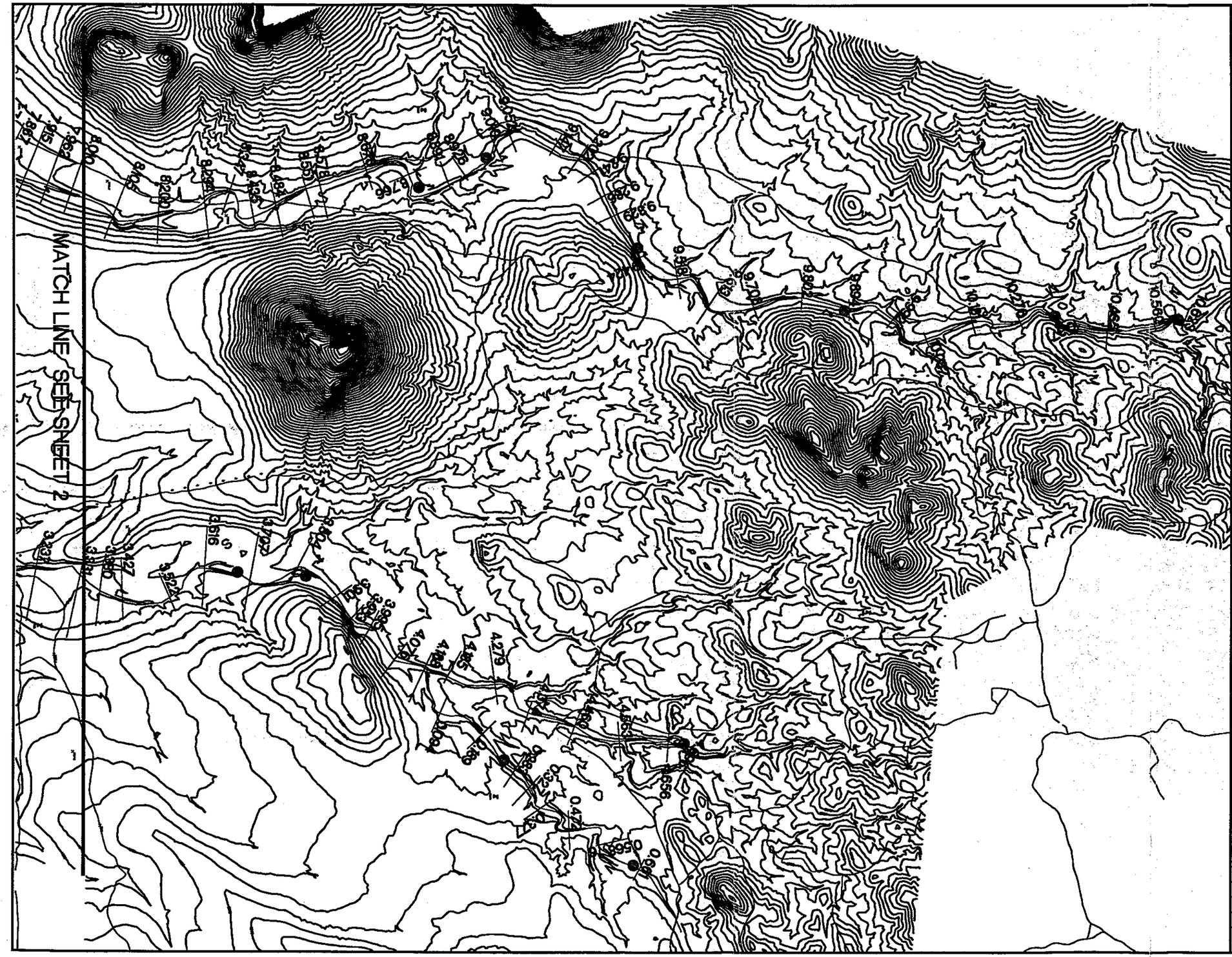
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND DIRECTOR, FLOOD CONTROL DISTRICT

SHEET 2 OF 3

MARI0029 tjcl 05/20/99 14:48:07 tjcl S:\CAD\MARI0029\HECRAS\FEMA\Ma29phc2.dwg



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

PHOTO LOCATION PONT

CROSS SECTION IDENTIFIER 3.707

N

1000 0 500 1000

1 inch =1000 ft.
CONTOUR INTERVAL = 10 FEET

DAVID EVANS AND ASSOCIATES, INC.
2929 E. CAMELBACK RD., STE. 240
PHOENIX, AZ 85016

	BY	DATE
DESIGN	--	--
DESIGN CHK.	--	--
PLANS	--	--
PLANS CHK.	--	--

SUBMITTED BY: DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

MAR10029 tjcl 05/20/99 14:50:16 tjcl S:\CAD\MAR10029\HECRAS\FEMA\Mod2photo3.dwg

A common method of selecting the roughness coefficient, *n*, is to first select a base value of *n* for the bed material (table 1). The base values of *n* are for a straight uniform channel of a given bed material. Cross-section irregularities, channel alignment, obstructions, vegetation, and other factors that increase roughness are accounted for by adding increments of roughness to the base value of *n*. Ranges of adjustments for the factors that may add to channel roughness are shown in table 2.

Many alluvial channels in Maricopa County have bed material that moves during floodflow. In addition to the changing channel geometry of these channels, the roughness coefficient may change during floodflow because of the changing form of the channel bed in parts of the channel cross section (Davidian, 1984). Bedforms, such as dunes, antidunes, and plane bed have been observed during large floods. Within a few minutes, dunes can appear, disappear, and reappear at different locations across a large stream channel. The Manning roughness coefficient can double or triple when the bedform changes from plane to dunes. A method of defining reliable values of Manning's *n* for unstable alluvial channels is not available. A plane bedform is common during large floods, and for this report, plane-bed conditions are assumed where the roughness coefficient is related to the size of the channel material and not the form of the channel bed. Plane-bed conditions were assumed for nearly all indirect measurements of peak discharge where the slope-area method was used.

Table 1.--*Base values of Manning's n for stable channels*

[Modified from Aldridge and Garrett, 1973, table 1]

Inches	Channel material	n	Size of bed material: Millimeters	Size of bed material: Inches	Base *n* values: Benson and Dalrymple (1967)[1]	Base *n* values: Chow (1959)[2]
	Concrete	.011	-------	--------	0.012-0.018	0.011
	Rock cut		-------	--------	----------	.025
	Firm soil	.020	-------	--------	.025- .032	.020
.04	Coarse sand	.022	1-2	--------	.026- .035	-----
.2	Fine gravel	.024	-------	--------	----------	.024
.5	Gravel	.026	2-64	0.08-2.5	.028- .035	-----
1.5	Coarse gravel	.028	-------	--------	----------	.028
3"-9"	Cobble	.030-.045	64-256	2.5-10.0	.030- .050	-----
11.5"-	Boulder	.05-.07	>256	>10.0	.040- .070	-----

[1]Straight uniform channel.
[2]Smoothest channel attainable in indicated material.

N Value Sensitivity Analysis

				$nb = (0.0926R^{1/6})/(0.794 + 1.85 \log R/d_{50})$[1]									
Routing Reach	WASH	HEC-RAS XSECS	Avg R HEC-RAS	d_{50} (ft)	$\log R/d_{50}$	nb	d_{50} (70%) (ft)	$\log R/d_{50}$	nb	d_{50}(130%) (ft)	$\log R/d_{50}$	nb	nb (DEA analysis)
6-7	Sweat	10.276-10.465	4.9	0.033	2.17	**0.025**	0.023	2.33	**0.024**	0.043	2.06	**0.026**	0.030
7-8	Sweat	9.992-10.276	4.7	0.083	1.75	**0.030**	0.058	1.91	**0.028**	0.108	1.64	**0.031**	0.030
8-9	Sweat	9.518-9.992	3.9	0.108	1.56	**0.032**	0.076	1.71	**0.029**	0.140	1.44	**0.034**	0.035
9-11	Sweat	9.007-9.518	3.8	0.125	1.48	**0.033**	0.088	1.64	**0.030**	0.163	1.37	**0.035**	0.035
11-12	Sweat	8.105-9.007	3.4	0.083	1.61	**0.030**	0.058	1.77	**0.028**	0.108	1.50	**0.032**	0.035
12-14	Sweat	7.631-8.105	4.5	0.083	1.73	**0.030**	0.058	1.89	**0.028**	0.108	1.62	**0.031**	0.029
14-15	Sweat	7.442-7.631	3.3	0.083	1.60	**0.030**	0.058	1.76	**0.028**	0.108	1.49	**0.032**	0.029
15-16	Sweat	6.684-7.442	1.9	0.008	2.38	**0.020**	0.006	2.50	**0.019**	0.010	2.28	**0.021**	0.024
16-17	Sweat	5.134-6.684	1.3	0.117	1.05	**0.035**	0.082	1.20	**0.032**	0.152	0.93	**0.038**	0.040
35-18	Sweat	4.741-5.134	1.6	0.108	1.17	**0.034**	0.076	1.32	**0.031**	0.140	1.06	**0.036**	0.035
18-19A	Sweat	4.222-4.741	1.8	0.083	1.34	**0.031**	0.058	1.49	**0.029**	0.108	1.22	**0.033**	0.031
20-21	Doe	4.138-4.696	2.9	0.092	1.50	**0.031**	0.064	1.66	**0.029**	0.120	1.38	**0.033**	0.035
24-25	Doe	3.804-4.138	3	0.042	1.85	**0.026**	0.029	2.01	**0.025**	0.055	1.74	**0.028**	0.033
25-26	Doe	2.734-3.804	1	0.067	1.17	**0.031**	0.047	1.33	**0.028**	0.087	1.06	**0.034**	0.035
26-32	Doe	1.231-2.734	0.9	0.108	0.92	**0.036**	0.076	1.07	**0.033**	0.140	0.81	**0.040**	0.035
32-35	Doe	.108-1.231	1.4	0.292	0.68	**0.048**	0.204	0.84	**0.042**	0.380	0.57	**0.053**	0.042
23-24	East	.094-.661	1.5	0.067	1.35	**0.030**	0.047	1.50	**0.028**	0.087	1.24	**0.032**	0.033

[1] Comparison of Verified Roughness Coefficients for Gravel-Bed Streams, Blodgett (1986)
(Range in D_{50} = 0.033 to 1.5, Range in Manning's n = 0.020 to 0.150)

N Value Sensitivity Analysis

				$nb = (0.0926R^{1/6})/(1.46 + 2.23 \log R/d_{50})^2$									
Routing	Wash	HEC-RAS	Avg R	d_{50}	$\log R/d_{50}$	nb	d_{50} (70%)	$\log R/d_{50}$	nb	d_{50}(130%)	$\log R/d_{50}$	nb	nb
Reach		XSECS	HEC-RAS	(ft)			(ft)			(fts)			(DEA analysis)
6-7	Sweat	10.276-10.465	4.9	0.033	2.17	**0.019**	0.023	2.33	**0.018**	0.043	2.06	**0.020**	0.030
7-8	Sweat	9.992-10.276	4.7	0.083	1.75	**0.022**	0.058	1.91	**0.021**	0.108	1.64	**0.023**	0.030
8-9	Sweat	9.518-9.992	3.9	0.108	1.56	**0.024**	0.076	1.71	**0.022**	0.140	1.44	**0.025**	0.035
9-11	Sweat	9.007-9.518	3.8	0.125	1.48	**0.024**	0.088	1.64	**0.023**	0.163	1.37	**0.026**	0.035
11-12	Sweat	8.105-9.007	3.4	0.083	1.61	**0.022**	0.058	1.77	**0.021**	0.108	1.50	**0.024**	0.035
12-14	Sweat	7.631-8.105	4.5	0.083	1.73	**0.022**	0.058	1.89	**0.021**	0.108	1.62	**0.023**	0.029
14-15	Sweat	7.442-7.631	3.3	0.083	1.60	**0.022**	0.058	1.76	**0.021**	0.108	1.49	**0.024**	0.029
15-16	Sweat	6.684-7.442	1.9	0.008	2.38	**0.015**	0.006	2.50	**0.015**	0.010	2.28	**0.016**	0.024
16-17	Sweat	5.134-6.684	1.3	0.117	1.05	**0.026**	0.082	1.20	**0.023**	0.152	0.93	**0.027**	0.040
35-18	Sweat	4.741-5.134	1.6	0.108	1.17	**0.025**	0.076	1.32	**0.023**	0.140	1.06	**0.026**	0.035
18-19A	Sweat	4.222-4.741	1.8	0.083	1.34	**0.023**	0.058	1.49	**0.021**	0.108	1.22	**0.024**	0.031
20-21	Doe	4.138-4.696	2.9	0.092	1.50	**0.023**	0.064	1.66	**0.021**	0.120	1.38	**0.024**	0.035
24-25	Doe	3.804-4.138	3	0.042	1.85	**0.020**	0.029	2.01	**0.019**	0.055	1.74	**0.021**	0.033
25-26	Doe	2.734-3.804	1	0.067	1.17	**0.023**	0.047	1.33	**0.021**	0.087	1.06	**0.024**	0.035
26-32	Doe	1.231-2.734	0.9	0.108	0.92	**0.026**	0.076	1.07	**0.024**	0.140	0.81	**0.028**	0.035
32-35	Doe	.108-1.231	1.4	0.292	0.68	**0.033**	0.204	0.84	**0.029**	0.380	0.57	**0.036**	0.042
23-24	East	.094-.661	1.5	0.067	1.35	**0.022**	0.047	1.50	**0.021**	0.087	1.24	**0.023**	0.033

[2] Comparison of Verified Roughness Coefficients for Gravel-Bed Streams, Central Arizona

(Range in D_{50} = 0.28 to 0.36, Range in Manning's n = 0.030 to 0.038)

(This method not chosen because D_{50} found in Sweat Canyon Wash is out of range of this method)

Average Hydraulic Radius

		AREA	Wetted Perimeter	Calculated Hydraulic Radius	
East Fork	0.094	67.56	198.55	0.3	
East Fork	0.189	102.22	93.75	1.1	
East Fork	0.283	146.97	55.66	2.6	
East Fork	0.327	195.45	74.5	2.6	
East Fork	0.377	183.64	82.22	2.2	
East Fork	0.472	173.38	143.27	1.2	
East Fork	0.568	102.75	267.31	0.4	
East Fork	0.661	125.97	109.9	1.1	
				1.5	**Avg Hyd Rad**
Doe Peak W	0.108	685.03	561.61	1.2	
Doe Peak W	0.21	549	461.04	1.2	
Doe Peak W	0.302	761.23	270.6	2.8	
Doe Peak W	0.396	692.21	251.51	2.8	
Doe Peak W	0.423	663.91	259.89	2.6	
Doe Peak W	0.489	411.28	395.38	1.0	
Doe Peak W	0.584	507.85	435.31	1.2	
Doe Peak W	0.681	597.4	444.41	1.3	
Doe Peak W	0.774	434.22	461.43	0.9	
Doe Peak W	0.869	684.6	632.38	1.1	
Doe Peak W	0.964	466.22	453.62	1.0	
Doe Peak W	1.058	558.19	475.04	1.2	
Doe Peak W	1.112	366.19	489.05	0.7	
Doe Peak W	1.153	471.24	586.98	0.8	
				1.4	**Avg Hyd Rad**
Doe Peak W	1.231	526.78	555.24	0.9	
Doe Peak W	1.343	383.47	309.41	1.2	
Doe Peak W	1.438	405.2	301.28	1.3	
Doe Peak W	1.534	540.56	371.8	1.5	
Doe Peak W	1.624	513.33	407.9	1.3	
Doe Peak W	1.722	367.82	425.62	0.9	
Doe Peak W	1.816	352.92	367.33	1.0	
Doe Peak W	1.91	469.08	362.73	1.3	
Doe Peak W	2.006	218.77	395.59	0.6	
Doe Peak W	2.101	228.39	303.56	0.8	
Doe Peak W	2.195	355.17	387.85	0.9	
Doe Peak W	2.29	235.91	474.3	0.5	
Doe Peak W	2.479	394	616.48	0.6	
Doe Peak W	2.573	223.02	307.26	0.7	
Doe Peak W	2.669	318.27	409.55	0.8	
				0.9	**Avg Hyd Rad**

Average Hydraulic Radius

Doe Peak W	2.734	185.37	407.51	0.5	
Doe Peak W	2.859	210.88	265.34	0.8	
Doe Peak W	2.903	293.91	252.38	1.2	
Doe Peak W	2.954	426.81	232.43	1.8	
Doe Peak W	3.048	224.98	285.65	0.8	
Doe Peak W	3.143	264.9	286.51	0.9	
Doe Peak W	3.237	227.09	281.95	0.8	
Doe Peak W	3.331	377.16	220.05	1.7	
Doe Peak W	3.38	556.79	398.9	1.4	
Doe Peak W	3.427	195.07	380.1	0.5	
Doe Peak W	3.522	317.93	225.18	1.4	
Doe Peak W	3.616	274.23	408	0.7	
Doe Peak W	3.707	234.69	281.72	0.8	
				1.0	**Avg Hyd Rad**
Doe Peak W	3.804	503.94	164.79	3.1	
Doe Peak W	3.901	347.79	104.78	3.3	
Doe Peak W	3.953	496.61	160.22	3.1	
Doe Peak W	3.995	386.9	122.23	3.2	
Doe Peak W	4.076	357.49	161.6	2.2	
				3.0	**Avg Hyd Rad**
Doe Peak W	4.138	384.31	108.46	3.5	
Doe Peak W	4.185	199.1	96.55	2.1	
Doe Peak W	4.279	151.81	67.95	2.2	
Doe Peak W	4.347	227.39	86.81	2.6	
Doe Peak W	4.469	187.43	70.04	2.7	
Doe Peak W	4.563	197.53	57.54	3.4	
Doe Peak W	4.658	131.67	40.25	3.3	
Doe Peak W	4.696	123.57	34.99	3.5	
				2.9	**Avg Hyd Rad**
Sweat Cany	4.222	1486.99	814.83	1.8	
Sweat Cany	4.317	1540.82	712.12	2.2	
Sweat Cany	4.412	1193	594.32	2.0	
Sweat Cany	4.507	890.94	315.5	2.8	
Sweat Cany	4.602	904.57	733.28	1.2	
Sweat Cany	4.697	1144.41	769.83	1.5	
Sweat Cany	4.728	1058.47	824.06	1.3	
				1.8	Avg Hyd Rad
Sweat Cany	4.741	1017.53	1184.57	0.9	
Sweat Cany	4.79	889.29	751.89	1.2	
Sweat Cany	4.829	882.74	1006.51	0.9	
Sweat Cany	4.949	996.94	1090.45	0.9	
Sweat Cany	5.058	901.06	599.82	1.5	
Sweat Cany	5.163	1095.79	271.91	4.0	
				1.6	**Avg Hyd Rad**

Average Hydraulic Radius

Sweat Cany	5.163	271.91	1095.79	0.2		
Sweat Cany	5.134	137.08	540.35	0.3		
Sweat Cany	5.169	287.33	805.18	0.4		
Sweat Cany	5.221	578.37	376.78	1.5		
Sweat Cany	5.264	475.98	482.72	1		
Sweat Cany	5.359	500.02	365.86	1.4		
Sweat Cany	5.453	681.56	289.74	2.4		
Sweat Cany	5.548	603.2	315.16	1.9		
Sweat Cany	5.643	627.86	374.92	1.7		
Sweat Cany	5.737	455.94	195.66	2.3		
Sweat Cany	5.832	681.06	500.98	1.4		
Sweat Cany	5.876	389.48	277.22	1.4		
Sweat Cany	5.927	595.7	278.39	2.1		
Sweat Cany	6.022	414.51	229.14	1.8		
Sweat Cany	6.077	420.94	490.81	0.9		
Sweat Cany	6.116	310.15	451.77	0.7		
Sweat Cany	6.211	568.23	260.92	2.2		
Sweat Cany	6.306	500.77	386.72	1.3		
Sweat Cany	6.351	486.05	470.78	1		
Sweat Cany	6.4	590.91	512.75	1.2		
Sweat Cany	6.495	567.4	508.95	1.1		
Sweat Cany	6.59	365.62	382.66	1		
				1.3	**Avg Hyd Rad**	
Sweat Cany	6.684	400.39	381.45	1		
Sweat Cany	6.732	473.15	463.28	1		
Sweat Cany	6.779	434.59	544.17	0.8		
Sweat Cany	6.833	320.84	577	0.6		
Sweat Cany	6.874	247.08	524.34	0.5		
Sweat Cany	6.922	428.39	462.61	0.9		
Sweat Cany	6.969	549.33	414.67	1.3		
Sweat Cany	7.063	580.03	310.33	1.9		
Sweat Cany	7.112	502.49	247.52	2		
Sweat Cany	7.158	595.02	171.92	3.5		
Sweat Cany	7.209	367.06	146.82	2.5		
Sweat Cany	7.253	535.53	147	3.6		
Sweat Cany	7.303	547.05	185.12	3		
Sweat Cany	7.347	494.01	128.07	3.9		
				1.9	**Avg Hyd Rad**	
Sweat Cany	7.442	747.56	194.15	3.9		
Sweat Cany	7.554	493.26	163.89	3		
Sweat Cany	7.587	496.77	157.83	3.1		
				3.3	**Avg Hyd Rad**	
Sweat Cany	7.631	586.06	221.43	2.6		
Sweat Cany	7.726	510.36	127.76	4		
Sweat Cany	7.773	653.85	157.53	4.2		
Sweat Cany	7.821	807.45	156.79	5.1		
Sweat Cany	7.867	611.27	142.16	4.3		
Sweat Cany	7.915	867.66	156.05	5.6		
Sweat Cany	7.962	731.32	160.53	4.6		

Average Hydraulic Radius

Sweat Cany	8.01	707.16	131.62	5.4		
				4.5	**Avg Hyd Rad**	
Sweat Cany	8.105	543.14	117.14	4.6		
Sweat Cany	8.2	777.89	191.11	4.1		
Sweat Cany	8.294	521.43	130.95	4		
Sweat Cany	8.347	706.03	189.47	3.7		
Sweat Cany	8.435	442.34	359.73	1.2		
Sweat Cany	8.484	406.19	215.64	1.9		
Sweat Cany	8.551	530.84	192.62	2.8		
Sweat Cany	8.578	610.94	119.05	5.1		
Sweat Cany	8.673	565.41	135.97	4.2		
Sweat Cany	8.766	597.42	150.06	4		
Sweat Cany	8.891	345.74	183.32	1.9		
				3.4	**Avg Hyd Rad**	
Sweat Cany	8.926	318.2	164	1.9		
Sweat Cany	9.01	407.9	146.67	2.8		
Sweat Cany	9.052	371.82	121.95	3		
Sweat Cany	9.147	509.48	102.52	5		
Sweat Cany	9.202	400.05	129.86	3.1		
Sweat Cany	9.241	388.45	96.22	4		
Sweat Cany	9.286	585.53	128.53	4.6		
Sweat Cany	9.329	680.55	141.83	4.8		
Sweat Cany	9.424	397.64	81.23	4.9		
				3.8	**Avg Hyd Rad**	
Sweat Cany	9.613	563.25	122.22	4.6		
Sweat Cany	9.708	391.96	201.13	1.9		
Sweat Cany	9.802	418.59	89.59	4.7		
Sweat Cany	9.894	527.2	100.08	5.3		
Sweat Cany	9.992	370.88	117.95	3.1		
				3.9	**Avg Hyd Rad**	
Sweat Cany	10.087	432.56	84.76	5.1		
Sweat Cany	10.181	442.19	92.71	4.8		
Sweat Cany	10.276	370.74	88.19	4.2		
				4.7	**Avg Hyd Rad**	
Sweat Cany	10.371	349.55	74.51	4.7		
Sweat Cany	10.465	307.68	64.64	4.8		
Sweat Cany	10.56	296.39	57.58	5.1		
				4.9	**Avg Hyd Rad**	

increased from +10.00 to +11.55 for sub-areas C and D. Therefore, to reduce flooding in sub-areas B, C, and D below the current BFE, forced drainage is warranted, as shown in the ultimate conditions investigation.

Scenario C

This scenario emulated the same flood reduction features as ultimate conditions. However, the design constraints allowed for "nuisance" flooding over the entire study area. The reason for this constraint was to reduce pump size by allowing for "minimal" flooding.

This investigation showed that two 118-cfs, two 89-cfs, and two 363-cfs pumps would be appropriate for sub-areas A, B, and C, respectively. With respect to the pump sizes determined under ultimate conditions, the reduction in forced drainage capacity is minimal, and thus a significant cost savings is not anticipated.

Construction Costs

Based on a unit cost of $5.50 per cubic yard, construction costs for filling would easily exceed $25 million plus required interior drainage improvements. This alternative was determined cost prohibitive. One hundred-year levee construction costs are estimated at $2.3 million, 25-year forced drainage costs are estimated at $6.0 million, and 5-year gravity drainage costs are estimated at $600,000.

Recommendations

This study provides decisionmaking information to the Chitimachas with respect to future development. A key consideration to future development is following FEMA regulations, specifically developing according to the FEMA 100-year BFE, in order to participate in the NFIP.

The current BFE in the study area is well above natural ground elevation. Thus flood reduction improvements are warranted. A 100-year hurricane protection levee is necessary to prevent surge inundation. However, if levee protection is provided without forced drainage, the BFE will increase in sub-areas C and D due to interior ponding. Although the BFEs in sub-areas A and B would decrease without forced drainage, fill requirements would remain cost prohibitive. Thus, to effectively reduce the BFE, 25-year forced drainage is required. In addition, 5-year gravity drainage is recommended to drain high-frequency events to reduce pump operation and maintenance costs.

COMPARISON OF VERIFIED ROUGHNESS COEFFICIENTS FOR GRAVEL-BED STREAMS IN CENTRAL ARIZONA WITH OTHER AREAS OF THE WESTERN UNITED STATES

Jeff V. Phillips and Todd L. Ingersoll
U.S. Geological Survey

Introduction

Manning's roughness coefficient, n, commonly is used to represent flow resistance for hydraulic computations of flow in open channels. The procedure for selecting n values is subjective and requires judgment and skill developed primarily through experience. The expertise necessary for proper selection of n values can be obtained, in part, by examining characteristics of channels with known or verified roughness coefficients.

In cooperation with the Flood Control District of Maricopa County, Arizona, the U.S. Geological Survey has undertaken a two-phase investigation to assess n values for stream channels in central Arizona. Thomsen and Hjalmarson (1991) concluded the first phase by publishing guidelines for determining n values and presented estimated n values for 16 stream channels in central Arizona. Phase two objectives include determining the validity of phase one results by verifying Manning's n for representative streams.

This paper presents verified n values for 13 discharge measurements at 5 selected gravel-bed streams in central Arizona and compares them with data from similar studies in other areas of the western United States. The verification data are used to develop an empirical relation between Manning's n, hydraulic radius, and median grain size. This relation can be used to transfer results to similar gravel-bed stream channels.

Data Collection

Site-selection and data-collection techniques used in this study generally were selected to meet, as closely as possible, criteria presented by Jarrett and Petsch (1985) for accurate n-verification measurements. Discharge

* *This manuscript benefited substantially from helpful discussions with H. Hjalmarson, T. Lehman, J. Tram, B. Aldridge, R. Jarrett, K. Nolan, and J. Capesius.*

08/18/98 11:50 8-18-1998 10:57AM FROM WEST CONSULTANTS 6194879448 MARICOPA CO. FCD P.2

used for each of the verification measurements was obtained by the current-meter method or from a well-defined stage-discharge relation. A transit-stadia survey was done at each reach either at the time of the current-meter measurement or soon after flow subsided to obtain accurate water-surface elevation and channel-geometry data. A particle-size distribution of the bed material was obtained by measuring the intermediate axis of 100 particles selected at random from the study reach (Benson and Dalrymple, 1967). These data were generally obtained after flows and used to determine median grain-size diameter (d_{50}) for each site.

Data Analysis

Computation of Manning's n

The fundamental equations on which many open-channel hydraulic computations are based include the Manning, the continuity, and the energy equations. The computer program NCALC, developed by Jarrett and Petsch (1985), is based on these equations and was used to compute the values of total roughness (n) presented in this report (Table 1).

Table 1. Summary of verification measurements including the magnitude of total (n) and base (n_b) roughness, the factors required to adequately describe flow resistance, and various channel and hydraulic parameters.

Date	Discharge (ft³/s)	n	n_b	n_1	n_2	n_3	n_4	m	R (ft)	d_{50} (ft)	R/d_{50}
Pasayampa River near Arlington											
7-8-94	80.5	0.034	0.034	0.000	0.000	0.000	0.000	1.0	1.29	0.28	4.61
6-10-94	45.5	0.036	0.036	0.000	0.000	0.000	0.000	1.0	0.87	0.28	3.46
6-15-94	17.0	0.036	0.036	0.000	0.000	0.000	0.000	1.0	0.56	0.28	2.07
Skunk Creek above Interstate 17											
1-5-95	323	0.034	0.034	0.000	0.000	0.000	0.000	1.0	1.28	0.29	4.41
1-5-95	168	0.037	0.037	0.000	0.000	0.000	0.000	1.0	0.83	0.29	2.86
1-26-95	723	0.031	0.031	0.000	0.000	0.000	0.000	1.0	1.71	0.29	5.90
1-26-95	180	0.035	0.035	0.000	0.000	0.000	0.000	1.0	0.90	0.29	3.10
Cave Creek above Deer Valley Road											
1-10-95	29	0.034	0.034	0.000	0.000	0.000	0.000	1.0	0.96	0.30	3.27
Salt River above Interstate 10											
2-18-92	4,900	0.030	0.030	0.000	0.000	0.000	0.000	1.0	2.61	0.31	8.42
1-15-92	2,070	0.034	0.034	0.000	0.000	0.000	0.000	1.0	1.64	0.31	5.29
1-9-92	1,000	0.038	0.038	0.000	0.000	0.000	0.000	1.0	1.16	0.31	3.74
Verde River Below Beeline Highway											
3-28-91	2,860	0.030	0.030	0.000	0.000	0.000	0.000	1.0	3.94	0.38	10.3
6-14-91	225	0.036	0.036	0.000	0.000	0.000	0.000	1.0	1.01	0.38	2.76

$$n = \frac{.0926\,R^{1/6}}{.794 + 1.85 \log R/d_{50}}$$

Components of Manning's n

The general approach for estimating resistance to flow in stream channels is to first select a base value of n for the bed material (Thomsen and Hjalmarson, 1991). The base value of Manning's n (n_b) is represented by the size and shape of the grains of the material that form the wetted perimeter and produce a retarding effect on flow (Chow, 1959). Cross-section irregularities (n_1), channel alignment (n_2), obstructions (n_3), vegetation (n_4), are then added to the base value of n; and the n value is then multiplied by a correction factor for channel meandering (m). Because the sites were selected for reach and cross-sectional uniformity (Jarrett and Petsch, 1985), factors or components of n (n_1 through n_4) at the sites were considered to have no effect on total roughness (Table 1).

Base Value of Manning's n for Gravel-Bed Streams

In the absence of vegetation and other bank obstructions, roughness in a uniform gravel-bed stream generally decreases with increasing depth (see Table 1). As flow approaches bankfull stage, however, roughness may asymptotically approach a constant value, as shown by several previous investigations (Blodgett, 1986; Benson and Dalrymple, 1967).

The basic roughness coefficient for gravel-bed streams should not vary greatly with depth of flow if the relative roughness (ratio of hydraulic radius, R, to intermediate diameter of the streambed material, d_{50}) is between about 5 and 276 (Benson and Dalrymple, 1967). Existing data indicate trends between hydraulic radius, median grain-size diameter, and verified base values of n for gravel-bed streams in some regions of the United States. For example, Blodgett (1986) examined verified values of n for 48 perennial gravel-bed streams in California, Colorado, Idaho, Montana, and Washington. Blodgett developed an equation that relates Manning's n to hydraulic radius (assumed to approximate mean depth of flow) and median grain size of the bed material (Table 2). A similar equation was developed for gravel-bed streams in central Arizona.

Table 2: Equations for the relation between base values of Manning's n, hydraulic radius (R), and median diameter of bed material for gravel-bed streams.

Source	Equation		Range in d_{50} (ft)	Range in Manning's n	Correlation Coefficient	Location
Blodgett (1986)	$n = \frac{0.0926\,R^{1/6}}{0.794 + 1.85 \log R/d_{50}}$	(1)	0.033 to 1.5	0.020 to 0.150	0.68	western U.S. (excluding arid regions)
central Arizona streams	$n = \frac{0.0926\,R^{1/6}}{1.45 + 2.23 \log R/d_{50}}$	(2)	0.28 to 0.36	0.030 to 0.038	0.93	Maricopa County, Arizona, U.S.

.033 to 1.5 0.020 to .150 .68

.28 to .36 .030 to .038 .93

$$n = \frac{0.0926\,R^{1/6}}{\ldots + 2.23 \log R/d_{50}}$$

Manning's n is plotted against relative roughness to compare data for gravel bed streams in different sites in the western U.S. (Figure 1). To compare the equations developed (see Table 2), trendlines also are plotted for d_{50} values equal to 0.3 feet and R values between 0.6 and 6 feet.

Discussion

Although several of the verified n values incorporated into Blodgett's data set are in close proximity to the data obtained from streams in central Arizona (see Figure 1), most n values are substantially larger for similar values of relative roughness. If the equations presented are to be properly used as aids in determining base values of Manning's n, adequate descriptions of channel characteristics from which the data were obtained must be presented. This discussion, therefore, presents potential factors that may account for the differences between the data sets (Figure 1).

As noted by Blodgett (1986), the large scatter in data points of the verification measurements used to develop equation 1 may reflect extraneous flow-retarding effects associated with irregularities in bank shape and changes in channel alignment. Many of the sites used by Blodgett are located in relatively pristine mountain areas where streams are unhindered by human influences. Three of the central Arizona sites, however, are located in river reaches that have been channelized. In

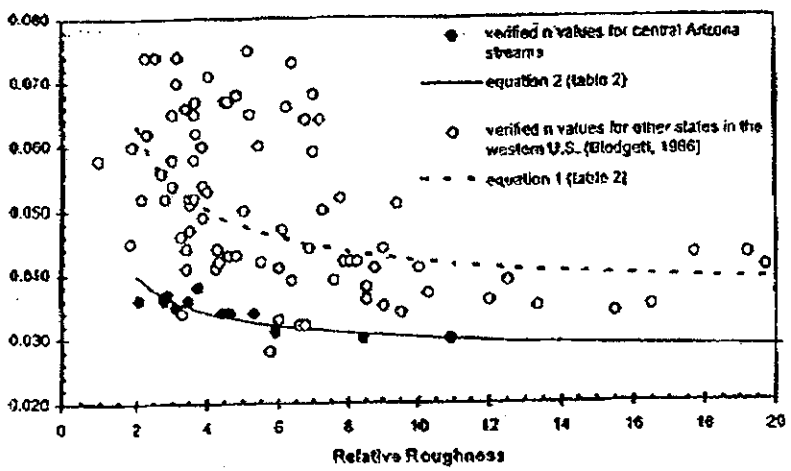


Figure 1. Relation of Manning's n and relative roughness for gravel-bed stream channels in central Arizona and the western United States. For simple comparison of equations, the value of d_{50} used to plot the trendlines is constant and equal to 0.3 feet.

addition to stabilizing channel banks, channelization projects generally tend to increase conveyance by straightening rivers, potentially resulting in a decrease of flow-retarding effects associated with channel meanders and other irregularities. Anthropogenic effects to river systems, therefore, may be one explanation for the differences in the data sets (Figure 1).

Another explanation may be that the selected sites in central Arizona lie at relatively large distances from the river's source, where the stream is considered base level. For base-level streams, individual particles can be rounder, and grain-size distributions may reflect better sorting and homogeneity than particles in higher-gradient piedmont channels (Leopold et al., 1964). Many streams used by Blodgett (1986) are higher-gradient piedmont streams. As suggested by Leopold et al. (1964), for these types of channels, particles that are substantially larger than the median can play an important role in flow resistance by increasing local energy losses and, compared to base-level streams with similar values of d_{50}, greater turbulence may occur near the channel bed, resulting in larger values of n_b. Additionally, the range in median diameter of particles for streams in central Arizona is much narrower than the range used to develop the equation for gravel-bed streams located in other states in the western United States (see Table 2). The sites with relatively large median grain sizes (boulder channels with values of d_{50} up to 1.5 feet, for example) that were employed in the development of Blodgett's equation may have had a disproportionate effect on roughness, a consequence that may skew or weight the line of best fit toward higher values of n.

A final explanation for the apparent shift in relations may be found by examining photographs and descriptions of Blodgett's (1986) sites. Although somewhat conjectural, the examinations indicate that the flow-retarding effects associated with bank vegetation may have contributed to the overall value of n. Several of the sites in question are presented in Barnes (1967). If the contribution of bank vegetation to total flow retardance was not considered at a substantial number of sites, the result could be an apparent upward shift for the relation between R, d_{50}, and n (see Figure 1). Sites used to develop equation 2 for gravel-bed streams in Arizona, however, were carefully examined so that no extraneous flow-retarding elements (such as bank vegetation) contributed to n_b.

Whatever the cause for the differences in verified n values for the separate regions of the United States, the vertical difference between trendlines indicates the application of Blodgett's equation to gravel-bed streams in central Arizona may result in gross overestimates of n_b (see Figure 1). Fortunately, recently published guidelines for estimating n values in Maricopa County suggest values of n_b similar to those obtained from equation 2 (Thomsen and Hjalmarson, 1991).

8-18-1998 10:59AM FROM WEST CONSULTANTS 6194879448 P.4

Summary and Conclusions

Thirteen roughness coefficients determined for five selected gravel-bed stream channels in central Arizona are presented here. Computed roughness-coefficient values ranged from 0.030 to 0.038 and median size of the streambed material ranged from 0.28 to 0.36 ft. Hydraulic radius, median grain-size diameter, and the verified n values obtained from streams in central Arizona were used to develop an equation that can be applied to similarly characterized streams. The data obtained for gravel-bed streams in central Arizona are compared to data gathered for other sites in the western United States. Although the equations derived for the separate regions are similar in form, the vertical difference between trendlines suggests the application of Blodgett's equation to gravel-bed streams in central Arizona may result in gross overestimates of n_b. The data set from which equation 2 is derived is limited in size and range and caution must be exercised if the equation is applied to channel conditions substantially beyond the range of data. Further study is required to extend equation 2 to larger flow depths similar to those at flood stages.

References

Benson, M.A., and Tate Dalrymple
1967 *General field and office procedures for indirect discharge measurements.* U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3. Washington, D.C.: Department of the Interior.

Blodgett, J.C.
1986 *Rock riprap design for protection of stream channels near highway structures.* WRIR 86-4127. Washington, D.C.: Department of the Interior, U.S. Geological Survey.

Chow, V.T.
1959 *Open channel hydraulics.* New York: McGraw-Hill Publishing.

Jarrett, R.D., and H.E. Petsch Jr.
1985 *Computer program NCALC user's manual—Verification of Manning's roughness coefficient in channels.* WRIR 85-4317. Washington D.C.: U.S. Geological Survey, Department of the Interior.

Leopold, L.B., M.G. Wolman, and J.P. Miller
1964 *Fluvial processes in geomorphology.* New York: Dover Publications Inc.

Thomsen, B.W., and H.W. Hjalmarson
1991 *Estimated Manning's roughness coefficients for stream channels and flood plains in Maricopa County, Arizona.* Phoenix, AZ: Flood Control District of Maricopa County.

CONTINUOUS HYDROLOGIC AND HYDRAULIC MODELING FOR FLOODPLAIN MAPPING ALONG THE WEST BRANCH DUPAGE RIVER, DUPAGE COUNTY, ILLINOIS

Frank Lan, Steve Rogers and John Sikora
Woodward-Clyde Consultants

Jeff Dailey
DuPage County Department of Environmental Concerns

Introduction

A new approach for estimating floodplain limits using continuous-simulation modeling and statistical analysis on the simulated peak stages was performed for the West Branch DuPage River in Illinois. FEQ, a one-dimensional unsteady flow hydraulic model with flood routing capabilities is coupled with a continuous-simulation hydrologic model to compute flood hydrographs and river stages.

The model was constructed using a large amount of field surveyed data consisting of river and floodplain cross sections and hydraulic structure data. The river network was divided into computational branches connected by representations for hydraulic structures, such as bridges, culverts, reservoirs, spillways, etc. The main stem model has approximately 100 branches, 20 reservoirs, 5 braided sections of channel, 3 in-stream dams and 55 bridges, culverts, and other hydraulic structures. The watershed hydrology was simulated using HSPF (EPA, 1993) and was developed using land use data, soil type information, and precipitation and evaporation records for the area. The precipitation data was obtained from six rain gages with approximately 50 years of record.

The hydraulic model was calibrated to U.S. Geological Survey continuous recording stream gauge records and high water marks along the river for recent large storm events. The calibrated model was verified by comparing simulation results with recorded peak discharges, stages, and volumes for a 50-year continuous record period through 1994. The calibrated model will ultimately be used to determine flood levels and delineate the floodplain for the West Branch DuPage River watershed based on a peak-to-volume statistical analysis that utilizes the simulated peak stages and flow volumes to estimate peak stage exceedence probabilities. In addition, the model has been used and will continue to be

8-18-1998 11:00AM FROM WEST CONSULTANTS 6194879448 P.5

Sweat Canyon Wash, Soil and Vegetation Characteristics between Cross Section 4.222 and 4.602 (Location A)

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Lake Pleasant Road looking west.

Lake Pleasant Road looking east.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

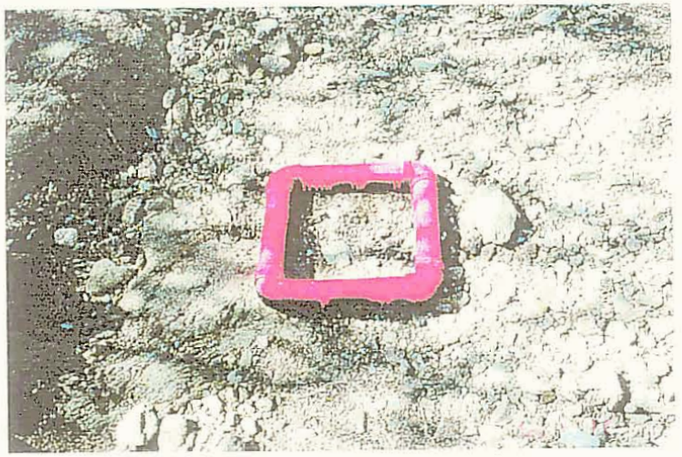
Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.



Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

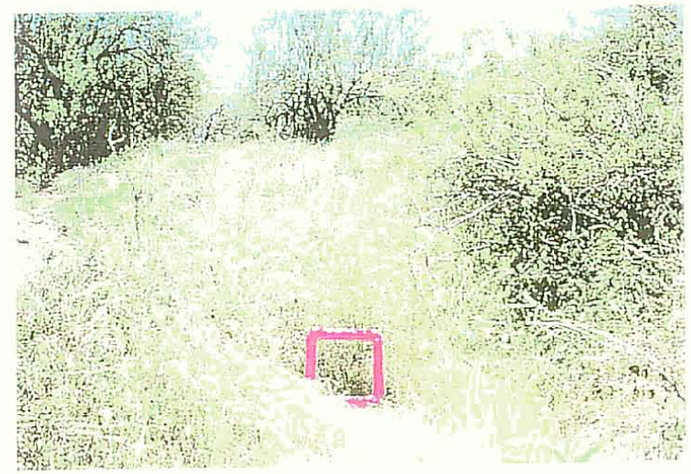
Right overbank vegetation.

Doe Peak Wash, Soil and Vegetation Characteristics between Cross Section 0.396 and 0.681 (Location P)

Main channel soil sample.

Typical cross section.

Left overbank vegetation



Right overbank vegetation.

Main channel soil sample.

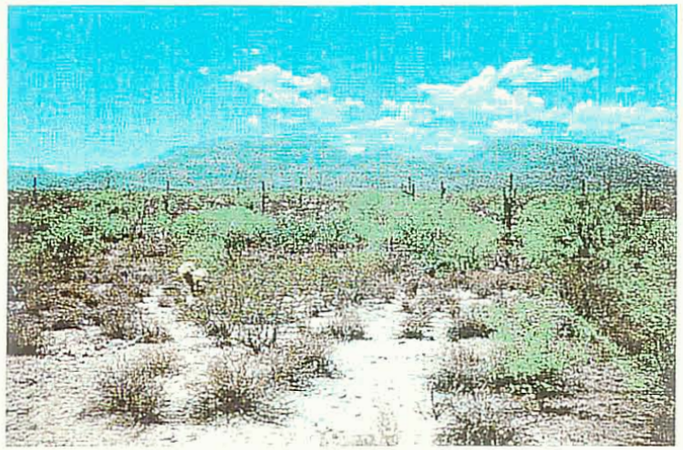
Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.



Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Doe Peak Wash, Soil and Vegetation Characteristics between Cross Section 3.804 and 4.279 (Location T)

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

d:\temp\dp3804.dco

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation (typical for right overbank).

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Rigtht overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation.

Right overbank vegetation.

South Fork Doe Peak Wash, Soil and Vegetation Characteristics between Cross Section 0.271 and 0.555 (Location Y)

Main channel soil sample.

Typical cross section.

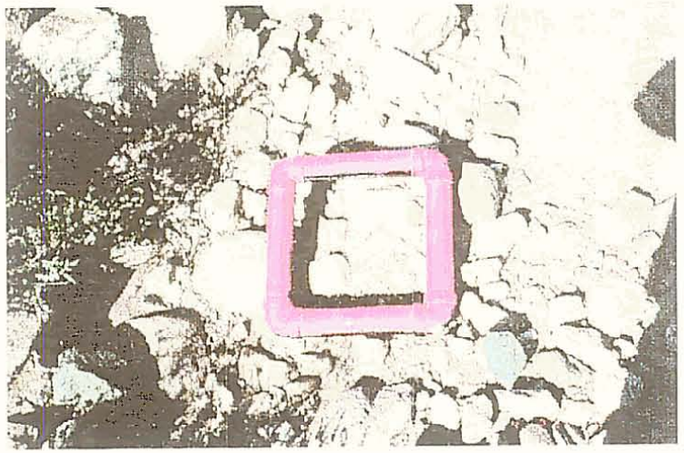
Left overbank vegetation.

Right overbank vegetation.

Main channel soil sample.

Typical cross section.

Left overbank vegetation (typical for right overbank).

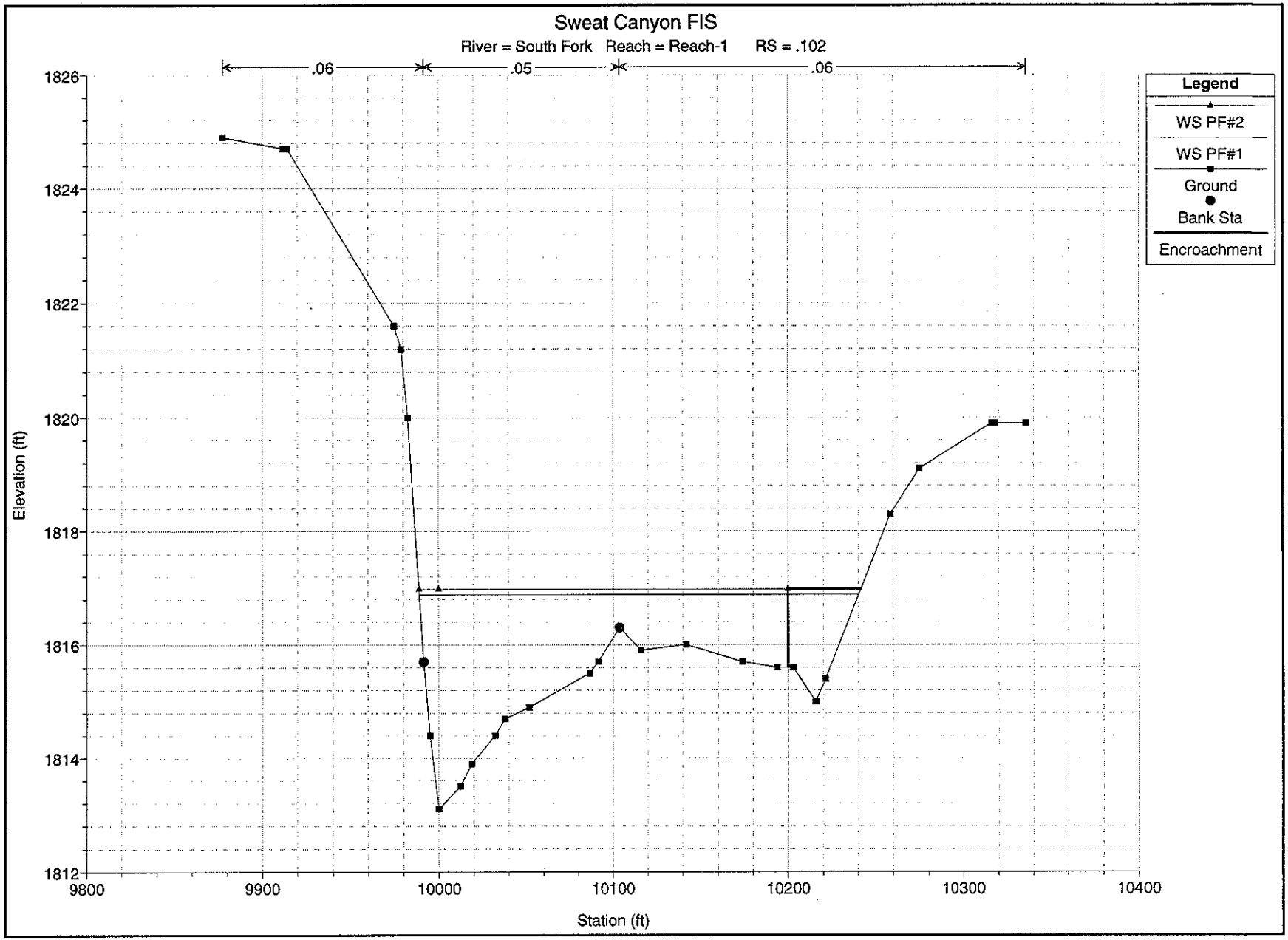


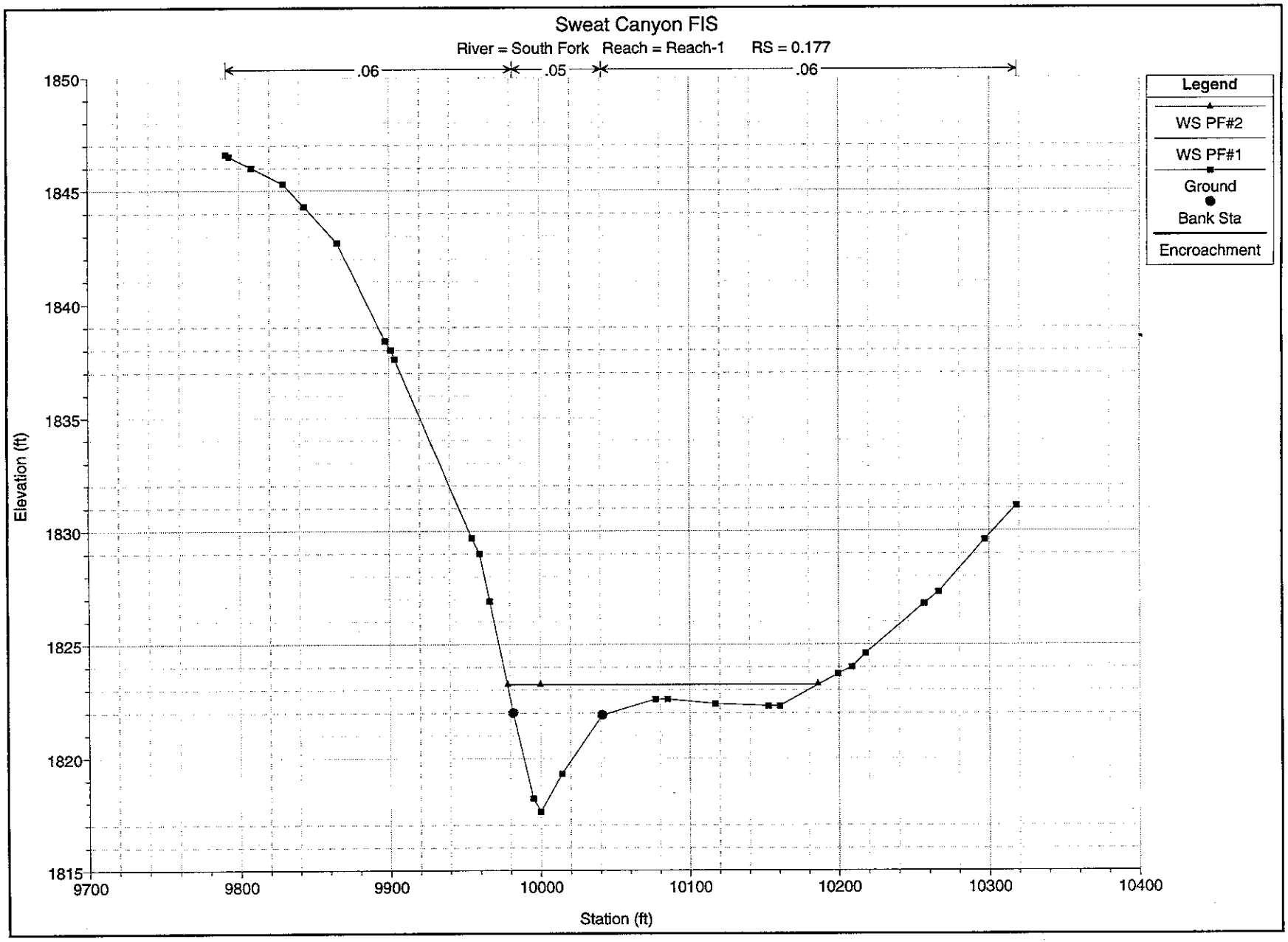
Main channel soil sample.

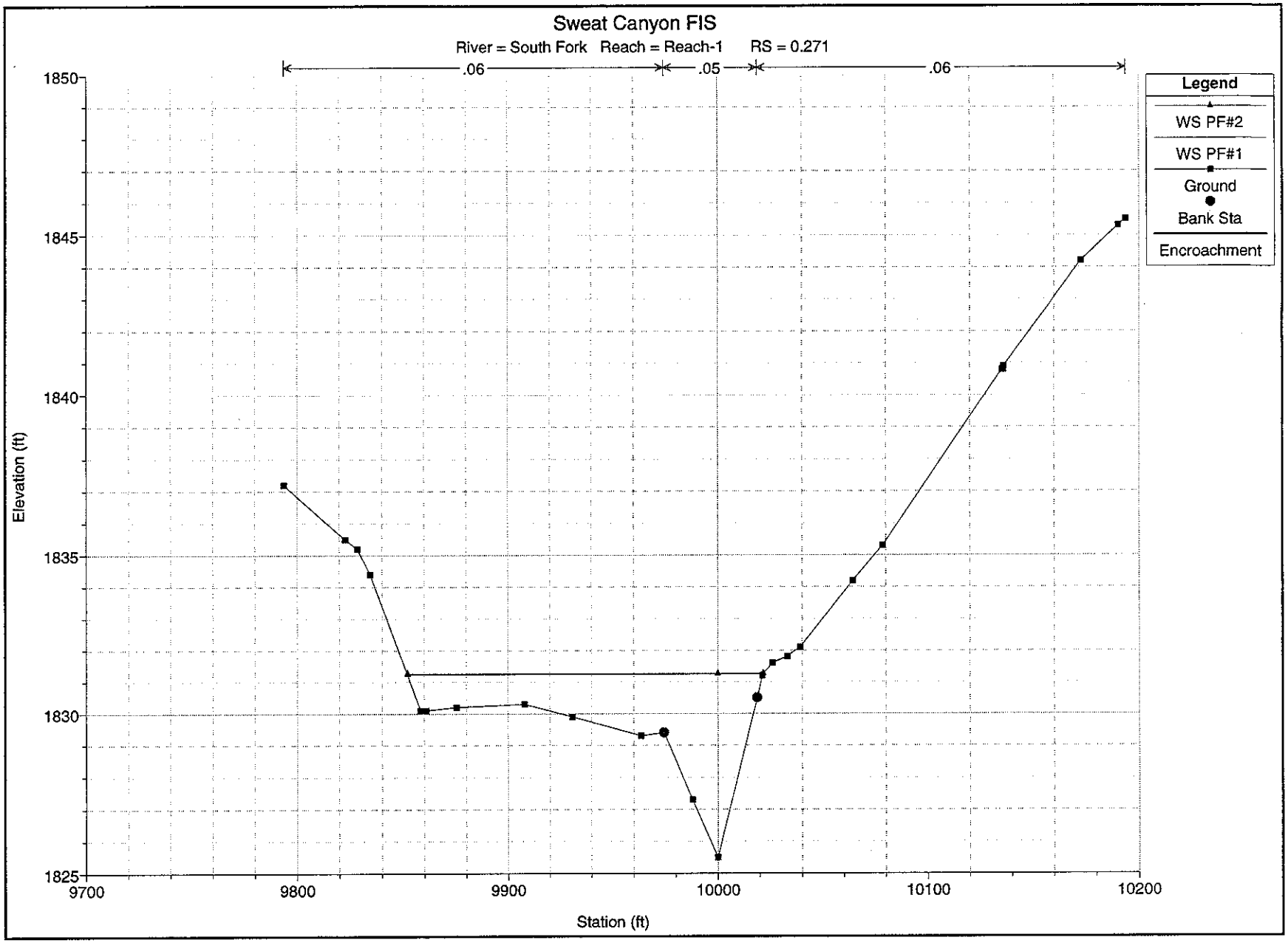
Typical cross section.

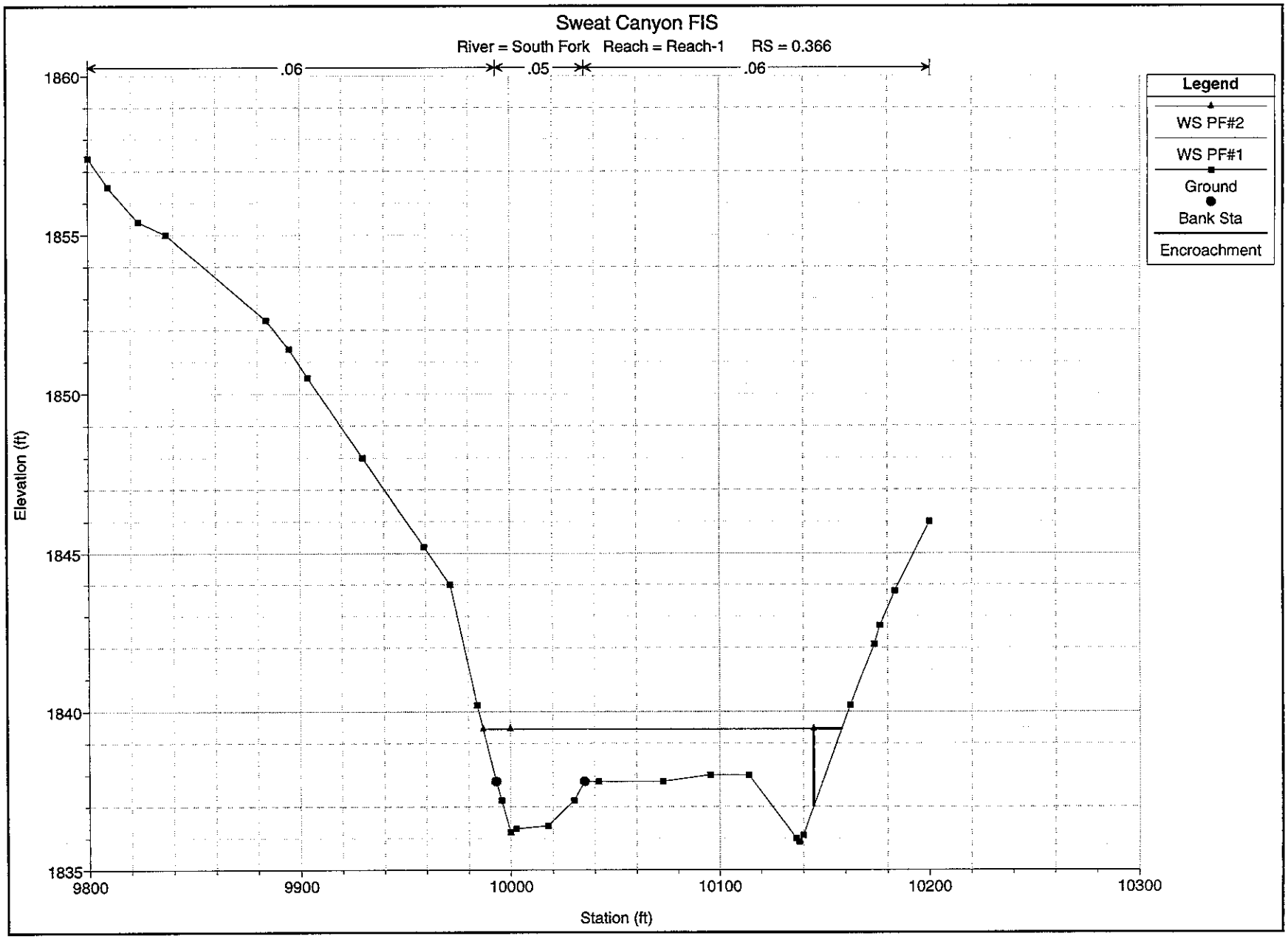
Left overbank vegetation.

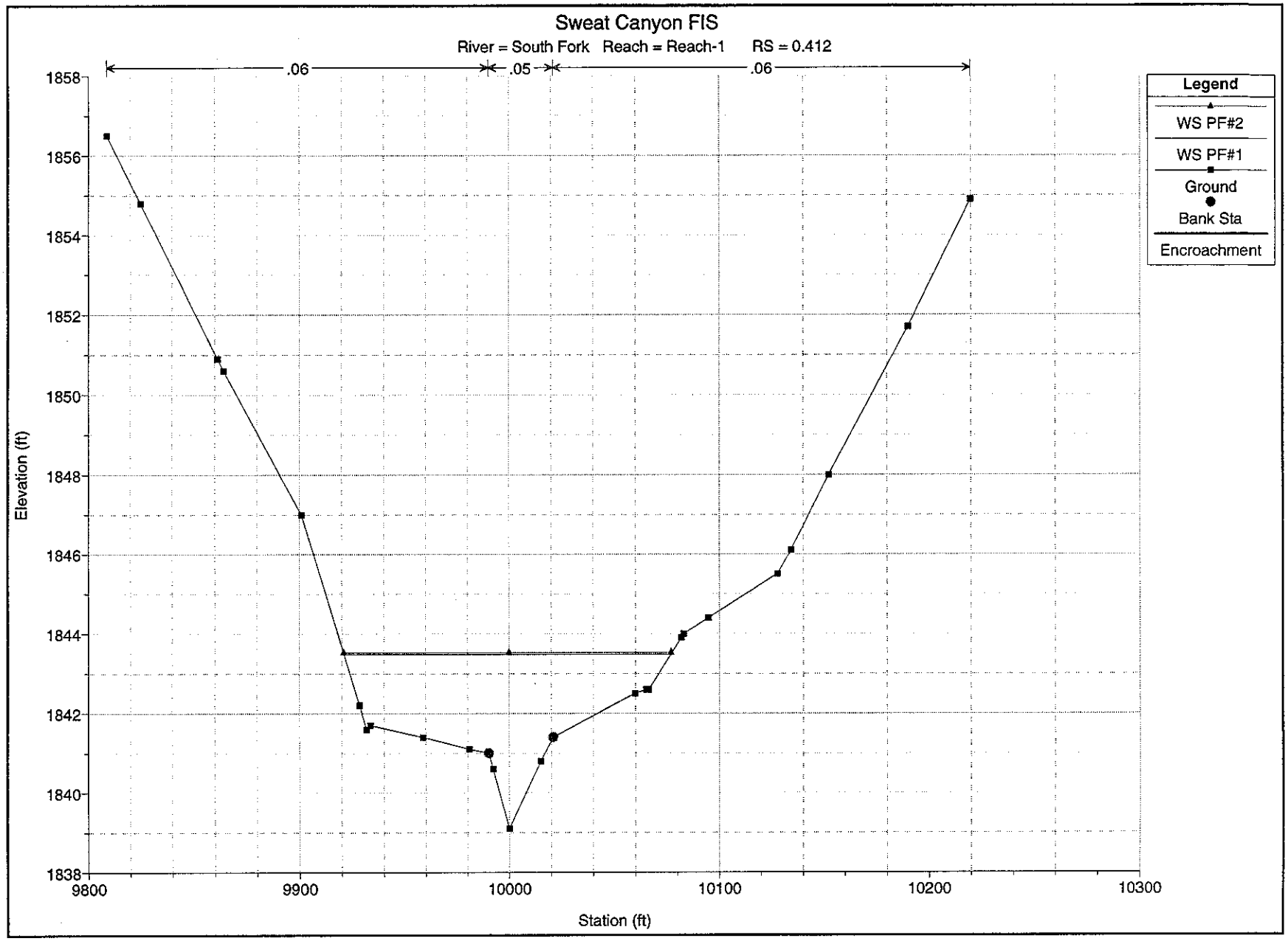
Right overbank vegetation.

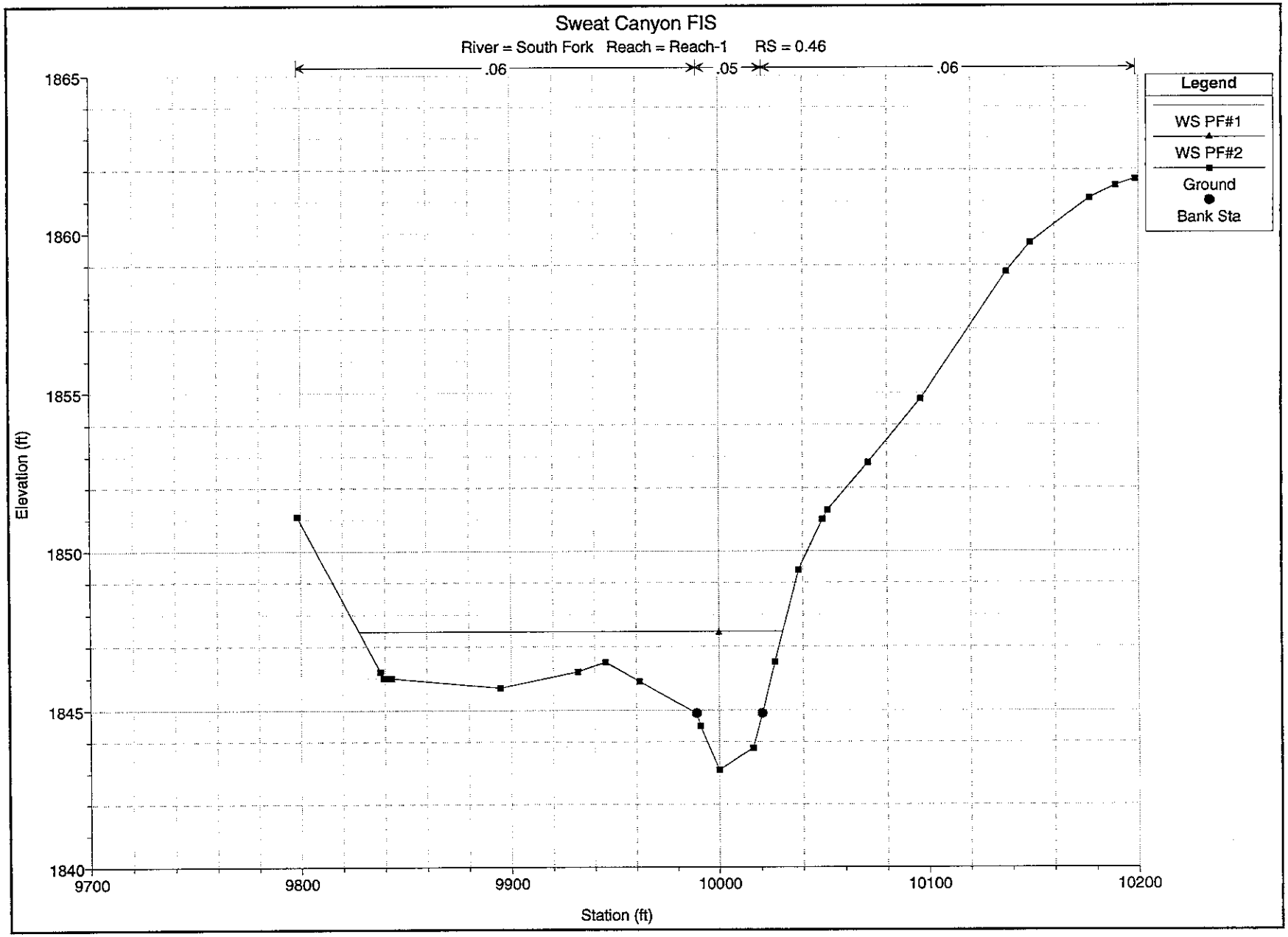

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = .102
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1826
1824
1822
1820
1818
1816
1814
1812
9800
9900
10000
10100
10200
10300
10400
Station (ft)

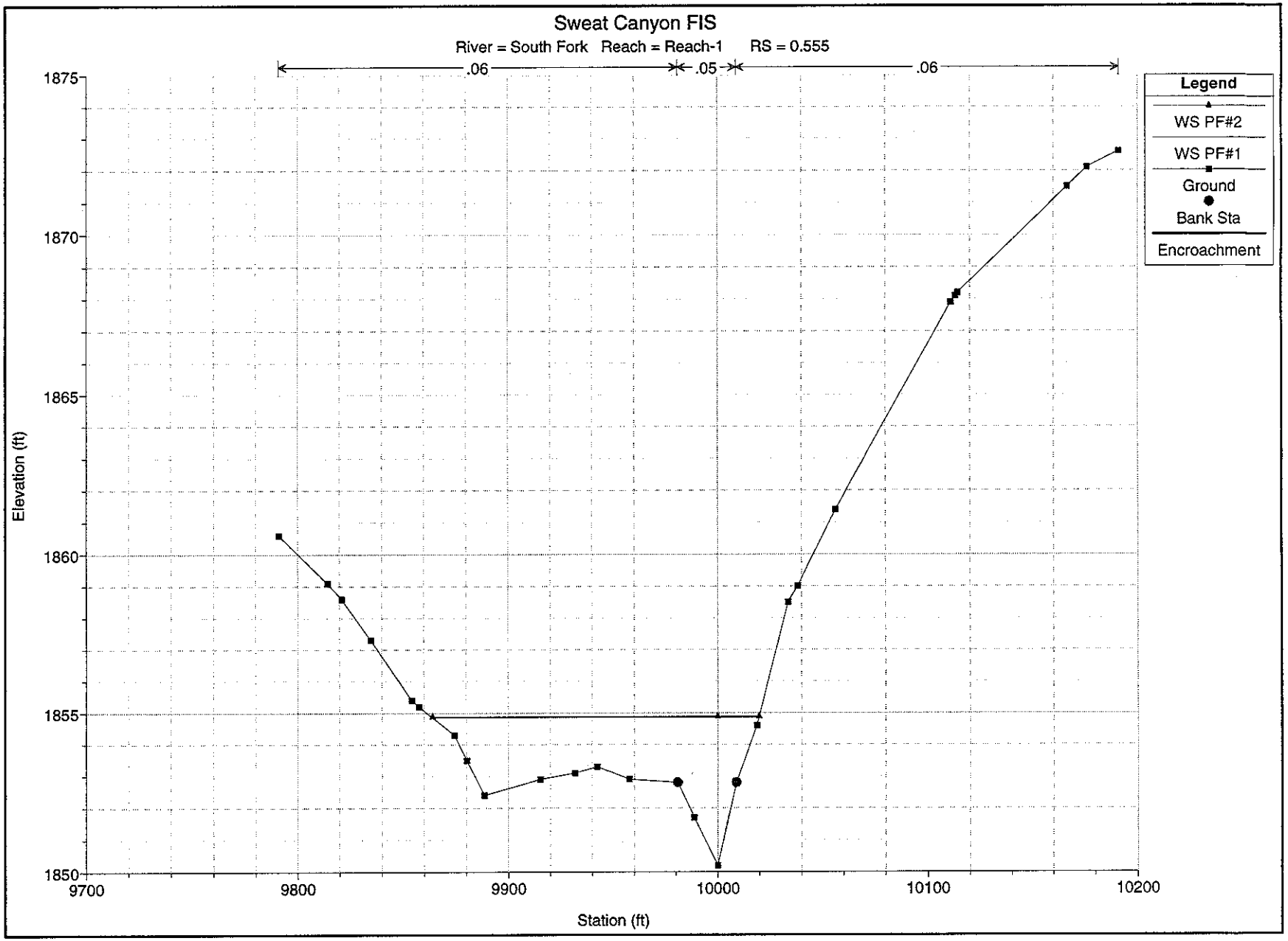

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.177
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1850
1845
1840
1835
1830
1825
1820
1815
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

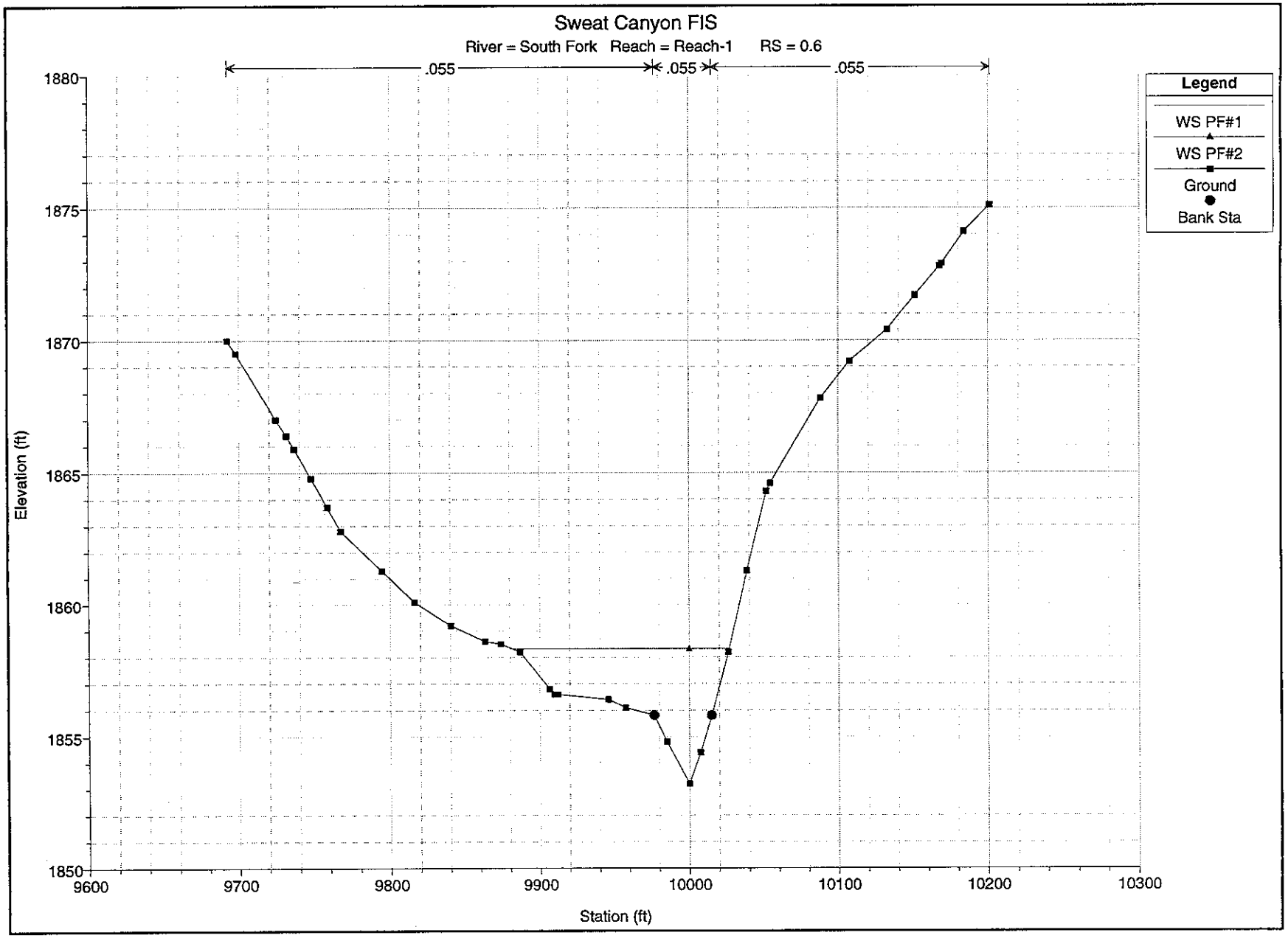

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.271
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1850
1845
1840
1835
1830
1825
9700
9800
9900
10000
10100
10200
Station (ft)

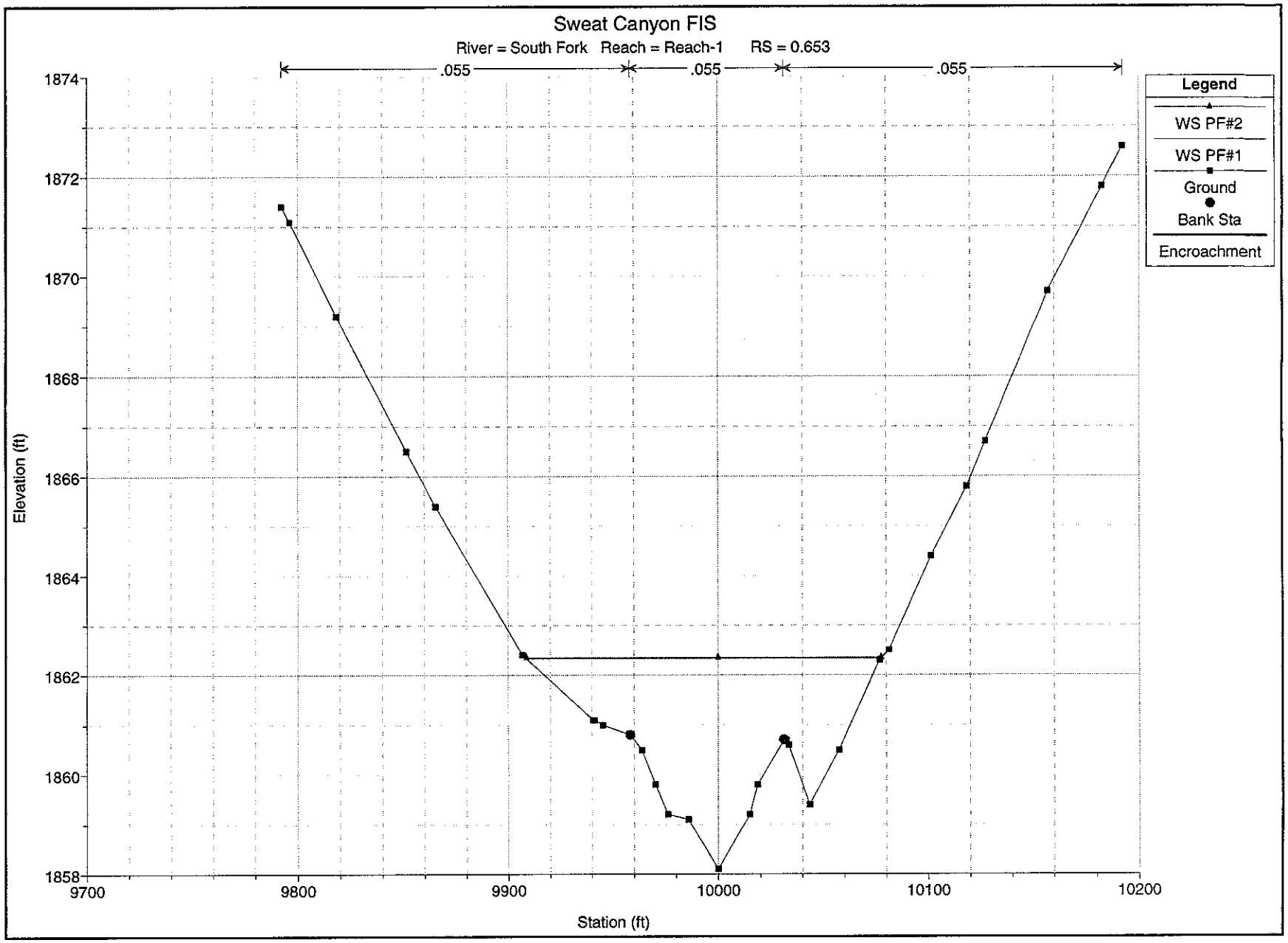

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.366
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1860
1855
1850
1845
1840
1835
9800
9900
10000
10100
10200
10300
Station (ft)

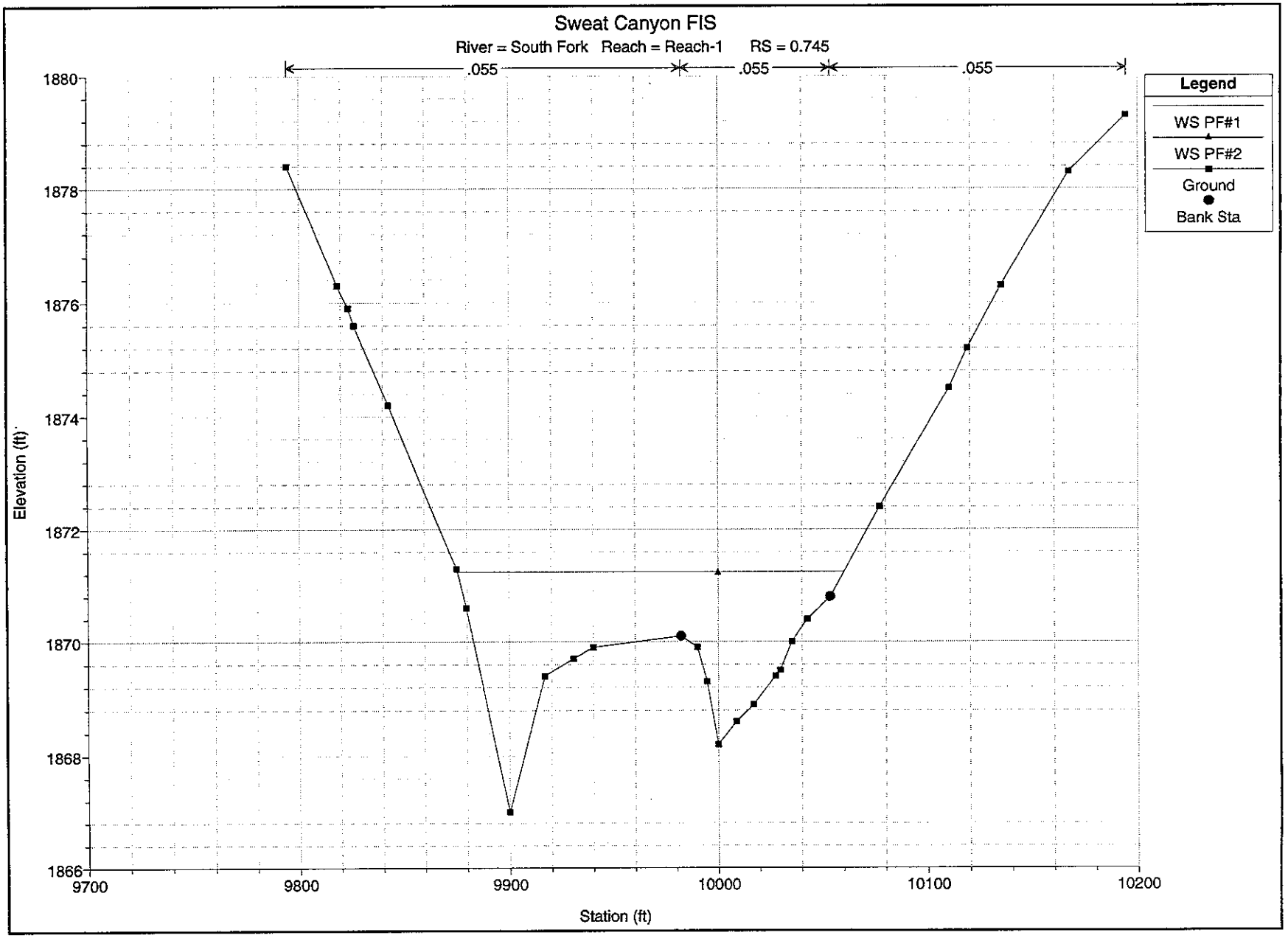

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.412
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1858
1856
1854
1852
1850
1848
1846
1844
1842
1840
1838
9800
9900
10000
10100
10200
10300
Station (ft)

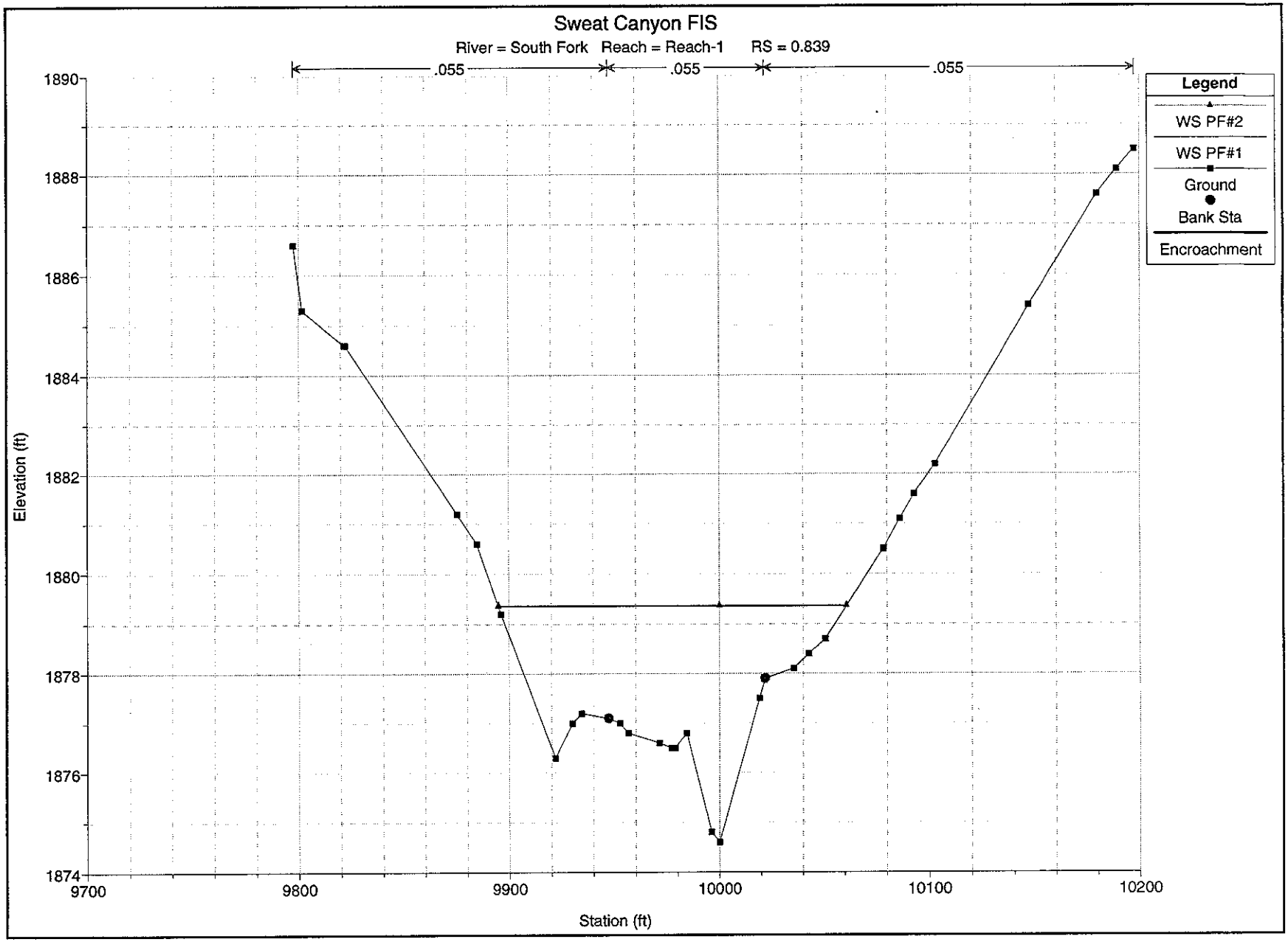

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.46
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1865
1860
1855
1850
1845
1840
9700
9800
9900
10000
10100
10200
Station (ft)

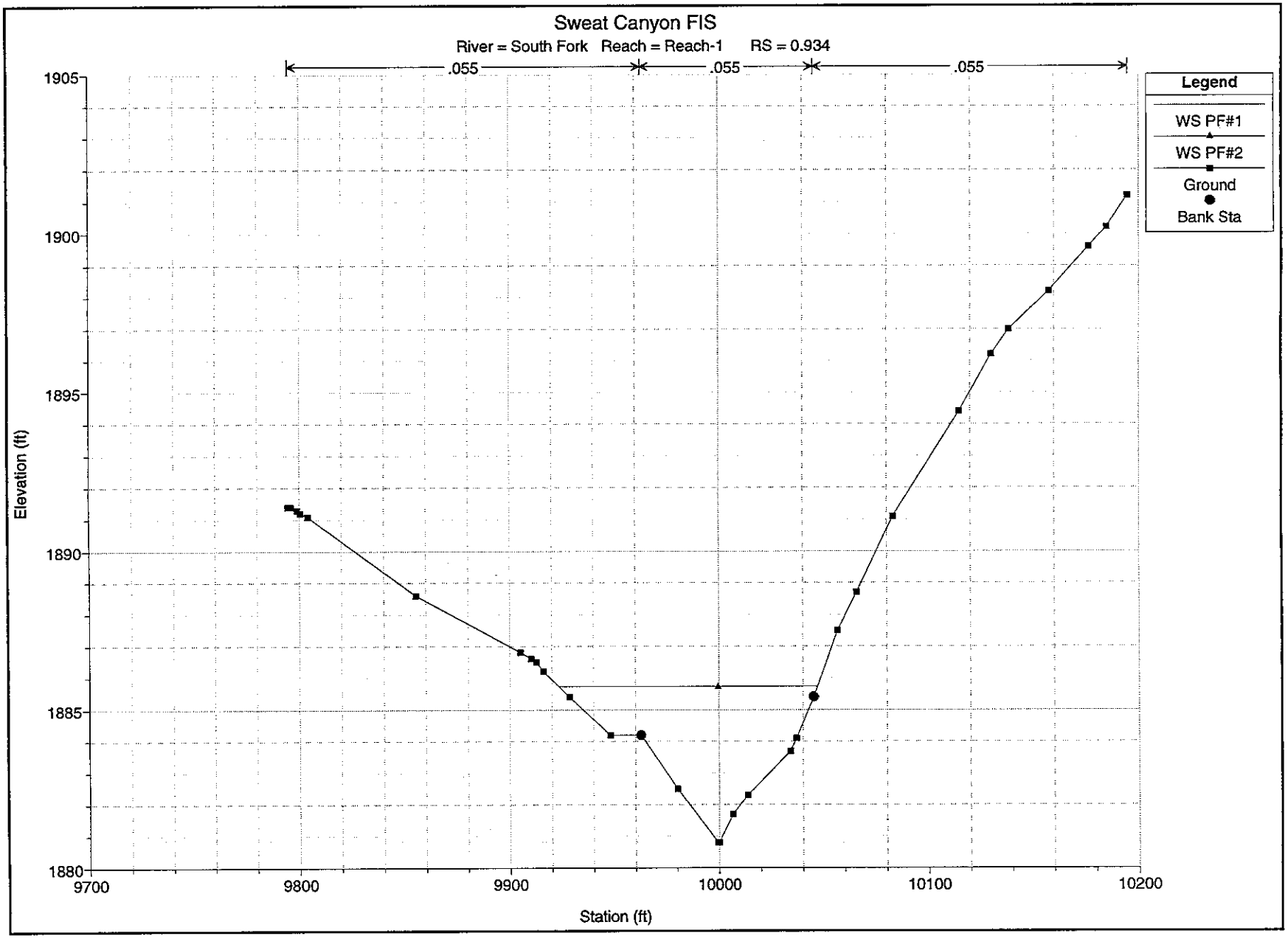

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.555
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1875
1870
1865
1860
1855
1850
9700
9800
9900
10000
10100
10200
Station (ft)

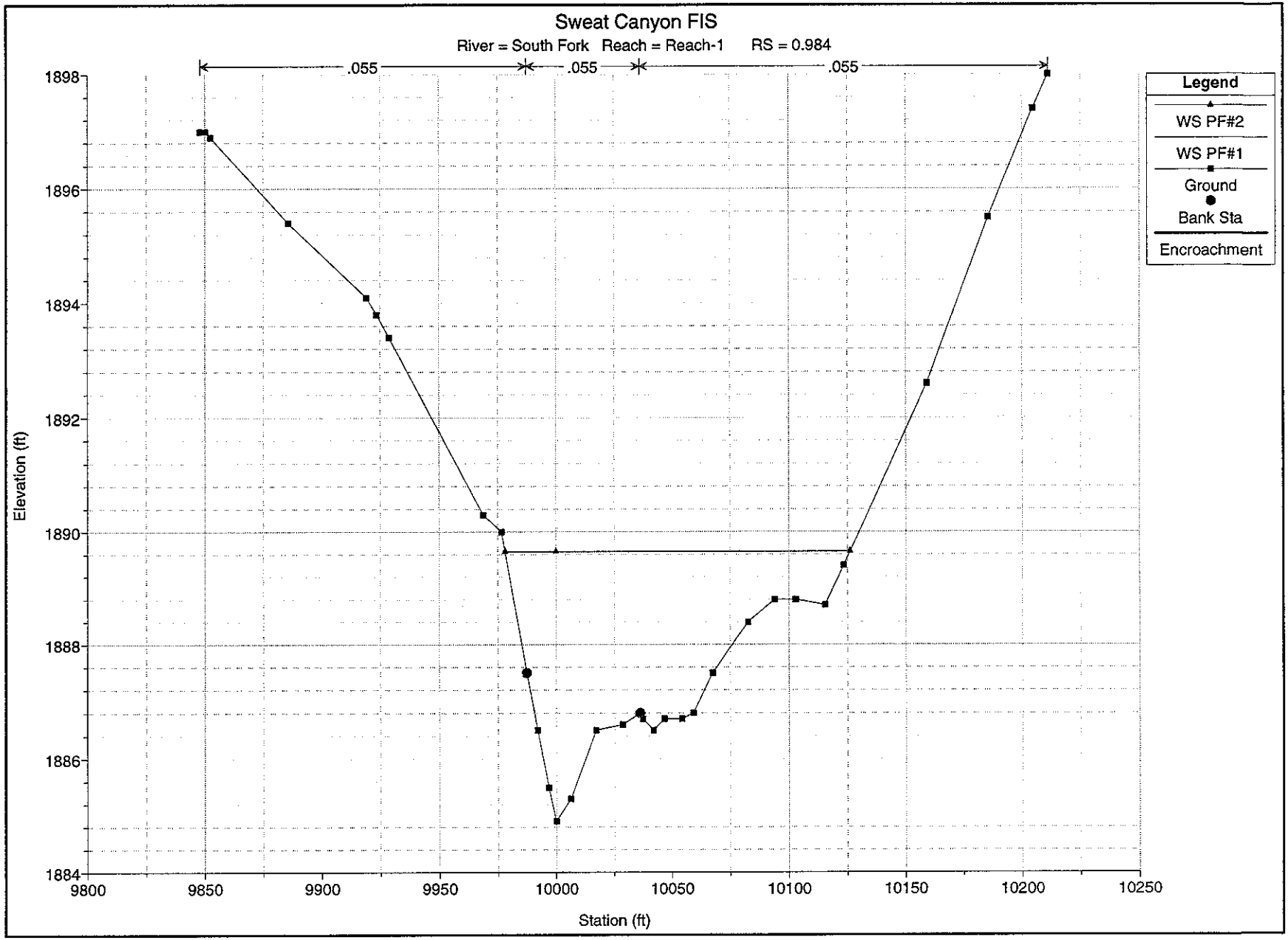

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.6
.055
.055
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1880
1875
1870
1865
1860
1855
1850
9600
9700
9800
9900
10000
10100
10200
10300
Station (ft)

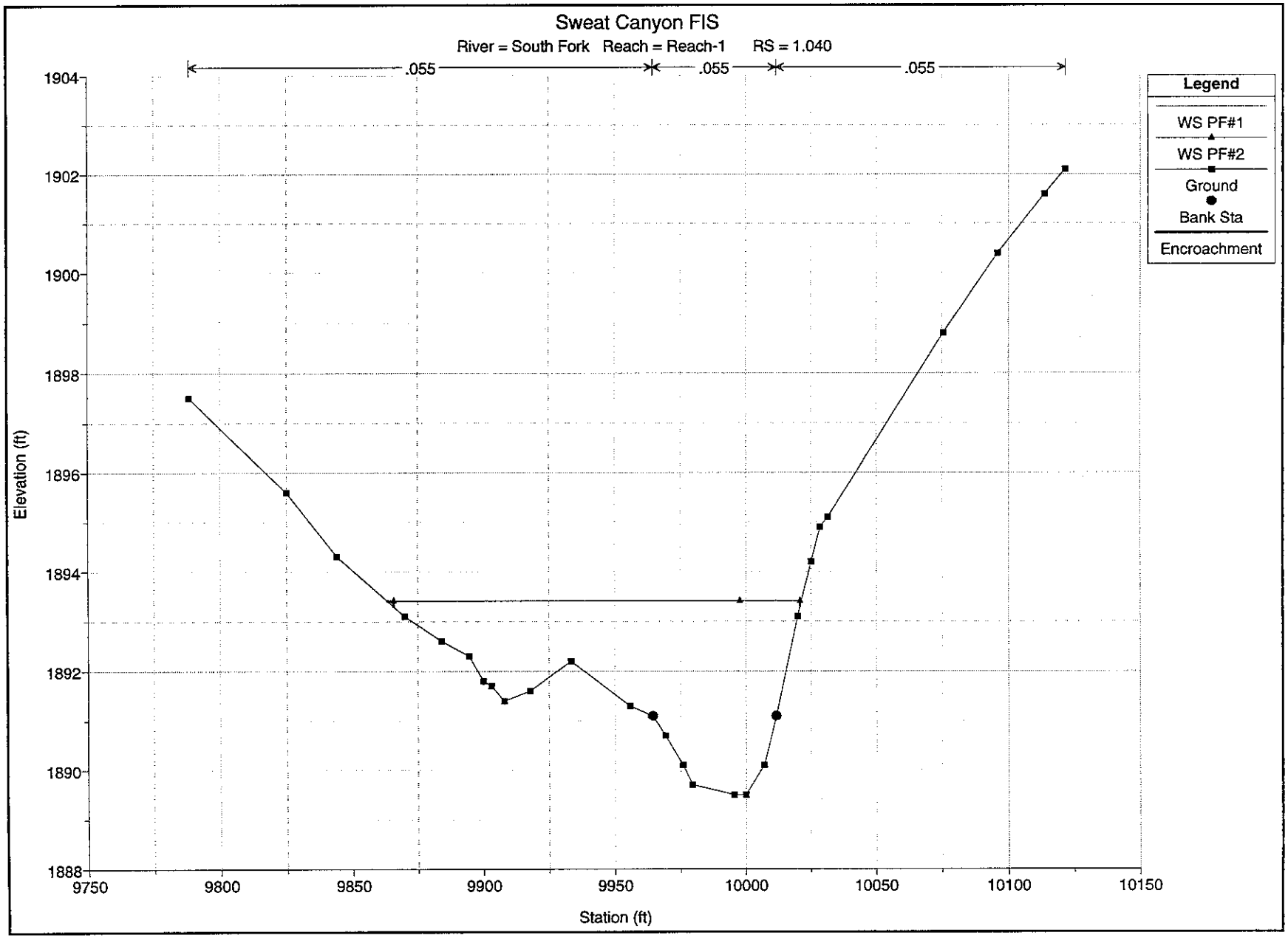

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.653
.055
.055
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1874
1872
1870
1868
1866
1864
1862
1860
1858
9700
9800
9900
10000
10100
10200
Station (ft)

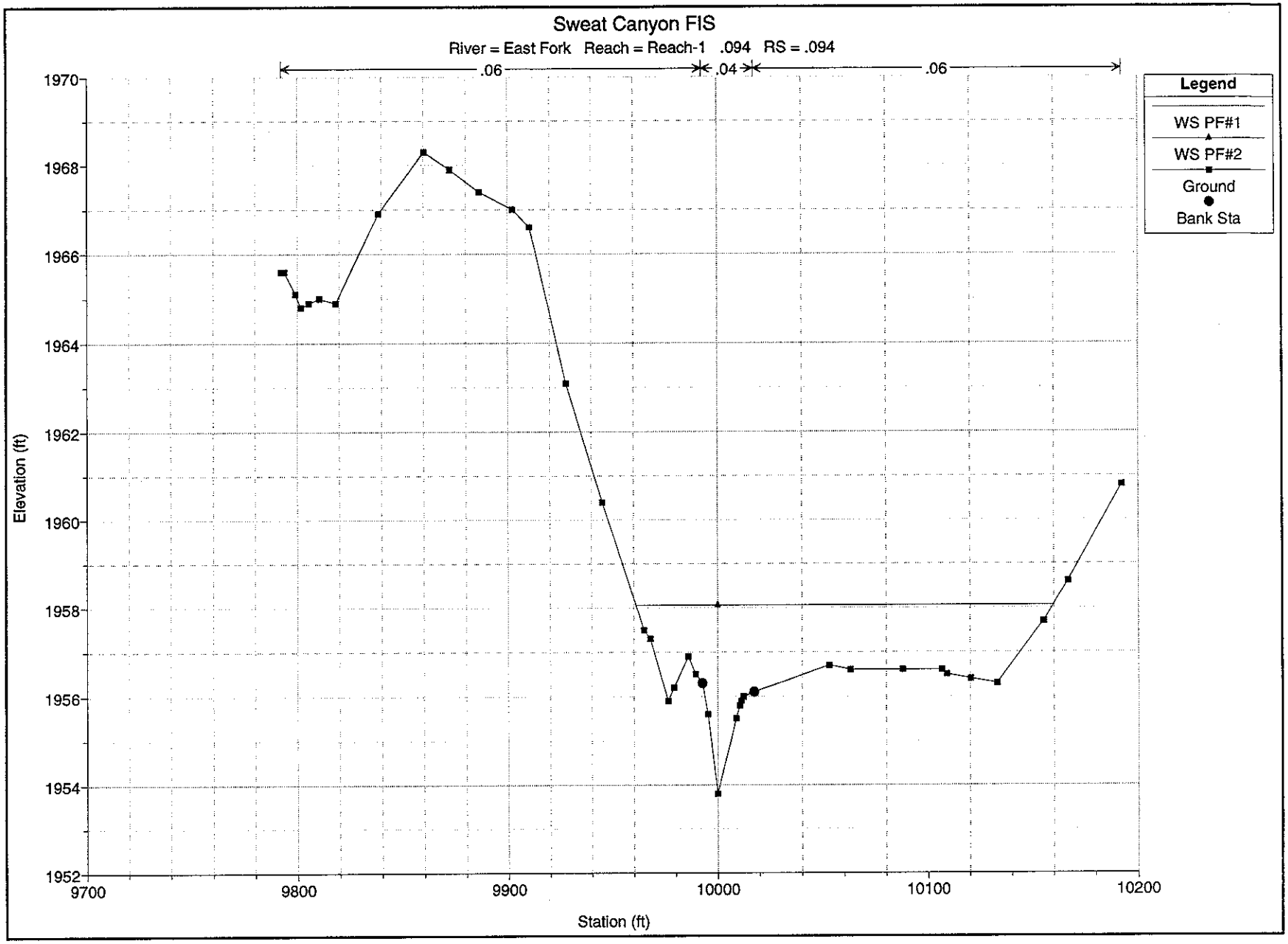

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.745
.055
.055
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1880
1878
1876
1874
1872
1870
1868
1866
9700
9800
9900
10000
10100
10200
Station (ft)

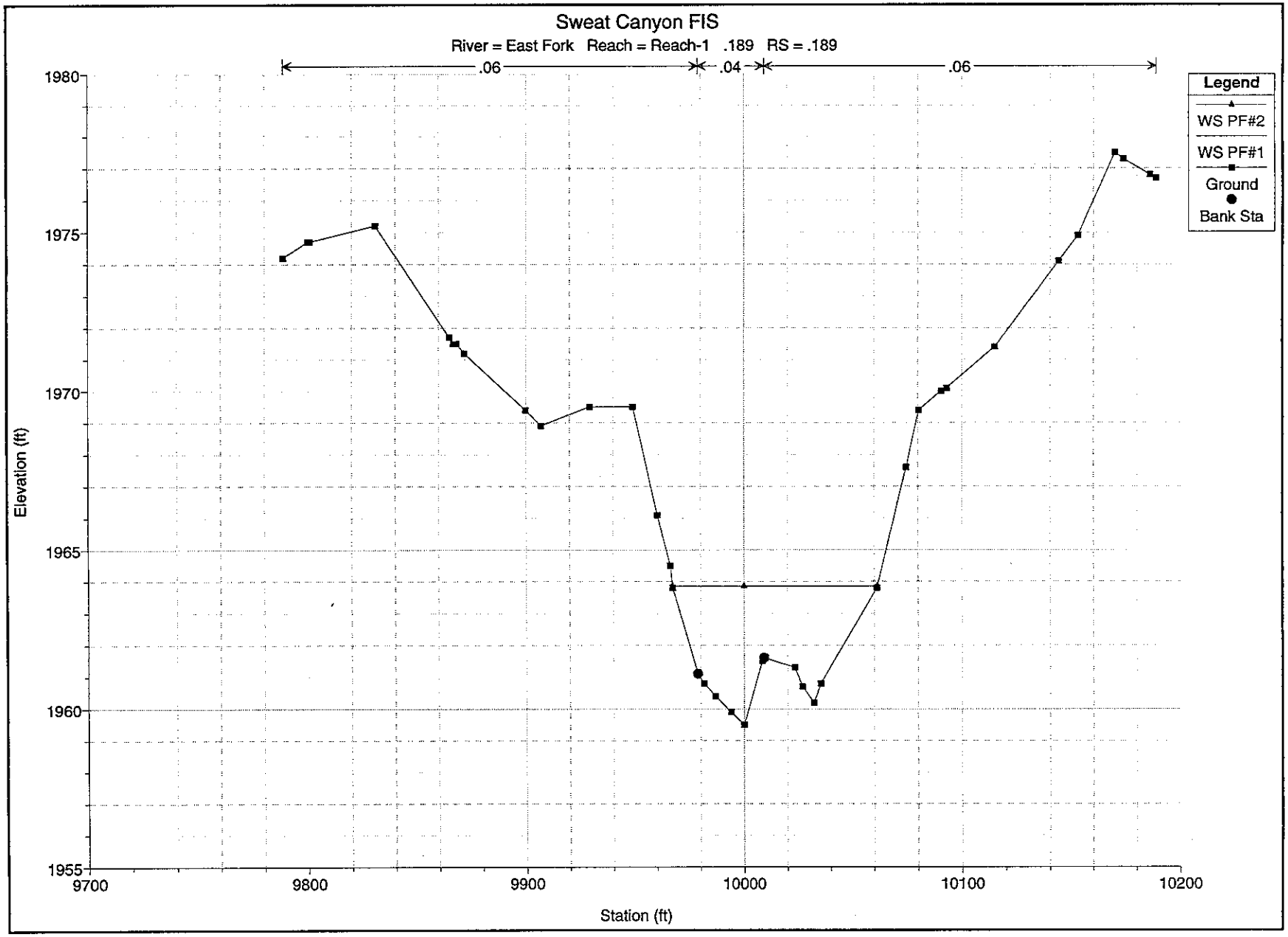

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.839
.055
.055
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1890
1888
1886
1884
1882
1880
1878
1876
1874
9700
9800
9900
10000
10100
10200
Station (ft)

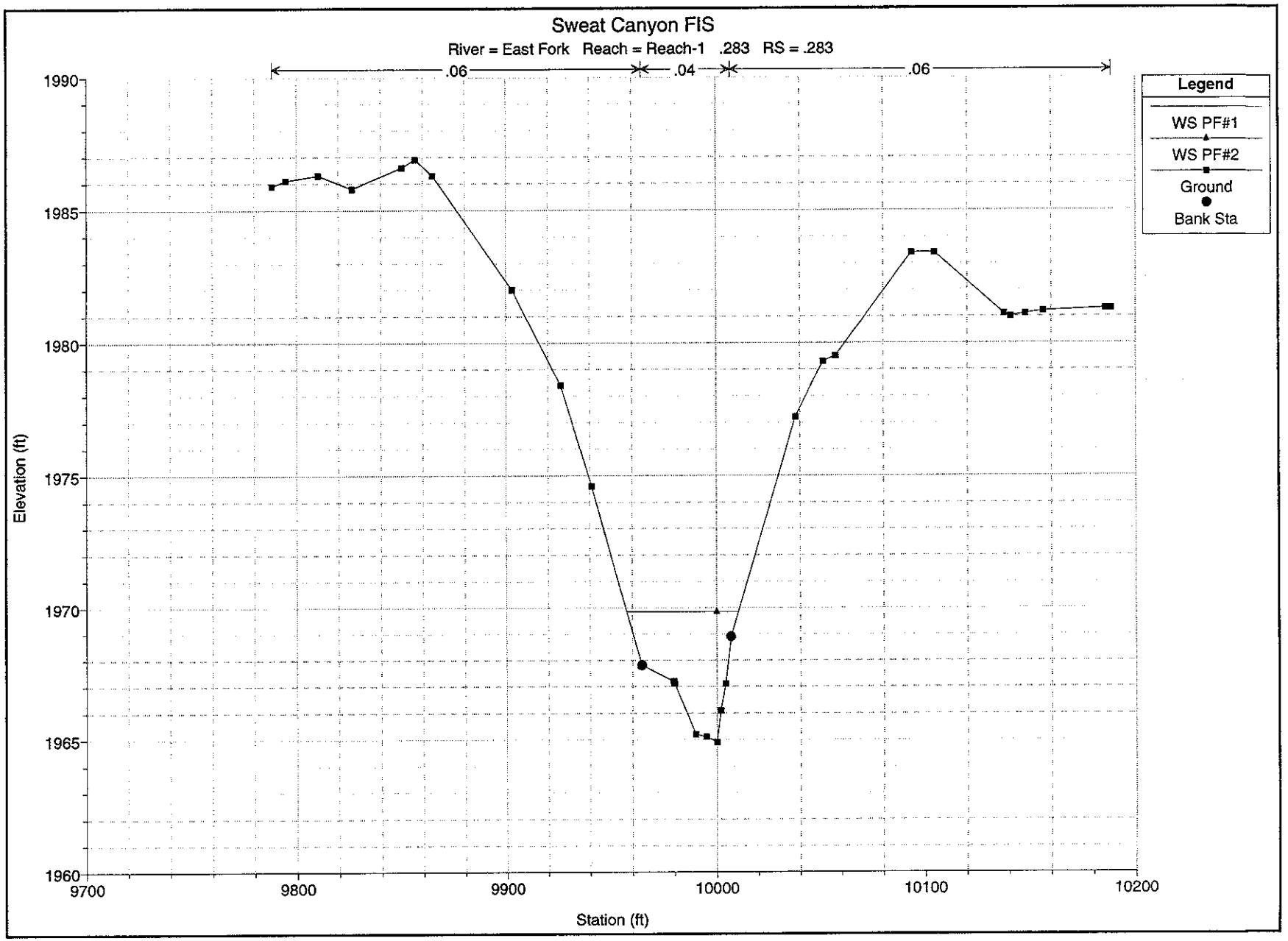

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.934
.055
.055
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1905
1900
1895
1890
1885
1880
9700
9800
9900
10000
10100
10200
Station (ft)

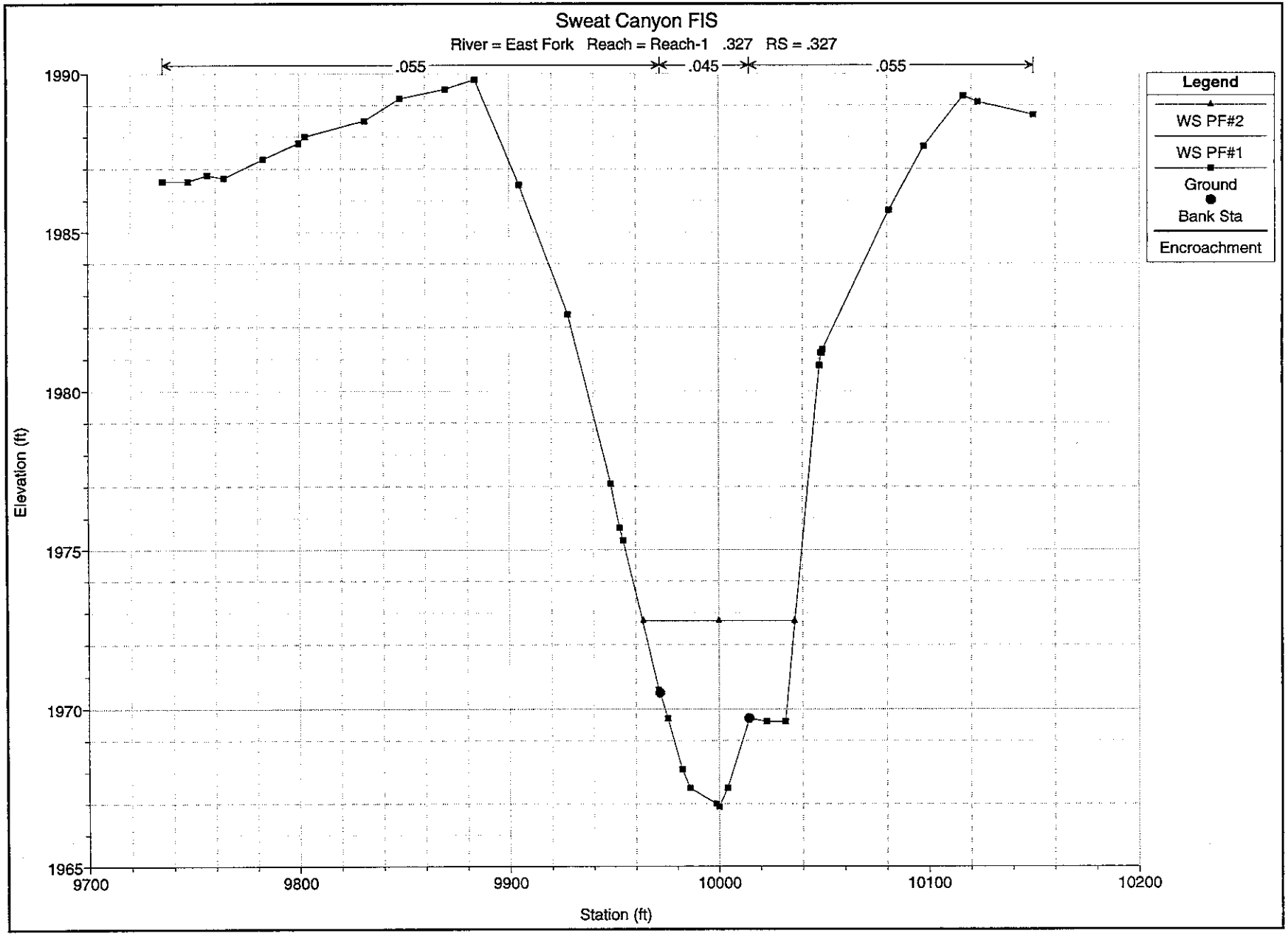

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 0.984
.055
.055
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1898
1896
1894
1892
1890
1888
1886
1884
9800
9850
9900
9950
10000
10050
10100
10150
10200
10250
Station (ft)

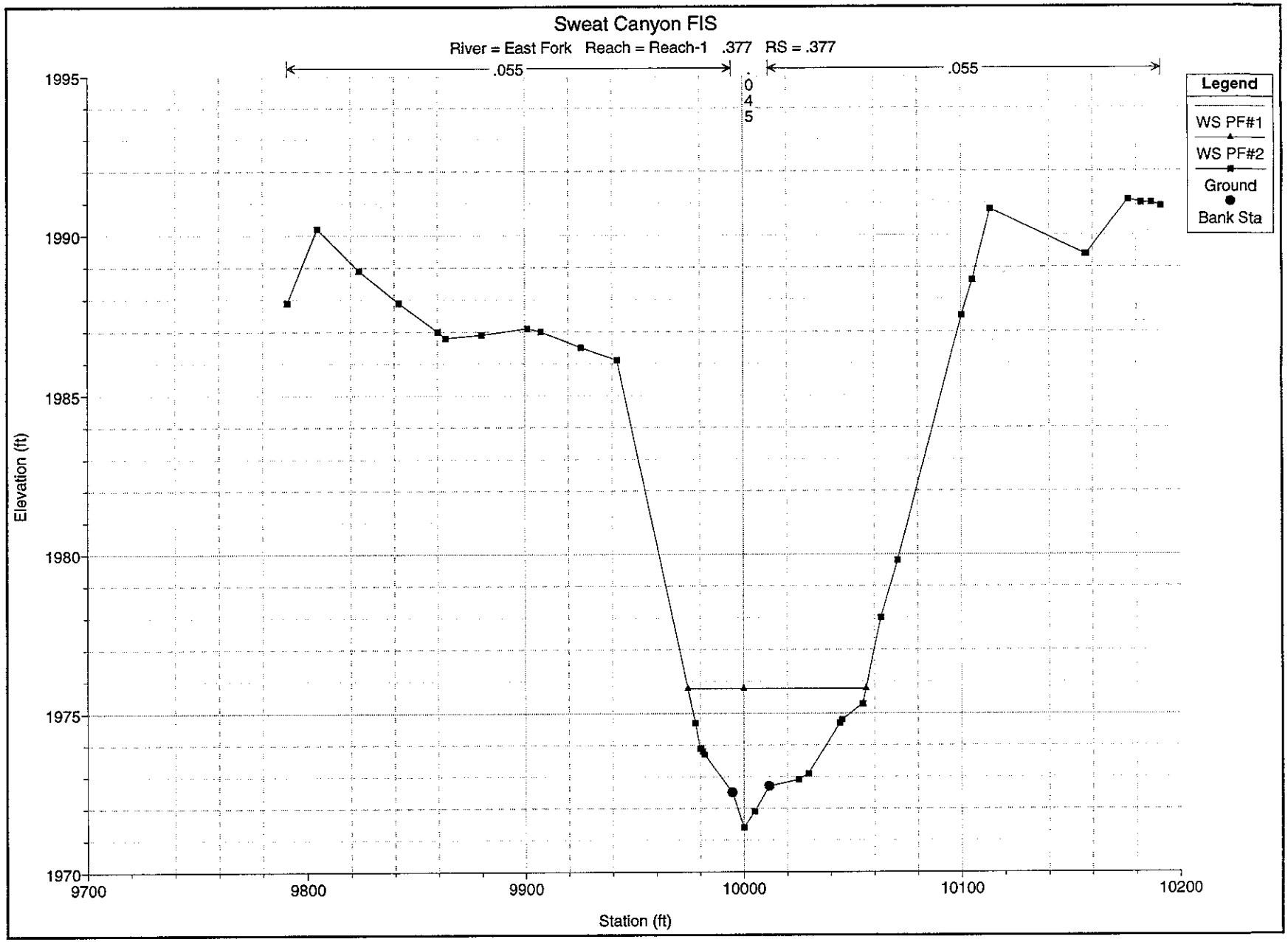

Sweat Canyon FIS
River = South Fork Reach = Reach-1 RS = 1.040
.055
.055
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Encroachment
Elevation (ft)
1904
1902
1900
1898
1896
1894
1892
1890
1888
9750
9800
9850
9900
9950
10000
10050
10100
10150
Station (ft)

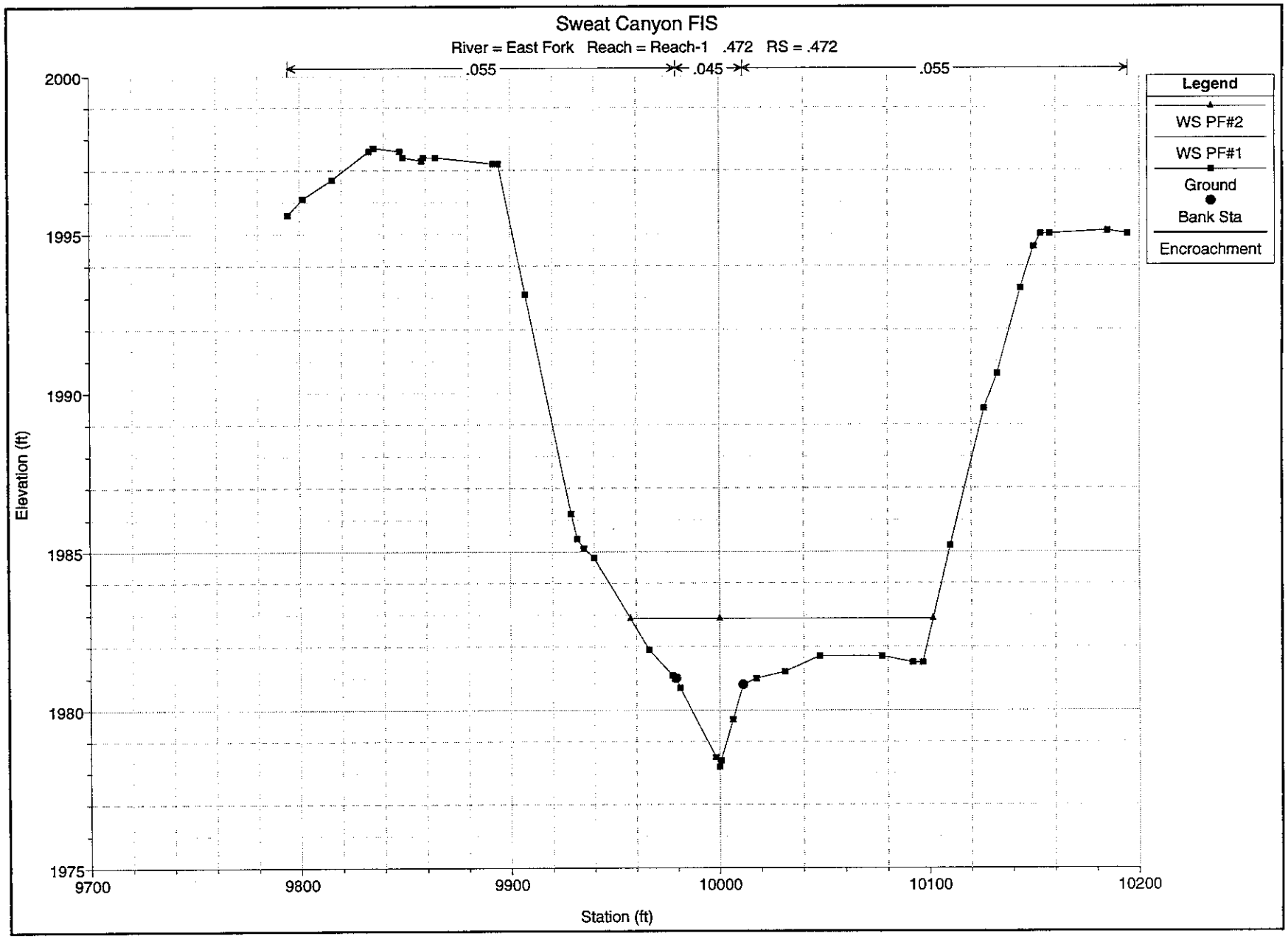

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .094 RS = .094
.06
.04
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1970
1968
1966
1964
1962
1960
1958
1956
1954
1952
9700
9800
9900
10000
10100
10200
Station (ft)

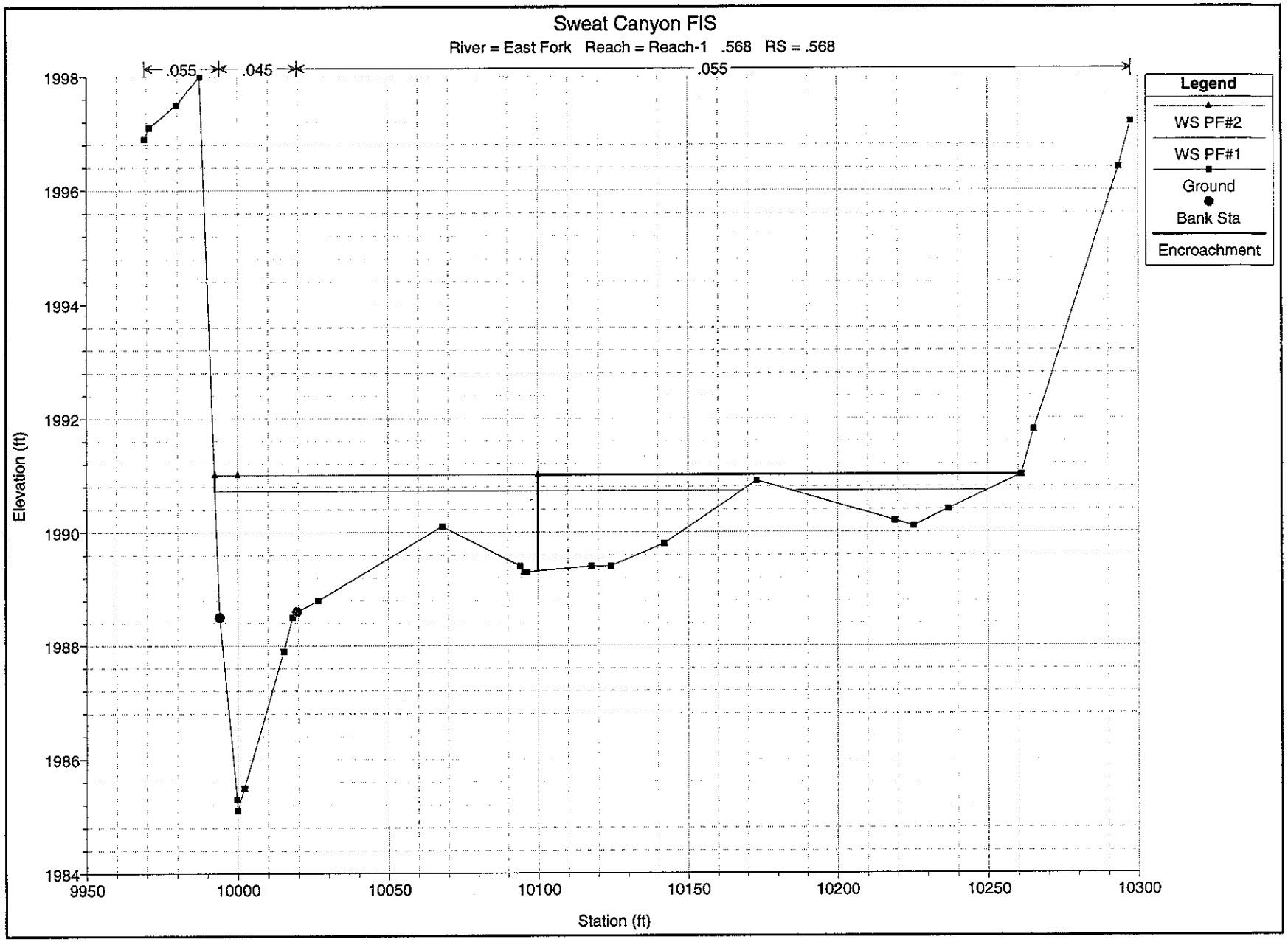

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .189 RS = .189
.06
.04
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1980
1975
1970
1965
1960
1955
9700
9800
9900
10000
10100
10200
Station (ft)

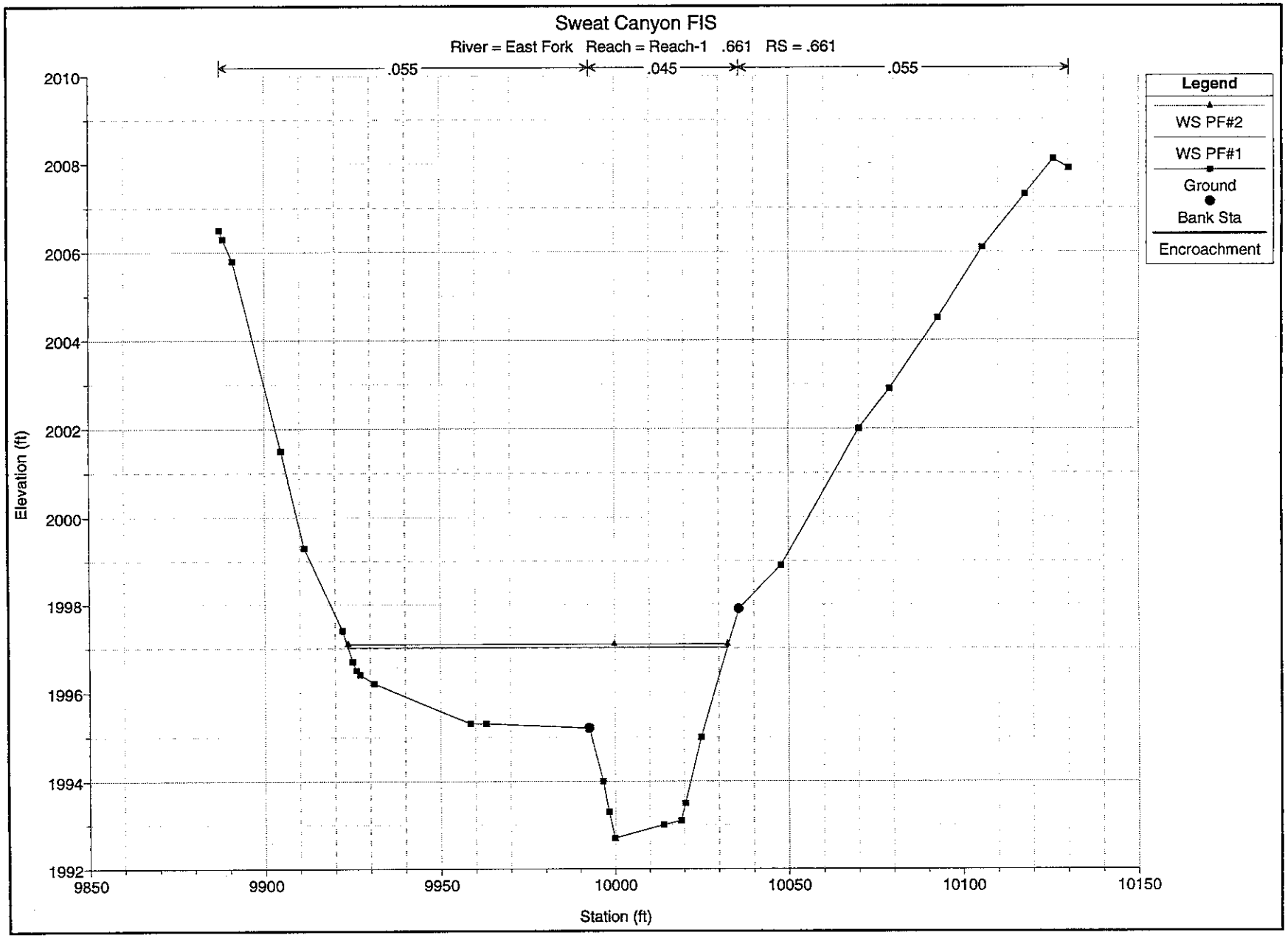

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .283 RS = .283
.06
.04
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1990
1985
1980
1975
1970
1965
1960
9700
9800
9900
10000
10100
10200
Station (ft)

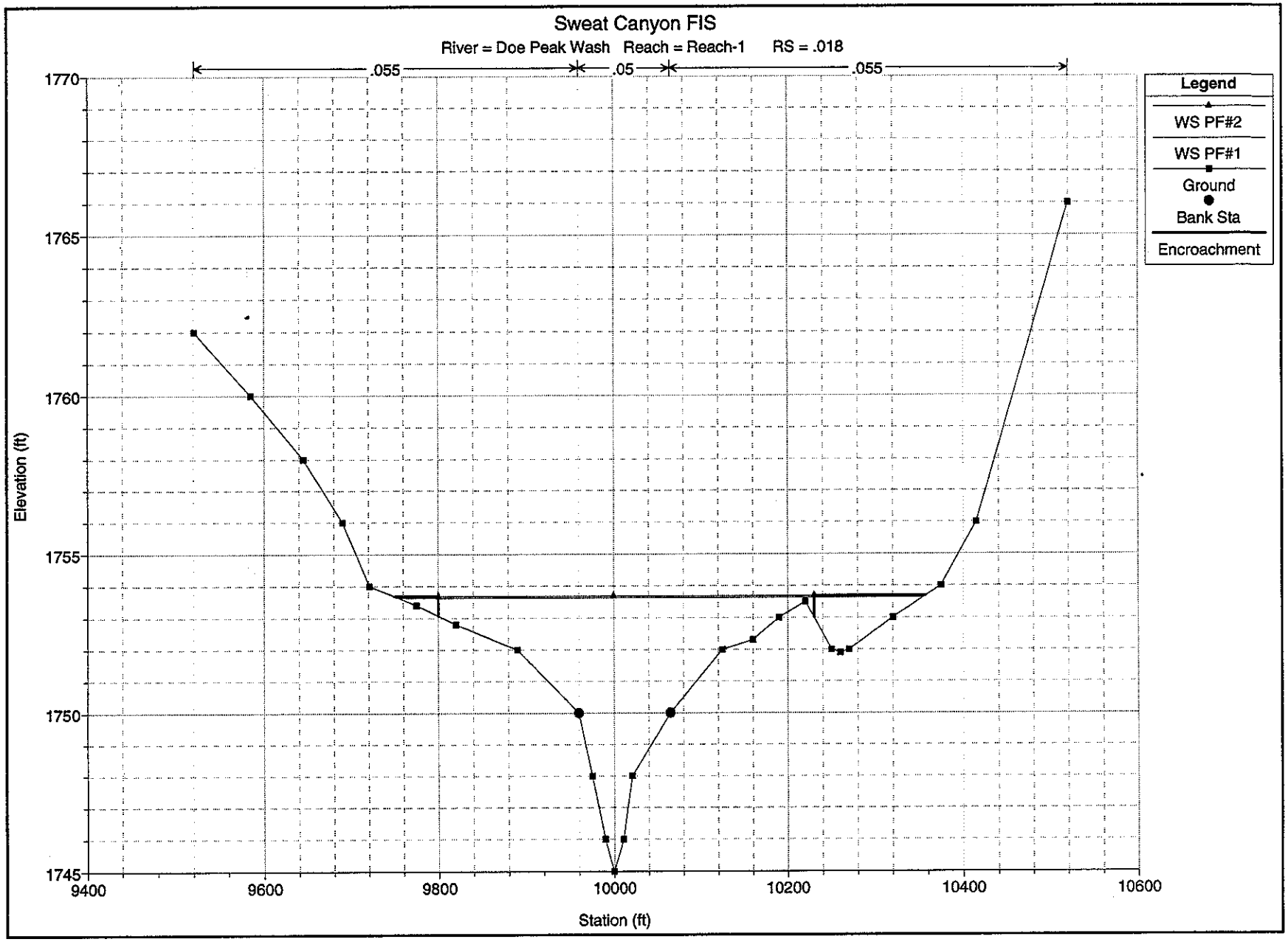

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .327 RS = .327
.055
.045
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1990
1985
1980
1975
1970
1965
9700
9800
9900
10000
10100
10200
Station (ft)

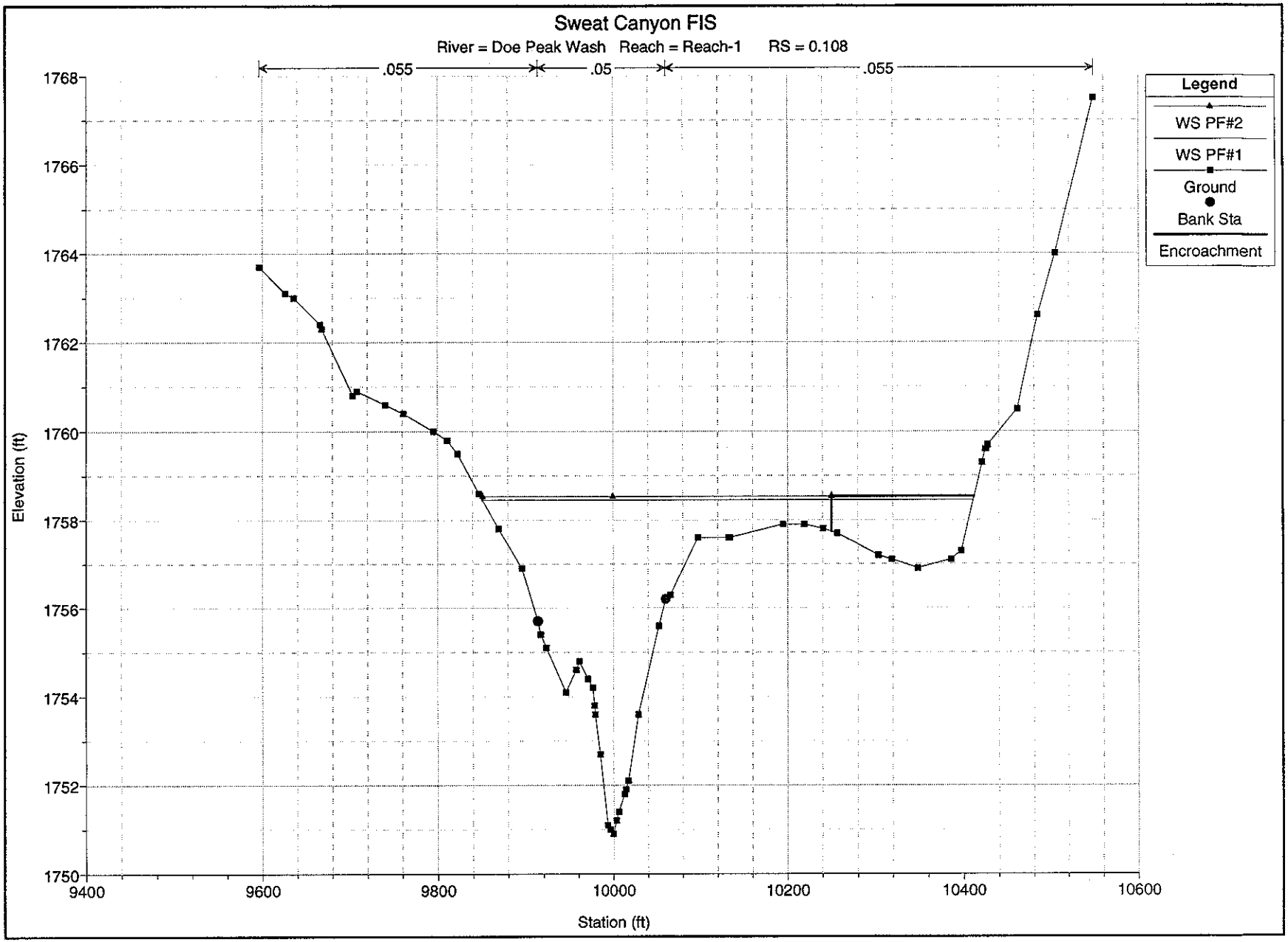

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .377 RS = .377
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1995
1990
1985
1980
1975
1970
9700
9800
9900
10000
10100
10200
Station (ft)

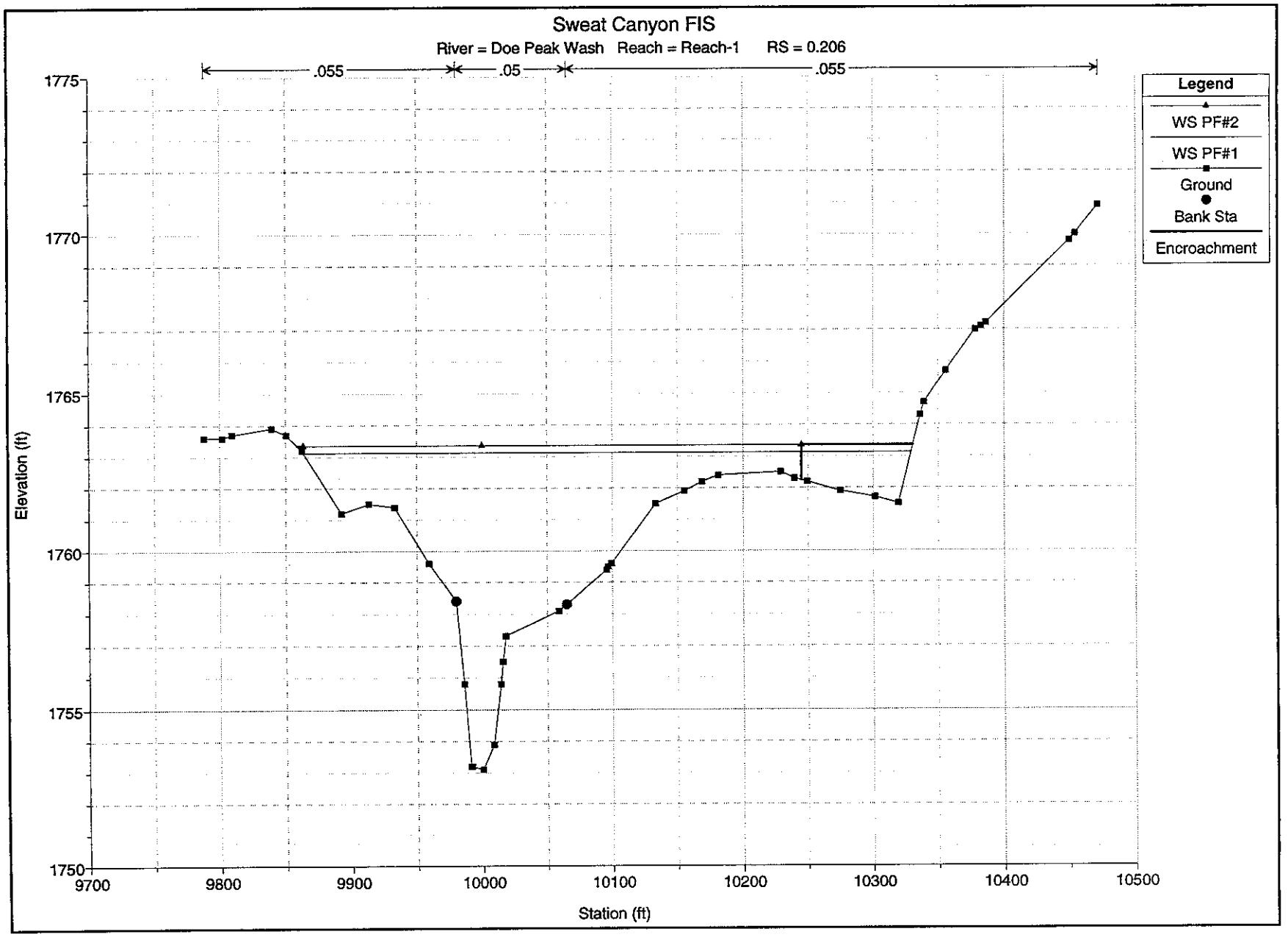

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .472 RS = .472
.055
.045
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
2000
1995
1990
1985
1980
1975
9700
9800
9900
10000
10100
10200
Station (ft)

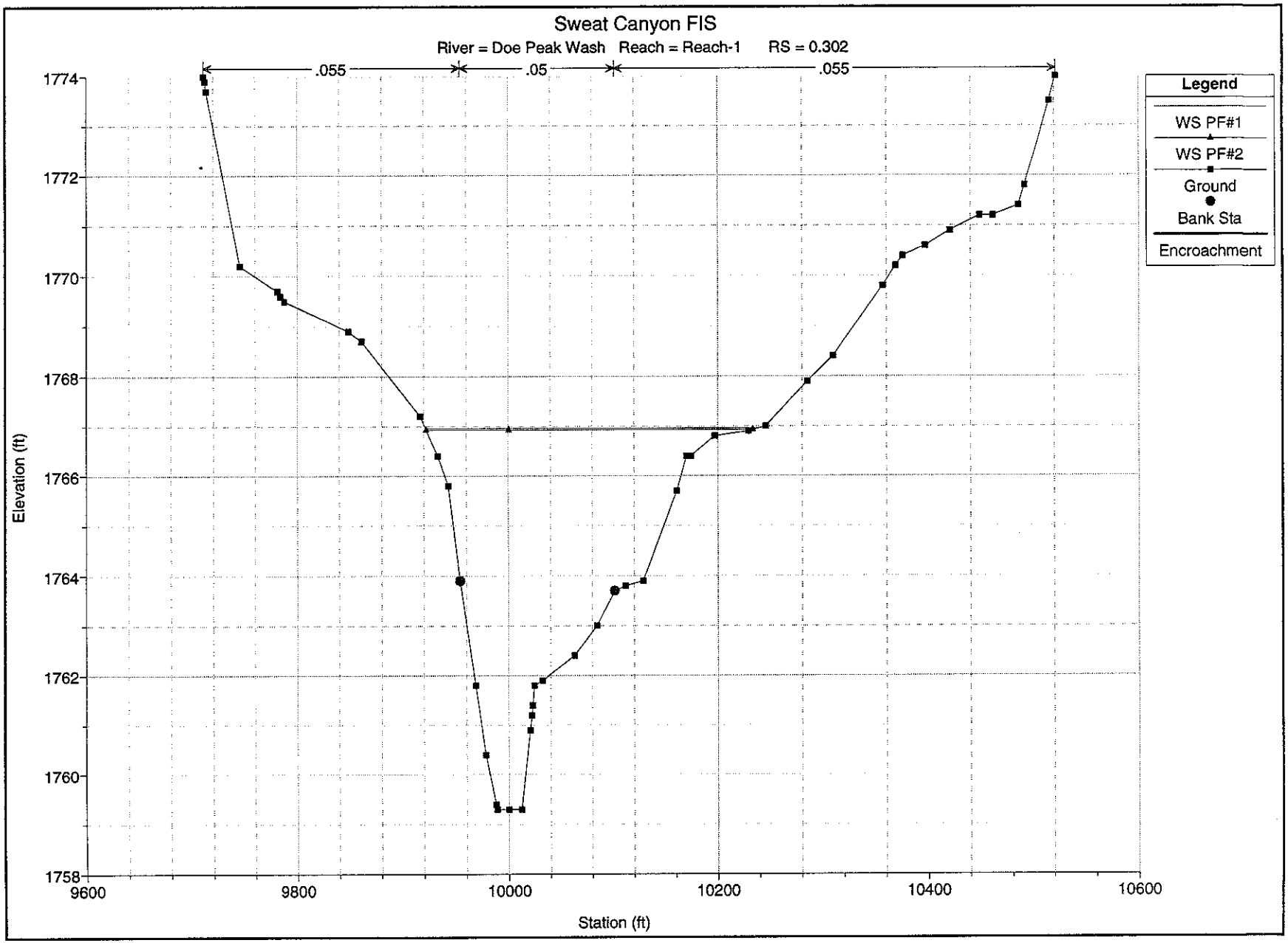

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .568 RS = .568
.055
.045
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1998
1996
1994
1992
1990
1988
1986
1984
9950
10000
10050
10100
10150
10200
10250
10300
Station (ft)

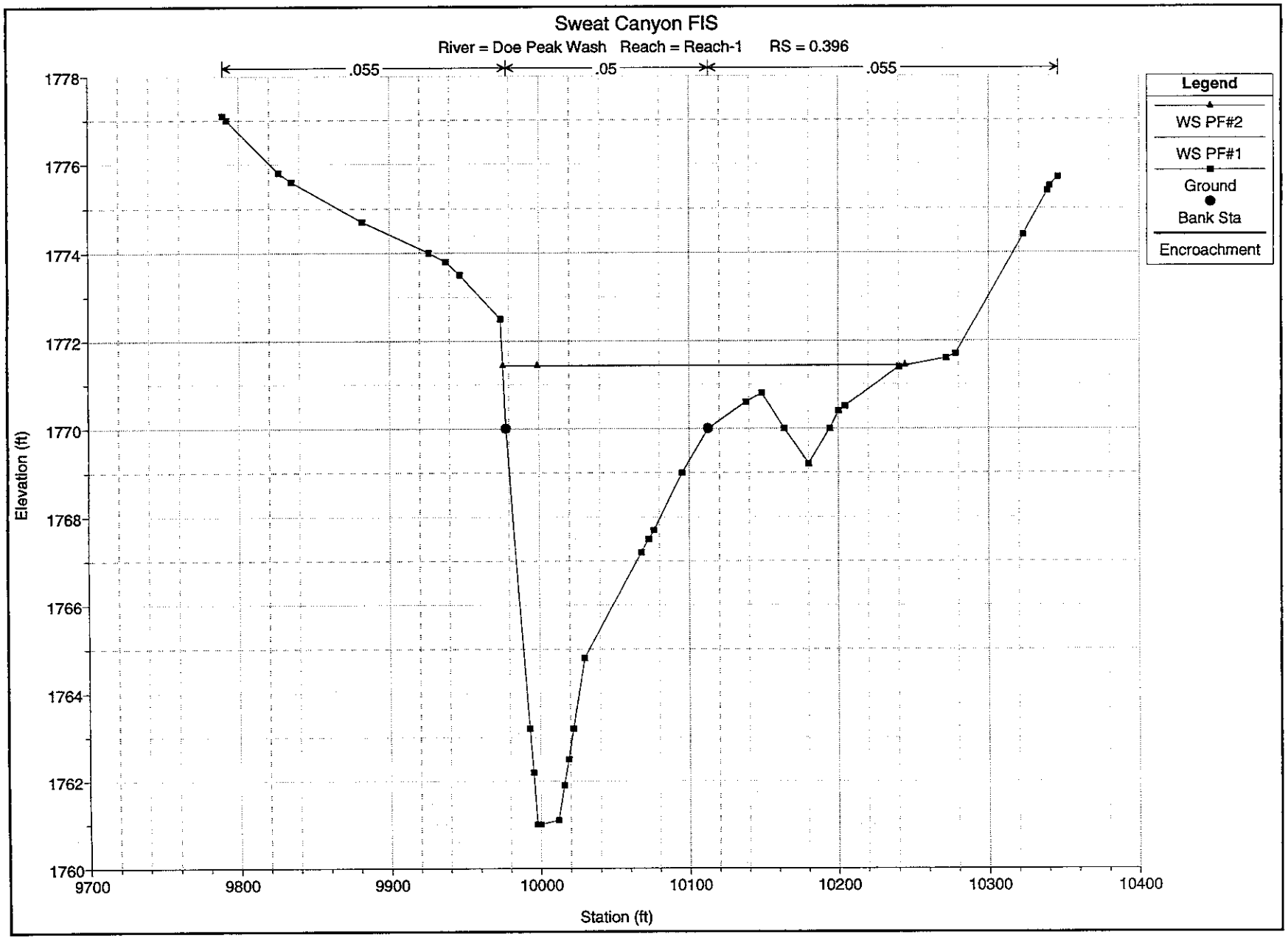

Sweat Canyon FIS
River = East Fork Reach = Reach-1 .661 RS = .661
.055
.045
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
2010
2008
2006
2004
2002
2000
1998
1996
1994
1992
9850
9900
9950
10000
10050
10100
10150
Station (ft)

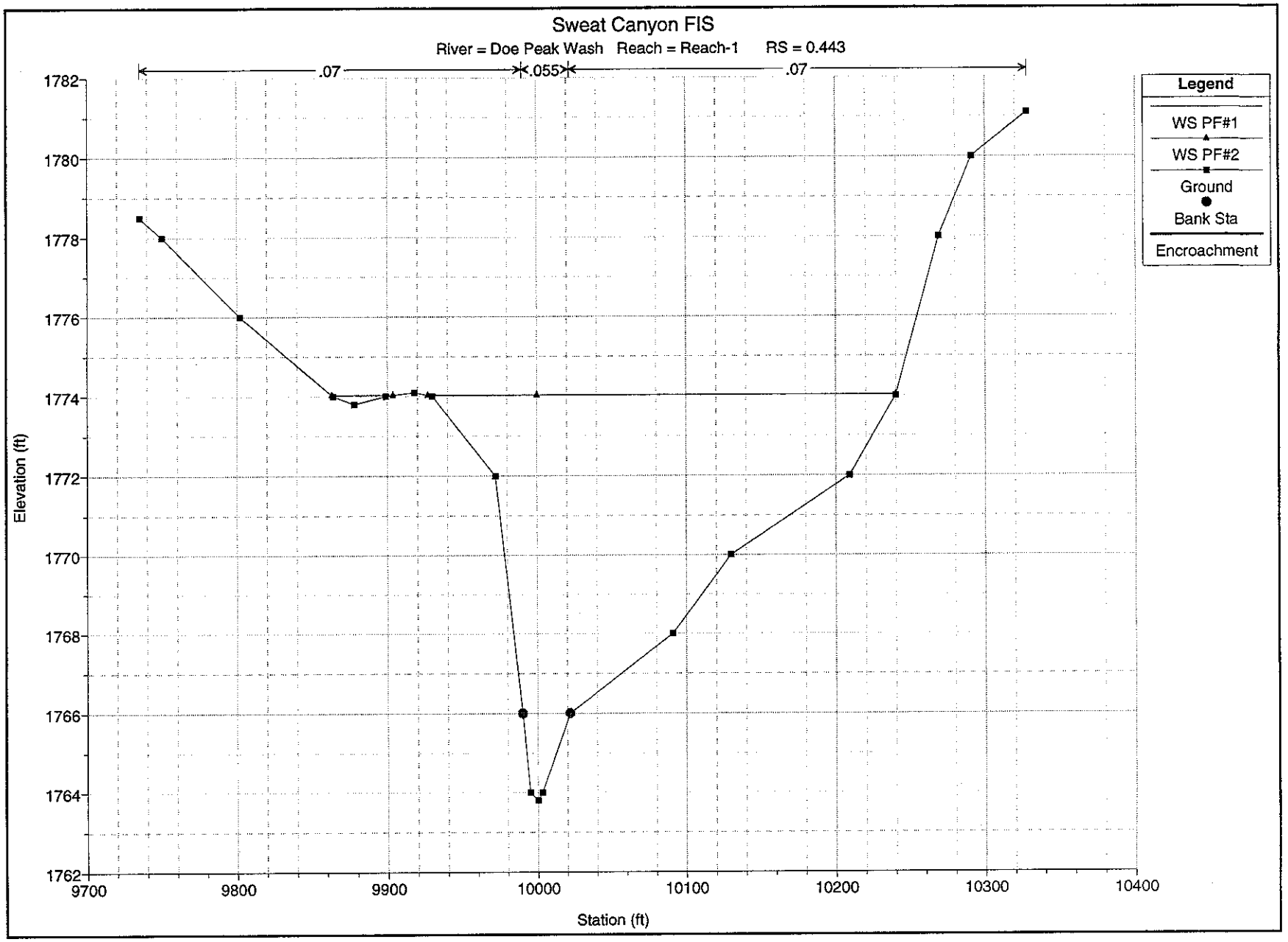

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = .018
.055
.05
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1770
1765
1760
1755
1750
1745
9400
9600
9800
10000
10200
10400
10600
Station (ft)

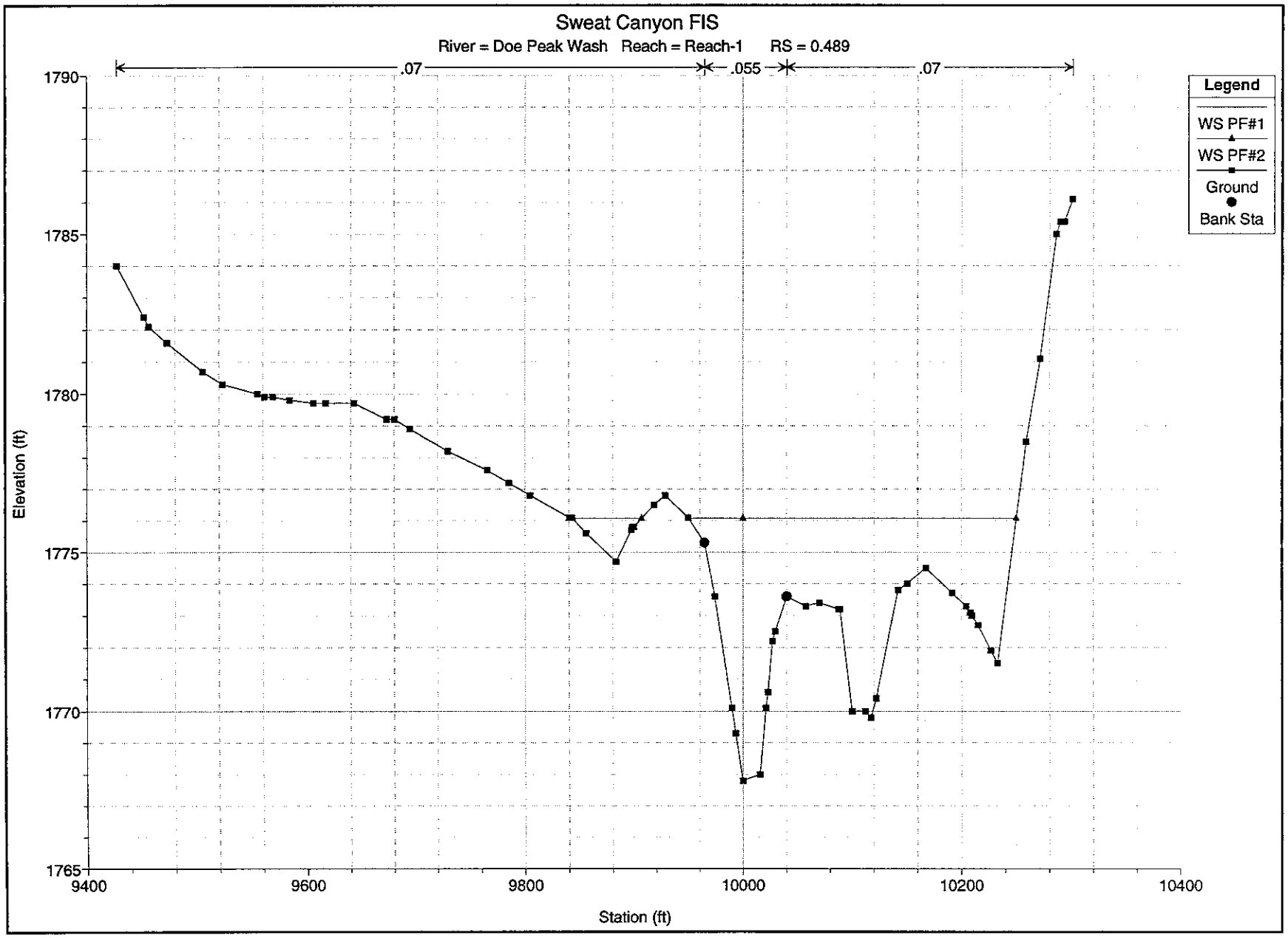

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.108
.055
.05
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1768
1766
1764
1762
1760
1758
1756
1754
1752
1750
9400
9600
9800
10000
10200
10400
10600
Station (ft)

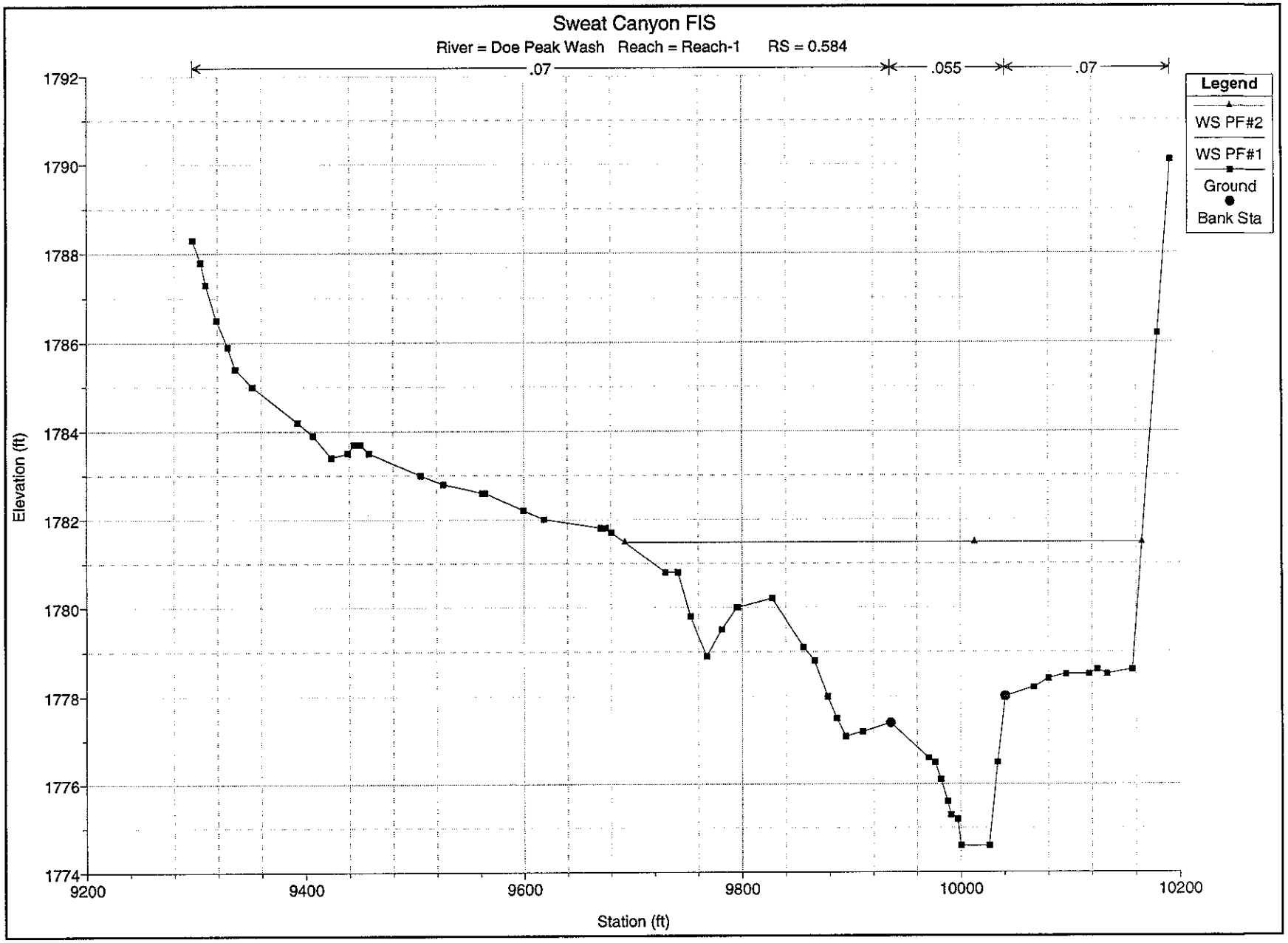

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.206
.055
.05
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1775
1770
1765
1760
1755
1750
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

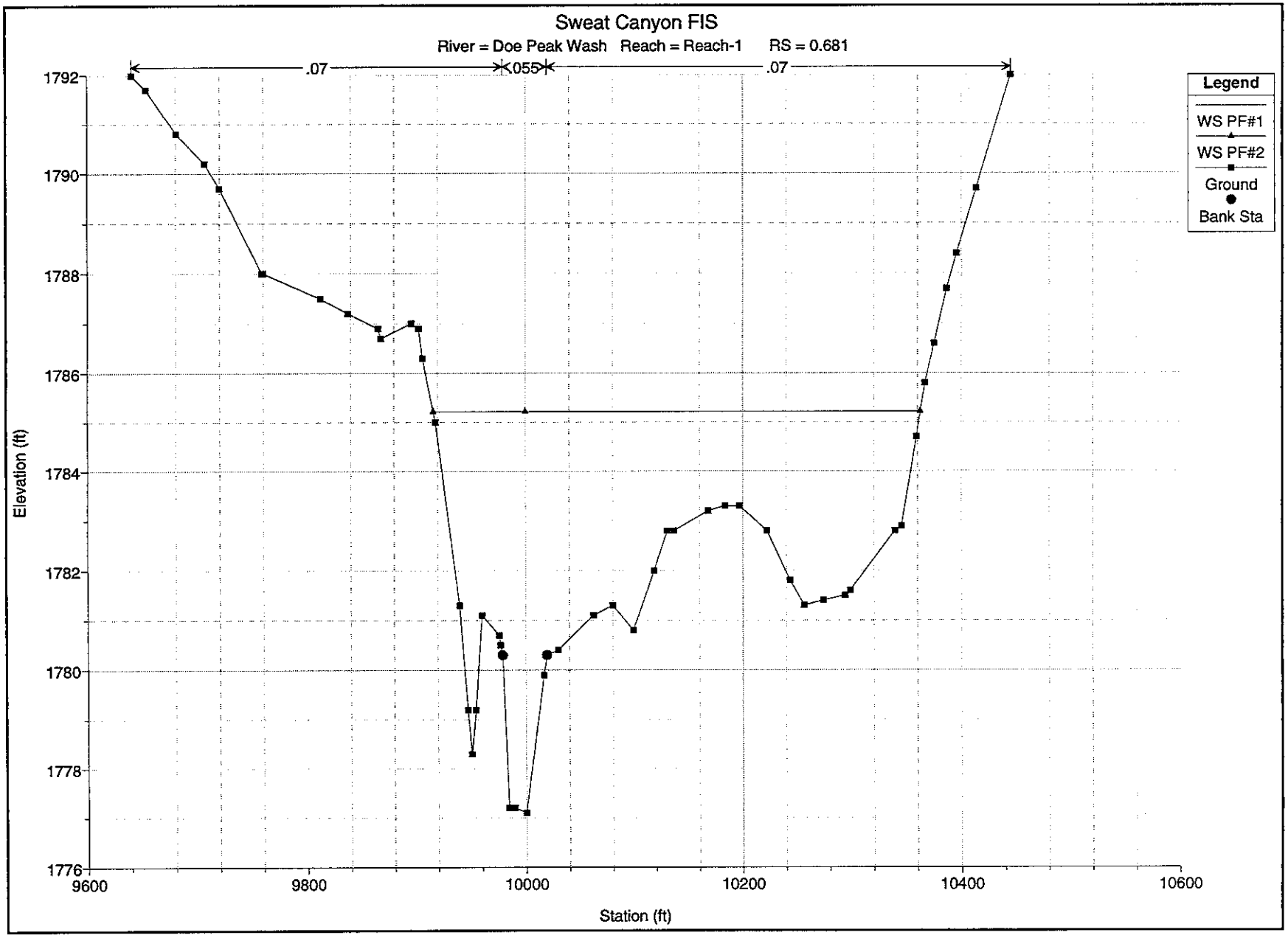

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.302
.055
.05
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Encroachment
Elevation (ft)
1774
1772
1770
1768
1766
1764
1762
1760
1758
9600
9800
10000
10200
10400
10600
Station (ft)

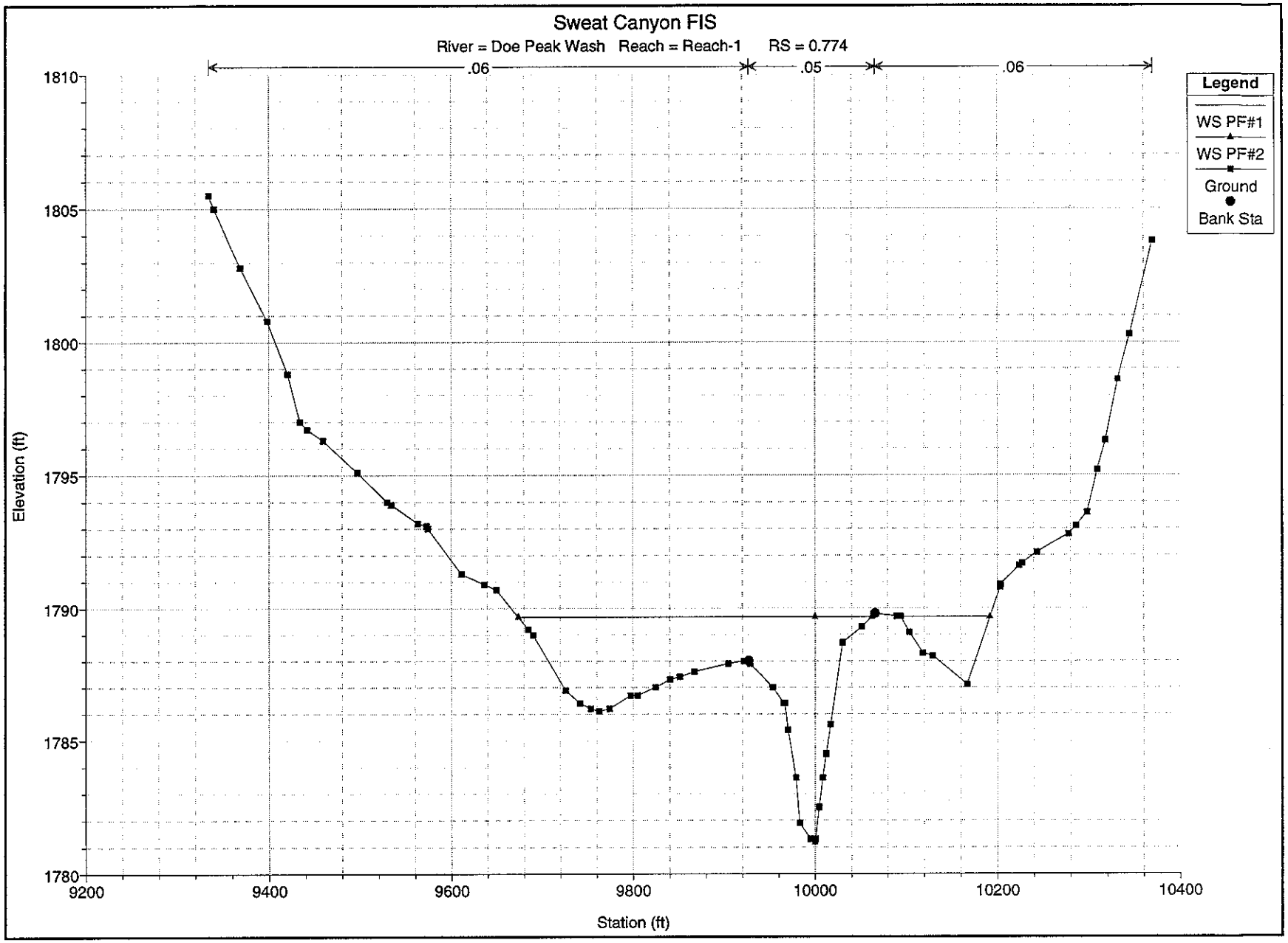

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.396
.055
.05
.055
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1778
1776
1774
1772
1770
1768
1766
1764
1762
1760
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

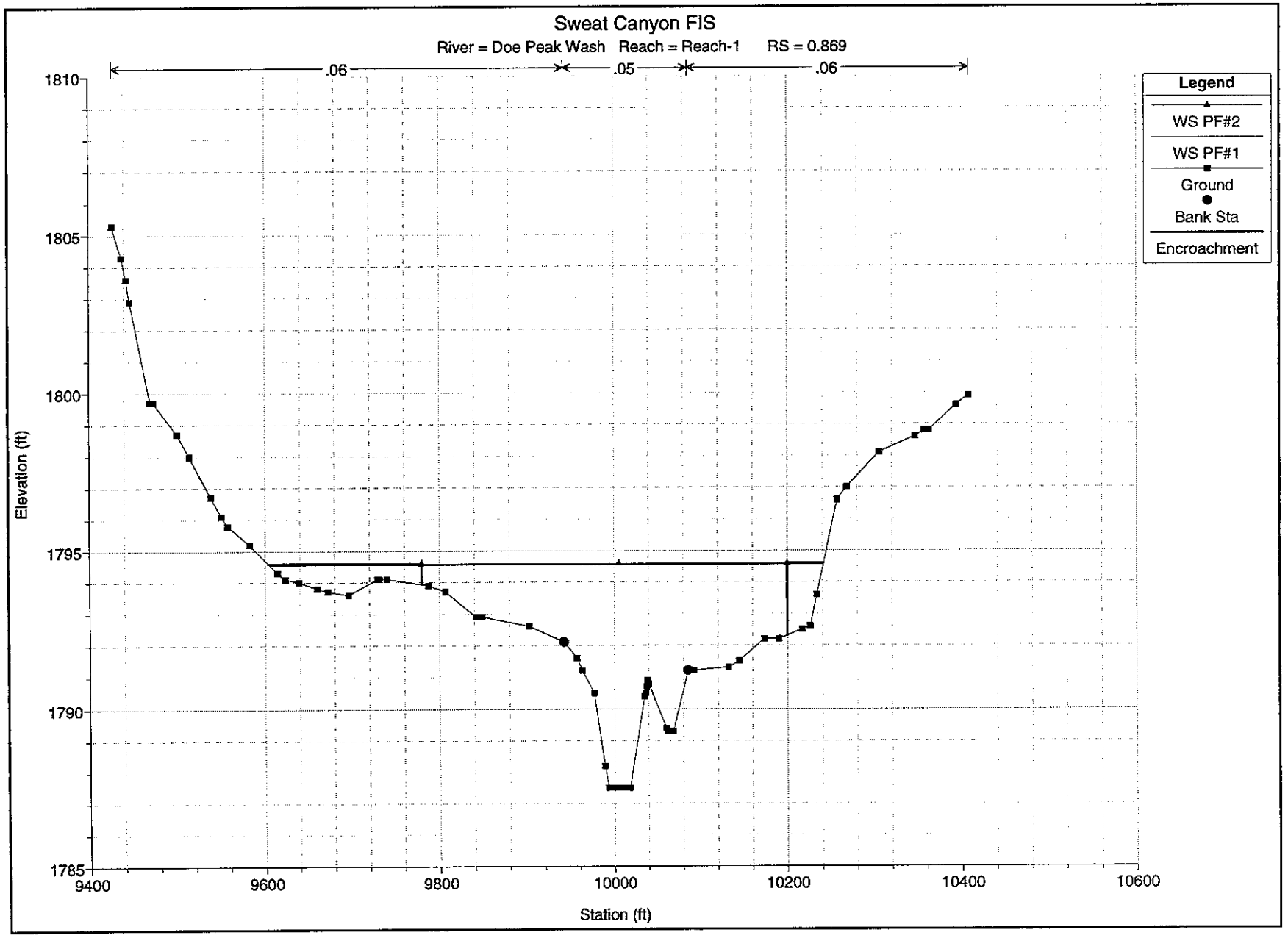

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.443
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Encroachment
Elevation (ft)
1782
1780
1778
1776
1774
1772
1770
1768
1766
1764
1762
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

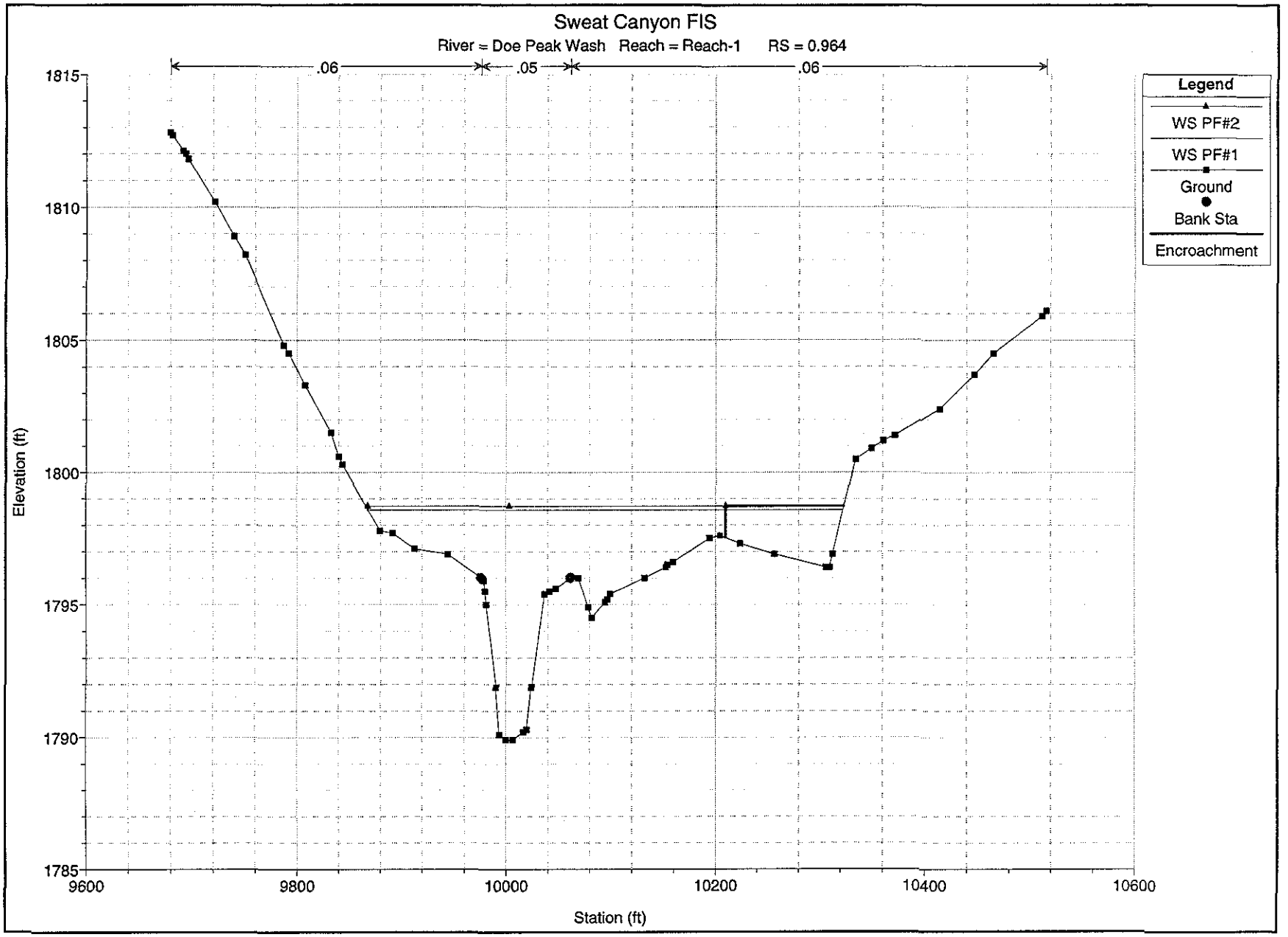

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.489
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1790
1785
1780
1775
1770
1765
9400
9600
9800
10000
10200
10400
Station (ft)

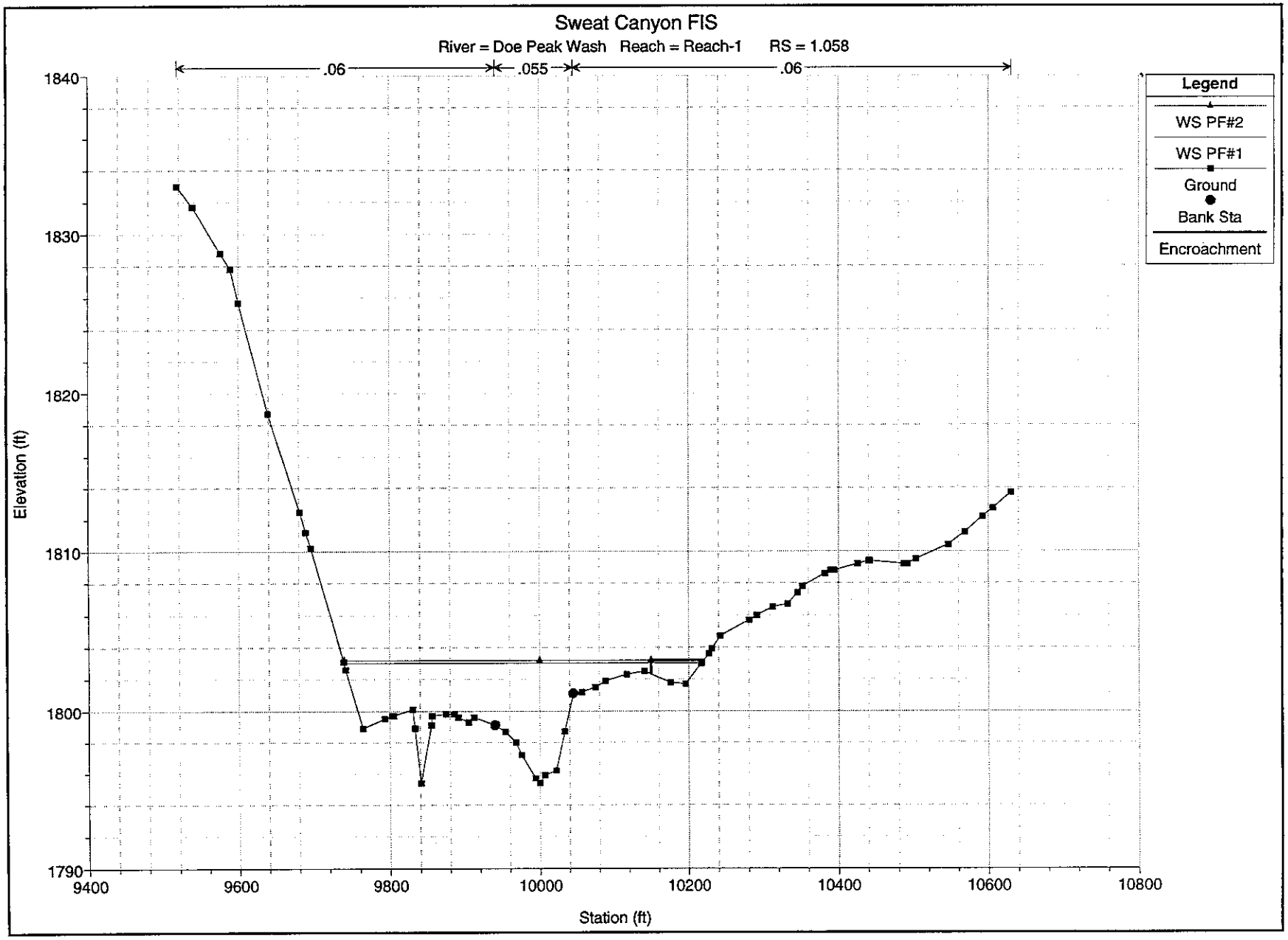

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.584
.07
.055
.07
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1792
1790
1788
1786
1784
1782
1780
1778
1776
1774
9200
9400
9600
9800
10000
10200
Station (ft)

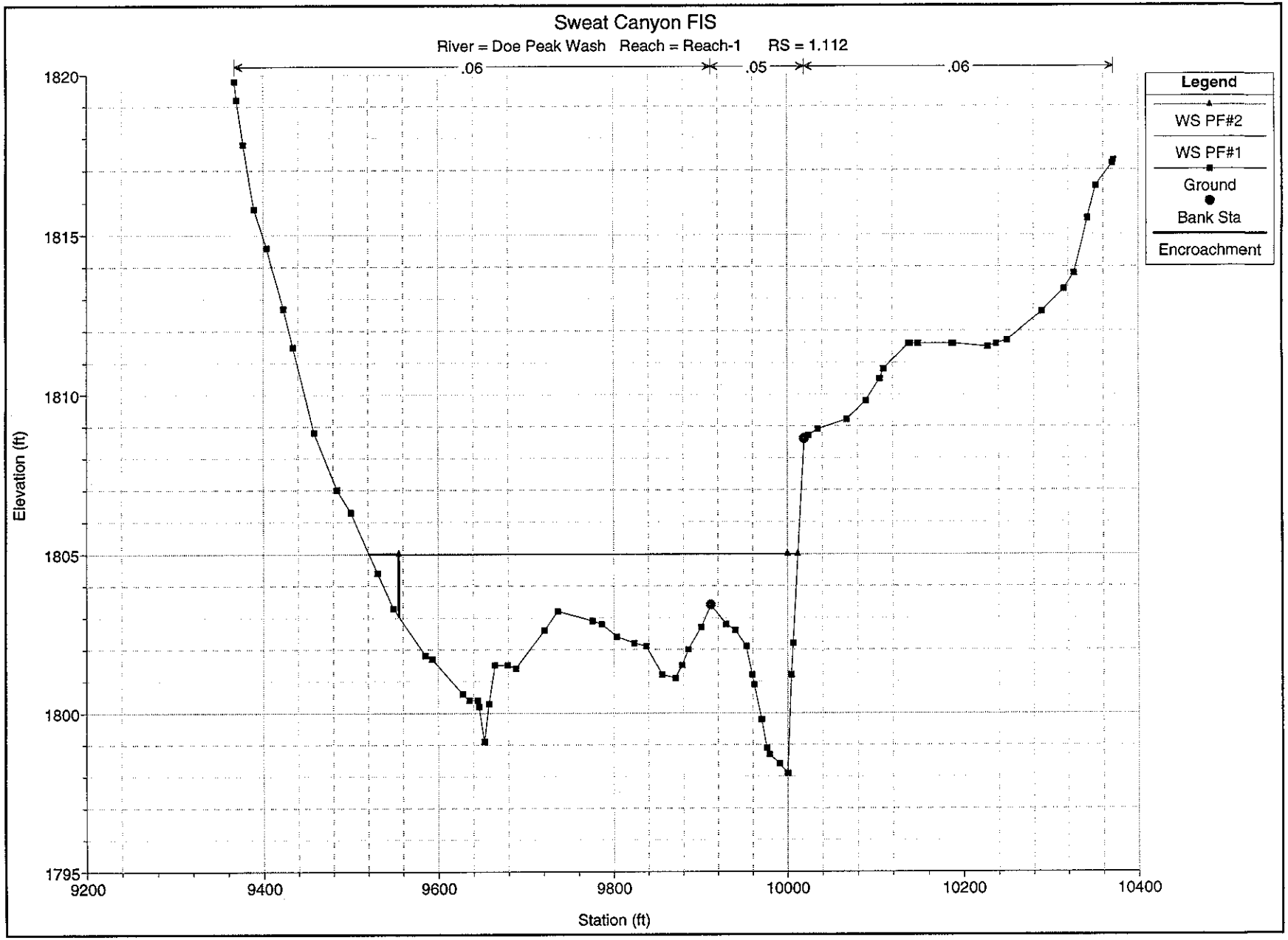

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.681
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1792
1790
1788
1786
1784
1782
1780
1778
1776
9600
9800
10000
10200
10400
10600
Station (ft)

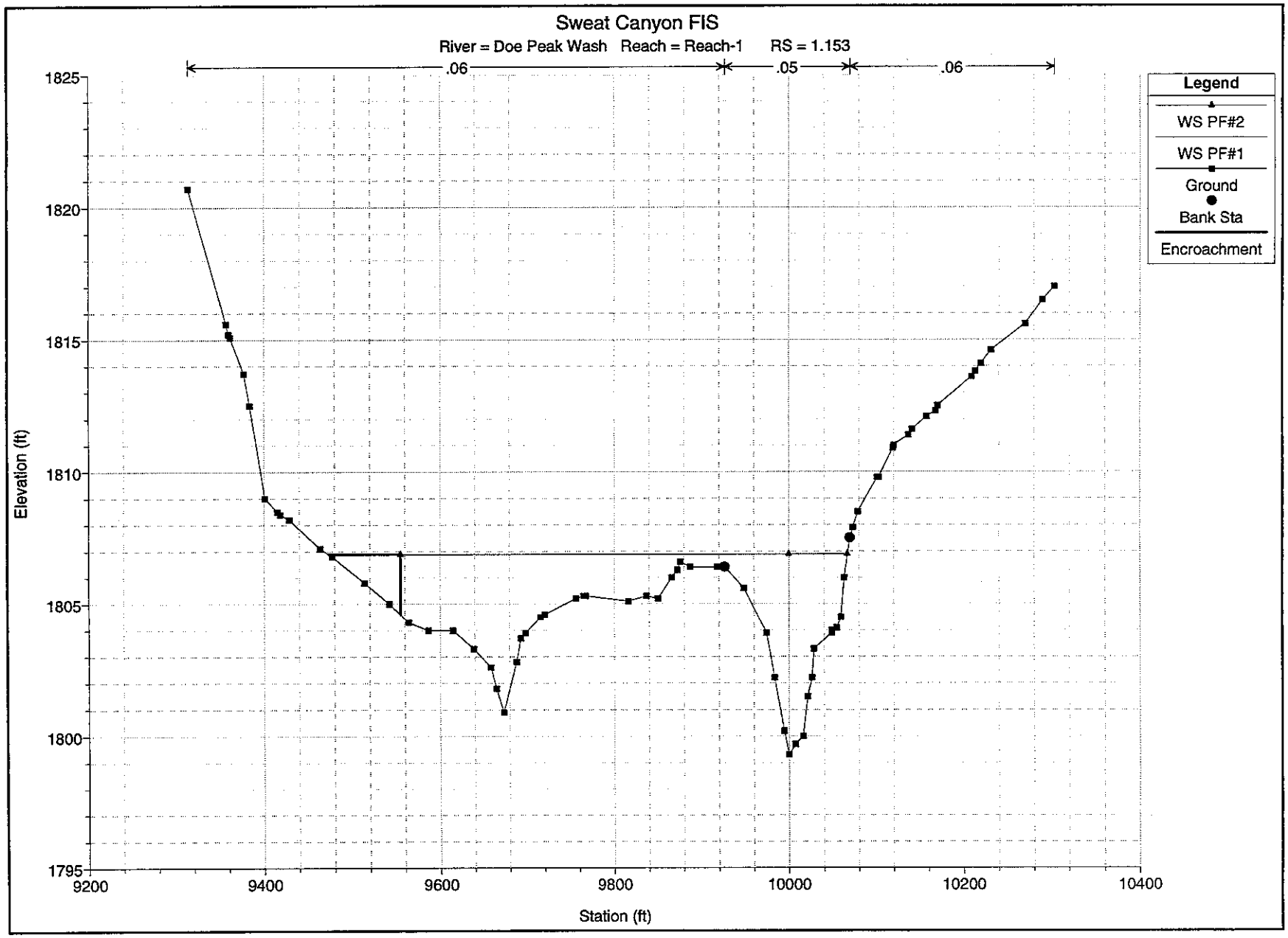

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.774
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1810
1805
1800
1795
1790
1785
1780
9200
9400
9600
9800
10000
10200
10400
Station (ft)

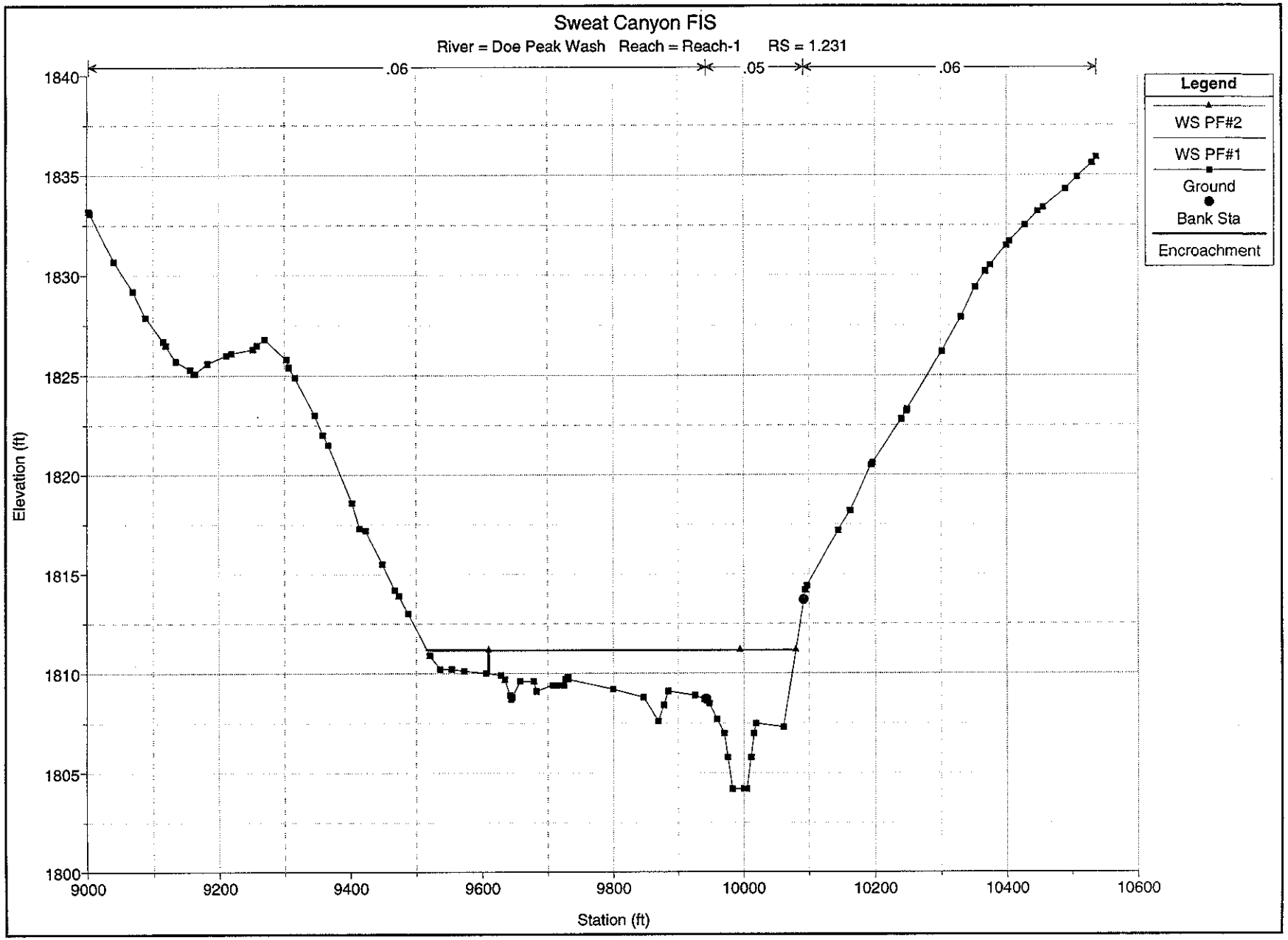

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.869
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1810
1805
1800
1795
1790
1785
9400
9600
9800
10000
10200
10400
10600
Station (ft)

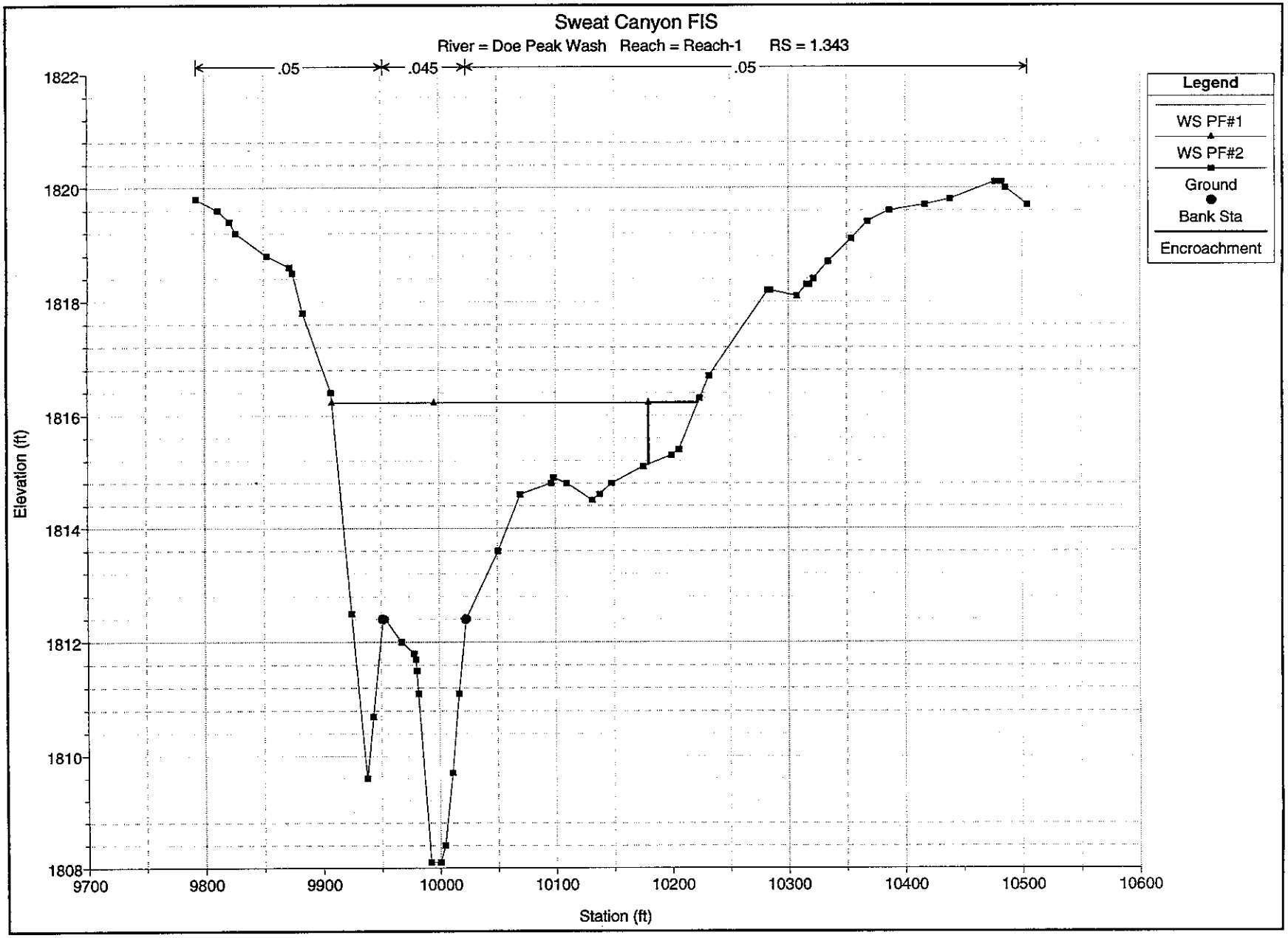

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 0.964
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1815
1810
1805
1800
1795
1790
1785
9600
9800
10000
10200
10400
10600
Station (ft)

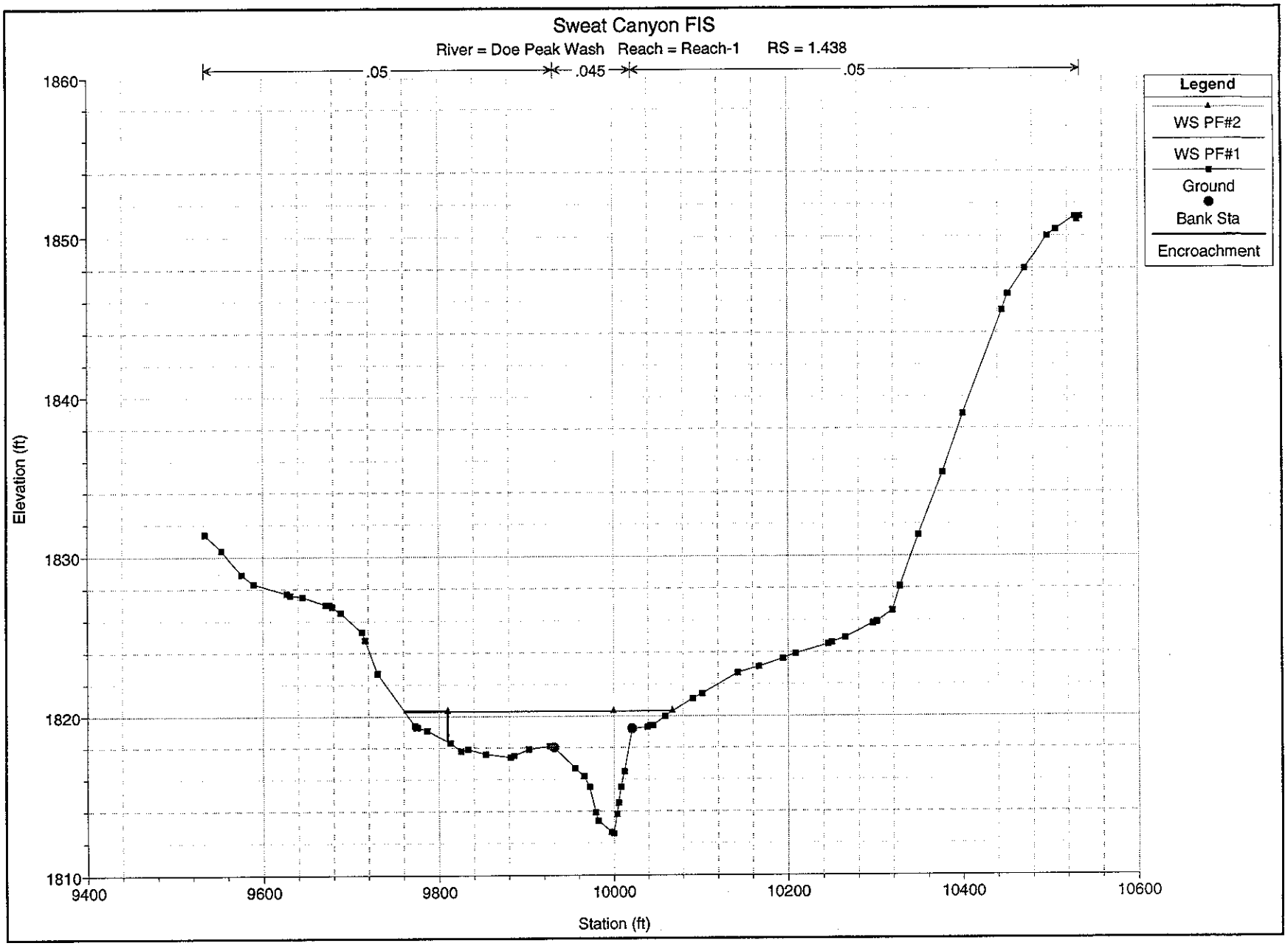

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.058
.06
.055
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1840
1830
1820
1810
1800
1790
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

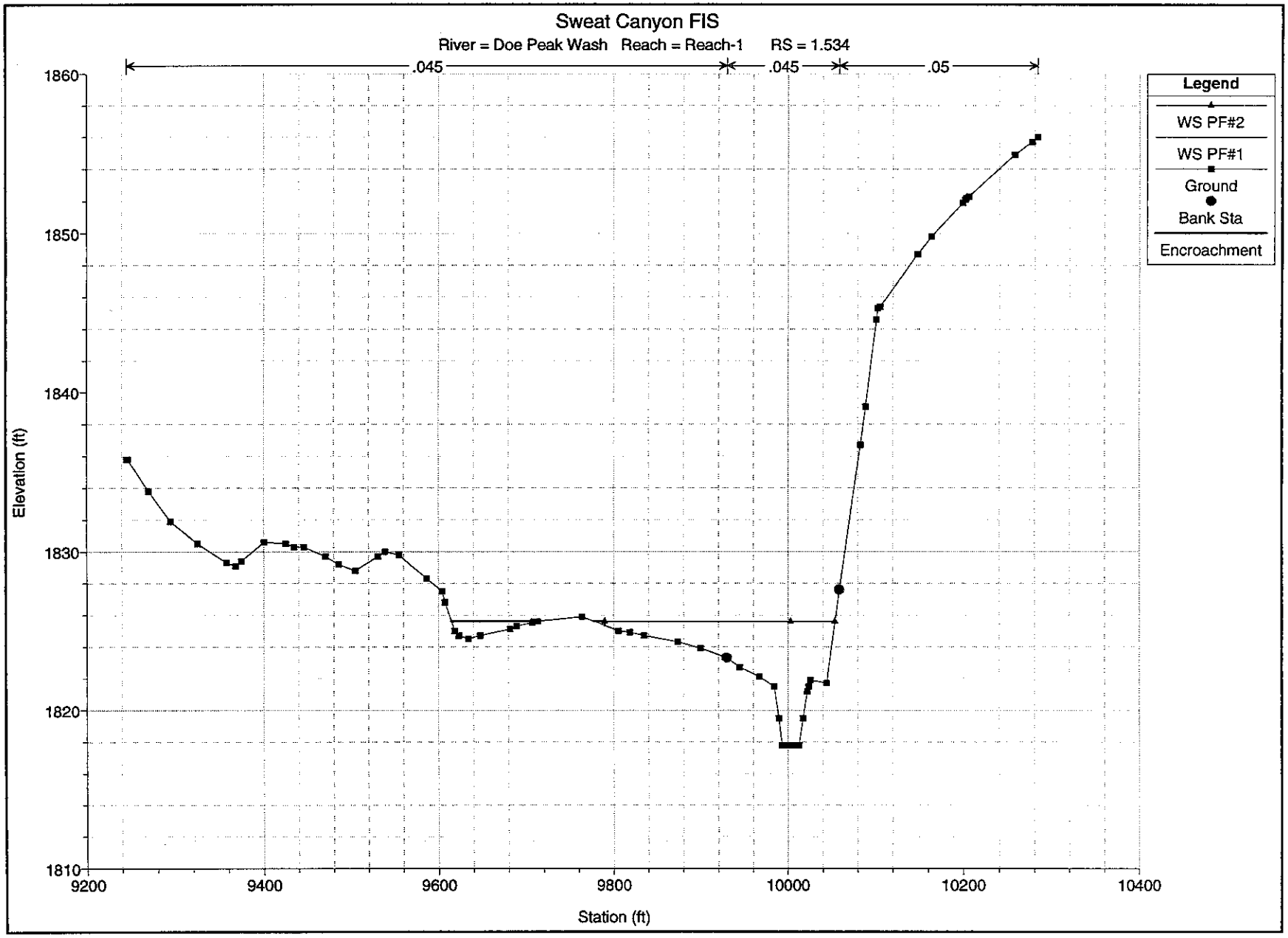

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.112
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1820
1815
1810
1805
1800
1795
9200
9400
9600
9800
10000
10200
10400
Station (ft)

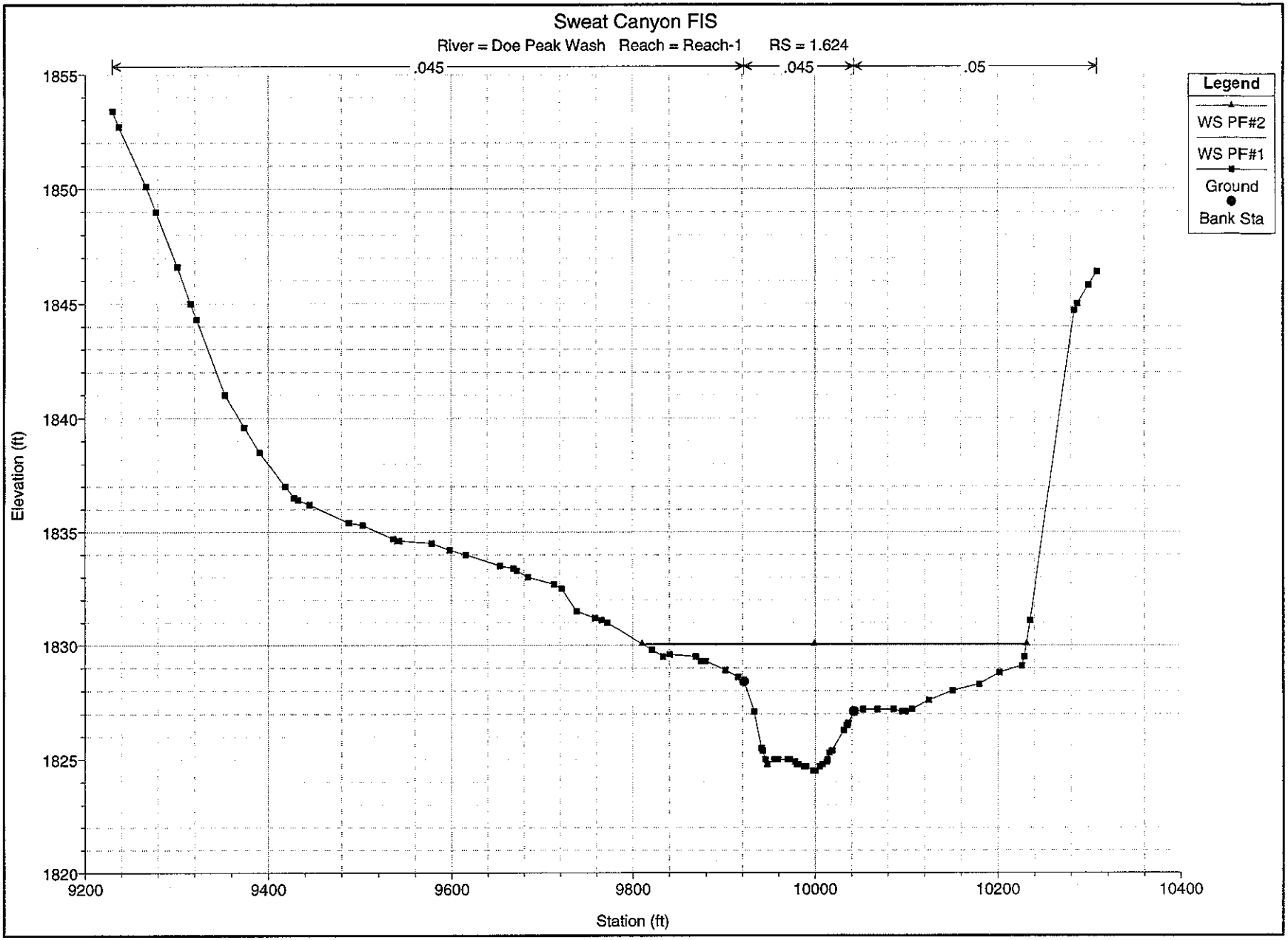

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.153
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1825
1820
1815
1810
1805
1800
1795
9200
9400
9600
9800
10000
10200
10400
Station (ft)

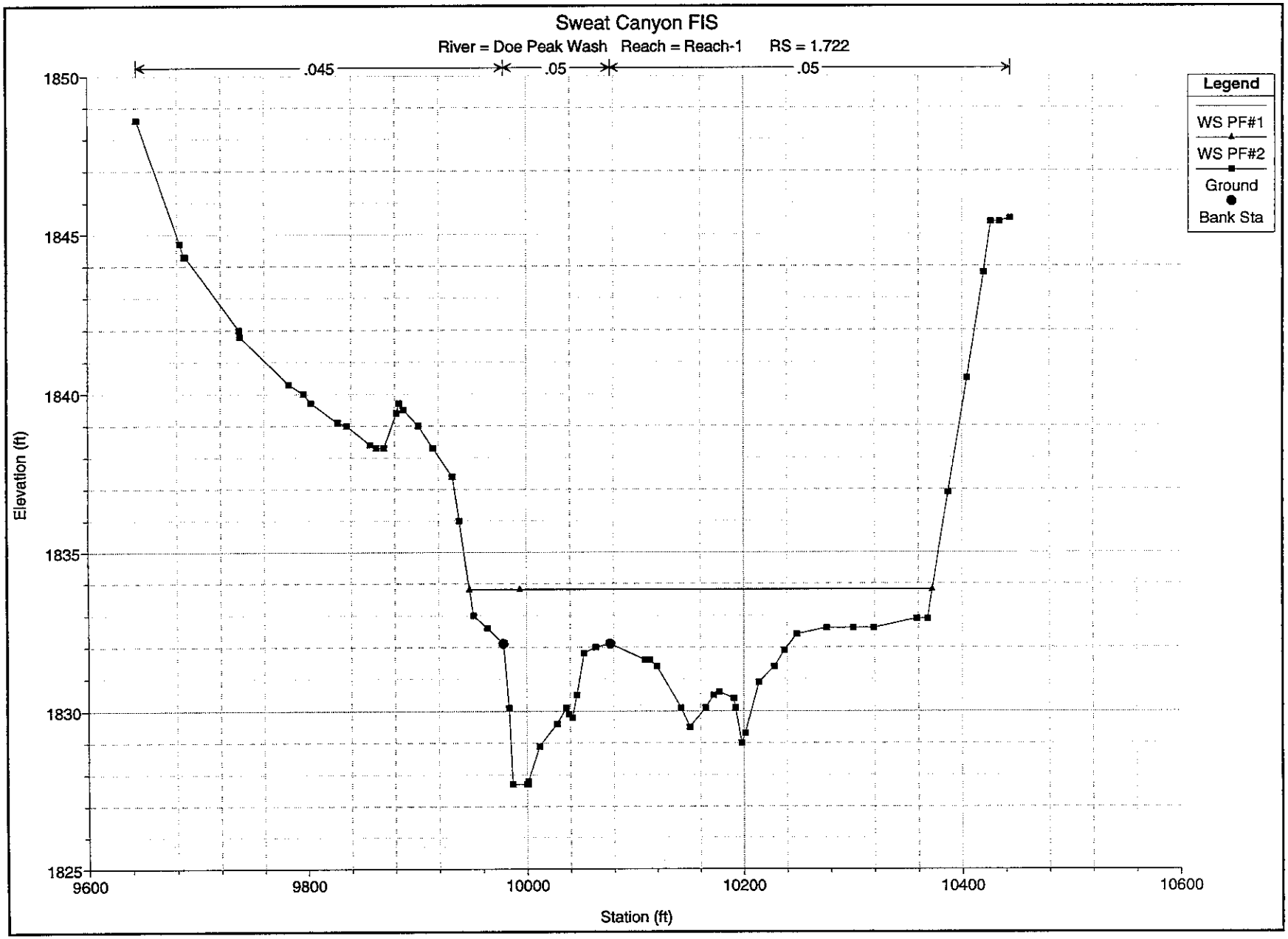

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.231
.06
.05
.06
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1840
1835
1830
1825
1820
1815
1810
1805
1800
9000
9200
9400
9600
9800
10000
10200
10400
10600
Station (ft)

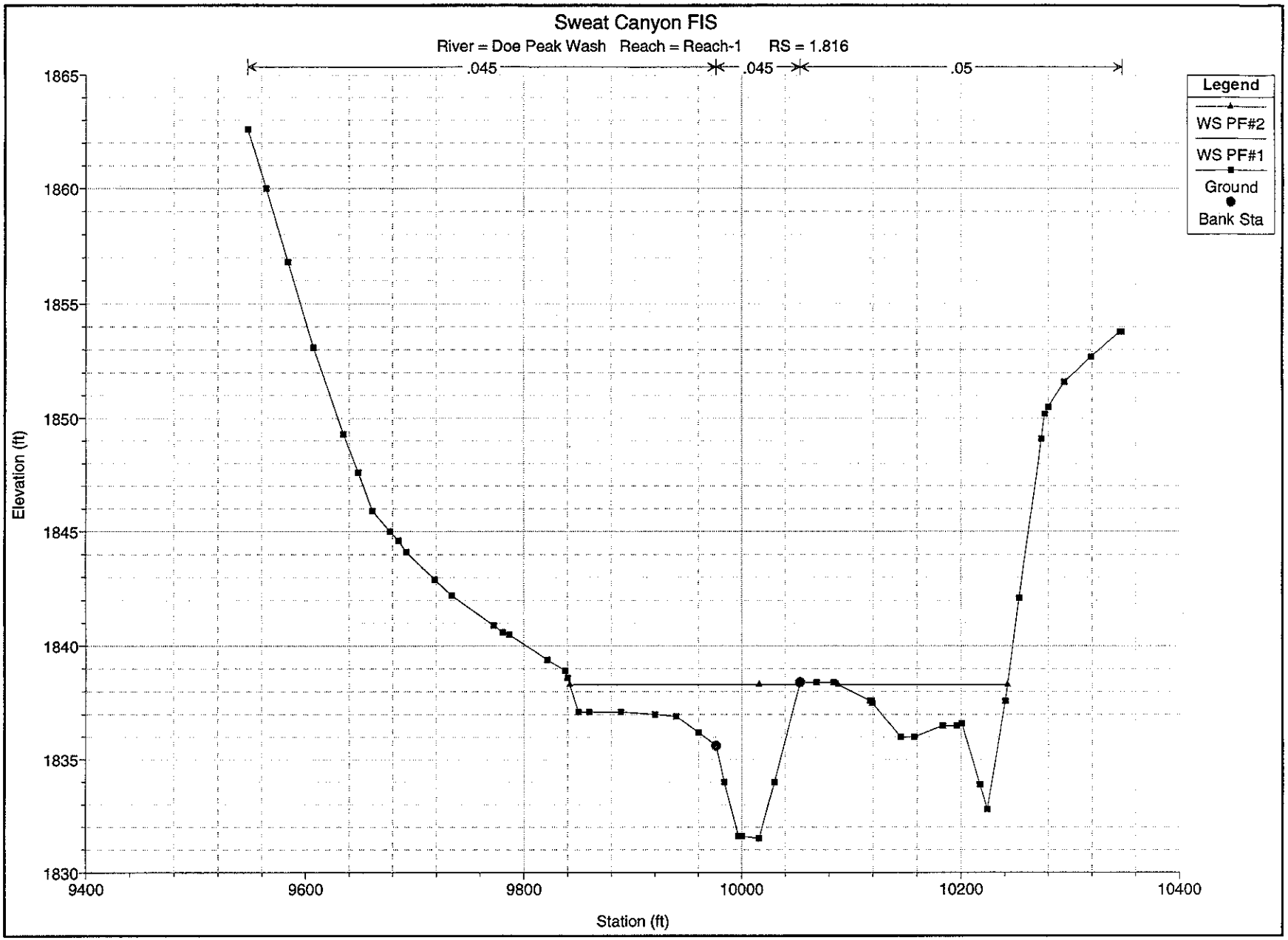

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.343
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Encroachment
Elevation (ft)
1822
1820
1818
1816
1814
1812
1810
1808
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

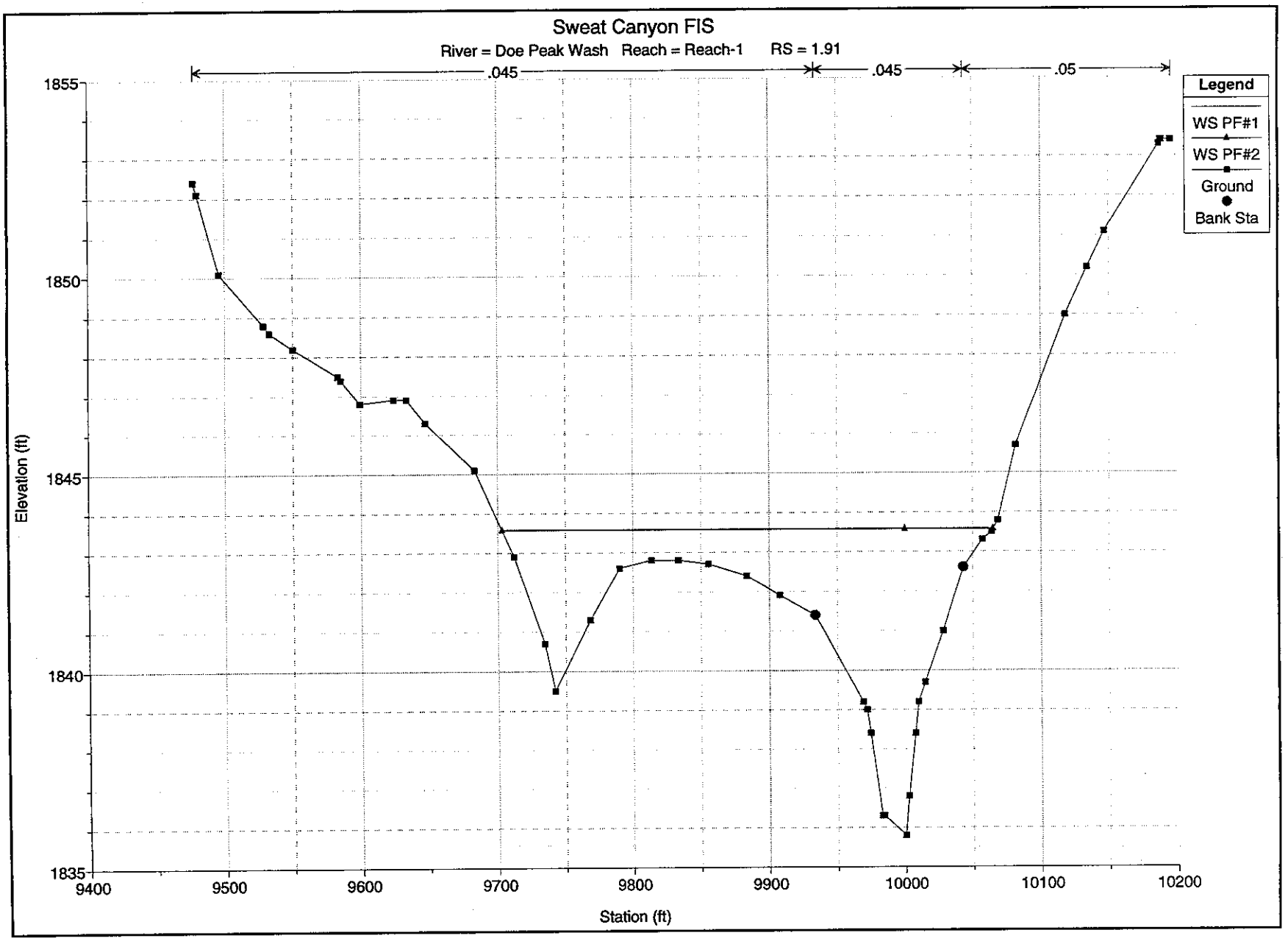

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.438
.05
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1860
1850
1840
1830
1820
1810
9400
9600
9800
10000
10200
10400
10600
Station (ft)

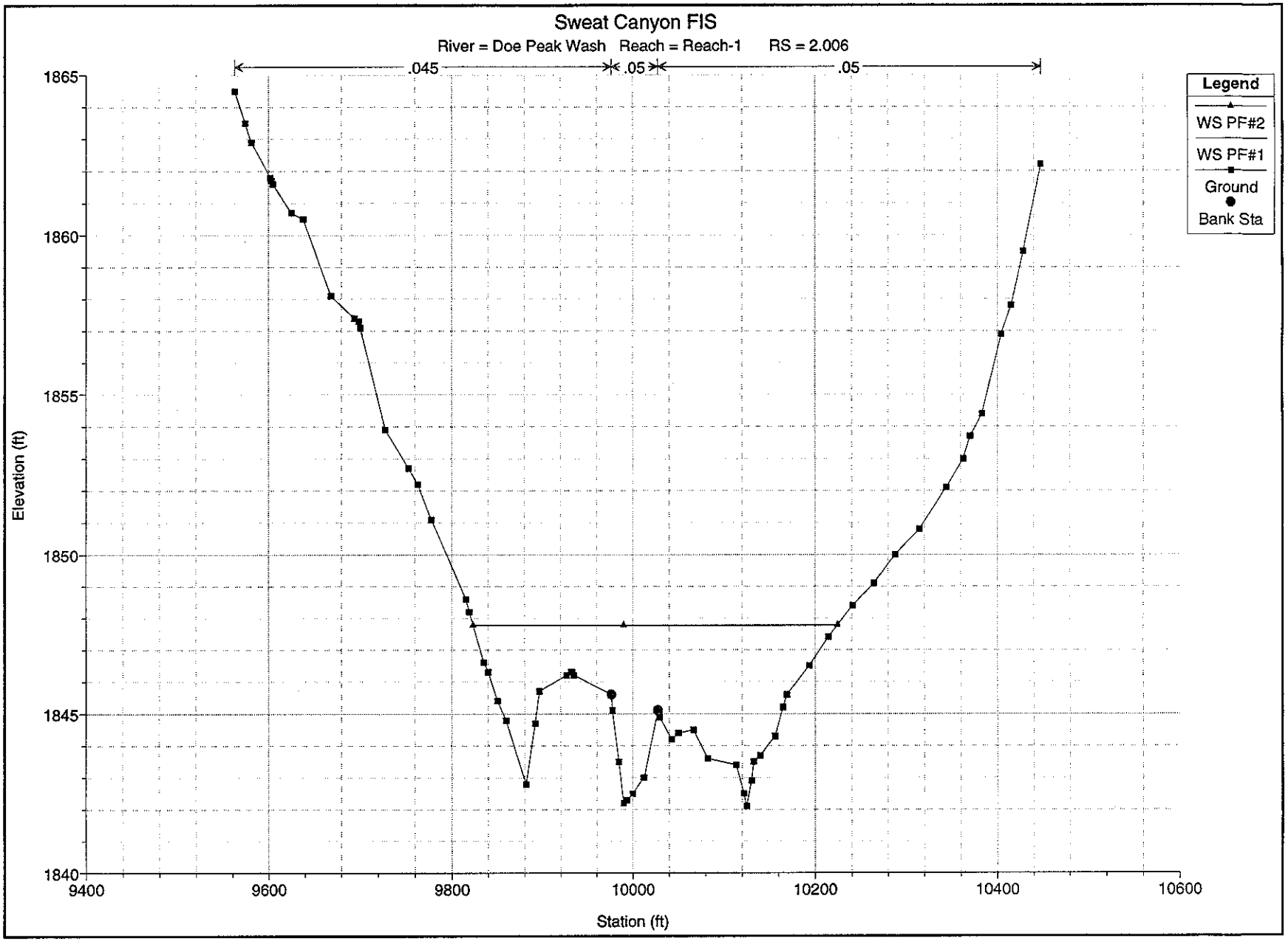

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.534
.045
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1860
1850
1840
1830
1820
1810
9200
9400
9600
9800
10000
10200
10400
Station (ft)

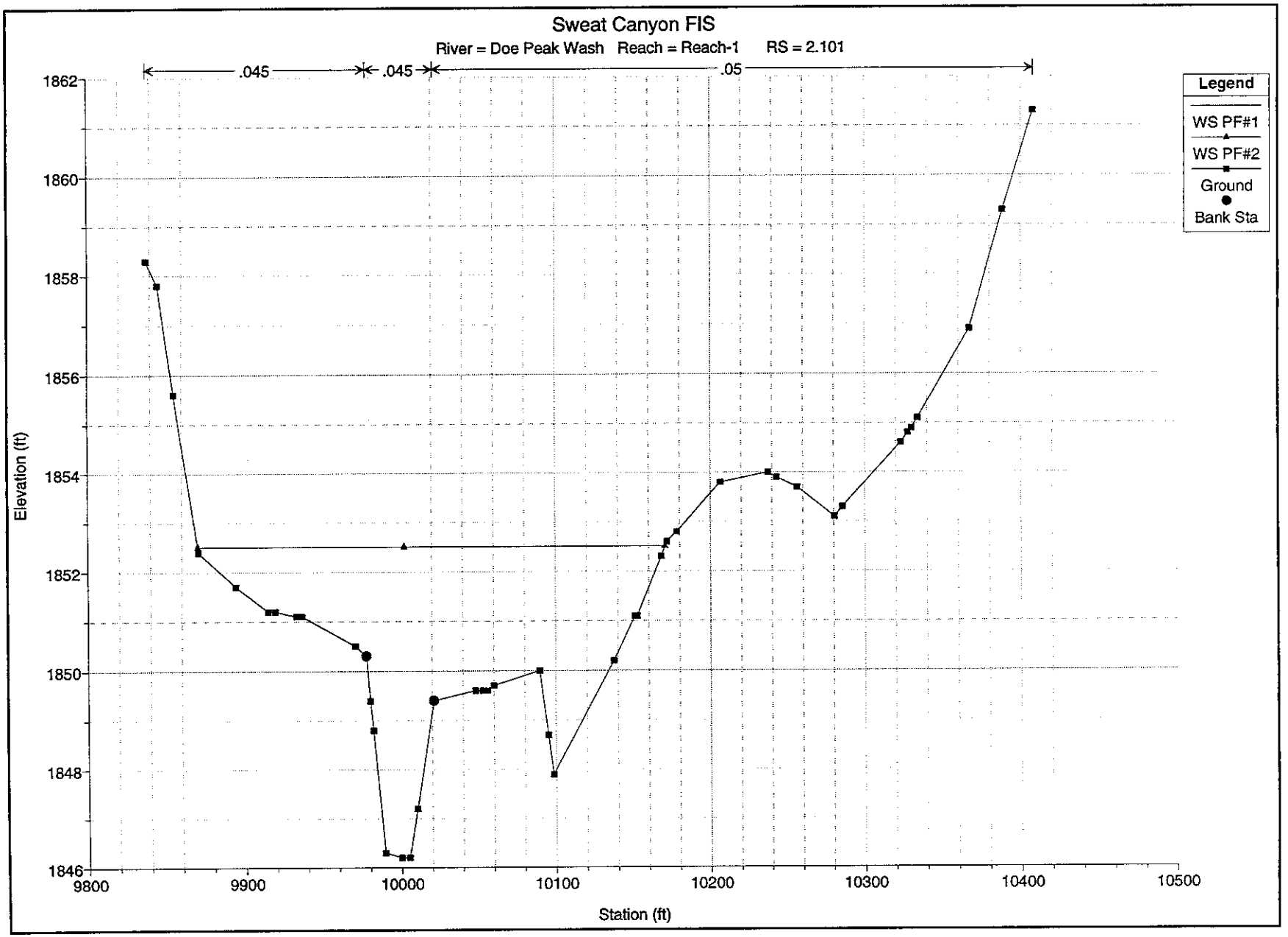

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.624
.045
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1855
1850
1845
1840
1835
1830
1825
1820
9200
9400
9600
9800
10000
10200
10400
Station (ft)

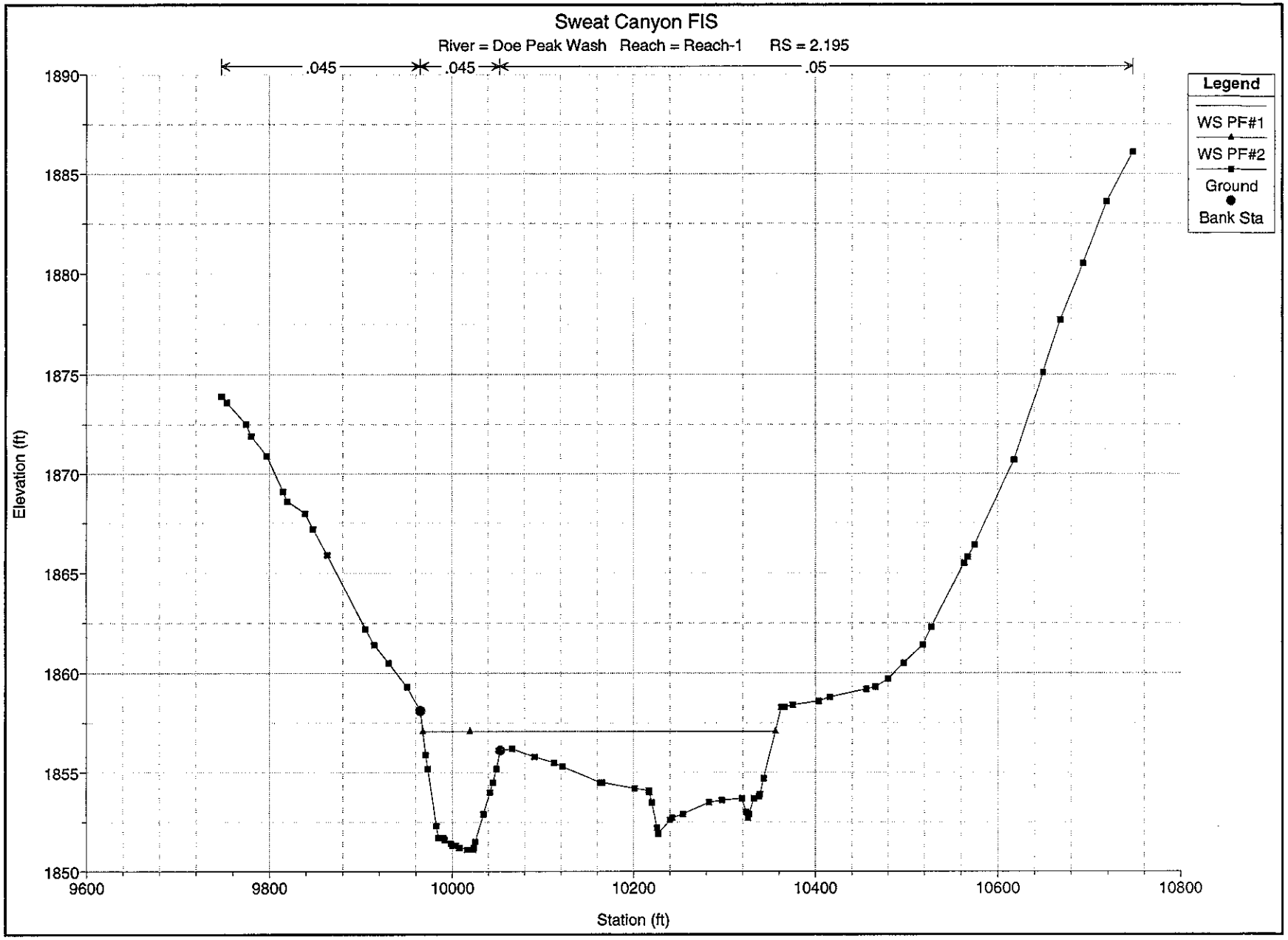

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.722
.045
.05
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1850
1845
1840
1835
1830
1825
9600
9800
10000
10200
10400
10600
Station (ft)

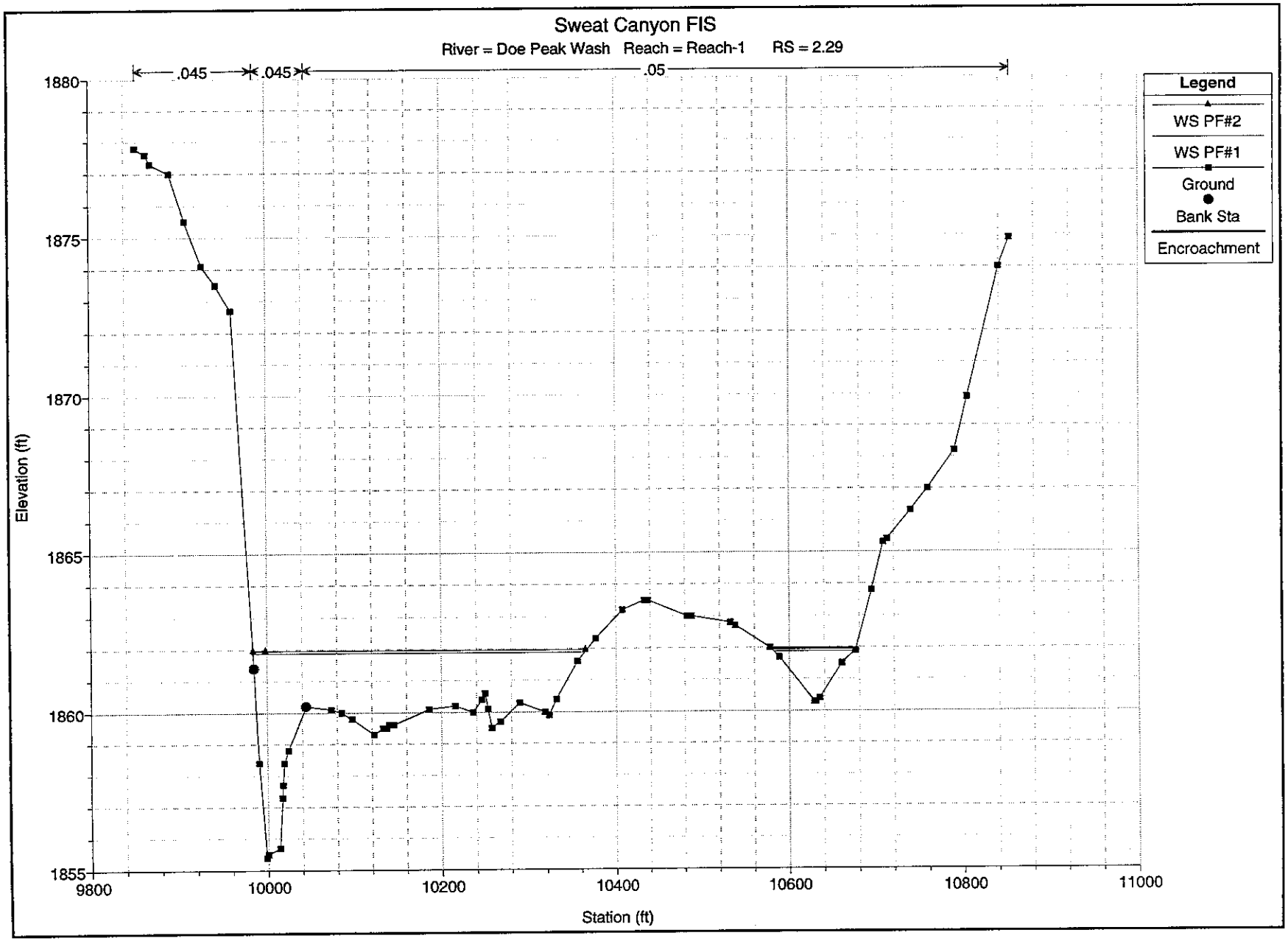

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.816
.045
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1865
1860
1855
1850
1845
1840
1835
1830
9400
9600
9800
10000
10200
10400
Station (ft)

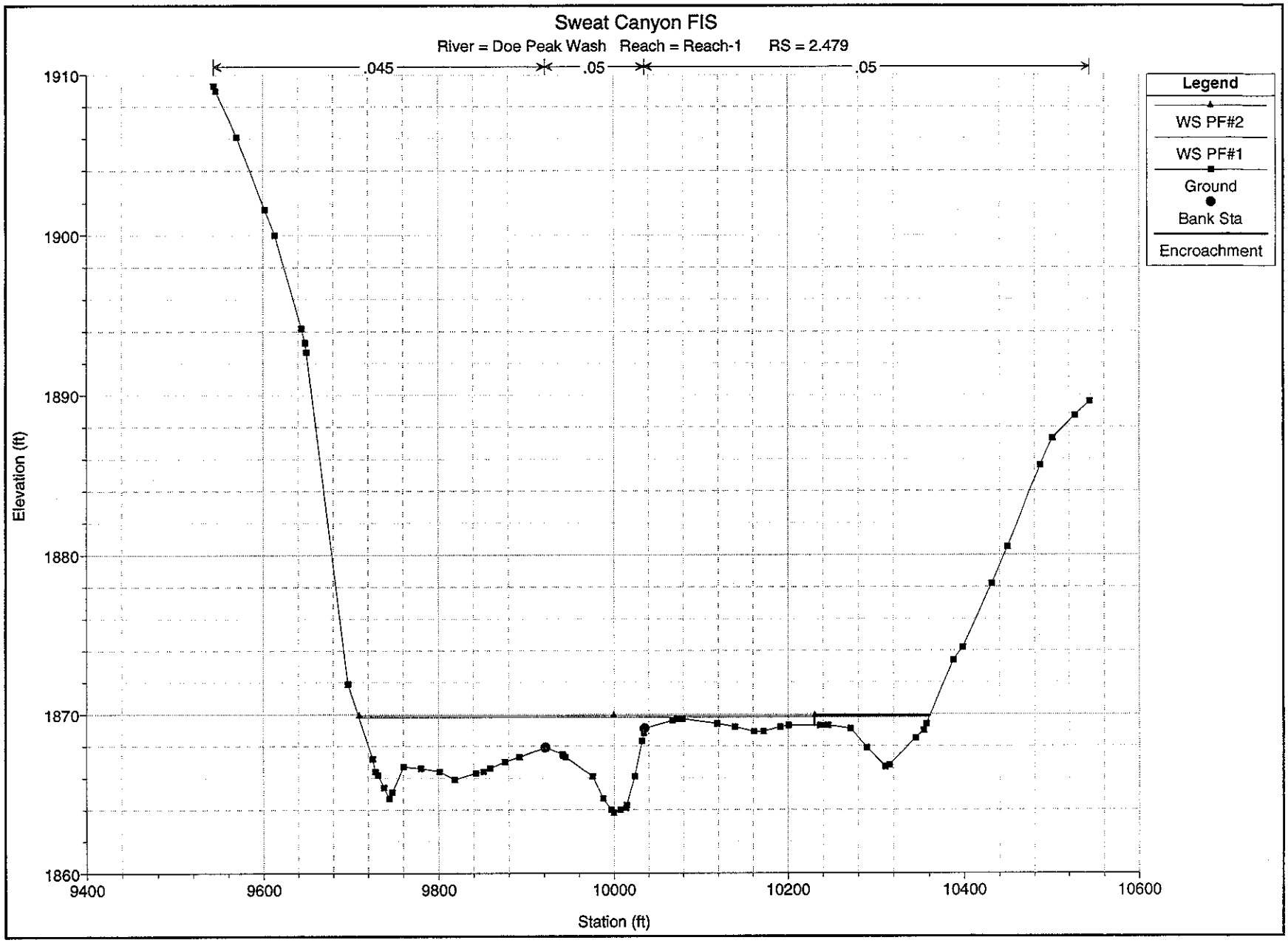

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 1.91
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1855
1850
1845
1840
1835
9400
9500
9600
9700
9800
9900
10000
10100
10200
Station (ft)

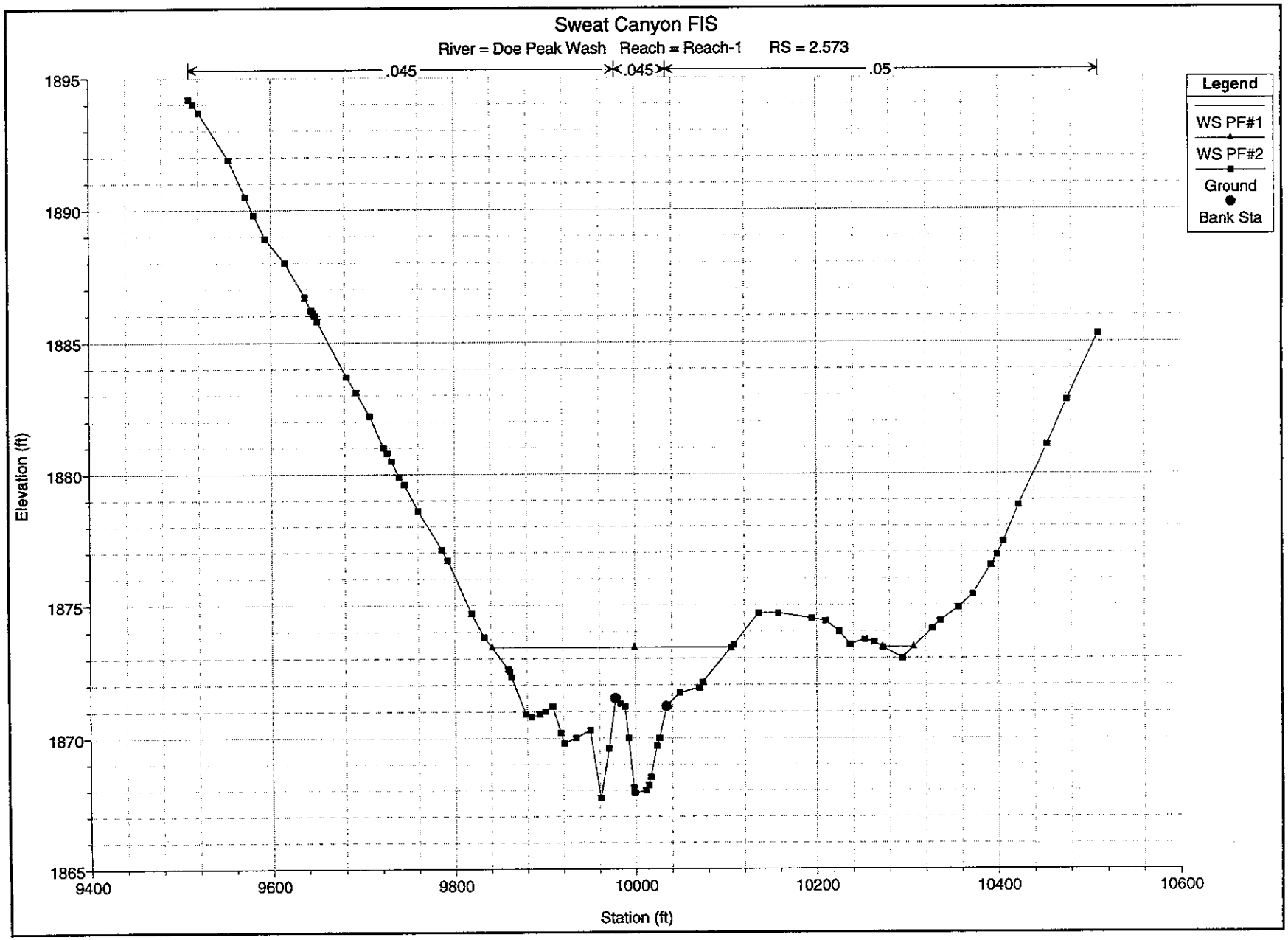

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.006
.045
.05
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1865
1860
1855
1850
1845
1840
9400
9600
9800
10000
10200
10400
10600
Station (ft)

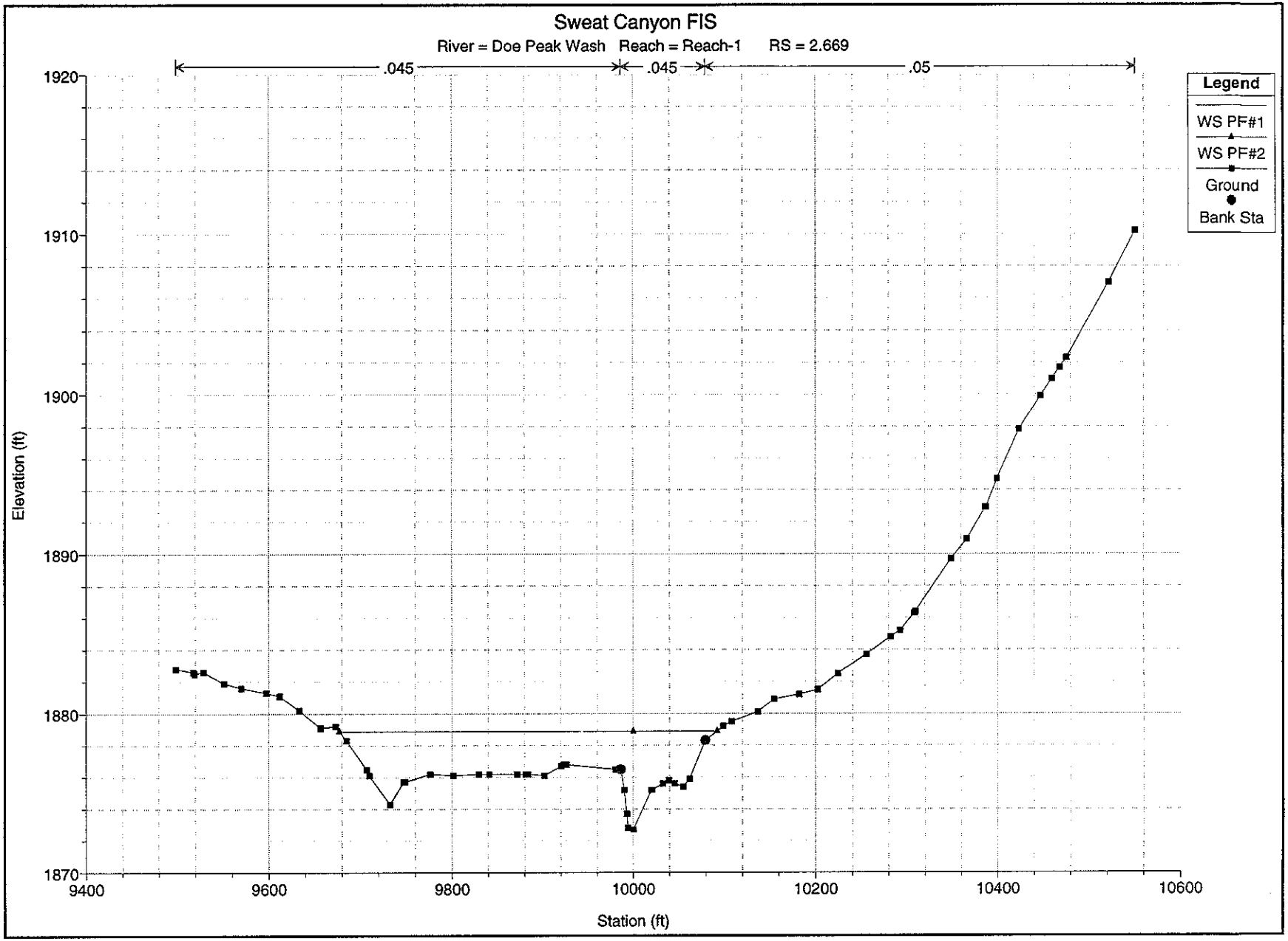

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.101
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1862
1860
1858
1856
1854
1852
1850
1848
1846
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

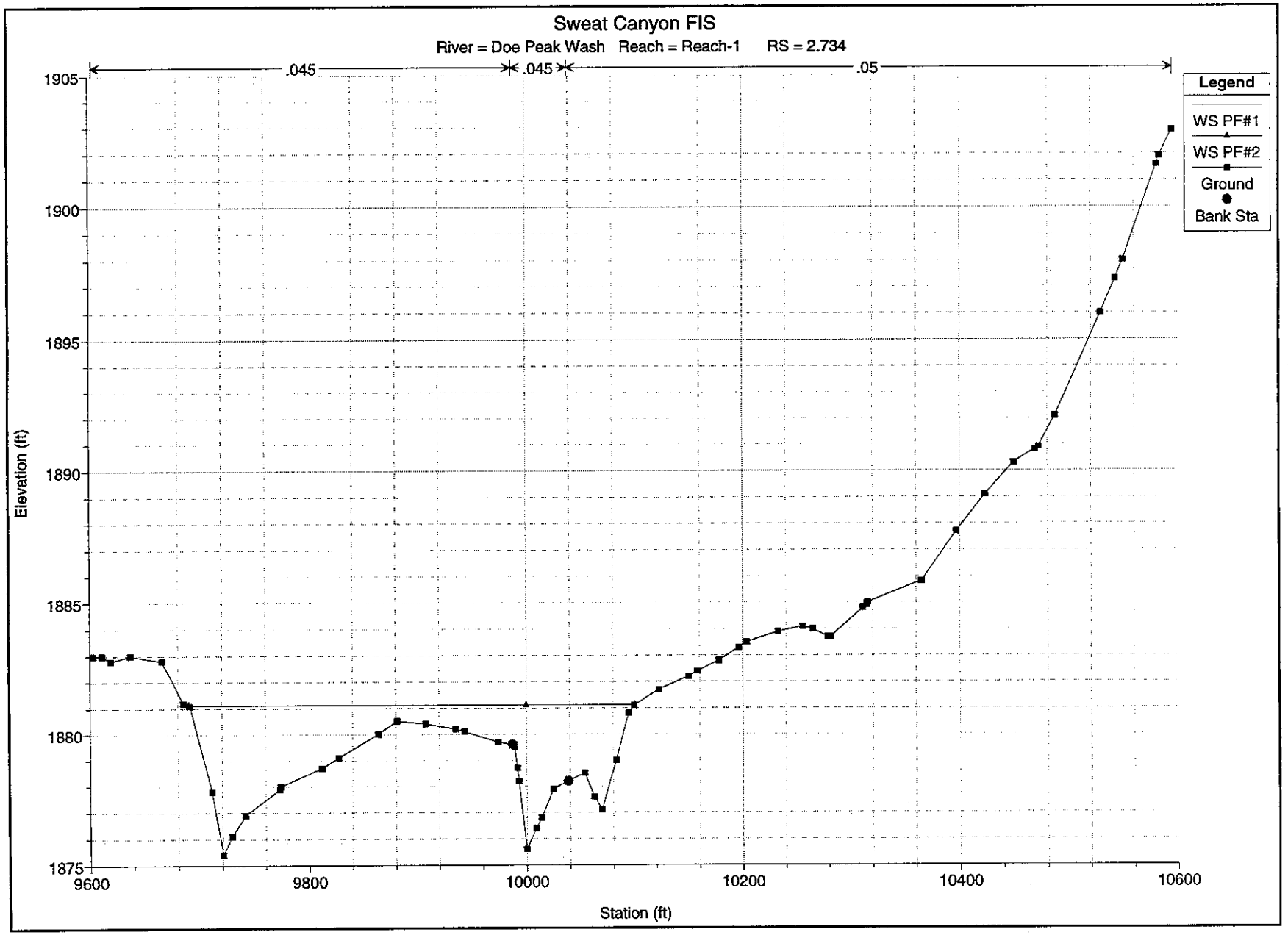

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.195
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1890
1885
1880
1875
1870
1865
1860
1855
1850
9600
9800
10000
10200
10400
10600
10800
Station (ft)

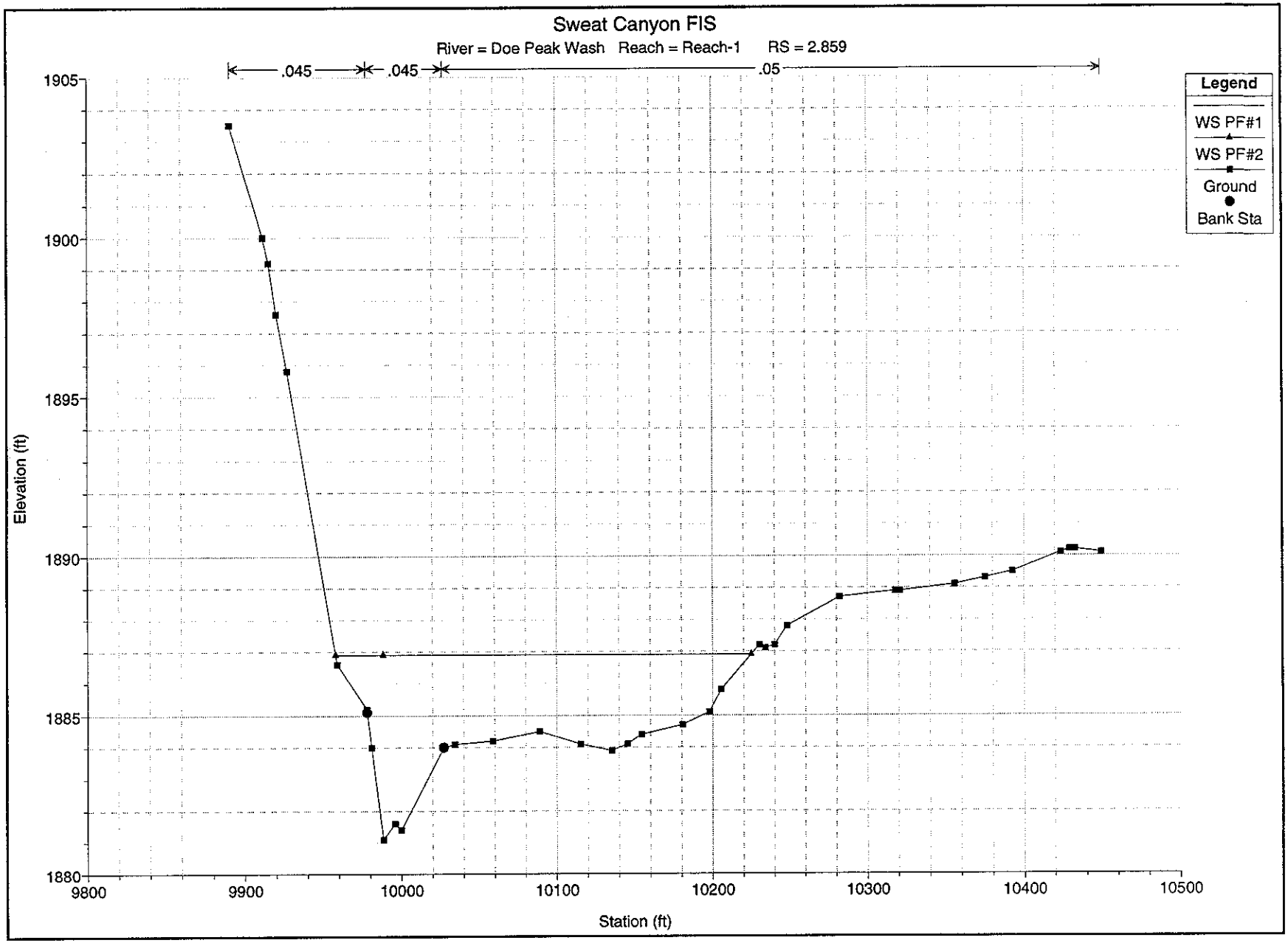

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.29
.045
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1880
1875
1870
1865
1860
1855
9800
10000
10200
10400
10600
10800
11000
Station (ft)

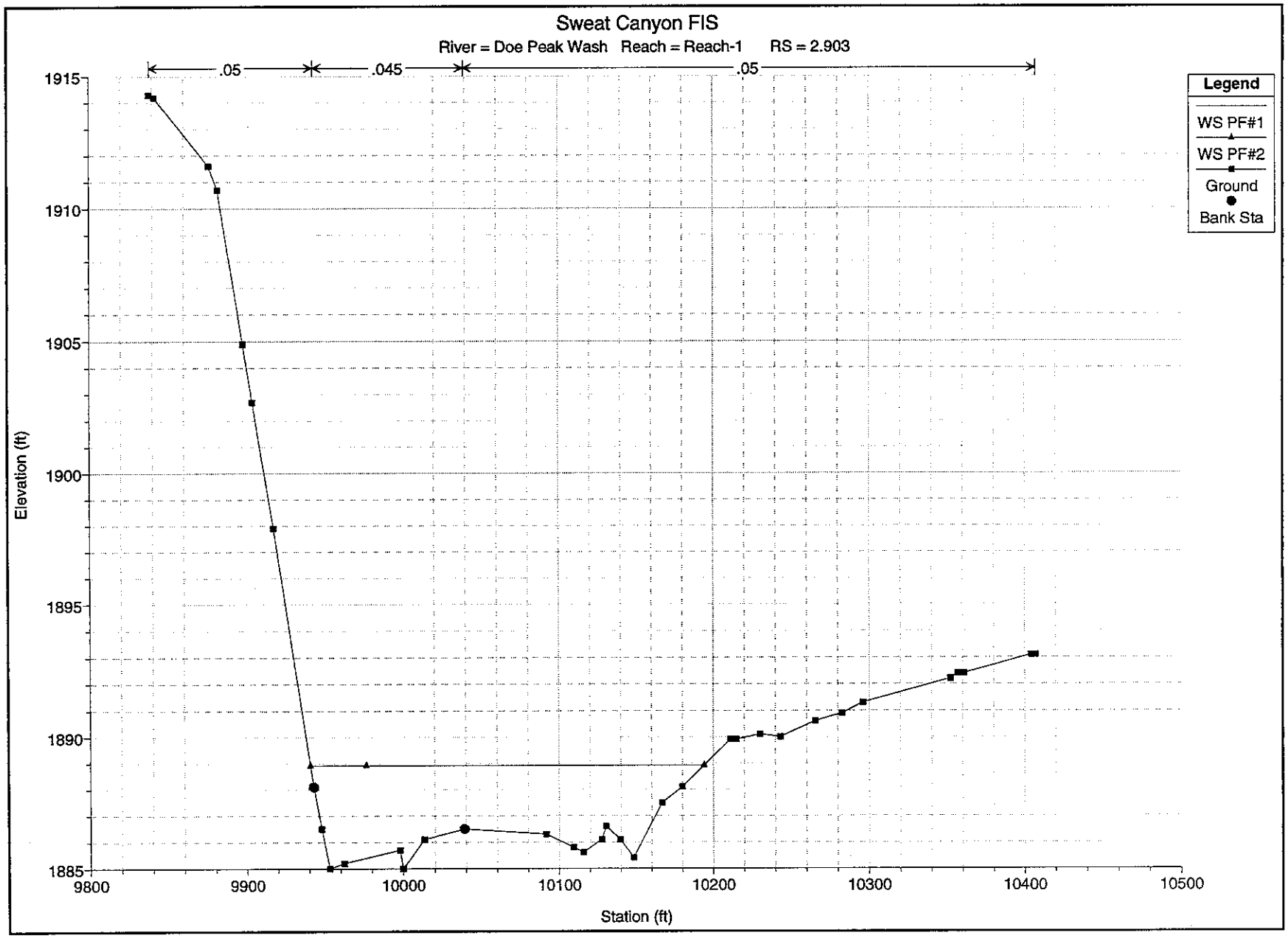

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.479
.045
.05
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1910
1900
1890
1880
1870
1860
9400
9600
9800
10000
10200
10400
10600
Station (ft)

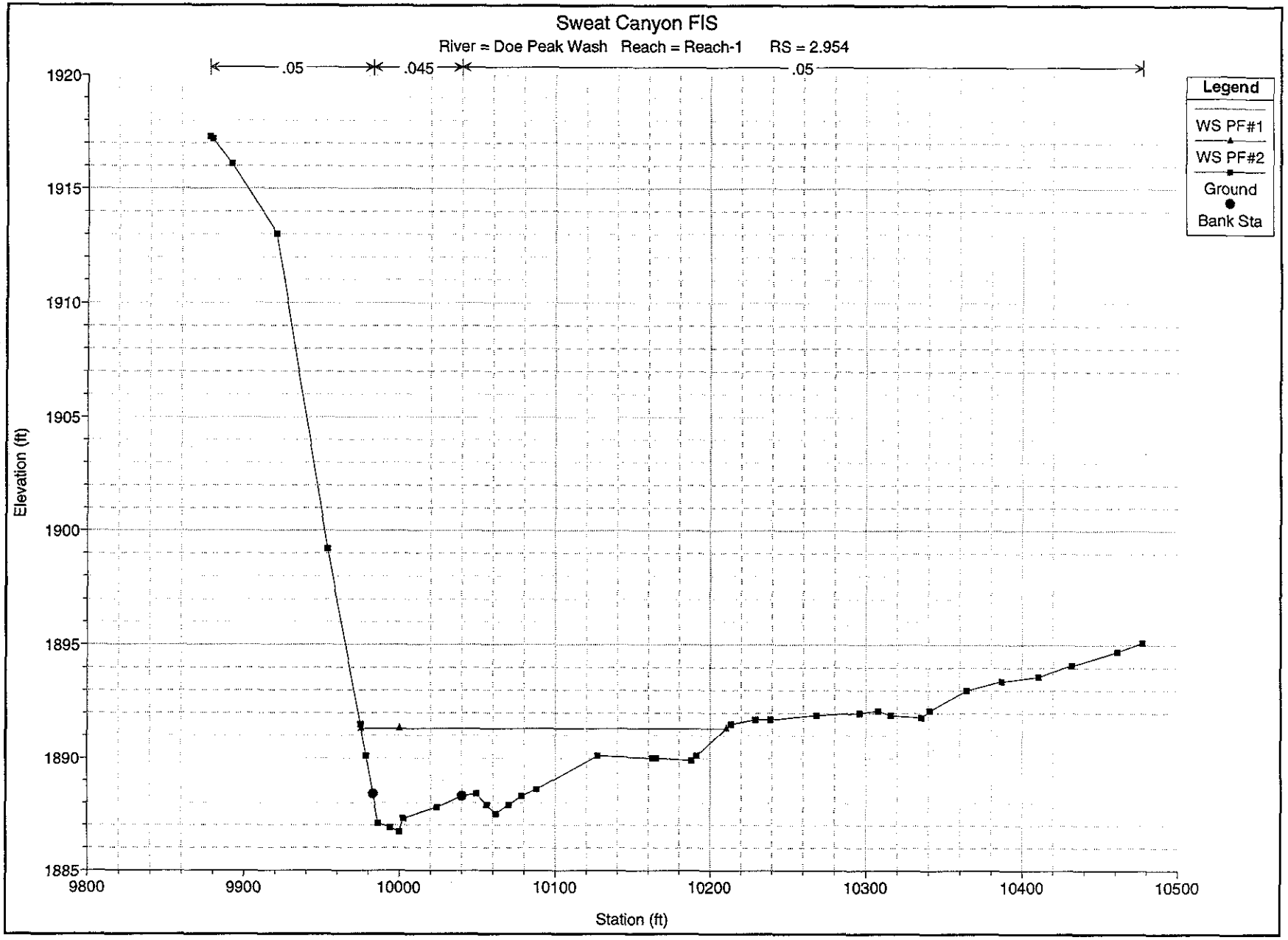

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.573
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1895
1890
1885
1880
1875
1870
1865
9400
9600
9800
10000
10200
10400
10600
Station (ft)

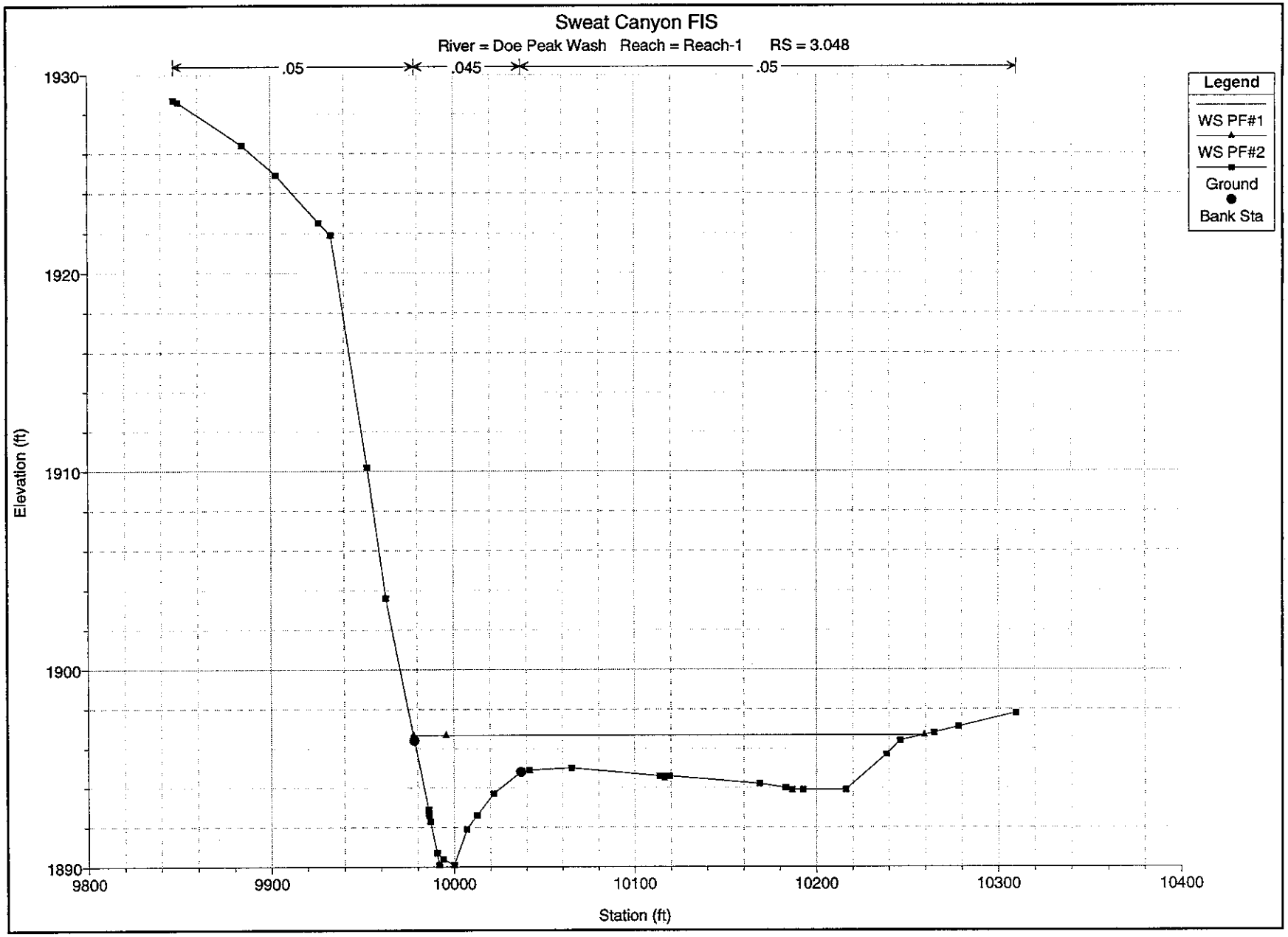

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.669
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1920
1910
1900
1890
1880
1870
9400
9600
9800
10000
10200
10400
10600
Station (ft)

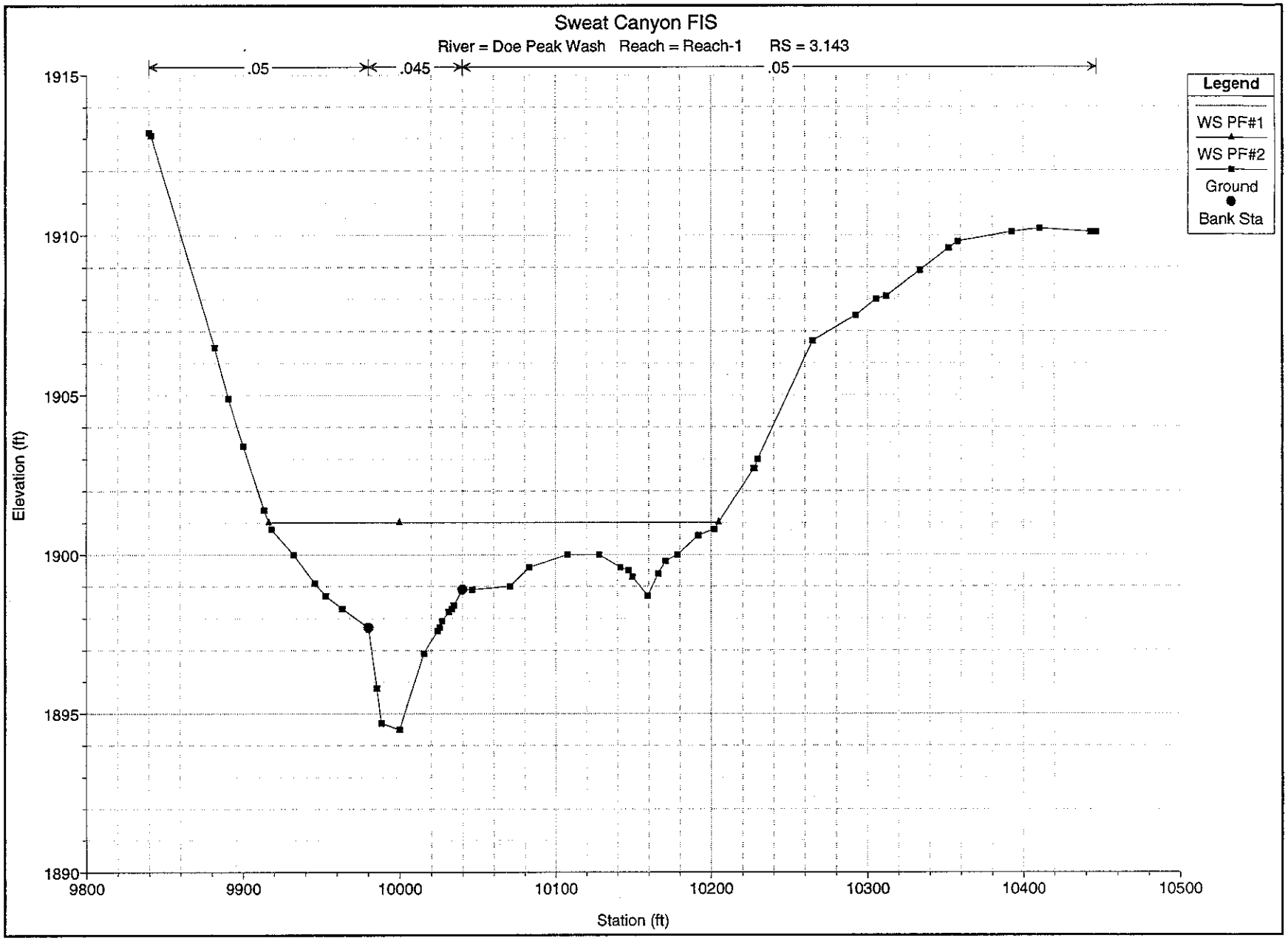

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.734
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1905
1900
1895
1890
1885
1880
1875
9600
9800
10000
10200
10400
10600
Station (ft)

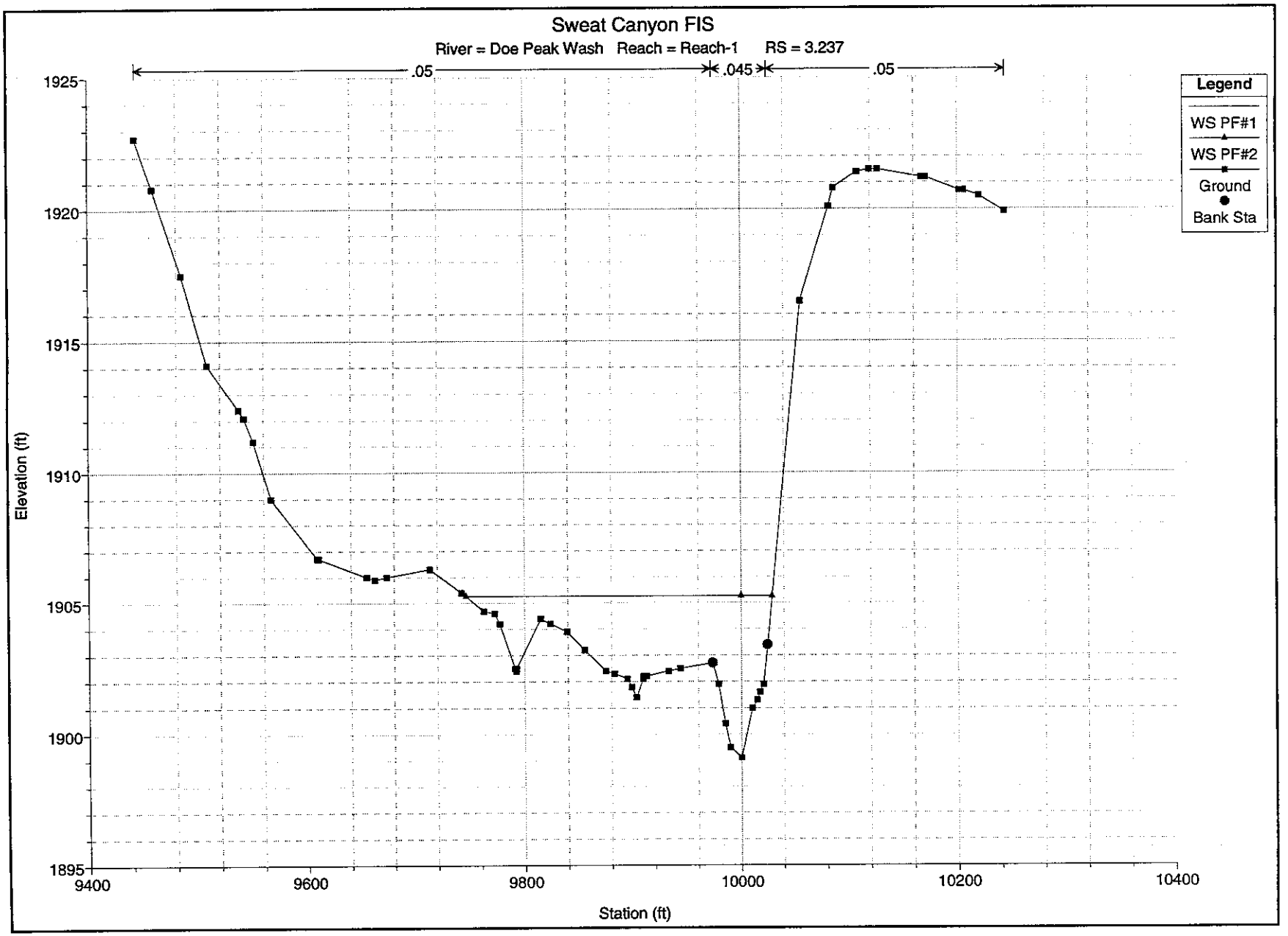

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.859
.045
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1905
1900
1895
1890
1885
1880
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

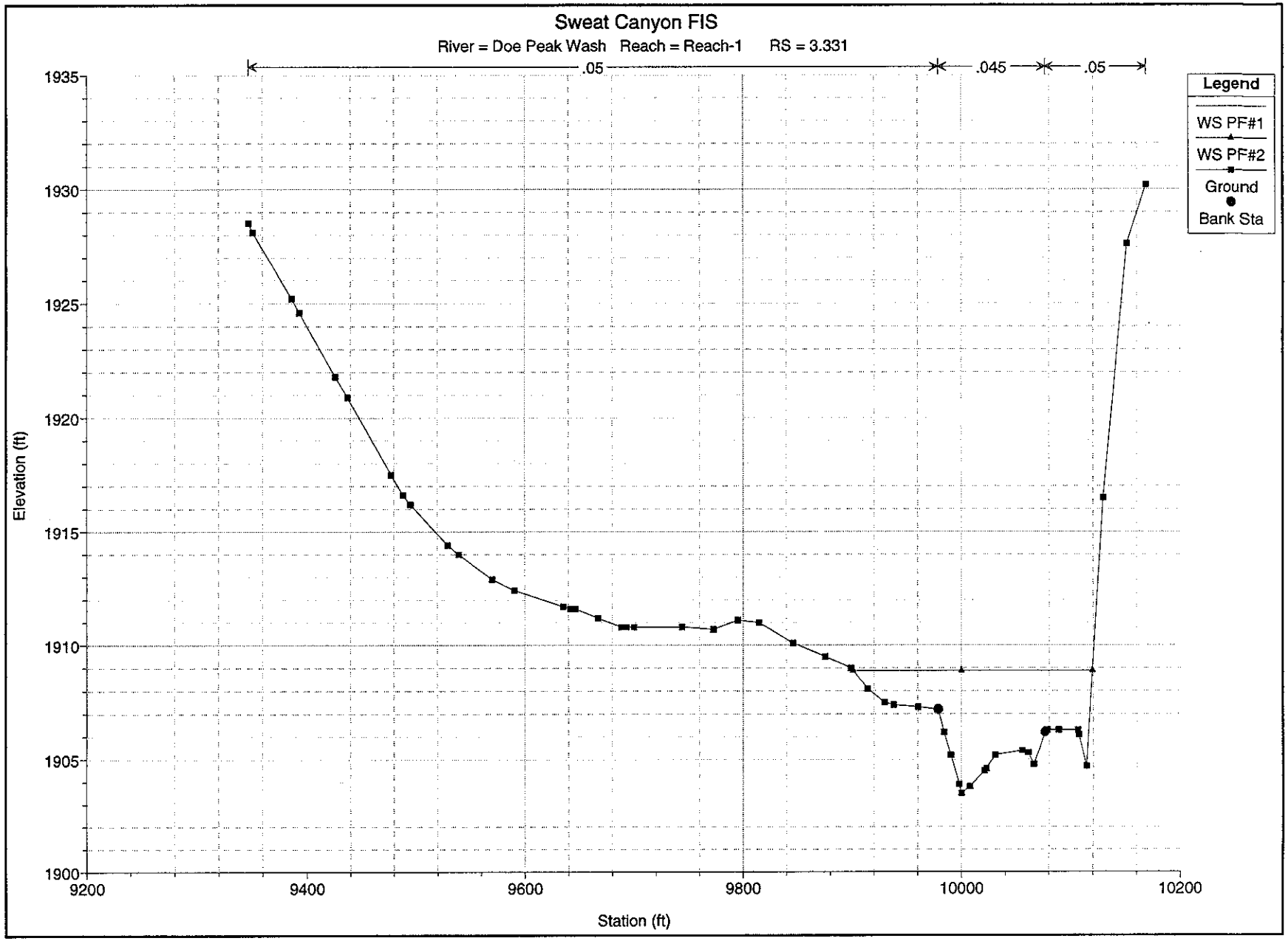

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.903
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1915
1910
1905
1900
1895
1890
1885
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

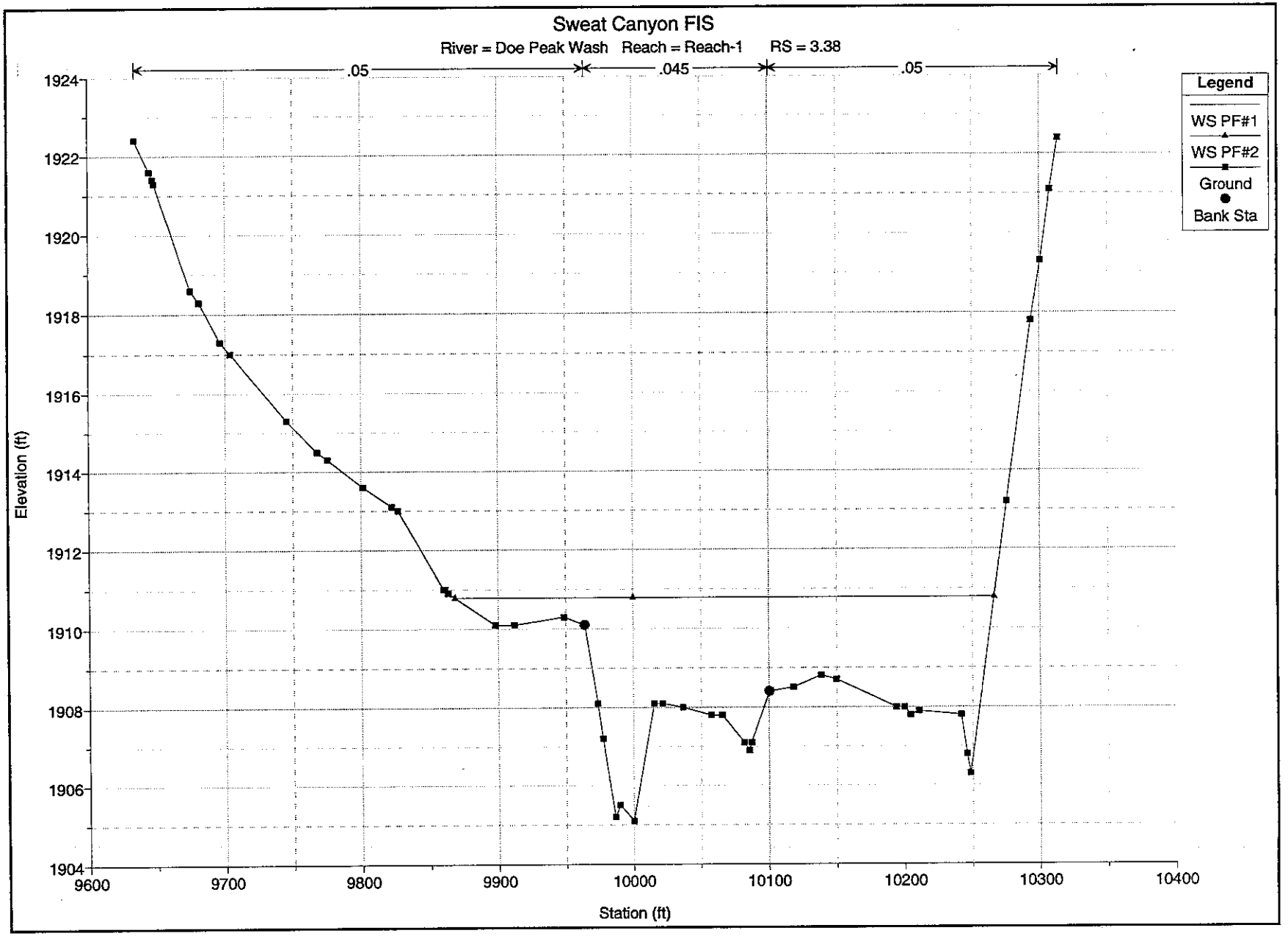

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 2.954
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1920
1915
1910
1905
1900
1895
1890
1885
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

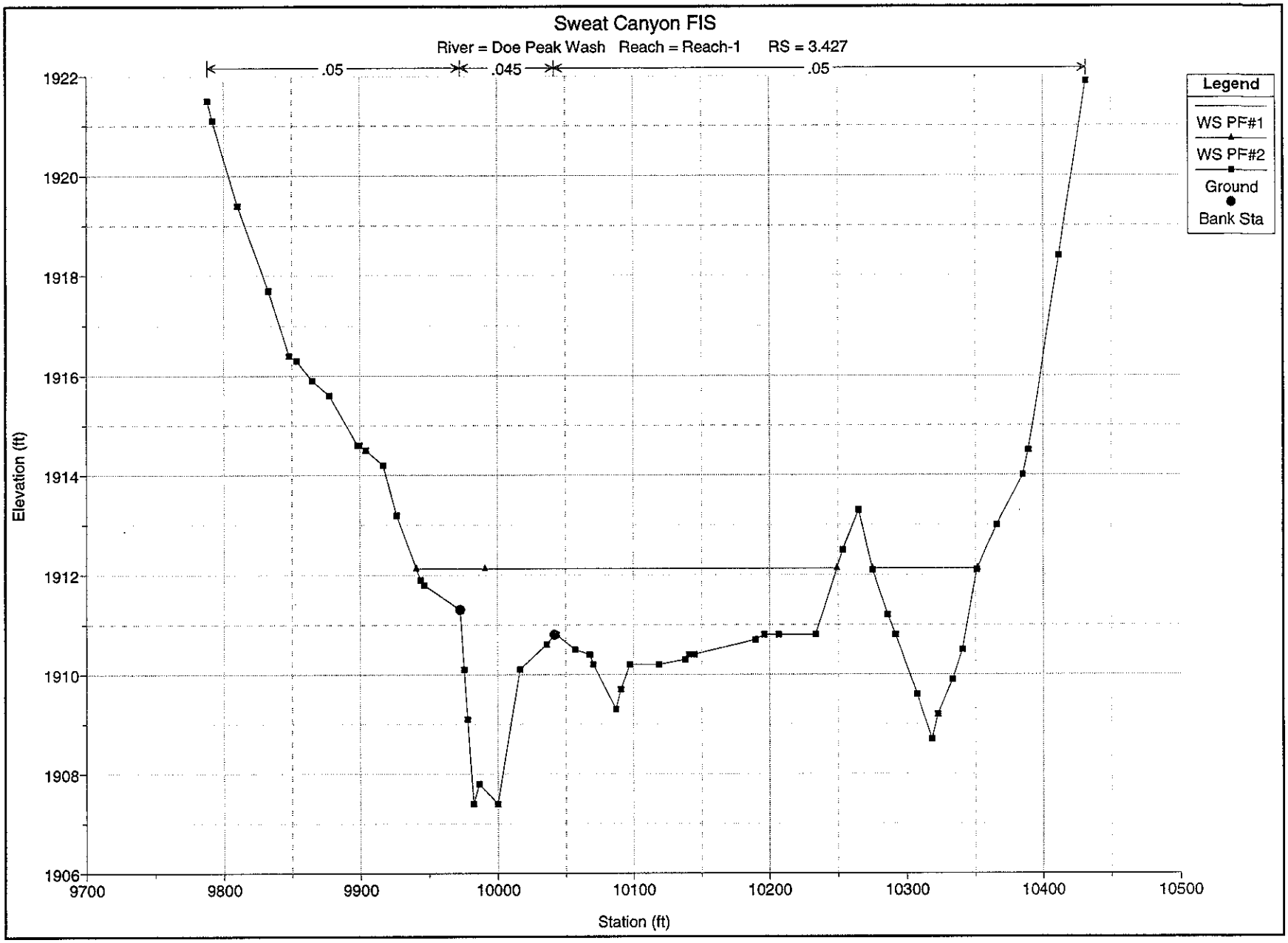

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.048
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1930
1920
1910
1900
1890
9800
9900
10000
10100
10200
10300
10400
Station (ft)

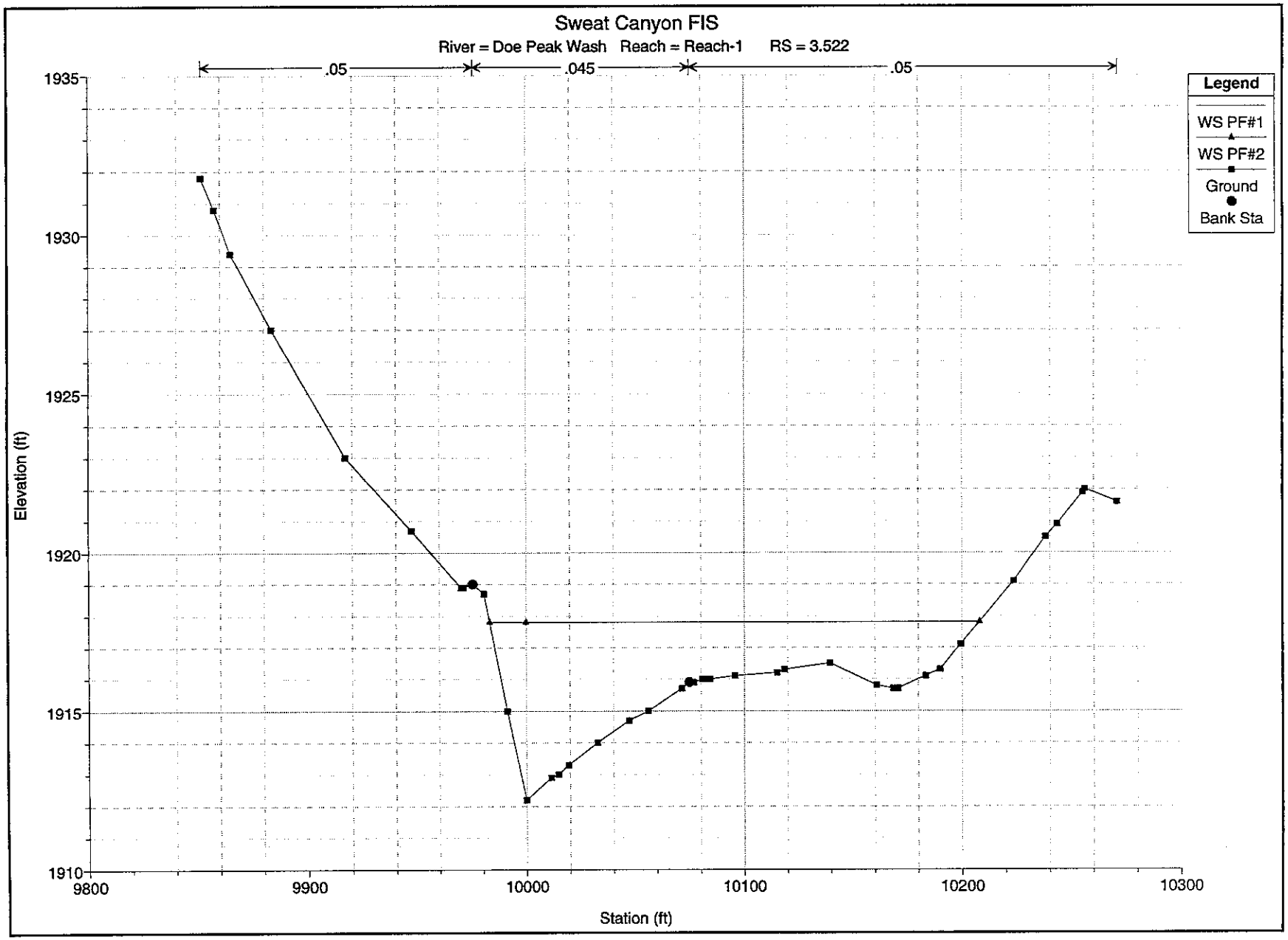

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.143
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1915
1910
1905
1900
1895
1890
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

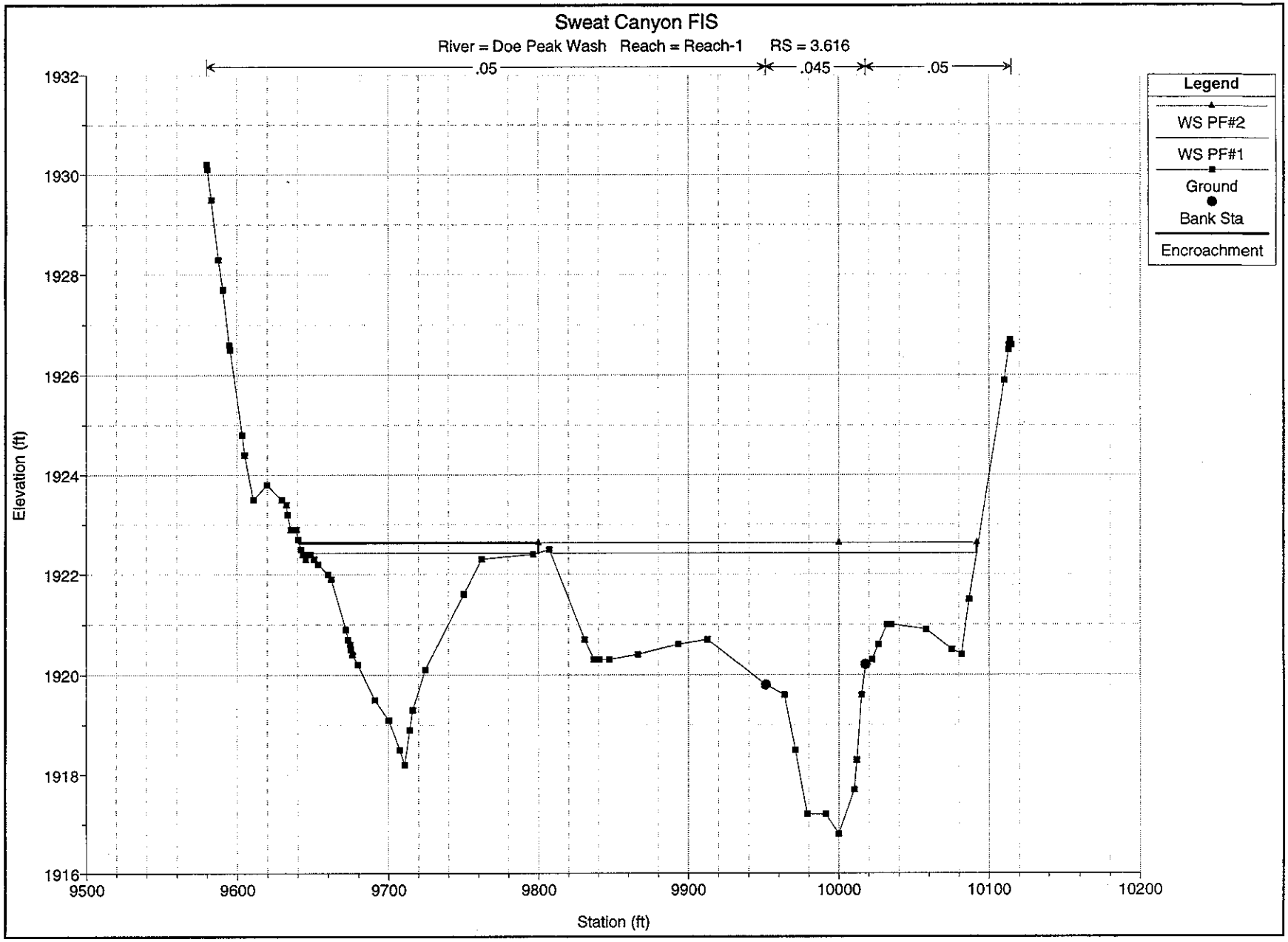

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.237
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1925
1920
1915
1910
1905
1900
1895
9400
9600
9800
10000
10200
10400
Station (ft)

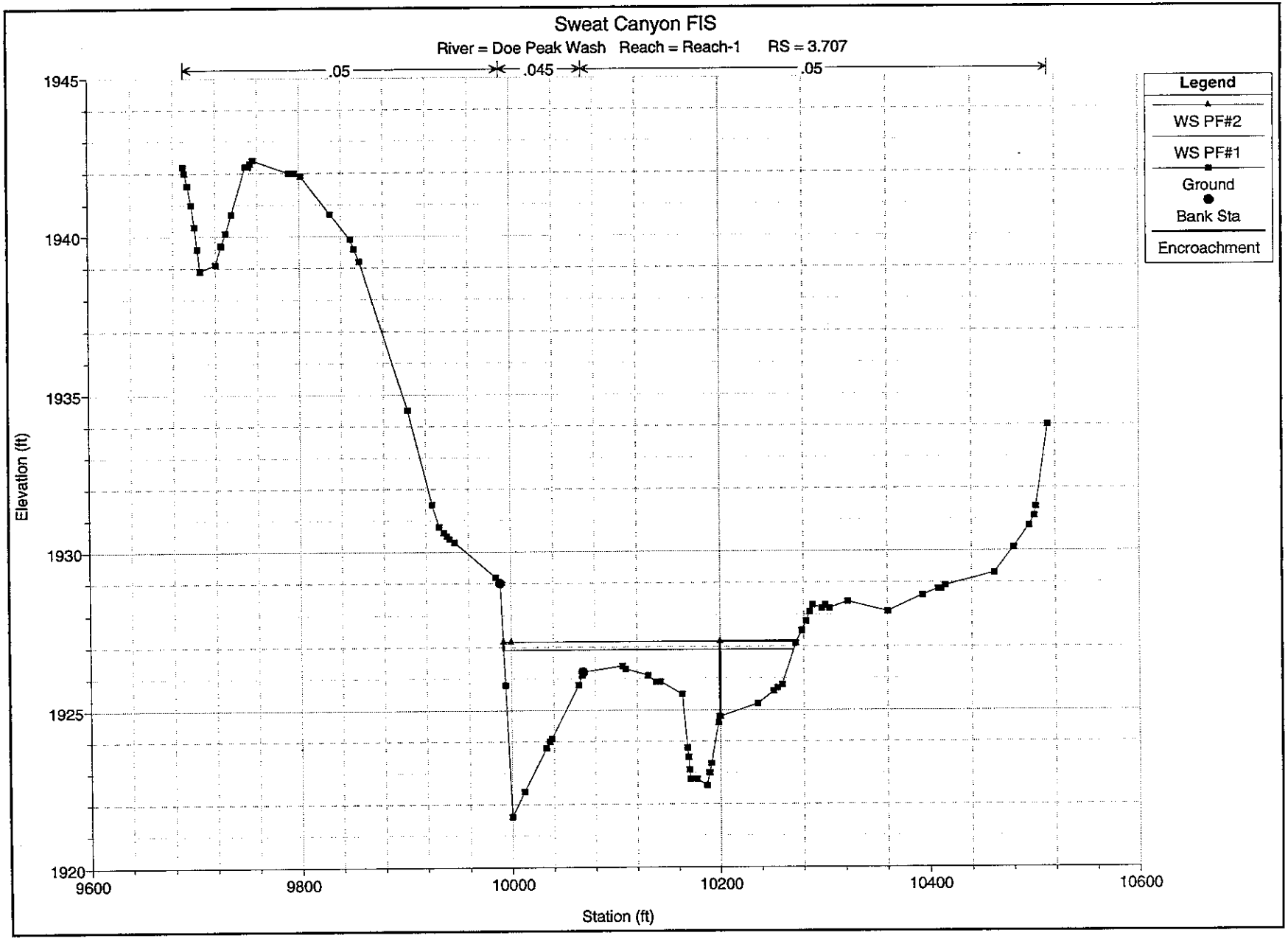

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.331
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1935
1930
1925
1920
1915
1910
1905
1900
9200
9400
9600
9800
10000
10200
Station (ft)

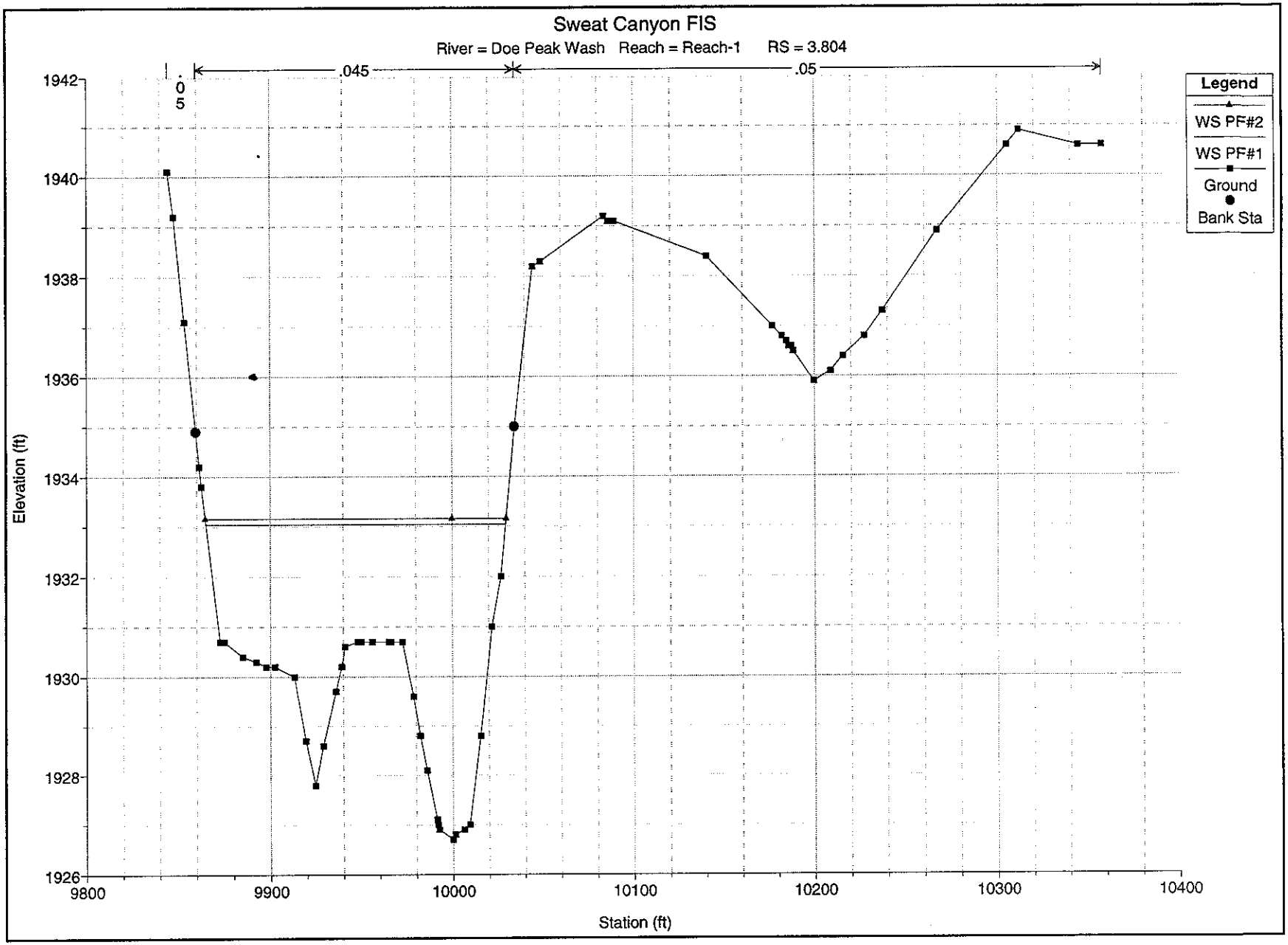

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.38
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1924
1922
1920
1918
1916
1914
1912
1910
1908
1906
1904
9600
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

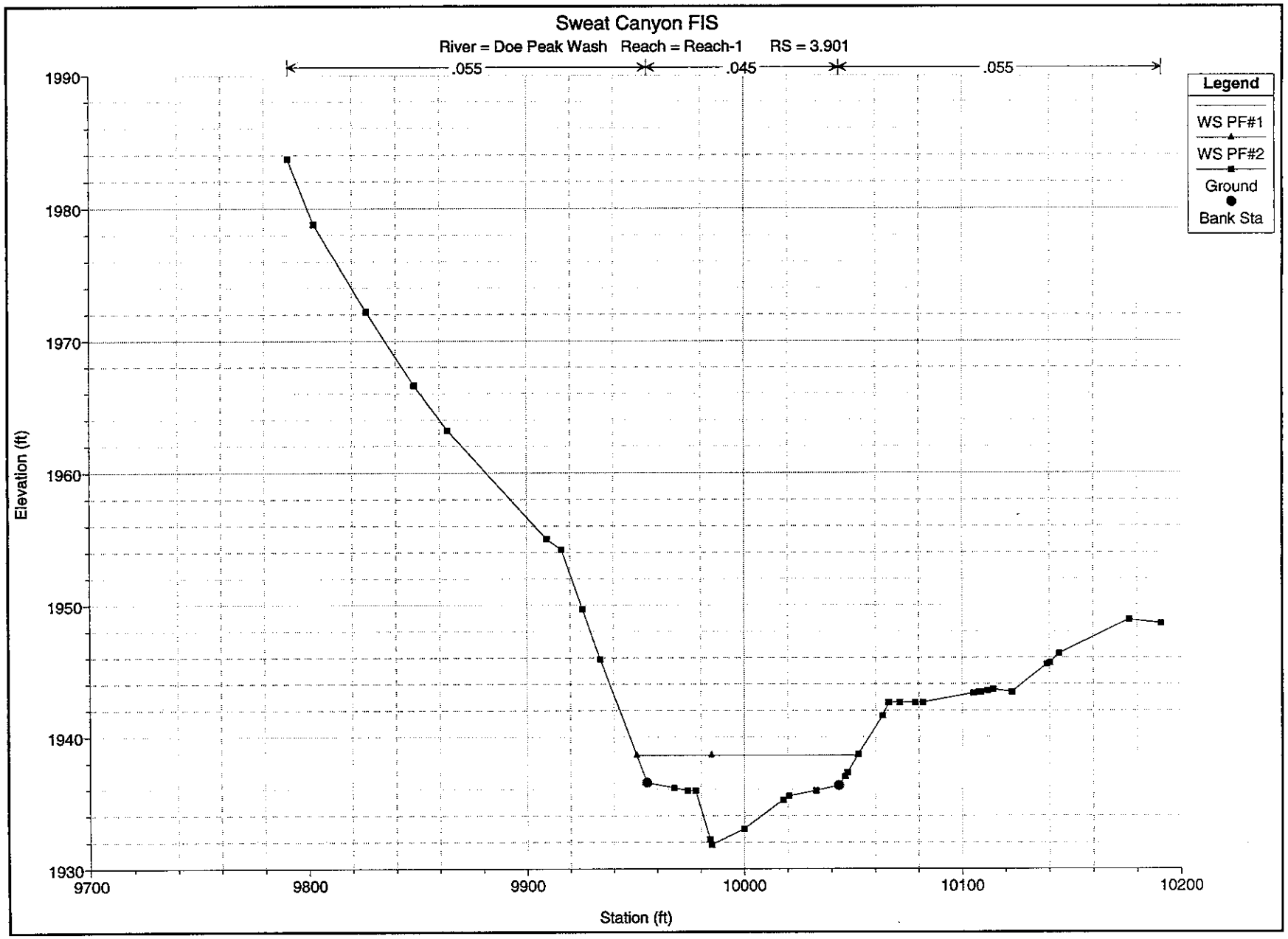

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.427
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1922
1920
1918
1916
1914
1912
1910
1908
1906
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

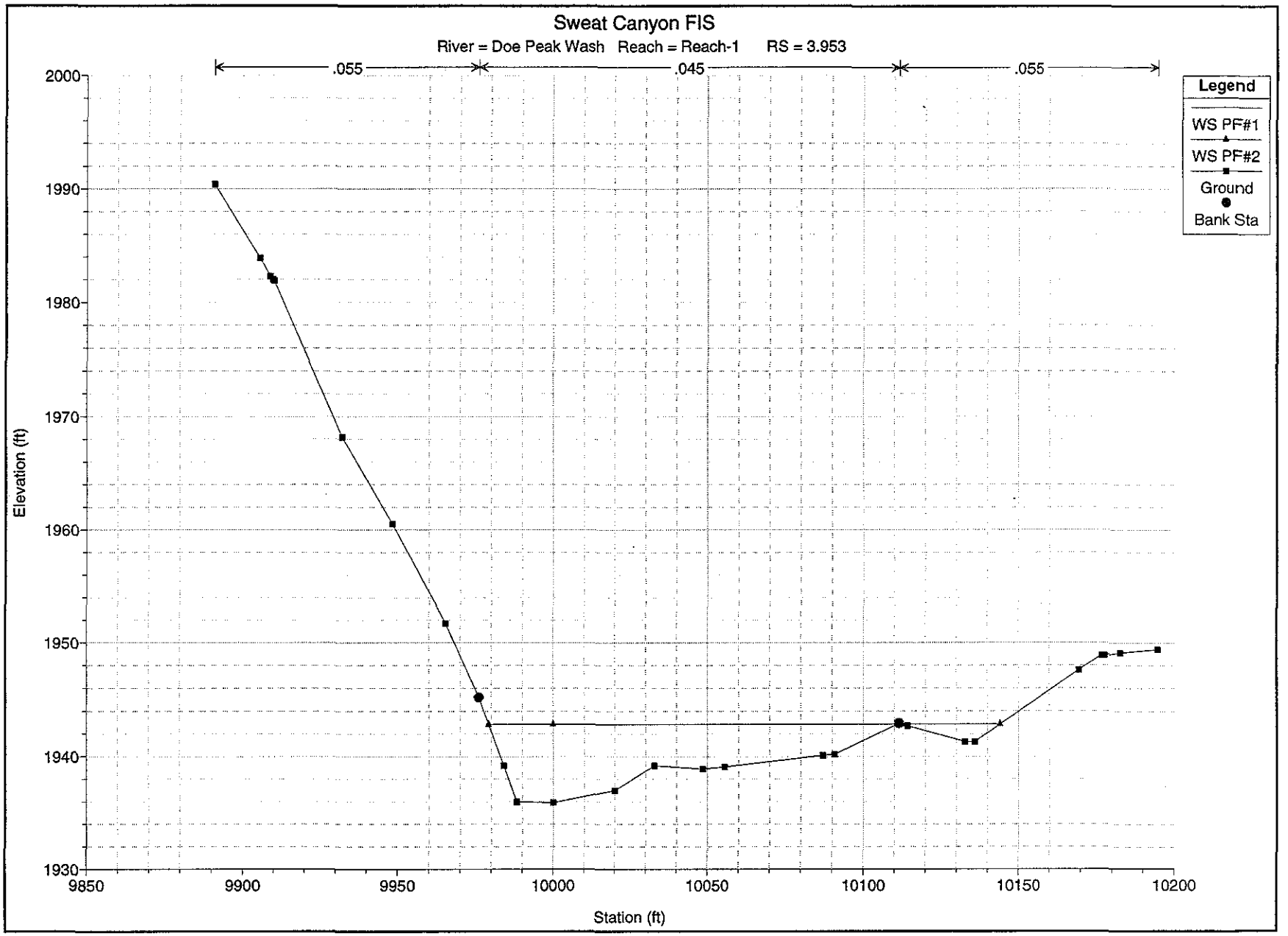

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.522
.05
.045
.05
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1935
1930
1925
1920
1915
1910
9800
9900
10000
10100
10200
10300
Station (ft)

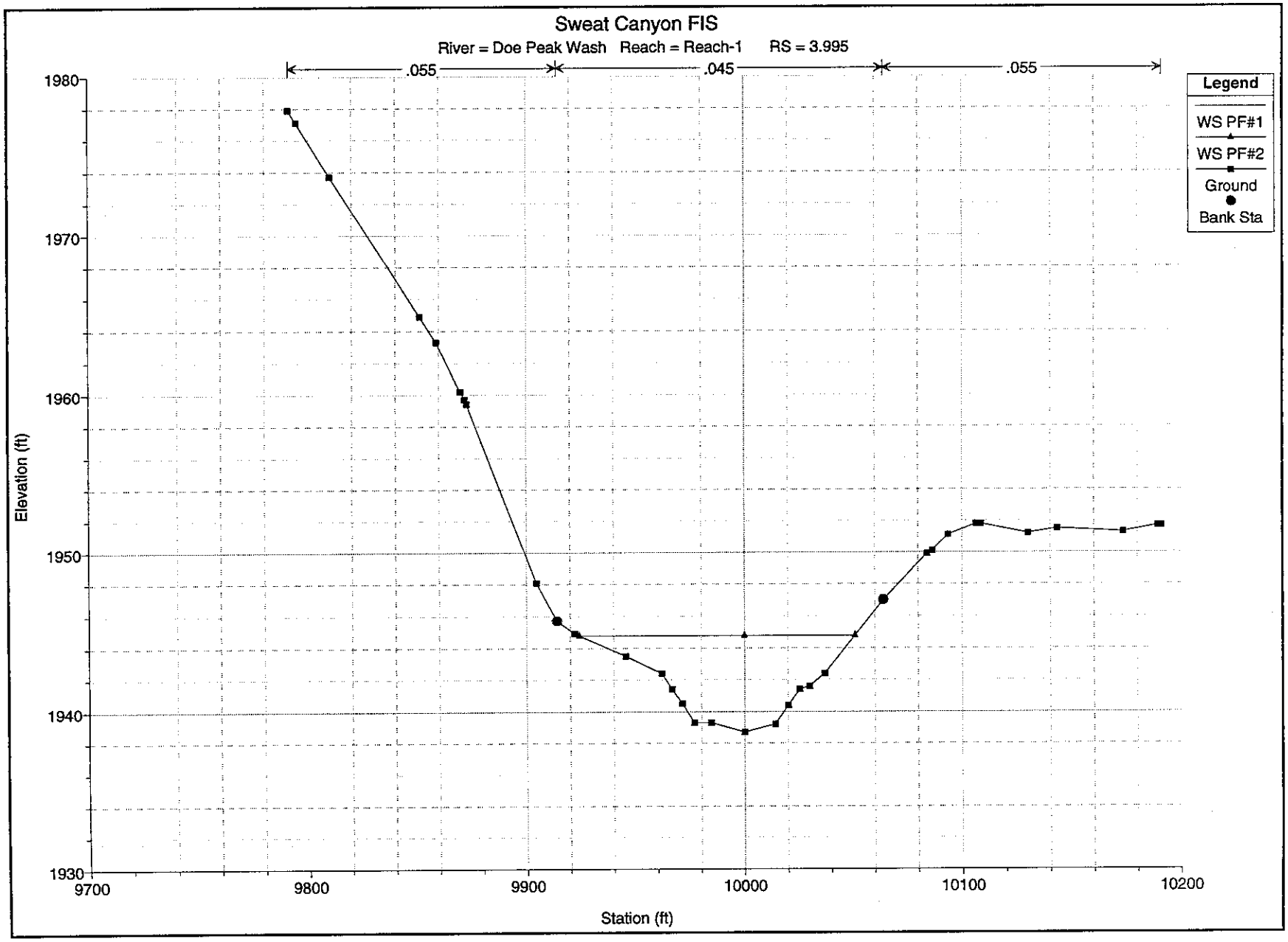

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.616
.05
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1932
1930
1928
1926
1924
1922
1920
1918
1916
9500
9600
9700
9800
9900
10000
10100
10200
Station (ft)

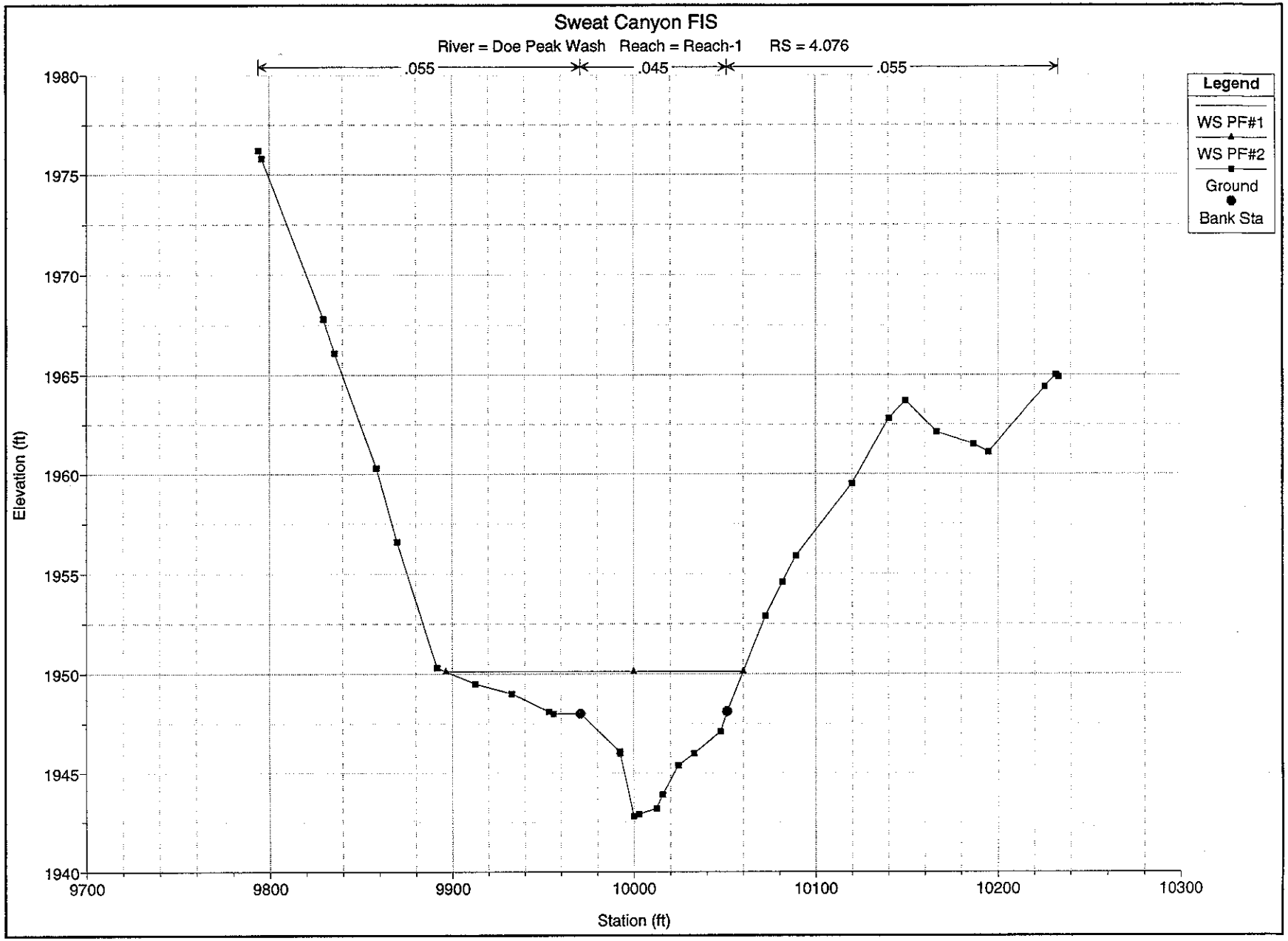

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.707
.05
.045
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1945
1940
1935
1930
1925
1920
9600
9800
10000
10200
10400
10600
Station (ft)

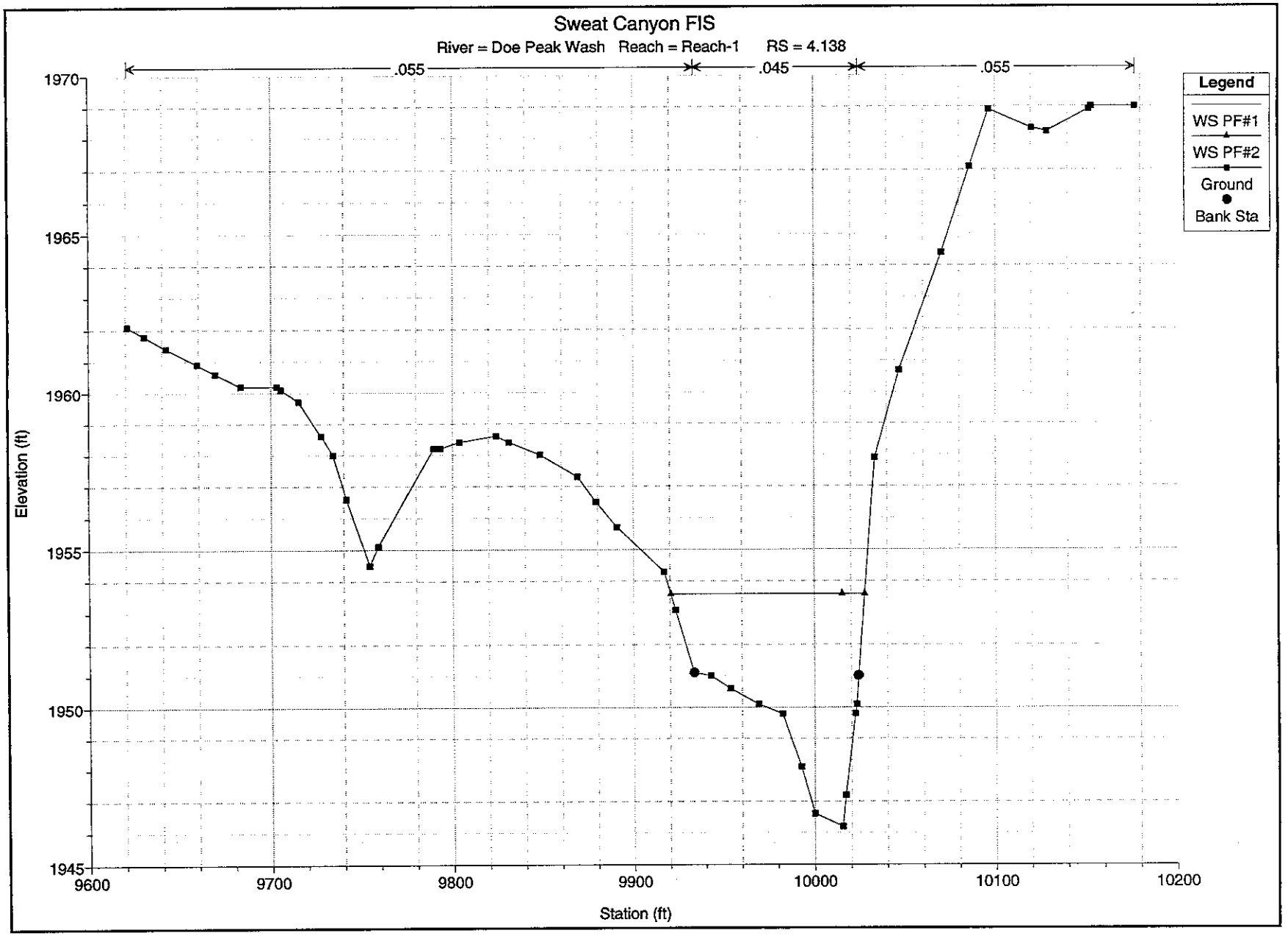

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.804
.045
.05
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1942
1940
1938
1936
1934
1932
1930
1928
1926
9800
9900
10000
10100
10200
10300
10400
Station (ft)

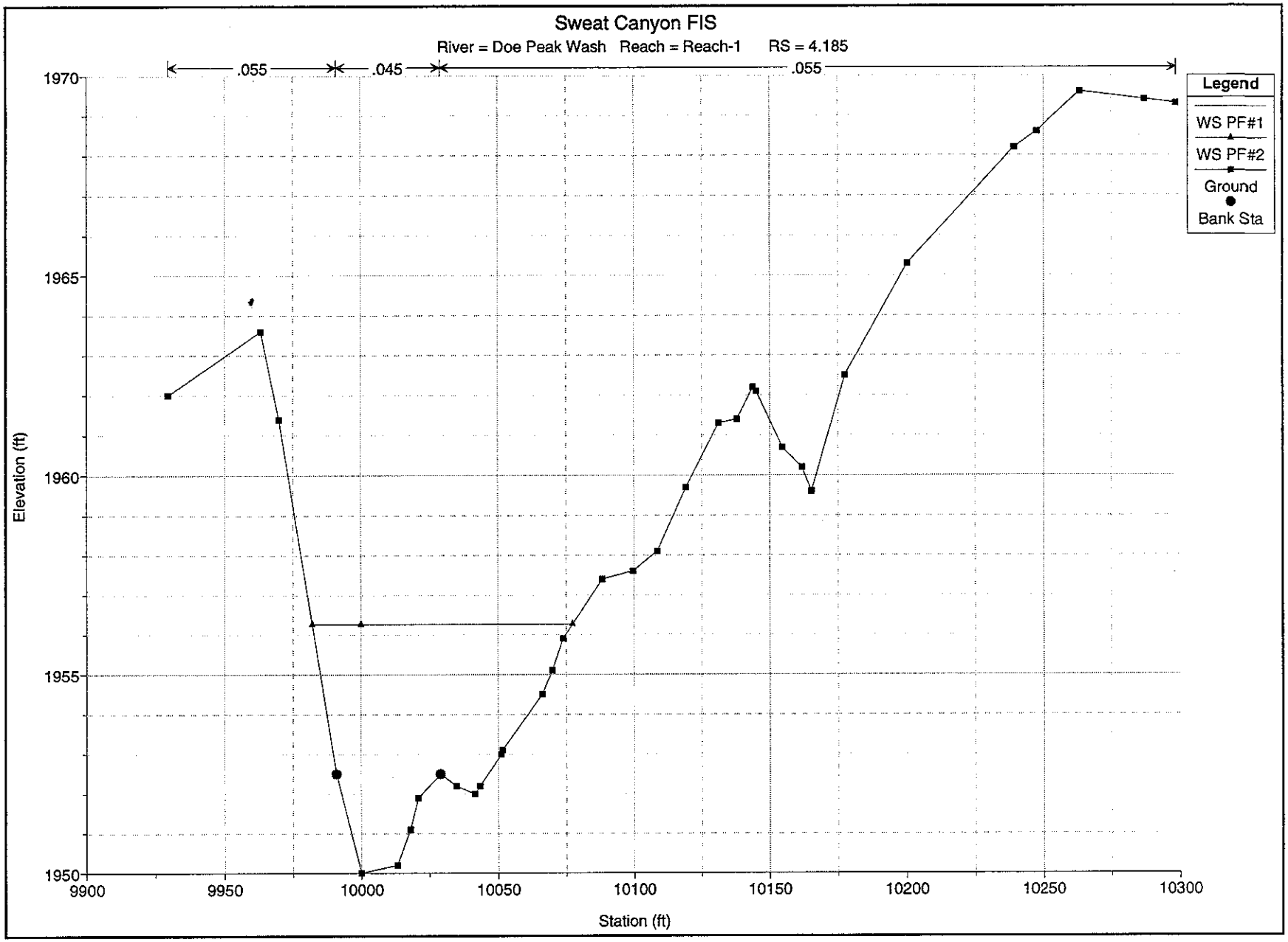

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.901
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1990
1980
1970
1960
1950
1940
1930
9700
9800
9900
10000
10100
10200
Station (ft)

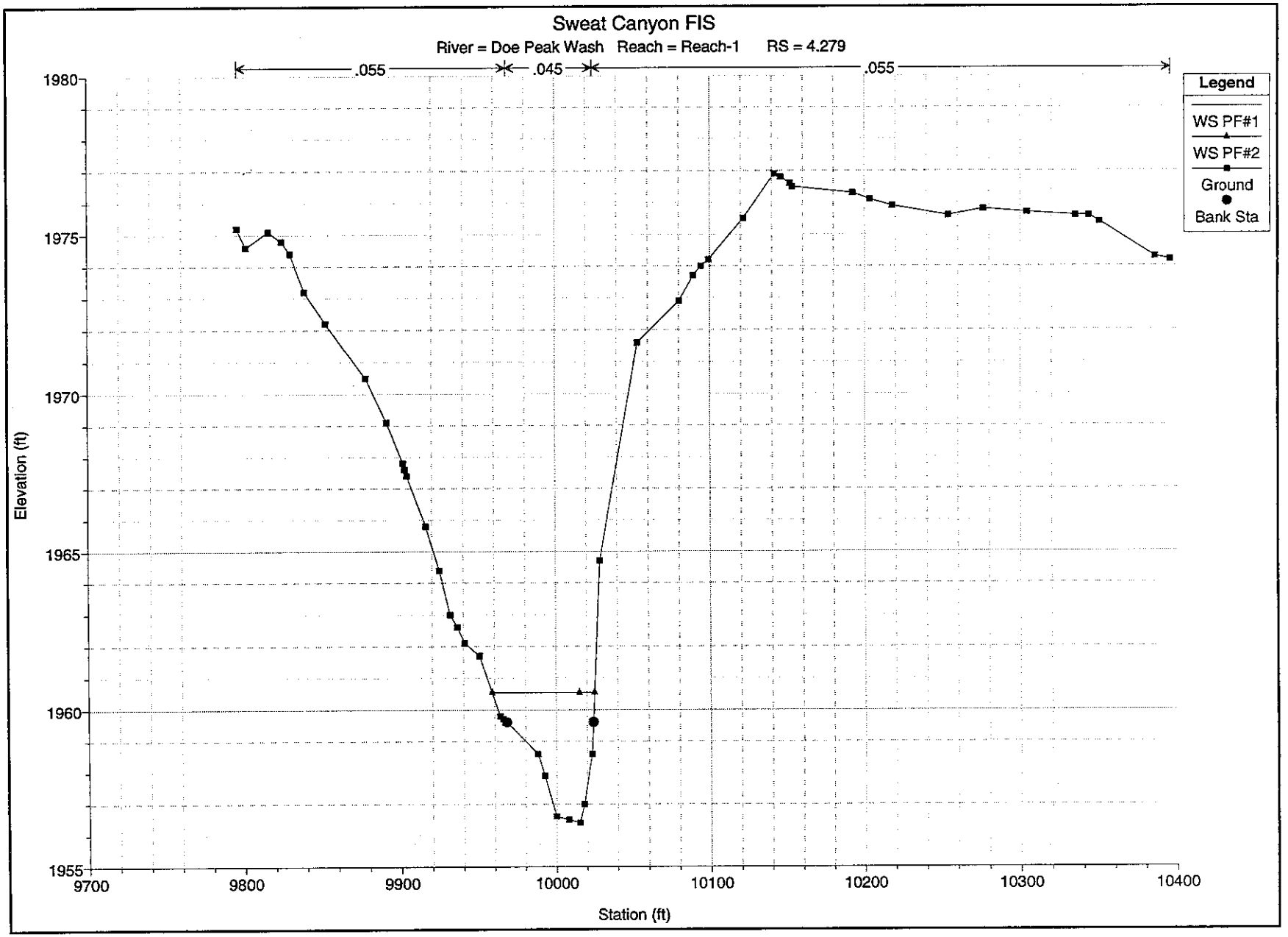

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.953
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2000
1990
1980
1970
1960
1950
1940
1930
9850
9900
9950
10000
10050
10100
10150
10200
Station (ft)

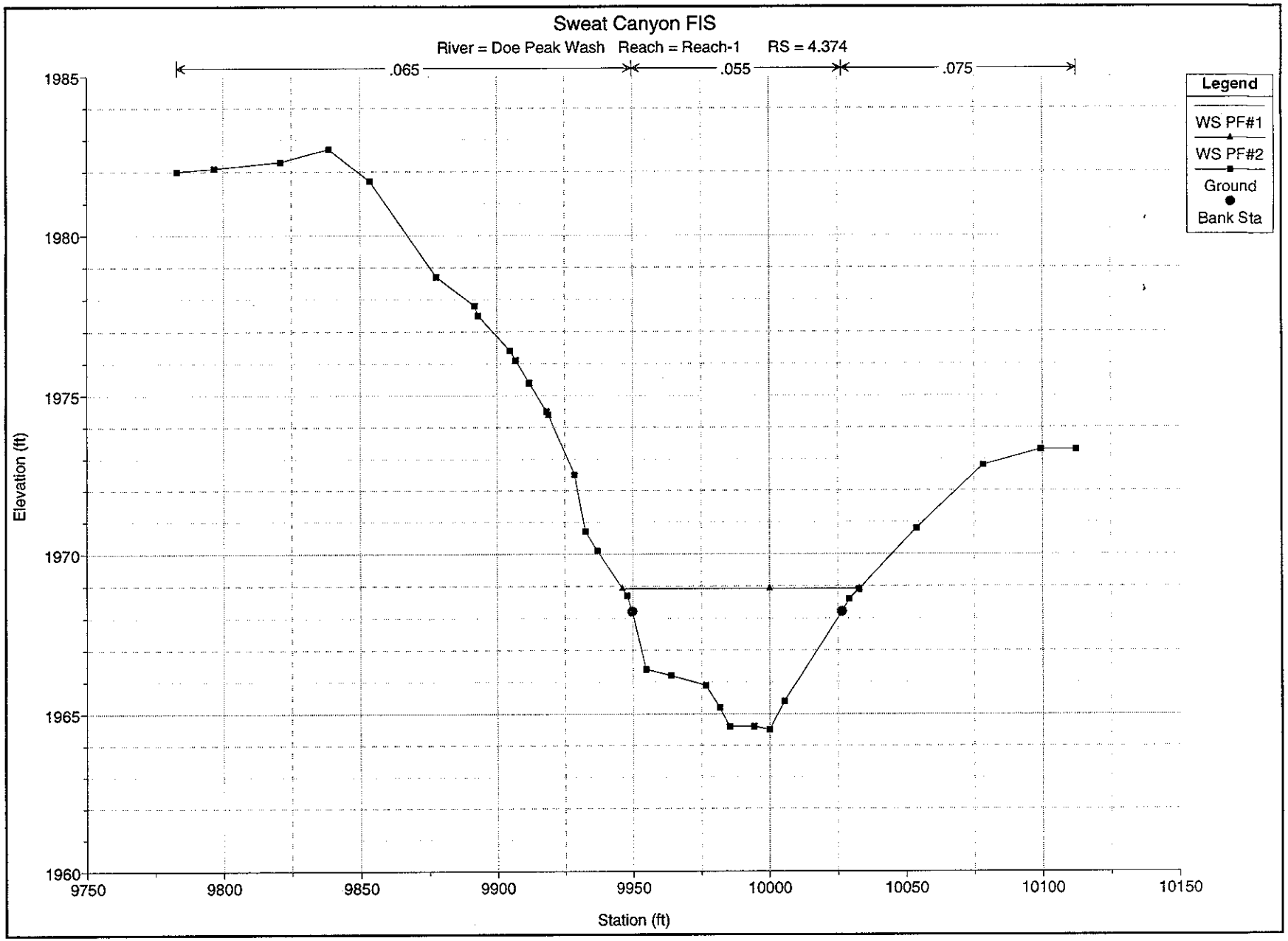

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 3.995
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1980
1970
1960
1950
1940
1930
9700
9800
9900
10000
10100
10200
Station (ft)

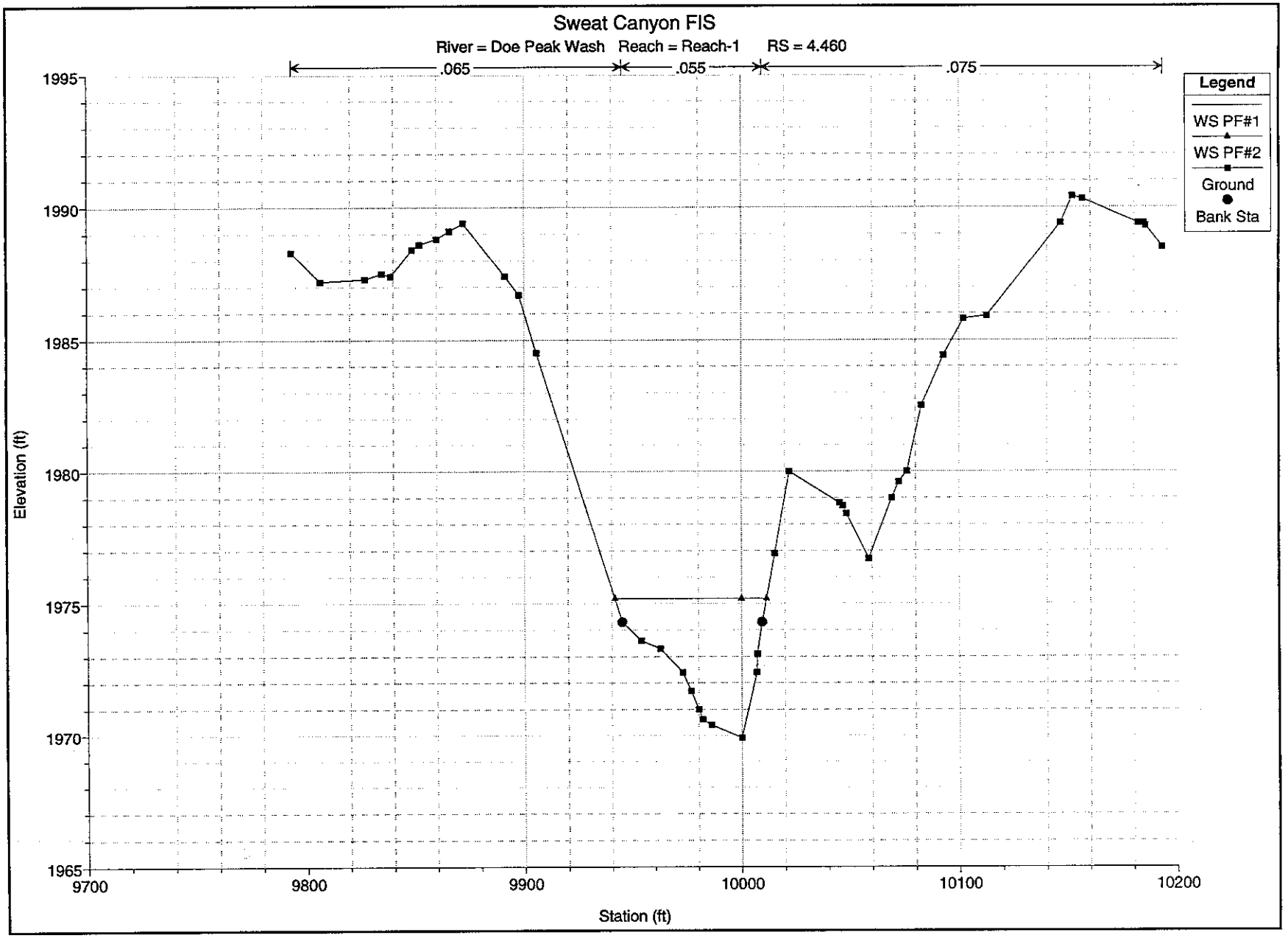

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.076
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1980
1975
1970
1965
1960
1955
1950
1945
1940
9700
9800
9900
10000
10100
10200
10300
Station (ft)

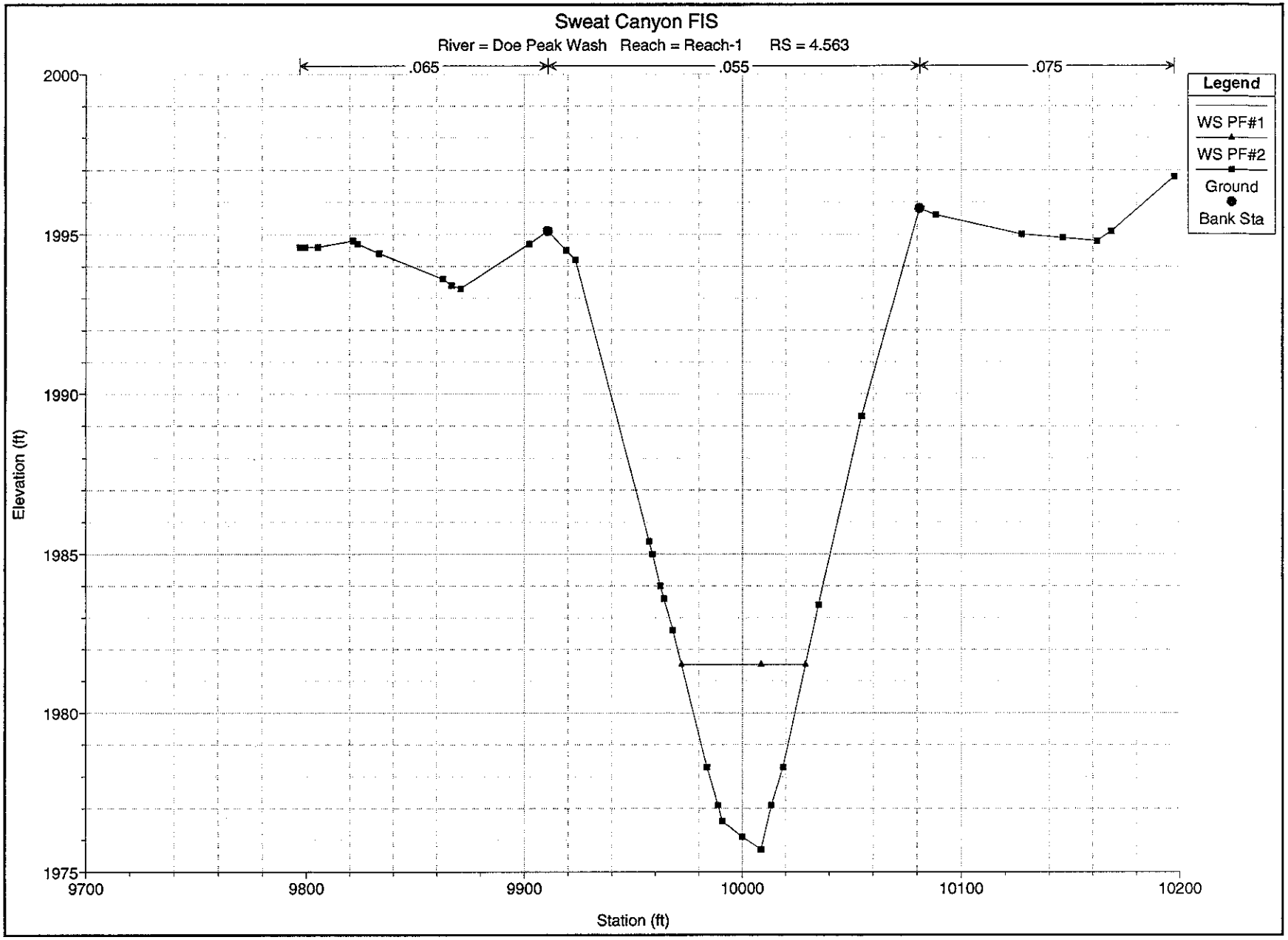

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.138
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1970
1965
1960
1955
1950
1945
9600
9700
9800
9900
10000
10100
10200
Station (ft)

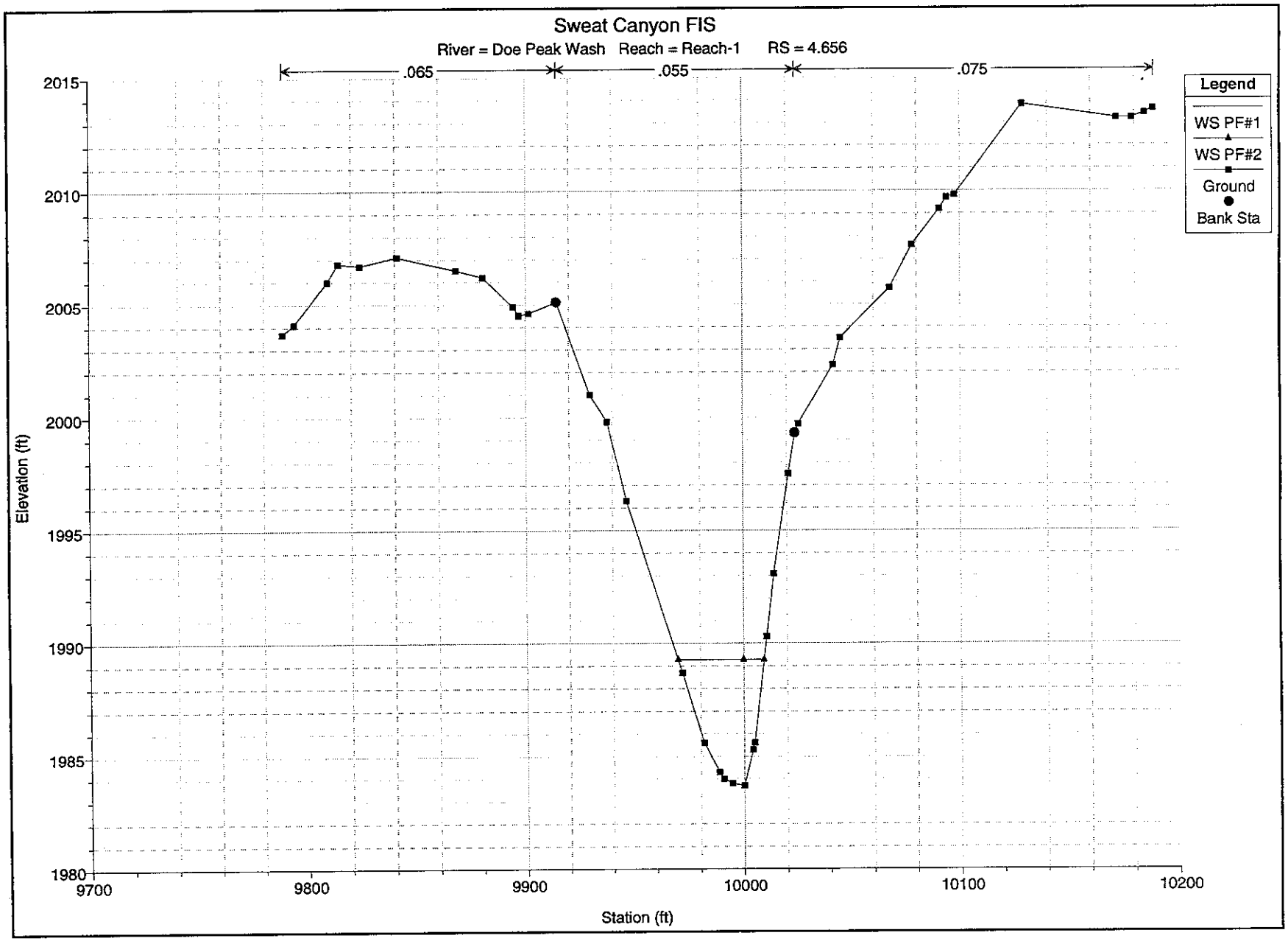

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.185
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1970
1965
1960
1955
1950
9900
9950
10000
10050
10100
10150
10200
10250
10300
Station (ft)

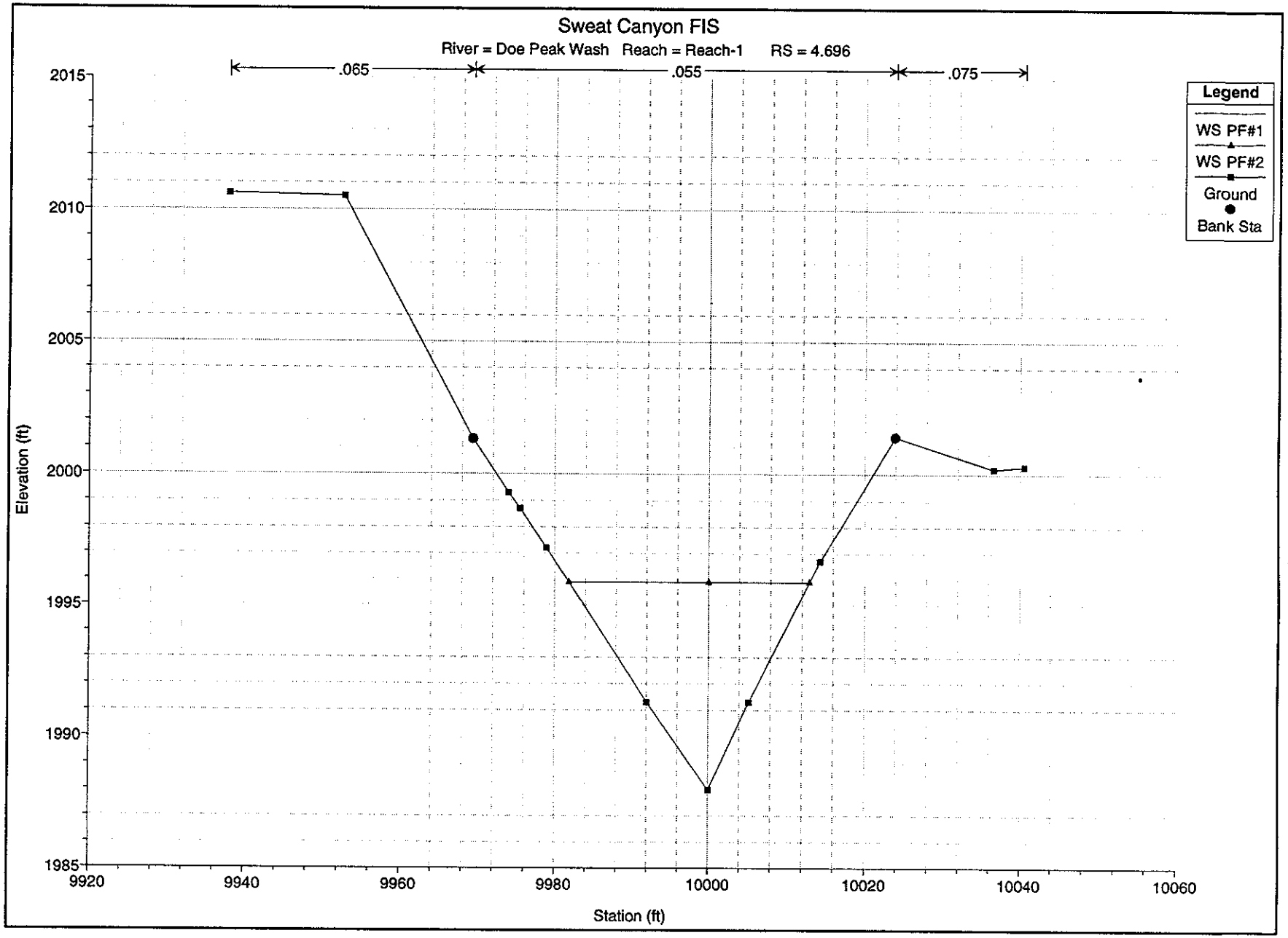

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.279
.055
.045
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1980
1975
1970
1965
1960
1955
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

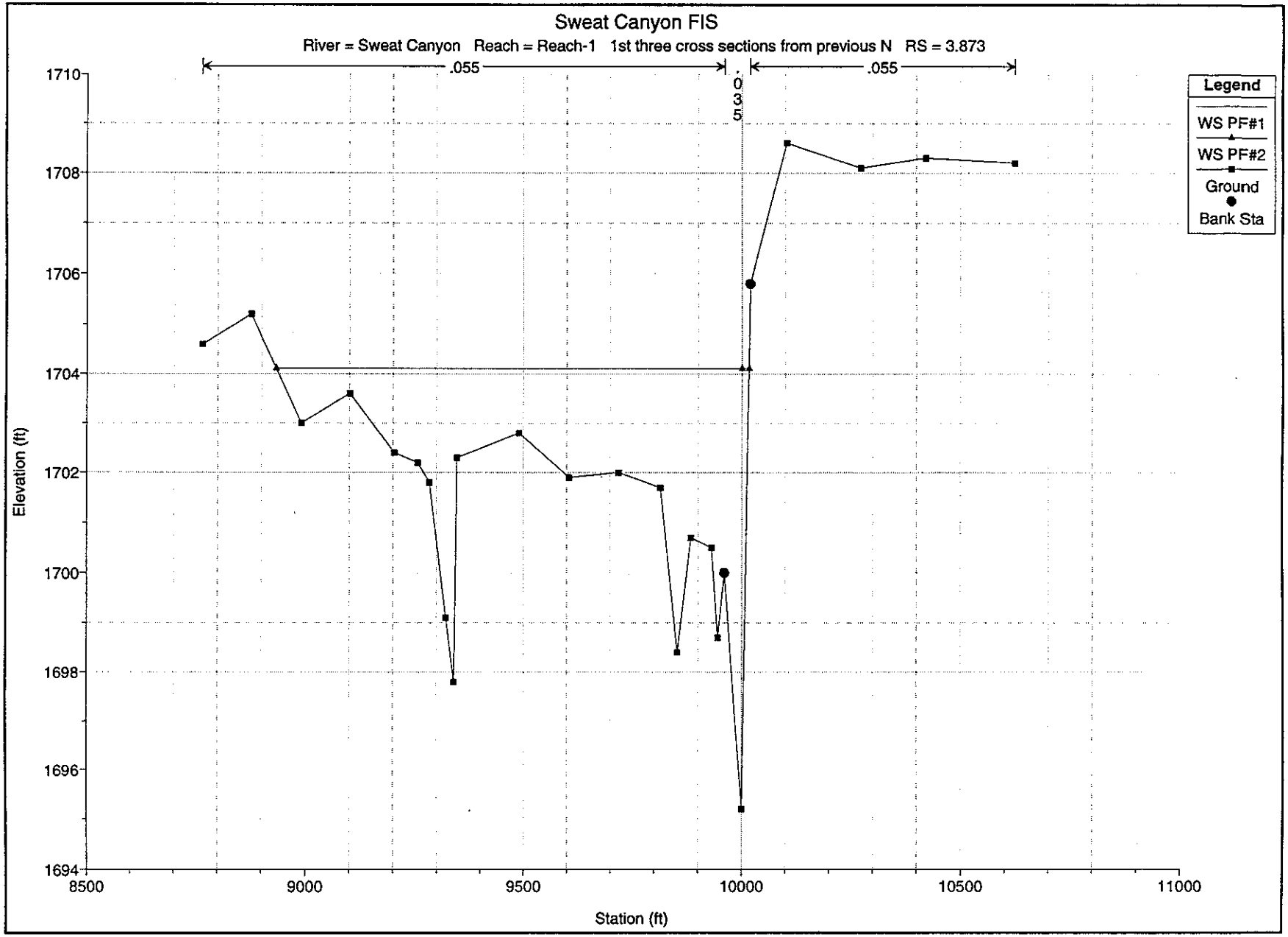

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.374
.065
.055
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1985
1980
1975
1970
1965
1960
9750
9800
9850
9900
9950
10000
10050
10100
10150
Station (ft)

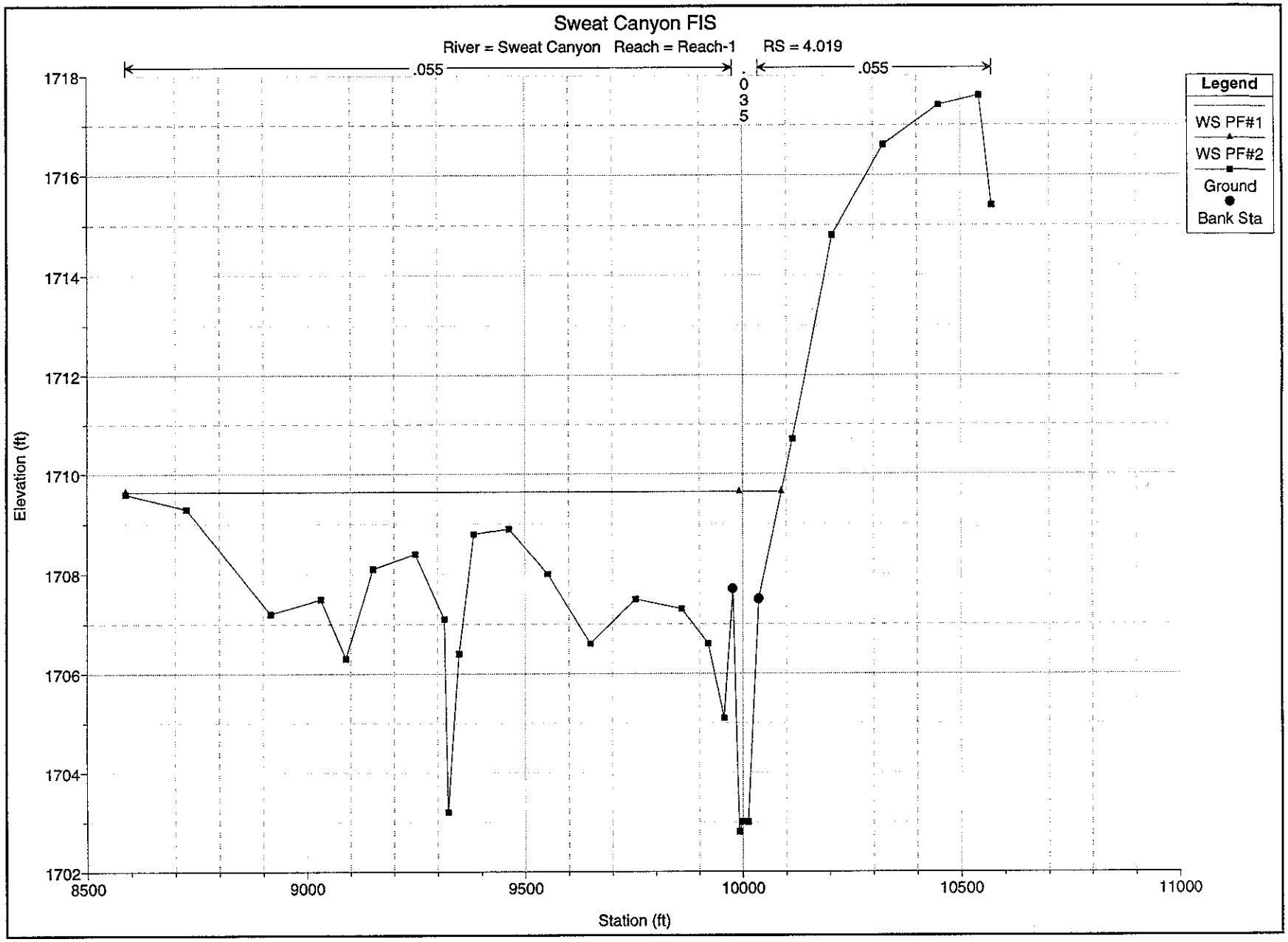

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.460
.065
.055
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1995
1990
1985
1980
1975
1970
1965
9700
9800
9900
10000
10100
10200
Station (ft)

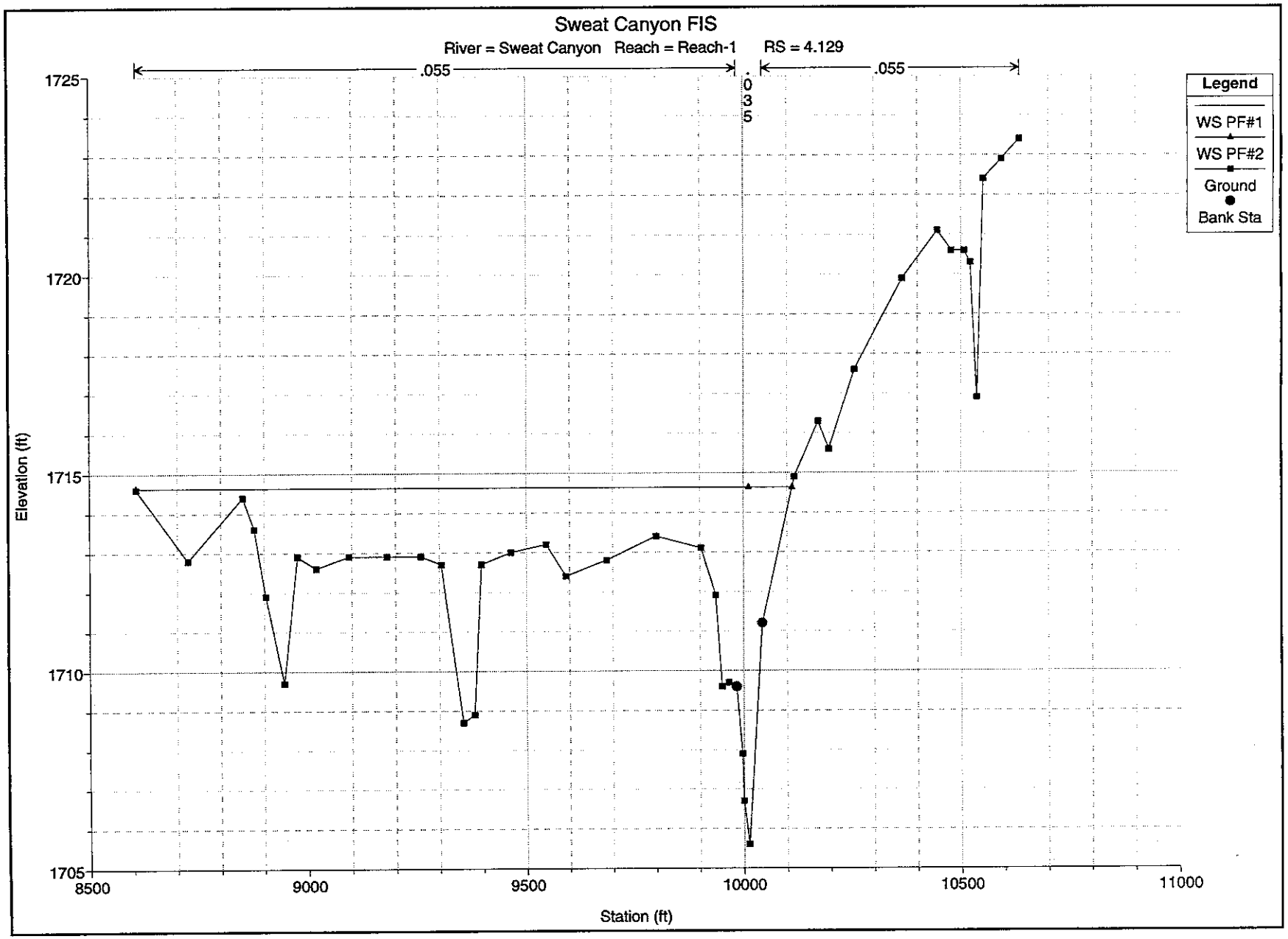

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.563
.065
.055
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2000
1995
1990
1985
1980
1975
9700
9800
9900
10000
10100
10200
Station (ft)

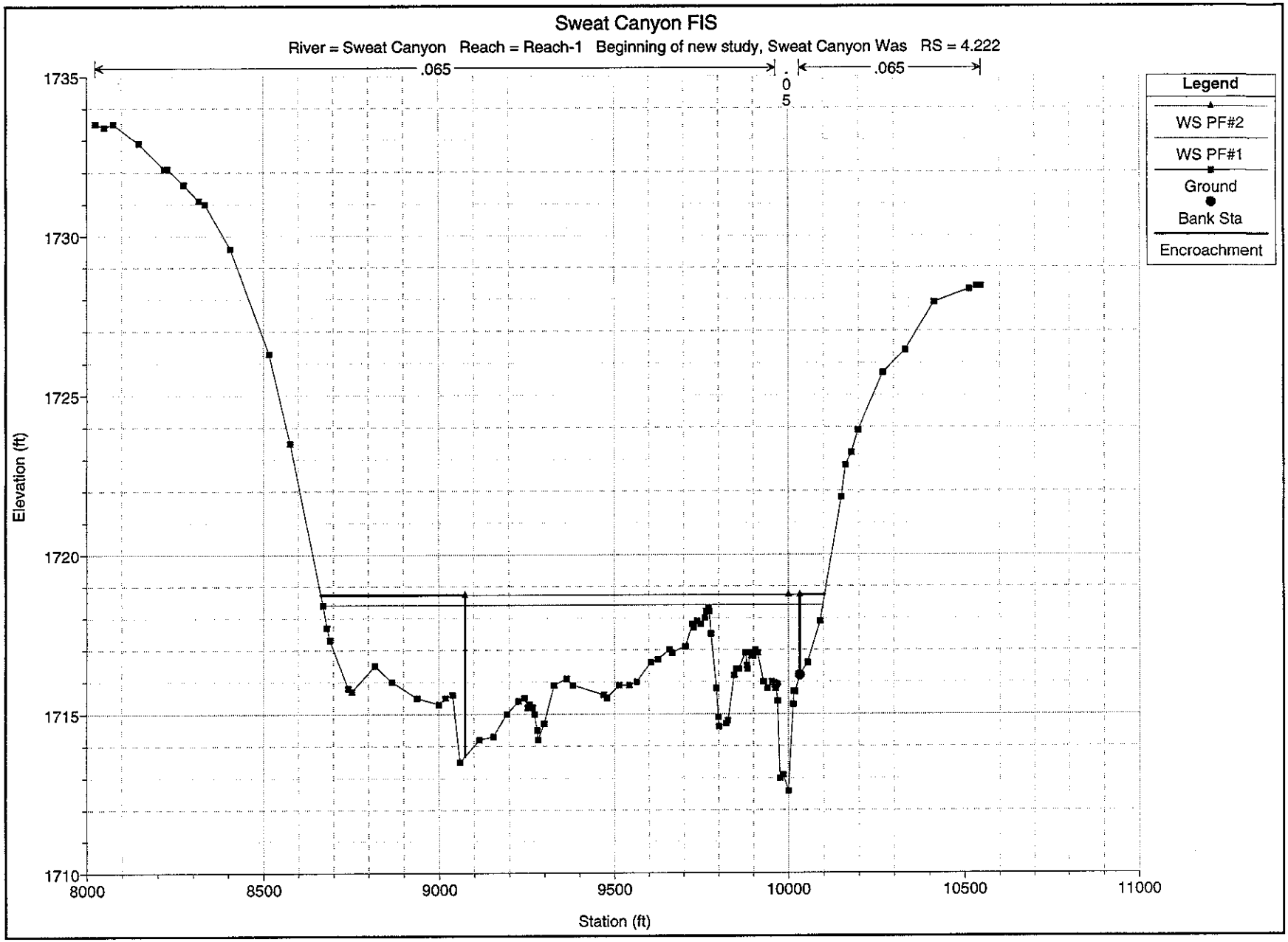

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.656
.065
.055
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2015
2010
2005
2000
1995
1990
1985
1980
9700
9800
9900
10000
10100
10200
Station (ft)

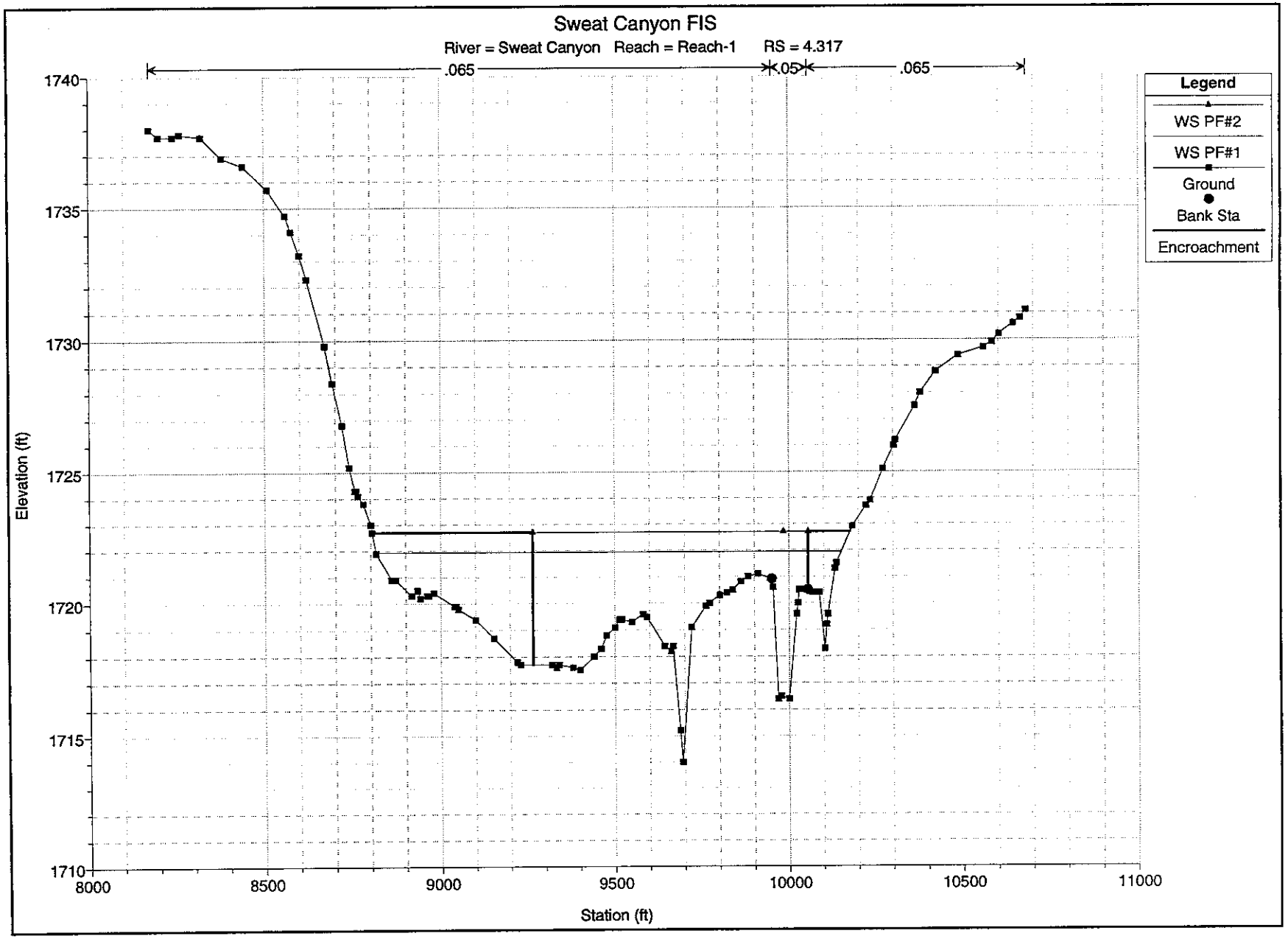

Sweat Canyon FIS
River = Doe Peak Wash Reach = Reach-1 RS = 4.696
.065
.055
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2015
2010
2005
2000
1995
1990
1985
9920
9940
9960
9980
10000
10020
10040
10060
Station (ft)

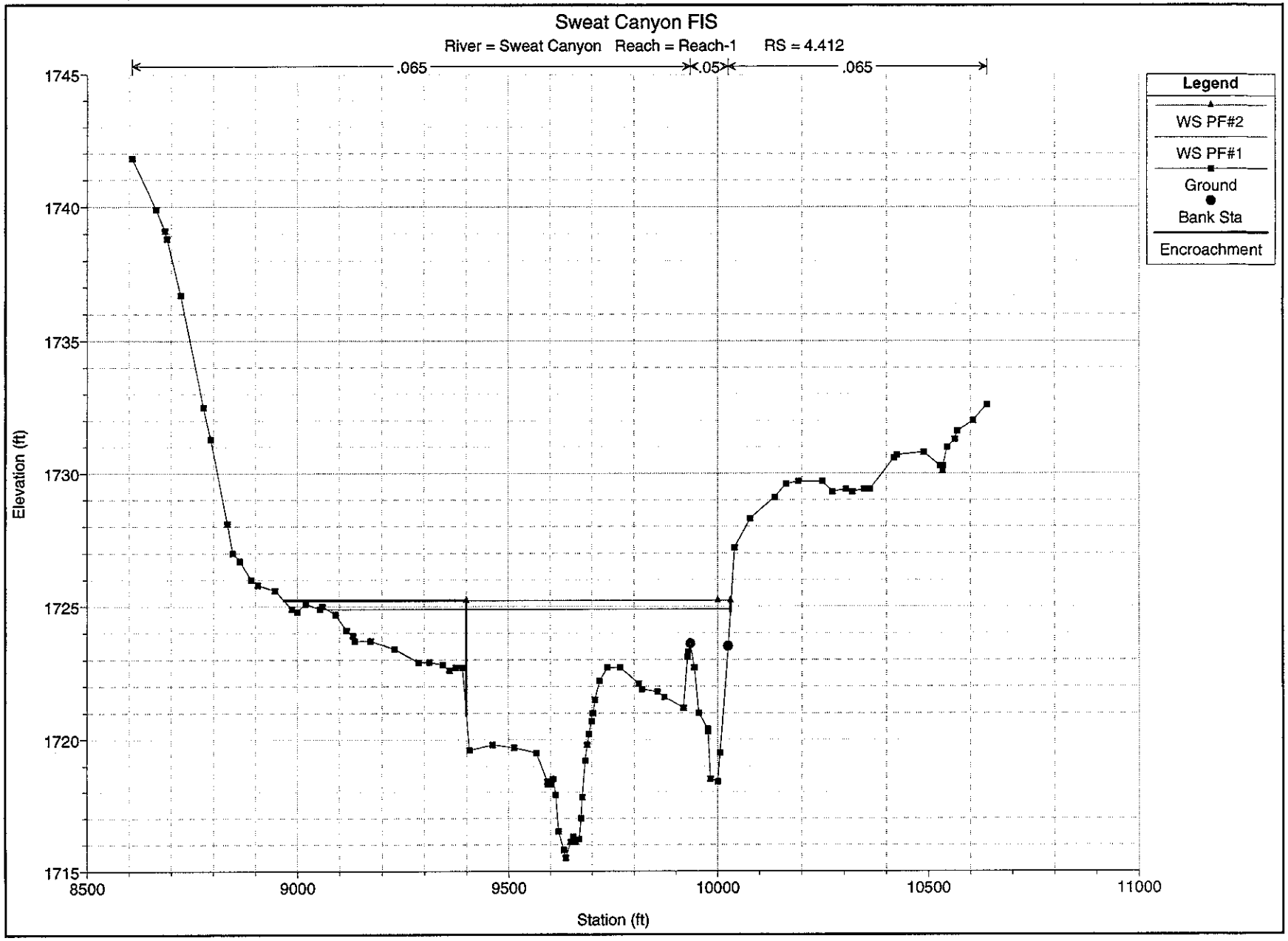

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 1st three cross sections from previous N RS = 3.873
.055
.035
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1710
1708
1706
1704
1702
1700
1698
1696
1694
8500
9000
9500
10000
10500
11000
Station (ft)

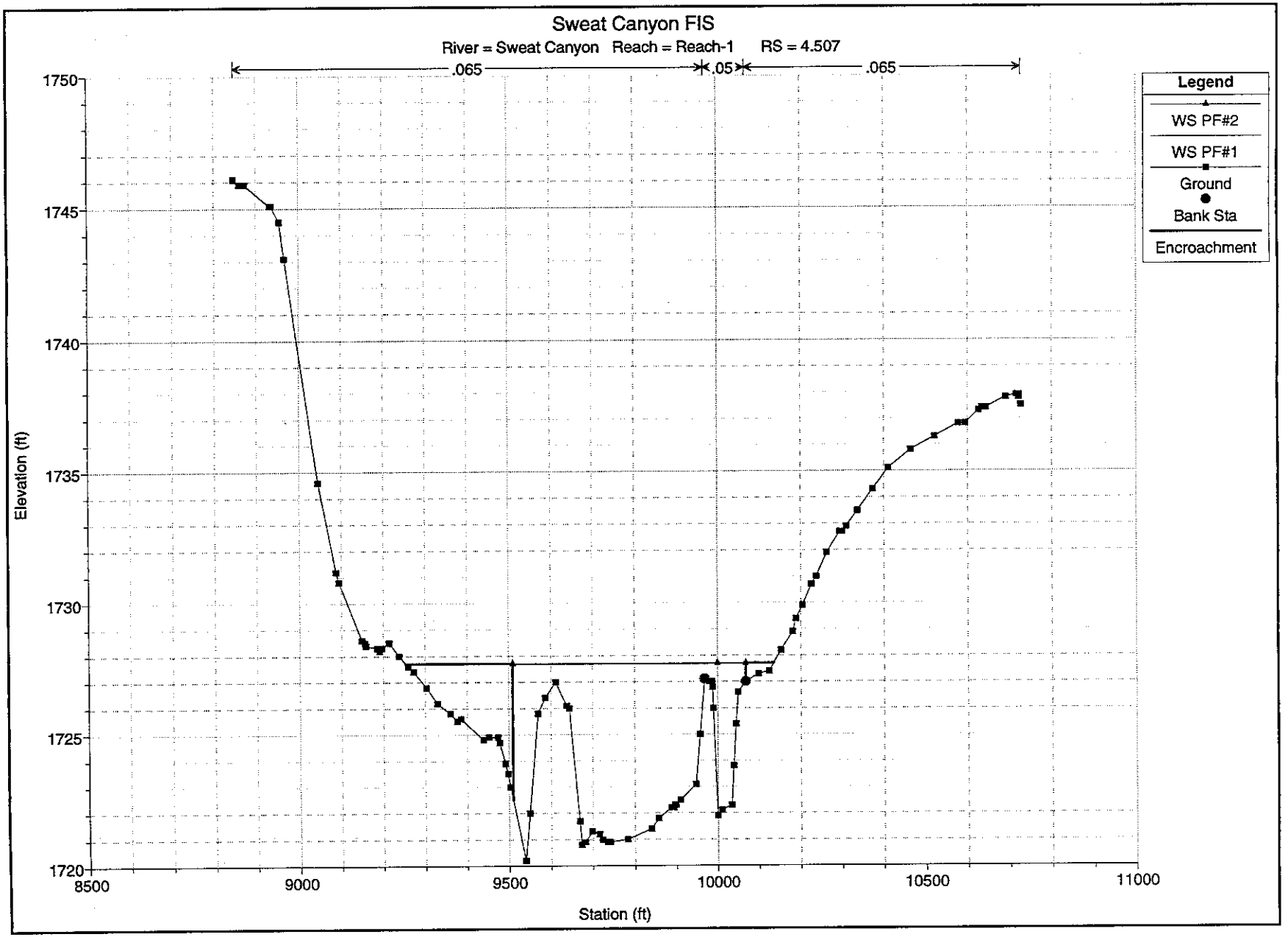

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.019
.055
.035
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1718
1716
1714
1712
1710
1708
1706
1704
1702
8500
9000
9500
10000
10500
11000
Station (ft)

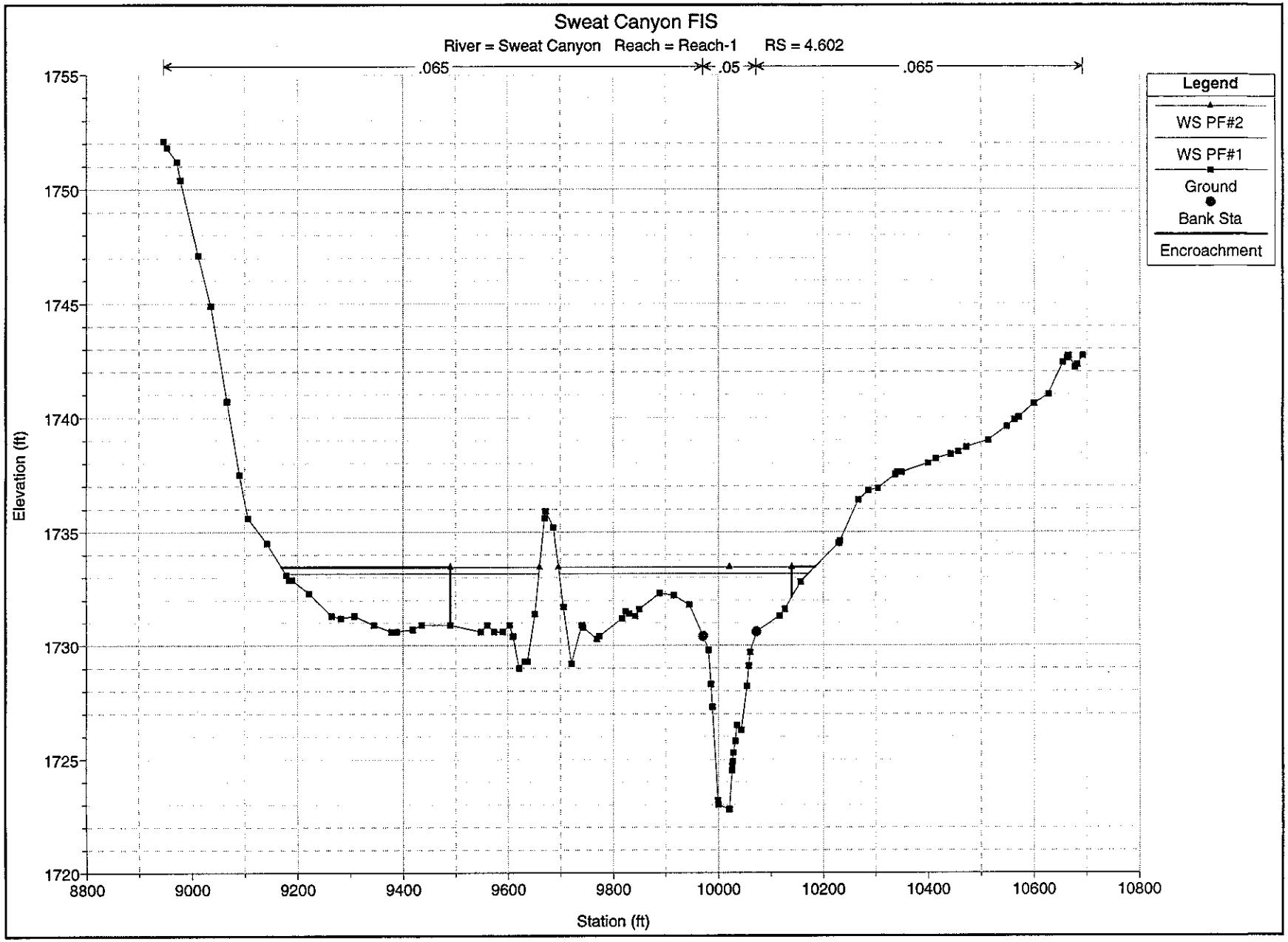

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.129
.055
.035
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1725
1720
1715
1710
1705
8500
9000
9500
10000
10500
11000
Station (ft)

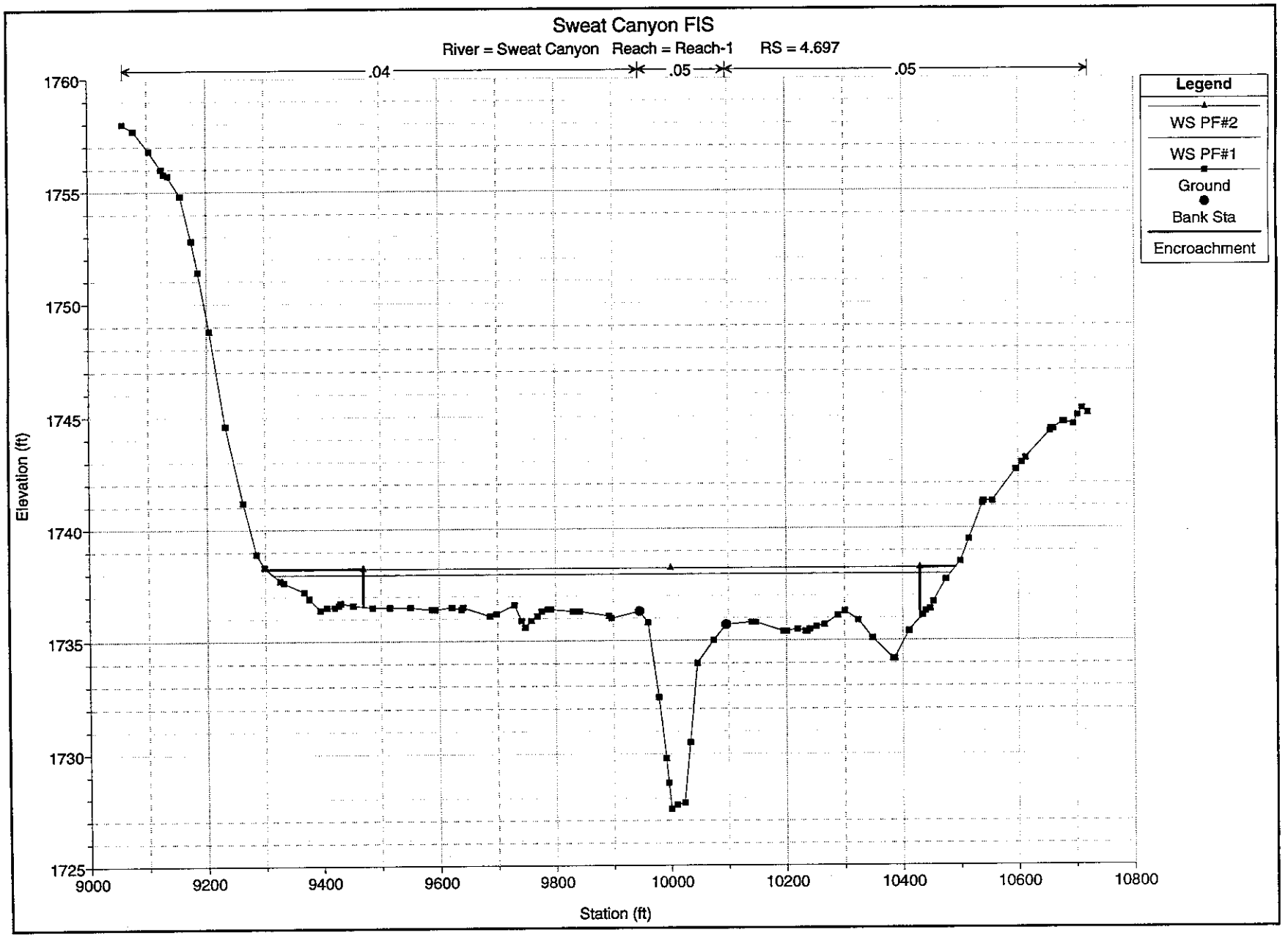

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 Beginning of new study, Sweat Canyon Was RS = 4.222
.065
.05
.065
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1735
1730
1725
1720
1715
1710
8000
8500
9000
9500
10000
10500
11000
Station (ft)

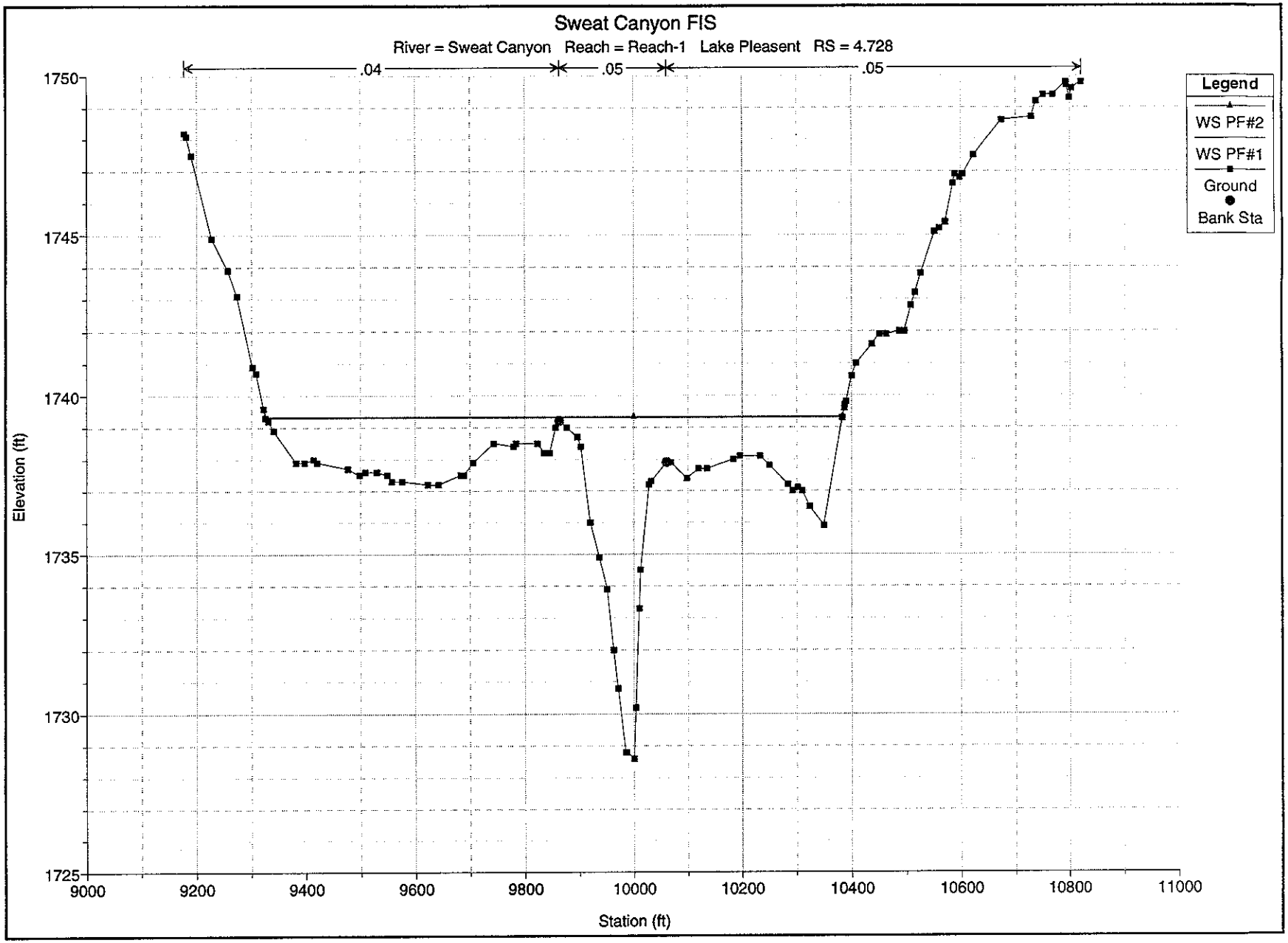

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.317
.065
.05
.065
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1740
1735
1730
1725
1720
1715
1710
8000
8500
9000
9500
10000
10500
11000
Station (ft)

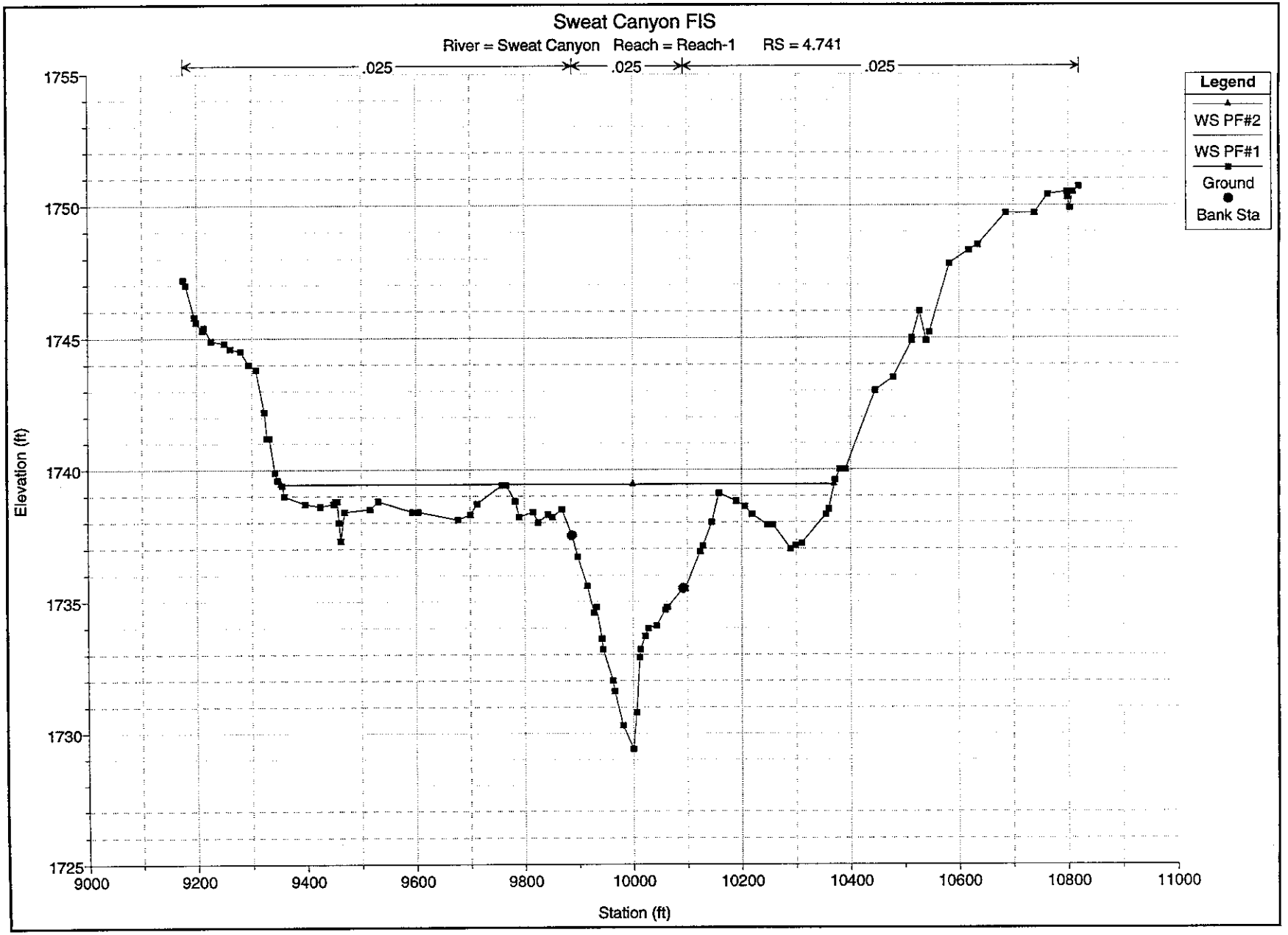

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.412
.065
.05
.065
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1745
1740
1735
1730
1725
1720
1715
8500
9000
9500
10000
10500
11000
Station (ft)

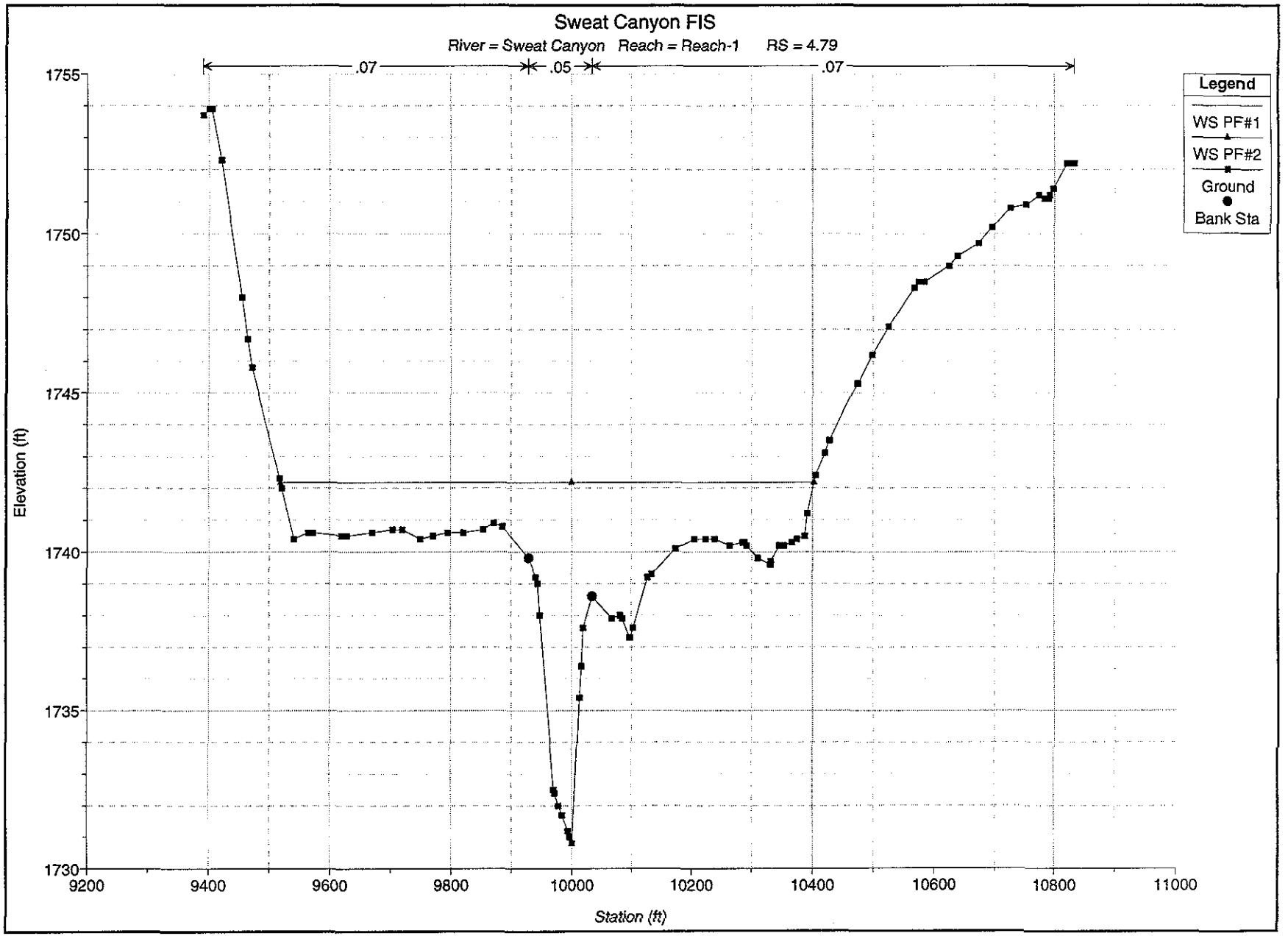

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.507
.065
.05
.065
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1750
1745
1740
1735
1730
1725
1720
8500
9000
9500
10000
10500
11000
Station (ft)

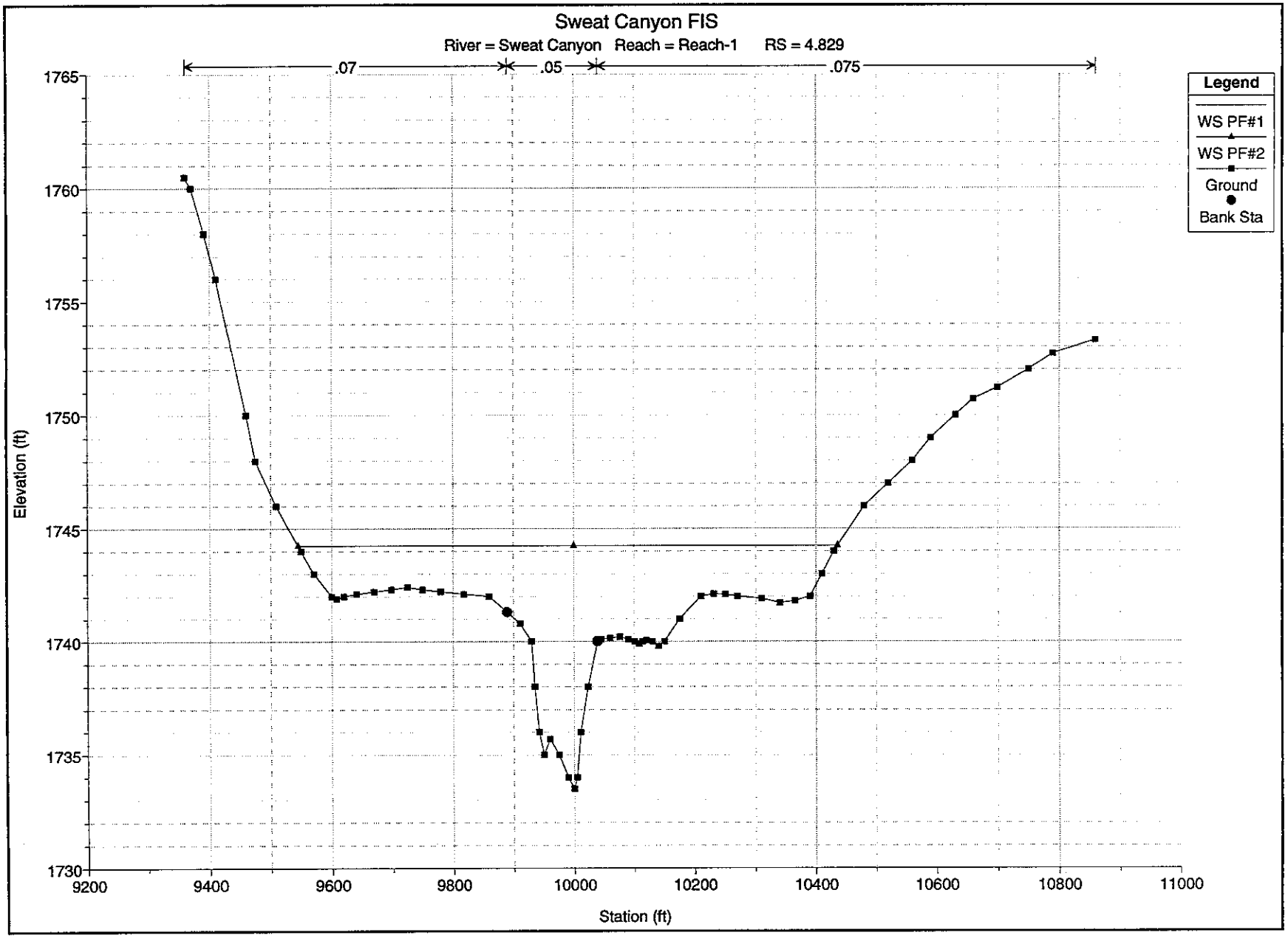

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.602
.065
.05
.065
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1755
1750
1745
1740
1735
1730
1725
1720
8800
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

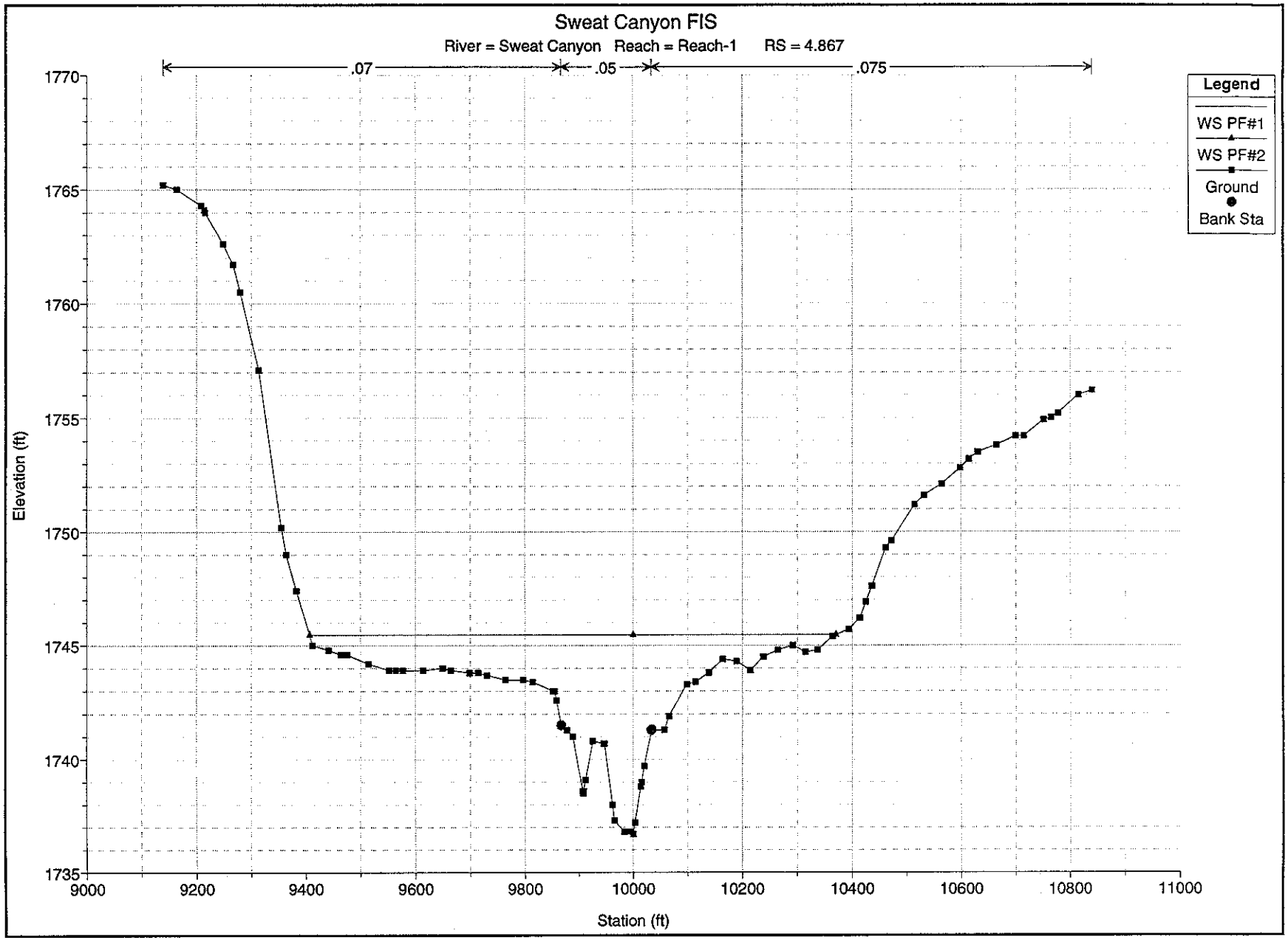

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.697
.04
.05
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Encroachment
Elevation (ft)
1760
1755
1750
1745
1740
1735
1730
1725
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

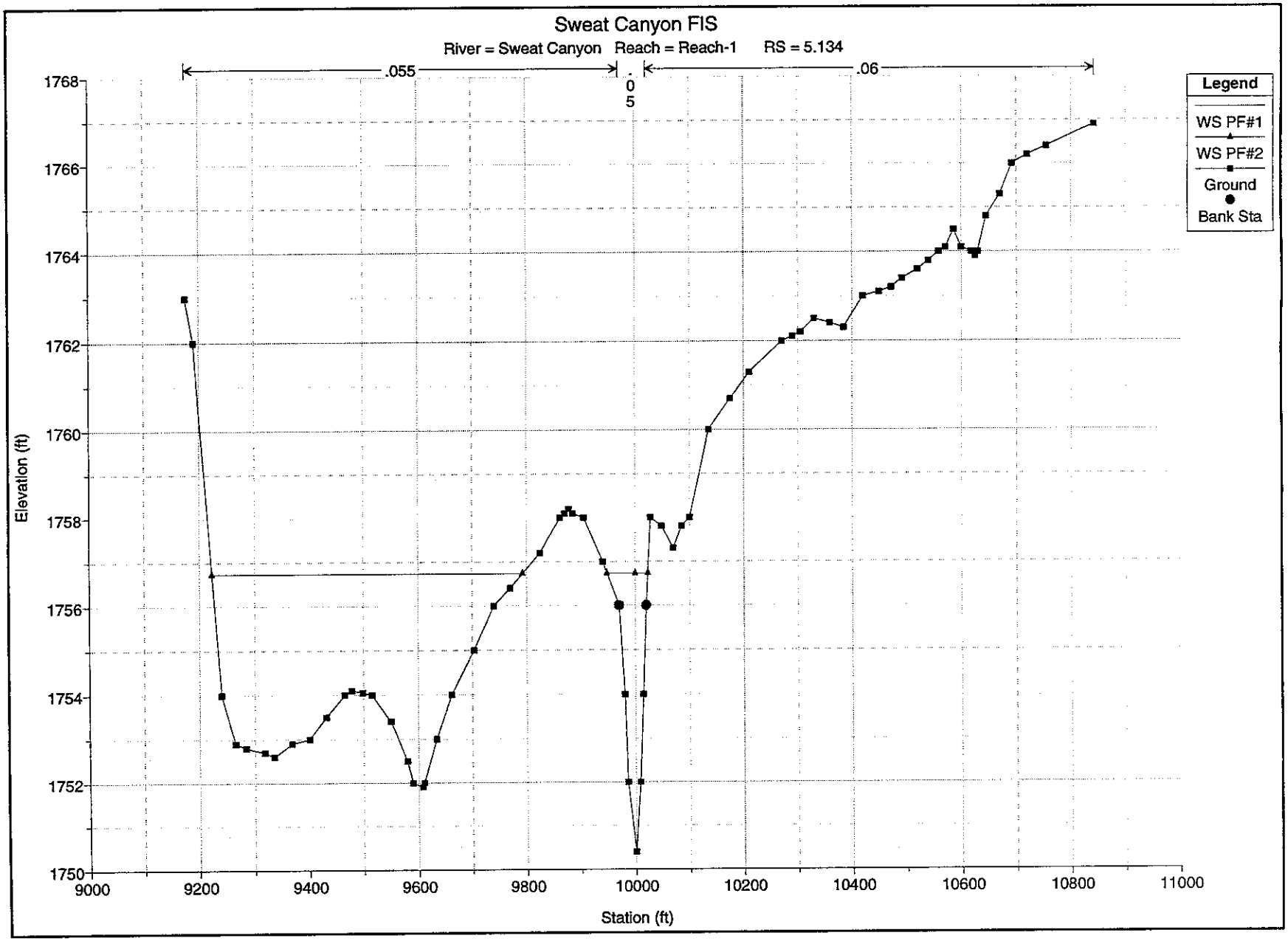

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 Lake Pleasent RS = 4.728
.04
.05
.05
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1750
1745
1740
1735
1730
1725
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

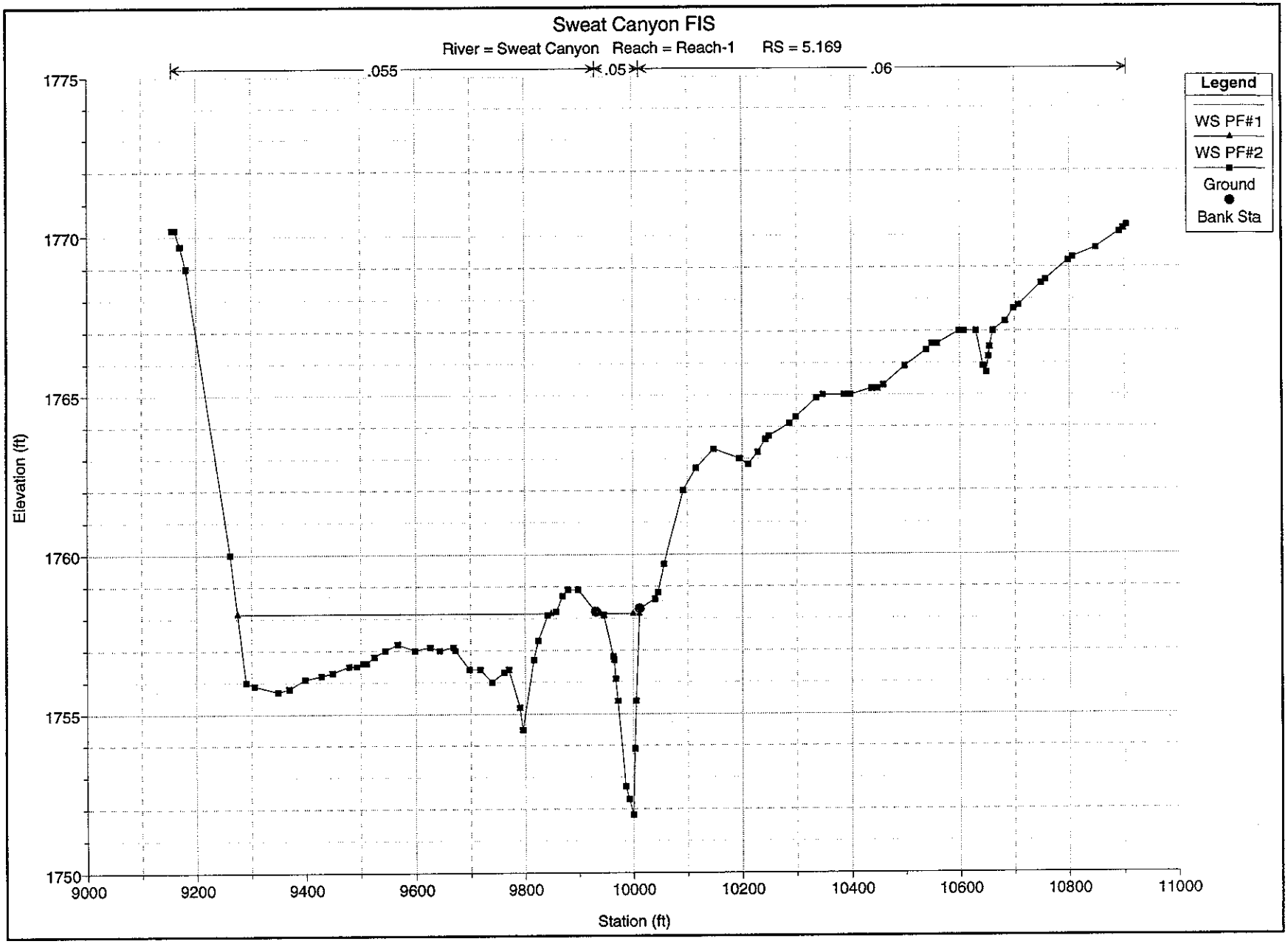

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.741
.025
.025
.025
Legend
WS PF#2
WS PF#1
Ground
Bank Sta
Elevation (ft)
1755
1750
1745
1740
1735
1730
1725
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

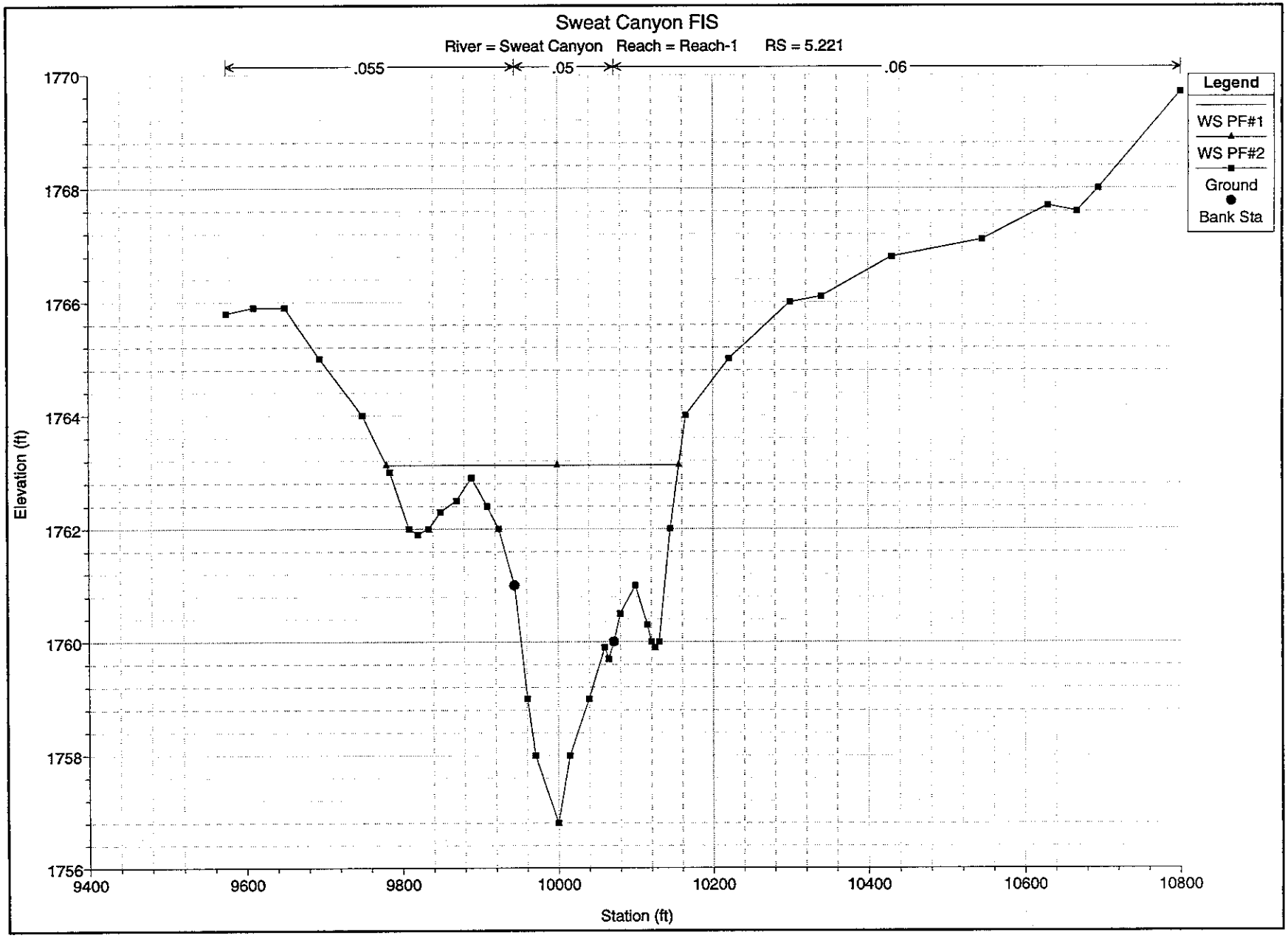

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.79
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1755
1750
1745
1740
1735
1730
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

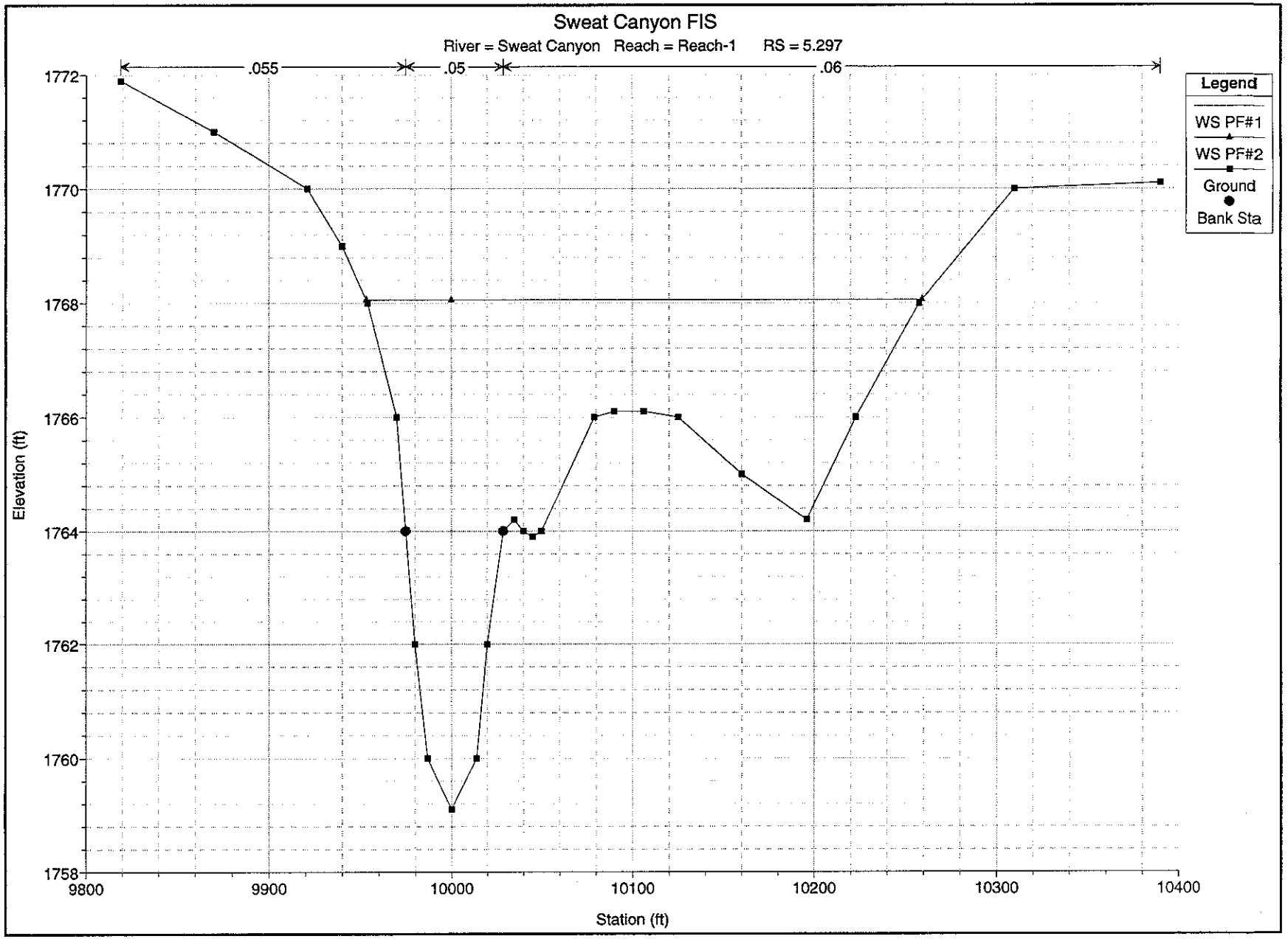

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.829
.07
.05
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1765
1760
1755
1750
1745
1740
1735
1730
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

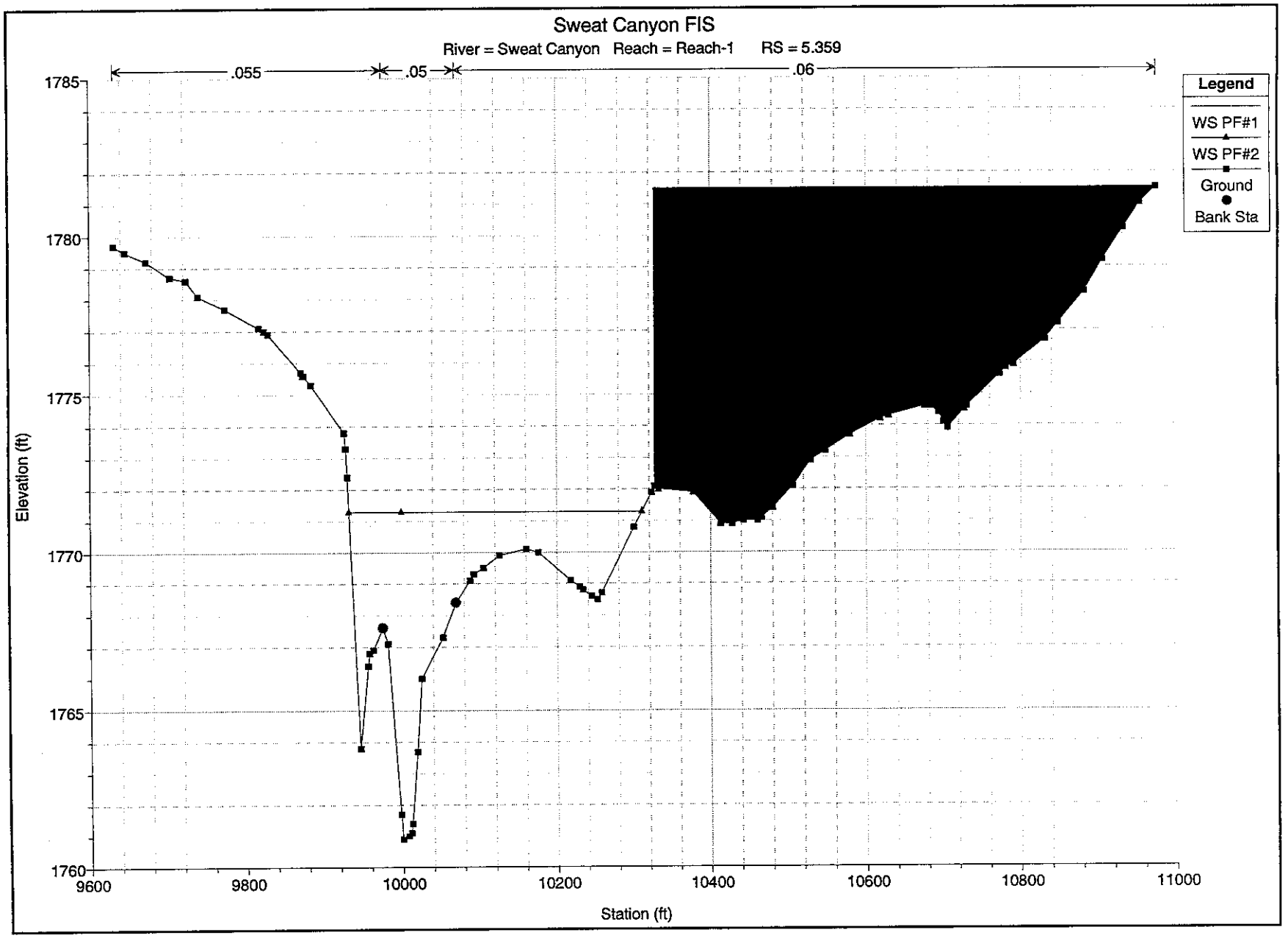

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 4.867
.07
.05
.075
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1770
1765
1760
1755
1750
1745
1740
1735
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

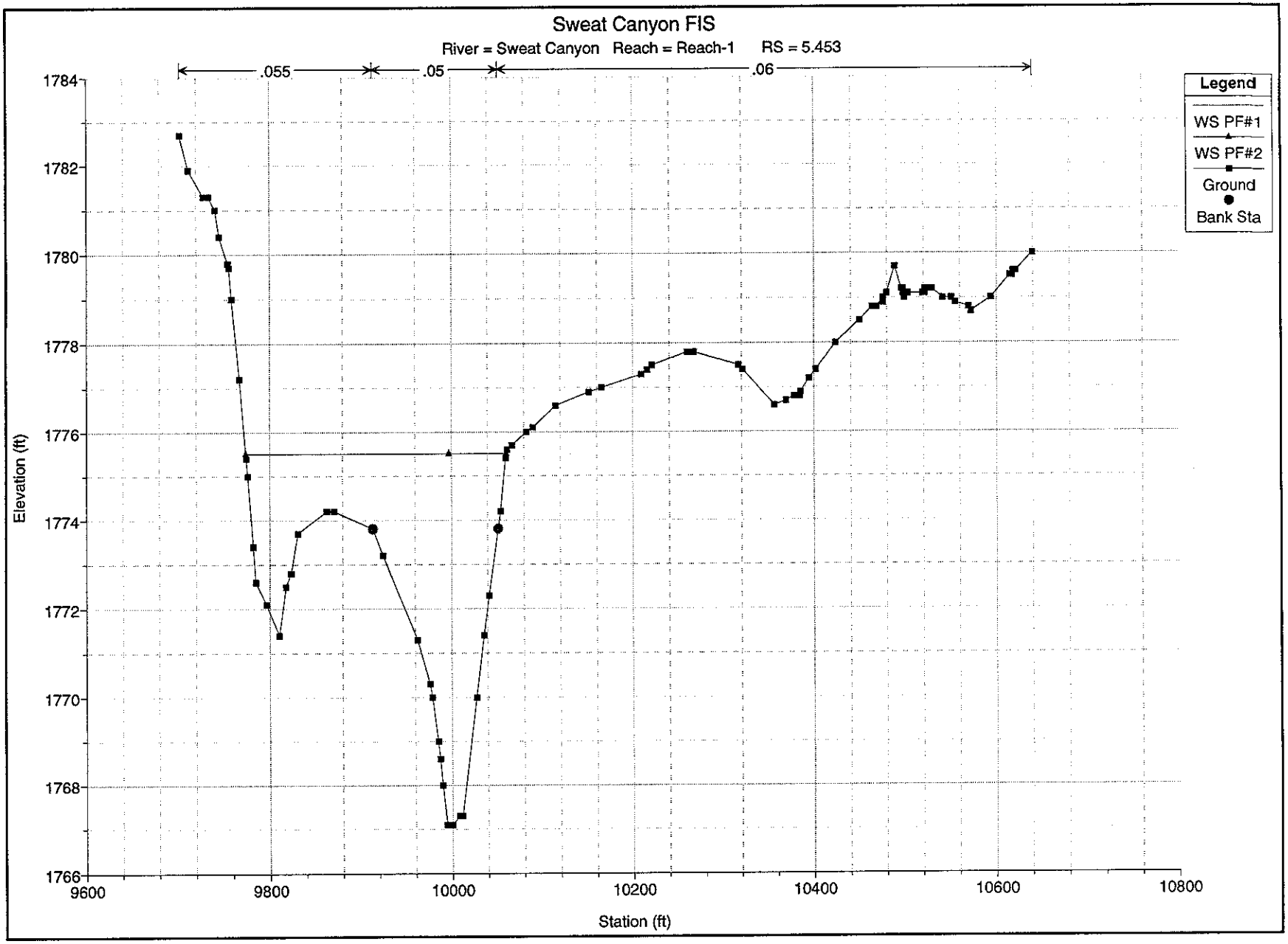

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.134
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1768
1766
1764
1762
1760
1758
1756
1754
1752
1750
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

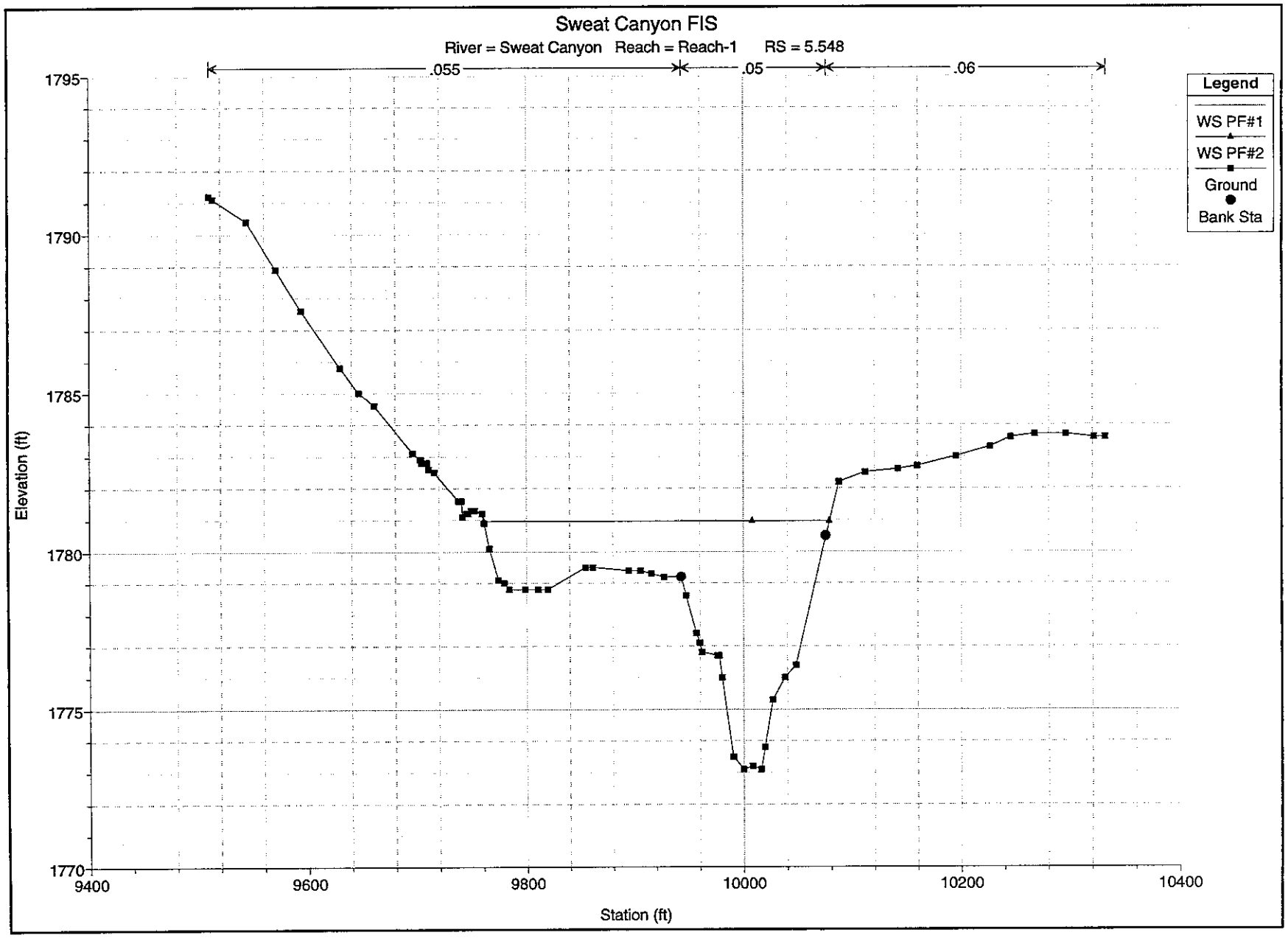

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.169
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1775
1770
1765
1760
1755
1750
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

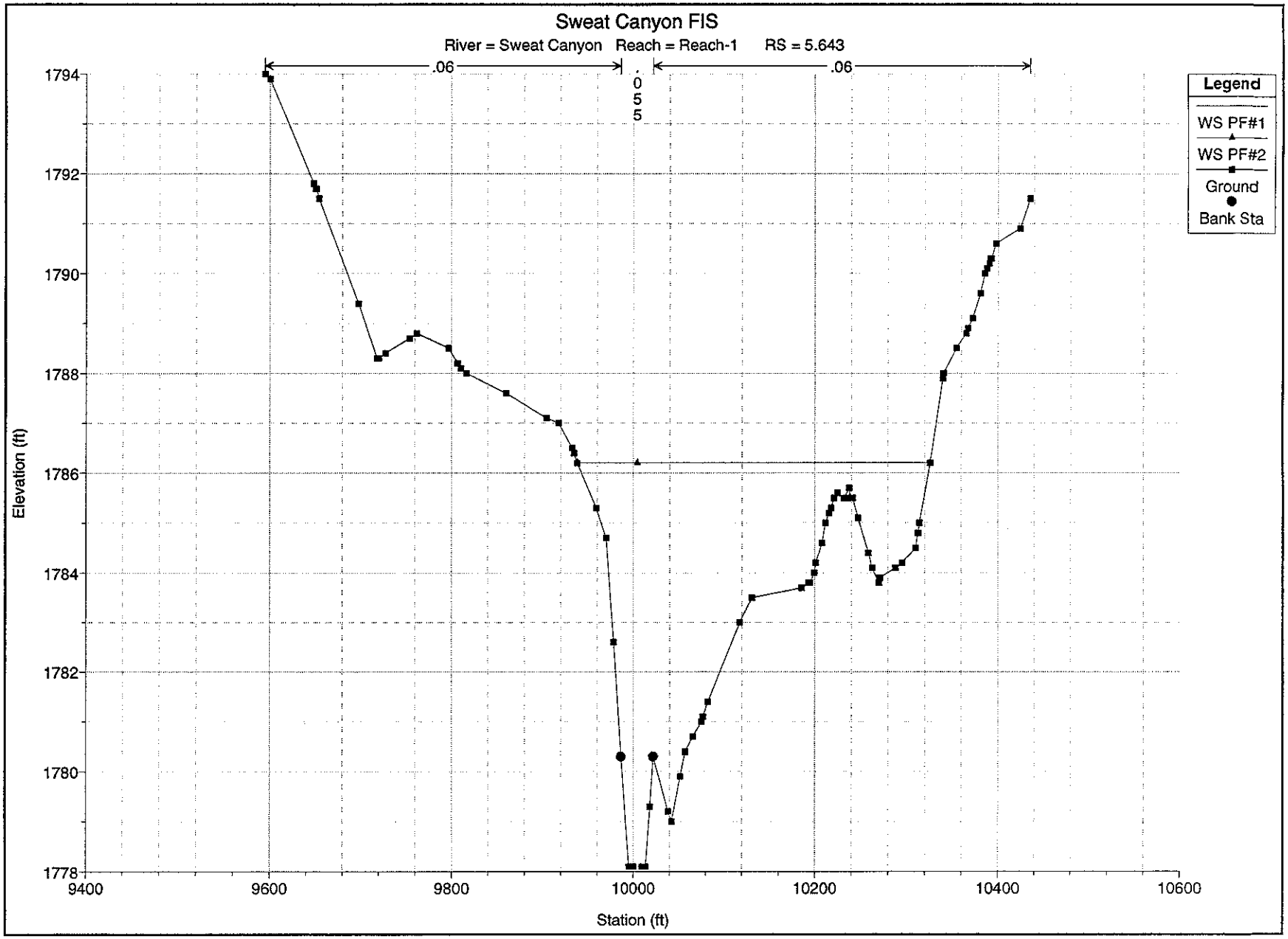

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.221
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1770
1768
1766
1764
1762
1760
1758
1756
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)

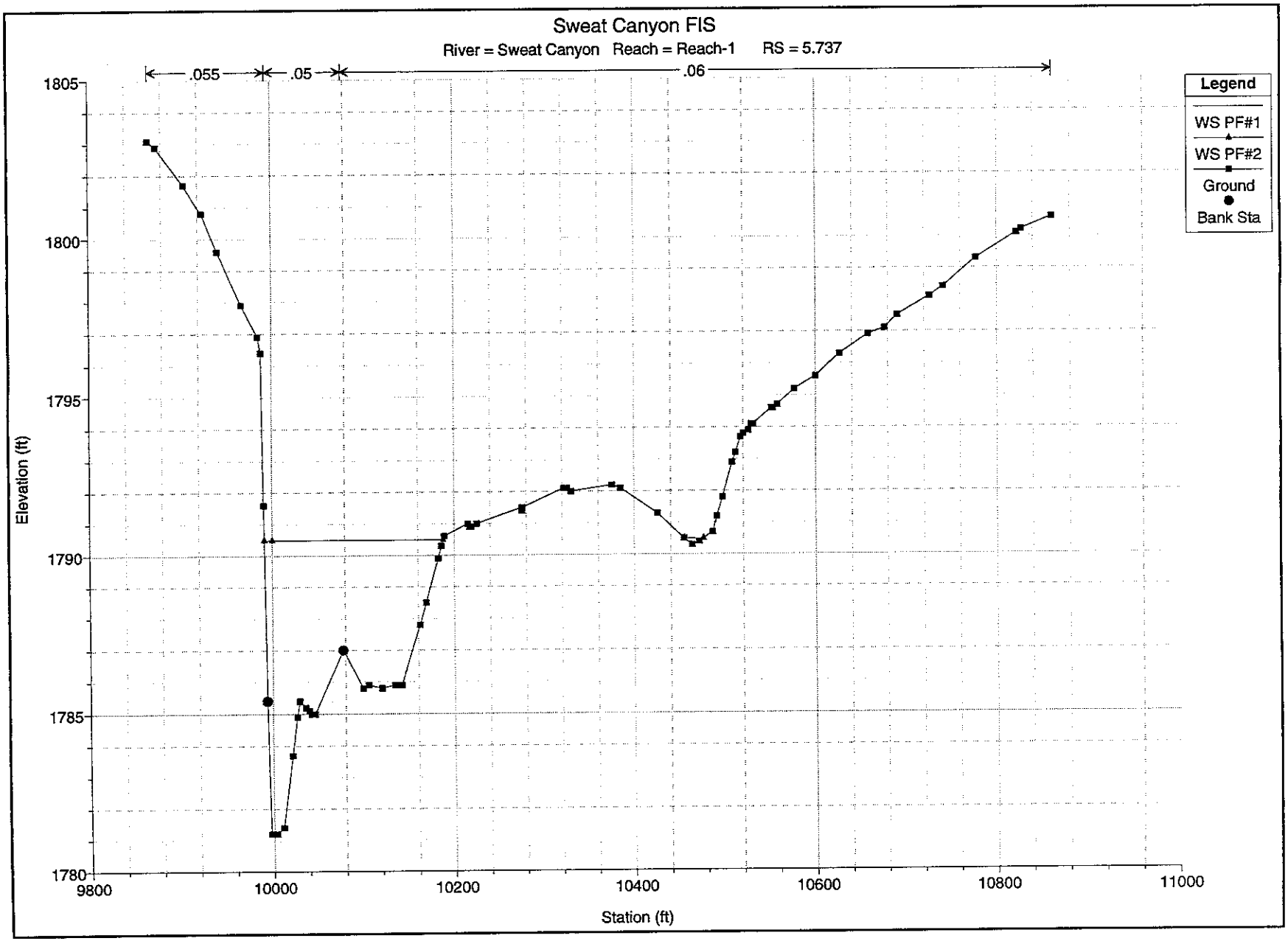

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.297
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1772
1770
1768
1766
1764
1762
1760
1758
9800
9900
10000
10100
10200
10300
10400
Station (ft)

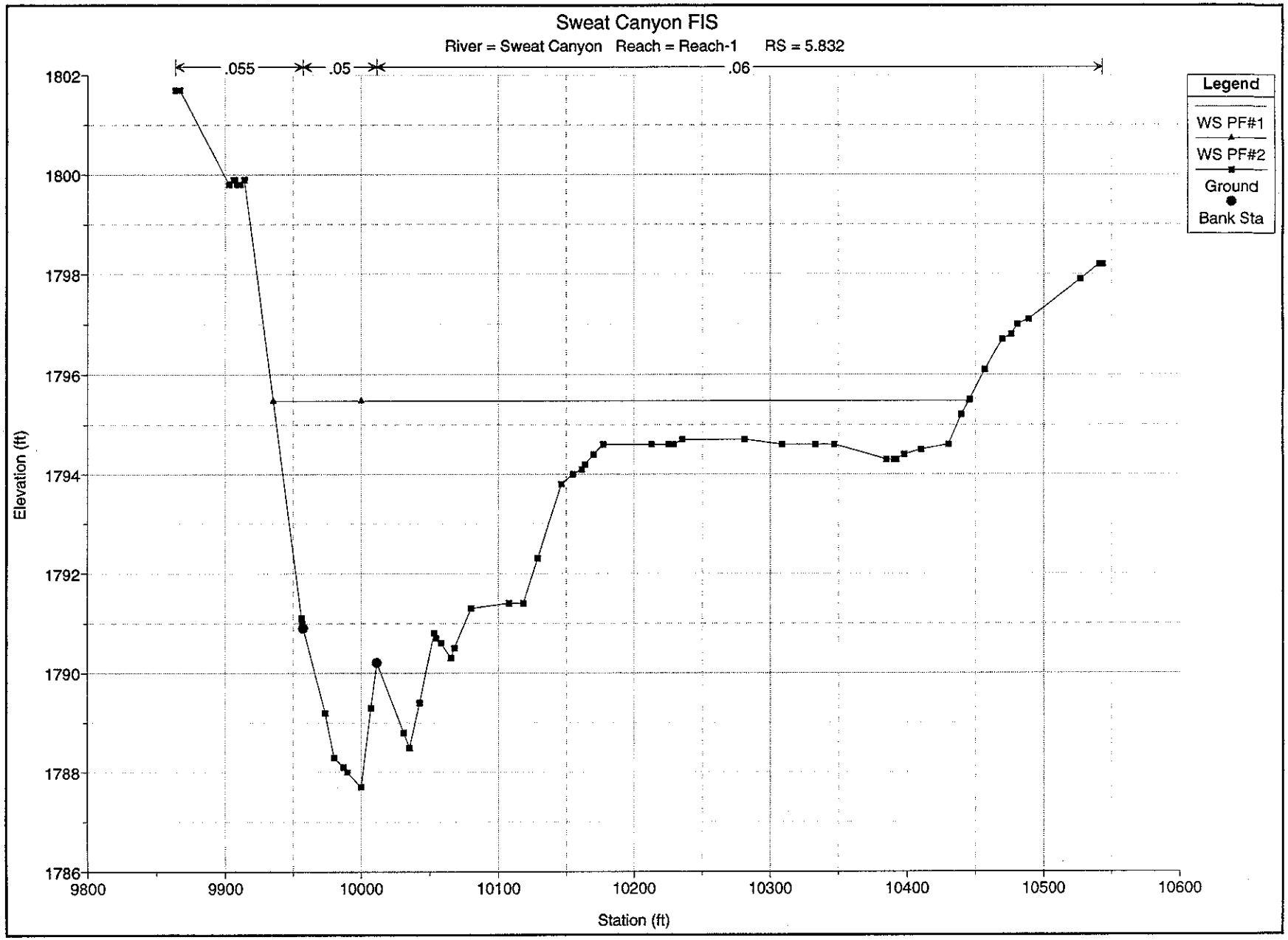

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.359
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1785
1780
1775
1770
1765
1760
9600
9800
10000
10200
10400
10600
10800
11000
Station (ft)

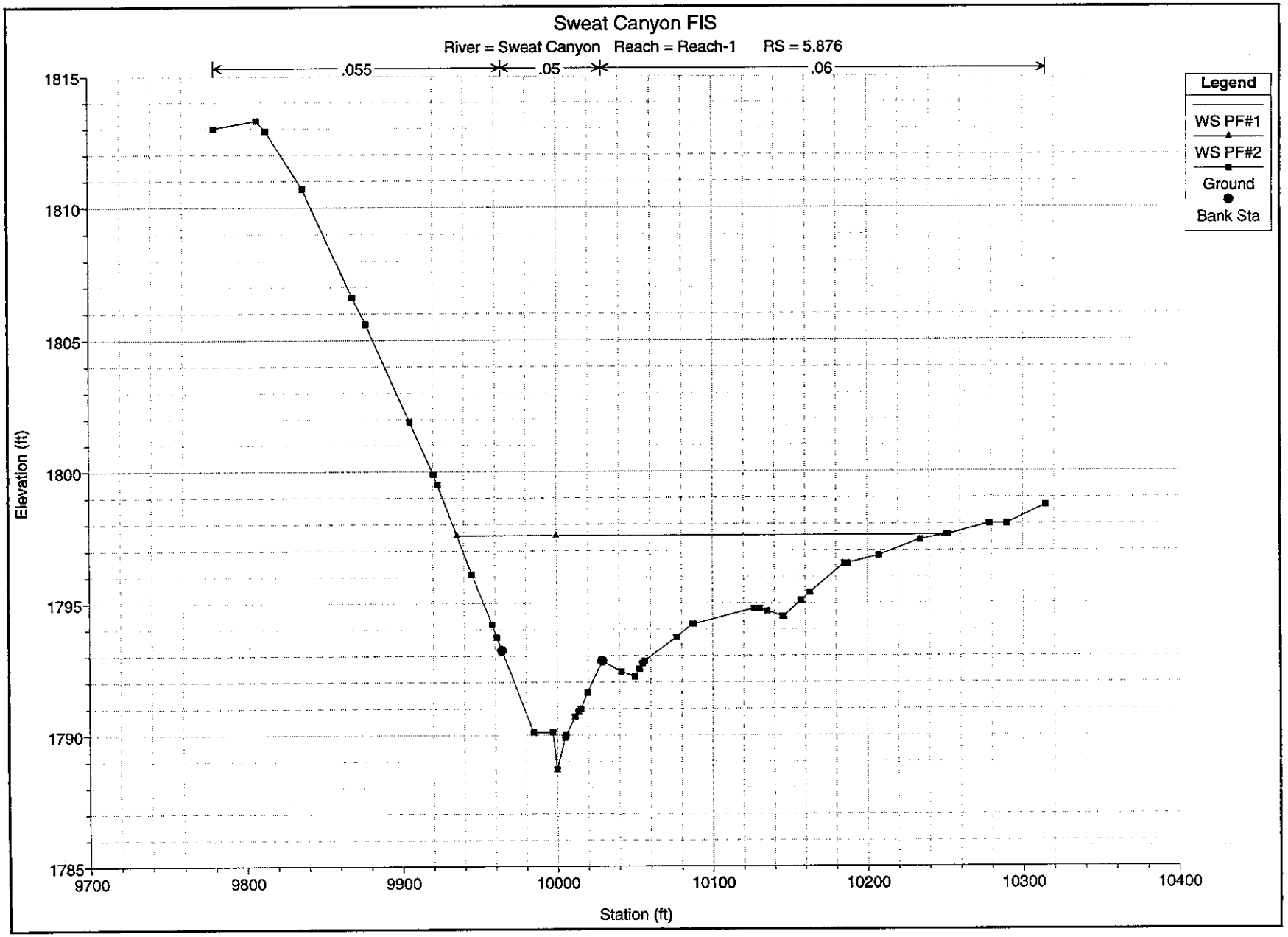

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.453
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1784
1782
1780
1778
1776
1774
1772
1770
1768
1766
9600
9800
10000
10200
10400
10600
10800
Station (ft)

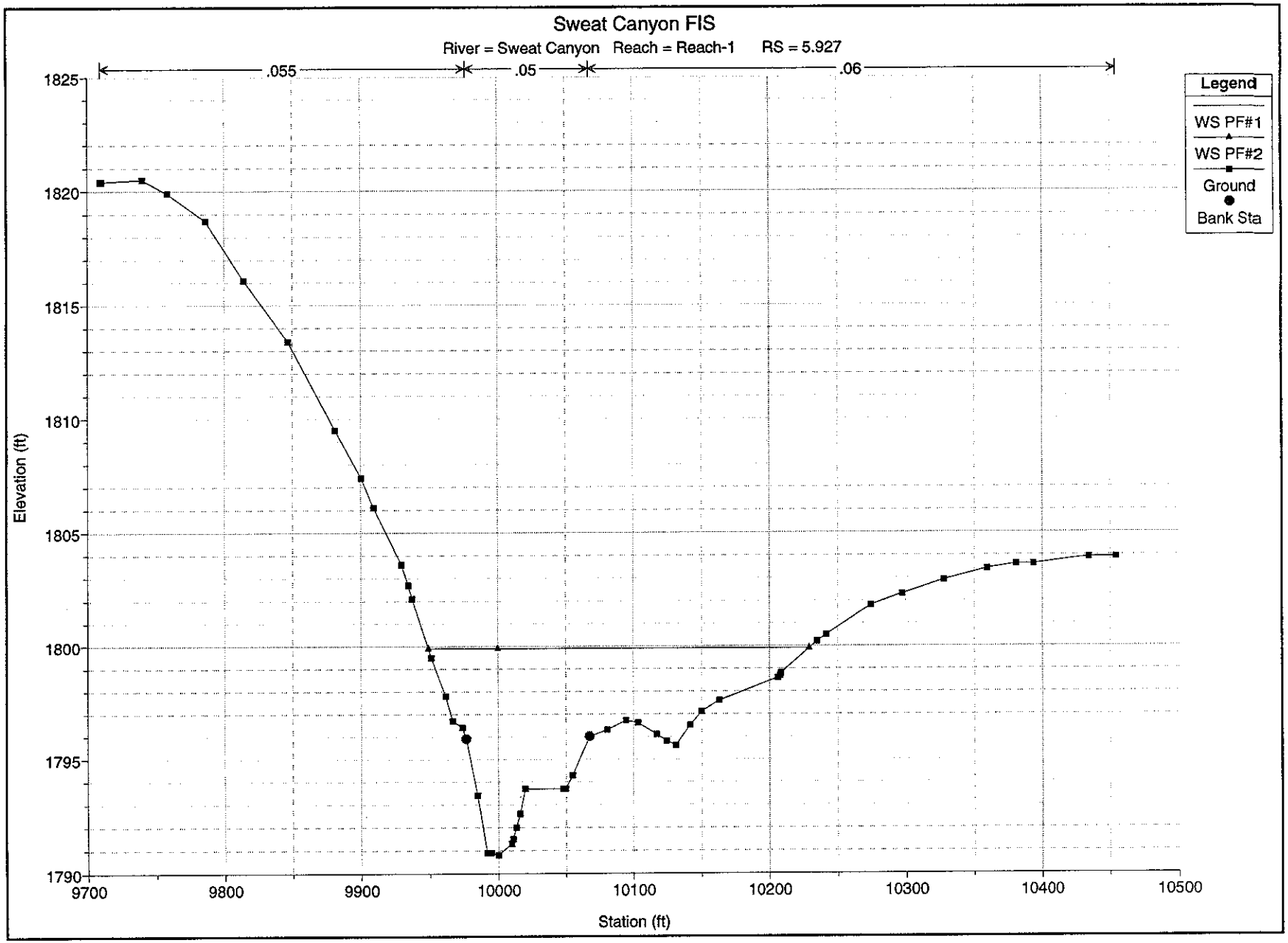

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.548
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1795
1790
1785
1780
1775
1770
9400
9600
9800
10000
10200
10400
Station (ft)

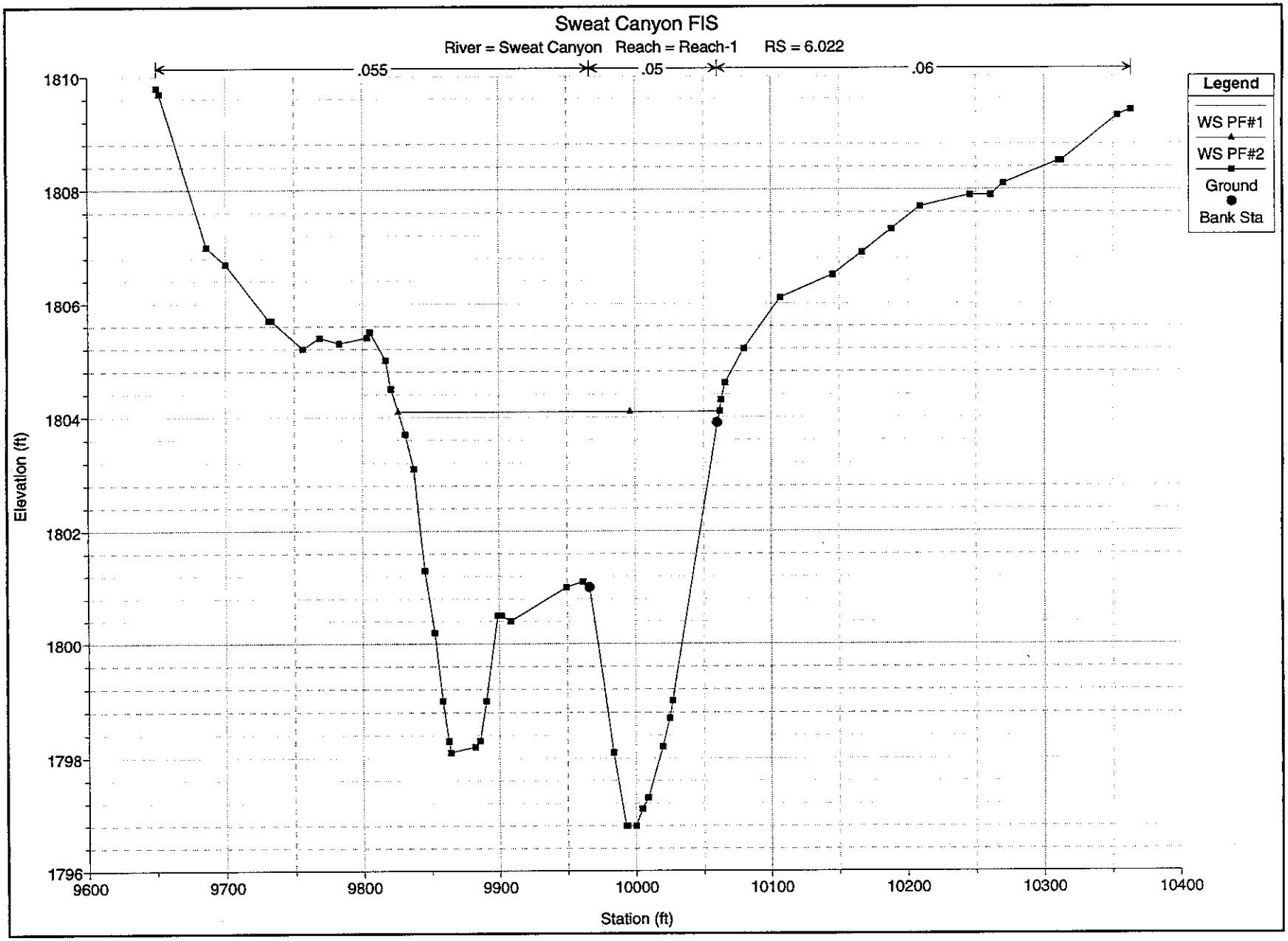

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.643
.06
.055
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1794
1792
1790
1788
1786
1784
1782
1780
1778
9400
9600
9800
10000
10200
10400
10600
Station (ft)

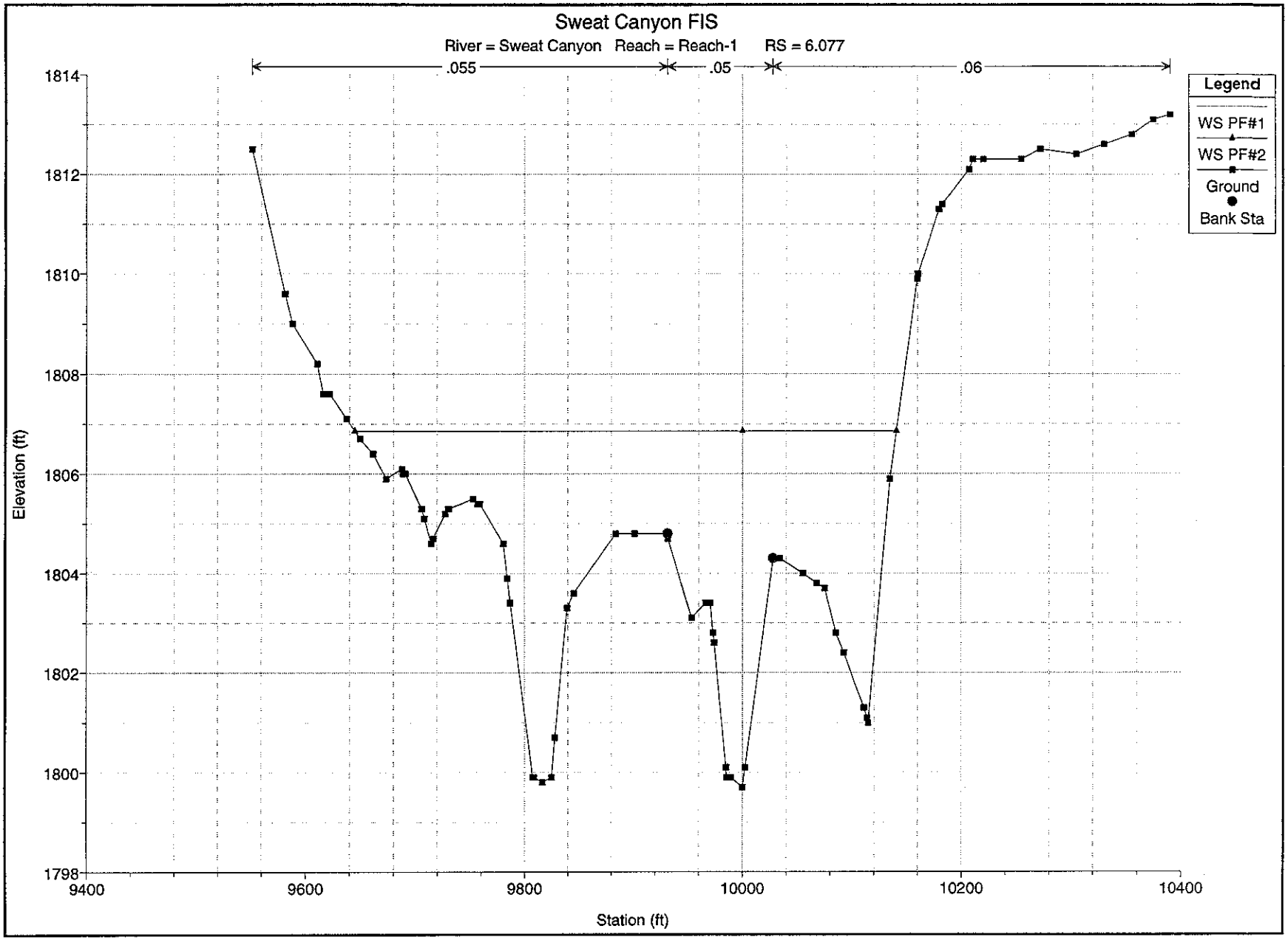

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.737
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1805
1800
1795
1790
1785
1780
9800
10000
10200
10400
10600
10800
11000
Station (ft)

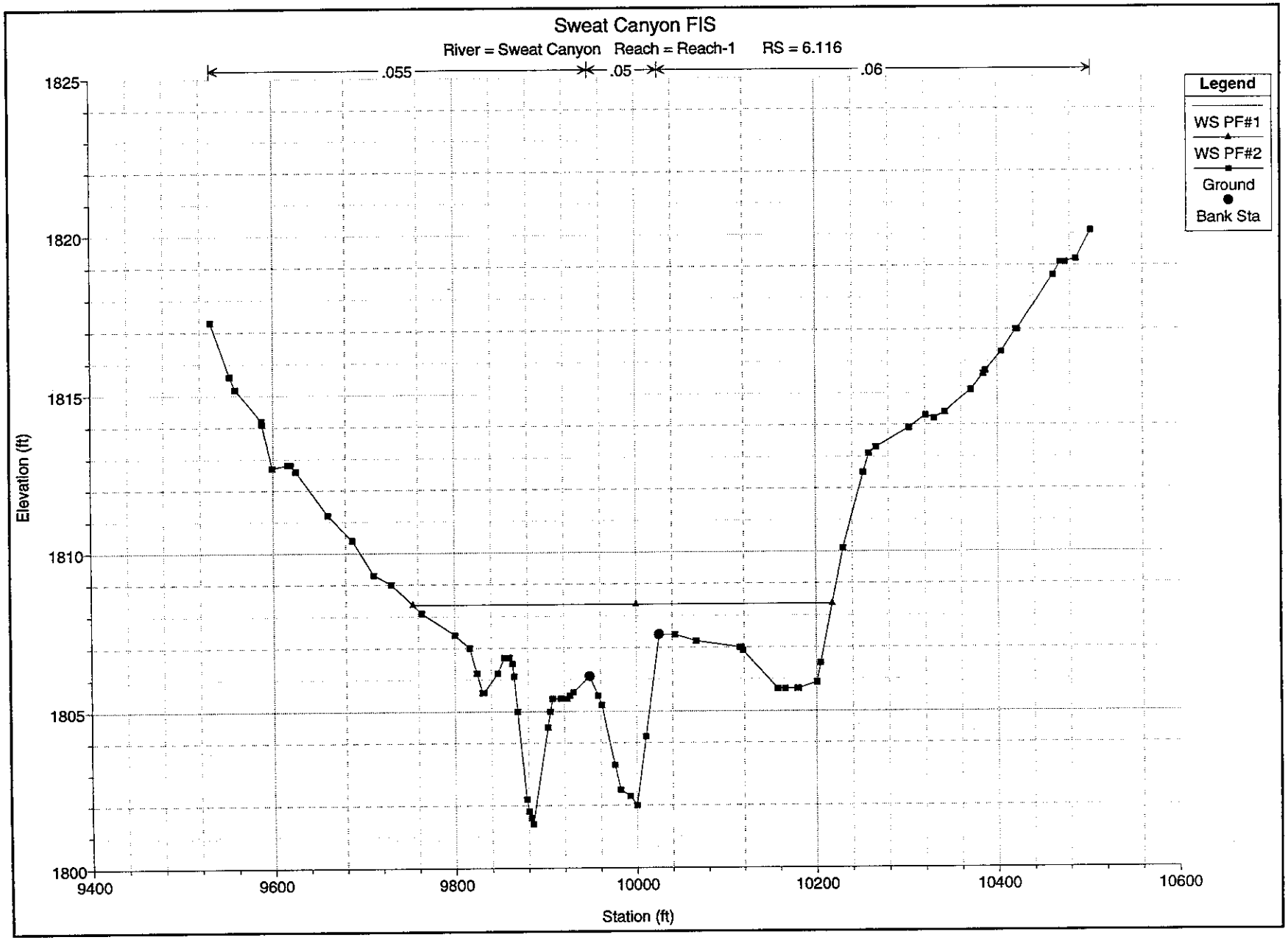

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.832
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1802
1800
1798
1796
1794
1792
1790
1788
1786
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

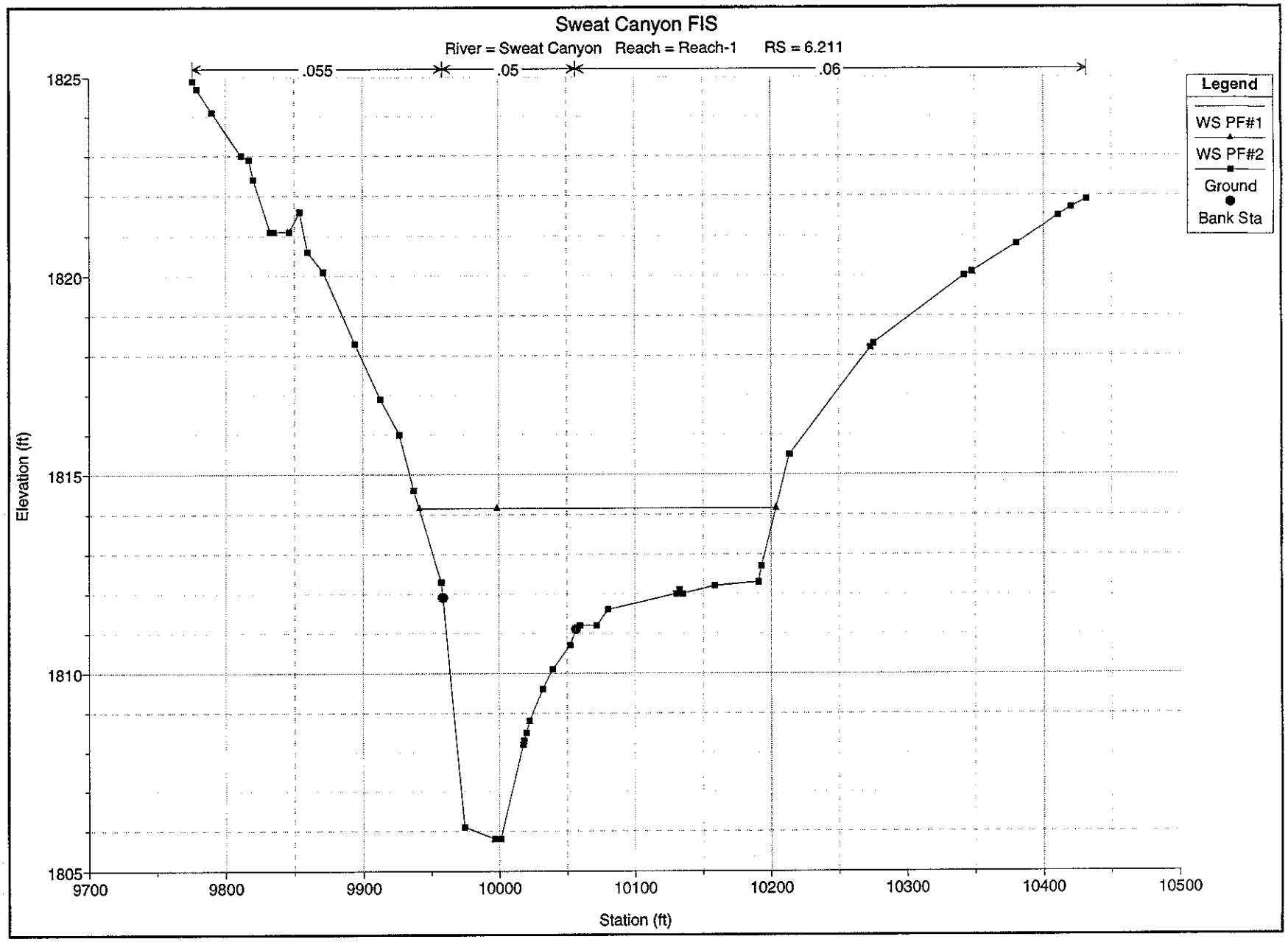

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.876
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1815
1810
1805
1800
1795
1790
1785
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

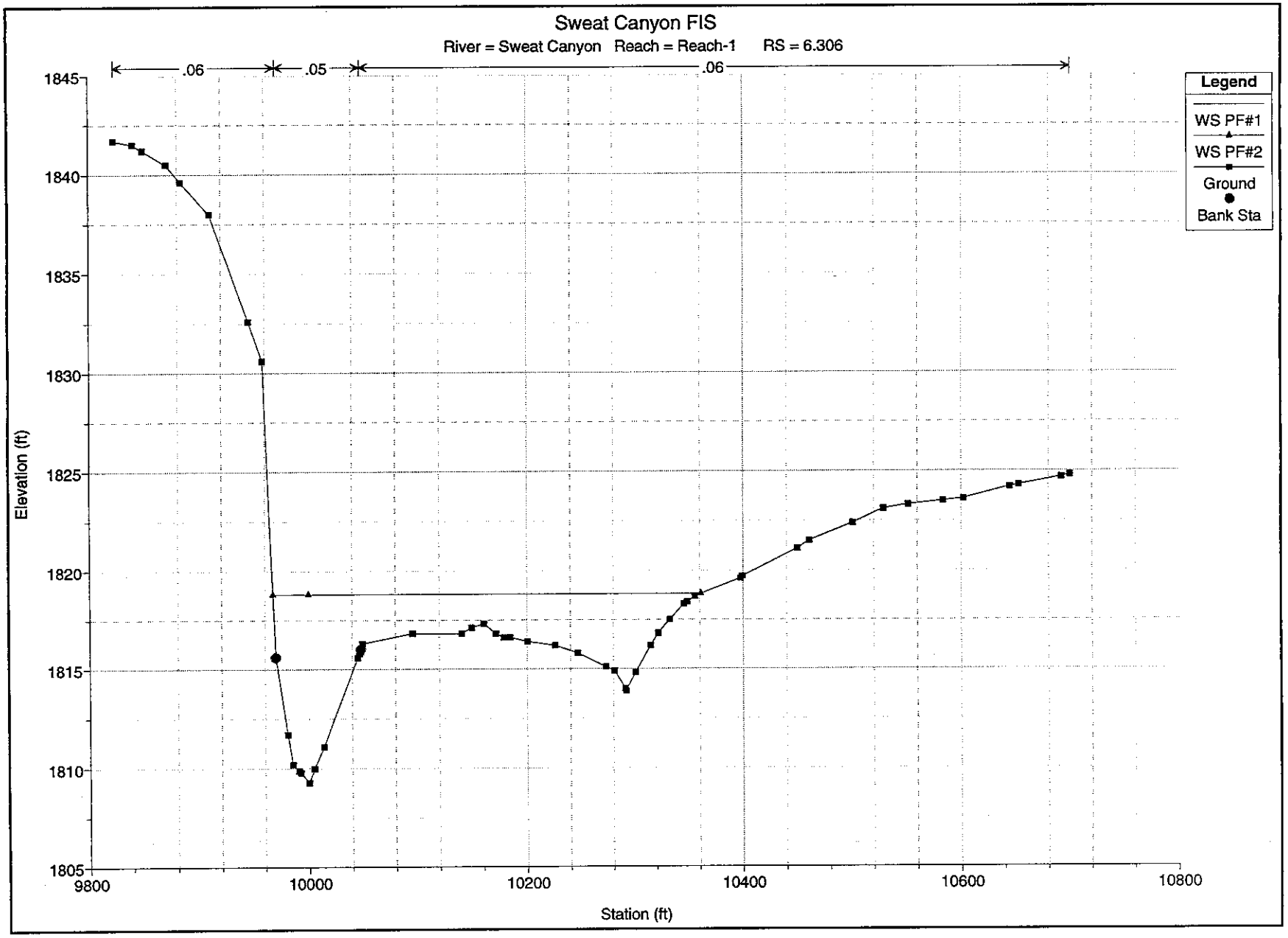

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 5.927
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1825
1820
1815
1810
1805
1800
1795
1790
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

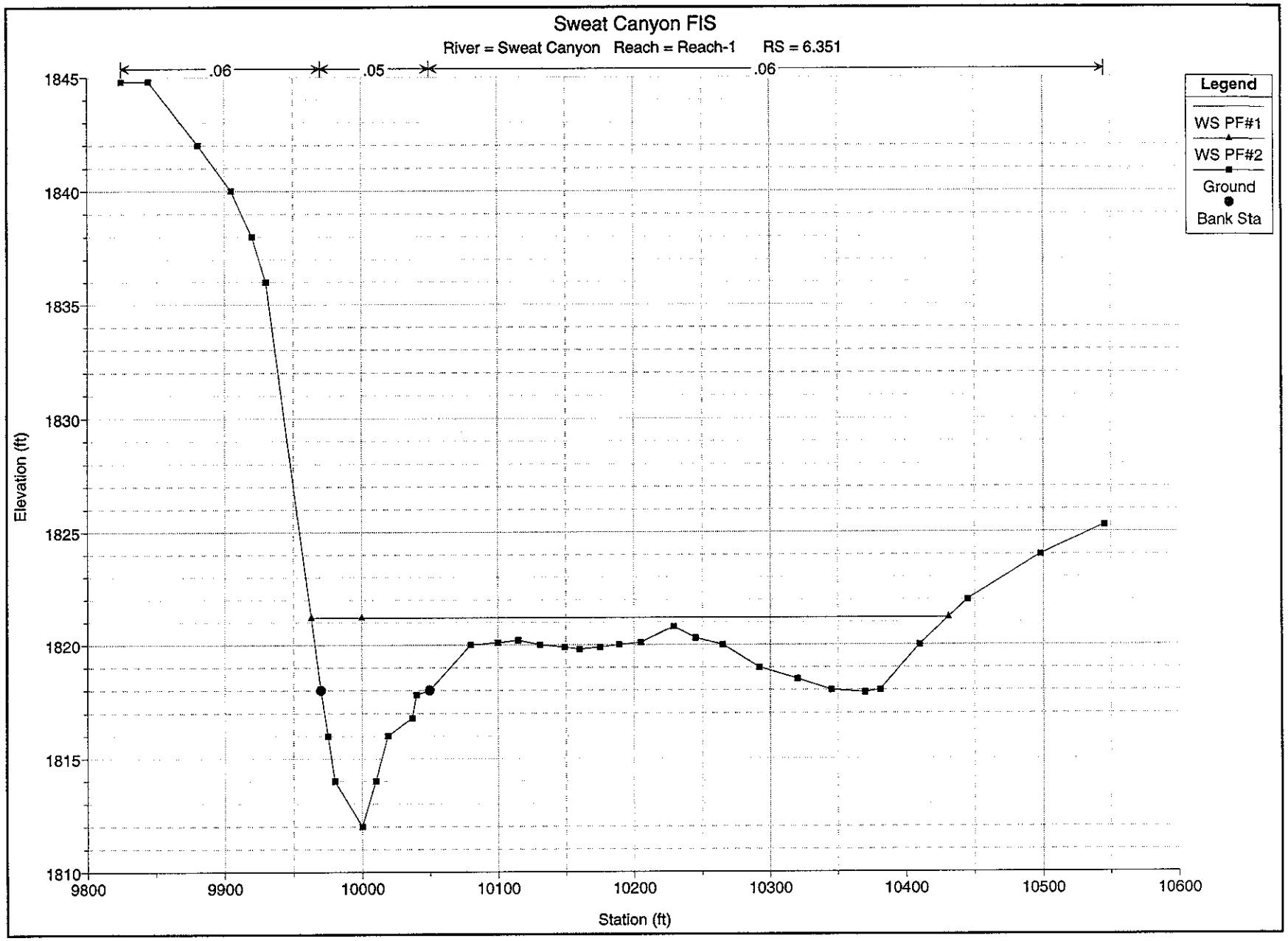

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.022
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1810
1808
1806
1804
1802
1800
1798
1796
9600
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

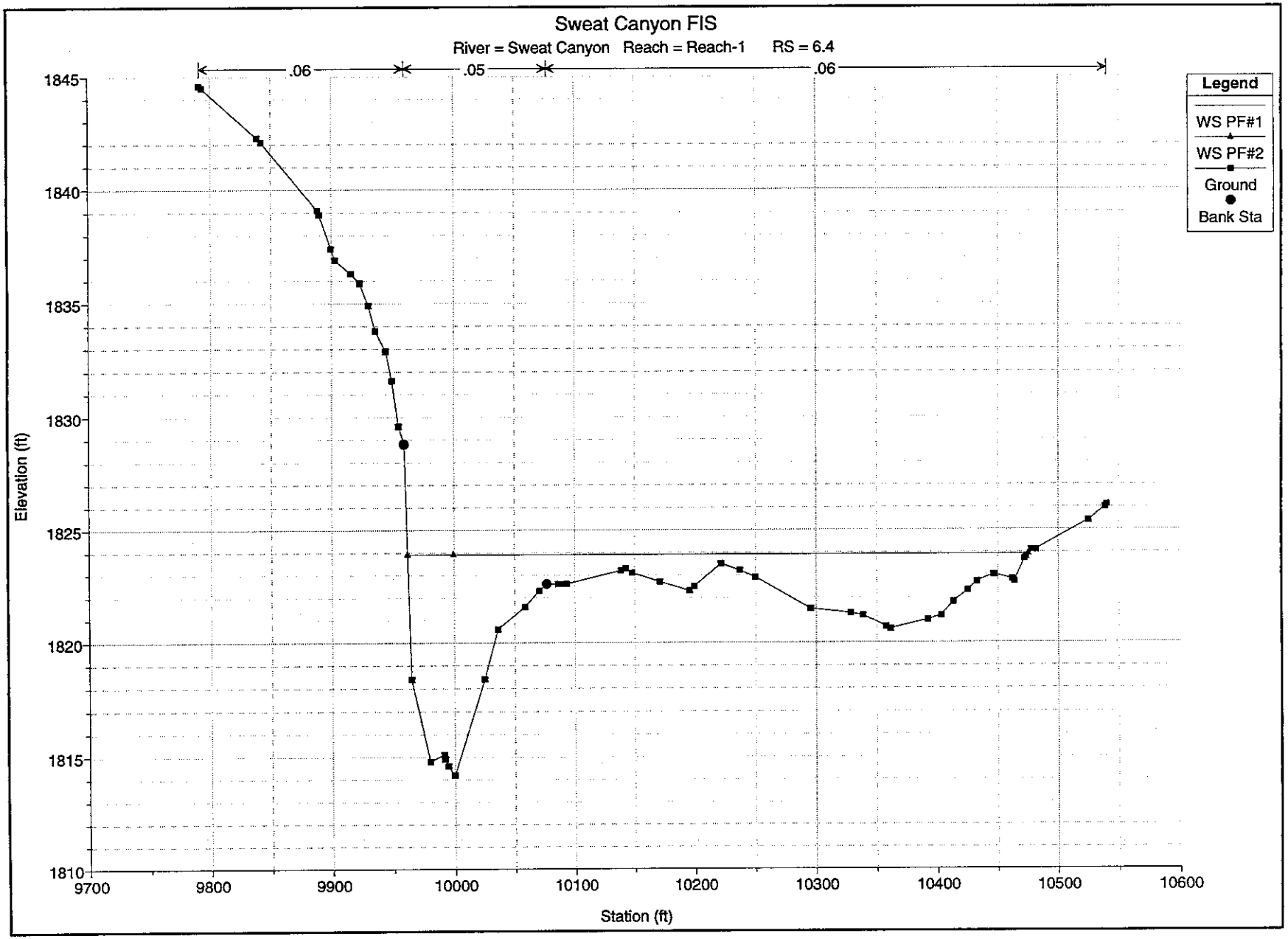

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.077
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1814
1812
1810
1808
1806
1804
1802
1800
1798
9400
9600
9800
10000
10200
10400
Station (ft)

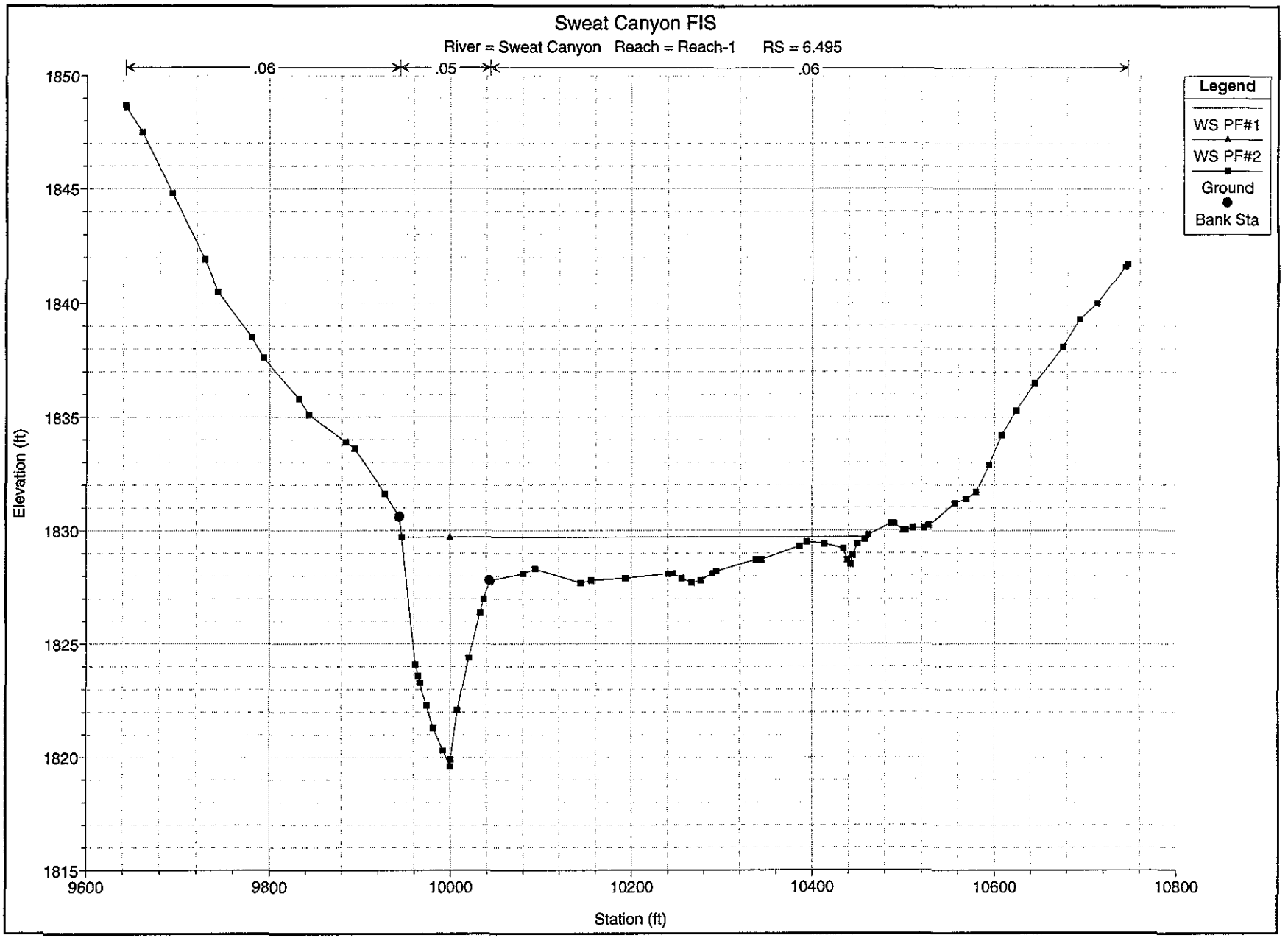

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.116
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1825
1820
1815
1810
1805
1800
9400
9600
9800
10000
10200
10400
10600
Station (ft)

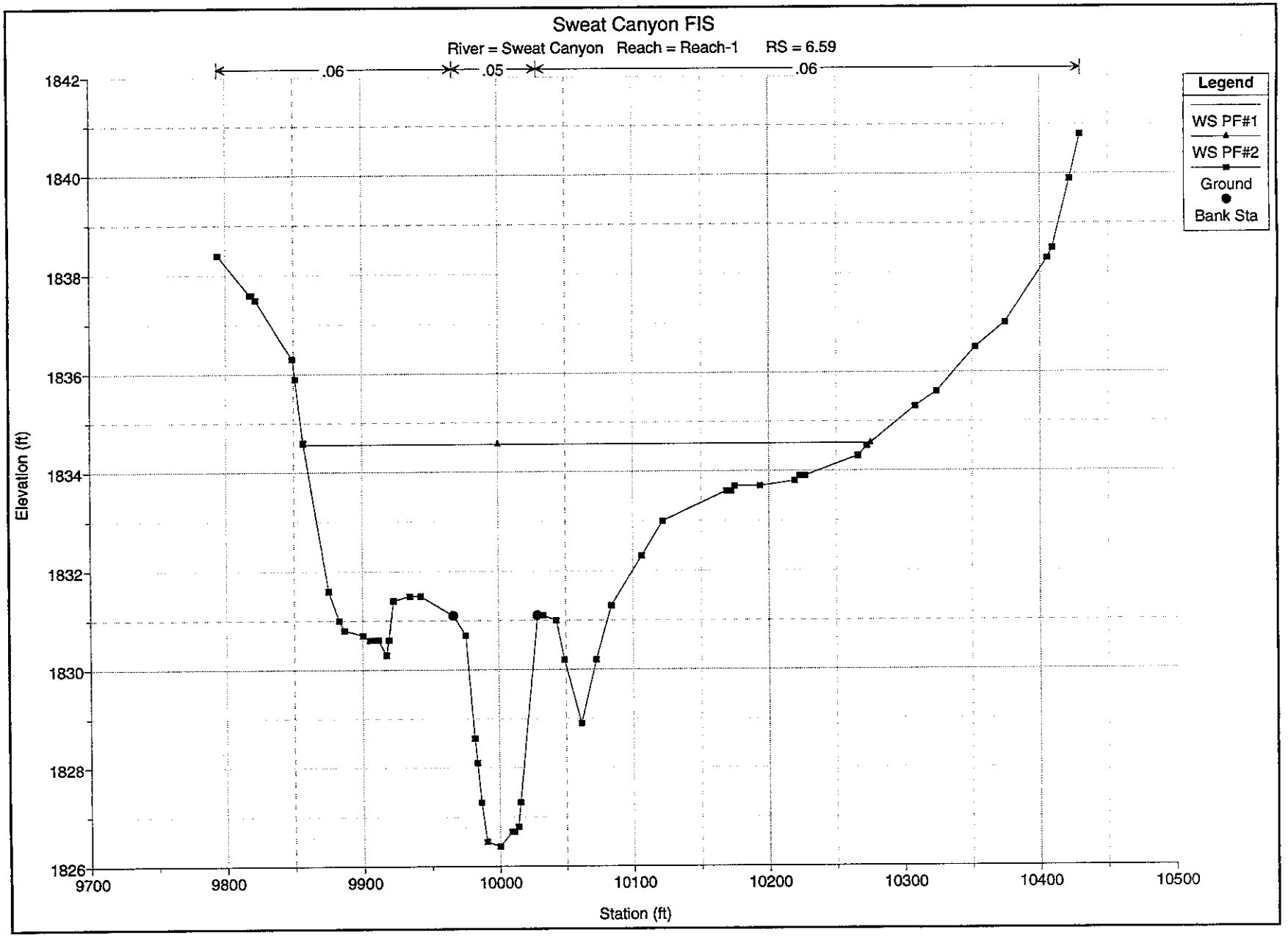

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.211
.055
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1825
1820
1815
1810
1805
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

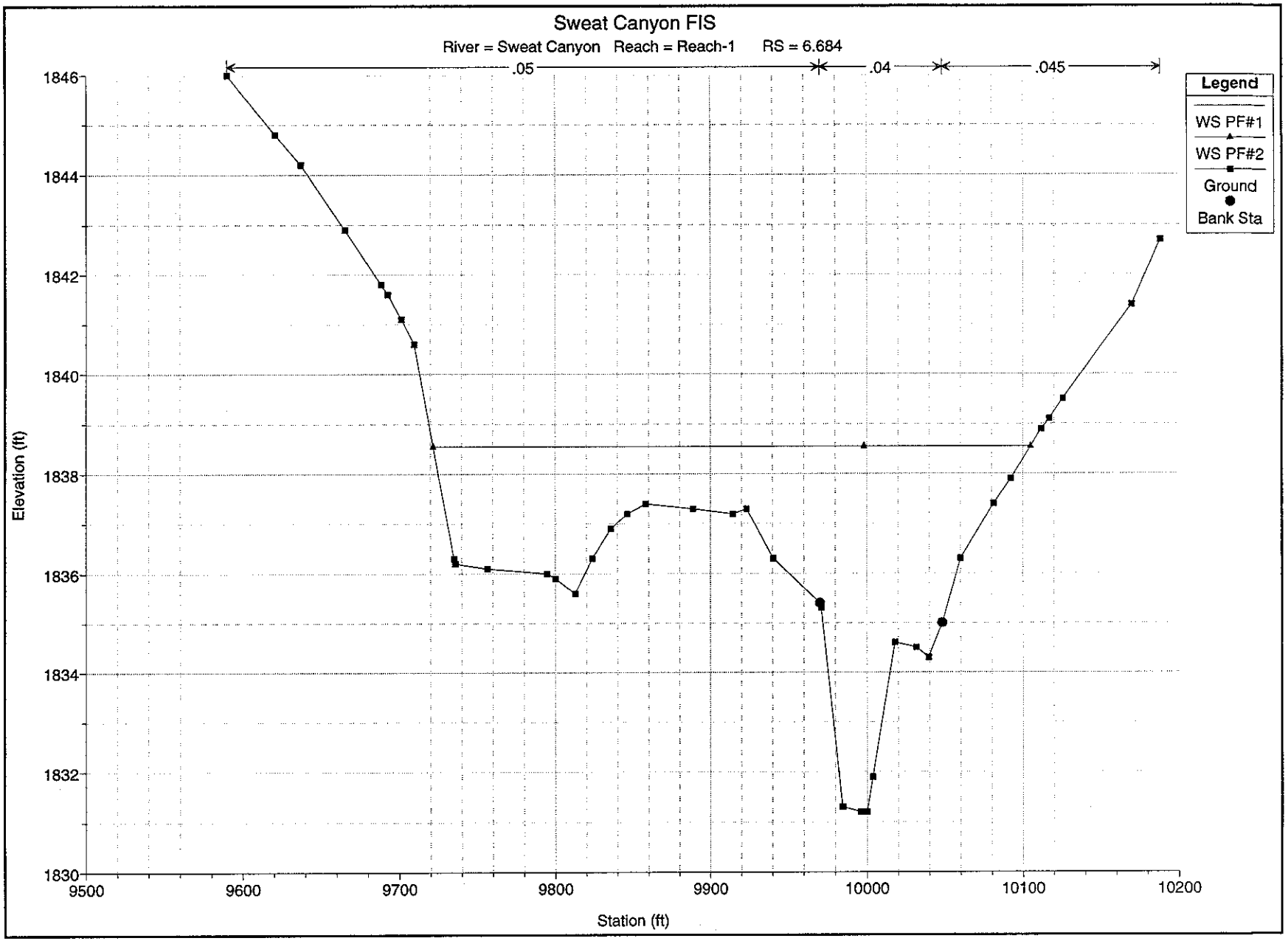

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.306
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1845
1840
1835
1830
1825
1820
1815
1810
1805
9800
10000
10200
10400
10600
10800
Station (ft)

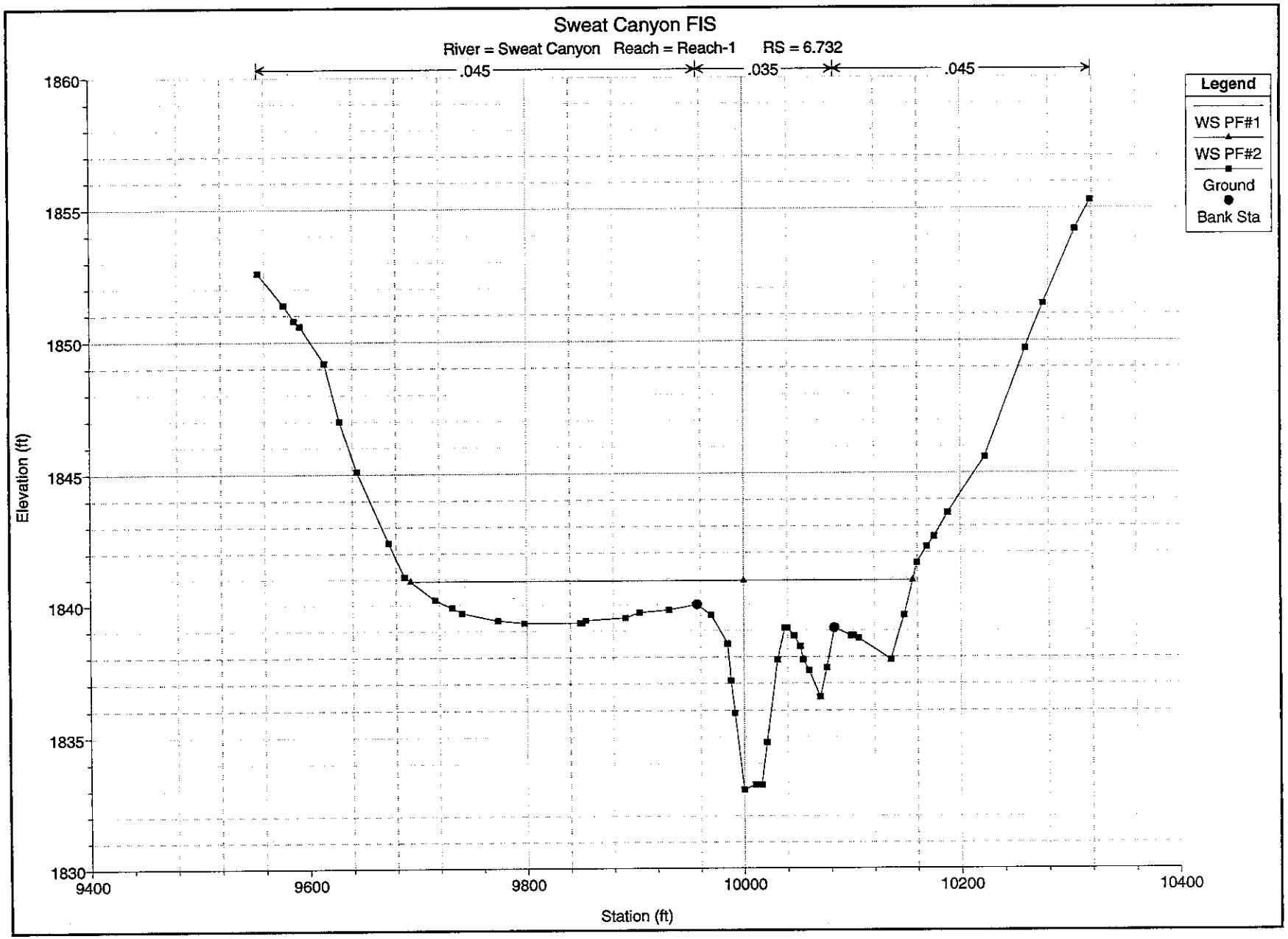

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.351
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1845
1840
1835
1830
1825
1820
1815
1810
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

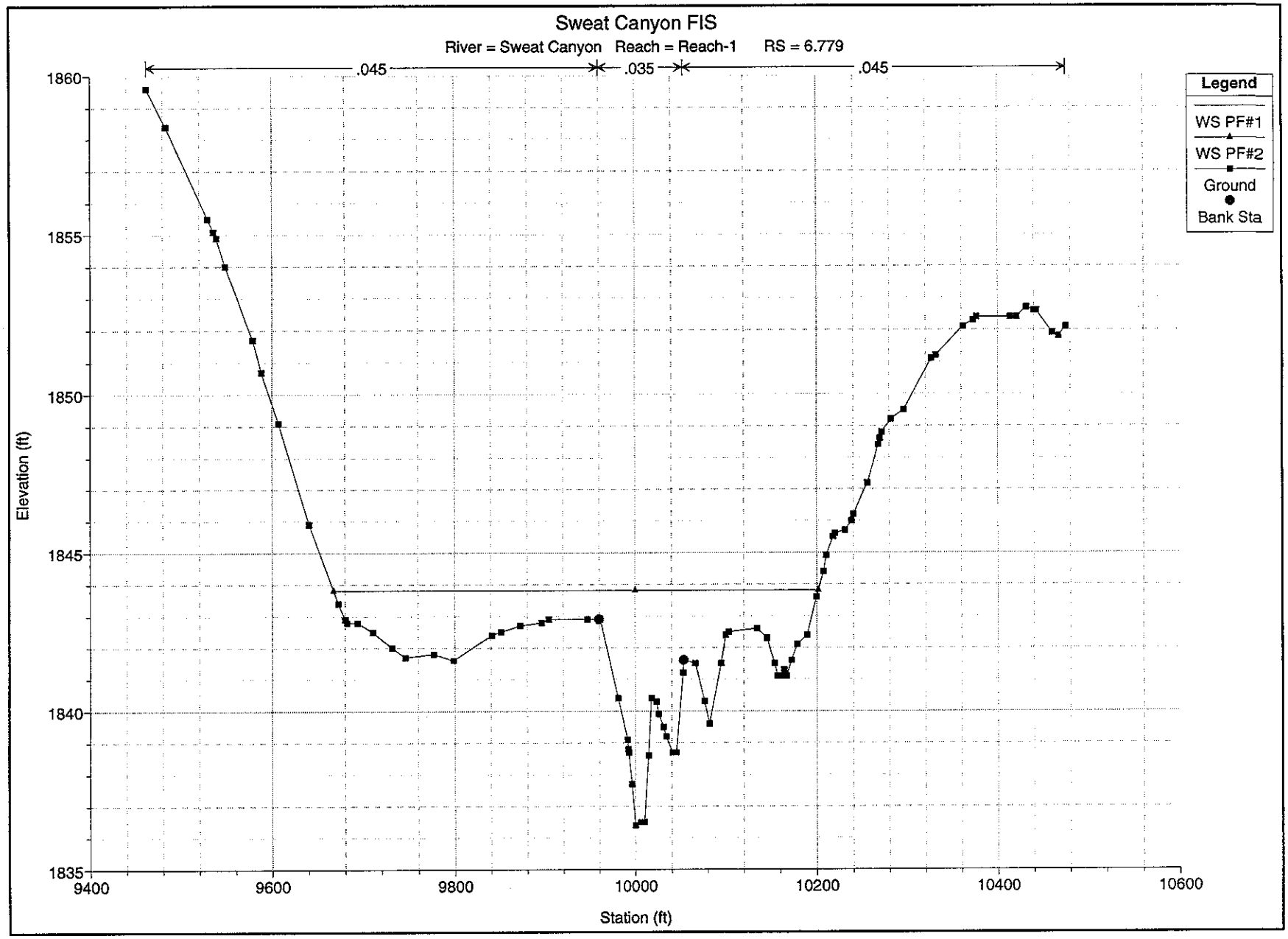

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.4
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1845
1840
1835
1830
1825
1820
1815
1810
9700
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

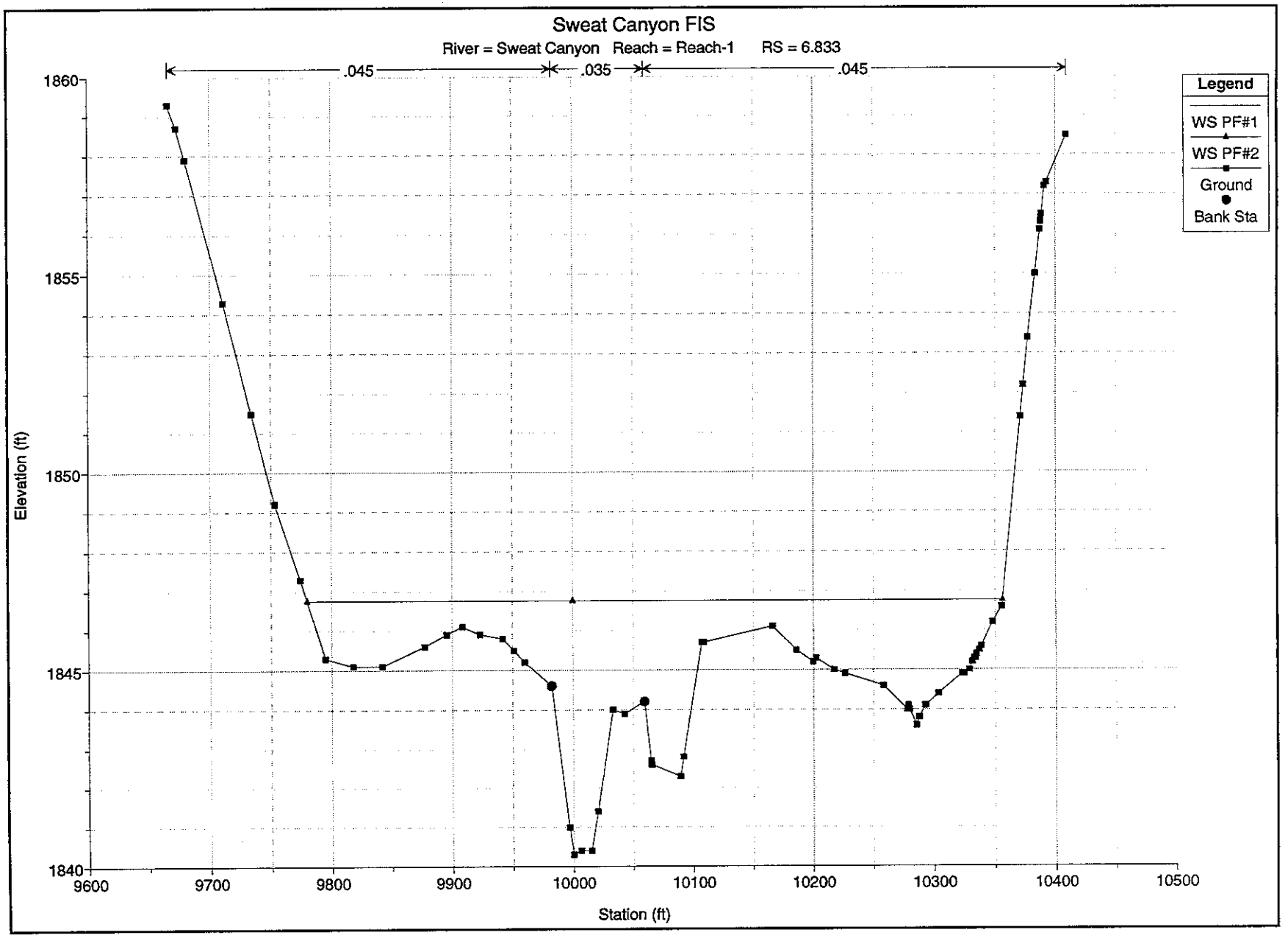

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.495
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1850
1845
1840
1835
1830
1825
1820
1815
9600
9800
10000
10200
10400
10600
10800
Station (ft)

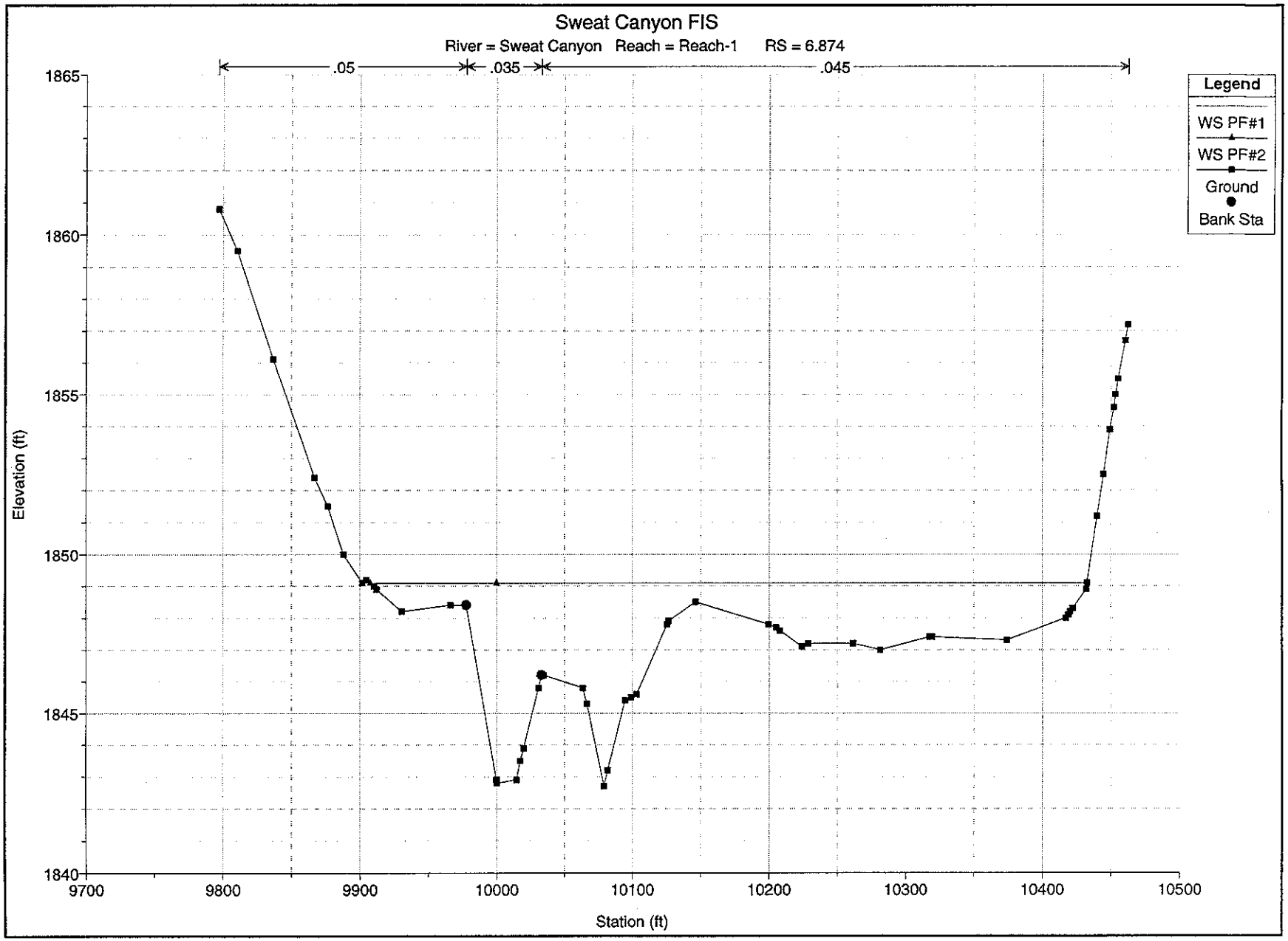

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.59
.06
.05
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1842
1840
1838
1836
1834
1832
1830
1828
1826
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

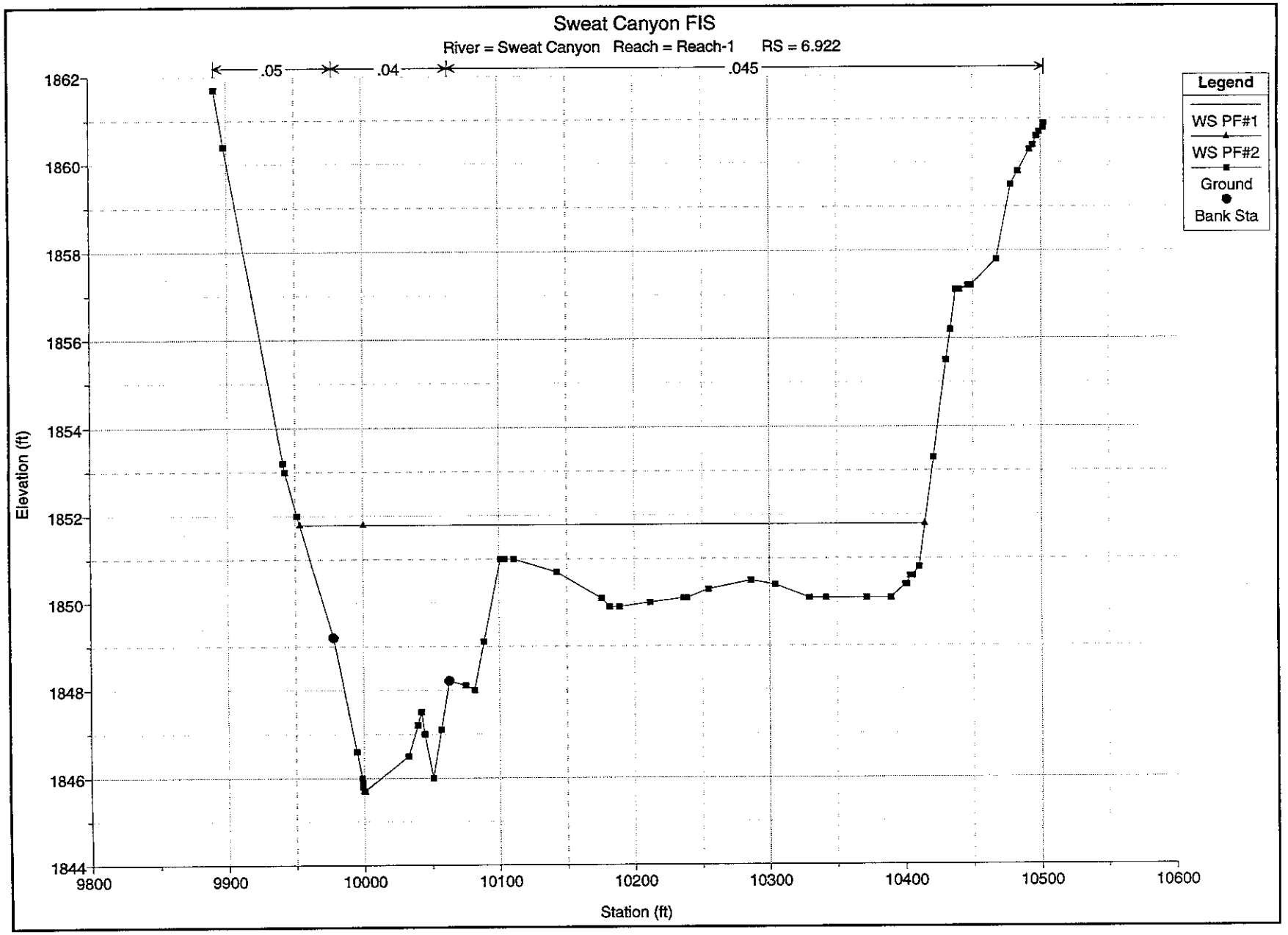

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.684
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1846
1844
1842
1840
1838
1836
1834
1832
1830
9500
9600
9700
9800
9900
10000
10100
10200
Station (ft)

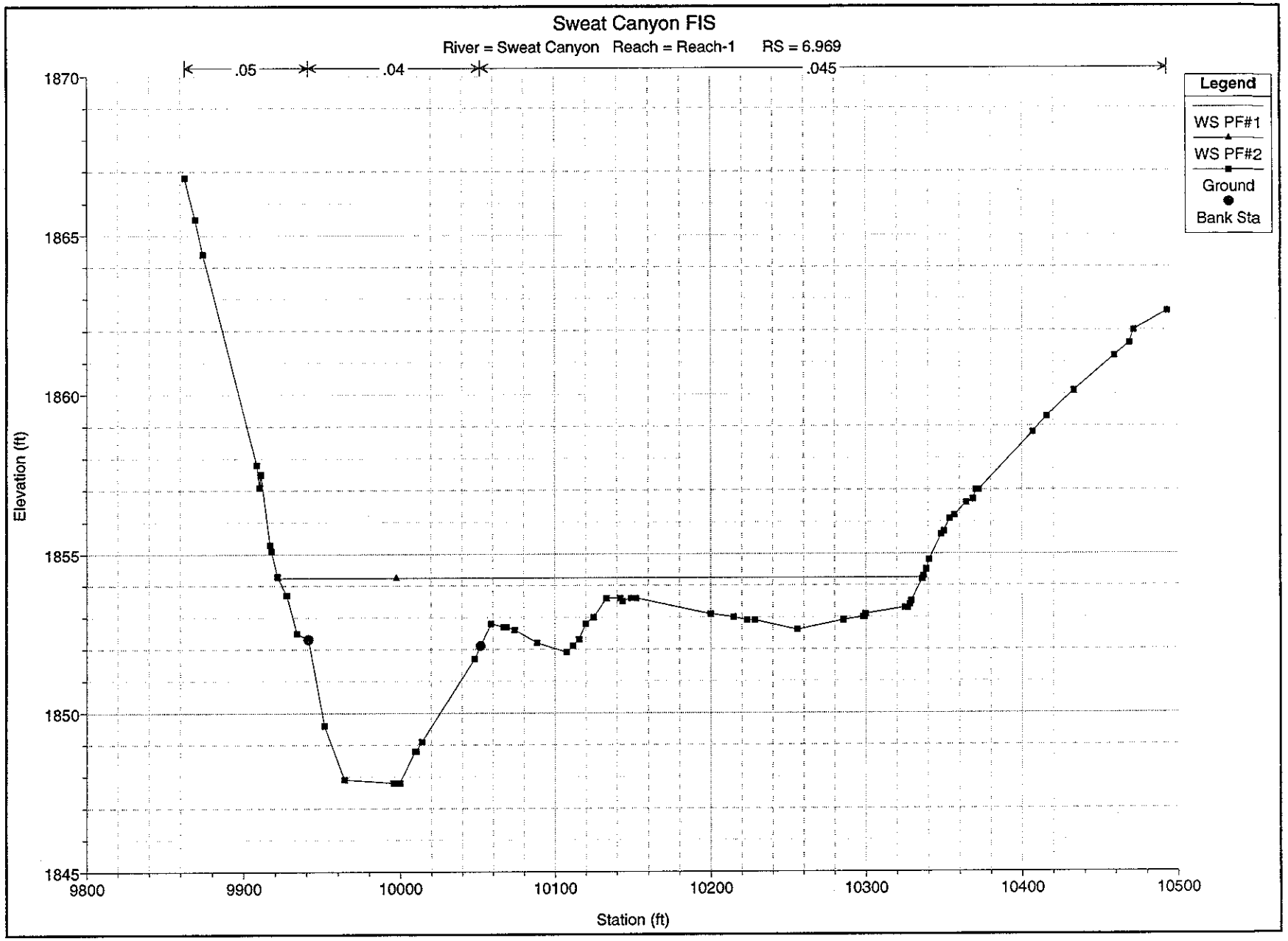

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.732
.045
.035
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1860
1855
1850
1845
1840
1835
1830
9400
9600
9800
10000
10200
10400
Station (ft)

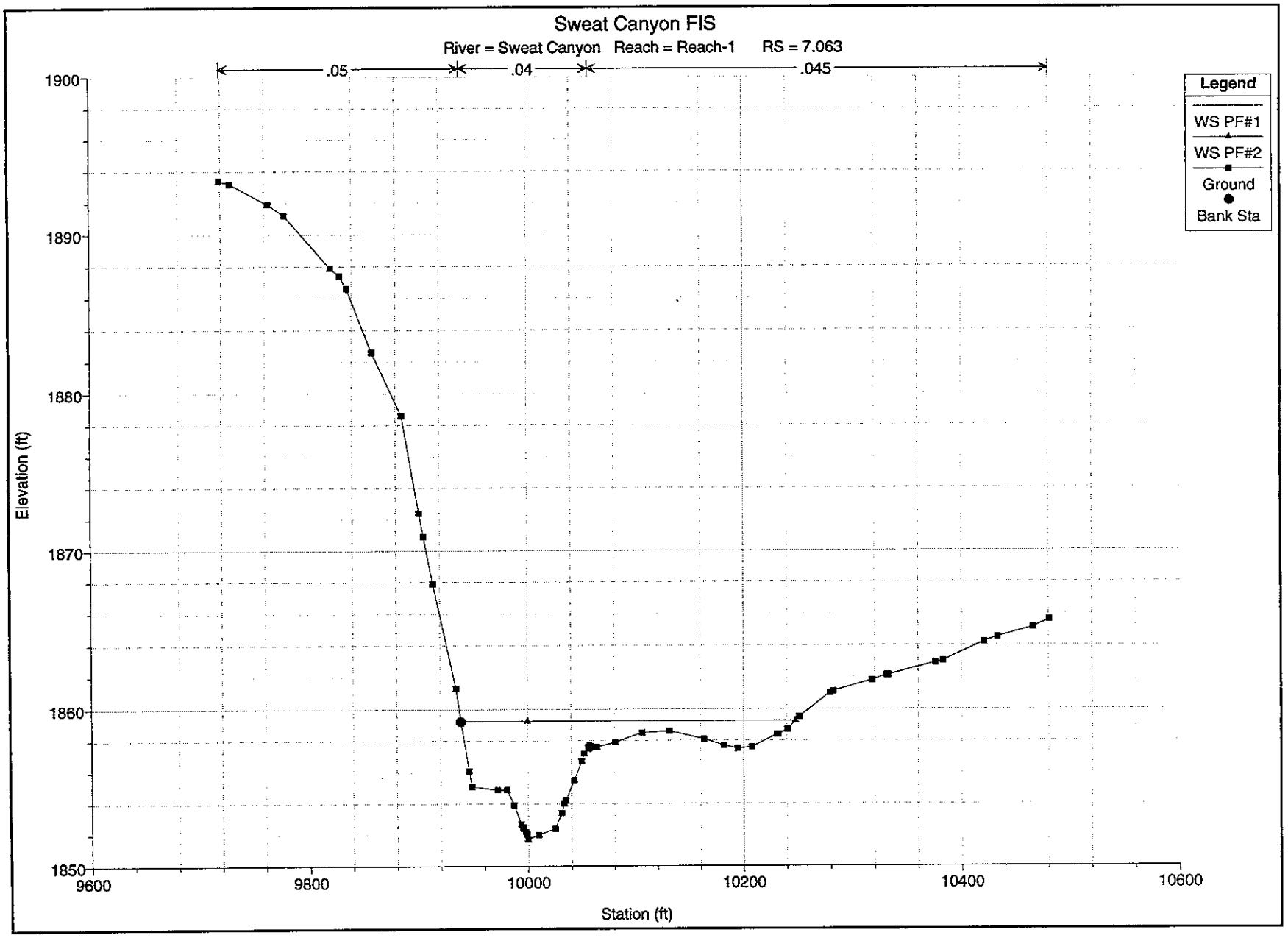

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.779
.045
.035
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1860
1855
1850
1845
1840
1835
9400
9600
9800
10000
10200
10400
10600
Station (ft)

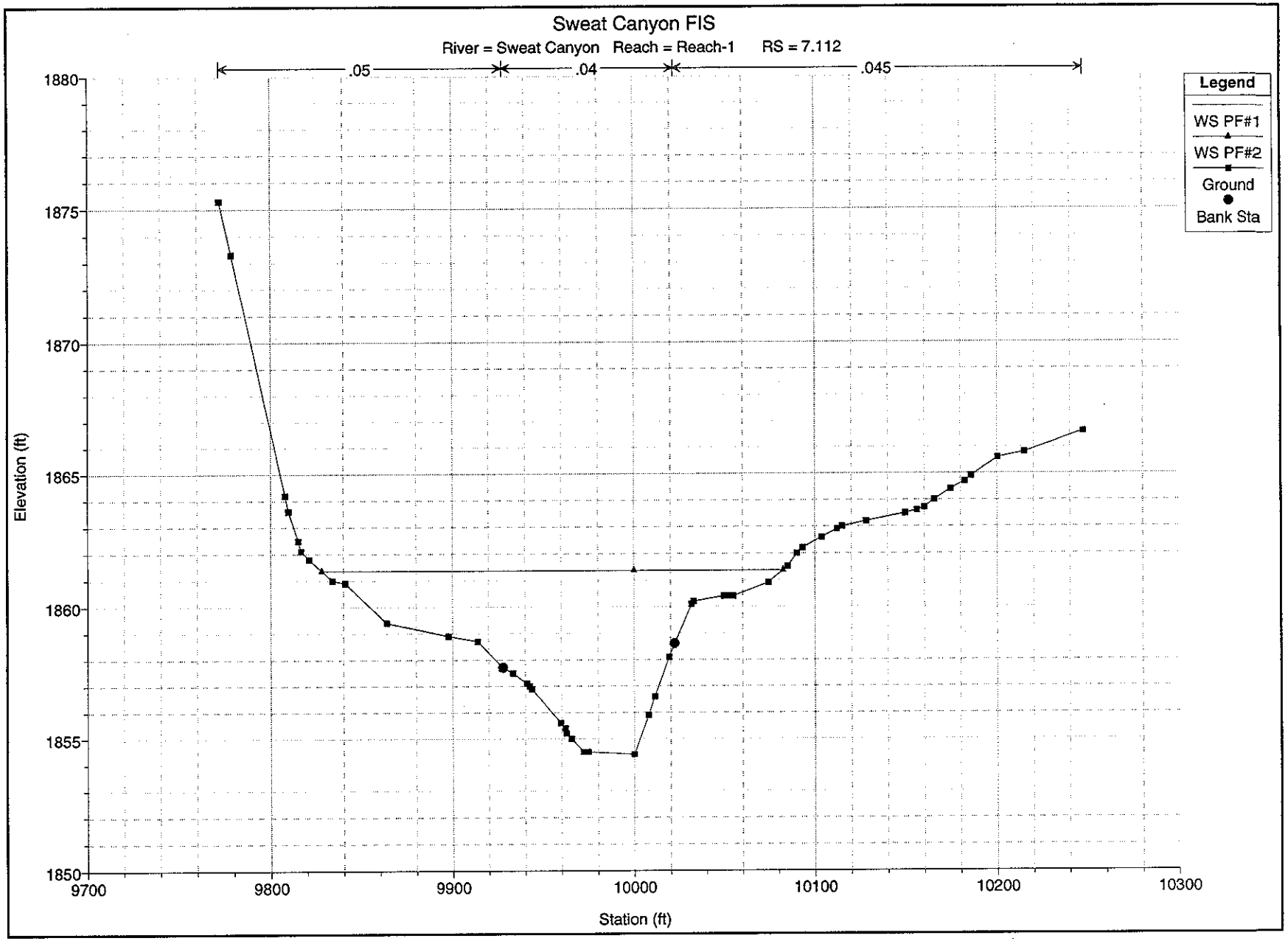

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.833
.045
.035
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1860
1855
1850
1845
1840
9600
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

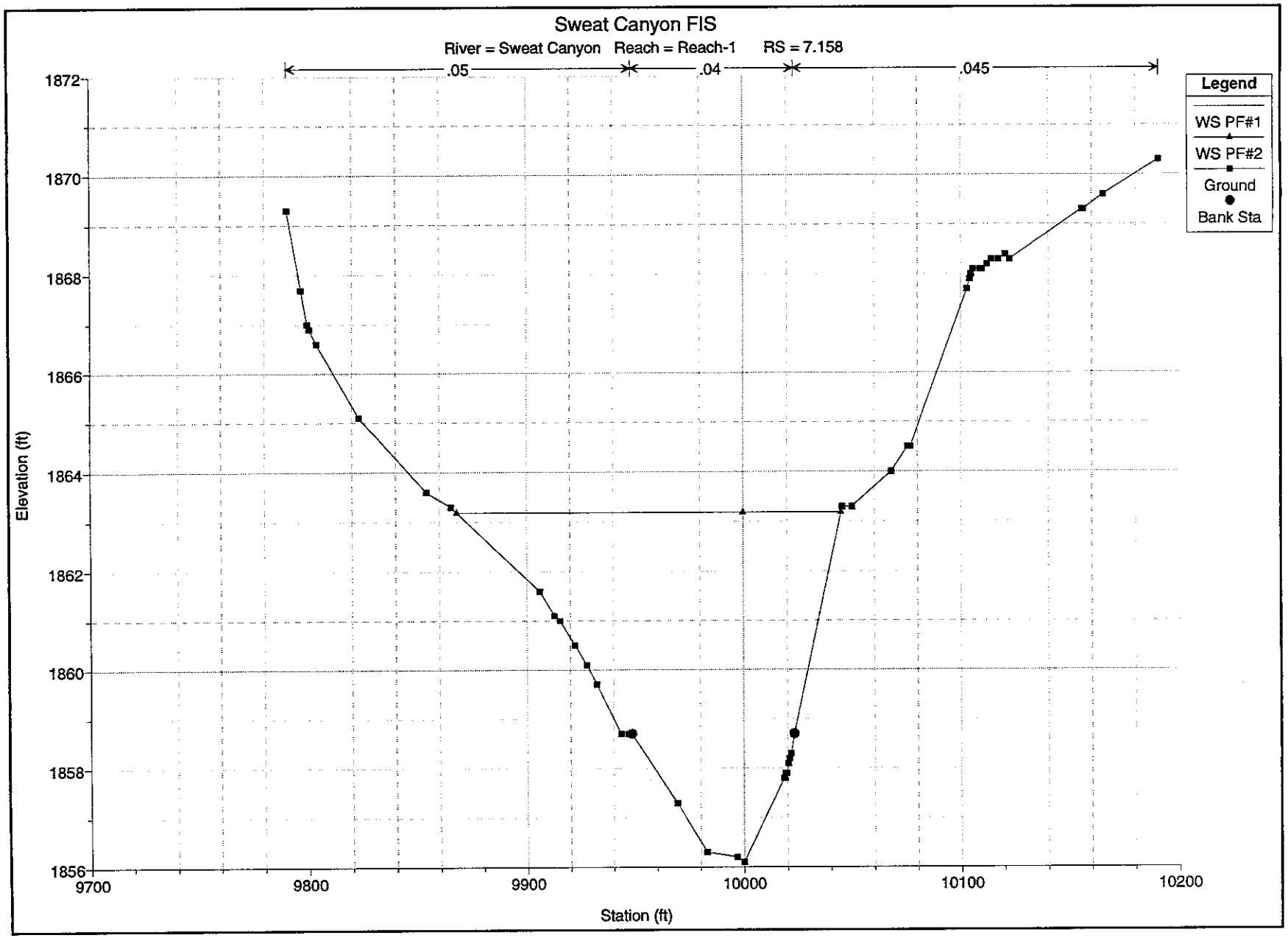

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.874
.05
.035
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1865
1860
1855
1850
1845
1840
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

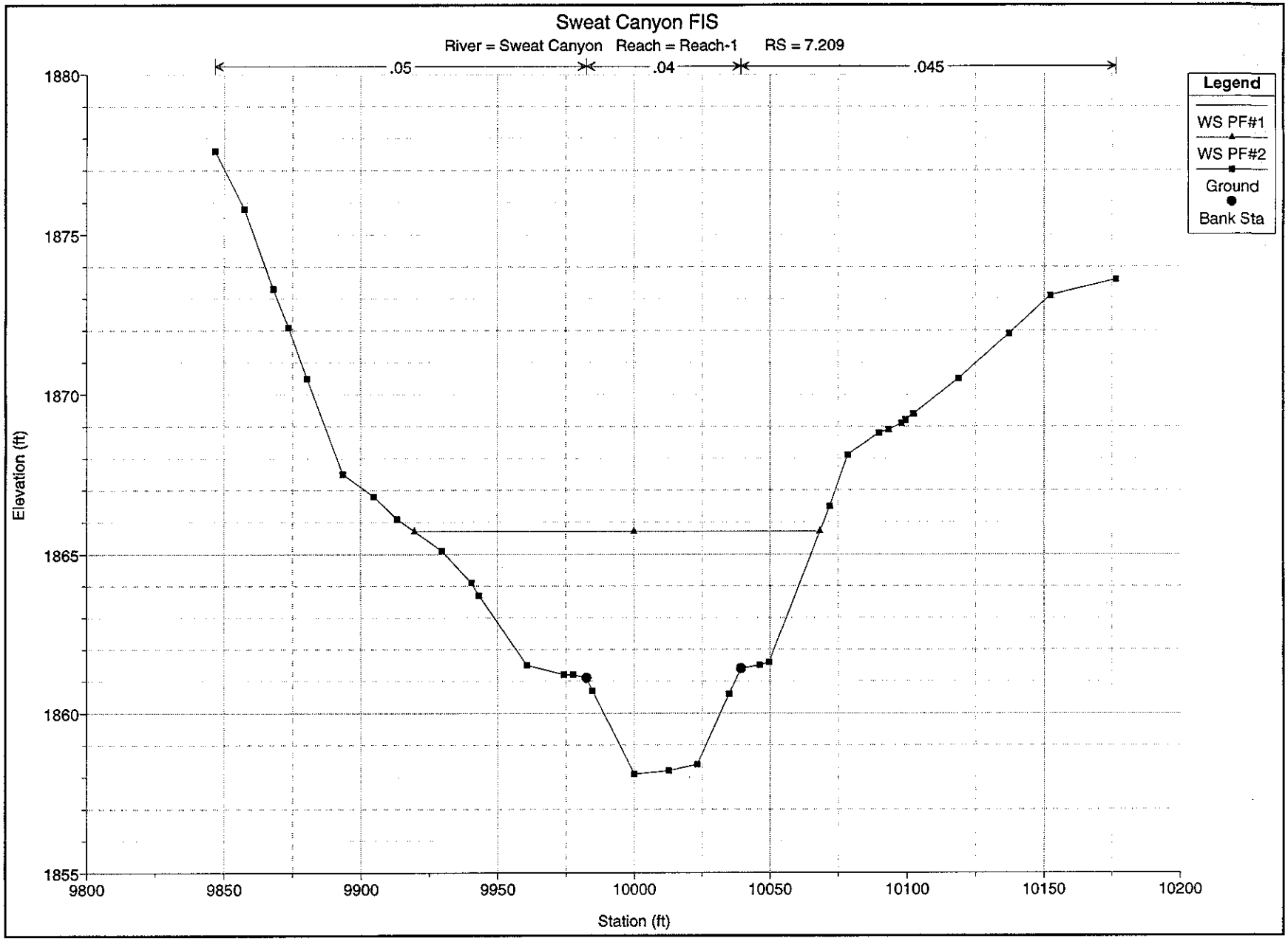

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.922
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1862
1860
1858
1856
1854
1852
1850
1848
1846
1844
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

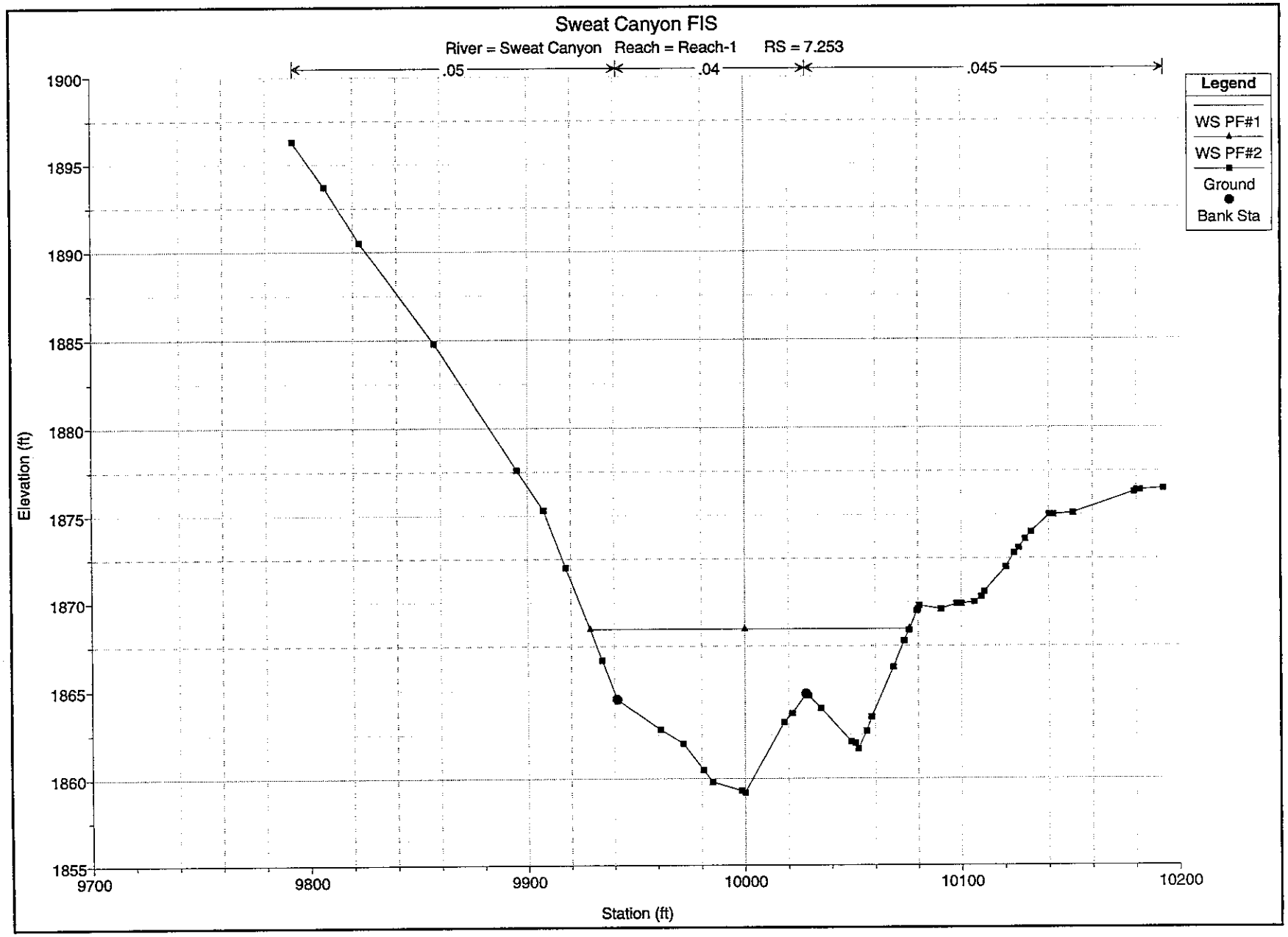

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 6.969
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1870
1865
1860
1855
1850
1845
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

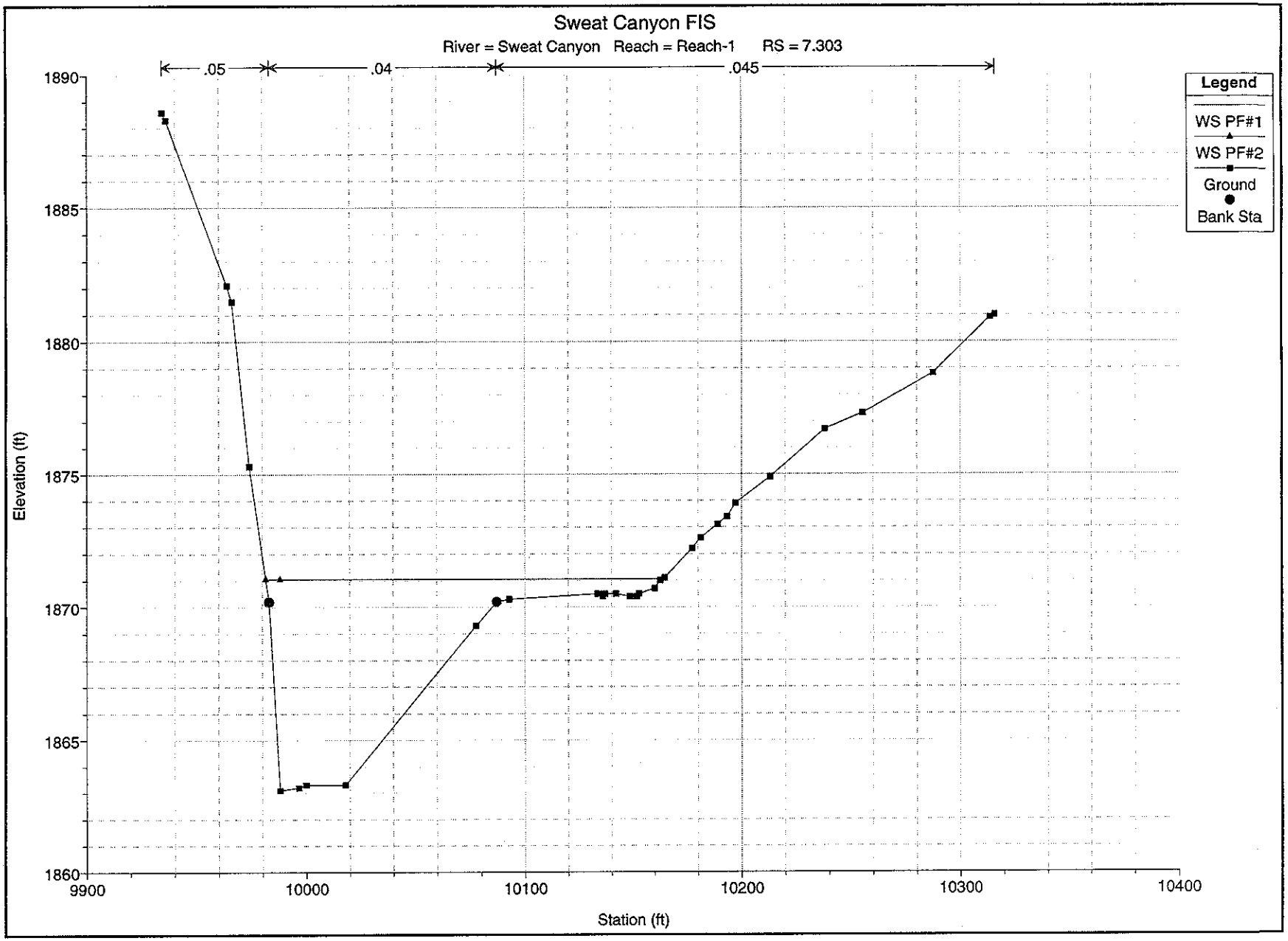

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.063
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1900
1890
1880
1870
1860
1850
9600
9800
10000
10200
10400
10600
Station (ft)

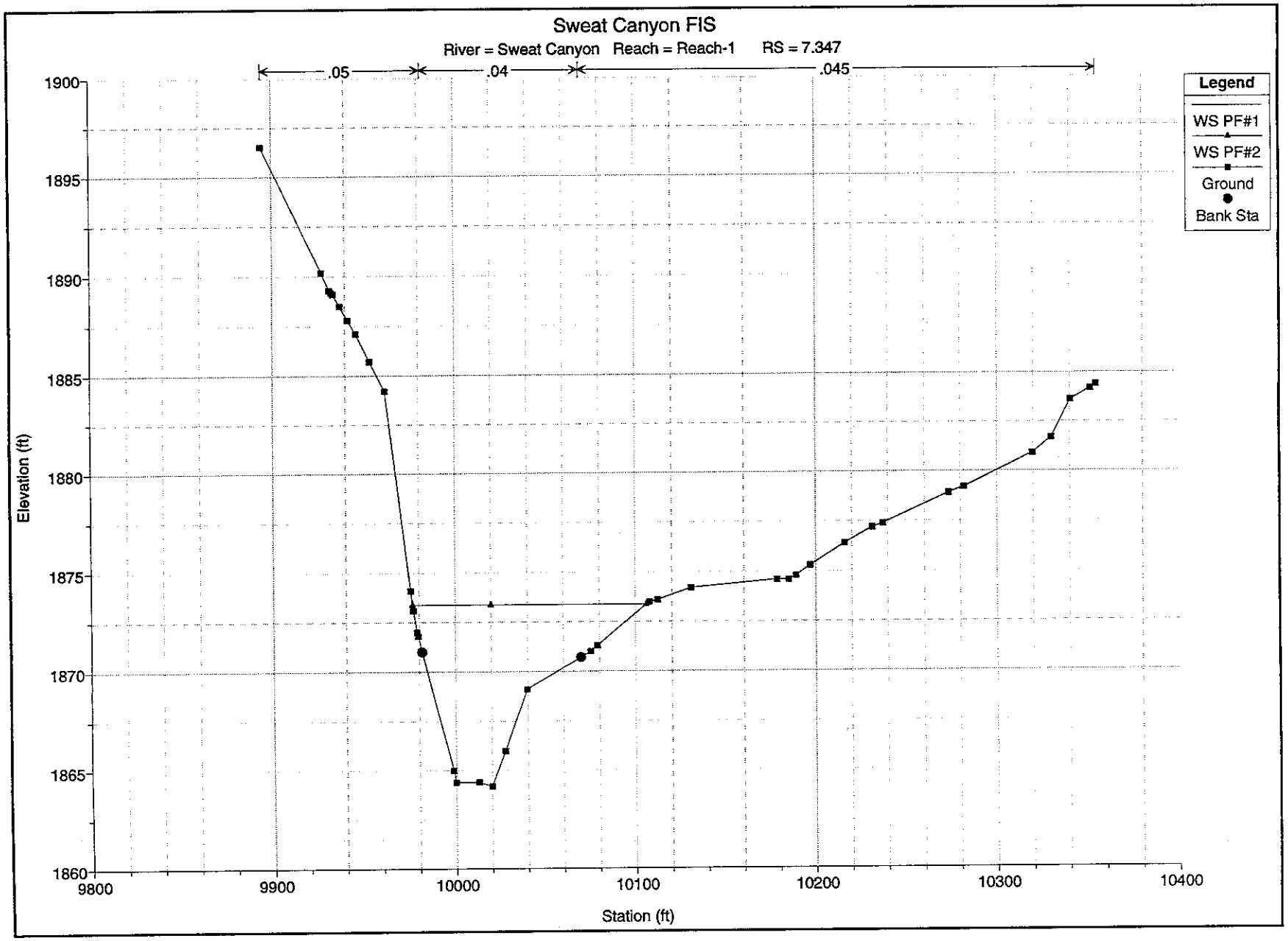

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.112
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1880
1875
1870
1865
1860
1855
1850
9700
9800
9900
10000
10100
10200
10300
Station (ft)

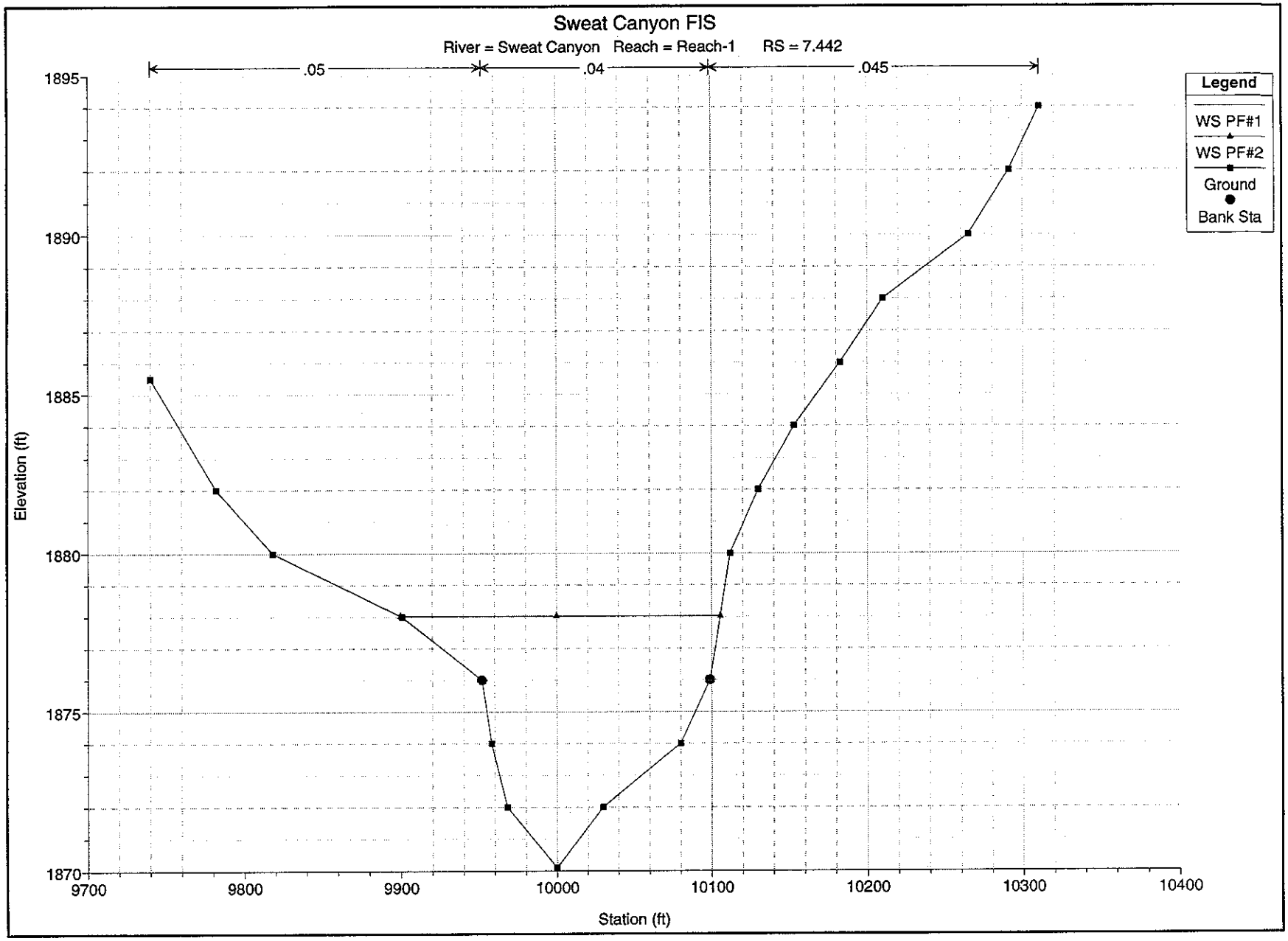

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.158
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1872
1870
1868
1866
1864
1862
1860
1858
1856
9700
9800
9900
10000
10100
10200
Station (ft)

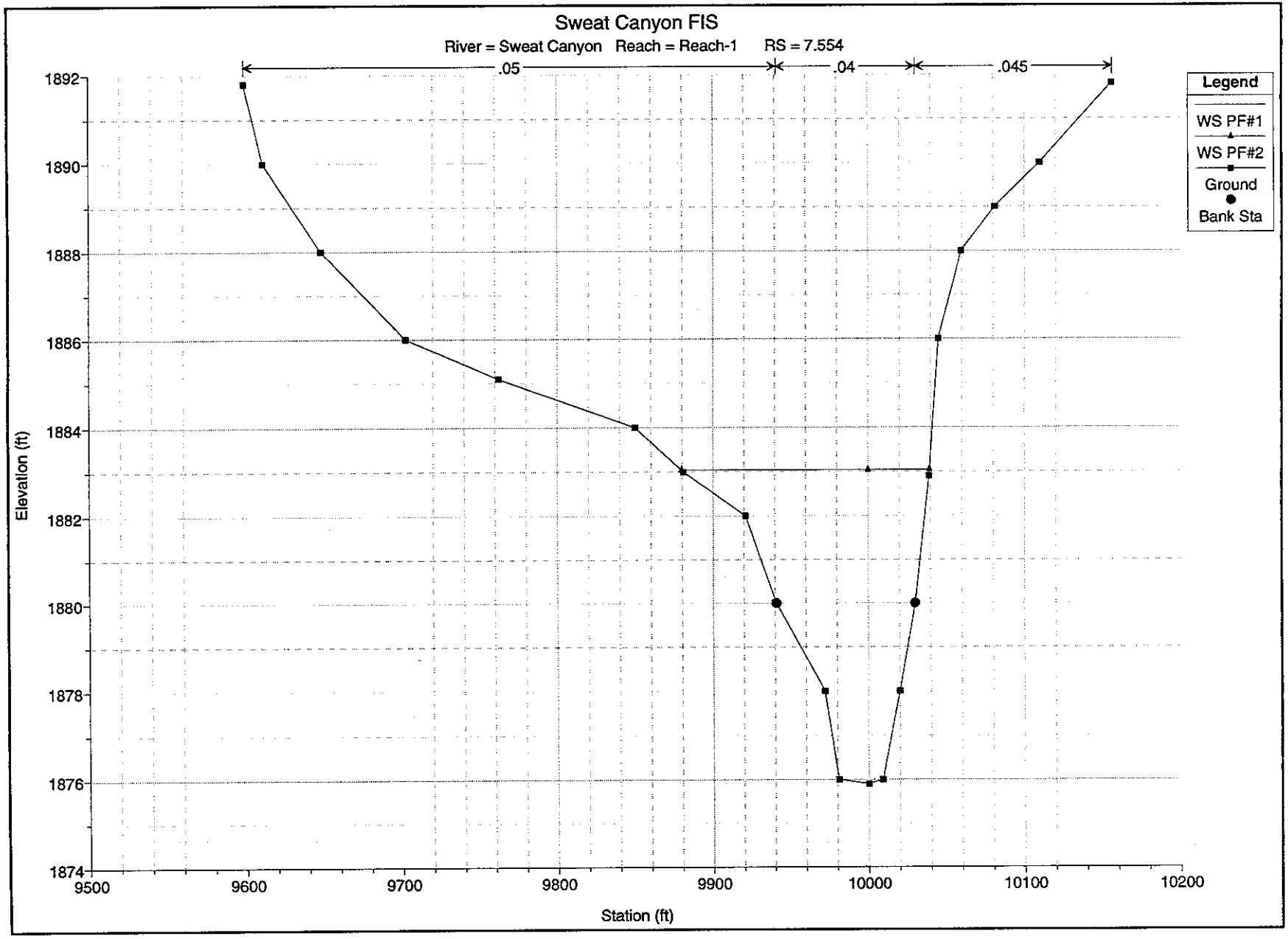

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.209
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1880
1875
1870
1865
1860
1855
9800
9850
9900
9950
10000
10050
10100
10150
10200
Station (ft)

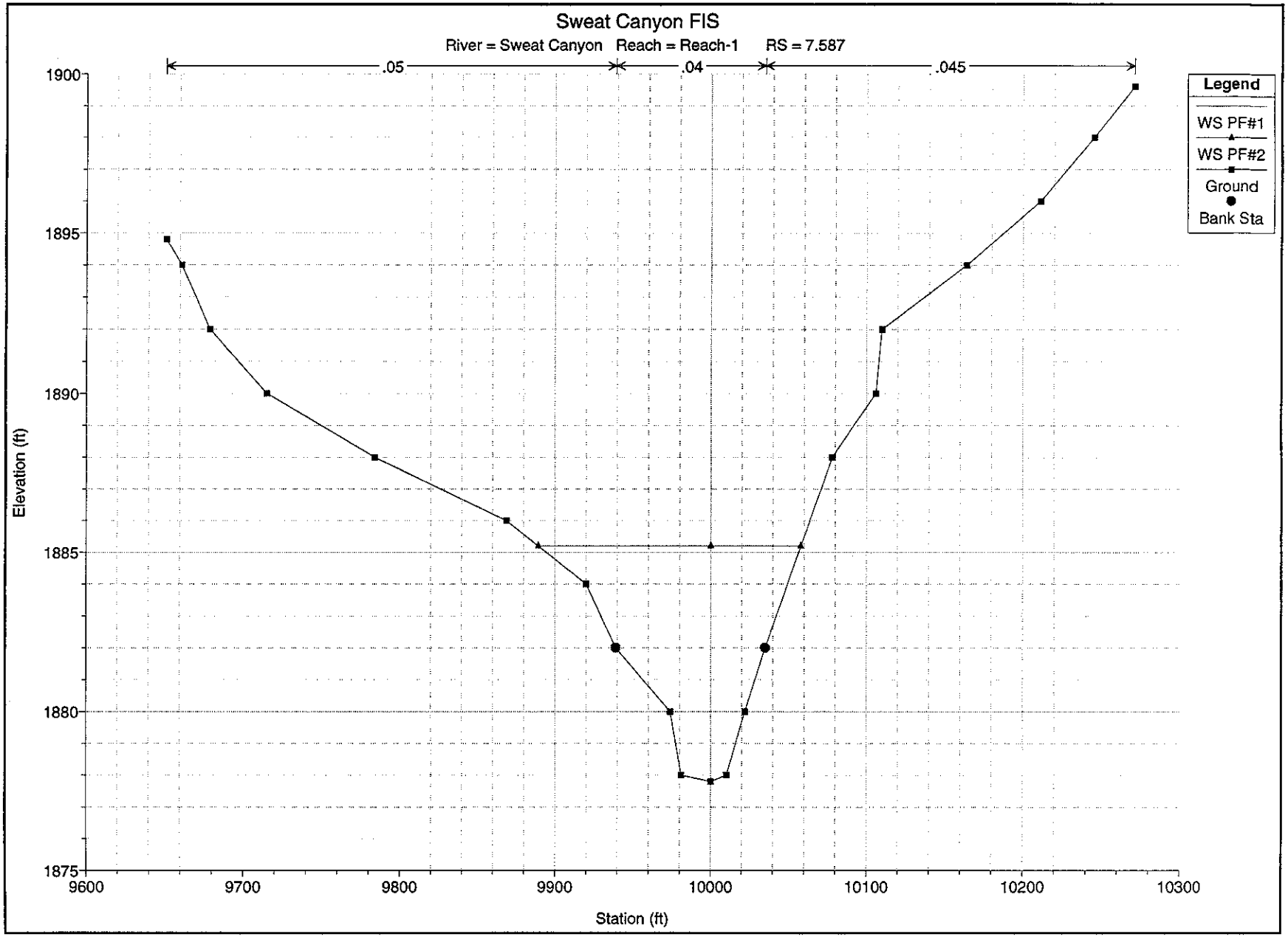

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.253
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1900
1895
1890
1885
1880
1875
1870
1865
1860
1855
9700
9800
9900
10000
10100
10200
Station (ft)

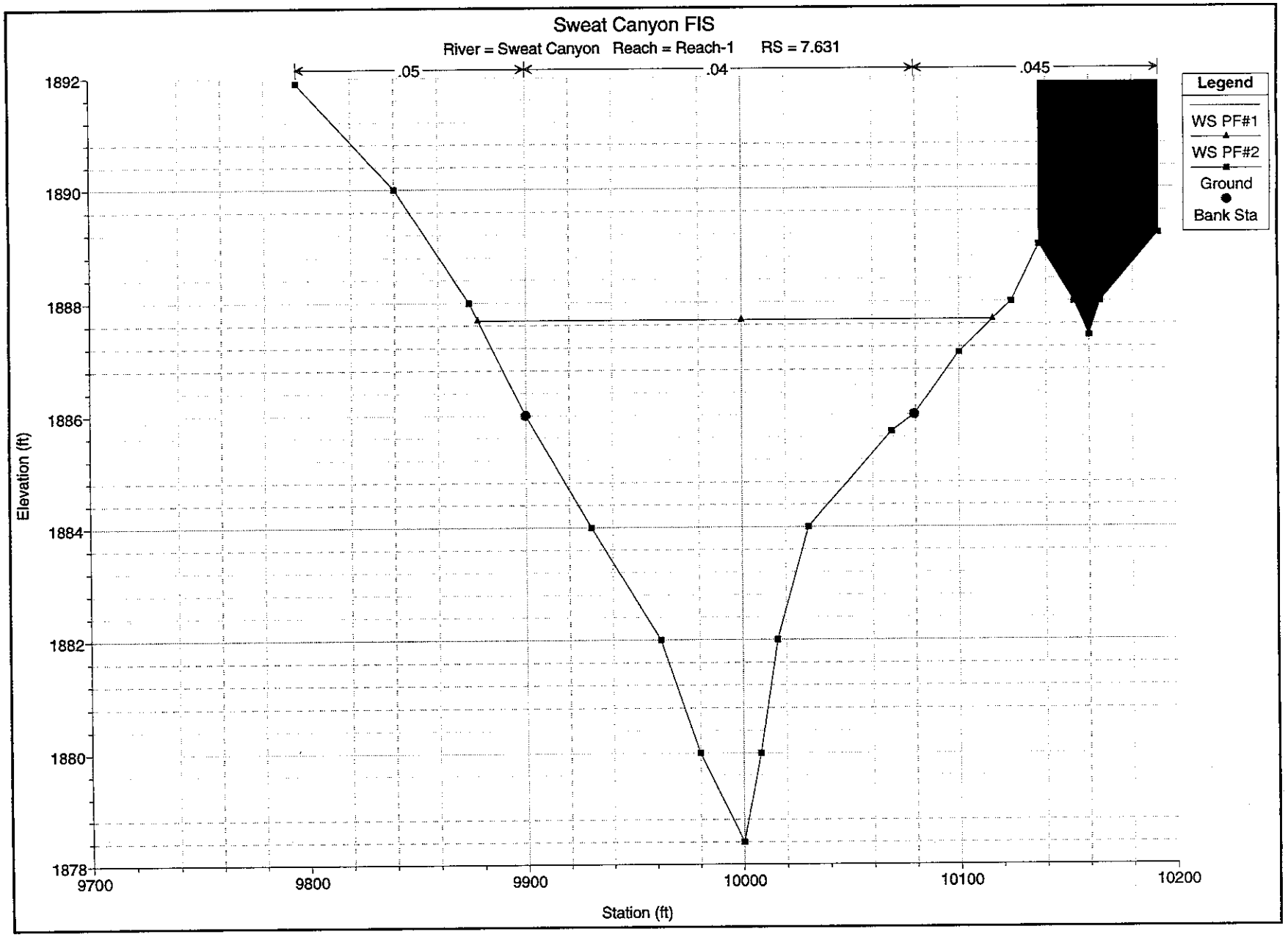

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.303
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1890
1885
1880
1875
1870
1865
1860
9900
10000
10100
10200
10300
10400
Station (ft)

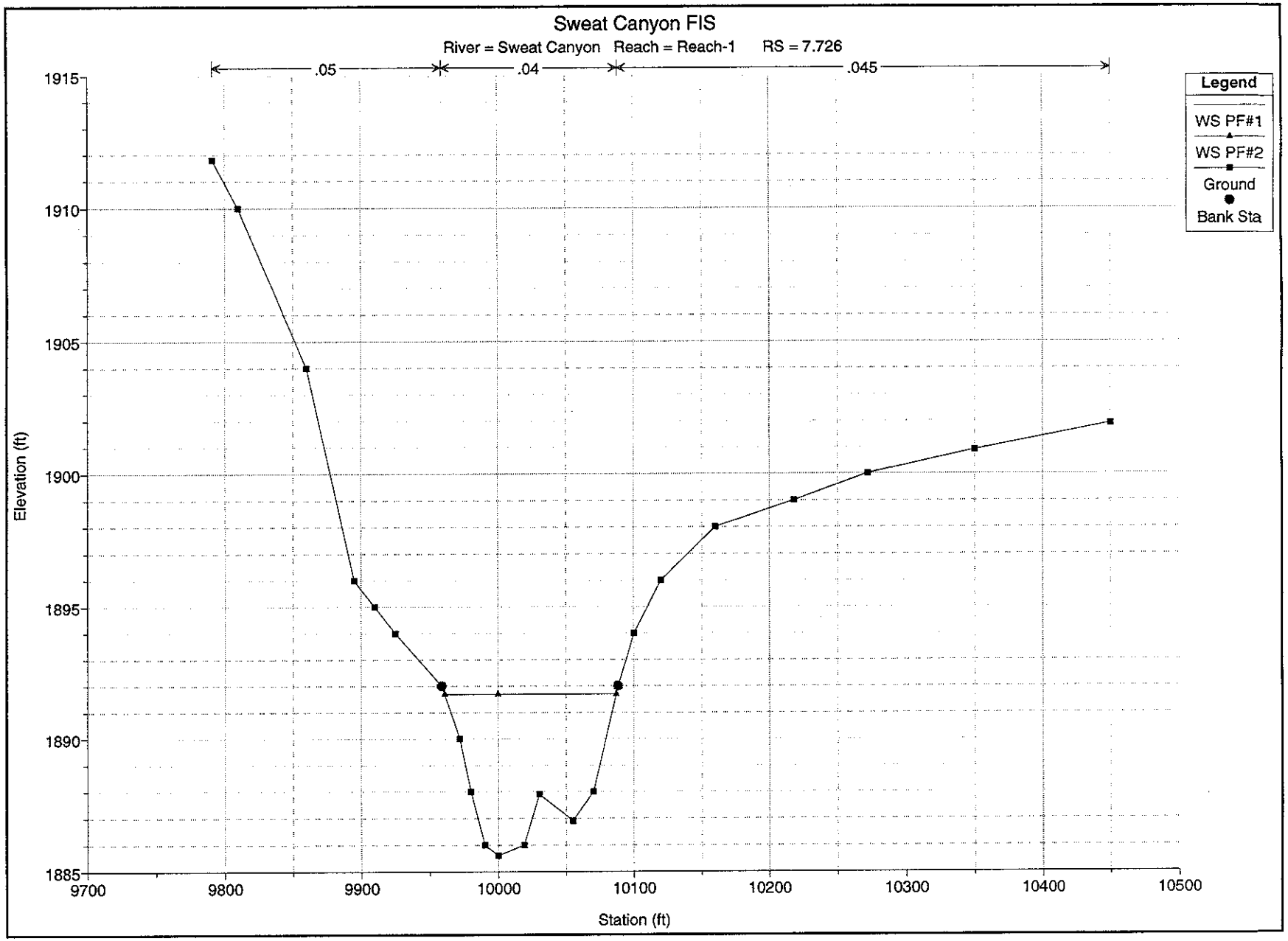

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.347
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1900
1895
1890
1885
1880
1875
1870
1865
1860
9800
9900
10000
10100
10200
10300
10400
Station (ft)

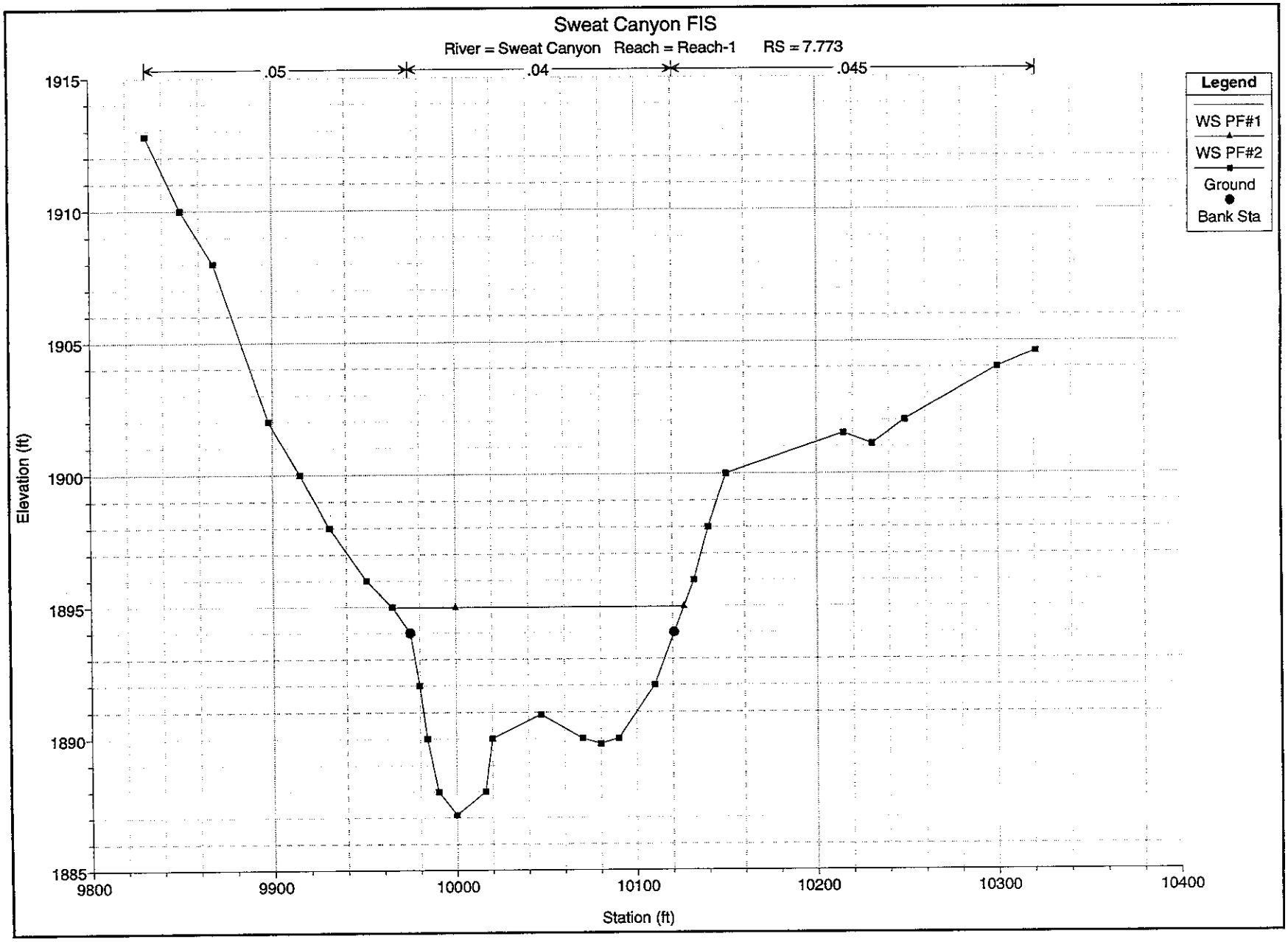

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.442
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1895
1890
1885
1880
1875
1870
9700
9800
9900
10000
10100
10200
10300
10400
Station (ft)

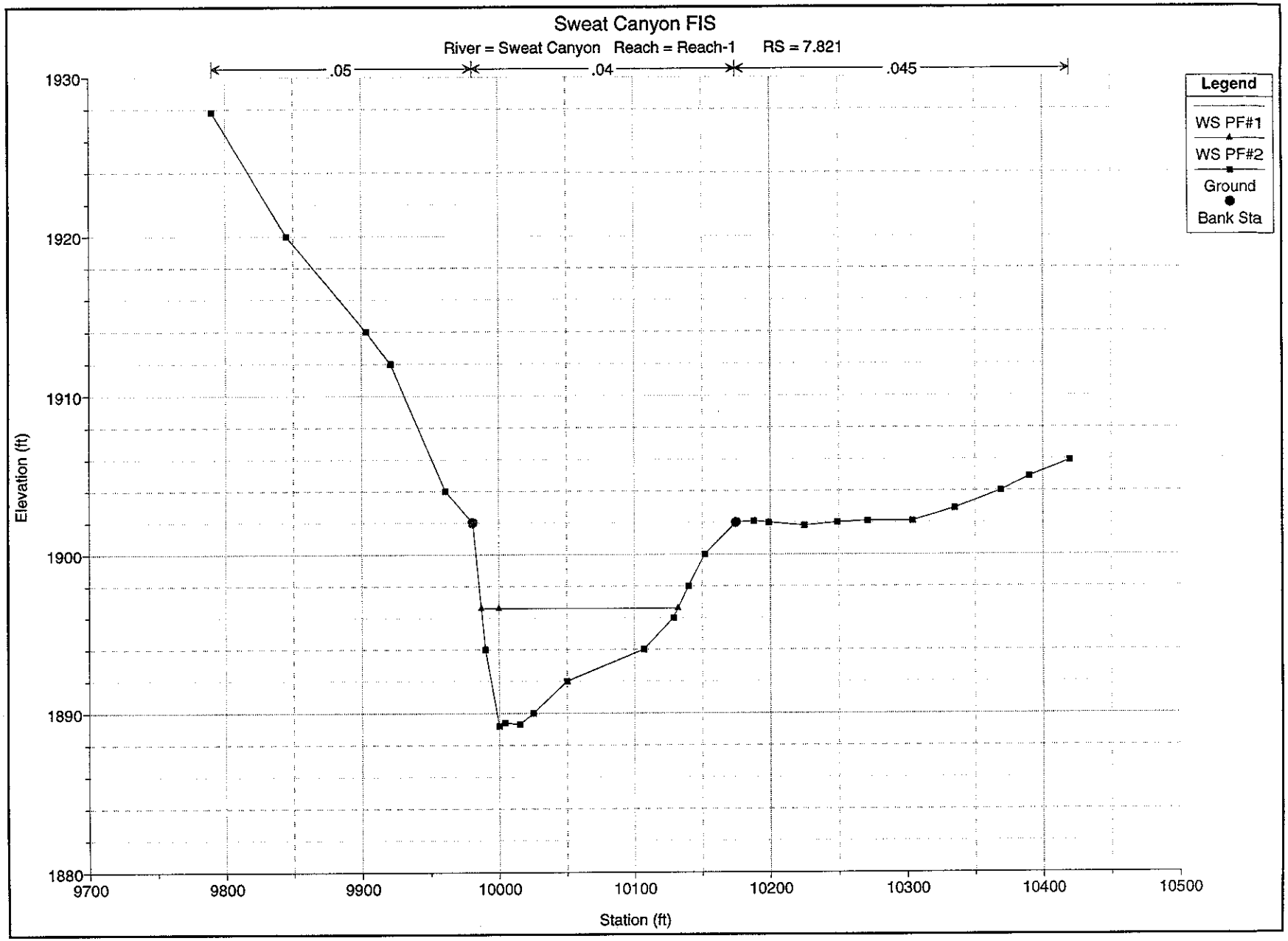

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.554
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1892
1890
1888
1886
1884
1882
1880
1878
1876
1874
9500
9600
9700
9800
9900
10000
10100
10200
Station (ft)

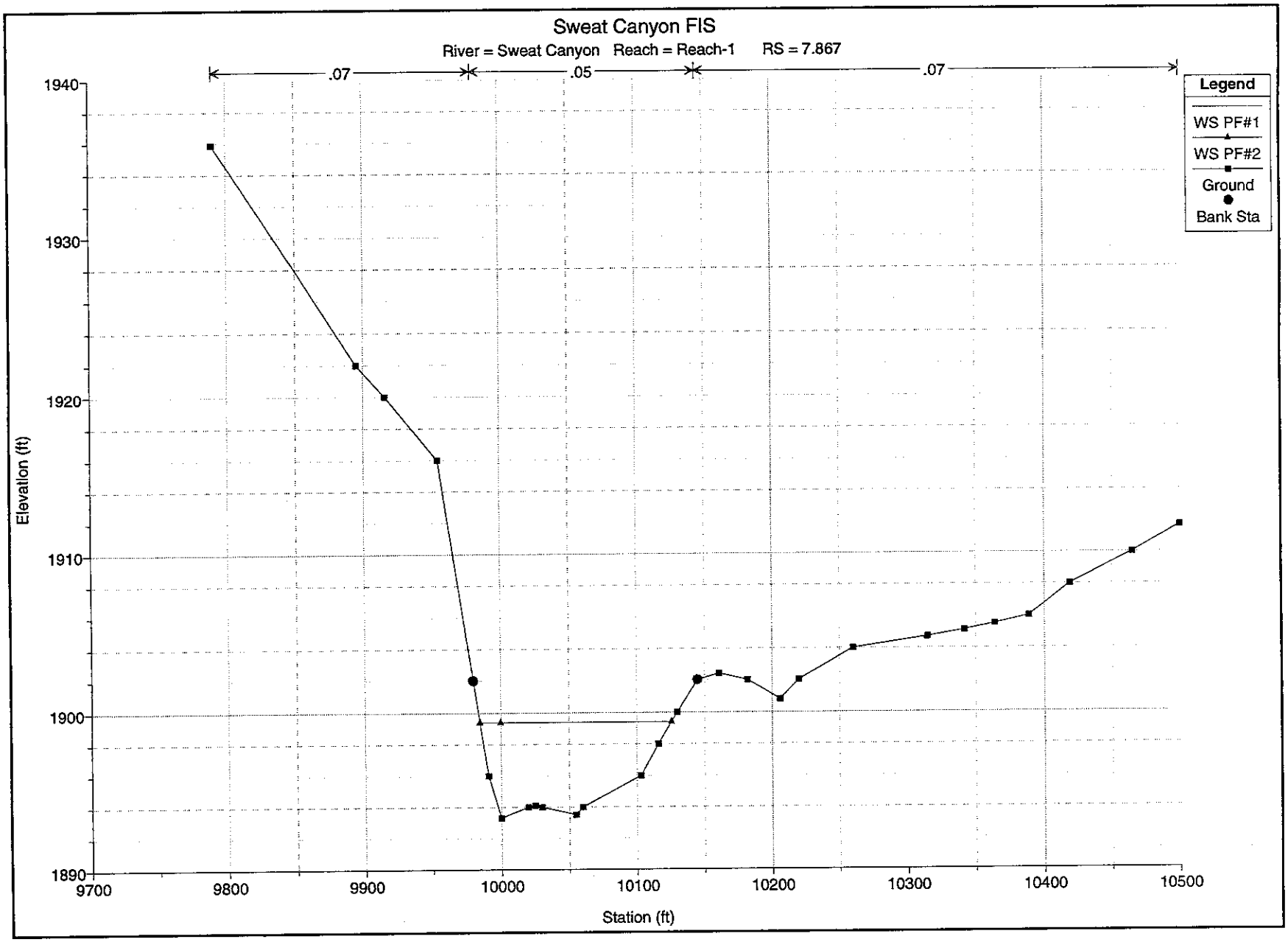

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.587
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1900
1895
1890
1885
1880
1875
9600
9700
9800
9900
10000
10100
10200
10300
Station (ft)

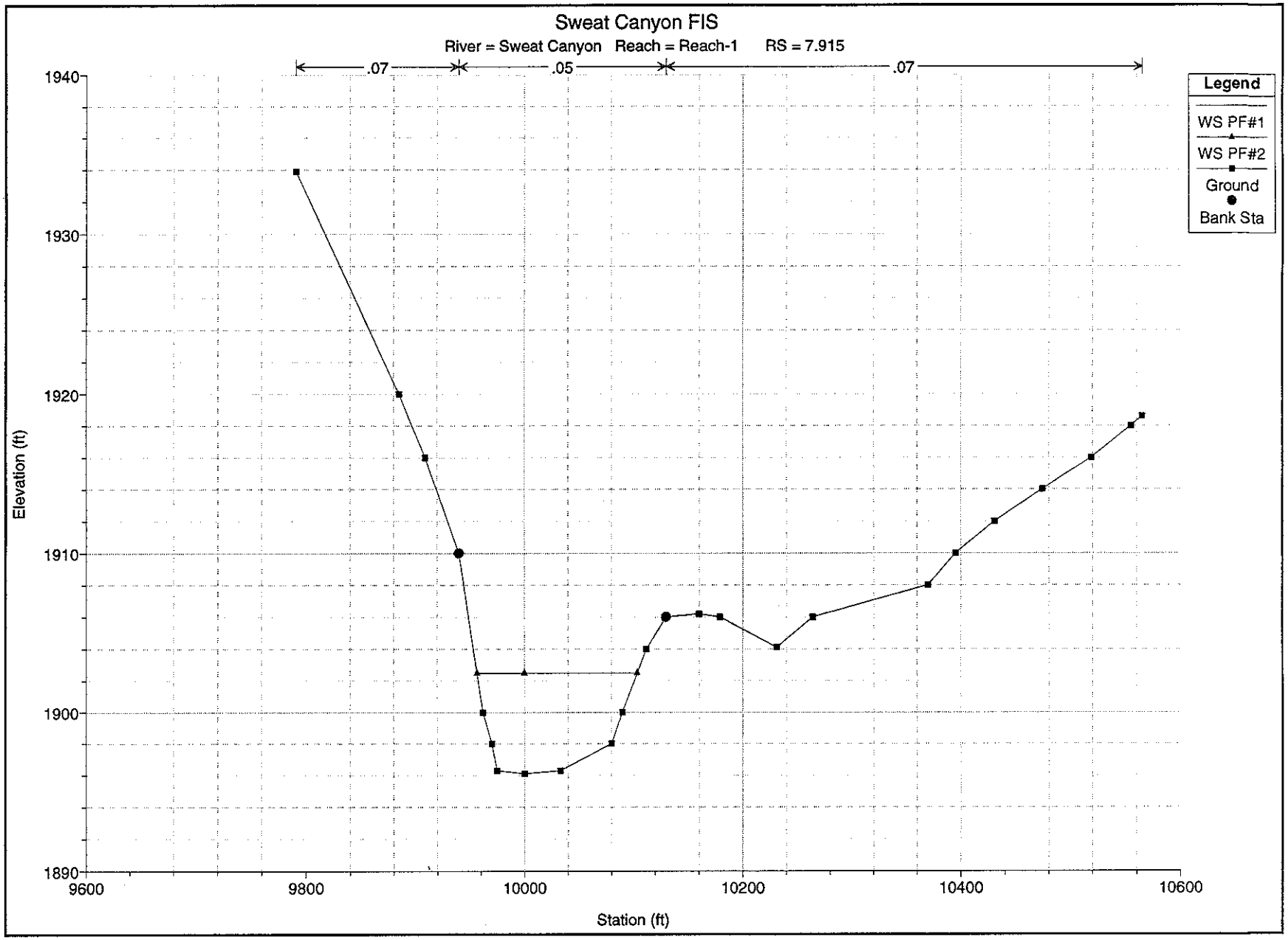

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.631
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1892
1890
1888
1886
1884
1882
1880
1878
9700
9800
9900
10000
10100
10200
Station (ft)

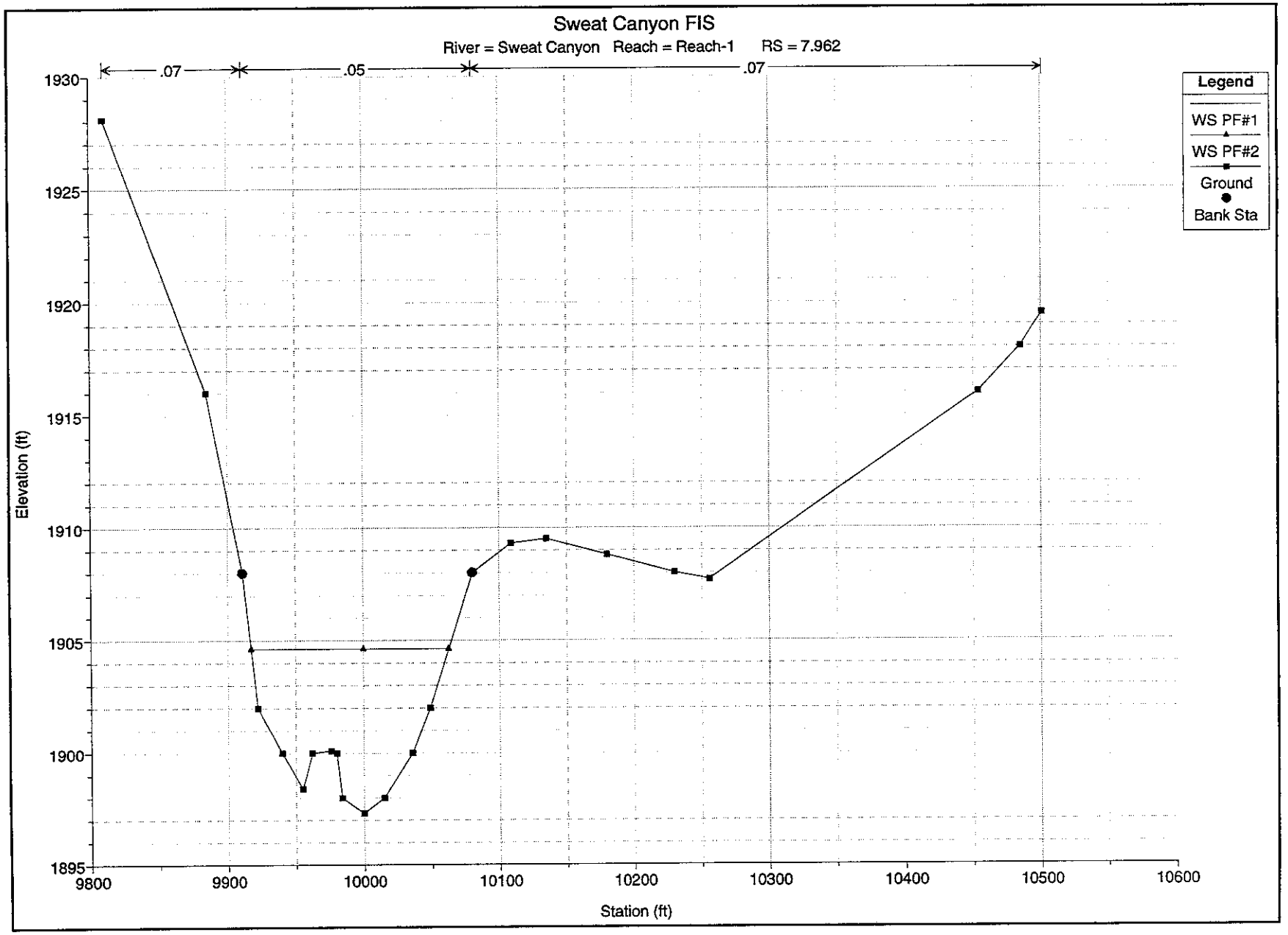

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.726
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1915
1910
1905
1900
1895
1890
1885
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

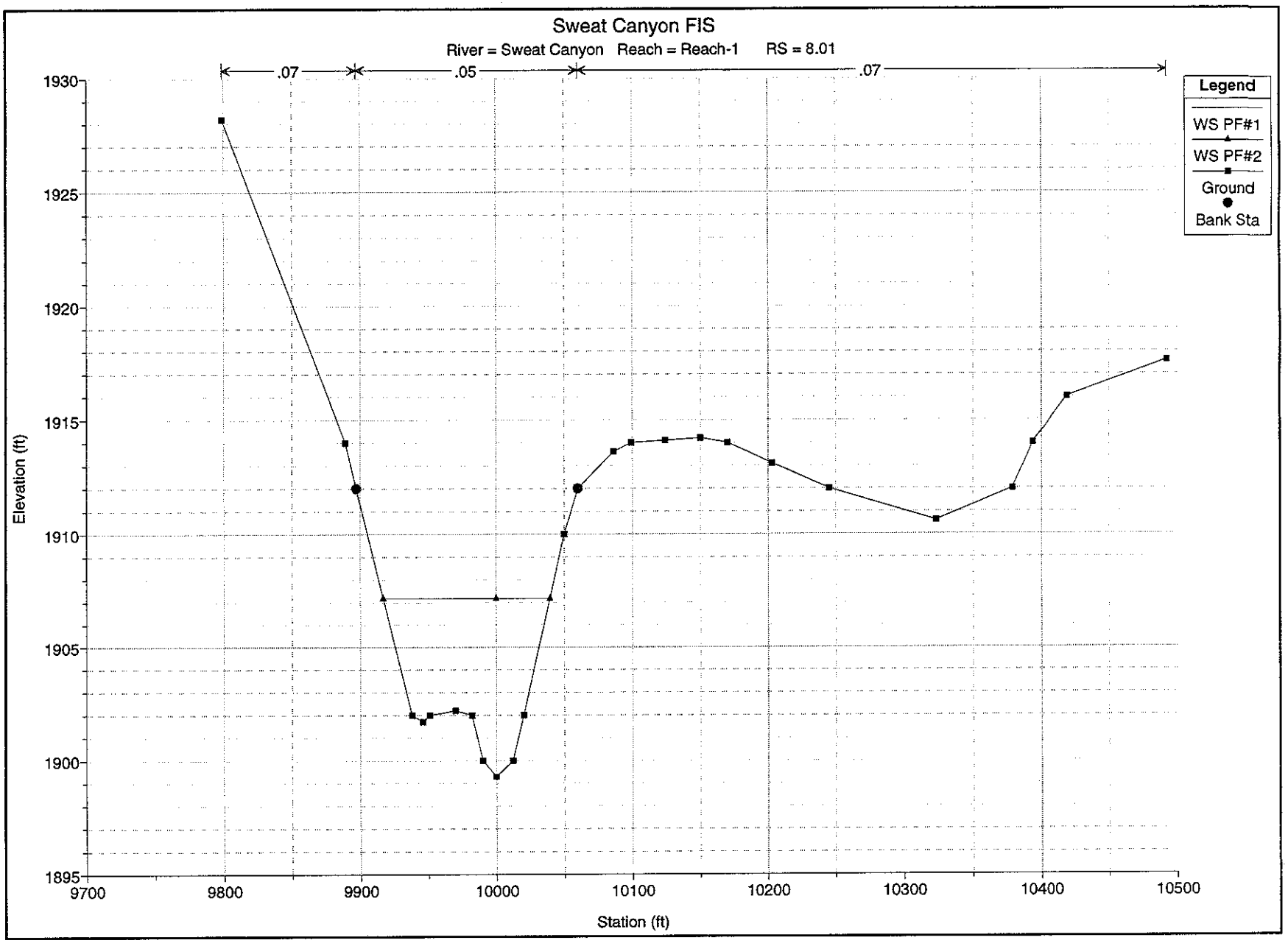

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.773
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1915
1910
1905
1900
1895
1890
1885
9800
9900
10000
10100
10200
10300
10400
Station (ft)

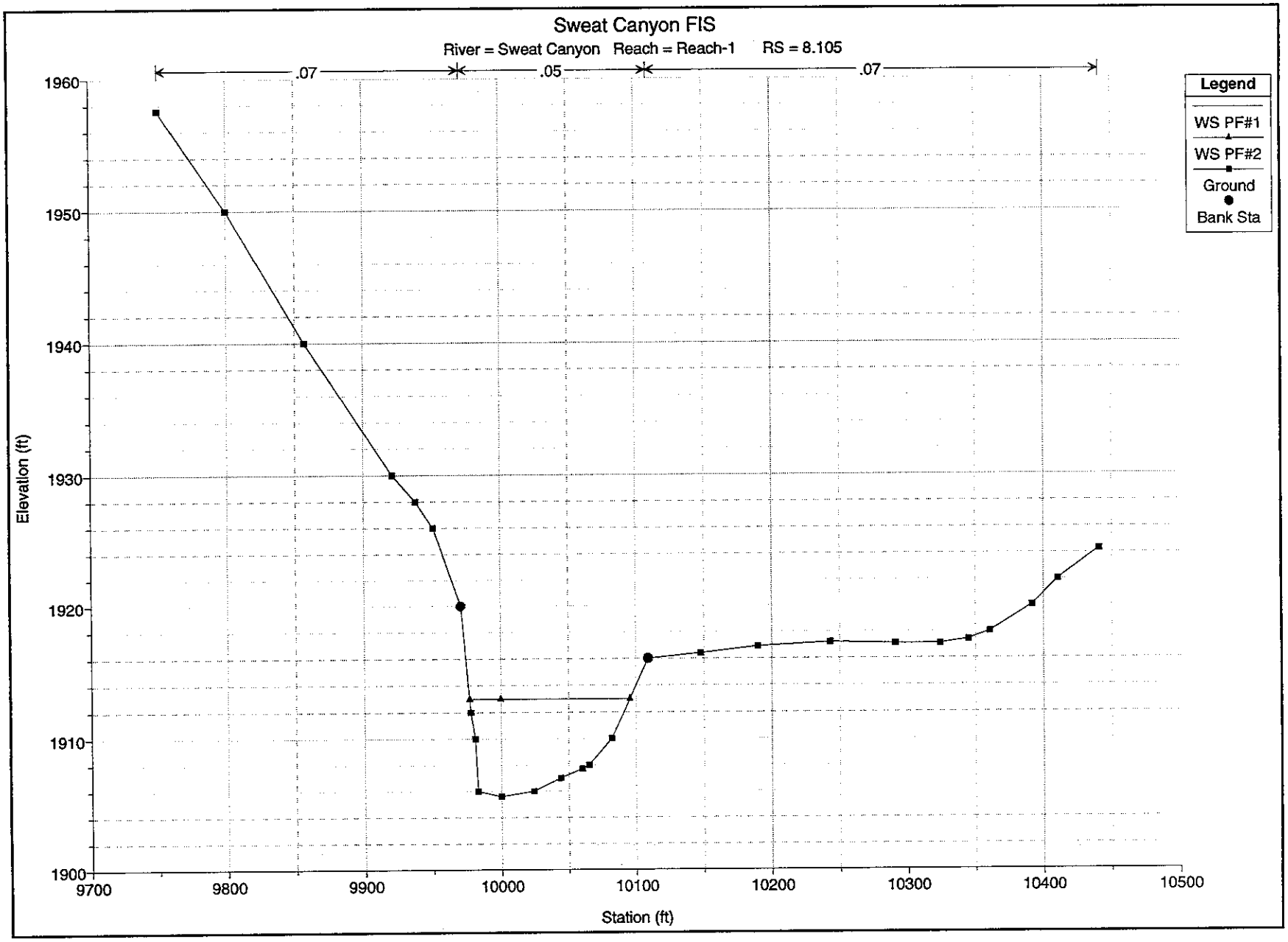

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.821
.05
.04
.045
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1930
1920
1910
1900
1890
1880
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

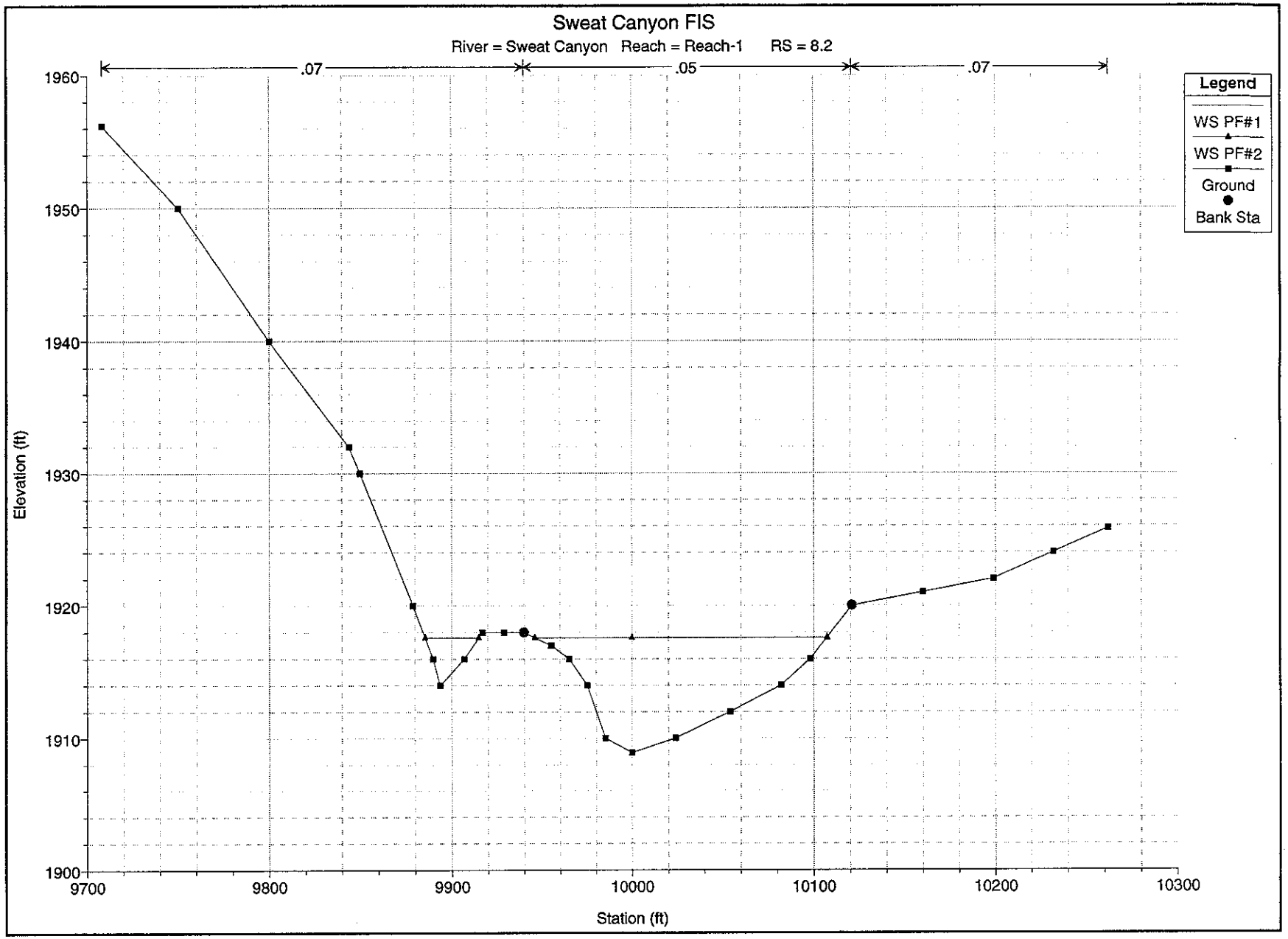

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.867
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1940
1930
1920
1910
1900
1890
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

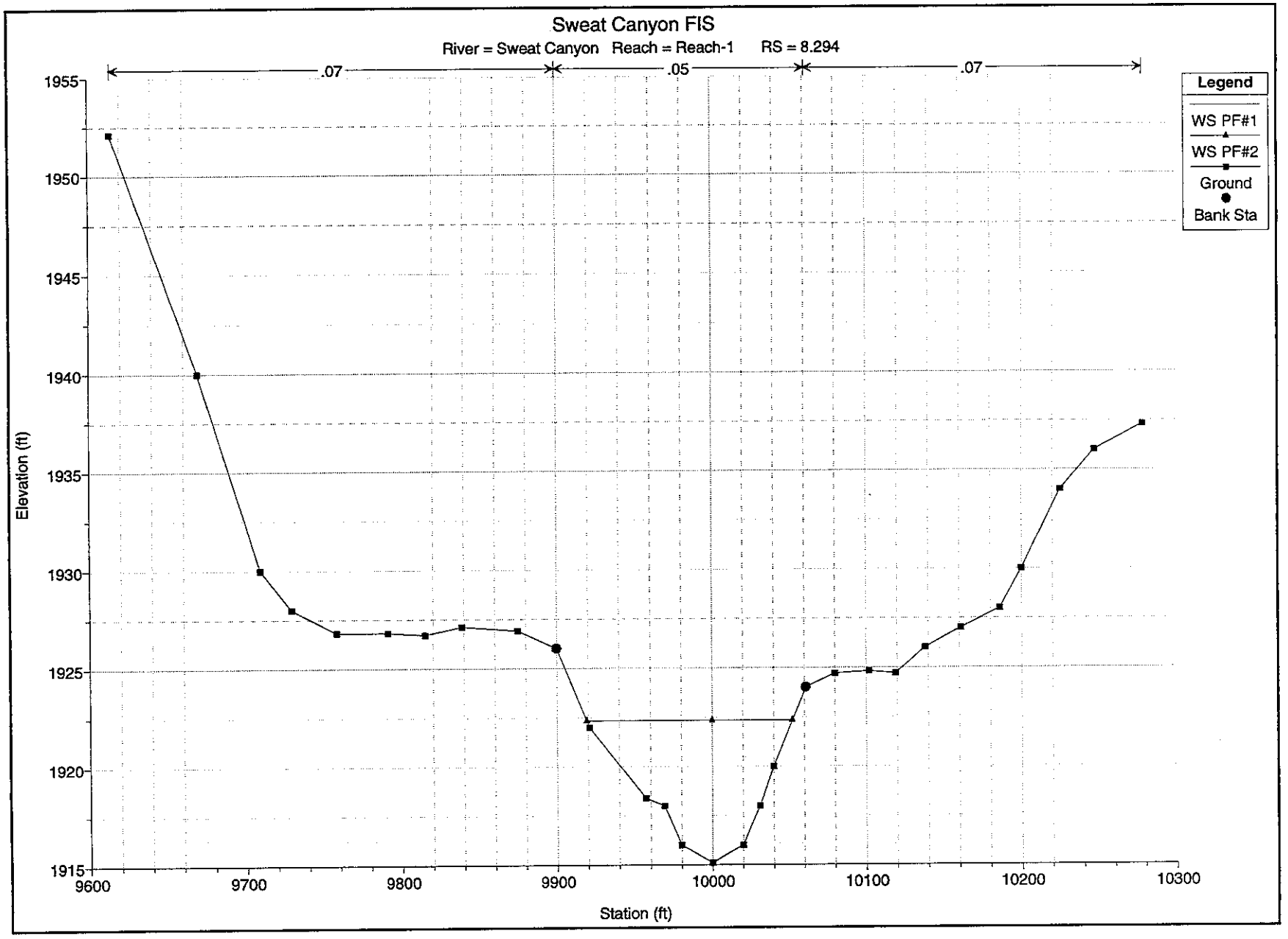

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.915
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1940
1930
1920
1910
1900
1890
9600
9800
10000
10200
10400
10600
Station (ft)

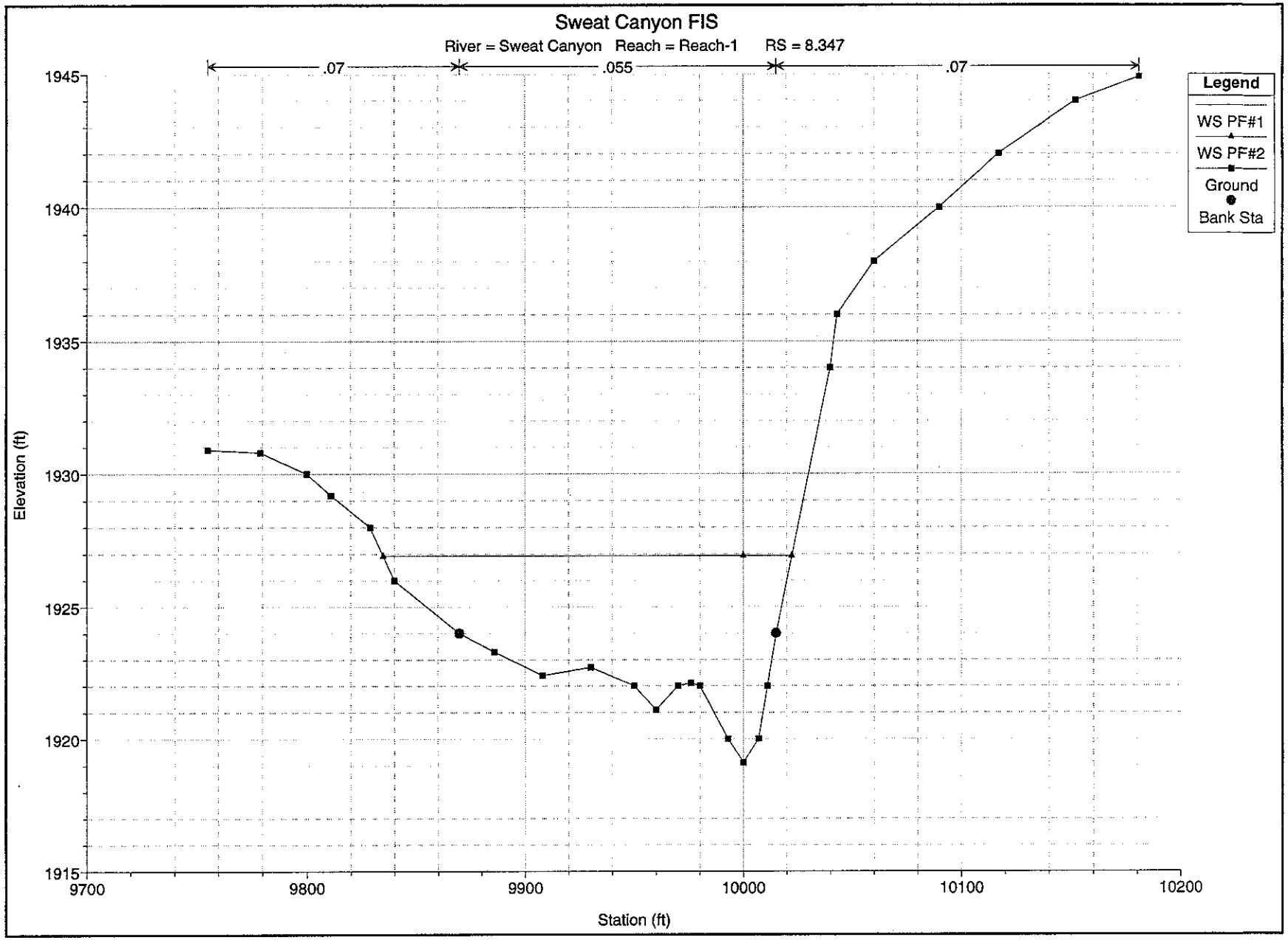

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 7.962
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1930
1925
1920
1915
1910
1905
1900
1895
9800
9900
10000
10100
10200
10300
10400
10500
10600
Station (ft)

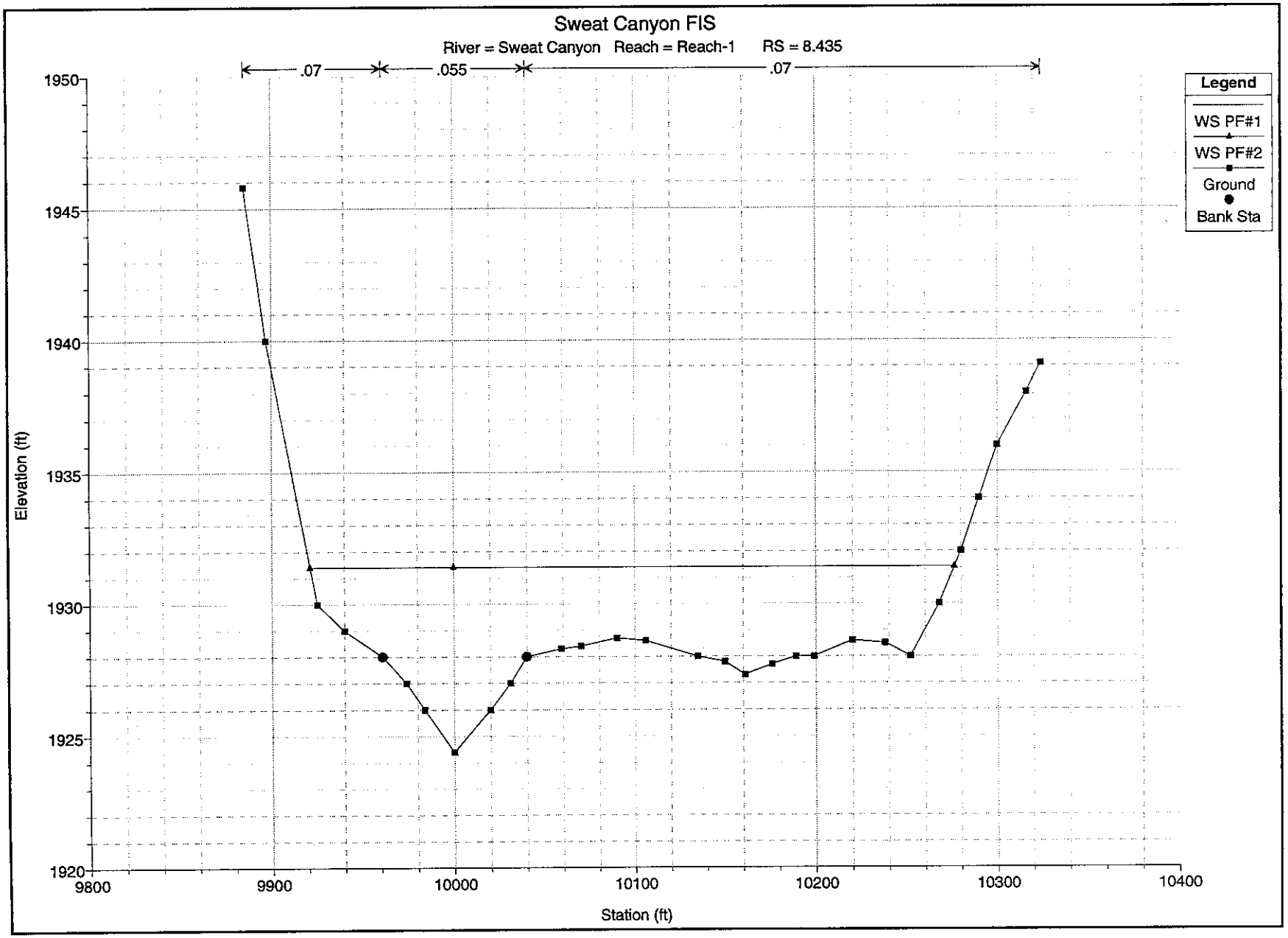

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.01
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1930
1925
1920
1915
1910
1905
1900
1895
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

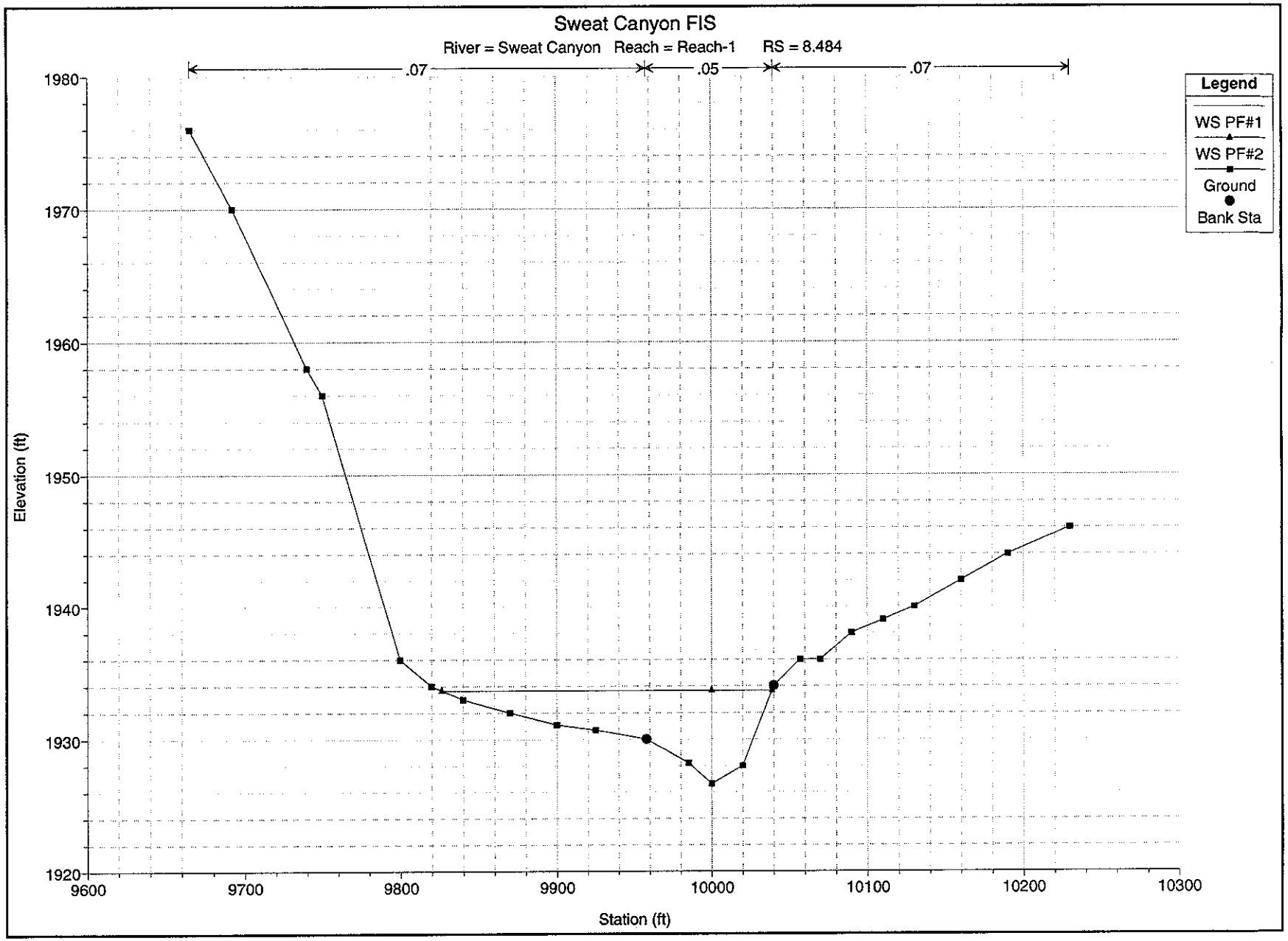

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.105
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1960
1950
1940
1930
1920
1910
1900
9700
9800
9900
10000
10100
10200
10300
10400
10500
Station (ft)

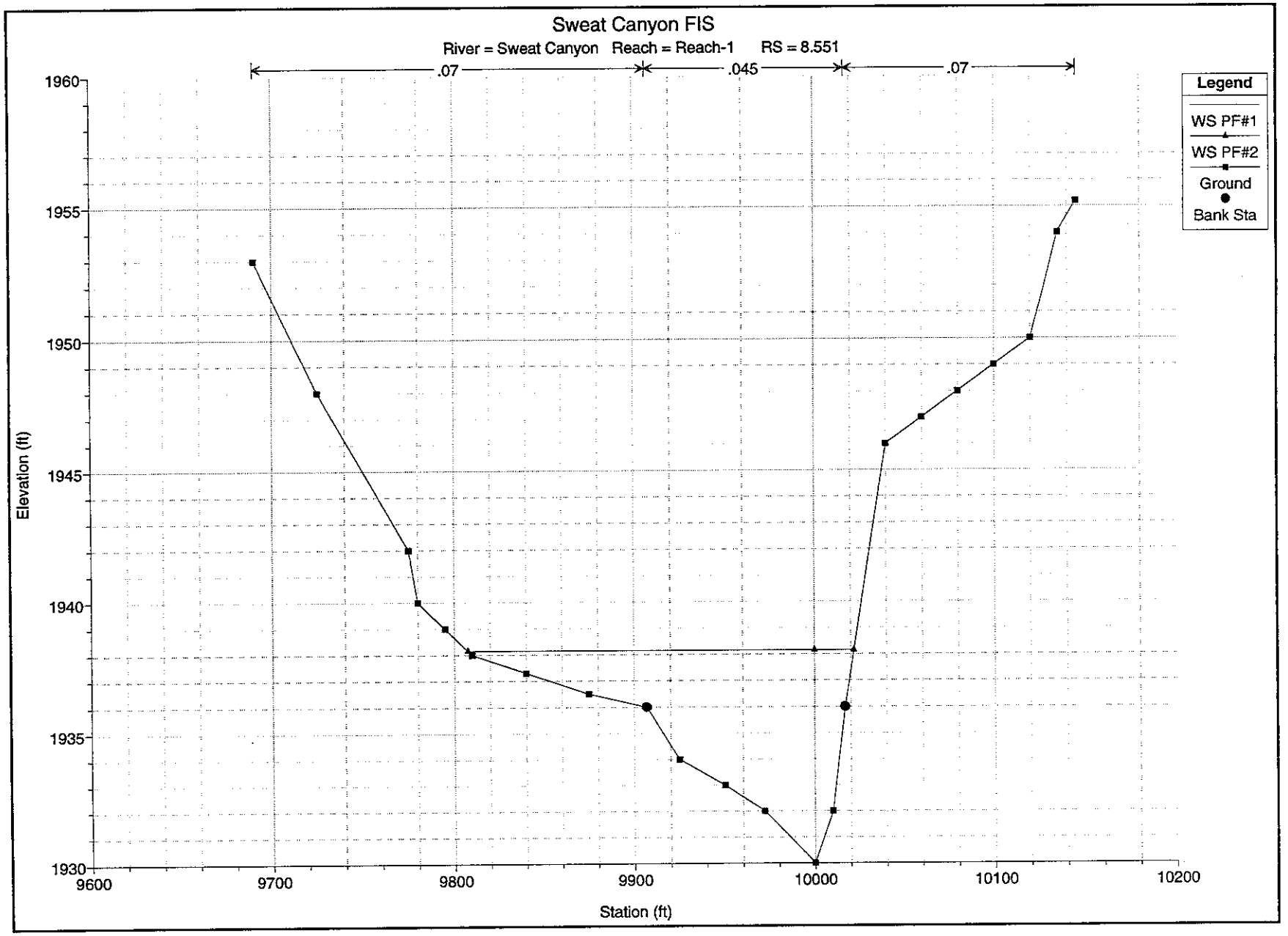

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.2
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1960
1950
1940
1930
1920
1910
1900
9700
9800
9900
10000
10100
10200
10300
Station (ft)

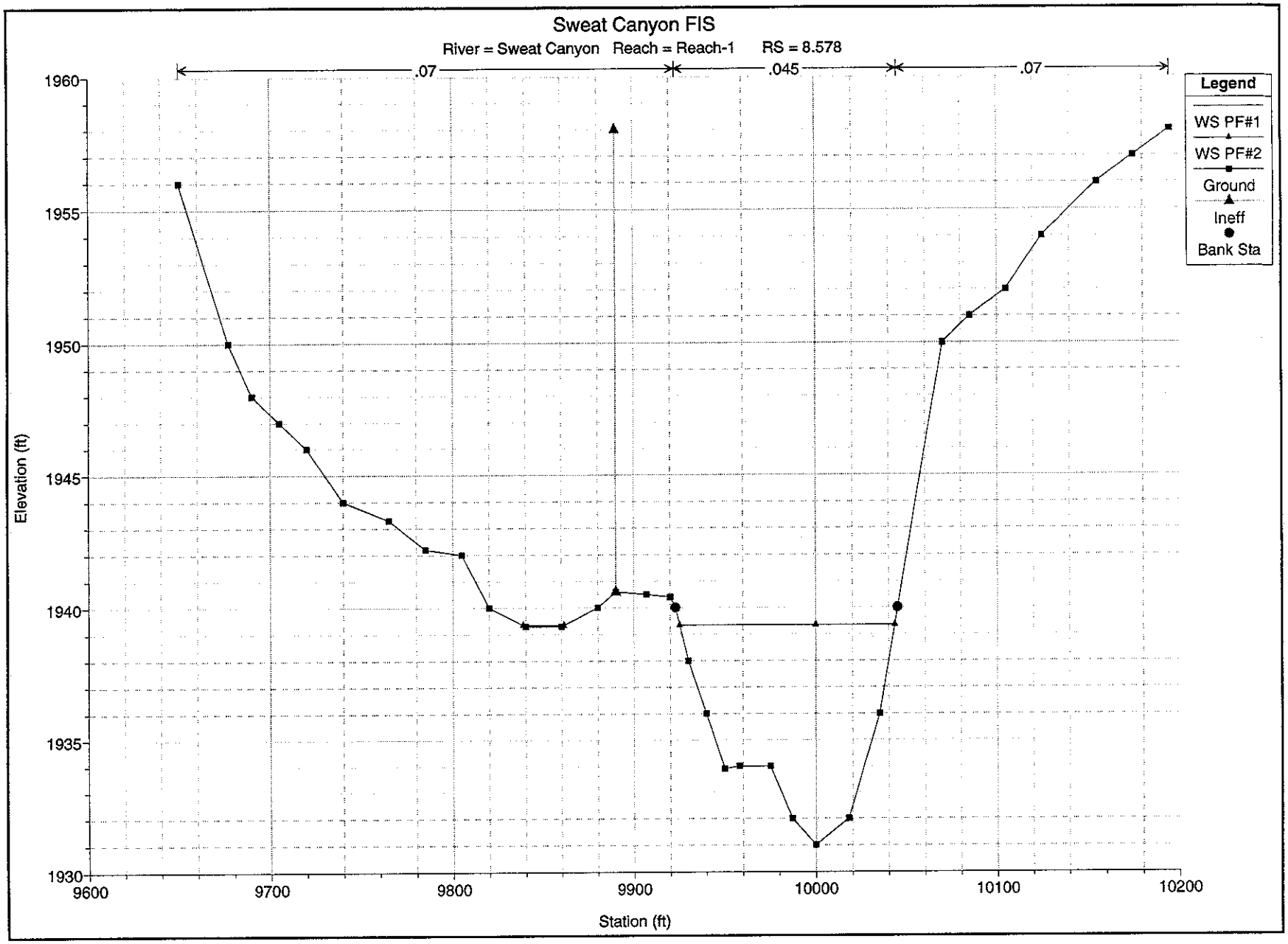

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.294
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1955
1950
1945
1940
1935
1930
1925
1920
1915
9600
9700
9800
9900
10000
10100
10200
10300
Station (ft)

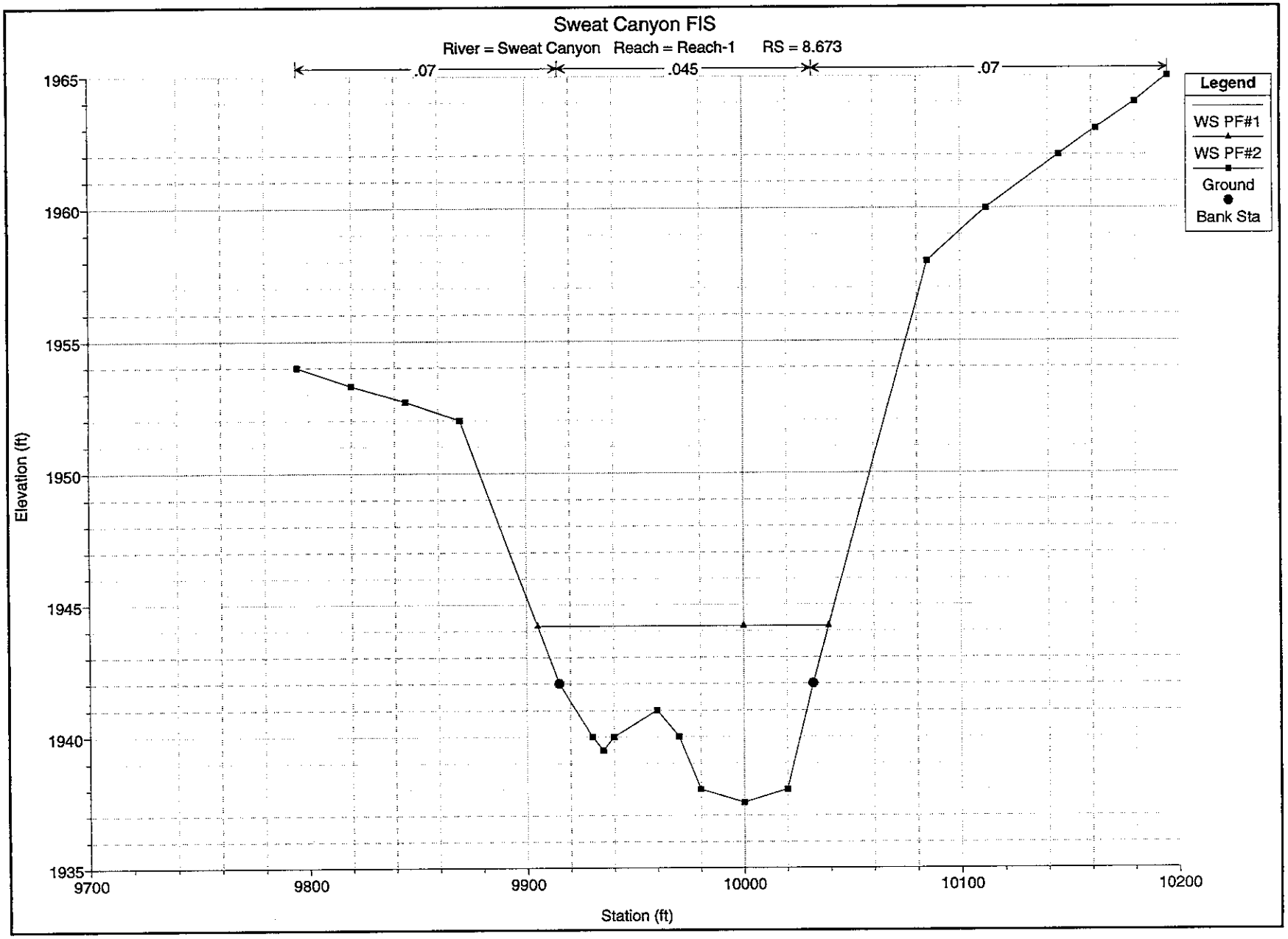

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.347
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1945
1940
1935
1930
1925
1920
1915
9700
9800
9900
10000
10100
10200
Station (ft)

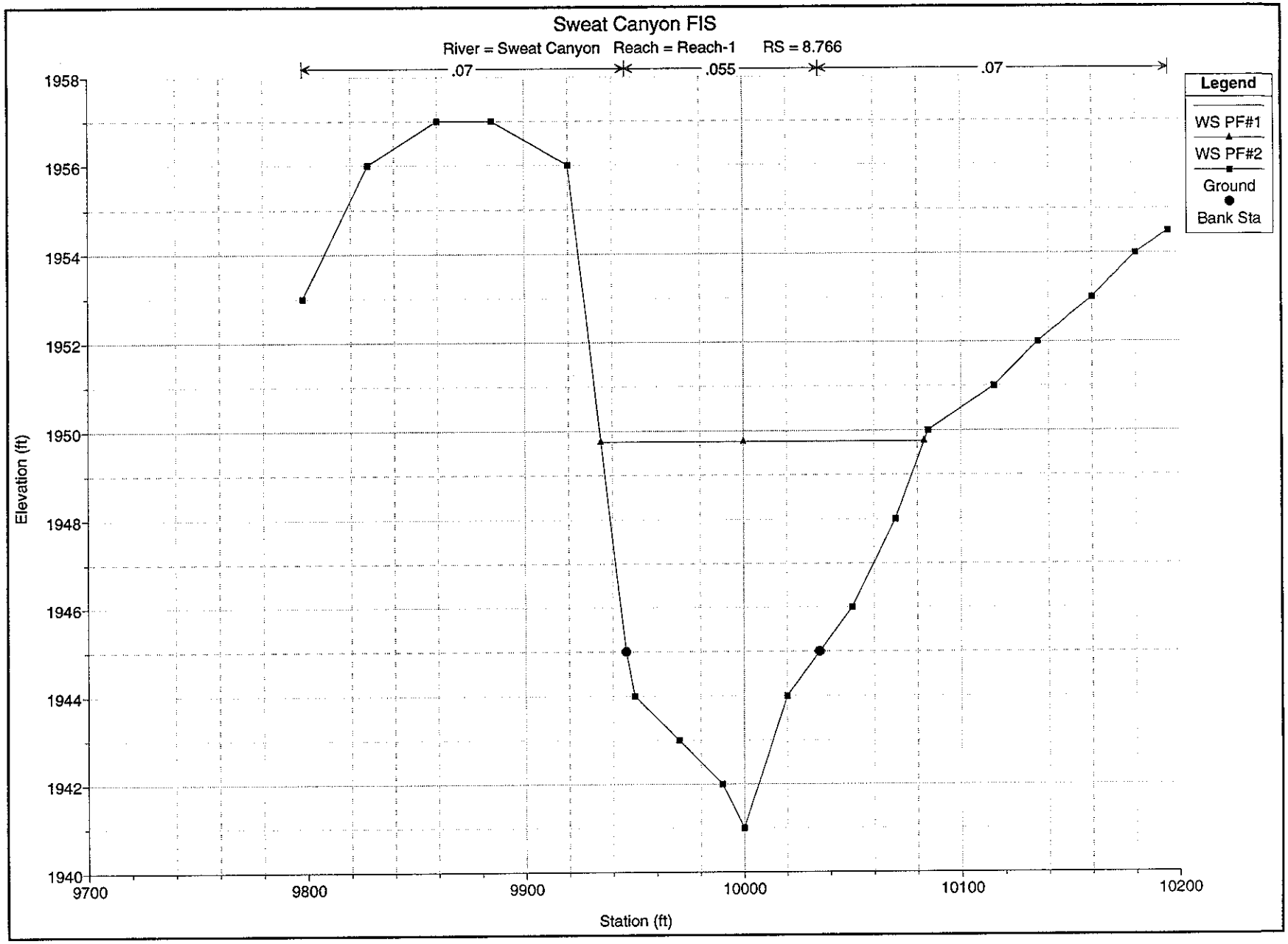

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.435
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1950
1945
1940
1935
1930
1925
1920
9800
9900
10000
10100
10200
10300
10400
Station (ft)

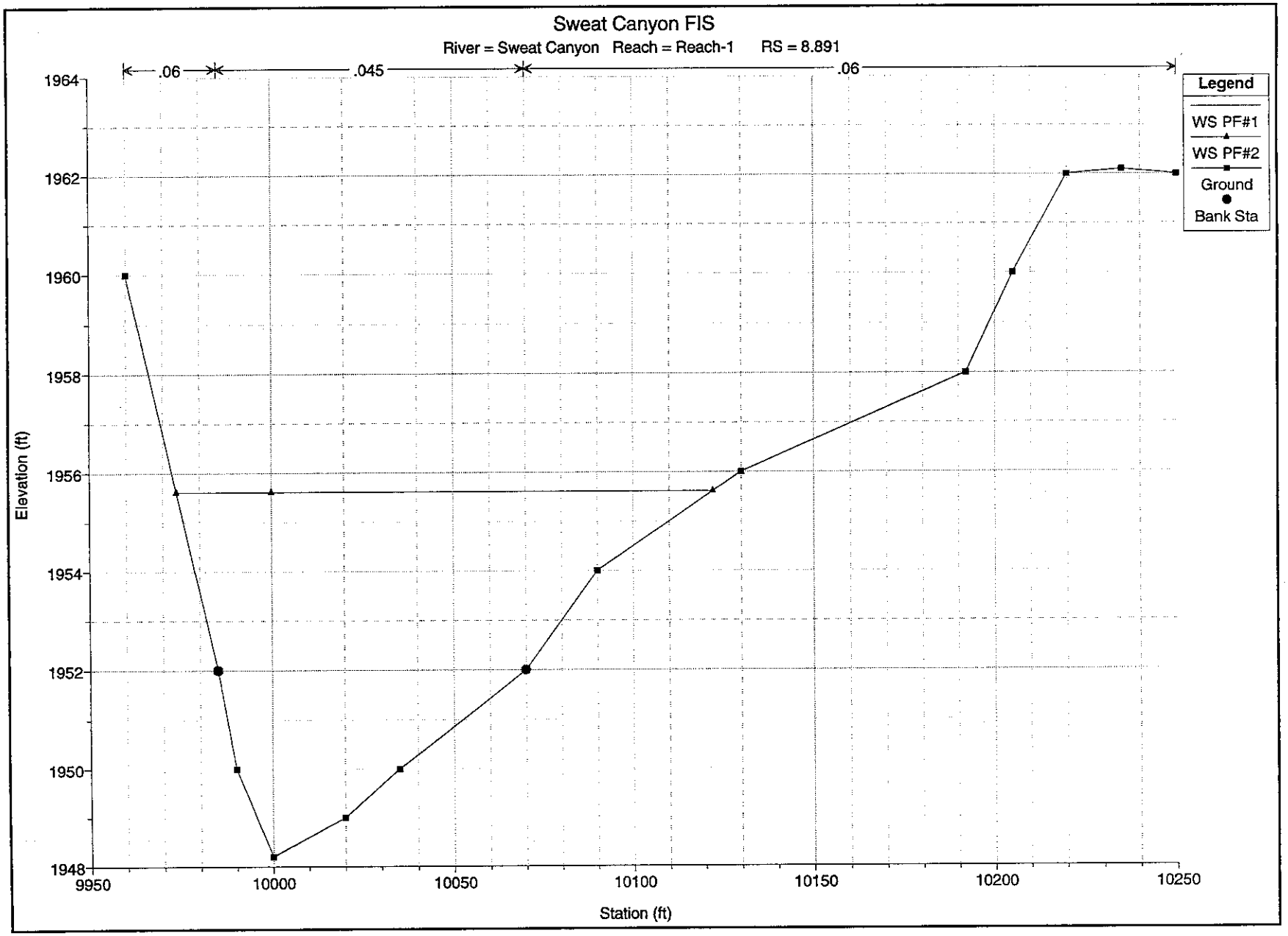

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.484
.07
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1980
1970
1960
1950
1940
1930
1920
9600
9700
9800
9900
10000
10100
10200
10300
Station (ft)

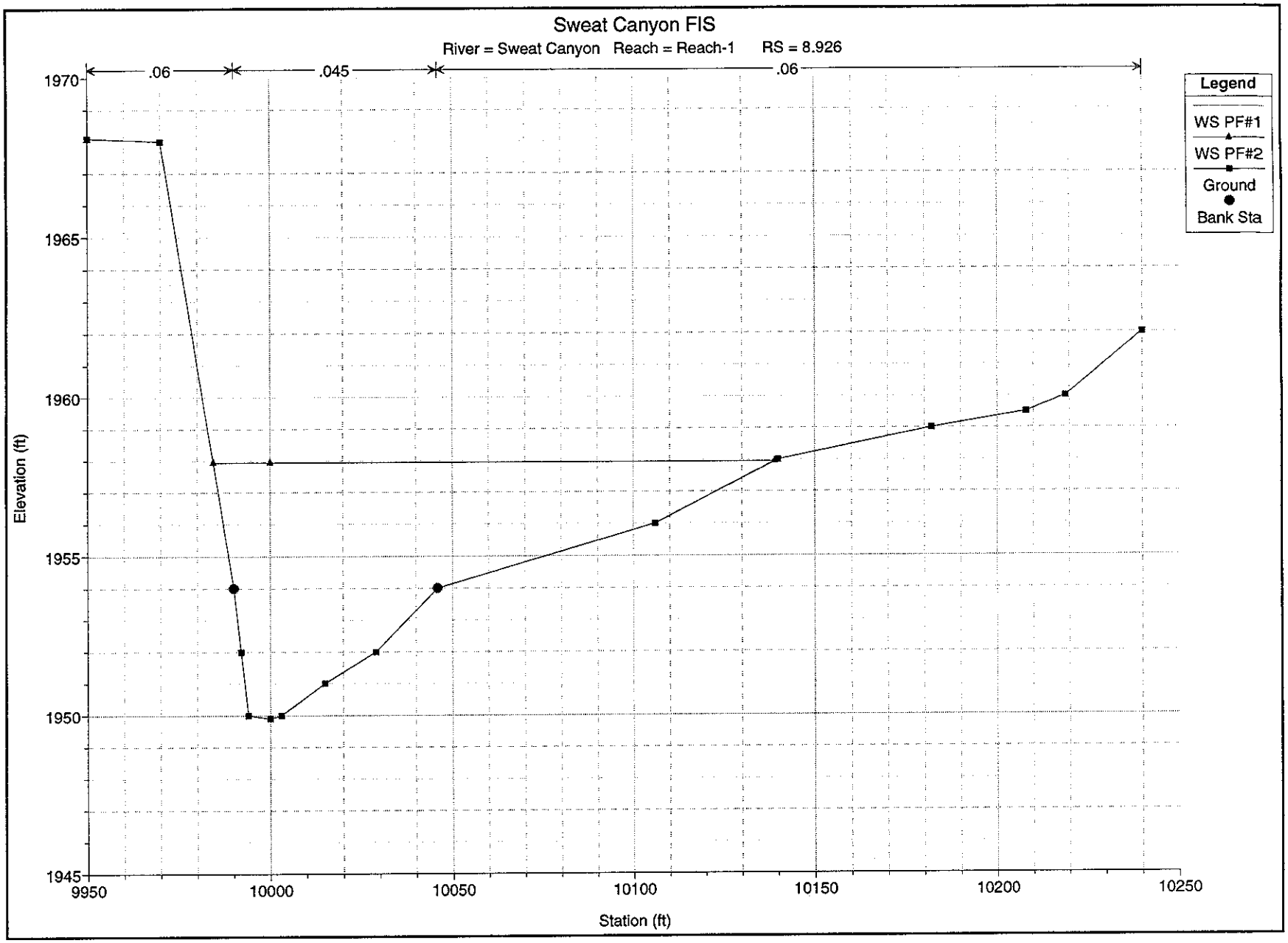

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.551
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1960
1955
1950
1945
1940
1935
1930
9600
9700
9800
9900
10000
10100
10200
Station (ft)

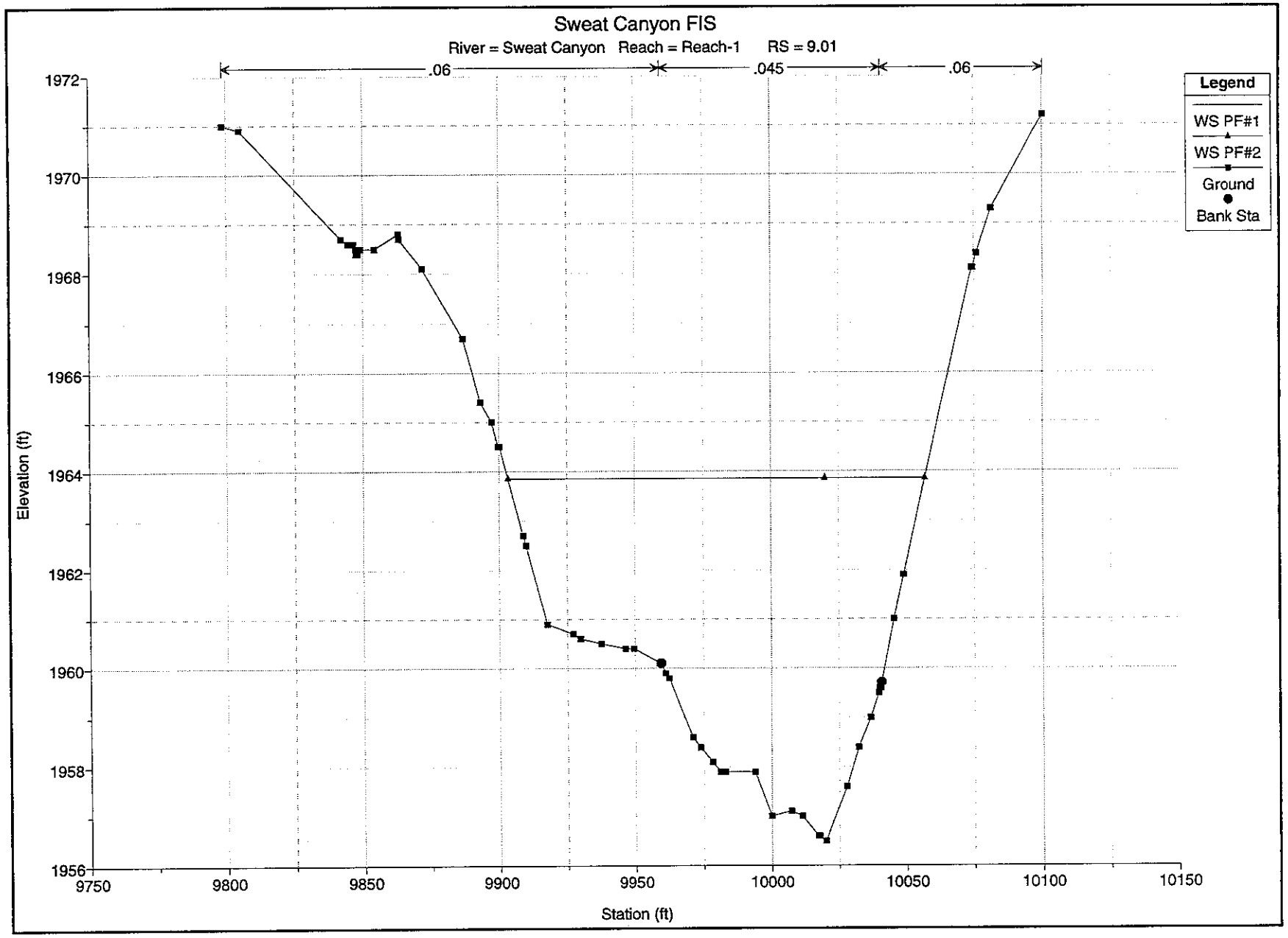

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.578
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Ineff
Bank Sta
Elevation (ft)
1960
1955
1950
1945
1940
1935
1930
9600
9700
9800
9900
10000
10100
10200
Station (ft)

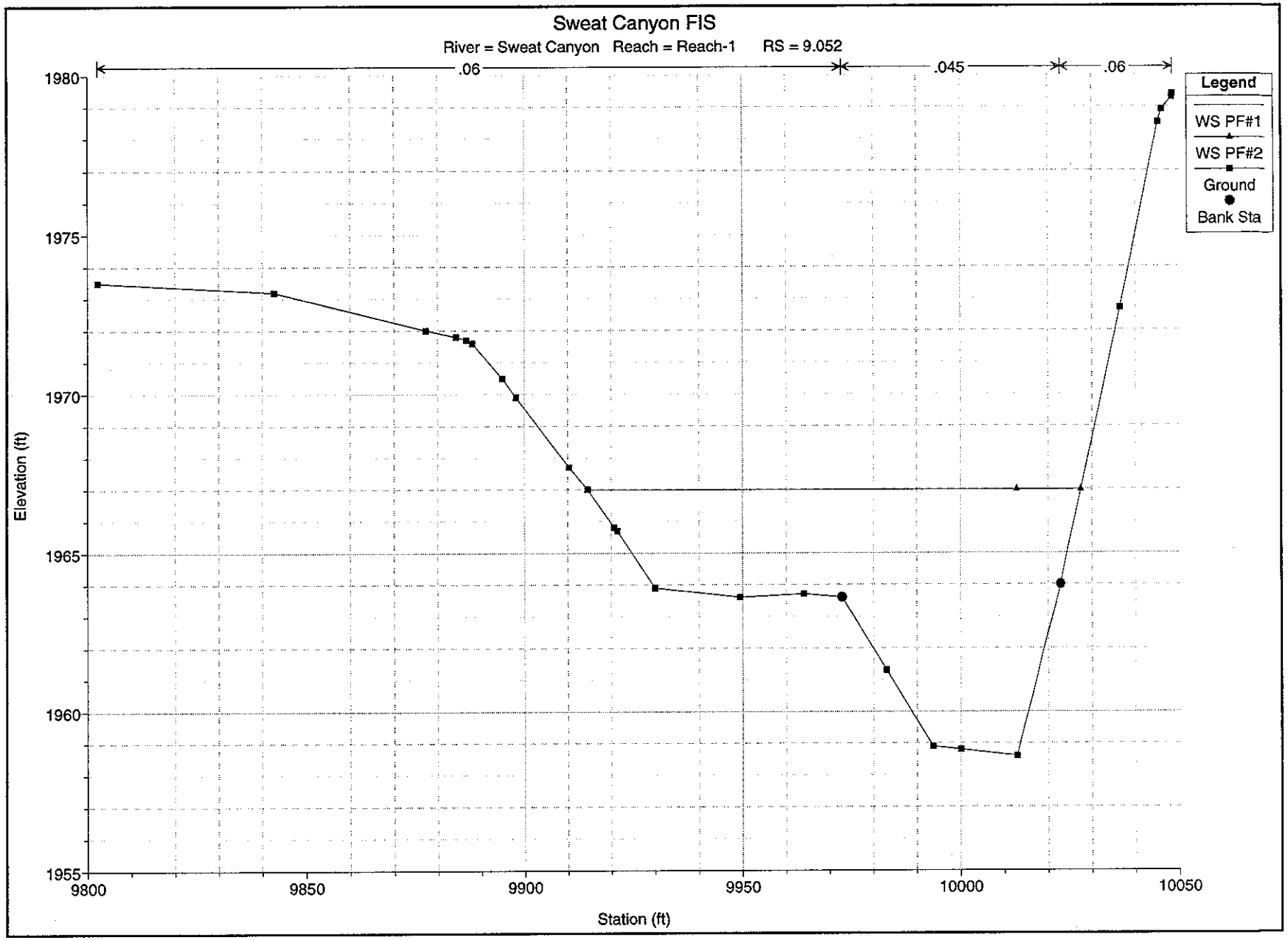

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.673
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1965
1960
1955
1950
1945
1940
1935
9700
9800
9900
10000
10100
10200
Station (ft)

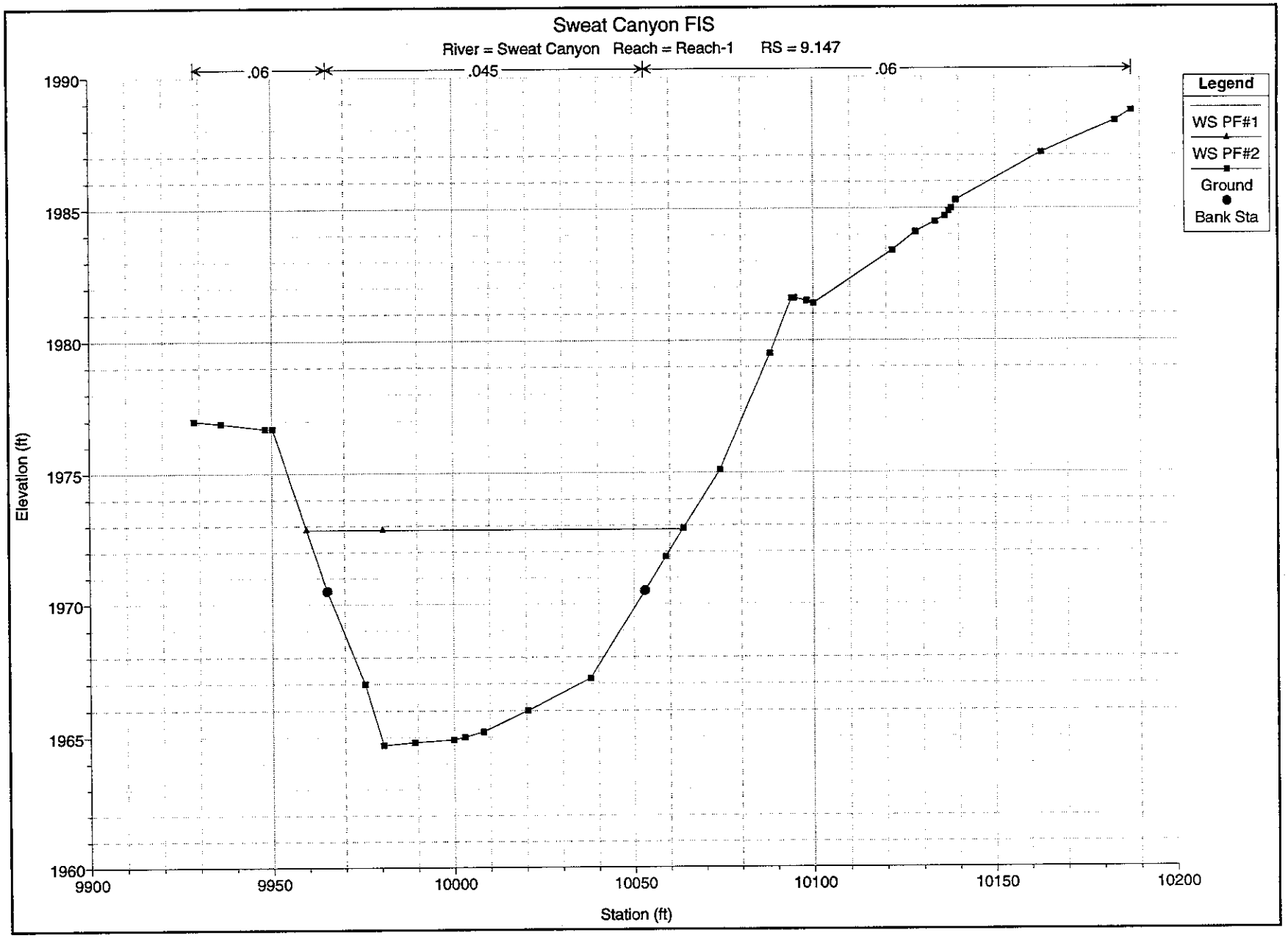

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.766
.07
.055
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1958
1956
1954
1952
1950
1948
1946
1944
1942
1940
9700
9800
9900
10000
10100
10200
Station (ft)

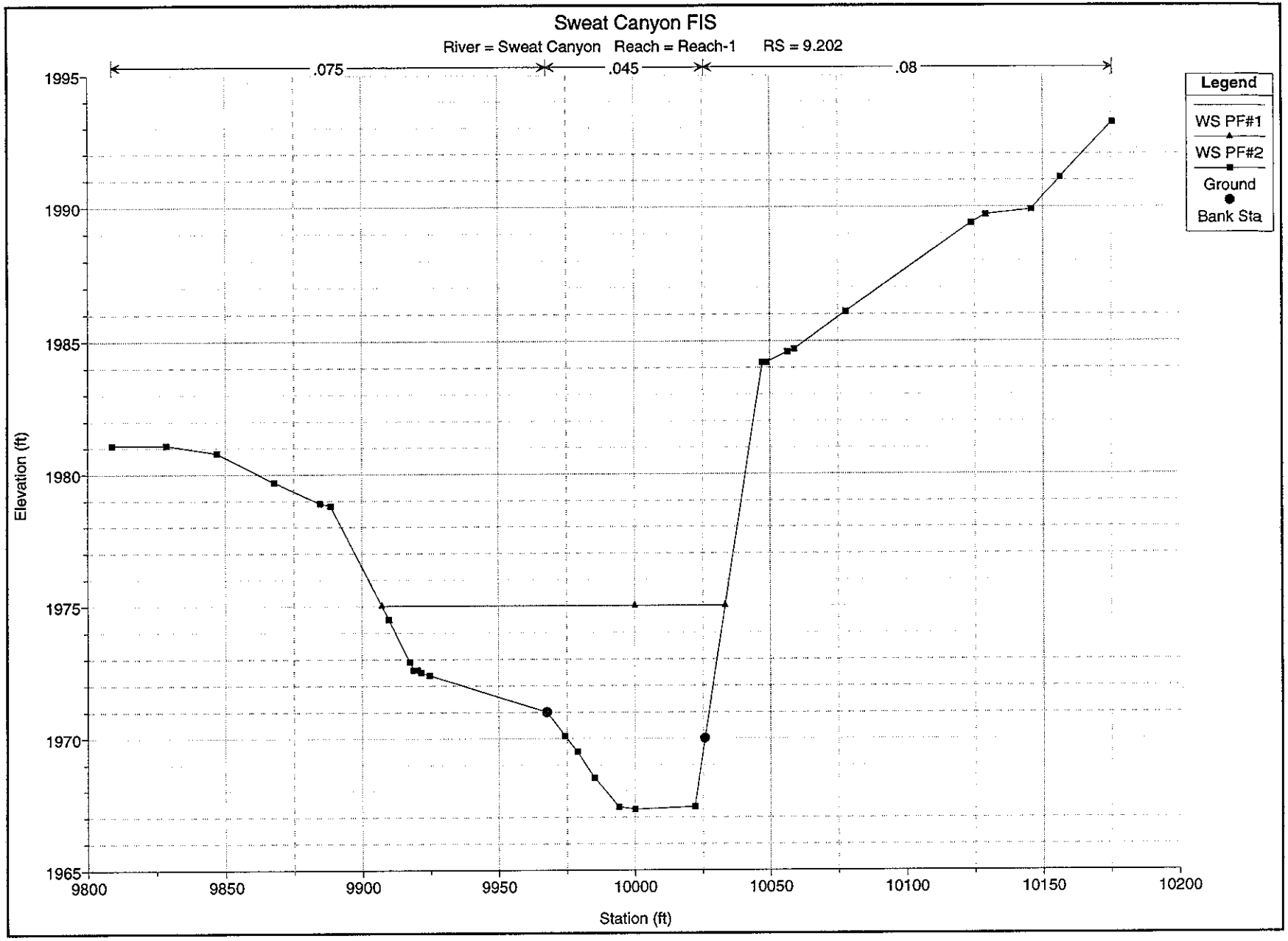

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.891
.06
.045
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1964
1962
1960
1958
1956
1954
1952
1950
1948
9950
10000
10050
10100
10150
10200
10250
Station (ft)

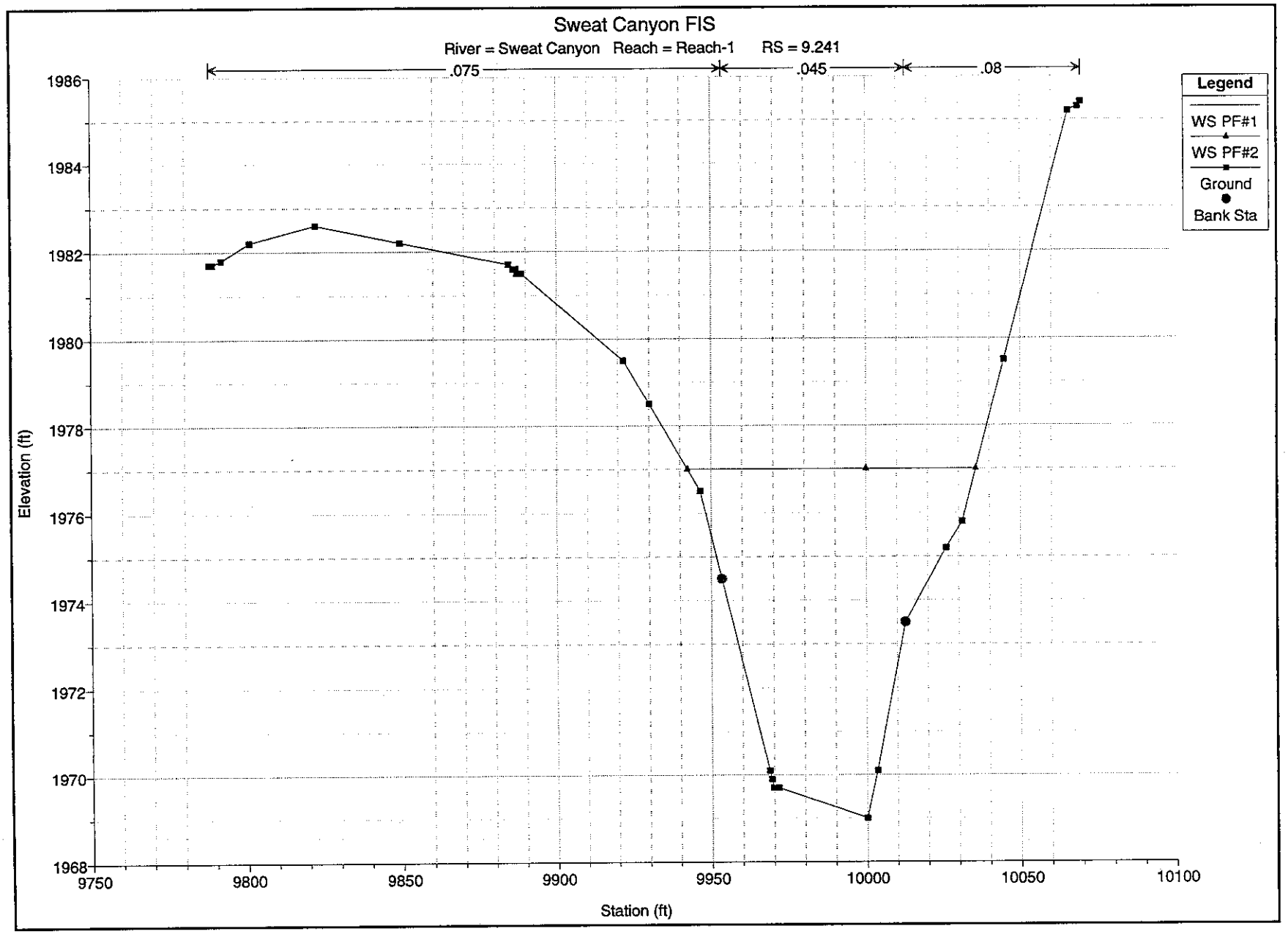

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 8.926
.06
.045
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1970
1965
1960
1955
1950
1945
9950
10000
10050
10100
10150
10200
10250
Station (ft)

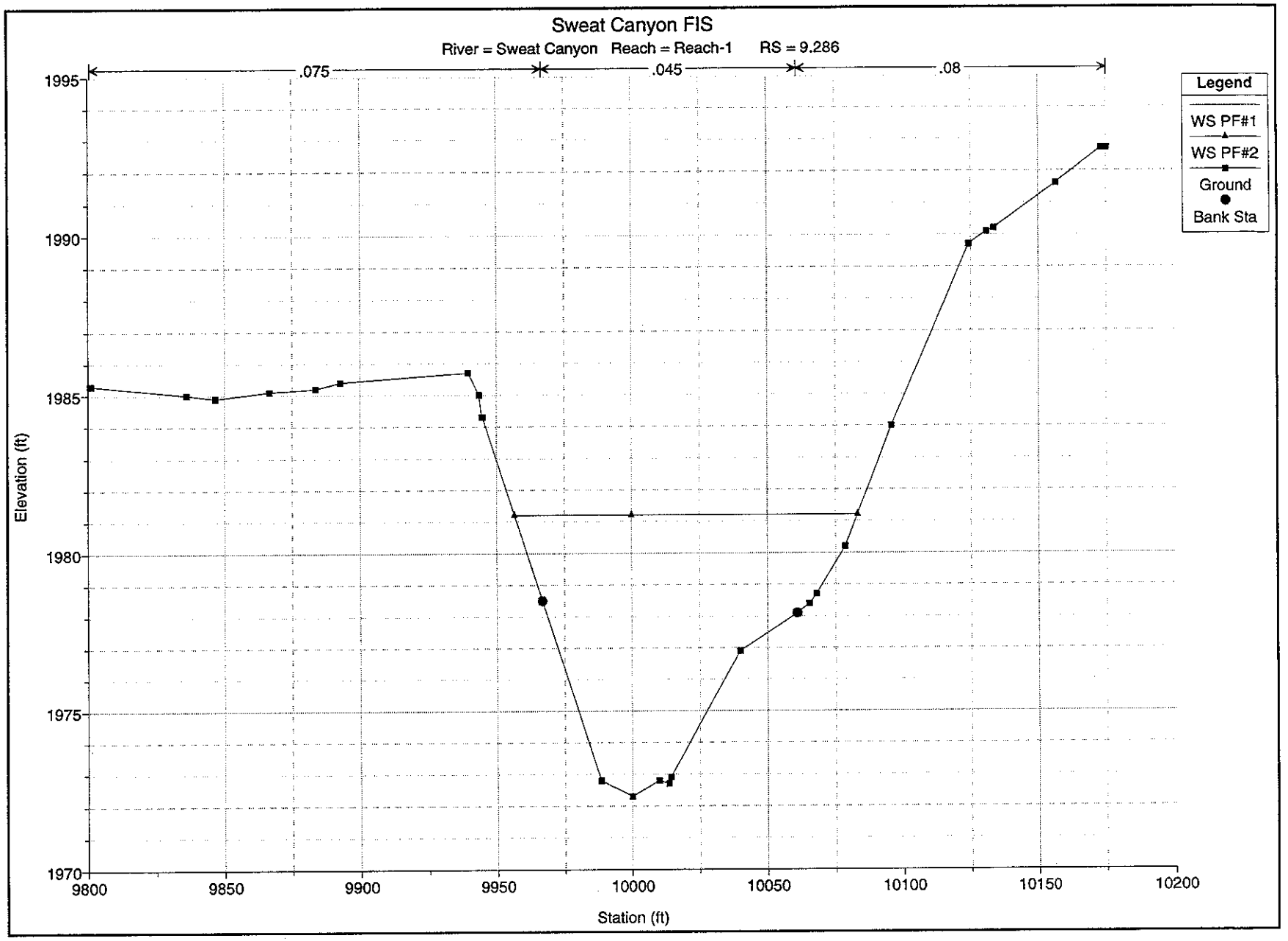

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.01
.06
.045
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1972
1970
1968
1966
1964
1962
1960
1958
1956
9750
9800
9850
9900
9950
10000
10050
10100
10150
Station (ft)

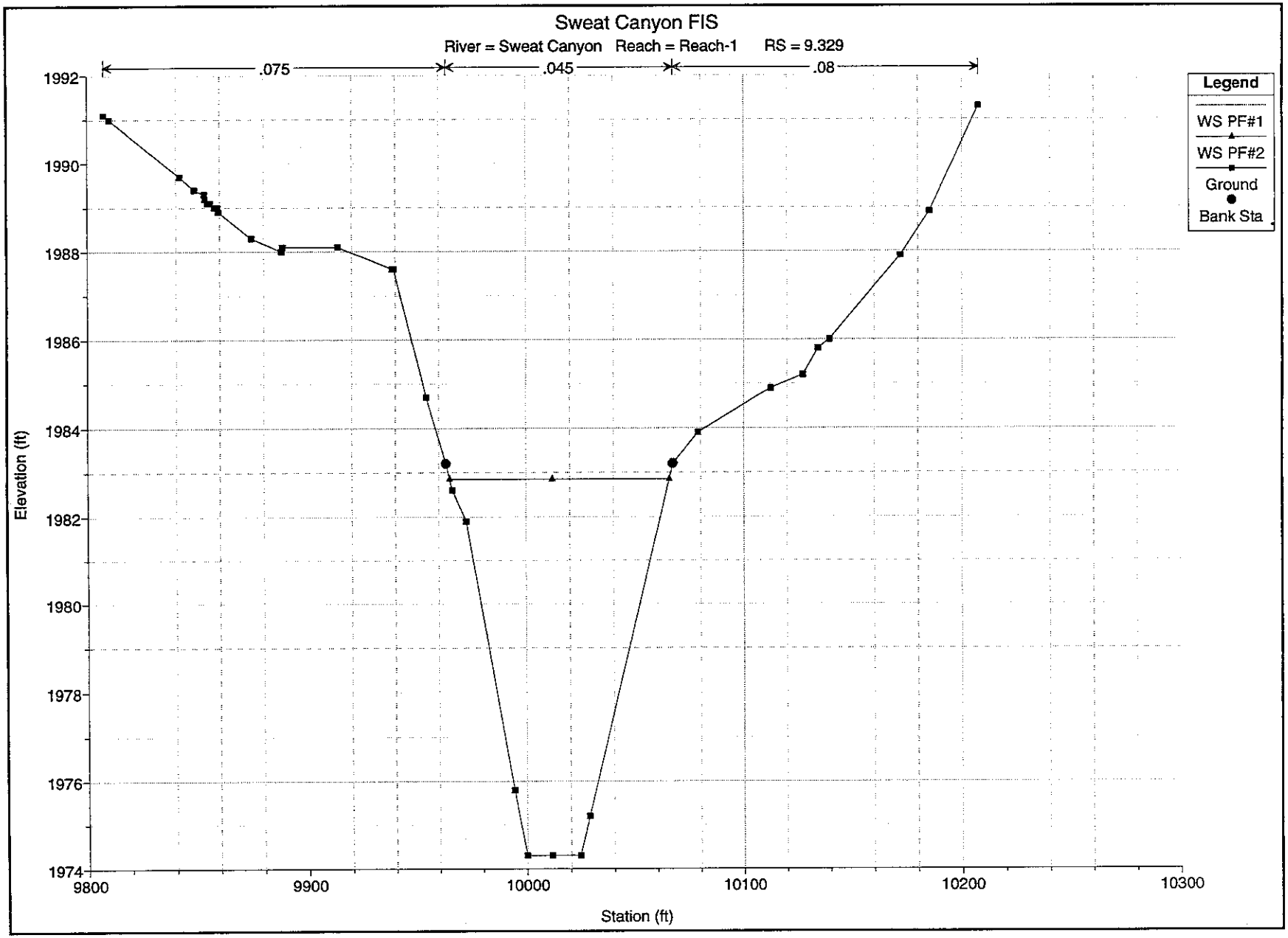

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.052
.06
.045
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1980
1975
1970
1965
1960
1955
9800
9850
9900
9950
10000
10050
Station (ft)

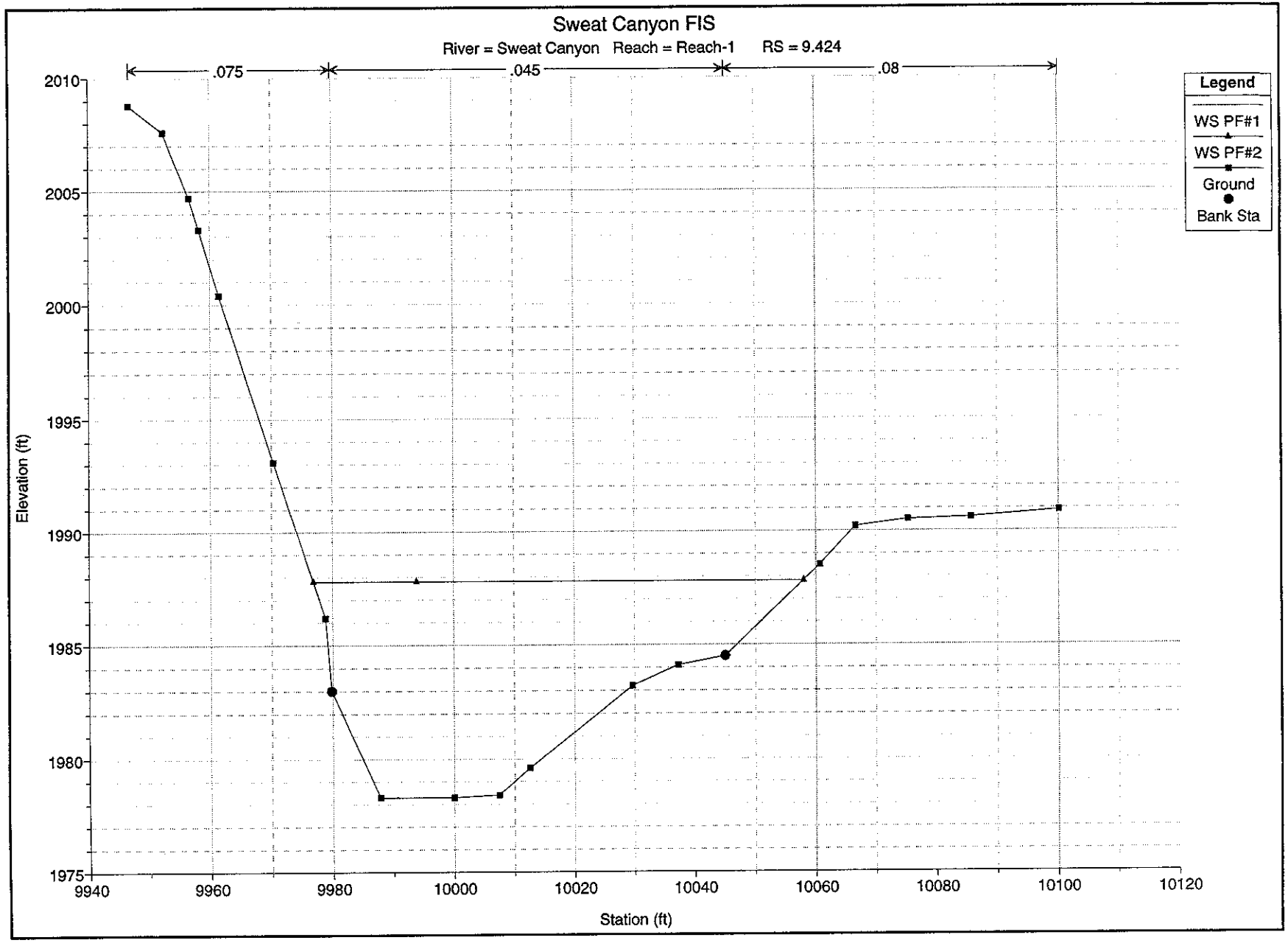

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.147
.06
.045
.06
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1990
1985
1980
1975
1970
1965
1960
9900
9950
10000
10050
10100
10150
10200
Station (ft)

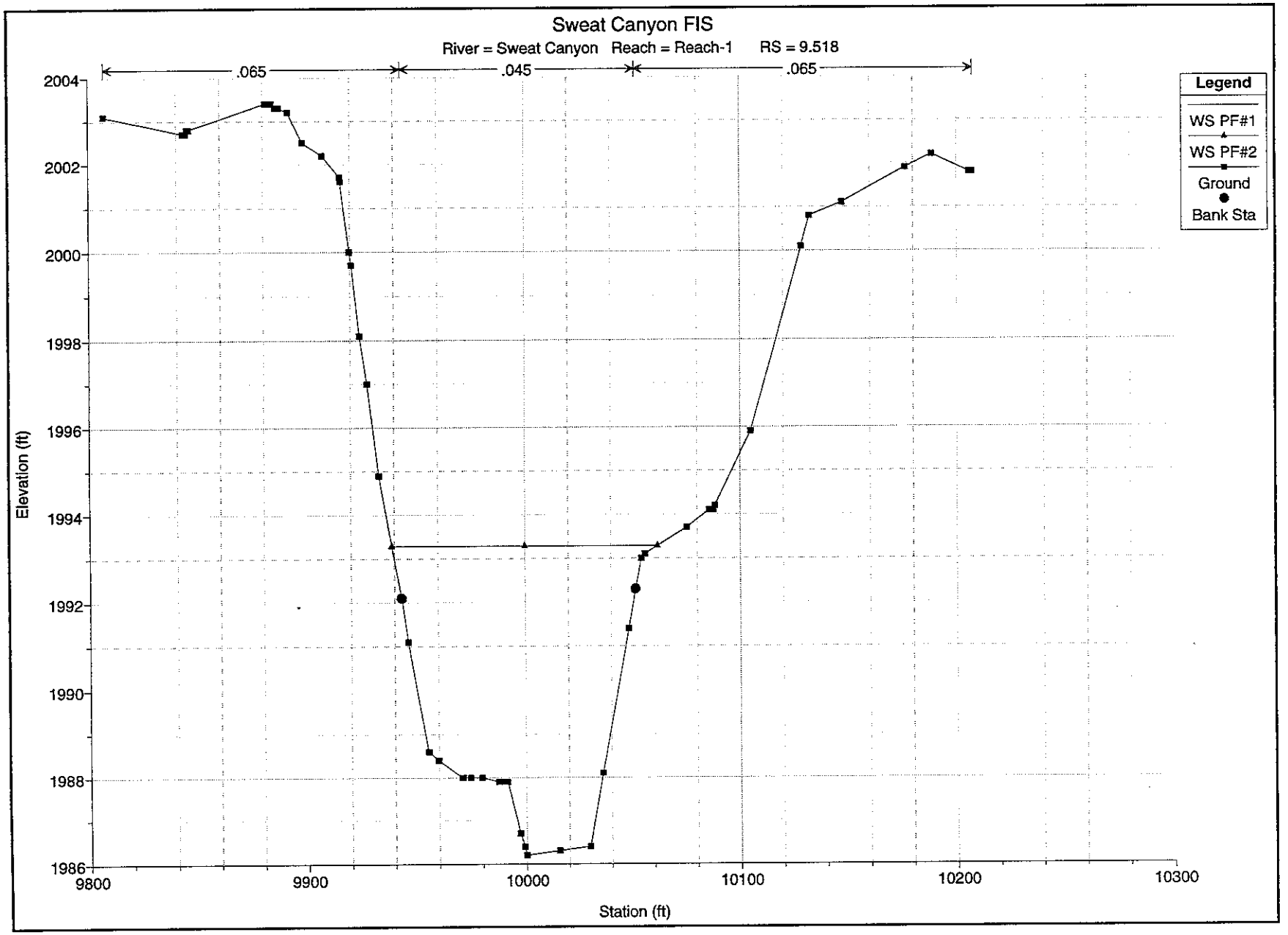

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.202
.075
.045
.08
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1995
1990
1985
1980
1975
1970
1965
9800
9850
9900
9950
10000
10050
10100
10150
10200
Station (ft)

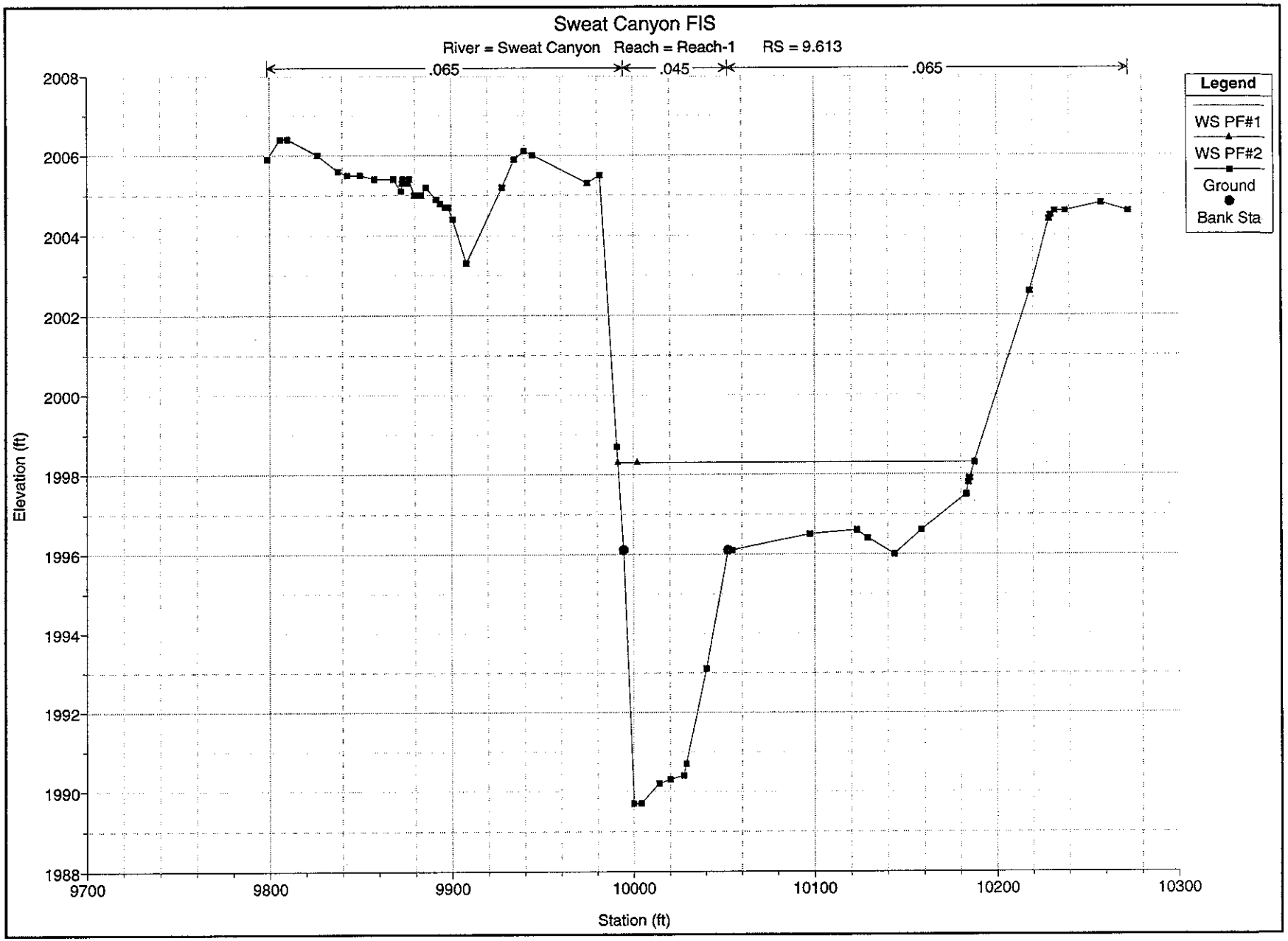

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.241
.075
.045
.08
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1986
1984
1982
1980
1978
1976
1974
1972
1970
1968
9750
9800
9850
9900
9950
10000
10050
10100
Station (ft)

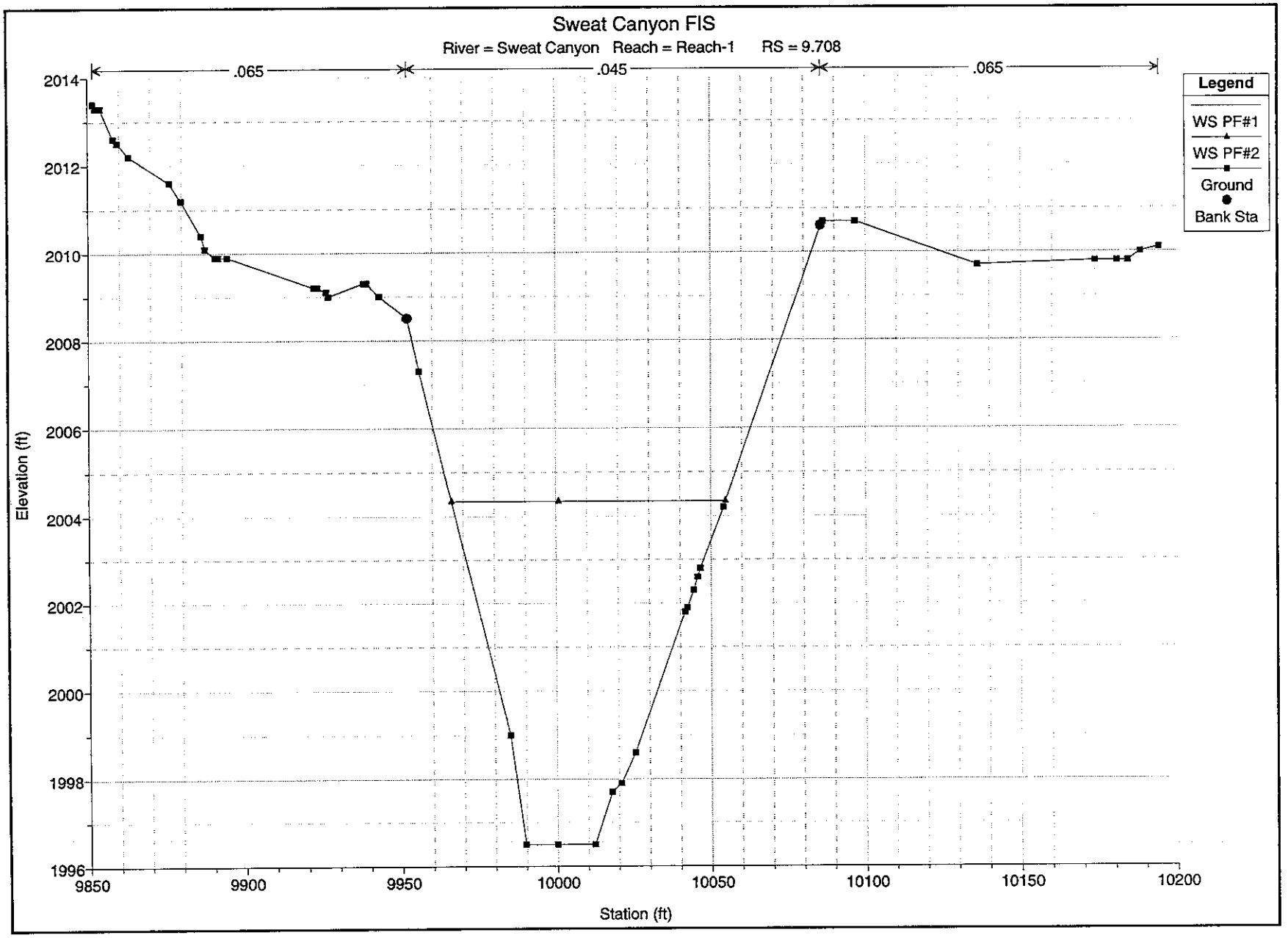

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.286
.075
.045
.08
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1995
1990
1985
1980
1975
1970
9800
9850
9900
9950
10000
10050
10100
10150
10200
Station (ft)

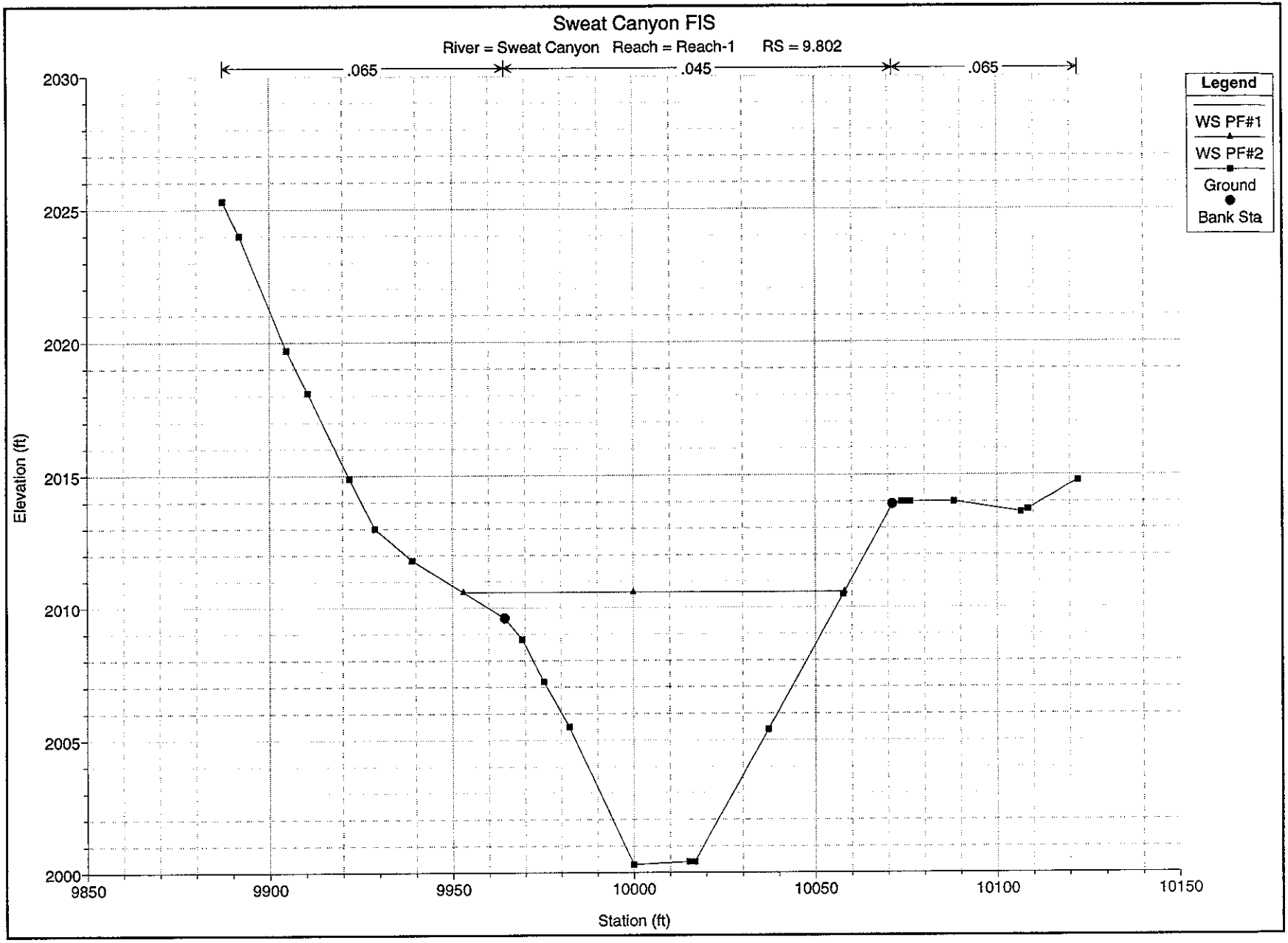

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.329
.075
.045
.08
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
1992
1990
1988
1986
1984
1982
1980
1978
1976
1974
9800
9900
10000
10100
10200
10300
Station (ft)

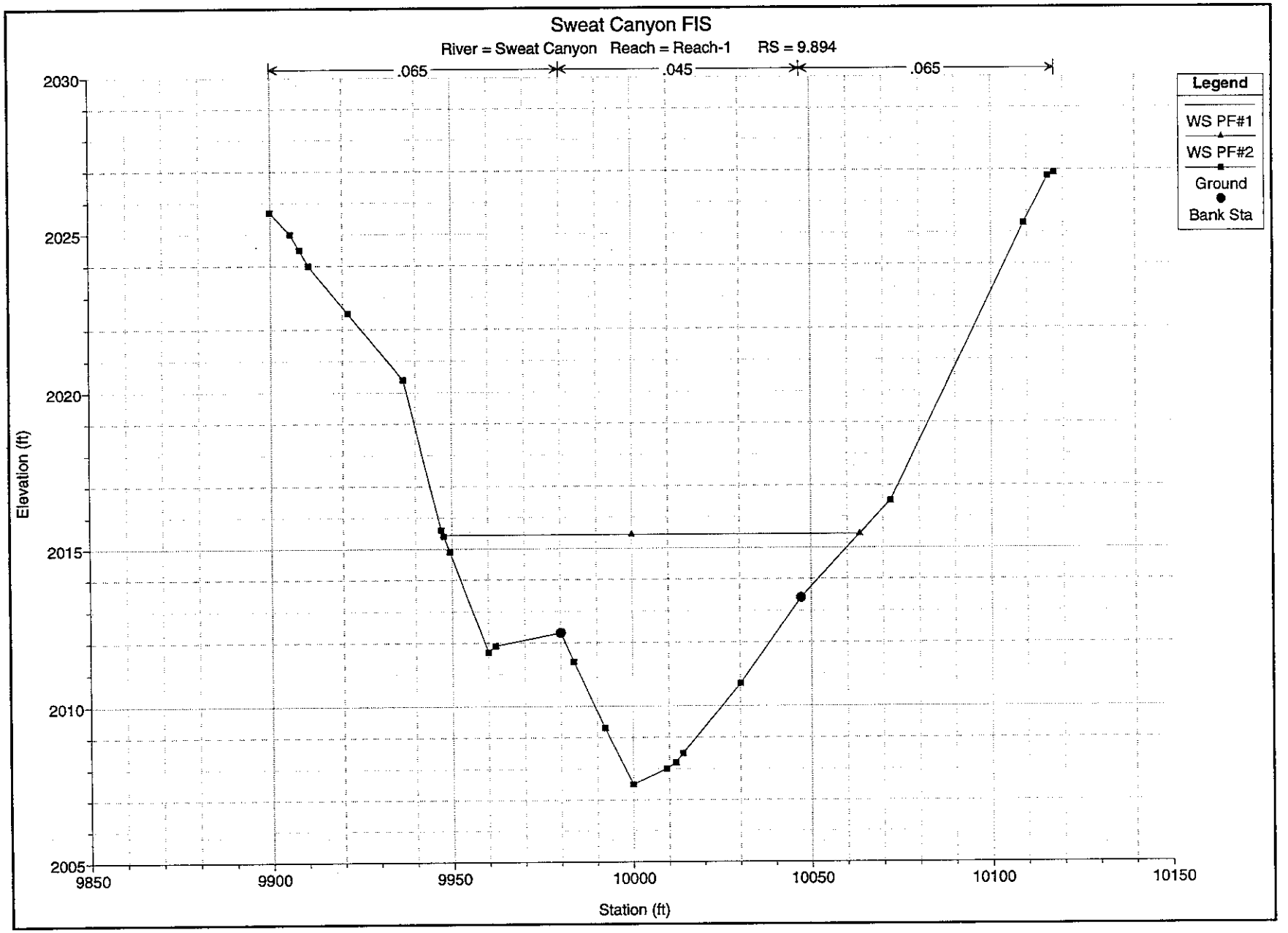

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.424
.075
.045
.08
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2010
2005
2000
1995
1990
1985
1980
1975
9940
9960
9980
10000
10020
10040
10060
10080
10100
10120
Station (ft)

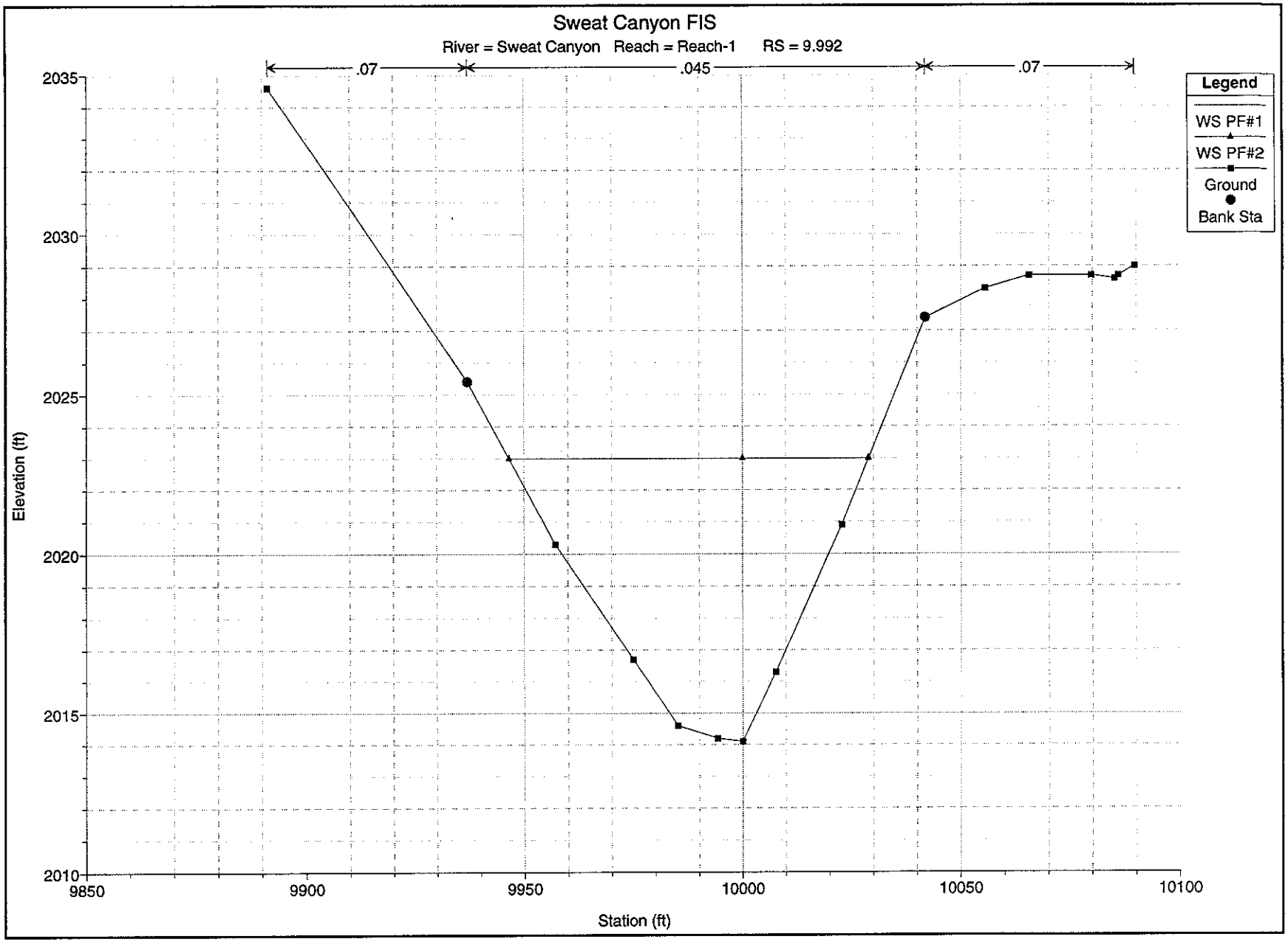

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.518
.065
.045
.065
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2004
2002
2000
1998
1996
1994
1992
1990
1988
1986
9800
9900
10000
10100
10200
10300
Station (ft)

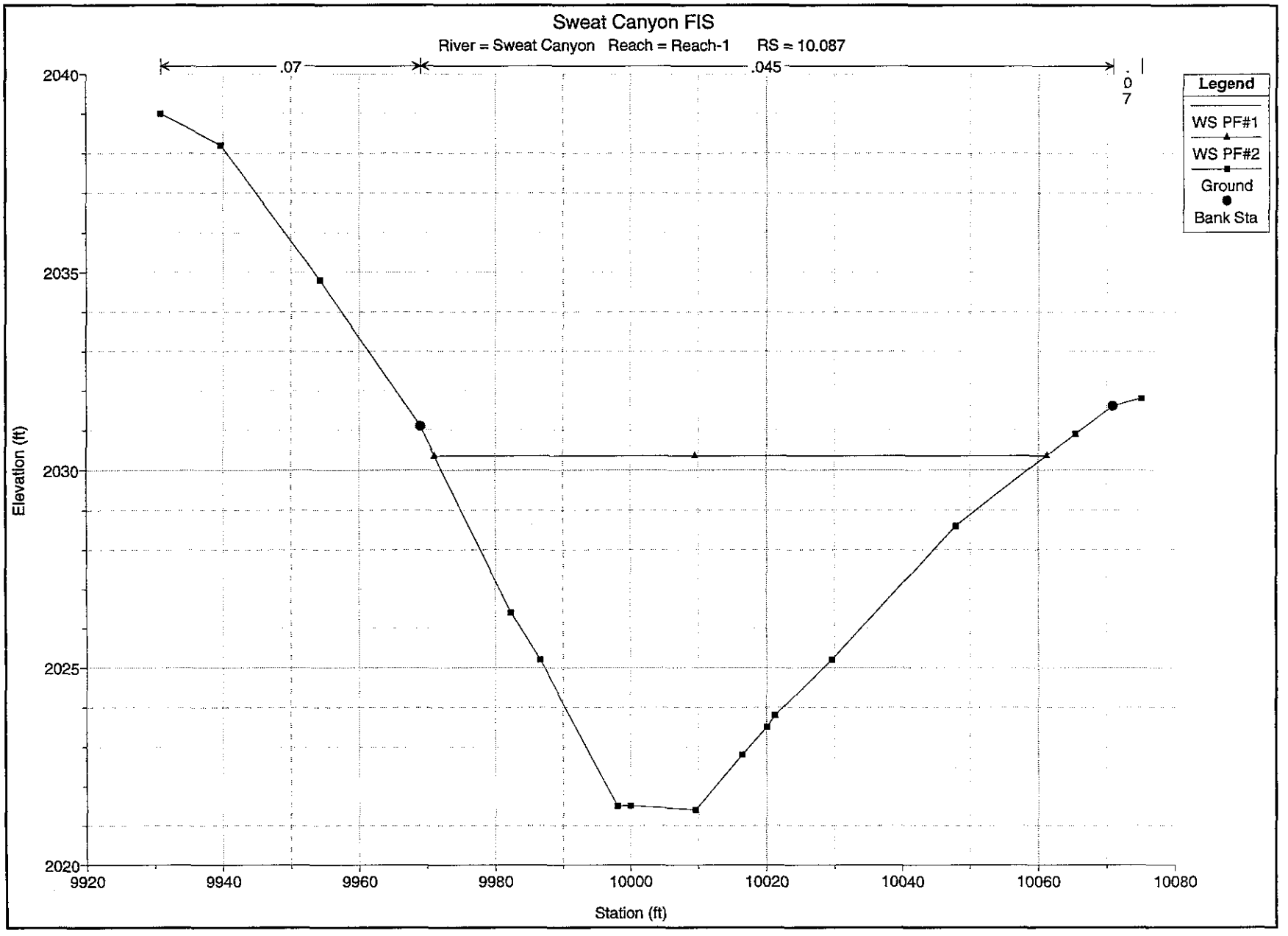

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.613
.065
.045
.065
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2008
2006
2004
2002
2000
1998
1996
1994
1992
1990
1988
9700
9800
9900
10000
10100
10200
10300
Station (ft)

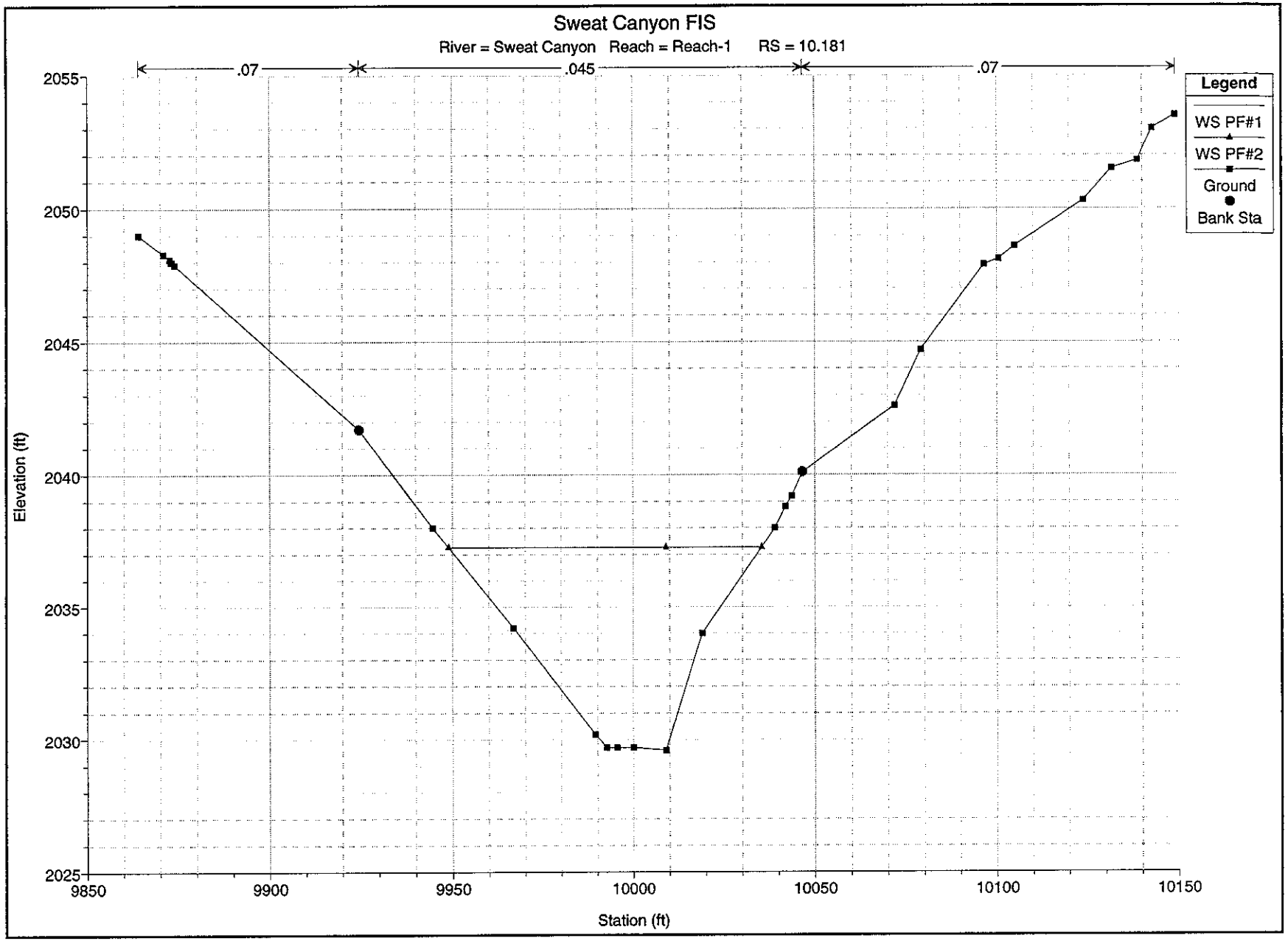

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.708
.065
.045
.065
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2014
2012
2010
2008
2006
2004
2002
2000
1998
1996
9850
9900
9950
10000
10050
10100
10150
10200
Station (ft)

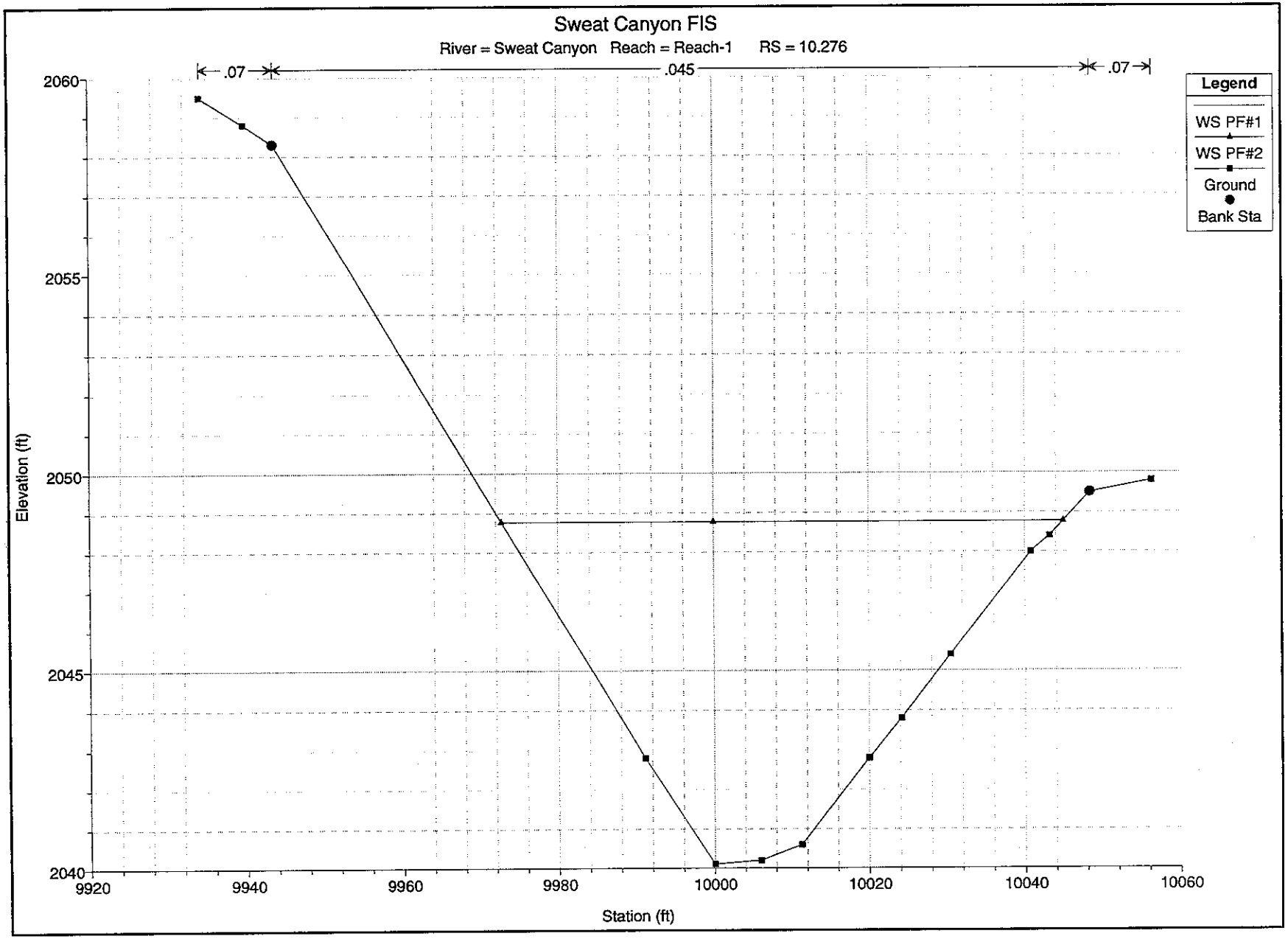

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.802
.065
.045
.065
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2030
2025
2020
2015
2010
2005
2000
9850
9900
9950
10000
10050
10100
10150
Station (ft)

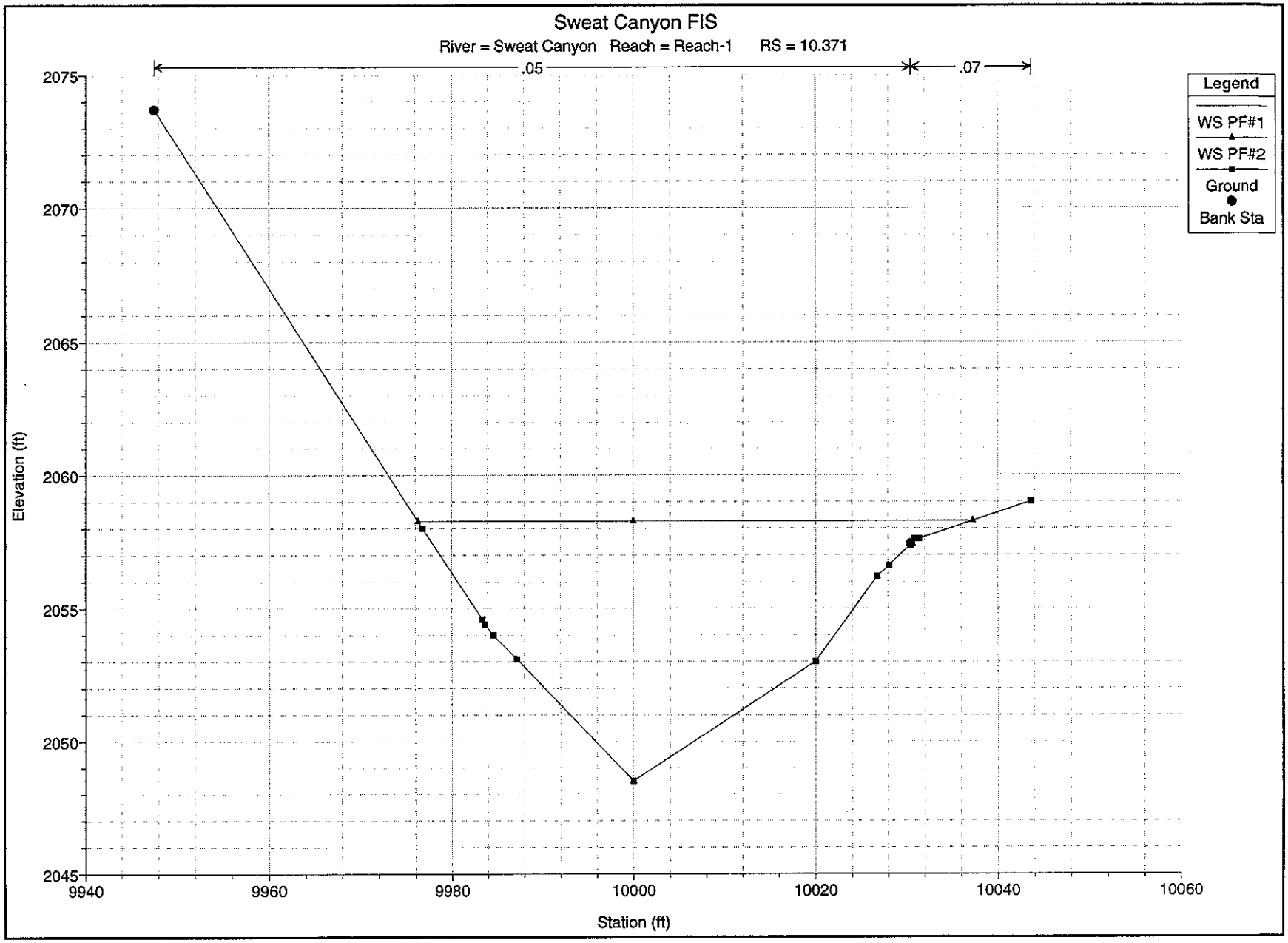

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.894
.065
.045
.065
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2030
2025
2020
2015
2010
2005
9850
9900
9950
10000
10050
10100
10150
Station (ft)

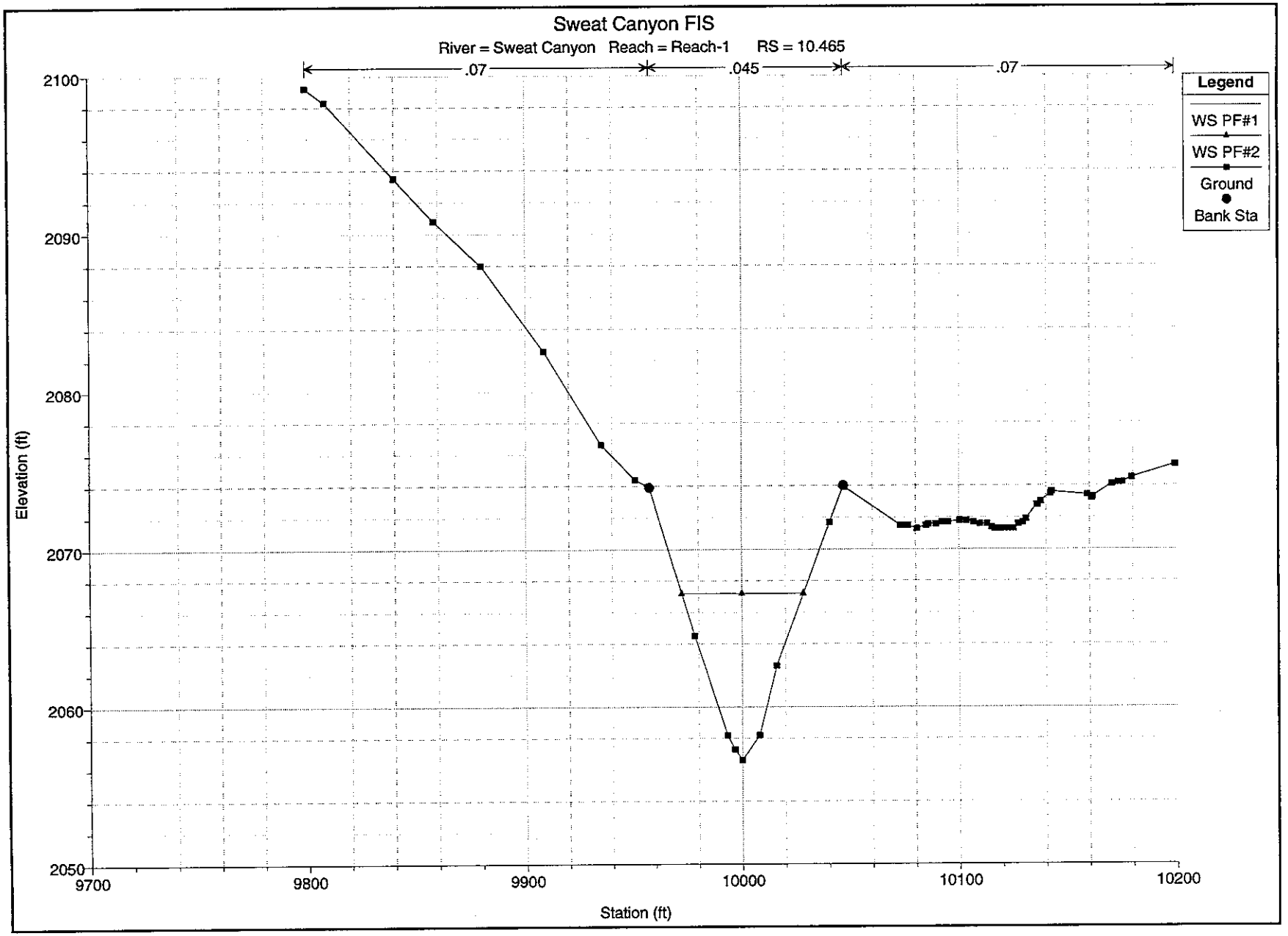

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 9.992
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2035
2030
2025
2020
2015
2010
9850
9900
9950
10000
10050
10100
Station (ft)

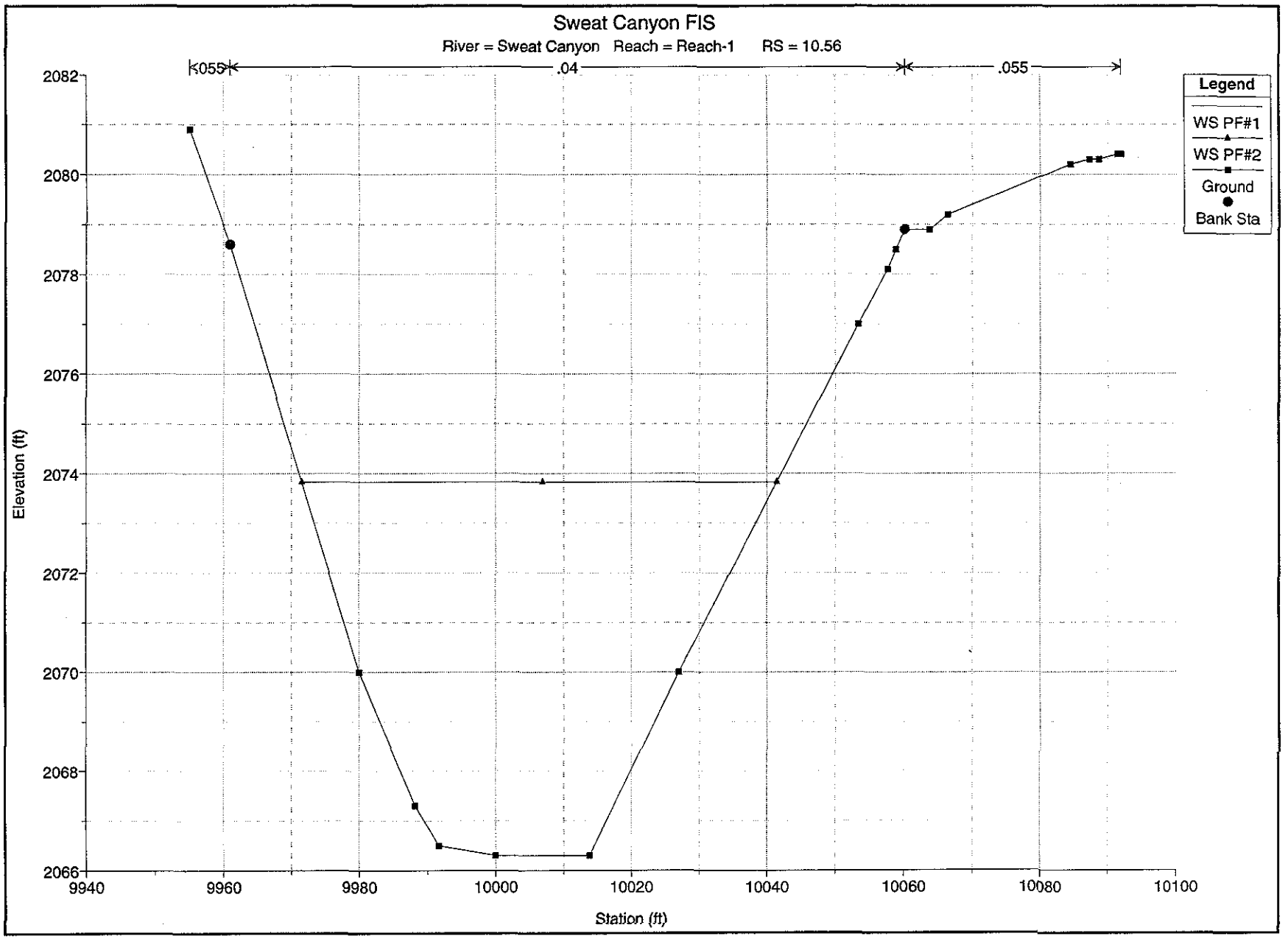

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.087
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2040
2035
2030
2025
2020
9920
9940
9960
9980
10000
10020
10040
10060
10080
Station (ft)

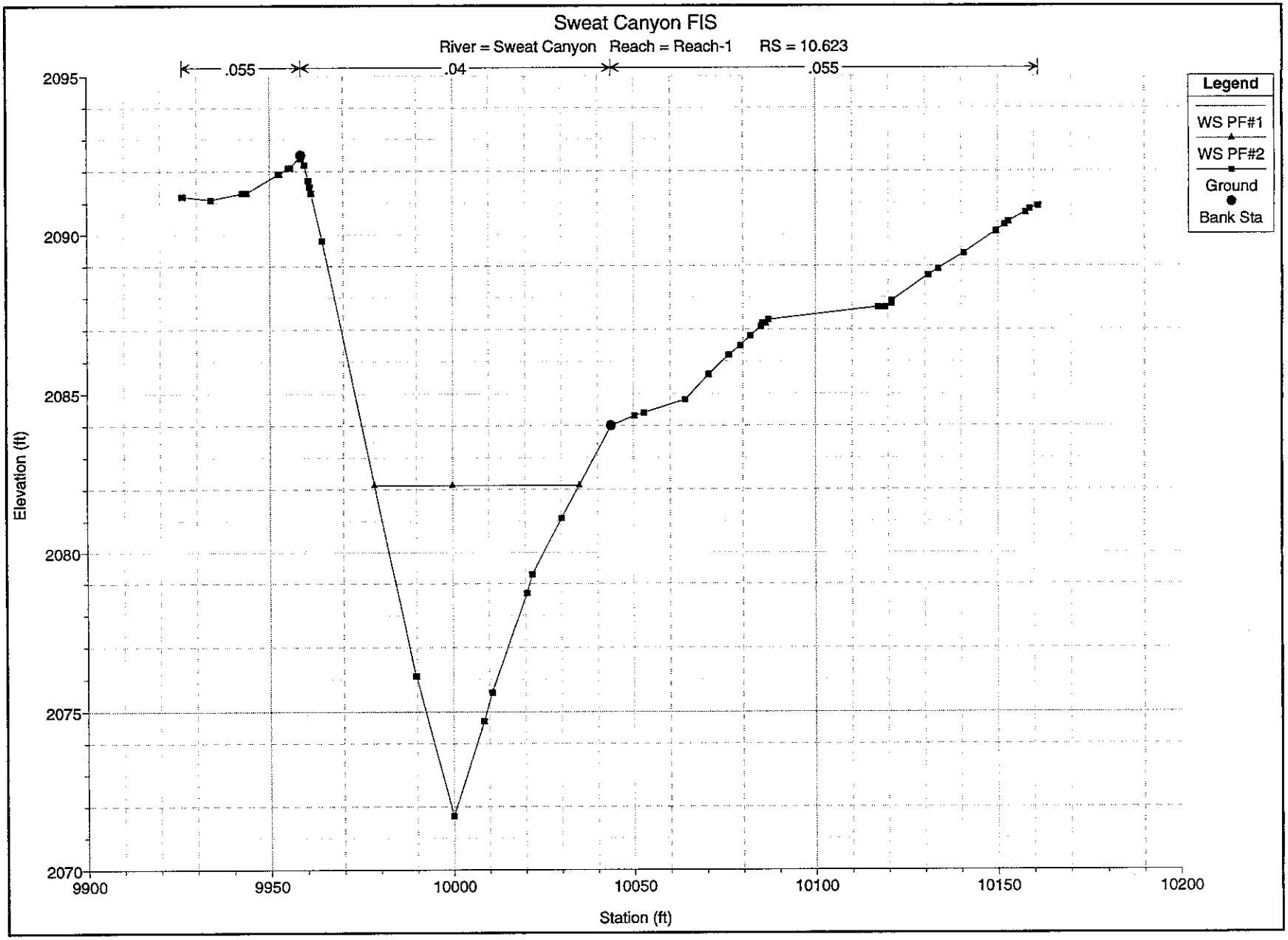

Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.181
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2055
2050
2045
2040
2035
2030
2025
9850
9900
9950
10000
10050
10100
10150
Station (ft)


Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.276
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2060
2055
2050
2045
2040
9920
9940
9960
9980
10000
10020
10040
10060
Station (ft)


Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.371
.05
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2075
2070
2065
2060
2055
2050
2045
9940
9960
9980
10000
10020
10040
10060
Station (ft)


Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.465
.07
.045
.07
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2100
2090
2080
2070
2060
2050
9700
9800
9900
10000
10100
10200
Station (ft)


Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.56
.055
.04
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2082
2080
2078
2076
2074
2072
2070
2068
2066
9940
9960
9980
10000
10020
10040
10060
10080
10100
Station (ft)


Sweat Canyon FIS
River = Sweat Canyon Reach = Reach-1 RS = 10.623
.055
.04
.055
Legend
WS PF#1
WS PF#2
Ground
Bank Sta
Elevation (ft)
2095
2090
2085
2080
2075
2070
9900
9950
10000
10050
10100
10150
10200
Station (ft)

E.4 Analysis of structures

There are no existing structures within the work study area.

Depth Verification

Routing Reach	HEC-RAS XSECS	Peak Q[1] (cfs)	Inter Depth HEC-1	Avg Depth FM[3]	Peak Q[2] (cfs)	Avg Depth HEC-RAS	Avg Depth FM[4]	Froude HEC-RAS	Froude FM[3]	Froude FM[4]
6-7	10.371-10.465	3520	7.9	8.5	3977	9.6	8.7	0.92	0.8	0.87
7-8	10.087-10.276	3945	9.3	9.3	4375	8.4	9.8	0.93	0.85	0.86
8-9	9.701-9.992	4308	7.4	8.0	5172	8.7	8.7	0.85	0.71	0.71
9-11	9.010-9.606	4819	8.9	9.3	5396	8.5	9.7	0.72	0.64	0.64
11-12	8.200-8.926	5008	8.8	8.9	5811	7.9	9.5	0.72	0.69	0.69
12-14	7.729-8.105	5605	6.0	6.4	5718	7.3	6.4	0.68	0.67	0.67
14-15	7.554-7.631	5721	8.6	9.2	6035	7.3	9.3	0.85	0.61	0.61
15-16	6.684-7.442	5867	9.0	9.1	6481	7.4	9.3	0.78	0.75	0.74
16-17	5.134-6.590	6078	8.7	9.2	7174	8.1	9.8	0.65	0.6	0.6
20-21	4.185-4.696	614	3.7	3.9	1392	5.5	5.4	0.79	0.78	0.81
23-24	.094-.661	991	4.5	5.1	1458	4.8	5.6	0.82	0.58	0.6
24-25	3.804-4.138	2634	4.4	4.7	3719	6.8	5.4	0.77	0.81	0.81
25-26	2.859-3.707	3457	7.3	7.5	3715	5.5	7.7	0.69	0.68	0.68
26-32	1.343-2.734	3351	4.7	4.6	5677	6.5	5.7	0.68	0.73	0.76
32-34B	.018-1.231	5275	9.2	10.2	7335	8.3	11.1	0.64	0.59	0.6
35-18	4.790-4.949	13524	10.9	11.1	13677	9.1	11.1	0.53	0.61	0.62
18-19A	4.222-4.741	12953	5.1	5.3	13034	8.1	5.3	0.58	0.47	0.47

Velocity Verification

Routing Reach	HEC-RAS XSECS	Peak Q[1] (cfs)	Interpolated Storage (ac-ft)	Routing Length (ft)	Conveyance Area (ft^2)	Velocity HEC-1	Avg Vel FM[3]	Peak Q[2] (cfs)	Avg Vel HEC-RAS	Avg Vel FM[4]
6-7	10.371-10.465	3520	8.1	1211	291	12.1	10.7	3977	12.1	11.7
7-8	10.087-10.276	3945	11	1462	328	12.0	12	4375	11.4	12.3
8-9	9.701-9.992	4308	26.3	2714	422	10.2	8.9	5172	11.4	9.3
9-11	9.010-9.606	4819	37	2934	549	8.8	8.1	5396	10.4	8.4
11-12	8.200-8.926	5008	52.3	4331	526	9.5	9.4	5811	9.5	9.9
12-14	7.729-8.105	5605	37.1	2565	630	8.9	8.2	5718	8.4	8.2
14-15	7.554-7.631	5721	11.9	766	677	8.5	7.4	6035	11.3	7.5
15-16	6.684-7.442	5867	76.1	4306	770	7.6	7.5	6481	10.1	7.7
16-17	5.134-6.590	6078	161.9	9527	740	8.2	7.2	7174	8.7	7.6
20-21	4.185-4.696	614	14	6955	88	7.0	6.4	1392	8.2	7.8
23-24	.094-.661	991	28.3	8047	153	6.5	4.4	1458	8.6	5.1
24-25	3.804-4.138	2634	13.9	1843	329	8.0	7.3	3719	8.6	7.9
25-26	2.859-3.707	3457	51.8	5507	410	8.4	8.2	3715	7.5	8.4
26-32	1.343-2.734	3351	91.5	7976	500	6.7	7	5677	8.1	8.4
32-34B	.018-1.231	5275	95.8	6403	652	8.1	6.3	7335	8.1	6.9
35-18	4.790-4.949	13524	32.9	682	2101	6.4	5.9	13677	6.9	5.9
18-19A	4.222-4.741	12953	199.3	3249	2672	4.8	4.4	13034	7.1	4.4

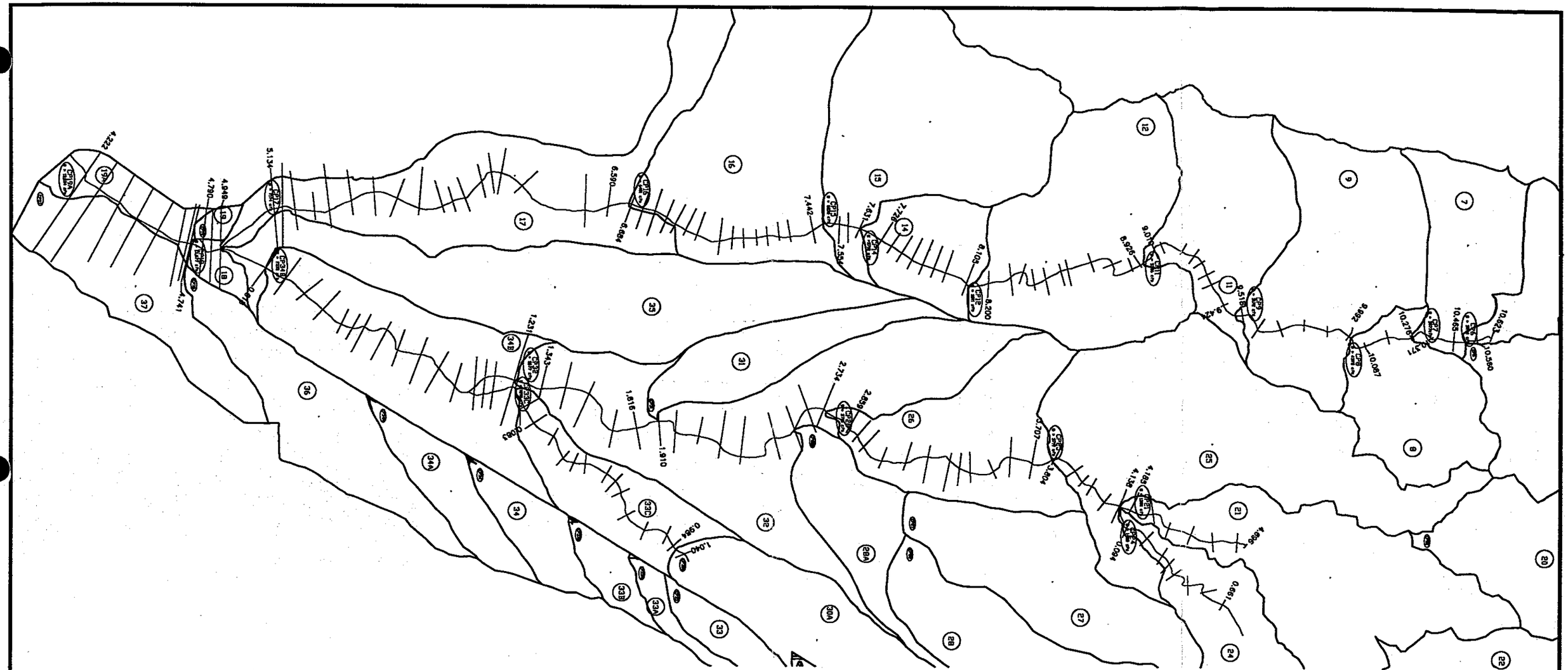
[1] HEC-1 routed flow

[2] Peak flow at concentration points

[3] FlowMaster using HEC-1 routed flow

[4] FlowMaster using peak flow at concentration point

s:\adm\mari0029\data\d_vferna.xls

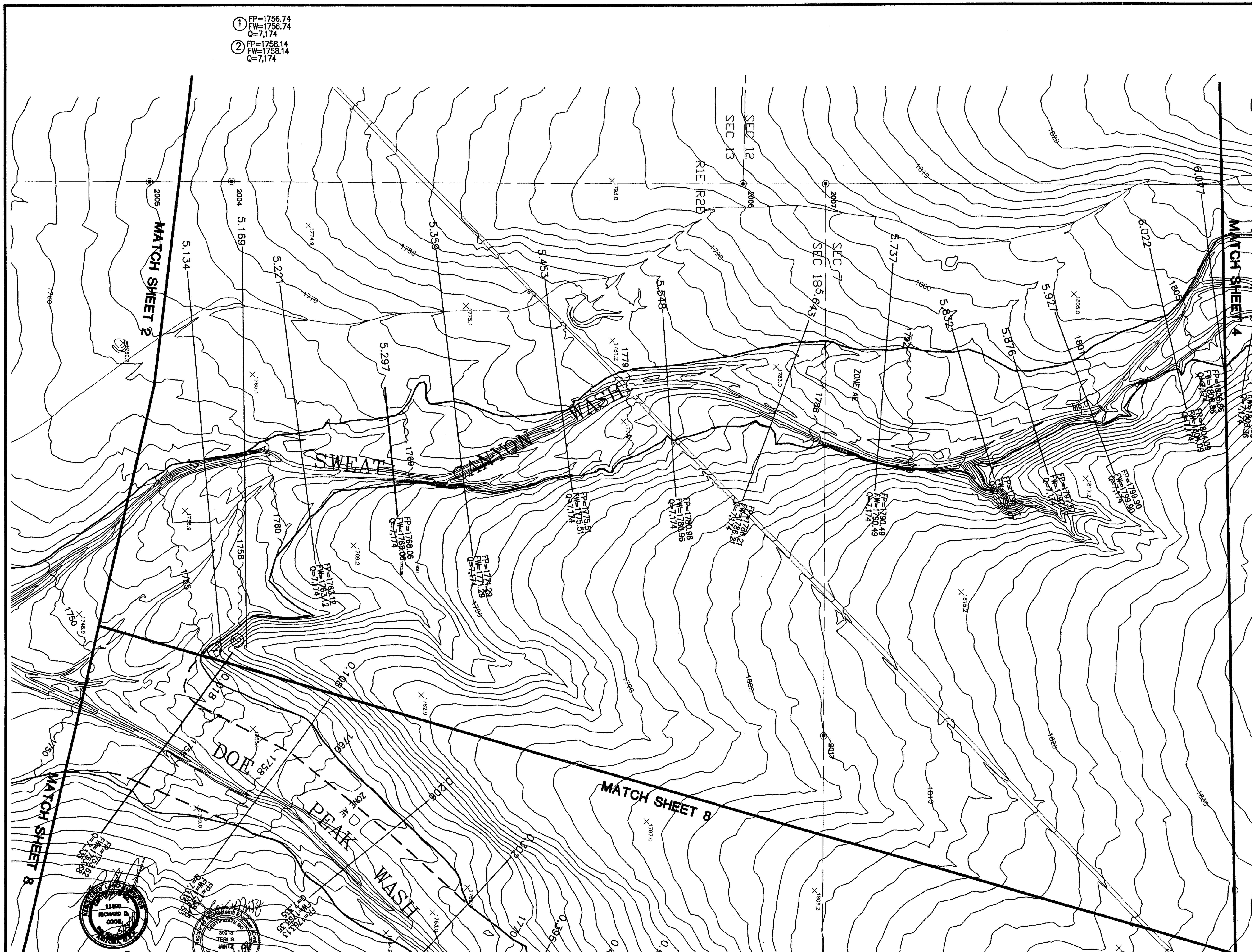


DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH STREET
PHOENIX, AZ. 85020 (602) 678-5151

SWEAT CANYON FIS HEC-RAS X-SEC'S AND CP'S

SECTION: XX	TWNSHP: XX	RANGE: XX
DRAWN BY: TJCL	DATE: 9/98	
CHECKED BY:	DRAWING NO.: M29CPX	
JOB NO.: MAR10029	SHEET 1 OF 1	

M29CPX.dwg tjcl 05/20/99 15:00:40 tjcl S:\CAD\MAR10029\HECRAS\FEMA\M29



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

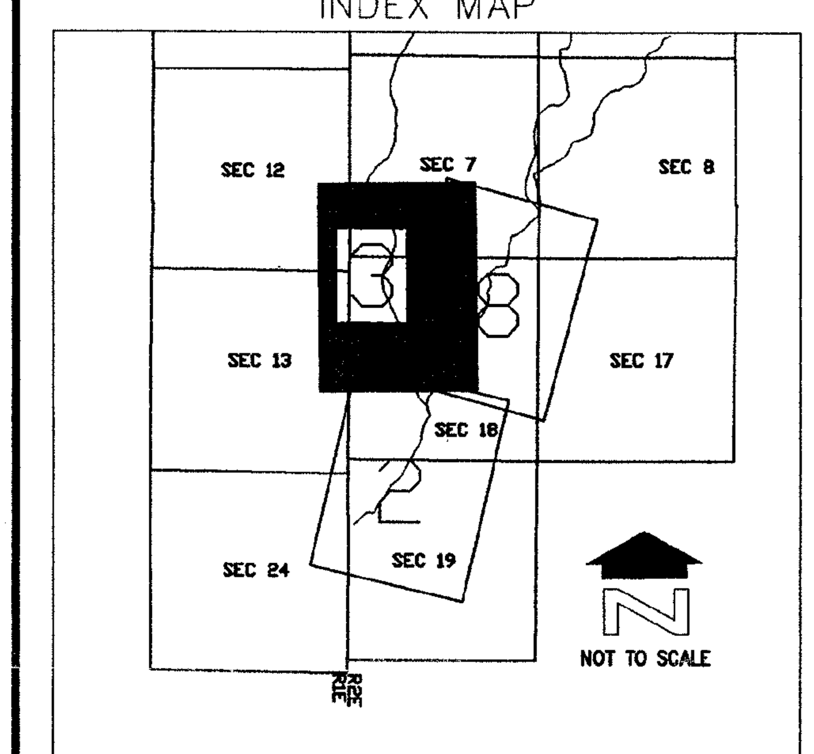
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2004	1772.17	GLO BC UP 1.00' W 1/4 COR, SEC 18, T 6N, R 2E
2005	1768.11	GLO BC UP 1.50' E 1/4 COR, SEC 13, T 6N, R 1E
2006	1798.16	GLO BC UP 2.00' 1/4 COR, SEC 12 & 13, T 6N, R 1E
2007	1804.03	GLO BC UP 1.75' / 1/4 COR, SEC 7 & 18, T 6N, R 2E
2017	1805.10	GLO BC UP 1.50' 1/4 COR SEC 7 & 18, T 6N, R 2E

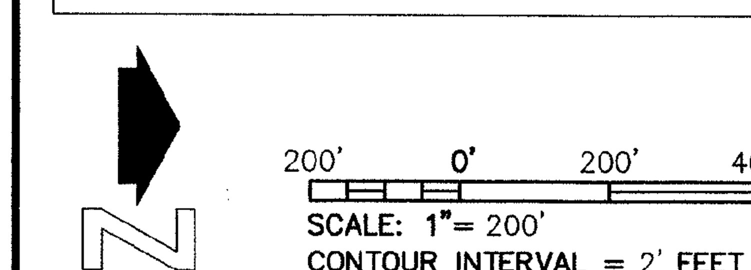
NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP





SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE
DESIGN	TJCL	11/98
DESIGN CHK.	FCDMC	11/98
PLANS	TJCL	11/98
PLANS CHK.	TSM	11/98
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

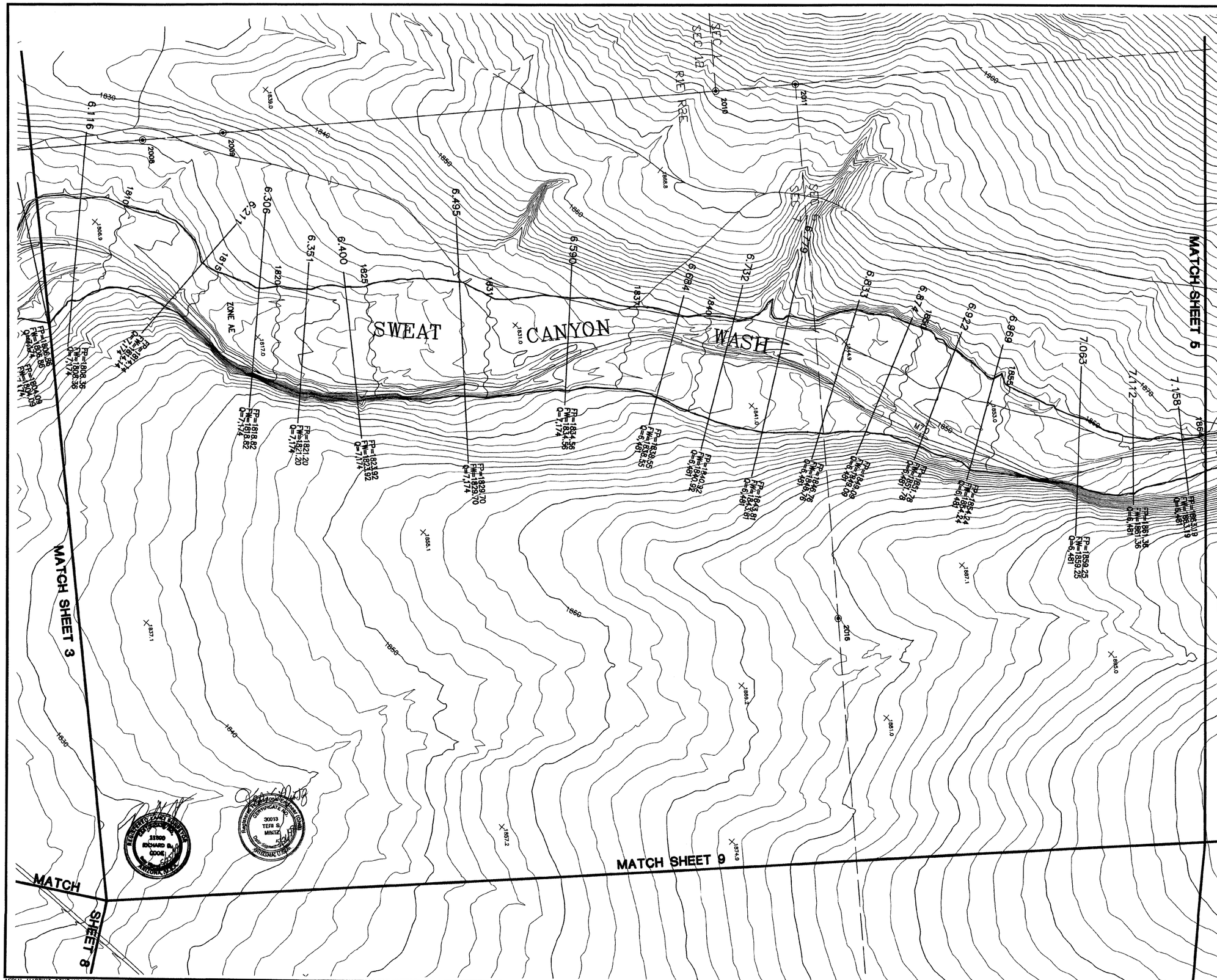
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 12

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND
CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES

MARI0029 tjcl 05/24/99 09:21:43 tjcl S:\CAD\MARI0029\HECRAS\FEMA\Ma29top3.dwg



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A FP=100 Yr WSE / FW=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

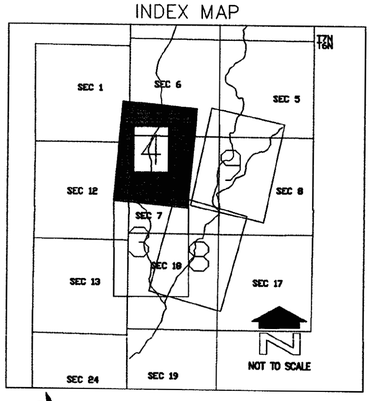
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2009	1827.97	GLO BC UP 2.00'/ E 1/4 COR, SEC 7, T 6N, R 2E
2008	1821.74	GLO BC UP 2.00'/ W 1/4 COR, SEC 12, T 6N, R 1E
2010	1885.15	GLO BC UP 2.00'/ 1/4 COR SEC 1 & 12, T 6N, R 1E
2011	1891.66	GLO BC UP 2.00'/ 1/4 COR SEC 6 & 7, T 6N, R 2E
2016	1879.52	GLO BC UP 2.00'/ 1/4 COR SEC 6 & 7, T 6N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE
DESIGN	TJCL	11/98
DESIGN CHK.	FCDMC	11/98
PLANS	TJCL	11/98
PLANS CHK.	TSM	11/98

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

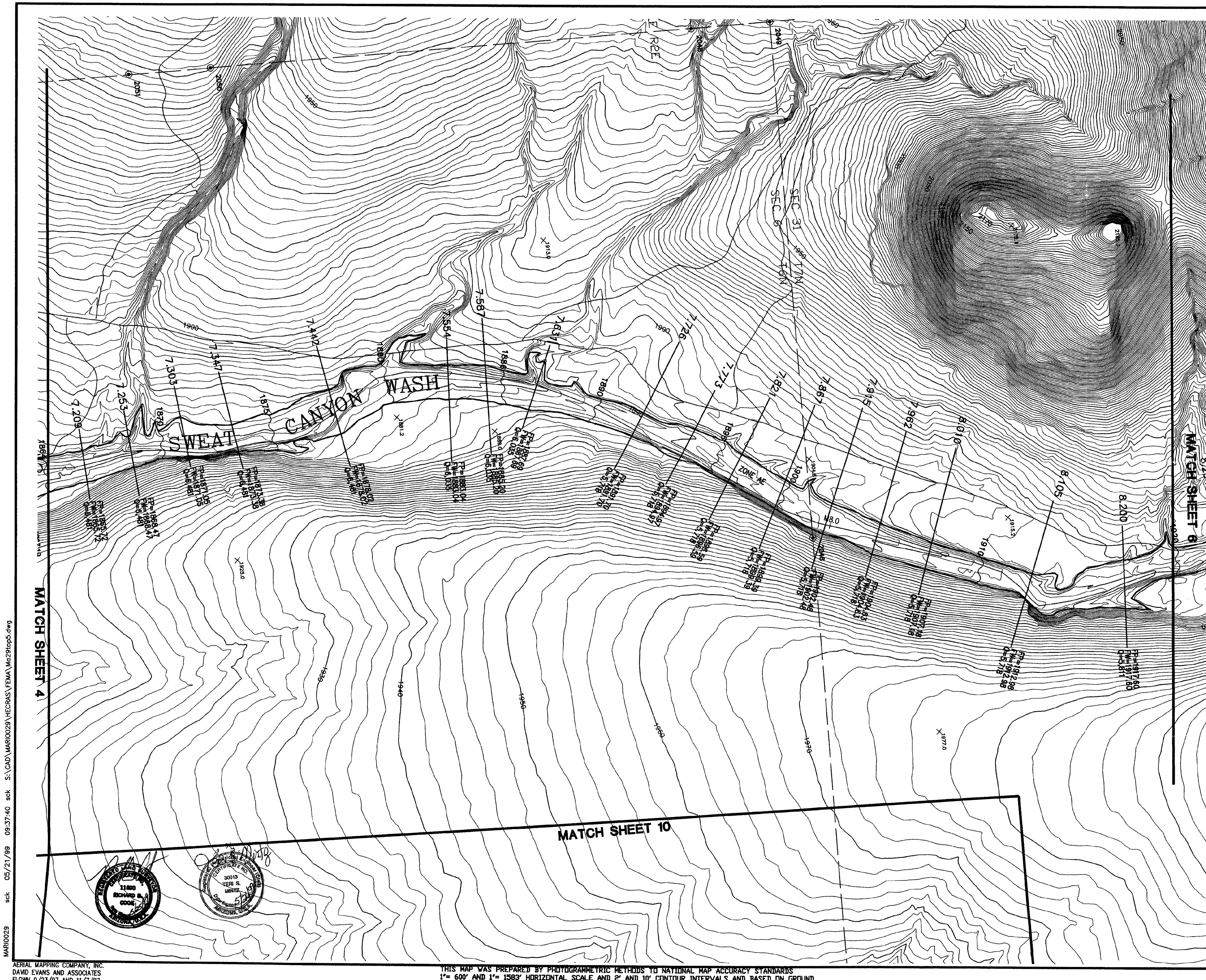
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 4 OF 12

MAR10029 sck 05/21/99 09:36:53 sck S:\CAD\MAR10029\HECRAS\FEMA\Ma29opt4.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND
CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE / FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

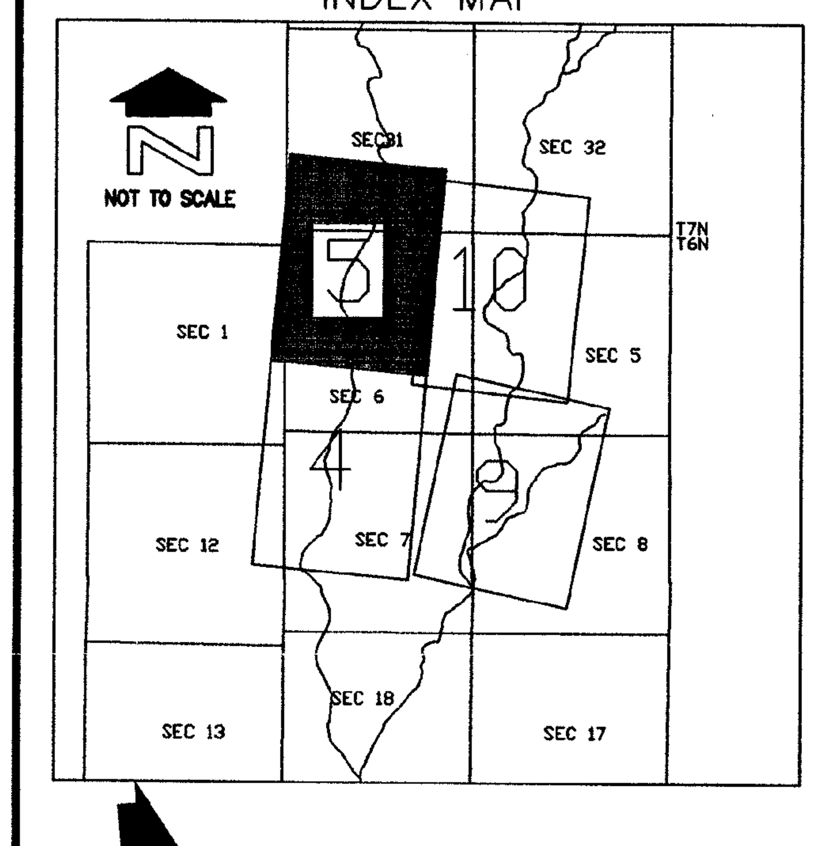
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2046	1917.43	GLO BC UP 3.00'/ N 1/4 COR, SEC 6, T 7N, R 1E & GLO BC / S 1/4 COR SEC 31, T 7N, R 2E
2048	1949.31	GLO BC UP 1.00'/ 1/4 COR, SEC 36, T 7N, R 1E & SEC 1, T 6N, R 2E
2049	1958.34	GLO BC UP 2.00'/ 1/4 COR, SEC 6, T 6N, R 2E & SEC 31, T 7N, R 2E
2050	1962.24	GLO BC UP 3.00'/ W 1/4 COR, SEC 6, T 6N, R 2E
2051	1958.57	GLO BC UP 3.00'/ E 1/4 COR, SEC 1, T 6N, R 1E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

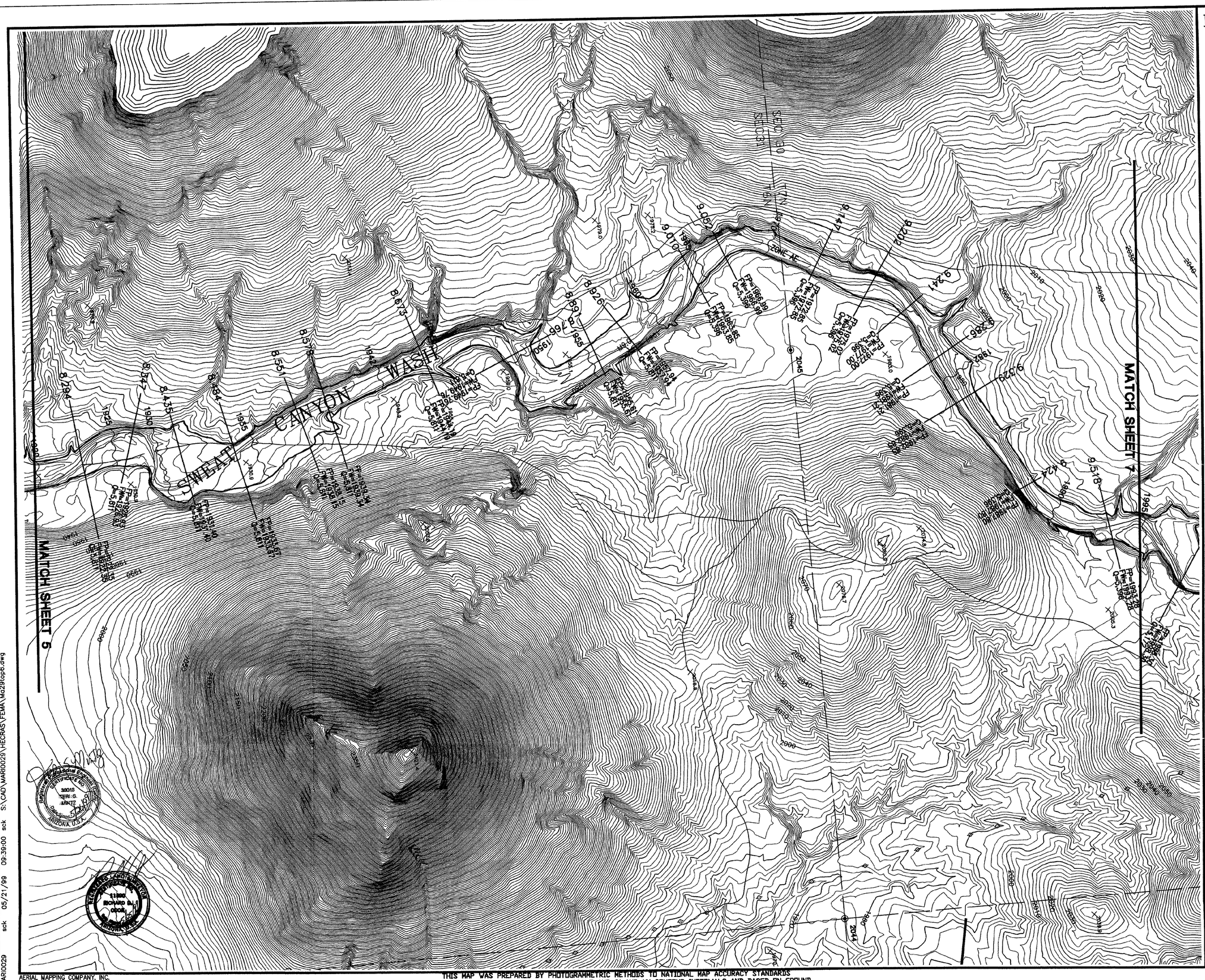
DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	RECOMMENDED BY: DATE
PLANS	TJCL	11/98	APPROVED BY: DATE
PLANS CHK.	TSM	11/98	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY:		DATE:	SHEET 5 OF 12

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND
CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES

MARI0029 sck 05/21/99 09:37:40 sck S:\CAD\MARI0029\HECRAS\FEMA\Mo29top5.dwg



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A FP=100 Yr WSE FW=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

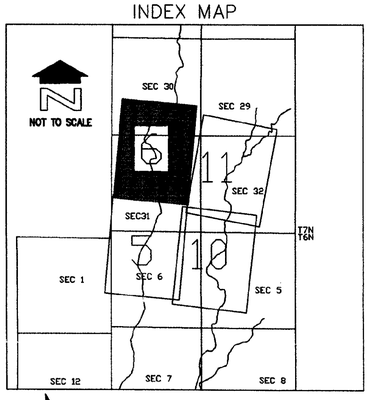
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2045	1978.45	GLO BC UP 2.00'/ 1/4 COR, SEC 30 & 31, T 7N, R 2E
2044	1976.92	GLO BC UP 2.00'/COR SEC 29, 30, 31 & 32 T 7N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

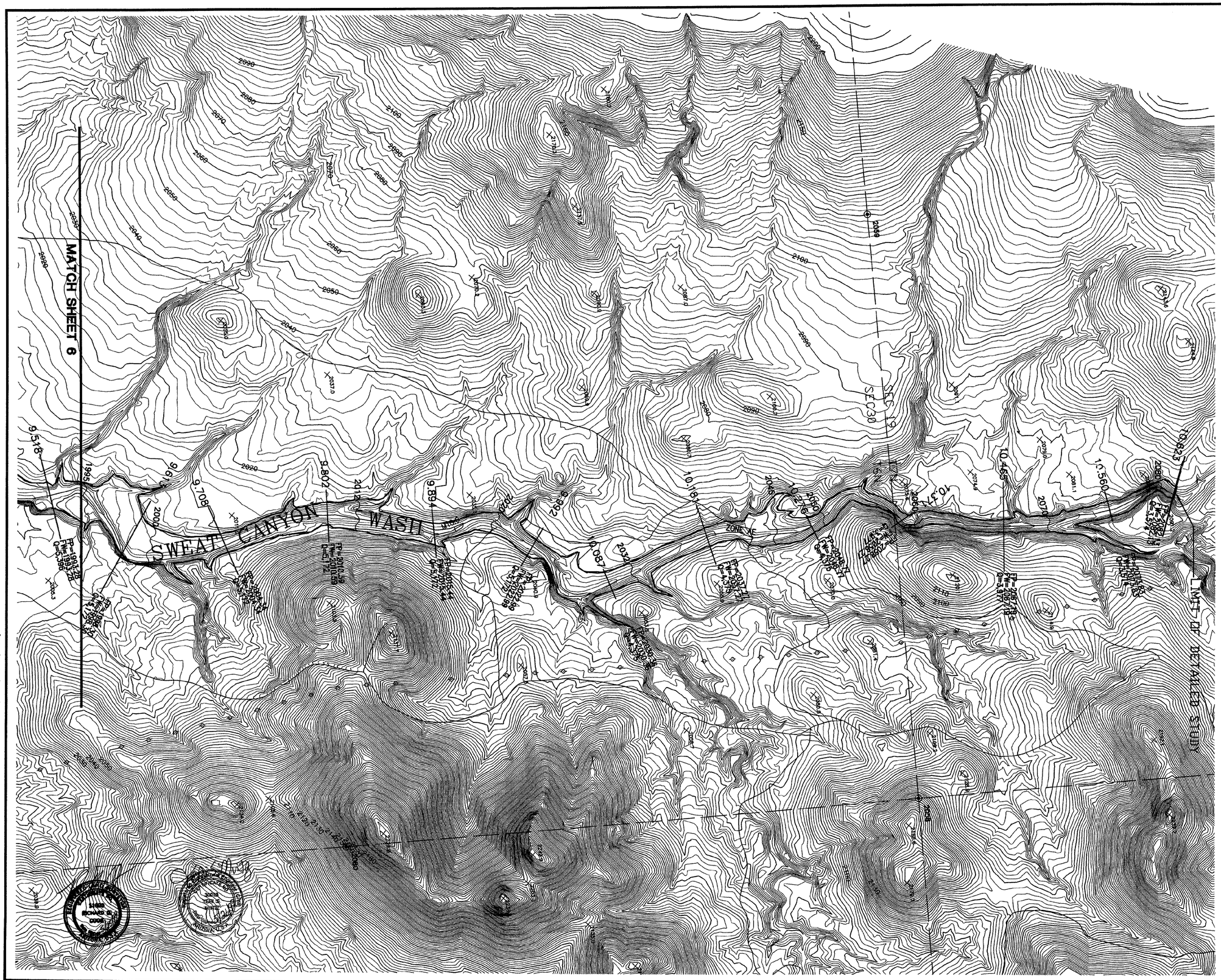
DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	
PLANS	TJCL	11/98	RECOMMENDED BY: DATE
PLANS CHK.	TSM	11/98	APPROVED BY: DATE
SUBMITTED BY: DATE:			CHIEF ENGINEER AND GENERAL MANAGER
			SHEET 6 OF 12

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES

MARI0029 sck 05/21/99 09:39:00 sck S:\CAD\MARI0029\HECRAS\FEMA\Mg29top6.dwg



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 91-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A FP=100 Yr WSE FW=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

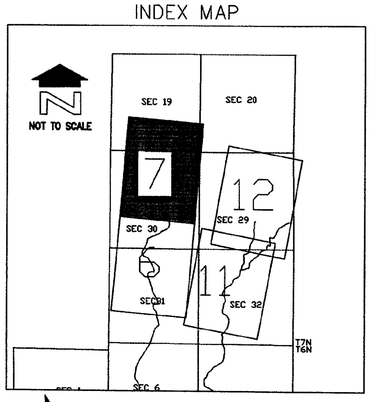
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2058	2149.12	GLO BC UP 2.00'/COR SEC 19, 20, 29 & 30 T 7N, R 2E
2059	2120.80	GLO BC UP 1.00'/ 1/4 COR SEC 19 & 30, T 7N, R 2E
2060	2154.45	GLO BC UP 2.50'/ 1/4 COR SEC 29 & 30, T 7N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

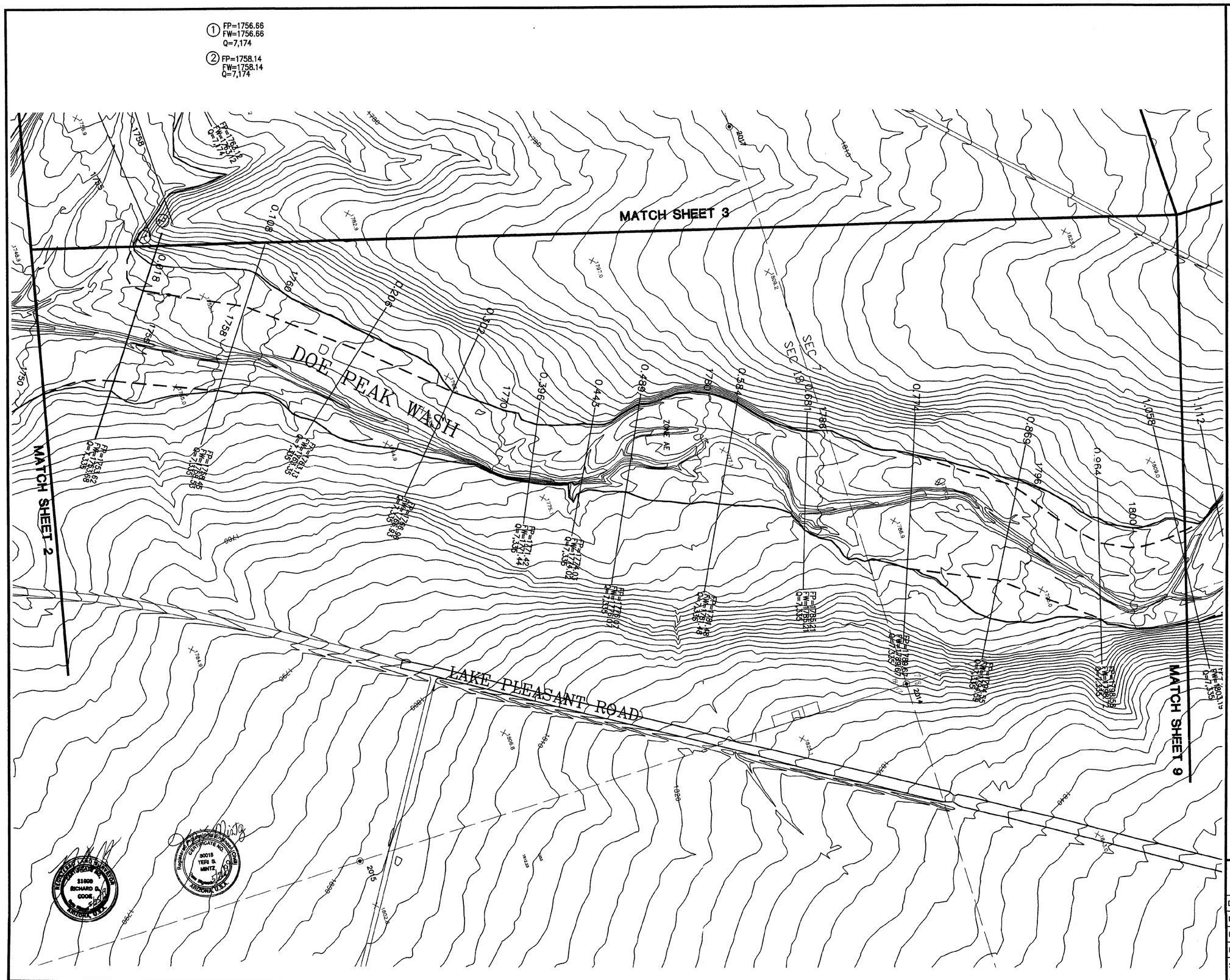
DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

DESIGN	BY TJCL	DATE 11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	RECOMMENDED BY: DATE
PLANS	TJCL	11/98	APPROVED BY: DATE
PLANS CHK.	TSM	11/98	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY: DATE:			SHEET 7 OF 12

MARI0029 sck 05/21/99 09:40:55 sck S:\CAD\MARI0029\HECRAS\FEMA\Mc29top7.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE / FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

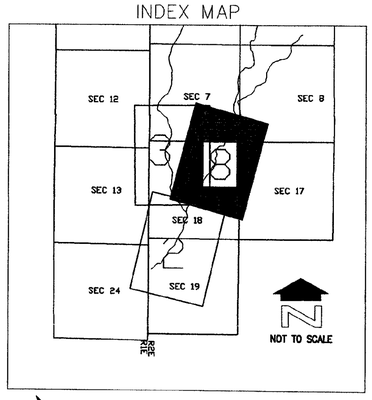
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2014	1821.03	GLO BC UP 1.00'/ COR SEC 7, 8, 17 & 18 T 6N, R 2E
2015	1802.36	GLO BC UP 1.50'/ 1/4 COR SEC 17 & 18, T 6N, R 2E
2017	1805.10	GLO BC UP 1.50'/ 1/4 COR SEC 7 & 18, T 6N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

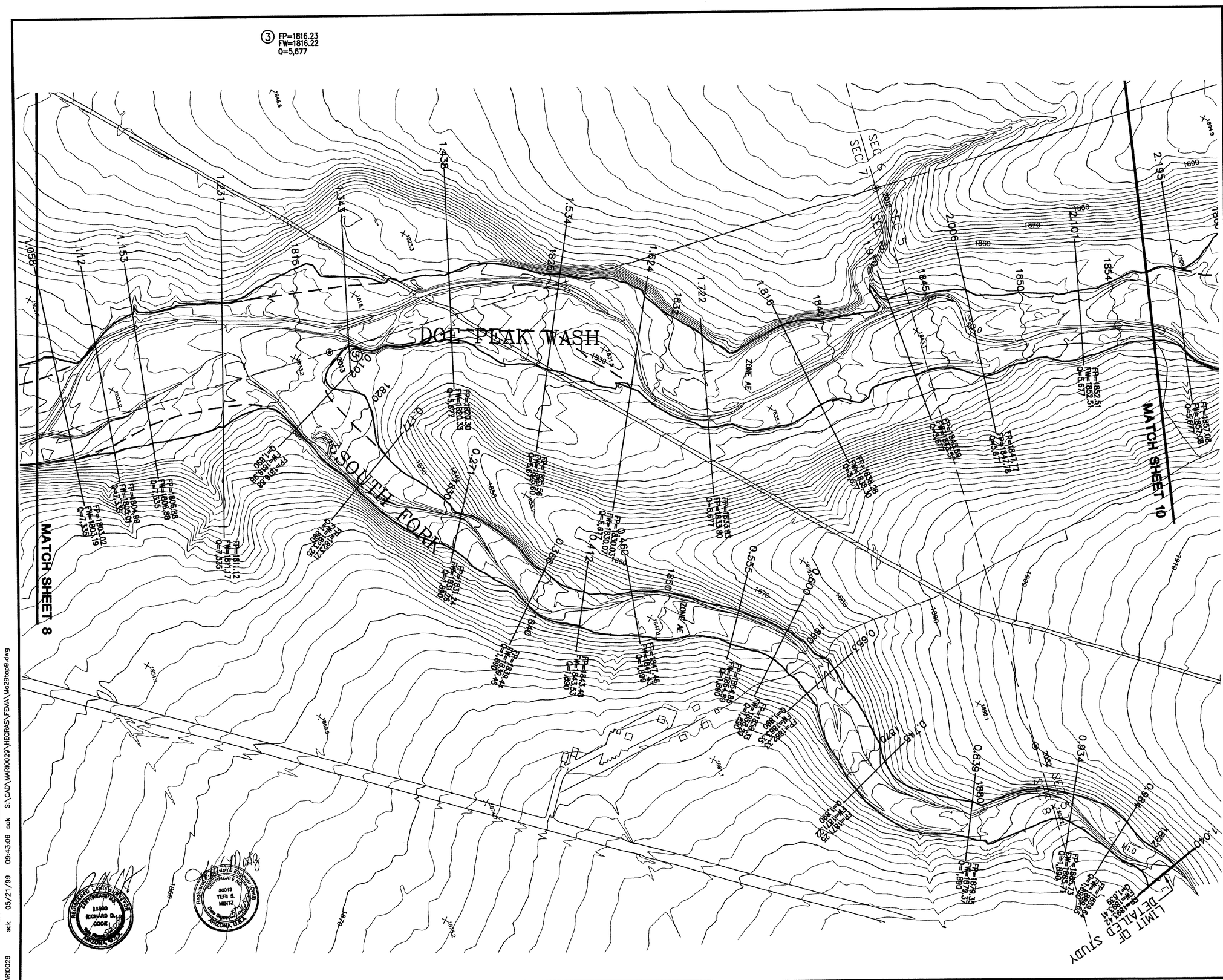
DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	RECOMMENDED BY: DATE
PLANS	TJCL	11/98	APPROVED BY: DATE
PLANS CHK.	TSM	11/98	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY:		DATE:	SHEET 8 OF 12

MARIO029 tjcl 05/24/99 09:23:24 tjcl S:\CAD\MARI0029\HECRAS\FEMA\Ma29top8.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND
CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

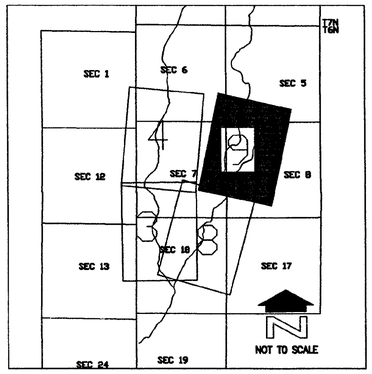
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2012	1871.56	GLO BC / COR SEC 5, 6, 7 &8 T 6N, R 2E
2013	1816.98	GLO BC / 1/4 COR SEC 7 & 8, T 6N, R 2E
2052	1902.90	GLO BC / E 1/4 COR SEC 5 & 8, T 6N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

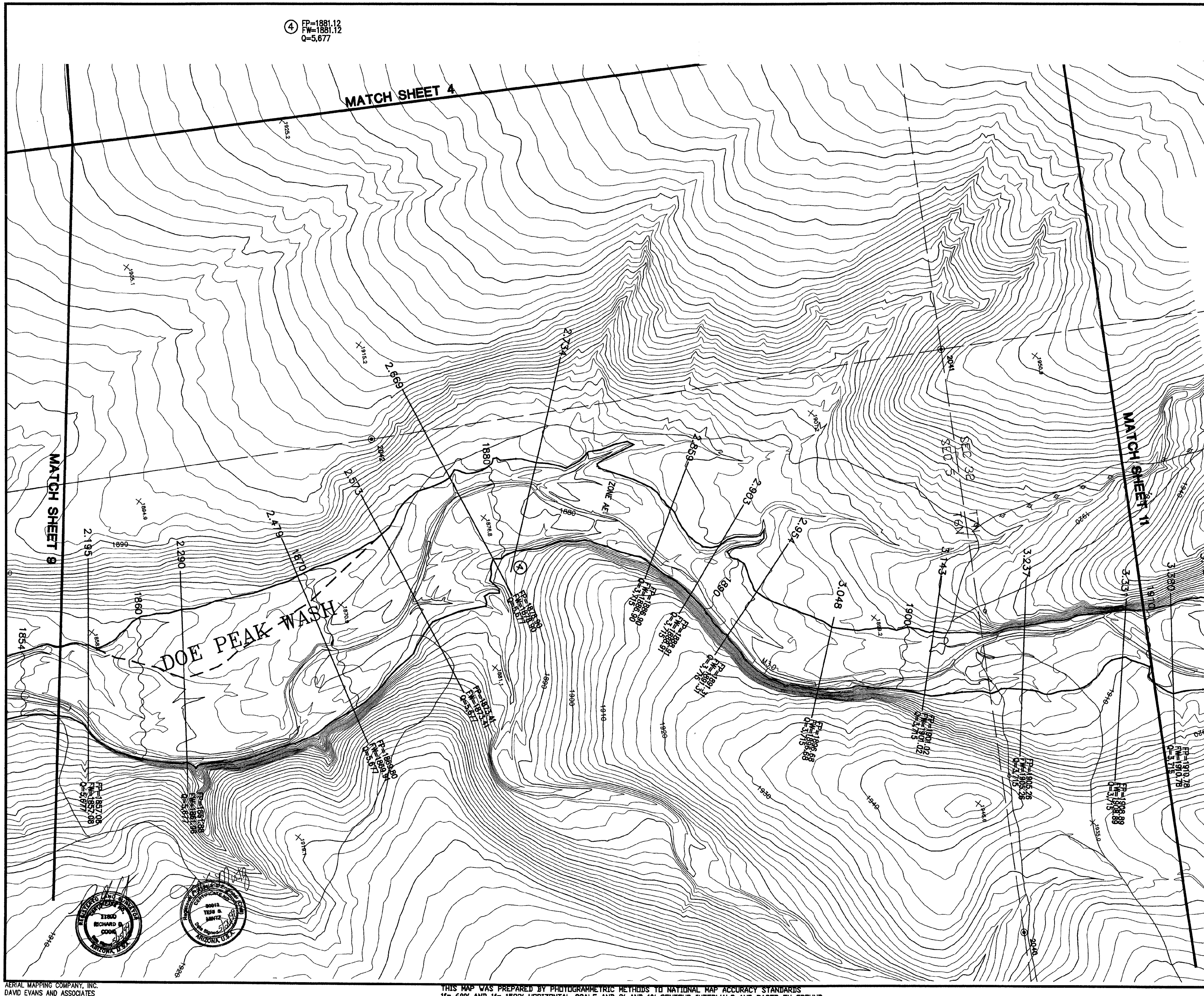
DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	
PLANS	TJCL	11/98	RECOMMENDED BY: DATE
PLANS CHK.	FCDMC	11/98	APPROVED BY: DATE
SUBMITTED BY: DATE:			CHIEF ENGINEER AND GENERAL MANAGER
			SHEET 9 OF 12

MARI0029 sck 05/21/99 09:43:06 sck S:\CAD\MARI0029\HECRAS\FEMA\Mkd29top8.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1563' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



MARI0029 sck 05/21/99 09:43:59 sck S:\CAD\MARI0029\HECRAS\FEMA\Ma29to10.dwg

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE / FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

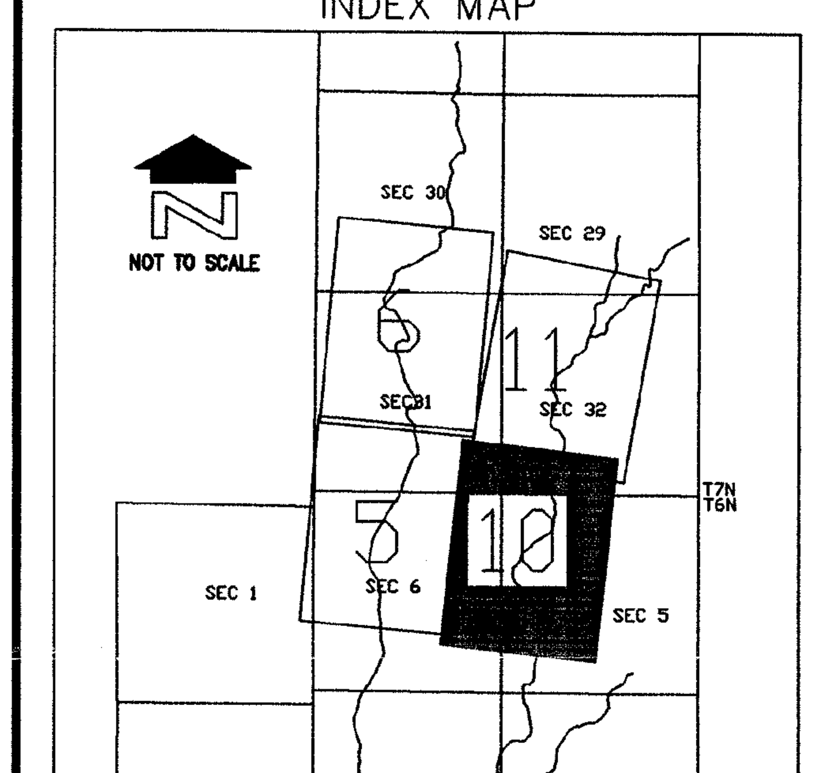
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2040	1930.53	GLO BC UP 2.00'/ N 1/4 COR, SEC 5, T 6N, R 2E & GLO BC / S 1/4 COR SEC 32, T 7N, R 2E
2041	1939.20	GLO BC UP 2.00'/ COR SEC 31 & 32, T 7N, R 2E & SEC 5 & 6, T 6N, R 2E
2042	1906.75	GLO BC UP 2.00'/ E 1/4 COR, SEC 6, T 6N, R 2E

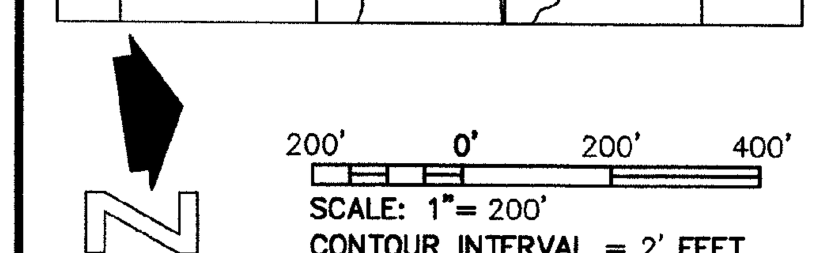
NOTES

- • REBAR
- ◉ BRASS CAP
- ◎ STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP





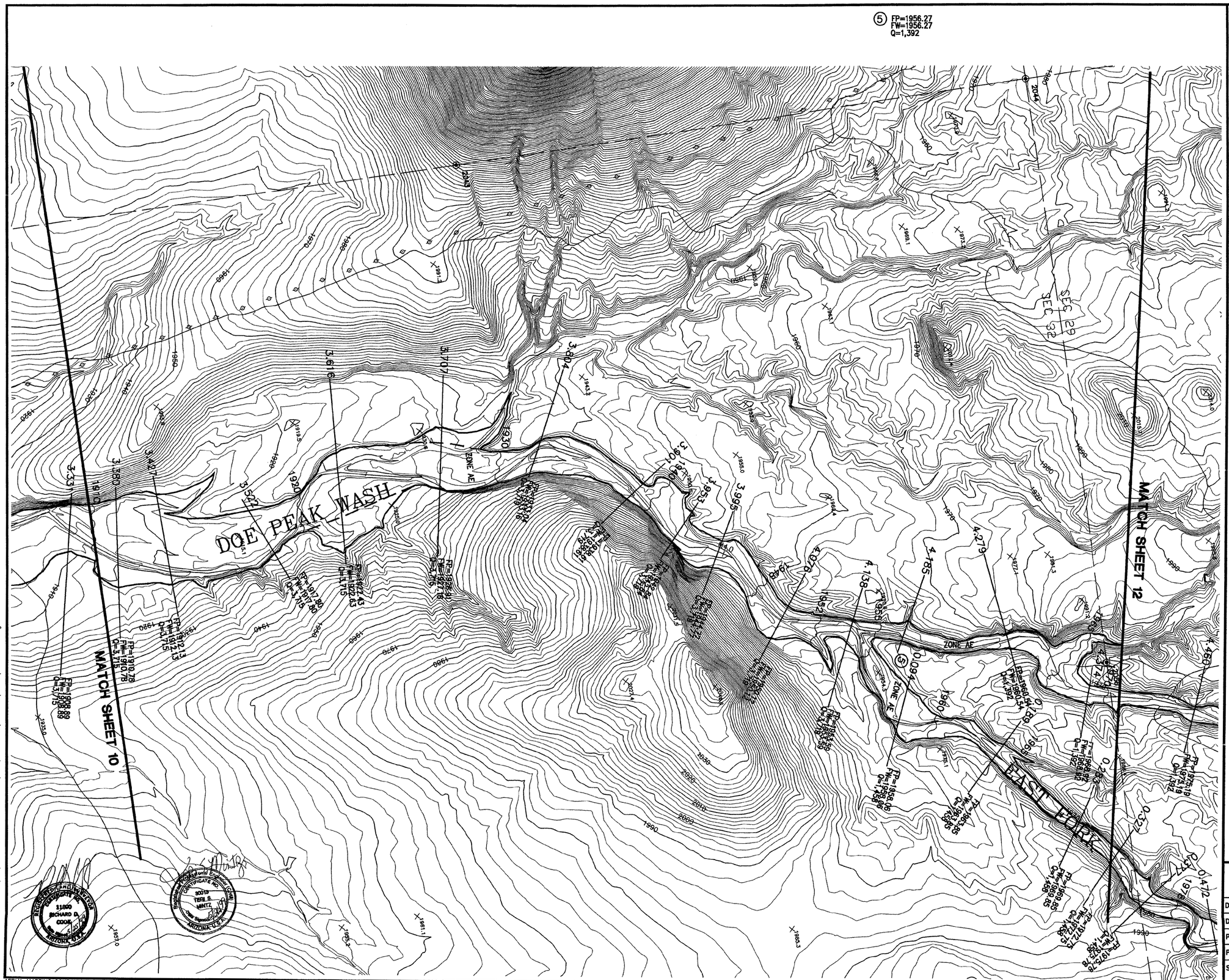
SCALE: 1"= 200'
CONTOUR INTERVAL = 2' FEET

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	
PLANS	TJCL	11/98	RECOMMENDED BY: DATE
PLANS CHK.	TSM	11/98	APPROVED BY: DATE CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY: DATE:			SHEET 10 OF 12

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A FP=100 Yr WSE FW=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

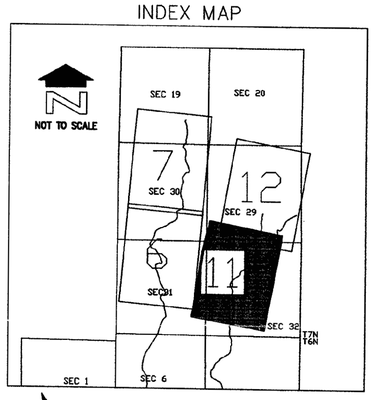
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2043	2023.03	GLO BC UP 3.00'/ 1/4 COR SEC 31 & 32, T 7N, R 2E
2044	1976.92	GLO BC UP 2.00'/ COR SEC 29, 30, 31 & 32 T 7N, R 2E
2056	1977.59	GLO BC UP 1.00'/ COR SEC 29 &32, T 7N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE
DESIGN	TJCL	11/98
DESIGN CHK.	FCDMC	11/98
PLANS	TJCL	11/98
PLANS CHK.	TSM	11/98
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

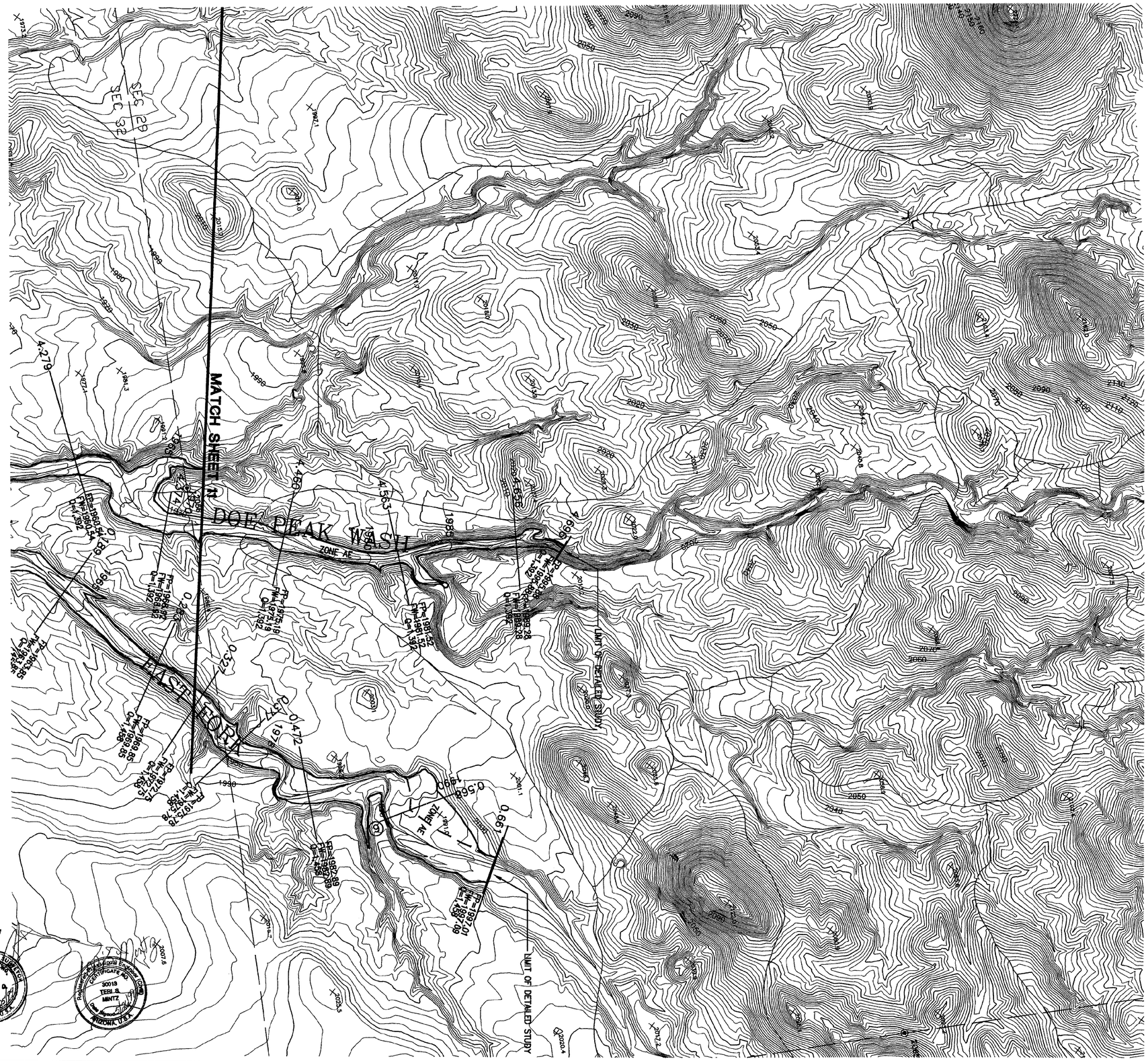
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 11 OF 12

MARI0029 sck 05/21/99 09:45:23 sck S:\CAD\MARI0029\HECRAS\FEMA\Mq29to11.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SWEAT CANYON WASH

F.C.D. CONTRACT NO. 97-12

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	(A) FP=100 Yr WSE / FW=Floodway WSE (A)
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary
SECTION LINES	

ELEVATION REFERENCE MARKS

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

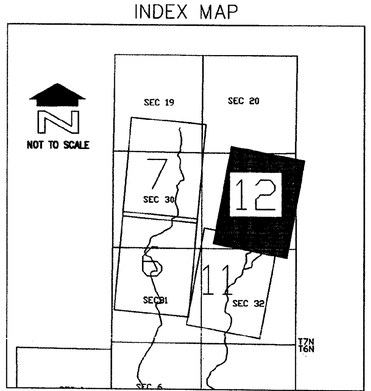
I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
2056	1977.59	GLO BC UP 1.00'/ 1/4 COR SEC 29 & 32, T 7N, R 2E
2065	2085.54	GLO BC UP 2.00'/ 1/4 COR SEC 28 & 29, T 7N, R 2E

NOTES

- REBAR
- BRASS CAP
- STONES

NAVD88 ELEVATION = NGVD29 ELEVATION + 2ft

INDEX MAP



200' 0' 200' 400'

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

DAVID EVANS AND ASSOCIATES, INC.
7878 N. 16TH ST., STE. 250
PHOENIX, AZ 85020

	BY	DATE	
DESIGN	TJCL	11/98	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	FCDMC	11/98	RECOMMENDED BY: DATE
PLANS	TJCL	11/98	APPROVED BY: DATE
PLANS CHK.	TSM	11/98	CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY: DATE:			SHEET 12 OF 12

MAR0029 sck 05/21/99 09:46:55 sck S:\CAD\MAR0029\HECRAS\FEMA\Ma29to12.dwg

AERIAL MAPPING COMPANY, INC.
DAVID EVANS AND ASSOCIATES
FLOWN 9/23/97 AND 11/7/97

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 600' AND 1"= 1583' HORIZONTAL SCALE AND 2' AND 10' CONTOUR INTERVALS AND BASED ON GROUND
CONTROL SURVEY DATA PROVIDED BY DAVID EVANS AND ASSOCIATES