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CARMEL PARK/SKUNK CREEK BANK STABILIZATION HYDRAULIC ANALYSIS

Coe & Van Loo Consultants, Inc.
4550 North 12th Street
Phoenix, Arizona 85014

CARMEL PARK/SKUNK CREEK BANK STABILIZATION HYDRAULIC ANALYSIS

October 12, 1994

Prepared for:

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Prepared by:

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
22208
JACK K.
MOODY
Date Signed 10/14/94
ARIZONA, U.S.A.

CVL

Carmel Park/Skunk Creek
Bank Stabilization Hydraulic Analysis

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Section I Hydraulic Analysis

Section II Scour Analysis

Section III Gabion Design

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1.0 Introduction

Continental Homes has developed a 72-acre single family subdivision within the City of Glendale. The site, known as "Carmel Park", is generally bounded by 51st Avenue to the east, the existing 55th Avenue drainage channel to the west, low density rural housing areas to the north, and Skunk Creek to the southeast. Several lots adjacent to Skunk Creek have not been developed due to the erosion and scour potential associated with the existing condition of Skunk Creek.

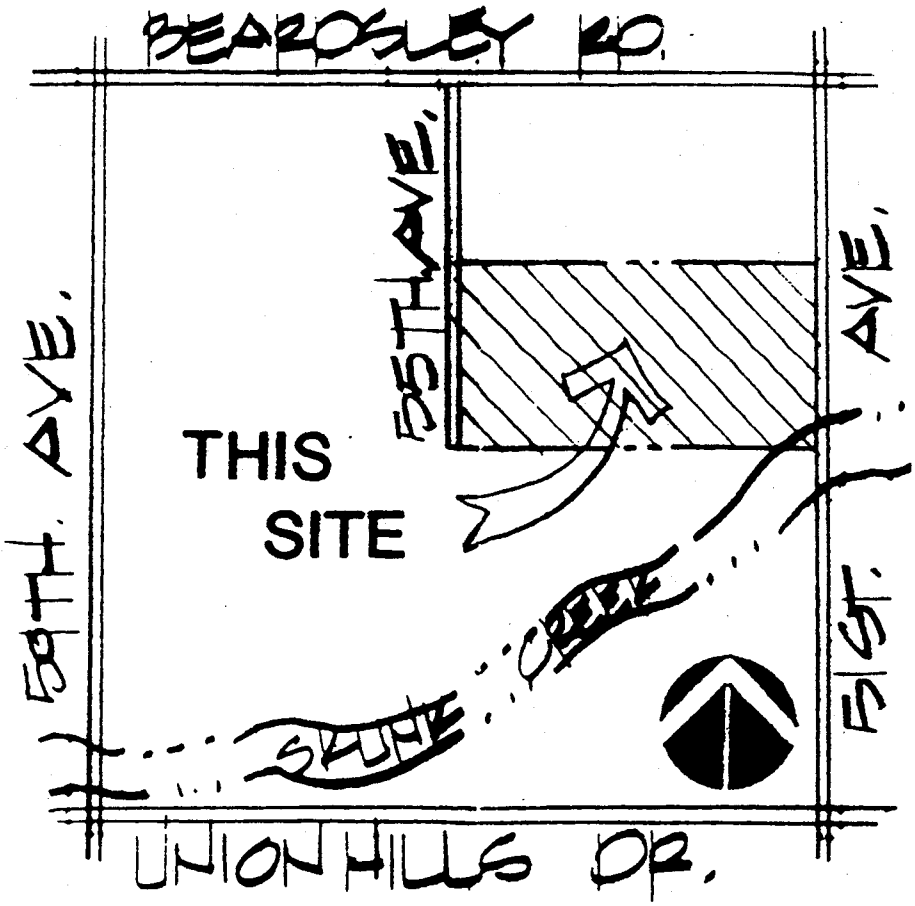
The site is located in the South Half of the Northeast Quarter of Section 29, Township 4 North, Range 2 East, of the Gila and Salt River Base and Meridian, Glendale, Arizona. Refer to Plate 1 (page 2) for the location and approximate boundary of Carmel Park.

Skunk Creek crosses under the 51st Avenue bridge, flows across the southeast corner of the site, and continues to the southeast. The purpose of this report is to document the design of the bank stabilization required to protect the development of Carmel Park adjacent to Skunk Creek.

2.0 Skunk Creek Background

Numerous manmade changes have been made to the Skunk Creek watercourse in this vicinity. A review of aerial photography dating from 1964 to the present indicates that substantial excavation was performed along Skunk Creek in the 1970's. This bank of Skunk Creek is now very steep and unstable, causing the potential for bank failure and erosion into Carmel Park to be high.

In the period of 1991-1992, a bridge was constructed over Skunk Creek at 51st Avenue. The construction drawings were prepared by Mathews, Kessler & Associates, Inc. for the City



N.T.S.

CARMEL PARK

LOCATION MAP

PLATE 1

COE & VAN LOO

Planning
Civil Engineering
Landscape Architecture
Hydrology
Sanitary Engineering
Surveying
Highway Engineering

of Phoenix Street Transportation Department (BR-885806) in cooperation with the City of Glendale (W-889002). As part of the bridge construction, Skunk Creek was channelized for approximately 350 feet downstream. In addition, bank protection (soil cement) is provided for approximately 100 feet downstream of the bridge. The *Hydraulic & Scour Analyses, 51st Avenue Bridge at Skunk Creek* (Ref. 3), indicates this section of the proposed channelization is designed to convey the 100-year flow.

The channelized area downstream of the soil cement is subject to serious erosion that can encroach into the Carmel Park subdivision. Clouse Engineering, Inc. (CEI) has recently proposed bank armoring on the south bank of Skunk Creek to protect the proposed Chelsea Village subdivision (Ref. 8). A request for a Letter of Map Revision (LOMR) has been submitted to the Federal Emergency Management Agency (FEMA) by CEI, but the construction of the channel improvements has not been completed at the time of this report.

3.0 Hydraulic Analysis

Although the channel improvements proposed by CEI have not yet been implemented, for the purposes of this report it is assumed that the protection of the south bank is in place. In order to determine maximum water surface elevations and channel velocities adjacent to the Carmel Park subdivision, cross-section data was taken from the CEI report for Chelsea Village. Although *Coe & Van Loo Consultants, Inc., (CVL)* has done hydraulic studies in Skunk Creek (the *Skunk Creek Floodplain Delineation Report*, Ref. 2), the CEI study represented the most recent topographic and hydraulic information in the area.

Both sub-critical and super-critical profiles were modeled for the 100-year flow. The hydraulic analysis indicates that flow through the bridge section and adjacent channelized areas

is near critical depth with velocities ranging from 12 to 13 feet per second. On the other hand, approximately 800 feet downstream of the channelized area, the flow is deep with velocities ranging from 3 to 4 feet per second due to backwater caused by a downstream constriction. Refer to the Appendix, Section I for the hydraulic analysis.

4.0 Gabion Design and Scour Analysis

The proposed bank stabilization will be accomplished with the use of Reno mattresses at a side slope of 2:1, or 3:1 in some areas. The mattresses will extend from the existing soil cement to a point where the river begins to pull away from the Carmel Park subdivision. A row of gabions will serve as a transition section between the existing soil cement and the proposed Reno mattresses. These gabions will help protect the upstream edge of the mattresses from under-cutting flows. In addition, gabions will be used as a toe down to a depth of 6 feet at the west end and 9' at the east end.

To determine toe-down requirements for slope protection adjacent to the project site, local scour computations have been performed using methodologies documented by the Bureau of Reclamation in the report titled, *Computing Degradation and Local Scour - Technical Guideline for Bureau of Reclamation* (Ref. 7). The results of the local scour computations are summarized in Table 2 along with the detailed local scour computation sheets in Appendix II.

As indicated in Table 2, the computed local scour values range from 3 to 6.5 feet, depending upon location. In addition, the total scour values listed in Table 2 include a value of 2' for long-term general degradation.

Hydraulic analysis indicates that 100-year flows remain nearly critical, or super-critical, to a distance of approximately 300 feet downstream of the bridge. Beyond this point the flow

becomes sub-critical, indicating the potential for a hydraulic jump somewhere adjacent to the Carmel Park subdivision. Since the profiles near the bridge were so close to critical depth, CVL conservatively used the water surface elevations from the sub-critical analysis to determine the height of bank projection, but used the velocities from the super-critical analysis to determine the local scour and degradation. A freeboard of 2.5' was used for the lining near the bridge, and a freeboard of 1.0' was used in the downstream sub-critical sections.

5.0 Conclusions

Based on this analysis, the bank of Skunk Creek adjacent to Carmel Park would be subject to erosion during a significant storm event. Therefore, it is recommended that the bank be protected. A gabion lining consisting of 9" Reno mattresses has been designed. The top of the lining has been designed to be above the 100-year water surface elevation plus one to two and one half feet of freeboard. In addition, a six to nine foot toe down is being provided to protect from local scour.

The construction of this bank stabilization will allow for the development of the remaining lots within the Carmel Park subdivision.

6.0 References

1. Coe & Van Loo Consultants, Inc., *Drainage Report for Carmel Park*, January 9, 1992.

2. Coe & Van Loo Consultants, Inc., *Skunk Creek, Between Arizona Canal Diversion Channel & Central Arizona Project, Flood Plain Delineation Report*, December 11, 1990.

3. Mathews Kessler & Associates, Inc., *Hydraulic & Sewer Analysis, 51st Avenue Bridge of Skunk Creek*, October 25, 1990.

4. Coe & Van Loo Consultants, Inc., *Drainage Report for Carmel Park*, January 9, 1992.

5. U.S. Army Corps of Engineers, The Hydrologic Engineering Center, *HEC-2, Water Surface Profiles*, September, 1990.

6. Chow Van Te, *Open Channel Hydraulics*, McGraw Hill, 1959.

7. Pemberton & Lara, *Computing Degradation and Local Scour - Technical Guidelines for Bureau of Reclamation*, 1984.

8. Clouse Engineering, Inc., *CLOMR Application, Hydraulic Analysis for Chelsea Village*, May 13, 1994.

Appendix

Section I
Hydraulic Analysis

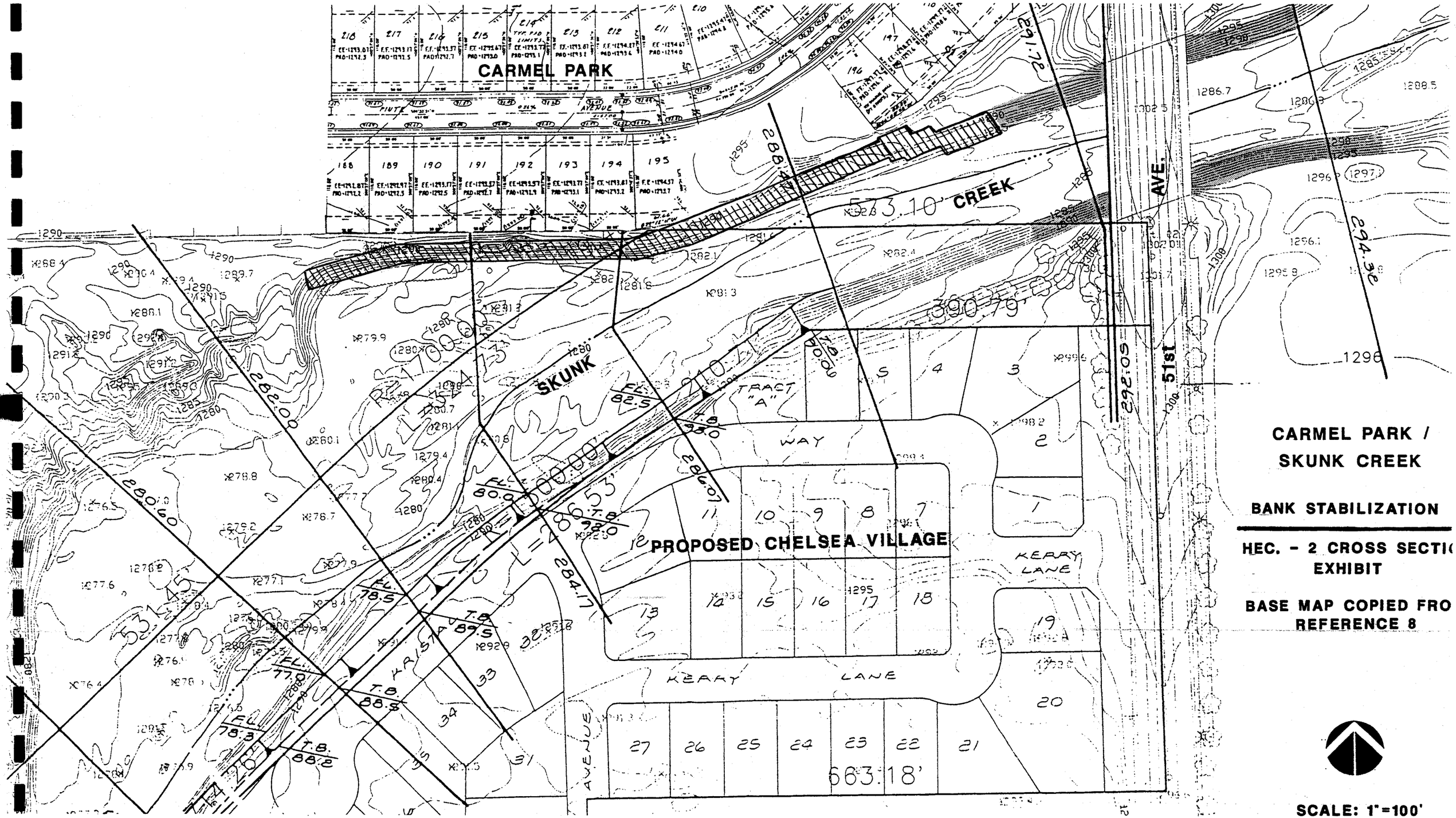
N:\920090\ADMIN\90-008RP.WP5

CVL

Table 1
Hydraulic Analysis Summary
(100-Year)

HEC-2 Cross Section	Subcritical Profile		Super Critical Profile	
	Water Surface Elevation	Velocity (fps)	Water Surface Elevation	Velocity (fps)
282.0	1287.34	3.15	1282.13*	9.79
284.17	1287.39	4.02	1282.79	11.31
286.07	1287.11	8.13	1285.63*	11.27
288.47	1287.72*	12.47	1287.72*	12.48
291.72	1291.16	11.52	1290.5	13.16

* Critical depth was assumed by the HEC-2 program.
Controlling flow regime



CARMEL PARK / SKUNK CREEK

BANK STABILIZATION

HEC. - 2 CROSS SECTI(EXHIBIT

BASE MAP COPIED FRO REFERENCE 8

SCALE: 1"=100'

PROPOSED BANK STABILIZATION

EXISTING SOIL CEMENT

COE & VAN LOO
PLANNING • ENGINEERING
LANDSCAPE ARCHITECTURE

```
*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.6.0;  February 1991          *
*                                           *
*  RUN DATE    16SEP94    TIME   16:22:21   *
*********************************************
```

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

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

SKUNK CREEK
SUBCRITICAL PROFILE

100-YEAR FLOW

THIS RUN EXECUTED 16SEP94 16:22:21

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************
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```
T1      CARMEL PARK / SKUNK CREEK BANK STABILIZATION
T2      PREPARED FOR CONTINENTAL HOMES, BY COE & VAN LOO CONSULT. (92-0090-01).
T3      100-YEAR, SUB-CRITICAL; SEPT 1994   (FILE NAME:  H2SCSUB2)

        SKUNK CREEK ANALYSIS DOWNSTREAM OF 51ST AVENUE BRIDGE
        PREPARED FOR CONTINENTAL HOMES TO EVALUATE THE SCOUR POTENTIAL ON THE
        CARMEL PARK SUBDIVISION.

        PREPARED BY COE & VAN LOO CONSULTANTS, INC. (CVL)

        THIS MODEL USES DATA FROM THE CHELSEA VILLAGE PROJECT
        PREPARED BY CLOUSE ENGINEERING, INC. (CEI) FOR SUBMITTAL
        TO THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA).
        CROSS-SECTION DATA FOR ALL SECTIONS (276.30 - 294.32),
        AND THE STARTING WATER SURFACE ELEVATION (@ STATION 276.30),
        WERE TAKEN FROM THE CEI MODEL, PEAK FLOWS WERE OBTAINED
        FROM FEMA STUDIES, PER THE CEI MODEL.


J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q       WSEL    FQ

             2                                                       1286.25

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

     1               -1.                             -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38      43      1       8       42      3       2       26      5       39
    53      54      68


NC    0.045   0.045   0.035   0.100   0.300
QT        1    8936
X1   276.30      25    9952   10132     106     149      95
X3       10
GR   1287.5    9900  1287.5    9952  1277.5    9972  1277.0    9976  1276.0    9980
GR   1276.1   10000  1277.0   10027  1277.0   10042  1280.0   10051  1280.0   10068
GR   1284.0   10106  1285.0   10117  1286.0   10132  1286.8   10144  1286.0   10158
GR   1283.2   10208  1288.0   10241  1288.0   10265  1288.2   10305  1288.0   10351
```

GR	1287.8	10364	1288.0	10381	1288.0	10410	1287.6	10431	1288.0	10504
QT	1	8910								
X1	277.95	15	9935	10287	170	95	165			
X3	10									
X4	1	1287.0	9946							
GR	1288.0	9900	1288.0	9935	1277.0	9957	1276.3	10000	1277.7	10064
GR	1277.0	10082	1276.7	10128	1277.0	10167	1286.0	10200	1287.0	10215
GR	1288.0	10224	1289.0	10256	1289.0	10277	1288.0	10287	1289.0	10310
QT	1	8884								
X1	280.60	25	9915	10368	278	235	265			
X3	10									
GR	1288.5	9850	1288.5	9905	1288.5	9915	1279.0	9934	1278.7	9942
GR	1278.4	9951	1278.0	9957	1278.0	9973	1277.0	10000	1278.0	10002
GR	1279.0	10009	1279.0	10021	1278.0	10032	1278.0	10047	1278.0	10069
GR	1278.0	10097	1278.0	10148	1277.0	10262	1277.0	10283	1278.0	10296
GR	1285.0	10312	1291.0	10368	1291.0	10390	1290.0	10398	1289.0	10462
QT	1	8858								
X1	282.00	24	9927	10322	130	238	140			
X3	10									
GR	1290.0	9920	1289.5	9927	1278.5	9949	1277.9	10000	1278.0	10007
GR	1279.0	10020	1279.0	10034	1278.0	10090	1278.0	10100	1278.9	10128
GR	1280.0	10189	1281.0	10212	1282.0	10248	1283.0	10275	1283.0	10295
GR	1284.0	10307	1289.0	10322	1287.5	10330	1290.0	10340	1291.0	10362
GR	1290.0	10390	1290.0	10442	1290.0	10458	1291.2	10473		
QT	1	8832								
X1	284.17	16	9872	10217	181	355	217			
X3	10									
GR	1292.0	9740	1292.0	9872	1280.0	9896	1280.0	9961	1280.8	9977
GR	1280.0	9992	1279.0	9997	1278.8	10000	1279.0	10013	1280.0	10053
GR	1281.0	10084	1281.0	10096	1280.0	10132	1280.0	10152	1281.0	10182
GR	1292.0	10217								
QT	1	8806								
X1	286.07	18	9868	10105	190	172	190			
GR	1293.0	9778	1293.0	9868	1282.5	9891	1282.0	9901	1282.0	9910
GR	1282.5	9921	1282.0	9928	1281.0	9963	1280.5	9976	1281.0	9986
GR	1281.0	9994	1280.6	10000	1281.0	10009	1282.0	10043	1282.0	10058
GR	1282.0	10077	1292.0	10097	1292.0	10105				

QT	1	8780								
X1	288.47	14	9872	10080	210	205	240			
GR	1298.4	9709	1298.0	9772	1297.0	9834	1295.0	9872	1290.0	9892
GR	1282.0	9918	1282.0	9955	1282.3	9975	1282.0	9992	1281.9	10000
GR	1282.0	10011	1285.0	10037	1290.0	10055	1295.0	10080		
QT	1	8754								
X1	291.72	12	9907	10078	325	330	325			
GR	1301.0	9893	1295.0	9907	1286.0	9931	1285.0	9963	1284.2	10000
GR	1285.0	10010	1286.0	10043	1294.0	10072	1295.0	10078	1296.0	10138
GR	1300.0	10162	1300.8	10175						
NC	0.03	0.03	0.03	0.3	0.6					
QT	1	8750								
X1	292.05	12	9906	10080	5	56	33			
GR	1296.0	9906	1286.0	9936	1285.0	9994	1284.9	9998	1296.0	9998.1
GR	1296.0	10000	1296.0	10001.9	1284.4	10002	1285.0	10010	1286.0	10040
GR	1287.0	10054	1296.0	10080						
QT	1	8750								
X1	293.05	11	9917	10086	100	100	100			
GR	1296.0	9917	1287.0	9944	1286.0	9954	1286.0	9968	1286.5	9998
GR	1296.0	9998.1	1296.0	10000	1296.0	10001.9	1286.4	10002	1287.0	10065
GR	1296.0	10086								
NC	0.045	0.045	0.035	0.1	0.3					
QT	1	8723								
X1	294.32	12	9900	10095	160	128	127			
GR	1296.8	9756	1296.0	9900	1288.0	9925	1287.5	9930	1287.2	9952
GR	1286.9	9970	1287.7	10000	1287.0	10050	1288.0	10058	1296.0	10085
GR	1297.0	10095	1297.5	10243						

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

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 276.300

3265 DIVIDED FLOW

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1287.50 ELREA= 1286.00

276.300	10.25	1286.25	1283.62	1286.25	1287.15	.89	.00	.00	1287.50
8936.0	.0	8657.5	278.5	.0	1124.2	115.5	.0	.0	1286.00
.00	.00	7.70	2.41	.000	.035	.045	.000	1276.00	9954.50
.002871	106.	95.	149.	0	18	0	.00	256.59	10228.97

*SECNO 277.950

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.59

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1288.00 ELREA= 1288.00

277.950	10.85	1287.15	1280.65	.00	1287.36	.21	.15	.07	1288.00
8910.0	.0	8910.0	.0	.0	2405.1	.0	6.8	.9	1288.00
.01	.00	3.70	.00	.000	.035	.000	.000	1276.30	9944.39
.000427	170.	165.	95.	2	18	0	.00	271.93	10216.32

*SECNO 280.600

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.51

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1288.50 ELREA= 1291.00

280.600	10.35	1287.35	1280.46	.00	1287.44	.09	.07	.01	1288.50
8884.0	.0	8884.0	.0	.0	3639.0	.0	25.2	3.0	1291.00
.04	.00	2.44	.00	.000	.035	.000	.000	1277.00	9917.30
.000186	278.	265.	235.	2	17	0	.00	416.64	10333.94

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

*SECNO 282.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .69

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1289.50 ELREA= 1289.00

282.000	9.44	1287.34	1282.13	.00	1287.50	.15	.04	.02	1289.50
8858.0	.0	8858.0	.0	.0	2809.6	.0	35.6	4.3	1289.00
.05	.00	3.15	.00	.000	.035	.000	.000	1277.90	9931.31
.000394	130.	140.	238.	2	18	0	.00	385.72	10317.03

*SECNO 284.170

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1292.00 ELREA= 1292.00

284.170	8.59	1287.39	1283.17	.00	1287.64	.25	.11	.03	1292.00
8832.0	.0	8832.0	.0	.0	2199.6	.0	48.0	6.1	1292.00
.07	.00	4.02	.00	.000	.035	.000	.000	1278.80	9881.22
.000696	181.	217.	355.	2	14	0	.00	321.10	10202.33

*SECNO 286.070

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .41

286.070	6.61	1287.11	1285.62	.00	1288.14	1.03	.26	.23	1293.00
8806.0	.0	8806.0	.0	.0	1082.9	.0	55.2	7.2	1292.00
.08	.00	8.13	.00	.000	.035	.000	.000	1280.50	9880.89
.004082	190.	190.	172.	2	14	0	.00	206.33	10087.23

*SECNO 288.470

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

288.470	5.82	1287.72	1287.72	.00	1290.14	2.42	1.51	.42	1295.00
8780.0	.0	8780.0	.0	.0	704.0	.0	60.1	8.2	1295.00
.08	.00	12.47	.00	.000	.035	.000	.000	1281.90	9899.40
.010863	210.	240.	205.	0	11	0	.00	147.40	10046.80

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

*SECNO 291.720

291.720	6.96	1291.16	1290.70	.00	1293.22	2.06	3.05	.04	1295.00
8754.0	.0	8754.0	.0	.0	760.1	.0	65.6	9.3	1295.00
.09	.00	11.52	.00	.000	.035	.000	.000	1284.20	9917.24
.008167	325.	325.	330.	2	8	0	.00	144.47	10061.71

CCHV= .300 CEHV= .600
*SECNO 292.050

3265 DIVIDED FLOW

292.050	6.96	1291.36	1291.09	.00	1293.57	2.21	.26	.09	1296.00
8750.0	.0	8750.0	.0	.0	733.4	.0	66.1	9.4	1296.00
.09	.00	11.93	.00	.000	.030	.000	.000	1284.40	9919.92
.007479	5.	33.	56.	2	8	0	.00	142.78	10066.59

*SECNO 293.050

3265 DIVIDED FLOW

293.050	6.10	1292.10	1291.88	.00	1294.35	2.25	.76	.02	1296.00
8750.0	.0	8750.0	.0	.0	726.8	.0	67.8	9.7	1296.00
.09	.00	12.04	.00	.000	.030	.000	.000	1286.00	9928.70
.007684	100.	100.	100.	2	15	0	.00	144.32	10076.90

CCHV= .100 CEHV= .300
*SECNO 294.320

3301 HV CHANGED MORE THAN HVINS

294.320	7.07	1293.97	1292.30	.00	1295.15	1.18	.70	.11	1296.00
8723.0	.0	8723.0	.0	.0	999.4	.0	70.3	10.2	1297.00
.10	.00	8.73	.00	.000	.035	.000	.000	1286.90	9906.35
.004098	160.	127.	128.	3	11	0	.00	171.78	10078.14

THIS RUN EXECUTED 16SEP94 16:22:21

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************
```

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

100-YEAR, SUB-CRITICAL;

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=    277.950  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    280.600  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    282.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    286.070  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    288.470  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    288.470  PROFILE=  1  MINIMUM SPECIFIC ENERGY
```

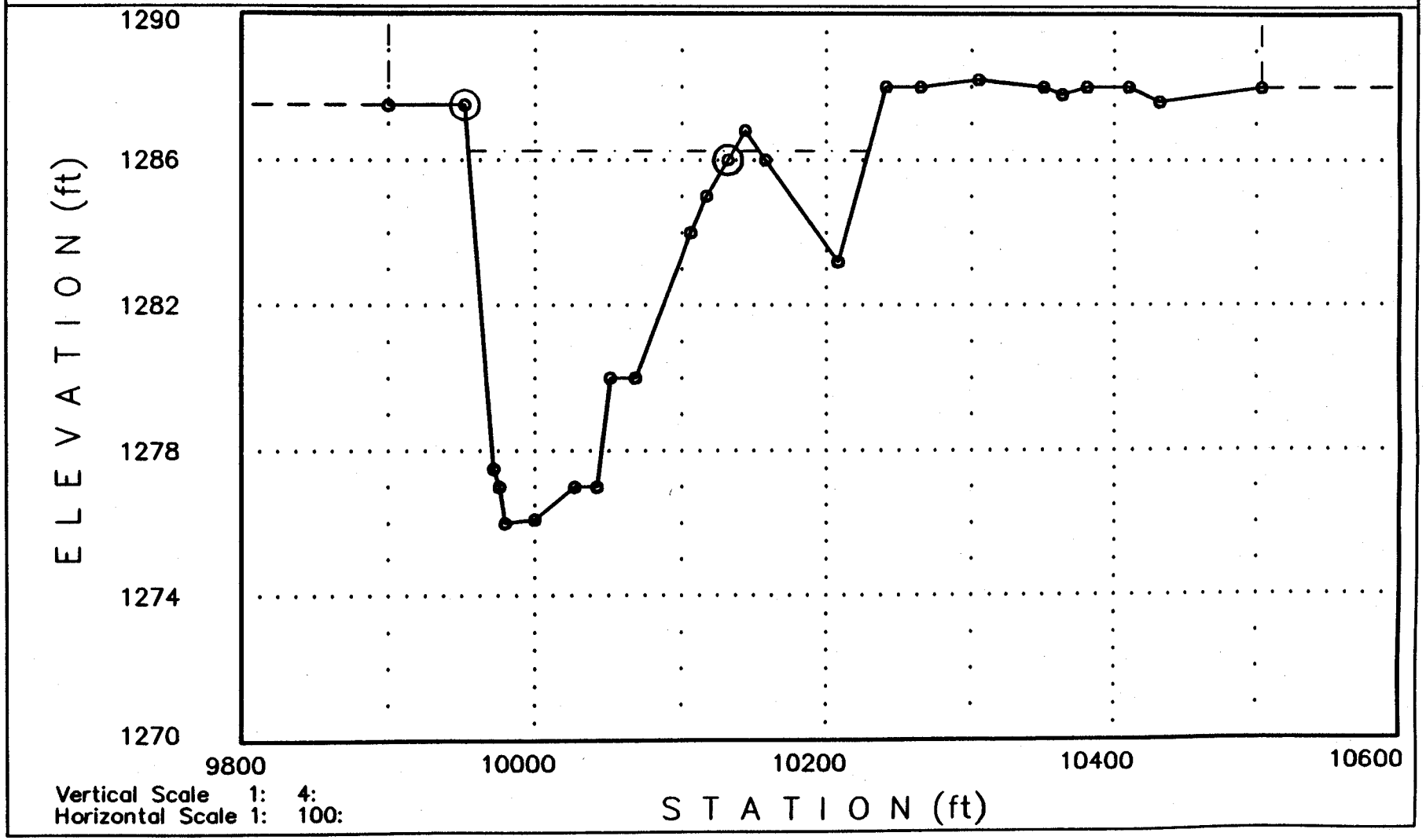
SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	ENDST	FRCH
	276.300	8936.00	1286.25	10.25	1276.00	1287.15	1283.62	7.70	28.71	.00	9954.50	10228.97	.54
*	277.950	8910.00	1287.15	10.85	1276.30	1287.36	1280.65	3.70	4.27	165.00	9944.39	10216.32	.22
*	280.600	8884.00	1287.35	10.35	1277.00	1287.44	1280.46	2.44	1.86	265.00	9917.30	10333.94	.15
*	282.000	8858.00	1287.34	9.44	1277.90	1287.50	1282.13	3.15	3.94	140.00	9931.31	10317.03	.21
	284.170	8832.00	1287.39	8.59	1278.80	1287.64	1283.17	4.02	6.96	217.00	9881.22	10202.33	.27
*	286.070	8806.00	1287.11	6.61	1280.50	1288.14	1285.62	8.13	40.82	190.00	9880.89	10087.23	.63
*	288.470	8780.00	1287.72	5.82	1281.90	1290.14	1287.72	12.47	108.63	240.00	9899.40	10046.80	1.01
	291.720	8754.00	1291.16	6.96	1284.20	1293.22	1290.70	11.52	81.67	325.00	9917.24	10061.71	.88
	292.050	8750.00	1291.36	6.96	1284.40	1293.57	1291.09	11.93	74.79	33.00	9919.92	10066.59	.94
	293.050	8750.00	1292.10	6.10	1286.00	1294.35	1291.88	12.04	76.84	100.00	9928.70	10076.90	.96
	294.320	8723.00	1293.97	7.07	1286.90	1295.15	1292.30	8.73	40.98	127.00	9906.35	10078.14	.64

<<<<<< Cross Section: 276.3: (FN = H2SCSUB2.0) >>>>>>

Q1= 8936cfs WS1= 1286.25

Manning-n Values: LOB: 0 CH: .035 ROB: .045



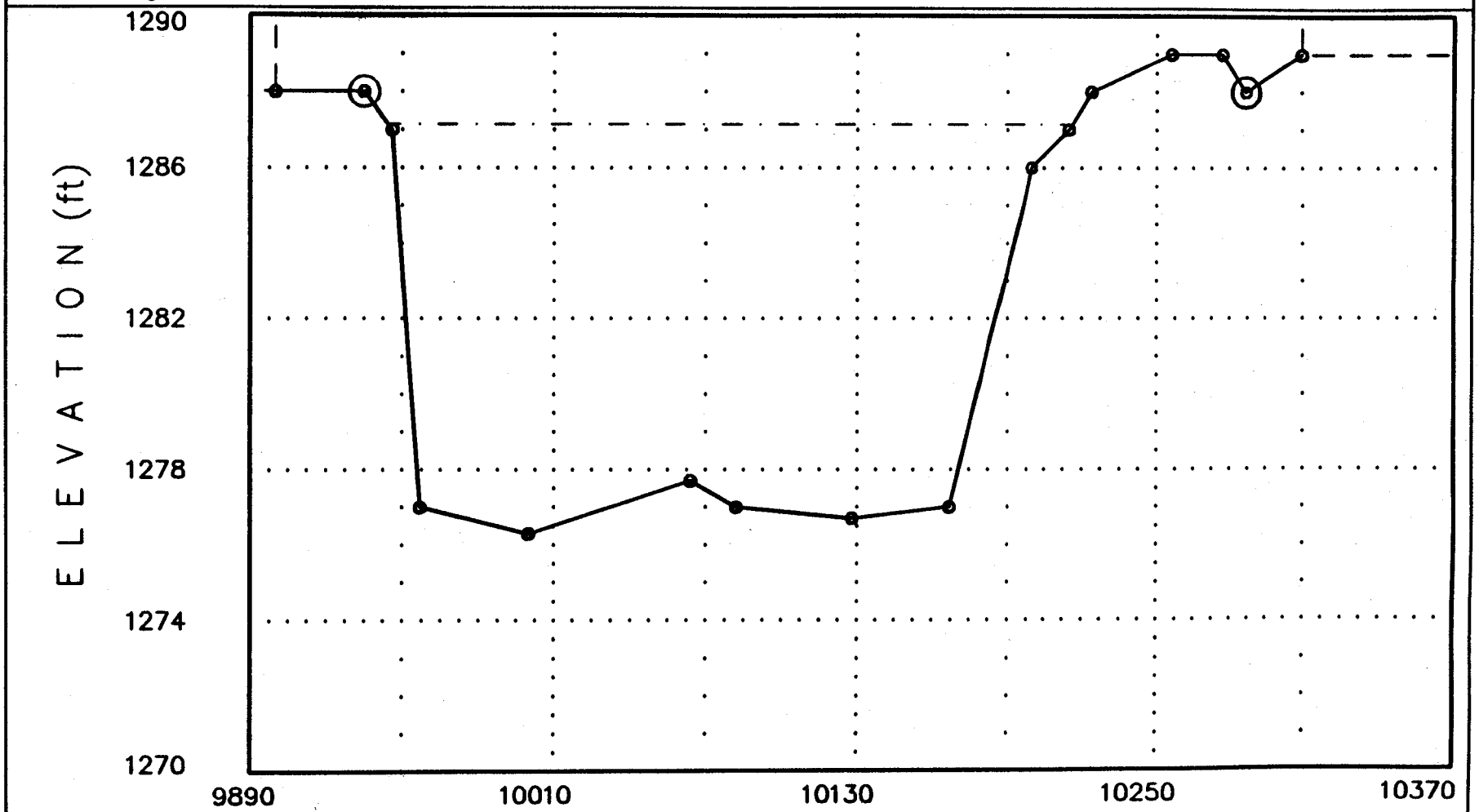
Vertical Scale 1: 4:
Horizontal Scale 1: 100:

09-16-1994

<<<<<< Cross Section: 277.95: (FN = H2SCSUB2.0) >>>>>>

Q1= 8910cfs WS1= 1287.15

Manning-n Values: LOB: 0 CH: .035 ROB: 0



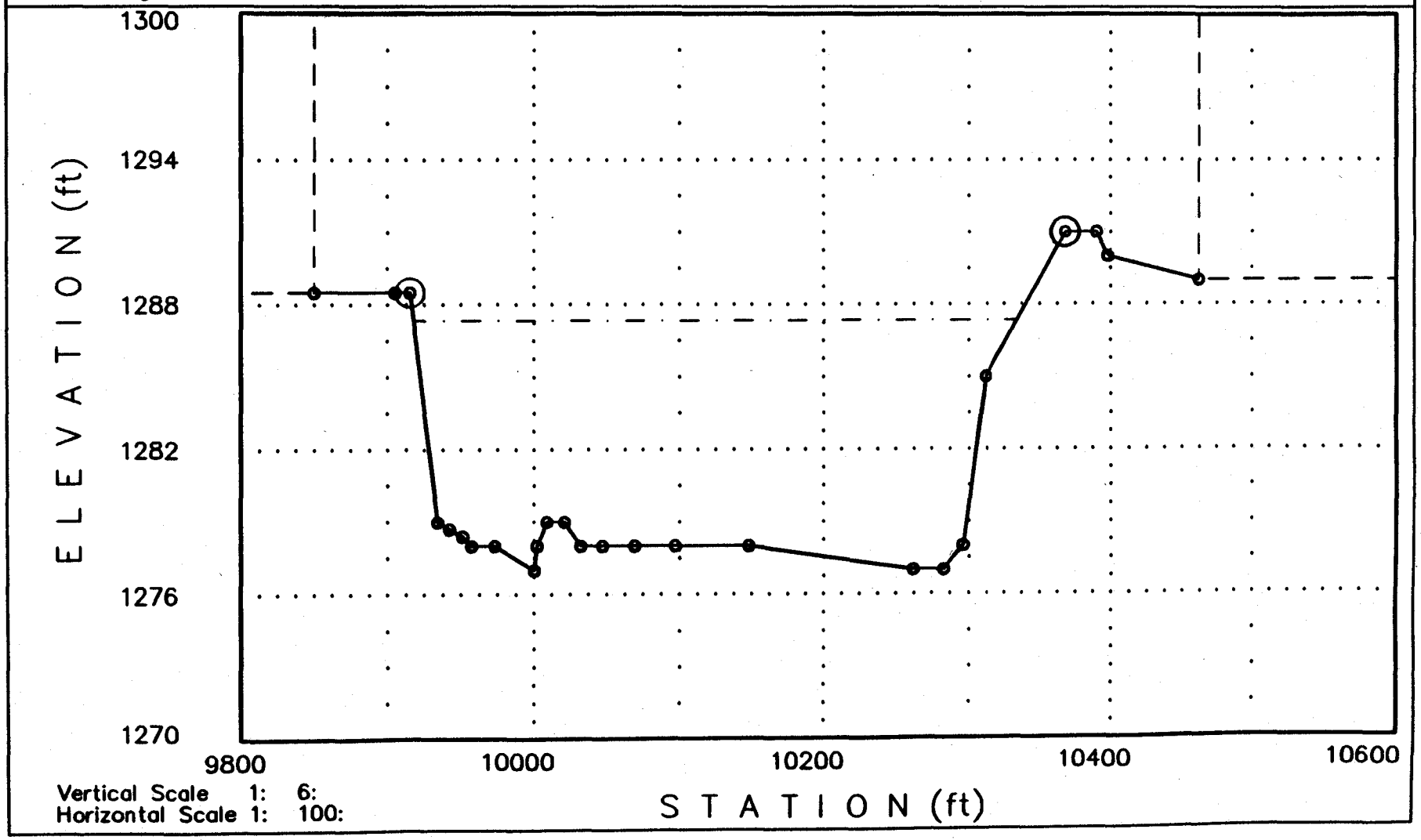
Vertical Scale 1: 4:
Horizontal Scale 1: 60:

09-16-1994

<<<<<< Cross Section: 280.6: (FN = H2SCSUB2.0) >>>>>>

Q1= 8884cfs WS1= 1287.35

Manning-n Values: LOB: 0 CH: .035 ROB: 0



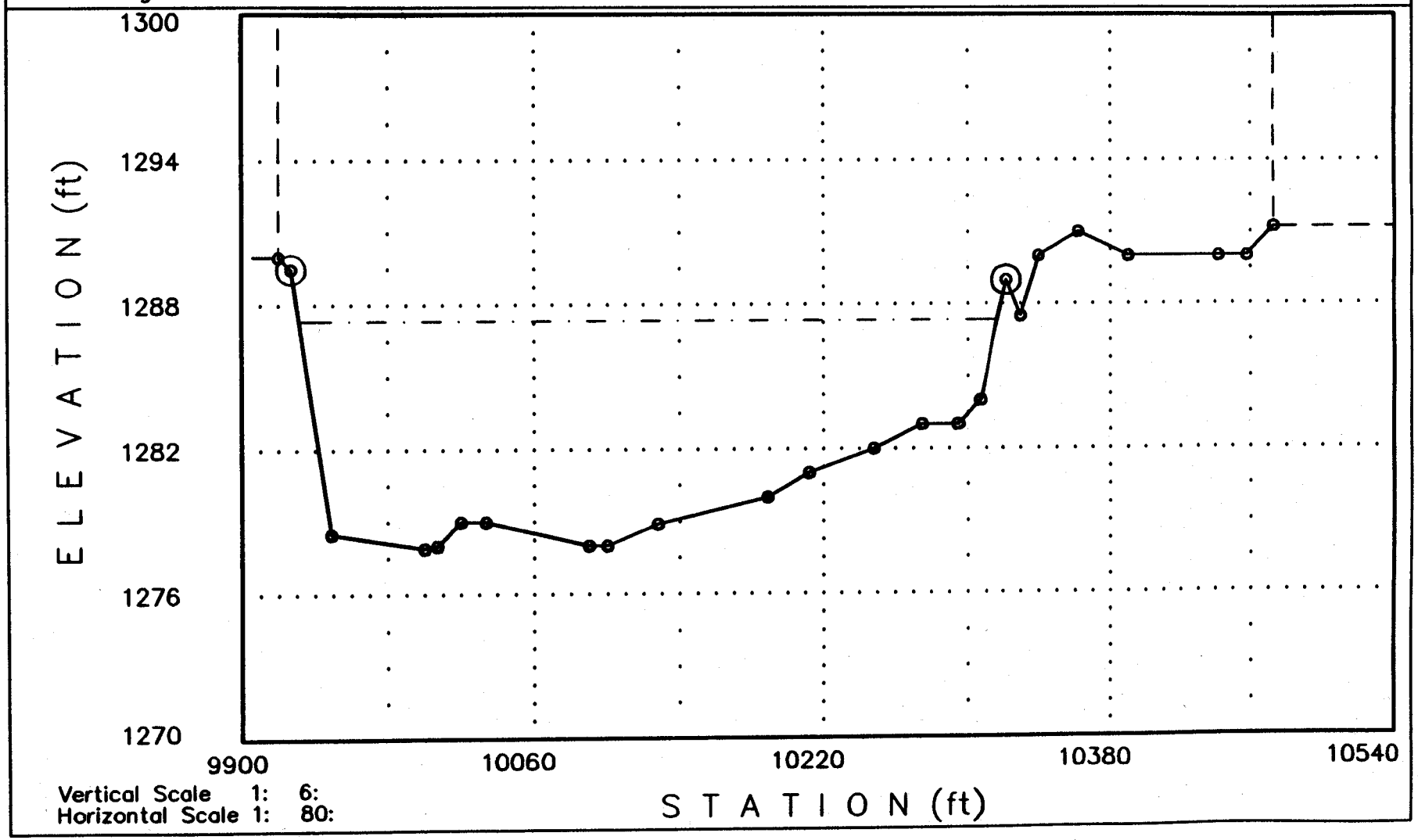
Vertical Scale 1: 6:
Horizontal Scale 1: 100:

09-10-1994

<<<<<< Cross Section: 282: (FN = H2SCSUB2.0) >>>>>>

Q1= 8858cfs WS1= 1287.34

Manning-n Values: LOB: 0 CH: .035 ROB: 0



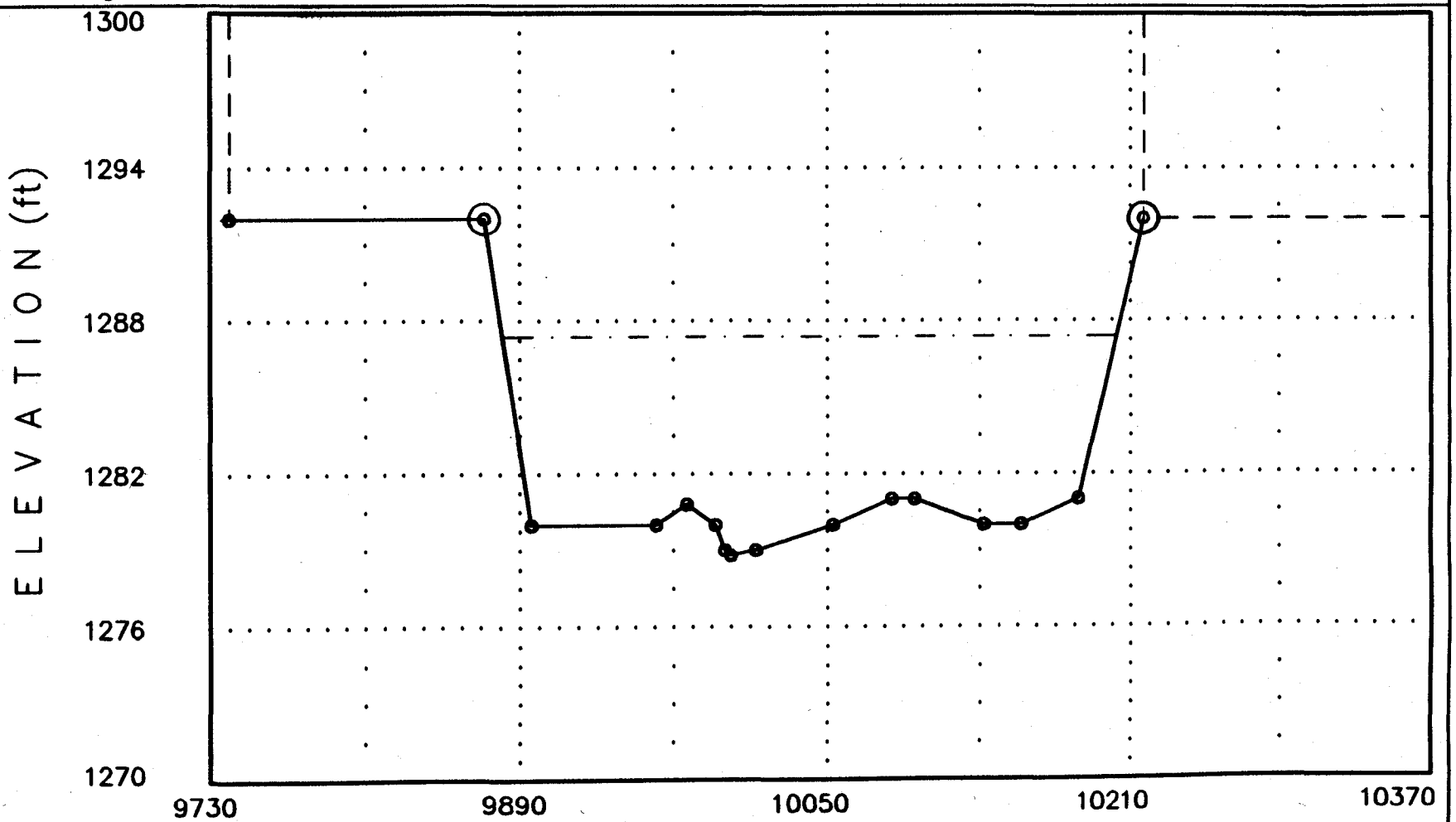
Vertical Scale 1: 6:
Horizontal Scale 1: 80:

09-16-1994

<<<<<< Cross Section: 284.17: (FN = H2SCSUB2.0) >>>>>>

Q1= 8832cfs WS1= 1287.39

Manning-n Values: LOB: 0 CH: .035 ROB: 0



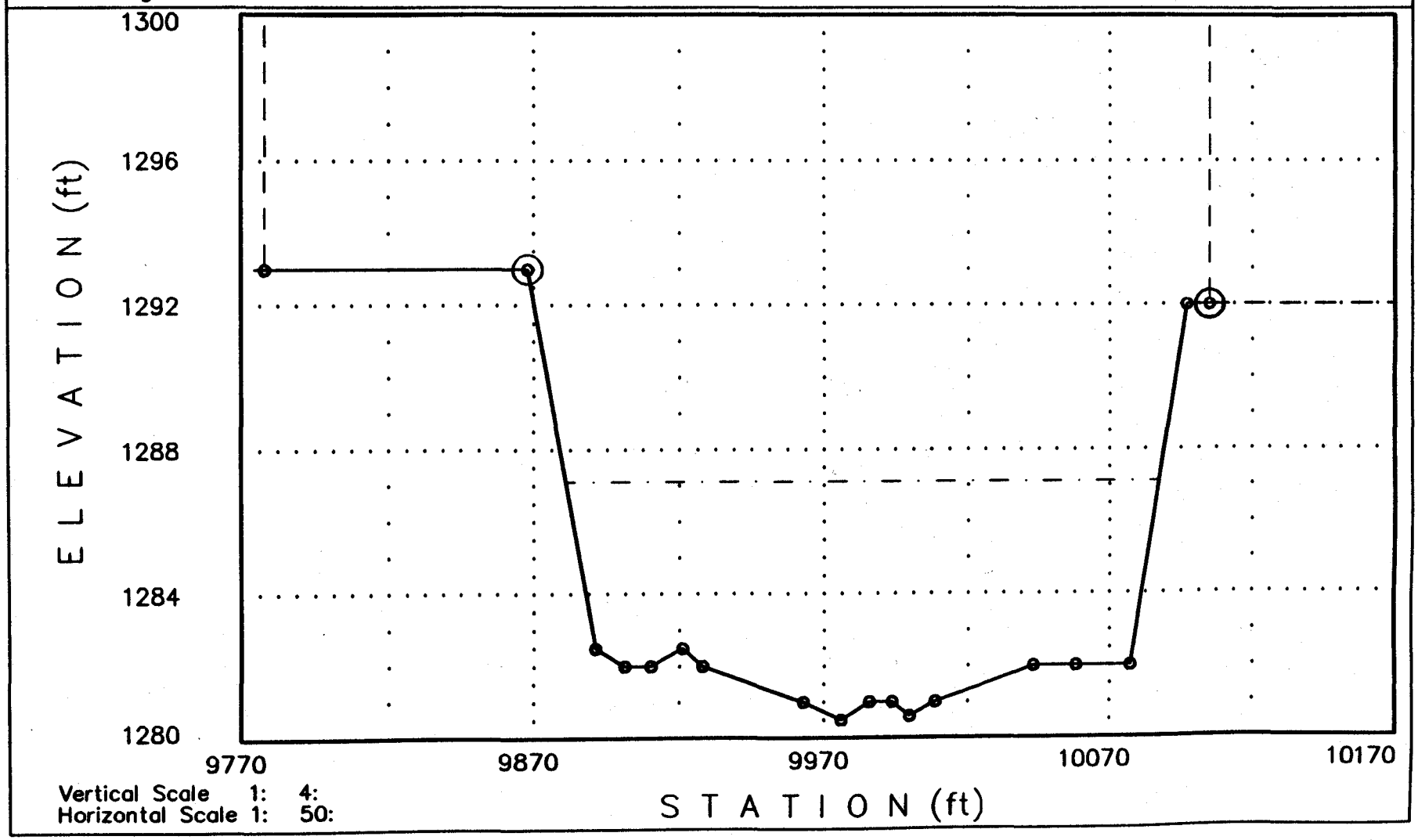
Vertical Scale 1: 6:
Horizontal Scale 1: 80:

09-10-1994

<<<<<< Cross Section: 286.07: (FN = H2SCSUB2.0) >>>>>>

Q1= 8806cfs WS1= 1287.11

Manning-n Values: LOB: 0 CH: .035 ROB: 0



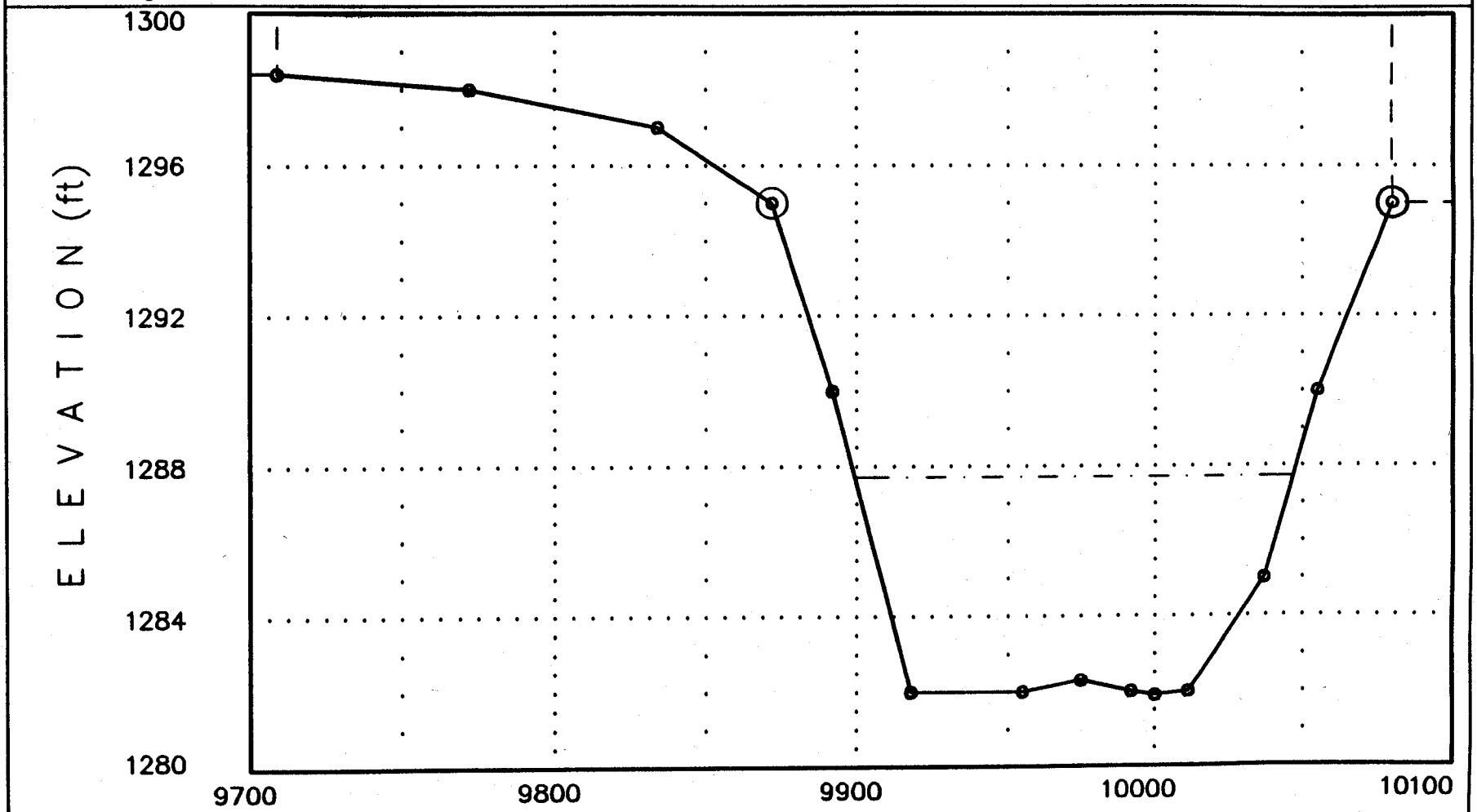
Vertical Scale 1: 4:
Horizontal Scale 1: 50:

09-19-1994

<<<<<< Cross Section: 288.47: (FN = H2SCSUB2.0) >>>>>>

Q1= 8780cfs WS1= 1287.72

Manning-n Values: LOB: 0 CH: .035 ROB: 0



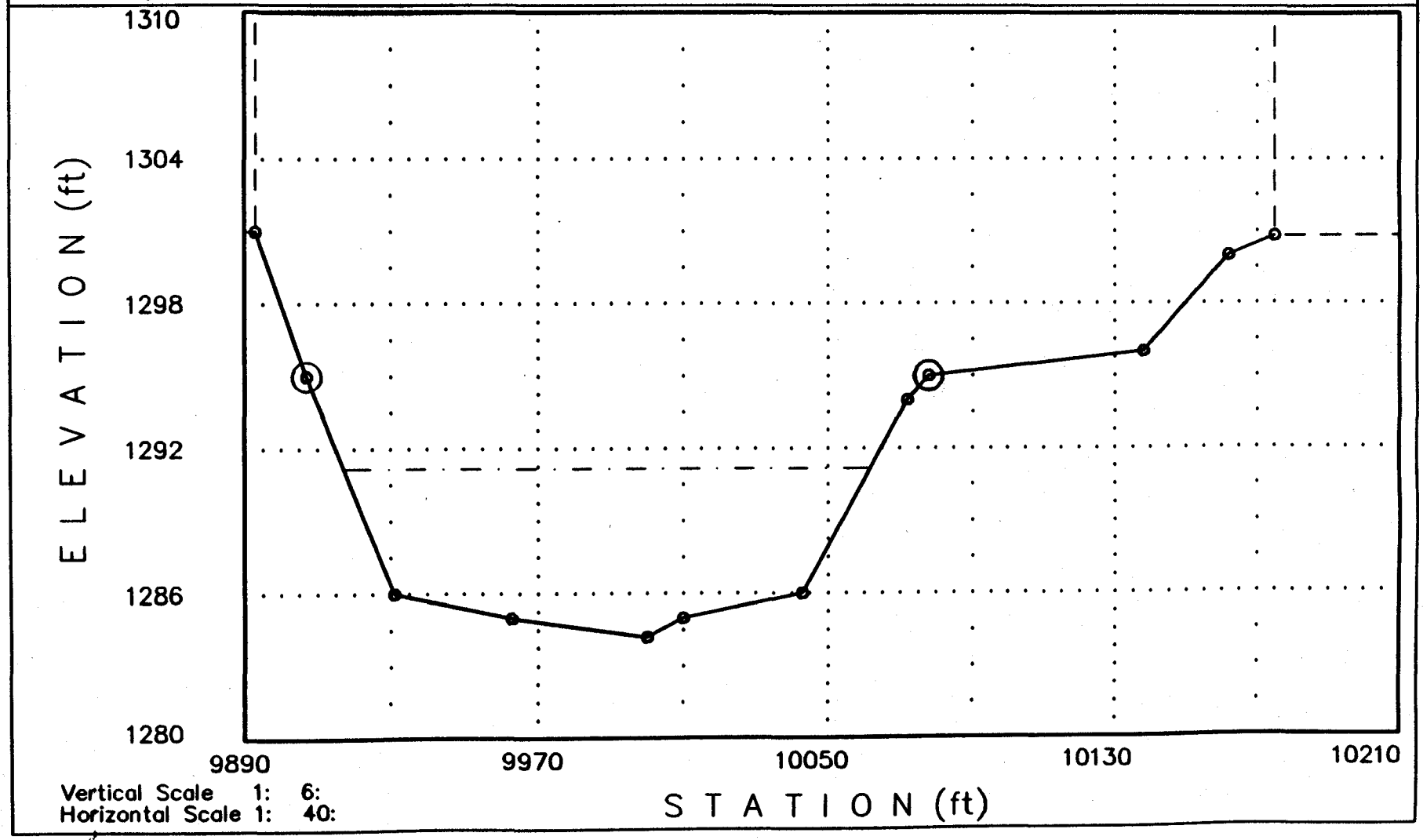
Vertical Scale 1: 4:
Horizontal Scale 1: 50:

08-10-1994

<<<<<< Cross Section: 291.72: (FN = H2SCSUB2.0) >>>>>>

Q1= 8754cfs WS1= 1291.16

Manning-n Values: LOB: 0 CH: .035 ROB: 0



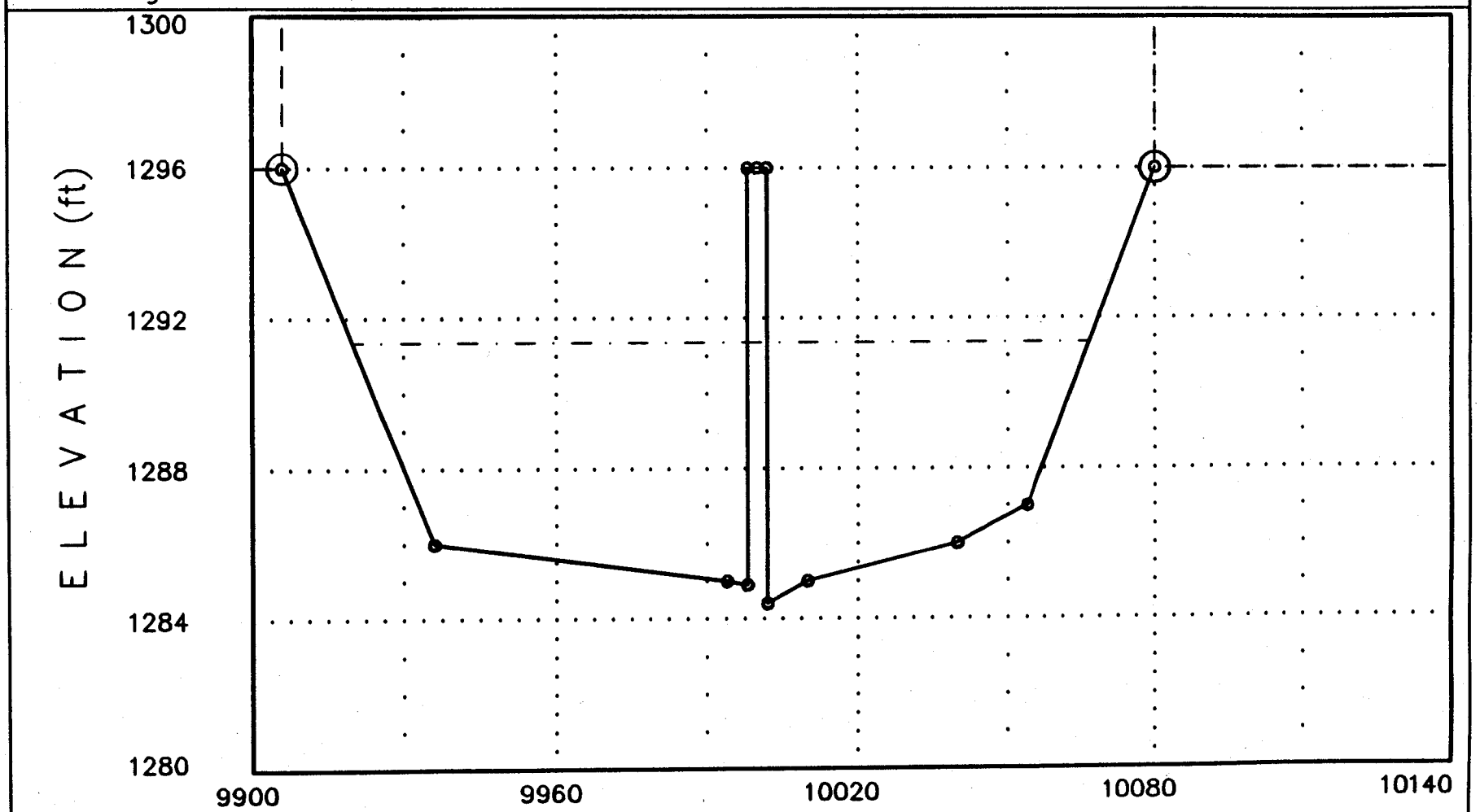
Vertical Scale 1: 6:
Horizontal Scale 1: 40:

08-10-1994

<<<<<< Cross Section: 292.05: (FN = H2SCSUB2.0) >>>>>>

Q1= 8750cfs WS1= 1291.36

Manning-n Values: LOB: 0 CH: .03 ROB: 0



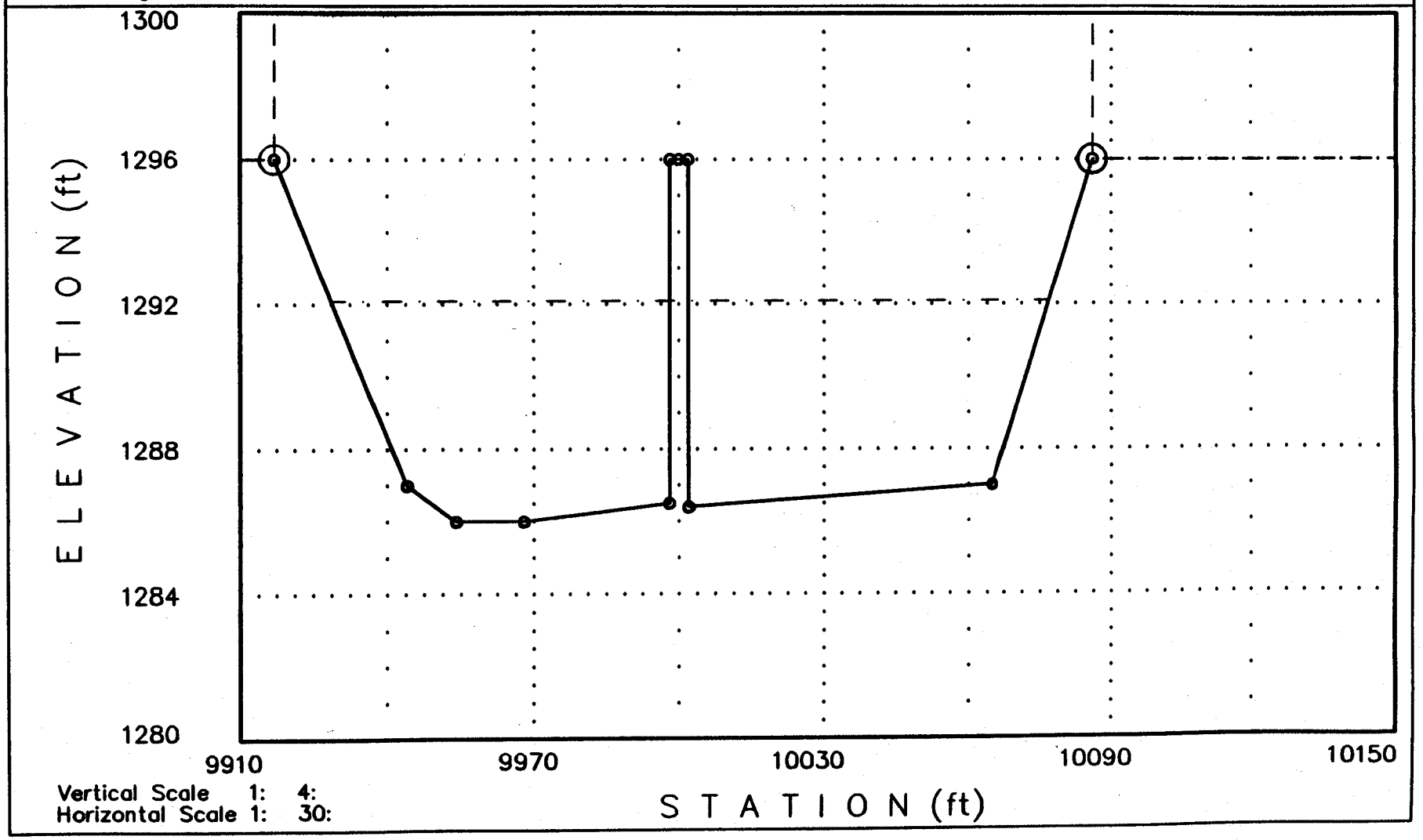
Vertical Scale 1: 4:
Horizontal Scale 1: 30:

09-19-1994

<<<<<< Cross Section: 293.05: (FN = H2SCSUB2.0) >>>>>>

Q1= 8750cfs WS1= 1292.1

Manning-n Values: LOB: 0 CH: .03 ROB: 0



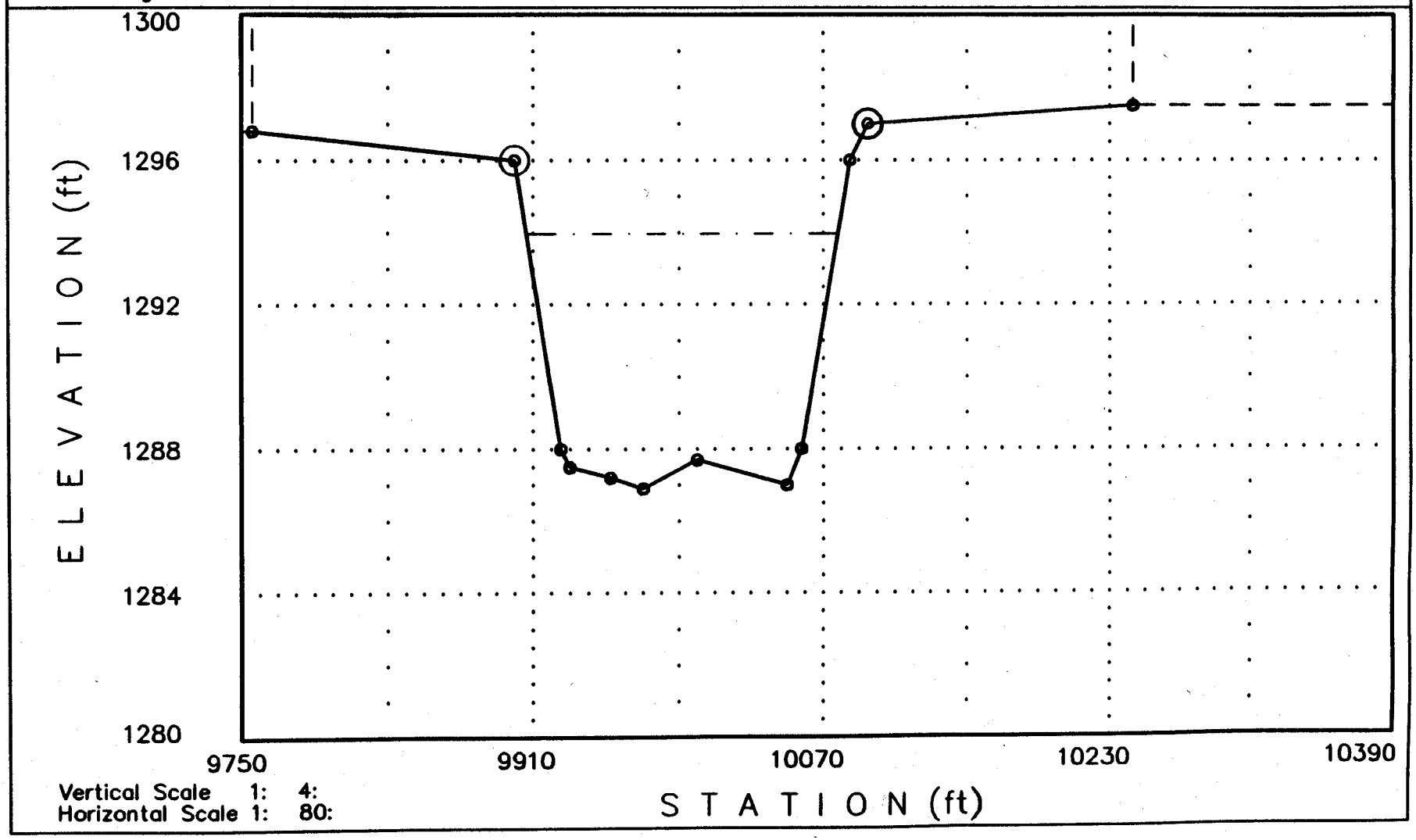
Vertical Scale 1: 4:
Horizontal Scale 1: 30:

08-10-1994

<<<<<< Cross Section: 294.32: (FN = H2SCSUB2.0) >>>>>>

Q1= 8723cfs WS1= 1293.97

Manning-n Values: LOB: 0 CH: .035 ROB: 0



Vertical Scale 1: 4:
Horizontal Scale 1: 80:

09-19-1994

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*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.6.0;  February 1991          *
*                                           *
*  RUN DATE    16SEP94    TIME   16:30:00   *
*********************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*          (916) 756-1104               *
*****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

SKUNK CREEK
SUPERCRITICAL PROFILE
100-YEAR FLOW

THIS RUN EXECUTED 16SEP94 16:30:00

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************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************


T1      CARMEL PARK / SKUNK CREEK BANK STABILIZATION
T2      PREPARED FOR CONTINENTAL HOMES, BY COE & VAN LOO CONSULT. (92-0090-01).
T3      100-YEAR, SUPER-CRITICAL; SEPT 1994  (FILE NAME:  H2SCSPR2)

        SKUNK CREEK ANALYSIS DOWNSTREAM OF 51ST AVENUE BRIDGE
        PREPARED FOR CONTINENTAL HOMES TO EVALUATE THE SCOUR POTENTIAL ON THE
        CARMEL PARK SUBDIVISION.

        PREPARED BY COE & VAN LOO CONSULTANTS, INC. (CVL)

        THIS MODEL USES DATA FROM THE CHELSEA VILLAGE PROJECT
        PREPARED BY CLOUSE ENGINEERING, INC. (CEI) FOR SUBMITTAL
        TO THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA).
        CROSS-SECTION DATA FOR ALL SECTIONS (276.30 - 294.32),
        WERE TAKEN FROM THE CEI MODEL. PEAK FLOWS WERE OBTAINED
        FROM FEMA STUDIES, PER THE CEI MODEL.

        STARTING WATER SURFACE ELEVATIONS WERE ASSUMED AT CRITICAL DEPTH.


J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

              2                 1       -1

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     1                -1.                                   -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38       43        1        8       42        3        2       26        5       39
    53       54       68

NC   0.045    0.045    0.035    0.1      0.3
QT       1    8723
X1  294.32       12     9900    10095      160      128      127
GR  1296.8     9756   1296.0     9900   1288.0     9925   1287.5     9930   1287.2     9952
GR  1286.9     9970   1287.7    10000   1287.0    10050   1288.0    10058   1296.0    10085
GR  1297.0    10095   1297.5    10243
```

QT	1	8750								
NC	0.03	0.03	0.03	0.3	0.6					
X1	293.05	11	9917	10086	100	100	100			
GR	1296.0	9917	1287.0	9944	1286.0	9954	1286.0	9968	1286.5	9998
GR	1296.0	9998.1	1296.0	10000	1296.0	10001.9	1286.4	10002	1287.0	10065
GR	1296.0	10086								
QT	1	8750								
X1	292.05	12	9906	10080	5	56	33			
GR	1296.0	9906	1286.0	9936	1285.0	9994	1284.9	9998	1296.0	9998.1
GR	1296.0	10000	1296.0	10001.9	1284.4	10002	1285.0	10010	1286.0	10040
GR	1287.0	10054	1296.0	10080						
QT	1	8754								
NC	0.045	0.045	0.035	0.1	0.3					
X1	291.72	12	9907	10078	325	330	325			
GR	1301.0	9893	1295.0	9907	1286.0	9931	1285.0	9963	1284.2	10000
GR	1285.0	10010	1286.0	10043	1294.0	10072	1295.0	10078	1296.0	10138
GR	1300.0	10162	1300.8	10175						
QT	1	8780								
X1	288.47	14	9872	10080	210	205	240			
GR	1298.4	9709	1298.0	9772	1297.0	9834	1295.0	9872	1290.0	9892
GR	1282.0	9918	1282.0	9955	1282.3	9975	1282.0	9992	1281.9	10000
GR	1282.0	10011	1285.0	10037	1290.0	10055	1295.0	10080		
QT	1	8806								
X1	286.07	18	9868	10105	190	172	190			
GR	1293.0	9778	1293.0	9868	1282.5	9891	1282.0	9901	1282.0	9910
GR	1282.5	9921	1282.0	9928	1281.0	9963	1280.5	9976	1281.0	9986
GR	1281.0	9994	1280.6	10000	1281.0	10009	1282.0	10043	1282.0	10058
GR	1282.0	10077	1292.0	10097	1292.0	10105				
QT	1	8832								
X1	284.17	16	9872	10217	181	355	217			
X3	10									
GR	1292.0	9740	1292.0	9872	1280.0	9896	1280.0	9961	1280.8	9977
GR	1280.0	9992	1279.0	9997	1278.8	10000	1279.0	10013	1280.0	10053
GR	1281.0	10084	1281.0	10096	1280.0	10132	1280.0	10152	1281.0	10182
GR	1292.0	10217								
QT	1	8858								
X1	282.00	24	9927	10322	130	238	140			
X3	10									
GR	1290.0	9920	1289.5	9927	1278.5	9949	1277.9	10000	1278.0	10007
GR	1279.0	10020	1279.0	10034	1278.0	10090	1278.0	10100	1278.9	10128
GR	1280.0	10189	1281.0	10212	1282.0	10248	1283.0	10275	1283.0	10295
GR	1284.0	10307	1289.0	10322	1287.5	10330	1290.0	10340	1291.0	10362
GR	1290.0	10390	1290.0	10442	1290.0	10458	1291.2	10473		

QT	1	8884								
X1	280.60	25	9915	10368	278	235	265			
X3	10									
GR	1288.5	9850	1288.5	9905	1288.5	9915	1279.0	9934	1278.7	9942
GR	1278.4	9951	1278.0	9957	1278.0	9973	1277.0	10000	1278.0	10002
GR	1279.0	10009	1279.0	10021	1278.0	10032	1278.0	10047	1278.0	10069
GR	1278.0	10097	1278.0	10148	1277.0	10262	1277.0	10283	1278.0	10296
GR	1285.0	10312	1291.0	10368	1291.0	10390	1290.0	10398	1289.0	10462
QT	1	8910								
X1	277.95	15	9935	10287	170	95	165			
X3	10									
X4	1	1287.0	9946							
GR	1288.0	9900	1288.0	9935	1277.0	9957	1276.3	10000	1277.7	10064
GR	1277.0	10082	1276.7	10128	1277.0	10167	1286.0	10200	1287.0	10215
GR	1288.0	10224	1289.0	10256	1289.0	10277	1288.0	10287	1289.0	10310
QT	1	8936								
X1	276.30	25	9952	10132	106	149	95			
X3	10									
GR	1287.5	9900	1287.5	9952	1277.5	9972	1277.0	9976	1276.0	9980
GR	1276.1	10000	1277.0	10027	1277.0	10042	1280.0	10051	1280.0	10068
GR	1284.0	10106	1285.0	10117	1286.0	10132	1286.8	10144	1286.0	10158
GR	1283.2	10208	1288.0	10241	1288.0	10265	1288.2	10305	1288.0	10351
GR	1287.8	10364	1288.0	10381	1288.0	10410	1287.6	10431	1288.0	10504

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

*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 294.320
2096 WSEL NOT GIVEN, AVG OF MAX, MIN USED
3720 CRITICAL DEPTH ASSUMED

294.320	5.40	1292.30	1292.30	.00	1294.57	2.27	.00	.00	1296.00
8723.0	.0	8723.0	.0	.0	722.0	.0	.0	.0	1297.00
.00	.00	12.08	.00	.000	.035	.000	.000	1286.90	9911.57
.011070	0.	0.	0.	0	7	0	.00	160.94	10072.51

CCHV= .300 CEHV= .600
*SECNO 293.050

3265 DIVIDED FLOW

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

293.050	5.88	1291.88	1291.88	.00	1294.34	2.46	1.25	1.19	1296.00
8750.0	.0	8750.0	.0	.0	695.6	.0	2.1	.4	1296.00
.00	.00	12.58	.00	.000	.030	.000	.000	1286.00	9929.35
.008769	160.	127.	128.	20	8	0	.00	143.16	10076.39

*SECNO 292.050

3265 DIVIDED FLOW

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

292.050	6.68	1291.08	1291.08	.00	1293.55	2.47	.88	.74	1296.00
8750.0	.0	8750.0	.0	.0	693.6	.0	3.7	.8	1296.00
.01	.00	12.62	.00	.000	.030	.000	.000	1284.40	9920.77
.008831	100.	100.	100.	20	8	0	.00	141.13	10065.78

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

CCHV=     .100 CEHV=     .300
*SECNO 291.720
   291.720      6.30   1290.50   1290.70       .00   1293.19      2.69       .34       .02   1295.00
    8754.0        .0    8754.0       .0        .0     665.0       .0       4.2        .9   1295.00
       .01       .00     13.16       .00      .000      .035      .000      .000   1284.20   9919.02
   .012240        5.       33.       56.         3         8         0       .00    140.27  10059.29

*SECNO 288.470
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   288.470      5.82   1287.72   1287.72       .00   1290.14      2.42      3.75      1.78   1295.00
    8780.0        .0    8780.0       .0        .0     703.4       .0       9.3       1.9   1295.00
       .01       .00     12.48       .00      .000      .035      .000      .000   1281.90   9899.41
   .010893      325.      325.      330.        20        11         0       .00    147.37  10046.79

*SECNO 286.070
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   286.070      5.13   1285.63   1285.63       .00   1287.60      1.97      2.70      1.15   1293.00
    8806.0        .0    8806.0       .0        .0     781.4       .0      13.4       2.9   1292.00
       .02       .00     11.27       .00      .000      .035      .000      .000   1280.50   9884.14
   .011583      210.      240.      205.        20        11         0       .00    200.12  10084.26

*SECNO 284.170

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=     1292.00 ELREA=     1292.00

   284.170      3.99   1282.79   1283.17       .00   1284.78      1.99      2.82       .00   1292.00
    8832.0        .0    8832.0       .0        .0     780.7       .0      16.8       4.0   1292.00
       .02       .00     11.31       .00      .000      .035      .000      .000   1278.80   9890.40
   .019697      190.      190.      172.         5        15         0       .00    297.32  10187.72

*SECNO 282.000
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
```

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

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1289.50 ELREA= 1289.00

282.000	4.23	1282.13	1282.13	.00	1283.62	1.49	3.40	2.09	1289.50
8858.0	.0	8858.0	.0	.0	904.7	.0	21.0	5.5	1289.00
.03	.00	9.79	.00	.000	.035	.000	.000	1277.90	9941.75
.012790	181.	217.	355.	20	8	0	.00	309.70	10251.45

*SECNO 280.600
3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1288.50 ELREA= 1291.00

280.600	3.45	1280.45	1280.45	.00	1281.78	1.32	1.83	.16	1288.50
8884.0	.0	8884.0	.0	.0	962.3	.0	24.0	6.6	1291.00
.03	.00	9.23	.00	.000	.035	.000	.000	1277.00	9931.09
.013305	130.	140.	238.	20	15	0	.00	370.52	10301.61

*SECNO 277.950

3301 HV CHANGED MORE THAN HVINS

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

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1288.00 ELREA= 1288.00

277.950	4.35	1280.65	1280.65	.00	1282.48	1.83	3.34	1.64	1288.00
8910.0	.0	8910.0	.0	.0	820.4	.0	29.4	8.4	1288.00
.04	.00	10.86	.00	.000	.035	.000	.000	1276.30	9952.98
.011960	278.	265.	235.	20	11	0	.00	227.41	10180.39

*SECNO 276.300

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

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

3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1287.50 ELREA= 1286.00

276.300	7.64	1283.64	1283.64	.00	1286.13	2.49	1.87	1.03	1287.50
8936.0	.0	8936.0	.0	.0	705.5	.0	32.3	9.1	1286.00
.04	.00	12.67	.00	.000	.035	.000	.000	1276.00	9959.72
.010808	170.	165.	95.	20	14	0	.00	142.84	10102.56

THIS RUN EXECUTED 16SEP94 16:30:01

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.0;  February 1991
************************************
```

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

100-YEAR, SUPER-CRITICAL

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	ENDST	FRCH
*	294.320	8723.00	1292.30	5.40	1286.90	1294.57	1292.30	12.08	110.70	.00	9911.57	10072.51	1.01
*	293.050	8750.00	1291.88	5.88	1286.00	1294.34	1291.88	12.58	87.69	127.00	9929.35	10076.39	1.02
*	292.050	8750.00	1291.08	6.68	1284.40	1293.55	1291.08	12.62	88.31	100.00	9920.77	10065.78	1.02
	291.720	8754.00	1290.50	6.30	1284.20	1293.19	1290.70	13.16	122.40	33.00	9919.02	10059.29	1.07
*	288.470	8780.00	1287.72	5.82	1281.90	1290.14	1287.72	12.48	108.93	325.00	9899.41	10046.79	1.01
*	286.070	8806.00	1285.63	5.13	1280.50	1287.60	1285.63	11.27	115.83	240.00	9884.14	10084.26	1.01
	284.170	8832.00	1282.79	3.99	1278.80	1284.78	1283.17	11.31	196.97	190.00	9890.40	10187.72	1.23
*	282.000	8858.00	1282.13	4.23	1277.90	1283.62	1282.13	9.79	127.90	217.00	9941.75	10251.45	1.01
*	280.600	8884.00	1280.45	3.45	1277.00	1281.78	1280.45	9.23	133.05	140.00	9931.09	10301.61	1.01
*	277.950	8910.00	1280.65	4.35	1276.30	1282.48	1280.65	10.86	119.60	265.00	9952.98	10180.39	1.01
*	276.300	8936.00	1283.64	7.64	1276.00	1286.13	1283.64	12.67	108.08	165.00	9959.72	10102.56	1.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=    294.320  PROFILE=  1  CRITICAL DEPTH ASSUMED

CAUTION SECNO=    293.050  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    293.050  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    293.050  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    292.050  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    292.050  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    292.050  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    288.470  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    288.470  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    288.470  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    286.070  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    286.070  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    286.070  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    282.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    282.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    282.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    280.600  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    280.600  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    280.600  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

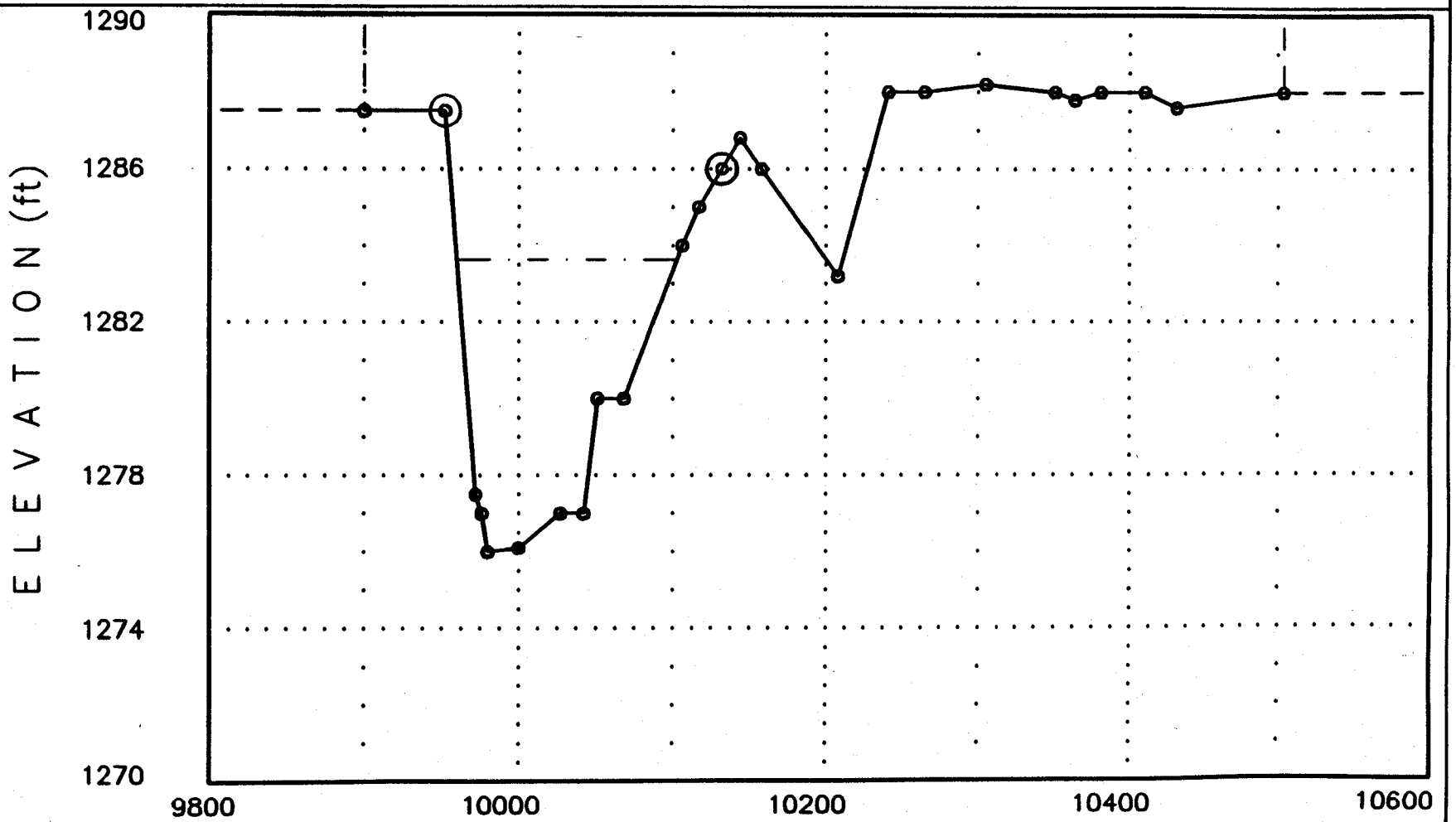
CAUTION SECNO=    277.950  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    277.950  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    277.950  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    276.300  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    276.300  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    276.300  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
```

<<<<<< Cross Section: 276.3: (FN = H2SCSPR2.0) >>>>>>

Q1= 8936cfs WS1= 1283.64

Manning-n Values: LOB: 0 CH: .035 ROB: 0



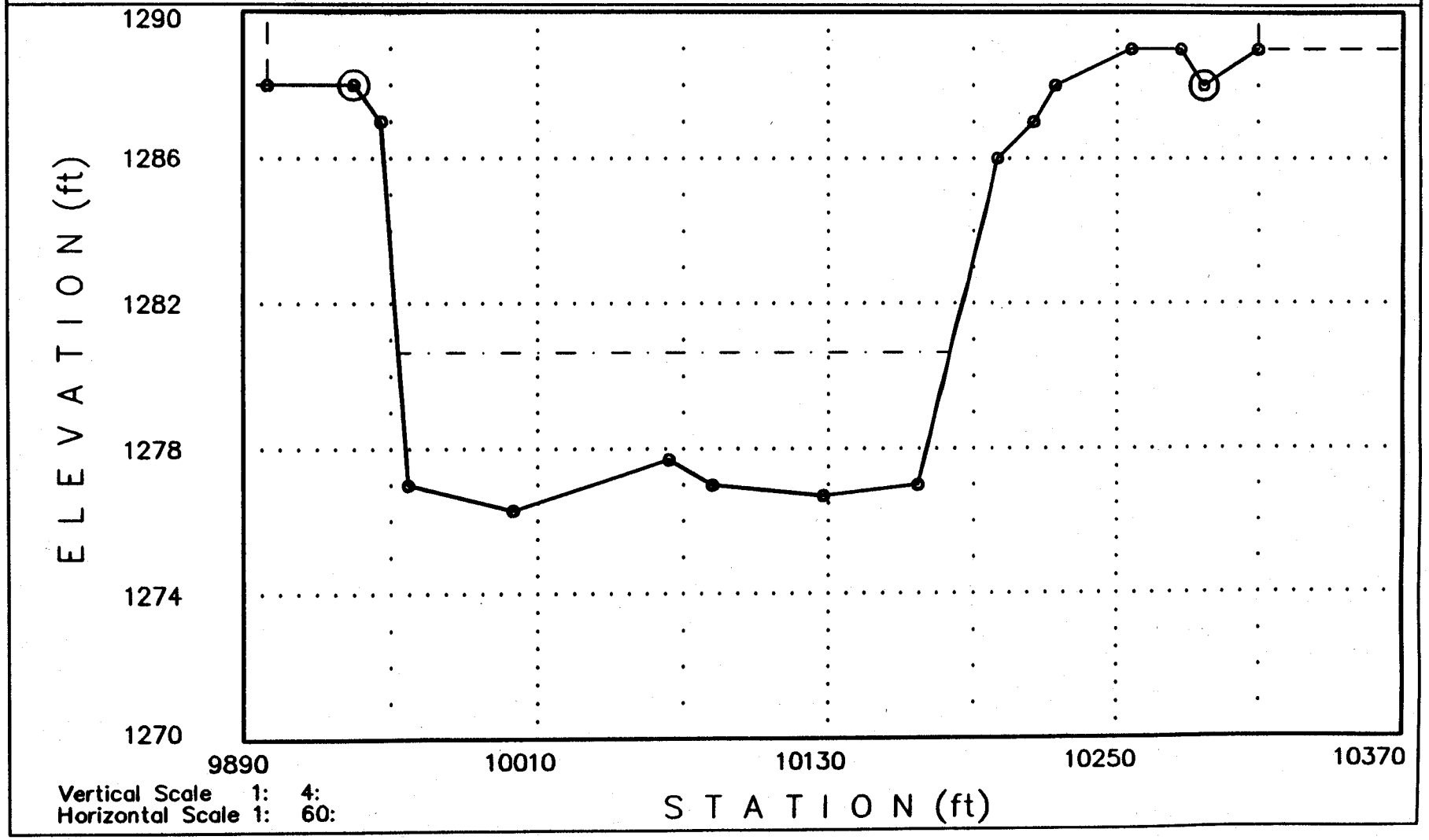
Vertical Scale 1: 4:
Horizontal Scale 1: 100:

08-19-1994

<<<<<< Cross Section: 277.95: (FN = H2SCSPR2.0) >>>>>>

Q1= 8910cfs WS1= 1280.65

Manning-n Values: LOB: 0 CH: .035 ROB: 0



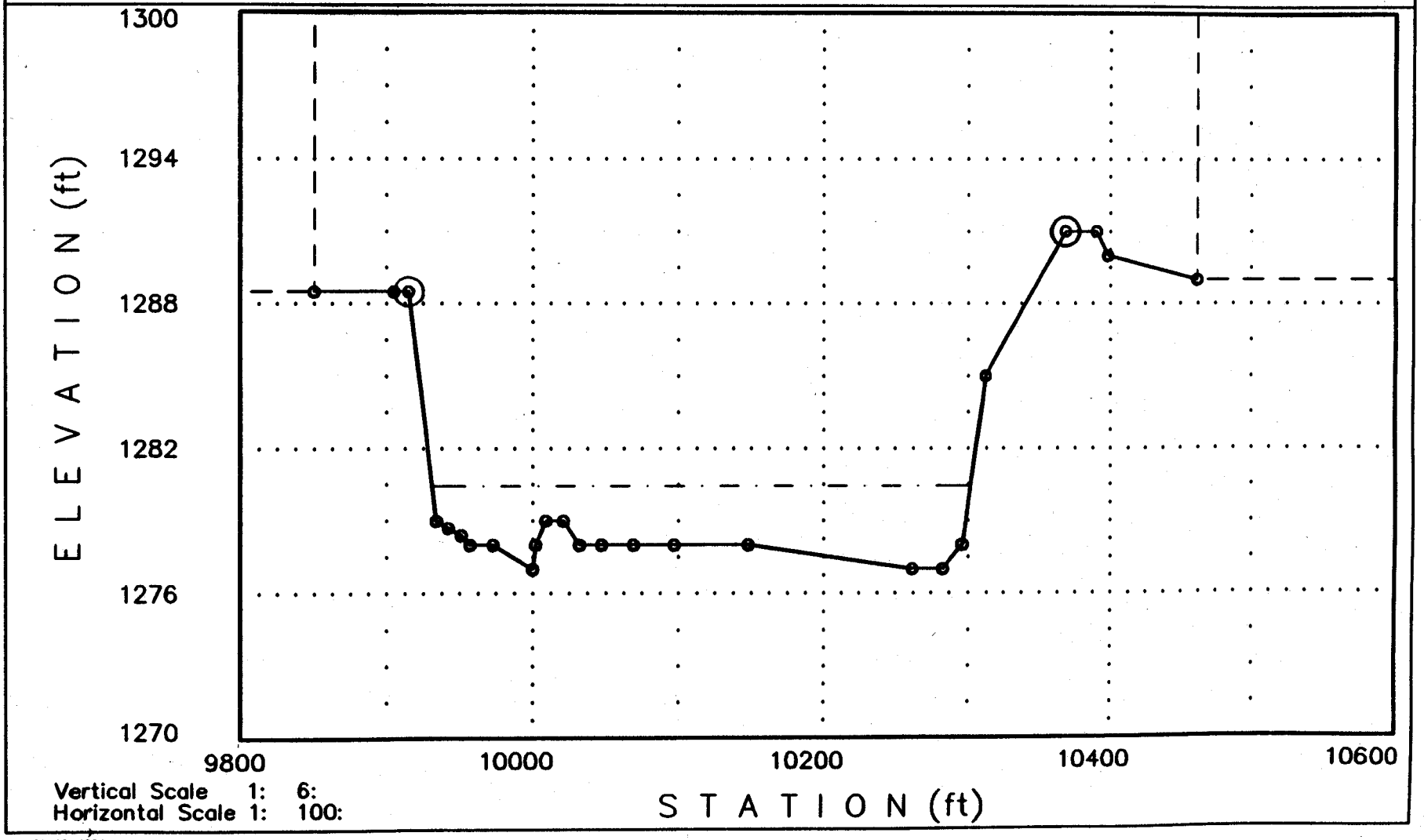
Vertical Scale 1: 4:
Horizontal Scale 1: 60:

09-19-1994

<<<<<< Cross Section: 280.6: (FN = H2SCSPR2.0) >>>>>>

Q1= 8884cfs WS1= 1280.45

Manning-n Values: LOB: 0 CH: .035 ROB: 0



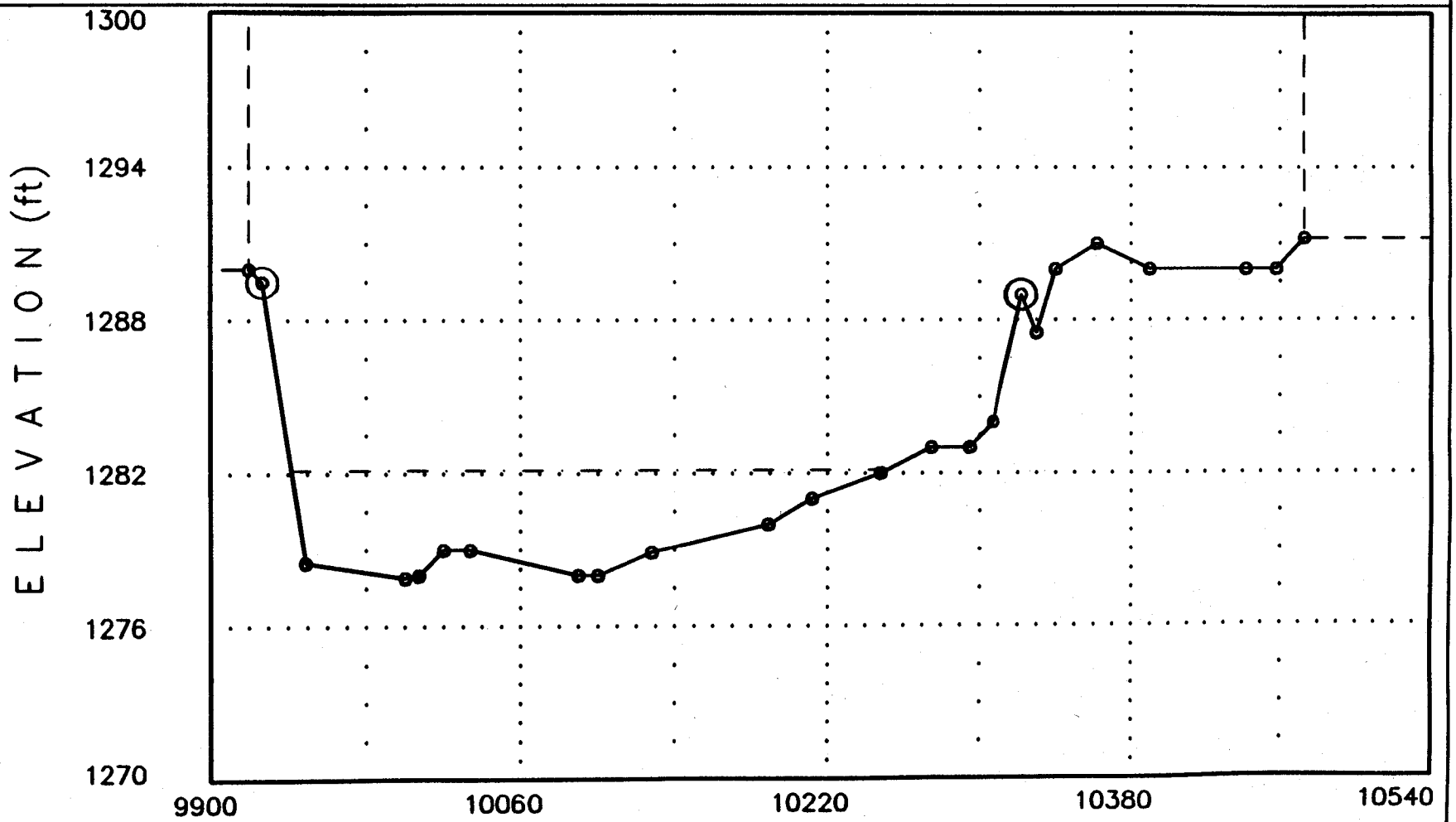
Vertical Scale 1: 6:
Horizontal Scale 1: 100:

00-10-1994

<<<<<< Cross Section: 282: (FN = H2SCSPR2.0) >>>>>>

Q1= 8858cfs WS1= 1282.13

Manning-n Values: LOB: 0 CH: .035 ROB: 0



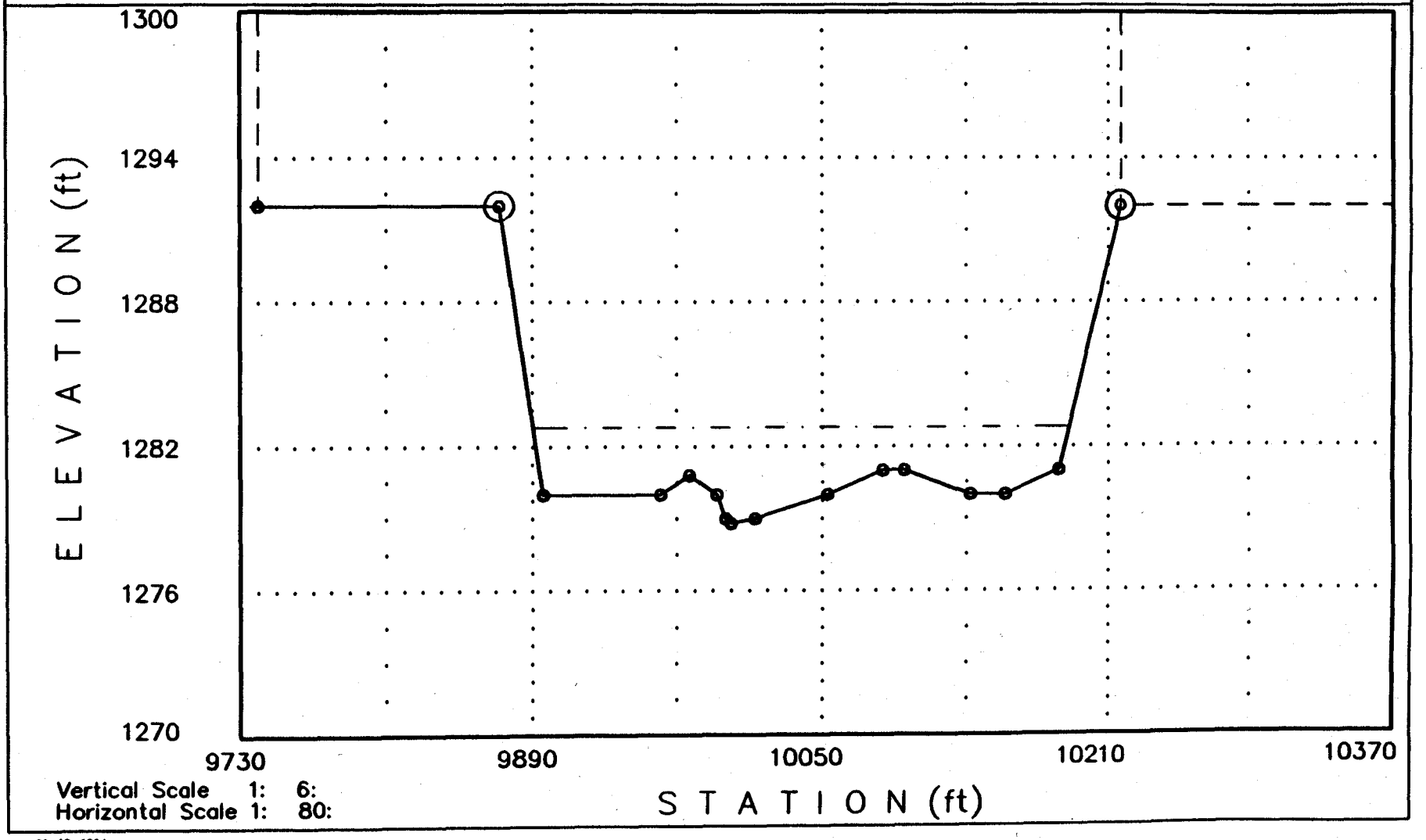
Vertical Scale 1: 6:
Horizontal Scale 1: 80:

08-10-1994

<<<<<< Cross Section: 284.17: (FN = H2SCSPR2.0) >>>>>>

Q1= 8832cfs WS1= 1282.79

Manning-n Values: LOB: 0 CH: .035 ROB: 0



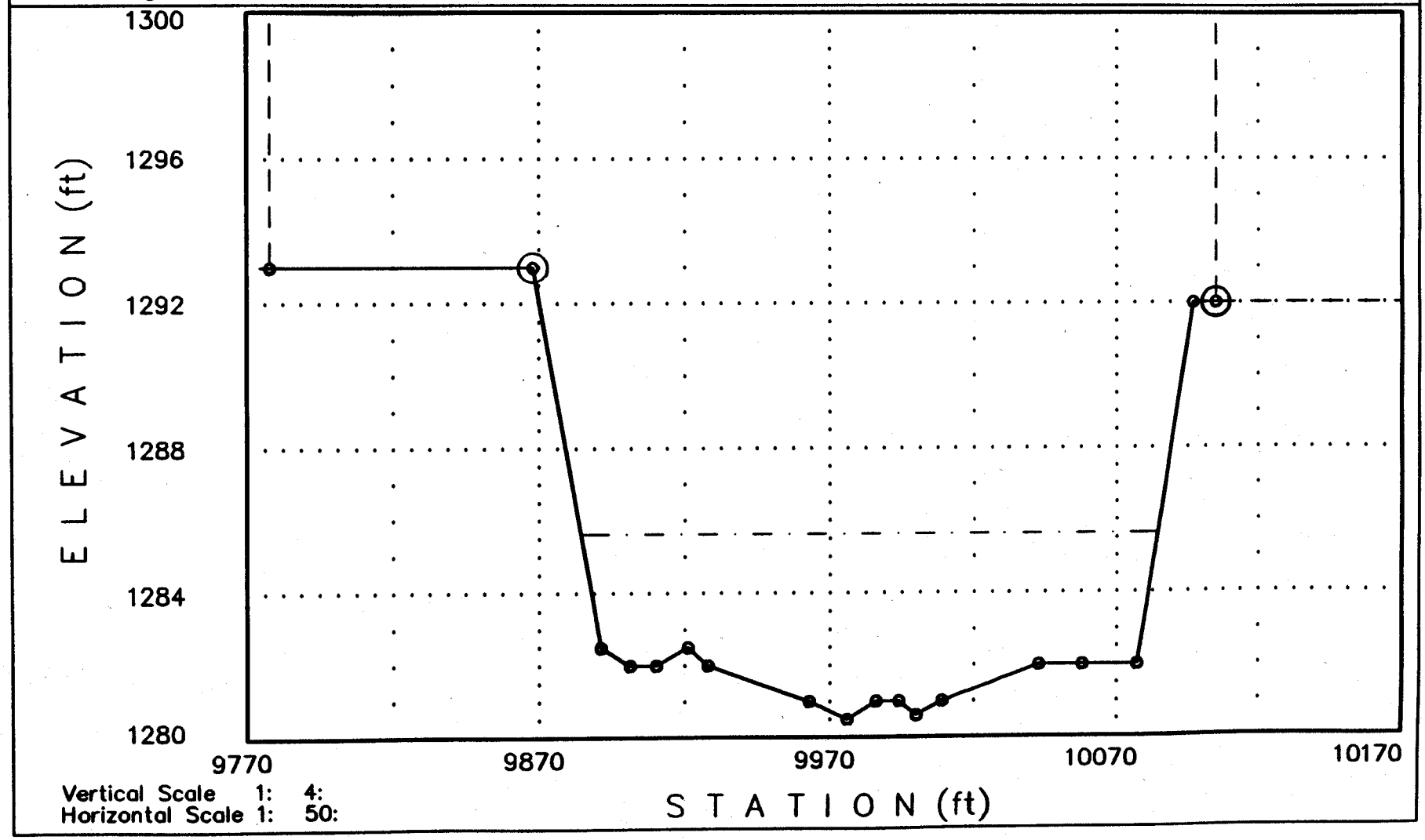
Vertical Scale 1: 6:
Horizontal Scale 1: 80:

09-19-1994

<<<<<< Cross Section: 286.07: (FN = H2SCSPR2.0) >>>>>>

Q1= 8806cfs WS1= 1285.63

Manning-n Values: LOB: 0 CH: .035 ROB: 0



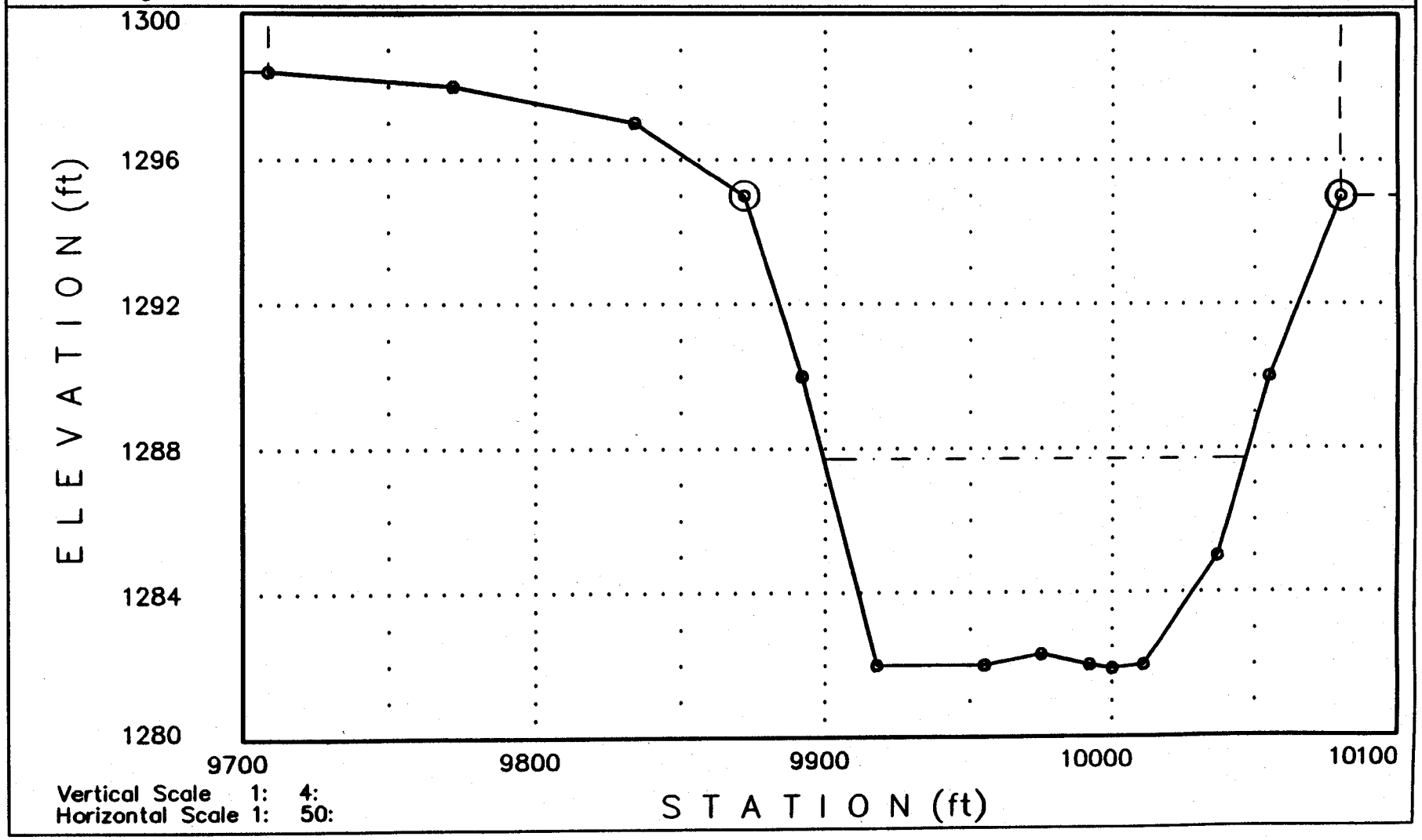
Vertical Scale 1: 4:
Horizontal Scale 1: 50:

09-10-1994

<<<<<< Cross Section: 288.47: (FN = H2SCSPR2.0) >>>>>>

Q1= 8780cfs WS1= 1287.72

Manning-n Values: LOB: 0 CH: .035 ROB: 0



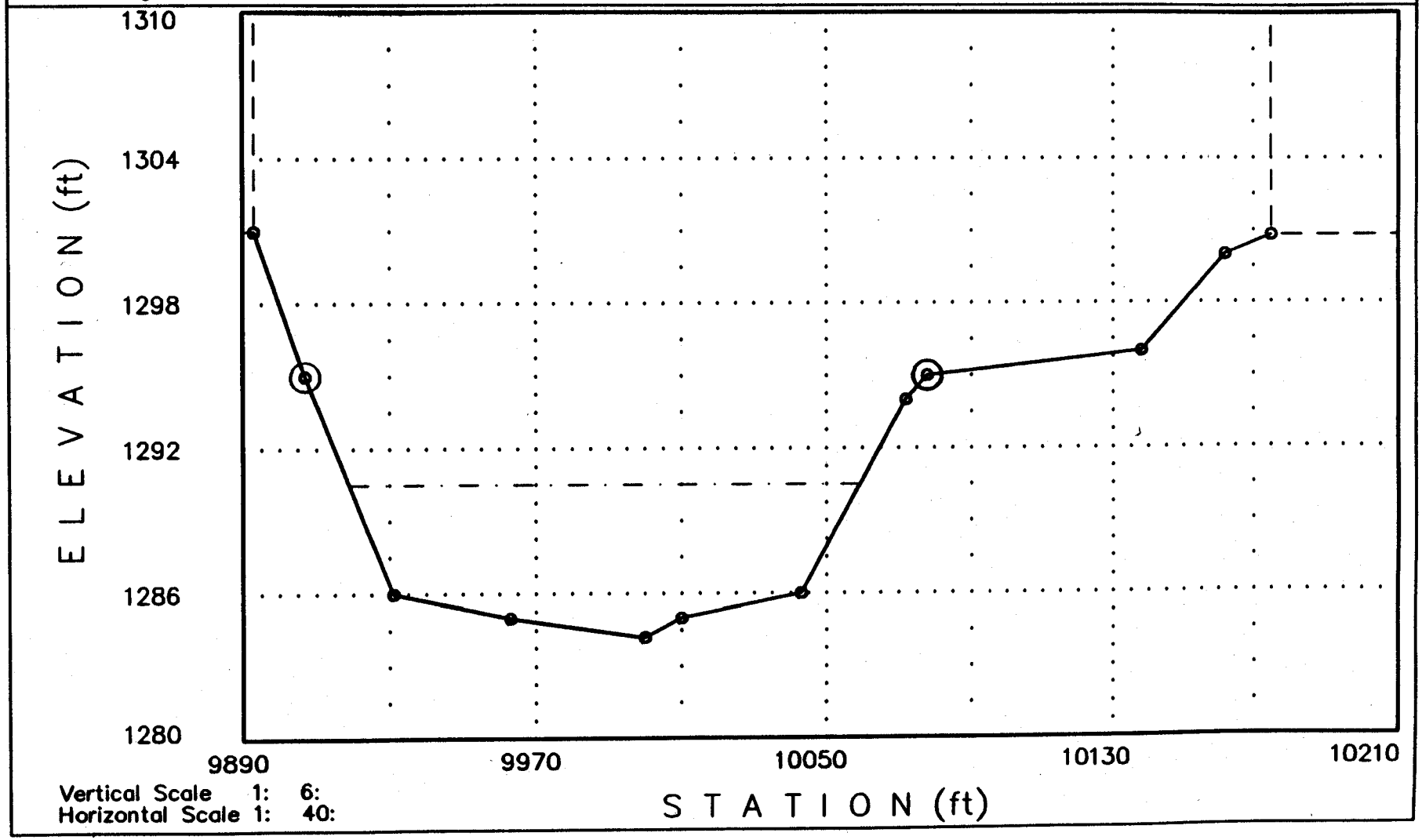
Vertical Scale 1: 4:
Horizontal Scale 1: 50:

08-19-1994

<<<<<< Cross Section: 291.72: (FN = H2SCSPR2.0) >>>>>>

Q1= 8754cfs WS1= 1290.5

Manning-n Values: LOB: 0 CH: .035 ROB: 0



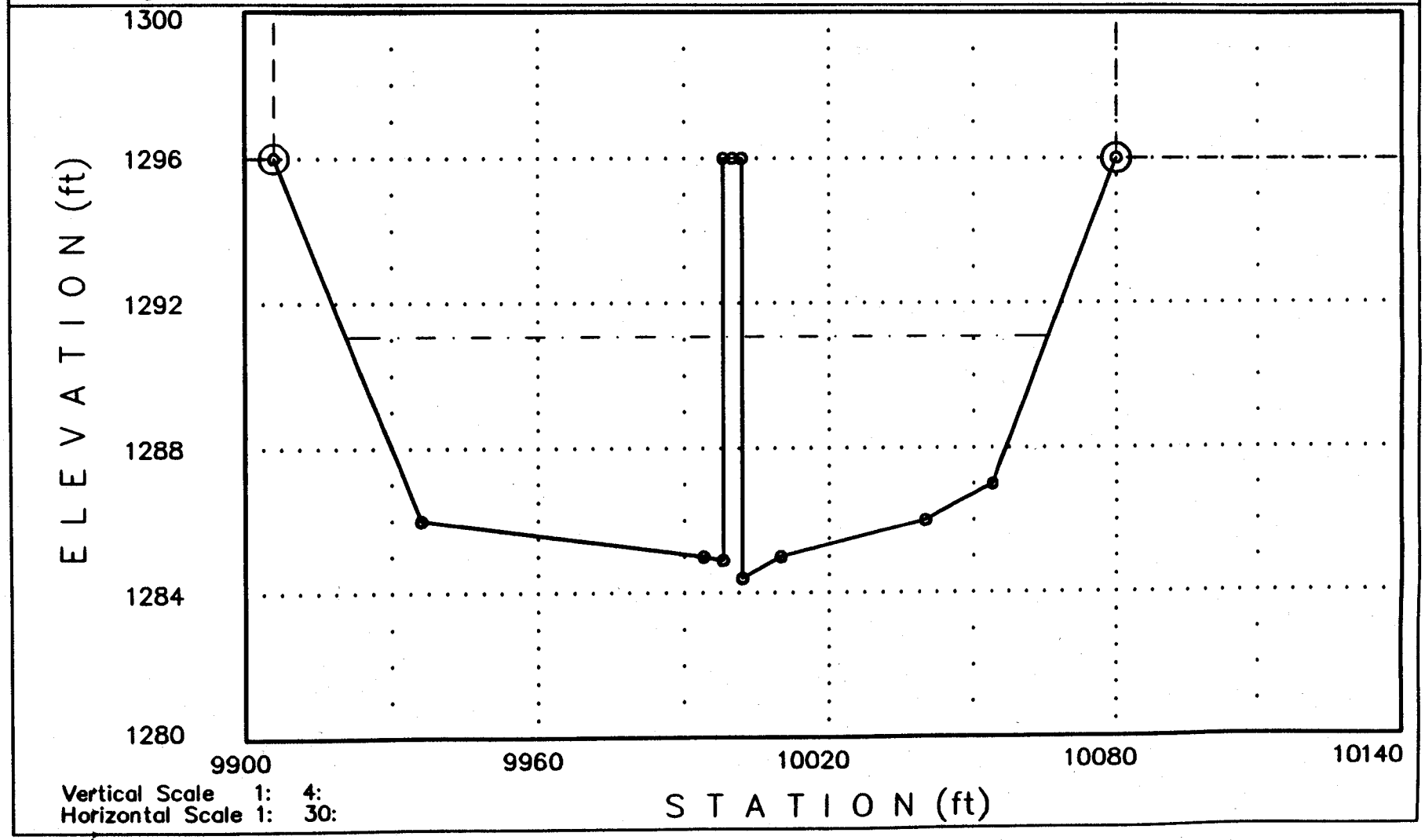
Vertical Scale 1: 6:
Horizontal Scale 1: 40:

08-19-1994

<<<<<< Cross Section: 292.05: (FN = H2SCSPR2.0) >>>>>>

Q1= 8750cfs WS1= 1291.08

Manning-n Values: LOB: 0 CH: .03 ROB: 0



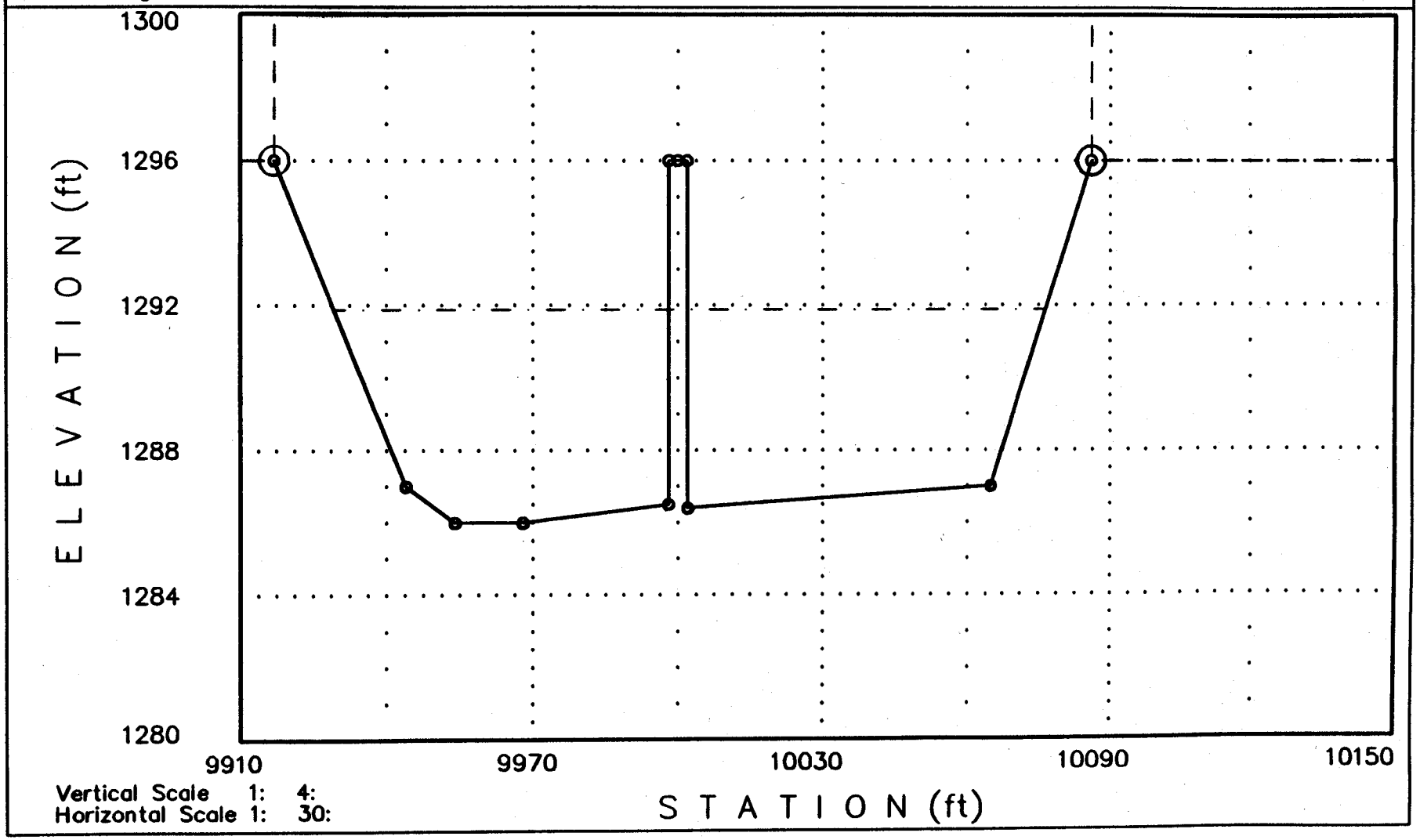
Vertical Scale 1: 4:
Horizontal Scale 1: 30:

08-19-1994

<<<<<< Cross Section: 293.05: (FN = H2SCSPR2.0) >>>>>>

Q1= 8750cfs WS1= 1291.88

Manning-n Values: LOB: 0 CH: .03 ROB: 0



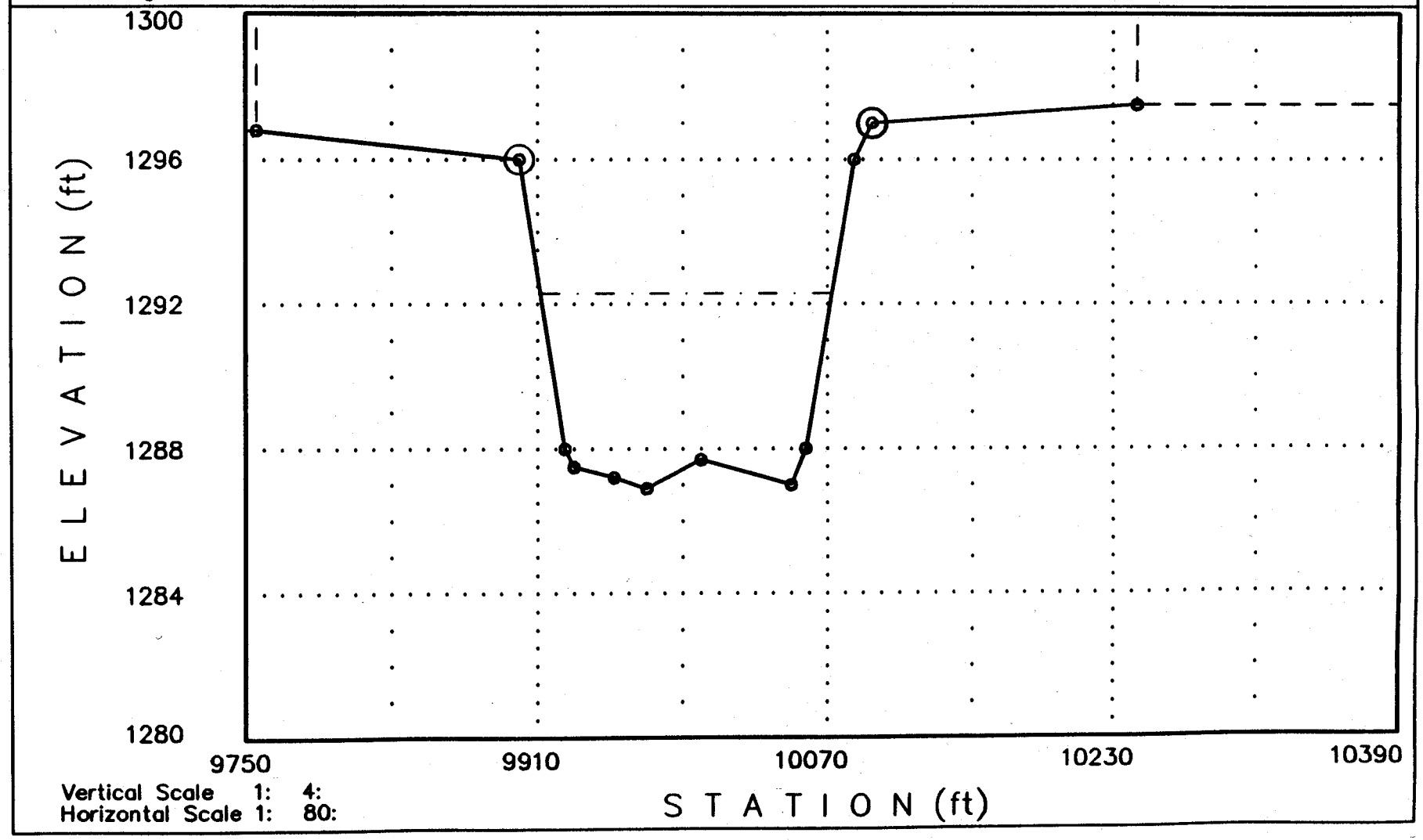
Vertical Scale 1: 4:
Horizontal Scale 1: 30:

09-19-1994

<<<<<< Cross Section: 294.32: (FN = H2SCSPR2.0) >>>>>>

Q1= 8723cfs WS1= 1292.3

Manning-n Values: LOB: 0 CH: .035 ROB: 0



Vertical Scale 1: 4:
Horizontal Scale 1: 80:

09-19-1994

Section II
Scour Analysis

Table 2
Summary of Local Scour Analysis

HEC-2 Cross Section	Flow Regime	100-Year Peak Discharge (cfs)	Flow Depth (ft)	Flow Velocity (fps)	Computed Local Scour Depth (ft)	Long Term General Degradation (ft)	Total Scour (ft)	Toe Down Design Depth (ft)
284.17	Subcritical	8832	7.0	4.0	3.3	2	5.3	6
286.07	Subcritical	8806	6.3	8.1	3.5	2	5.5	6
288.47	Transitional	8780	4.8	12.5	6.2	2	8.2	9
291.72	Supercritical	8754	4.9	13.2	6.5	2	8.5	9

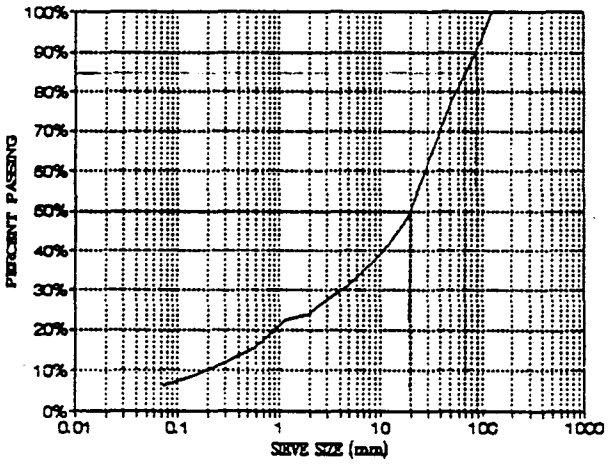
SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: CARMEL PARK--SKUNK CREEK
SOURCE: SAMPLE #1

JOB NO. LT92-3843
W.O. NO. 2
LAB NO. 4
DATE 9/21/92

SIEVE ANALYSIS ASTM D-422

SIEVE SIZE	PERCENT PASSING
5"	100%
4"	94%
3"	87%
2"	78%
1 1/2"	68%
1"	56%
3/4"	48%
1/2"	42%
3/8"	38%
1/4"	34%
#4	31%
#8	26%
#10	24%
#16	22%
#30	16%
#40	14%
#50	12%
#100	9%
#200	6.3%



Sample #1

D_{50} = 20 mm

D_{85} = 70 mm

D_{90} = 85 mm

Project Carmel Park / Skunk Creek
Project No. 92-0090
Sheet No. 1 of 4
Calculated by JM Date 9/21/94
Section 284.170 (Sub)

LOCAL SCOUR COMPUTATION SHEET

Equation Type	Application Description
A or B	Local scour in natural channels at bends, restrictions, or along bankline structures. Moderate Bend

GIVEN CONDITIONS:

Design Discharge-Q(cfs)= 8832.0 : Mean Flow Velocity---V(fps)= 4.0
Mean Water Depth-D(ft) = 7.00 : Channel Bottom Width-B(ft)= 280.0
D50(mm)= 20.0: D90(mm)= 85.0: D85(mm) = 70.0

SUMMARY OF COMPUTED LOCAL SCOUR DEPTHS(Ds):

Method	Equation	Local Scour(ft)
USBR(Abbott,1963)	Ds = 2.45(Q/B)^.24	n/a
Lacey Regime Eq.	Dm = .47(Q/f)^.33: Ds = Z Dm ..... (f = 1.76(D50)^.5):Z = 0.50)	2.4
Blench Eq.	Dfo = ((Q/B)^.667)/(Fbo^.33) Ds = Z Dfo:(Z = 0.60).....	3.9
Competent Vel. Eq.	Ds = D((V/Vc) - 1) ..... (Vc = 7.4 (fps))	n/a
Mean Vel.Eq.(USBR)	DS = Z D: (Z = 0.50)	3.5

CONCLUSIONS/RECOMMENDATIONS:

$$\overline{D_s} = \frac{2.4 + 3.9 + 3.5}{3} = 3.3'$$

REFERENCE:

Pemberton E. and Lara J., COMPUTING DEGRADATION AND LOCAL SCOUR, Bureau of Reclamation - Engineering and Research Center, Denver, Jan. 1984.

Project Carmel Park / Skunk Creek
Project No. 92-0090
Sheet No. 2 of 4
Calculated by JM Date 9/21/94
Section 286.070 (Sub)

LOCAL SCOUR COMPUTATION SHEET

Equation Type	Application Description
A or B	Local scour in natural channels at bends, restrictions, or along bankline structures. Moderate Bend

GIVEN CONDITIONS:

Design Discharge-Q(cfs)= 8806.0 : Mean Flow Velocity---V(fps)= 8.1
Mean Water Depth-D(ft) = 6.30 : Channel Bottom Width-B(ft)= 190.0
D50(mm)= 20.0: D90(mm)= 85.0: D85(mm) = 70.0

SUMMARY OF COMPUTED LOCAL SCOUR DEPTHS(Ds):

Method	Equation	Local Scour(ft)
USBR(Abbott,1963)	Ds = 2.45(Q/B)^.24	n/a
Lacey Regime Eq.	Dm = .47(Q/f)^.33: Ds = Z Dm ..... (f = 1.76(D50)^.5):Z = 0.50)	2.4
Blench Eq.	Dfo = ((Q/B)^.667)/(Fbo^.33) Ds = Z Dfo:(Z = 0.60).....	5.0
Competent Vel. Eq.	Ds = D((V/Vc) - 1) ..... (Vc = 6.9 (fps))	~~D~~ n/a
Mean Vel.Eq.(USBR)	DS = Z D: (Z = 0.50)	3.2

CONCLUSIONS/RECOMMENDATIONS:

$\overline{D_s} = \frac{2.4 + 5.0 + 3.2}{3} = 3.5'$

REFERENCE:

Pemberton E. and Lara J., COMPUTING DEGRADATION AND LOCAL SCOUR, Bureau of Reclamation - Engineering and Research Center, Denver, Jan. 1984.

Project Carmel Park / Skunk Creek
Project No. 92-0090
Sheet No. 3 of 4
Calculated by JM Date 9/21/94
Section 288,470 (Sub & Super)

LOCAL SCOUR COMPUTATION SHEET

Equation Type	Application Description
A or B	Local scour in natural channels at bends, restrictions, or along bankline structures. Moderate Bend

GIVEN CONDITIONS:

Design Discharge-Q(cfs)= 8780.0 : Mean Flow Velocity---V(fps)= 12.5
Mean Water Depth-D(ft) = 4.80 : Channel Bottom Width-B(ft)= 110.0
D50(mm)= 20.0: D90(mm)= 85.0: D85(mm) = 70.0

SUMMARY OF COMPUTED LOCAL SCOUR DEPTHS(Ds):

Method	Equation	Local Scour(ft)
USBR(Abbott,1963)	Ds = 2.45(Q/B)^.24	n/a
Lacey Regime Eq.	Dm = .47(Q/f)^.33: Ds = Z Dm ..... (f = 1.76(D50)^.5):Z = 0.50)	~~2.4~~ n/a
Blench Eq.	Dfo = ((Q/B)^.667)/(Fbo^.33) Ds = Z Dfo:(Z = 0.60).....	7.2
Competent Vel. Eq.	Ds = D((V/Vc) - 1) ..... (Vc = 6.0 (fps))	5.2
Mean Vel.Eq.(USBR)	DS = Z D: (Z = 0.50)	~~2.4~~ n/a

CONCLUSIONS/RECOMMENDATIONS:

$\overline{D_s} = \frac{7.2 + 5.2}{2} = 6.2'$

REFERENCE:

Pemberton E. and Lara J., COMPUTING DEGRADATION AND LOCAL SCOUR, Bureau of Reclamation - Engineering and Research Center, Denver, Jan. 1984.

Project Carmel Park / Skunk Creek
Project No. 92-0090
Sheet No. 4 of 4
Calculated by JM Date 9/21/94
Section 291.720 (Super)

LOCAL SCOUR COMPUTATION SHEET

Equation Type	Application Description
A or B	Local scour in natural channels at bends, restrictions, or along bankline structures. Moderate Bend

GIVEN CONDITIONS:

Design Discharge-Q(cfs)= 8754.0 : Mean Flow Velocity---V(fps)= 13.2
Mean Water Depth-D(ft) = 4.90 : Channel Bottom Width-B(ft)= 110.0
D50(mm)= 20.0: D90(mm)= 85.0: D85(mm) = 70.0

SUMMARY OF COMPUTED LOCAL SCOUR DEPTHS(Ds):

Method	Equation	Local Scour(ft)
USBR(Abbott,1963)	Ds = 2.45(Q/B)^.24	n/a
Lacey Regime Eq.	Dm = .47(Q/f)^.33: Ds = Z Dm ..... (f = 1.76(D50)^.5):Z = 0.50)	~~2.4~~ n/a
Blench Eq.	Dfo = ((Q/B)^.667)/(Fbo^.33) Ds = Z Dfo:(Z = 0.60).....	7.2
Competent Vel. Eq.	Ds = D((V/Vc) - 1) ..... (Vc = 6.0 (fps))	5.8
Mean Vel.Eq.(USBR)	DS = Z D: (Z = 0.50)	~~2.5~~ n/a

CONCLUSIONS/RECOMMENDATIONS:

$\overline{D_s} = \frac{7.2 + 5.8}{2} = 6.5'$

REFERENCE:

Pemberton E. and Lara J., COMPUTING DEGRADATION AND LOCAL SCOUR, Bureau of Reclamation - Engineering and Research Center, Denver, Jan. 1984.

Section III
Gabion Design

N:\920090\ADMIN\90-008RP.WP5

CVL

Table 3
Gabion Design Summary

Station	HEC-2 Cross Section	Flow Regime	100-Year Water Surface Elevation	Top of Lining Elevation	Freeboard (ft)	Toe Down (ft)
10+40[1]	Between 282.0 & 284.17	Subcritical	1287.37	1288.5	1.1	6
12+06	284.17	Subcritical	1287.39	1288.5	1.1	6
13+88	286.07	Subcritical	1287.11	1288.5	1.4	6
15+90	288.47	Transitional	1287.72	1290.8	3.1	9
18+17[2]	Between 288.47 & 291.72	Subcritical Supercritical	1290.30 1289.80	1293.0 1293.0	2.7 3.2	9

Bank lining consists of 9" thick Reno mattresses with 4" average stone fill. Toe down consists of 1.5′ high by 3′ wide gabion baskets stacked at a 1.5′ offset to obtain a 1:1 slope.

(1) Downstream end of bank stabilization.
(2) Upstream end of bank stabilization, end of existing soil cement.

CHECK FOR LINING - DESIGN DATA

Hydraulic parameters of flow

- Water level at the point considered	Y	= ft	7.0
- Average water velocity	Vm	= ft/s	4.0
- Allowable velocity for the base soil	Ve	= ft/s	2.95
- Froude number	F	=	.27
- Bed slope	i	= %	.16

Geometric parameters of section

- Bank slope at the point considered	Ô	= deg	26.6
- Multiplying factor for bends (·1)	K	=	1

Lining characteristics

- Average diameter for stone fill	dm	= ft	.33
- Unit weight of stone fill	pr	= lb/ft3	160
- Thickness of lining	t	= ft	.75

CHECK FOR LINING - RESULTS

Check for tractive forces (for Ô < 35)

- Actual shear stress	Ób	= lb/ft2	.523
- Critical shear stress	Óc	= lb/ft2	2.371

[Check satisfied (Ób<Óc)]

Check for water velocities

- Average water velocity	Vm	= ft/s	4.000
- Allowable critical velocity	Vc	= ft/s	14.832

[Check satisfied (Vm<Vc)]

Check for residual velocities under lining

- Average water velocity under lining	Vb	= ft/s	.895
- Max allowable velocity at bed-lining interface .	Ve	= ft/s	2.950

[Check satisfied : no filter is required]

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CHECK FOR LINING - DESIGN DATA

Hydraulic parameters of flow

- Water level at the point considered	Y	= ft	6.3
- Average water velocity	Vm	= ft/s	8.1
- Allowable velocity for the base soil	Ve	= ft/s	2.95
- Froude number	F	=	.63
- Bed slope	i	= %	.8

Geometric parameters of section

- Bank slope at the point considered	Ō	= deg	26.6
- Multiplying factor for bends (·1)	K	=	1

Lining characteristics

- Average diameter for stone fill	dm	= ft	.33
- Unit weight of stone fill	pr	= lb/ft3	160
- Thickness of lining	t	= ft	.75

CHECK FOR LINING - RESULTS

Check for tractive forces (for Ō < 35)

- Actual shear stress	Ób	= lb/ft2	2.354
- Critical shear stress	Óc	= lb/ft2	2.371

[Check satisfied (Ób<Óc)]

Check for water velocities

- Average water velocity	Vm	= ft/s	8.100
- Allowable critical velocity	Vc	= ft/s	14.832

[Check satisfied (Vm<Vc)]

Check for residual velocities under lining

- Average water velocity under lining	Vb	= ft/s	2.001
- Max allowable velocity at bed-lining interface .	Ve	= ft/s	2.950

[Check satisfied : no filter is required]

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Hydraulic parameters of flow

- Water level at the point considered	Y	= ft	4.8
- Average water velocity	Vm	= ft/s	12.5
- Allowable velocity for the base soil	Ve	= ft/s	2.95
- Froude number	F	=	1
- Bed slope	i	= %	.8

Geometric parameters of section

- Bank slope at the point considered	Ó	= deg	26.6
- Multiplying factor for bends (·1)	K	=	1

Lining characteristics

- Average diameter for stone fill	dm	= ft	.33
- Unit weight of stone fill	pr	= lb/ft3	160
- Thickness of lining	t	= ft	.75

CHECK FOR LINING - RESULTS

Check for tractive forces (for Ó < 35)

- Actual shear stress	Ób	= lb/ft2	1.793
- Critical shear stress	Óc	= lb/ft2	2.371

[Check satisfied (Ób<Óc)]

Check for water velocities

- Average water velocity	Vm	= ft/s	12.500
- Allowable critical velocity	Vc	= ft/s	14.832

[Check satisfied (Vm<Vc)]

Check for residual velocities under lining

- Average water velocity under lining	Vb	= ft/s	2.001
- Max allowable velocity at bed-lining interface .	Ve	= ft/s	2.950

[Check satisfied : no filter is required]

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E.O.S.C

CHECK FOR LINING - DESIGN DATA

Hydraulic parameters of flow

- Water level at the point considered	Y	= ft	5.7
- Average water velocity	Vm	= ft/s	13.0
- Allowable velocity for the base soil	Ve	= ft/s	2.95
- Froude number	F	=	1.1
- Bed slope	i	= %	.8

Geometric parameters of section

- Bank slope at the point considered	ô	= deg	18.4
- Multiplying factor for bends (·1)	K	=	1

Lining characteristics

- Average diameter for stone fill	dm	= ft	.33
- Unit weight of stone fill	pr	= lb/ft3	160
- Thickness of lining	t	= ft	.75

CHECK FOR LINING - RESULTS

Check for tractive forces (for ô < 35)

- Actual shear stress	ób	= lb/ft2	2.129
- Critical shear stress	óc	= lb/ft2	2.845

[Check satisfied (ób<óc)]

Check for water velocities

- Average water velocity	Vm	= ft/s	13.000
- Allowable critical velocity	Vc	= ft/s	14.832

[Check satisfied (Vm<Vc)]

Check for residual velocities under lining

- Average water velocity under lining	Vb	= ft/s	2.001
- Max allowable velocity at bed-lining interface .	Ve	= ft/s	2.950

[Check satisfied : no filter is required]

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