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STEHEKIN RIVER FLOODPLAIN MAPPING PROJECT

Riedel

February 1993

Stehekin River Floodplain Mapping Project, Lake Chelan National Recreational Area

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Technical Report NPS/PNRNOCA/NRTR-93/011

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I INTRODUCTION

A. Location and Description of the Stehekin River

This study of the Stehekin River floodplain was made between October 1990 and April 1992. It covers the lower 9.2 miles of the Stehekin River upstream from Lake Chelan in Chelan County Washington (Figure 1). In 1981 the Federal Emergency Management Agency (FEMA) published a flood zonation map for the lower 5.1 miles of the river, and in 1986 the U.S. Geological Survey (USGS) extended FEMA's map 1.5 miles further upstream (FEMA, 1981) (USGS, 1986). This study incorporates data from the earlier studies with data recently collected to develop a new floodplain map of the lower Stehekin River. The new map covers an additional 2.6 miles upstream from the previous maps.

The Stehekin River begins as the meltwater of glaciers high in the North Cascade Mountains near Cascade Pass. As it flows through a glacial U-shaped valley, major tributaries adding to the flow of the Stehekin River include Bridge Creek, Company Creek, Agnes Creek, Rainbow Creek, and Boulder Creek.

Within the study area, the river has two different reaches. Between the lake and approximately river mile (R.M.) 4 (Figure 2A), the river's gradient is generally under 30 ft/mile. In this reach the river has a few meander bends and a cobble and gravel bed. Above R.M. 4, the river gradient is generally over 50 ft/mile and the river bed is composed of cobbles and boulders (Figure 2B).

The Stehekin River ends at Lake Chelan. Lake Chelan is a natural lake 50 miles long and 1,650 ft deep. A dam constructed in 1927 added 20 ft to the level of Lake Chelan, giving it a modern full pool water surface elevation (WSEL) of 1099.9 ft (1982-1990 mean). The level of the lake fluctuates on an annual basis, with an average drawdown of 18 ft by late winter-early spring. Full pool is usually restored by early July.

Most of the Stehekin River watershed is within North Cascades National Park and Glacier Peak Wilderness. The part of the river studied in this report is within Lake Chelan National Recreation Area. The Stehekin Community is located primarily in the lower 6.6 miles of the valley on both sides of the river.

B. Purpose of study

The National Park Service undertook this study to provide basic data for the development of a General Management Plan for **federal land** in Lake Chelan National Recreation Area. If accepted by the local government, and the Federal Emergency Management Agency, this floodplain map could be used by valley residents in the National Flood Insurance Program. This study also will provide the basis for the development of a Stehekin River Management Plan by the NPS.

C. Scope of study

This study identifies the 100 and 500 year floodplains of the lower 9.2 miles of the Stehekin River above Lake Chelan. Those parts of the Stehekin River tributaries' floodplains on the valley bottom were taken directly from a FEMA work map. Fifty year floodplain boundaries were not determined.

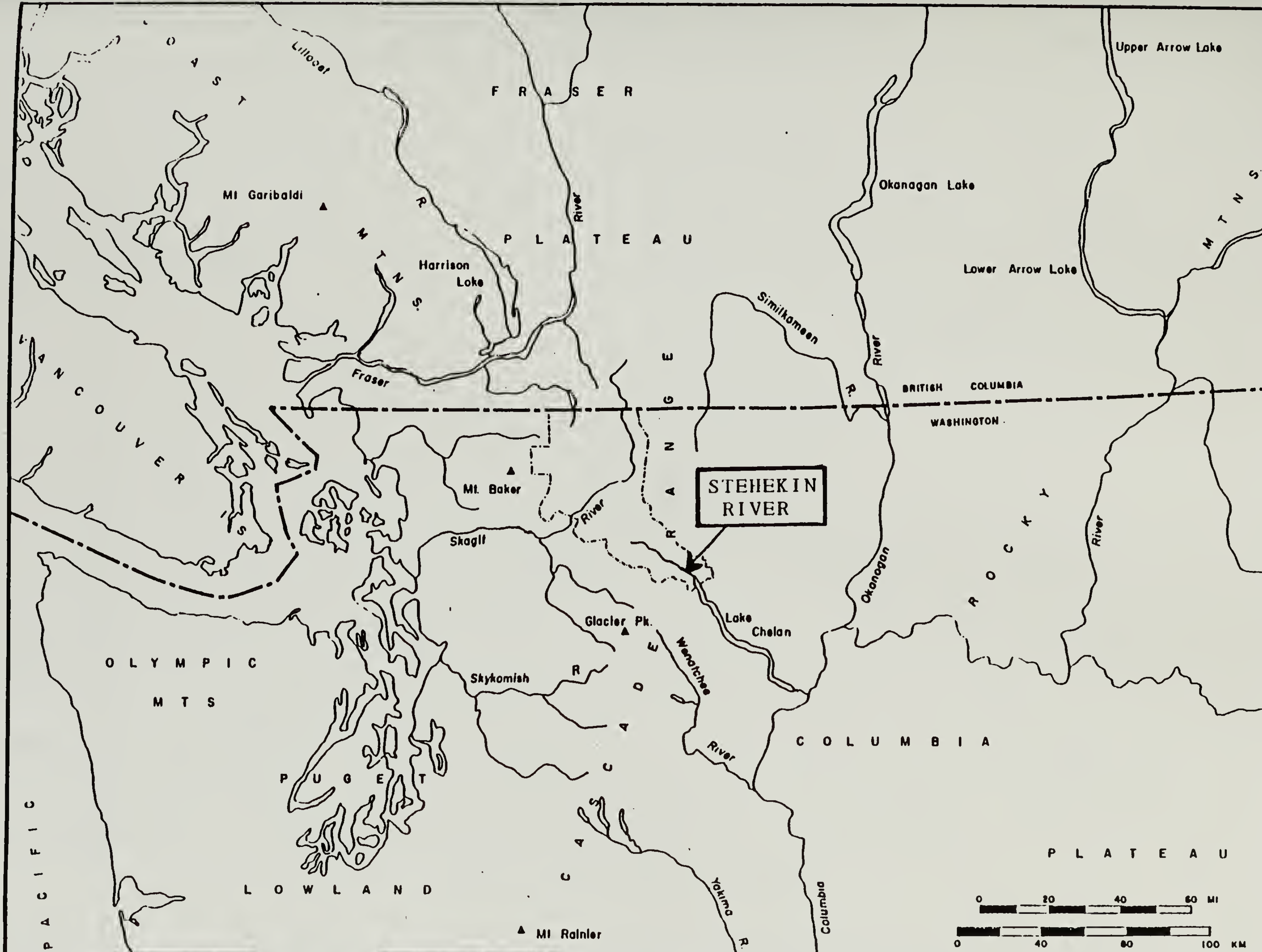

FIGURE 1. GENERAL LOCATION OF THE LOWER STEHEKIN RIVER IN THE PACIFIC NORTHWEST.

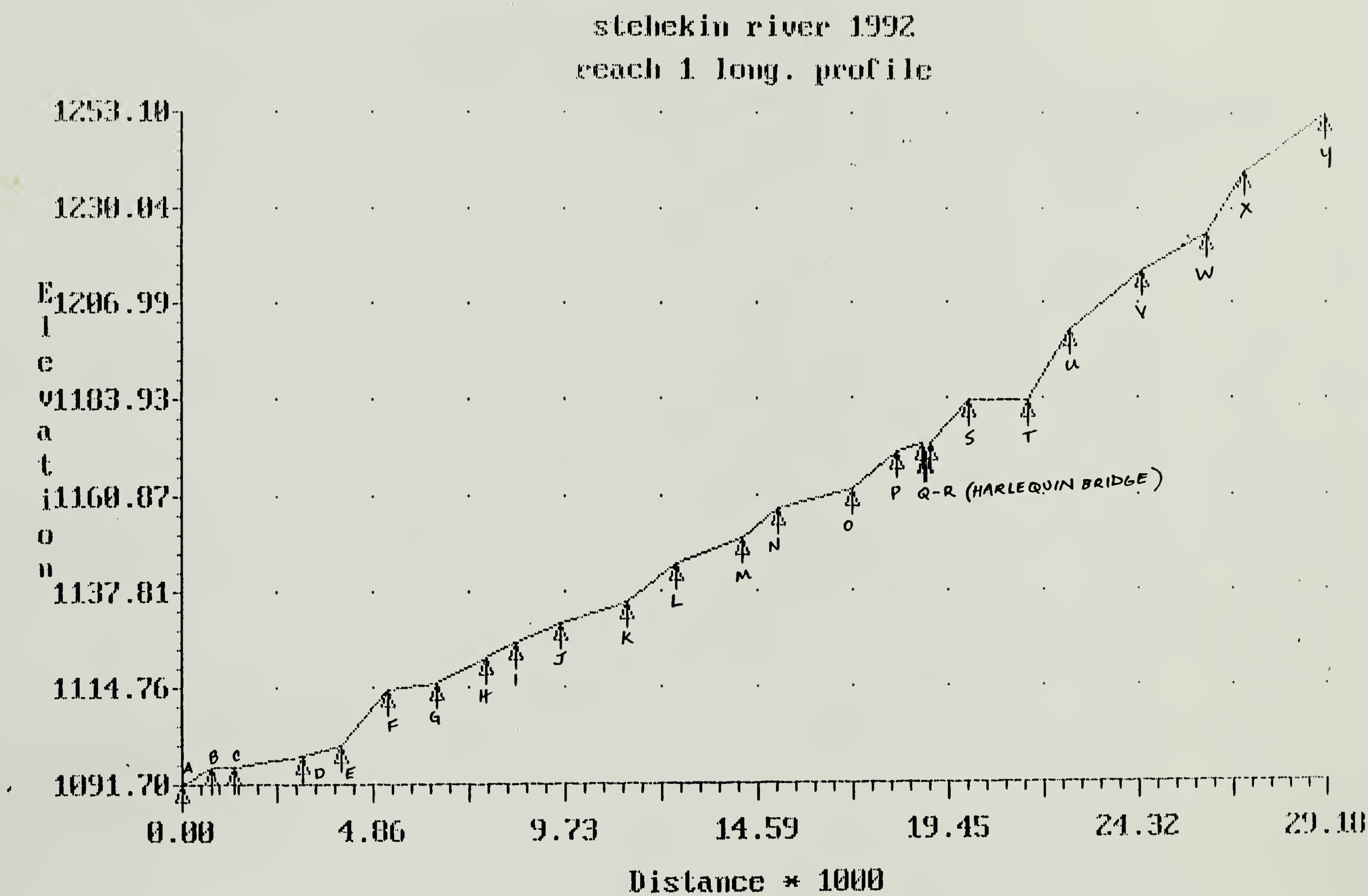

FIGURE 2A. LONGITUDINAL PROFILE AND CROSS SECTION LOCATIONS ALONG REACH 1 OF THE LOWER STEHEKIN RIVER.

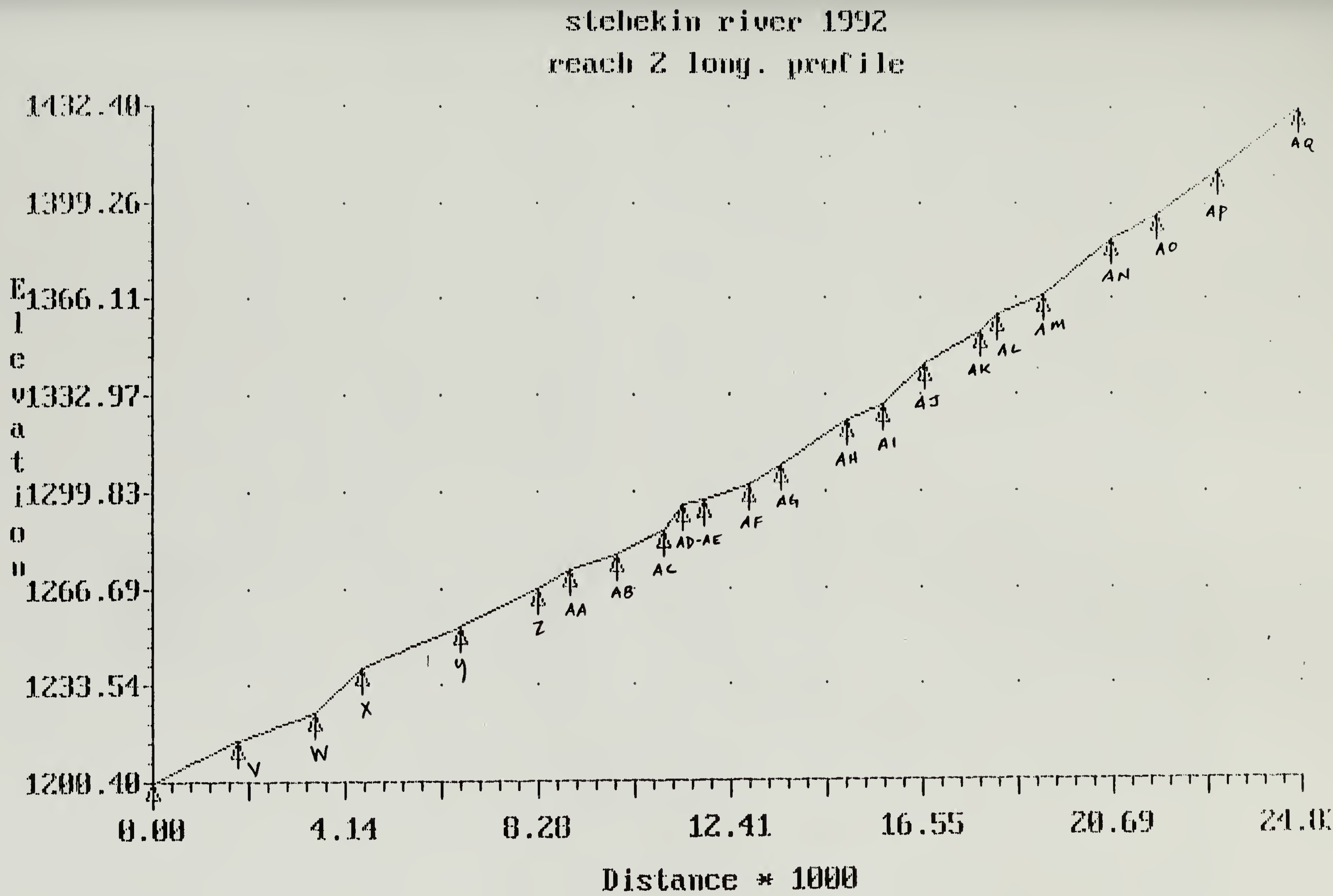

FIGURE 2B. LONGITUDINAL PROFILE AND CROSS SECTION LOCATIONS ALONG REACH 2 OF THE LOWER STEHEKIN RIVER.

II PREVIOUS FLOODPLAIN STUDIES

A. Federal Emergency Management Agency, 1981

In 1981 the Federal Emergency Management Agency (FEMA) published a floodplain map of the lower 5.12 miles of the Stehekin River Valley. FEMA contracted with CH2M Hill of Seattle to conduct the floodplain study. A 1976 version of the HEC2 step-backwater computer model was used to determine the boundaries of the Stehekin River floodplain. The contractor surveyed 23 cross-sections in the lower Stehekin Valley in October of 1975 (Figures 2A and 3A). Based on available records of this study, tributary floodplains were not modelled, but based on rough estimates by the contractor.

B. U.S. Geological Survey - Water Resources Division, 1986

The U.S. Geological Survey (USGS, 1986) Water Resources Division from Tacoma, Washington extended the FEMA floodplain map 1.45 miles upstream. The USGS field surveyed 7 cross-sections between river miles 5.12 (W) and 6.57 (AD) in September, 1982 (Figures 2B and 3B). They also used the same 23 cross-sections and flood discharge data as CH2M Hill did in the FEMA study. Although the USGS used a different backwater model than HEC2 to analyze flood flows on the Stehekin, their flood surface profile was found to be "nearly identical" to the one FEMA published in 1981 (see results for profile comparison).

The USGS (1986) reviewed changes in the Stehekin River channel and assessed the accuracy of the FEMA cross-sections. However, the USGS model and data, based in large part on the FEMA cross-sections, was not available from the USGS Water Resources Branch in Tacoma.

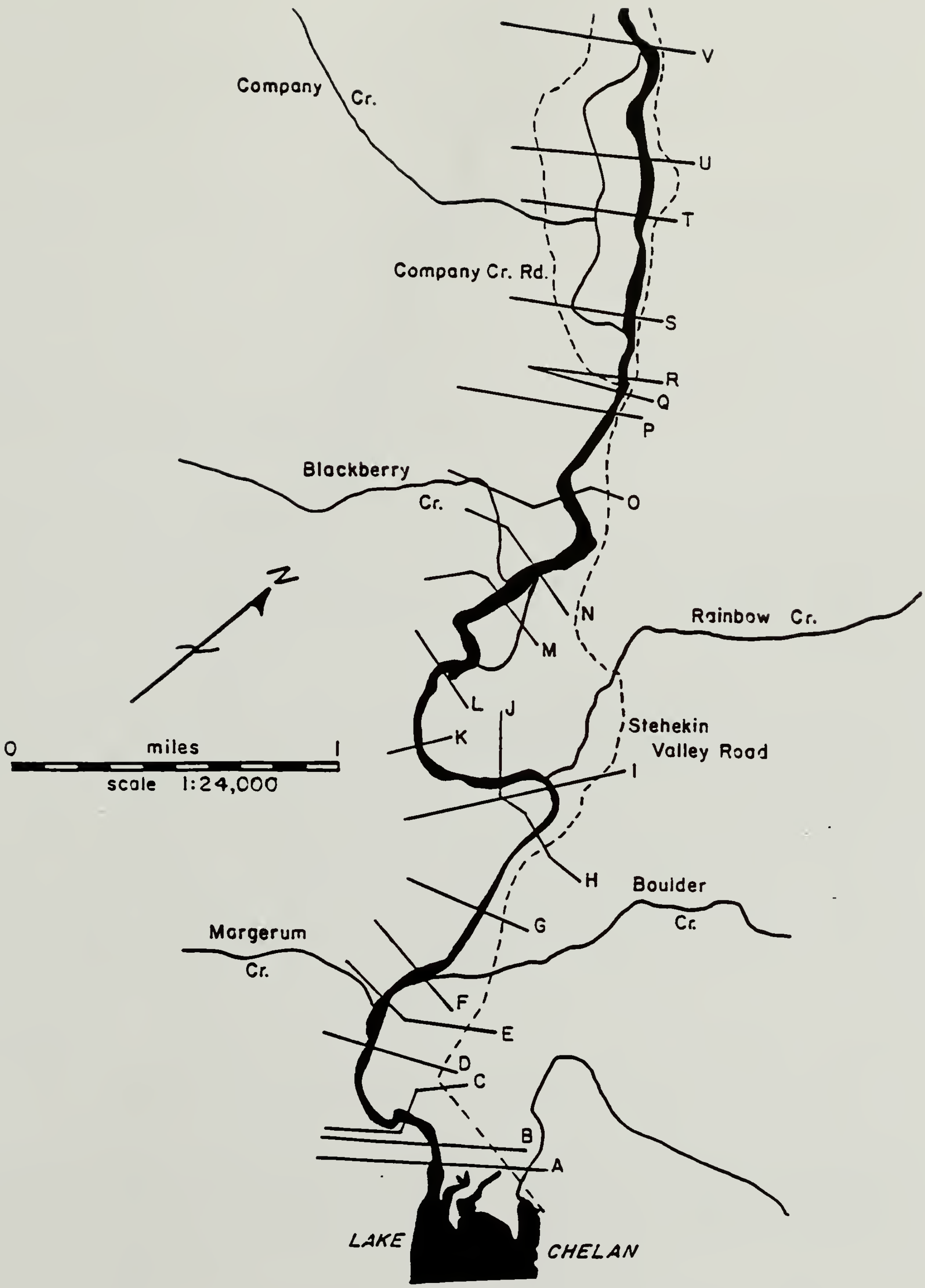

FIGURE 3A. LOCATION OF CROSS SECTIONS ON REACH 1 OF THE LOWER STEHEKIN RIVER.

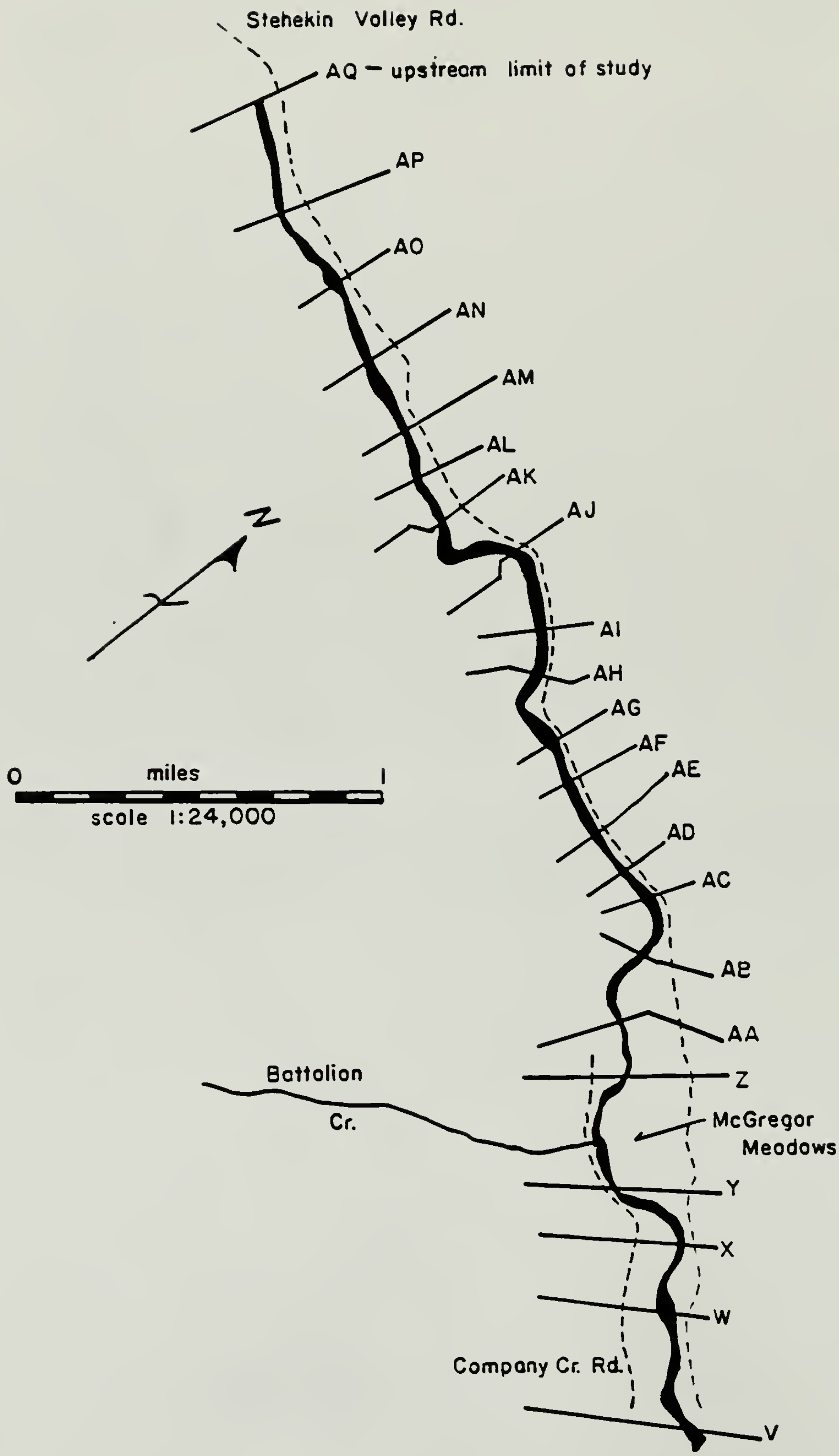

FIGURE 3B. LOCATION OF CROSS SECTIONS ON REACH 2 OF THE LOWER STEHEKIN RIVER.

III ACCURACY OF COMPUTED WATER SURFACE PROFILES AND FLOODPLAIN MAPS

This floodplain study uses a computer program called HEC2 to estimate the water surface elevation of various magnitude floods. HEC2 was developed by the U.S. Army Corps of Engineers at the Davis, California Hydraulic Enginnering Center.

In reviewing the accuracy of water surface profiles computed with HEC2, the U.S. Army Corps of Engineers Hydrologic Engineering Center (U.S.A.C.E, 1986) identified two main factors that control profile accuracy. These factors are accuracy of floodplain geometry measurements and hydraulic roughness estimates.

Floodplain geometry measurements based on field surveys were found to be the most accurate. Floodplain geometry measurements from topographic maps caused inaccuracy in computer models that used them. Further, model accuracy decreased indirectly as the contour interval of the topographic maps used increased.

The 1986 HEC study found that when conventional field surveys are used, errors in the computed water surface profile were a function of hydraulic roughness estimates. Accurate estimates of hydraulic roughness are difficult even when using standard procedures such as field reconnaissance and calibration. In the 1986 HEC study, estimates of hydraulic roughness varied more as roughness increased.

Flood water elevation is a complex, dynamic phenomenon. In order to compute flood water elevation, computer models must make several assumptions - some of which are false. The most critical false assumption made by all step-backwater computer models is that the bed and banks of the stream are immobile. Recent research suggests that for high-gradient streams in the pacific northwest, the bed and banks of streams become mobile during 50 year or greater magnitude floods (Grant et al., 1990). Despite the false assumptions made by HEC2, this program represents the best method available to determine floodplain boundaries and it is widely used in the United States.

IV METHODOLOGY

A. Use of FEMA (1981) and USGS (1986) Cross Sections

Channel changes affecting FEMA and USGS cross section accuracy were reviewed in this study by several methods. First, aerial photographs taken in 1978 were compared to a set taken in 1988. Second, bank recession measurements were gathered from the 1986 USGS study, field surveys and resident interviews.

Overall, the channel of the Stehekin River has been stable over the last 10 years. At several cross sections, however, erosion on the outside of meander bends has modified channel cross section geometry since 1978. Changes to FEMA cross-sections are summarized in Table 1 and shown on the cross-sections in Appendix C. No changes were made to the USGS cross sections. Data was entered into HEC2 directly from the cross section notes taken by the USGS.

Several survey errors in the FEMA study were discovered, which resulted in some inaccurate cross-sections. Where these inaccuracies were found, the cross-sections were modified using a 10 ft contour map and then field checked.

B. Mapping and Survey of Cross Sections AC through AQ

In addition to the 23 cross-sections surveyed by FEMA and the 7 surveyed by the USGS, 13 additional cross sections were surveyed between RM 6.57 and 9.20. Cross-section geometry was measured to the nearest 0.1 ft with a Bausch and Lomb level and 25 ft fiberglass rod in September, 1990. Elevations were tied into temporary datums near cross-sections AN and AF. Cross-sections were laid out along the Stehekin Valley road and plotted on a 1:6,000 scale mylar topographic map with a 10 ft contour interval.

FEMA (1981) cross-sections were plotted onto the mylar work maps by overlaying the basemaps on the 1;6,000 scale FEMA work maps. River mile location and channel distance between cross sections were measured from the work maps. Due to river thalweg lengthening caused by meander loop development, the river mile location of the cross sections increased from those published by FEMA (1981) and the USGS (1986).

TABLE 1. SUMMARY OF MODIFICATIONS TO FEMA CROSS SECTIONS

CROSS-SECTION ---	SUMMARY OF MODIFICATIONS
A	adjusted left over bank geometry along valley wall
B	removed large hill on FEMA xs, expand channel by 50 ft into left bank
H	expanded left bank of channel 24 ft
I	expanded left bank of channel 60 ft
J	modify channel geometry
Q	corrected 10 ft survey error on right over bank near NPS maintenance yard, this xs also used for overbank geometry around Harlequin Bridge
BR	used original US Forest Service drawings of Harlequin bridge for bridge opening geometry

Cross sections were located at changes in bed slope and where channel geometry changed significantly (meander loops, channel constrictions and enlargements, etc.). Jarret (1985) recommends that cross sections be spaced approximately 75 to 100 times mean depth. On the Stehekin River mean depth for the 100 year flood is approximately 11 ft. Therefore, cross section spacing should be 825 to 1100 ft. In the 1986 USGS study cross section spacing (W to AD) averaged 1107 ft, whereas cross section spacing from AD to AQ averaged 987 ft.

C. Hydrology

Floodplain studies usually focus on large floods that occur on average once during 50, 100 and 500 year periods (recurrence interval). Recurrence interval represents the long-term average period between floods of a particular magnitude. A 50 year flood has a 2 percent chance of being equalled or exceeded during any given year, while the 100 year flood has a 1 percent chance and the 500 year flood a 0.2 percent chance of occurring. However, because climatic factors that produce large floods can often persist, it is possible that rare floods could occur within shorter (than average) intervals - or even within a single year (FEMA, 1981). The likelihood of a rare flood increases when longer periods of time are considered.

Stehekin River floods can occur at three times a year. Summer floods occur during thunderstorms and associated intense rainfall. These floods usually effect areas less than 10 square miles (FEMA, 1981). Due to the size of the Stehekin watershed (344 square miles), these floods effect tributary streams more than the Stehekin River.

Spring floods occur in May or June because of snowmelt. The magnitude of these floods varies depending upon winter snowpack and spring weather (rain, freezing level, temperature). Since 1950 the average peak daily spring flood is 8,891 cfs. Spring flood extremes are 16,400 cfs in May 1948 and 4,700 cfs in May 1979.

Floods on the Stehekin River can also occur in the late fall to early winter period (Table 2). The Thanksgiving flood of November 1990 occurred because of a large magnitude precipitation event associated with unusually warm temperatures (high freezing level) and a pre-existing heavy snowpack.

The Stehekin River has been gaged by the U.S. Geological Survey since 1911, although no data was collected between 1917 and 1926. Based on this long record of discharge measurement, the amount of water the river carries during 10 year and 50 year floods is well established (Tables 2 and 3). Discharge for larger floods, such as 100 year and 500 year events, are less well established because they have never been measured at the gage.

Peak discharge frequency was determined in 1979 for the FEMA study using a log-Pearson III frequency analysis. In 1986 the USGS checked the 1979 frequency analysis and determined it had changed "insignificantly ". This study used the same estimated 100 and 500 year discharge as FEMA (1981) and the USGS (1986). Drainage area ratios were used to adjust (decrease) discharge upstream from the gage (Table 3).

TABLE 2. LARGEST FLOODS ON RECORD FOR THE STEHEKIN RIVER

DATE	PEAK DISCHARGE @ GAGE (cubic feet per second)	APPROXIMATE RECURRENCE INTERVAL
05-29-1948	18,900	90 yr.
06-21-1950	13,500	10 yr.
06-21-1967	13,900	10 yr.
06-02-1968	14,400	10 yr.
06-10-1972	14,400	10 yr.
06-16-1974	16,600	25 yr.
11-24-1990	14,700	10 yr.

TABLE 3. PEAK DISCHARGE FOR 50, 100 AND 500 YEAR FLOODS ON THE STEHEKIN RIVER (SITE # 12451000).

X.S.-	DRAINAGE AREA	PEAK DISCHARGE (cfs)		
river mile	--sq. miles--	50 yr.	100 yr.	500 yr.
MOUTH - 0	344	17,900	19,200	22,100
J - 2.0	308	16,500	17,700	20,300
U - 4.46	277	15,200	16,300	18,800
AE - 6.73	256	13,920	14,928	17,217

D. Hydraulics

As discussed in the introduction, the Stehekin is hydraulically two different rivers within the study reach. Between Lake Chelan and approximately river mile (R.M.) 4, the river's gradient is generally under 30 ft/mile (Figure 3A). In this reach the channel morphology is meandering and has a sand and gravel bed. Above R.M. 4, the river gradient is generally over 50 ft/mile and the river bed is composed of cobbles and boulders (Figure 3B). Channel shape in this reach is classified as an island-bar channel (Schumm and Brackenridge, 1987).

Hydraulic roughness estimates used were generally higher than those used by FEMA (1981). Values for hydraulic roughness used in the USGS study were not available. Higher hydraulic roughness estimates were used because recent work by the USGS suggests that roughness is higher in densely vegetated overbank areas than was believed at the time of the FEMA study (Arcement and Schneider, 1987)(Prych, 1988)(Jarret, 1985).

Hydraulic roughness was estimated for this study using a procedure originally developed by Cowan (1956), modified by Aldridge and Garrett (1973) and further modified by Arcement and Schnieder (1987). Base N values were determined using Barnes (1967) and checked by calculating the channel N value at the USGS gage. Appendix D details the hydraulic roughness estimating procedure for each cross-section.

Flow regime was not modelled at supercritical in the steeper upper reach of the Stehekin River. Recent investigations by the USGS (Jarret, 1984)(Trieste, personal communication, 1992) show that supercritical flow <u>does not</u> occur in natural channels of high gradient streams (>.002). According to Jarret's research, energy dissipated by the mobility of the bed and banks of the river keeps flow in a subcritical regime.

The sensitivity of WSEL and the Froude number calculated by HEC2 to channel hydraulic roughness was tested at each cross section. Increasing channel roughness from .045 to .05 decreased the Froude number to less than 1 at every cross-section, but had minor effects on WSEL.

E. Modelling

The September, 1990 version of HEC2 was used for calculation of the 100 and 500 yr. floodplain of the Stehekin River and to assess high flood hazard areas. After data was entered into the program, the arrangement and values of data were checked using the Edit2 sub-program and visually. When the program was edited so that all error messages were removed, the HEC2 program was run. By the time of this report some 20 data sets were developed, edited and run on HEC2. The results given below are based on one and a half years of model refinement. All of the models used in calibration, testing of conditions and final modelling are listed by file name in Table 4.

The first step of modelling was to use data from FEMA and the USGS to rebuild their 1981 and 1986 models (file STEHEK6.DAT). Building of the final model entailed modification of FEMA cross section data, estimation and adjustment of hydraulic roughness values, measurement of channel distance and bank stations, and addition of 13 upstream cross-sections.

Richard Hayes of the HEC in Davis, California, Joe Webber of the Seattle FEMA office, Bruce Stoker of Ebasco Environmental in Seattle and Bob Jarret of the USGS in Denver offered valuable suggestions with modelling. This floodplain study was reviewed and approved by the Water Resources Division of the National Park Service.

TABLE 4. HEC2 DATA INPUT FILES (ON DISKETTE).

FILENAME	CONTENTS
STEHEK6.DAT	FEMA data set
STEHEK22.DAT	supercritical profile XS O - AC
STEHEK24.DAT	supercritical profile XS AA - AQ
STEHEK31.DAT	subcritical profile for entire study reach
STEHEK33.DAT	subcritical profile with drawdown analysis
STEHE500.DAT	reach 1 final data set
STEHE502.DAT	reach 2 final data set
CALIBRAT.DAT	calibration of model at gage

1. Split Flow

An attempt was made to model split flow at two locations along the Stehekin River. Between cross sections AN-AI and O-L, where large secondary channels carry significant amounts of flood water, split flow modelling was attempted, but failed. The results were not used because cross section spacing was too far apart and the secondary channels too short for significantly different WSELs to develop between the main channel and the secondary channels.

2. Woody Debris Accumulations

Woody debris accumulations (WDAs) play a significant role in the geomorphology of and flooding on the Stehekin River. The US Army Corps of Engineers removed WDAs along the lower two miles of the river in 1975 to ease flooding. In a 1988 study over 100 individual WDAs were identified and mapped along the Stehekin (Appendix E). The WDAs are located in the main channel, at bends in the river, at the head of side-channels and at the upstream ends of bars and islands. Because of the unpredictable instability of WDAs during large floods, their effect on flood height was not analyzed. WDAs probably increase flood height by increasing hydraulic roughness and restricting flow from the main channel into side channels. Therefore, this model probably underestimates flood height by not considering WDAs.

3. Side Channels

Over 61 side channels were analyzed for blockage by WDAs within the study reach. In total, 26 of the 61 channels are blocked by WDAs. Because the stability of WDAs are so unpredictable - especially during large floods - all of the channels were left open in the model. The effect of WDA blockage on flood discharge was limited to the affect they had on hydraulic roughness. Therefore, considering all of the side-channels were left open, this model probably underestimates the actual WSEL for a 100 yr. flood.

4. Lake Chelan Levels

Lake Chelan is the base level for the Stehekin River. The natural depth of the lake is 1,600 ft. In the 1920s a dam added 22 ft to the lake's surface elevation. Its pool elevation fluctuates approximately 18 ft annually. Average low pool elevation occurs in May. Average full pool elevation is 1099.92 ft, is usually reached in June and persists until drawdown begins in September.

The annual cycle of lake levels was analyzed to determine its influence on 100 yr. flood WSEL at the mouth of the river. A model was constructed that used a cross-section in the drawdown of Lake Chelan at the mouth of the river to determine if floods that occurred during Lake Chelan drawdown had lower WSELs than floods during full pool at the river mouth (see file stehek33.dat). Several runs were made using different lake levels of lake Chelan as starting WSELs for the model.

5. Calibration

Several factors prevented good calibration of the model. First, the remote location and sparse development along the Stehekin River meant no historic data exists documenting floods. Nobody in the valley today can provide detailed information on the 1948 flood, although a few spot elevation estimations were recorded. Further, no large floods have occurred on the Stehekin since 1948 (Table 2). Recollections of floods in 1974 were better, and aided in checking the calculated WSEL at several cross sections. The opportunity to use the 1990 flood to calibrate the model was missed.

Other than checking calculated WSELs by interviewing valley residents and comparing WSELs to the FEMA and USGS studies, two other methods were used to calibrate the model. Calibration was made by comparing known WSELs based on the June 6, 1989 rating curve at the USGS gage (see file calibrat.dat). Water surface elevations at cross section G (R.M. 1.39) for discharges of 800cfs, 2000cfs and 5000cfs were compared to gage heights for corresponding discharges at the USGS gage (Table 5). At all three discharges the model agreed with the USGS gage height within a few tenths of a foot.

An additional test made on the accuracy of this model was to compare model-predicted WSEL with geomorphic features of the landscape. For example, if the model is accurate, breaks in slope at the edge of the channel and terraces should generally correspond to the WSEL for frequently occurring flood discharge.

TABLE 5. COMPARISON OF MODEL PREDICTED WSEL AT X.S. G AND USGS GAGE HEIGHT FOR THREE DISCHARGES.

DISCHARGE (cfs)	MODEL WSEL	USGS GAGE WSEL
800	1119.65	1120.1
2,000	1121.23	1121.3
5,000	1123.72	1123.2

To test model accuracy, the mean annual peak spring flood was run through the model. At nearly every cross section there is good correspondence between model predicted flood elevation and geomorphic features of the floodplain. Figure 4 is an example of this method of testing of model accuracy.

6. Mapping Floodplain Boundaries

Floodplain boundaries and high flood hazard areas were drawn on 1:6000 scale maps of the valley by locating the floodplain boundary along each cross-section. Boundaries between cross sections followed the topography as indicated on the 10 ft contour map and the 61 mapped secondary channels. Once mapped on the mylar work map, floodplain boundaries were entered into a GRASS Geographic Information System (GIS). An Altek hand-held digitizer and Sunview work station were used to load the data into the GIS.

V RESULTS AND DISCUSSION

The floodplain map produced in this study was plotted from a GIS. Original work maps are held at the National Park Service office in Marblemount. Data and output from this study are available on diskette upon request from the NPS.

Considering the accuracy of computed flood profiles, differences between the profile computed in this study versus the USGS and FEMA profiles are minimal. The difference between the profile computed in this study and the FEMA and USGS was a foot or so rise in WSEL, which is most likely due to higher overbank roughness values (Table 7). A hardcopy of the data set, flood water distribution on 43 cross sections and detailed output from this project is given for the two reaches of the Stehekin River in Appendices A, B, and C.

This floodplain map is more accurate in downstream areas than the FEMA (1981) and USGS (1986) maps for several reasons. First, FEMA and USGS maps were made without benefit of the 10 ft contour, 1:6000 scale map used in this study. Second, the new map was based on more accurate estimations of hydraulic roughness than the FEMA study. Third, several survey and data entry errors in the FEMA study were corrected. Fourth, recent studies by the USGS (Jarret,1985; Jarret and Trieste, 1987) have suggested better ways to model flood flows in natural channels.

Differences between water surface profiles computed by modelling flow as supercritical vs. subcritical in the upper reach of the river were generally minimal (see files stehek22.dat and stehek24.dat) (Table 6). At six locations the supercritical profile had a WSEL more than two feet less than the subcritical profile, including cross-sections T, V, Y, AE, AG, and AJ.

Annual fluctuations in the surface elevation of Lake Chelan did not have a significant effect on the flood profiles at the mouth of the river (see file stehek33.dat). At cross-section A (R.M. 0.15) the profile computed with Lake Chelan at low pool was less than a half foot below the profile computed with the lake at full pool.

Based on model results, the 500 yr. floodplain of the Stehekin River differs slightly from the 100 year floodplain. The reason why the 500 year and 100 year floodplain boundaries are so similar is that the Stehekin Valley is wide and flat at its lower end. Once floodwater spills out of the channel into overbank areas, it spreads laterally into the wide floodplain. Any increase in discharge once the river is already over its banks, therefore, is distributed over the wide valley and has minimal effect in WSEL.

At every cross section other than near the Harlequin Bridge, the 500 year WSEL is less than one ft above the 100 year WSEL. Because of the scale of the maps used, it was impossible to map the 500 year floodplain as distinct from the 100 year floodplain.

Areas of particularly fast or deep flood water adjacent to the main channel were mapped as a high flood hazard area (see floodplain map). They were mapped following the procedure described for the 100 year floodplain. The high flood hazard area represents several parts of the Stehekin River's 100 year floodplain. High flood hazard areas include those areas where flood water velocities were in excess of three feet per second, flood water depths were greater than six feet and areas in and adjacent to the main channel where rapid bank erosion and channel deposition could cause shifts in the main channel of the Stehekin River. Many secondary (flood) channels adjacent to the river were included in the high flood hazard area. The high flood hazard area is similar to the floodway concept used in the National Flood Insurance Program.

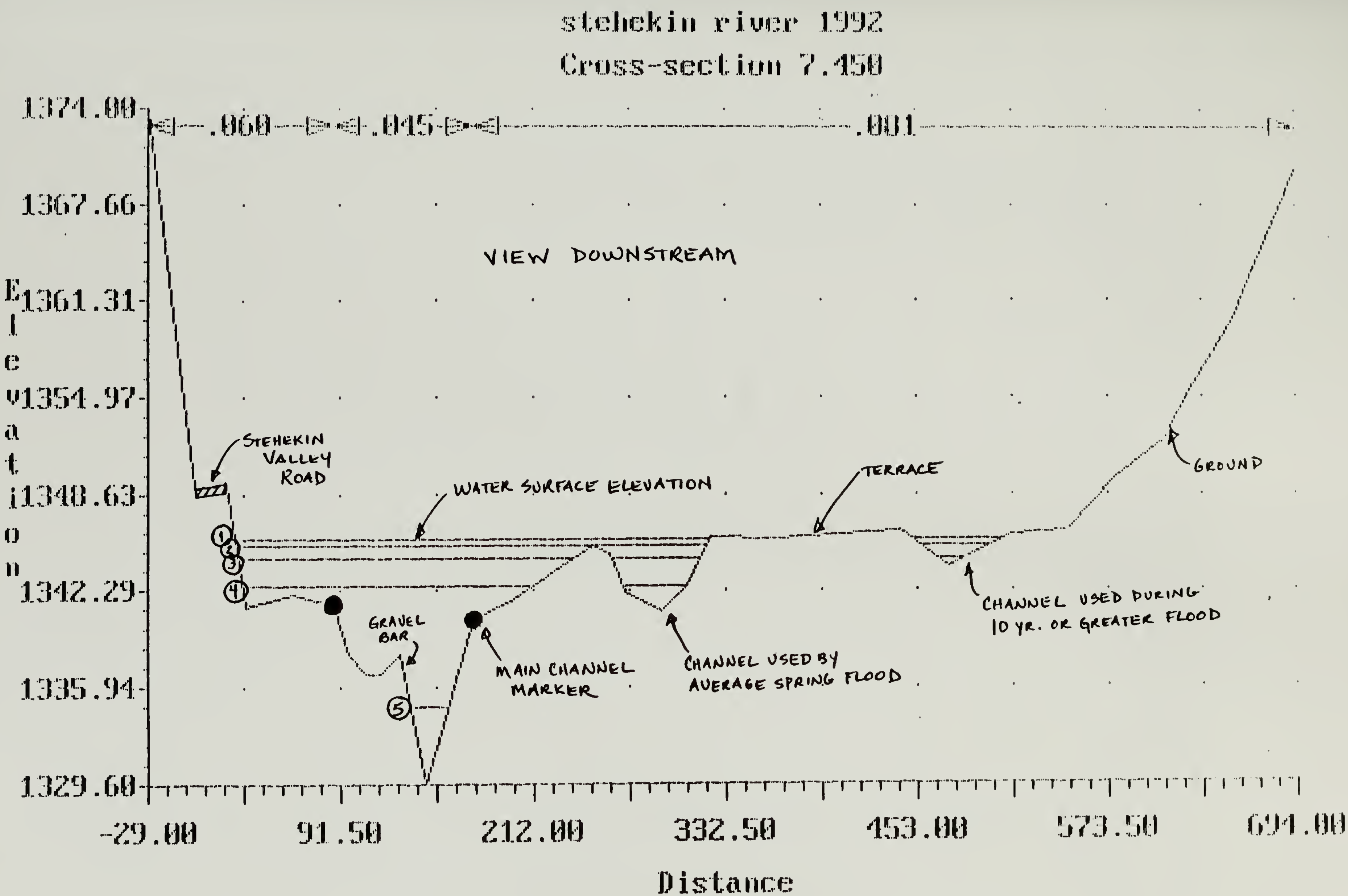

FIGURE 4. EXAMPLE OF THE MODEL-PREDICTED FLOOD LEVELS AND THEIR CORRESPONDENCE TO GEOMORPHIC FEATURES OF THE LANDSCAPE. FLOOD DISCHARGES ARE AS FOLLOWS: (1) 500 YR. FLOOD; (2) 100 YR. FLOOD; (3) 50 YR. FLOOD; (4) 10 YR. FLOOD AND (5) AVERAGE FALL LOW FLOW.

TABLE 6. COMPARISON OF SUPERCRITICAL AND SUBCRITICAL PROFILES FOR THE STEHEKIN RIVER ABOVE RIVER MILE 4.

CROSS SECTION	AND R.M.		SUPERCRITICAL WSEL (Froude > 1.0)		SUBCRITICAL WSEL (Froude < 1.0)
S	3.98		1194.1		1194.2
*T	4.26	*********	1193.5	**************	1198.6
U	4.46		1208.0		1208.4
*V	4.81	*********	1222.8	**************	1225.0
W	5.12		1236.3		1236.5
X	5.32		1250.6		1250.7
*Y	5.72	*********	1261.0	**************	1263.5
Z	6.04		1274.2		1274.0
AA	6.18		1281.2		1282.5
AB	6.38		1287.0		1288.6
AC	6.57		1293.5		1295.2
AD	6.64		1304.6		1303.4
*AE	6.73	*********	1305.3	**************	1308.9
AF	6.91		1312.2		1312.4
*AG	7.03	*********	1318.4	**************	1320.5
AH	7.30		1333.8		1333.8
AI	7.45		1345.0		1345.7
*AJ	7.63	**********	1349.9	*************	1352.7
AK	7.87		1363.3		1363.4
AL	7.93		1366.4		1367.4
AM	8.13		1373.8		1374.8
AN	8.42		1393.9		1393.9
AO	8.61		1404.0		1405.9
AP	8.86		1419.3		1419.3
AQ	9.20		1439.8		1439.9

TABLE 7. COMPUTED WATER SURFACE ELEVATIONS (WSEL) FOR STEHEKIN RIVER CROSS-SECTIONS (see mapset 1 for locations).

cross-section and RM	computed water surface elevation FEMA (1981)	USGS (1986)	NPS (1991)
A 0.15	1103.7	1103	1102.7
B 0.29	1105.4	1105	1106.4
C 0.42	1106.9	1106	1107.6
D 0.74	1113.3	1112	1112.3
E 0.93	1117.7	1119	1117.5
F 1.16	1123.0	1123	1124.3
G 1.39	1128.7	1129	1129.2
H 1.62	1131.8	1133	1133.1
I 1.78	1133.0	1134	1134.6
J 2.00	1136.2	1137	1137.4
K 2.30	1143.4	1143	1143.8
L 2.57	1152.1	1152	1153.2
M 2.89	1157.2	1157	1158.6
N 3.06	1164.3	1164	1163.9
O 3.42	1171.0	1172	1172.8
P 3.63	1177.8	1178	1179.9
Q 3.74	1184.5	1185	1184.5
BR 3.76			
BR 3.78	1186.6	1186	1188.2
BR 3.80			
S 3.98	1193.0	1190	1194.2
T 4.26	1197.5	1194	1198.6
U 4.46	1207.5	1208	1208.4

TABLE 7. COMPUTED WATER SURFACE ELEVATIONS (WSEL) FOR STEHEKIN RIVER CROSS-SECTIONS (see mapset 1 for locations).

cross-section and RM		water surface elevation FEMA (1981)	USGS (1986)	NPS (1991)
V	4.81	1126.7	1227	1225.0
W	5.12	1236.2	1237	1236.5
X	5.32	--	1251	1250.7
Y	5.72	--	1262	1263.5
Z	6.04	--	1274	1274.0
AA	6.18	--	1281	1282.5
AB	6.38	--	1287	1288.6
AC	6.57	--	1295	1295.2
AD	6.64	--	1304	1303.4
AE	6.73	--	--	1308.9
AF	6.91	--	--	1312.4
AG	7.03	--	--	1320.5
AH	7.30	--	--	1333.8
AI	7.45	--	--	1345.7
AJ	7.63	--	--	1352.7
AK	7.87	--	--	1363.4
AL	7.93	--	--	1367.4
AM	8.13	--	--	1374.8
AN	8.42	--	--	1393.9
AO	8.61	--	--	1405.9
AP	8.86	--	--	1419.3
AQ	9.20	--	--	1439.9

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APPENDIX A
HEC2 PRIMARY INPUT

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UMMARY OF ERRORS

1   HEC2 WATER SURFACE PROFILE FOR THE STEHEKIN RIVER -REACH 2
2   17 NOV. 1992 SUBCRITICAL PROFILE - 100 AND 500 YR. FLOODPLAIN
3   JON L. RIEDEL-NORTH CASCADES NATIONAL PARK
      5.720 - NOTE - GR RECORD - STA =    947.000 MINIMUM ELEVATION NOT WITHIN
                     CHANNEL

      6.040 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      6.180 - NOTE - GR RECORD - STA =    917.000 MINIMUM ELEVATION NOT WITHIN
                     CHANNEL

      6.180 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      6.380 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      6.570 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      6.640 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.030 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.300 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.450 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.630 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.870 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      7.930 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      8.130 - NOTE - GR RECORD - STA =    552.500 MINIMUM ELEVATION NOT WITHIN
                     CHANNEL

      8.130 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      8.610 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

      8.860 - NOTE - GR RECORD - IT IS RECOMMENDED THAT STATION NUMBERS
                     BE STRICTLY POSITIVE

     500 YEAR FLOODPLAIN FOR STEHEKIN RIVER (FILE STEHE502.DAT)
     STEHEKIN RIVER - REACH 2
     SUBCRITICAL RUN
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GR1366.5     431   1366.6     472   1363.7     483   1366.7     487   1365.7      51
GR1364.2   528.5   1365.1     557   1365.1   583.5   1366.4   641.5   1365.0    708.
GR1363.5     715   1364.6     724   1365.5     775   1365.5     845   1365.3    906.
GR1364.3     970   1362.8  1021.5   1361.6  1063.5   1361.9    1110   1360.8   1133.
GR1366.9  1136.5     1400    1186

NH     3     .10      0.1    .111      111     .14    137.5    .045      314     .09
NH 502.5    .045    567.5    .111      781      .1      974
X1  8.13      52    137.5     314     1025    1050     1025       0        0
GR1410.5    -341   1405.3  -296.5   1400.3  -247.5   1393.9    -182   1389.3     -13
GR1385.4     -51   1385.5   -19.5  1385.77     0.1   1378.5      31   1378.0     64.
GR1377.4     111   1378.1     117   1376.8   124.5   1372.9   137.5   1371.7    140.
GR1368.7     144   1368.2   160.5   1368.3   187.5   1368.3   210.5   1367.8    230.
GR1368.2   250.5   1369.0     269   1371.1     292   1371.7     304   1372.4      31
GR1372.7     329   1372.4     344   1370.6     354   1374.0   367.5   1373.6    392.
GR1373.8     424   1373.4     451   1371.6     469   1372.6     479   1370.1    502.
GR1368.2     514   1367.6   537.5   1366.9   552.5   1372.4   567.5   1374.8    577.
GR1374.9   632.5   1372.0   637.5   1375.2   644.5   1375.8     671   1375.7      78
GR1379.0   842.5   1381.2   877.5   1382.4     904   1386.3     914   1395.4    927.
GR1397.9     964   1400.5     974

NH     8     .05      585     .03    748.5    .146    805.5    .046     1100     .10
NH  1149    .045   1343.5    .115     1470    .135     1607
X1  8.42      44     1149  1343.5     1500    1450     1500       0        0
GR1432.1       0   1414.4   156.5   1410.1     323   1399.5     585   1402.1      61
GR1401.3     666   1400.9   748.5   1397.4     770   1397.1   790.5   1398.4    805.
GR1398.6     821   1399.7     851   1399.0   883.5   1397.7   903.5   1399.2      92
GR1402.1     943   1399.6    1006   1398.9    1056   1399.2    1078   1392.6     110
GR1392.7    1100   1394.2    1105   1392.6  1111.5   1393.1    1149   1390.6     116
GR1389.2    1170   1388.8    1193   1388.5    1210   1388.4  1228.5   1388.4     124
GR1388.2    1270   1387.8    1297   1387.7    1310   1387.3  1323.5   1386.7     132
GR1388.4  1332.5   1393.2  1343.5   1393.0    1357   1392.0    1384   1390.5     141
GR1389.0    1437   1387.3    1462   1391.4    1470     1450    1607

NH     8     .15    -17.5    .101       92    .045    223.5    .095    305.5     .05
NH 323.5    .126    436.5    .101      485    .125      655
X1  8.61      32       92   223.5     1000    1200     1003       0        0
GR1434.7  -202.5   1416.7    -158   1408.3    -140   1406.3   -65.5   1405.9      -1
GR1406.0       0   1406.2      47   1405.3      92   1399.5      95   1395.8    115.
GR1397.7     157   1398.5     167   1399.0     180   1400.6   198.5   1401.9    223.
GR1400.6   249.5   1398.7   279.5   1397.8   305.5   1397.9   323.5   1399.8    339.
GR1402.1   351.5   1405.2   376.5   1404.6     405   1402.6   436.5   1400.8    461.
GR1399.9     485   1408.7     545   1411.0     565   1410.0   593.5   1414.9      60
GR  1420     630     1430     655

NH     6    .106      251    .085    280.5    .095    318.5    .045    513.5      .0
NH 541.5    .095      793
X1  8.86      44    318.5   513.5     1400    1350     1320       0        0
GR1459.8    -492   1435.4    -430   1435.3    -430   1433.6  -393.5   1431.4     -30
GR1431.2    -276   1418.4    -237   1418.7  -172.5   1414.4    -162   1415.2     -13
GR1418.9  -126.5   1418.7   -54.5   1418.7      -3   1419.1       0   1419.2       1
GR1416.8    23.5   1418.5   107.5   1417.5   116.5   1418.9     129   1418.1      19
GR1417.5     251   1413.8     267   1417.7   280.5   1418.5   318.5   1416.2    328.
GR1414.4   343.5   1412.8     360   1412.3   373.5   1411.2     388   1411.8      42
GR1413.3     430   1414.9   443.5   1412.5     472   1414.2     495   1416.0    513.
GR1430.0   541.5   1431.8     565   1431.7   611.5   1431.0     655   1430.1    683.
GR1435.5   696.5   1455.0     743   1459.0     751   1474.0     793

NH     5     .15     55.5     .09      288    .095    479.5    .045    665.5      .0
NH1318.5
X1  9.20      54    479.5   665.5     1730    1850     1795       0        0
GR1471.3       0   1457.9      22   1437.8    55.5   1436.9    91.5   1437.4      10
GR1438.5   166.5   1441.9   227.5   1439.3     248   1439.5   258.5   1439.3    284.
GR1440.0     288   1437.3   334.5   1433.6   377.5   1434.7     390   1440.6      40
GR1442.0     449   1441.7   479.5   1437.6   483.5   1437.1     493   1435.5      49
GR1434.0     498   1433.1     508   1432.4     521   1433.1   534.5   1433.5    561.
GR1433.3   574.5   1433.8     608   1434.3     628   1434.2     651   1435.4    654.
GR1440.7   665.5   1440.4   674.5   1440.8   714.5   1442.2   756.5   1442.0    801.
GR1441.7     828   1440.0     852   1440.4     858   1441.1     868   1440.3      87
GR1438.7   894.5   1441.9   926.5   1437.2     993   1438.7  1041.5   1438.0   1071.
GR1438.2  1126.5   1438.2    1155   1437.8  1188.5   1450.5  1218.5   1449.1   1243.
GR1451.5    1270   1457.9  1288.5   1459.0  1292.5   1459.8  1318.5
EJ

T1    500 YEAR FLOODPLAIN FOR STEHEKIN RIVER (FILE STEHE302.DAT)
T2    STEHEKIN RIVER - REACH 2
T3    SUBCRITICAL RUN
J1       0       3        0       0        0       0        0       0  1209.10
J2       2       1        0       0        0       0        0       0        0
```

GR1343.0	0	1335.8	66.5	1331.6	103	1312.7	159.5	1311.3	238
GR1309.2	340	1308.8	421.5	1308.5	510	1306.3	522	1305.9	543
GR1306.0	587.5	1306.3	609	1305.9	623	1302.3	648.5	1300.2	670.5
GR1300.3	703.5	1298.6	721.5	1297.0	745	1298.1	763.5	1298.7	777
GR1298.7	807	1299.8	817	1302.3	827	1305.2	833.5	1310.3	845
GR1310.9	857	1311.0	903.5	1311.1	940.5	1312.8	957	1325.7	983.5
GR1331.1	999								
NH 5	.15	354.5	.036	682.5	.19	689.5	.045	829	.126
NH1010.5									
X1 6.91	30	689.5	829	900	1000	950	0	0	0
GR1338.5	0	1334.1	88.5	1331.6	146	1327.0	238	1323.3	310
GR1320.1	326.5	1318.2	354.5	1318.2	355.5	1316.5	510.5	1317.1	605
GR1317.1	682.5	1316.9	689.5	1307.3	706.5	1304.7	715	1304.4	723
GR1304.3	743.5	1304.6	755	1304.9	766.5	1302.0	786.5	1304.0	806.5
GR1304.6	813.5	1306.9	823.5	1309.9	829	1310.9	840	1313.6	870
GR1314.7	896.5	1314.0	936.5	1314.0	961.5	1328.7	991.5	1333.5	1010.5
NH 6	.13	0.1	.056	37	.045	202	.15	243.5	.054
NH 366	.101	490							
X1 7.03	34	37	202	675	700	700	0	0	0
GR1346.0	-235	1341.7	-207	1342.5	-192	1327.1	-179	1324.6	-153.5
GR1324.8	-106	1323.8	-58	1323.3	-35	1323.4	-16.5	1323.6	0.1
GR1323.8	14.5	1322.7	27	1318.7	30	1315.7	37	1312.4	50.5
GR1311.1	63.5	1309.0	74	1309.0	85	1311.4	97	1312.3	113.5
GR1313.9	137	1314.2	178.5	1315.0	202	1317.2	205	1318.5	217
GR1317.8	243.5	1314.2	246.5	1314.9	300.5	1315.17	320.5	1321.9	366
GR1322.5	374	1322.0	404	1326.7	410.5	1336.0	490		
NH 7	.15	22	.126	79	.045	254	.15	317.5	.081
NH 357.5	.121	722.5	.15	929					
X1 7.30	36	79	254	1400	1500	1425	0	0	0
GR1364.3	-418	1361.5	-368	1351.4	-290	1348.3	-221	1344.1	-137
GR1340.6	-88	1339.4	0	1337.5	2.5	1337.7	22	1338.8	32.5
GR1337.1	75.5	1331.9	79	1328.0	91	1325.9	101	1324.4	115
GR1324.9	127	1326.1	141	1327.6	161	1328.6	192.5	1329.1	207.5
GR1329.1	251	1331.4	254	1332.5	297.5	1332.3	317.5	1329.2	329.5
GR1327.8	341	1329.6	349.5	1332.5	357.5	1334.8	401	1335.6	481
GR1333.7	559	1333.3	612.5	1332.3	702.5	1333.2	722.5	1330.9	729
GR 1350	929								
NH 4	.06	87.5	.045	174	.081	694	.15	694	
X1 7.45	29	87.5	174	850	750	775	0	0	0
GR1374.0	-29	1349.1	0	1349.3	20.5	1341.2	32.5	1342.0	62.5
GR1341.3	87.5	1338.1	97.5	1336.8	107.5	1336.8	117.5	1338.0	129
GR1329.6	145.5	1340.3	174	1341.5	195.5	1345.2	249	1344.7	260
GR1342.1	269	1340.9	292.5	1342.5	309	1345.8	322.5	1345.7	362.5
GR1346.3	442.5	1343.9	472.5	1345.9	512.5	1346.3	547.5	1349.7	579
GR1352.2	609	1355.8	629	1360	654	1370	694		
NH 4	.06	25.5	.126	314	.045	542.5	.15	1040	
X1 7.63	36	314	542.5	1050	850	925	0	0	0
GR1378.0	-25	1358.4	0	1357.6	25.5	1349.9	38	1349.4	51
GR1349.6	66.5	1351.9	101.5	1350.6	173	1350.7	173	1351.2	215.5
GR1348.2	227.5	1348.3	228	1345.9	269	1347.7	276	1347.1	314
GR1345.4	342.5	1343.6	362.5	1343.3	379	1343.4	407.5	1343.7	426
GR1345.9	446	1347.6	462.5	1347.2	482.5	1344.9	496	1343.6	506
GR1344.8	524	1349.5	542.5	1350.6	577.5	1349.3	619	1350.7	670.5
GR1351.4	710.5	1351.3	750.5	1351.4	800.5	1352.2	840.5	1380.0	990
GR1390.0	1040.0								
NH 6	.15	0.1	.14	49	.045	184	.09	391	.04
NH 1044	.125	1128							
X1 7.87	46	49	184	1200	1250	1200	0	0	0
GR1395.0	-201	1379.2	-162.5	1377.5	-98.5	1374.9	-23.5	1373.1	-22
GR1374.4	0.1	1370.8	17.5	1369.2	42	1360.2	49	1357.5	53
GR1356.1	69	1354.6	81	1355.6	97	1357.0	109	1357.8	129
GR1359.2	149	1361.1	184	1360.4	212	1359.5	222	1360.8	235.5
GR1362.1	270.5	1361.9	317	1361.6	359	1361.5	417.5	1361.3	499
GR1359.4	517.5	1357.9	531	1359.9	541	1364.5	561	1362.6	607.5
GR1361.3	627.5	1362.7	641	1364.3	667.5	1365.4	717.5	1364.3	779
GR1363.6	837.5	1362.9	867.5	1361.9	891	1358.3	907.5	1362.0	947.5
GR1362.8	977.5	1362.1	984.5	1357.8	1031	1360.5	1044	1367.3	1091
GR 1400	1128								
NH 7	.10	0.1	.15	275.5	.045	461	.044	588.5	.11
NH1027.5	.045	1133.5	.125	1186					
X1 7.93	42	275.5	461	350	350	350	0	0	0
GR1394.3	-105	1387.9	-26	1385.2	-24	1385.9	0.1	1378.7	100.5
GR1374.9	187	1371.2	273	1367.2	275.5	1363.5	282.5	1361.8	298.5
GR1360.5	311	1360.5	323	1352.5	335.5	1352.9	352	1363.5	365.5

GR1263.2	272	1263.3	277	1263.2	305	1260.3	332	1261.5	35
GR1263.1	403	1263.3	407	1262.4	490	1263.1	601	1262.8	71
GR1263.1	825	1263.1	839	1257.7	853	1258.9	876	1258.2	91
GR1257.1	937	1254.1	942	1253.1	947	1253.1	957	1258.6	97
GR1260.2	992	1260.4	1044	1264.1	1052	1263.6	1077	1261.8	113
GR1262.8	1195	1262.1	1269	1260.8	1317	1263.5	1332	1263.6	133
GR1264.1	1347	1261.2	1353	1259.9	1375	1261.5	1396	1260.3	140
GR1258.4	1408	1257.4	1446	1255.1	1456	1254.6	1461	1254.2	146
GR1254.9	1496	1255.6	1518	1256.2	1524	1255.9	1528	1256.8	155
GR1257.9	1590	1257.7	1612	1259.1	1623	1259.4	1650	1261.1	166
GR1263.7	1670	1260.8	1699	1262.2	1771	1259.9	1807	1264.2	190
GR1265.5	1963	1266.8	2013	1268.9	2053	1276.2	2073		
NH 5	.116	339	.047	660	.108	837	.045	1137	.14
NH 2246									
X1 6.04	60	837	1137	1700	1700	1675	0	0	
GR1276.7	-386	1272.3	-326	1270.5	-290	1269.8	-263	1273.4	-24
GR1275.2	-210	1275.2	-138	1275.6	-68	1274.4	-29	1273.1	-2
GR1272.9	-6	1272.4	0	1271.7	10	1271.8	63	1271.8	11
GR1273.3	134	1273.1	197	1274.2	264	1273.9	293	1274.5	32
GR1272.8	339	1272.7	403	1271.3	426	1273.3	482	1273.2	57
GR1272.9	660	1275.1	706	1275.8	742	1274.9	797	1275.0	83
GR1270.2	837	1268.6	839	1268.2	842	1267.4	847	1266.8	85
GR1266.8	857	1267.1	893	1267.9	896	1268.8	915	1269.9	93
GR1270.7	945	1270.8	988	1272.2	997	1271.3	1042	1268.8	105
GR1269.1	1105	1269.3	1120	1274.2	1137	1274.5	1160	1273.8	123
GR1275.5	1326	1276.7	1437	1276.0	1526	1276.0	1583	1273.9	160
GR1276.8	1618	1277.1	1656	1276.3	1798	1276.4	1846	1276.4	224
NH 5	.116	339	.047	660	.108	931	.045	1174	.14
NH 2246									
X1 6.18	56	931	1174	700	650	675			
GR1283.7	-386	1279.3	-326	1277.5	-290	1276.8	-263	1280.4	-24
GR1282.2	-210	1282.2	-138	1282.6	-68	1281.4	-29	1280.1	-2
GR1279.9	-6	1279.4	0	1278.7	10	1278.8	63	1278.8	11
GR1280.3	134	1280.1	197	1281.2	264	1280.9	293	1281.5	32
GR1279.8	339	1279.7	403	1278.3	426	1280.3	482	1280.2	57
GR1279.9	660	1282.1	706	1282.8	742	1281.9	797	1282.0	83
GR1280.0	840	1276.6	845	1278.0	895	1273.5	917	1280.1	93
GR1278.6	983	1276.2	1047	1275.3	1067	1275.2	1091	1274.5	111
GR1274.2	1135	1274.7	1143	1274.1	1153	1274.9	1161	1276.8	116
GR1280.0	1174	1282.9	1179	1283.9	1195	1283.0	1526	1283.0	158
GR1280.9	1600	1283.8	1618	1284.1	1656	1283.3	1798	1283.4	184
GR1283.4	2246								
NH 6	.101	445	.08	515	.045	698	.126	772	.042
NH 816	.125	1198							
X1 6.38	44	515	698	880	1055	1030	0	0	
GR1313.4	-343	1288.4	-318	1288.4	-168	1287.8	-150	1288.2	-118
GR1288.7	-48	1288.8	-20	1289.0	-5	1290.5	0	1289.1	73
GR1289.1	108	1285.8	130	1287.7	148	1288.4	200	1292.0	267
GR1293.4	327	1290.7	372	1285.5	408	1286.6	445	1286.6	513
GR1285.7	521	1282.0	527	1279.8	529	1279.2	532	1278.7	54
GR1279.1	566	1280.0	568	1280.6	585	1281.9	610	1282.8	64
GR1282.1	684	1285.6	698	1285.9	742	1284.6	772	1282.2	779
GR1281.0	798	1286.1	816	1286.5	836	1281.2	865	1281.0	880
GR1285.9	890	1290.0	898	1295.0	1023	1300	1198		
NH 5	.145	1	.045	206	.15	267	.065	397	.1
NH 719									
X1 6.57	35	1	206	1095	995	1030	0	0	
GR1301.4	-377	1301.4	-227	1296.4	-177	1295.6	-167	1292.5	-149
GR1293.0	-119	1292.8	-110	1293.9	-72	1292.2	-44	1295.4	-32
GR1295.8	-7	1295.4	1	1295.0	5	1289.8	23	1287.6	30
GR1287.5	36	1286.8	41	1286.8	46	1286.9	57	1287.5	93
GR1288.0	107	1289.0	137	1289.8	158	1291.6	183	1292.9	20
GR1292.3	267	1288.4	309	1289.5	343	1286.9	365	1285.8	38
GR1294.4	397	1297.9	409	1300	619	1302	669	1320	719
NH 3	.126	18	.045	221	.126	433			
X1 6.64	35	18	221	450	390	400	0	0	0
GR1316.2	-430	1311.2	-360	1309.1	-342	1307.9	-298	1307.2	-252
GR1306.7	-198	1307.0	-178	1306.0	-110	1304.5	-88	1304.8	-31
GR1303.9	-25	1303.8	-5	1305.4	0	1302.8	13	1299.4	39
GR1299.0	71	1298.8	90	1297.5	105	1297.0	115	1296.9	12
GR1296.2	127	1295.5	130	1295.8	170	1296.3	177	1298.7	18
GR1295.8	193	1297.0	200	1298.5	205	1303.3	219	1306.7	22
GR1308.2	224	1307.4	264	1306.4	358	1310.0	368	1320.0	433
CT 2	14928	17217							
NH 5	.15	153.5	.101	509	.128	523	.045	833.5	.095
NH 845	15	[illegible]							

```
************************************
*                                  *
*            E D I T 2             *
*                                  *
* HEC-2 DATA CHECKER               *
* May 1991                         *
* FOR THE IBM PC/XT/AT             *
*                                  *
* U.S. ARMY CORPS OF ENGINEERS     *
* HYDROLOGIC ENGINEERING CENTER    *
* 609 SECOND STREET                *
* DAVIS, CALIFORNIA 95616-4687     *
* (916) 756-1104                   *
* RUN DATE 25FEB93  TIME 12:50:20  *
*                                  *
************************************
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STEHEKIN RIVER FLOODPLAIN STUDY - DATA INPUT FILE STEHE500.DAT

```
 HEC2 WATER SURFACE PROFILE FOR THE STEHEKIN RIVER -REACH 2
 17 NOV. 1992 SUBCRITICAL PROFILE - 100 AND 500 YR. FLOODPLAIN
 JON L. RIEDEL-NORTH CASCADES NATIONAL PARK
       0       2       0       0       0       0       0       0 1209.10

       1       1       0       0       0       0       0       0       0       1
     110     200
       2   16300   18800
       0       0       0     0.1     0.3       0       0       0       0       0
       5    0.14     290   0.066     427   0.045     595   0.126    1390     .15
    2140
    4.46      27     427     595    1100    1190    1100       0       0       0
  1222.2       0  1222.2      10    1209      35  1207.8      50    1210     193
  1209.2     290  1209.2     297  1204.1     305  1203.7     325  1206.4     330
  1206.6     387  1207.1     427  1202.4     445  1200.4     460  1201.4     525
  1202.4     535  1205.6     565  1204.7     583  1209.1     595  1211.1     715
  1213.1     835  1203.3    1275  1205.3    1280    1203    1320    1205    1360
  1216.3    1390  1250.6    2140

       5    0.15     110    0.05     485    0.13     620    .047    1130    .132
    2820
    4.81      26     110     485    1875    1850    1850
  1241.2       0  1238.2      50  1223.2      55  1225.6      65  1225.4     110
  1218.6     115  1216.6     116  1216.6     155  1218.6     185  1224.1     270
  1221.7     350  1214.9     380  1214.6     455  1227.2     485  1226.6     620
  1222.0     730  1228.0     905  1226.2    1055  1222.6    1130  1229.4    1190
  1228.3    1370  1222.0    1770  1230.0    2010  1226.0    2400  1230.0    2710
    1250    2820

       7     .15     135    .045     440     .12     635     .04     690    .126
     990    .076    1470    .132    2440
    5.12      25     135     440    1650    1550    1650       0       0       0
  1265.7       0    1257     115  1244.6     132    1235     135  1233.1     145
  1229.1     150  1224.1     180  1229.2     210  1234.4     275  1233.8     350
  1234.2     440  1236.0     515  1235.5     590  1233.7     635  1230.7     640
  1237.6     690  1238.4     840  1237.6     990  1241.0    1140  1238.0    1470
  1232.0    1630  1236.0    1790  1233.0    1950  1236.0    2270  1256.0    2440

       6    .031     131     .10     205    .045     354    .095     376    .045
     540    .137    1859
    5.32      60     208     354    1100     950    1000       0       0       0
  1254.9       0  1251.5       5  1251.8      23  1252.7      25  1249.3      35
  1248.2      60  1250.1      79  1250.3     131  1251.7     171  1250.8     200
  1250.2     205  1248.3     208  1243.7     217  1242.6     219  1240.7     222
  1240.5     227  1239.7     232  1239.2     240  1240.2     250  1241.2     259
  1241.6     264  1241.7     269  1242.7     279  1243.7     289  1247.5     329
  1247.8     354  1248.1     376  1245.5     390  1246.4     402  1247.8     411
  1248.3     436  1250.0     448  1249.2     501  1250.4     524  1249.7     573
  1245.7     598  1247.4     626  1248.6     640  1252.7     654  1252.9     696
  1248.9     706  1250.1     742  1250.4     824  1248.2     842  1248.7     861
  1250.2     862  1249.0     886  1249.4     929  1248.0     966  1249.0    1013
  1247.3    1047  1249.0    1057  1246.8    1079  1248.8    1099  1253.4    1109
  1255.4    1159  1250.0    1309  1248.0    1359  1250.0    1399  1260.0    1859

       8    .082     407    .037     601    .126     937    .047     957    .108
    1404    .055    1664    .026    1771     .15    2073
    5.72      69    1404    1664    2000    2250    2100       0       0       0
  1269.4       0  1259.3      25  1263.4      43  1263.6      51  1261.8      83
```

SUMMARY OF ERRORS

```
T1   HEC2 WATER SURFACE PROFILE FOR THE STEHEKIN RIVER -REACH 1
T2   17 NOV. 1992 SUBCRITICAL PROFILE - 100 AND 500 YR. FLOODPLAIN
T3   JON L. RIEDEL-NORTH CASCADES NATIONAL PARK
      2.890 - NOTE - GR RECORD - STA =    551.000 MINIMUM ELEVATION NOT WITHIN
                     CHANNEL

      3.780 - NOTE - NORMAL BRIDGE SHOULD NOT BE SPECIFIED ON BOTH
                     X2 AND BT RECORDS

      5.720 - NOTE - GR RECORD - STA =    947.000 MINIMUM ELEVATION NOT WITHIN
                     CHANNEL

T1    500 YEAR FLOODPLAIN FOR STEHEKIN RIVER (FILE STEHE500.DAT)
T2    STEHEKIN RIVER - REACH 1
T3    SUBCRITICAL RUN    (jlr 11-17-92)
```

```
R1213.5      115   1216.5      116   1216.5      155   1218.5      185   1224.1      270
R1221.7      350   1214.9      380   1214.6      455   1227.2      485   1226.6      620
R1222.0      730   1228.0      905   1226.2     1055   1222.5     1130   1229.4     1190
R1228.3     1370   1222.0     1770   1230.0     2010   1226.0     2400   1230.0     2710
R   1250    2820

H      7     .15      135     .045      440      .12      535      .04      690     .126
H    990    .076     1470     .132     2440
1   5.12      25      135      440     1650     1550     1650        0        0        0
R1265.7        0     1257      115   1244.6      132     1235      135   1233.1      145
R1229.1      150   1224.1      180   1229.2      210   1234.4      275   1233.8      350
R1234.2      440   1236.0      515   1235.5      590   1233.7      635   1230.7      640
R1237.5      690   1238.4      840   1237.6      990   1241.0     1140   1238.0     1470
R1232.0     1630   1236.0     1790   1233.0     1950   1236.0     2270   1256.0     2440

H      5    .031      131      .10      205     .045      354     .095      376     .045
H    640    .137     1859
1   5.32      60      208      354     1100      950     1000        0        0        0
R1254.9        0   1251.5        5   1251.8       23   1252.7       25   1249.3       35
R1248.2       60   1250.1       79   1250.3      131   1251.7      171   1250.8      200
R1250.2      205   1243.3      208   1243.7      217   1242.5      219   1240.7      222
R1240.5      227   1239.7      232   1239.2      240   1240.2      250   1241.2      259
R1241.5      264   1241.7      269   1242.7      279   1243.7      289   1247.6      329
R1247.8      354   1248.1      376   1245.5      390   1246.4      402   1247.8      411
R1249.3      436   1250.0      448   1249.2      501   1250.4      524   1249.7      573
R1245.7      598   1247.4      626   1248.6      640   1252.7      654   1252.9      696
R1248.9      706   1250.1      742   1250.4      824   1248.2      842   1248.7      861
R1250.2      862   1249.0      886   1249.4      929   1248.0      966   1249.0     1013
R1247.3     1047   1249.0     1057   1246.8     1079   1248.8     1099   1253.4     1109
R1255.4     1159   1250.0     1309   1248.0     1359   1250.0     1399   1260.0     1859

H      8    .082      407     .037      601     .126      937     .047      957     .108
H   1404    .055     1664     .026     1771      .15     2073
1   5.72      69     1404     1664     2000     2250     2100        0        0        0
R1259.4        0   1259.3       25   1263.4       43   1263.6       61   1261.8       83
R1262.5       94   1265.0      129   1264.6      163   1263.3      219   1263.2      252
R1263.2      272   1263.3      277   1263.2      305   1260.8      332   1261.5      363
R1263.1      403   1263.3      407   1262.4      490   1263.1      601   1262.8      717
R1263.1      825   1263.1      839   1257.7      853   1258.9      876   1258.2      918
R1257.1      937   1254.1      942   1253.1      947   1253.1      957   1258.6      977
R1260.2      992   1260.4     1044   1264.1     1052   1263.6     1077   1261.8     1133
R1262.8     1195   1262.1     1269   1260.8     1317   1263.5     1332   1263.6     1333
R1264.1     1347   1261.2     1353   1259.9     1375   1261.5     1396   1260.3     1404
R1258.4     1408   1257.4     1446   1255.1     1456   1254.6     1461   1254.2     1466
R1254.9     1496   1255.6     1518   1256.2     1524   1255.9     1528   1256.8     1569
R1257.9     1590   1257.7     1612   1259.1     1623   1259.4     1650   1261.1     1664
R1263.7     1670   1260.8     1699   1262.2     1771   1259.9     1807   1264.2     1905
R1265.5     1963   1266.8     2013   1268.9     2053   1276.2     2073
J

1   500 YEAR FLOODPLAIN FOR STEHEKIN RIVER (FILE STEHE500.DAT)
2   STEHEKIN RIVER - REACH 1
3   SUBCRITICAL RUN    (jlr 11-17-92)
1      0       3        0        0        0        0        0        0  1099.9

2      2       1        0        0        0        0        0        0        0
```

GR	1171.0	389	1170.5	1105	1169.6	1515	1172.1	1516	1170	17
GR	1168.0	1991	1168	2324	1168	2563	1192	2610		
NH	5	.06	45	.076	140	.045	367	.13	460	.1
NH	3355									
X1	3.63	24	140	367	1150	1250	1175	0	0	
GR	1188.1	0	1178.1	20	1178	45	1178.9	75	1177.8	1
GR	1179.3	140	1176.6	165	1174.6	185	1172.9	295	1171.3	3
GR	1173.8	365	1178.1	367	1178.5	460	1178.0	580	1178.0	5
GR	1178.0	630	1178.0	645	1178.0	665	1177.5	695	1178.5	7
GR	1178.9	1005	1184.9	2255	1190	3205	1200	3355	0	
NH	4	0.06	38	0.04	190	0.126	215	0.101	1620	
X1	3.74	23	38	190	600	600	600	0	0	
GR	1200	0	1189.2	10	1189.4	24	1181.6	38	1178.3	
GR	1177.3	75	1175.8	95	1173.3	141	1175.8	187	1181	1
GR	1181.3	215	1183.7	668	1183.7	748	1180.7	748	1180.7	7
GR	1183.7	758	1182	800	1182	950	1183	1080	1180	10
GR	1180	1140	1185	1170	1190.0	1620				
NH	4	0.07	70	0.04	222	0.08	748	0.1	1700	
X1	3.76	37	70	222	110	90	100	0	-.5	
GR	1192.0	0	1192.0	10	1185.2	40	1181.3	70	1191.9	70.
GR	1191.9	72	1181.3	72.01	1178.7	91	1178.3	93	1170.8	1
GR	1173.2	120	1176.4	134	1174.7	149	1172.8	163	1172.0	1
GR	1171.0	180	1175.3	203	1179.5	205	1182.0	222	1191.9	222.
GR	1191.9	224	1182.0	224.01	1186	255	1192.0	262	1188.2	3
GR	1183.7	668	1183.7	747	1180.7	748	1180.7	759	1183.7	7
GR	1183.0	800	1182.0	950	1183	1080	1180	1090	1180	11
GR	1185	1170	1190	1700						
NC	0.1	0.1	0.045	0.6	1.0					
X1	3.78	0	0	0	22	22	22	0	0	
X2	0	0	0	1191.1	1192.5	0	0			
BT	24	10	1192	1192	40	1192.5	1191.9	70	1192.5	1191
BT	70.01	1192.5	1191.9	72	1192.5	1191.9	72.01	1192.5	1191.9	
BT	1192.5	1191.9	93	1192.5	1191.9	106	1192.5	1191.1	120	1192
BT	1191.1	134	1192.25	1191.1	149	1192.5	1191.1	163	1192.5	1191
BT	180	1192.5	1191.1	203	1192.5	1191.1	205	1192.5	1191.9	2
BT	1192.5	1191.9	222.01	1192.5	1191.9	224	1192.5	1191.9	224.01	1192
BT	1191.9	255	1192.5	1191.9	262	1192.0	1192.0	382	1188.2	1188
BT	668	1183.7	1183.7							
NC	0	0	0	0.1	0.3					
NH	3	0.1	50	0.04	190	0.1	1700			
X1	3.80	21	50	190	100	100	100	0	0	
GR	1200	0	1191	10	1191	24	1183	38	1180	5
GR	1179	75	1178	95	1176	130	1173	141	1176	1
GR	1181	190	1182	215	1184	508	1184	588	1185	8
GR	1185	970	1185	1030	1180	1090	1180	1140	1185	11
GR	1190	1700								
NH	3	0.1	147	0.04	265	0.127	1530			
X1	3.98	21	147	265	1000	900	975	0	-0	
GR	1225.6	0	1225.6	17	1195.5	57	1191.4	147	1185.7	16
GR	1185	214	1184.7	220	1183.2	250	1185.7	252	1191.4	26
GR	1191.4	365	1191.4	450	1185.4	455	1192.2	505	1192.0	11
GR	1188.6	1185	1188.6	1257	1200	1272	1204.4	1320	1208	141
GR	1213.9	1530								
NH	5	0.14	137	0.047	327.2	0.076	870	0.03	935	.1
NH	1810									
X1	4.26	16	137	327.2	1500	1450	1500	0	0	
GR	1227.6	0	1221.4	93	1202.6	127	1192.7	137	1183.5	20
GR	1186.8	267	1186.5	317	1188.9	327.2	1198	870	1192	37
GR	1192	930	1200	935	1204.2	1270	1216.4	1285	1240.6	178
GR	1241.5	1810								
QT	2	16300	18800							
NH	5	0.14	290	0.066	427	0.045	595	0.126	1390	.1
NH	2140									
X1	4.46	27	427	595	1100	1190	1100	0	0	
GR	1222.0	0	1222.2	10	1209	35	1207.8	50	1210	19
GR	1209.2	290	1209.2	297	1204.1	305	1203.7	325	1205.4	33
GR	1205.5	387	1207.1	427	1202.4	445	1200.4	460	1201.4	52
GR	1202.4	535	1205.5	565	1204.7	583	1209.1	595	1211.1	71
GR	1213.1	835	1203.3	1275	1205.3	1280	1203	1320	1205	136
GR	1216.3	1390	1250.3	2140						
NH	5	0.15	110	0.05	485	0.13	520	.047	1130	.13
NH	2625									
X1	4.81	26	110	486	1875	1850	1850			

R1114.5	837	1116.4	955	1122	985	1123.[illegible]	1055	1122.[illegible]	119[illegible]
R 1120	1415	1122	1565	1120	1715	1118	1717	1118	1727
R 1120	1729	1125	1985	1135	2100	1175	2300	0	0
H 4	0.125	310	0.045	543	0.15	810	0.14	2110	0
1 1.39	23	310	543	1250	1200	1230	0	0	0
R 1172	0	1172.1	10	1160	120	1134.8	300	1130.6	310
R1124.5	312	1120	320	1118.4	333	1116.9	340	1119.3	363
R1116.5	403	1115.7	433	1118.5	463	1122.7	513	1130.6	543
R1130.7	663	1140	810	1140	1210	1122.7	1510	1119	1512
R 1136	1522	1140	1524	1140	2110	0	0	0	0
H 5	0.128	195	0.045	360	0.14	1430	0.147	1430	0.126
H 3050									
1 1.62	26	195	360	1300	1225	1250	0	0	0
R1170.3	0	1158.4	120	1153.3	166	1130	195	1122.3	200
R1122.0	235	1121.7	236	1122.4	319	1124.4	320	1130.2	360
R1126.5	390	1124.6	391	1125.5	839	1125.6	840	1131.5	842
R1131.6	990	1133.4	1190	1133.7	1240	1128.6	1340	1134.7	1380
R1136.1	1430	1133.8	1880	1130.1	2105	1131.8	2450	1140	2650
R1152.0	3050								
H 4	0.15	436	0.045	995	0.147	1740	0.126	3360	
1 1.78	30	436	995	800	300	750	0	0	0
R1145.3	0	1142	180	1139.9	280	1137.3	400	1136.7	435
R1131.6	436	1127.1	445	1126.6	446	1126.6	459	1127.1	460
R1130.1	500	1127.6	530	1125.6	585	1127.2	640	1131.3	740
R1130.4	905	1132.0	995	1130.8	1190	1131.7	1250	1133.2	1380
R1133.4	1500	1133.7	1550	1128.6	1650	1134.7	1690	1136.1	1740
R1133.8	2190	1130.1	2415	1131.8	2760	1140	2960	1152	3360
T 2	17700	20300							
H 4	0.15	341	0.126	950	0.045	1161	0.126	3225	
1 2.00	28	950	1161	1350	950	1150	0	0	0
R1154.5	0	1150.2	162	1146.1	179	1143	330	1135.7	341
R1137.1	425	1136.5	559	1136.5	726	1137.2	950	1133.6	970
R1131.2	1070	1130.0	1095	1130.0	1120	1130.0	1159	1131.1	1160
R1135.5	1161	1135.3	1205	1133.4	1375	1133.7	1425	1134	1525
R1134.7	1565	1136.1	1615	1133.8	2065	1130.1	2290	1131.8	2635
R1131.8	2835	1140	3205	1152	3225				
H 4	0.036	940	0.101	1000	0.045	1230	0.176	1347	
1 2.30	15	1000	1230	1650	2100	1650	0	0	0
R1154.5	0	1153.1	200	1147.4	300	1144.9	940	1144.4	1000
R 1139	1025	1135	1035	1138.8	1150	1136.5	1200	1138.5	1225
R1145.5	1230	1146	1280	1156	1310	1160	1320	1170	1347
H 4	0.036	840	0.08	1150	0.045	1150	0.15	1390	
1 2.57	15	840	1150	1050	1350	1250	0	0	0
R1154.5	70	1153.8	150	1153.9	540	1149.8	580	1150	840
R1145.5	870	1144.5	871	1144.3	1139	1145.3	1140	1148.4	1150
R1147.9	1240	1147.7	1340	1147.7	1370	1157.7	1380	1167.7	1390
H 8	0.125	135	0.12	535	0.065	605	0.125	775	0.045
1015	.10	1245	.09	1400	.172	2100			
1 2.89	33	775	1015	1650	1750	1690	0	0	0
R1174.6	0	1170.3	75	1164.5	135	1159.9	150	1158.7	270
R1157.2	305	1158.7	395	1159.5	535	1151.5	550	1150.5	551
R1150.5	590	1151.5	591	1155.2	605	1157.2	685	1153.9	775
R1152.4	776	1151.9	999	1153.4	1000	1155.8	1015	1156.9	1040
R1155.5	1095	1157.9	1100	1157.1	1205	1156.2	1245	1151	1310
R1153.1	1350	1158.5	1400	1158.6	1510	1156	1730	1158	1850
R 1155	1920	1155	2060	1174	2100				
H 5	0.125	490	0.115	680	0.045	865	0.034	1350	0.15
H 2792									
1 3.06	29	680	865	700	1000	900	0	0	0
R1204.3	0	1196	130	1184.7	400	1180.2	490	1175.9	570
R1154.0	580	1158.2	600	1158.2	540	1160.7	580	1158.7	581
R1157.6	839	1159.6	840	1161.6	865	1162.5	890	1160.5	910
R1162.3	1030	1164.3	1150	1161.5	1250	1163.4	1350	1157.3	1355
R1168.8	1440	1165.8	1490	1170.0	1678	1167.0	1888	1163.0	2097
R 1168	2326	1152.0	2506	1165.0	2726	1185.0	2792		
H 5	0.12	235	0.127	510	0.045	805	0.03	985	.15
H 2510									
1 3.42	34	510	305	1975	1800	1875	0	0	0
R1186.7	0	1174.4	15	1165.9	30	1167.4	75	1170.4	77
R1171.5	135	1170.5	175	1166.5	180	1167.5	225	1170.9	235
R 1172	335	1172.4	380	1171.2	480	1172.4	510	1165.9	590
R1164.9	591	1164.9	519	1165.9	520	1170.9	545	1159.3	545
R1162.2	780	1168.2	800	1172.2	805	1172.2	850	1168.1	955

```
***************************************
*                                     *
*              E D I T 2              *
*                                     *
*   HEC-2 DATA CHECKER                *
*   May 1991                          *
*   FOR THE IBM PC/XT/AT              *
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*   609 SECOND STREET                 *
*   DAVIS, CALIFORNIA 95616-4687      *
*   (916) 756-1104                    *
*   RUN DATE 25FEB93   TIME 12:43:56  *
*                                     *
***************************************
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STEHEKIN RIVER FLOODPLAIN STUDY - DATA INPUT FILE STEHE500.D

```
T1   HEC2 WATER SURFACE PROFILE FOR THE STEHEKIN RIVER -REACH
T2   17 NOV. 1992 SUBCRITICAL PROFILE - 100 AND 500 YR. FLOODPLAIN
T3   JON L. RIEDEL-NORTH CASCADES NATIONAL PARK
J1        0       2       0       0       0       0       0       0  1099.9

J2        1       1       0       0       0       0       0       0       0
J3      110     200
QT        2   19200   22100
NC        0       0       0     0.1     0.3       0       0       0       0
NH        5     .13     760   0.062    1140    0.13    1940    0.04    2092   0.
NH2737.1      0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00   0.
X1     0.15      32    1940    2092       0       0       0       0       0
GR     1160      40    1120     100    1116     200    1103     300    1101   7
GR     1101     760    1103     770    1103     790  1101.5    1140    1102  15
GR1101.8      1780    1101    1795  1096.9    1800  1098.1    1823  1099.7  18
GR1097.8      1940  1097.3    1973  1094.7    1990  1091.7    2030  1095.2  20
GR1099.2      2092  1099.2    2122  1100.8    2180  1095.8    2181  1095.8  22
GR1100.8      2201  1100.8    2358  1095.8    2364  1095.8    2433  1100.8  24
GR1105.8      2683    1106  2737.1

NH        4    0.13     200    0.12    1721    0.04    1930    0.15    2620
X1    0.290      34    1721    1930     750     750     739       0       0
GR     1132     180    1104     200    1108     500    1103     800    1103  11
GR     1105    1110    1105    1130    1103    1140  1104.5    1700    1107  17
GR1107.1      1720    1102    1721    1096    1725    1096    1755  1096.3  17
GR1097.8      1853  1101.8    1930  1098.9    1970  1100.9    1983  1100.6  20
GR1101.6      2056  1099.6    2057  1099.6    2086  1099.5    2087  1099.6  21
GR1101.6      2121  1100.0    2220  1100.0    2250  1101.6    2251  1101.6  24
GR     1098    2431    1098    2450    1102    2451  1106.6    2620

NH        8    0.08     500   0.104     750   0.052     883   0.105    1063  .0
NH     1231    .145    1410    .074    1430     .15    1775
X1     0.42      22    1063    1231     725     575     625       0       0
GR     1110       0    1107     500  1110.3     583  1109.2     750  1097.8  7
GR1100.9       850  1102.9     883  1102.2     917  1104.9     964  1101.4  10
GR1097.6      1167  1097.0    1200  1095.6    1215  1095.5    1230  1101.6  12
GR1101.6      1410    1098    1410  1098.0    1430    1102    1431  1106.0  15
GR     1110    1650    1120    1775       0       0       0       0       0

NH        7   0.097    1070    0.05    1117   0.115    1185   0.045    1377  .1
NH     1640    .044    1670    .115    1700
X1     0.74      16    1185    1377    1450    2100    1700       0       0
GR     1114       0  1114.4    1070    1109    1117  1111.3    1180  1111.3  11
GR1104.2      1195  1098.2    1215  1104.3    1280  1106.7    1317  1108.1  13
GR1114.1      1527    1106    1640    1103    1645    1103    1665    1106  16
GR     1121    1700

NH        4   0.105    1122   0.110    1365   0.045    1540    .115    1925
X1     0.93      20    1365    1540     980    1200    1000       0       0
GR     1140       0    1135       5  1135.3      15  1118.2    1122    1112  11
GR1115.5      1152  1116.9    1182    1116    1212  1112.8    1225  1111.3  12
GR1115.1      1335  1115.1    1365    1112    1375  1110.3    1401  1100.8  15
GR1110.8      1525  1116.9    1540  1120.7    1541    1120    1595    1160  19

NH        5   0.095      15   0.055     535   0.103     755   0.045     985  .13
NH     2300
X1     1.18      24     765     985    1200    1175    1200       0       0
GR     1150       0    1150       5    1140      15    1120     535  1127.5  73
```

APPENDIX B
HEC2 OUTPUT

```
*-------------------------------------*
:              S U M P O              :
:                                     :
:   Interactive Summary Printout      :
:   for MS/PC-DOS micro computers     :
:             May 1991                :
*-------------------------------------*
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

L. RIEDEL-NORTH CASCADES

DATA OUTPUT FILE STEHE500.OUT

Summary Printout Table 150

		SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS
*	A	.15	.00	.00	.00	1091.70	19200.00	1102.72	1102.72
*		.15	.00	.00	.00	1091.70	22100.00	1103.18	1103.18
*	B	.29	739.00	.00	.00	1096.00	19200.00	1106.31	.00
*		.29	739.00	.00	.00	1096.00	22100.00	1106.73	.00
	C	.42	625.00	.00	.00	1095.60	19200.00	1107.53	.00
		.42	625.00	.00	.00	1095.60	22100.00	1108.00	.00
*	D	.74	1700.00	.00	.00	1098.20	19200.00	1112.29	.00
*		.74	1700.00	.00	.00	1098.20	22100.00	1112.95	.00
	E	.93	1000.00	.00	.00	1100.30	19200.00	1117.46	.00
		.93	1000.00	.00	.00	1100.30	22100.00	1118.11	.00
	F	1.16	1200.00	.00	.00	1114.50	19200.00	1124.33	.00
		1.16	1200.00	.00	.00	1114.50	22100.00	1124.95	.00
	G	1.39	1230.00	.00	.00	1115.70	19200.00	1129.20	.00
		1.39	1230.00	.00	.00	1115.70	22100.00	1129.71	.00
	H	1.62	1250.00	.00	.00	1121.70	19200.00	1133.07	.00
		1.62	1250.00	.00	.00	1121.70	22100.00	1133.35	.00
	I	1.78	750.00	.00	.00	1125.60	19200.00	1134.58	.00
		1.78	750.00	.00	.00	1125.60	22100.00	1135.19	.00
	J	2.00	1150.00	.00	.00	1130.00	17700.00	1137.35	.00
		2.00	1150.00	.00	.00	1130.00	20300.00	1137.74	.00
*	K	2.30	1650.00	.00	.00	1135.00	17700.00	1143.84	.00
*		2.30	1650.00	.00	.00	1135.00	20300.00	1144.16	.00
*	L	2.57	1250.00	.00	.00	1144.30	17700.00	1153.21	.00
*		2.57	1250.00	.00	.00	1144.30	20300.00	1153.35	.00
	M	2.89	1690.00	.00	.00	1150.30	17700.00	1158.75	.00
		2.89	1690.00	.00	.00	1150.30	20300.00	1159.16	.00
*	N	3.06	900.00	.00	.00	1157.60	17700.00	1163.94	1163.94
*		3.06	900.00	.00	.00	1157.60	20300.00	1164.22	1164.22
*	O	3.42	1875.00	.00	.00	1162.20	17700.00	1172.77	.00
*		3.42	1875.00	.00	.00	1162.20	20300.00	1173.11	.00
*	P	3.63	1175.00	.00	.00	1171.30	17700.00	1179.92	1179.92
*		3.63	1175.00	.00	.00	1171.30	20300.00	1180.39	1180.39
*	Q	3.74	600.00	.00	.00	1173.30	17700.00	1184.47	1184.18
		3.74	600.00	.00	.00	1173.30	20300.00	1184.37	1184.69
*	BRIDG	3.75	100.00	.00	.00	1170.30	17700.00	1181.47	1181.46
*		3.76	100.00	.00	.00	1170.30	20300.00	1188.72	1188.72
*		3.78	22.00	1192.50	1191.10	1170.30	17700.00	1183.18	1183.12
*		3.78	22.00	1192.30	1191.10	1170.30	20300.00	1190.55	.00
*	G	3.80	100.00	.00	.00	1173.00	17700.00	1185.12	1185.12

	E	3.30	100.00	.00	.00	1172.00	20300.00	1190.38	.00
*	S	3.99	975.00	.00	.00	1183.20	17700.00	1194.23	1194.23
*		3.98	975.00	.00	.00	1183.20	20300.00	1194.57	1194.57
*	T	4.26	1500.00	.00	.00	1183.50	17700.00	1198.55	.00
*		4.26	1500.00	.00	.00	1183.50	20300.00	1199.15	.00
*	U	4.46	1100.00	.00	.00	1200.40	16300.00	1208.39	1208.39
*		4.46	1100.00	.00	.00	1200.40	18800.00	1208.80	1208.80
*	V	4.81	1850.00	.00	.00	1214.60	16300.00	1225.04	.00
*		4.81	1850.00	.00	.00	1214.60	18800.00	1225.48	.00
	W	5.12	1650.00	.00	.00	1224.10	16300.00	1236.45	.00
		5.12	1650.00	.00	.00	1224.10	18800.00	1236.78	.00
*	X	5.32	1000.00	.00	.00	1239.20	16300.00	1250.69	1250.69
*		5.32	1000.00	.00	.00	1239.20	18800.00	1251.02	1251.02
*	Y	5.72	2100.00	.00	.00	1253.10	16300.00	1263.49	.00
*		5.72	2100.00	.00	.00	1253.10	18800.00	1263.87	.00

		EG	10K*S	VCH	AREA	0.01K	Q	CWSEL	DIFWSP
*	A	1104.26	61.36	11.38	4253.27	2451.15	19200.00	1102.72	.00
*		1104.69	59.26	11.81	5260.31	2870.74	22100.00	1103.18	.46
*	B	1106.75	19.58	6.72	8039.53	4339.48	19200.00	1106.31	.00
*		1107.20	20.39	7.09	8963.82	4894.53	22100.00	1106.73	.42
	C	1107.99	19.11	6.93	5155.71	4392.66	19200.00	1107.53	.00
		1108.53	20.55	7.44	5635.41	4875.06	22100.00	1108.00	.47
*	D	1113.53	57.13	9.33	2312.65	2540.29	19200.00	1112.29	.00
*		1114.28	55.96	10.27	2874.83	2954.30	22100.00	1112.95	.66
	E	1118.96	48.54	10.23	2466.96	2755.92	19200.00	1117.46	.00
		1119.78	50.23	10.92	2736.28	3118.14	22100.00	1118.11	.65
	F	1125.21	55.20	8.89	4659.96	2584.21	19200.00	1124.33	.00
		1125.79	48.76	8.85	5572.64	3164.97	22100.00	1124.95	.62
	G	1130.24	31.09	8.32	2656.19	3443.43	19200.00	1129.20	.00
		1130.95	35.14	9.08	2833.98	3728.15	22100.00	1129.71	.51
	H	1133.48	21.29	6.72	6978.45	4160.87	19200.00	1133.07	.00
		1134.25	19.79	6.33	8317.58	4967.64	22100.00	1133.35	.78
	I	1134.90	26.16	5.08	6687.59	3753.99	19200.00	1134.58	.00
		1135.50	22.49	5.06	7976.79	4660.17	22100.00	1135.19	.61
	J	1137.50	22.53	4.88	9245.60	3729.07	17700.00	1137.35	.00
		1137.89	22.43	5.09	10324.13	4285.88	20300.00	1137.74	.39
*	K	1146.33	132.44	12.65	1399.31	1533.00	17700.00	1143.84	.00
*		1147.11	149.04	13.30	1471.16	1662.79	20300.00	1144.16	.32
*	L	1153.50	31.17	4.27	4702.29	3170.55	17700.00	1153.21	.00
*		1154.15	28.55	4.30	5246.02	3799.44	20300.00	1153.85	.64
	M	1159.22	36.11	6.34	5025.35	2945.61	17700.00	1158.75	.00
		1159.65	36.53	7.16	5724.79	3358.70	20300.00	1159.16	.41
*	N	1165.13	108.53	10.35	2445.01	1699.00	17700.00	1163.94	.00
*		1165.47	109.18	10.94	2747.71	1942.81	20300.00	1164.22	.28
*	O	1172.96	21.82	4.91	8676.79	3789.40	17700.00	1172.77	.00
*		1173.31	21.85	5.11	9583.58	4342.67	20300.00	1173.11	.34
*	P	1181.71	106.17	11.33	2698.32	1717.79	17700.00	1179.92	.00
*		1182.20	101.07	11.61	3282.62	2019.23	20300.00	1180.39	.47
*	Q	1185.96	49.39	10.36	3224.38	2503.95	17700.00	1184.47	.00
		1186.44	51.31	11.41	3735.11	2820.18	20300.00	1184.87	.40
*		1186.10	190.09	17.46	1124.37	1283.30	17700.00	1181.47	.00
*		1190.02	57.04	8.85	7756.24	2687.92	20300.00	1188.72	7.25
*		1185.38	100.31	12.98	1906.20	1762.35	17700.00	1183.18	.00
*		1190.73	6.00	4.56	10575.60	8299.57	20300.00	1190.55	7.37

*	1187.11	64.72	12.25	2622.19	2199.17	17700.00	1186.18	.00
	1190.30	5.91	5.14	10421.27	8350.02	20300.00	1190.58	5.41
*	1195.34	64.93	12.20	3797.52	2196.56	17700.00	1194.23	.00
*	1196.32	69.42	12.95	4199.59	2436.44	20300.00	1194.37	.34
*	1198.30	3.96	4.38	5419.06	5914.60	17700.00	1198.55	.00
*	1199.42	9.29	5.14	5898.97	6659.63	20300.00	1199.15	.50
*	1210.26	150.11	12.68	2195.34	1330.39	16300.00	1208.39	.00
*	1210.79	150.04	13.24	2482.96	1534.79	18800.00	1208.80	.42
*	1225.72	52.43	6.39	2938.65	2251.01	16300.00	1225.04	.00
*	1226.21	52.16	7.20	3353.94	2603.11	18800.00	1225.48	.44
	1237.36	101.22	8.36	3313.17	1620.12	16300.00	1236.45	.00
	1237.74	99.93	9.24	3743.60	1880.66	18800.00	1236.79	.33
*	1251.96	82.92	10.77	2579.16	1790.00	16300.00	1250.69	.00
*	1252.34	84.99	11.24	2940.77	2039.31	18800.00	1251.02	.32
*	1263.36	40.32	5.93	4170.14	2566.98	16300.00	1263.49	.00
*	1264.25	39.53	6.11	4839.29	2986.25	18800.00	1263.97	.38

		DIFWSX	DIFKWS	TOPWID	XLCH
*	A	.00	2.82	2079.54	.00
*		.00	3.28	2255.85	.00
*	B	3.59	.00	2173.45	739.00
*		3.55	.00	2243.48	739.00
	C	1.22	.00	966.00	625.00
		1.27	.00	1061.73	625.00
*	D	4.76	.00	523.49	1700.00
*		4.95	.00	556.79	1700.00
	E	5.19	.00	416.36	1000.00
		5.16	.00	418.09	1000.00
	F	6.87	.00	1415.78	1200.00
		6.84	.00	1486.65	1200.00
	G	4.86	.00	347.88	1230.00
		4.75	.00	358.97	1230.00
	H	3.88	.00	1636.39	1250.00
		4.14	.00	1813.57	1250.00
	I	1.51	.00	2045.08	750.00
		1.34	.00	2197.36	750.00
	J	2.77	.00	2746.76	1150.00
		2.55	.00	2765.01	1150.00
*	K	6.49	.00	226.23	1650.00
*		5.42	.00	227.92	1650.00
*	L	9.37	.00	829.92	1250.00
*		9.69	.00	1071.02	1250.00
	M	5.54	.00	1670.39	1690.00
		5.31	.00	1783.38	1690.00
*	N	5.19	.00	1028.93	900.00
*		5.06	.00	1114.25	900.00
*	O	8.83	.00	2556.40	1875.00
*		8.89	.00	2557.34	1875.00
*	P	7.15	.00	1201.22	1175.00
*		7.23	.00	1299.43	1175.00
*	Q	4.53	.00	1134.00	600.00
		4.49	.00	1137.09	600.00
*		-3.00	.00	585.21	100.00
*		3.25	.00	1499.98	100.00
*		1.71	.00	593.25	22.00

*	1.33	.00	1650.66	22.00
*	2.00	.00	1154.49	100.00
	.04	.00	1675.27	100.00
* S	9.06	.00	1179.59	975.00
*	3.99	.00	1187.50	975.00
* T	4.32	.00	803.00	1500.00
*	4.57	.00	303.93	1500.00
* U	9.84	.00	662.83	1100.00
*	9.66	.00	716.67	1100.00
* V	16.65	.00	895.17	1250.00
*	16.68	.00	996.48	1250.00
W	11.41	.00	1309.70	1650.00
	11.30	.00	1323.67	1650.00
* X	14.24	.00	1100.32	1000.00
*	14.24	.00	1144.71	1000.00
* Y	12.80	.00	1711.32	2100.00
*	12.85	.00	1783.95	2100.00

Summary of Errors and Special Notes

CAUTION SECNO= .150 PROFILE= 1 Critical depth assumed

CAUTION SECNO= .150 PROFILE= 2 Critical depth assumed

WARNING SECNO= .290 PROFILE= 1 KRATIO outside acceptable range

WARNING SECNO= .290 PROFILE= 2 KRATIO outside acceptable range

WARNING SECNO= .740 PROFILE= 1 KRATIO outside acceptable range

WARNING SECNO= .740 PROFILE= 2 KRATIO outside acceptable range

WARNING SECNO= 2.300 PROFILE= 1 KRATIO outside acceptable range

WARNING SECNO= 2.300 PROFILE= 2 KRATIO outside acceptable range

WARNING SECNO= 2.570 PROFILE= 1 KRATIO outside acceptable range

WARNING SECNO= 2.570 PROFILE= 2 KRATIO outside acceptable range

CAUTION SECNO= 3.060 PROFILE= 1 Critical depth assumed

CAUTION SECNO= 3.060 PROFILE= 1 Minimum specific energy

CAUTION SECNO= 3.060 PROFILE= 2 Critical depth assumed

CAUTION SECNO= 3.060 PROFILE= 2 Minimum specific energy

WARNING SECNO= 3.420 PROFILE= 1 KRATIO outside acceptable range

WARNING SECNO= 3.420 PROFILE= 2 KRATIO outside acceptable range

CAUTION SECNO= 3.630 PROFILE= 1 Critical depth assumed

CAUTION SECNO= 3.630 PROFILE= 1 Probable minimum specific energy

CAUTION SECNO= 3.630 PROFILE= 1 20 trials attempted to balance WSEL

CAUTION SECNO= 3.630 PROFILE= 2 Critical depth assumed

CAUTION SECNO= 3.630 PROFILE= 2 Probable minimum specific energy

CAUTION SECNO= 3.630 PROFILE= 2 20 trials attempted to balance WSEL

```
CAUTION  SECNO=      [illegible]  PROFILE=  2  20 trials attempted to balance WSEL

WARNING  SECNO=      3.740  PROFILE=  1  KRATIO outside acceptable range

CAUTION  SECNO=      3.760  PROFILE=  1  WSEL assumed based on min DIFF
CAUTION  SECNO=      3.760  PROFILE=  1  20 trials attempted to balance WSEL
CAUTION  SECNO=      3.760  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      3.760  PROFILE=  2  Minimum specific energy

CAUTION  SECNO=      3.780  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      3.780  PROFILE=  1  20 trials attempted to balance WSEL
WARNING  SECNO=      3.780  PROFILE=  2  KRATIO outside acceptable range

CAUTION  SECNO=      3.800  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      3.800  PROFILE=  1  Probable minimum specific energy
CAUTION  SECNO=      3.800  PROFILE=  1  20 trials attempted to balance WSEL

CAUTION  SECNO=      3.980  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      3.980  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=      3.980  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      3.980  PROFILE=  2  Probable minimum specific energy
CAUTION  SECNO=      3.980  PROFILE=  2  20 trials attempted to balance WSEL

WARNING  SECNO=      4.260  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=      4.260  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=      4.460  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      4.460  PROFILE=  1  Probable minimum specific energy
CAUTION  SECNO=      4.460  PROFILE=  1  20 trials attempted to balance WSEL
CAUTION  SECNO=      4.460  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      4.460  PROFILE=  2  Probable minimum specific energy
CAUTION  SECNO=      4.460  PROFILE=  2  20 trials attempted to balance WSEL

WARNING  SECNO=      4.310  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=      4.810  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=      5.320  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      5.320  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=      5.320  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      5.320  PROFILE=  2  Minimum specific energy

WARNING  SECNO=      5.720  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=      5.720  PROFILE=  2  KRATIO outside acceptable range
```

```
*-------------------------------------*
:              S U M P C              :
:                                     :
:   Interactive Summary Printout      :
:   for MS/PC-DOS micro computers     :
:            May 1991                 :
*-------------------------------------*
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NOTE - Asterisk (*) at left of profile number
indicates message in summary of errors
list

L. RIEDEL-NORTH CASCADES   DATA OUTPUT FILE STEHE 502.OUT

Summary Printout Table 150

		SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS
*	u	4.48	.00	.00	.00	1200.40	16300.00	1208.41	1208.41
*		4.48	.00	.00	.00	1200.40	18800.00	1208.79	1208.79
*	v	4.81	1850.00	.00	.00	1214.60	16300.00	1225.09	.00
*		4.81	1850.00	.00	.00	1214.60	18800.00	1225.48	.00
	w	5.12	1650.00	.00	.00	1224.10	16300.00	1236.46	.00
		5.12	1650.00	.00	.00	1224.10	18800.00	1236.77	.00
*	x	5.32	1000.00	.00	.00	1239.20	16300.00	1250.69	1250.69
*		5.32	1000.00	.00	.00	1239.20	18800.00	1251.02	1251.02
*	y	5.72	2100.00	.00	.00	1258.10	16300.00	1258.49	.00
*		5.72	2100.00	.00	.00	1258.10	18800.00	1258.87	.00
*	z	6.04	1675.00	.00	.00	1266.80	16300.00	1274.01	1274.01
*		6.04	1675.00	.00	.00	1266.80	18800.00	1274.45	1274.45
	AA	6.18	675.00	.00	.00	1273.50	16300.00	1281.58	.00
		6.18	675.00	.00	.00	1273.50	18800.00	1281.70	.00
	AB	6.38	1030.00	.00	.00	1278.70	16300.00	1288.57	.00
		6.38	1030.00	.00	.00	1278.70	18800.00	1289.10	.00
	AC	6.57	1030.00	.00	.00	1286.30	16300.00	1295.15	.00
		6.57	1030.00	.00	.00	1286.30	18800.00	1295.64	.00
*	AD	6.64	400.00	.00	.00	1295.50	16300.00	1303.83	1303.83
*		6.64	400.00	.00	.00	1295.50	18800.00	1304.49	1304.49
*	AE	6.73	450.00	.00	.00	1297.00	14928.00	1308.97	.00
*		6.73	450.00	.00	.00	1297.00	17217.00	1309.60	.00
*	AF	6.91	950.00	.00	.00	1302.00	14928.00	1312.44	1312.20
*		6.91	950.00	.00	.00	1302.00	17217.00	1312.97	1312.97
*	AG	7.03	700.00	.00	.00	1309.00	14928.00	1320.45	.00
*		7.03	700.00	.00	.00	1309.00	17217.00	1321.31	.00
*	AH	7.30	1425.00	.00	.00	1324.40	14928.00	1333.79	1333.79
*		7.30	1425.00	.00	.00	1324.40	17217.00	1334.32	1334.32
*	AI	7.45	775.00	.00	.00	1329.60	14928.00	1345.65	1345.65
*		7.45	775.00	.00	.00	1329.60	17217.00	1346.45	1346.45
*	AJ	7.58	925.00	.00	.00	1343.30	14928.00	1352.67	.00
*		7.58	925.00	.00	.00	1343.30	17217.00	1353.16	.00
*	AK	7.87	1200.00	.00	.00	1354.60	14928.00	1363.40	1363.40
*		7.87	1200.00	.00	.00	1354.60	17217.00	1363.72	1363.72
	AL	7.98	350.00	.00	.00	1360.50	14928.00	1367.38	.00
		7.98	350.00	.00	.00	1360.50	17217.00	1367.73	.00
	AM	8.18	1025.00	.00	.00	1366.90	14928.00	1374.84	.00
		8.18	1025.00	.00	.00	1366.90	17217.00	1375.26	.00
*	AN	8.42	1500.00	.00	.00	1386.70	14928.00	1393.94	1393.94

	8.42	1300.00	.00	.00	1286.10	17217.00	1294.42	1294.42
* AO	8.51	1008.00	.00	.00	1398.30	14928.00	1405.88	.00
*	8.51	1008.00	.00	.00	1398.30	17217.00	1406.42	.00
* AP	8.96	1320.00	.00	.00	1411.20	14928.00	1419.29	1419.29
*	8.96	1320.00	.00	.00	1411.20	17217.00	1419.71	1419.71
AQ	9.20	1795.00	.00	.00	1432.40	14928.00	1439.88	1439.77
	9.20	1795.00	.00	.00	1432.40	17217.00	1440.27	1440.17

	EG	10K*S	VCH	AREA	0.01K	Q	CWSEL	DIFWSP
* U	1210.25	148.26	12.63	2207.52	1338.68	16300.00	1208.41	.00
*	1210.80	151.04	13.27	2475.33	1529.74	18800.00	1208.79	.39
* V	1225.71	52.80	6.91	2924.38	2243.26	16300.00	1225.02	.00
*	1226.21	51.94	7.19	3360.22	2603.37	18800.00	1225.48	.46
W	1237.36	100.52	8.34	3322.77	1628.75	16300.00	1236.46	.00
	1237.74	100.46	9.25	3735.69	1875.72	18800.00	1236.77	.31
* X	1251.96	82.94	10.77	2578.90	1789.22	16300.00	1250.69	.00
*	1252.64	84.98	11.24	2940.91	2039.40	18800.00	1251.02	.32
* Y	1263.36	40.92	5.93	4170.25	2567.01	16300.00	1263.49	.00
*	1264.25	39.64	6.11	4839.07	2986.10	18800.00	1263.87	.38
* Z	1275.27	126.37	9.93	2390.19	1449.99	16300.00	1274.01	.00
*	1275.62	108.98	9.81	2920.44	1801.72	18800.00	1274.45	.44
AA	1282.36	86.05	3.31	3109.01	1757.16	16300.00	1281.53	.00
	1282.56	97.33	9.59	3320.90	1905.59	18800.00	1281.70	.17
AB	1289.62	60.71	9.30	2522.22	2091.97	16300.00	1288.57	.00
	1290.20	59.48	9.66	2994.95	2437.61	18800.00	1289.10	.53
AC	1296.09	65.31	3.30	2425.94	2009.24	16300.00	1295.15	.00
	1296.69	67.44	9.31	2685.33	2299.20	18800.00	1295.64	.49
* AD	1306.79	167.14	13.30	1184.52	1260.30	16300.00	1303.83	.00
*	1307.66	156.13	14.29	1338.69	1504.59	18800.00	1304.49	.66
* AE	1309.77	30.15	7.73	2205.20	2718.56	14928.00	1308.37	.00
*	1310.57	29.94	8.12	2563.35	3146.73	17217.00	1309.60	.73
* AF	1315.94	138.73	14.38	1038.17	1267.39	14928.00	1312.44	.00
*	1316.90	148.49	15.96	1124.18	1412.93	17217.00	1312.97	.53
* AG	1321.34	50.07	9.10	1940.34	2109.61	14928.00	1320.46	.00
*	1322.42	45.00	9.26	2223.38	2566.42	17217.00	1321.31	.86
* AH	1336.08	135.15	12.73	1583.36	1284.09	14928.00	1333.79	.00
*	1336.74	129.78	13.19	1816.51	1511.28	17217.00	1334.32	.54
* AI	1348.15	96.56	14.11	1548.96	1519.18	14928.00	1345.65	.00
*	1348.83	87.36	14.15	1912.18	1842.09	17217.00	1346.45	.79
* AJ	1353.44	35.46	7.32	3120.38	2506.99	14928.00	1352.67	.00
*	1354.01	36.61	7.98	3519.64	2846.55	17217.00	1352.16	.49
* AK	1364.56	113.24	11.24	2110.26	1372.32	14928.00	1363.40	.00
*	1365.05	116.88	11.70	2371.74	1579.08	17217.00	1363.72	.32
AL	1367.94	72.32	7.48	2689.71	1748.16	14928.00	1367.38	.00
	1368.34	72.96	7.86	2987.37	2015.68	17217.00	1367.73	.35
AM	1375.95	78.54	9.40	1862.04	1684.47	14928.00	1374.84	.00
	1376.47	80.75	9.99	2030.64	1915.95	17217.00	1375.26	.42
* AN	1396.22	169.97	12.37	1486.12	1145.02	14928.00	1393.94	.00
*	1396.39	164.90	13.45	1669.52	1340.75	17217.00	1394.42	.48
* AO	1406.95	66.38	9.94	2300.30	1825.44	14928.00	1405.88	.00
*	1407.51	67.90	10.31	2597.79	2089.46	17217.00	1406.43	.55
* AP	1421.08	116.25	11.47	1886.01	1384.38	14928.00	1419.29	.00
*	1421.50	114.71	11.94	2206.84	1607.35	17217.00	1419.71	.42
AQ	1441.43	110.76	11.14	2103.71	1418.45	14928.00	1439.38	.00
	1441.39	111.79	11.81	2299.64	1628.48	17217.00	1440.27	.39

		DIFWCX	DIFKWC	TOFWID	LCH
*	U	.00	.02	665.10	.00
*		.00	.40	715.39	.00
*	V	16.62	.00	893.25	1850.00
*		16.69	.00	999.17	1850.00
	W	11.43	.00	1310.01	1650.00
		11.29	.00	1323.41	1650.00
*		14.23	.00	1100.29	1000.00
*	X	14.24	.00	1144.72	1000.00
*	Y	12.30	.00	1711.34	2100.00
*		12.35	.00	1783.93	2100.00
*	Z	10.52	.00	1111.30	1675.00
*		10.58	.00	1288.11	1675.00
	AA	7.52	.00	1215.31	675.00
		7.23	.00	1233.52	675.00
	AB	7.04	.00	852.87	1030.00
		7.40	.00	932.18	1030.00
	AC	6.58	.00	527.60	1030.00
		6.54	.00	555.19	1030.00
*	AD	8.68	.00	214.59	400.00
*		8.85	.00	240.22	400.00
*	AE	5.04	.00	434.56	450.00
*		5.10	.00	522.71	450.00
*	AF	3.58	.00	159.75	950.00
*		3.37	.00	166.54	950.00
*	AG	3.01	.00	327.55	700.00
*		3.34	.00	333.98	700.00
*		13.33	.00	507.78	1425.00
*	AH	13.01	.00	545.99	1425.00
*		11.87	.00	353.02	775.00
*	AI	12.12	.00	524.13	775.00
*	AJ	7.02	.00	809.48	925.00
*		6.72	.00	312.92	925.00
*	AK	10.73	.00	790.50	1200.00
*		10.56	.00	826.19	1200.00
	AL	3.98	.00	860.55	350.00
		4.01	.00	860.39	350.00
	AM	7.46	.00	477.90	1025.00
		7.53	.00	517.73	1025.00
*	AN	19.10	.00	379.47	1500.00
*		19.16	.00	383.13	1500.00
*	AO	11.94	.00	462.95	1003.00
*		12.01	.00	599.55	1003.00
*	AP	13.41	.00	759.79	1320.00
*		13.28	.00	761.91	1320.00
	AQ	20.59	.00	739.19	1795.00
		20.36	.00	777.49	1795.00

Summary of Errors and Special Notes

```
CAUTION  SECNO=   4.460  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   4.460  PROFILE=  2  Critical depth assumed

WARNING  SECNO=   4.810  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=   4.810  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=   5.320  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   5.320  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=   5.320  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   5.320  PROFILE=  2  Minimum specific energy

WARNING  SECNO=   5.720  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=   5.720  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=   6.040  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   6.040  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=   6.040  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   6.040  PROFILE=  2  Minimum specific energy

CAUTION  SECNO=   6.640  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   6.640  PROFILE=  1  Probable minimum specific energy
CAUTION  SECNO=   6.640  PROFILE=  1  20 trials attempted to balance WSEL
CAUTION  SECNO=   6.640  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   6.640  PROFILE=  2  Probable minimum specific energy
CAUTION  SECNO=   6.640  PROFILE=  2  20 trials attempted to balance WSEL

WARNING  SECNO=   6.730  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=   6.730  PROFILE=  2  KRATIO outside acceptable range
WARNING  SECNO=   6.910  PROFILE=  1  KRATIO outside acceptable range
CAUTION  SECNO=   6.910  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   6.910  PROFILE=  2  Minimum specific energy

WARNING  SECNO=   7.030  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=   7.030  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=   7.300  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   7.300  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=   7.300  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   7.300  PROFILE=  2  Minimum specific energy

CAUTION  SECNO=   7.450  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=   7.450  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=   7.450  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=   7.450  PROFILE=  2  Minimum specific energy
```

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WARNING  SECNO=      7.630  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=      7.630  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=      7.870  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      7.870  PROFILE=  1  Probable minimum specific energy
CAUTION  SECNO=      7.870  PROFILE=  1  20 trials attempted to balance WSEL
CAUTION  SECNO=      7.870  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      7.870  PROFILE=  2  Probable minimum specific energy
CAUTION  SECNO=      7.870  PROFILE=  2  20 trials attempted to balance WSEL

CAUTION  SECNO=      8.420  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      8.420  PROFILE=  1  Probable minimum specific energy
CAUTION  SECNO=      8.420  PROFILE=  1  20 trials attempted to balance WSEL
CAUTION  SECNO=      8.420  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      8.420  PROFILE=  2  Probable minimum specific energy
CAUTION  SECNO=      8.420  PROFILE=  2  20 trials attempted to balance WSEL

WARNING  SECNO=      8.610  PROFILE=  1  KRATIO outside acceptable range
WARNING  SECNO=      8.610  PROFILE=  2  KRATIO outside acceptable range
CAUTION  SECNO=      8.860  PROFILE=  1  Critical depth assumed
CAUTION  SECNO=      8.860  PROFILE=  1  Minimum specific energy
CAUTION  SECNO=      8.860  PROFILE=  2  Critical depth assumed
CAUTION  SECNO=      8.860  PROFILE=  2  Minimum specific energy
```
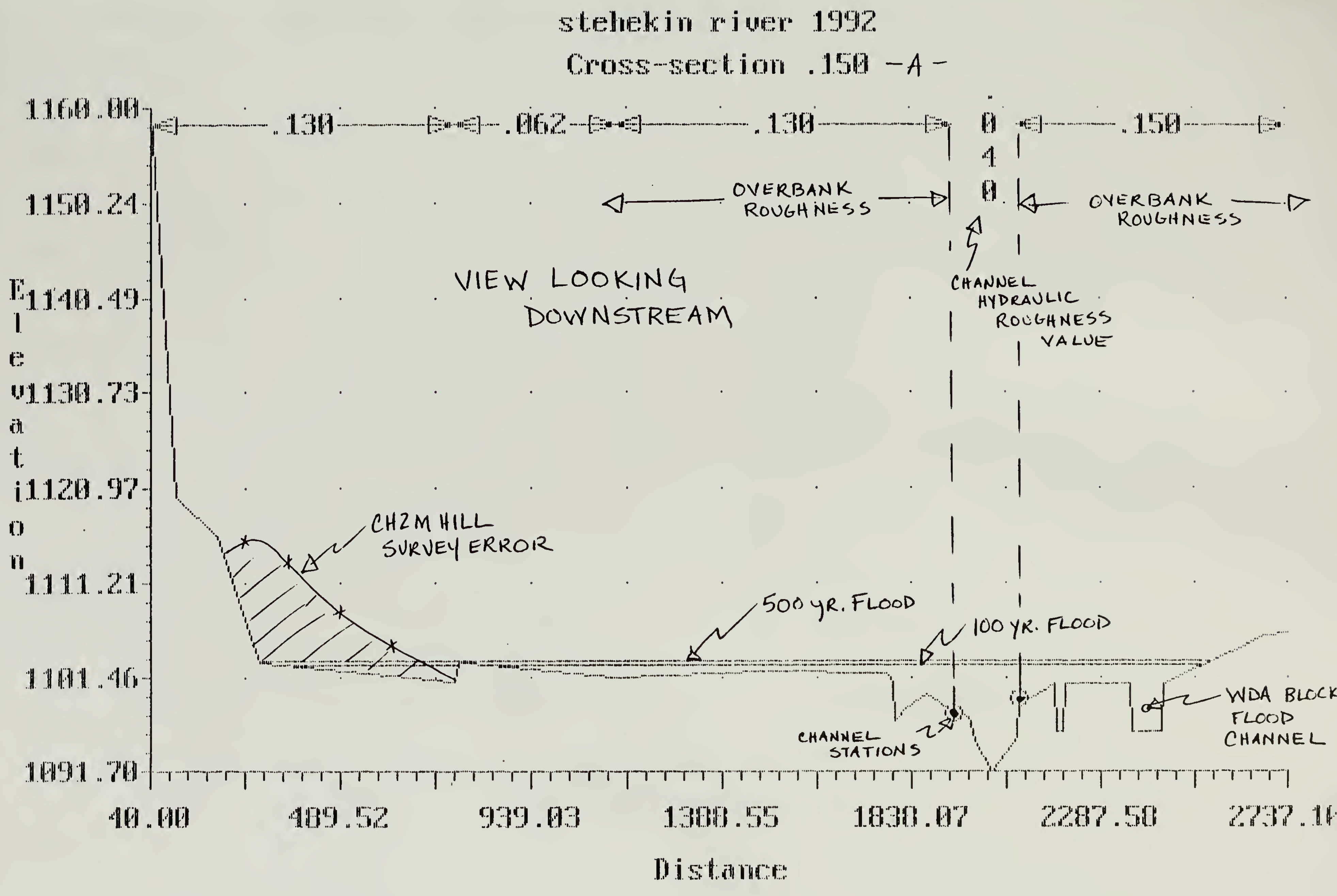
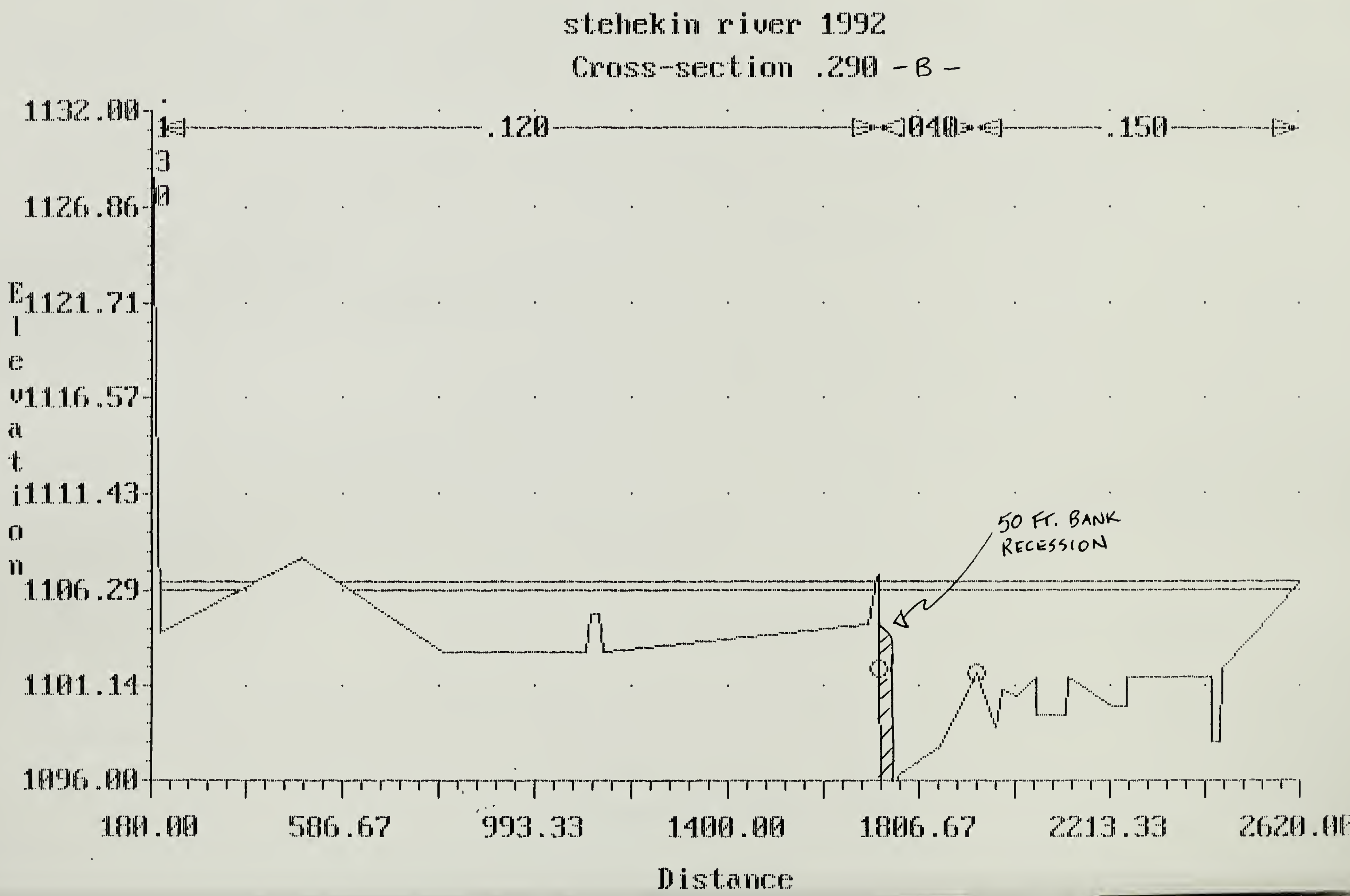
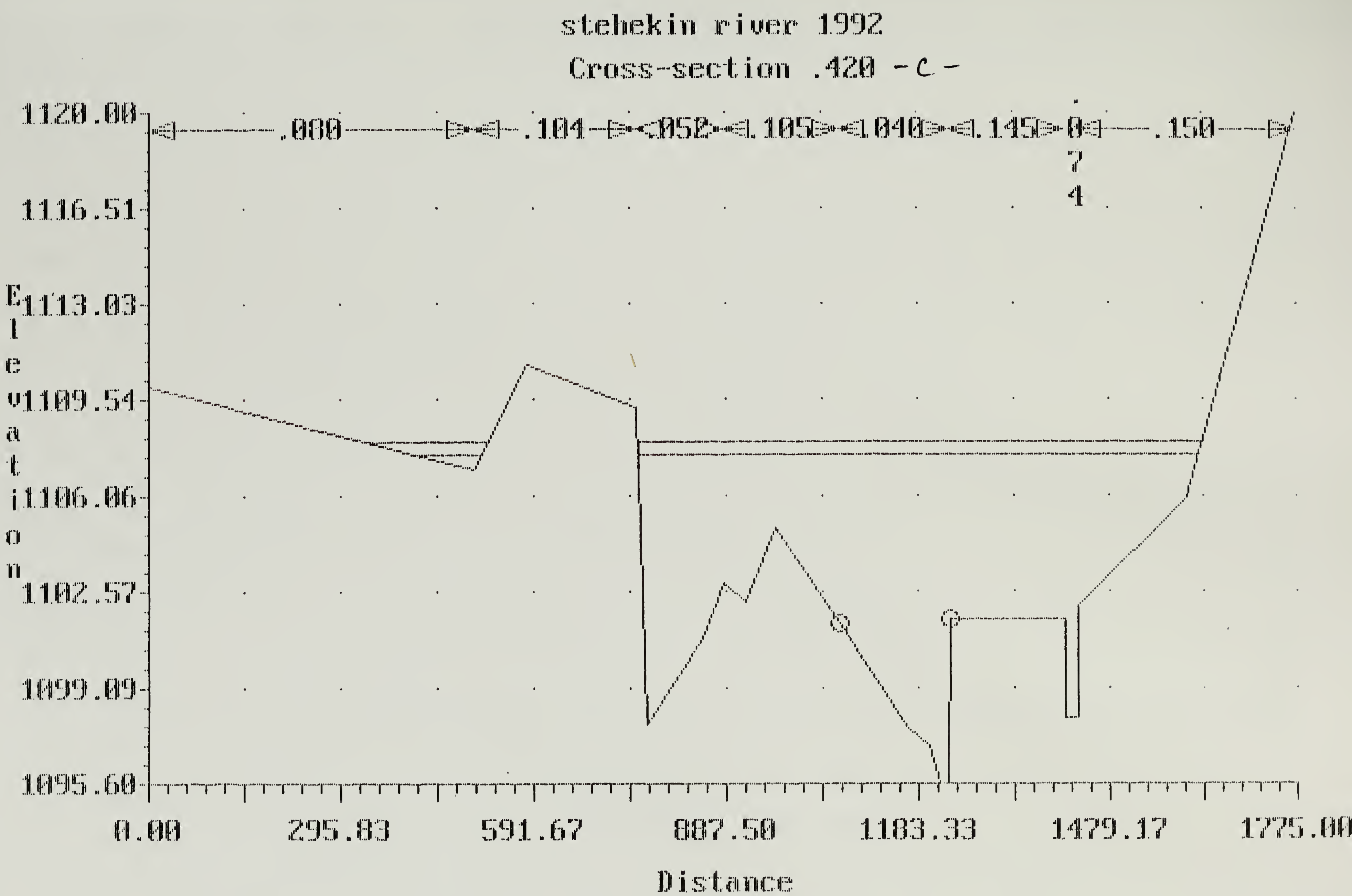

APPENDIX C
CROSS SECTION PLOTS

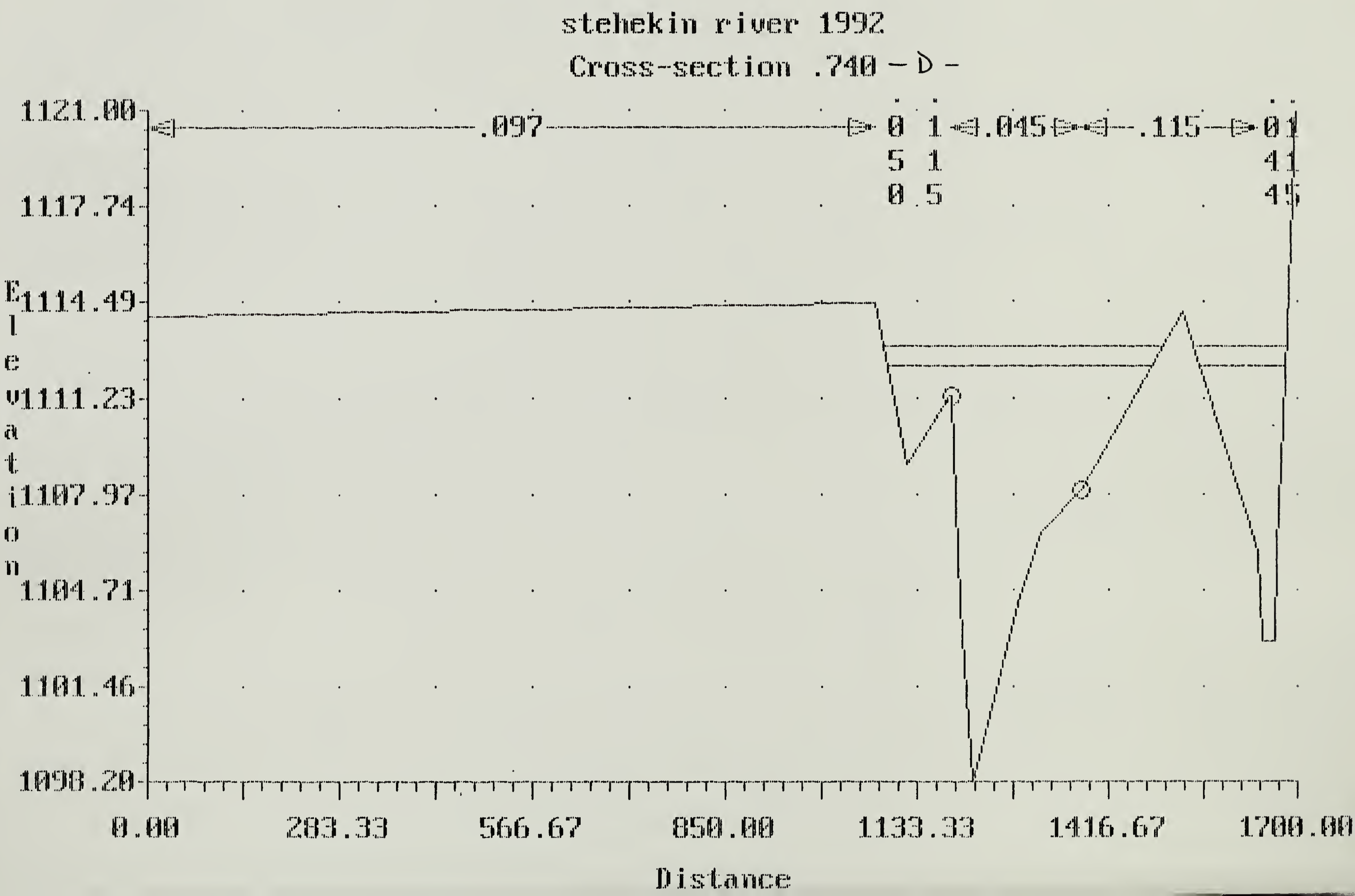


stehekin river 1992
Cross-section .150 -A-
.130
.062
.130
0
4
0
.150
OVERBANK ROUGHNESS
OVERBANK ROUGHNESS
CHANNEL HYDRAULIC ROUGHNESS VALUE
VIEW LOOKING DOWNSTREAM
CH2M HILL SURVEY ERROR
500 YR. FLOOD
100 YR. FLOOD
CHANNEL STATIONS
WDA BLOCK FLOOD CHANNEL
Elevation
1160.00
1150.24
1140.49
1130.73
1120.97
1111.21
1101.46
1091.70
40.00
489.52
939.03
1388.55
1838.07
2287.58
2737.10
Distance

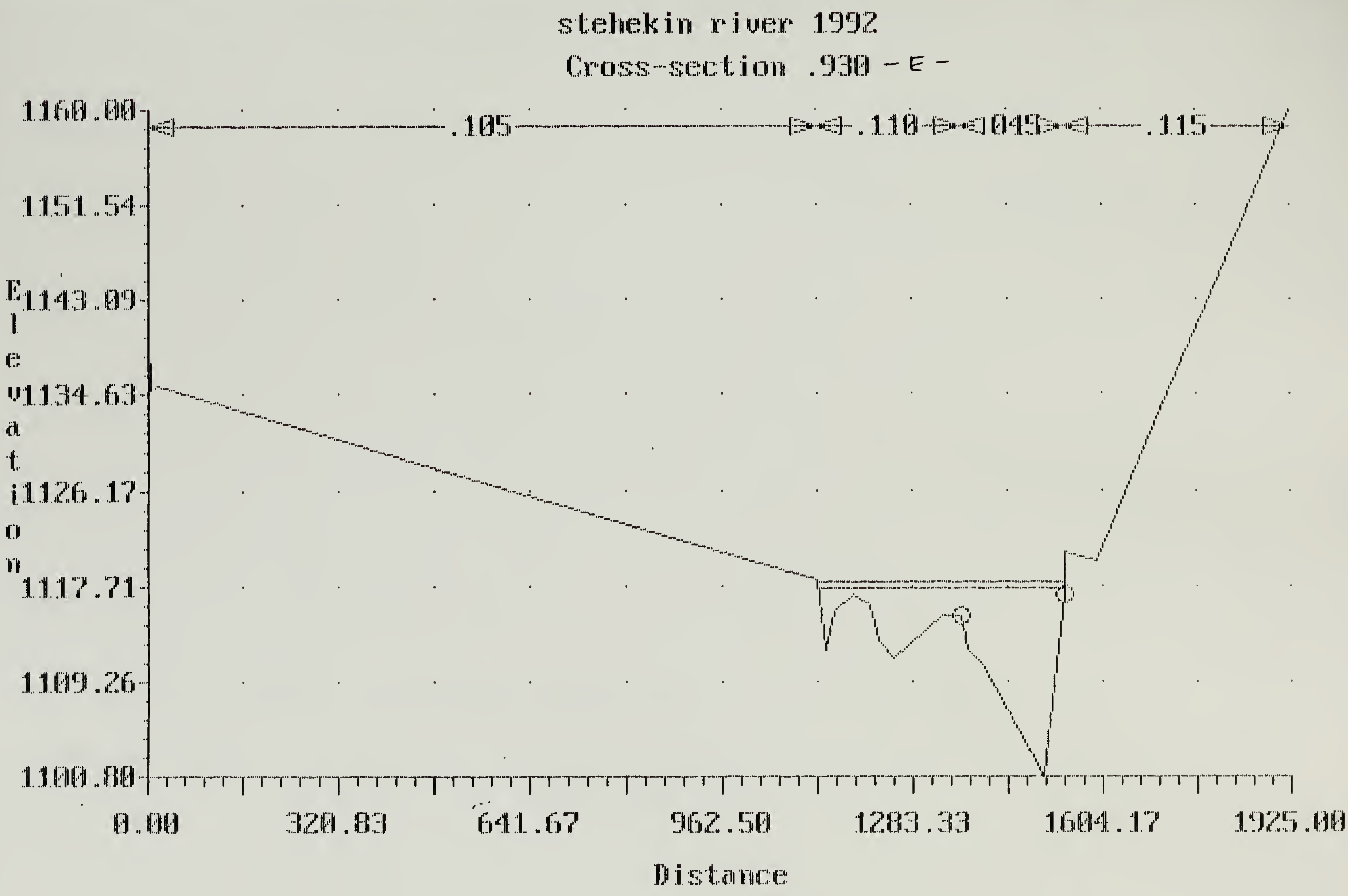


stehekin river 1992
Cross-section .290 - B -
1132.00
1126.86
1121.71
1116.57
1111.43
1106.29
1101.14
1096.00
Elevation
.120
.040
.150
50 FT. BANK RECESSION
100.00
586.67
993.33
1400.00
1806.67
2213.33
2620.00
Distance


stehekin river 1992
Cross-section .420 -C-
.000
.104
.052
.105
.040
.145
.074
.150
1120.00
1116.51
1113.03
1109.54
1106.06
1102.57
1099.09
1095.60
Elevation
0.00
295.83
591.67
887.50
1183.33
1479.17
1775.00
Distance

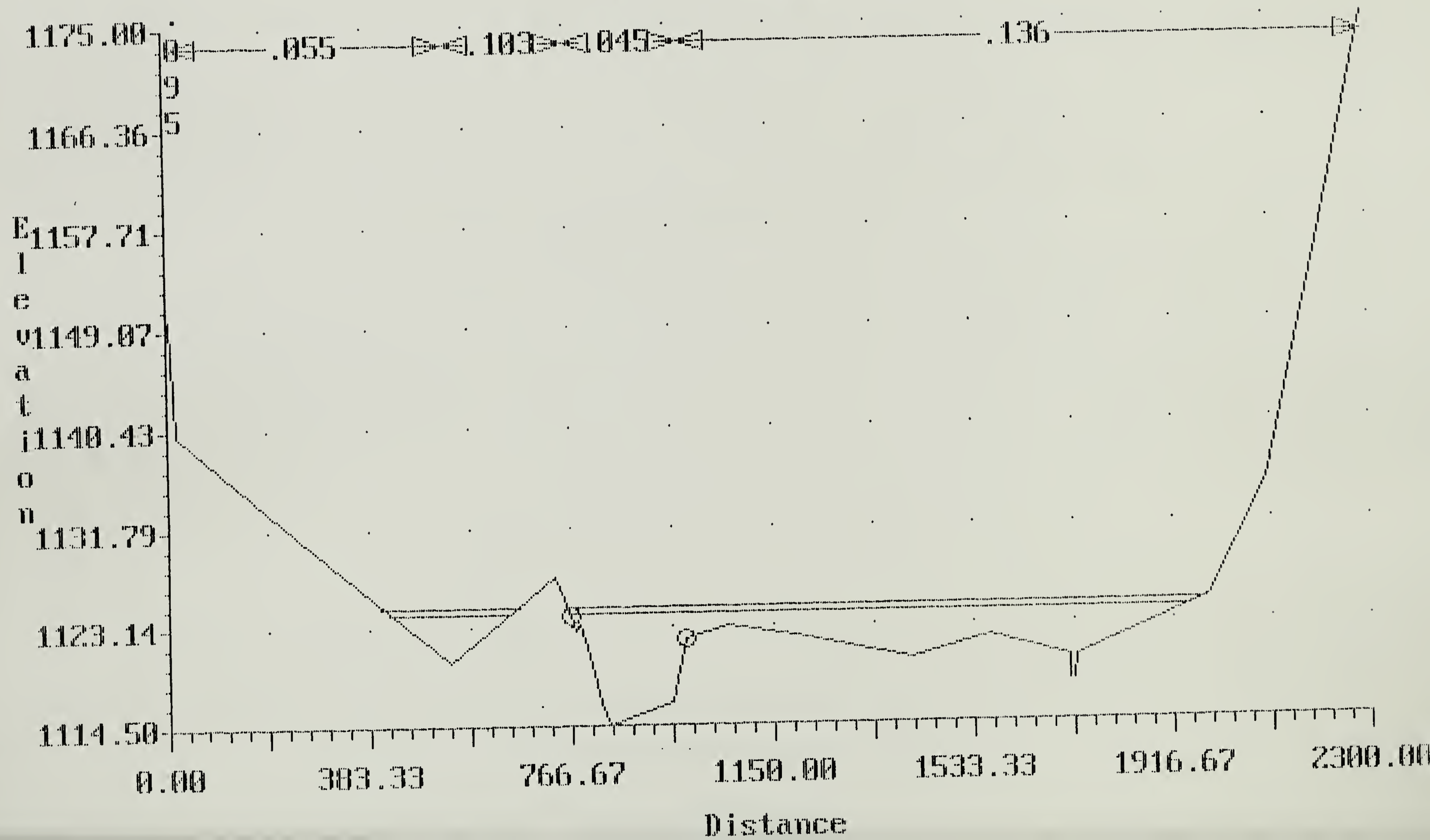


stehekin river 1992
Cross-section .740 – D –
.097
.045
.115
1121.00
1117.74
1114.49
1111.23
1107.97
1104.71
1101.46
1098.20
Elevation
0.00
283.33
566.67
850.00
1133.33
1416.67
1700.00
Distance


stehekin river 1992
Cross-section .930 - E -
.105
.110
045
.115
Elevation
1160.00
1151.54
1143.09
1134.63
1126.17
1117.71
1109.26
1100.00
0.00
320.83
641.67
962.50
1283.33
1604.17
1925.00
Distance

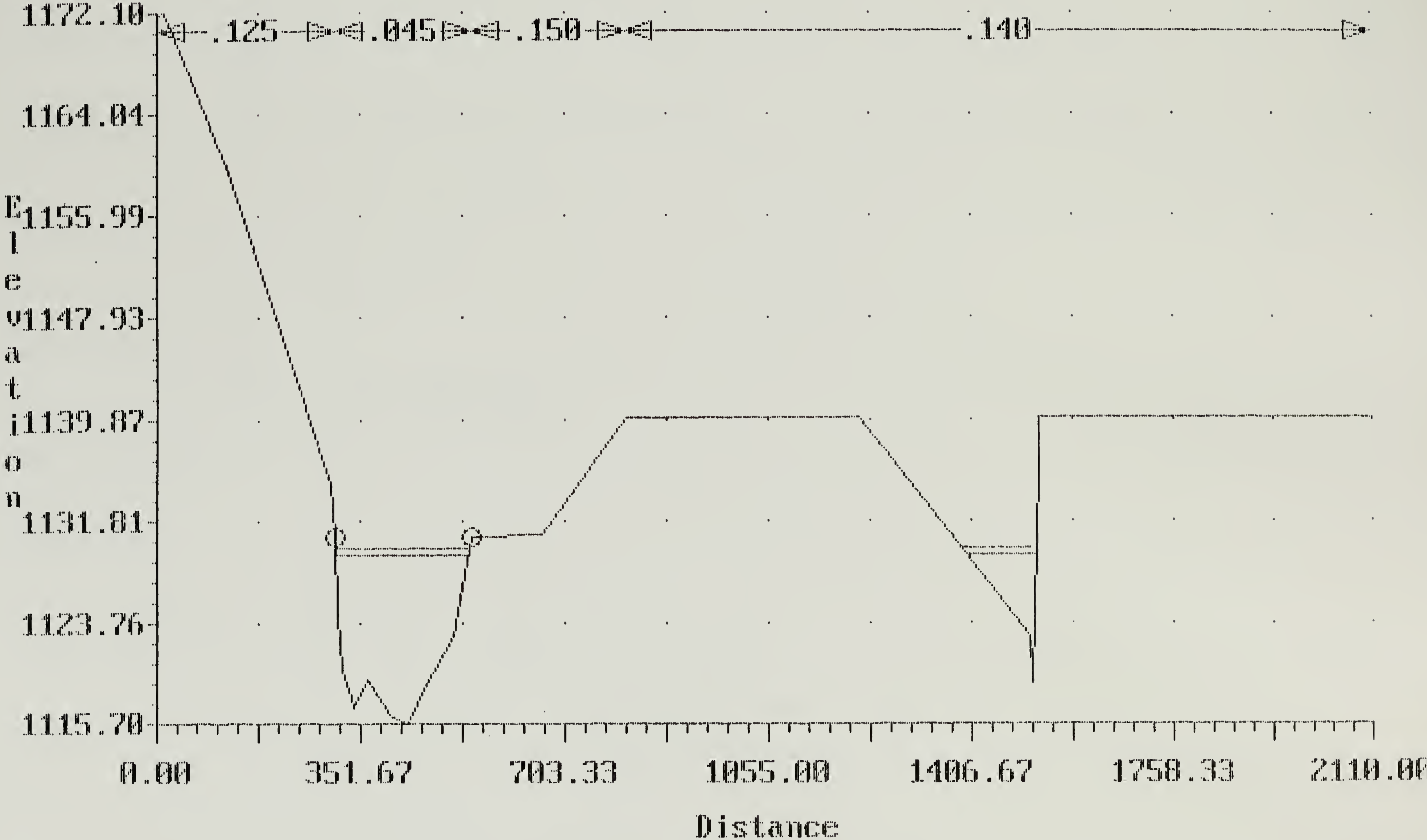
stehekin river 1992

Cross-section 1.160 -F-



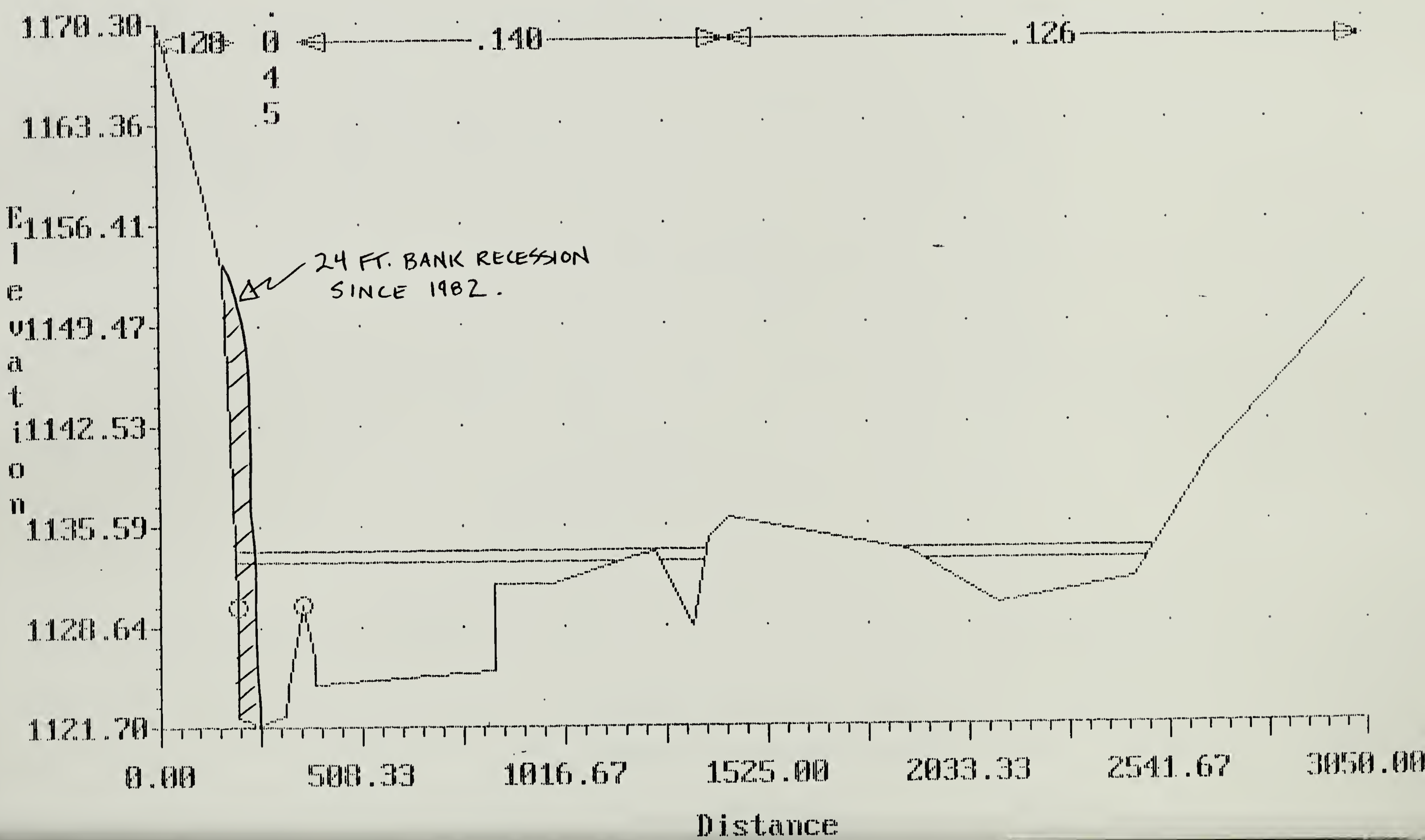
stehekin river 1992

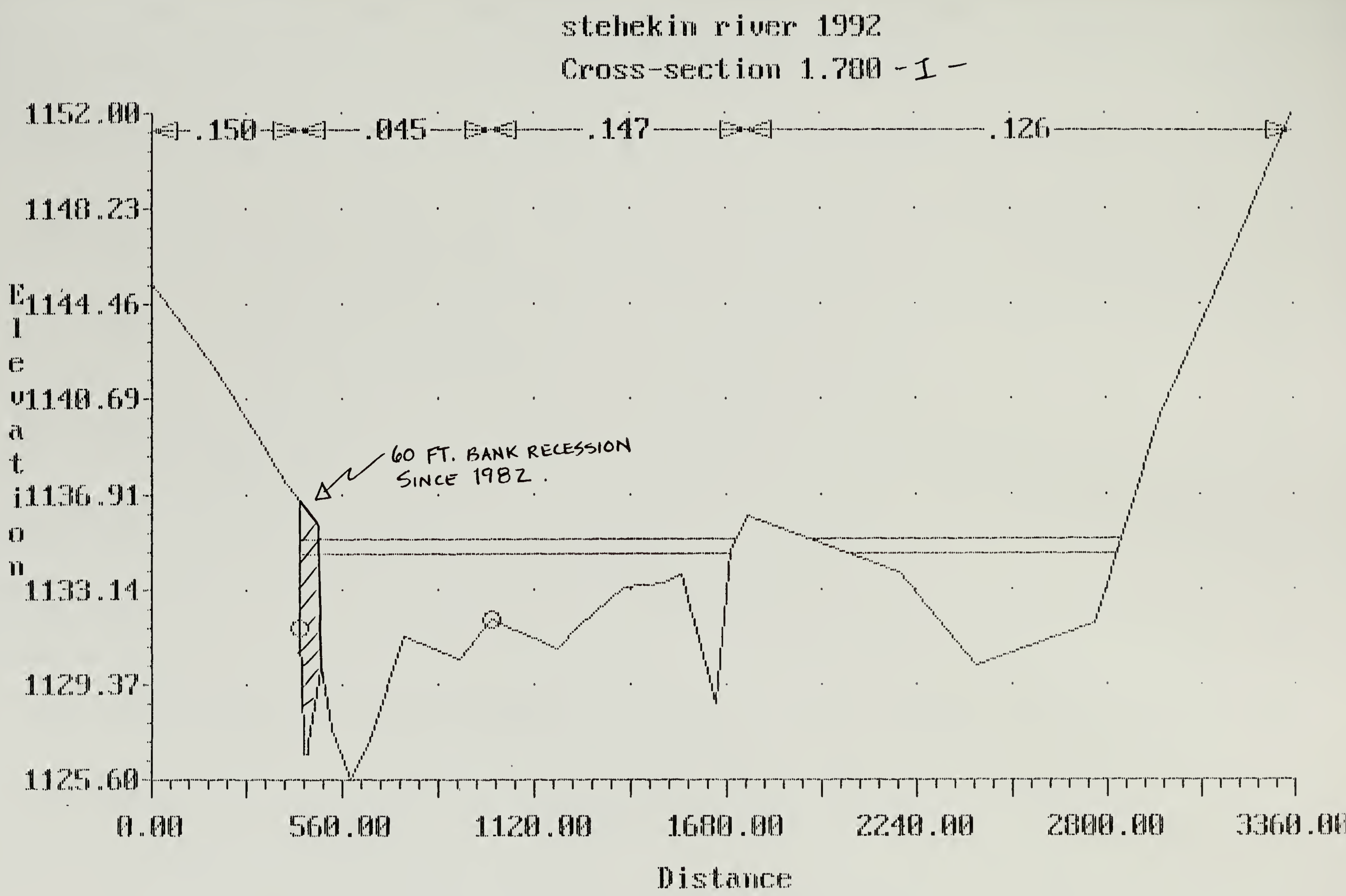
Cross-section 1.390 - 6 -



stehekin river 1992

Cross-section 1.620 - H -

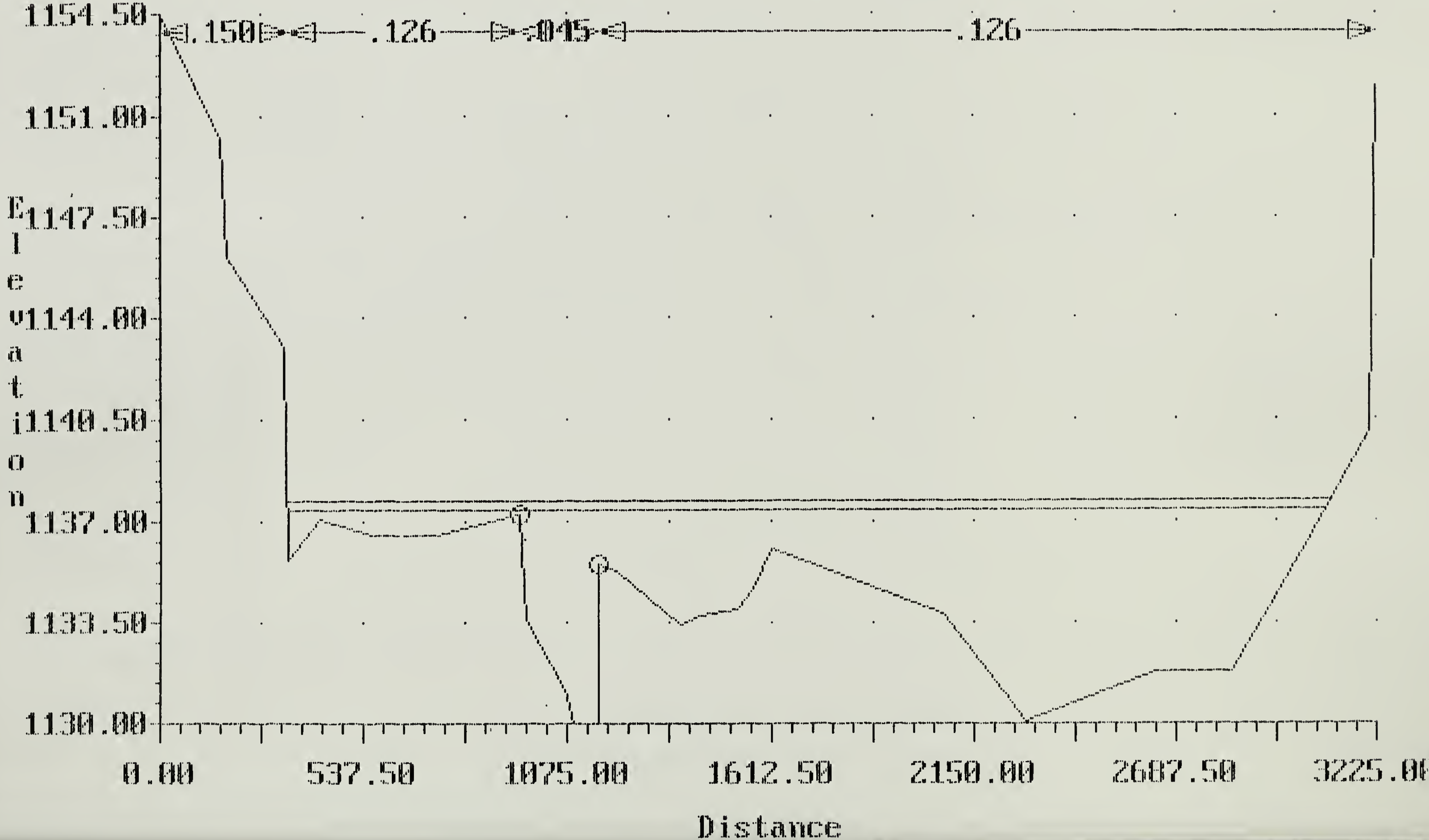


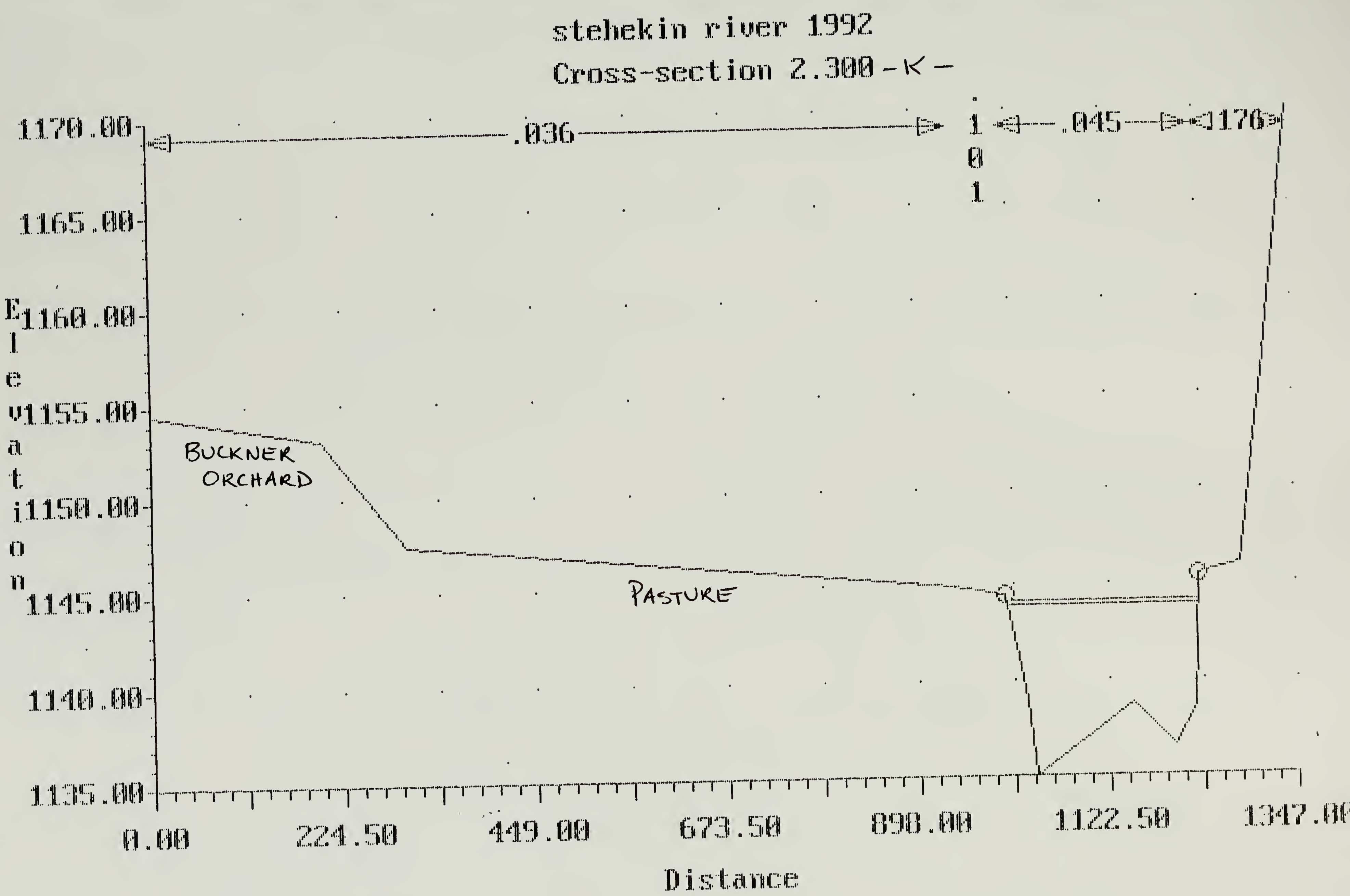


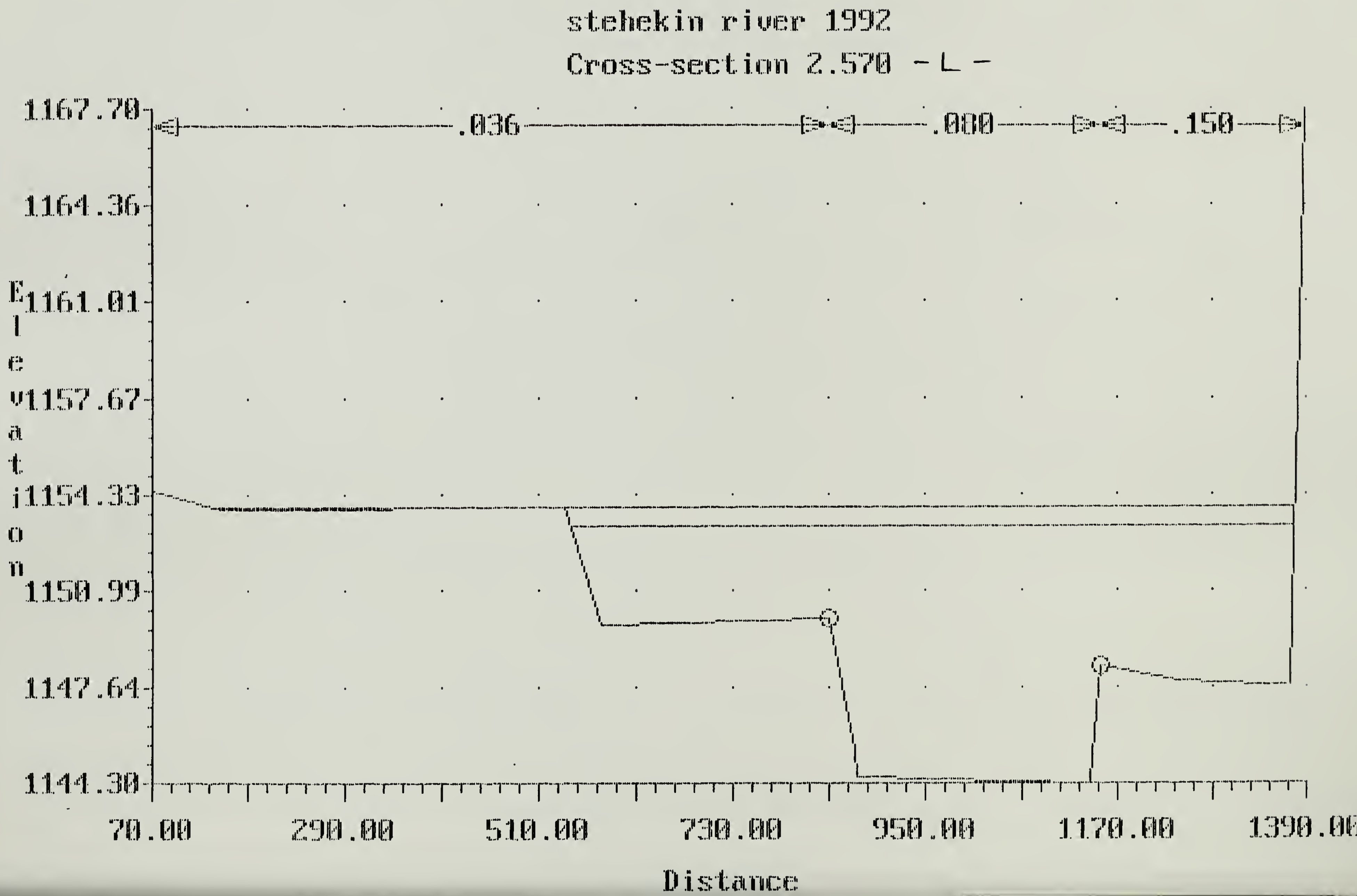
stehekin river 1992
Cross-section 1.700 -1-
.150
.045
.147
.126
60 FT. BANK RECESSION
SINCE 1982.
1152.00
1148.23
1144.46
1140.69
1136.91
1133.14
1129.37
1125.60
Elevation
0.00
560.00
1120.00
1680.00
2240.00
2800.00
3360.00
Distance

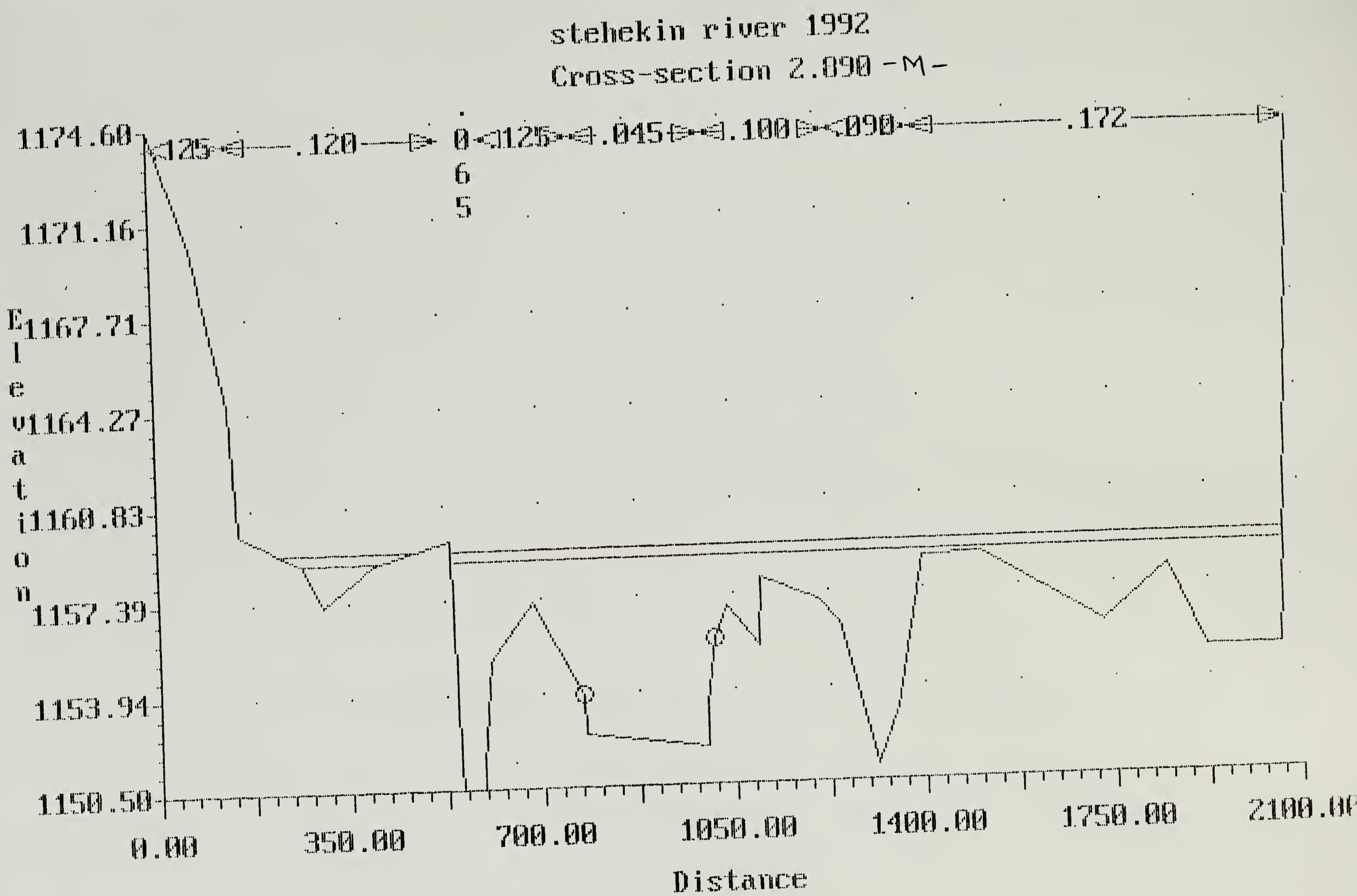
stehekin river 1992

Cross-section 2.000 -J-



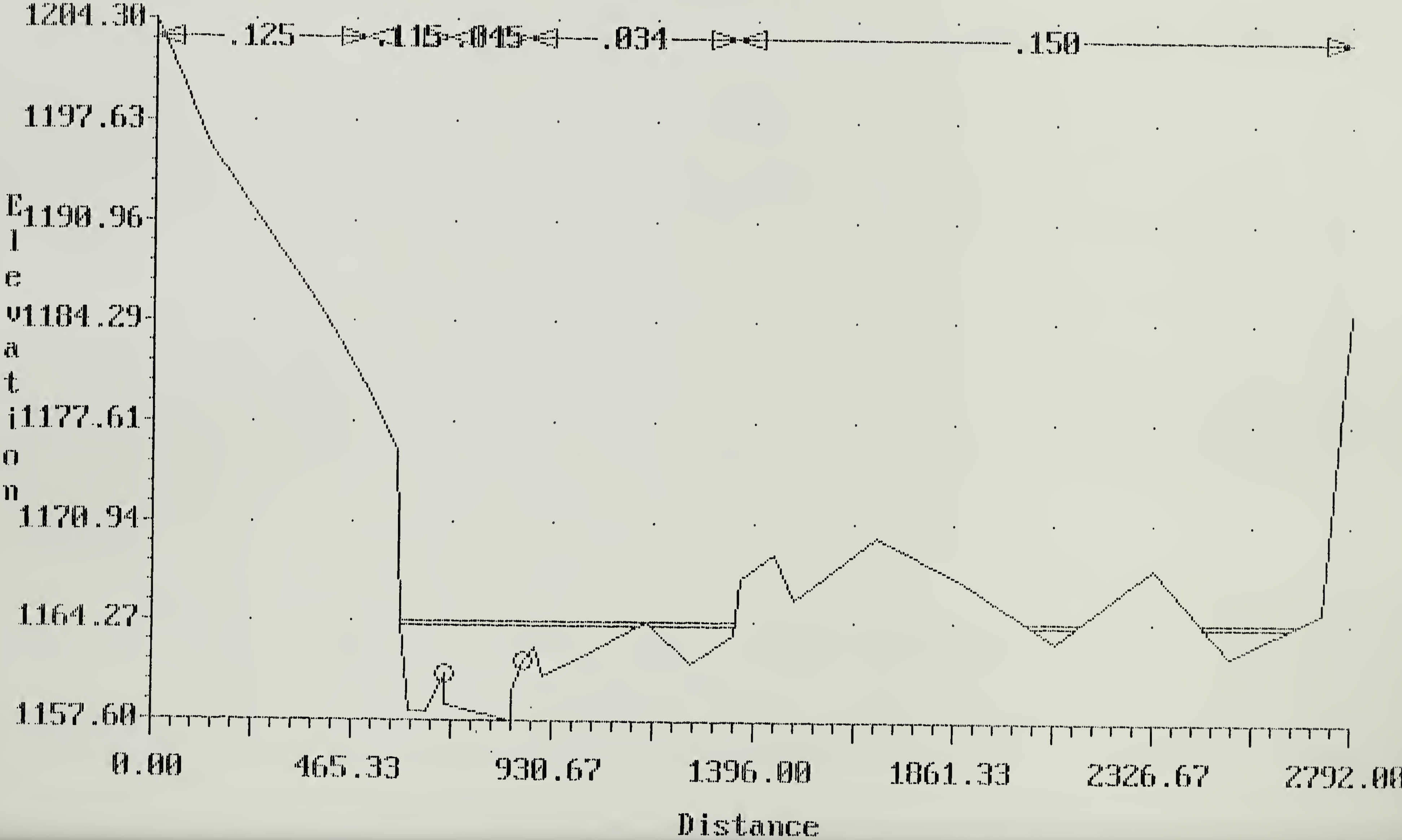

stehekin river 1992
Cross-section 2.300 -K-
.036
.045
176
1
0
1
1170.00
1165.00
1160.00
1155.00
1150.00
1145.00
1140.00
1135.00
Elevation
BUCKNER
ORCHARD
PASTURE
0.00
224.50
449.00
673.50
898.00
1122.50
Distance

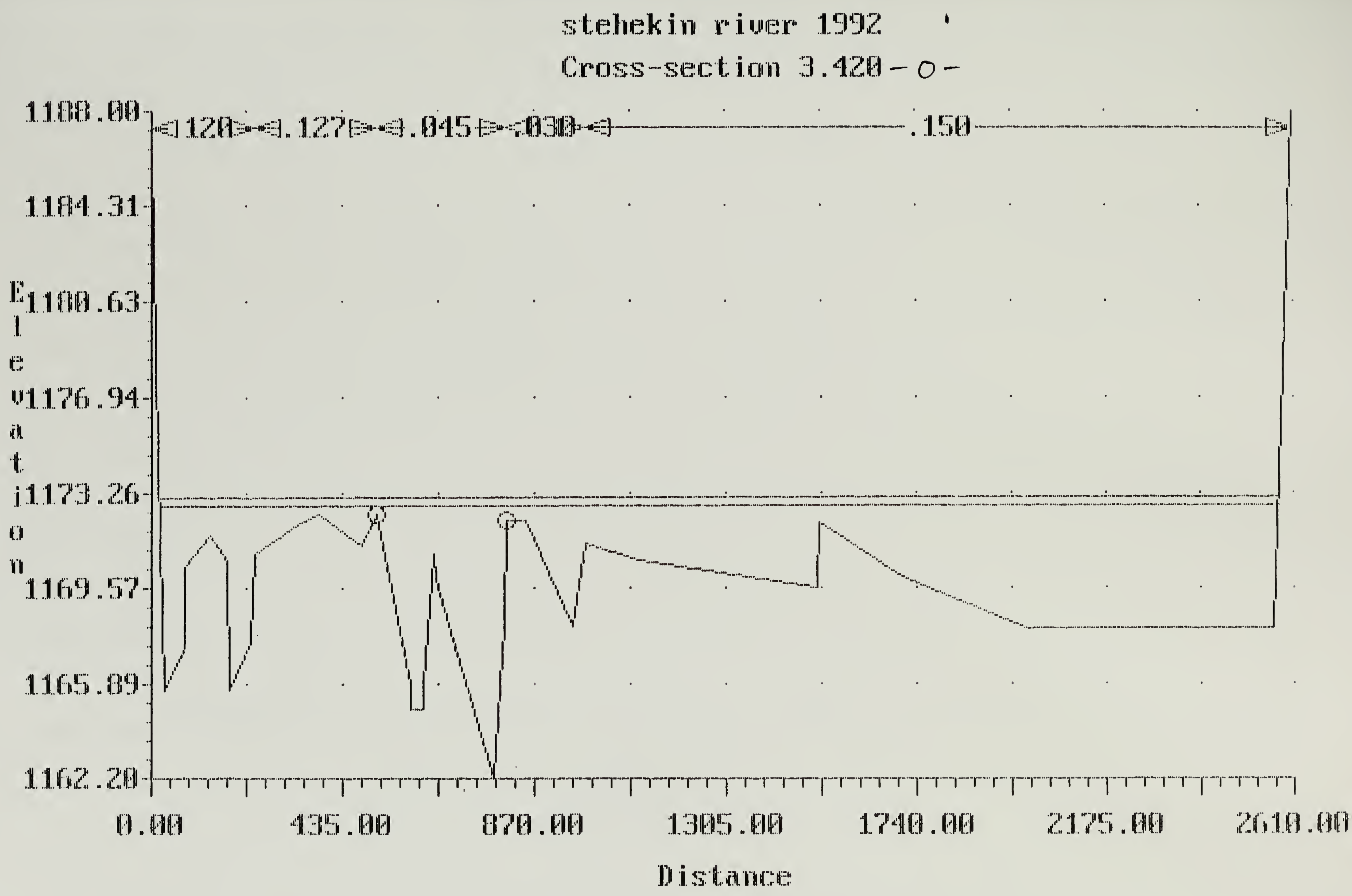

stehekin river 1992
Cross-section 2.570 - L -
.036
.000
.150
1167.70
1164.36
1161.01
1157.67
1154.33
1150.99
1147.64
1144.30
Elevation
70.00
290.00
510.00
730.00
950.00
1170.00
1390.00
Distance

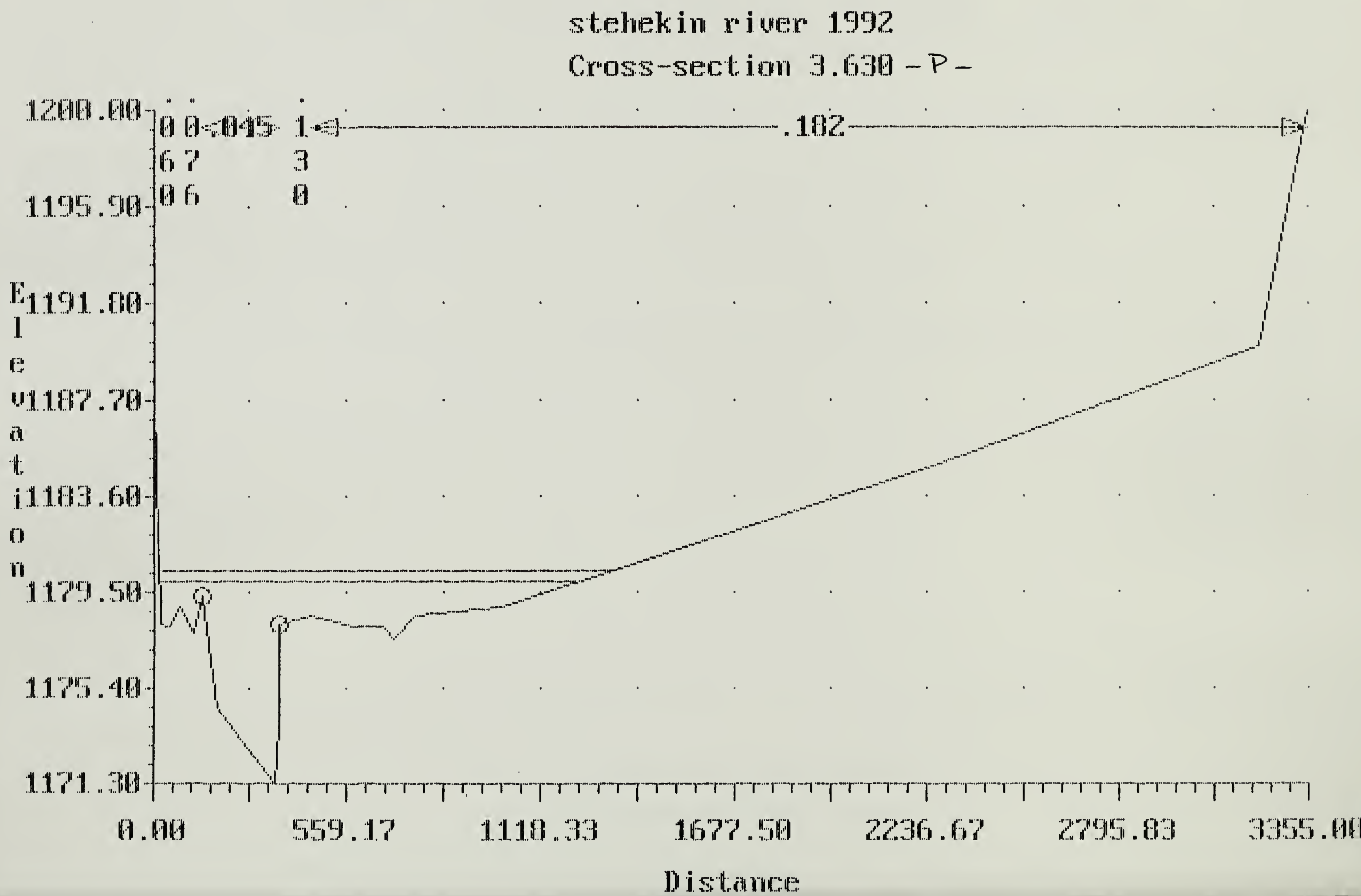

stehekin river 1992
Cross-section 2.090 -M-
.125
.120
0
6
5
.125
.045
.100
.090
.172
Elevation
1174.60
1171.16
1167.71
1164.27
1160.83
1157.39
1153.94
1150.50
0.00
350.00
700.00
1050.00
1400.00
1750.00
2100.00
Distance

stehekin river 1992

Cross-section 3.060 -N -

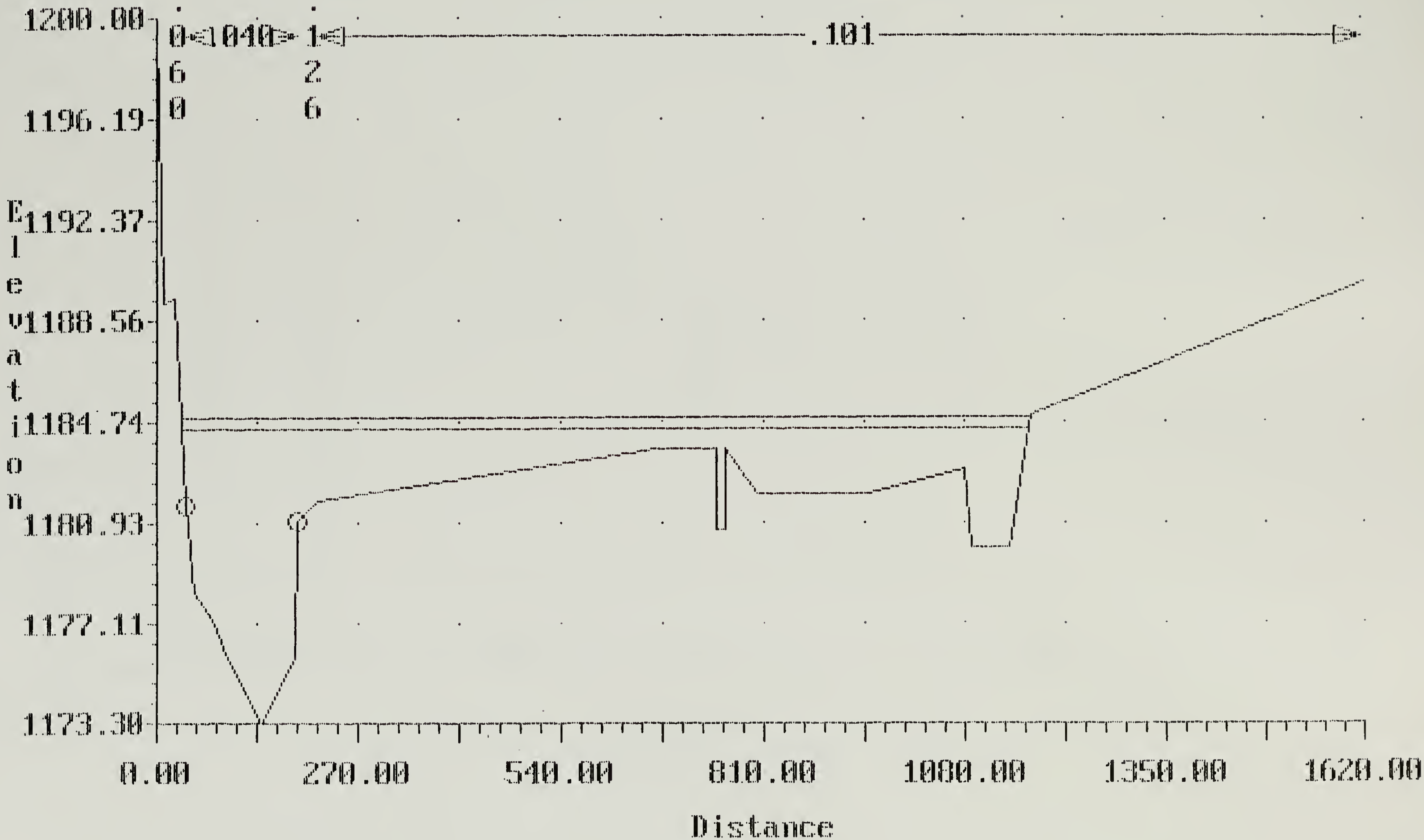


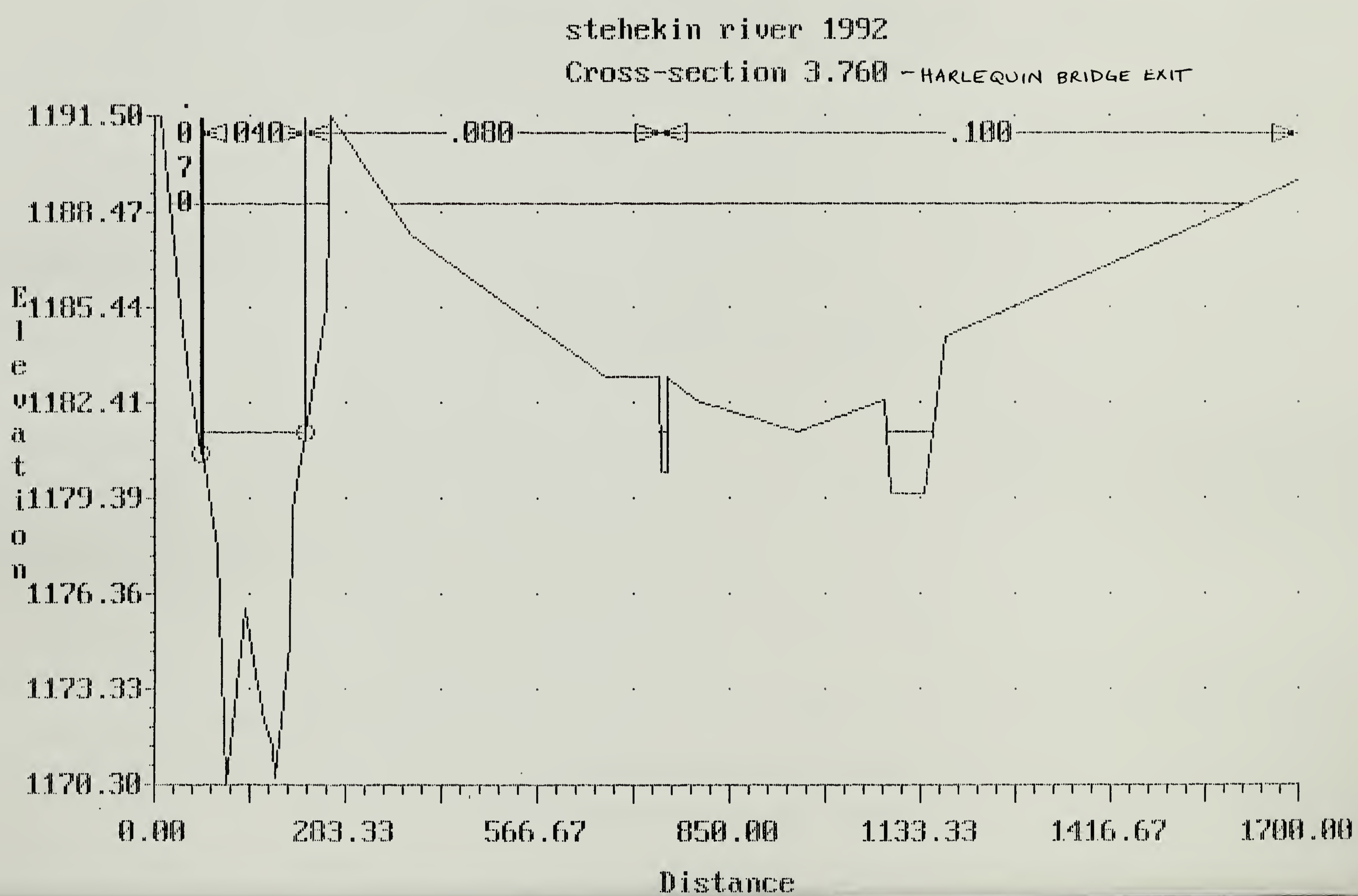

stehekin river 1992
Cross-section 3.420 - 0 -
.120
.127
.045
.030
.150
1188.00
1184.31
1180.63
1176.94
1173.26
1169.57
1165.89
1162.20
Elevation
0.00
435.00
870.00
1305.00
1740.00
2175.00
2610.00
Distance


stehekin river 1992
Cross-section 3.630 - P -
.102
Elevation
1200.00
1195.90
1191.80
1187.70
1183.60
1179.50
1175.40
1171.30
0.00
559.17
1118.33
1677.50
2236.67
2795.83
3355.00
Distance

stehekin river 1992

Cross-section 3.740 – Q –

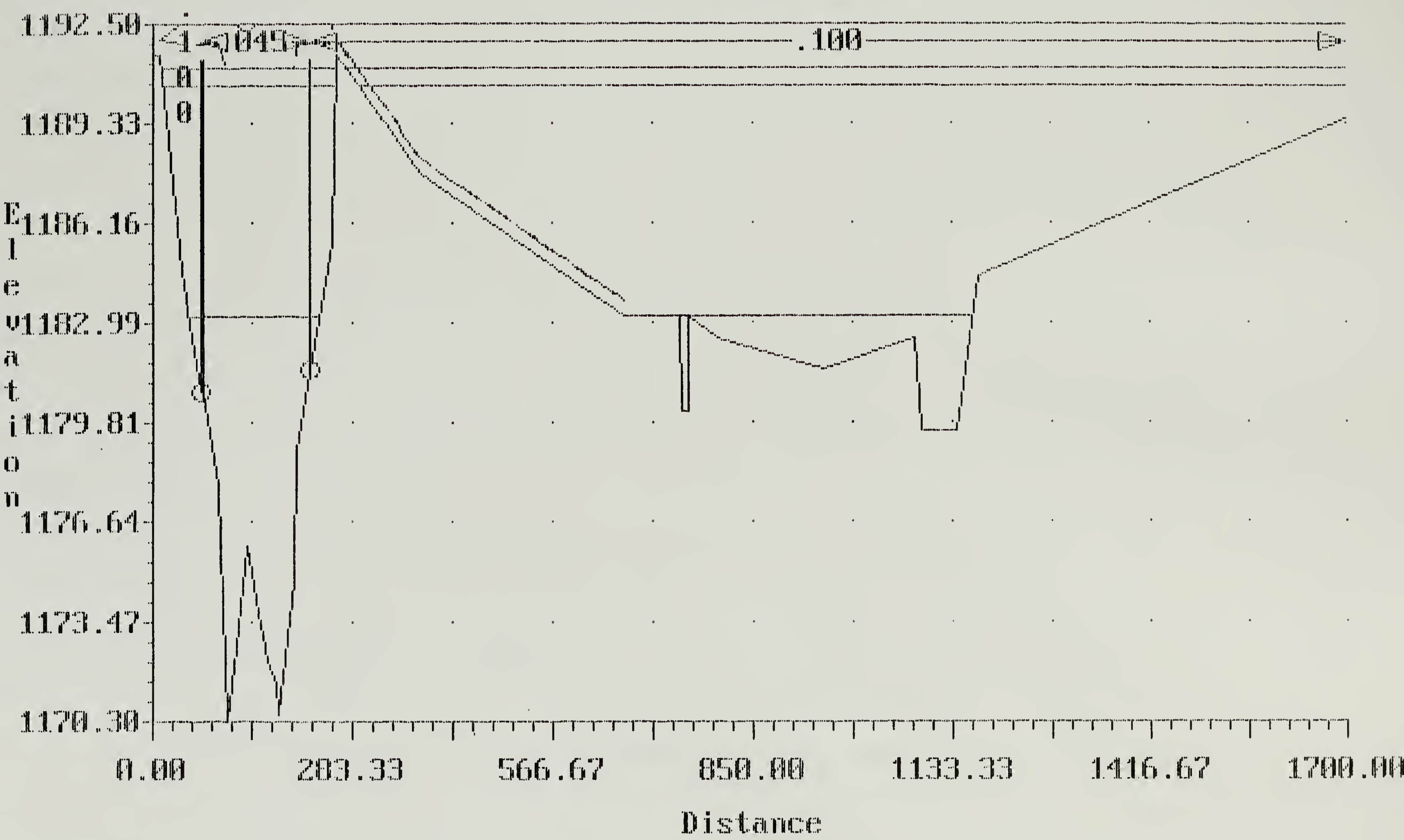


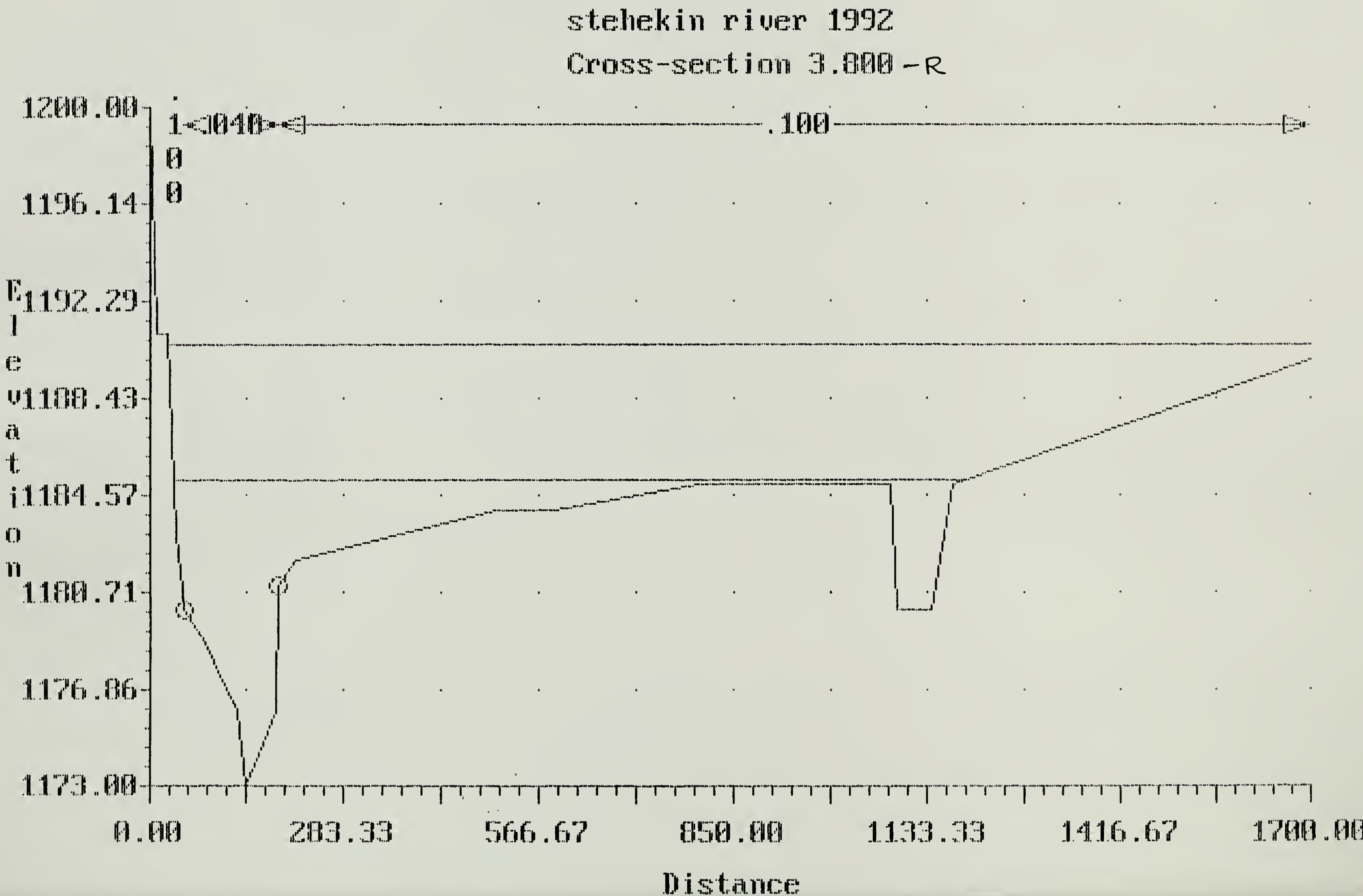


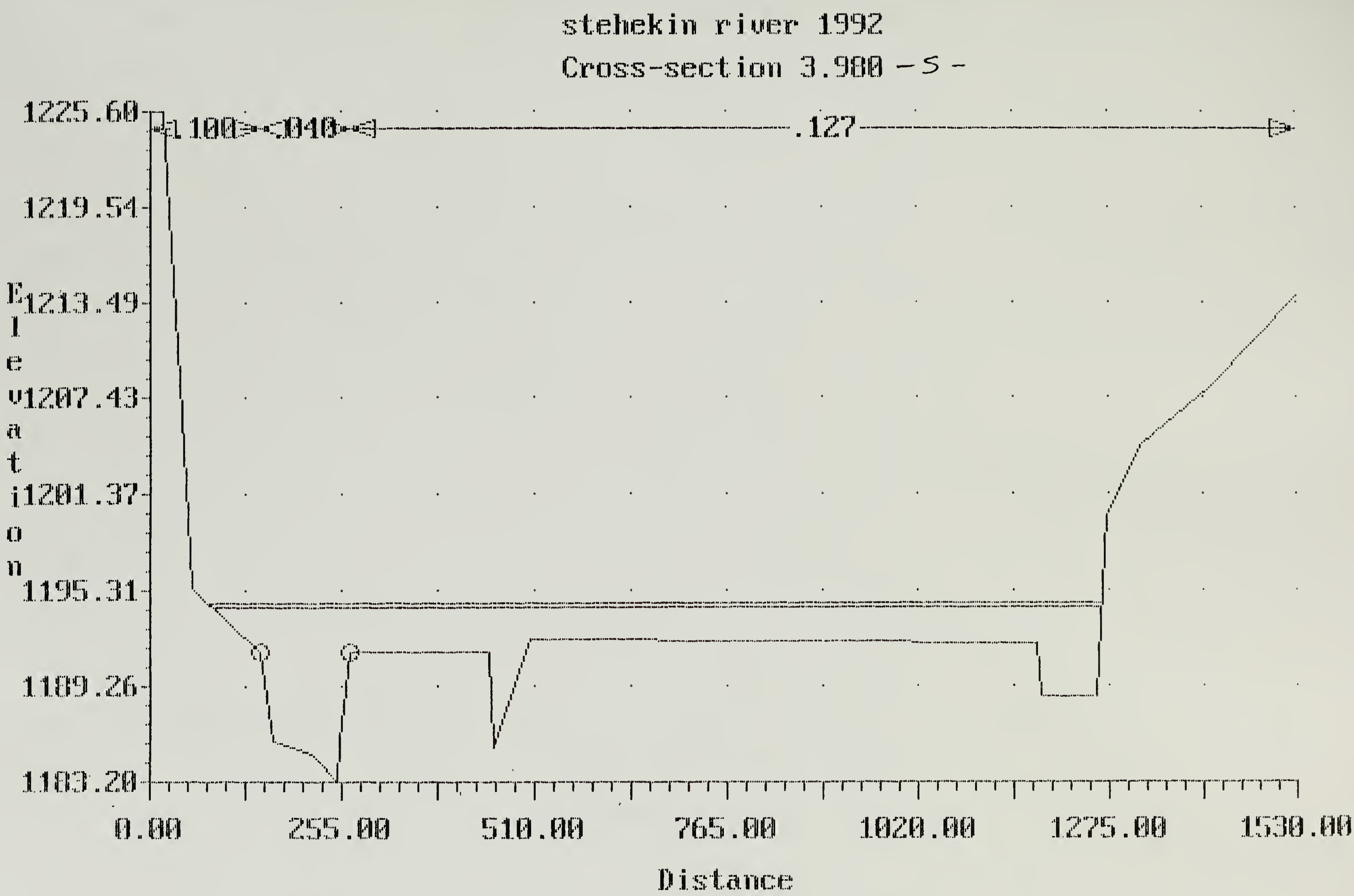
stehekin river 1992
Cross-section 3.760 - HARLEQUIN BRIDGE EXIT
.040
.080
.100
0
7
0
Elevation
1191.50
1188.47
1185.44
1182.41
1179.39
1176.36
1173.33
1170.30
0.00
283.33
566.67
850.00
1133.33
1416.67
1700.00
Distance

stehekin river 1992

Cross-section 3.700 – HARLEQUIN BRIDGE ENTRANCE

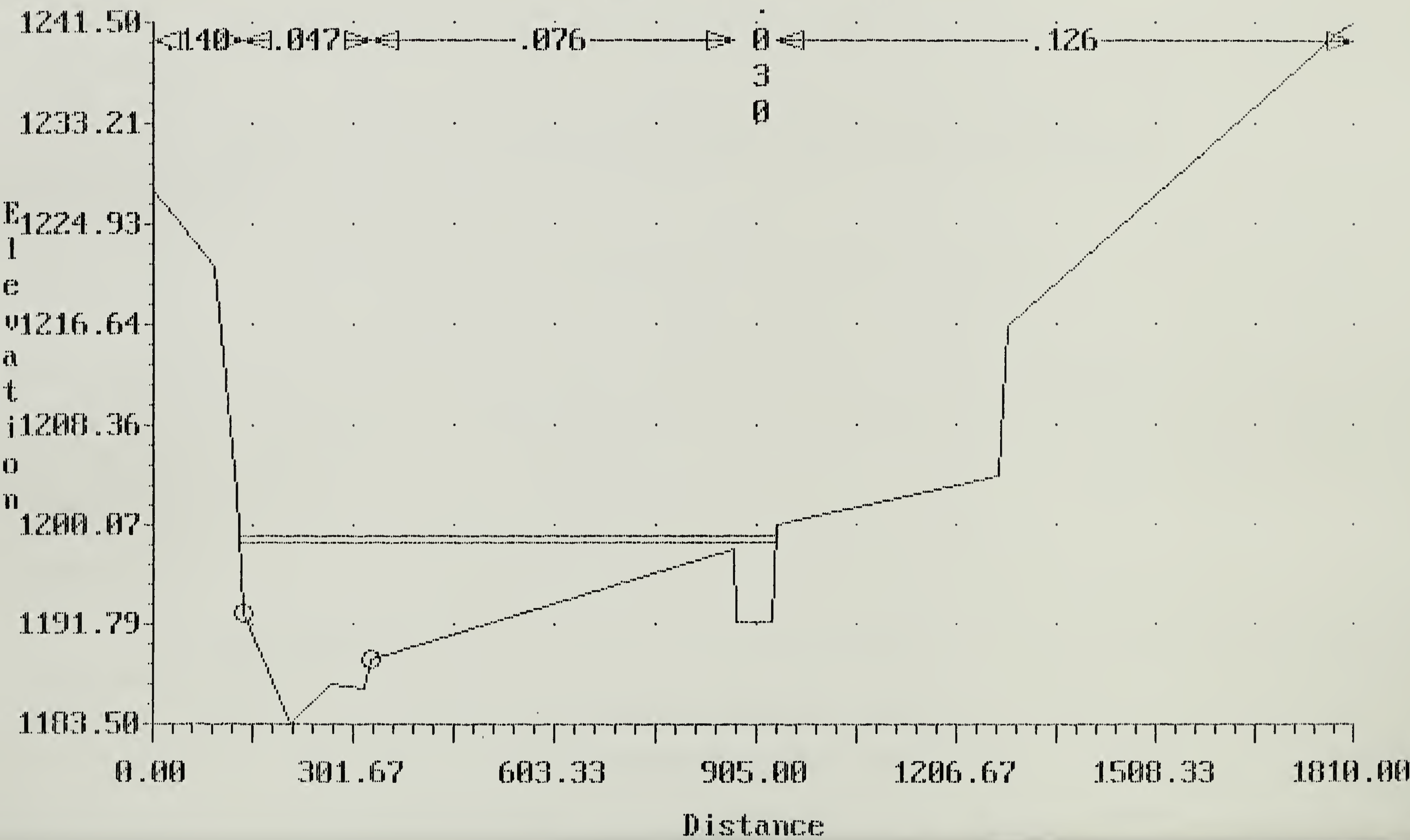



stehekin river 1992
Cross-section 3.000 -R
1200.00
1196.14
1192.29
1188.43
1184.57
1180.71
1176.86
1173.00
Elevation
.040
.100
0.00
283.33
566.67
850.00
1133.33
1416.67
1700.00
Distance


stehekin river 1992
Cross-section 3.980 -S-
.100
.040
.127
Elevation
1225.60
1219.54
1213.49
1207.43
1201.37
1195.31
1189.26
1183.20
0.00
255.00
510.00
765.00
1020.00
1275.00
1530.00
Distance

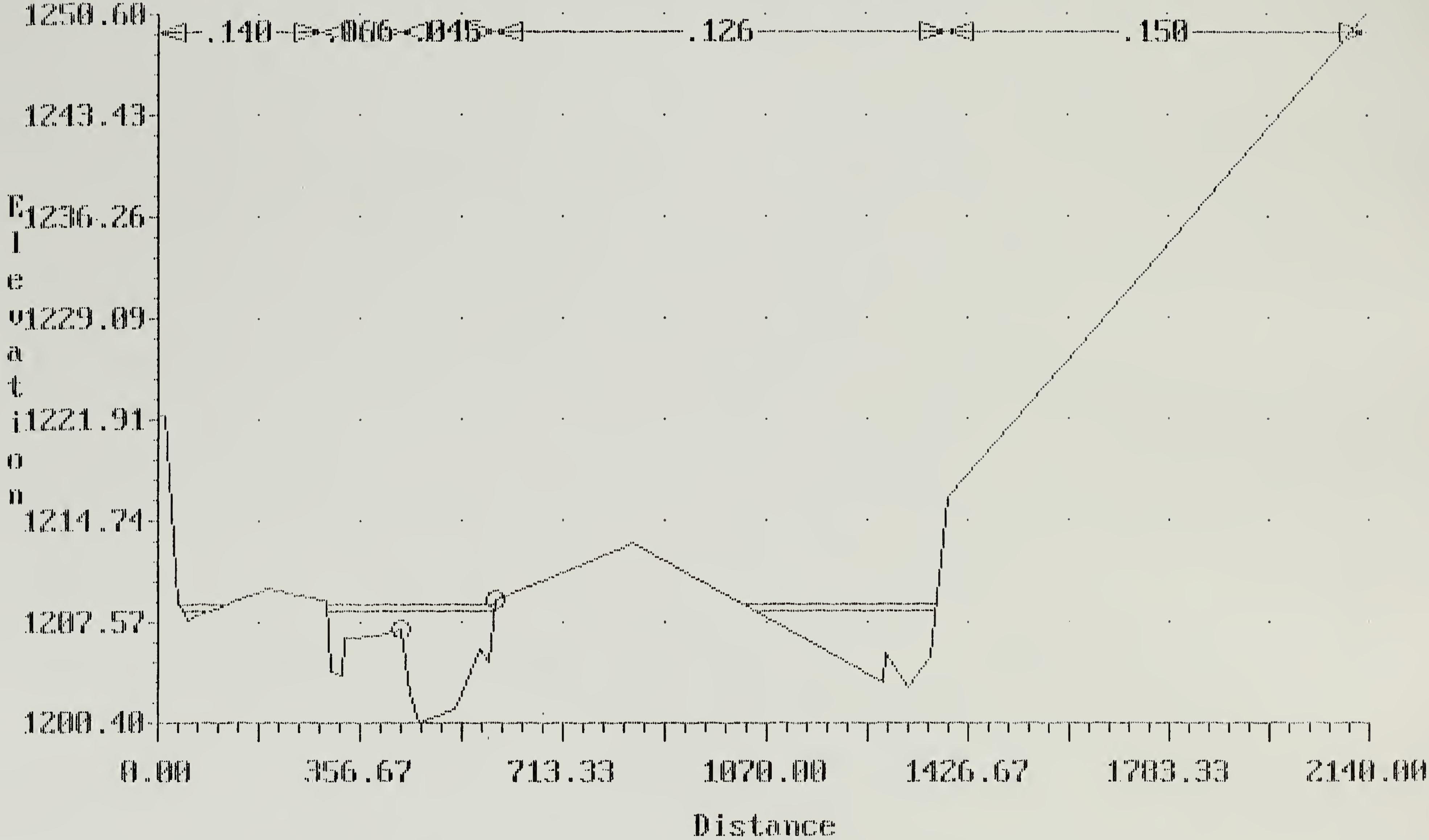
stehekin river 1992

Cross-section 4.260 -T-



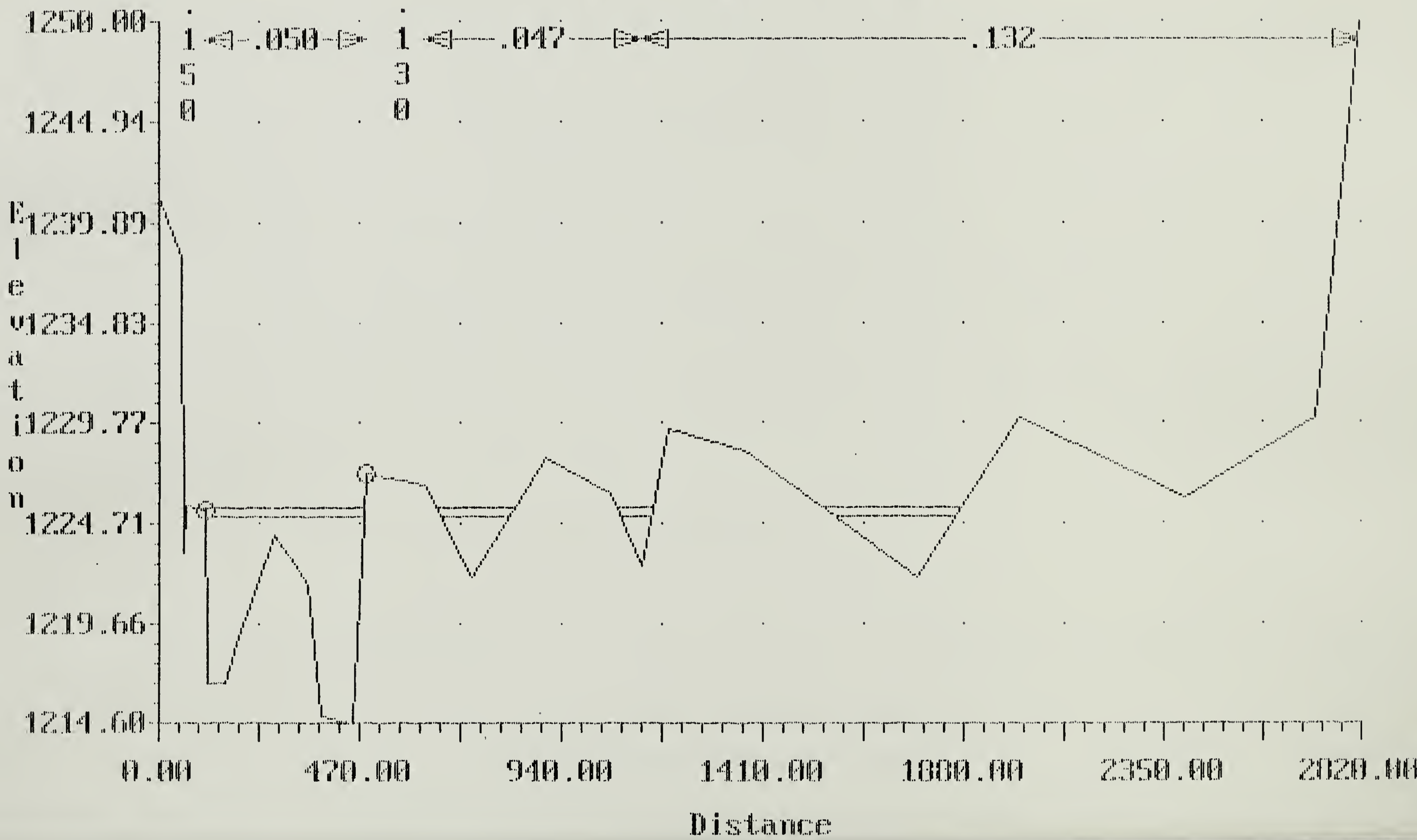
stehekin river 1992

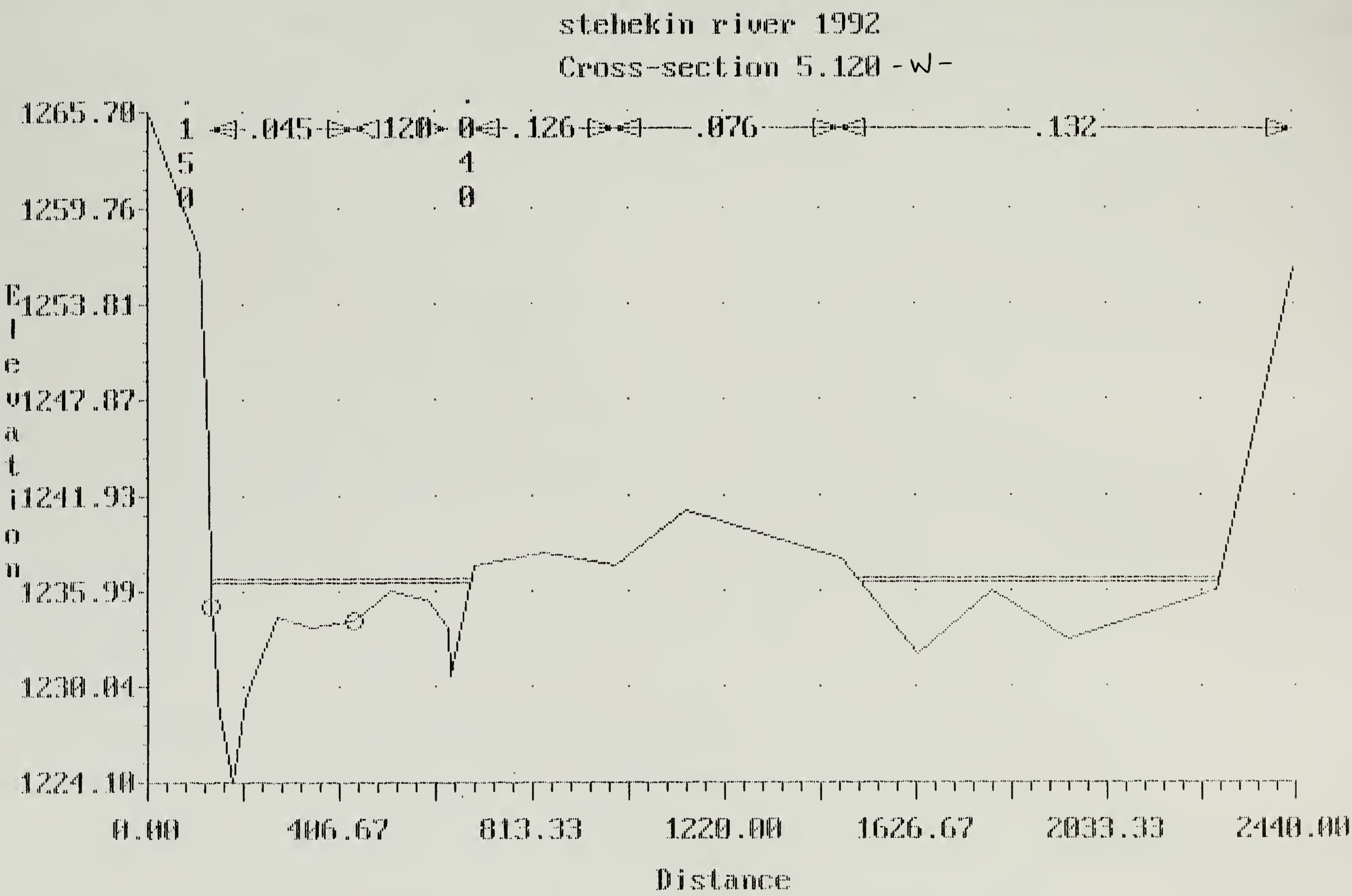
Cross-section 4.460 -u-



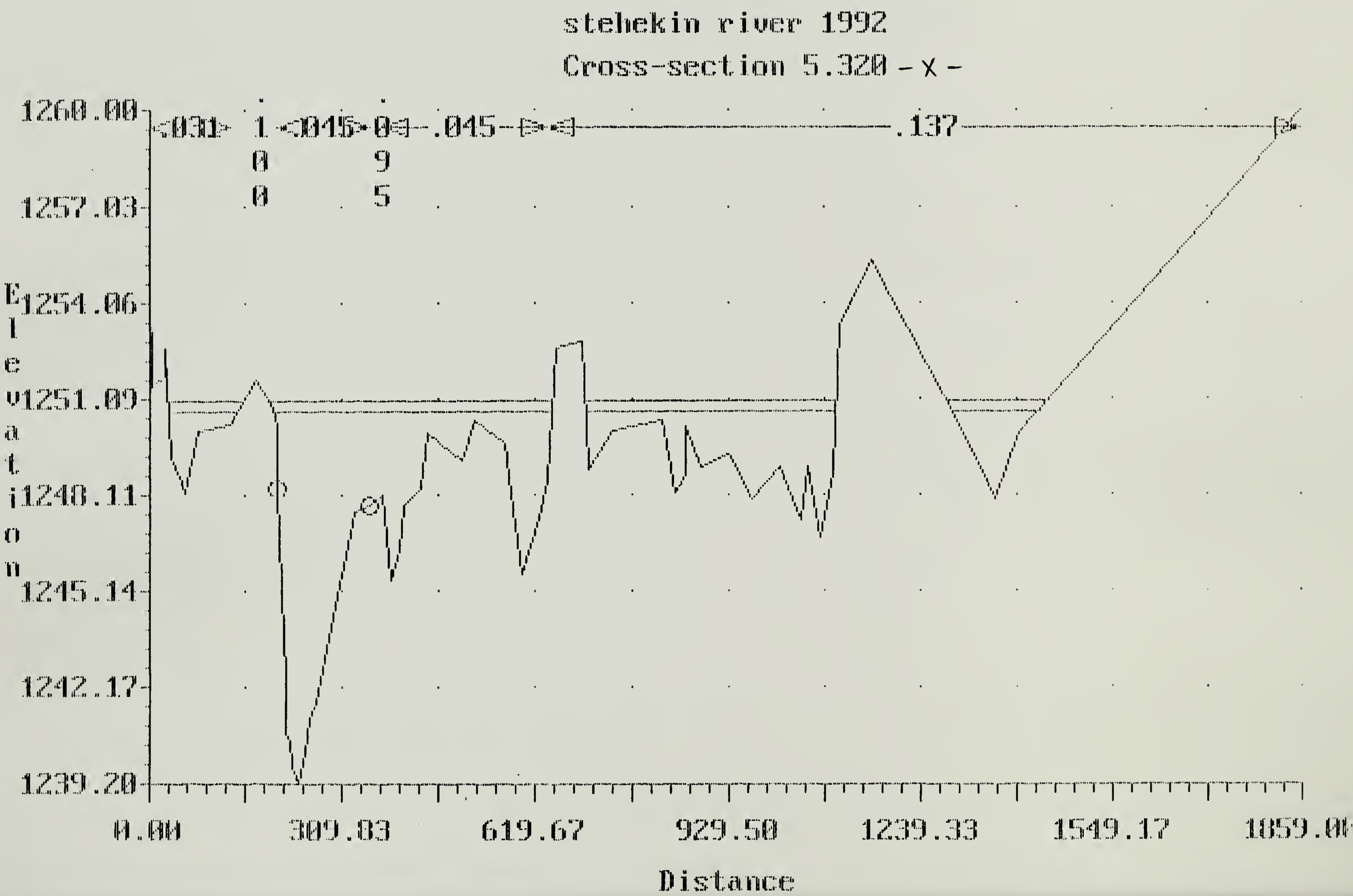
stehekin river 1992

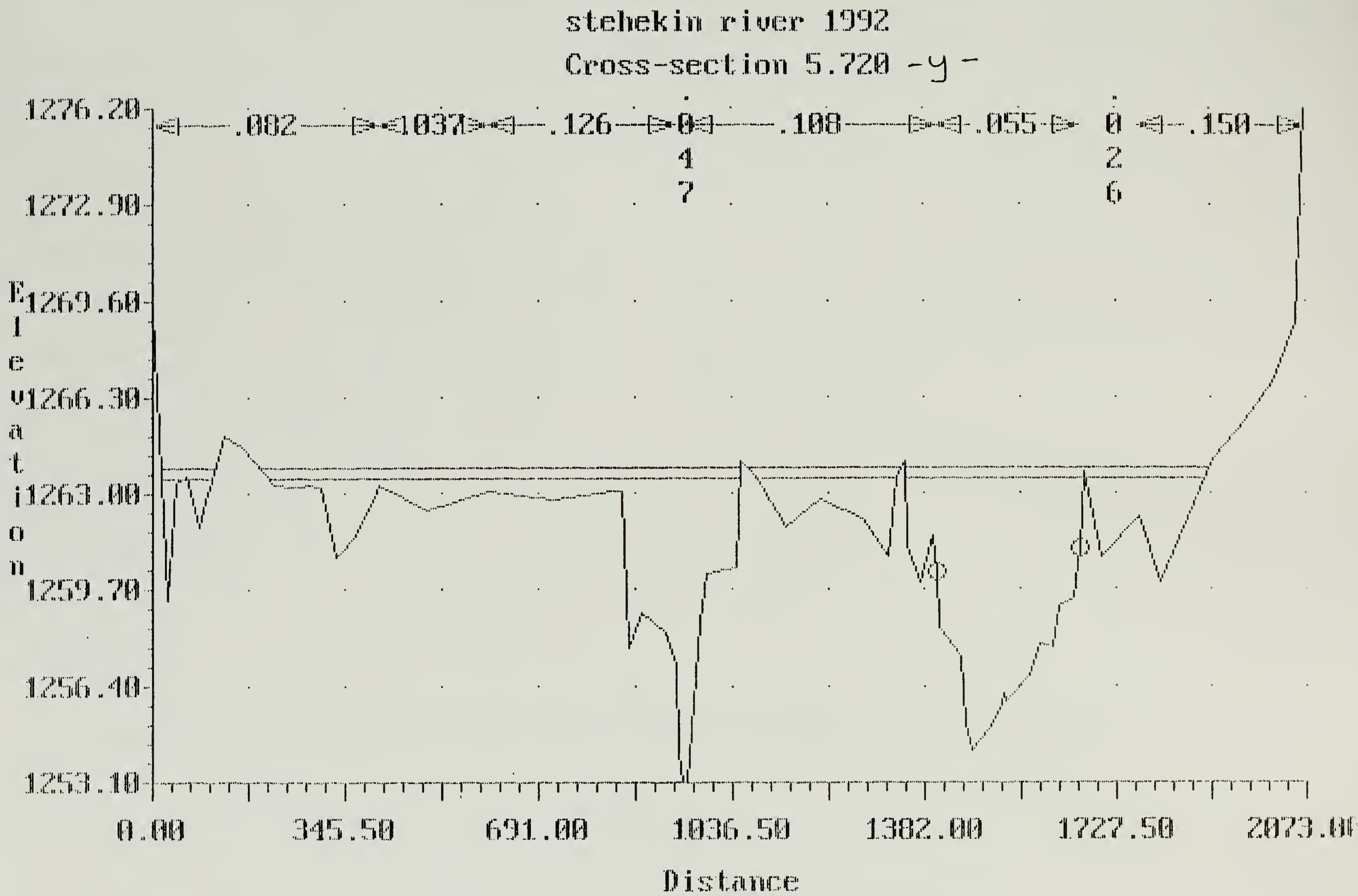
Cross-section 4.810 -v-





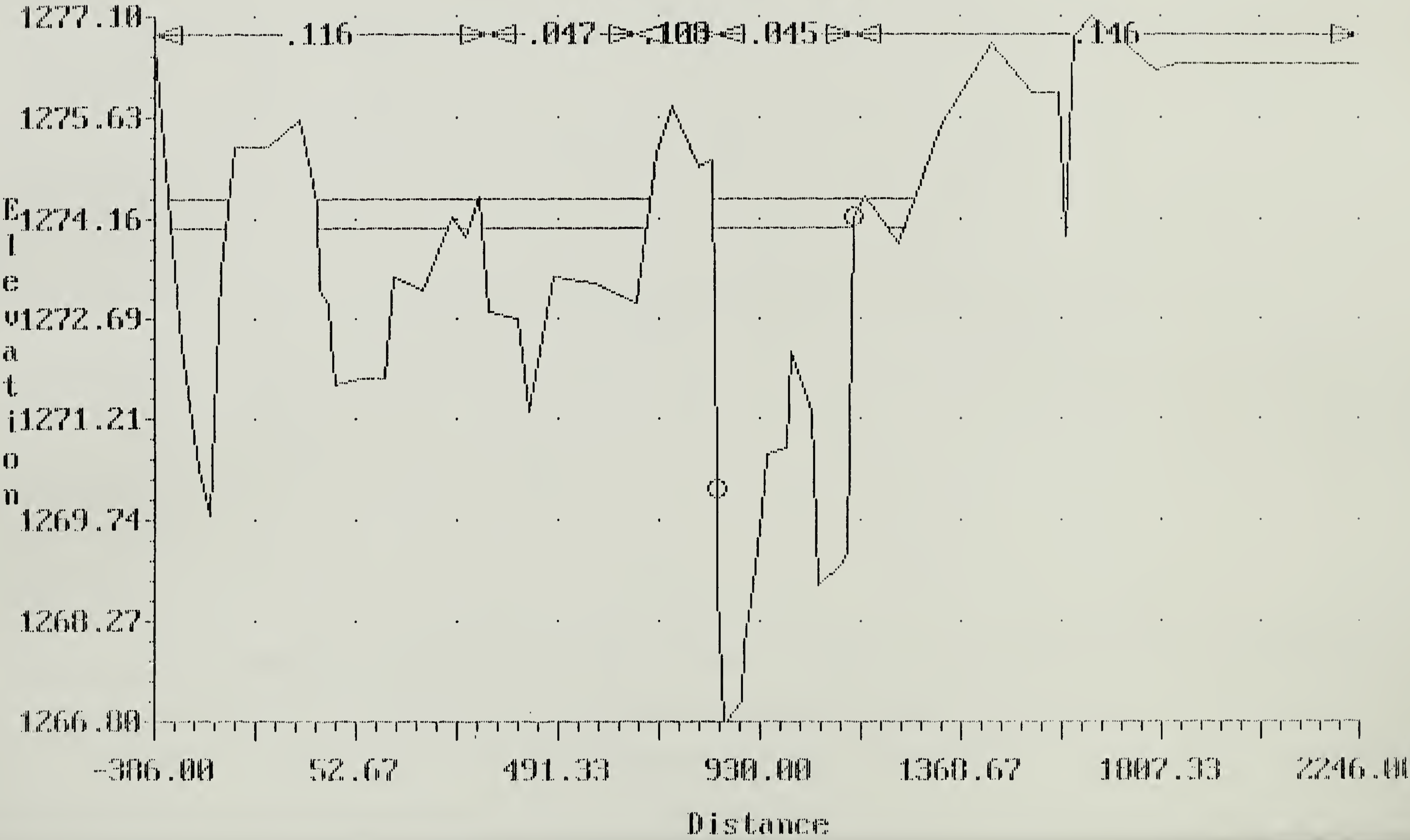
stehekin river 1992
Cross-section 5.120 -W-
.045
120
.126
.076
.132
150
040
1265.70
1259.76
1253.81
1247.87
1241.93
1235.99
1230.04
1224.10
Elevation
0.00
406.67
813.33
1220.00
1626.67
2033.33
2440.00
Distance


stehekin river 1992
Cross-section 5.320 - X -
<031> 1 <3015> 0 <- .045 -> <- .137 ->
0 9
0 5
1260.00
1257.03
1254.06
1251.09
1248.11
1245.14
1242.17
1239.20
Elevation
0.00
309.83
619.67
929.50
1239.33
1549.17
1859.00
Distance


stehekin river 1992
Cross-section 5.720 -y-
.002
.037
.126
.047
.108
.055
.026
.150
1276.20
1272.90
1269.60
1266.30
1263.00
1259.70
1256.40
1253.10
Elevation
0.00
345.50
691.00
1036.50
1382.00
1727.50
2073.00
Distance

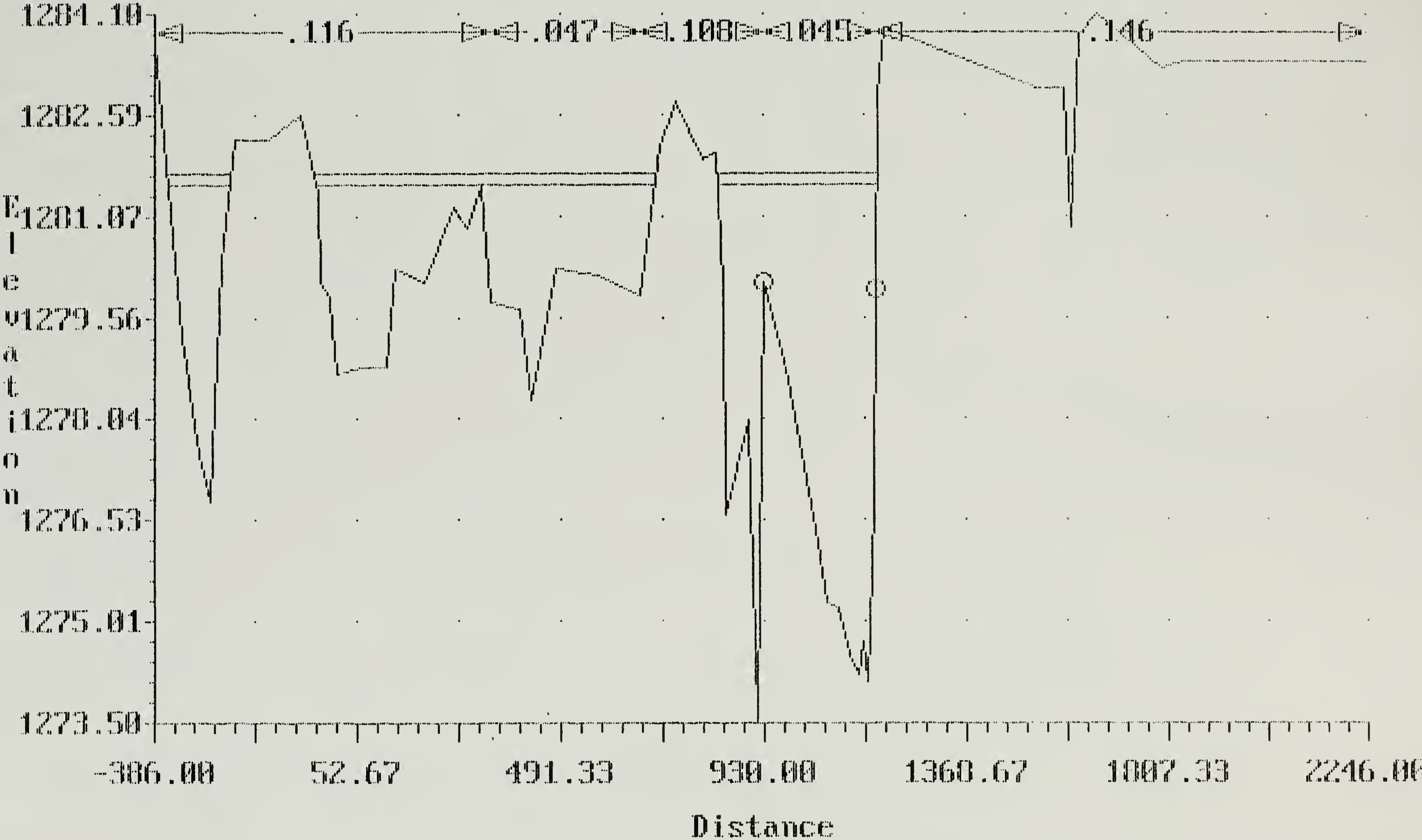
stehekin river 1992

Cross-section 6.040 - Z -



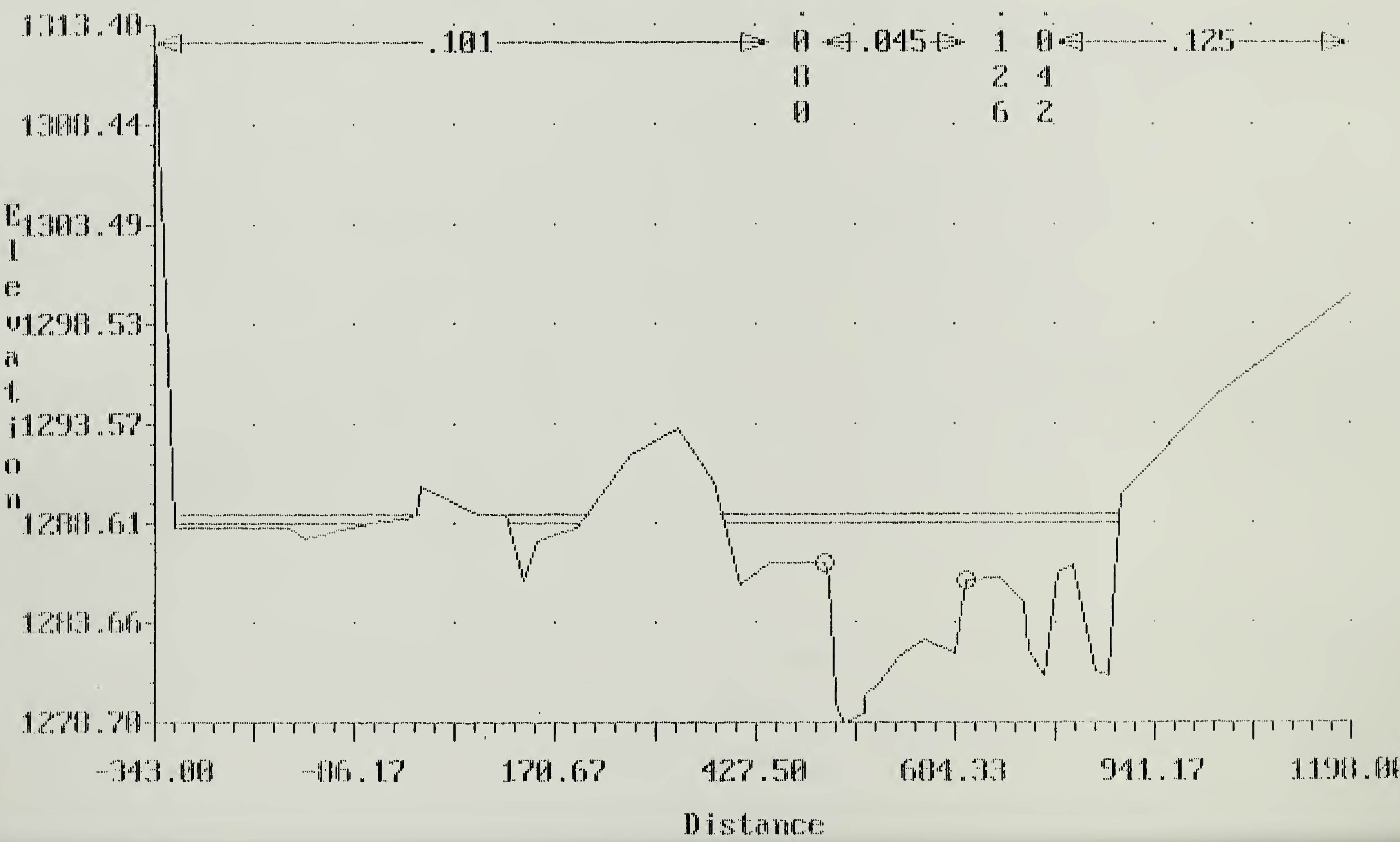
stehekin river 1992

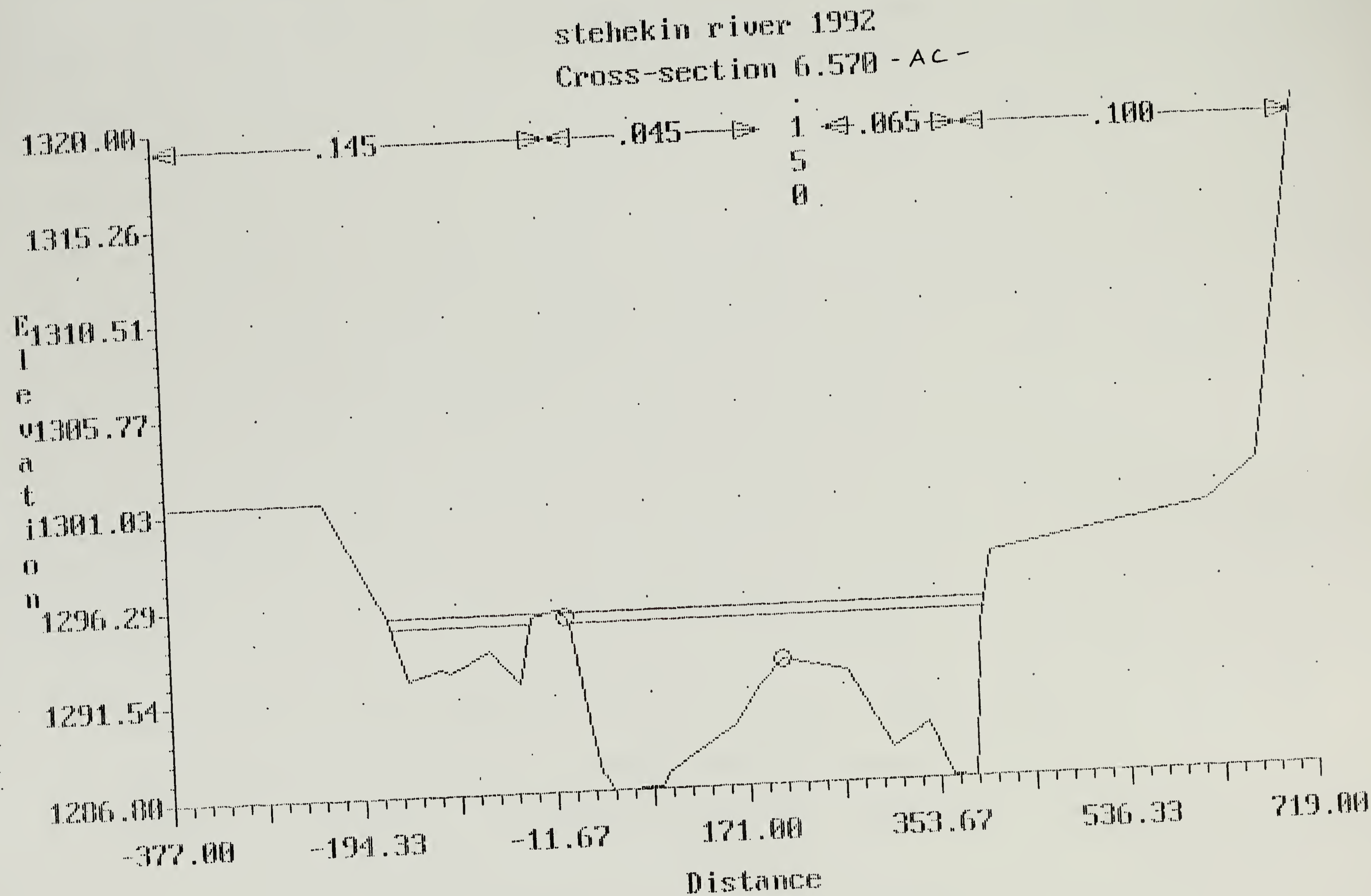
Cross-section 6.180 - AA -



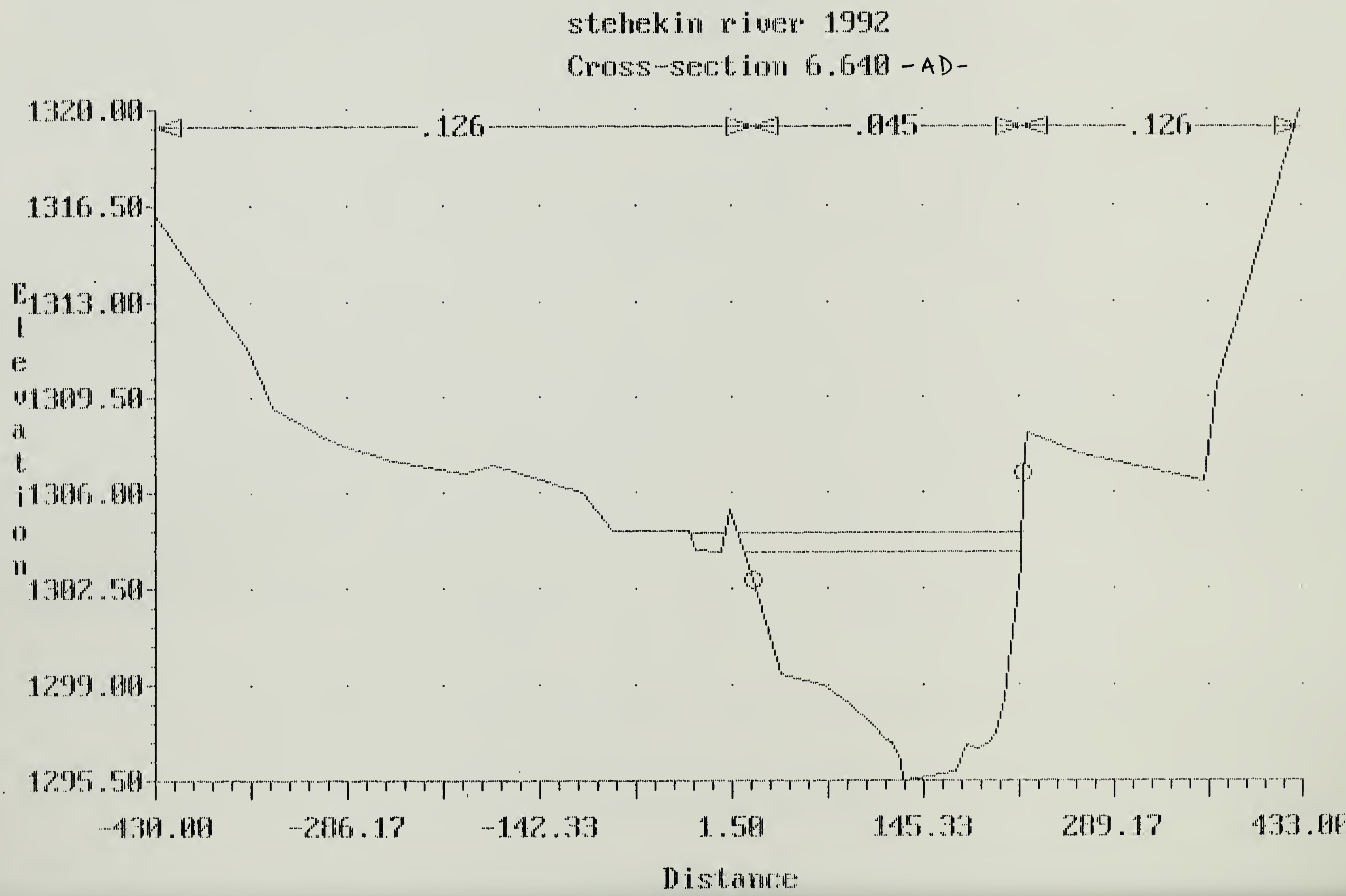
stehekin river 1992

Cross-section 6.380 - AB -





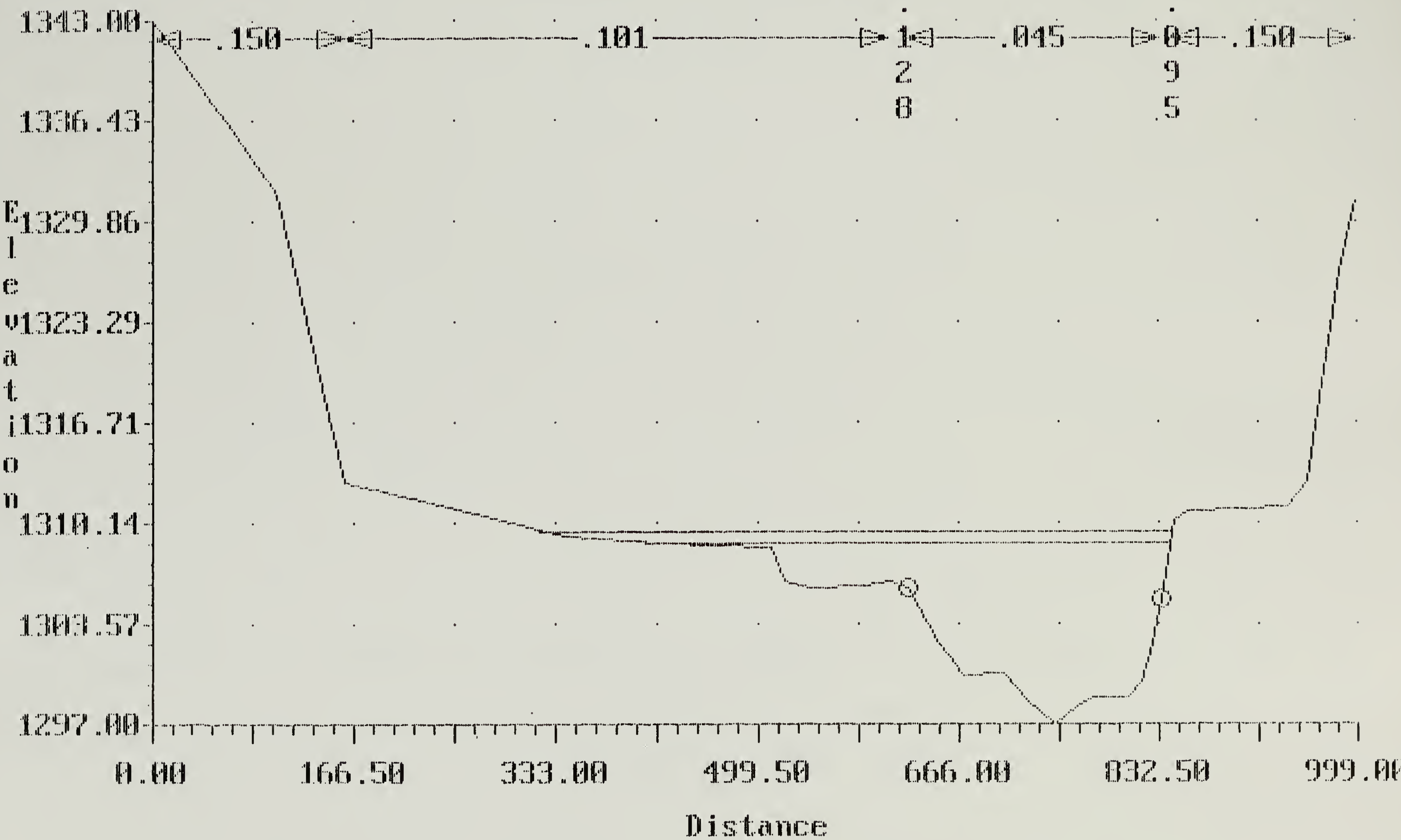
stehekin river 1992
Cross-section 6.570 - AC -
.145
.045
150
.065
.100
1320.00
1315.26
1310.51
1305.77
1301.03
1296.29
1291.54
1286.80
Elevation
-377.00
-194.33
-11.67
171.00
353.67
536.33
719.00
Distance



stehekin river 1992
Cross-section 6.640 -AD-
.126
.045
.126
1320.00
1316.50
1313.00
1309.50
1306.00
1302.50
1299.00
1295.50
Elevation
-430.00
-286.17
-142.33
1.50
145.33
289.17
433.00
Distance

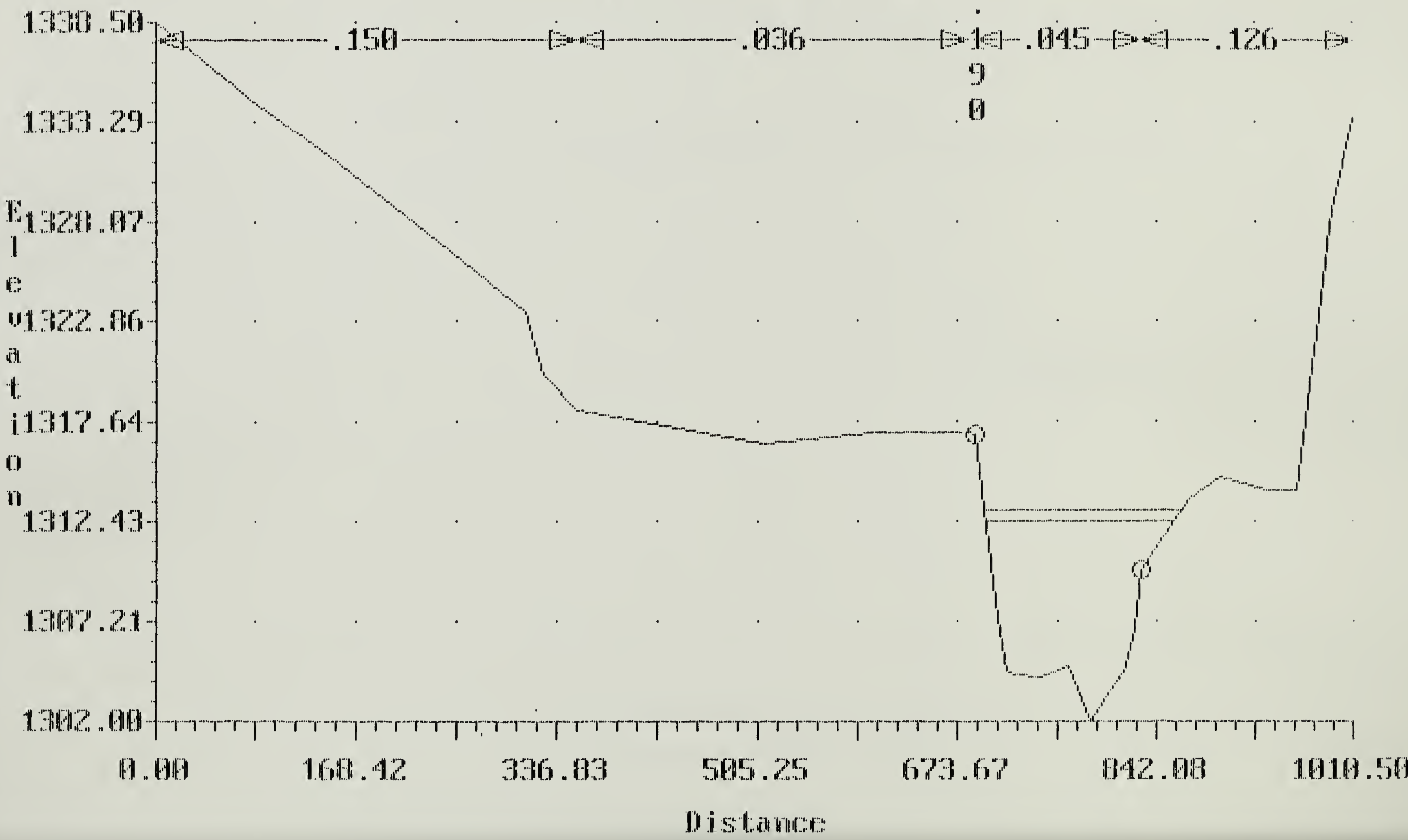
stehekin river 1992

Cross-section 6.730 – AE –



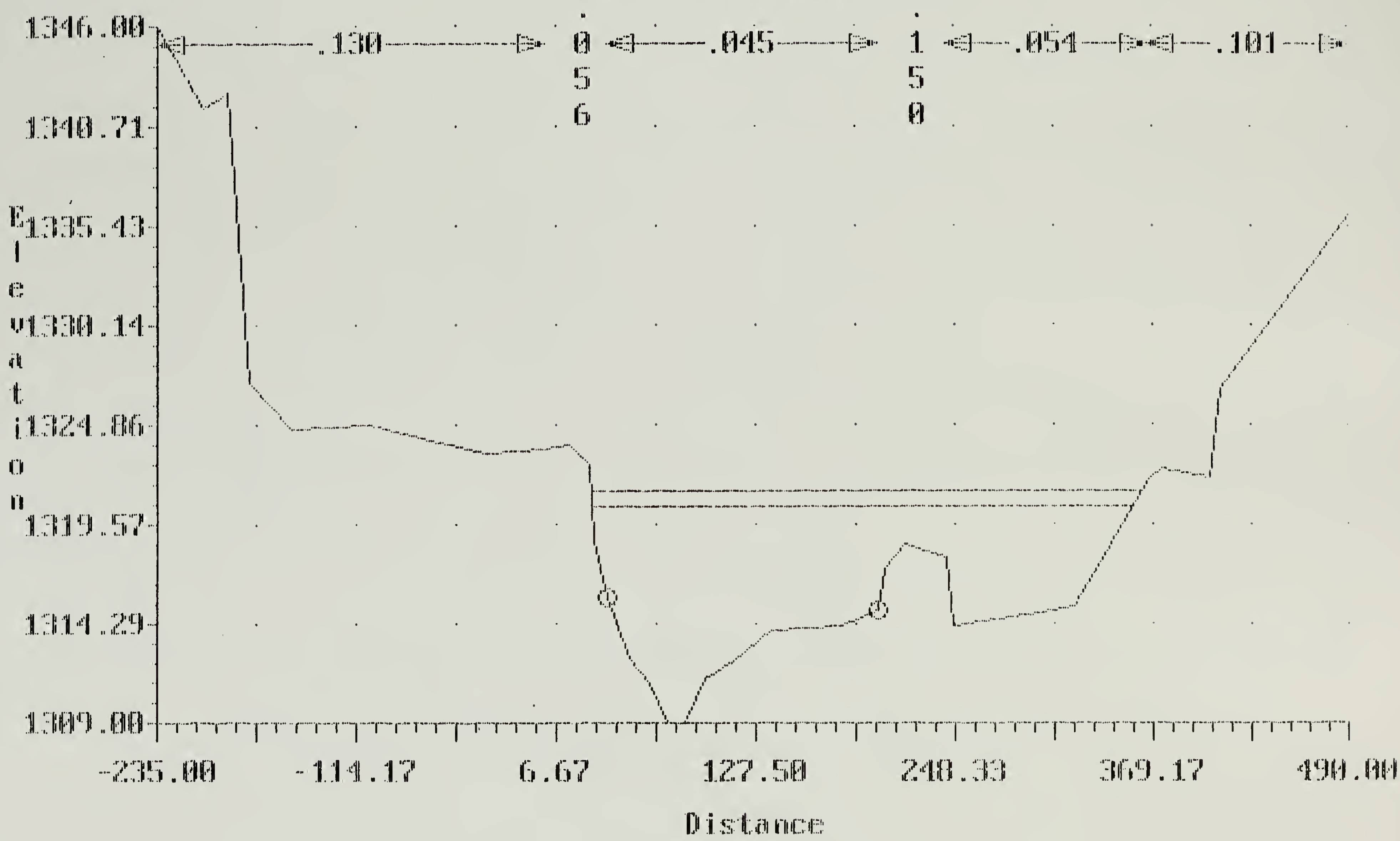
stehekin river 1992

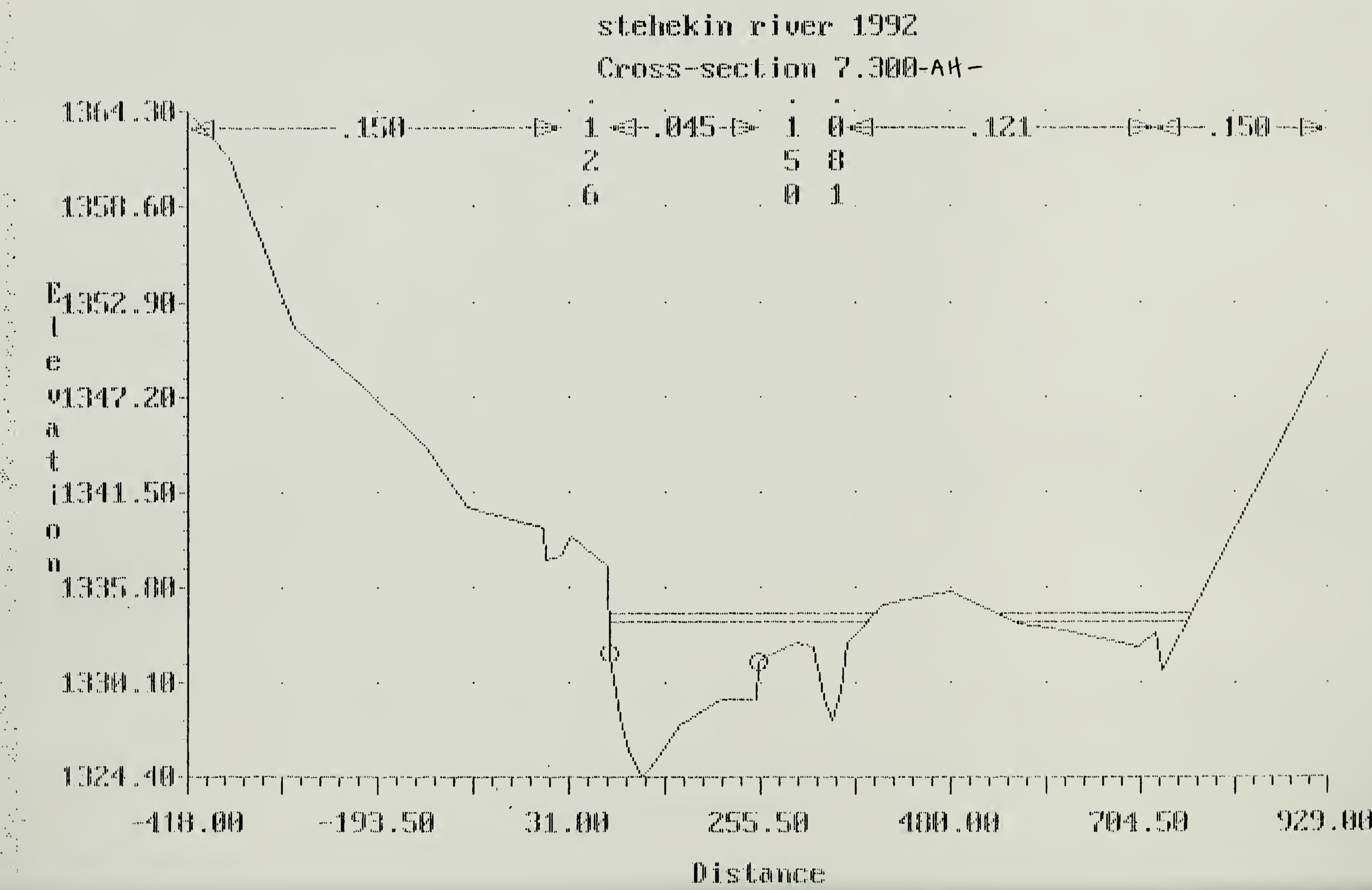
Cross-section 6.910 -AF -



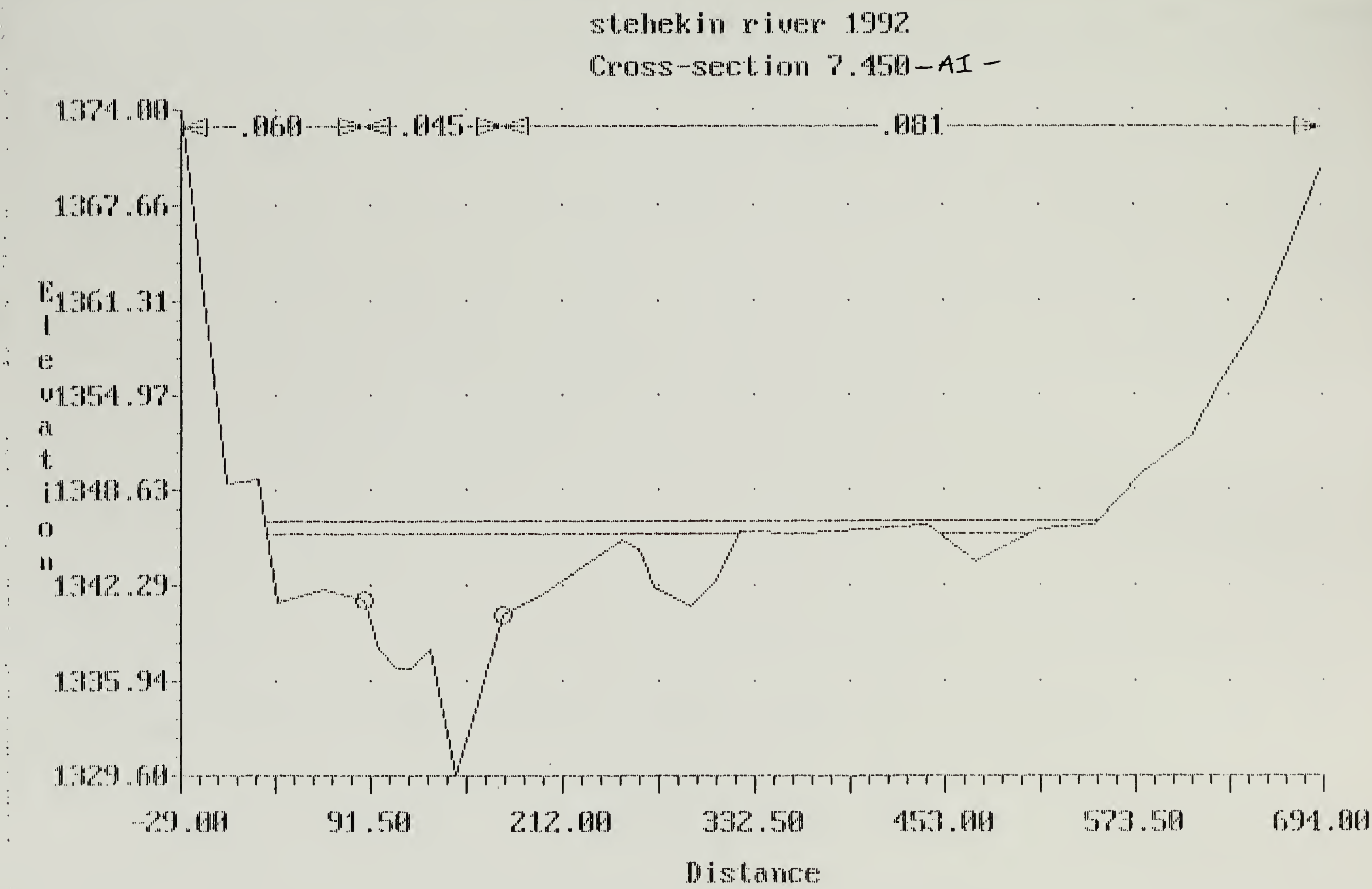
stehekin river 1992

Cross-section 7.030 AG



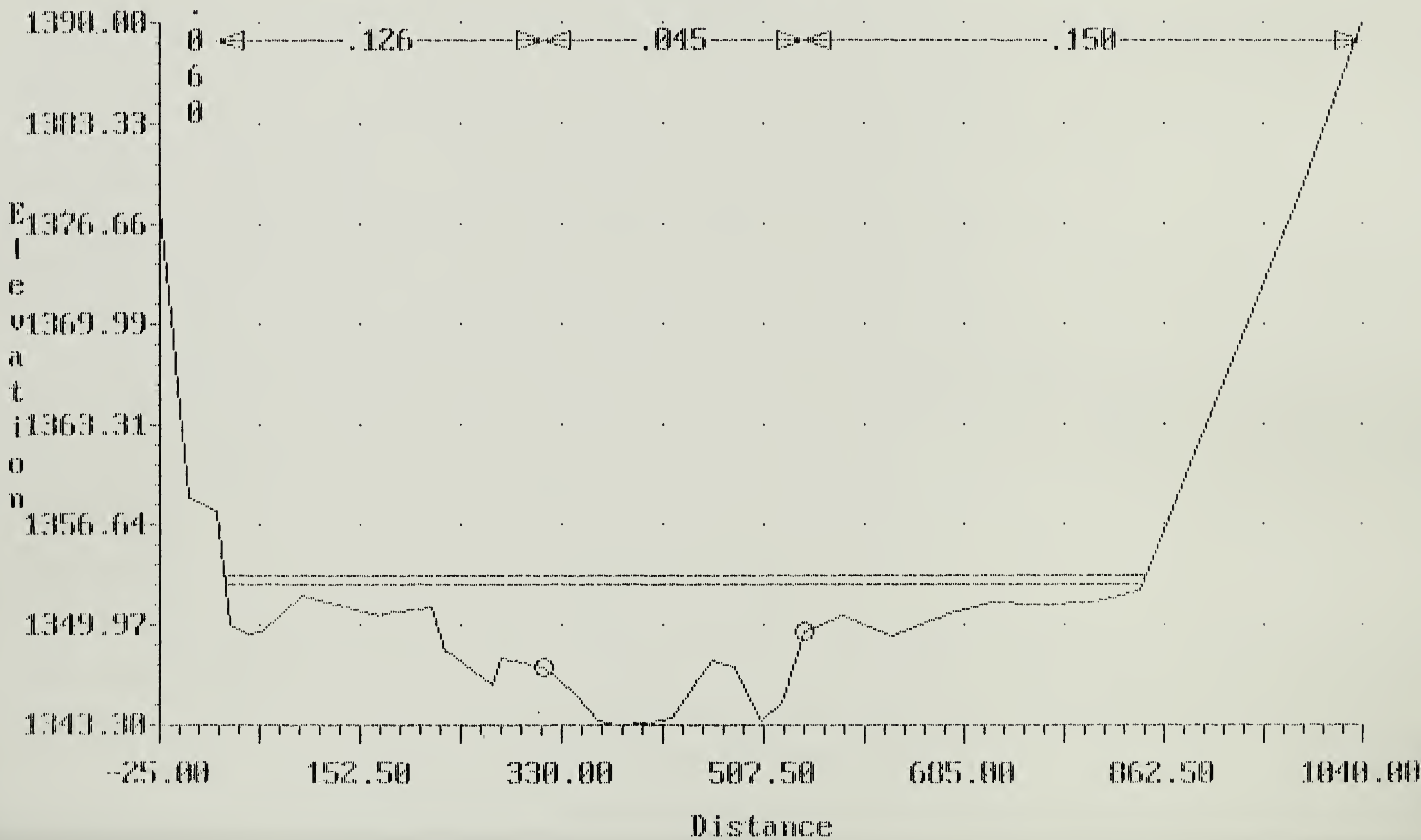


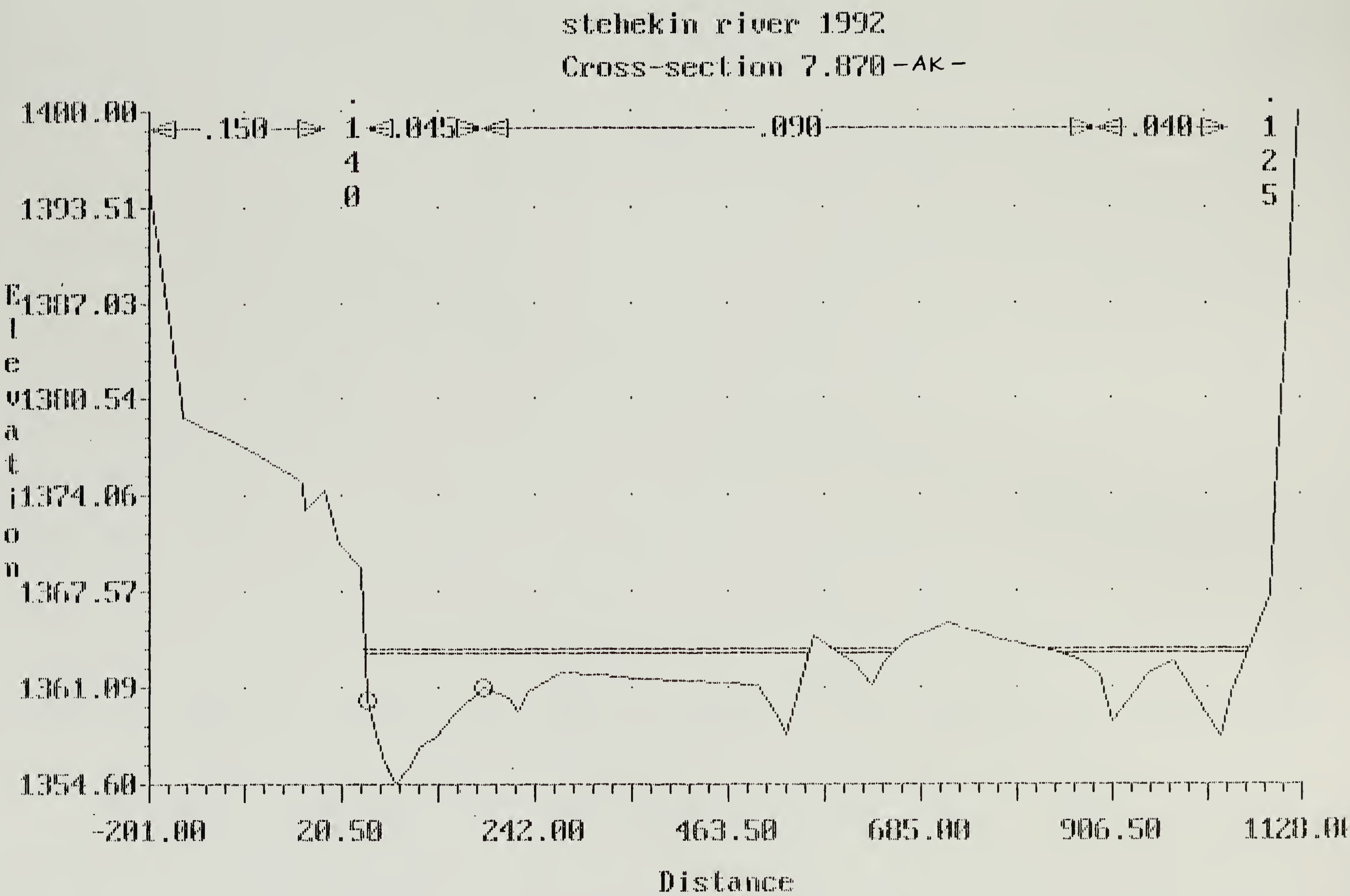
stehekin river 1992
Cross-section 7.300-AH-
.150
1 2 6
.045
1 5 0
0 8 1
.121
.150
1364.30
1358.60
1352.90
1347.20
1341.50
1335.80
1330.10
1324.40
Elevation
-418.00
-193.50
31.00
255.50
480.00
704.50
929.00
Distance


stehekin river 1992
Cross-section 7.450-A1 -
.060
.045
.081
1374.00
1367.66
1361.31
1354.97
1348.63
1342.29
1335.94
1329.60
Elevation
-29.00
91.50
212.00
332.50
453.00
573.50
694.00
Distance

stehekin river 1992

Cross-section 7.630 -AJ-

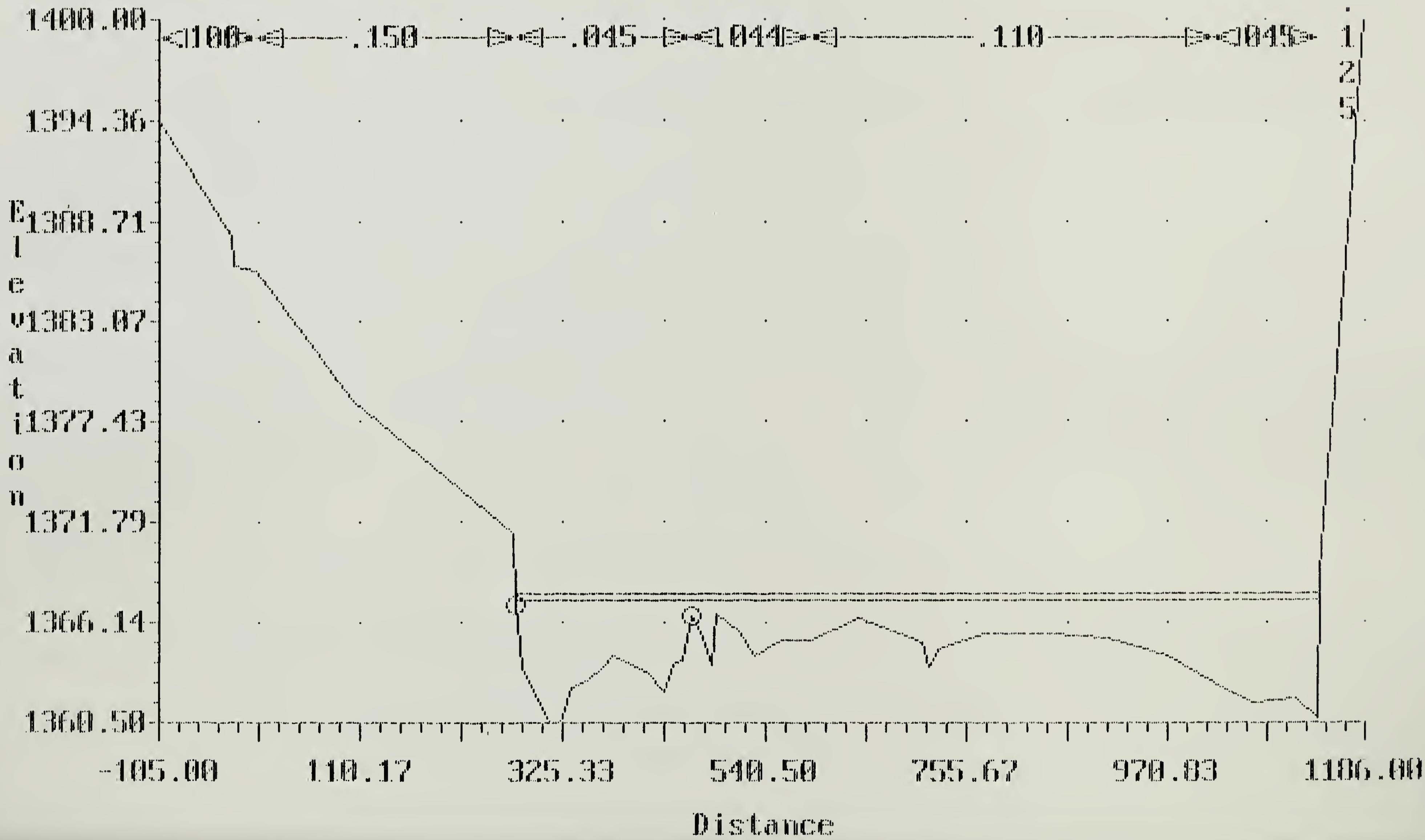


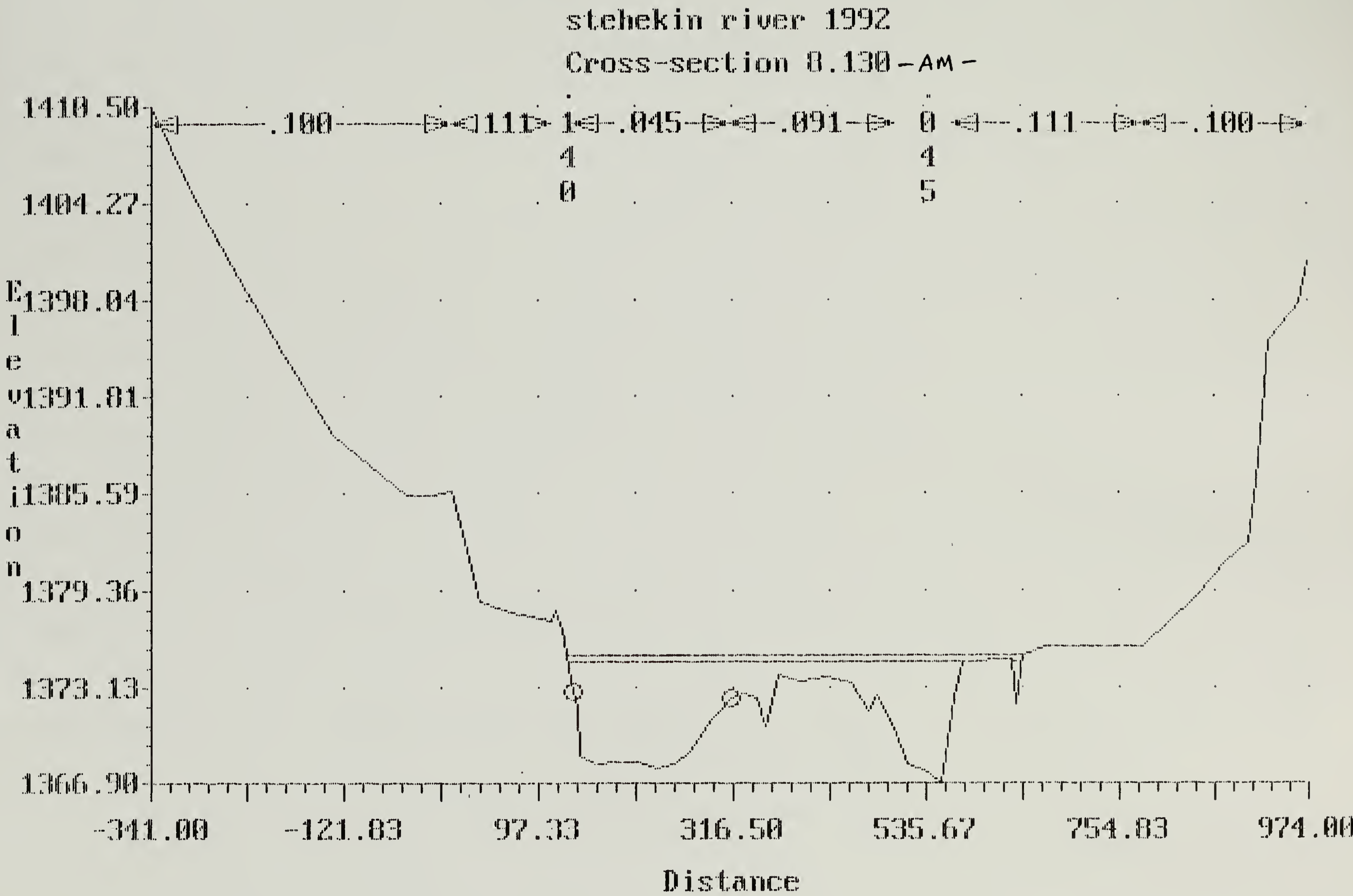


stehekin river 1992
Cross-section 7.870 -AK-
.150
140
.045
.090
.040
125
1400.00
1393.51
1387.03
1380.54
1374.06
1367.57
1361.09
1354.60
Elevation
-201.00
20.50
242.00
463.50
685.00
906.50
1128.00
Distance

stehekin river 1992

Cross-section 7.930 -AL -

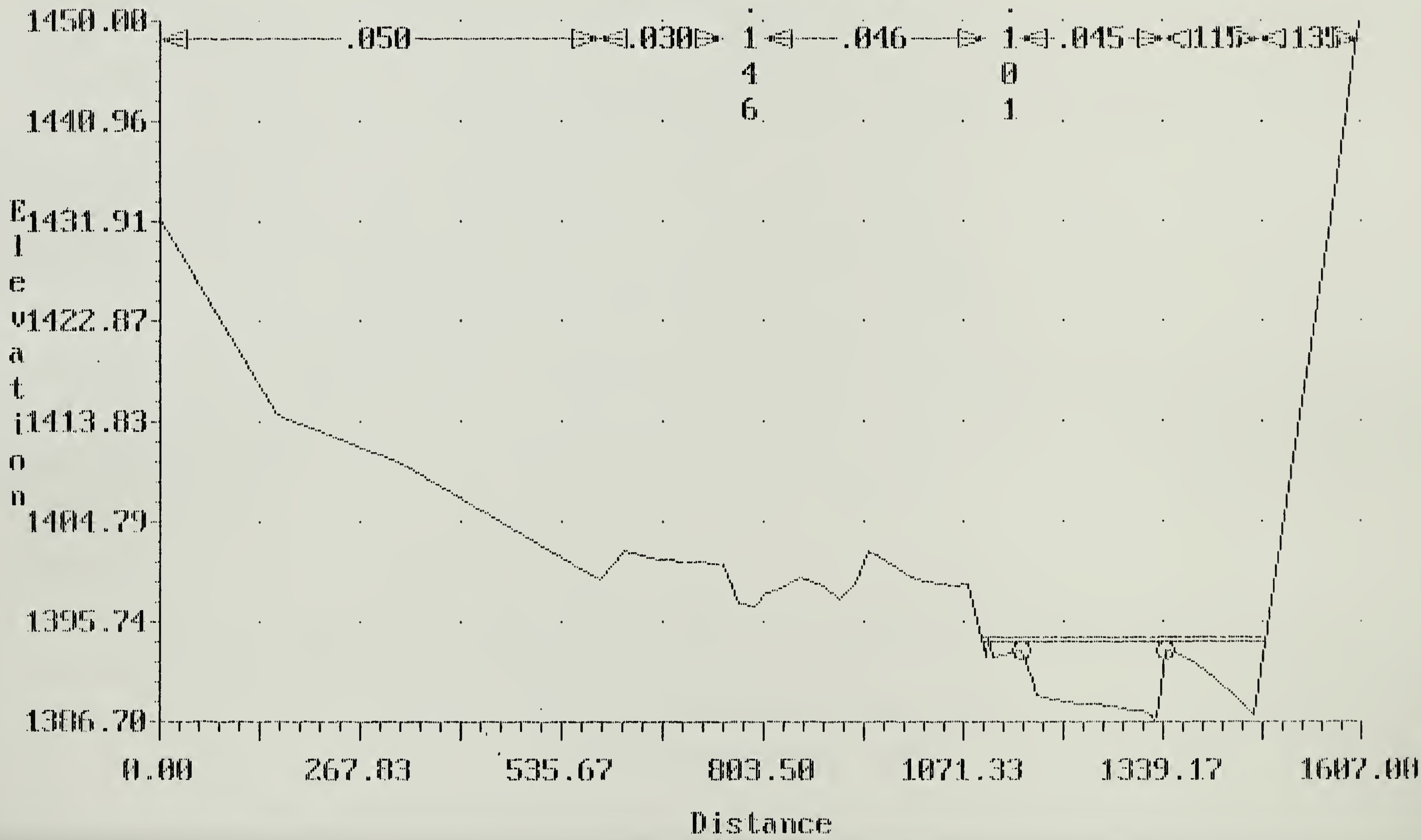


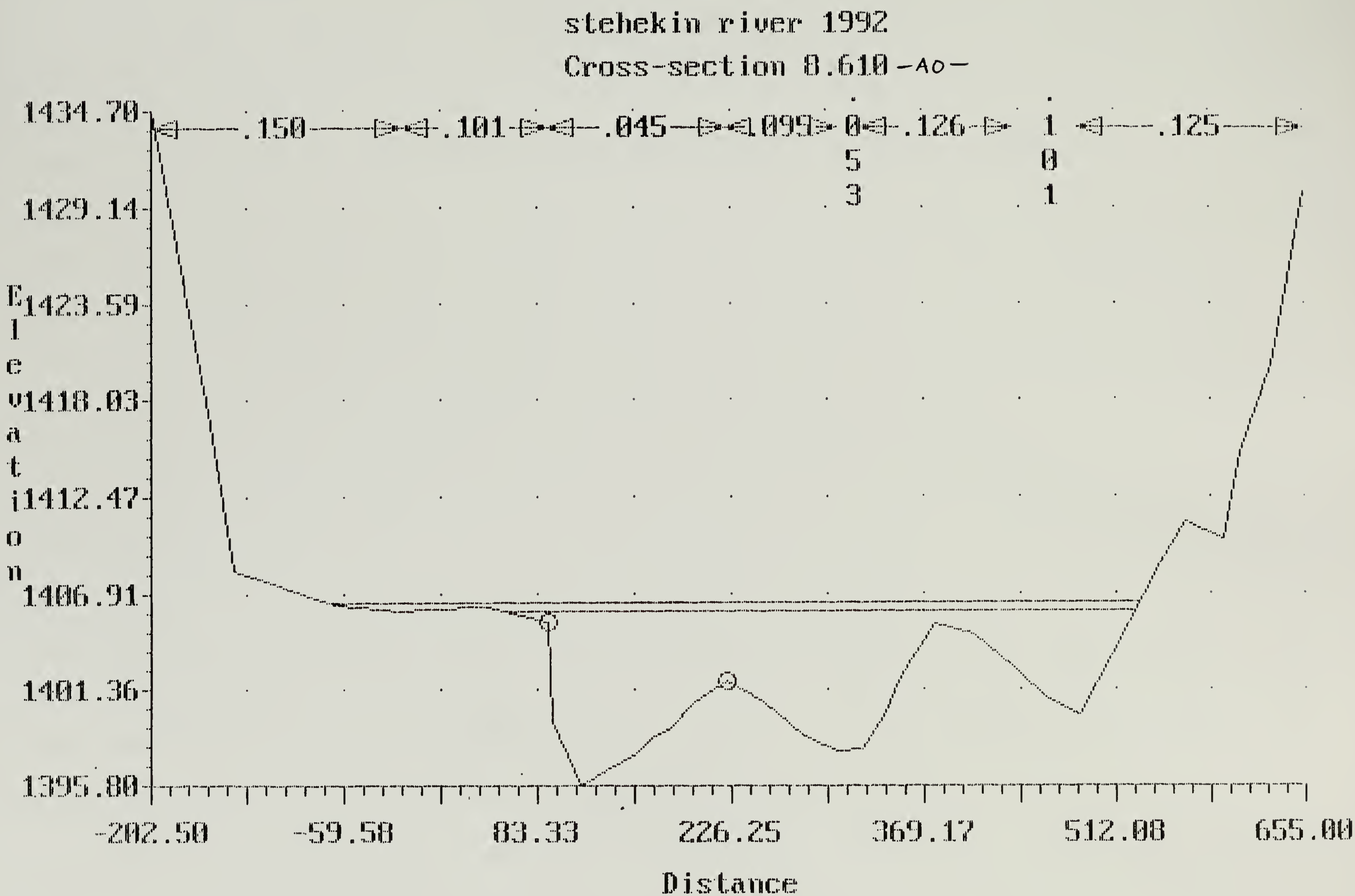


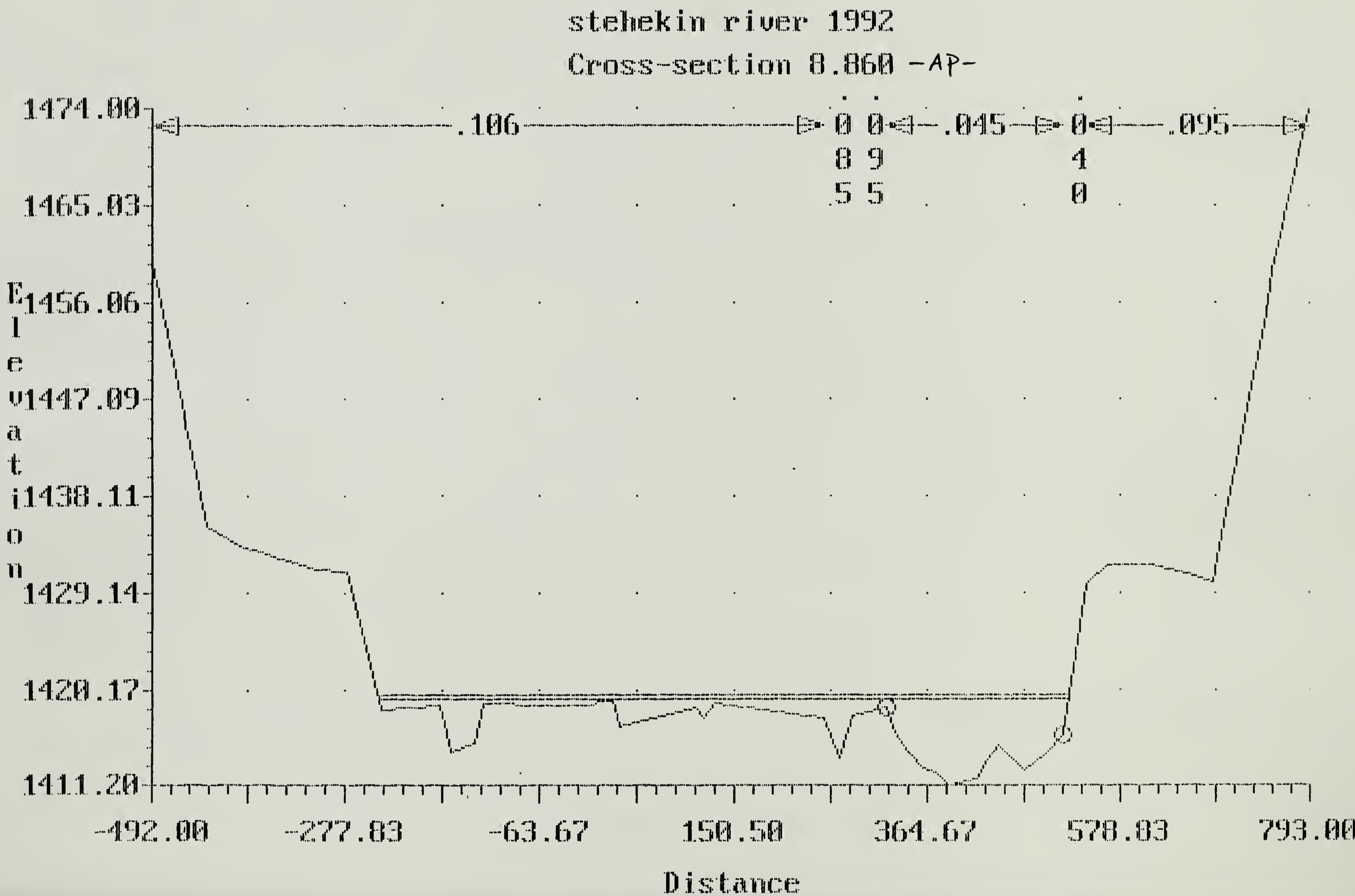
stehekin river 1992
Cross-section 8.130 -AM-
.100
.111
.140
.045
.091
.045
.111
.100
1410.50
1404.27
1398.04
1391.81
1385.59
1379.36
1373.13
1366.90
Elevation
-341.00
-121.83
97.33
316.50
535.67
754.83
974.00
Distance

stehekin river 1992

Cross-section 8.420 -AN-



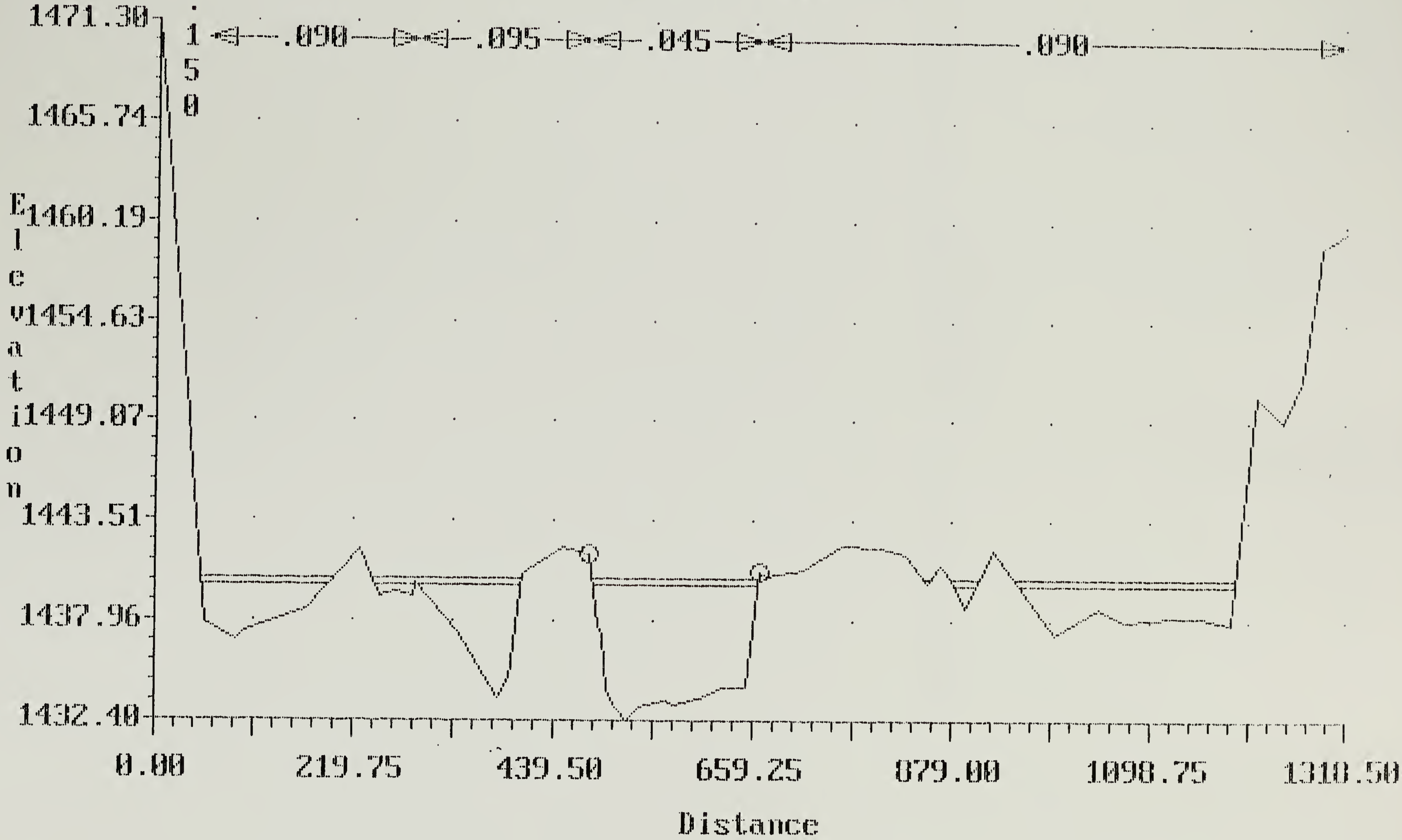

stehekin river 1992
Cross-section 8.610 -AO-
.150
.101
.045
.099
.053
.126
.101
.125
1434.70
1429.14
1423.59
1418.03
1412.47
1406.91
1401.36
1395.80
Elevation
-202.50
-59.58
83.33
226.25
369.17
512.08
655.00
Distance



stehekin river 1992
Cross-section 8.860 -AP-
.106
.085
.095
.045
.040
.095
1474.00
1465.03
1456.06
1447.09
1438.11
1429.14
1420.17
1411.20
Elevation
-492.00
-277.83
-63.67
150.50
364.67
578.83
793.00
Distance

stehekin river 1992

Cross-section 9.200 -AQ-



APPENDIX D
HYDRAULIC ROUGHNESS CALCULATIONS

BASE 'n' value / Qal

Boulder / Cobble (CHANNEL)		— .050
Cobble		— .045
Cobble/Gravel	LAD -2° channels	— .040
Gravel		— .03
Sand		— .026
Sand + Silt (VAD)		— .020

X.S. — "n" REGION	nb/no	n_1	n_2	n_3	n_4	N final	
A ① BROCK - UW	.05 —	0	—	—	.08	.13	- x - 760
② FP, Qal, MARSH	.02 —	0	—	—	.06	.062	760-114[illegible]
③ FLAT, MIXED FOREST.	.02 —	0	—	.010 HOUSES	.10	.13	1140-1795
④ MC — .04 — (1795-2030) →						.04	1795-203[illegible]
⑤ ALDER - (LO T.) w/ (C1 - C2) —	.026	0	.06 CHANNELS	.005 HONDA	.10	.15 .191	2030-243
⑥ ALLUVIAL FAN - MIXED VEG.	.05	0	—	—	.10	.15	2433 - X
B ① UPLAND - (UW)	.05	0	—	—	.08	.13	x - 200
② UPLAND - (FP) - MESIC	.02	0	—	0	.10	.12	200-1750
③ MC — .04 →						.04	1750-208[illegible]
④ ALDER LO T. (C1-C2)	.026	.01	—	.01 CHANNELS	.15	.15 .196	2050-24[illegible]
⑤ OPEN MIXED DECIDUOUS (AF)	.05	—	—	0	.10	.15	2430 —
① FOREST (FP) Qal (VAD)	.020	0	—	0	.05	.08	x - 503
② FOREST (FP) Qal (LAD)	.026	0	—	.003 HOUSES	.075	.104	- 750
③ 2° CHANNEL	.045	0	—	.005	.002	.052	- 883
④ ALDER - GRAVEL BAR	.04	.01	—	.005	.050	.105	- 1063
⑤ MC — .045 →						.045	- 1230
⑥ ALDER - C/WOOD GRAVEL/C BAR	.04	0	—	.005	.10	.145	- 141[illegible]
⑦ 2° CHANNEL CC/3	.02	0	—	.004	.05	.074	- 143[illegible]
⑧ AF OPEN FOREST	.05 →					.15	- 160[illegible]

FINAL

X.S.	SUB REACH DESCRIPTION	n_b	n_1	n_3	n_4	FINAL	S
D ①	FOREST - FP	.02	0	.002	.075	.097	X - 107
②	2° CHANNEL C-2	.04	0	.005	.005	.05	-1117
③	ALDER G-BAR	.045	.0	0	.050	.115	-1185
④	MC - .045 →					.045	- 1377
⑤	ALDER/CWOOD G.BAR	.045	0	.02	.050	.115	-1640
⑥	2° CHANNEL C-4	.035	.004 RIF/POOL	.005	0	.044	-1670
⑦	STEEP BR VW OPEN FOREST	.04	0	0	.075	.115	— X
E ①	FOREST - FEW HOMES (AF)	.05	—	.005	.05	.105	-1107
②	ALDER - C/WOOD G BAR	.045	.010	.005 WDA	.050	.110	- 1386
③	MC →	.045				.045	- 1525
④	OPEN FOREST - ROCKY, STEEP VW	.04	.0	0	.075	.115	- X
F ①	MIXED FOREST (VW)	.04	0	.005 HOUSES	.05	.095	— 0
②	C17	.035	0	.020 WDA	—	.055	- 520
③	ALDER + C/WOOD G.BAR	.045	.003	.005 WDA	.05	.103	- 72
④	MC →	.045				.045	- 970
⑤	DENSE F.P. W/ CHANNELS Qal (VAD)	.026	.01	0	.10	.136	- 197
G ①	OPEN FOREST (AF)	.05	0	—	.075	.125	- 302
②	MC →	.045				.045	- 533
③	LO T. W/ DENSE CEDAR	.045	—	—	.15	.15 .195	- 800
④	FP	.026	.003	—	.15	.18 .18	- 2100

Sub reach	X.S.	Description	n_b	n_1	n_3	n_4		Final Stn.
H	①	AF - OPEN FOREST	.05	0	.003	.075	.128	-190
	②	MC	.045	→			.045	-320
	③	ALDER C.WOOD ISLAND	.04	.002	.005	.10	.14	-590
	④	~~FP w/ WOA + S/G + ALDER~~						
	⑤	FP w/ WDA + S/G + ALDER	.03	.002	.02	.001	.147	-1430
	⑥	FP FOREST	.026	0	0	.10	.126	-3050
I	①	AF DENSE C.WOOD	.05	0	—	.10	.15	-435
	②	MC	.045	→			.045	-740
	③	FP w/ WDA + S/G + ALDER	.03	.002	.02	.001	.147	-1740
	④	FP MOD. DENSE FOREST (INCLUDES C-6)	.026	.008	—	.10	.126	-3360
J	①	AF MOD. DENSE	.05	0	0	.10	.15	-341
	②	ALDER + CEDAR F.P.	.026	0	0	.10	.126	-950
	③	MC	→				.045	-1150
	④	GRAVEL BAR	→				.045	-1615
	⑤	FP FOREST	SEE H + I →				.126	-3235
K	①	FP (TERRACES) OPEN FIELD	.026	0	0	.01	.036	-940
	②	FP OPEN FOREST-(LO.T)	.026	0	0	.075	.101	-1000
	③	MC	.045	→			.045	-1230
	④	VD V. DENSE FOREST	.026	0	0	.15	.176	-X
L	①	FP TERRACES	SEE K-① →				.036	-940
	②	V. OPEN FOREST FP	.03	0	0	.05	.080	-1000
	③	MC + GRAVEL BAR / WOA	→		.0075 (WOA) →		.045	-1225
	④	DENSE FOREST FP	.026	0	0	.15	.15 .176	-X

X.S	SUB REACH - DESCRIPTION	Nb	N_1	N_3	N_4	N FINAL	-S
4 ①	AF - V. OPEN PINES.	.05	—	—	.075	.125	-135
②	C18 - OPEN FOREST - OPEN w/ 4 WOA	.045	.005	.02	.05	.12	-535
③	2° CHANNEL w/ WOA	.045	—	.02	—	.065	-605
④	ALDER - C.WOOD + HEAVY WOA	.045	0	.03	.05	.125	-775
⑤	MC →	.045	→			.045	-1095
⑥	ALDER FP - IRREGULAR	.04	.01	—	.05	.10	-124
⑦	C 8A	.04	0	0	.05	.09	-1400
⑧	FOREST FP w/ BEAVER DAMS + FP CHANNELS	.026	.006	.02 DAMS	.12	.172	-X
1 ①	AF FOREST	.05	—	—	.075	.125	-570
②	2° CHANNEL w/ 5.5' WOA - ALDER	.045	—	.02	.05	.115	-
③	MC w/ GRAVEL BAR.	.045	→			.045	-1150
④	2° CHANNEL	.030	—	.004	—	.034	-1350
⑤	DENSE FOREST F.P.	SEE M⑧ →				.172 .15	-X
2 ①	- LO.T. w/ C19-C20/WOA - ALDER + C.WOOD	.04	.007	.02	—	.067	-235
②	- ISLAND COTTONWOOD.	.03	.002	.02	.075	.127	-590
③	MC w/ G. BAR.	.045	→			.045	-805
④	2° CHANNEL (G/S)	.028	—	—	—	.028	-985
⑤	DENSE FOREST FP	SEE M⑧ →				.15 .172	-X
3 ①	TALUS	.06	→			.06	-45
②	LOW T. w/ CHANNELS C19/20	.04	.006	.03	—	.076	-1
③	MC	.045	→			.045	-367
④	FOREST	.03	—	—	.1	.13	-460
⑤	C11 w/ B. DAMS DENSE FOREST w/	.026	.006	—	.15	.182	-X

X.S.	Surface Description	Nb	N1	N3	N4	Nf	
Q ①	TALUS	.06	→			.06	— 38
②	MC	.040	→			.04	— 190
③	DENSE CEDAR (Harlequin CG)	.026	—	—	.10	.126	— 215
④	FOREST w/ OPEN FAIRWAYS	.026	—	—	.075	.101	— x
R+R ①	TALUS	.06	→			.06	— 38
②	MC	.040	→			.04	— 190
③	ROB - DENSE FOREST + COMPANY CR ROAD	.026	.005	—	.15	.181	— x
RIDGE ①	MC.	.040	→			.04	
S ①	TALUS	.06	→			.06	— 57
②	MC w/ GRAVEL BAR	.045	→			.045	— 265
③	FP DENSE w/ CHANNELS	.026	.001	—	.10	.127	— x
①	UW - FOREST	.04			.10	.14	x — 137
②	mc —	.045		.002	→	.047	— 327
③	FP - FOREST/ALDER	.026	—	—	.05	.076	— 370
④	C14	.03	→			.03	— 935
⑤	FP/AF	.026	—	—	.1	.126	— x
①	Hi T. + FOREST	.04	0	—	.10	.14	— 297
②	C21 - C22 + ALDER + SG + WDA	.04	.006	.020	—	.066	— 595
③	MC	.045	→			.045	— 715
④	Old F.P CHANNEL (Qal-VAD)	.026	0	—	.10	.126	— 1370
⑤	AF w/ FOREST	.05	0	—	.10	.15	— x

X.S.	Sub Reach Description	Nb	N_1	N_3	N_4		Nf
V	① VW	.05	—	—	.1	.15	—1
	② MC w/ VEG. GRAVEL BAR	.045	→			.045	—4
	③ FOREST	.03	—		.10	.13	—6
	④ CHANNELS	.045	—	.002	—	.047	—
	⑤ FP w/ FLOOD CHANNELS	.026	.006	—	.10	.132	—
W	① VW - FOREST	.05	—	—	.10	.15	—
	② MC	.045	→			.045	—
	③ ALDER + LOGS + C/G	.04	—	.03	.05	.12	—6
	④ 2° CHANNEL C/23	.04	—	0	—	.04	—6
	⑤ FP - FOREST	.026	-		.10	.126	—9
	⑥ C/24	.020	—	—	.05	.076	—1
	⑦ FP.	.026	.006	—	.10	.132	
X	① C/29 + Road + WDA	.026	—	.005	—	.031	—1
	② ALDER - C/B	.045	—	.005	.05	.10	—1
	③ MC	.045	→			.045	—3
	④ ALDER G./BAR	.045	—	—	.05	.095	—3
	⑤ 2° CHANNEL	.045	→			.045	—4
	⑥ C26 - OPEN - C/NFS	.035	—	.02	—	.045	—6
	⑦ FP C/27/28 - CLOSED - @ o/vAD	.026	.011	—	.10	.137	—

X.S.	Sub Reach Description	Nb	N_1	N_3	N_4	Nf	
①	C32/C31 – CLOSED	.026	.006	—	.05	.082	– 130
②	OPEN FIELD	.026	—	—	.001	.037	– 324
③	FOREST – FP – Qal	.026	—	—	.10	.126	– 660
④	C/30 – C/B – OPEN (Bridged	.045	—	—	.02	.047	– 680
⑤	FP FOREST + HOUSES	.026	.004	.003	.075	.108	– 1127
⑥	MC + WOOD CRIBBING	.045	—	.01	—	.055	– 1346
⑦	WOOD CRIBBING					X	– 1393
⑧	C/28 + CLOSED	.026	—	—	—	.026	– 1494
⑨	VW	.05	—	—	.10	.15	– X
①	FP + C35/C34 + FOREST	.026	.015	—	.075	.116	– 339
②	C.33/30	.045	→			.047	– 660
③	FP – FOREST W/HOUSES SCATTERED	.03	—	.003	.075	.108	– 839
④	MC	.045	→			.045	– 1105
⑤	FP	.036	.01	—	.10	.146	– X
①	FP + OPEN FOREST	.026	—	—	.075	.101	– 445
②	ALDER/RIPARIAN STRIP	.030	—	—	.05	.08	– 515
③	MC	.045	→			.045	– 742
④	FP SEGMENT + FOREST	.026	—	—	.10	.126	– 772
⑤	C37/C38 + OPEN + C/B	.040	—	.002	—	.042	– 816
⑥	VW + FOREST	.05	—	—	.075	.125	– X

X.S.	SUB REACH DESCRIPTION	N_b	N_1	N_3	N_4	Nf.	-STA
B ①	FP + C 40	.045	—	—	.10	.145	— 0
②	MC	.045	⟶			.045	- 183
③	ALDER + FOREST	.026	—	—	.15	.176 .15	-267
④	C 39 + OPEN + C/B	.045	—	.02	—	.065	- 397
⑤	VW + OPEN FOREST	.05	—	—	.05	.10	- 669
[illegible] ①	FP + FOREST (Qal-VAO)	.026	—	—	.10	.126	-18[illegible]
②	MC	.045	⟶			.045	-221
③	FP + FOREST	.026	—	—	.10	.126	-433
[illegible] ①	AF + FOREST	.05	—	—	.10	.15	(-)499
②	FP + OPEN FOREST + Qal VAO	.026	—	—	.075	.101	- [illegible]
③	C. BANK FOREST + Qal	.026	—	.002	.10	.128	-16
④	MC	.045	⟶			.045	- 218
⑤	CEDAR CHANNEL BANK	.045	—	—	.05	.095	- 236
⑥	VW + MOD. DENSE	.05	—	—	.10	.15	- 390
F ①	AF	.05	—	—	.10	.15	- (-)348
②	FP - OPENFIELD	.026	—	—	.001	.036	- 0
③	FOREST STRIP @ C. BANK	.04	—	—	.15	.19	- 7
④	MC	.045	⟶			.045	- 146.5
⑤	FP + VW FOREST	.026	—	—	.10	.126	- X

X.S.	SUB REACH DESCRIPTION	Nb	N_1	N_3	N_4	N	FINAL-S
AG ①	AF-T + FP + Qal	.03	—	—	.10	.13	— 0
②	BANK. BL MAPLE SAPLINGS	.026	—	—	.03	.056	— 27
③	MC	.045	→	→	→	.045	— 202
④	GRAVEL BAR	.045	—	—	.15	~~.19~~ .15	— 243.5
⑤	C/41 + WDA + C/B	.045	—	.009	—	.054	— 366
⑥	FP → VW FOREST	.026	—	—	.075	.101	— X
H ①	AF MOD. DENSE FOREST	.05	—	—	.1	.15	— 22
②	FP M. DENSE FOREST	.026	—	—	.1	.126	— 75.5
③	MC	.045	→	→	→	.045	— 251
④	FP + DENSE FOREST	.026	—	—	.15	~~.176~~ .15	— 317.5
⑤	C/42 (FP channel w/ woody debris)	.026		.005	.05	.081	— 357.5
⑥	FP w/ BEAVER DAMS/OPEN FOREST	.026	—	.02	.075	.121	— 722.5
⑦	VW + MOD. DENSE FOREST	.05	—	—	.10	.15	— 929
I ①	VW-Qg	.05	—	—	.01	.06	— 20.5
②	MC	.045	→	→	→	.045	— 195.5
③	C/42	SEE AH ⑤ →				.081	— 694
④	FP — DENSE FOREST	.026	—	—	.15	~~.176~~ .15	— X
J ①	VW	.05	—	—	.01	.06	— 22.5
②	C44 — CLOSED FP	.026	—	—	.10	.126	— 227.5
③	MC	.045	→	→	→	.045	— 524
④	FP —	.026	—	—	.15	~~.176~~ .15	— X

X.S.		SUB REACH DESCRIPTION	N_b	N_1	N_3	N_4	N_F	STATION
K	①	AF – M. DENSE FOREST	.05	—	—	.10	.15	– 0
	②	BANK. M. DENSE FOREST	.04			.10	.14	– 42
	③	MC	.045	→	→	→	.045	– 184
	④	FP w/ C 45 – 46	.035	—	.005	.05	.09	– 891
	⑤	C 47	.04	—	—	—	.04	– 1044
	⑥	VW FOREST	.05	—	—	.075	.125	– 1128
	①	VW OPEN DOGWOOD	.05	—	—	.05	.10	– 0
	②	AF MOD. DENSE FOREST	.05			.10	.15	– 273
	③	MC	.045	→	→	→	.045	– 461
	④	C 48/49	.035	—	.009	—	.044	– 588
	⑤	FP w/ C 50	.026	—	.009	.075	.11	– 1021
	⑥	C 47 – OPEN	.045	→	→	→	.045	–
	⑦	VW – FOREST	.05	—	—	.075	.125	
M	①	AF – OPEN FOREST	.05	—	—	.05	.10	– 0
	②	TERRACE – FOREST	.026	—	—	.085	.111	– 112
	③	BANK VEG. – DENSE CEDAR	.04			.10	.14	– 137.5
	④	MC	.045	→	→	→	.045	– 314
	⑤	FP – DENSE ALDER	.026	—	—	.065	.091	– 502
	⑥	C 47 – OPEN C/B	.045	→	→	→	.045	– 567.5
	⑦	FP – FOREST	.026	—	—	.075	.111	– 731
	⑧	VALLEY WALL – FOREST	.05	—	—	.05	.10	– X

	X.S	Sub Reach Description	Nb	N_1	N_3	N_4	Nf - STN
N	①	AF - B/C	.05	—	—	—	.05 - (-220)
	②	FP-T open pasture	.001	—	—	.002	.03 - (-78)
	③	FP-T - C/B - dense pine	.04	.006	—	.10	.146 - (-15.5)
	④	FP-T - C/B - C/52 open	.04	.006	—		.046 - 279
	⑤	2° channel + dense cedar	.026	—	—	.075	.101 - 328
	⑥	MC	.045	→	→	→	.045 - 522
	⑦	C/53 - open	.045	—	.02	.05	.115 - 649
	⑧	VW (BR + talus)	.06	—	—	.075	.135 - 786
O	①	AF - mod. dense forest	.05	—	—	.10	.15 - (-17.5)
	②	FP - open forest	.026	—	—	.075	.101 - 92
	③	MC	.045	→	→	→	.045 - 249.5
	④	Alder + logs / island	.04	—	.005	.05	.095 - 305.5
	⑤	C/54 - C/B - open - logs	.045	—	.008	—	.053 - 331.5
	⑥	T - mod dense cedar - Qal/UAD	.026	—	—	.10	.126 - 436.5
	⑦	C/55 closed VFS + silt	.026	—	—	.075	.101 - 485
	⑧	VW - forest	.05	—	—	.075	.125 - 545
	①	AF - open forest - C/56	.05	.006	—	.05	.106 - 18
	②	FP - open forest	.05	.006	—	.05	.106 - 251
	③	C/57 - open C/B - some shrubs	.045	—	—	.04	.085 - 280.5
	④	FP - C/B	.045	—	—	.05	.095 - 318.5
	⑤	MC	.045	→	→	→	.045 - 513.5
	⑥	Cut bank C/B	.040	→	→	→	.040 - 541.5
	⑦	T - open D.Fir	.045	—	—	.05	.095 - X

X.S.	SUB REACH DESCRIPTION	N_b	N_1	N_3	N_4	N_{FINAL}	S
AQ ①	AF - MOD. DENSE FOREST	.05	—	—	.10	.15	— (2
②	FP - C/B - BARS	.04	—	—	.05	.09	— 0
③	C/58 - CLOSED - C/B	.045	———	———	.05	.095	- 191
④	MC	.045	————	————	———→	.045	- 377
⑤	FP - C/B - OPEN FOREST	.04			.05	.09	— X

APPENDIX E
WOODY DEBRIS ACCUMULATIONS

(Mason and Koon, 1985)

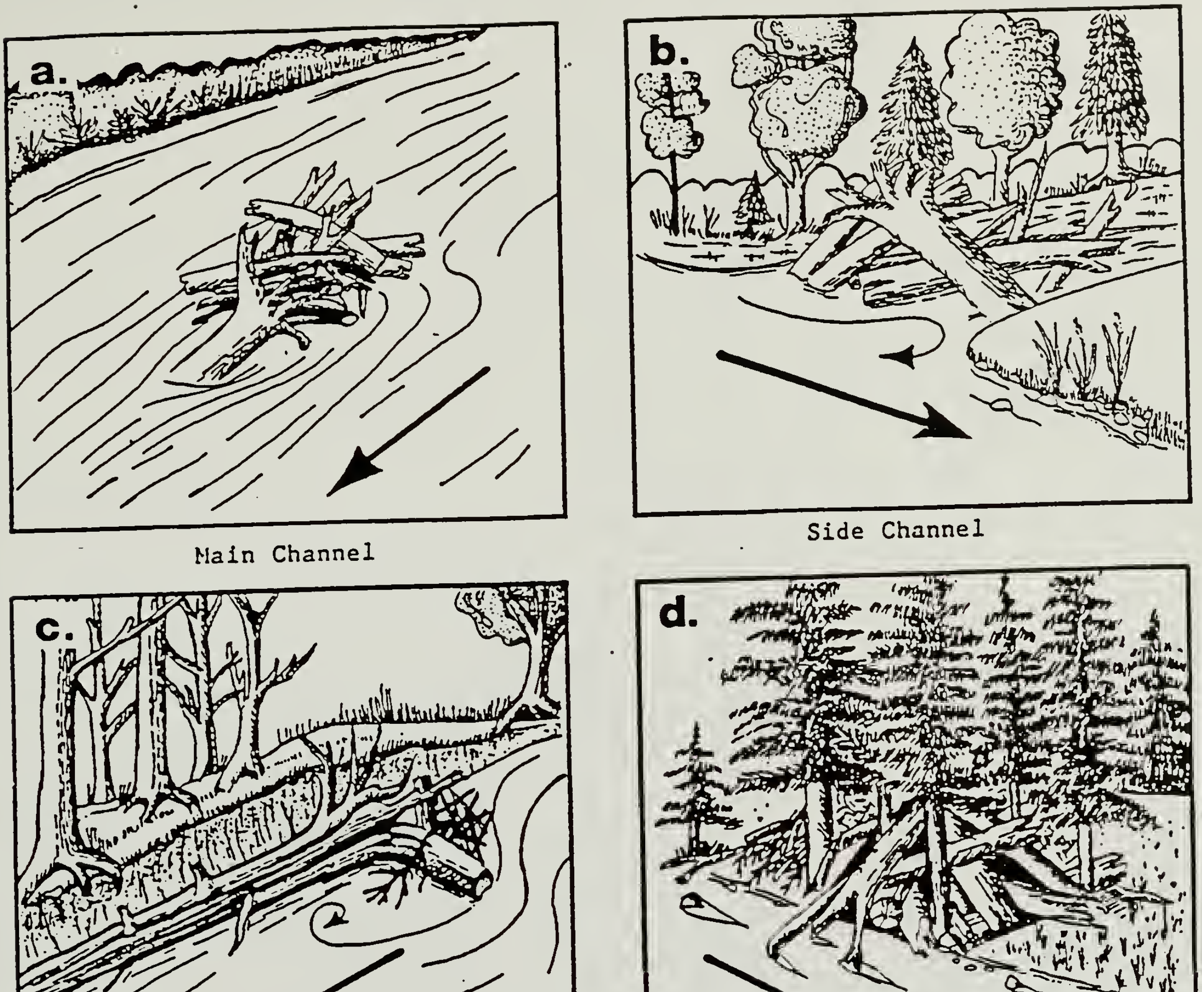
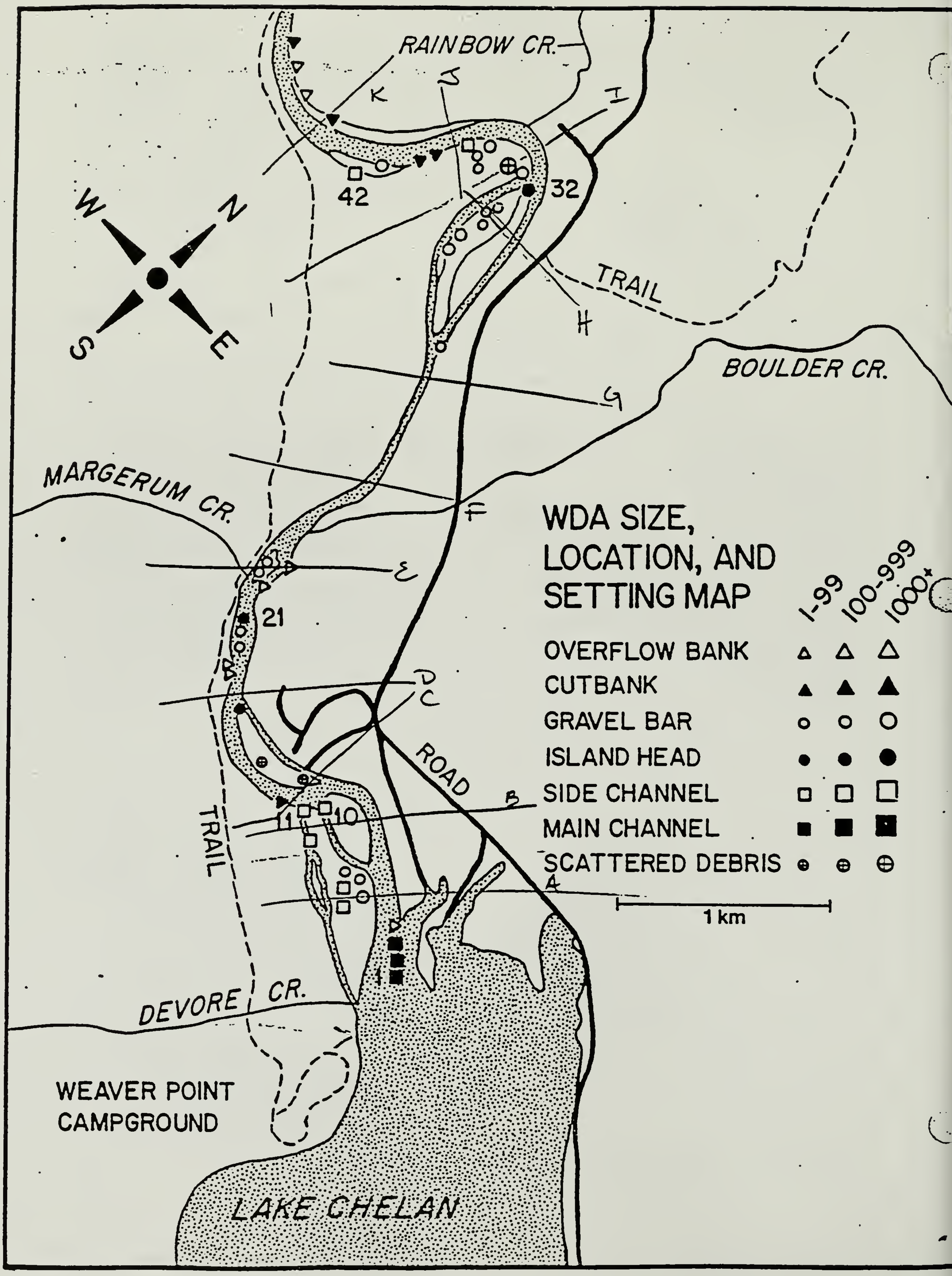
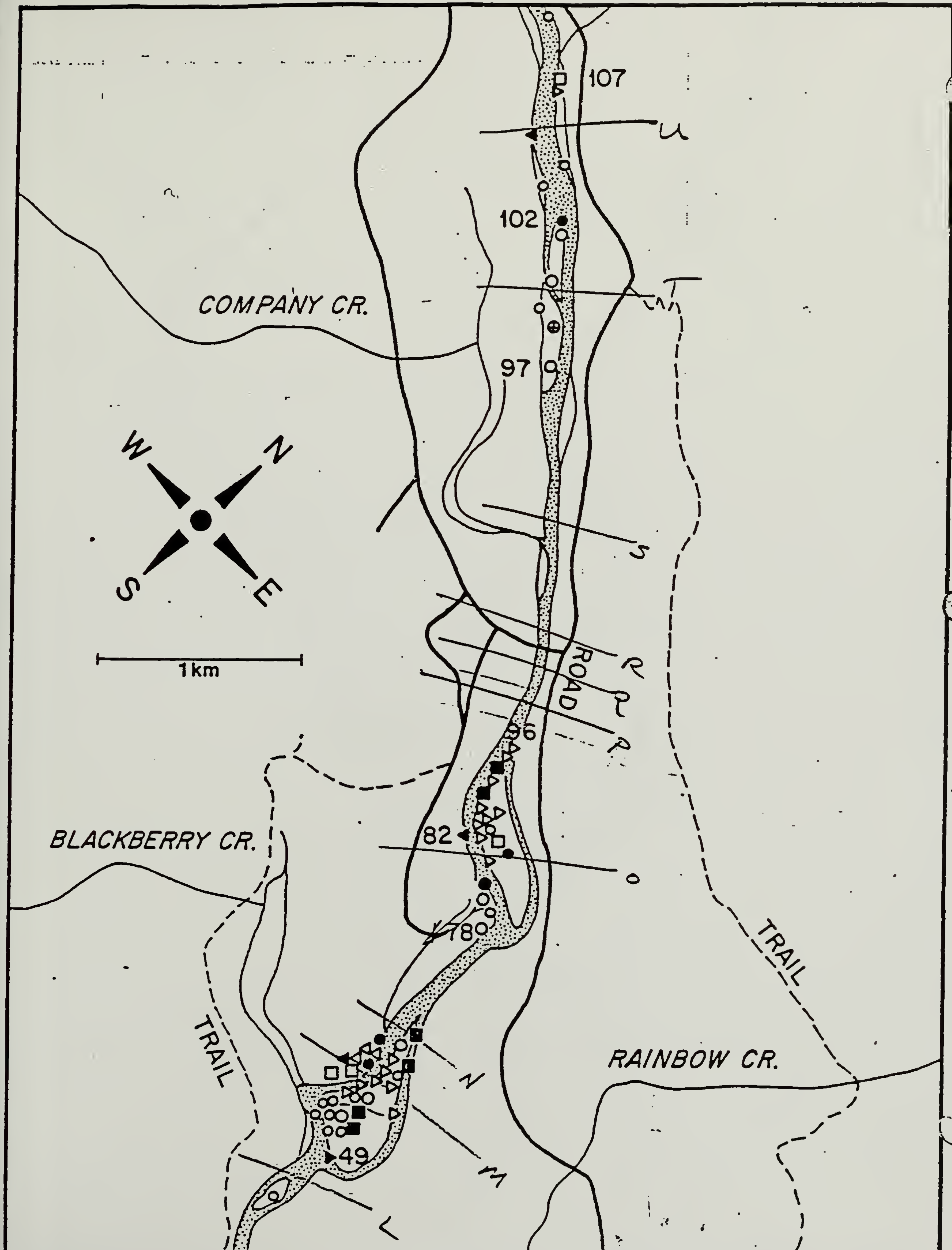


FIGURE 1. Island head

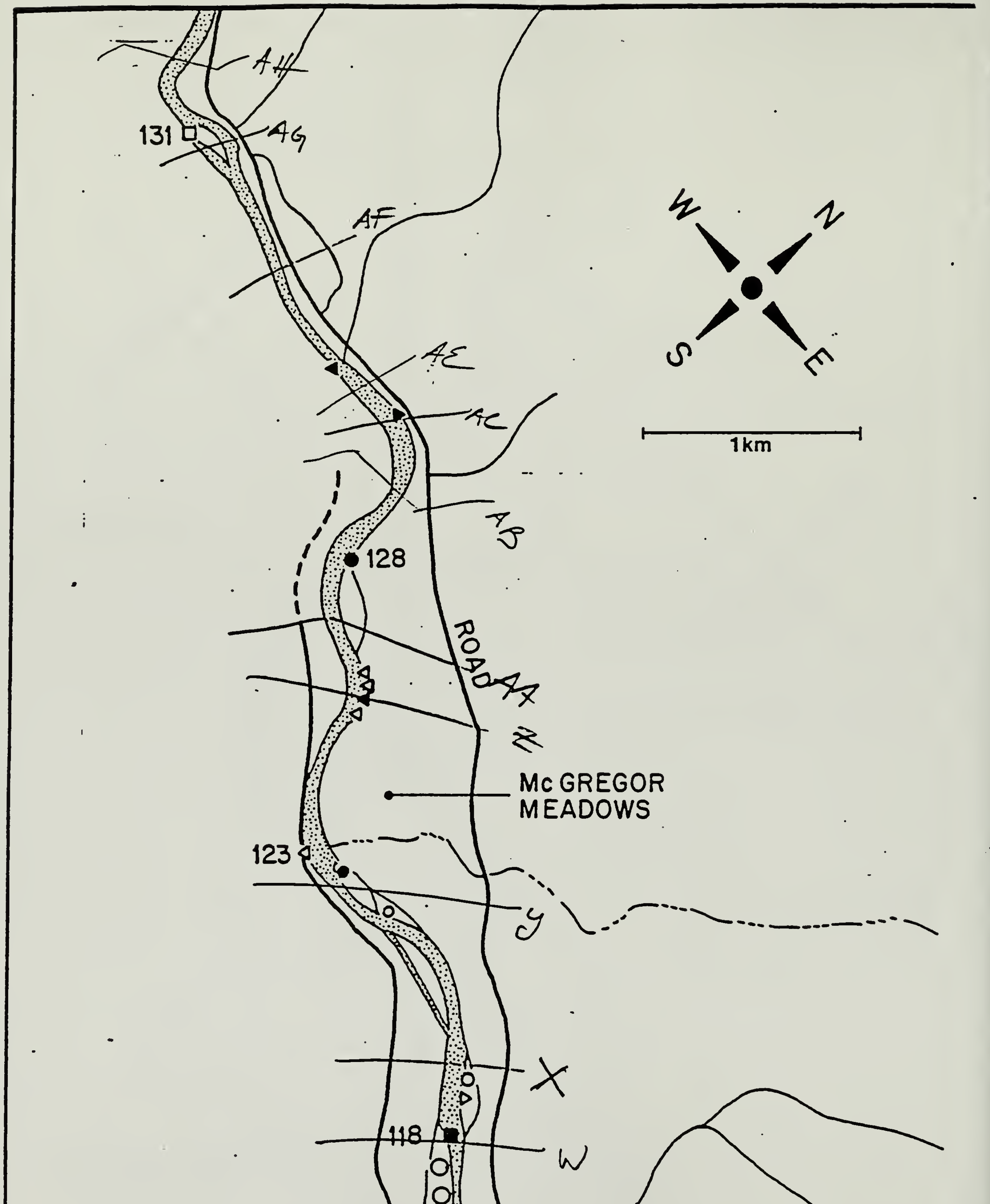
Gravel bar


RAINBOW CR.
K
J
I
42
32
W
N
S
E
TRAIL
H
BOULDER CR.
G
MARGERUM CR.
F
E
21
D
C
ROAD
B
11
10
A
TRAIL
1 km
DEVORE CR.
WEAVER POINT
CAMPGROUND
LAKE CHELAN
WDA SIZE,
LOCATION, AND
SETTING MAP
1-99
100-999
1000+
OVERFLOW BANK
CUTBANK
GRAVEL BAR
ISLAND HEAD
SIDE CHANNEL
MAIN CHANNEL
SCATTERED DEBRIS



107
U
102
COMPANY CR.
T
97
W
N
S
E
1km
S
R
ROAD
Q
P
96
82
BLACKBERRY CR.
O
78
TRAIL
TRAIL
N
RAINBOW CR.
M
49
L

FIGURE 2b



AH
131
AG
AF
W
N
S
E
AE
AC
1km
AB
128
ROAD
AA
Z
Mc GREGOR
MEADOWS
123
Y
X
118
W
112
V

FIGURE 2c.

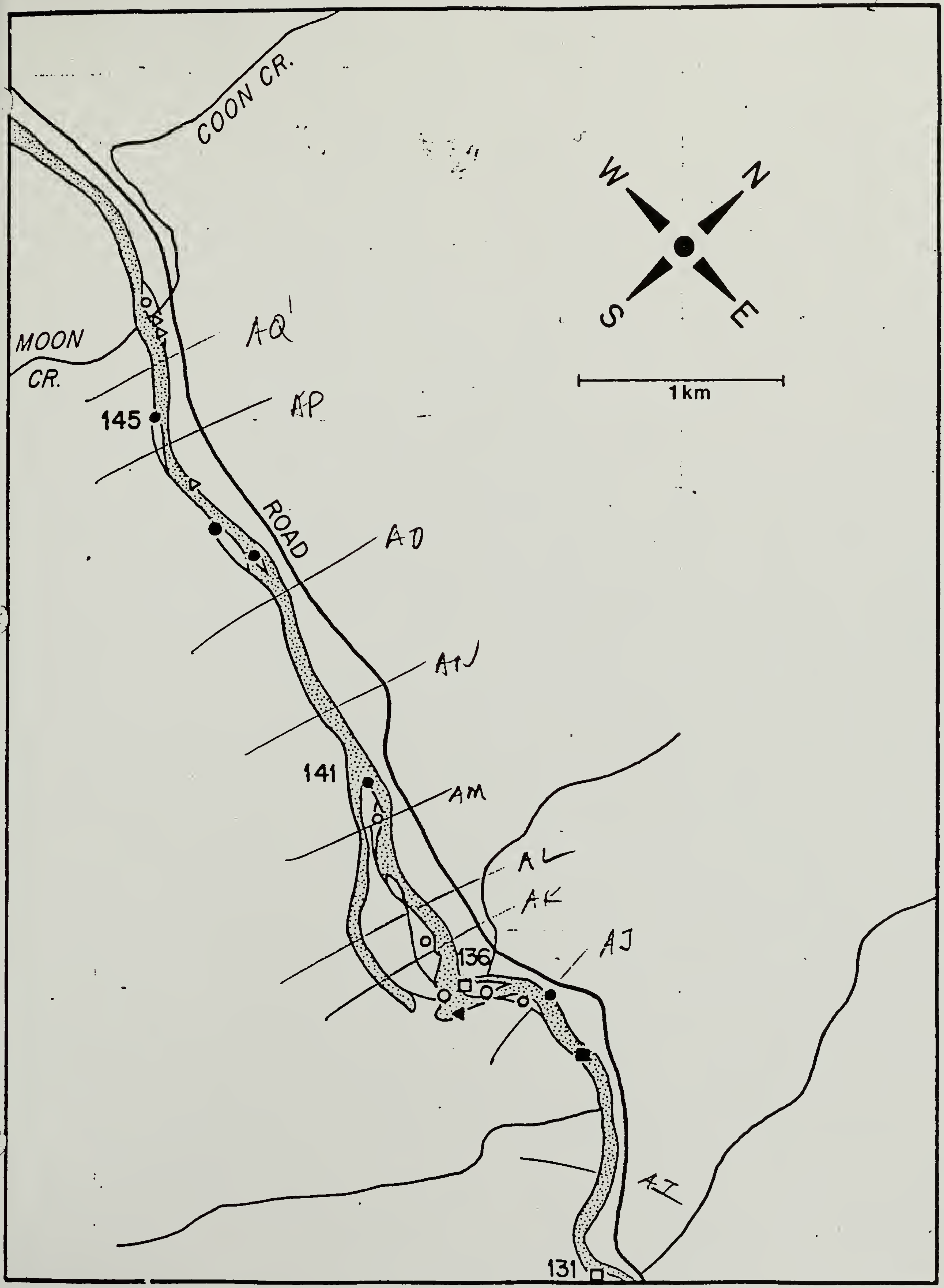

COON CR.
MOON CR.
W
N
S
E
1 km
AQ'
AP
145
ROAD
AO
AN
141
AM
AL
AK
136
AJ
AI
131

FIGURE 24