UNIVERSITY OF MINNESOTA

# ST. ANTHONY FALLS HYDRAULIC LABORATORY

Project Report No. 251

# APPLICATION OF BUREAU OF RECLAMATION GSTARS TO WILLOW CREEK UNPROTECTED SPILLWAY

by

Charles C. S. Song

and

Yifan Zen

Submitted to

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Denver Federal Center
Denver, Colorado

Contract No. USDI-6-CR-81-06940

April, 1987
Minneapolis, Minnesota

St. Anthony Falls Hydraulic Laboratory
Department of Civil & Mineral Engineering
University of Minnesota
Mississippi River at 3rd Ave. S.E.
Minneapolis, Minnesota 55414

Project Report No. 251

# APPLICATION OF BUREAU OF RECLAMATION GSTARS TO WILLOW CREEK UNPROTECTED SPILLWAY

by

Charles C. S. Song

and

Yifan Zen

Submitted to

U. S. Department of the Interior
Bureau of Reclamation
Denver Federal Center
Denver, Colorado

Contract No. USDI-6-CR-81-06940

April, 1987

# TABLE OF CONTENTS

Page No.

I. INTRODUCTION .................................... 1

II. DESCRIPTION OF THE MODEL .......................... 3

A. Hydraulic Computation .......................... 3
B. Sediment Routing ............................... 3
C. Determination of Sedimentation Pattern .......... 6

III. DESCRIPTION OF THE TEST CASE ...................... 8

A. Reservoir and Spillway ......................... 8
B. Geology of the Spillway ........................ 8

IV. RESULTS OF THE STUDY .............................. 10

A. Program Adjustment ............................. 10
B. Numerical Instabilities and Errors .............. 10
C. The Results of Computation for 100 Year Storm ... 11
D. The Results of Computation for 0.5 IDF .......... 13

CONCLUSIONS AND RECOMMENDATIONS .................... 14

References ........................................ 16

List of Figures ................................... 17

Figures 1 through 12 .............................. 18-94

APPENDIX .......................................... 95

A. Description of the Example Problem ............ 96
B. Table A-1 - Input Data of the Example ......... 99
C. Table A-2 - Computer Output of the Example .... 103
D. Input Hydrograph Figure ....................... 131
E. Figures A-2 through A-26 ...................... 133
F. List of GSTARS Program ........................ 159
G. List of XSPLOT Program ........................ 213
H. List of WSPLOT Program ........................ 217

# I. INTRODUCTION

When there is a significant change in discharge or sediment load, due to flood or construction of a reservoir for example, erosion and deposition cause the geometry of an alluvial channel to change rapidly in order to achieve a new equilibrium condition. Because the process is a highly complex multi-component, multi-dimensional, and time dependent process its complete mathematical modeling is not feasible at the present time.

Most existing mathematical models, such as HEC6, treat the flow in a river as a one-dimensional flow. They usually ignore the lateral variations and assume that the erosion and deposition take place only at the river bed. Consequently, the change in channel width cannot be computed by such models.

In order to predict the variation of channel width as well as the river bed elevation, it is necessary to distinguish the sedimentation at the bank from that of the bed. One possibility is to develop a two-dimensional flow model which can calculate the lateral variation of mean flow and sedimentation quantities. This conventional approach requires a very large amount of computational effort and, hence, is not widely used at this time.

The Bureau of Reclamation GSTARS model is based on a new concept which combines the conventional one-dimensional flow model with the theory of minimum energy dissipation rate such that the variation of channel shape can be calculated efficiently. Because the concept is relatively new, the model should be thoroughly tested before it can be introduced to the engineering community for general use. The detail of this model is described in the User's Manual of the Bureau of Reclamation [1]*.

The St. Anthony Falls Hydraulic Laboratory has been selected by the Bureau of Reclamation (Contract No. USDI-6-CR-81-06940) to conduct some case studies for the purpose of evaluating the capability of the model as a practical engineering tool. This report describes the results of the first case study that has just been completed.

---

*Numbers in brackets indicate references on page 15.

As the first case study, the model has been used to predict the erosion process of the unpaved spillway of the Willow Creek Reservoir under different size floods: 100 year flood, half of the Inflow Design Flood (IDF), and the IDF. The Bureau conducted a field survey and provided the topographic and geologic data. The Bureau also estimated inflow hydrographs and routed them through the reservoir to obtain the overflow hydrographs to be used for this study. A field trip was made in the spring of 1986. It was noted that there was a substantial amount of large size rocks which might not be included in the sediment size analysis. For this reason some amount of engineering judgement was needed in conducting this study.

It appears that the results obtained are quite reasonable.

## II. DESCRIPTION OF MODEL

The model consists of three major program components: A: hydraulic computation, B: sediment routing, and C: determination of sedimentation pattern. These three components are briefly explained below.

### A. Hydraulic Computation

At the beginning of each time step, the hydraulic computation is first performed to determine the water surface profile and the mean velocity at each cross section. At this stage of computation the flow is assumed to be steady and one-dimensional. The discharge is assumed to be equal to the mean value of the inflow within the preassigned time interval. A backwater computation method for one-dimensional gradually varied steady open channel flow (proposed by Molinas and Yang [2]) is adopted here. A backwater curve for a steep slope and a mild slope with or without a hydraulic jump can be computed without interruption.

### B. Sediment Routing

Before the sediment routing can be performed, the channel is first subdivided into a number of parallel stream tubes or subchannels of equal conveyance. For example, Fig. 1 shows the sketch of a channel cross section which is subdivided into three parts: left channel, center channel, and right channel. The two vertical lines in Fig. 1 are so drawn that the conveyance of subchannels

$$K_j = \frac{1.49}{n_j} R_j^{2/3} A_j \tag{1}$$

are equal to each other. This means each subchannel will carry one-Jth of the total discharge. The top view of the channel as shown in Fig. 2 indicates that the channel is subdivided into J×I elements. Here I is the number of reaches and J is the number of subchannels.

The sediment load at each subcross section, $Q_{sij}$, is calculated according to one of the three sediment transport equations specified in the model. Three sediment transport equations included in the model are that of 1) Yang, 2) Ackers and White, and 3) Engelund and Hansen.

The amount of scouring or deposition occurring at each subcross section is calculated by applying the sediment continuity equation

$$\eta \frac{\partial A_d}{\partial t} + \frac{\partial Q_s}{\partial x} = 0 \qquad (2)$$

where $\eta$ is set equal to a commonly used value of 0.6 and $A_d$ is the volume of sediment deposition per unit length. This equation neglects the effect of suspended load on channel geometry variation.

Equation 2 is a kinematic wave equation which may be solved by an explicit finite difference method using forward difference in $t$ and backward difference in $x$. The backward derivative for the second term in Eq. 2 for a cross section ij is

$$\frac{\Delta Q_s}{\Delta x} = \frac{2(Q_{sij} - Q_{si-1j})}{\Delta x_{i-1} + \Delta x_i} \qquad (3)$$

Since scouring or deposition can cause either the bed elevation change or the channel width change, the finite difference version of the first term of Eq. 2 takes one of the following two alternative forms.

### 1. Bed elevation change

If scouring or deposition is assumed to cause the bed elevation to change the amount $\Delta z$ as shown in Fig. 3, then the finite difference form of the first term is

$$\eta \left( \frac{\Delta A_d}{\Delta t} \right)_{ij} = \frac{\eta (W_{i-1j} + 2W_{ij} + W_{i+1j}) \Delta Z_{ij}}{4 \Delta t} \qquad (4)$$

where $W_{ij}$ is the width at water surface level. If the subchannel is wide and shallow then the width $W_{ij}$ may be replaced by the wetted perimeter $P_{ij}$. Current code uses $P_{ij}$ rather than $W_{ij}$ in Eq. 4.

Equation 4 implies that the change in bed elevation occurs only at the original wetted perimeter $\overline{AB}$ as shown in Fig. 3. Depending on the property of the bank material, it may be necessary to limit the bank slope and include the material under the triangle ADE. However, this option is not provided in the current model. As a result, the bank tends to steepen indefinitely if erosion continues.

## 2. Channel width change

Consider the case when scouring is to take place in the lateral direction by the amount $\Delta W$ over the submerged portion of the bank as shown in Fig. 4. This would erode the shaded area ABE resulting in an unstable overhang AE. A more likely event is to erode the additional amount ADE where the line AD is a portion of the original bank profile above water surface and DE is determined by stability consideration. The material in ADE was omitted in the original model but included in the current model. Its inclusion is found to be essential to the stability of the numerical procedure.

The finite difference version of the first term of Eq. 2 is proposed to be as follows:

$$\eta \left( \frac{\Delta A_d}{\Delta t} \right) = \frac{\eta \Delta W_{ij}}{4\Delta t} (y_{i-1j} + 2y_{ij} + y_{i+1j} + 2h_{ij}) \tag{5}$$

In the current model, DE is a straight line tangent to the bank profile under water surface. It may be desirable to make the slope of DE equal to the angle of repose which may be specified based on the bank material.

After the partial derivatives are replaced by appropriate finite differences, Eq. 2 may be solved for either $\Delta Z_{ij}$ or $\Delta W_{ij}$. For bed elevation change we have

$$\Delta Z_{ij} = \frac{8(Q_{si-1j} - Q_{sij})\Delta t}{\eta(W_{i-1j} + 2W_{ij} + W_{i+1j})(\Delta X_{i-1} + \Delta x_i)} \tag{6}$$

For channel width change we have

$$\Delta W_{ij} = \frac{8(Q_{si-1j} - Q_{sij})\Delta t}{\eta(y_{i-1j} + 2y_{ij} + y_{i+1j} + 2h_{ij})(\Delta x_{i-1} + \Delta x_i)} \tag{7}$$

The effect of nonuniform sediment size distribution on sediment transport rate and erosion is included in the model. The bed material is divided into a number of size ranges and the composition of sediment sizes within an active layer is updated at every time step. The active layer thickness is defined by:

$$\delta = 50\sqrt{d_1 d_2} \tag{8}$$

where $d_1$ and $d_2$ are the two limits of the coarsest size range.

## C. Determination of Sedimentation Pattern

The amount of deposition (positive) or erosion (negative) occurring at each element was computed under part B of the program. It now remains to determine whether the change should be applied to the depth or the width. For all internal elements, in subchannel C of Figs. 1 and 2, the only change possible is in the vertical direction or the change in the bed elevation. But for boundary elements the water-sediment boundary may move in either the vertical or the horizontal direction. Movement in the horizontal direction will change the width without changing the depth.

Since each boundary element has two possible ways of change, there are a total of 4**I combinations of changes possible for the entire channel. According to the theory of minimum energy dissipation rate, the most likely pattern of change is the one that results in the smallest energy dissipation rate. That is:

$$\phi = \Sigma(\gamma Q_{ij} + \gamma Q_{sij}) S_{ij} \Delta x_i = \text{Min} \tag{9}$$

If we neglect the contribution of sediment on the energy dissipation rate, then Eq. 9 simplifies to:

$$\phi = \gamma \Sigma Q_{ij} S_{ij} \Delta x_i = \text{Min} \tag{10}$$

In the above equation $Q_{ij}$ has been assumed to be a constant, and equal to $Q/J$. Furthermore, $S_{ij}$ is an energy slope which is independent of $j$ for one-dimensional flow. It is related to the conveyance as:

$$S_i = \frac{Q^2}{K_i^2} \tag{11}$$

In summary, the minimization principle reduces to:

$$\Sigma \frac{\Delta X_i}{k_i^2} = \text{Min} \tag{12}$$

In the above equation $\Delta X_i$ is predetermined. Therefore, the minimization of $\phi$ depends only on the distribution of $K^2{}_i$. Under a subcritical flow condition, $K^2{}_i$ will depend on conditions at all elements. Even if we ignore the effect of change in internal elements, the possible number of combinations of changes is 4**I. A straight forward search for the minimum out of this many alternatives is prohibitively expensive. For this reason, this model ignores the non-linear interactions between the changes at different elements. That is, we assume that the change in $K^2{}_i$ due to the geometrical change at one element is independent of the geometrical change at all other elements. The number of alternatives remain to be evaluated under this assumption is 4I.

The assumption described above makes the search for minimum value very simple. It is only necessary to select one boundary element at a time and consider a variation in width or depth. The resulting change in $\phi$ is calculated using the Program A. Select the case that will result in smaller $\phi$ as the direction of change for that element. Repeat the process for all boundary elements and the pattern of geometrical change to be taken is determined.

Because the flow computation of Program A must be repeated for every alternative tested, this portion of the program, Program C, is still quite time consuming and should not be applied at every time step. An engineering judgement is required to determine how frequently this program is called.

# III. DESCRIPTION OF THE TEST CASE

## A. Reservoir and Spillway

The emergency spillway of Willow Creek Reservoir located near Great Falls, Montana, was selected for this case study. The dam, a homogeneous earthfill structure, was constructed on Willow Creek about 1-1/2 miles upstream from the Sun River. It was initially built by the Bureau of Reclamation between 1907 and 1911, and later raised in 1917 and 1941. The reservoir has an active storage capacity of 32,000 acre feet at a normal water surface elevation of 4,142.0 feet. A grass lined, uncontrolled, open channel spillway is located about 3,600 feet north of the dam. It consists of a 700 ft long, 6 ft high buried concrete cutoff wall that is protected on both sides by riprap. The top of the concrete crest is at elevation 4,144.0 ft. Water from the reservoir spillway flows along a grass-lined channel for a distance of about 2,900 ft before entering the incised Sun River Valley.

A topographic map of the spillway has been provided by the Bureau (Fig. 5), from which the existing geometry of the open channel can be determined.

## B. Geology of the Spillway

A series of geologic investigations were completed in the existing spillway area between 1968 and 1979 to determine what material underlies the spillway and the material's erosive characteristics. The results of these studies are summarized in a report by Glenn J. Tancher [3]. According to this report, the investigations included (1) augering eleven 12-inch diameter power auger holes, (2) drilling six Nx-size core holes, (3) excavating two test pits, and (4) conducting soils analyses on four samples, two from each pit. The size distribution of the soils according to this analysis are plotted in Fig. 6.

The existing grass-lined spillway is underlain by up to 100 ft of glacial till over the Two Medicine Formation along most of its length. At the lower end of the spillway near the Sun River Valley, sand and gravel terrace deposits mantle the Two Medicine Formation. There is a steep drop into the Sun River Valley where the bed rock is exposed and clearly visible. This is an ideal location to be used as the downstream end of the spillway model because it is a critical point and also because further deepening of the channel is not possible there.

Field observation revealed some previous erosion exposing larger-sized cobbles and boulders. Wave cut slopes that have been eroded to depths of up to 5 ft immediately upstream from the spillway crest are covered with fragments ranging from 1/4 inch to several cubic yards in size, averaging about 6 inches in diameter. These larger-sized material should be an important factor in stabilizing the spillway after a substantial amount of initial erosion. The grain size distribution curves of Fig. 6 do not adequately reflect the existence of larger-sized material, although it is an important factor for the final stability of the spillway. For this reason the given size distribution was slightly adjusted to include the rest of these coarse materials.

## IV. RESULTS OF THE STUDY

### A. Program Adjustment

The computer program is relatively new and some errors are to be expected. For this reason some trial runs were made initially. The first step in these trial runs was to reproduce the result of the sample run given in the Bureau's manual. Even after the perfect reproduction of the sample run, a few errors were found and corrected. The sample run deals with a relatively inactive situation in which the changes are relatively small and slow. Under this condition, some errors are rather difficult to discover. The example problem was solved with the updated code and the solution is included in this report as an APPENDIX.

After the errors were corrected, the model was ready for a severe test with the case of the flood flow over the spillway of Willow Creek Reservoir. The existing topography of the spillway is as described below. There is a short stretch of relatively steep slope immediately downstream of the spillway followed by a stretch of mild slope. This mild slope is followed by a stretch of narrow but very steep slope which feeds into a small lake. The lake is drained by the final stretch of a mild slope. The steepness of the slope causes two different types of numerical instability problems, which are discussed in the following section.

### B. Numerical Instabilities and Errors

The first type of numerical instability known as CFL instability is common to all explicit numerical schemes. The sediment routing procedure used in this model is an explicit scheme because the x-derivative represented by Eq. 3 is calculated at the beginning of the time step. An explicit method must satisfy the CFL stability criterion given by:

$$\Delta t < \frac{\Delta x}{U_s} \tag{13}$$

in which $U_s$ is the kinematic wave speed of bedload. This kinematic wave speed is essentially equal to the speed of the dunes. As the Froude number approaches one, the celerity of a dune increases asymptotically while its amplitude decreases.

For the present case the time step of as small as 20 minutes was found, by trial, necessary for the stability of the numerical procedure. It was found that the suggested $\Delta t$ of 1 hour would cause the model to diverge.

The second type of instability occurs only in the width change case. Figure 4 clearly shows that h is a function of $\Delta W$. This makes Eq. 7 an implicit equation which should be solved by an iteration process. The original code solves Eq. 7 by an explicit method equivalent to setting h=0 when $\Delta W_{ij}$ is being calculated. This may result in substantial over estimation of $\Delta W_{ij}$ when y is small. An overestimation of $\Delta W_{ij}$ at present time means an excess sediment input which results in over deposition or channel widening at station i+1 j at the next time step. Thus an oscillation of ever increasing amplitude reminiscent of Kolen instability [4, 5] is introduced. This type of instability is unlikely in the case of bed elevation change calculated by Eq. 6 because $W_{ij}$ are usually very large compared with depth. An iterative procedure is introduced in the model and the instability is avoided.

Because the channel slope and the discharge are very large for the spillway overflow problem studied herein, the erosion rate is also very high at some locations. The amount of erosion that should take place within a given time step can easily exceed the mixing layer thickness given by Eq. 8. The model limits the amount of erosion to the available material within the mixing layer when the demand exceeds the supply. Under this condition, the model will underestimate the overall erosion rate. To avoid this problem, it is necessary to either decrease the time step size or to increase the mixing layer thickness.

### C. The Results of Computation for 100 Year Flood

#### 1. Run No. 1

The first run was completed using the 100 year flood as the input. The sediment size distribution was given in five ranges with the maximum diameter equal to 10 mm. The time step of 20 minutes was selected to insure numerical stability. For the active layer thickness, the original equation, Eq. 8, was used.

The calculated bed and water surface profiles are plotted at 5-hour intervals in Figs. 7a through 7h. The channel cross sections at 16 stations are also plotted at 5-hour intervals as shown in Figs. 8a through 8p. The trend of the erosion process shown by these figures appears qualitatively correct. Where the original channel slope is steep, the erosion rate is high and a deep triangular shaped cut occurs. Because of the rapid erosion, a steep slope tends to migrate in the upstream direction. Some of the material eroded from the upstream portion of the channel tends to deposit at the downstream portion of the channel where the slope is mild.

A closer examination of the output reveals, however, that the erosion process is substantially underpredicted. The amount of potential erosion calculated for the steep slope portion of the channel is so large that it exceeds the amount of sediment available within the active layer for almost every time step. Under this circumstance, the actual amount of allowable erosion, according to the model, is the amount within the active layer. For this reason, this run substantially underestimates the erosion rate.

### 2. Run No. 2

Partially to increase the active layer thickness and partially to account for the existence of large cobbles, one more size range was added. The largest size range for this run is between 20 mm and 100 mm. Although the sediment transport equations were not meant to be applied to such a large size material, the same sediment transport equation (in this case Yang's equation) was used. According to Eq. 8, the active layer is increased by a factor of about 4.6.

Mainly because of the increased availability of erodible sediment for each time step, the erosion rate calculated by this run is substantially greater. This is indicated by the increased rate of bed profile migration and the reduction in the overall bed slope. Examination of the detailed output again reveals that there are still some instances when the potential erosion rate exceeds the available bed material within the active layer. For this reason, this run still does not represent the true condition.

### 3. Run No. 3

The condition for this run is the same as that of Run No. 2, except that the active layer thickness is doubled in an attempt to avoid the problem of insufficient sediment supply.

The computed longitudinal profiles at every 5 hours are plotted in Figs. 9a through 9h. The corresponding plots for cross-sectional profiles are shown in Figs. 10a through 10p. The results of that run are considered to be a good quantitative representation of the true condition under a 100 year flood. These figures indicate substantial increase in erosion rate due to removal of artificial limitation in the form of allowable erosion depth at each time step. The maximum erosion depth reached about 40 ft at about 600 ft downstream of the weir. The maximum bed slope of about 31 degrees occurred immediately downstream of the weir. Such a bed slope raises the question about the safety of the weir and the spillway.

Based on the runs made so far, it may be premature to conclude the safety of the spillway. The maximum sediment size used in this run is

100 mm or about 4 inches. Boulders of much larger size observable in the field should become important at the later stage of scouring. However, the actual amount of the coarse material is not known.

### D. The Results of Computation for 0.5 IDF

#### 1. Run No. 4

The condition of this run is identical to that of Run No. 2 except that the inflow hydrograph is changed to 50 percent of the Inflow Design Hydrograph.

This run also clearly under predicts the erosion rate because the potential erosion rate at some instances has exceeded the active layer thickness.

#### 2. Run No. 5

This run was made under the identical condition as Run No. 4, except that the active layer thickness is doubled.

The resulting longitudinal profiles at 5-hour intervals are plotted in Figs. 11a through 11i. The corresponding plots for cross-sectional profiles are shown in Figs. 12a through 12p.

Figures 11a through 11i clearly show that the erosion rate is so high that the channel bed almost reaches the bed rock elevation over almost the entire river in about 5 hours. Some coarse material does remain above the bed lock for the entire flood period, acting as the armore layer.

All the computations are based on the assumption that the concrete weir at the upstream end will stay and act as a flow control point. However, the result of this run indicates that the slope of the bed immediately behind the weir becomes so steep that it will not sustain itself. Clearly, it is logical to conclude that the spillway and the weir will not hold under the flow as large as 50 percent of the Inflow Design Flood.

# CONCLUSIONS AND RECOMMENDATIONS

The Bureau of Reclamation GSTARS model has been used to simulate the condition of Willow Creek Reservoir Spillway at various conditions. Considering the fact that there are some uncertainties on the accuracies of the input data as well as the underlying equations and assumptions, and the fact that there is no erosion data available for calibration purposes, the mathematical model produced quite reasonable results.

Pending further refinement of the model and input data and confirmations by other independent analysis, the results of this analysis cast some doubt on the safety of the Willow Creek Reservoir Spillway. The spillway may be only marginally stable under a 100-year flood. For floods of magnitude equal to or greater than 50 percent of the maximum probable design flood, it is desirable to conduct further studies taking into consideration the effect of some of the uncertainties related to the current study.

Some of the uncertainties related to the input data are listed below:

1. The magnitude and distribution of materials coarser than 10 mm need to be ascertained from further field study.
2. More detailed data on the bedrock profile is necessary.
3. Data on the stability of the undisturbed material (angle of repose) under wet and dry conditions for evaluation of channel side slope.
4. Stability of the cut-off weir under different erosion conditions.
5. Resistance of vegetation to initial erosion.

Some of the uncertainties related to the basic equations and numerical procedures and suggested improvements are listed below:

1. Accuracy of sediment transport equations for coarse sediment greater than 10 mm.
2. Accuracy of sediment transport equations when applied to grated sediment.
3. Accuracy of sediment transport equations when applied to supercritical flows.
4. Effect of suspended load on erosion rate and sediment continuity equation.

5. Effect of suspended load on erosion pattern.

6. Effect of hydraulic jump on local sediment transport capacity and erosion rate.

7. Erosion due to turbulence of flow separation behind a fixed weir.

8. Method of determining chocking condition at a rapid contraction and adverse slope.

9. Automatic determination of active layer as the flow and channel geometry changes.

10. Automatic determination of maximum computational time step to insure numerical stability.

11. Improvement on computational efficiency for the determination of erosion pattern.

12. Inclusion of maximum side slope under channel deepening condition.

13. A program to determine head cutting process when the upstream end is erodible.

The mathematical model is basically in an operating condition under the condition tested. But, further case studies are desirable to improve the efficiency and the confidence level of the model. For future test cases, it is desirable to use cases for which erosion data are available for calibration purposes.

# REFERENCES

1. Molinas, Albert, "Variable Width Stream Tube Computer Model for Scour and Deposition in Alluvial Channels," U. S. Bureau of Reclamation, User's Manual (preliminary), March, 1986.

2. Molinas, Albert and C. T. Yang, "Generalized Water Surface Profile Computations," Jour. of the Hydraulics Division, ASCE, Vol. 111, No. HY3, March, 1985.

3. Tancher, Glenn J., "Geologic Report on the Modification of Willow Creek Dam," U. S. Bureau of Reclamation, Feb., 1980.

4. Koren, Y. I., "The Analysis of Stability of Some Explicit Finite Difference Schemes for the Integration Saint-Venant Equations," Meterologiya i Gidrologiya, No. 1, 1967 (in Russian).

5. Huang Jingxiang and Charles C. S. Song, "Stability of Dynamic Flood Routing Schemes," Jour. of Hydraulic Engineering, Vol. 111, No. 12, Dec., 1985.

# LIST OF FIGURES

Figure No.

1 Cross section of the channel subdivided

2 Top view of the channel showing J×I elements

3 Scouring or deposition due to bed elevation change

4 Scouring or deposition due to width change

5 Topographic map of the study site

6 Grain size distribution

7a-7h Water surface and bed profiles, 100 year flood, Run No. 1

8a-8p Channel cross sections, 100 year flood, Run No. 1

9a-9h Water surface and bed profiles, 100 year flood, Run No. 3

10a-10p Channel cross section, 100 year flood, Run No. 3

11a-11i Water surface and bed profiles, 0.5 IDF, Run No. 5

12a-12p Channel cross section, 0.5 IDF, Run No. 5

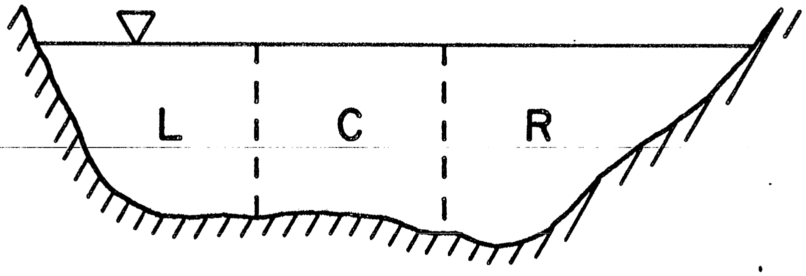


Fig. 1. Cross section of the channel subdivided.

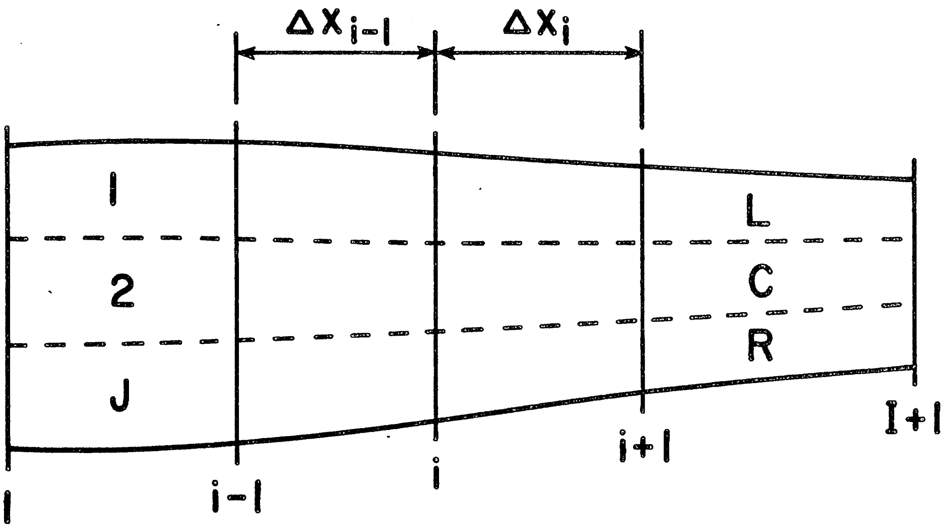


Fig. 2. Top view of the channel showing JxI elements.

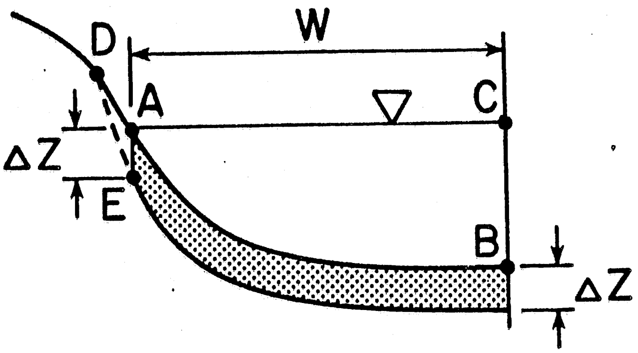


Fig. 3. Scouring or deposition due to bed elevation change.

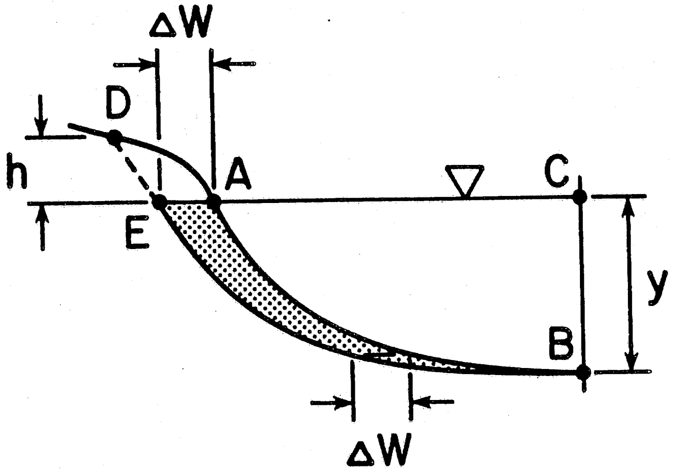


Fig. 4. Scouring or deposition due to width change.

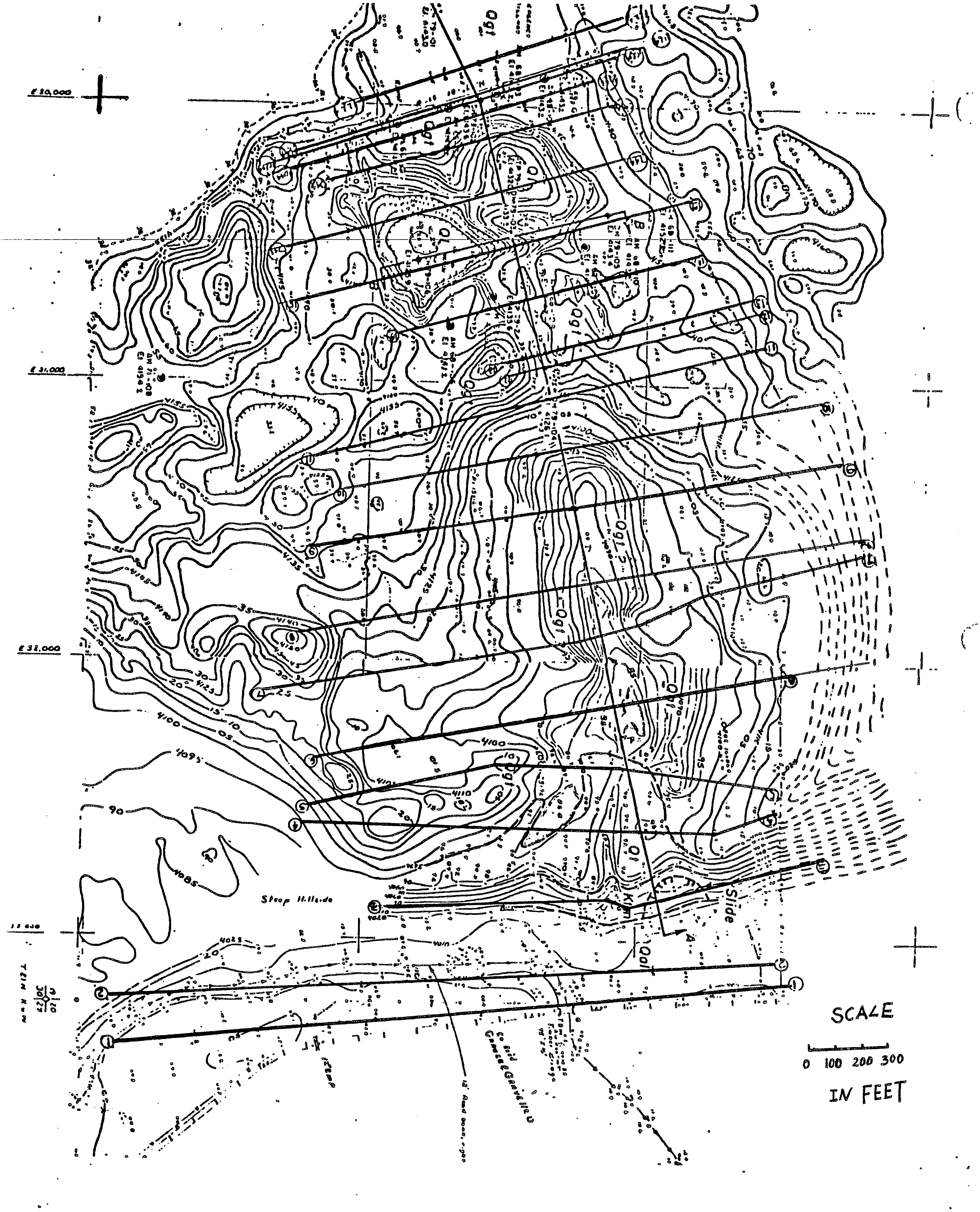


Fig. 5. Topographic map of the spillway.

7-1714
(3-62)

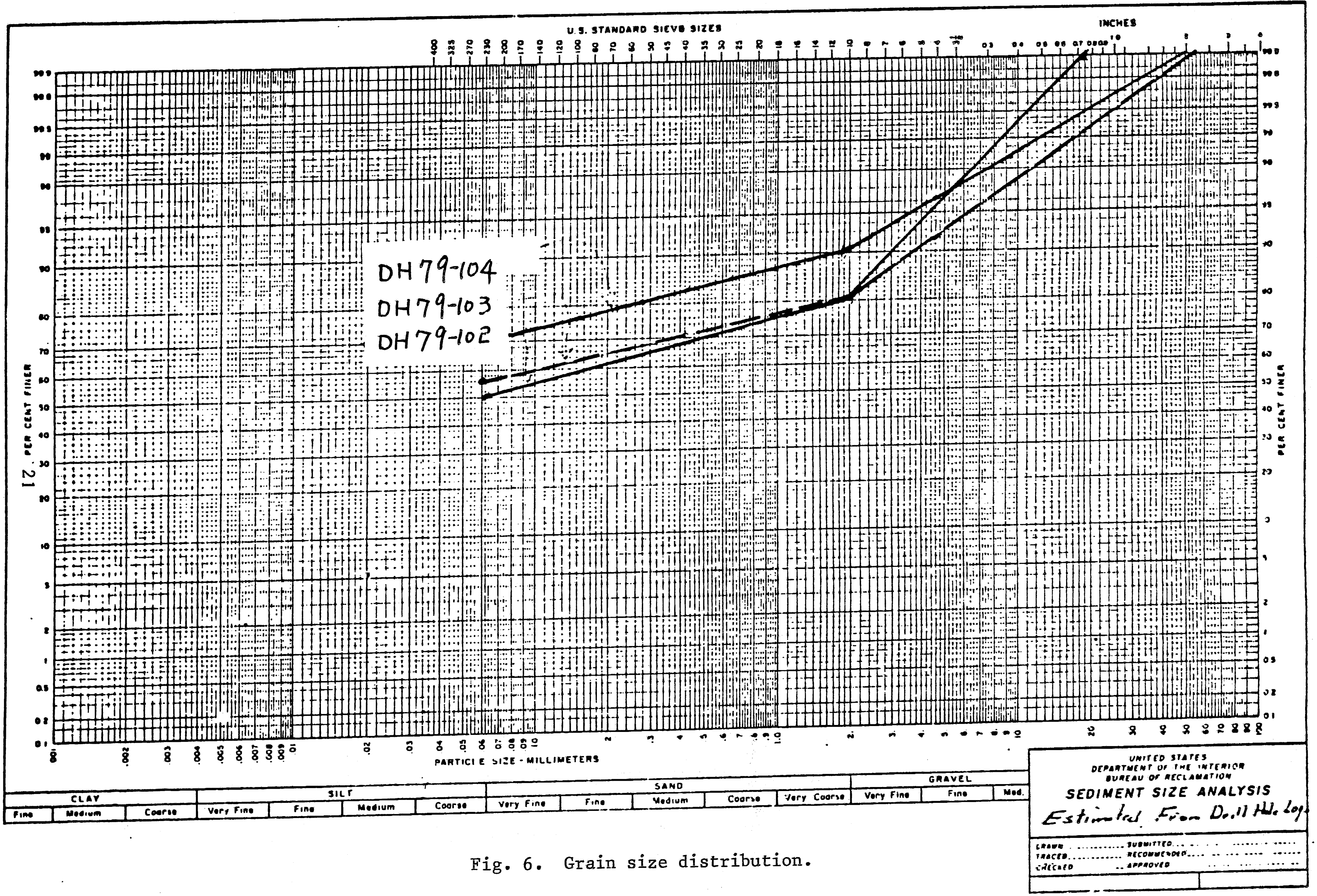
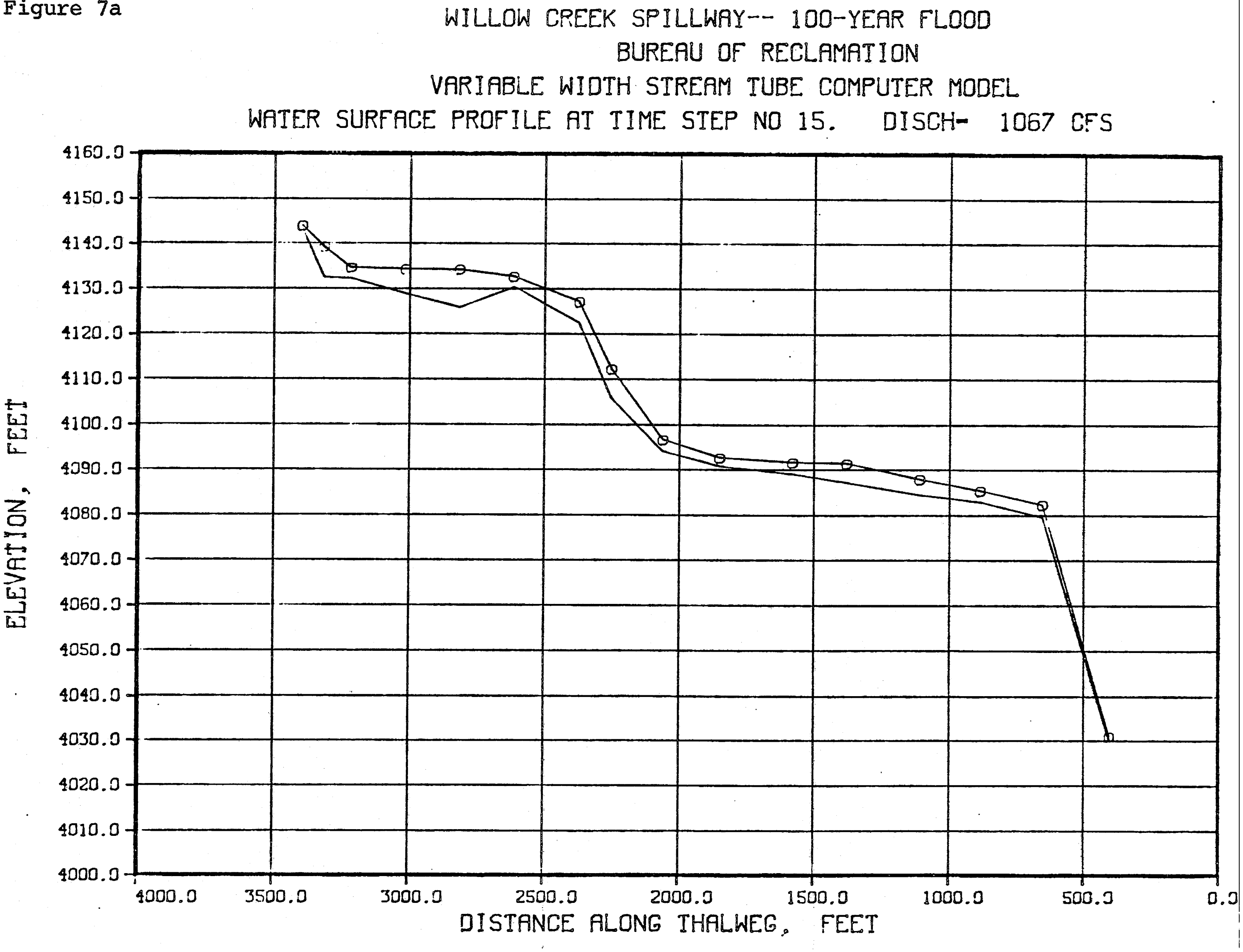


Fig. 6. Grain size distribution.

GPO 654581

Figure 7a


PLOT 1 21.04.22 TUES 25 NOV, 1986 JOB=7IXK6: . JCG DISSPLA 9.0
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 15. DISCH= 1067 CFS
ELEVATION, FEET
4160.0
4150.0
4140.0
4130.0
4120.0
4110.0
4100.0
4090.0
4080.0
4070.0
4060.0
4050.0
4040.0
4030.0
4020.0
4010.0
4000.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
DISTANCE ALONG THALWEG, FEET

PLOT 2 21.34.24 TUES 25 NOV, 1986 10B-?TXK6: . UCC DISSPLA 9.3

Figure 7b

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 30. DISCH- 2285 CFS

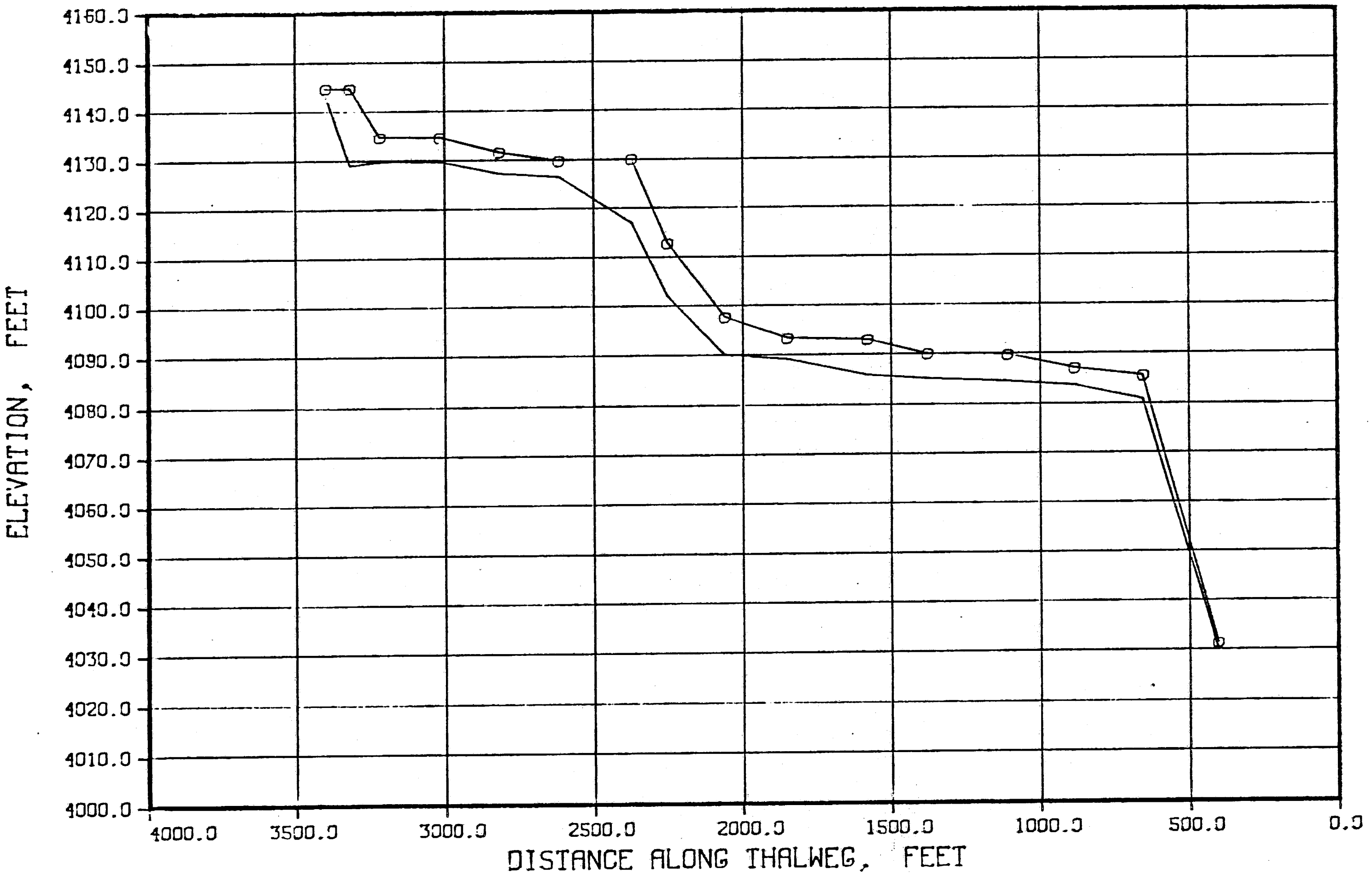
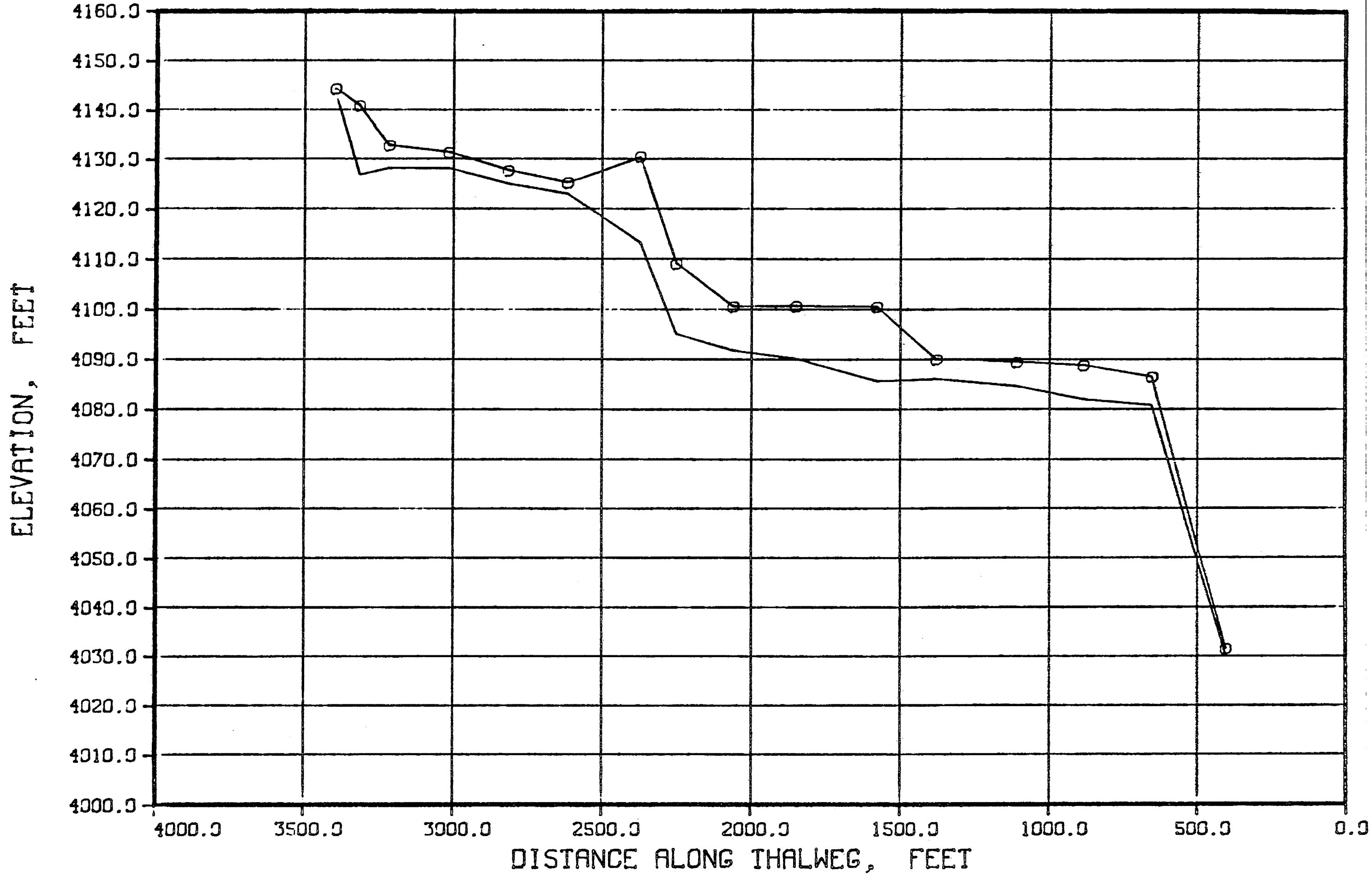


**Figure 7c**

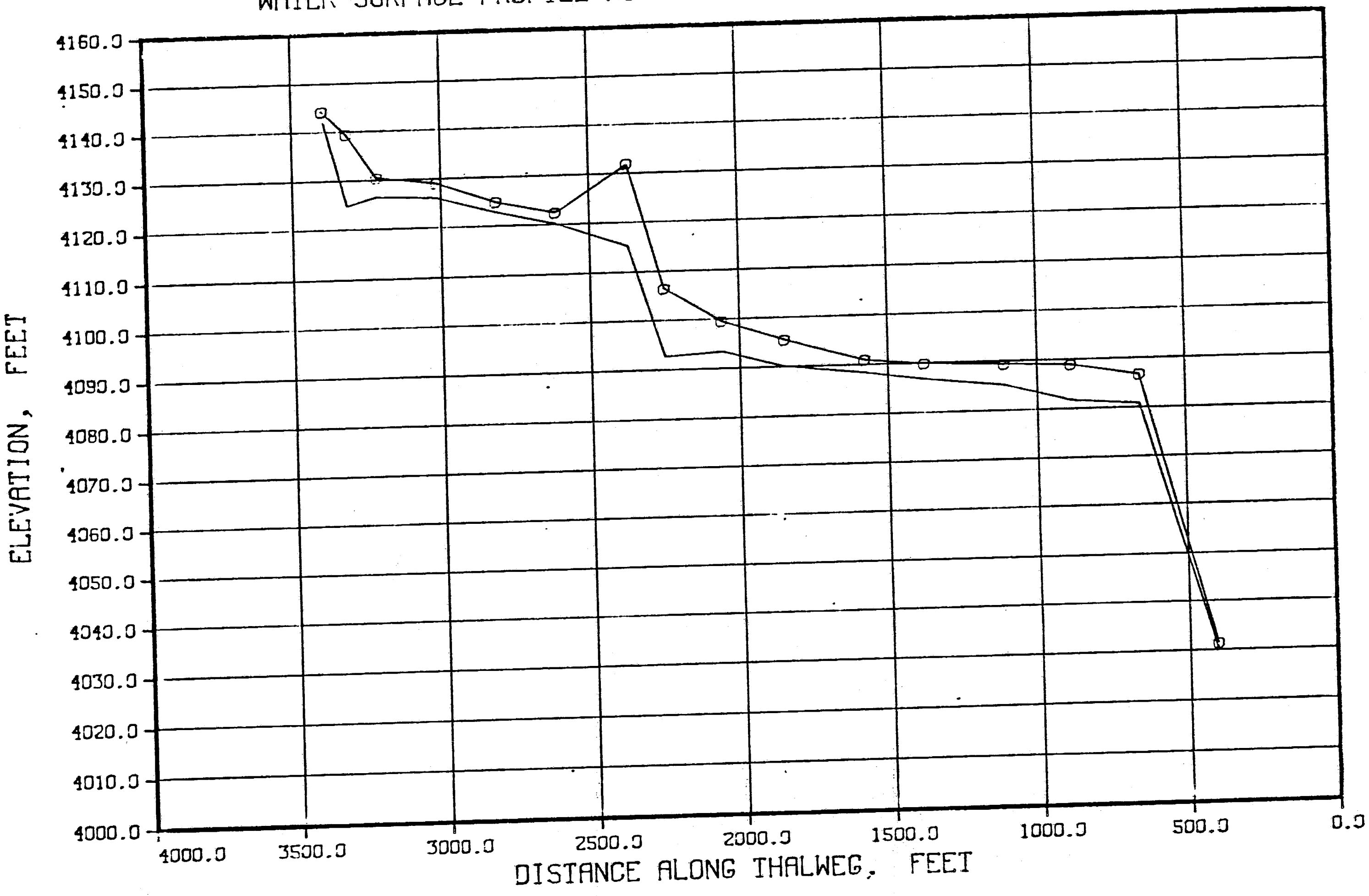
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 45. DISCH= 2538 CFS



PLOT 4 21.04.30 TUES 25 NOV, 1986 JOB=7TXK8: . UCC DISSPLA 9.0

**Figure 7d**

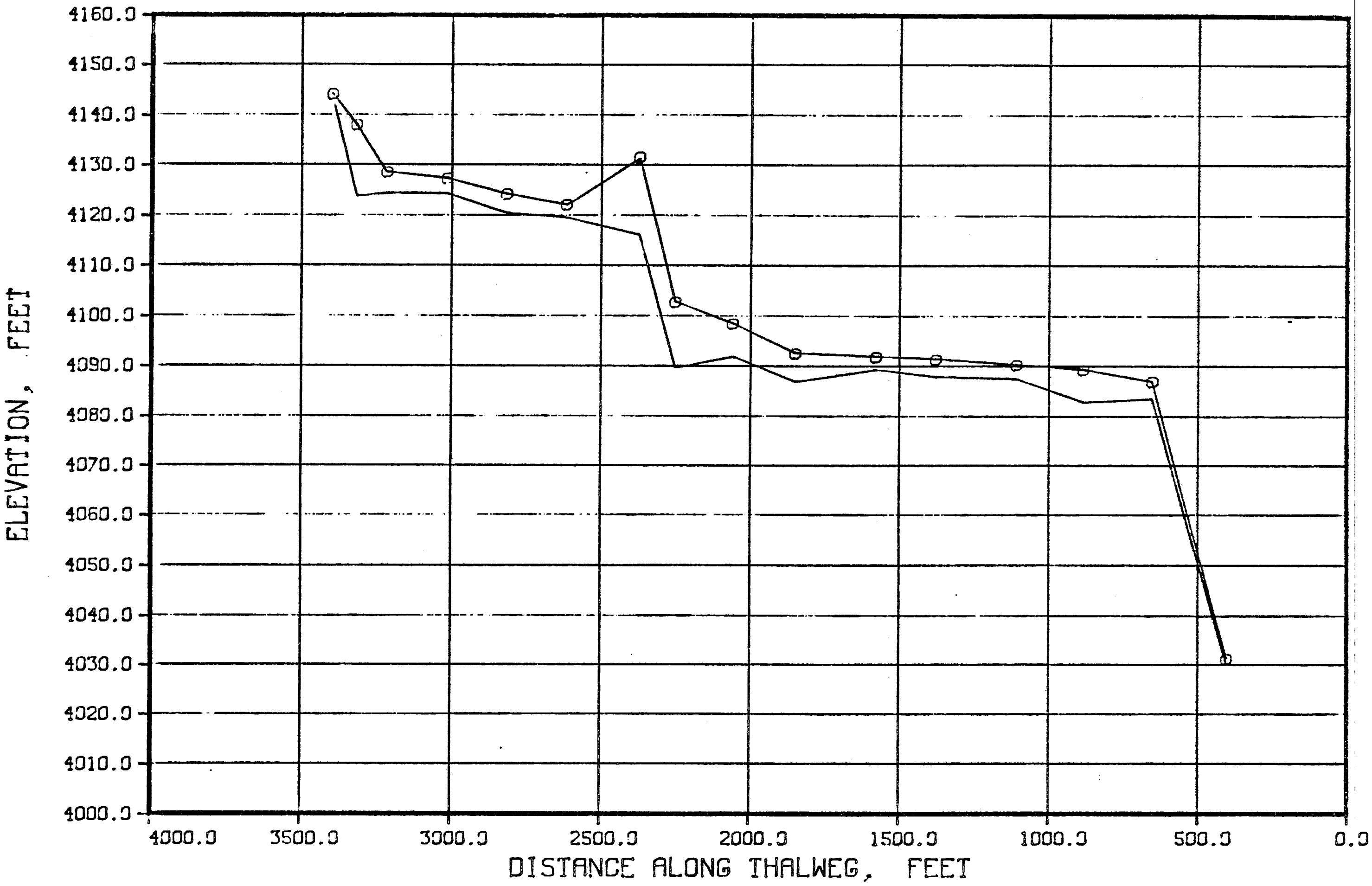
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 60. DISCH- 2246 CFS



PLOT 5 21.04.33 TUES 25 NOV, 19.. JOB-?TXK6: . UCC DISSPLA 9.0

**Figure 7e**

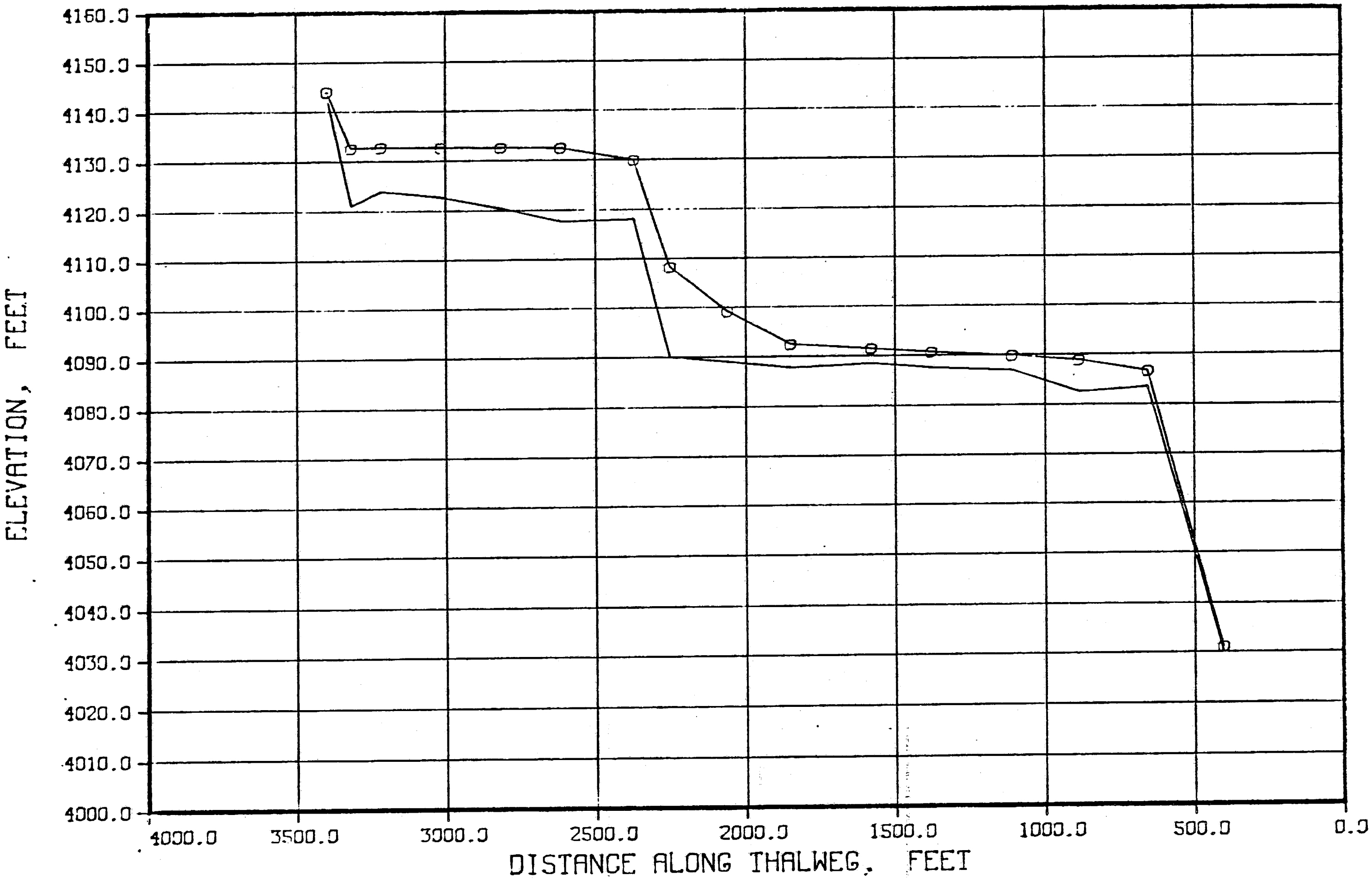
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 75. DISCH- 1824 CFS



PLOT 6 21.04.36 TUES 25 NOV, 1986 JOB=7IXK6: UCC DISSPLA 9.0

Figure 7f

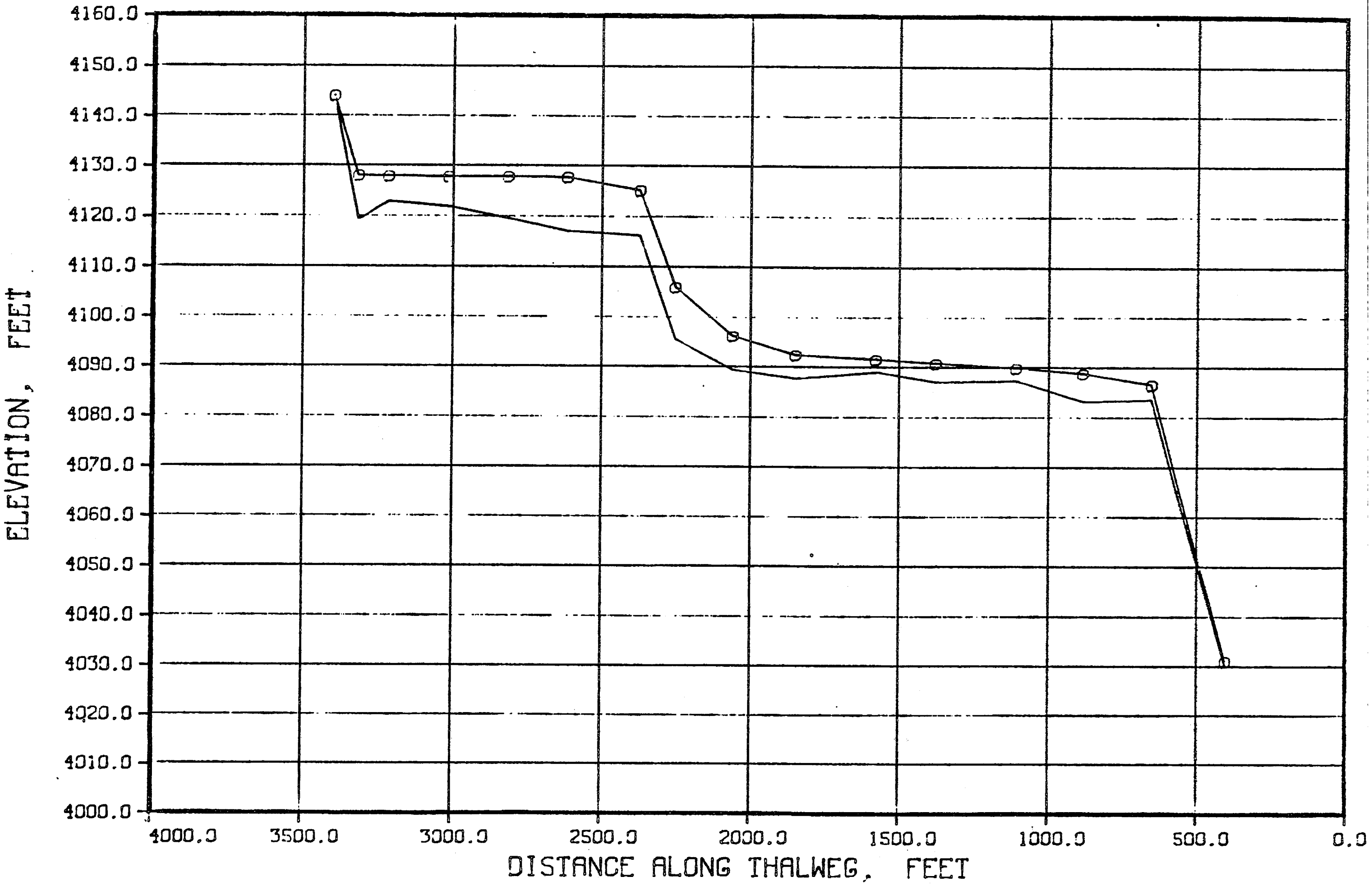
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 90. DISCH= 1415 CFS



PLOT 7 21.04.43 TUES 25 NOV, 1986 JOB-7TXK6: . UCC DISSPLA 9.0

Figure 7g

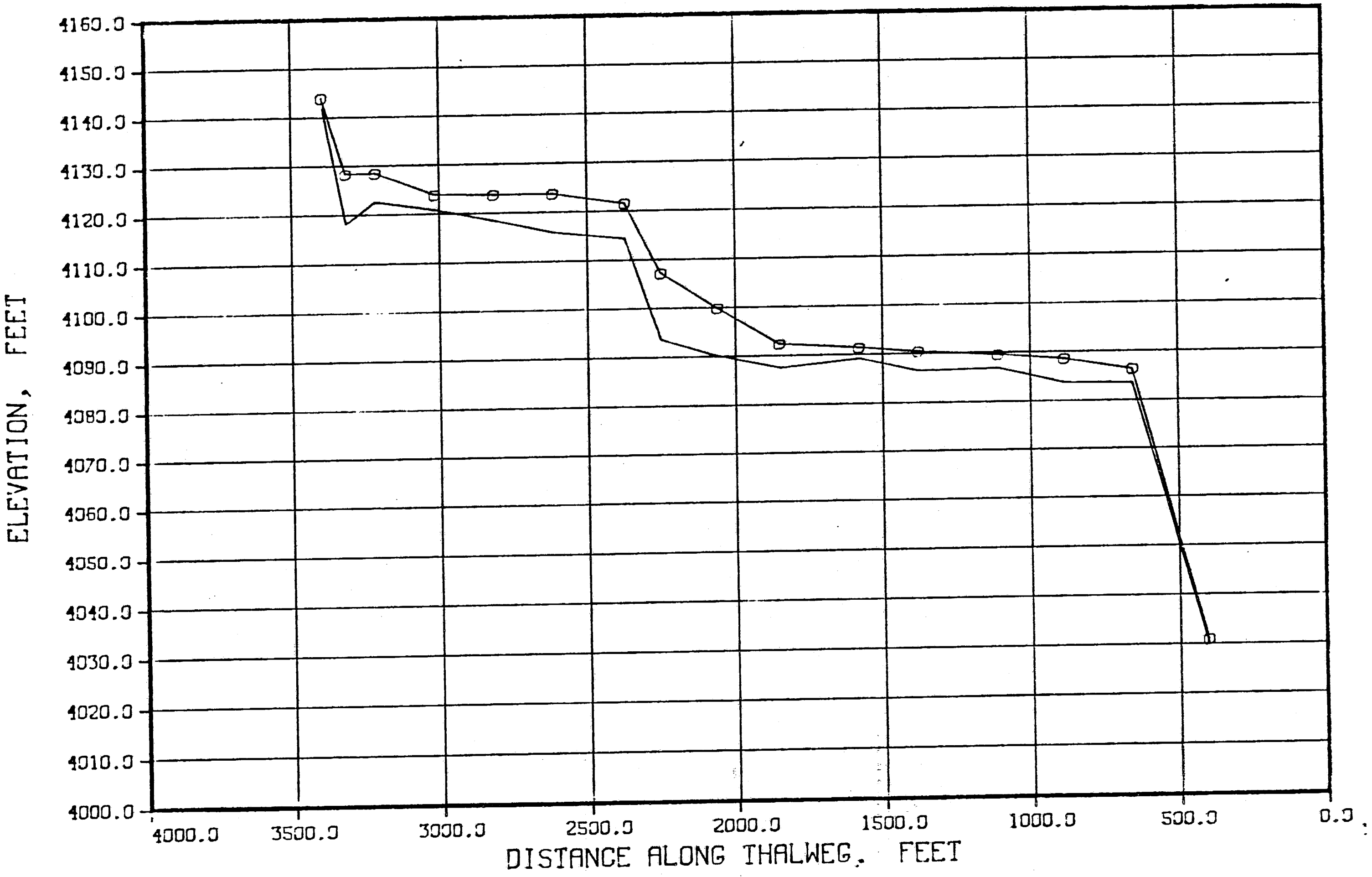
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO105. DISCH- 1244 CFS



PLOT 8 21.04.51 TUES 25 NOV, 1986 JOB-7IXK6: UCG DISSPLA 9.0

Figure 7h

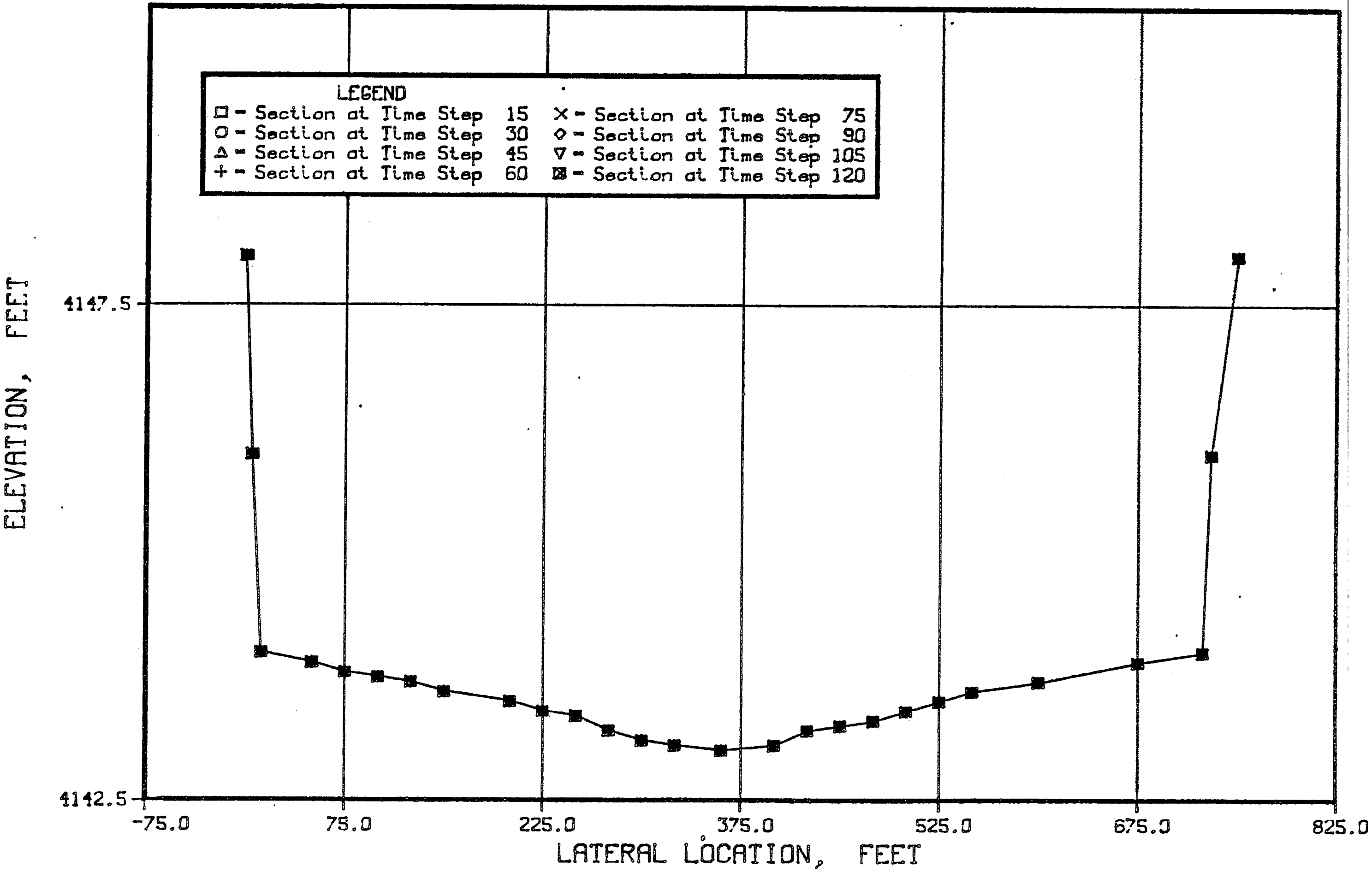
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO120. DISCH- 1063 CFS



PLOT 1 20.40.25 TUES 25 NOV, 1986 JOB=7TXK3: . UCC DISSPLA 9.0

Figure 8a

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3396. FT.

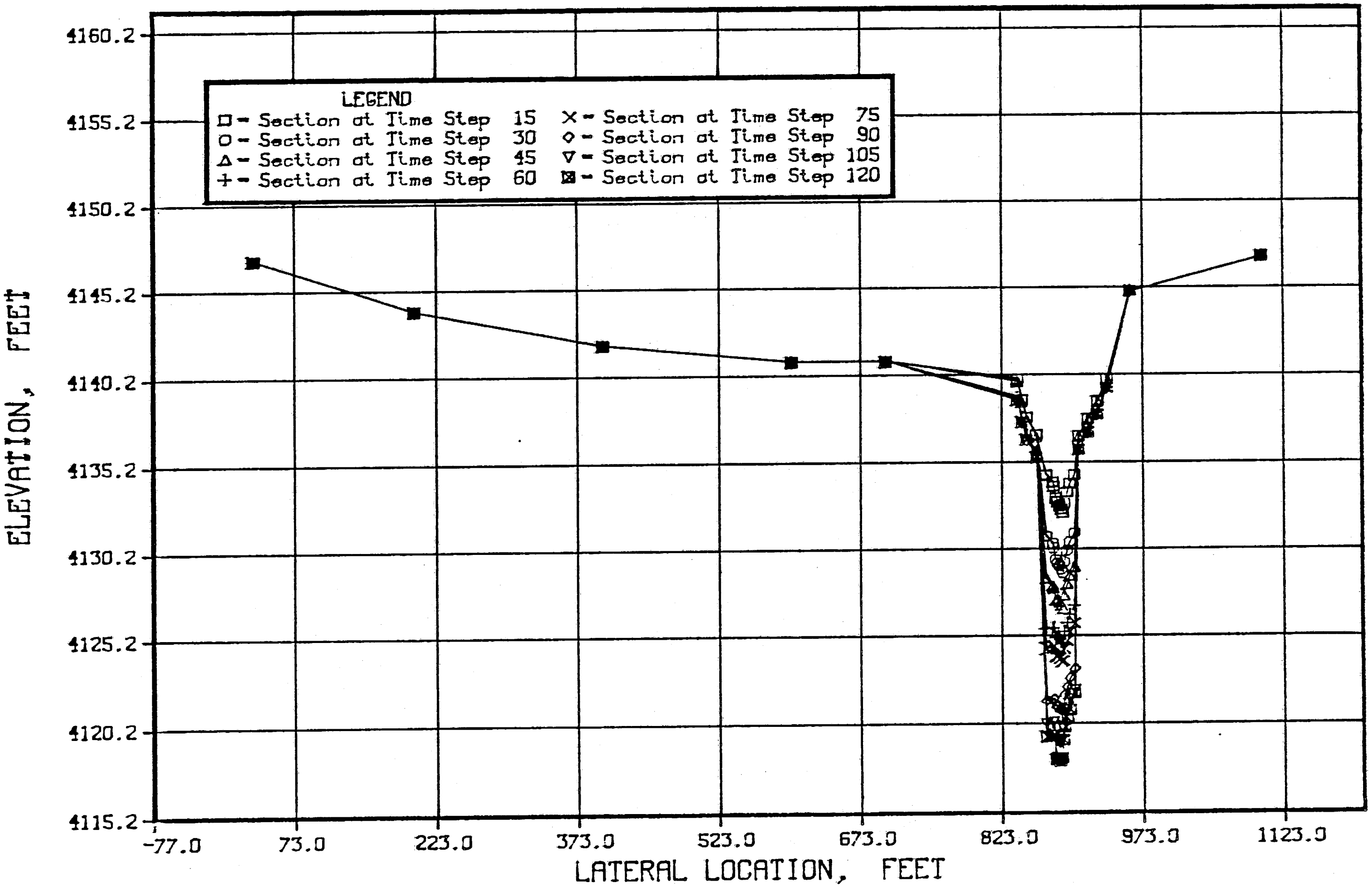


No 200

PLOT 2 20.40.33 TUES 25 NOV, 1986 JOB-7IXK3: . JCC DISSPLA 9.0

Figure 8b

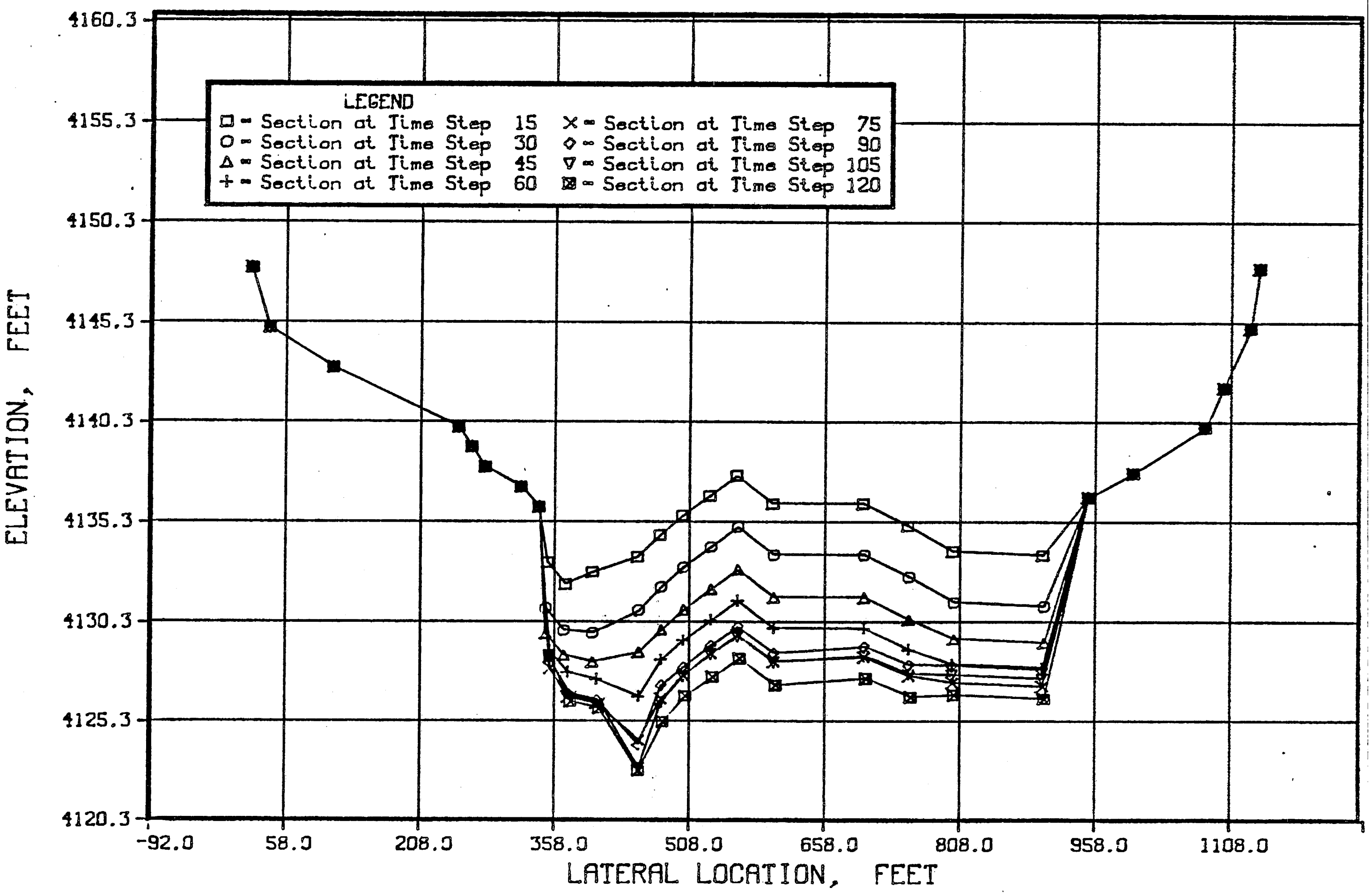
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3316. FT.



PLOT 3 20.40.44 TUES 25 NOV, 1986 JOB-7IXK3: . UCC DISSPLA 9.0

Figure 8c

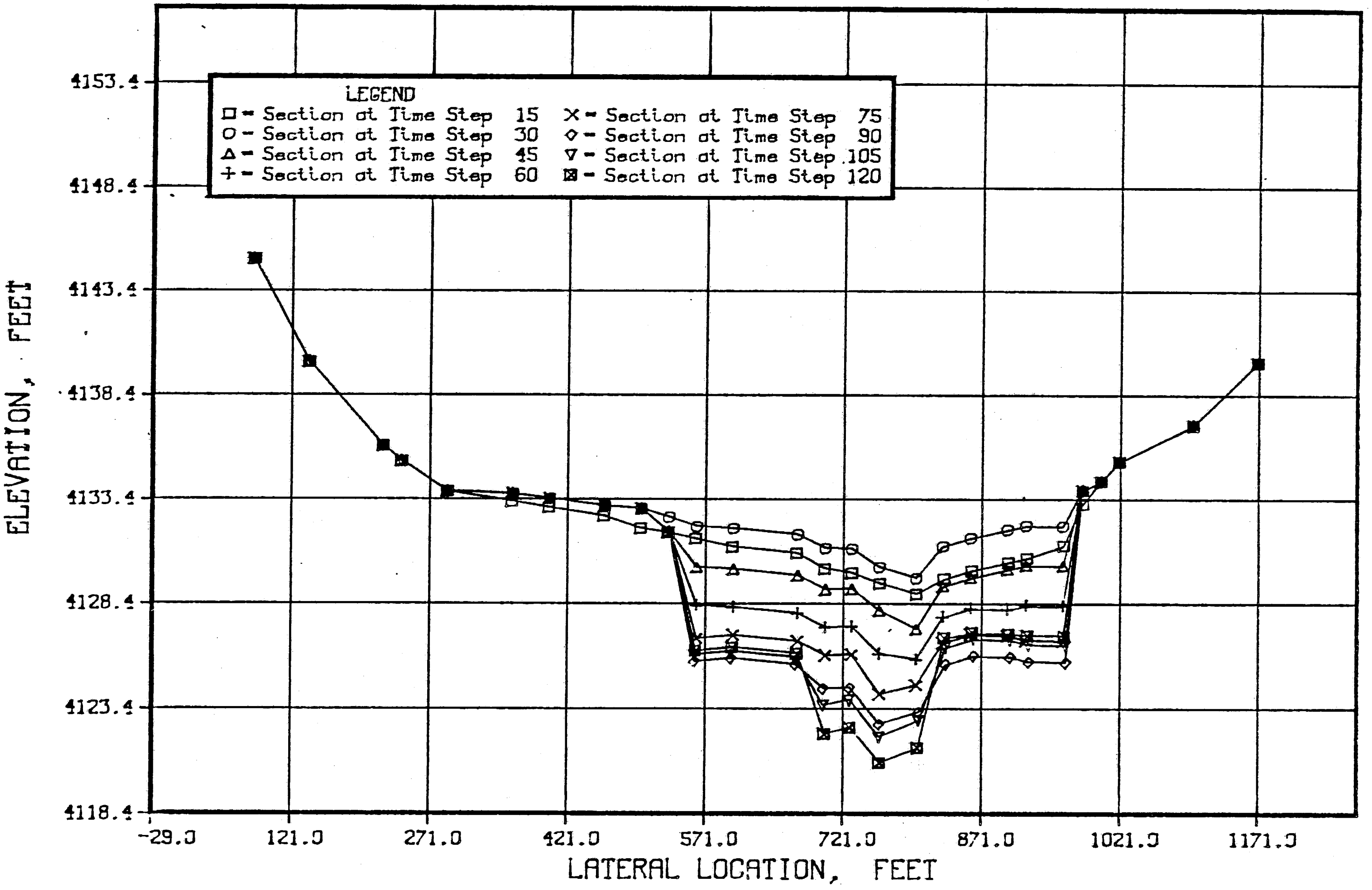
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3216. FT.



PLOT 1 20.40.54 TUES 25 NOV, 1986 JOB-?TXK3: , UCC DISSPLA 9.0

Figure 8d

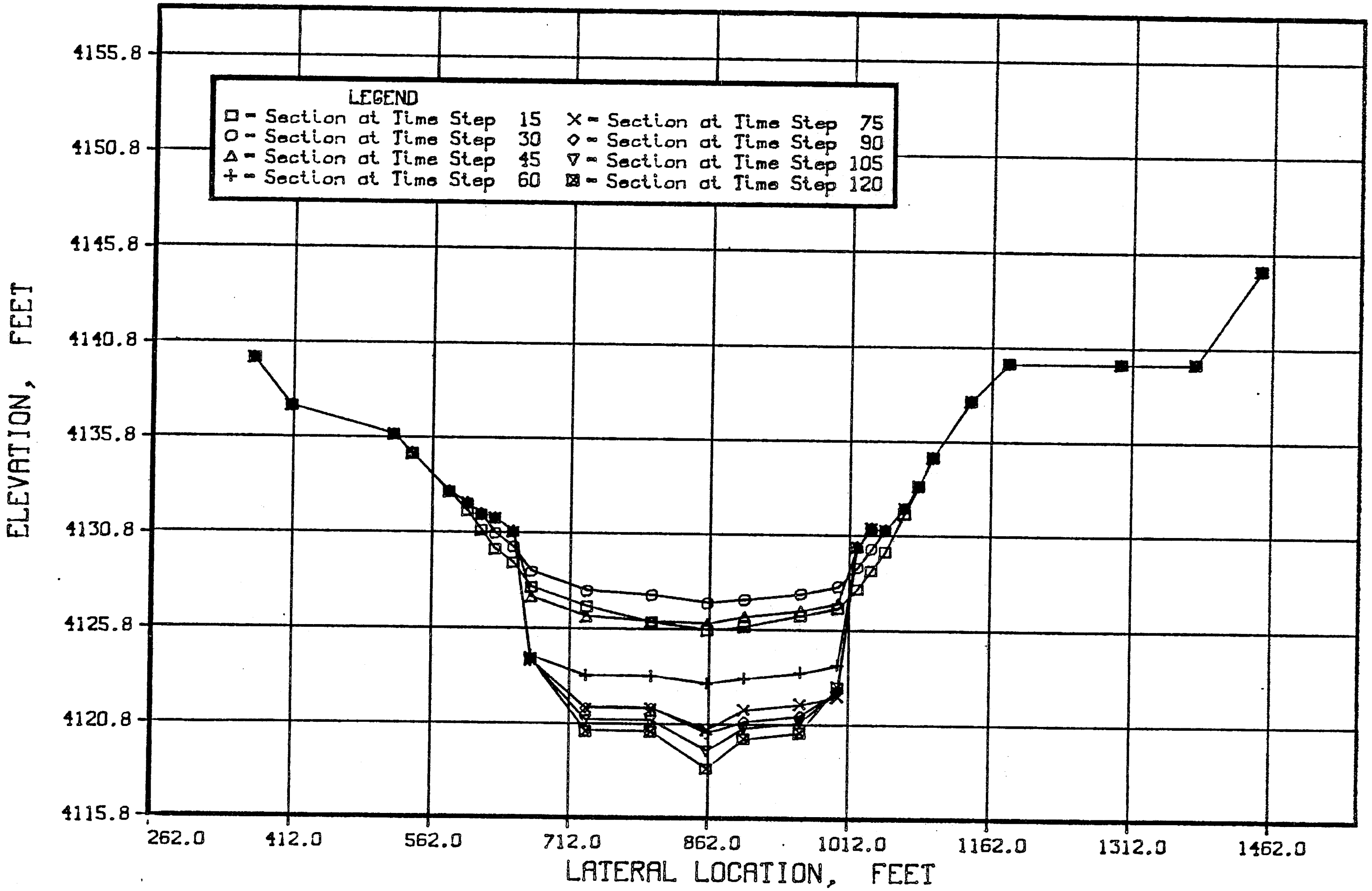
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3016. FT.



PLOT 5 20.41.33 TUES 25 NOV, 1986 JOB-?TXK3: . JCC DISSPLA 9.0

Figure 8e

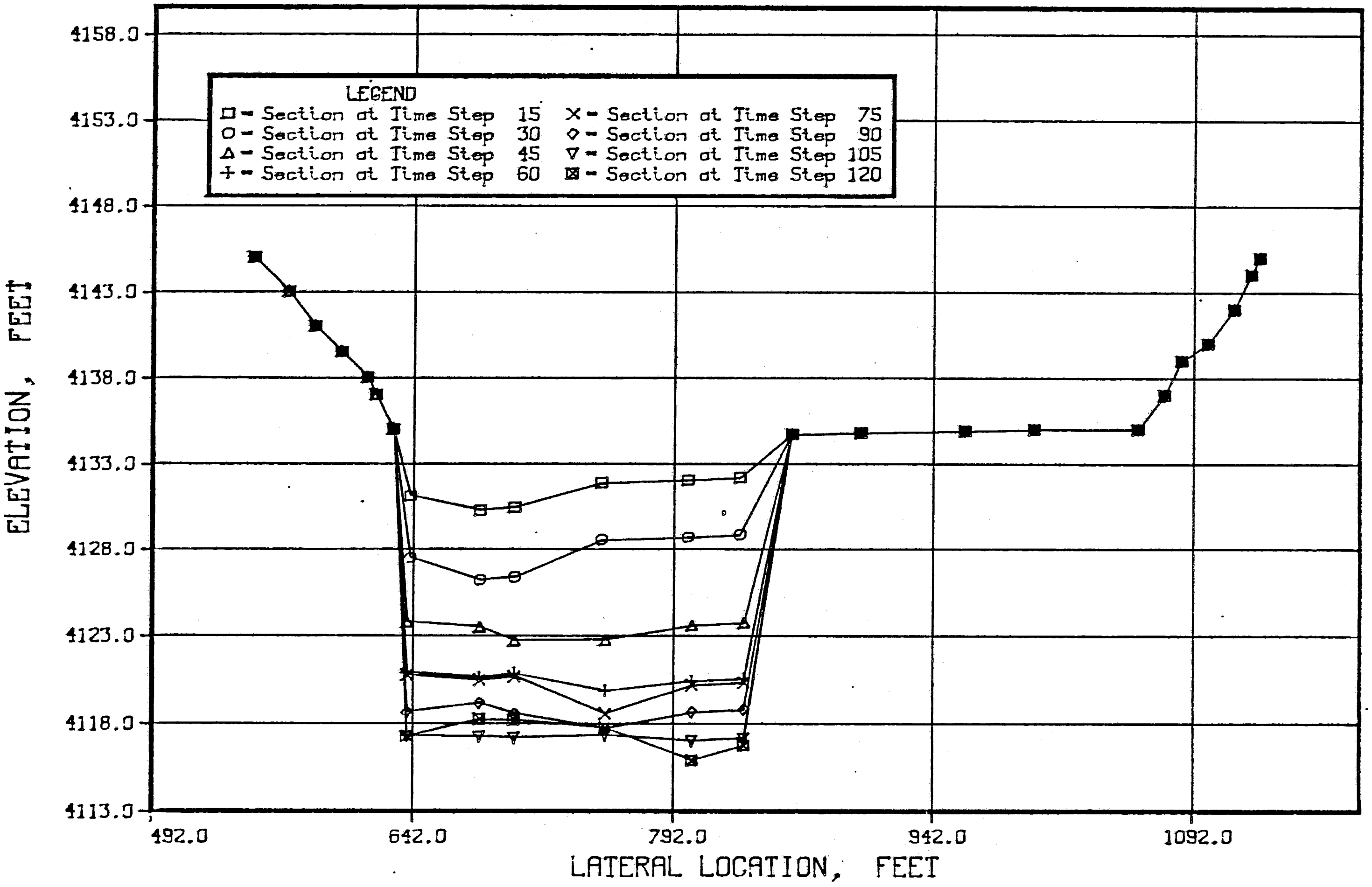
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2816. FT.



PLOT 6 20.41.11 TUES 25 NOV, 1986 JOB=7IXK3: , UCC DISSPLA 9.0

Figure 8f

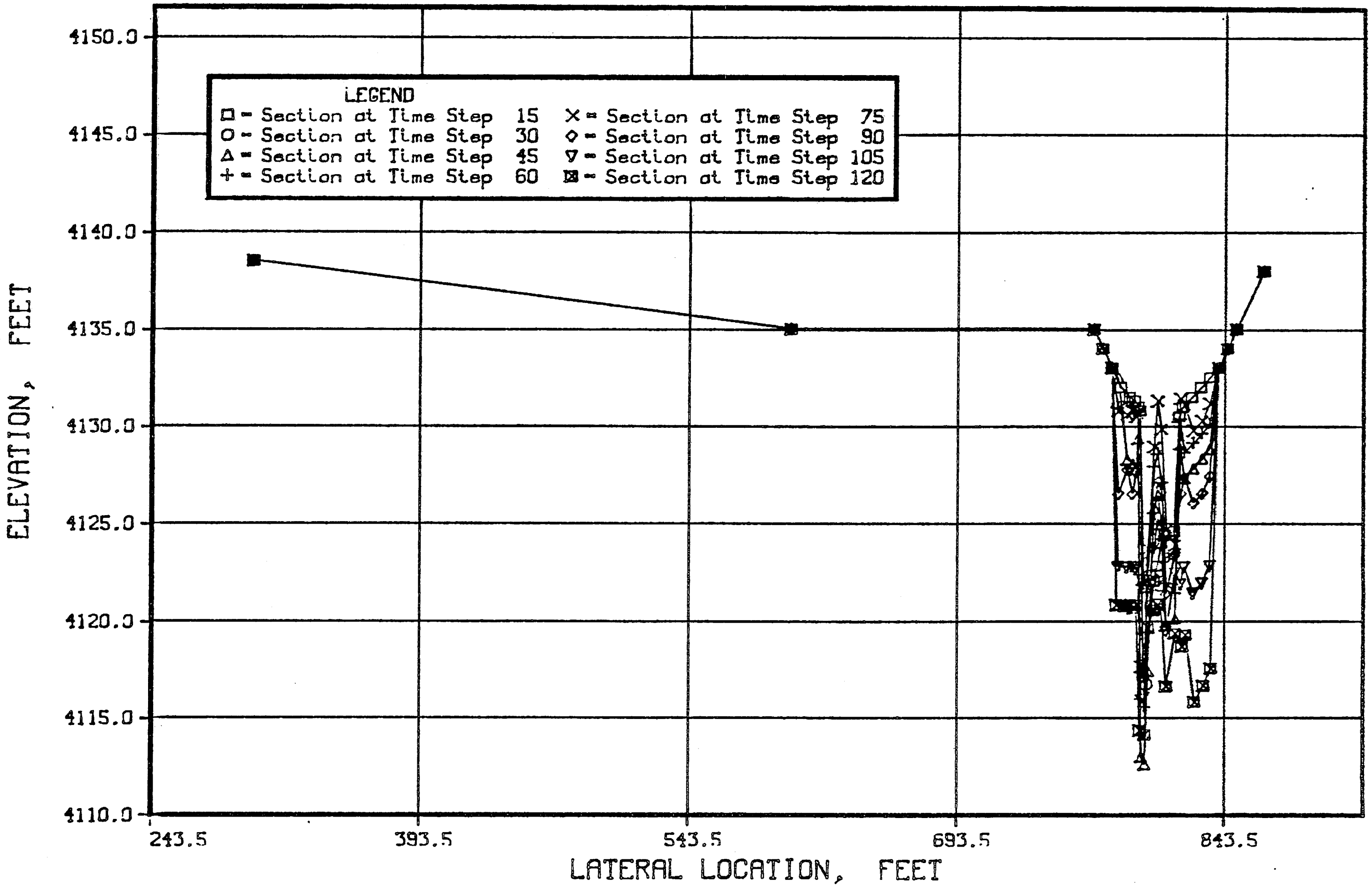
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2616. FT.



PLOT 7 20.41.20 TUES 25 NOV, 1986 JOB=7IXK3: . UCC DISSPLA 9.0

Figure 8g

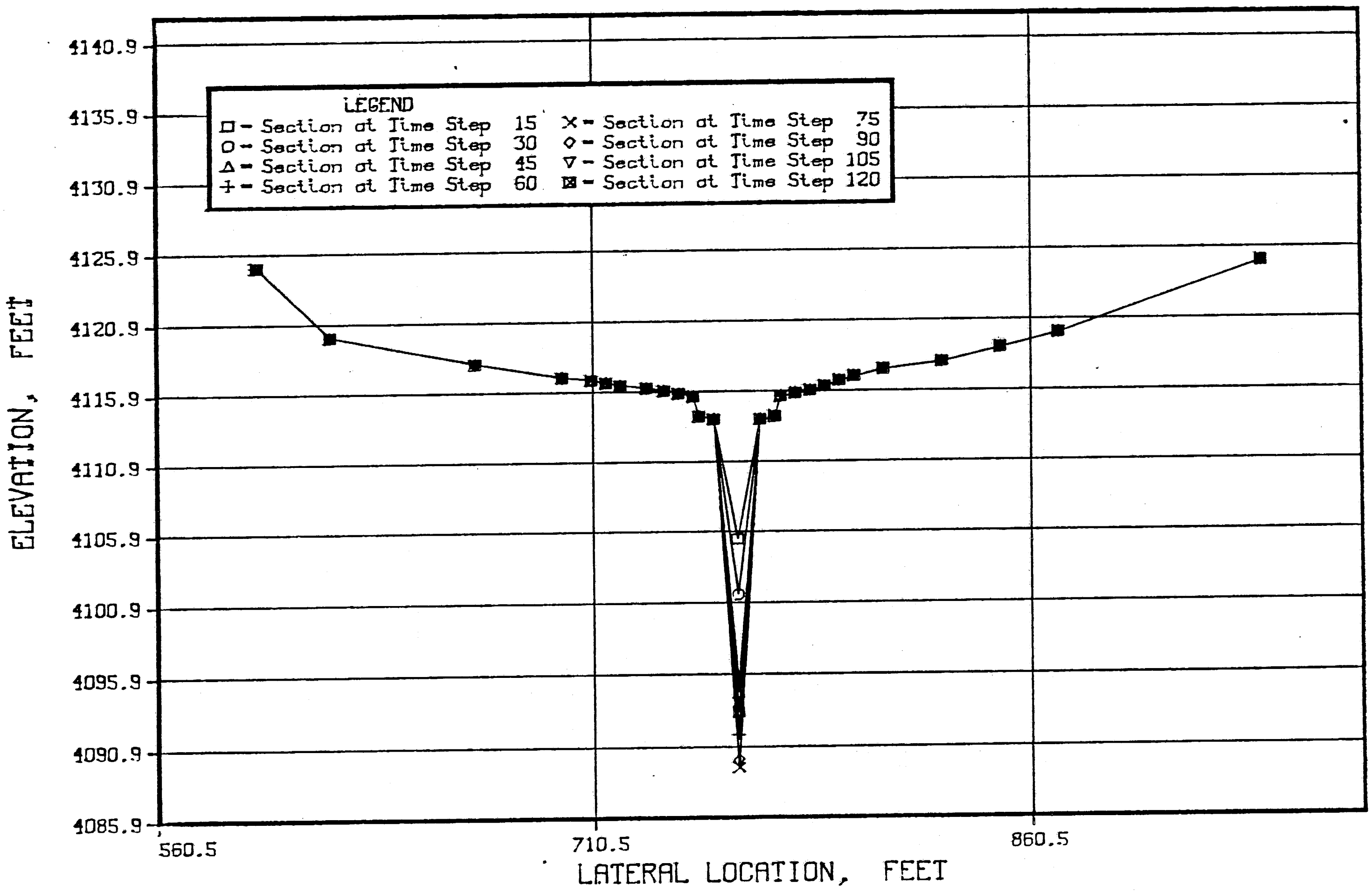
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2372. FT.



PLOT 8 20.41.28 TUES 25 NOV, 1986 JOB-7IXK3: . UCC DISSPLA 9.0

Figure 8h

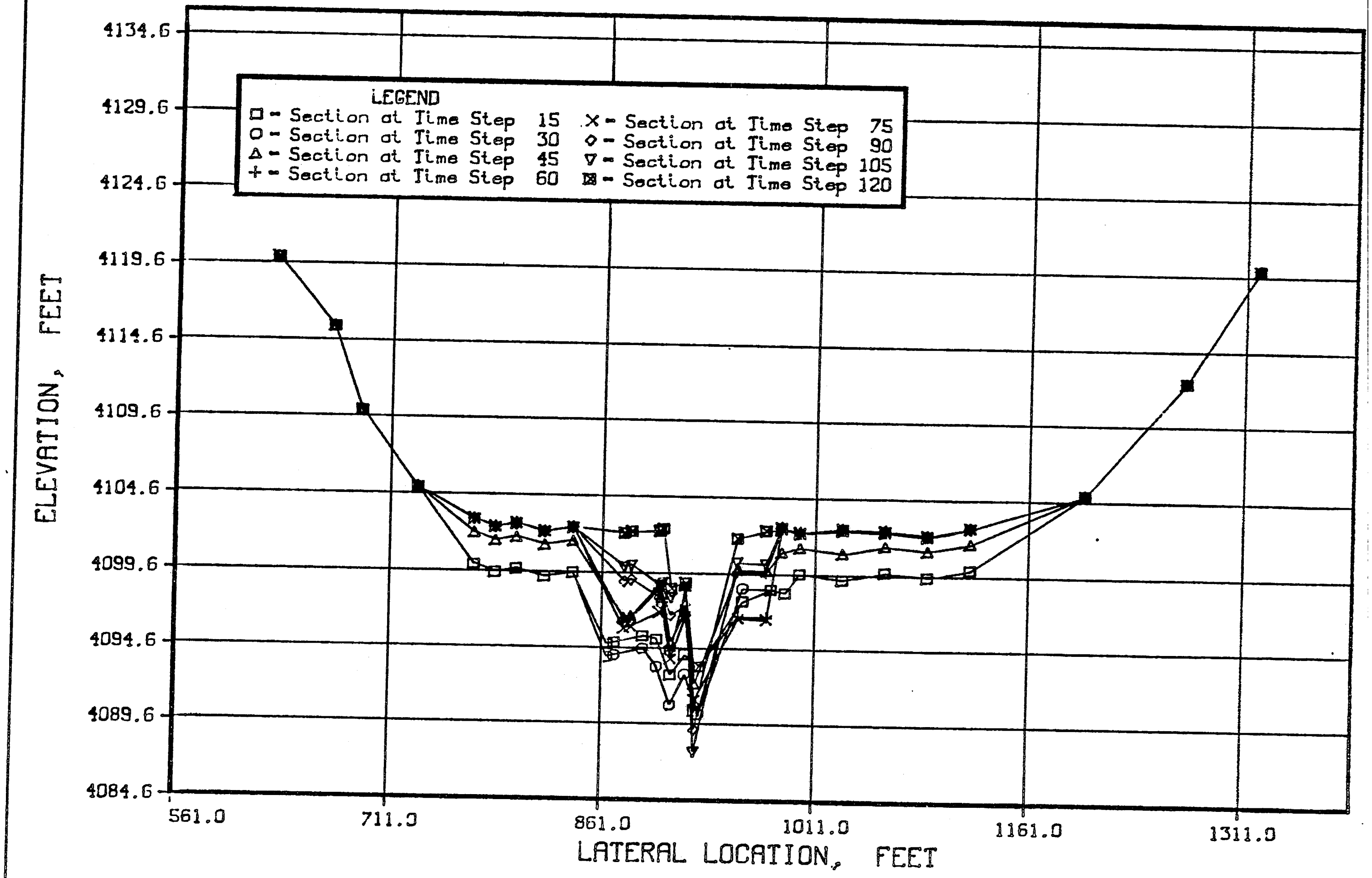
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2252. FT.



PLOT 9 20.41.36 TUES 25 NOV, 1986 JOB-7TXK3: UCC DISSPLA 9.0

Figure 8i

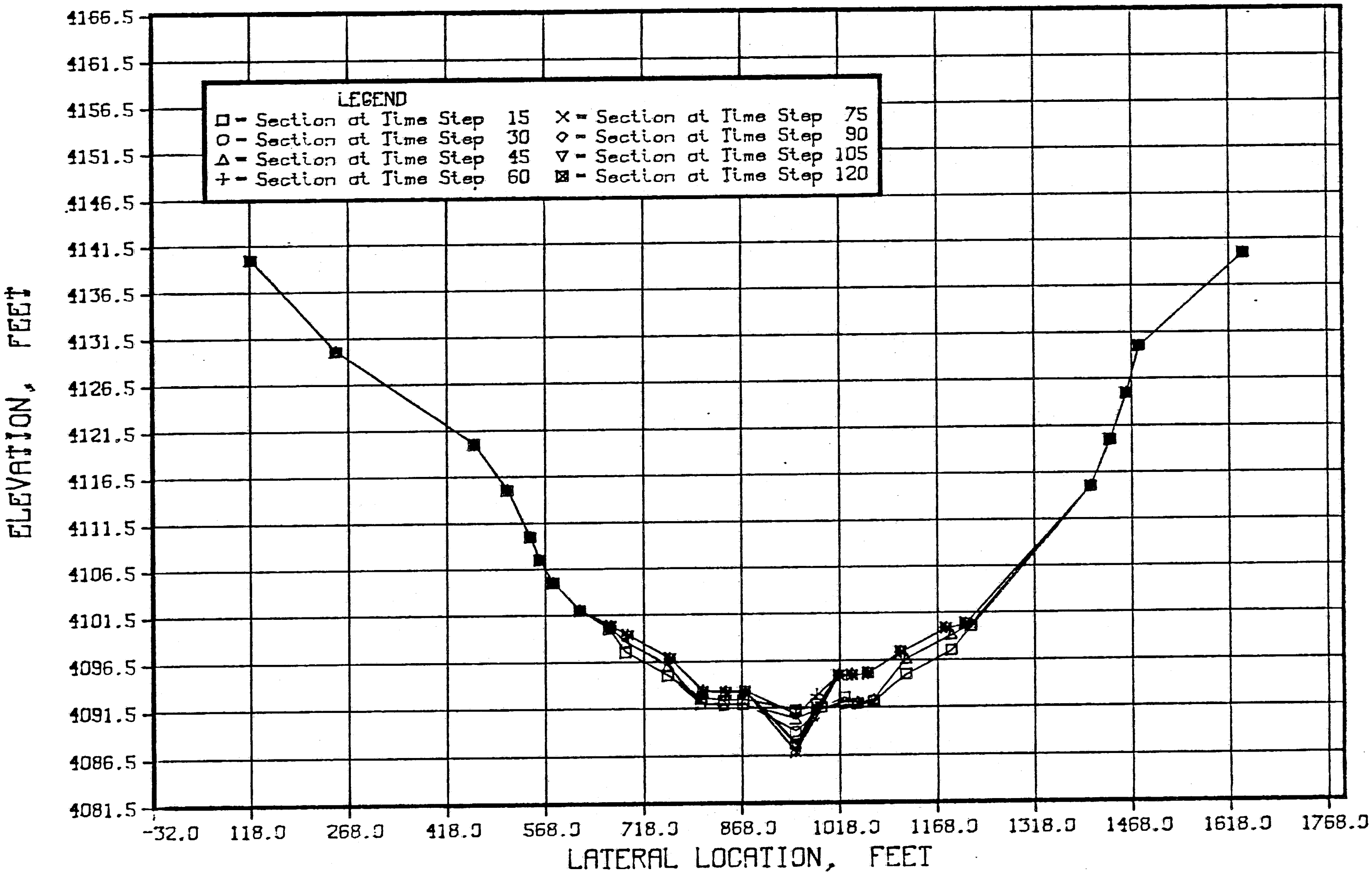
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2060. FT.



PLOT 10 20.41.45 TUES 25 NOV, 1986 JOB-7IXK3: . UCC DISSPLA 9.0

Figure 8j

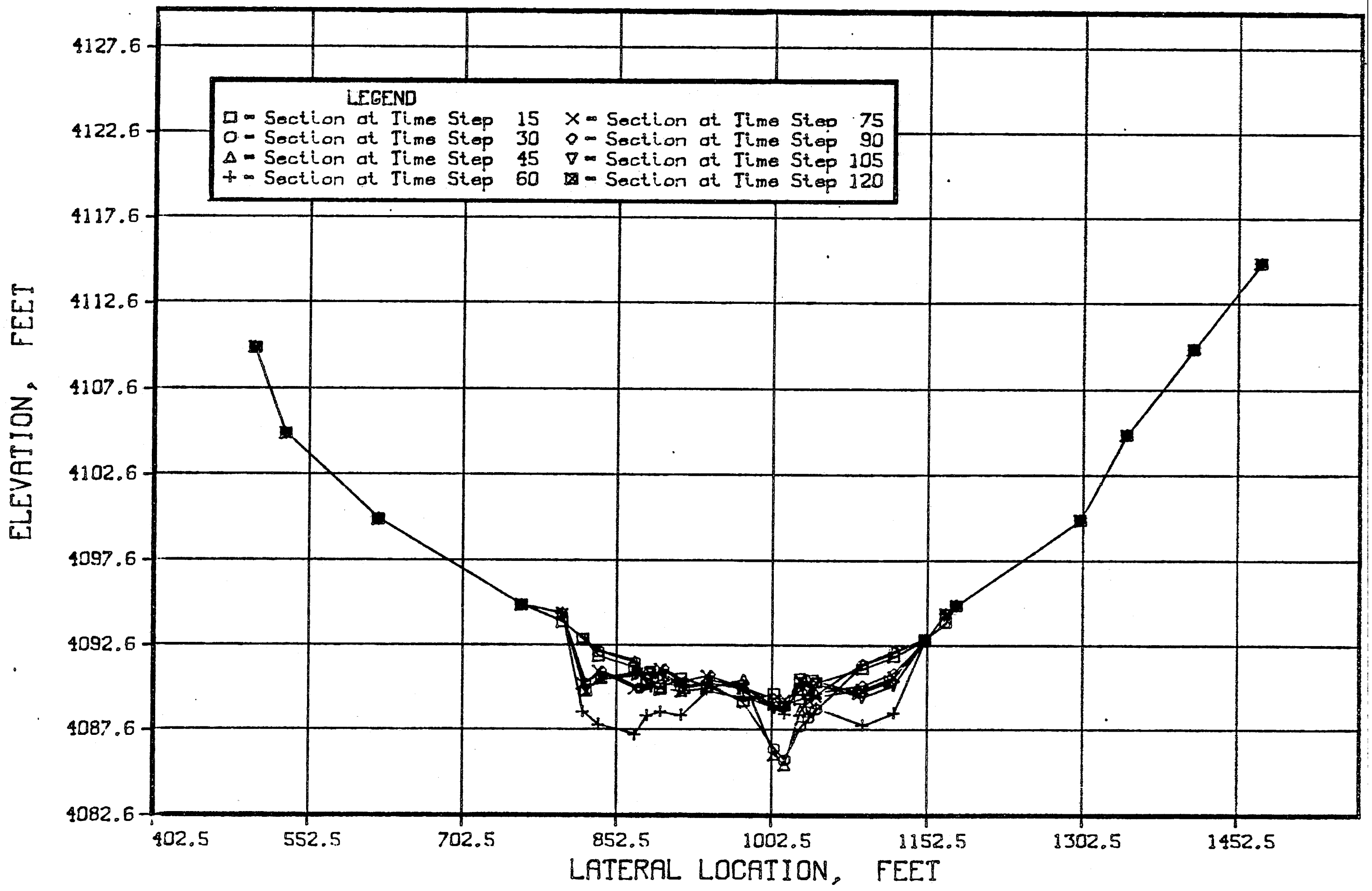
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1850. FT.



PLOT 11 20.41.53 TUES 25 NOV, 1986 JOB=7TXK3: . UCC DISSPLA 9.0

Figure 8k

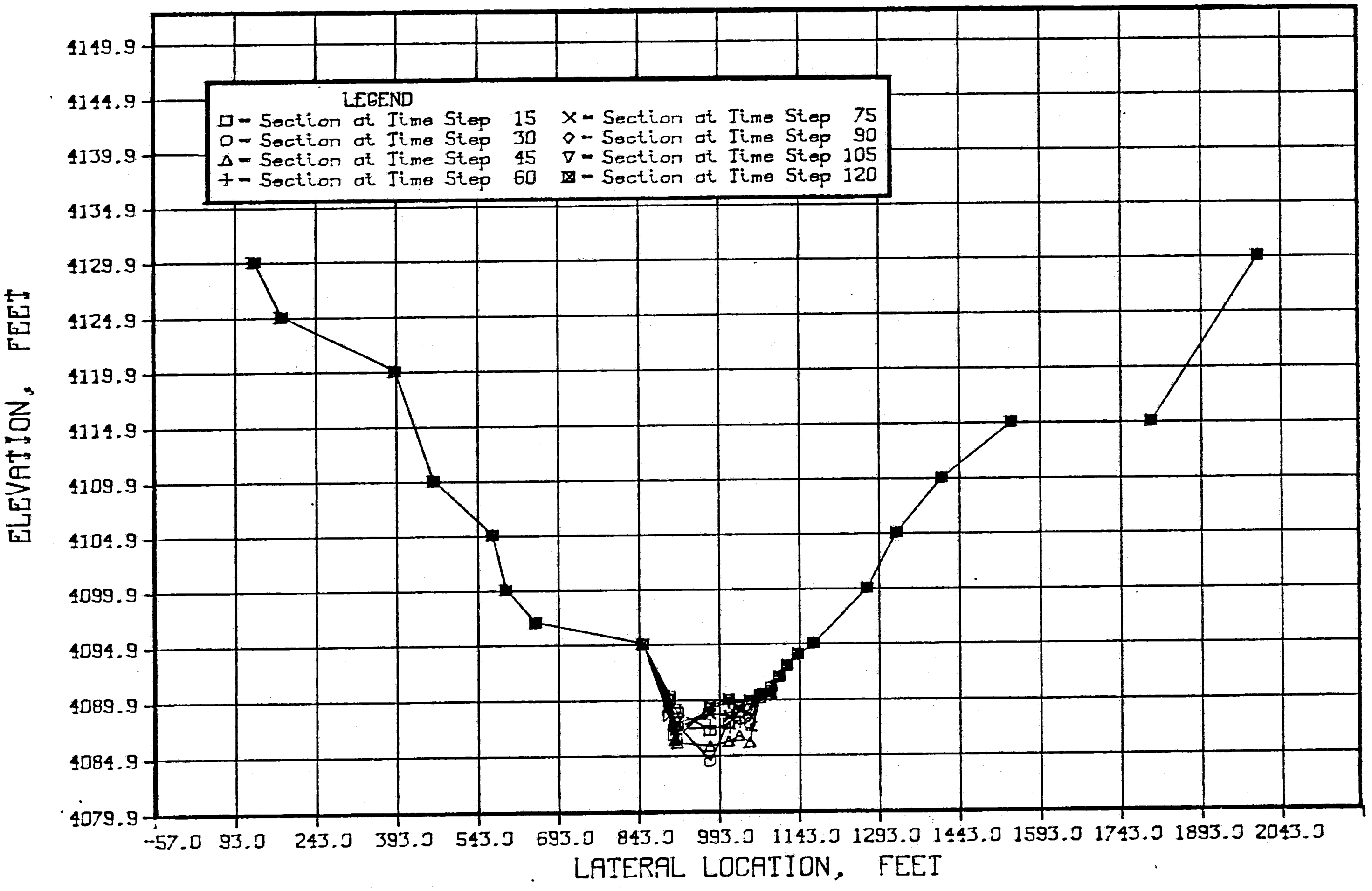
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1580. FT.



PLOT 12 20.42.01 TUES 25 NOV, 1986 JOB-7IXK3: . UCG DISSPLA 9.0

Figure 81

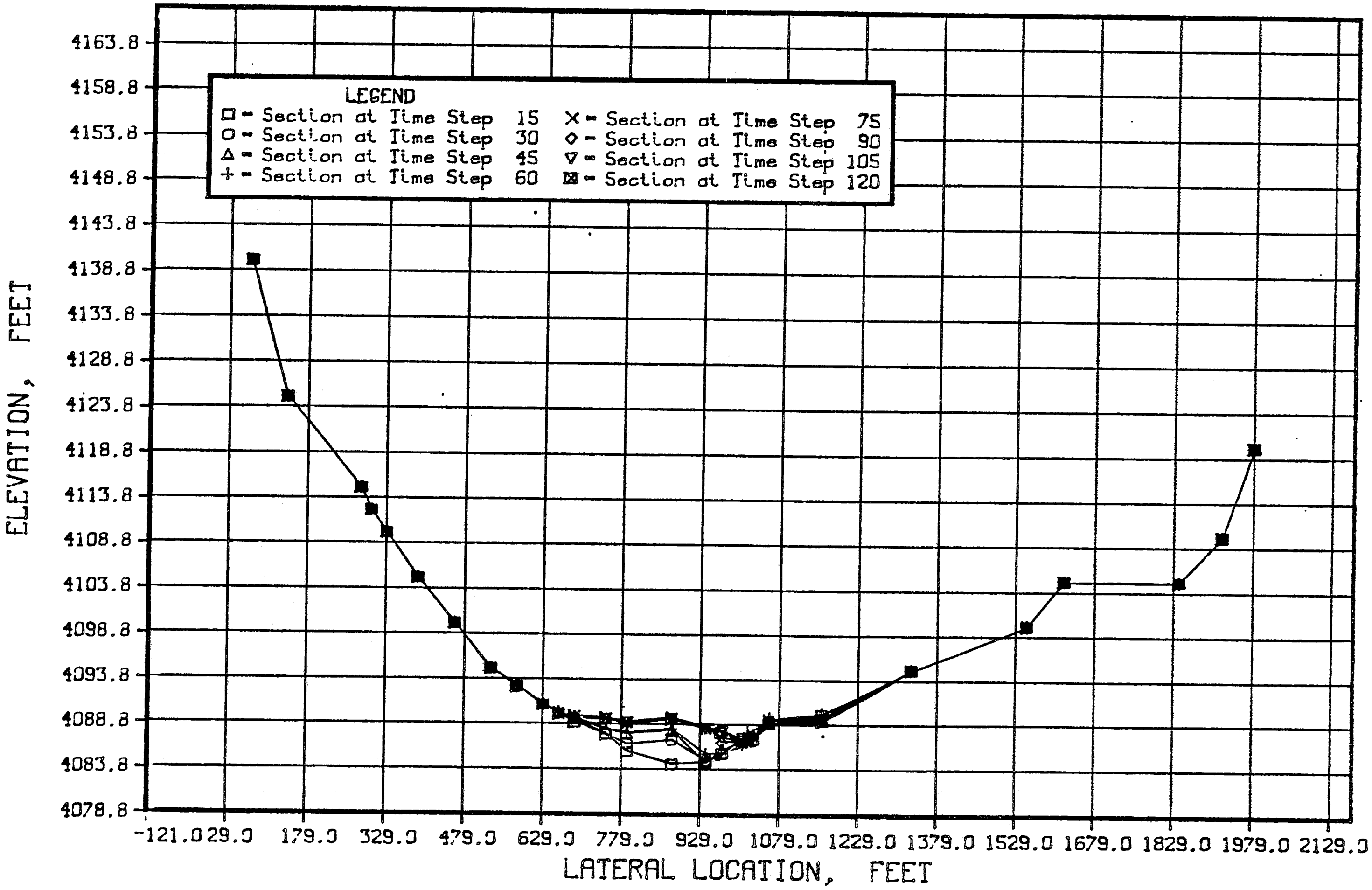
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1380. FT.



PLOT 13 20.42.10 TUES 25 NOV, 1986 JOB-?TXK3: . UCC DISSPLA 9.0

Figure 8m

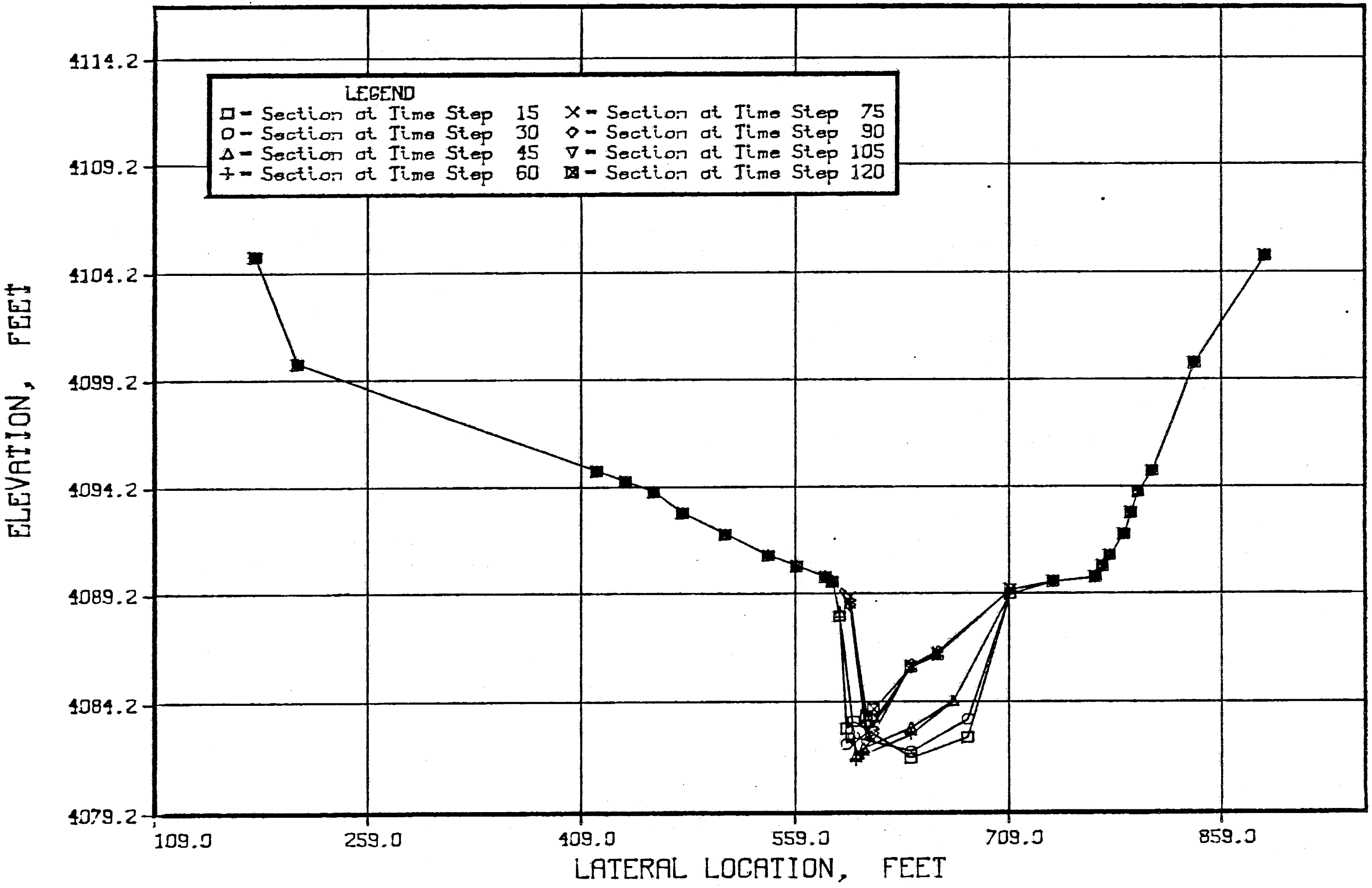
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1110. FT.



PLOT 11 20.12.18 TUES 25 NOV, 1986 JOB-7IXK3: , UCC DISSPLA 9.0

Figure 8n

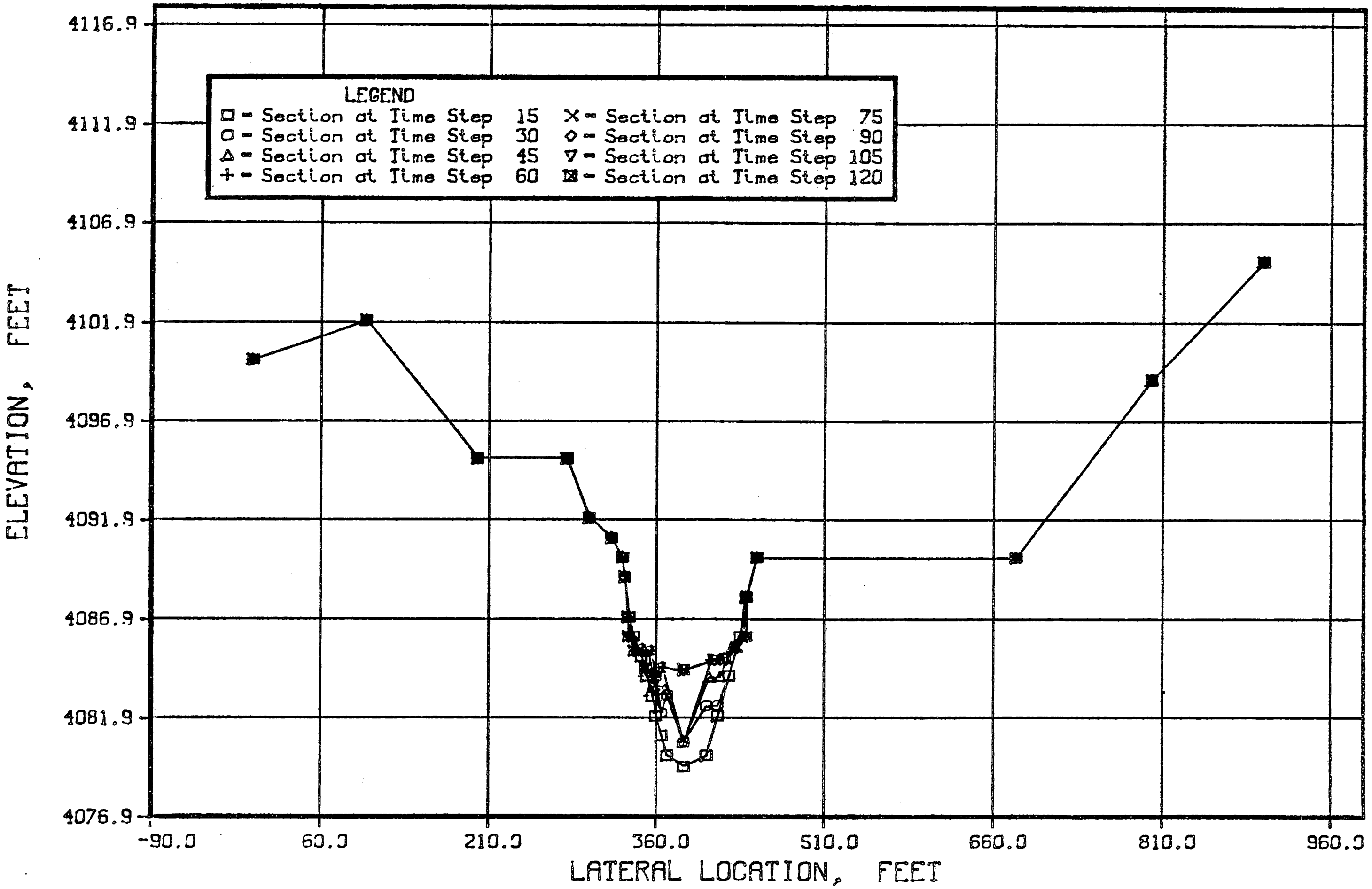
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 885. FT.



PLOT 15 20.42.26 TUES 25 NOV, 1986 JOB=7TXK3: . UCC DISSPLA 9.0

Figure 8o

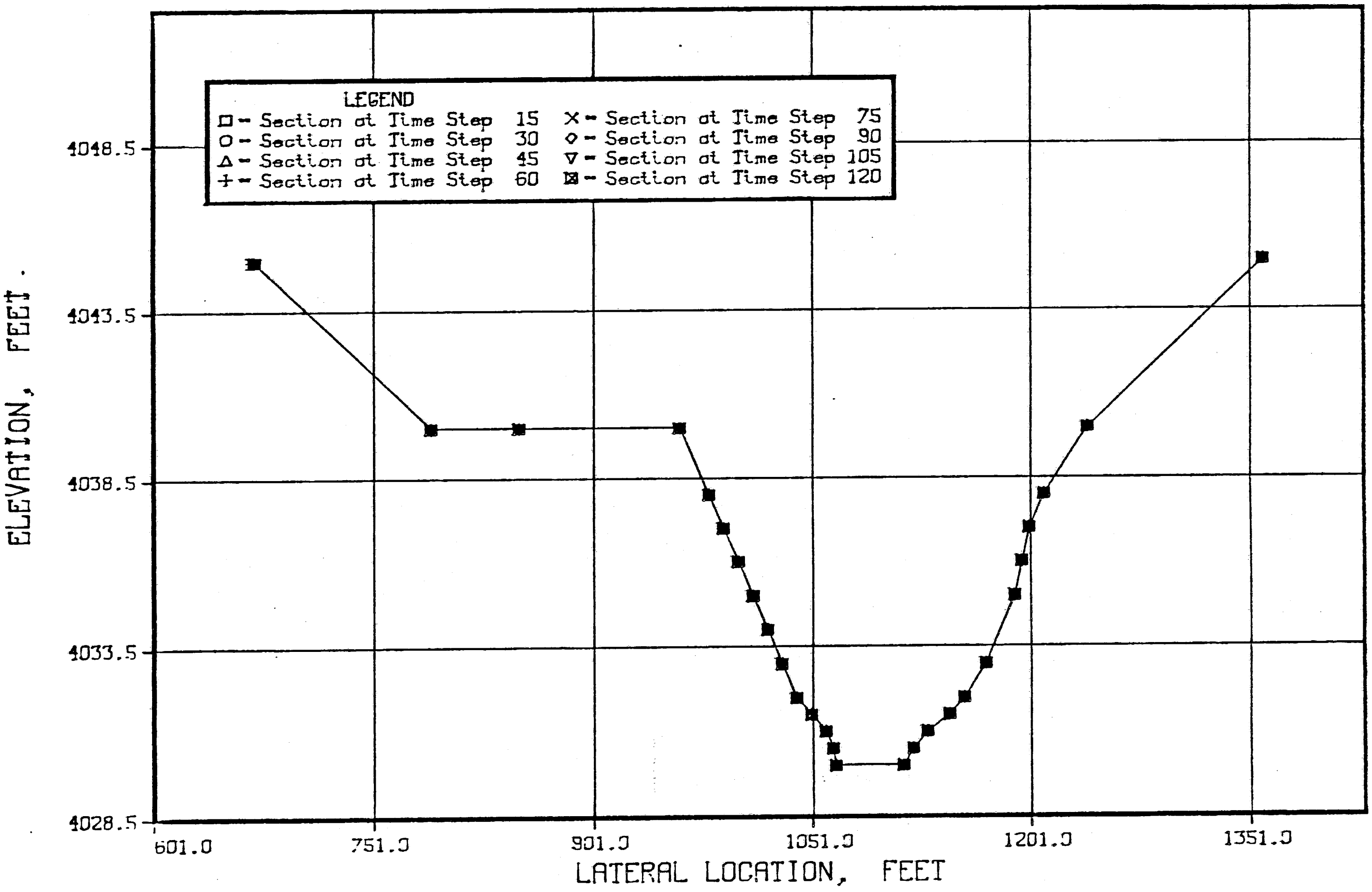
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 655. FT.



PLOT 16 20.42.31 TUES 25 NOV, 1986 JOB-7IXK3: UCC DISSPLA 9.0

Figure 8p

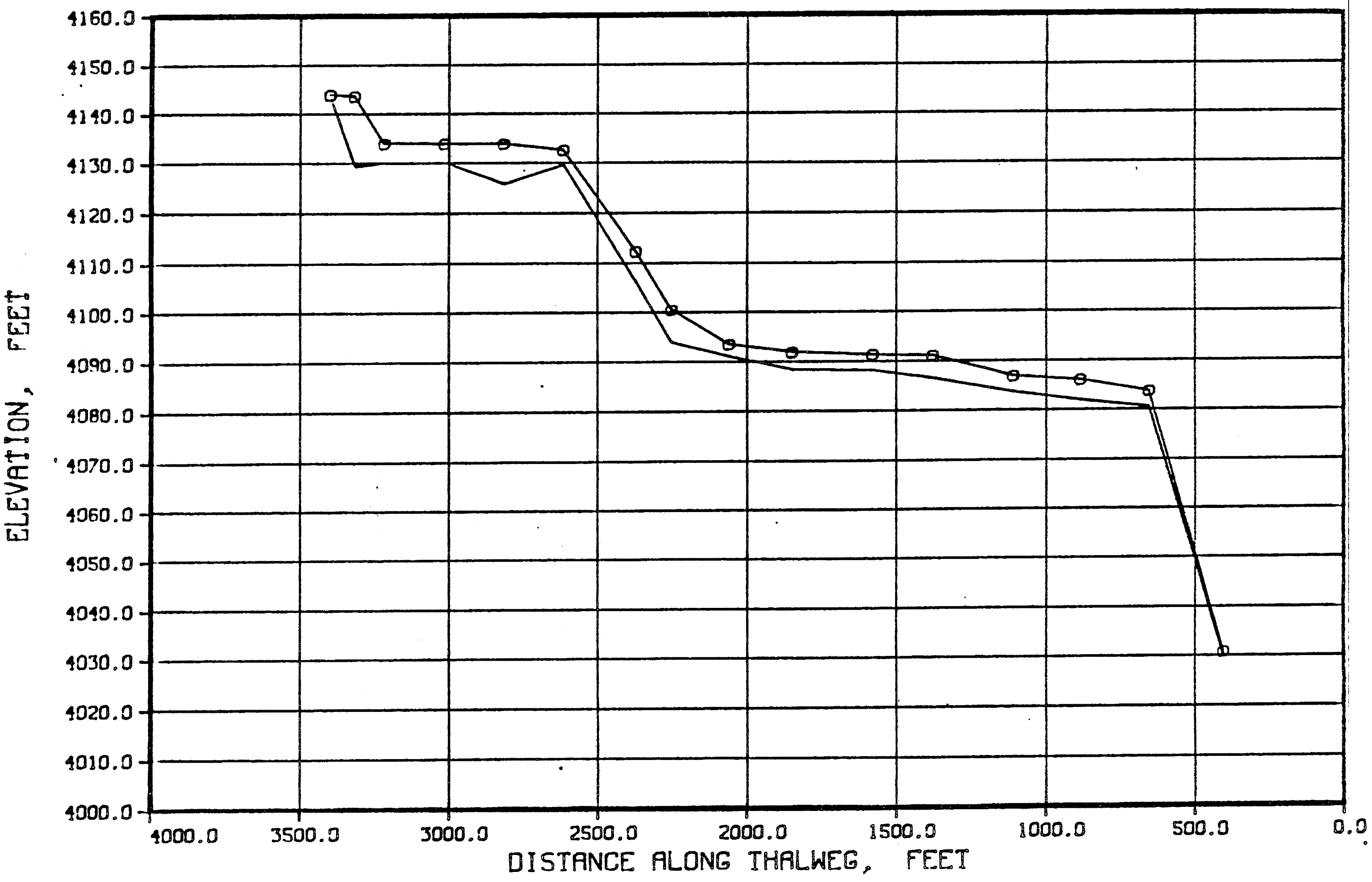
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 405. FT.



PLOT 1 21.22.56 TUES 25 NOV, 1986 .10A-F006439 , UCC DISSPLA 9.0

Figure 9a

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 15. DISCH- 1067 CFS



PLOT 2 21.23.02 TUES 25 NOV, 1986 10B-F006429 , UCC DISSPLA 9.0

Figure 9b

WILLOW CREEK SPILLWAY--- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 30. DISCH- 2285 CFS

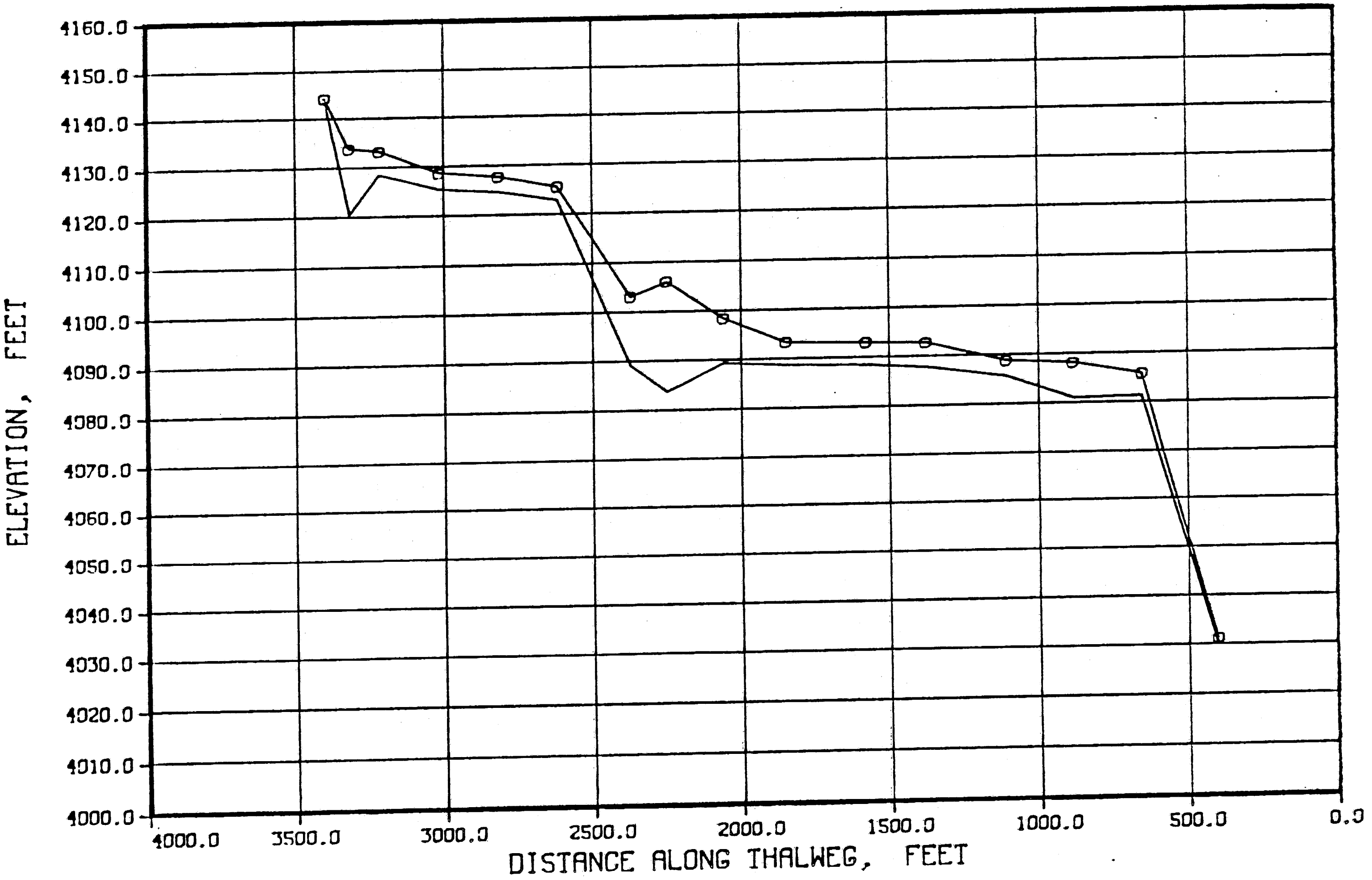


Figure 9c

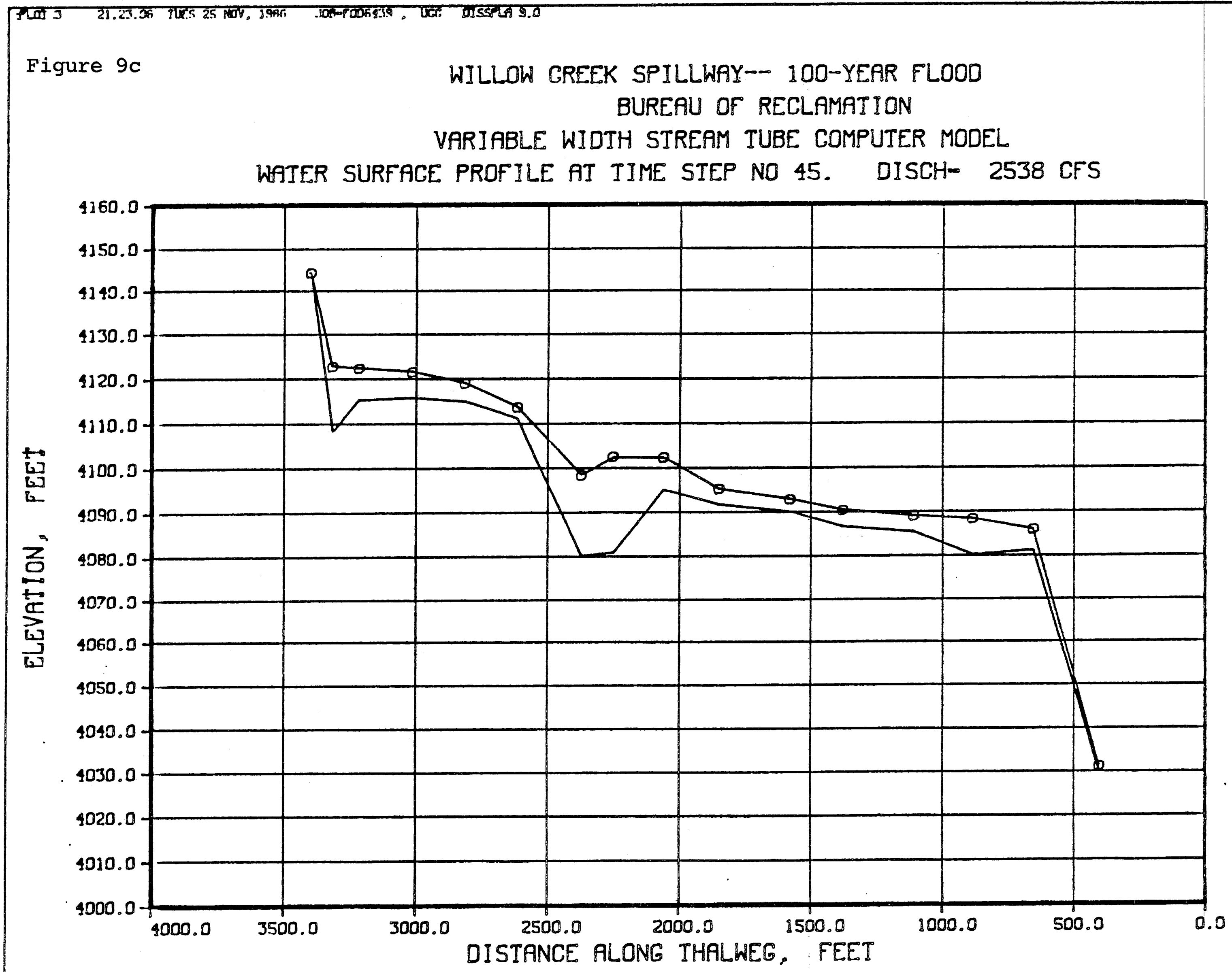
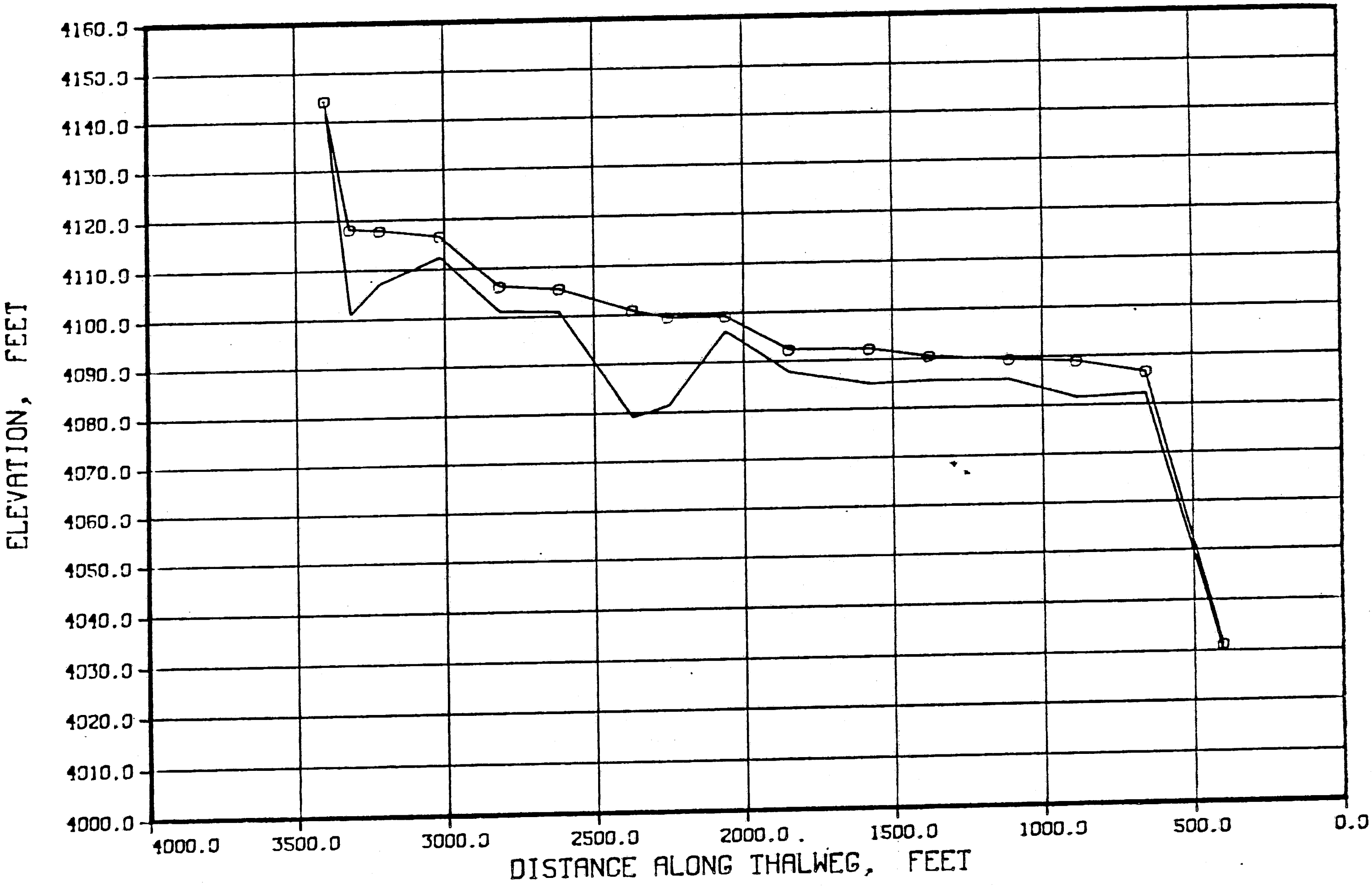

PLOT 3 21.23.36 TUES 25 NOV, 1986 JOB-F006939 , UGC DISSPLA 9.0
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 45. DISCH- 2538 CFS
ELEVATION, FEET
4160.0
4150.0
4140.0
4130.0
4120.0
4110.0
4100.0
4090.0
4080.0
4070.0
4060.0
4050.0
4040.0
4030.0
4020.0
4010.0
4000.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
DISTANCE ALONG THALWEG, FEET

Figure 9d

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 60. DISCH- 2246 CFS



PLOT 5 21.[illegible].16 TUES 25 NOV, 1986 IOA-F006439 , UCC DISSPLA 9.0

Figure 9e

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 75. DISCH- 1824 CFS

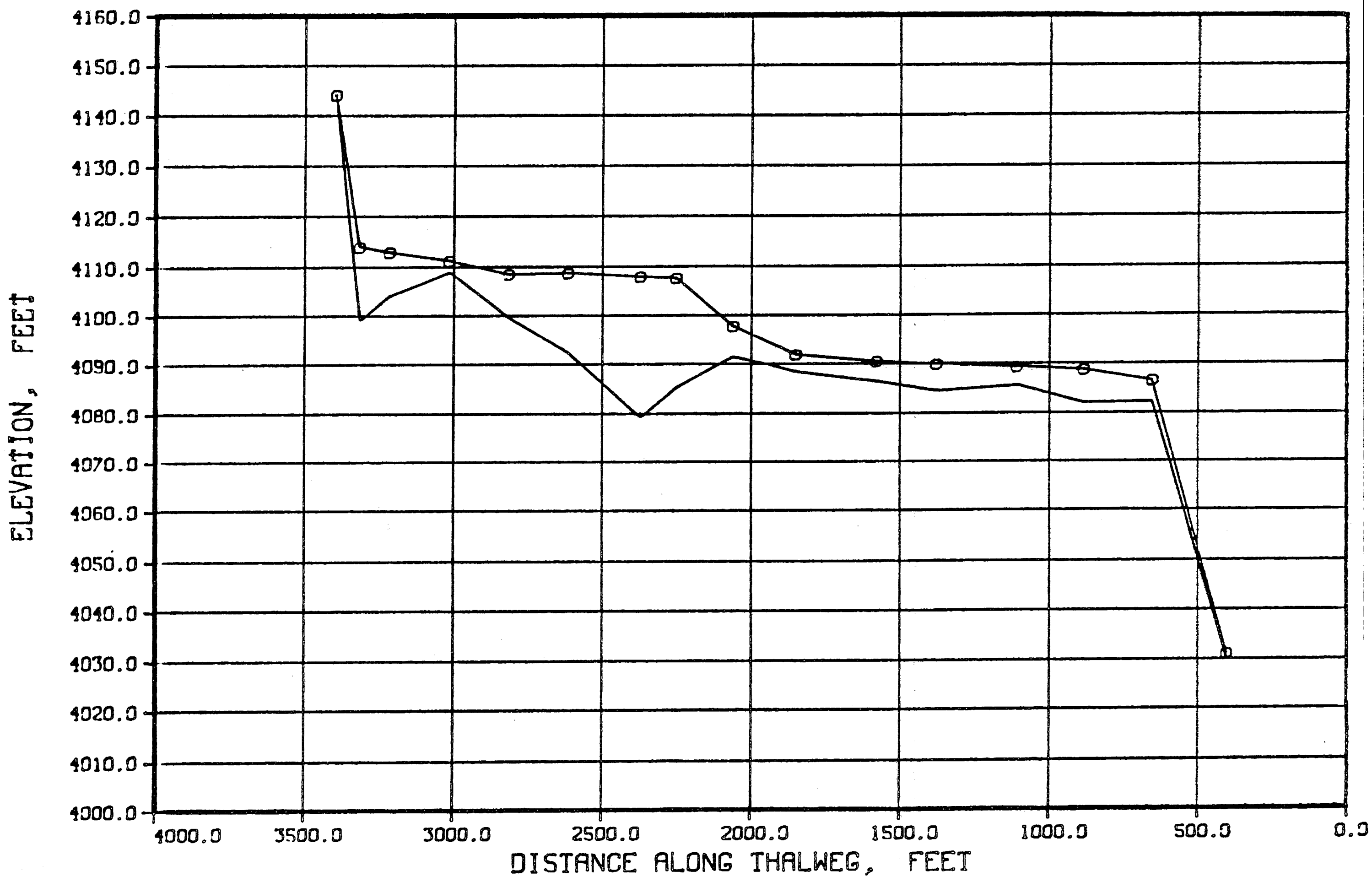


Figure 9f

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 90. DISCH- 1415 CFS

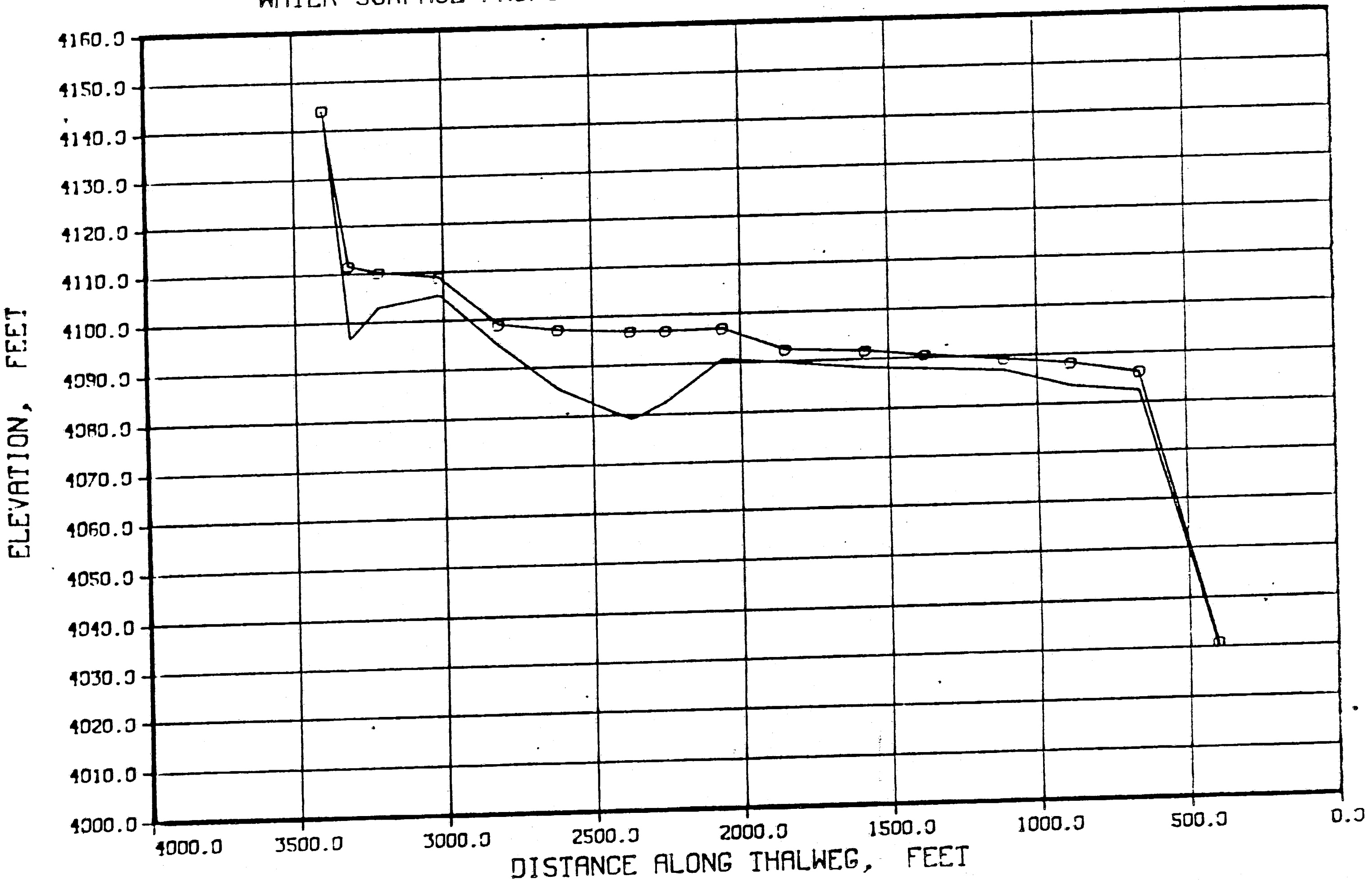
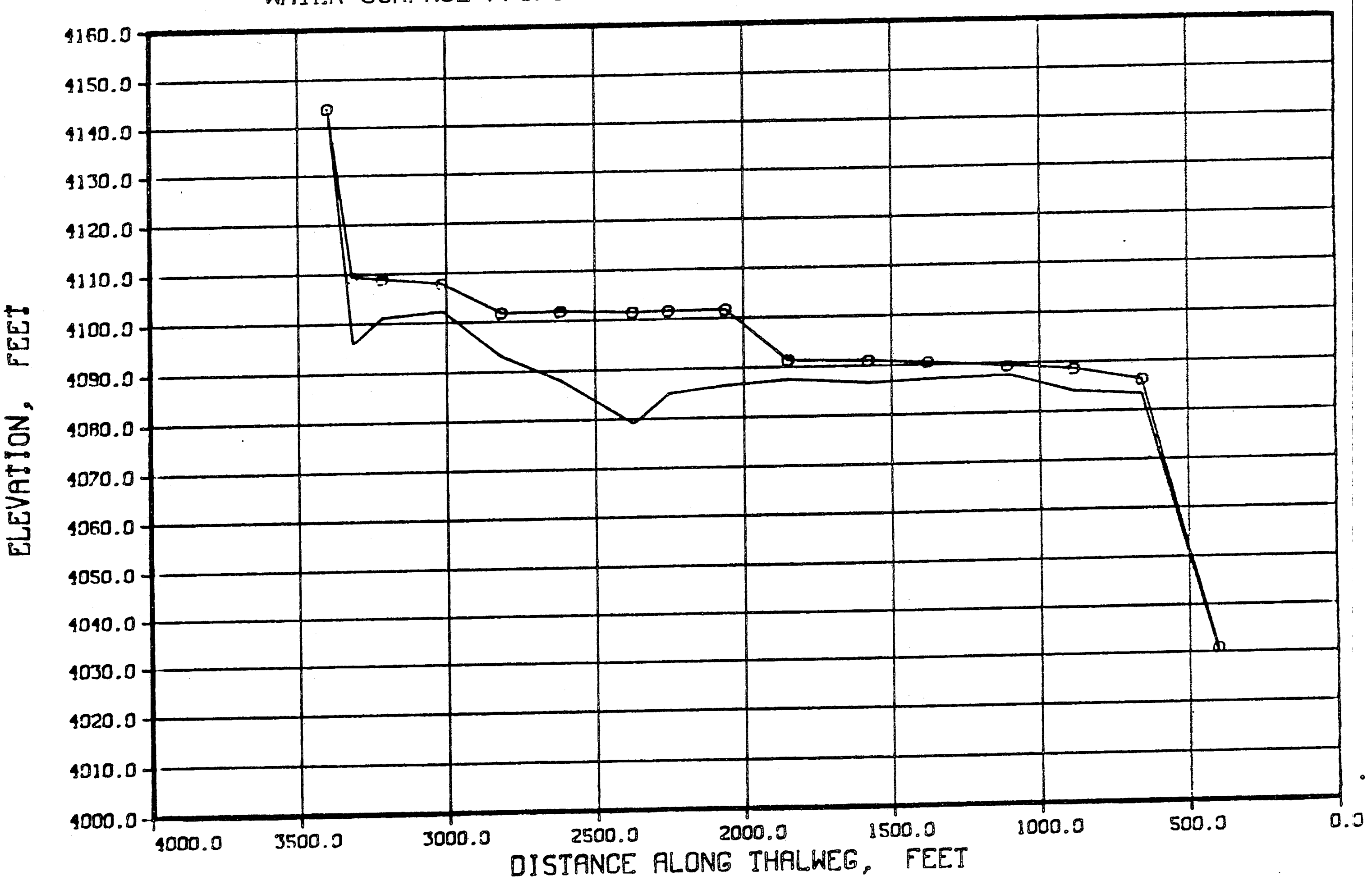


Figure 9g

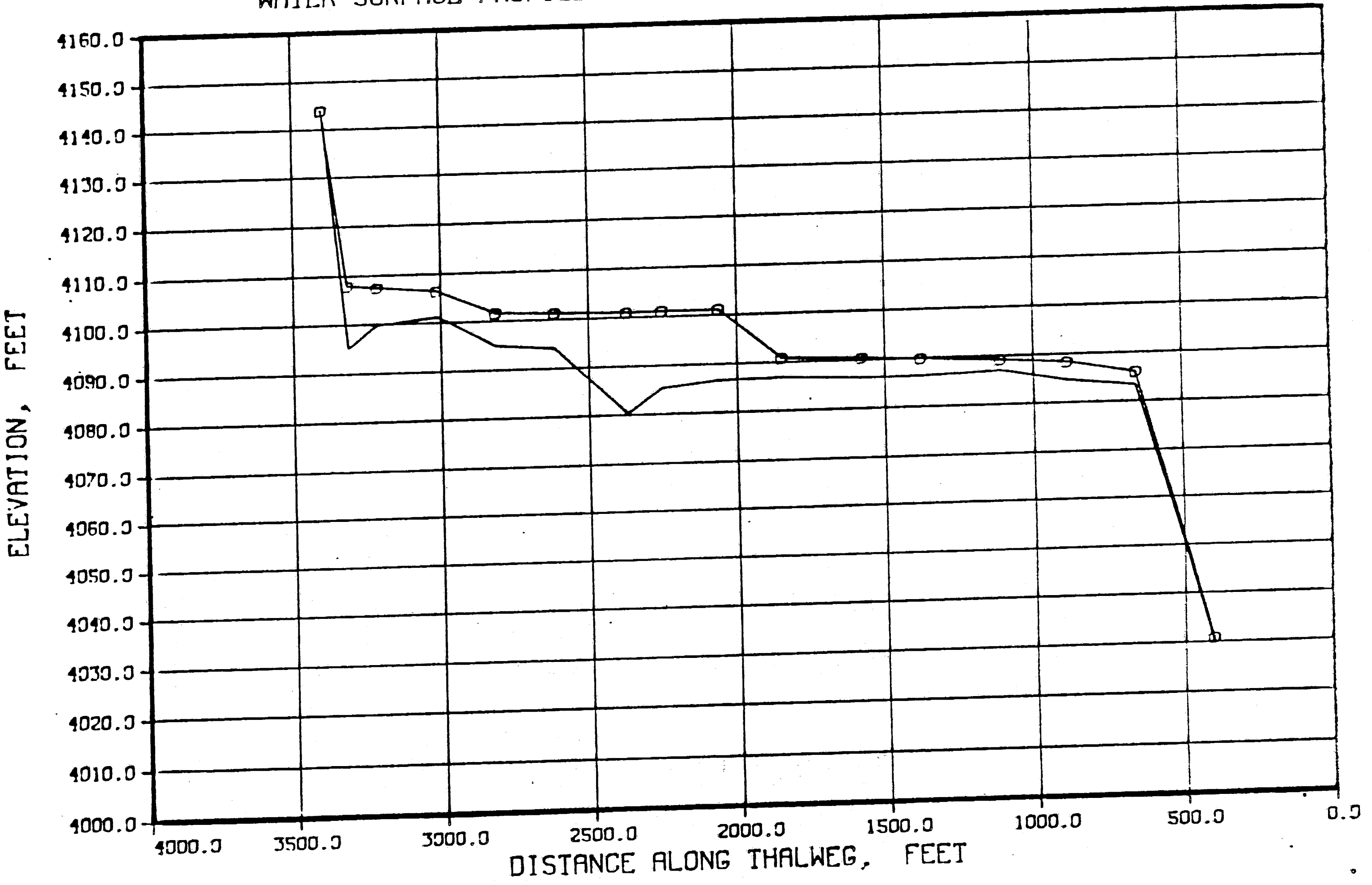
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO105. DISCH= 1244 CFS



PLOT # [illegible] TUES 25 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 9h

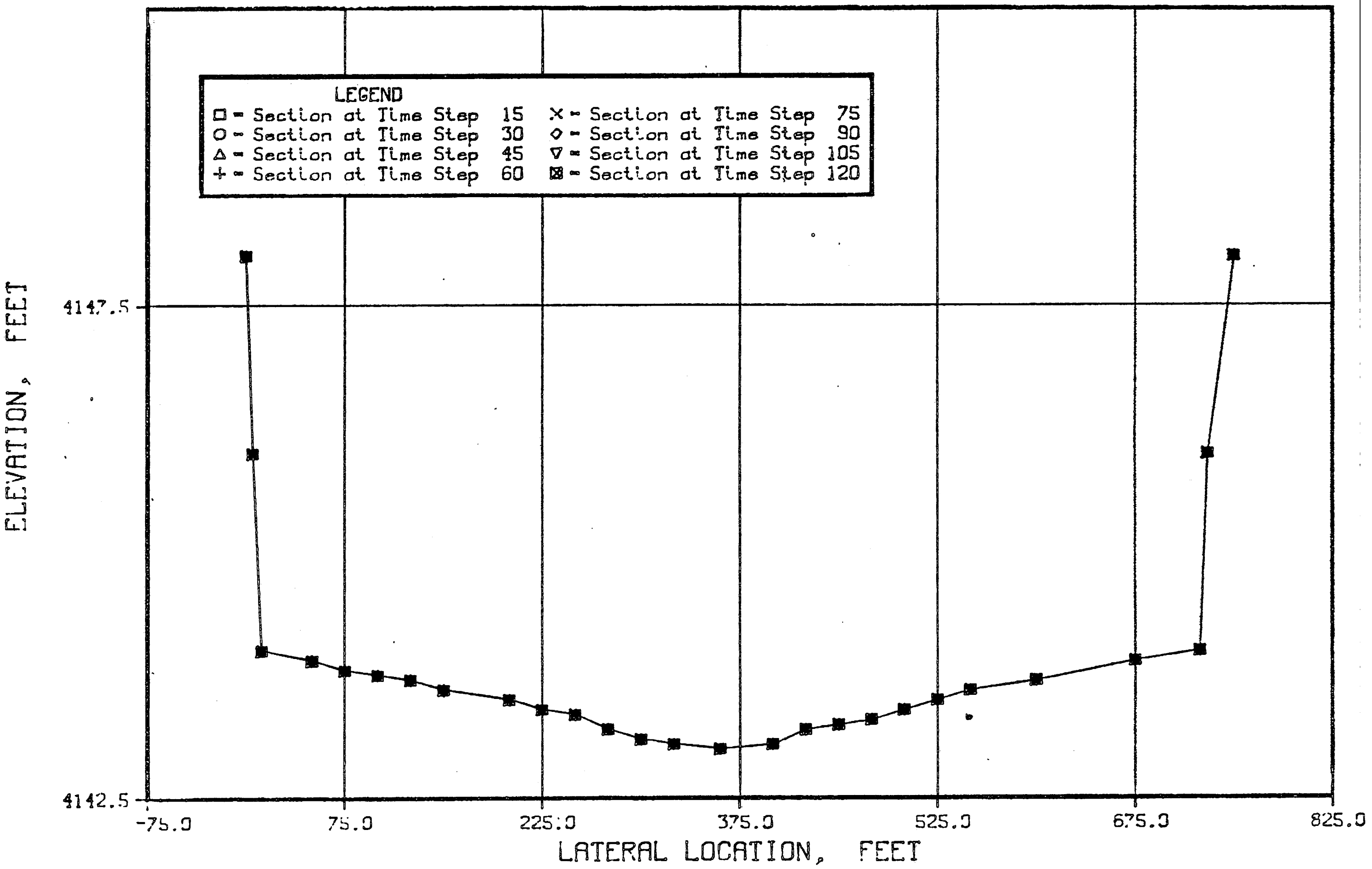
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO120. DISCH= 1063 CFS



PLOT 1 21.09.09 TUES 25 NOV, 1986 .IOB-7IXK6: UCC DISSPLA 9.0

**Figure 10a**

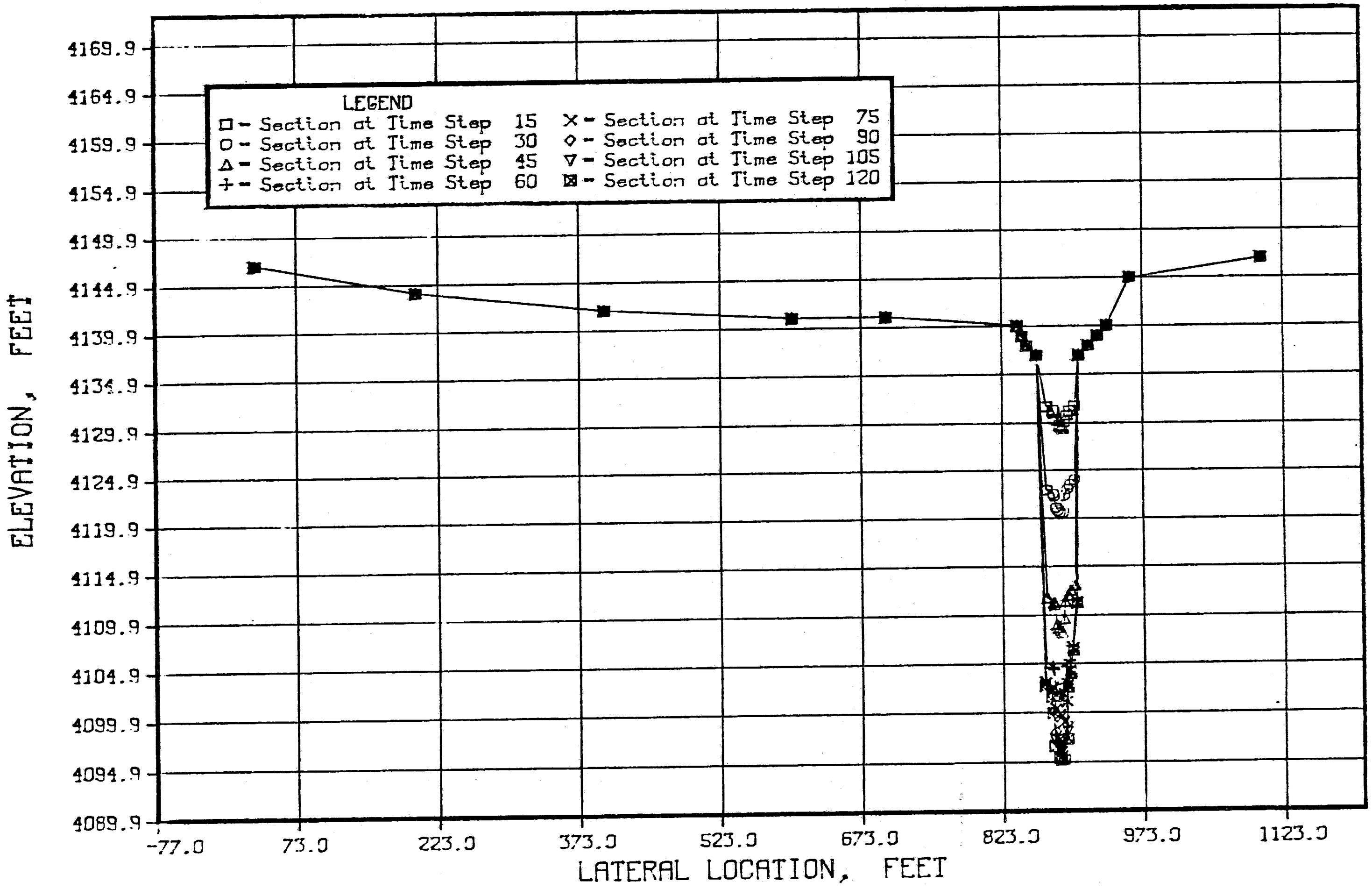
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3396. FT.



PLOT 2 21.09.15 TUES 25 NOV, 1986 JOB-7IXK6: UCC DISSPLA 9.0

Figure 10b

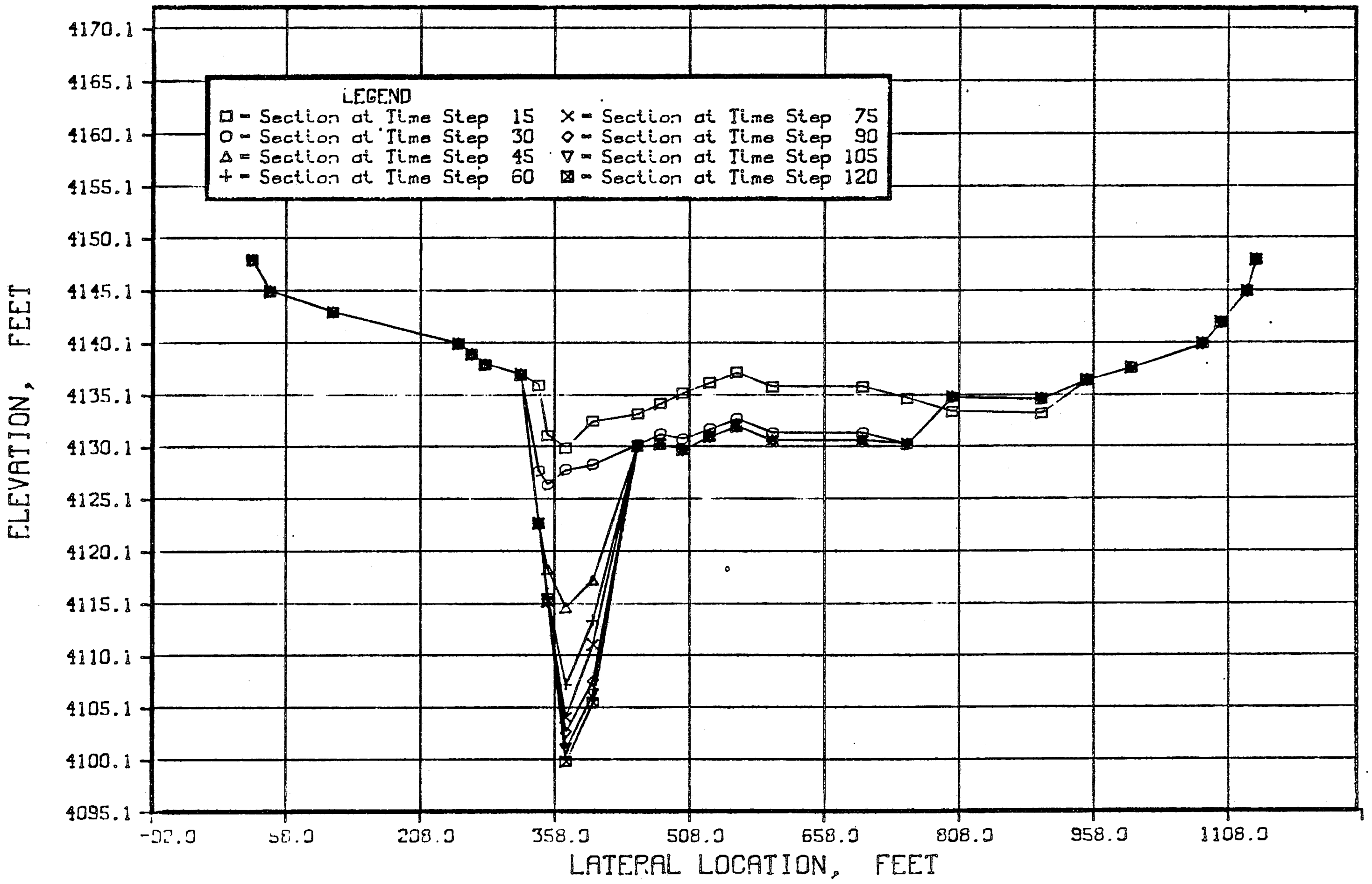
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3316. FT.



PLOT 3 21.39.22 TUES 25 NOV, 1986 JOB-7IXK6: . UCC DISSPLA 9.0

Figure 10c

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3216. FT.

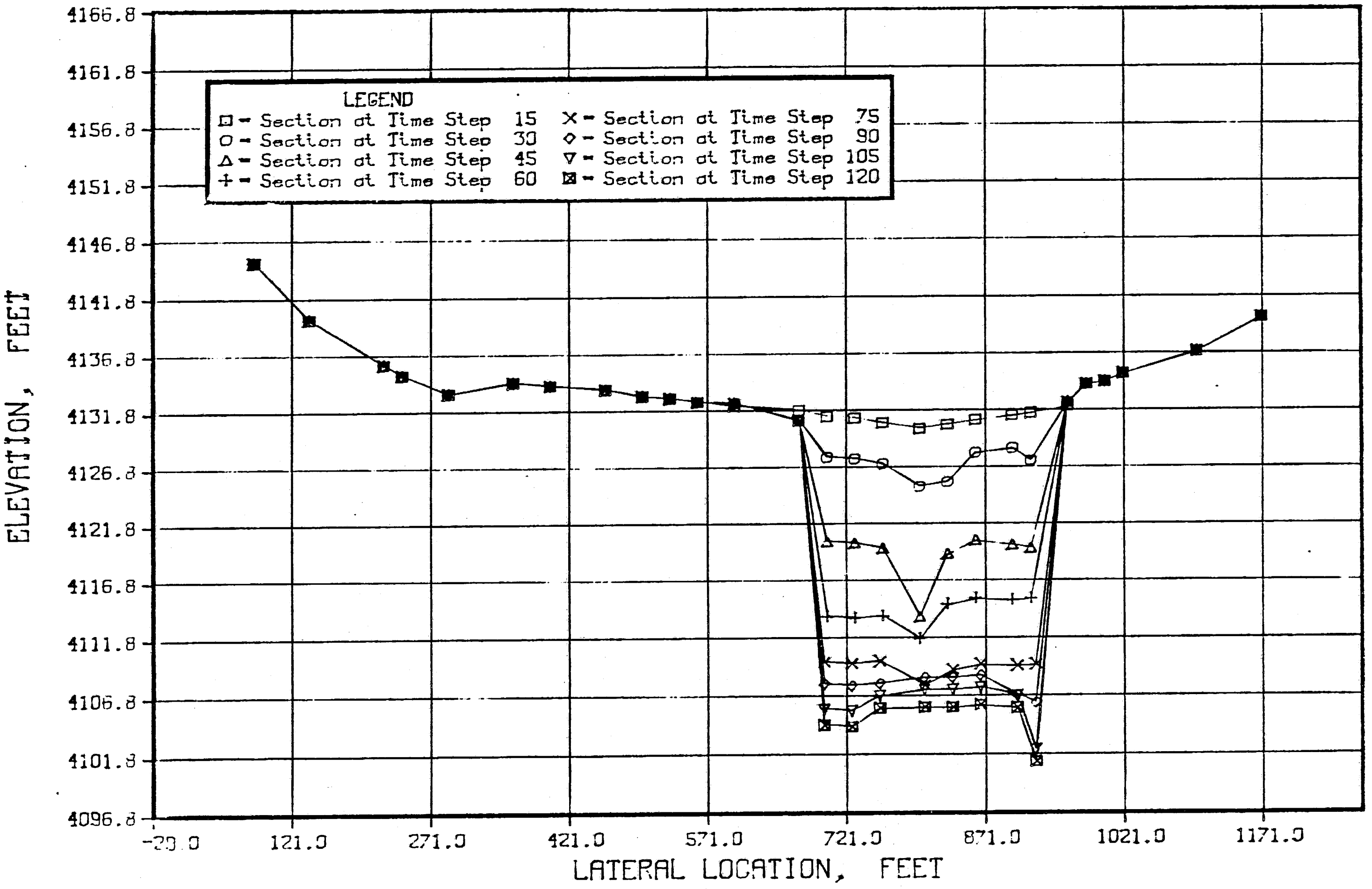


No. 200

PLOT 1 21.09.30 TUES 25 NOV, 1986 JOB=?TXK6: . JCG DISSPLA 9.0

**Figure 10d**

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3016. FT.



PLOT 5 21.39.36 TUES 25 NOV, 1986 JOB-7TXK6 . UCC DISSPLA 9.3

Figure 10e

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2816. FT.

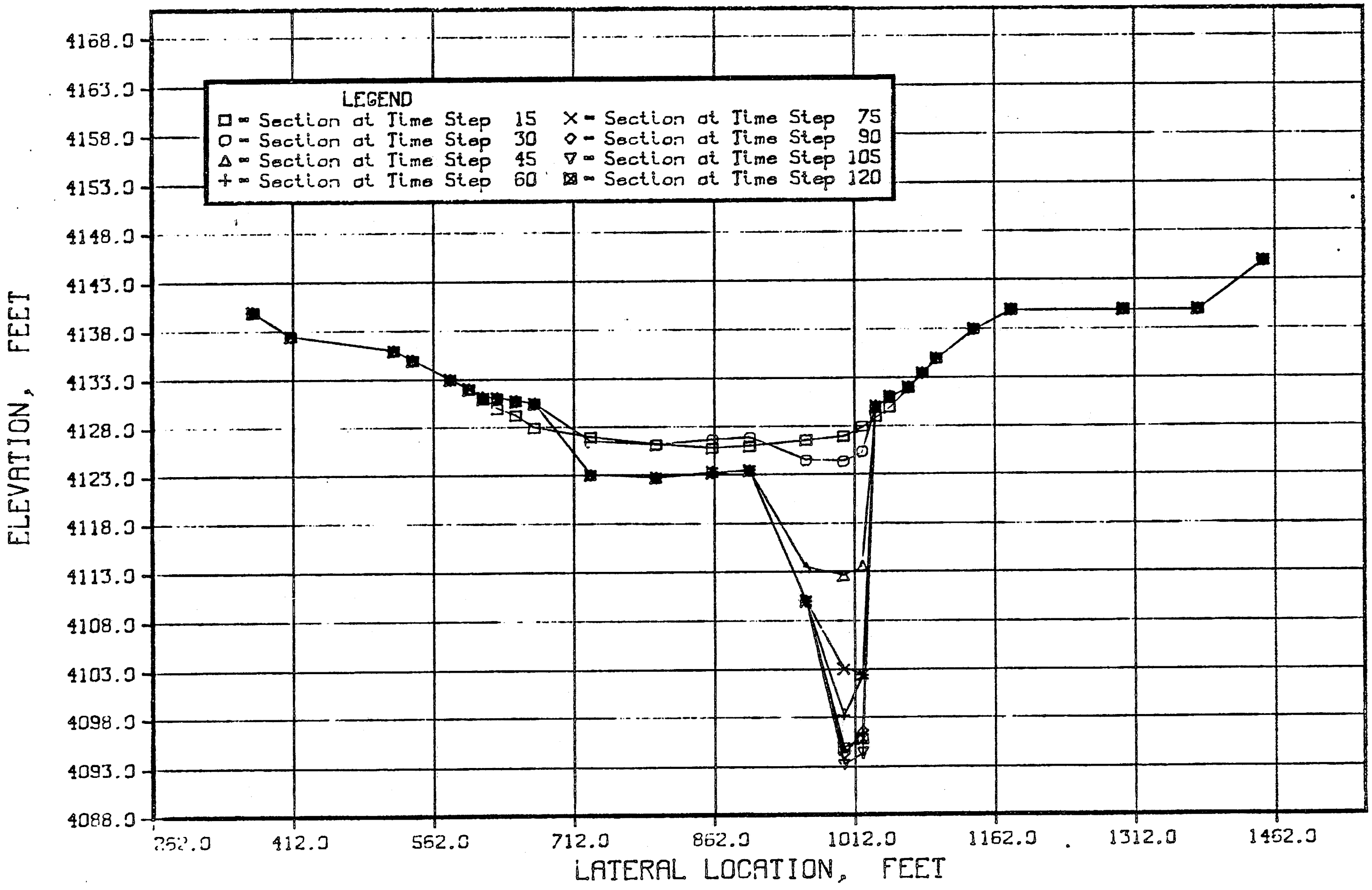
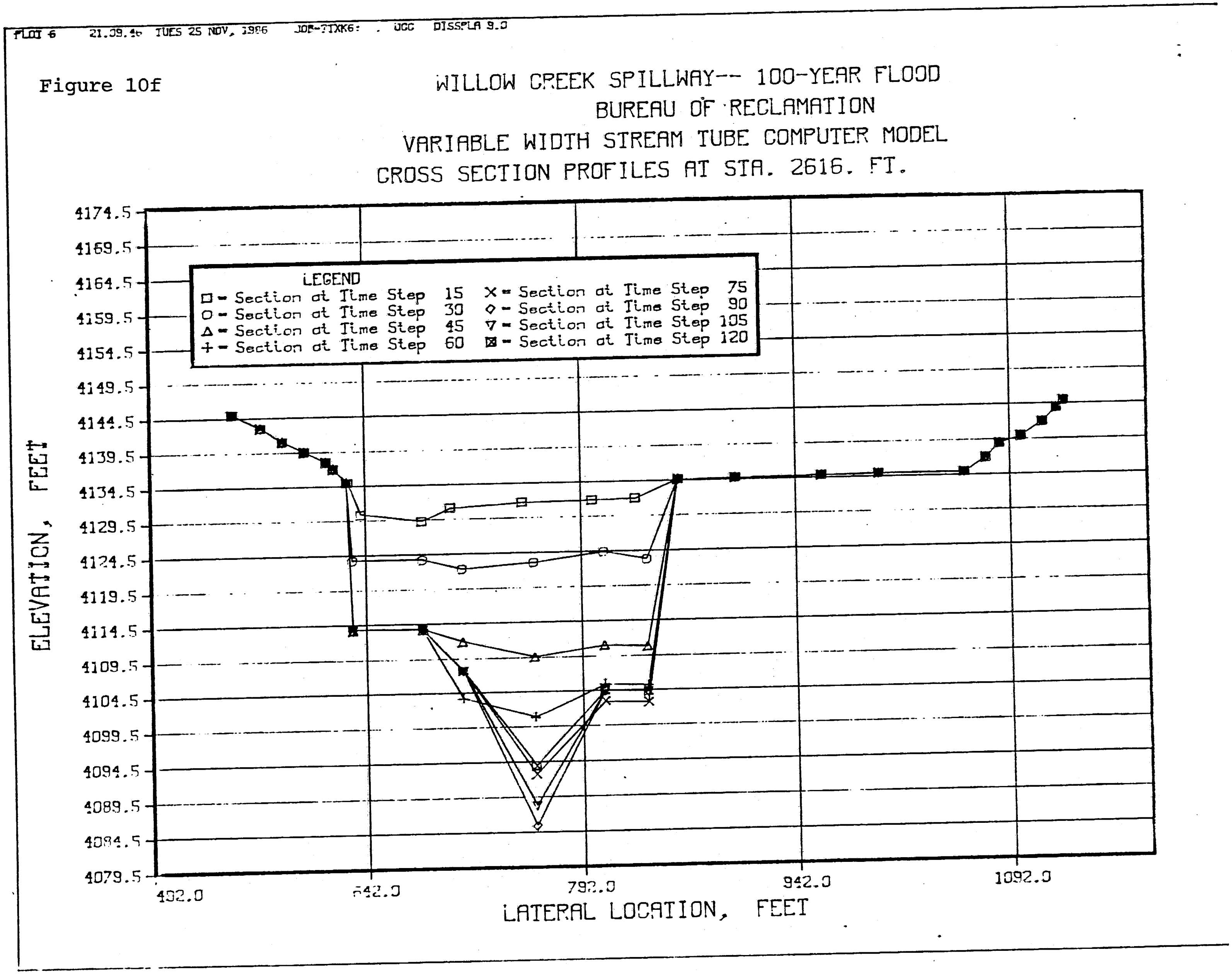


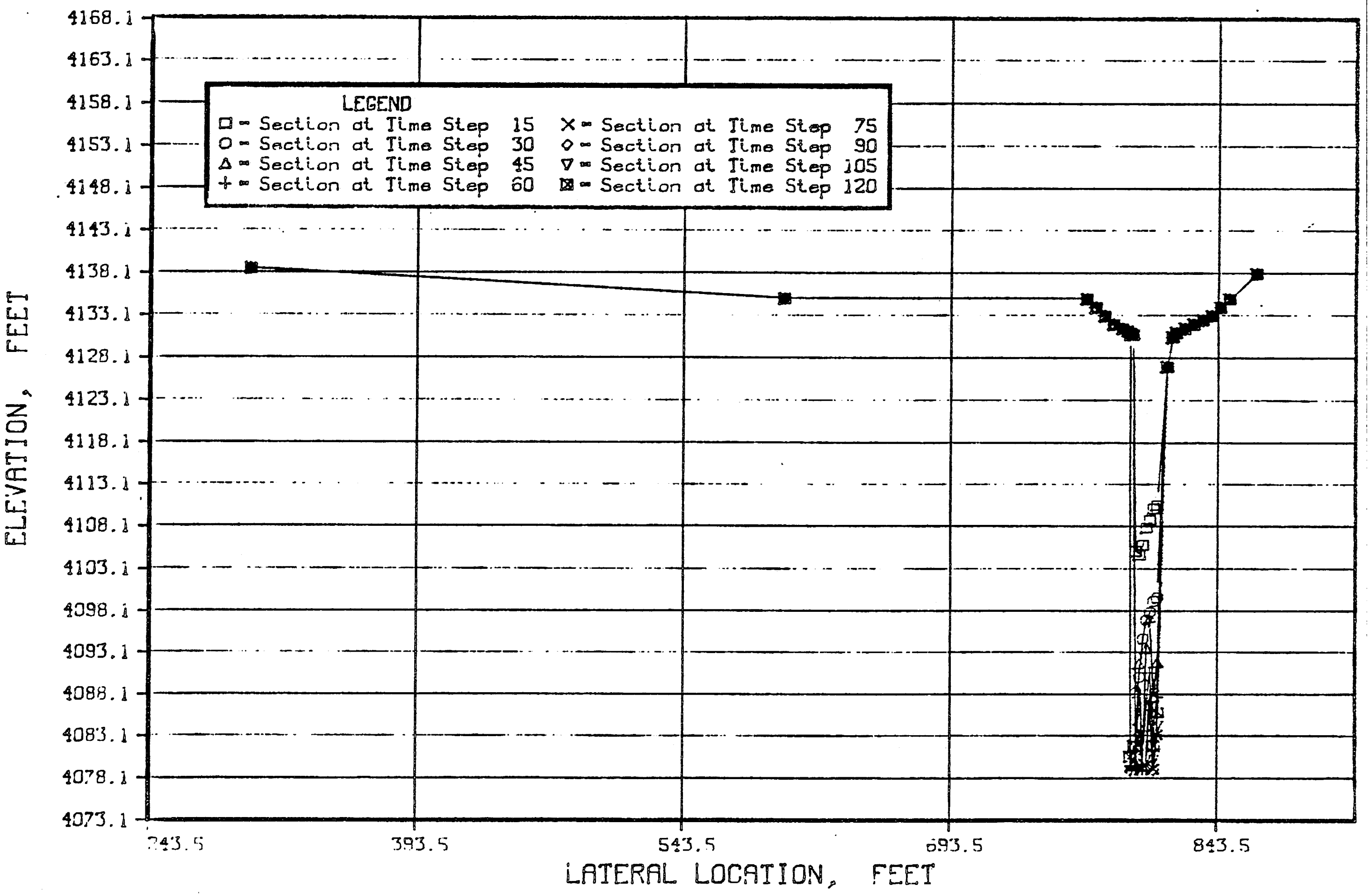
**Figure 10f**


PLOT 6 21.39.46 TUES 25 NOV, 1986 JOB-7IXK6: . UCC DISSPLA 9.0
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2616. FT.
LEGEND
□ - Section at Time Step 15
○ - Section at Time Step 30
△ - Section at Time Step 45
+ - Section at Time Step 60
× - Section at Time Step 75
◇ - Section at Time Step 90
▽ - Section at Time Step 105
⊠ - Section at Time Step 120
ELEVATION, FEET
4174.5
4169.5
4164.5
4159.5
4154.5
4149.5
4144.5
4139.5
4134.5
4129.5
4124.5
4119.5
4114.5
4109.5
4104.5
4099.5
4094.5
4089.5
4084.5
4079.5
492.0
642.0
792.0
942.0
1092.0
LATERAL LOCATION, FEET

PLOT 7 21.39.52 TUES 25 NOV, 1986 JOB-7IXK6: UCC DISSPLA 9.0

Figure 10g

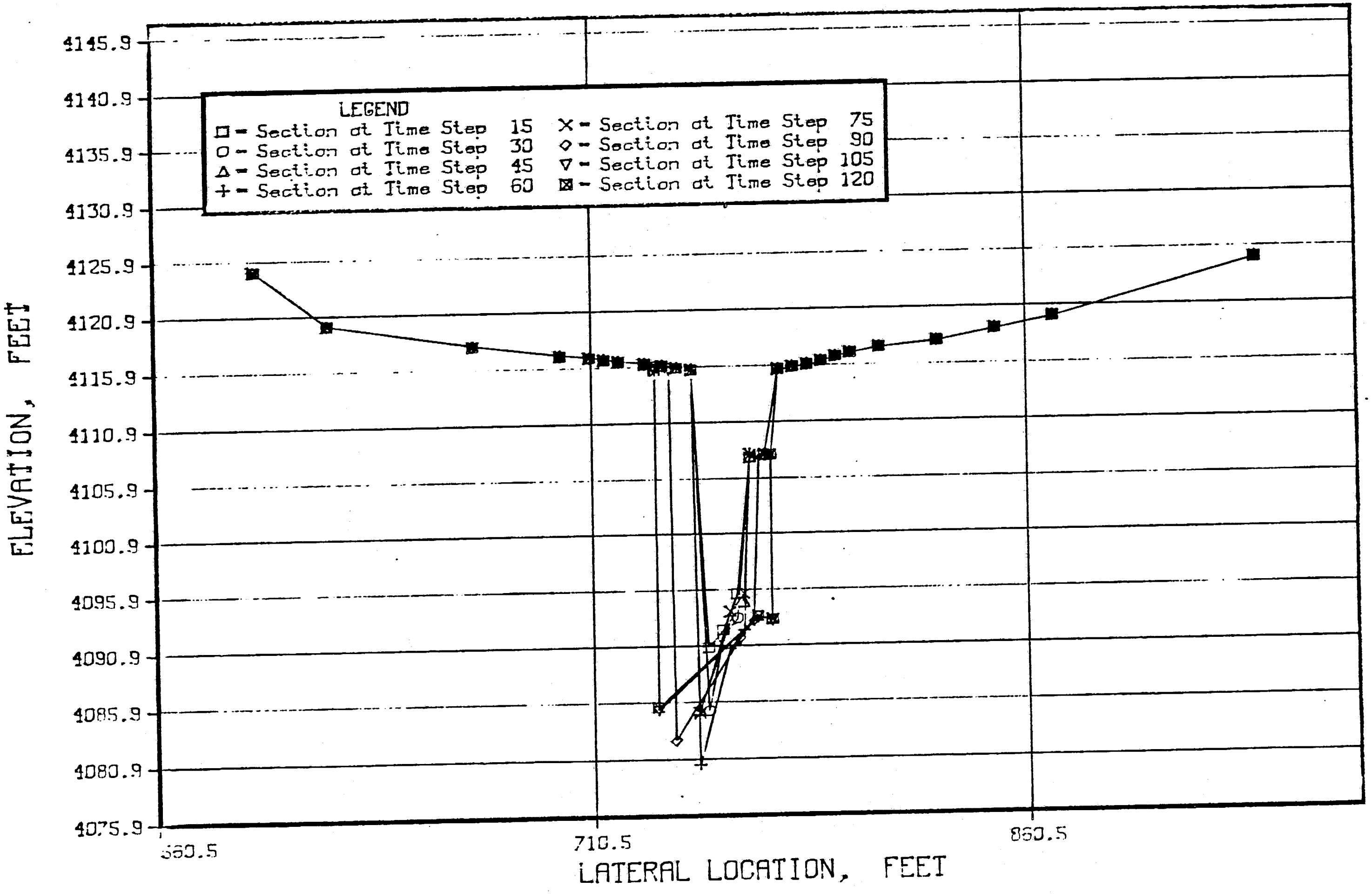
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2372. FT.



PLOT 8 21.10.30 TUES 25 NOV, 1986 JOB-7IXK6: . UCC DISSPLA 9.0

Figure 10h

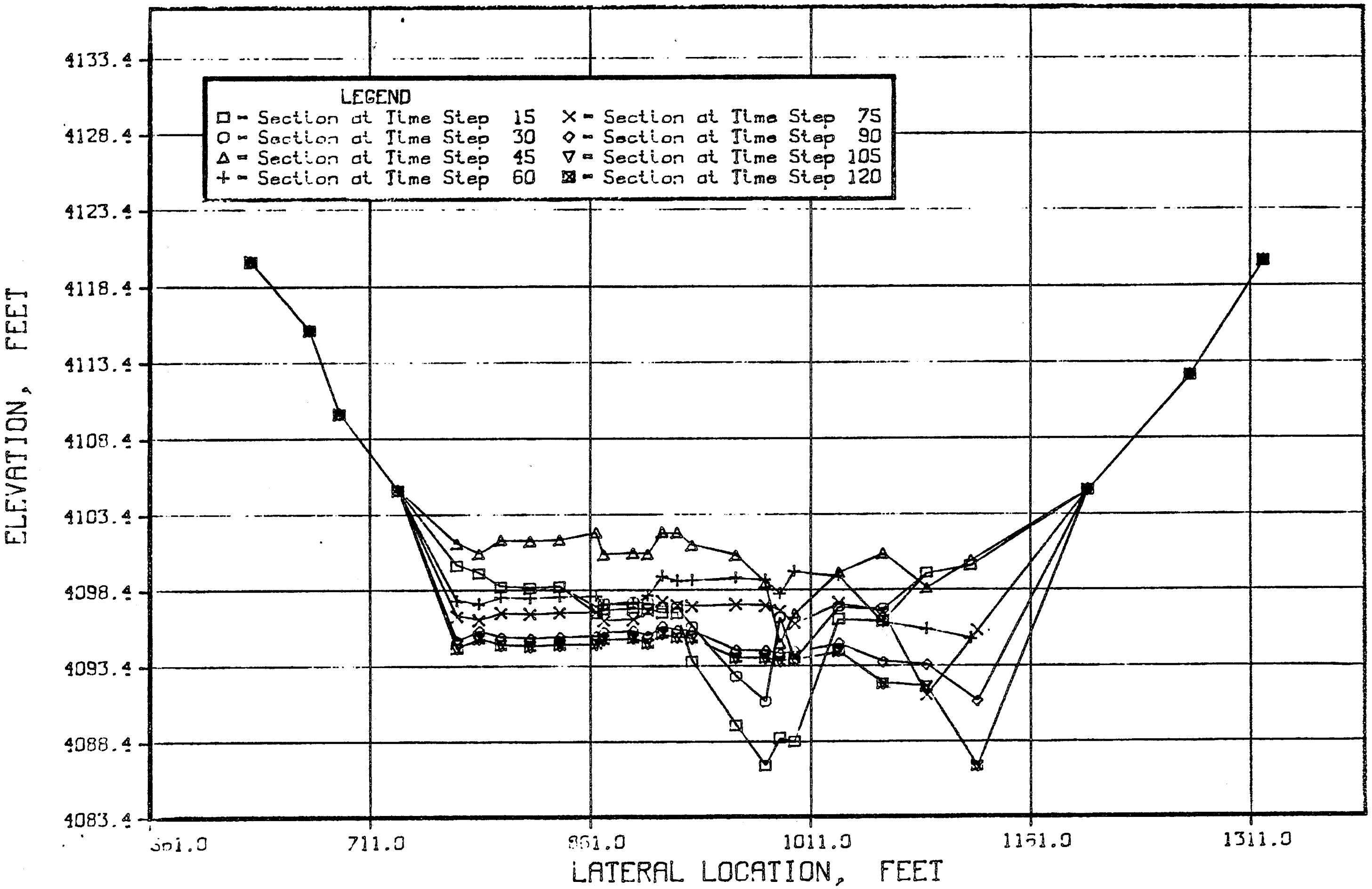
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2252. FT.



PLOT 9 21.10.05 TUES 25 NOV, 1986 JOB-?TXK6: UCC DISSPLA 9.0

Figure 10i

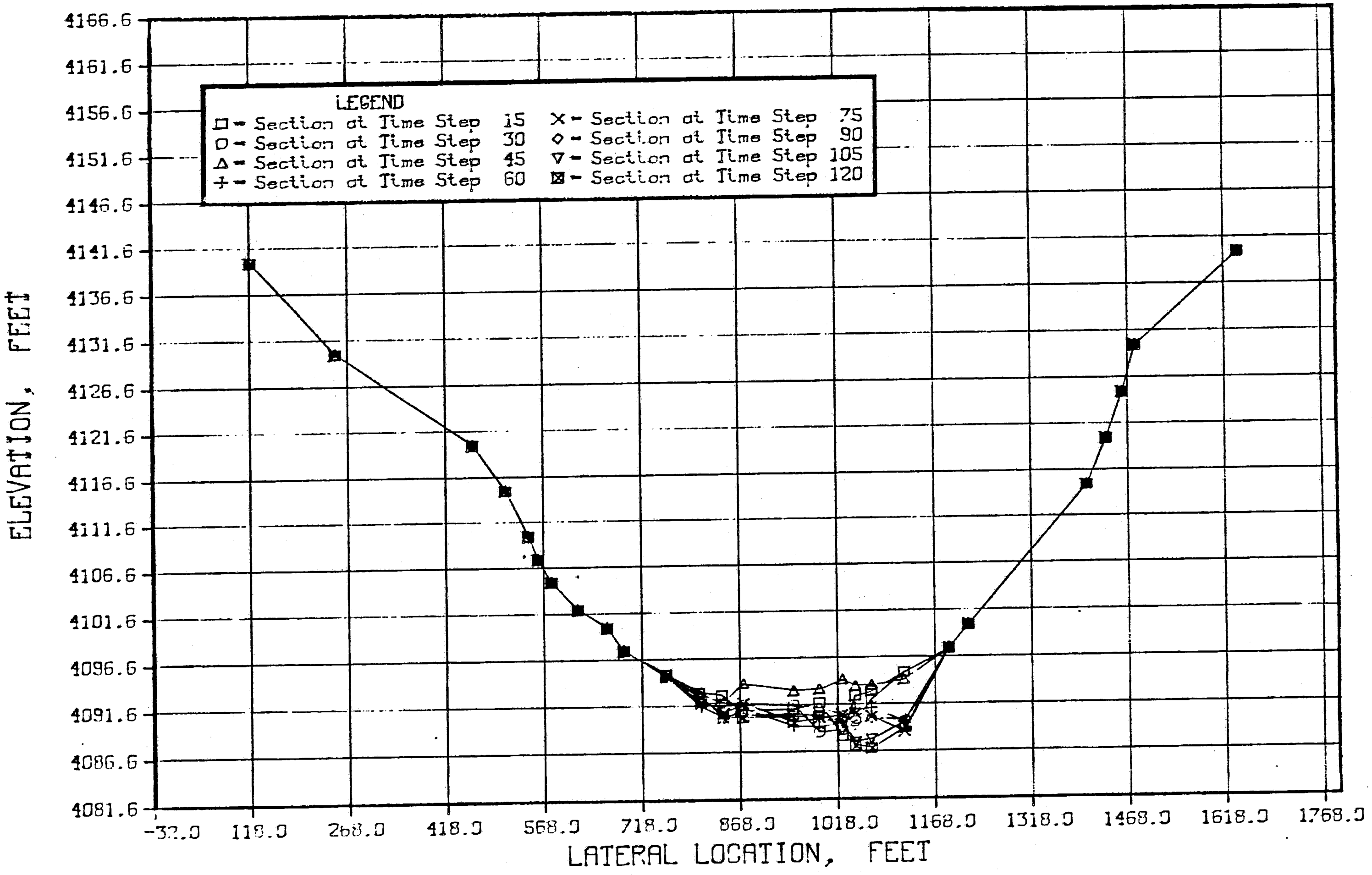
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2060. FT.



PLOT 10 21.10.11 TUES 25 NOV, 1986 JOB-7IDXK6: , UCC DISSPLA 9.0

Figure 10j

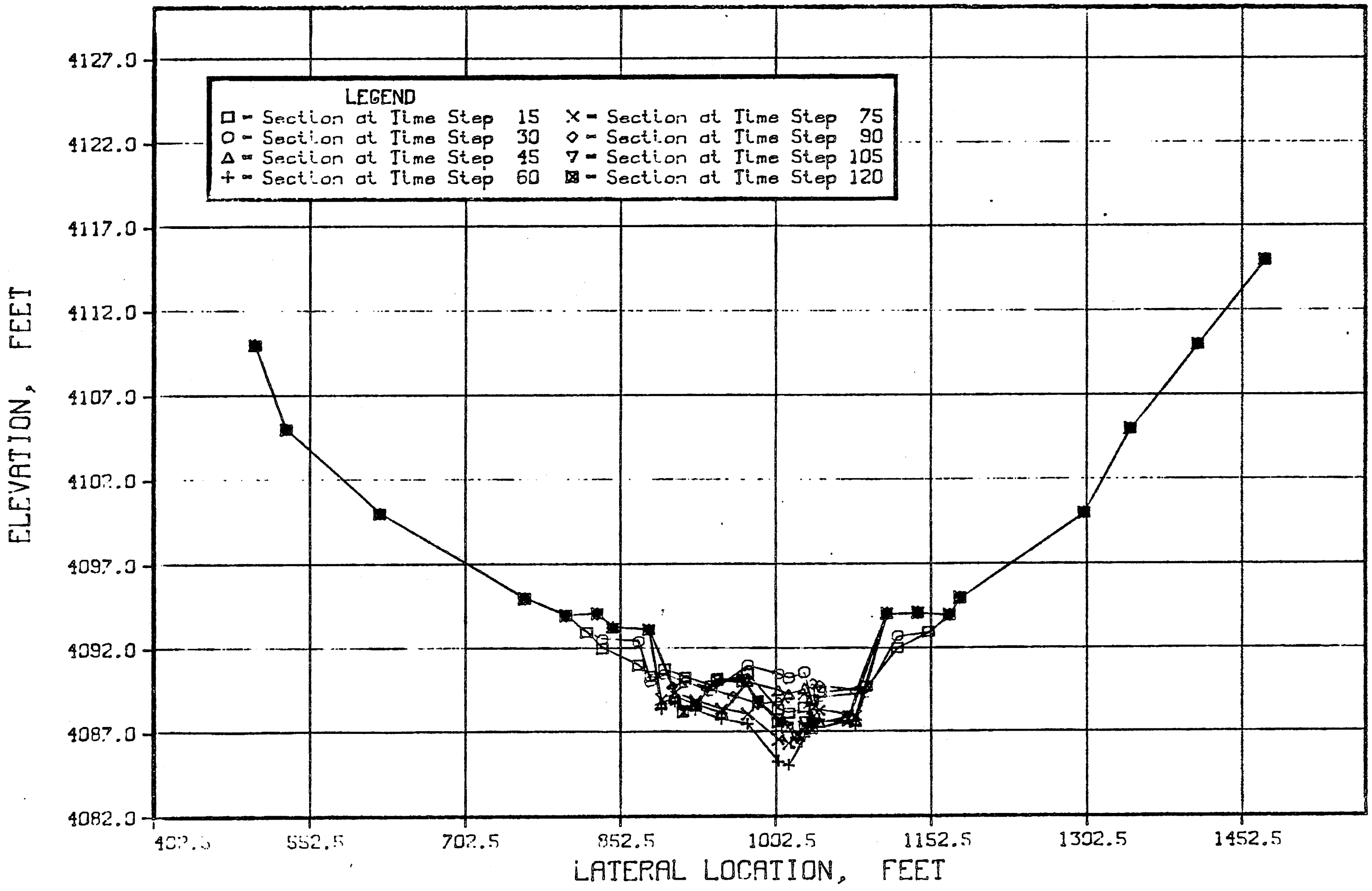
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1850. FT.



PLOT 11 21.10.18 TUES 25 NOV, 1986 JOB-7TXK6 UCC DISSPLA 9.0

**Figure 10k**

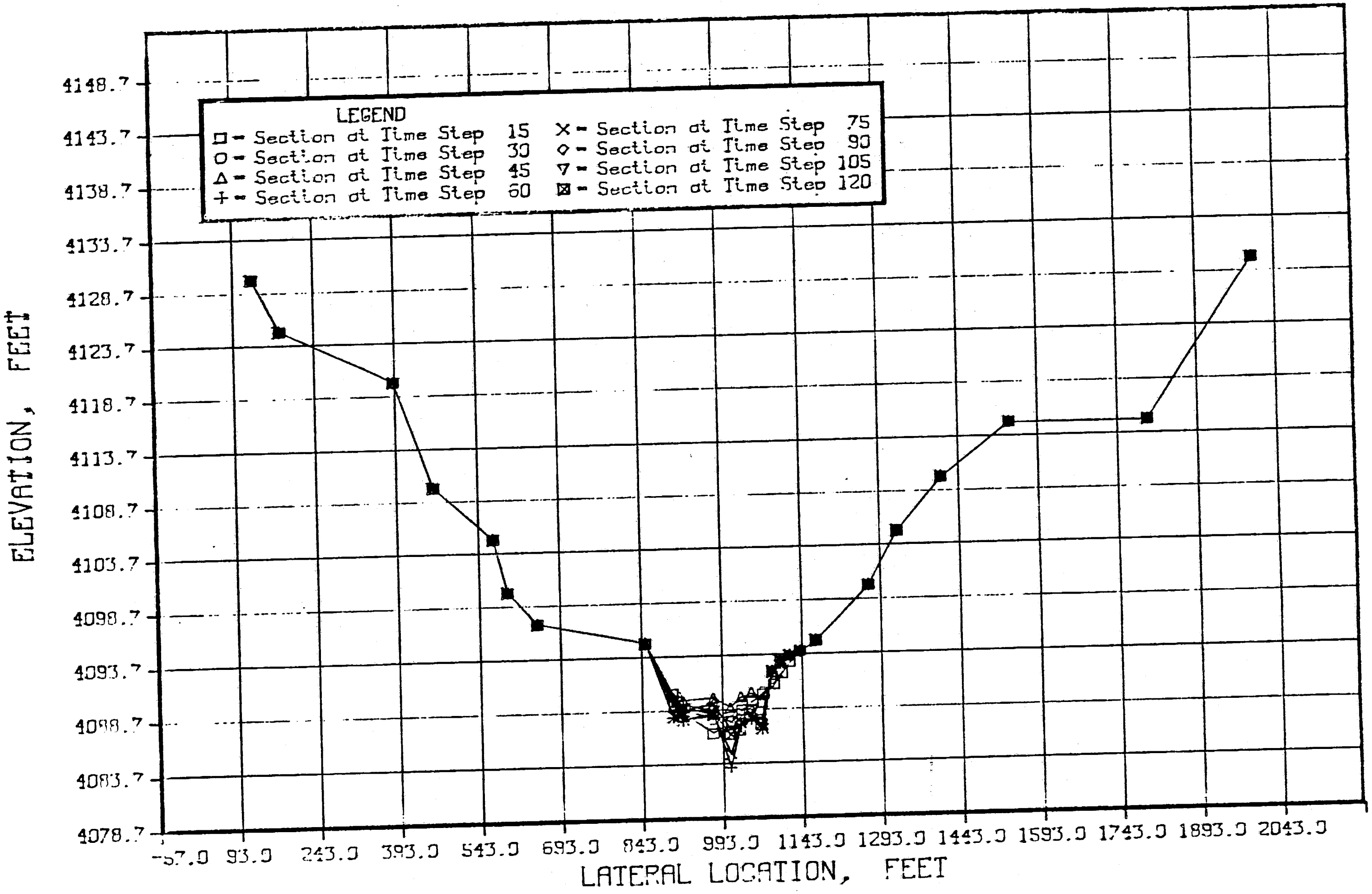
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1580. FT.



FLOW J2 21.10.24 TUES 25 NOV, 1986 JOB-7TXK6: UCC DISSPLA 9.0

**Figure 101**

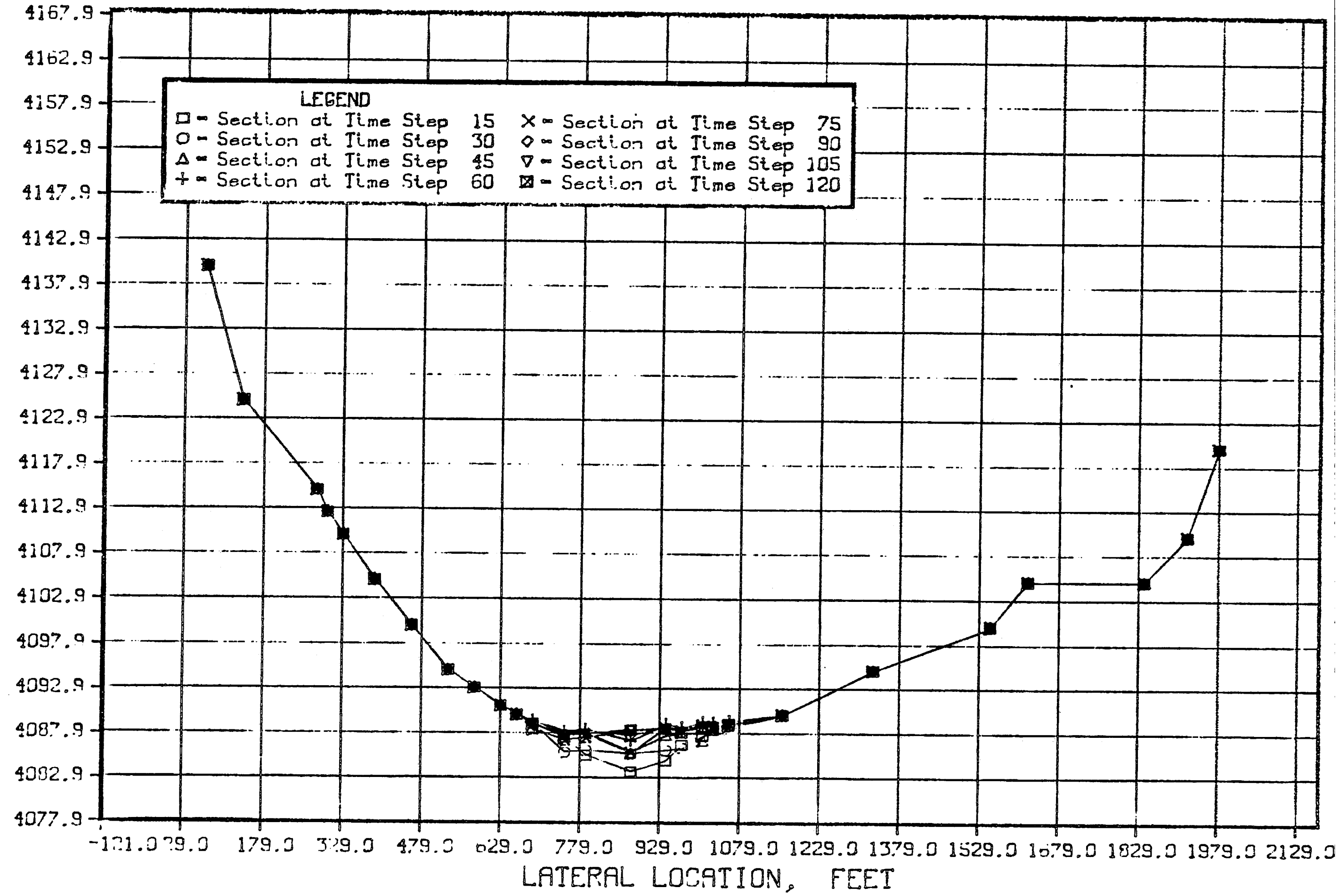
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1380. FT.



PLOT 13 21.10.30 TUES 25 NOV, 1986 JOB=7TXK6: . UCC DISSPLA 9.0

Figure 10m

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1110. FT.

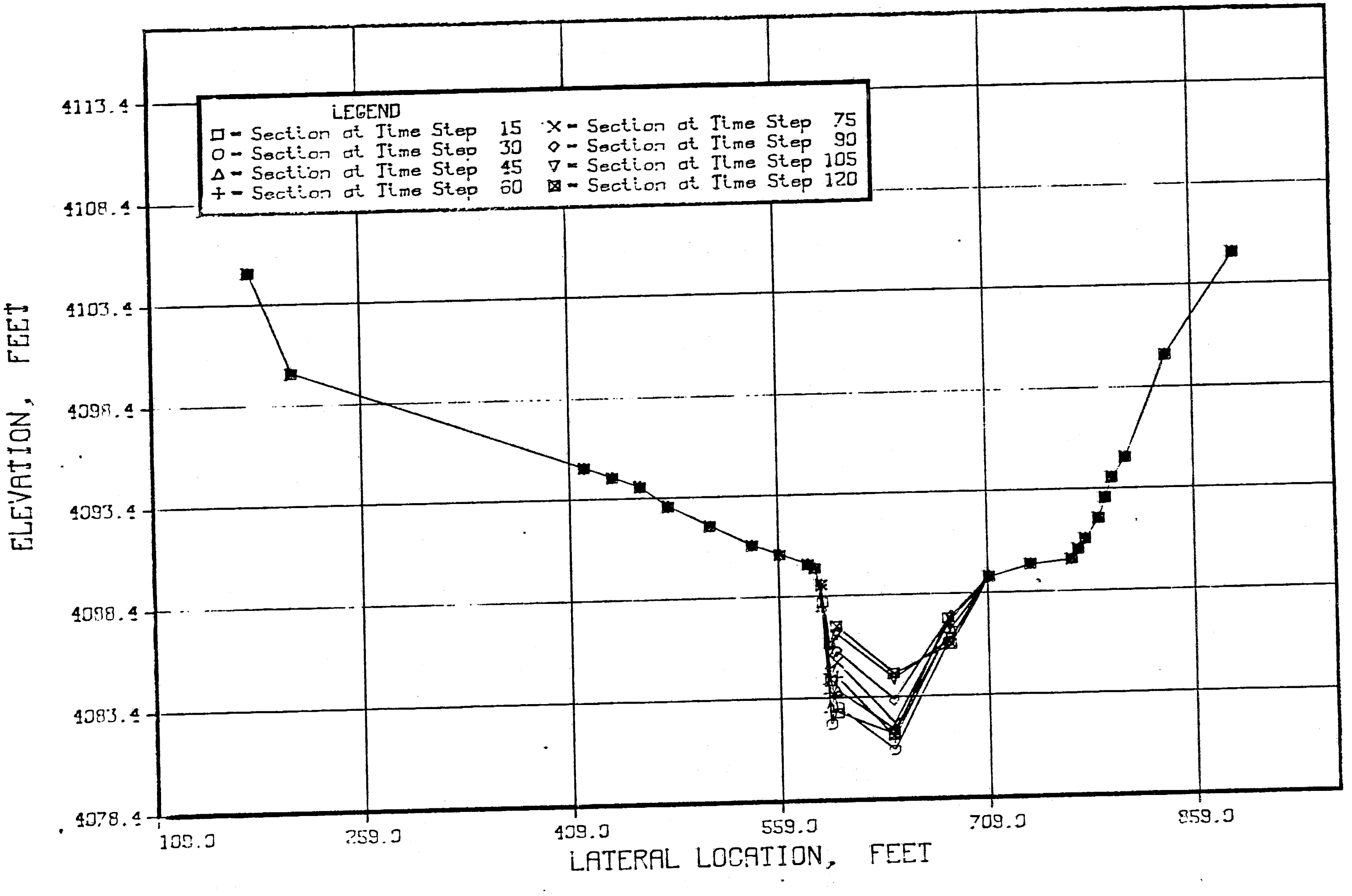


No. 200

PLOT 14 21.10.36 TUES 25 NOV, 1986 JOB-7IXK6: UCC DISSPLA 9.0

**Figure 10n**

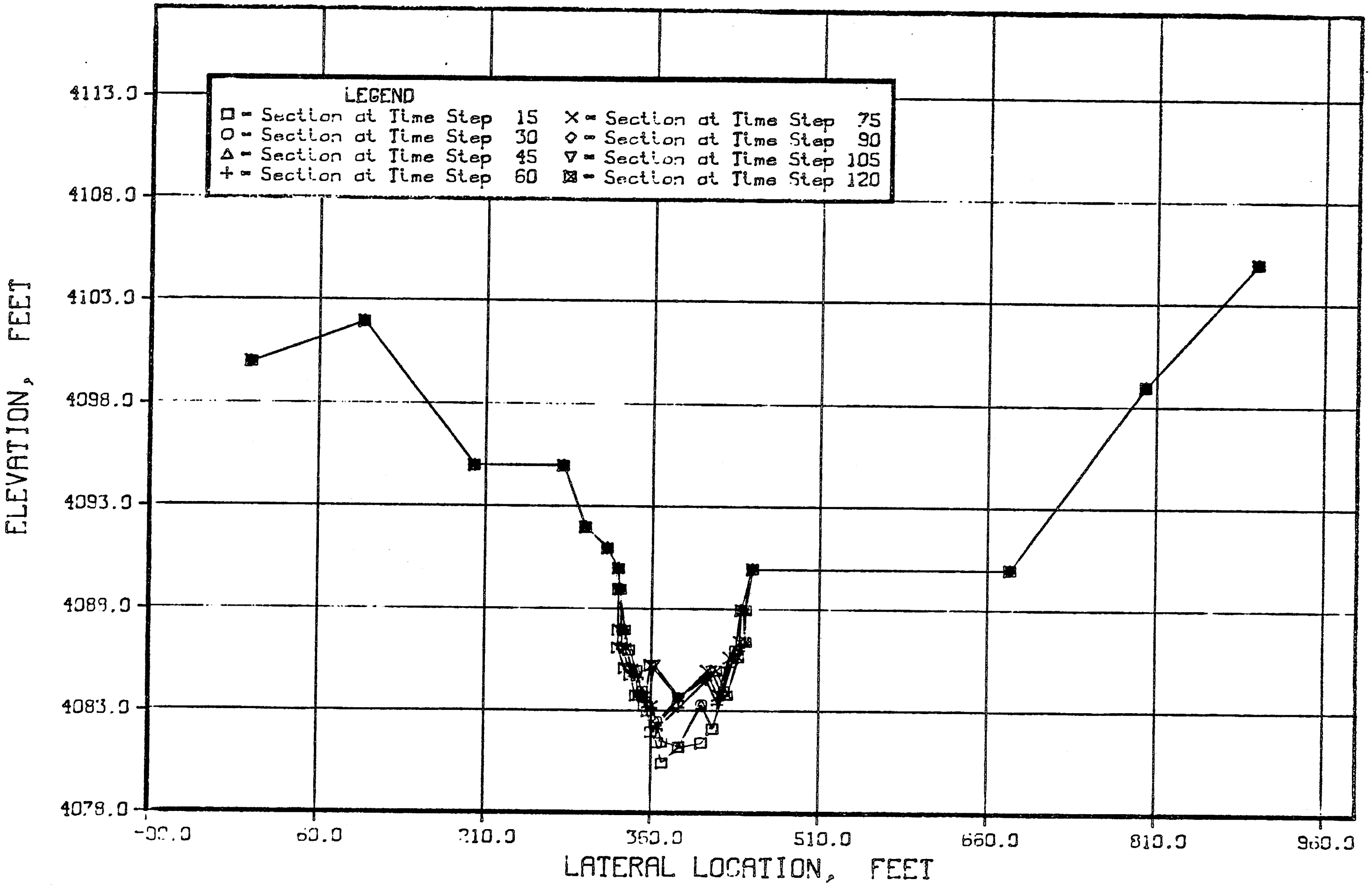
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 885. FT.



PLOT 15 21.10.45 TUES 25 NOV, 1986 JOB=?IXK6: . UCC DISSPLA 9.0

**Figure 10o**

WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 655. FT.

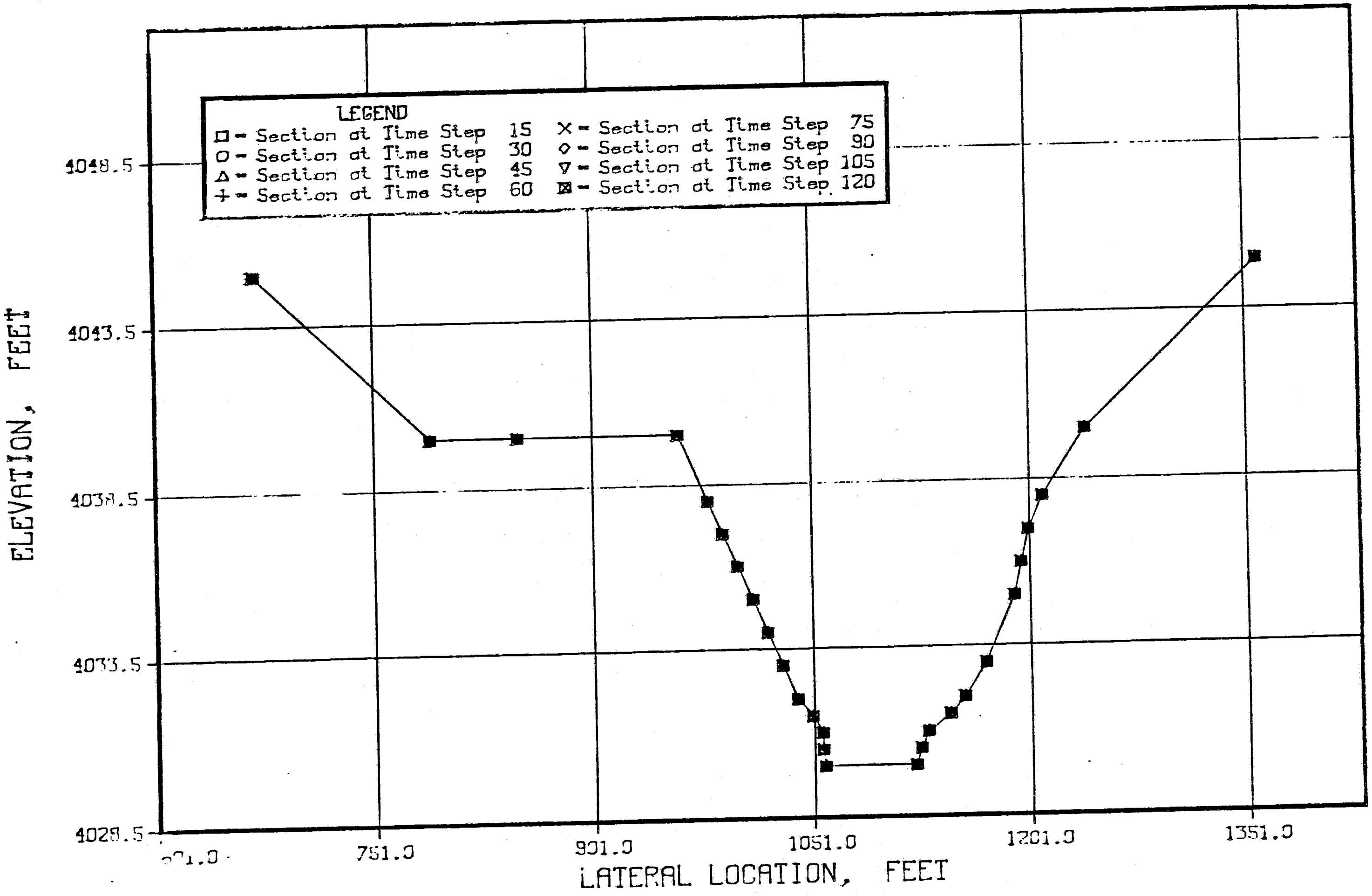


No. 200

PLOT 16 21.10.59 TUES 25 NOV, 1986 JOB-7IXK6: JCC DISSPLA 9.0

**Figure 10p**

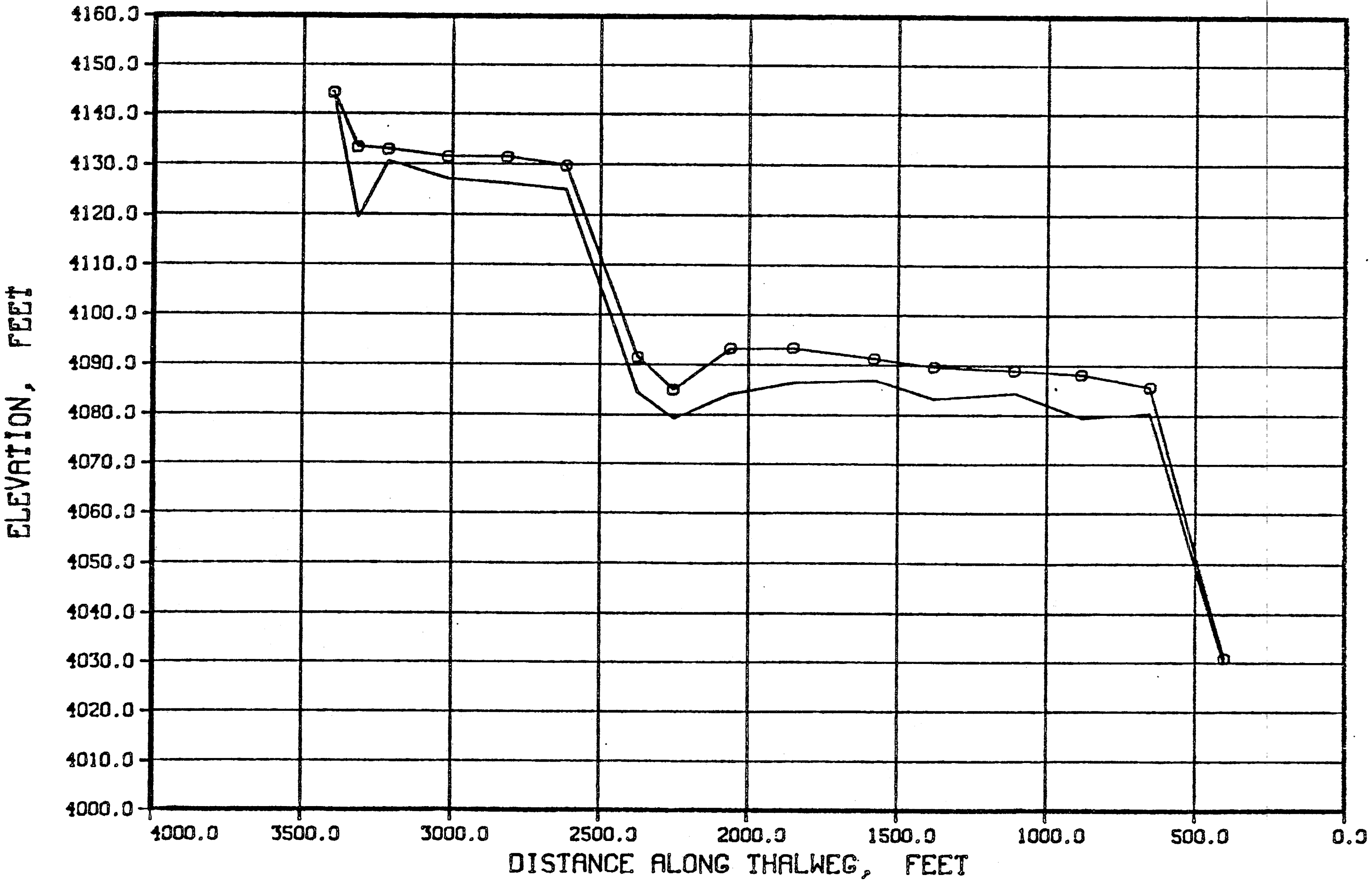
WILLOW CREEK SPILLWAY-- 100-YEAR FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 405. FT.



PLOT 3 23.46.54 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11a

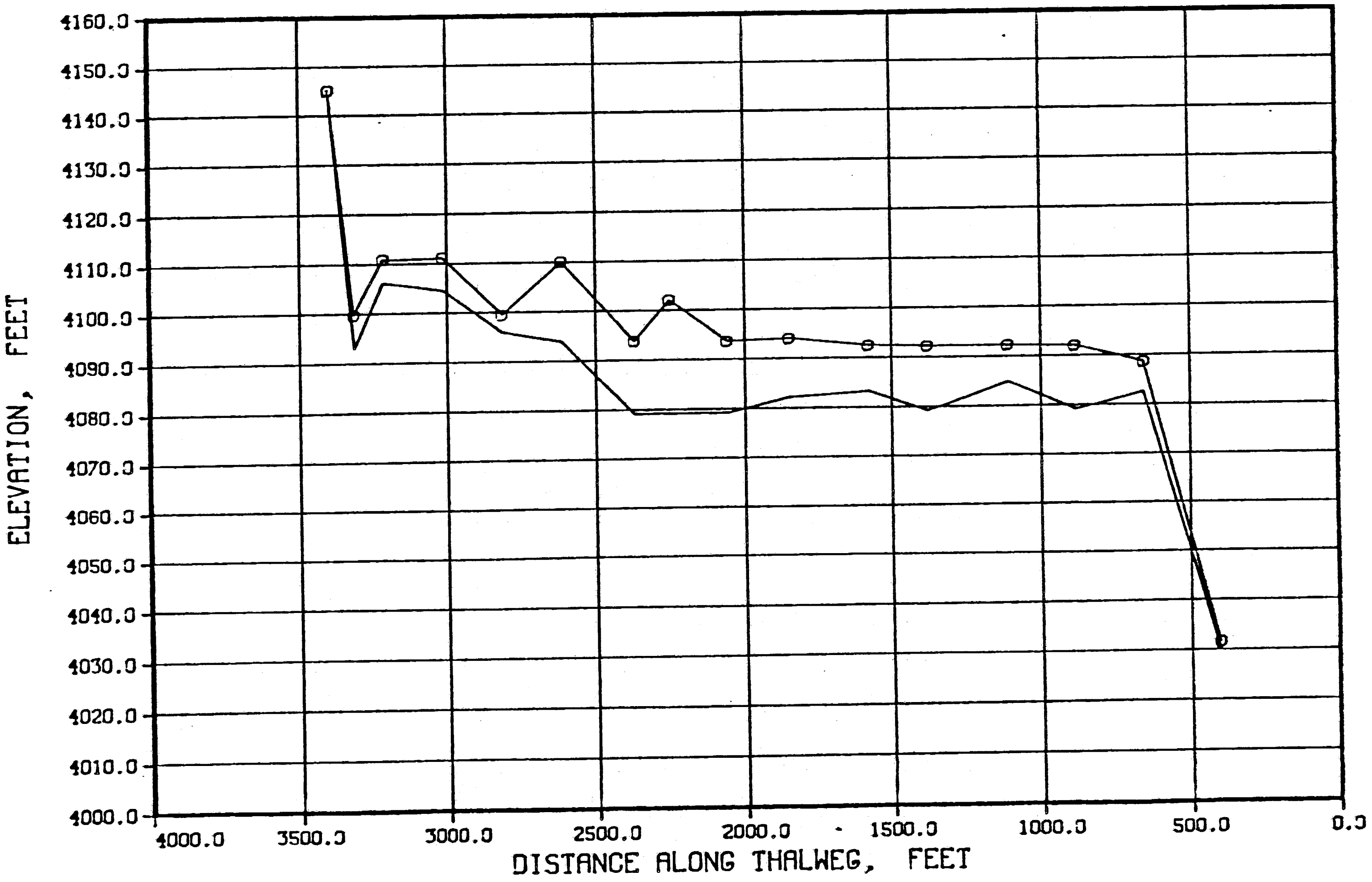
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 15. DISCH- 2991 CFS



PLOT 2 23.46.56 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11b

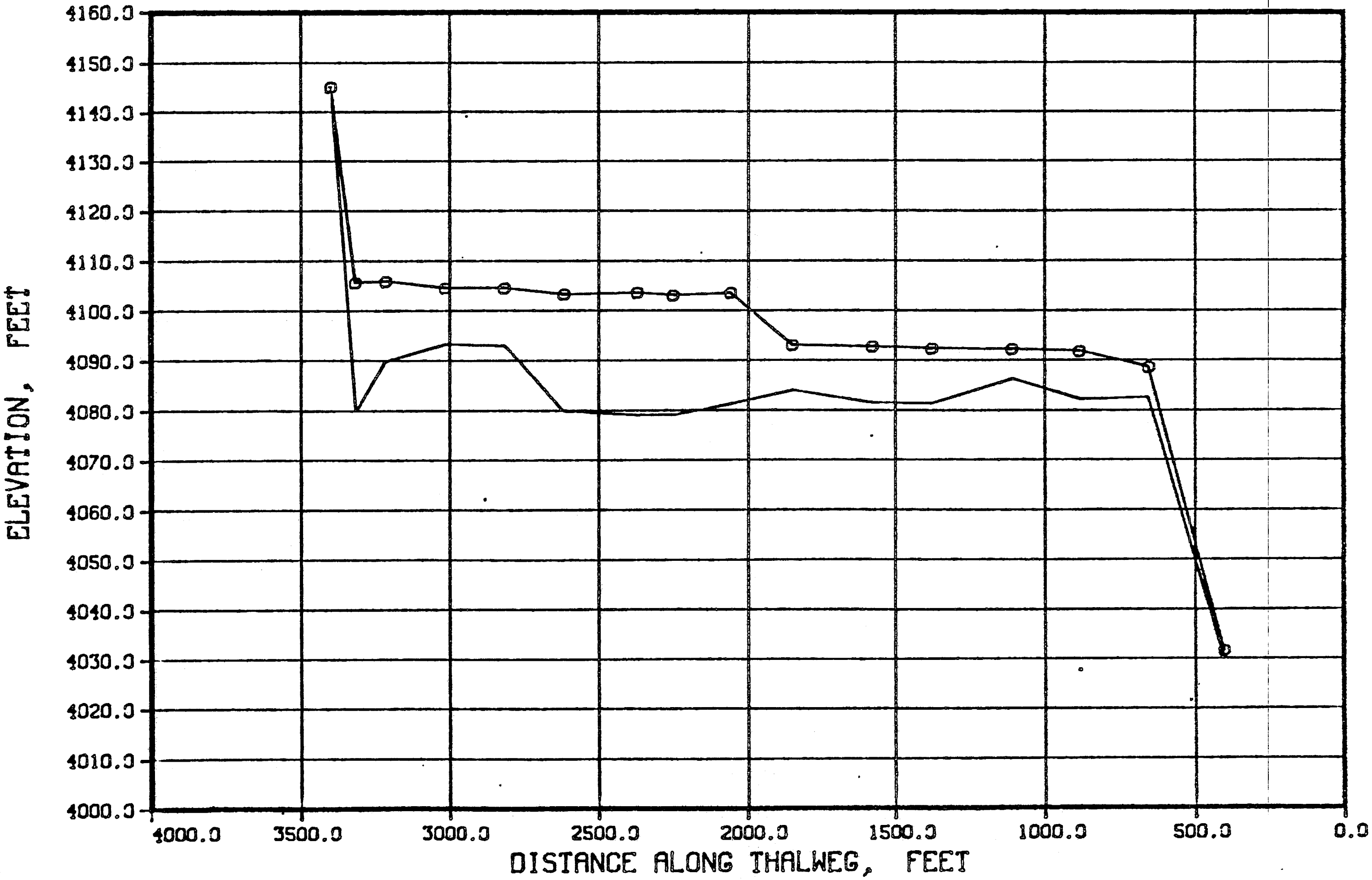
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 30. DISCH- 7865 CFS



PLOT 3 23.46.59 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11c

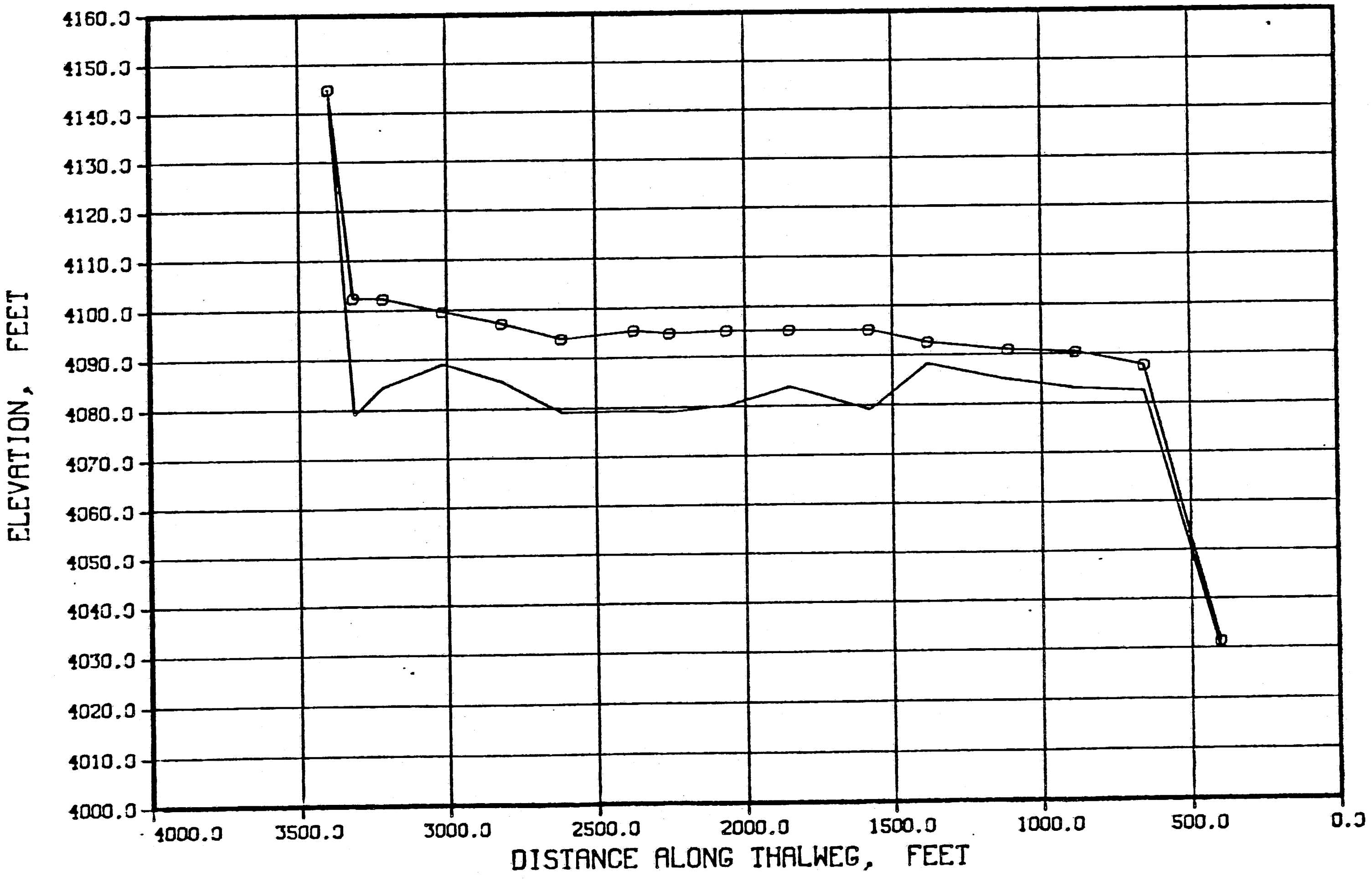
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 45. DISCH- 7630 CFS



PLOT 1 23.47.32 MON 24 NOV, 1986 JOB-F006539 , UCC DISSPLA 9.0

Figure 11d

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 60. DISCH= 6070 CFS

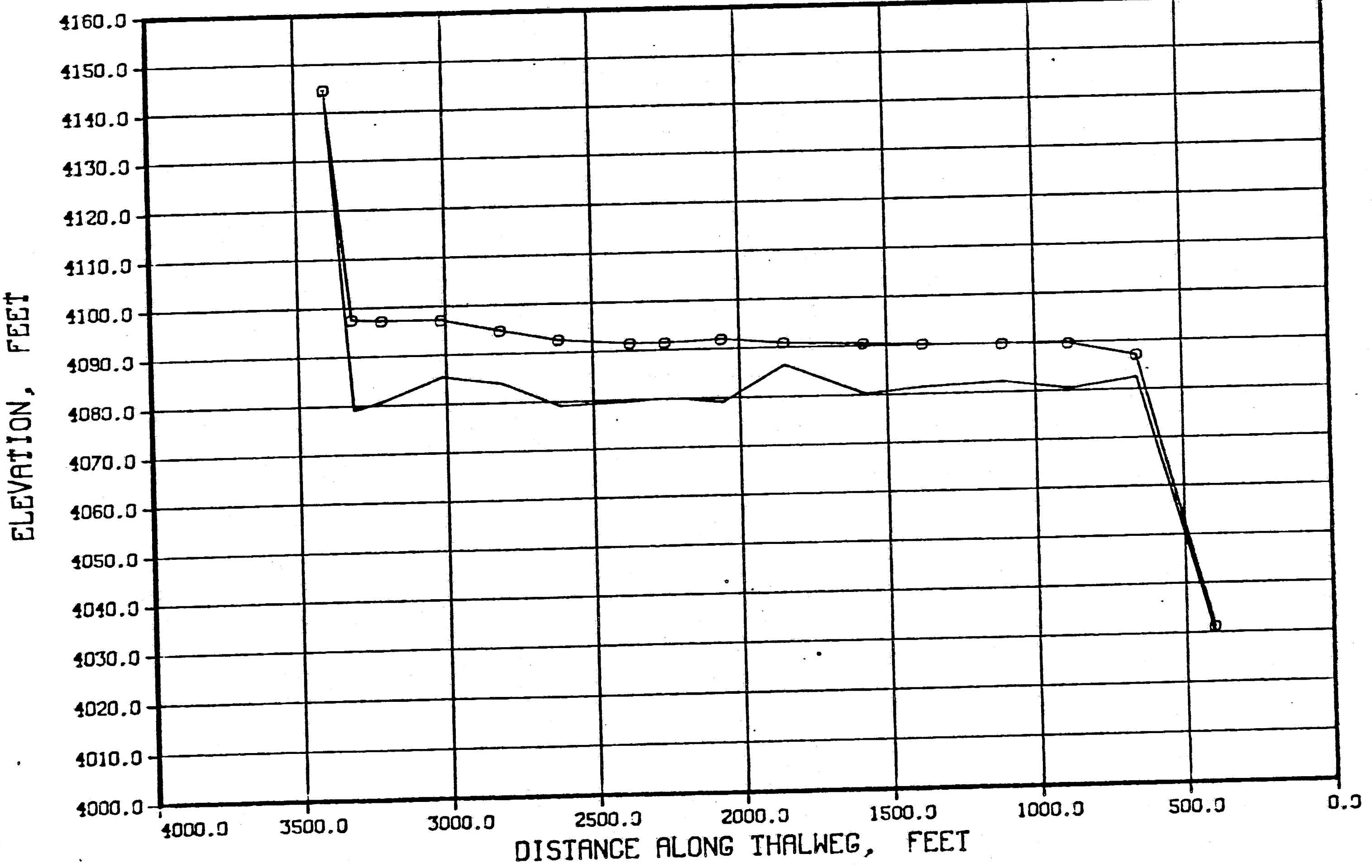


```
    4      317.7       -.3     DEPTH     623.     749.     653.    1271:     546.
    5      369.7       -.1     DEPTH     767.     544.     255.    2512.     391.
    6      351.1        .0     DEPTH    1067.     233.     885.    1918.     142.
    7      505.3       -.3     DEPTH    1315.     539.    1306.    2516.     433.
    8      338.3        .2     DEPTH     215.    1233.    1100.    1434.     108.
    9      532.9       -.2     DEPTH     475.    2136.    1524.    2071.     236.
   10      539.9       -.0     DEPTH     799.    1731.     846.    2557.     594.
           ************************************************
           *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
           ************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN  SEDIMENT LOAD FOR    DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE        1        2        3        4        5     .
*******************************************************    *******************************.


    1          0         0     DEPTH       0        0        0        0        0
    2      227.9       -.4     DEPTH     389.     386.     383.     755.     841.
    3      243.7       -.0     DEPTH     450.     578.     737.     667.     516.
    4      375.1       -.2     DEPTH     691.     848.     708.    1725.     564.
    5      474.7       -.1     DEPTH     981.     594.     517.    3234.     412.
    6      885.7       -.3     DEPTH    1934.    2103.    2328.    3827.     516.
    7      855.1        .0     DEPTH    2251.    5680.    1093.    1021.     291.
    8      349.9        .2     DEPTH     274.    1853.     737.    1167.     200.
    9      713.2       -.1     DEPTH    1131.    2336.    1797.    2540.     820.
   10      853.9       -.1     DEPTH    1491.    3445.    1854.    2722.     812.

TIME STEP NO. 5
DISCHARGE= .750000E+04



          STEP METHOD COMPUTATIONS



I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      6.6016
CONTROL ELEV.= 2306.3016

I=      2
I=      3
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      6.7449
CONTROL ELEV.= 2302.4257

I=      4
      WSE BEFORE AND AFTER ADJUSTING   .2300185E+04   .2299236E+04S2
I=      5
      WSE BEFORE AND AFTER ADJUSTING   .2299425E+04   .2298234E+04S2
I=      6
I=      7
      WSE BEFORE AND AFTER ADJUSTING   .2296770E+04   .2295585E+04S2
I=      8
I=      9
I=     10


                ******************************************
                *     RESULTS OF BACKWATER COMPUTATIONS     *
                *       DISCHARGE =    7500.00  C.F.S.      *
                ******************************************
```

PLOT 5 23.47.04 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11e

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 75. DISCH- 4595 CFS



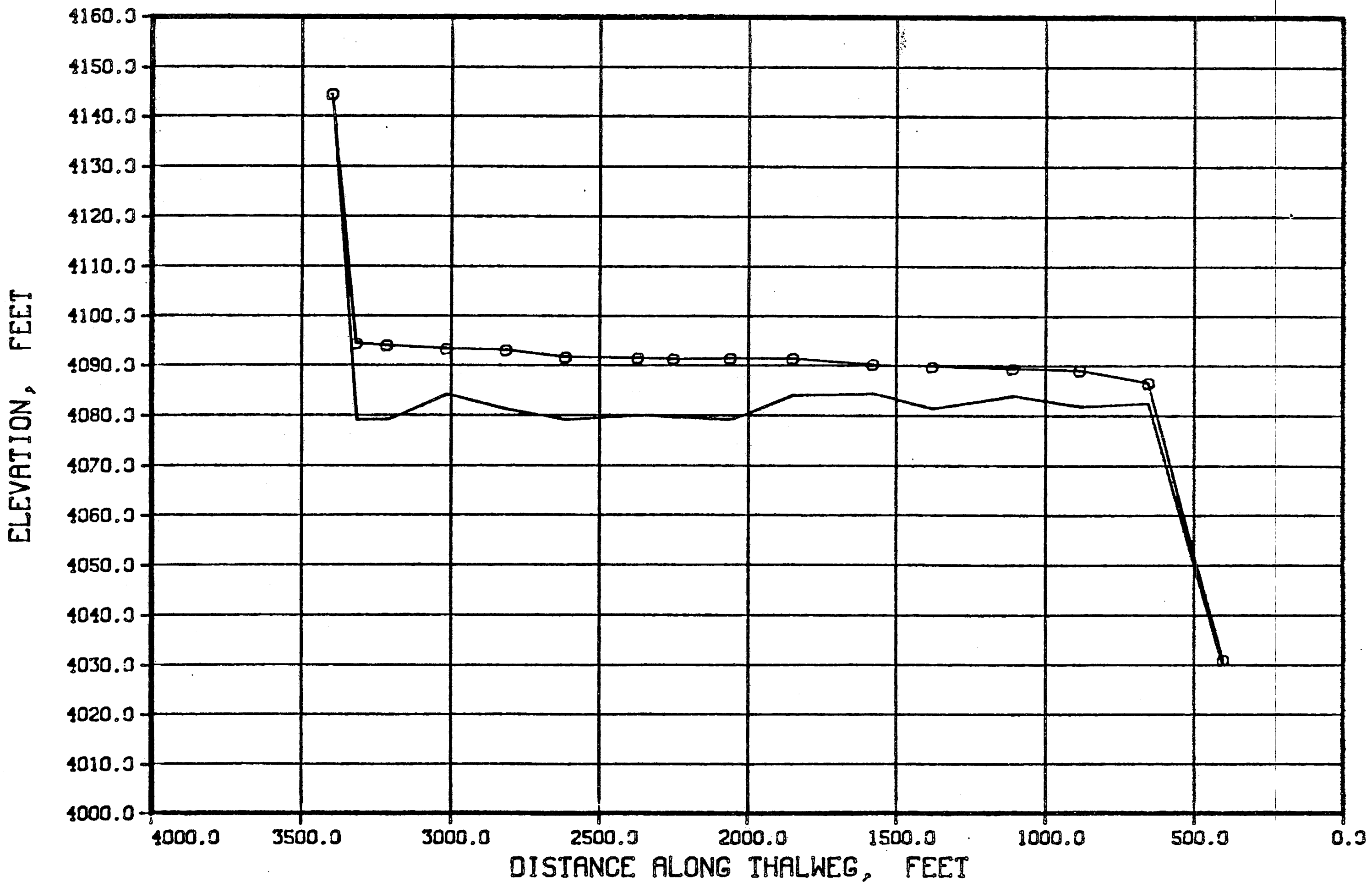
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

PRINTED IN U.S.A.

PLOT 6 23.47.07 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11f

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 90. DISCH- 3554 CFS

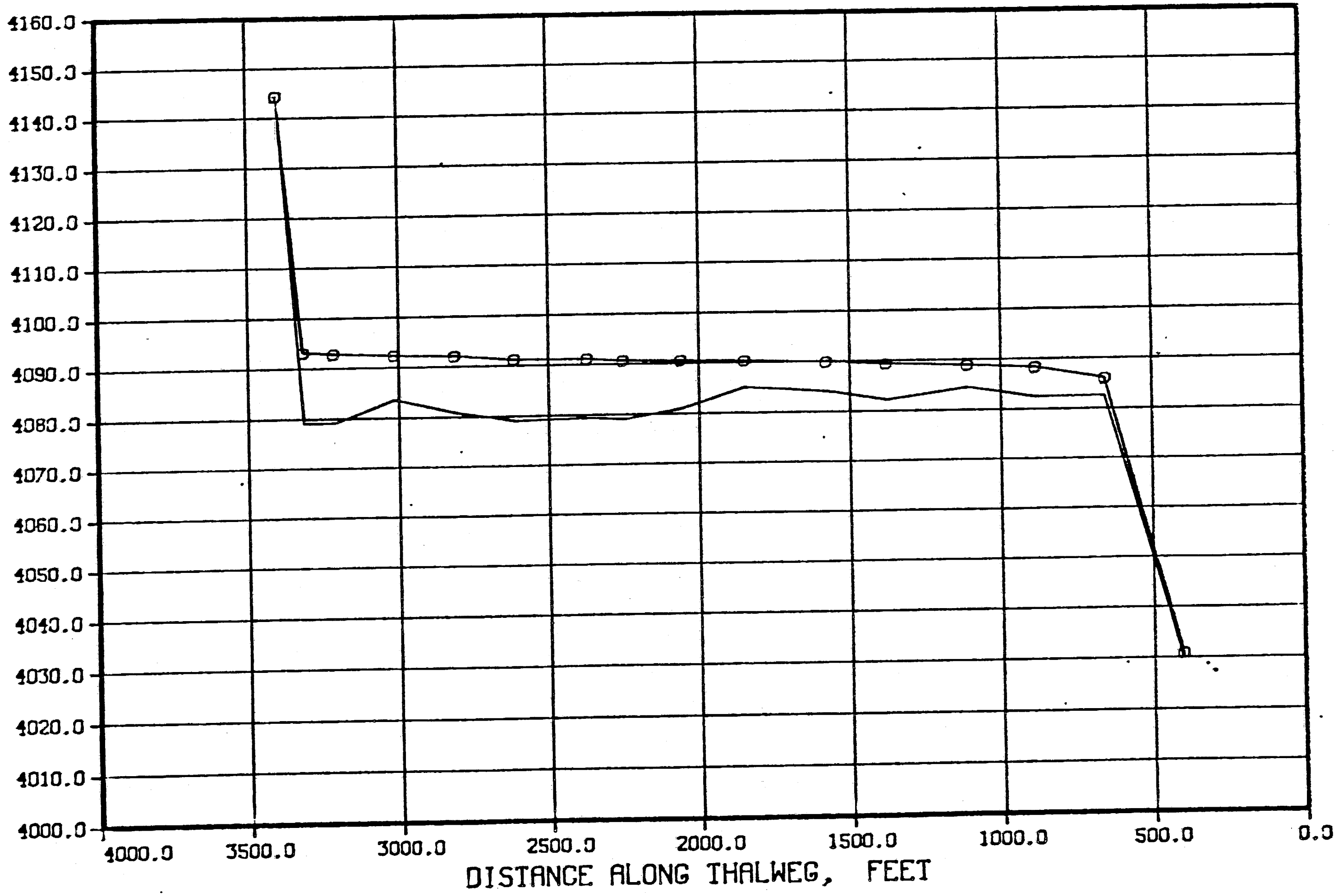


No. 200

PLOT 7 23.47.14 MON 24 NOV, 1986 JOB-F006139 , UCC DISSPLA 9.0

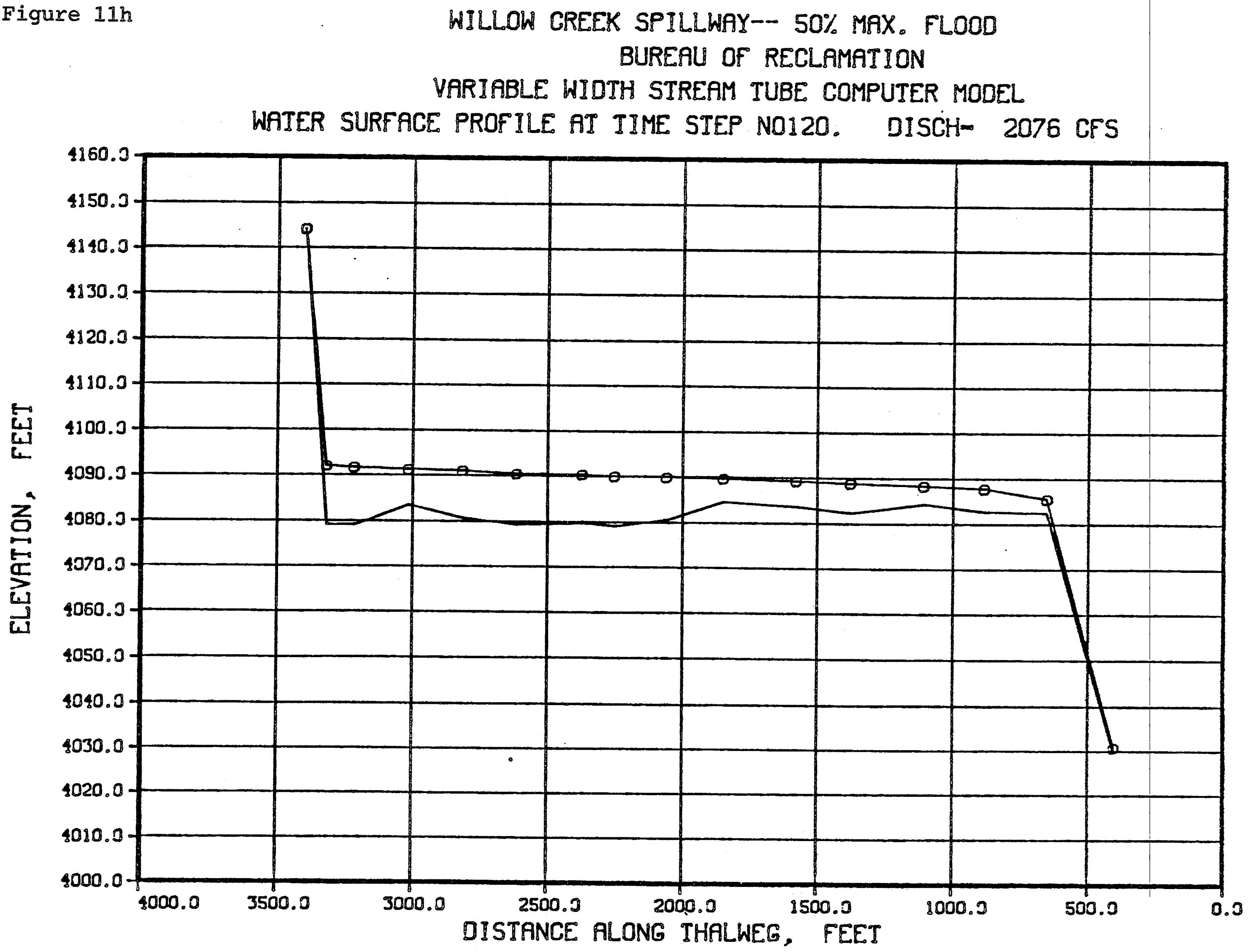
Figure 11g

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO105. DISCH= 2761 CFS



PLOT 8 23.47.21 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11h

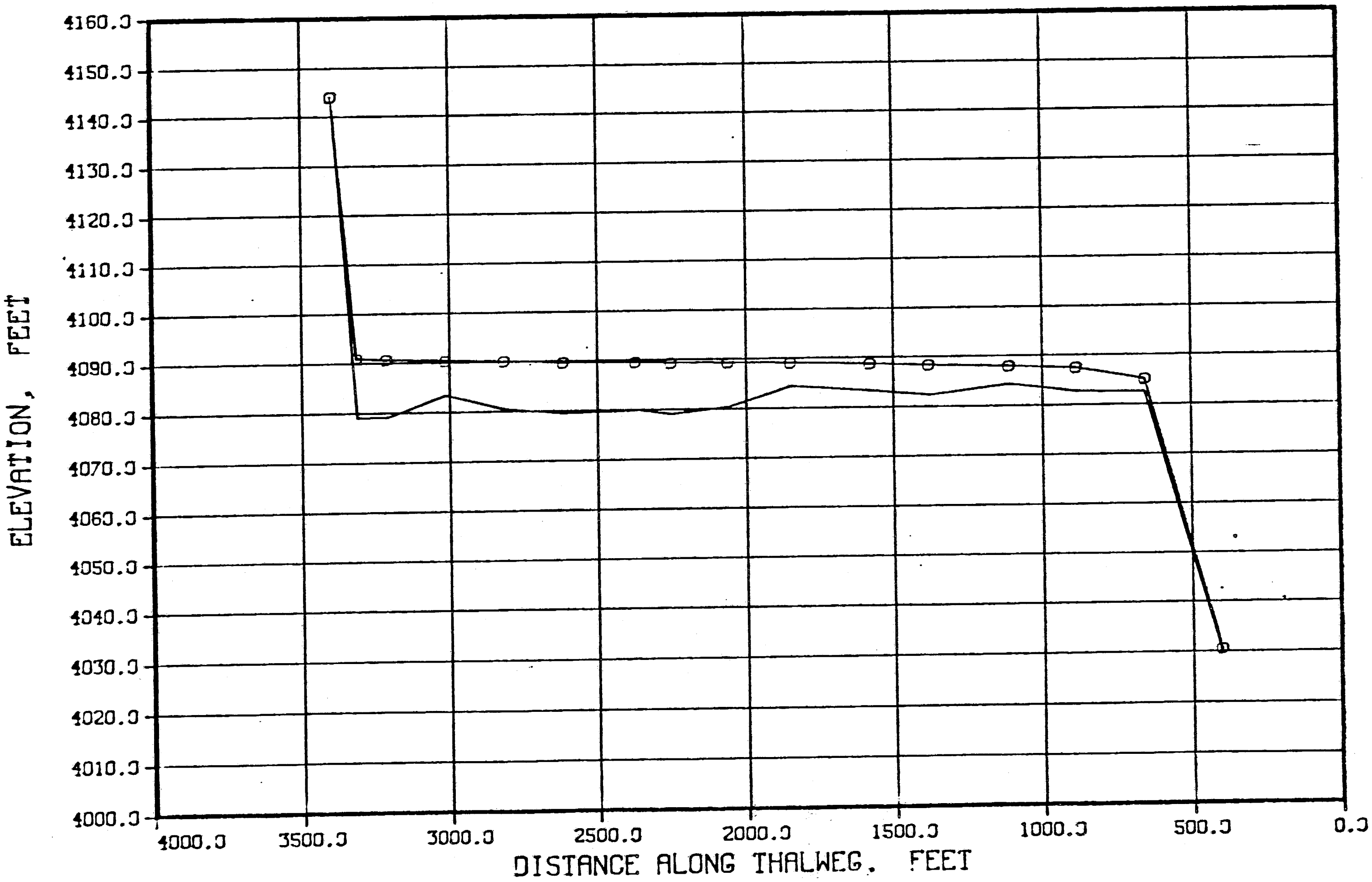

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO120. DISCH- 2076 CFS

No. 200

PLOT 9 23.47.29 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 11i

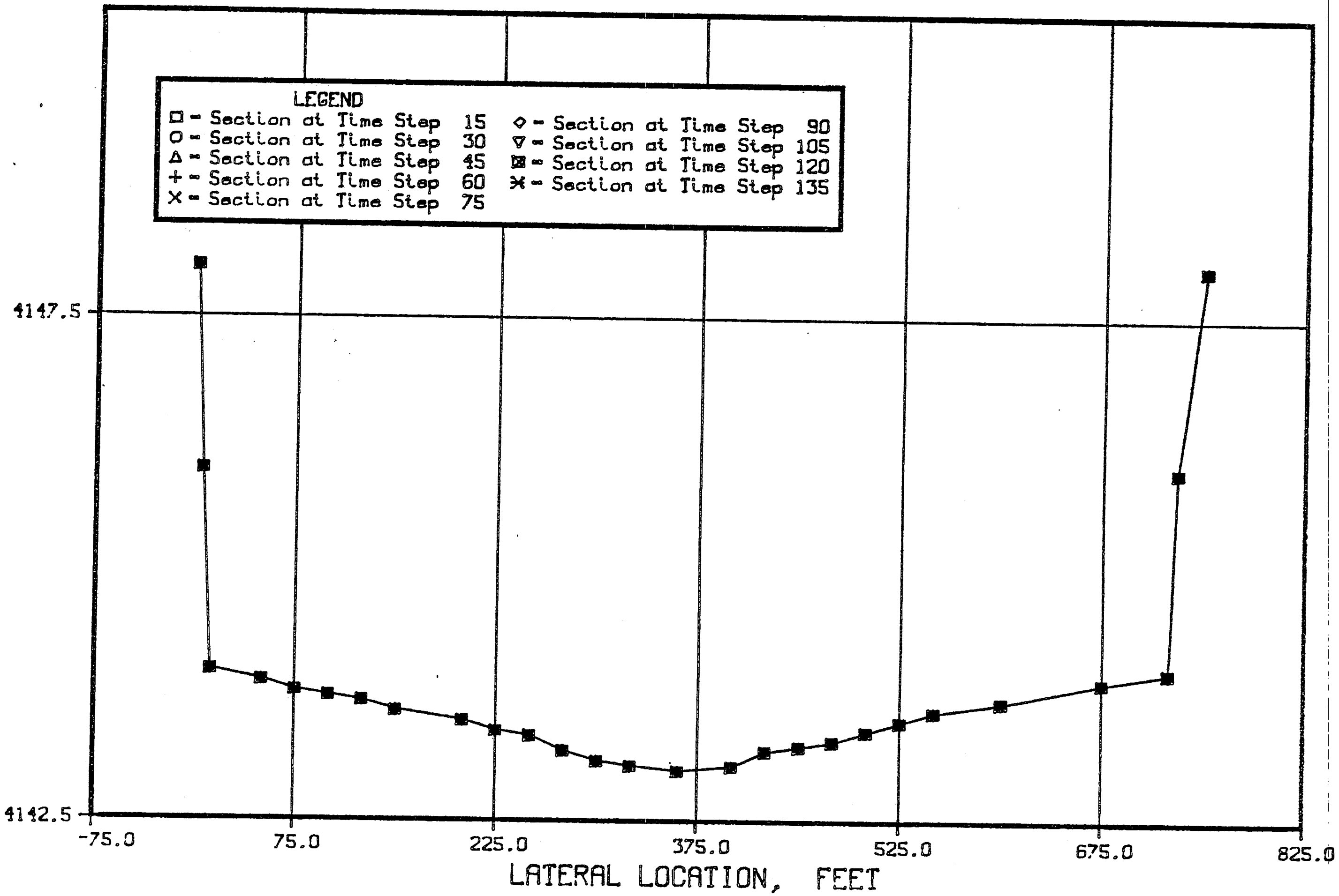
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO135. DISCH= 1517 CFS



PLOT 1 23.23.04 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 12a

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3396. FT.



No. 200

PLOT 2 23.23.14 MON 24 NOV, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

Figure 12b

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3316. FT.

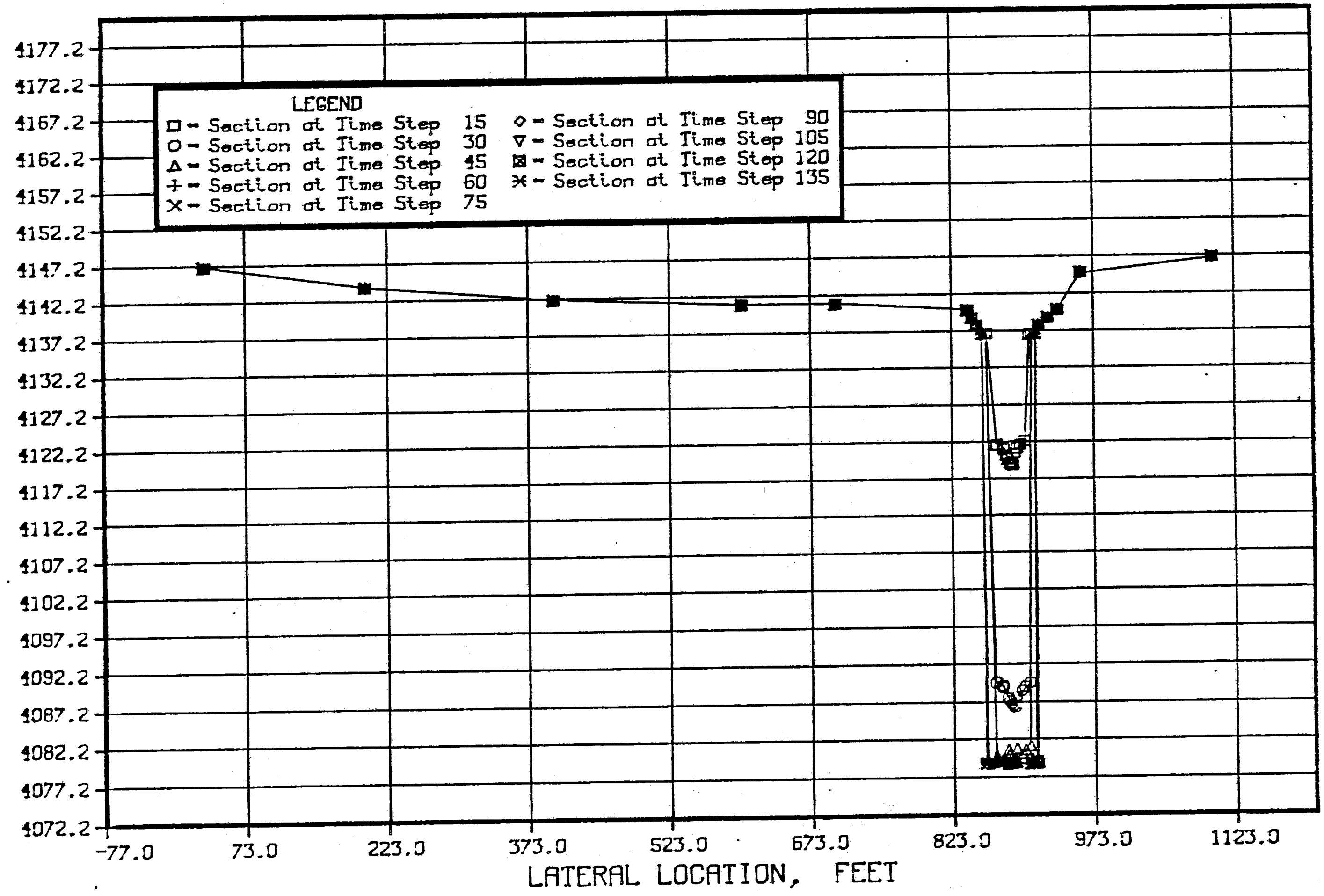
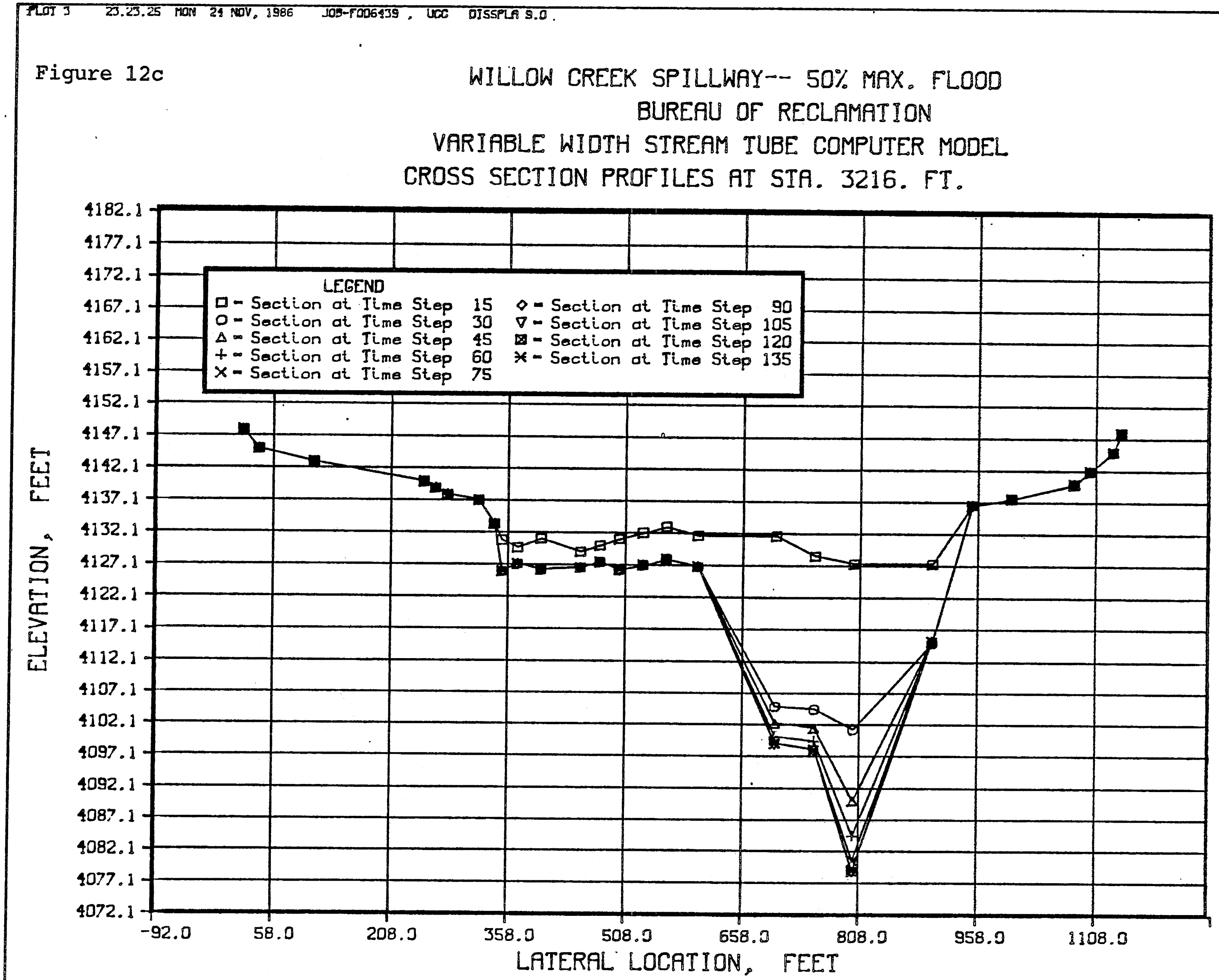


Figure 12c

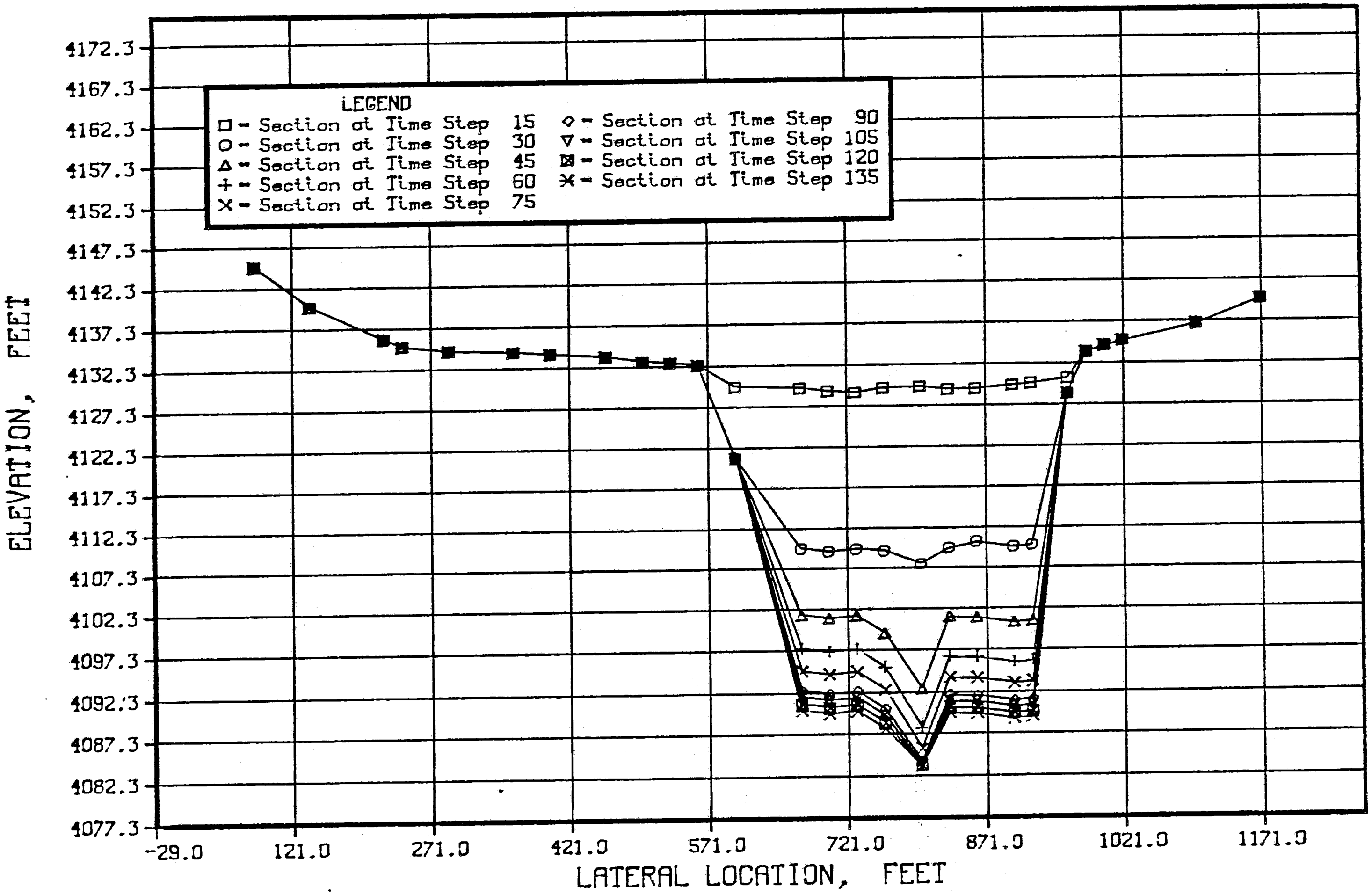


No. 200

PLOT 1 23.23.39 MON 24 NOV, 1986 JOB-FOO6439 , UCC DISSPLA 9.0

Figure 12d

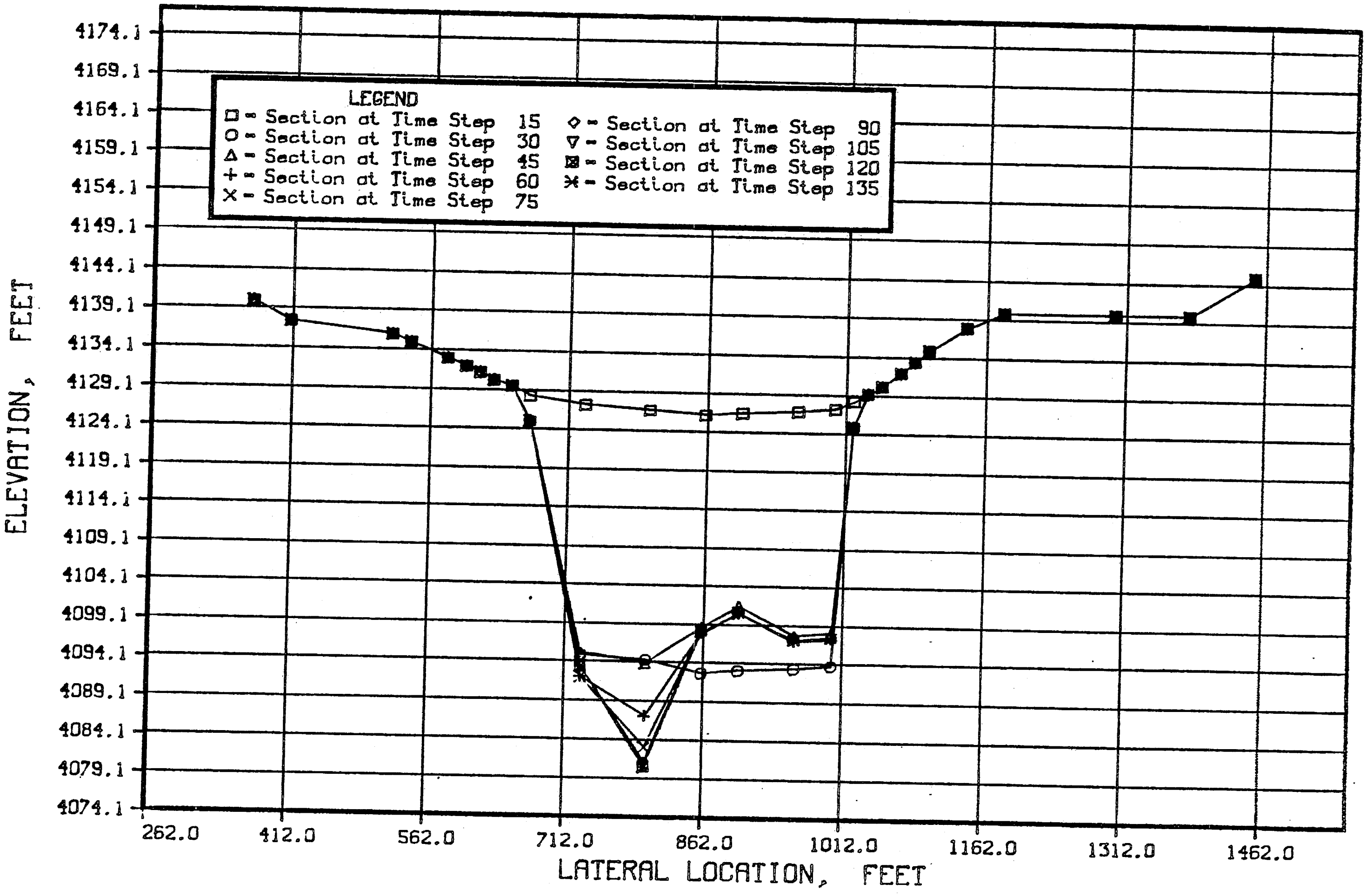
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3016. FT.



PLOT 5 23.23.54 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 12e

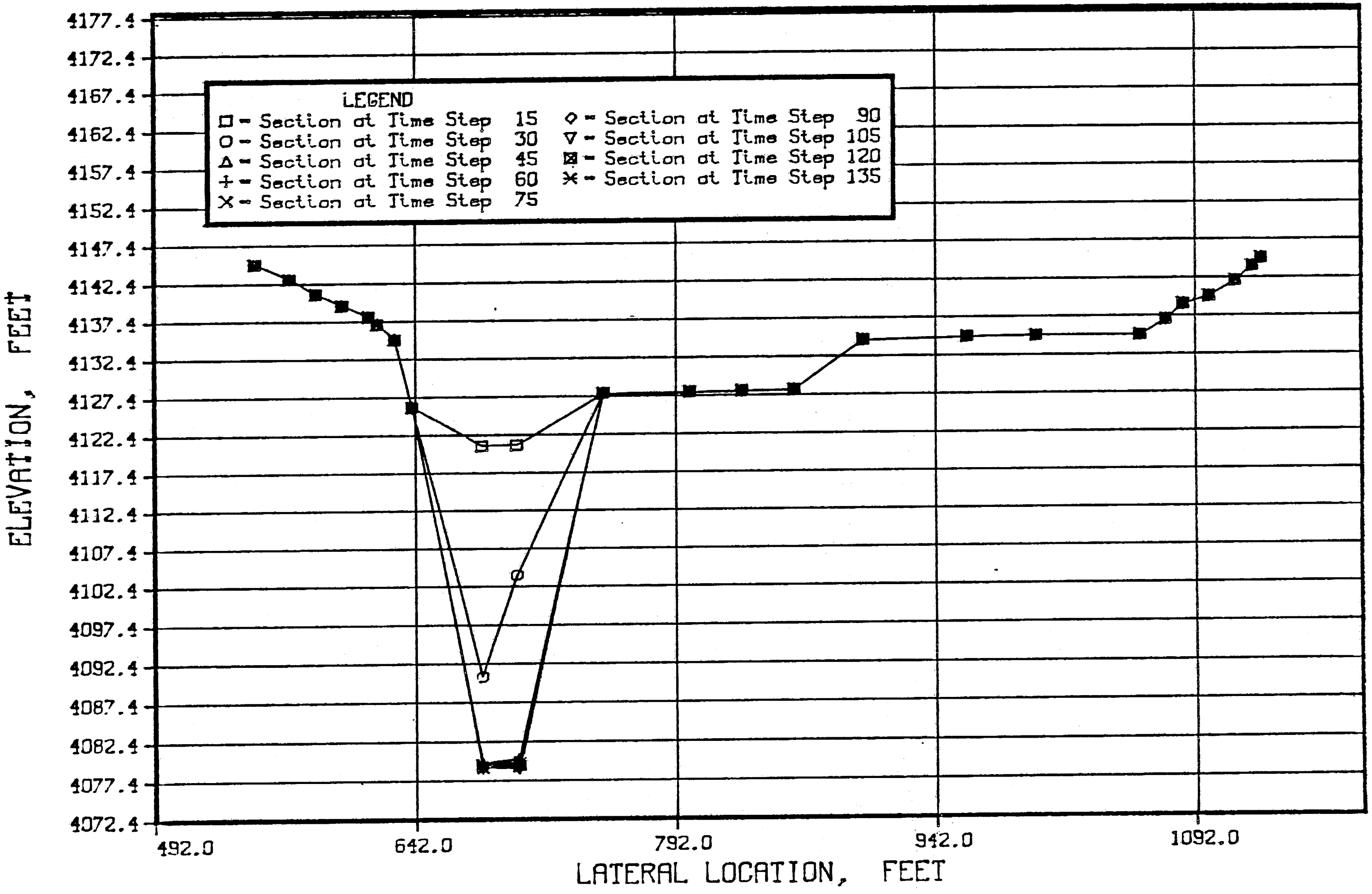
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2816. FT.



PLOT 6 23.24.33 MON 24 NOV, 1986 JOB-FQ06439 , UCC DISSPLA 9.0

Figure 12f

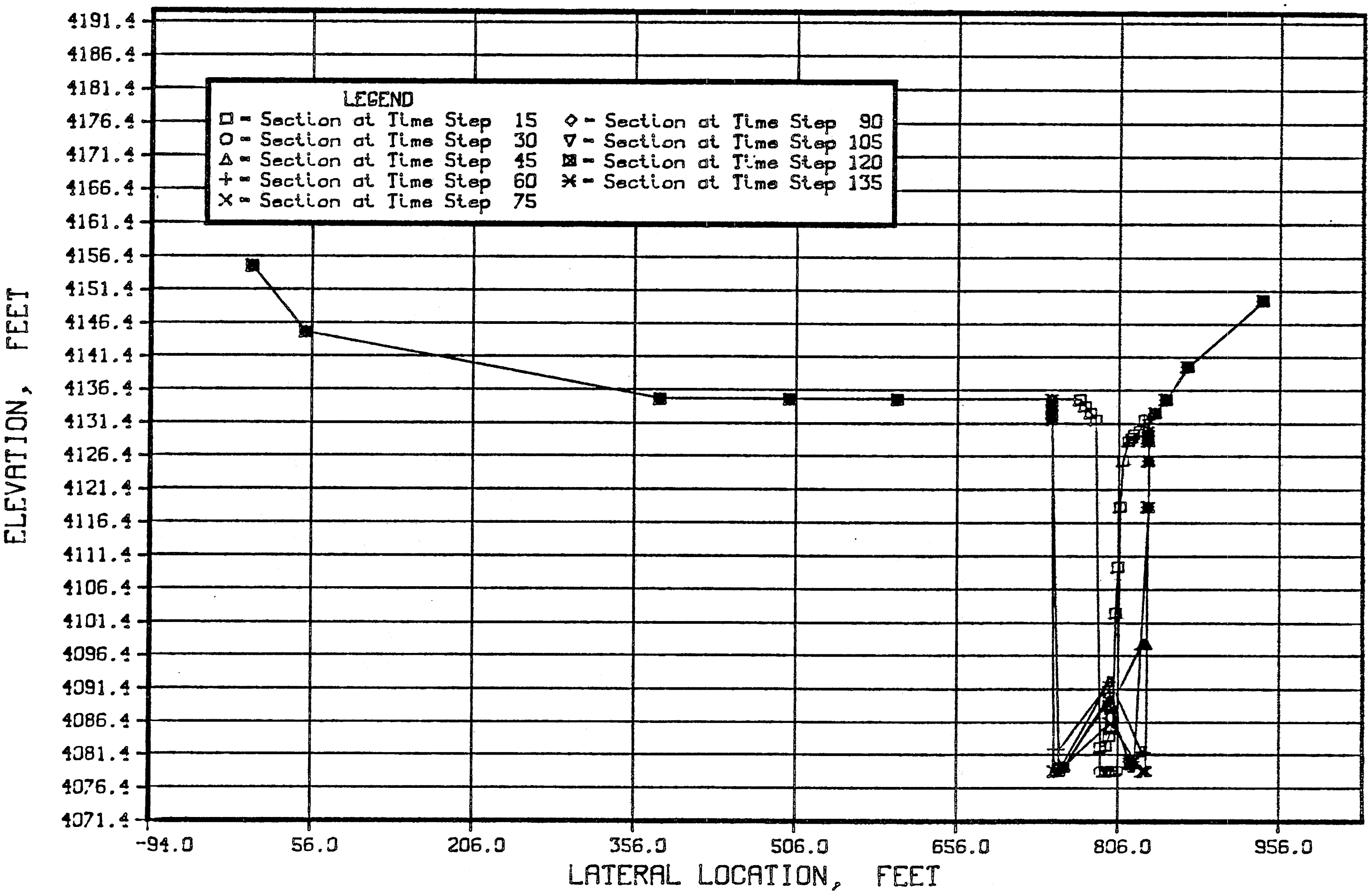
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2616. FT.



PLOT 7 23.24.14 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 12g

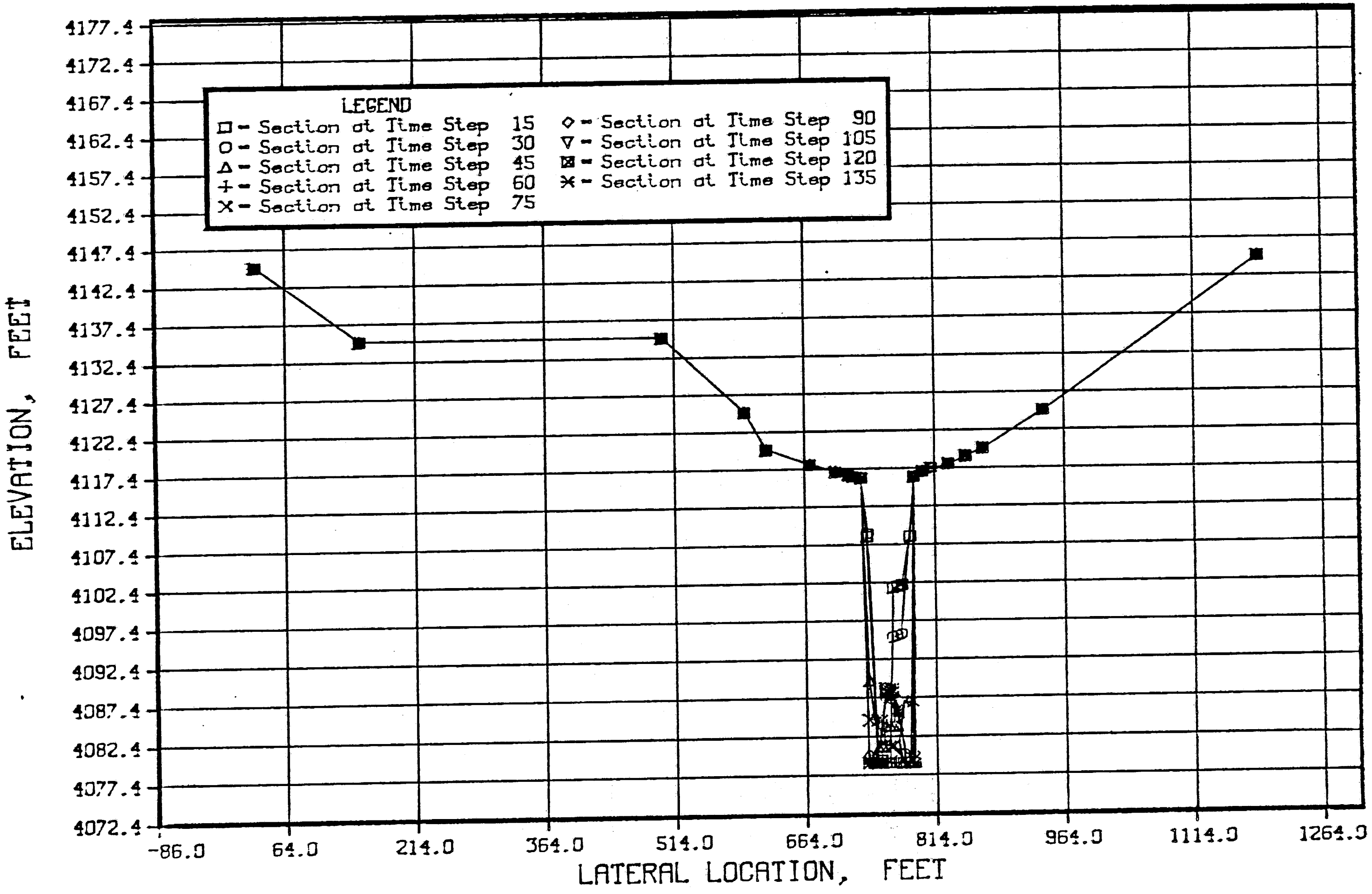
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2372. FT.



PLOT 8    23.24.24  MON  24 NOV, 1986    JOB=F006439 ,  UCC    DISSPLA 9.0

Figure 12h

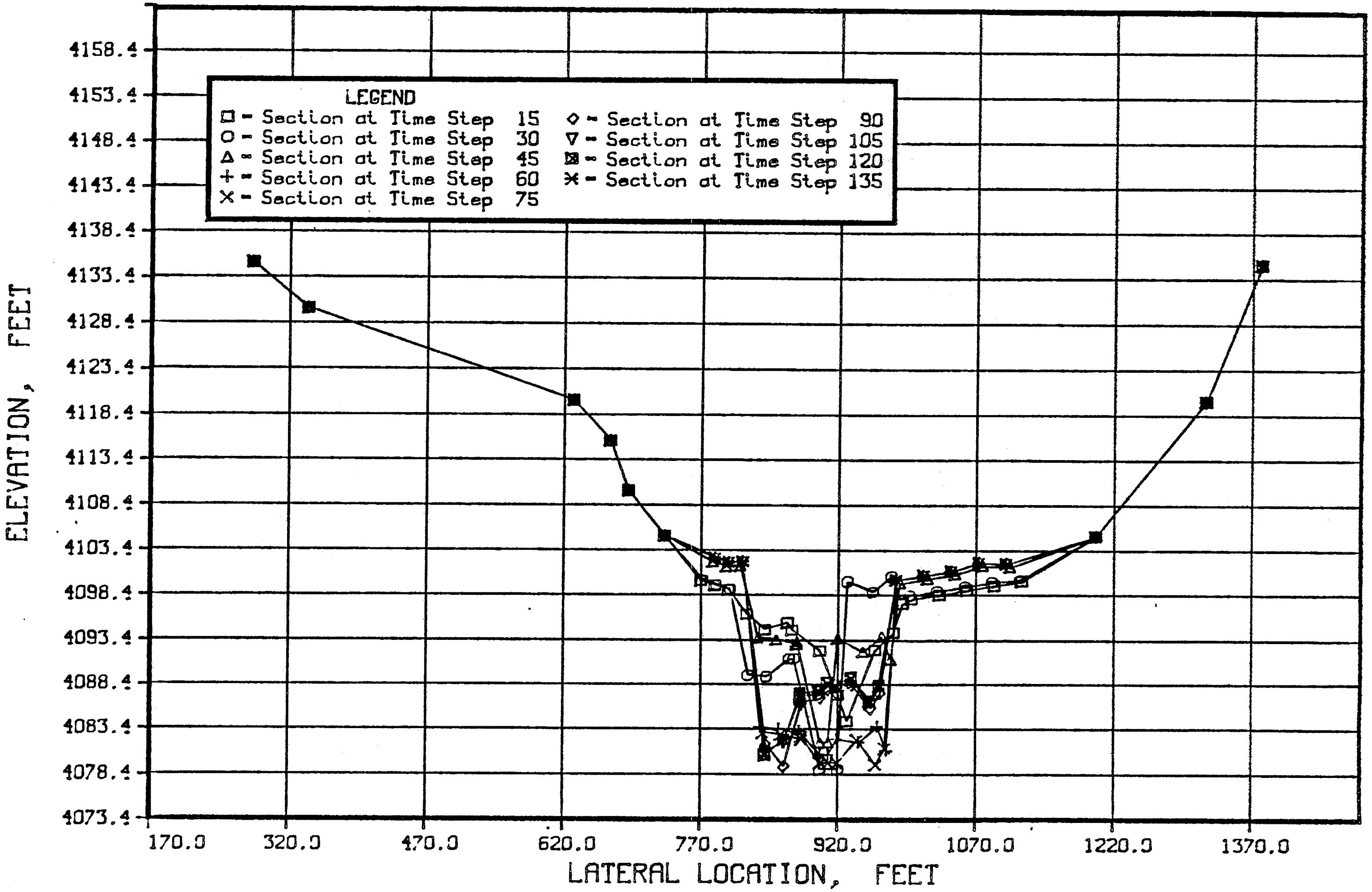
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2252. FT.



PLOT 9 23.24.35 MON 24 NOV, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

Figure 12i

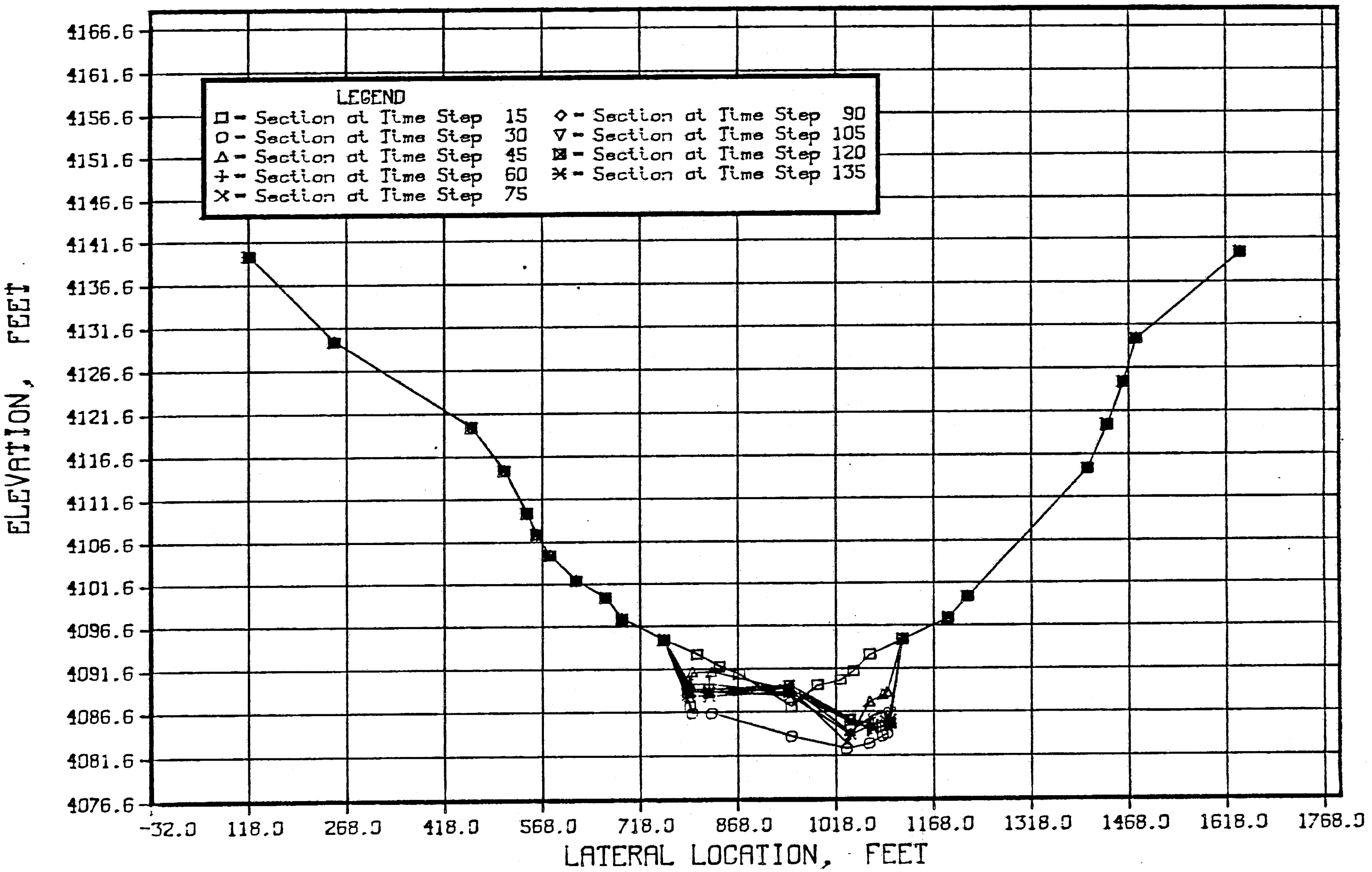
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2060. FT.



PLOT 10 23.24.44 MON 24 NOV, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

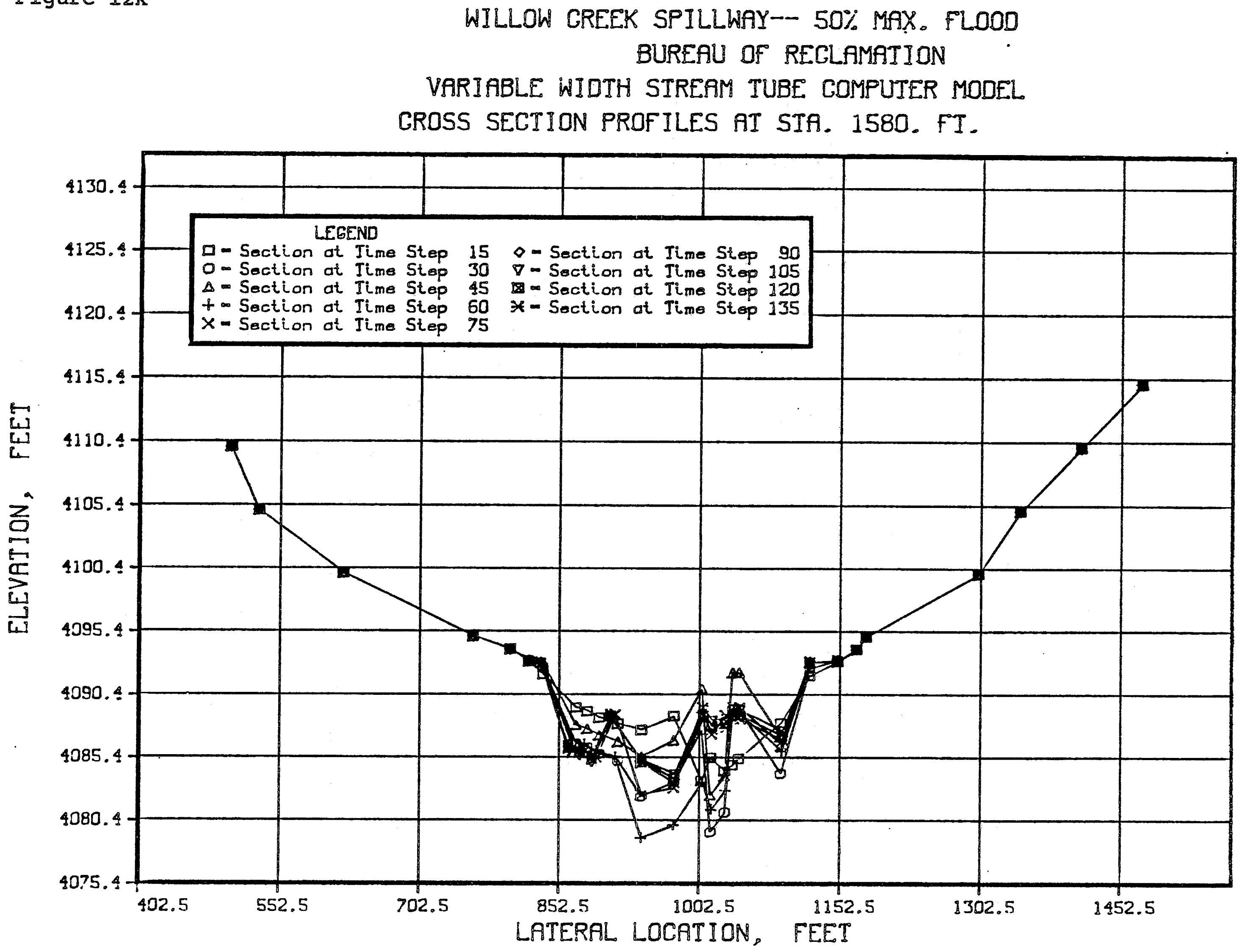
Figure 12j

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1850. FT.



PLOT 11 23.24.54 MON 24 NOV, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

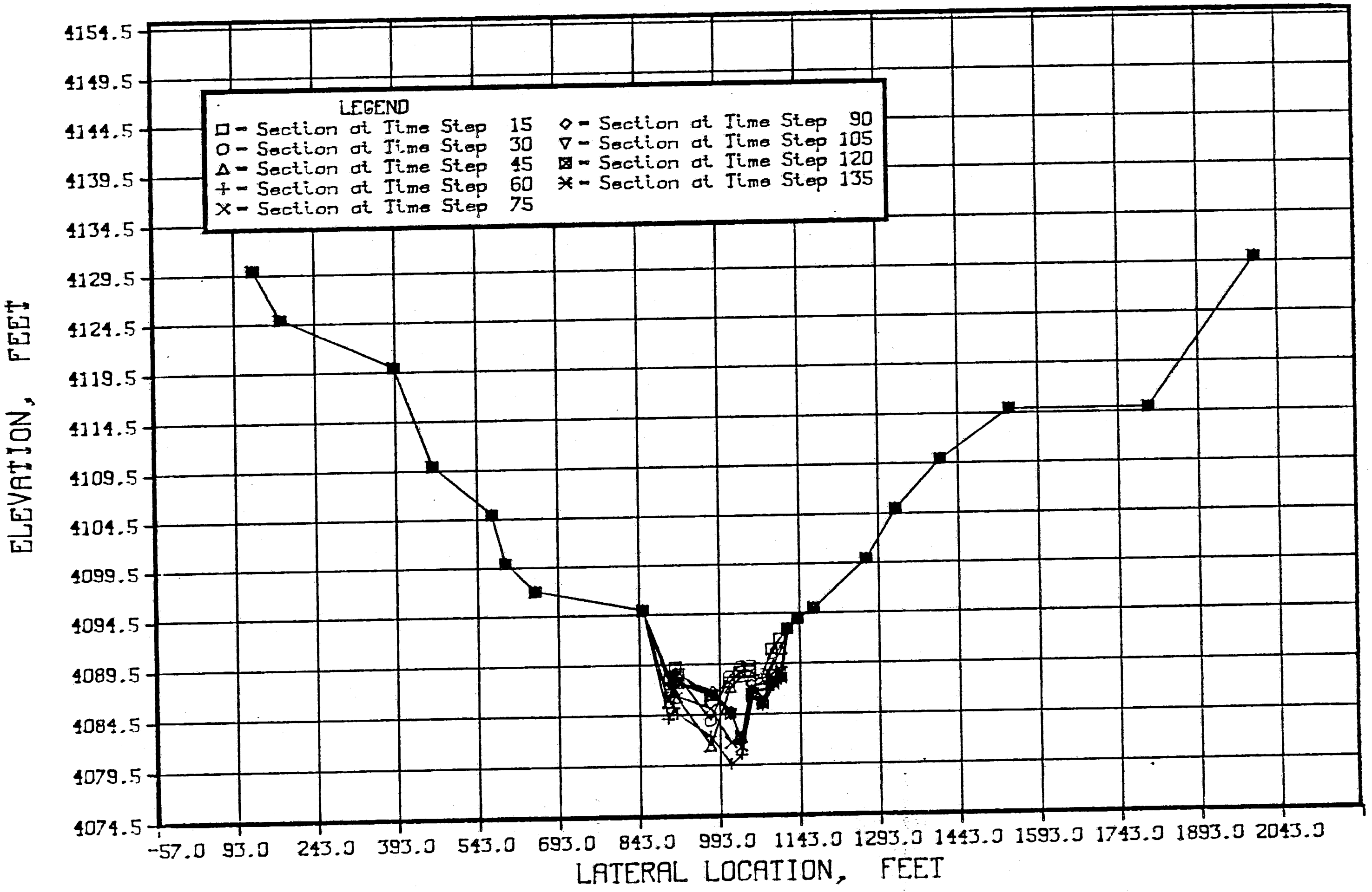
Figure 12k



PLOT 12 23.25.00 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 121

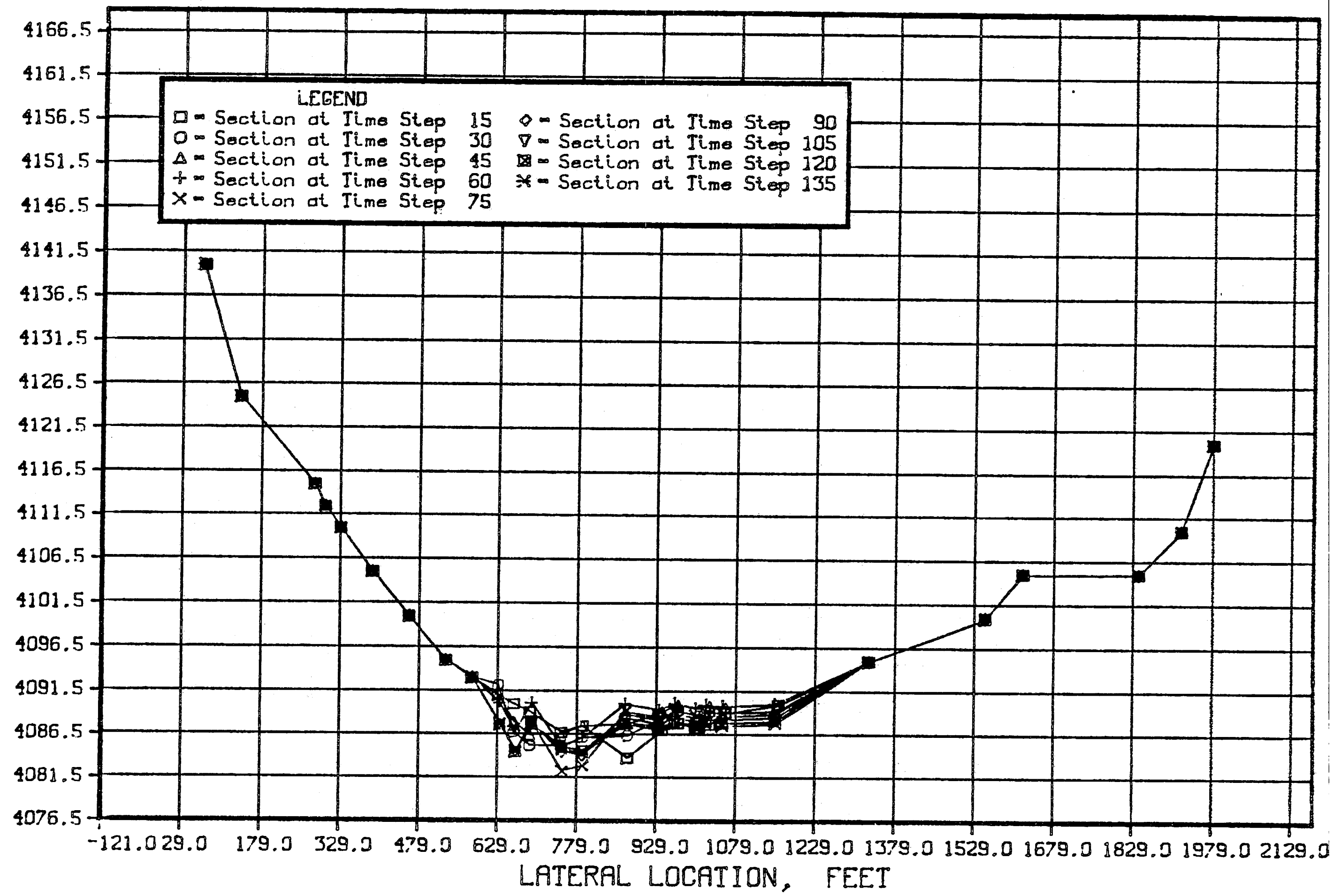
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1380. FT.



PLOT 13 23.25.06 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 12m

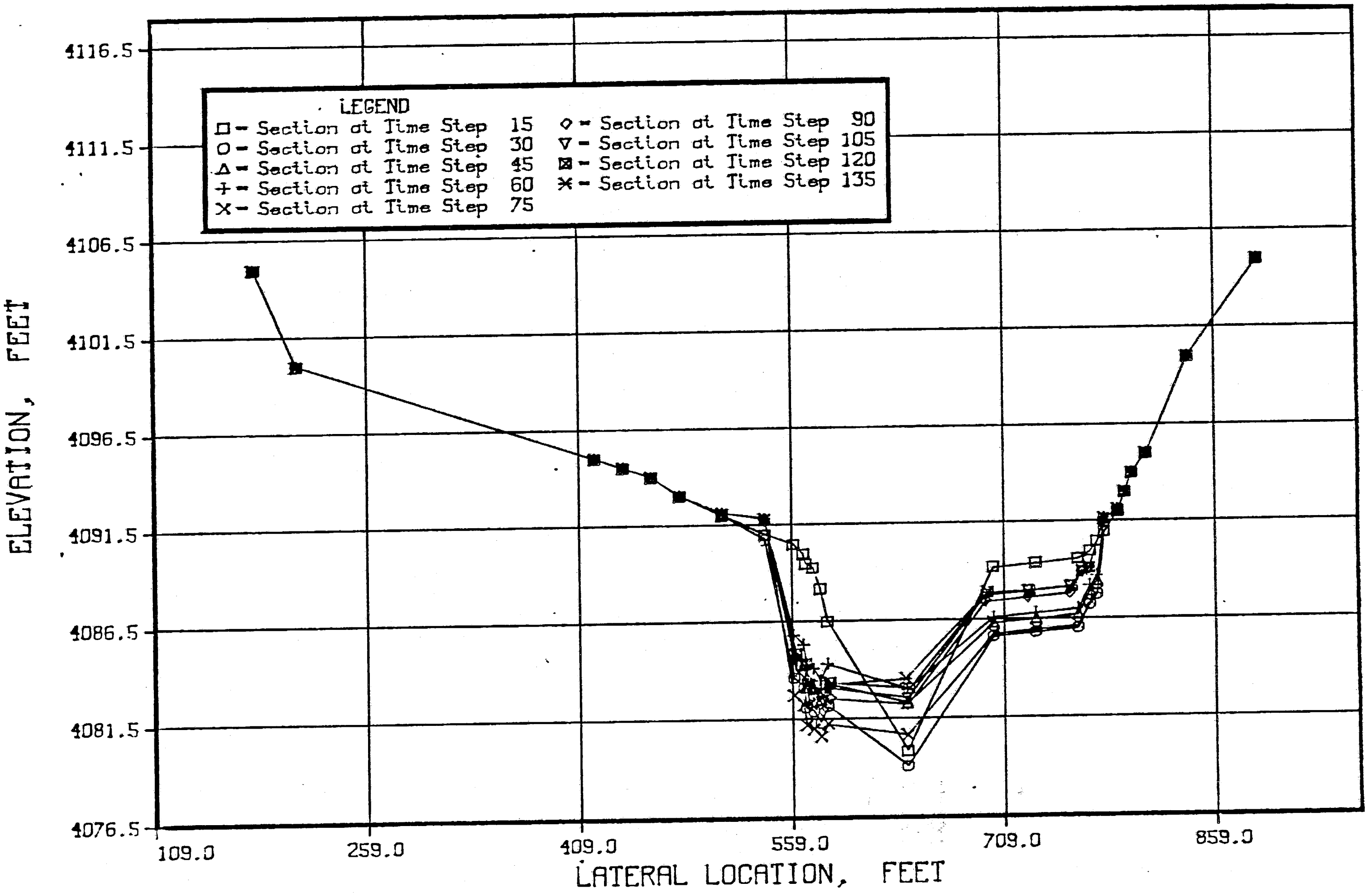
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1110. FT.



PLOT 14   23.25.13  MON  24 NOV, 1986    JOB-F006139 ,  UCC   DISSPLA 9.0

Figure 12n

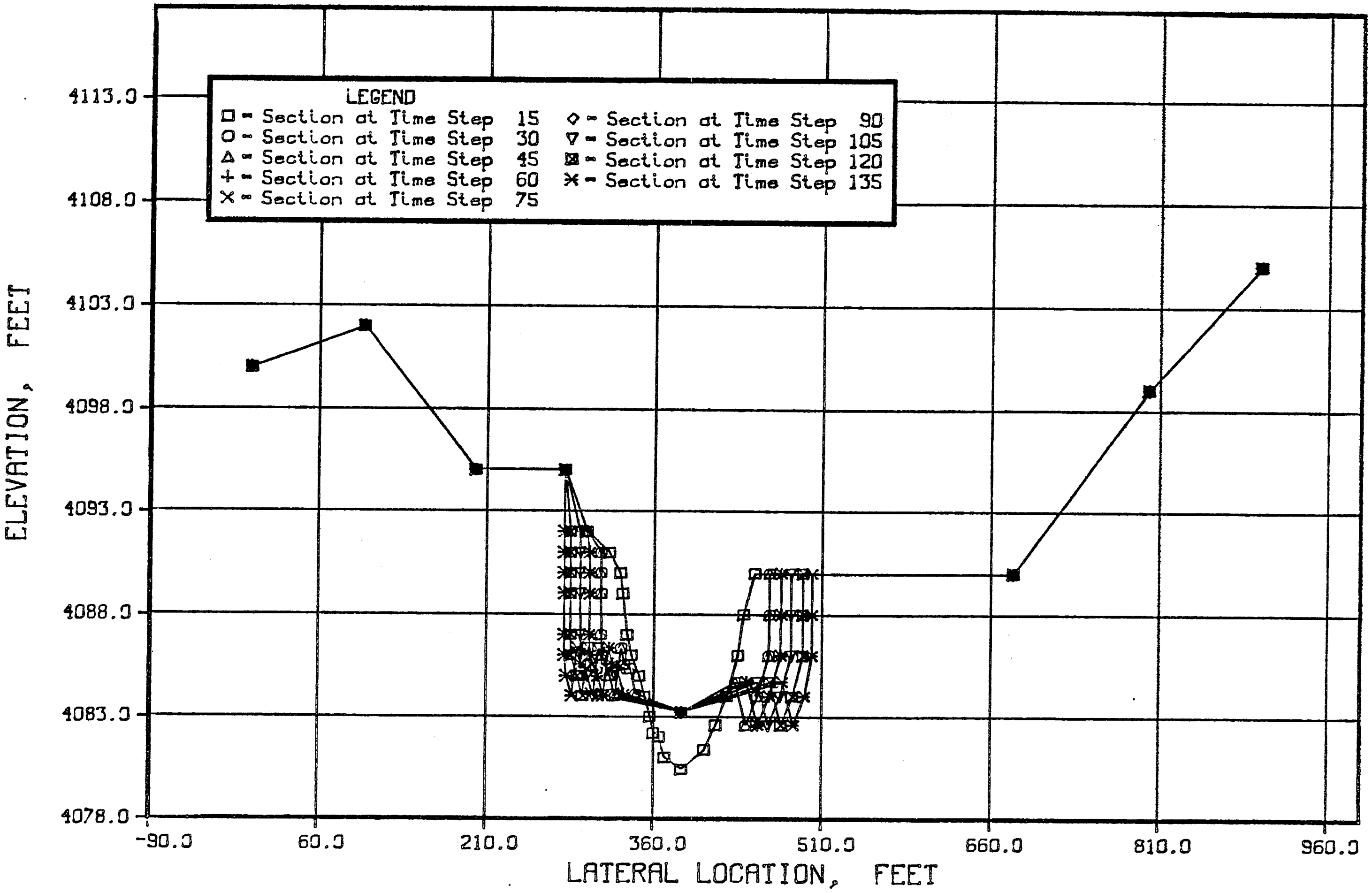
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA.  885. FT.



PLOT 15 . 23.25.20 MON 24 NOV, 1986 JOB-F006439 , UCG DISSPLA 9.0

Figure 12o

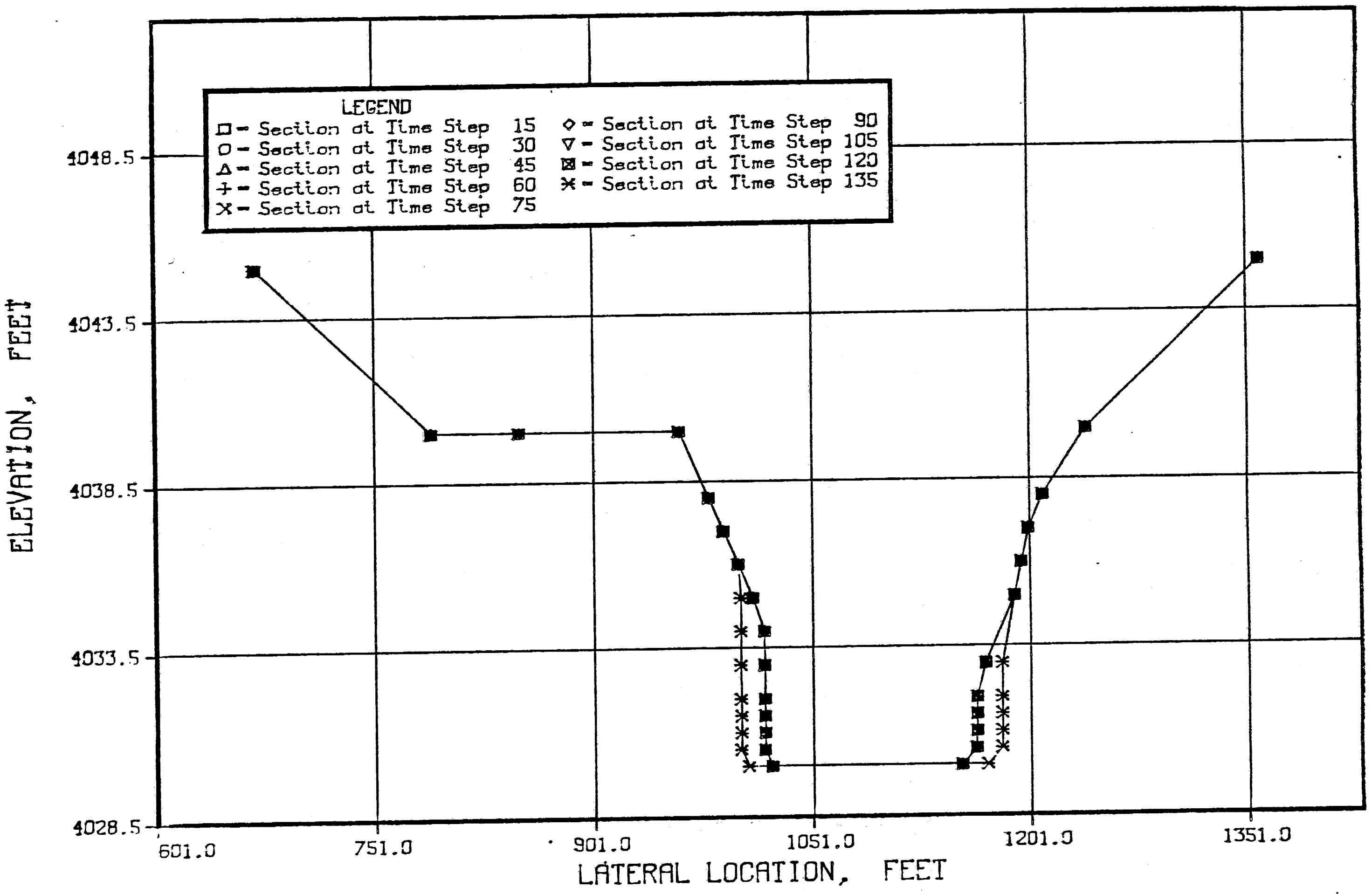
WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 655. FT.



PLOT 16 23.25.26 MON 24 NOV, 1986 JOB-F006439 , UCC DISSPLA 9.0

Figure 12p

WILLOW CREEK SPILLWAY-- 50% MAX. FLOOD
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 405. FT.



# APPENDIX A

## EXAMPLE PROBLEM

## A. Description of the Example Problem

For an example application of the Variable Width Stream Tube Computer program, a 4,365-foot study reach at Silver Croft Wash between Speedway and Grant Road between sections No. 0.7 and No. 9 has been chosen. This reach contains 10 cross sections. The average channel bottom slope for the reach is 0.005 ft/ft. The range of slopes between cross sections lies between 0.0025 and 0.0092 ft/ft. Hydraulically, these subreaches correspond to steep and mild sections. Supercritical flows and hydraulic jumps are expected to occur. The design water discharge hydrograph is given in Figure A-1. Sediment inflow hydrograph into the study reach is unknown. To study the extreme erosion event, the water entering the reach is assumed to be clear (i.e., zero sediment inflow at the upstream boundary). The average bed material size distribution for the reach is given as:

| No. | Size group (mm) | Percent found in channel |
|---|---|---|
| 1 | 0.08 - 0.29 | 14 |
| 2 | 0.29 - 0.50 | 14 |
| 3 | 0.50 - 0.60 | 14 |
| 4 | 0.60 - 1.80 | 28 |
| 5 | 1.80 - 5.00 | 30 |

Time step of 0.2 hours is selected. In the present study, the number of stream tubes selected for water and sediment routing computations is three. The channel roughness throughout this study reach is assumed to be equal to a constant Manning's coefficient of 0.02. Coefficients of losses for local losses other than expansion and contraction losses were assumed to be zero along the reach.

In each time step, sediment routing computations were performed only once using C. T. Yang's 1973 and 1984 equations for estimating sediment transport capacities. In the minimization computations, no restrictions on the eroding portions of the channel were set. The water and sediment routing computations were carried out by setting the upstream-most station as fixed bed. The results of computations are presented in Figures A-2 through A-26. In Figures A-17 through A-26 the channel cross sections at the end of time steps 3, 6, 9, 12 and 15 are plotted along with the original bed profiles. Figures A-2 through A-16 show the water surface and thalweg profiles along the reach at different time steps. These water surface profiles indicate the presence of hydraulic jumps, subcritical and supercritical flows. The computer output of this example is shown in Table A-2.

# APPENDIX B

## Table A-1 - Input Data of the Example

```
T1           EXAMPLE  PROBLEM FOR THE USBR
T2      TO BE USED IN THE VARIABLE WIDTH MODEL
T3           MAY 19, 1986, ALBERT MOLINAS
NS   10.0
ST4365.0     14.0      0.0      0.0  2000.0       1.0
ND    3.0   461.0    539.0    540.0
XS 309.7    460.0    299.7    461.0    299.     470.0    299.7    485.0    299.7    488.0
XS 299.7    490.0    299.7    495.0    299.7    500.0    299.7    505.0    299.7    510.0
XS 299.7    515.0    299.7    530.0    299.7    539.0    309.7    540.0
ST3865.0     14.0      0.0      0.0  2000.0       1.0
ND    3.0   461.0    539.0    540.0
XS 307.5    460.0    297.5    461.0    297.5    470.0    297.5    485.0    297.5    488.0
XS 297.5    490.0    297.5    495.0    297.5    500.0    297.5    505.0    297.5    510.0
XS 297.5    515.0    297.5    530.0    297.5    539.0    307.5    540.0
ST3585.0     14.0    0.0      0.0  2000.0       1.0
ND    3.0   461.0    539.0    540.0
XS 306.2    460.0    296.2    461.0    296.2    470.0    296.2    485.0    296.2    488.0
XS 296.2    490.0    296.2    495.0    296.2    500.0    296.2    505.0    296.2    510.0
XS 296.2    515.0    296.2    530.0    296.2    539.0    306.2    540.0
ST3380.0     14.0      0.0      0.0  2000.0       1.0
ND    3.0   461.0    539.0    540.0
XS 305.3    460.0    295.3    461.0    295.3    470.0    295.3    485.0    295.3    488.0
XS 295.3    490.0    295.3    495.0    295.3    500.0    295.3    505.0    295.3    510.0
XS 295.3    515.0    295.3    530.0    295.3    539.0    305.3    540.0
ST2940.0     14.0      0.0      0.0  2000.0       1.0
ND    3.0   461.0    539.0    540.0
XS 303.3    460.0    293.3    461.0    293.3    470.0    293.3    485.0    293.3    488.0
XS 293.3    490.0    293.3    495.0    293.3    500.0    293.3    505.0    293.3    510.0
XS 293.3    515.0    293.3    530.0    293.3    539.0    303.3    540.0
ST2440.0     23.0      0.0      0.0  2000.0       1.0
ND    3.0   456.0    544.0    610.0
XS 310.0    398.0    298.3    400.0    298.3    456.0    291.3    460.0    291.3    470.0
XS 291.3    475.0    291.3    480.0    291.3    485.0    291.3    490.0    291.3    495.0
XS 291.3    500.0    291.3    505.0    291.3    510.0    291.3    515.0    291.3    520.0
XS 291.3    525.0    291.3    530.0    291.3    535.0    291.3    540.0    294.8    542.0
XS 298.3    544.0    298.3    600.0    310.0    610.0
ST2050.0     22.0      0.0      0.0  2000.0       1.0
ND    3.0   450.0    540.0    640.0
XS 300.0    110.0    298.0    350.0    296.0    440.0    294.0    450.0    289.3    460.0
XS 289.3    465.0    289.3    470.0    289.2    475.0    289.2    480.0    289.1    485.0
XS 289.1    490.0    289.1    500.0    289.1    505.0    289.2    510.0    289.2    515.0
XS 289.3    520.0    289.3    525.0    291.0    530.0    296.0    540.0    298.0    560.0
XS 300.0    570.0    300.5    640.0
ST1550.0     25.0      0.0      0.0  2000.0       1.0
ND    3.0   450.0    580.0    820.0
XS 298.0    120.0    296.0    275.0    294.0    450.0    292.0    460.0    290.0    470.0
XS 288.0    475.0    288.0    480.0    288.0    485.0    288.0    490.0    288.0    495.0
XS 288.0    500.0    288.0    505.0    288.0    510.0    288.0    520.0    288.0    530.0
XS 289.0    535.0    290.0    540.0    292.0    545.0    296.0    560.0    296.1    573.0
```

```
XS 296.3    600.0    296.5    626.0    296.9    640.0    297.5    760.0    298.0    820.0
ST 750.0     24.0      0.0      0.0   2000.0      1.0
ND.  3.0    450.0    540.0    800.0
XS 294.0    170.0    292.0    450.0    292.0    460.0    289.0    465.0    286.0    470.0
XS 285.9    475.0    285.8    480.0    285.7    485.0    285.6    490.0    285.5    495.0
XS 285.5    500.0    285.6    505.0    285.6    510.0    285.7    515.0    285.7    520.0
XS 285.8    525.0    285.8    530.0    287.5    535.0    290.0    540.0    290.5    580.0
XS 291.0    620.0    291.5    660.0    292.0    700.0    294.0    800.0
ST   0.0     25.0      0.0      0.0   2000.0      1.0
ND   3.0    390.0    555.0    635.0
XS 291.0      0.0    291.0    390.0    290.5    418.0    290.3    433.0    290.0    445.0
XS 287.0    455.0    284.0    465.0    281.0    475.0    278.0    485.0    278.0    490.0
XS 278.0    495.0    278.0    500.0    278.0    505.0    278.0    510.0    278.0    515.0
XS 278.0    520.0    278.0    525.0    280.0    530.0    282.0    535.0    286.0    545.0
XS 290.0    555.0    290.3    562.0    290.9    576.0    291.0    605.0    290.0    635.0
RE       MANNING
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020     .020     .020     .020     .020     .020
RH  .020     .020     .020     .020     .020
CL   0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
CB       THALWEG
NT   3.0
IT  15.0      1.0   .00833
QQ       TABLE OF DISCHARGES
SS       STAGE DISCHARGE TABLE
TL  10.0
SQ 3250. 2283.50
SQ 5100. 2284.90
```

```
SQ 6800.  2286.05
SQ 7800.  2286.30
SQ 7500.  2286.40
SQ 7000.  2286.00
SQ 5300.  2284.85
SQ 4150.  2284.05
SQ 3350.  2283.30
SQ 2550.  2282.55
SQ 1950.  2281.95
SQ 1500.  2281.40
SQ 1150.  2281.05
SQ  950.  2280.60
SQ  800.  2280.25
SO        SEDIMENT TRANSPORT IS REQUESTED
QS   15.0       0.0
SE    1.0
TM   15.0      70.0
SF    5.0
SG    .08       .29
SG    .29       .50
SG    .50       .60
SG    .60      1.80
SG   1.80      5.00
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
SD    .14       .14       .14       .28       .30
PR    0.0       1.0
PL        PLOTTING IS REQUESTED
PX        CHANNEL CROSS SECTION PLOTS                3.
PW        WATER SURFACE PROFILE PLOTS                1.
MN        MINIMIZATION IS REQUESTED
MI    5.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
MR -50.0     900.0   2270.0   2310.0
```

## APPENDIX C

## Table A-2 - Computer Output of the Example

```
TIME STEP NO. 1
DISCHARGE= .325000E+04


          STEP METHOD COMPUTATIONS


I=     1
CONTROL AT SECTION    1
CONTROL TYPE =   NATURAL
CONTROL DEPTH=      3.7938
CONTROL ELEV.= 2303.4938

I=     2
I=     3
I=     4
I=     5
I=     6
I=     7
I=     8
CONTROL AT SECTION    8
CONTROL TYPE =   NATURAL
CONTROL DEPTH=      4.3933
CONTROL ELEV.= 2292.3933

   WSE BEFORE AND AFTER ADJUSTING   .2290676E+04   .2290110E+04S2
I=     9
I=    10


                ******************************************
                *    RESULTS OF BACKWATER COMPUTATIONS   *
                *      DISCHARGE =    3250.00  C.F.S.    *
                ******************************************


 STA NO.      STATION      W.S. ELV      AREA       E.G.ELV    FROUDE NO.
******************************************************************      ********


     1         4365.0     2303.49      .29735E+03  .23054E+04      1.00
     2         3865.0     2301.00      .27416E+03  .23032E+04      1.12
     3         3585.0     2299.80      .28237E+03  .23019E+04      1.07
     4         3380.0     2298.93      .28421E+03  .23010E+04      1.06
     5         2940.0     2296.83      .27689E+03  .22990E+04      1.11
     6         2440.0     2295.01      .30476E+03  .22968E+04      1.00
     7         2050.0     2294.25      .38590E+03  .22954E+04       .73
     8         1550.0     2292.39      .31411E+03  .22942E+04      1.00
     9          750.0     2290.11      .30375E+03  .22920E+04      1.02
    10              0     2281.74      .19010E+03  .22866E+04      1.77
             ************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
             ************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU
  NO.    (T/DAY)      FT.  OF CHANGE        1         2         3         4         5
*****************************************************      ***************************


     1          0         0      DEPTH        0         0         0         0         0
     2      208.9       -.4      DEPTH     486.      554.      561.      768.      158.
     3      232.0       -.1      DEPTH     787.      678.      500.      693.      146.
     4      261.1       -.1      DEPTH    1189.      660.      487.      677.      144.
     5      326.7       -.1      DEPTH    1778.      737.      539.      742.      154.
     6      282.6        .1      DEPTH    1847.      513.      384.      549.      123.
     7       98.3        .2      DEPTH     568.      184.      146.      231.       59.
     8      245.3       -.1      DEPTH    1463.      488.      366.      524.      125.
     9      242.4        .0      DEPTH    1556.      444.      335.      487.      108.
    10      602.1       -.4      DEPTH    2350.     1348.     1366.     1942.      273.
             ************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
             ************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (C
  NO.    (T/DAY)      FT.  OF CHANGE        1         2         3         4         5
```

```
*****************************************************       ******************************


  1        0         0     DEPTH        0        0        0        0        0
  2    192.0       -.4     DEPTH     403.     459.     524.     787.     148.
  3    224.1       -.1     DEPTH     654.     695.     512.     711.     137.
  4    247.5       -.1     DEPTH     987.     677.     499.     695.     134.
  5    305.4       -.1     DEPTH    1479.     755.     553.     760.     144.
  6    288.4        .0     DEPTH    1888.     526.     394.     563.     116.
  7     89.6        .4     DEPTH     510.     169.     136.     219.      48.
  8    199.4       -.2     DEPTH    1104.     422.     321.     471.      93.
  9    238.2       -.1     DEPTH    1524.     440.     334.     489.      93.
 10    503.9       -.4     DEPTH    2052.    1042.    1020.    1773.     204.
          ***********************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
          ***********************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE          1         2        3        4        5
*****************************************************       ******************************


  1        0         0     DEPTH        0        0        0        0        0
  2    208.9       -.4     DEPTH     486.     554.     561.     768.     158.
  3    232.0       -.1     DEPTH     787.     678.     500.     693.     146.
  4    261.1       -.1     DEPTH    1189.     660.     487.     677.     144.
  5    326.7       -.1     DEPTH    1778.     737.     539.     742.     154.
  6    282.6        .1     DEPTH    1847.     513.     384.     549.     123.
  7     95.1        .3     DEPTH     547.     178.     142.     226.      57.
  8    235.7       -.1     DEPTH    1456.     449.     339.     491.     114.
  9    358.1       -.1     DEPTH    2405.     641.     472.     656.     156.
 10    704.6       -.4     DEPTH    3229.    1581.    1544.    1906.     260.

TIME STEP NO. 2
DISCHARGE= .510000E+04


          STEP METHOD COMPUTATIONS


I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       5.1099
CONTROL ELEV.= 2304.8099

I=      2
I=      3
I=      4
I=      5
        WSE BEFORE AND AFTER ADJUSTING    .2296396E+04    .2296184E+04S3
I=      6
I=      7
        WSE BEFORE AND AFTER ADJUSTING    .2294113E+04    .2293478E+04S2
I=      8
I=      9
I=     10

              ******************************************
              *    RESULTS OF BACKWATER COMPUTATIONS   *
              *      DISCHARGE =    5100.00  C.F.S.    *
              ******************************************
```

```
STA NO.      STATION     W.S. ELV      AREA       E.G.ELV    FROUDE NO.
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *        * * * * * * * * *


   1          4365.0      2304.81      .40118E+03  .23073E+04     1.00
   2          3865.0      2301.49      .34176E+03  .23050E+04     1.27
   3          3585.0      2301.22      .40031E+03  .23038E+04     1.00
~~   4          3380.0      2299.97      .37134E+03  .23029E+04     1.12~~
   5          2940.0      2297.83      .36303E+03  .23009E+04     1.16
   6          2440.0      2296.18      .39982E+03  .22988E+04     1.05
   7          2050.0      2294.70      .40179E+03  .22973E+04     1.09
   8          1550.0      2293.48      .42820E+03  .22959E+04     1.05
   9           750.0      2291.55      .51823E+03  .22935E+04     1.23
  10               0      2282.55      .26562E+03  .22887E+04     1.76
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)        FT.  OF CHANGE          1          2          3          4          5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *      * * * * * * * * * * * * * * * * * * * * * * * * * * *


   1          0          0       DEPTH          0          0          0          0          0
   2      289.6        -.5       DEPTH       506.       577.       658.      1501.       259.
   3      298.8        -.0       DEPTH       822.       933.       695.       986.       177.
   4      706.6        -.9       WIDTH      2918.      1270.       928.      1271.       213.
   5      778.2        -.5       WIDTH      5986.      1392.      1011.      1370.       225.
   6      540.3         .4       DEPTH      3607.       983.       730.      1028.       184.
   7      567.4        -.0       WIDTH      3810.      1028.       761.      1065.       196.
   8      476.6         .1       WIDTH      3139.       867.       648.       922.       187.
   9      295.6         .1       WIDTH      1840.       550.       423.       634.       126.
  10      765.8        -.4       DEPTH      2735.      1570.      1586.      3014.       354.
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)        FT.  OF CHANGE          1          2          3          4          5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *      * * * * * * * * * * * * * * * * * * * * * * * * * * *


   1          0          0       DEPTH          0          0          0          0          0
   2      229.8        -.5       DEPTH       398.       453.       517.      1178.       233.
   3      268.7        -.1       DEPTH       645.       735.       706.      1004.       159.
   4      373.7        -.3       DEPTH       975.      1111.       944.      1295.       193.
   5      455.2        -.1       DEPTH      1463.      1413.      1028.      1395.       204.
   6      403.3         .1       DEPTH      1929.       995.       740.      1045.       169.
   7      424.5        -.0       DEPTH      2440.       915.       676.       955.       147.
   8      401.1         .0       DEPTH      2583.       744.       564.       825.       133.
   9      285.3         .1       DEPTH      1673.       563.       438.       664.       112.
  10      593.8        -.5       DEPTH      2233.      1201.      1166.      2325.       253.
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
             * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)        FT.  OF CHANGE          1          2          3          4          5
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *      * * * * * * * * * * * * * * * * * * * * * * * * * * *


   1          0          0       DEPTH          0          0          0          0          0
   2      229.7        -.4       DEPTH       369.       350.       391.      1261.       407.
   3      272.2        -.1       DEPTH       427.       587.       853.      1222.       201.
   4      405.9        -.8       WIDTH       716.      3031.      1069.      1449.       240.
   5      448.6        -.5       WIDTH      1294.      6279.      1111.      1554.       266.
   6      415.4         .6       DEPTH      1753.      1207.       825.      1071.       166.
   7      473.4        -.1       WIDTH      3172.      1004.       665.       832.       111.
```

```
  8     284.9        .1     WIDTH     780.      801.      652.      996.      214.
  9     497.4      -.5      WIDTH   12146.      975.      725.     1004.      365.
 10    1603.0      -.2      DEPTH   12586.     2159.     1256.     2861.      518.


TIME STEP NO. 3
DISCHARGE= .680000E+04



             STEP METHOD COMPUTATIONS



I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      6.1921
CONTROL ELEV.= 2305.8921

I=      2
I=      3
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      6.2415
CONTROL ELEV.= 2302.2008

I=      4
I=      5
        WSE BEFORE AND AFTER ADJUSTING    .2299329E+04    .2297702E+04S2
I=      6
I=      7
        WSE BEFORE AND AFTER ADJUSTING    .2295977E+04    .2294529E+04S2
I=      8
I=      9
I=     10

                  *******************************************
                  *    RESULTS OF BACKWATER COMPUTATIONS    *
                  *      DISCHARGE =    6800.00  C.F.S.     *
                  *******************************************


 STA NO.      STATION     W.S. ELV      AREA       E.G.ELV    FROUDE NO.
*************************************************************         *********


    1          4365.0     2305.89     .48682E+03  .23090E+04     1.00
    2          3865.0     2301.68     .39213E+03  .23064E+04     1.38
    3          3585.0     2302.20     .48495E+03  .23053E+04     1.00
    4          3380.0     2300.59     .43469E+03  .23044E+04     1.19
    5          2940.0     2298.80     .44759E+03  .23024E+04     1.13
    6          2440.0     2297.70     .49787E+03  .23007E+04     1.03
    7          2050.0     2295.05     .43802E+03  .22990E+04     1.30
    8          1550.0     2294.53     .54087E+03  .22973E+04     1.25
    9           750.0     2291.89     .58657E+03  .22947E+04     1.49
   10               0     2283.28     .33904E+03  .22900E+04     1.69
              ***************************************************
              *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1 *
              ***************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE        1         2         3         4         5
*********************************************************     ****************************
```

```
    1          0          0      DEPTH          0          0          0          0          0
    2      249.5        -.4      DEPTH       504.       502.       489.       925.       597.
    3      316.4        -.2      DEPTH       583.       189.       749.      2063.       242.
    4      441.1        -.2      DEPTH      1024.       693.      1323.      2007.       287.
    5      538.8        -.1      DEPTH      1669.      1428.      1333.      1816.       266.
    6      544.6        -.0      DEPTH      3810.      1150.       716.       828.        80.
    7      904.7        -.3      DEPTH      4494.      2146.      1685.      2273.       341.
    8     1088.4        -.1      DEPTH      6505.      2389.      1665.      2132.       467.
    9      951.0         .1      DEPTH      8074.      1249.       865.      1143.       166.
   10     1275.5        -.3      DEPTH      8920.      2080.      1660.      2060.       701.
             *****************************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
             *****************************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1          2          3          4          5
***********************************************************************      *********************************


    1          0          0      DEPTH          0          0          0          0          0
    2      195.9        -.4      DEPTH       385.       383.       374.       710.       516.
    3      252.8        -.2      DEPTH       470.       302.       509.      1520.       256.
    4      372.1        -.3      DEPTH       643.       455.       818.      2216.       366.
    5      449.1        -.1      DEPTH       777.       788.      1410.      2161.       293.
    6      393.9         .1      DEPTH       429.      1406.      1234.      1540.       153.
    7      551.9        -.3      DEPTH       512.      1977.      1711.      2221.       251.
    8      367.5         .2      DEPTH       986.      1237.       872.      1194.       154.
    9      482.4        -.1      DEPTH      2316.      1281.       895.      1196.       145.
   10      671.6        -.3      DEPTH      2850.      1809.      1404.      1557.       500.
             *****************************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
             *****************************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1          2          3          4          5
***********************************************************************      *********************************


    1          0          0      DEPTH          0          0          0          0          0
    2      225.7        -.4      DEPTH       402.       405.       411.       825.       685.
    3      254.7        -.1      DEPTH       485.       352.       179.      1709.       354.
    4      397.0        -.3      DEPTH       545.       875.       769.      2288.       322.
    5      503.8        -.1      DEPTH       668.      1583.      1466.      2059.       314.
    6      463.4         .1      DEPTH          0      4684.       383.       519.        17.
    7      522.9        -.1      DEPTH       309.      3086.       970.      1726.       232.
    8      530.7        -.0      DEPTH      3373.      1035.       737.      1058.       213.
    9      950.0        -.1      DEPTH      5878.      1853.      1349.      1809.       595.
   10     1154.6        -.1      DEPTH      7562.      1293.      1606.      2787.       711.

TIME STEP NO. 4
DISCHARGE= .780000E+04



           STEP METHOD COMPUTATIONS



I=      1
CONTROL AT SECTION    1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      6.7771
CONTROL ELEV.= 2306.4771

I=      2
```

```
I=      3
CONTROL AT SECTION      3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       6.9049
CONTROL ELEV.= 2302.6678

I=      4
        WSE BEFORE AND AFTER ADJUSTING      .2299791E+04     .2299263E+04S2
I=      5
        WSE BEFORE AND AFTER ADJUSTING      .2300223E+04     .2298537E+04S2
I=      6
I=      7
        WSE BEFORE AND AFTER ADJUSTING      .2297530E+04     .2295314E+04S2
I=      8
I=      9
I=     10

                  *****************************************
                  *    RESULTS OF BACKWATER COMPUTATIONS   *
                  *      DISCHARGE =    7800.00   C.F.S.   *
                  *****************************************


 STA NO.      STATION      W.S. ELV      AREA       E.G.ELV    FROUDE NO.
************************************************************************       *********


    1          4365.0      2306.48     .53320E+03   .23098E+04     1.00
    2          3865.0      2301.59     .41545E+03   .23071E+04     1.45
    3          3585.0      2302.67     .53336E+03   .23060E+04     1.00
    4          3380.0      2300.69     .46406E+03   .23051E+04     1.23
    5          2940.0      2299.26     .49474E+03   .23031E+04     1.12
    6          2440.0      2298.54     .59385E+03   .23015E+04     1.42
    7          2050.0      2295.09     .46352E+03   .22998E+04     1.38
    8          1550.0      2295.31     .69323E+03   .22978E+04     1.28
    9           750.0      2291.97     .62424E+03   .22953E+04     1.59
   10             0        2283.69     .38330E+03   .22907E+04     1.64
               *********************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.   1   *
               *********************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1         2          3          4          5
***********************************************************       ******************************


    1          0          0     DEPTH          0         0          0          0          0
    2      233.9        -.4     DEPTH        428.      416.       403.       781.       800.
    3      267.5        -.1     DEPTH        517.      824.       592.       842.       460.
    4      391.4        -.2     DEPTH        737.      946.       384.      2179.       485.
    5      497.7        -.1     DEPTH       1004.      321.      1456.      2876.       361.
    6      894.6        -.3     DEPTH       1987.     1693.      2948.      3628.       559.
    7      778.1         .1     DEPTH       2986.     1787.      1384.      2642.       608.
    8      692.3         .0     DEPTH       1622.     2103.      1714.      2315.       616.
    9      779.0        -.0     DEPTH       3043.     2580.      1644.      1938.       213.
   10      847.3        -.1     DEPTH       3609.     2106.      1062.      2606.       861.
               *********************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.   2   *
               *********************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1         2          3          4          5
***********************************************************       ******************************


    1          0          0     DEPTH          0         0          0          0          0
    2      185.5        -.4     DEPTH        329.      322.       314.       611.       667.
    3      209.2        -.1     DEPTH        422.      544.       441.       687.       435.
```

```
STA NO.      STATION     W.S. ELV      AREA       E.G.ELV   FROUDE NO.
***************************************************************         *****.***


   1          4365.0     2306.30     .51928E+03  .23096E+04     1.00
   2          3865.0     2304.52     .67685E+03  .23065E+04      .67
   3          3585.0     2302.43     .51954E+03  .23057E+04     1.00
~~ 4          3380.0     2300.12     .43858E+03  .23047E+04     1.29~~
   5          2940.0     2299.24     .49986E+03  .23028E+04     1.06
   6          2440.0     2298.23     .58332E+03  .23011E+04     1.40
   7          2050.0     2295.04     .46030E+03  .22994E+04     1.33
   8          1550.0     2295.58     .74059E+03  .22977E+04     1.19
   9           750.0     2291.71     .58242E+03  .22952E+04     1.62
  10             0       2283.46     .36920E+03  .22904E+04     1.66
           ******************************************************
           *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
           ******************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1          2           3          4          5
*****************************************************          *****************************


   1          0          0      DEPTH          0          0          0          0          0
   2       116.5        -.2     DEPTH        416.       306.       202.       256.       228.
   3       193.1        -.2     DEPTH        478.       397.       196.       687.       576.
   4       332.7        -.3     DEPTH        686.       670.       768.      1241.       656.
   5       442.5        -.1     DEPTH        850.      1604.       366.      2139.       390.
   6       764.5        -.2     DEPTH       1602.      1712.      1068.      4061.       799.
   7       702.3         .0     DEPTH        891.      1291.      2970.      2876.       463.
   8       574.2         .0     DEPTH       2921.      1100.       928.      1551.       441.
   9       656.3        -.0     DEPTH        925.      2526.      1897.      2323.       263.
  10       836.1        -.2     DEPTH       1038.      3554.      3058.      1688.       770.
           ******************************************************
           *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
           ******************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1          2           3          4          5
*****************************************************          *****************************


   1          0          0      DEPTH          0          0          0          0          0
   2       107.2        -.2     DEPTH        312.       310.       215.       278.       181.
   3       147.8        -.1     DEPTH        358.       311.       110.       477.       530.
   4       233.2        -.2     DEPTH        540.       491.       287.       816.       684.
   5       300.9        -.1     DEPTH        634.       913.       914.       757.       421.
   6       292.1         .0     DEPTH        327.       857.       170.      2004.       172.
   7       385.4        -.2     DEPTH        585.      1117.       423.      2070.       465.
   8       300.7         .1     DEPTH       1369.       130.       683.      1364.        90.
   9       494.6        -.2     DEPTH       1693.       483.      1374.      2113.       316.
  10       517.4        -.0     DEPTH       1269.      1075.      2248.      1166.       498.
           ******************************************************
           *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
           ******************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1          2           3          4          5
*****************************************************          *****************************


   1          0          0      DEPTH          0          0          0          0          0
   2       114.3        -.2     DEPTH        404.       296.       197.       254.       230.
   3       170.4        -.1     DEPTH        444.       225.       136.       657.       598.
   4       280.3        -.2     DEPTH        664.       444.       608.       932.       741.
   5       408.9        -.1     DEPTH        818.      1119.       985.      1682.       438.
   6       783.3        -.3     DEPTH       1141.      2549.       872.      4226.       682.
   7       710.1         .1     DEPTH       1363.       677.      1795.      4506.       245.
```

```
                                                                                      106.
  8       411.7          .1     DEPTH     1761.      2150.      437.       523.       910.
  9       820.5         -.1     DEPTH     1967.      2658.     1712.      2673.       846.
 10       792.5          .0     DEPTH     2192.      1504.     2096.      2943.

TIME STEP NO. 6
DISCHARGE= .700000E+04



        STEP METHOD COMPUTATIONS



I=     1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=        6.3091
CONTROL ELEV.= 2306.0091

I=     2
I=     3
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=        6.4471
CONTROL ELEV.= 2301.9867

I=     4
I=     5
I=     6
I=     7
      WSE BEFORE AND AFTER ADJUSTING    .2298074E+04    .2295803E+04S2
I=     8
I=     9
I=    10

                 *******************************************
                 *    RESULTS OF BACKWATER COMPUTATIONS    *
                 *       DISCHARGE =    7000.00  C.F.S.    *
                 *******************************************

 STA NO.     STATION     W.S. ELV      AREA       E.G.ELV   FROUDE NO.
*********************************************************************         *********


    1         4365.0     2306.01     .49609E+03  .23091E+04     1.00
    2         3865.0     2304.05     .65499E+03  .23058E+04      .66
    3         3585.0     2301.99     .49696E+03  .23051E+04     1.00
    4         3380.0     2299.58     .41377E+03  .23040E+04     1.32
    5         2940.0     2299.09     .49682E+03  .23022E+04     1.00
    6         2440.0     2297.52     .51116E+03  .23005E+04     1.02
    7         2050.0     2294.93     .45088E+03  .22989E+04     1.28
    8         1550.0     2295.80     .78466E+03  .22975E+04     1.08
    9          750.0     2291.35     .52657E+03  .22949E+04     1.68
   10              0     2283.08     .34593E+03  .22900E+04     1.68
               ************************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1      *
               ************************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.   OF CHANGE        1          2      3          4          5
************************************************************  ****************************
```

```
   1          0          0      DEPTH        0         0         0         0         0
   2       87.9        -.1      DEPTH     195.      183.      172.      290.      222.
   3      158.5        -.2      DEPTH     285.      293.      357.      414.      566.
   4      279.1        -.2      DEPTH     519.      531.      590.      941.      793.
   5      297.2        -.0      DEPTH     660.      279.      915.     1332.      408.
   6      318.3        -.0      DEPTH     957.      876.      348.     1328.      339.
   7      584.7        -.2      DEPTH    1599.     1528.      522.     2994.      426.
   8      242.3         .1      DEPTH     129.      620.      864.     1044.      273.
   9      662.8        -.1      DEPTH    2769.     1495.     1385.     2076.      288.
  10      794.9        -.1      DEPTH    3074.     1403.      511.     3858.      764.
             *********************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2   *
             *********************************************************
 STA   TOTAL LOAD   CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)       FT.  OF CHANGE        1         2          3         4         5
******************************************************     ******************************


   1          0          0      DEPTH        0         0         0         0         0
   2       80.3        -.2      DEPTH     181.      144.      159.      301.      186.
   3      134.0        -.2      DEPTH     225.      246.      349.      329.      473.
   4      211.9        -.2      DEPTH     369.      385.      482.      585.      740.
   5      207.9         .0      DEPTH     499.      369.      166.     1035.      445.
   6      308.9        -.2      DEPTH     803.      827.     1116.      753.      236.
   7      302.7         .0      DEPTH     959.      518.      265.     1494.      424.
   8      182.5         .2      DEPTH     128.      708.      266.     1024.       81.
   9      358.2        -.2      DEPTH     503.      777.      743.     1951.      357.
  10      516.2        -.2      DEPTH     966.      968.      478.     3399.      429.
             *********************************************************
             *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3   *
             *********************************************************
 STA   TOTAL LOAD   CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)       FT.  OF CHANGE        1         2          3         4         5
******************************************************     ******************************


   1          0          0      DEPTH        0         0         0         0         0
   2       86.7        -.1      DEPTH     192.      180.      169.      284.      223.
   3      153.5        -.2      DEPTH     236.      356.      348.      342.      574.
   4      264.5        -.2      DEPTH     421.      536.      523.      899.      819.
   5      260.3         .0      DEPTH     584.      329.      646.     1129.      458.
   6      327.4        -.1      DEPTH     932.      634.      874.     1182.      336.
   7      488.5        -.2      DEPTH     477.     1978.      424.     2754.      273.
   8      215.7         .1      DEPTH     566.      731.      393.      854.       64.
   9      847.6        -.2      DEPTH    1558.     3318.     1606.     2713.     1052.
  10      746.5         .0      DEPTH     293.     4016.     1400.     2512.      805.

TIME STEP NO. 7
DISCHARGE= .530000E+04



            STEP METHOD COMPUTATIONS



I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      5.2562
CONTROL ELEV.= 2304.9562

I=      2
I=      3
```

```
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       5.3734
CONTROL ELEV.= 2300.7259

I=     4
I=     5
I=     6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       5.2723
CONTROL ELEV.= 2296.4712

I=     7
I=     8
CONTROL AT SECTION     8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       7.0693
CONTROL ELEV.= 2295.0703

I=     9
I=    10


               ********************************************
               *    RESULTS OF BACKWATER COMPUTATIONS     *
               *      DISCHARGE =   5300.00  C.F.S.       *
               ********************************************


 STA NO.      STATION     W.S. ELV     AREA       E.G.ELV   FROUDE NO.
*****************************************************************         *********


   1         4365.0     2304.96     .41274E+03  .23075E+04     1.00
   2         3865.0     2302.67     .55688E+03  .23041E+04      .64
   3         3585.0     2300.73     .41103E+03  .23033E+04     1.00
   4         3380.0     2298.46     .34141E+03  .23022E+04     1.33
   5         2940.0     2298.06     .41511E+03  .23006E+04      .99
   6         2440.0     2296.47     .42753E+03  .22989E+04     1.00
   7         2050.0     2295.85     .55083E+03  .22974E+04      .75
   8         1550.0     2295.07     .59483E+03  .22966E+04     1.00
   9          750.0     2290.36     .38334E+03  .22938E+04     1.61
  10            0       2281.91     .27207E+03  .22883E+04     1.75
             ***********************************************************
             *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1       *
             ***********************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)      FT.   OF CHANGE        1         2         3         4         5
*****************************************************************    ******************************


                                                0         0         0         0         0
   1          0         0       DEPTH
   2        57.8       -.1      DEPTH         143.       99.       101.      189.     .166.
   3       132.3       -.2      DEPTH        |259.      219.       197.      479.      446.
   4       535.9       -.6      WIDTH        1248.     1049.       867.      460.      741.
   5       194.2       1.7      WIDTH         312.      602.       350.      706.      377.
   6       229.3       -.6      WIDTH         854.      964.       904.      963.      271.
   7        87.6        .2      DEPTH        |22.       147.       128.      491.      171.
   8       .319.3      -.1      DEPTH        1|45.      730.       669.     1101.      216.
   9       455.9       -.1      DEPTH        1252.     1126.      1165.     1668.      301.
  10       607.0       -.1      DEPTH        1446.     1696.      2405.     1114.      677.
             ***********************************************************
             *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2       *
             ***********************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT
  NO.    (T/DAY)      FT.   OF CHANGE        1         2         3         4         5
```

```
**********************************************************     ******************************


   1          0          0     DEPTH        0         0         0         0         0
   2       53.2        -.1     DEPTH     136.       87.       90.      184.      146.
   3      124.0        -.2     DEPTH     226.      184.      187.      529.      372.
   4      173.5        -.1     DEPTH     358.      314.      315.      461.      649.
   5      132.9         .1     DEPTH      78.      287.      544.      292.      406.
   6      182.2        -.1     DEPTH     165.      280.      138.     1357.      263.
~~   7       85.3         .2     DEPTH      39.      272.      488.      124.      108.~~
   8      154.0        -.1     DEPTH     751.      264.      136.      647.       64.
   9      309.4        -.2     DEPTH    1018.      797.      354.     1222.      350.
  10      399.4        -.1     DEPTH    1262.      993.      915.     1125.      533.
            ************************************************************
            *     SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
            ************************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE        1         2         3         4         5
**********************************************************     ******************************


   1          0          0     DEPTH        0         0         0         0         0
   2       57.2        -.1     DEPTH     142.       98.       99.      186.      167.
   3      132.0        -.2     DEPTH     252.      217.      175.      503.      449.
   4      506.0        -.5     WIDTH    1167.     1006.      840.      486.      748.
   5      164.1        1.9     WIDTH     103.      517.      331.      628.      405.
   6      213.3        -.4     WIDTH     731.     1235.      496.      955.      311.
   7      137.9         .2     DEPTH     748.      120.      403.      282.      115.
   8      151.6        -.0     DEPTH     281.      598.      224.      685.       44.
   9      737.1        -.2     DEPTH    1010.     1875.     1753.     3174.     1099.
  10      618.3         .1     DEPTH    1882.     1602.     1421.     1896.      674.

TIME STEP NO. 8
DISCHARGE= .415000E+04



           STEP METHOD COMPUTATIONS


I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       4.4372
CONTROL ELEV.= 2304.1372

I=      2
I=      3
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       4.6279
CONTROL ELEV.= 2299.7332

I=      4
I=      5
I=      6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       4.4875
CONTROL ELEV.= 2295.0002

I=      7
I=      8
```

```
CONTROL AT SECTION     8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       5.4469
CONTROL ELEV.= 2293.3621

I=     9
I=    10

                  ***********************************************
                  *    RESULTS OF BACKWATER COMPUTATIONS        *
                  *       DISCHARGE =    4150.00  C.F.S.        *
                  ***********************************************


 STA NO.      STATION      W.S. ELV      AREA       E.G.ELV    FROUDE NO.
****************************************************************           *********


    1          4365.0      2304.14     .34807E+03  .23064E+04     1.00
    2          3865.0      2301.51     .47321E+03  .23027E+04      .63
    3          3585.0      2299.73     .34913E+03  .23019E+04     1.00
    4          3380.0      2299.36     .42171E+03  .23009E+04      .76
    5          2940.0      2297.48     .35401E+03  .22996E+04      .97
    6          2440.0      2295.60     .36097E+03  .22977E+04     1.00
    7          2050.0      2295.21     .47196E+03  .22965E+04      .72
    8          1550.0      2293.36     .38087E+03  .22953E+04     1.00
    9           750.0      2289.78     .33295E+03  .22925E+04     1.37
   10             0        2281.11     .22387E+03  .22868E+04     1.78
               *****************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
               *****************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE         1          2          3          4          5
*************************************************************     ****************************


   1          0          0      DEPTH           0          0          0          0          0
   2        42.7        -.1     DEPTH          95.        72.        73.       141.       136.
   3       107.9        -.2     DEPTH         220.       199.       198.       316.       373.
   4        79.0         .1     DEPTH         418.       129.        81.        96.       231.
   5       140.1        -.1     DEPTH         218.       425.       248.       504.       298.
   6       171.8        -.0     DEPTH         321.        78.       702.       746.       232.
   7        97.4         .1     DEPTH         406.       210.       179.       293.        90.
   8       197.2        -.1     DEPTH          88.       564.       574.      1013.       145.
   9       231.1        -.0     DEPTH         390.       572.       587.       995.       250.
  10       415.4        -.2     DEPTH         645.       822.       420.      2526.       609.
               *****************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
               *****************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR       DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE         1          2          3          4          5
*************************************************************     ****************************


   1          0          0      DEPTH           0          0          0          0          0
   2        39.8        -.1     DEPTH          90.        66.        67.       135.       123.
   3        97.4        -.2     DEPTH         209.       189.       193.       263.       324.
   4        69.3         .1     DEPTH         284.        69.        39.       249.       196.
   5       122.7        -.1     DEPTH         537.       210.       120.       302.       314.
   6       146.2        -.0     DEPTH         169.       306.       590.       426.       276.
   7        68.3         .1     DEPTH         113.       120.       129.       402.        62.
   8       177.9        -.1     DEPTH         187.       536.       531.       791.       105.
   9       165.0         .0     DEPTH         437.       299.       257.       719.       282.
  10       284.0        -.2     DEPTH         581.       431.       340.      1580.       502.
               *****************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
```

```
              ****************************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE         1         2         3         4         5
***********************************************************        ******************************


    1          0         0     DEPTH          0         0         0         0         0
    2       42.3       -.1     DEPTH        94.       71.       72.      138.      136.
    3      108.6       -.2     DEPTH       220.      200.      215.      303.      375.
~~    4       77.6        .1     DEPTH       404.      121.       80.      101.      233.~~
    5      119.1       -.1     DEPTH        72.      365.      234.      448.      320.
    6      143.0       -.0     DEPTH       194.      153.      382.      733.      267.
    7       94.3        .1     DEPTH       306.      328.      193.      250.       64.
    8      273.6       -.1     DEPTH      1013.      862.      434.      928.       71.
    9      479.3       -.1     DEPTH      1766.      931.      626.     1685.      786.
   10      487.3       -.0     DEPTH       244.     1440.     1311.     2343.      553.

TIME STEP NO. 9
DISCHARGE= .335000E+04



           STEP METHOD COMPUTATIONS



I=     1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      3.8522
CONTROL ELEV.= 2303.5522

I=     2
I=     3
CONTROL AT SECTION     3
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      4.0475
CONTROL ELEV.= 2298.9499

I=     4
I=     5
I=     6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      3.9230
CONTROL ELEV.= 2294.9915

I=     7
I=     8
CONTROL AT SECTION     8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      4.7857
CONTROL ELEV.= 2292.6157

I=     9
I=    10

                 ********************************************
                 *     RESULTS OF BACKWATER COMPUTATIONS    *
                 *       DISCHARGE =    3350.00   C.F.S.    *
                 ********************************************
```

```
STA NO.      STATION     W.S. ELV      AREA       E.G.ELV    FROUDE NO.
*****************************************************************************    **********

  1         4365.0      2303.55     .30196E+03  .23055E+04     1.00
  2         3865.0      2300.62     .40880E+03  .23017E+04      .64
  3         3585.0      2298.95     .30156E+03  .23009E+04     1.00
  4         3380.0      2298.61     .35622E+03  .23000E+04      .79
  5         2940.0      2296.74     .30344E+03  .22987E+04      .99
  6         2440.0      2294.99     .31235E+03  .22968E+04     1.00
  7         2050.0      2294.46     .39516E+03  .22956E+04      .73
  8         1550.0      2292.62     .32241E+03  .22944E+04     1.00
  9          750.0      2289.26     .28599E+03  .22915E+04     1.17
 10             0       2280.42     .18912E+03  .22857E+04     1.82
          ******************************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
          ******************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE        1          2          3          4          5
*********************************************************************    ****************************

                                         0          0          0          0          0
  1         0        0     DEPTH        63.        56.        57.       110.       114.
  2      33.1      -.1     DEPTH       171.       162.       137.       293.       323.
  3      89.9      -.1     DEPTH        51.       149.       124.       170.       194.
  4      56.8       .1     DEPTH       357.       161.       144.       301.       289.
  5     103.6      -.1     DEPTH        45.       373.       268.       534.       225.
  6     119.5      -.0     DEPTH       216.       110.       224.       276.        70.
  7      74.1       .1     DEPTH       564.       357.       401.       740.       143.
  8     182.4      -.1     DEPTH       130.       433.       436.       755.       203.
  9     161.8       .0     DEPTH       411.       733.      1102.       880.       600.
 10     308.2      -.2     DEPTH
          ******************************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
          ******************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE        1          2          3          4          5
*********************************************************************    ****************************

                                         0          0          0          0          0
  1         0        0     DEPTH        67.        52.        52.       105.       106.
  2      31.6      -.1     DEPTH       164.       146.       117.       296.       284.
  3      83.3      -.2     DEPTH        46.       156.       140.       193.       166.
  4      57.9       .1     DEPTH        74.        43.        67.       253.       321.
  5      62.7      -.0     DEPTH       477.       154.        82.       312.       261.
  6     106.4      -.1     DEPTH       122.       134.       215.       257.        52.
  7      64.5       .1     DEPTH       205.       291.       334.       699.       112.
  8     135.7      -.1     DEPTH       120.       463.       405.       562.       204.
  9     145.1      -.0     DEPTH       311.       662.       652.       609.       487.
 10     225.1      -.1     DEPTH
          ******************************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
          ******************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE        1          2          3          4          5
*********************************************************************    ****************************

                                         0          0          0          0          0
  1         0        0     DEPTH        60.        56.        56.       108.       115.
  2      32.6      -.1     DEPTH       170.       164.       130.       294.       326.
  3      89.7      -.1     DEPTH        47.       146.       130.       164.       194.
  4      56.4       .1     DEPTH       415.       129.       120.       252.       301.
  5     100.7      -.1     DEPTH       106.       327.       230.       482.       245.
  6     114.9      -.0     DEPTH       155.       199.       182.       267.        59.
  7      71.3       .1     DEPTH       201.       699.       368.       719.        82.
  8     171.2      -.1     DEPTH       439.       614.       376.       855.       383.
  9     220.6      -.0     DEPTH
```

```
  10      331.4      -.1     DEPTH    1625.     320.     187.    1332.     542.


TIME STEP NO.10
DISCHARGE= .255000E+04


           STEP METHOD COMPUTATIONS


I=     1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      3.2088
CONTROL ELEV.= 2302.9088

I=     2
I=     3
I=     4
I=     5
I=     6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      3.2794
CONTROL ELEV.= 2294.3247

      WSE BEFORE AND AFTER ADJUSTING    .2292965E+04    .2292569E+04S2
I=     7
I=     8
CONTROL AT SECTION     8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      4.1078
CONTROL ELEV.= 2291.8384

I=     9
I=    10


              *******************************************
              *    RESULTS OF BACKWATER COMPUTATIONS    *
              *      DISCHARGE =    2550.00  C.F.S.     *
              *******************************************


 STA NO.      STATION      W.S. ELV      AREA       E.G.ELV   FROUDE NO.
****************************************************************     *********


    1        4365.0      2302.91      .25132E+03   .23045E+04     1.00
    2        3865.0      2299.64      .33606E+03   .23005E+04      .65
    3        3585.0      2298.24      .25811E+03   .22998E+04      .96
    4        3380.0      2297.79      .28431E+03   .22990E+04      .84
    5        2940.0      2296.11      .25801E+03   .22976E+04      .96
    6        2440.0      2294.44      .26900E+03   .22959E+04      .95
    7        2050.0      2293.70      .32432E+03   .22947E+04      .72
    8        1550.0      2291.84      .26304E+03   .22934E+04     1.00
    9         750.0      2288.68      .24217E+03   .22905E+04     1.06
   10             0      2279.68      .15363E+03   .22843E+04     1.86
           *************************************************
           *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
           *************************************************
 STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)       FT.   OF CHANGE          1          2          3          4          5
```

```
**********************************************************          ********************************

  1         0          0      DEPTH         0         0         0         0         0
  2      25.5        -.0      DEPTH       44.       43.       43.       83.       95.
  3      65.0        -.1      DEPTH      138.       97.      104.      200.      246.
  4      67.9        -.0      DEPTH      263.      122.      100.      167.      169.
  5      73.4        -.0      DEPTH      173.      149.      124.      213.      228.
  6      99.4        -.0      DEPTH      488.      117.      128.      290.      179.
  7      46.7         .1      DEPTH       37.      122.      145.      207.       53.
  8     115.5        -.1      DEPTH      167.      244.      308.      545.      131.
  9     143.9        -.0      DEPTH      636;      234.      258.      469.      144.
 10     271.5        -.1      DEPTH      871.      465.      310.     1099.      537.
          *************************************************************
          *     SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2   *
          *************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE          1        2        3         4         5
**********************************************************          ********************************

  1         0          0      DEPTH         0         0         0         0         0
  2      24.7        -.1      DEPTH       48.       40.       40.       80.       89.
  3      62.9        -.1      DEPTH      134.      120.      104.      183.      219.
  4      65.7        -.0      DEPTH      253.      112.       92.      190.      148.
  5      51.5         .0      DEPTH       16.      121.       93.      149.      243.
  6      58.4        -.0      DEPTH       95.       72.       86.      239.      213.
  7      64.8        -.0      DEPTH      370.       91.      106.      171.       46.
  8      97.9        -.0      DEPTH      108.      210.      264.      498.      103.
  9     104.5        -.0      DEPTH      209.      217.      233.      445.      159.
 10     179.2        -.1      DEPTH      337.      338.      222.      845.      424.
          *************************************************************
          *     SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3   *
          *************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE          1        2        3         4         5
**********************************************************          ********************************

  1         0          0      DEPTH         0         0         0         0         0
  2      25.2        -.0      DEPTH       43.       42.       42.       82.       95.
  3      64.8        -.1      DEPTH      138.       94.      105.      199.      248.
  4      67.8        -.0      DEPTH      264.      122.       99.      164.      170.
  5      69.9        -.0      DEPTH      159.      141.      119.      191.      236.
  6      97.9        -.0      DEPTH      515.      112.      111.      256.      189.
  7      50.1         .1      DEPTH       74.      155.      127.      201.       48.
  8     125.2        -.1      DEPTH      196.      455.      272.      511.       79.
  9     108.5         .0      DEPTH      132.      351.      201.      434.      194.
 10     249.3        -.1      DEPTH      166.      817.      590.      889.      551.

TIME STEP NO.11
DISCHARGE= .195000E+04



          STEP METHOD COMPUTATIONS


I=     1
CONTROL AT SECTION     1
CONTROL TYPE =   NATURAL
CONTROL DEPTH=      2.6823
CONTROL ELEV.= 2302.6823
```

```
I=     2
I=     3
I=     4
I=     5
I=     6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      2.7693
CONTROL ELEV.= 2293.7749

      WSE BEFORE AND AFTER ADJUSTING    .2292615E+04   .2292167E+04S2
I=     7
I=     8
CONTROL AT SECTION     8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      3.5401
CONTROL ELEV.= 2291.2031

I=     9
I=    10

                  ******************************************
                  *    RESULTS OF BACKWATER COMPUTATIONS   *
                  *      DISCHARGE =    1950.00  C.F.S.    *
                  ******************************************


 STA NO.      STATION     W.S. ELV      AREA       E.G.ELV    FROUDE NO.
*************************************************************     ********


    1          4365.0     2302.38     .20994E+03  .23037E+04     1.00
    2          3865.0     2298.81     .27465E+03  .22996E+04      .67
    3          3585.0     2297.78     .23098E+03  .22989E+04      .87
    4          3380.0     2297.21     .23802E+03  .22983E+04      .84
    5          2940.0     2295.62     .22018E+03  .22969E+04      .93
    6          2440.0     2293.91     .22716E+03  .22951E+04      .93
    7          2050.0     2293.08     .26845E+03  .22939E+04      .72
    8          1550.0     2291.20     .21595E+03  .22925E+04     1.00
    9           750.0     2288.20     .20722E+03  .22897E+04     1.01
   10               0     2279.03     .12549E+03  .22832E+04     1.90
              **********************************************************
              *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
              **********************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1         2          3         4         5
*****************************************************       ***************************


    1           0          0      DEPTH          0         0          0         0         0
    2        20.9        -.0      DEPTH        35.       35.        34.       66.       82.
    3        41.6        -.1      DEPTH       101.       61.        60.      120.      161.
    4        35.7         .0      DEPTH         5.       79.        75.      129.      144.
    5        54.5        -.0      DEPTH       177.       92.        79.      138.      172.
    6        53.6         .0      DEPTH        72.      115.       103.      208.      150.
    7        49.1         .0      DEPTH       256.       75.        87.      136.       40.
    8        87.7        -.0      DEPTH       148.      183.       221.      392.      115.
    9        68.9         .0      DEPTH        32.      166.       188.      335.      112.
   10       188.1        -.1      DEPTH       239.      370.       502.      686.      477.
              **********************************************************
              *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
              **********************************************************
  STA   TOTAL LOAD   CHANGE   DIRECTN    SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.   OF CHANGE          1         2          3         4         5
*****************************************************       ***************************
```

```
  1          0          0      DEPTH         0         0         0         0         0
  2       20.0        -.0      DEPTH       35.       33.       33.       64.       78.
  3       39.1        -.1      DEPTH       98.       52.       58.      118.      146.
  4       35.7         .0      DEPTH        6.       88.       73.      137.      128.
  5       54.7        -.0      DEPTH      247.       72.       59.      108.      174.
  6       40.4         .0      DEPTH       17.       80.       67.      148.      176.
  7       34.7         .0      DEPTH       92.       67.       79.      137.       44.
  8       96.5        -.1      DEPTH      434.      141.      170.      335.       87.
  9       62.1         .1      DEPTH        4.      142.      168.      316.      121.
 10      134.3        -.1      DEPTH      124.      263.      406.      460.      371.
           ****************************************************************
           *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3            *
           ****************************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE          1         2         3         4         5
****************************************************************   ******************************


  1          0          0      DEPTH         0         0         0         0         0
  2       20.6        -.0      DEPTH       35.       34.       34.       65.       82.
  3       41.5        -.1      DEPTH      101.       60.       60.      119.      161.
  4       35.8         .0      DEPTH        8.       78.       75.      127.      145.
  5       54.1        -.0      DEPTH      188.       88.       75.      125.      178.
  6       50.8         .0      DEPTH       69.      107.       94.      186.      158.
  7       49.8         .0      DEPTH      262.       91.       78.      132.       38.
  8       87.3        -.0      DEPTH       81.      324.      203.      374.       73.
  9       79.6         .0      DEPTH      141.      242.      148.      295.      136.
 10      181.6        -.1      DEPTH      343.      393.      251.      695.      514.


TIME STEP NO.12
DISCHARGE= .150000E+04


           STEP METHOD COMPUTATIONS


I=      1
CONTROL AT SECTION      1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       2.2582
CONTROL ELEV.= 2301.9582

I=      2
I=      3
I=      4
I=      5
I=      6
CONTROL AT SECTION      6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       2.3698
CONTROL ELEV.= 2293.3769

       WSE BEFORE AND AFTER ADJUSTING    .2292185E+04    .2291780E+04S2
I=      7
I=      8
CONTROL AT SECTION      8
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       3.0413
CONTROL ELEV.= 2290.6640
```

```
I=     9
I=    10

                    *********************************************
                    *    RESULTS OF BACKWATER COMPUTATIONS      *
                    *      DISCHARGE =    1500.00  C.F.S.       *
                    *********************************************

 STA NO.      STATION     W.S. ELV     AREA       E.G.ELV   FROUDE NO.
*****************************************************************      *********


    1          4365.0     2301.96     .17665E+03  .23031E+04     1.00
    2          3865.0     2296.96     .13193E+03  .22990E+04     1.56
    3          3585.0     2297.43     .20859E+03  .22982E+04      .78
    4          3380.0     2296.65     .19169E+03  .22976E+04      .90
    5          2940.0     2295.39     .20441E+03  .22962E+04      .80
    6          2440.0     2293.38     .18141E+03  .22945E+04     1.00
    7          2050.0     2292.56     .22665E+03  .22933E+04      .70
    8          1550.0     2290.66     .17790E+03  .22918E+04     1.00
    9           750.0     2287.75     .17379E+03  .22890E+04     1.00
   10               0     2278.48     .10287E+03  .22822E+04     1.93
               *********************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1    *
               *********************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)       FT.  OF CHANGE         1         2         3         4         5
*************************************************************      *****************************


    1          0         0     DEPTH         0         0         0         0         0
    2      105.7       -.2     DEPTH       58.      183.      251.      390.      397.
    3       23.2        .2     DEPTH       41.       35.       35.       70.      100.
    4       41.5       -.0     DEPTH      140.       62.       60.      106.      134.
    5       23.6        .0     DEPTH       21.       47.       42.       75.      100.
    6       55.3       -.1     DEPTH      166.       98.       87.      171.      146.
    7       28.7        .5     WIDTH      100.       55.       61.       98.       32.
    8       79.1       -.1     DEPTH      295.      128.      155.      281.       97.
    9       57.0        .0     DEPTH      106.      119.      136.      240.       88.
   10      153.0       -.1     DEPTH      297.      310.      251.      575.      416.
               *********************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2    *
               *********************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)       FT.  OF CHANGE         1         2         3         4         5
*************************************************************      *****************************


    1          0         0     DEPTH         0         0         0         0         0
    2       89.6       -.2     DEPTH       44.      134.      183.      368.      353.
    3       23.0        .3     DEPTH       50.       34.       34.       68.       92.
    4       40.4       -.0     DEPTH      144.       57.       57.      110.      120.
    5       20.2        .0     DEPTH        3.       40.       33.       62.      106.
    6       52.7       -.1     DEPTH      228.       70.       59.      121.      160.
    7       21.6        .1     DEPTH       28.       48.       53.       95.       37.
    8       55.9       -.1     DEPTH       75.      118.      136.      267.       79.
    9       78.5       -.0     DEPTH      431.      108.      111.      212.       88.
   10      143.4       -.1     DEPTH      547.      224.      166.      473.      323.
               *********************************************************
               *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3    *
               *********************************************************
  STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)       FT.  OF CHANGE         1         2         3         4         5
*************************************************************      *****************************
```

```
                                                                0         0         0         0         0
  1          0          0     DEPTH          62.      195.      246.      370.      409.
  2      106.1        -.2     DEPTH          39.       35.       34.       68.      100.
  3       22.8         .2     DEPTH         137.       61.       60.      105.      135.
  4       41.1        -.0     DEPTH          20.       45.       40.       70.      102.
  5       22.9         .0     DEPTH         185.       91.       79.      151.      153.
  6       54.5        -.0     DEPTH         109.       64.       56.       95.       31.
  7       29.3         .5     WIDTH         257.      223.      144.      267.       64.
  8       79.0        -.1     DEPTH          47.      193.      116.      221.      105.
  9       56.4         .0     DEPTH         222.      333.      251.      502.      455.
 10      145.9        -.1     DEPTH

TIME STEP NO.13
DISCHARGE= .115000E+04



           STEP METHOD COMPUTATIONS


I=    1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      1.8926
CONTROL ELEV.= 2301.5926

I=    2
I=    3
I=    4
I=    5
I=    6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      2.0114
CONTROL ELEV.= 2292.9625

I=    7
I=    8
I=    9
CONTROL AT SECTION     9
CONTROL TYPE =    NATURAL
CONTROL DEPTH=      2.8070
CONTROL ELEV.= 2287.3486

I=   10

                 ******************************************
                 *    RESULTS OF BACKWATER COMPUTATIONS   *
                 *       DISCHARGE =    1150.00  C.F.S.   *
                 ******************************************

 STA NO.       STATION      W.S. ELV       AREA        E.G.ELV   FROUDE NO.
*****************************************************************************************


     1          4365.0      2301.59     .14798E+03   .23025E+04      1.00
     2          3865.0      2298.26     .24923E+03   .22986E+04       .46
     3          3585.0      2296.95     .15270E+03   .22978E+04       .96
     4          3380.0      2296.33     .16961E+03   .22971E+04       .83
     5          2940.0      2294.88     .16336E+03   .22957E+04       .85
     6          2440.0      2293.08     .16092E+03   .22939E+04       .91
```

```
  7        2050.0     2291.92     .17319E+03  .22926E+04      .79
  8        1550.0     2290.36     .15923E+03  .22912E+04      .89
  9         750.0     2287.35     .14504E+03  .22884E+04     1.00
 10             0     2278.00     .84177E+02  .22813E+04     1.96
          *************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
          *************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE         1         2         3         4         5
*****************************************************      *****************************


  1         0         0      DEPTH         0         0         0         0         0
  2       3.9       -.0      DEPTH       14.        5.        4.       11.       15.
  3      36.4       -.1      DEPTH       44.       77.       86.      127.      106.
  4      18.5        .0      DEPTH        3.       33.       33.       61.       94.
  5      27.5       -.0      DEPTH       93.       43.       38.       66.       92.
  6      29.3       -.0      DEPTH       42.       56.       52.      103.      102.
  7      30.8       -.0      DEPTH      114.       59.       64.      100.       35.
  8      38.1       -.0      DEPTH       88.       70.       83.      156.       64.
  9      49.8       -.0      DEPTH      180.       85.       98.      171.       69.
 10     129.9       -.1      DEPTH      333.      210.      242.      435.      351.
          *************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
          *************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE         1         2         3         4         5
*****************************************************      *****************************


  1         0         0      DEPTH         0         0         0         0         0
  2       4.0       -.0      DEPTH       15.        5.        4.       10.       15.
  3      34.0       -.1      DEPTH       29.       68.       77.      140.       97.
  4      17.8        .0      DEPTH        4.       30.       31.       64.       86.
  5      27.3       -.0      DEPTH      108.       38.       32.       57.       96.
  6      24.6        .0      DEPTH       29.       42.       37.       76.      114.
  7      30.2       -.0      DEPTH      138.       50.       50.       88.       40.
  8      29.2        .0      DEPTH       24.       61.       70.      147.       52.
  9      35.9       -.0      DEPTH        2.       88.       93.      176.       76.
 10      91.9       -.1      DEPTH      105.      190.      212.      328.      277.
          *************************************************
          *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
          *************************************************
 STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR     DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.   (T/DAY)      FT.  OF CHANGE         1         2         3         4         5
*****************************************************      *****************************


  1         0         0      DEPTH         0         0         0         0         0
  2       3.7       -.0      DEPTH       12.        4.        4.       11.       14.
  3      35.8       -.1      DEPTH       48.       78.       81.      118.      108.
  4      18.4        .0      DEPTH        3.       32.       33.       61.       94.
  5      26.5       -.0      DEPTH       86.       42.       37.       61.       94.
  6      26.9       -.0      DEPTH       32.       51.       47.       90.      105.
  7      31.5       -.0      DEPTH      124.       69.       59.       96.       34.
  8      38.8       -.0      DEPTH       80.      119.       78.      149.       43.
  9      52.3       -.0      DEPTH      174.      138.       84.      157.       79.
 10     133.8       -.1      DEPTH      323.      277.      211.      404.      402.

TIME STEP NO.14
DISCHARGE= .950000E+03
```

```
STEP METHOD COMPUTATIONS


I=     1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       1.6660
CONTROL ELEV.= 2301.3660

I=     2
I=     3
I=     4
I=     5
I=     6
CONTROL AT SECTION     6
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       1.7923
CONTROL ELEV.= 2292.7448

I=     7
I=     8
I=     9
CONTROL AT SECTION     9
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       2.5495
CONTROL ELEV.= 2287.0803

I=    10


                 ******************************************
                 *     RESULTS OF BACKWATER COMPUTATIONS   *
                 *       DISCHARGE =     950.00  C.F.S.    *
                 ******************************************


 STA NO.      STATION      W.S. ELV      AREA        E.G.ELV    FROUDE NO.
*****************************************************************************      *********


   1         4365.0      2301.37      .13022E+03  .23022E+04       1.00
   2         3865.0      2297.74      .20902E+03  .22981E+04        .49
   3         3585.0      2296.80      .14817E+03  .22974E+04        .83
   4         3380.0      2296.05      .14362E+03  .22967E+04        .88
   5         2940.0      2294.82      .16021E+03  .22954E+04        .72
   6         2440.0      2292.74      .13322E+03  .22935E+04       1.00
   7         2050.0      2291.64      .15292E+03  .22923E+04        .78
   8         1550.0      2290.12      .14136E+03  .22909E+04        .87
   9          750.0      2287.08      .12739E+03  .22880E+04       1.00
  10            0        2277.67      .72811E+02  .22807E+04       1.99
              ****************************************************
              *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1  *
              ****************************************************
 STA   TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR        DIFFERENT SIZE FRACTIONS (CU.FT)
 NO.    (T/DAY)      FT.   OF CHANGE        1         2          3          4          5
*******************************************************************  ******************************


   1         0        0     DEPTH           0         0          0          0          0
   2       4.0      -.0     DEPTH         14.        5.         4.        11.        15.
   3      17.1      -.0     DEPTH          7.       30.        37.        62.        71.
   4      21.3      -.0     DEPTH         33.       39.        38.        61.        87.
   5      11.7       .0     DEPTH         16.       20.        19.        35.        52.
   6      35.0      -.0     DEPTH        103.       57.        53.       101.       109.
   7      21.8       .0     DEPTH         61.       46.        48.        77.        31.
   8      30.0      -.0     DEPTH         82.       53.        62.       116.        51.
```

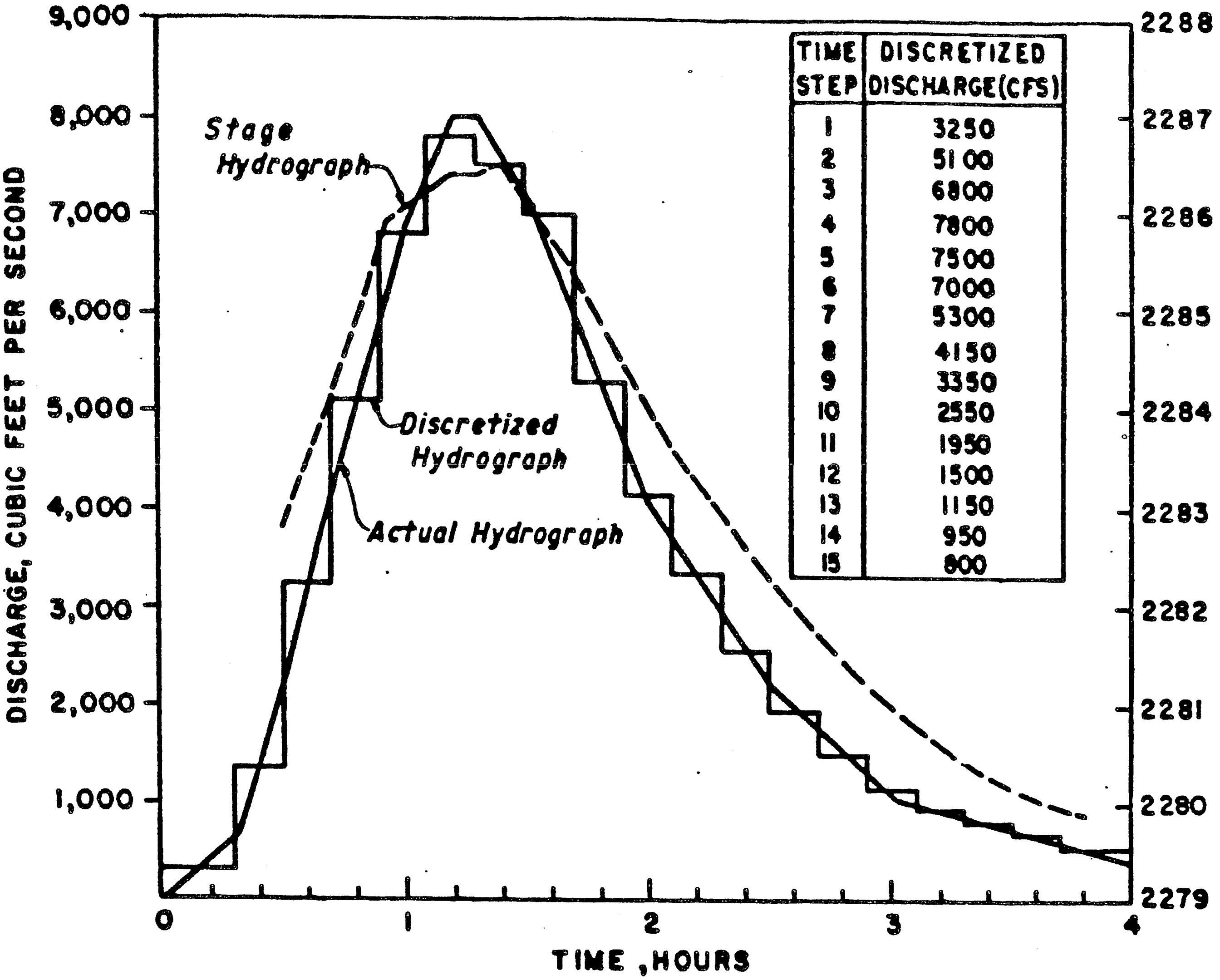
```
    9      37.0       -.0     DEPTH     103.      68.      78.     138.      60.
   10     .105.8      -.1     DEPTH     233.     187.     191.     361.     308.
              ********************************************
              *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2  *
              ********************************************
  STA   TOTAL LOAD   CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.  OF CHANGE         1         2         3         4         5
*********************************************************      ******************************


    1         0         0     DEPTH       0         0        0        0         0
    2       4.1       -.0     DEPTH      15.        6.       4.      10.       15.
    3      15.9       -.0     DEPTH       6.       24.      31.      64.       67.
    4      20.6       -.0     DEPTH      29.       37.      37.      68.       78.
    5      11.0        .0     DEPTH      13.       18.      16.      31.       55.
    6      32.4       -.0     DEPTH     119.       43.      37.      73.      121.
    7      20.0        .0     DEPTH      59.       39.      39.      69.       35.
    8      25.9       -.0     DEPTH      73.       44.      50.     105.       41.
    9      30.1       -.0     DEPTH      20.       65.      72.     140.       66.
   10      79.4       -.1     DEPTH     110.      155.     144.     303.      248.
              ********************************************
              *    SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3  *
              ********************************************
  STA   TOTAL LOAD   CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.    (T/DAY)       FT.  OF CHANGE         1         2         3         4         5
*********************************************************      ******************************


    1         0         0     DEPTH       0         0        0        0         0
    2       3.8       -.0     DEPTH      12.        5.       4.      10.       15.
    3      16.6       -.0     DEPTH       6.       30.      35.      58.       70.
    4      21.2       -.0     DEPTH      35.       38.      37.      59.       87.
    5      11.6        .0     DEPTH      17.       20.      18.      32.       53.
    6      31.4       -.0     DEPTH      83.       51.      46.      86.      114.
    7      22.2        .0     DEPTH      66.       52.      45.      74.       30.
    8      30.8       -.0     DEPTH      79.       88.      59.     112.       35.
    9      38.0       -.0     DEPTH      87.      110.      68.     127.       68.
   10     113.6       -.1     DEPTH     224.      237.     188.     354.      371.

TIME STEP NO.15
DISCHARGE= .800000E+03



             STEP METHOD COMPUTATIONS


I=      1
CONTROL AT SECTION     1
CONTROL TYPE =    NATURAL
CONTROL DEPTH=       1.4832
CONTROL ELEV.= 2301.1832

I=      2
I=      3
I=      4
I=      5
I=      6
I=      7
I=      8
I=      9
CONTROL AT SECTION     9
CONTROL TYPE =    NATURAL
```

```
CONTROL DEPTH=      2.3489
CONTROL ELEV.= 2286.8729

I=    10

                    ******************************************
                    *   RESULTS OF BACKWATER COMPUTATIONS    *
                    *     DISCHARGE =     800.00  C.F.S.     *
                    ******************************************

 STA NO.     STATION     W.S. ELV     AREA       E.G.ELV    FROUDE NO.     *********
********************************************************************************

                                                                 1.00
    1         4365.0     2301.18     .11591E+03   .23019E+04      .49
    2         3865.0     2297.47     .18798E+03   .22978E+04      .81
    3         3585.0     2296.58     .13405E+03   .22971E+04      .83
    4         3380.0     2295.91     .13331E+03   .22965E+04      .82
    5         2940.0     2294.45     .13088E+03   .22950E+04      .88
    6         2440.0     2292.66     .12933E+03   .22933E+04      .78
    7         2050.0     2291.42     .13532E+03   .22920E+04      .85
    8         1550.0     2289.91     .12680E+03   .22906E+04     1.00
    9          750.0     2286.87     .11377E+03   .22877E+04     2.03
   10             0      2277.39     .63751E+02   .22802E+04
                 ***********************************************************
                 *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  1       *
                 ***********************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE        1        2         3        4        5
                                                           ****************************
**************************************************************************

                                           0        0        0        0        0
   1          0         0     DEPTH       10.       4.       3.       8.      12.
   2        3.1       -.0     DEPTH       12.      21.      26.      45.      60.
   3       13.5       -.0     DEPTH        9.      25.      26.      43.      65.
   4       13.9       -.0     DEPTH       27.      27.      24.      41.      64.
   5       15.1       -.0     DEPTH       28.      32.      31.      61.      71.
   6       18.3       -.0     DEPTH       62.      37.      39.      63.      27.
   7       18.8       -.0     DEPTH       59.      40.      47.      88.      41.
   8       22.8       -.0     DEPTH       73.      53.      61.     110.      54.
   9       29.0       -.0     DEPTH      186.     153.     163.     306.     274.
  10       89.4       -.1     DEPTH
                 ***********************************************************
                 *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  2       *
                 ***********************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE        1        2         3        4        5
                                                           ****************************
**************************************************************************

                                           0        0        0        0        0
   1          0         0     DEPTH       11.       4.       3.       7.      12.
   2        3.1       -.0     DEPTH       14.      17.      22.      45.      57.
   3       12.8       -.0     DEPTH        3.      23.      25.      48.      60.
   4       13.2       -.0     DEPTH       24.      24.      21.      37.      67.
   5       14.3       -.0     DEPTH       20.      25.      23.      45.      78.
   6       15.8       -.0     DEPTH       70.      31.      31.      55.      32.
   7       18.1       -.0     DEPTH       53.      35.      40.      82.      35.
   8       20.3       -.0     DEPTH       53.      49.      56.     111.      57.
   9       27.0       -.0     DEPTH      133.     128.     136.     259.     222.
  10       72.6       -.1     DEPTH
                 ***********************************************************
                 *   SEDIMENT ROUTING RESULTS FOR STREAM TUBE NO.  3       *
                 ***********************************************************
  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR      DIFFERENT SIZE FRACTIONS (CU.FT)
  NO.   (T/DAY)      FT.  OF CHANGE        1        2         3        4        5
```

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA    AAAAAAAAAAAAAAAAAAAAAAAAAAAAA

   1        0        0    DEPTH      0      0      0      0      0
   2      2.9      -.0    DEPTH     9.     4.     3.     8.    12.
   3     12.9      -.0    DEPTH    10.    21.    25.    42.    58.
   4     13.6      -.0    DEPTH     8.    25.    25.    42.    65.
   5     14.9      -.0    DEPTH    28.    26.    23.    38.    65.
   6     16.9      -.0    DEPTH    29.    28.    26.    50.    71.
   7     18.6      -.0    DEPTH    59.    42.    37.    60.    27.
   8     24.1      -.0    DEPTH    60.    68.    47.    87.    30.
   9     30.3      -.0    DEPTH    66.    86.    54.   102.    58.
  10    104.1      -.1    DEPTH   194.   215.   173.   325.   351.
.17.43.UCLP, CA, H9H7C11,      2.304KLNS.EA
```

# APPENDIX D

## Input Hydrograph Figure



| TIME STEP | DISCRETIZED DISCHARGE(CFS) |
|---|---|
| 1 | 3250 |
| 2 | 5100 |
| 3 | 6800 |
| 4 | 7800 |
| 5 | 7500 |
| 6 | 7000 |
| 7 | 5300 |
| 8 | 4150 |
| 9 | 3350 |
| 10 | 2550 |
| 11 | 1950 |
| 12 | 1500 |
| 13 | 1150 |
| 14 | 950 |
| 15 | 800 |

Fig. A-1. - Stage and discharge hydrographs at the downstream end of the study reach.

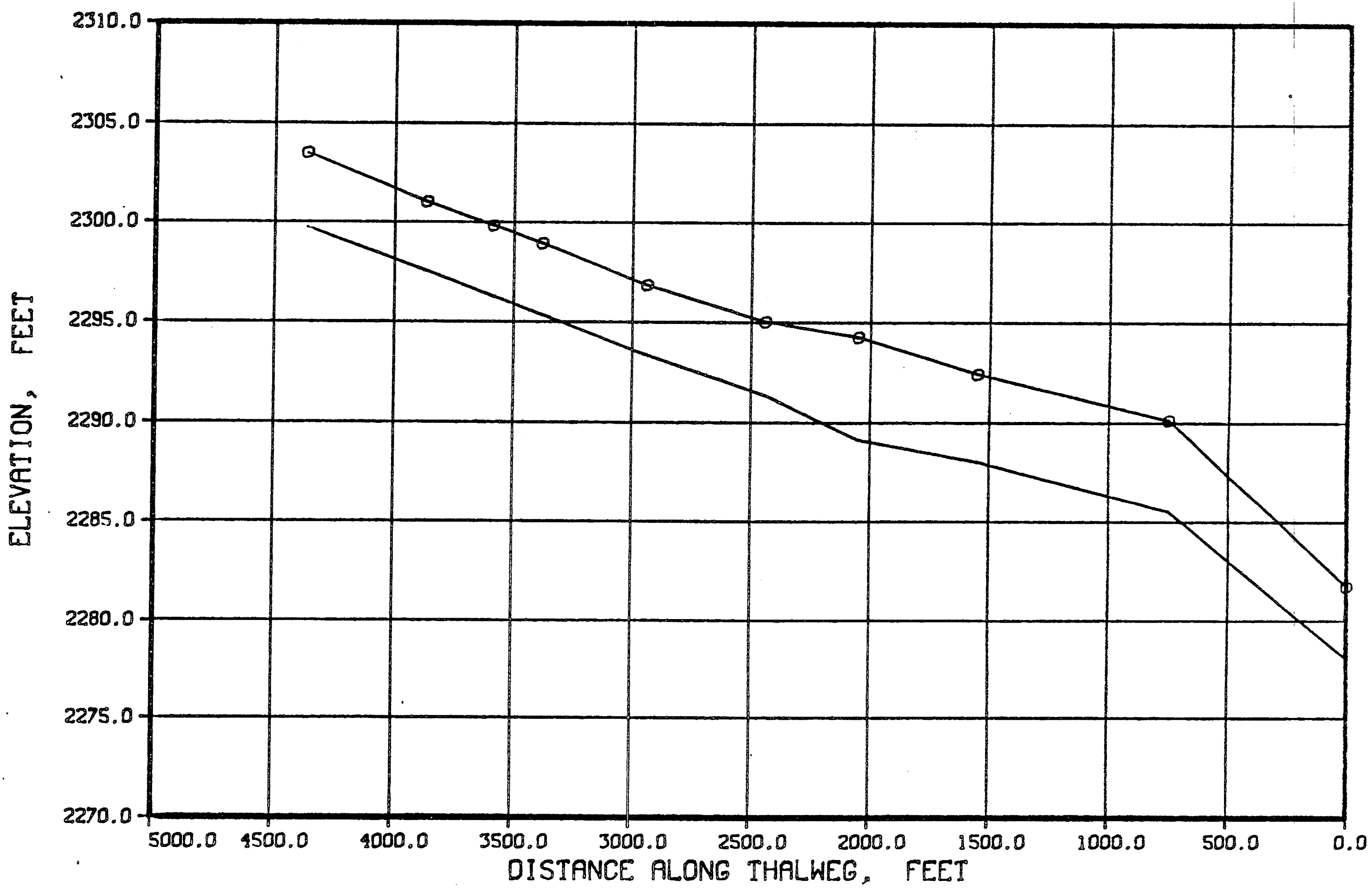
# APPENDIX E

## Figures A-2 through A-26

PLOT 1 16.28.13 WED 31 DEC. 1986 JOB-F006439 , UCC DISSPLA 9.0

FIG. A-2

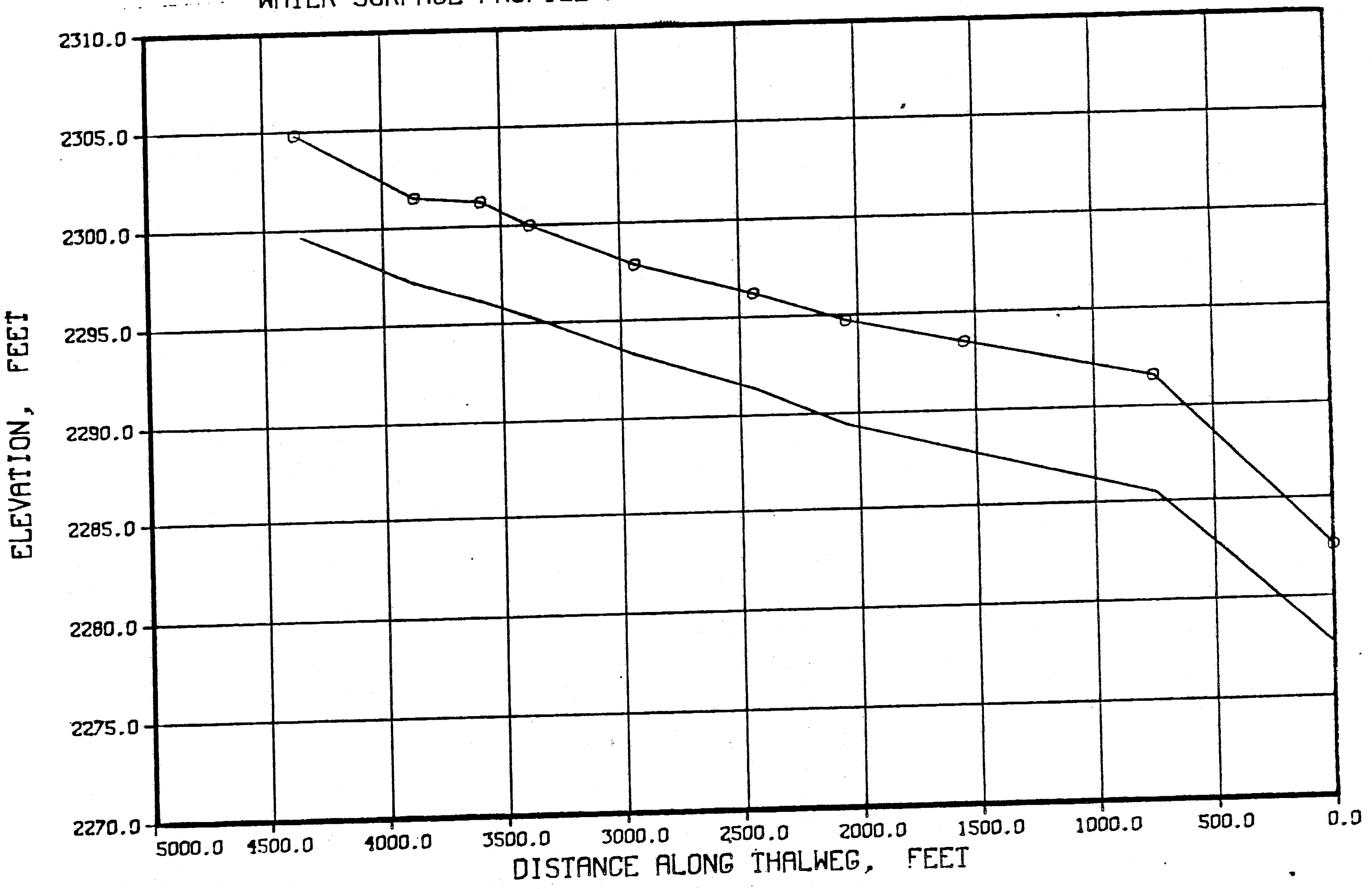
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 1 DISCH- 3250 CFS



PLOT 2 16.28.16 WED 31 DEC, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

Fig. A-3

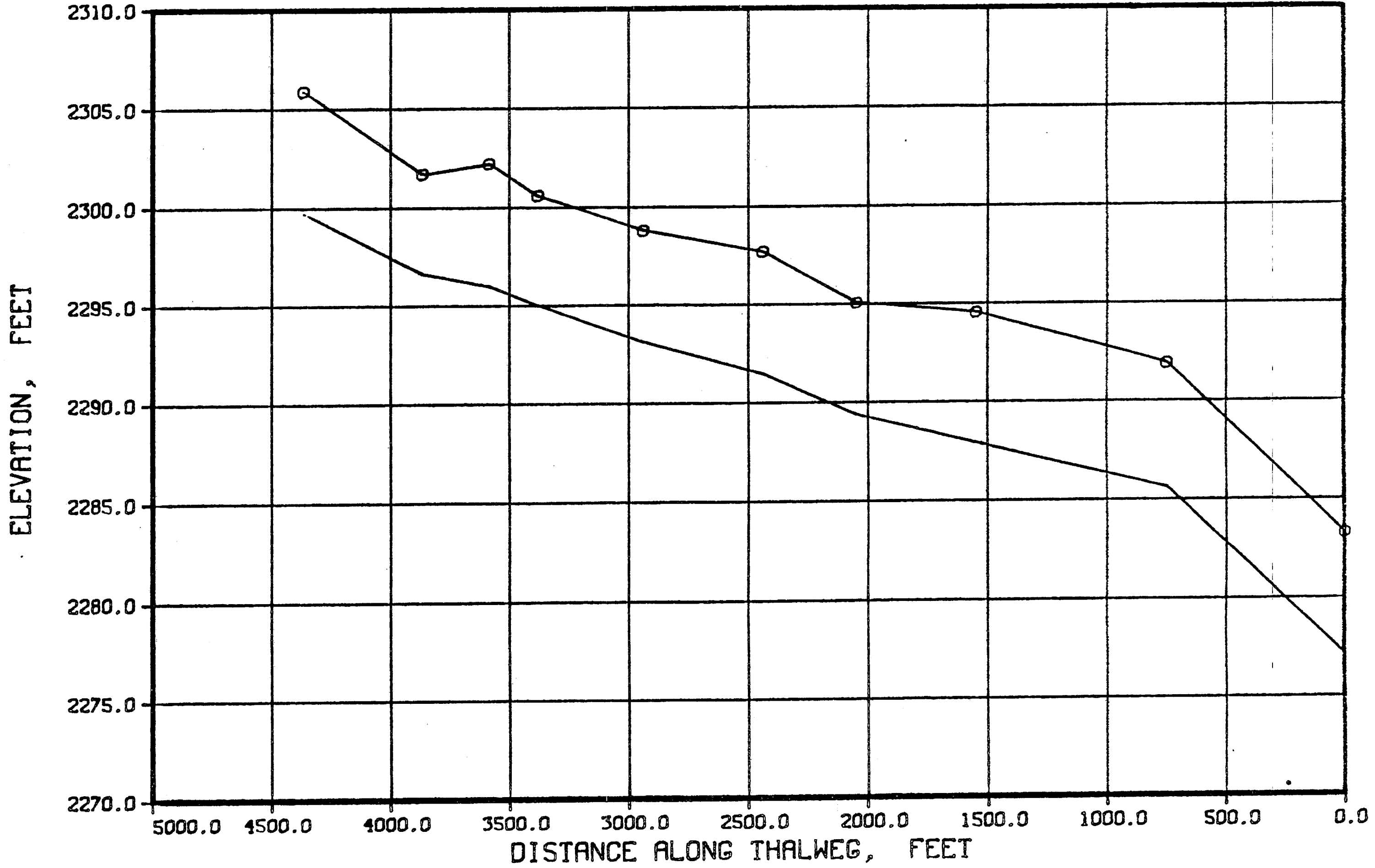
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 2 DISCH- 5100 CFS



PLOT 3 16.28.18 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-4

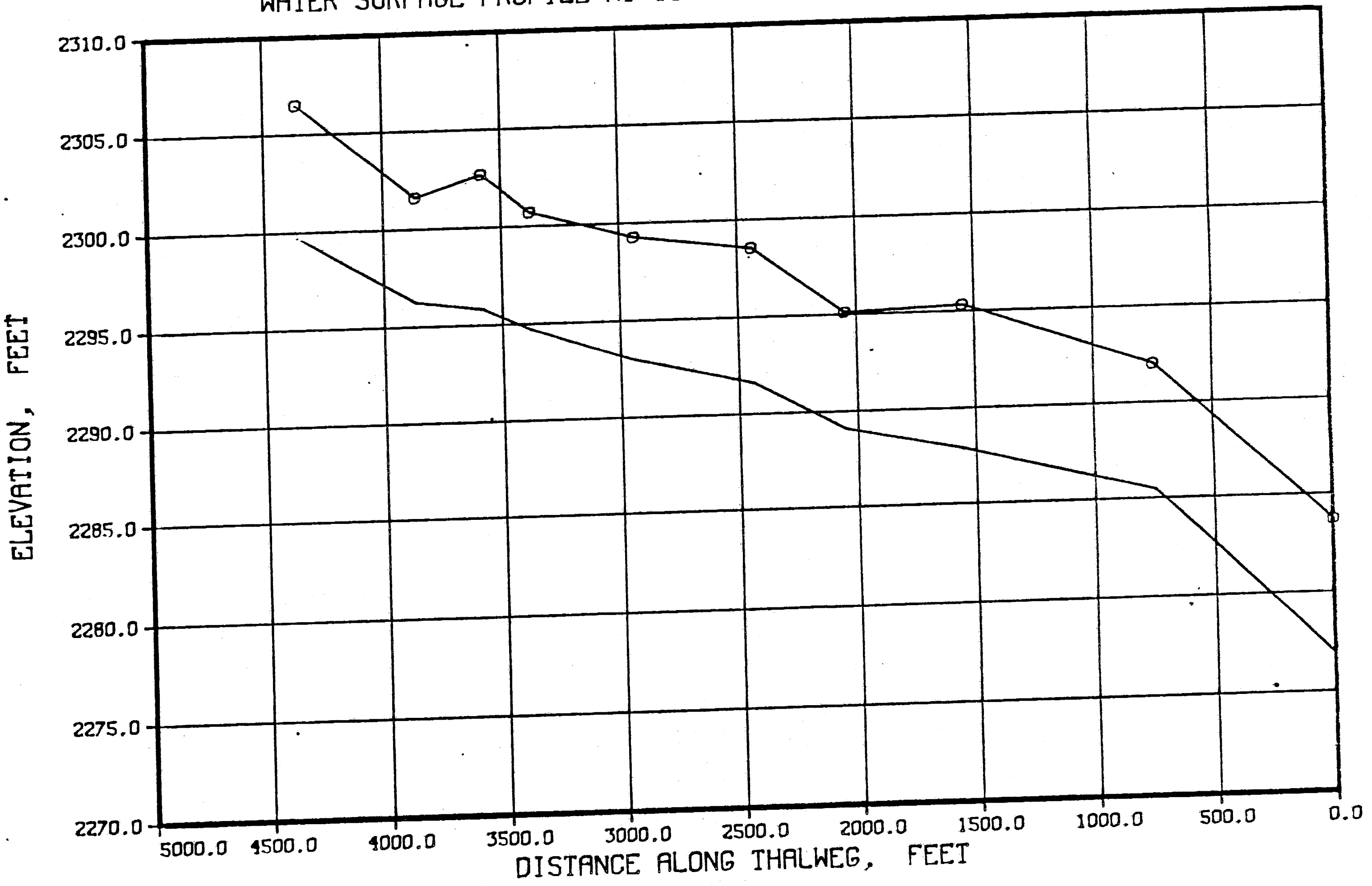
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 3 DISCH- 6800 CFS



PLOT 1 16.28.20 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-5

EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 4. DISCH- 7800 CFS



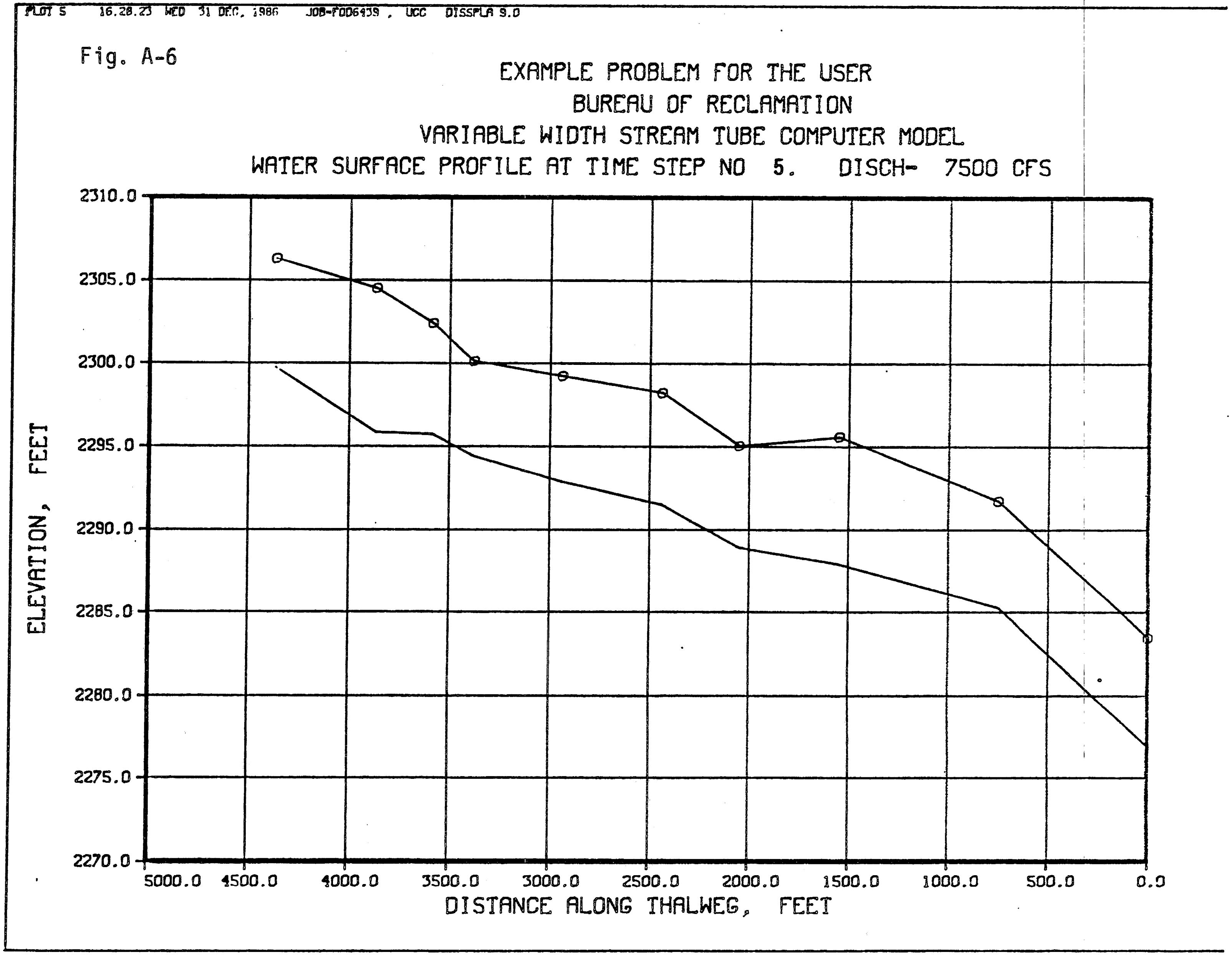

PLOT 5 16.28.23 WED 31 DEC, 1986 JOB-F006939 , UCC DISSPLA 9.0
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 5. DISCH- 7500 CFS
2310.0
2305.0
2300.0
2295.0
2290.0
2285.0
2280.0
2275.0
2270.0
ELEVATION, FEET
5000.0
4500.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
DISTANCE ALONG THALWEG, FEET

Fig. A-6

PLOT 6 16.28.25 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-7

EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 6. DISCH- 7000 CFS

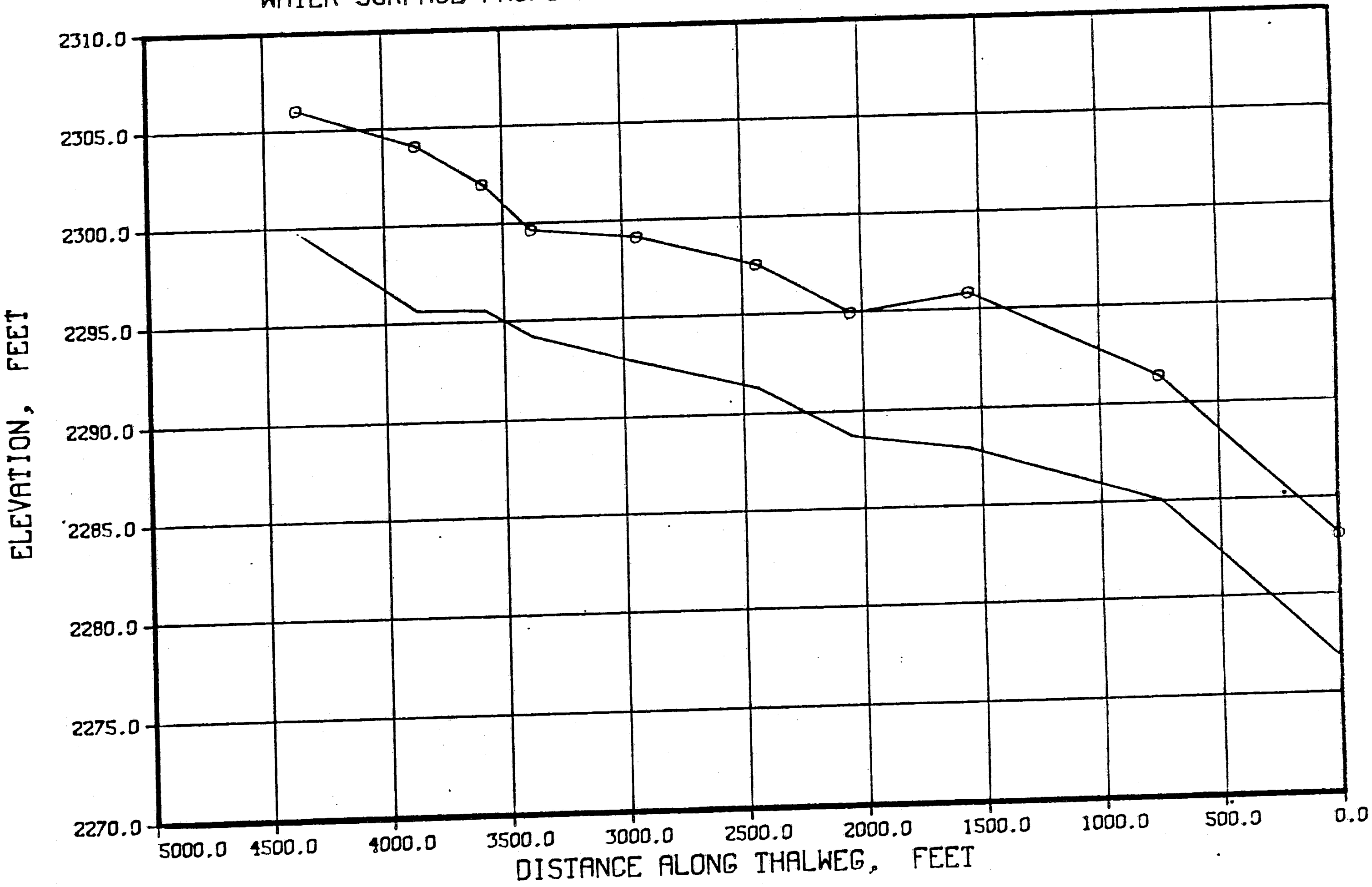
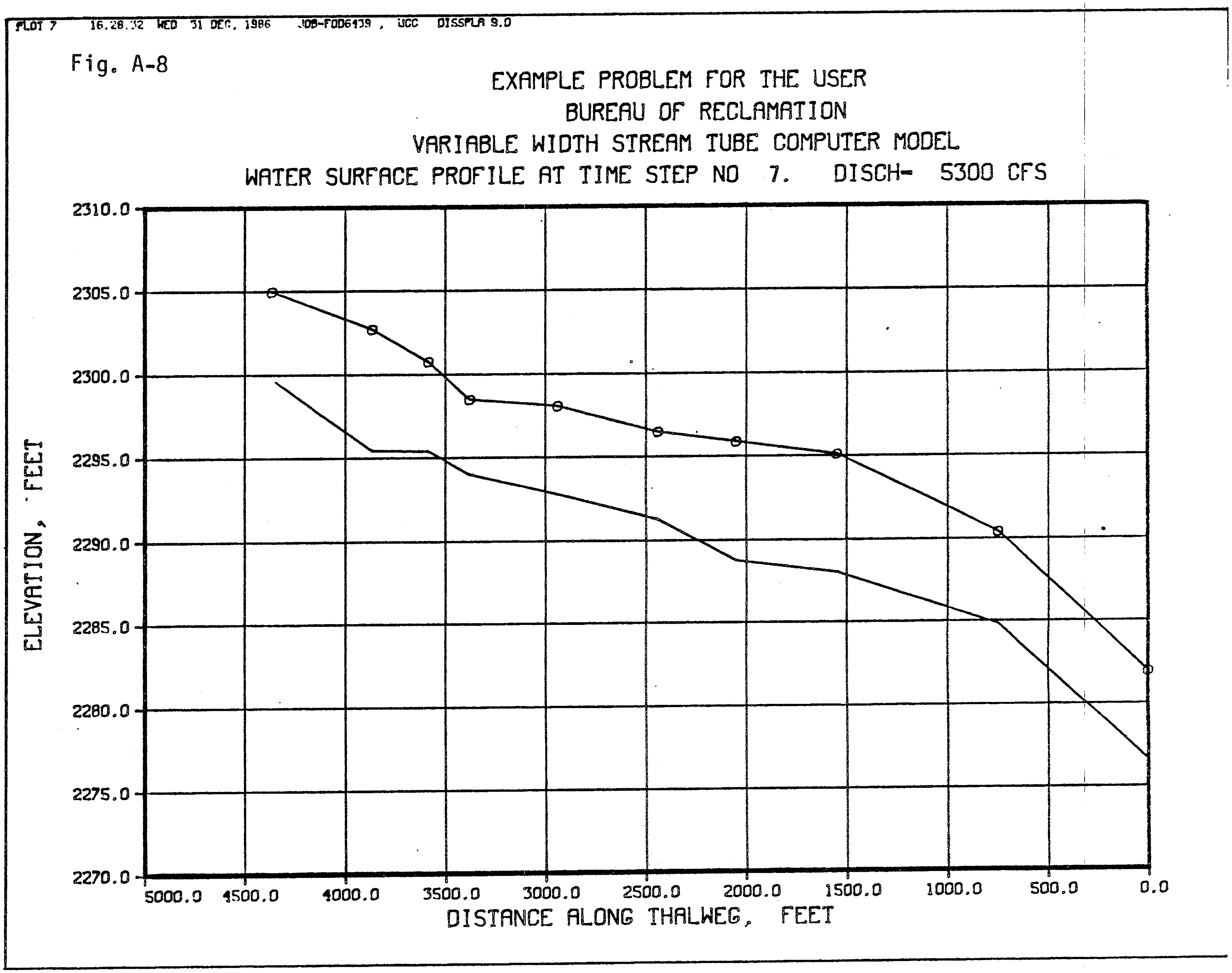


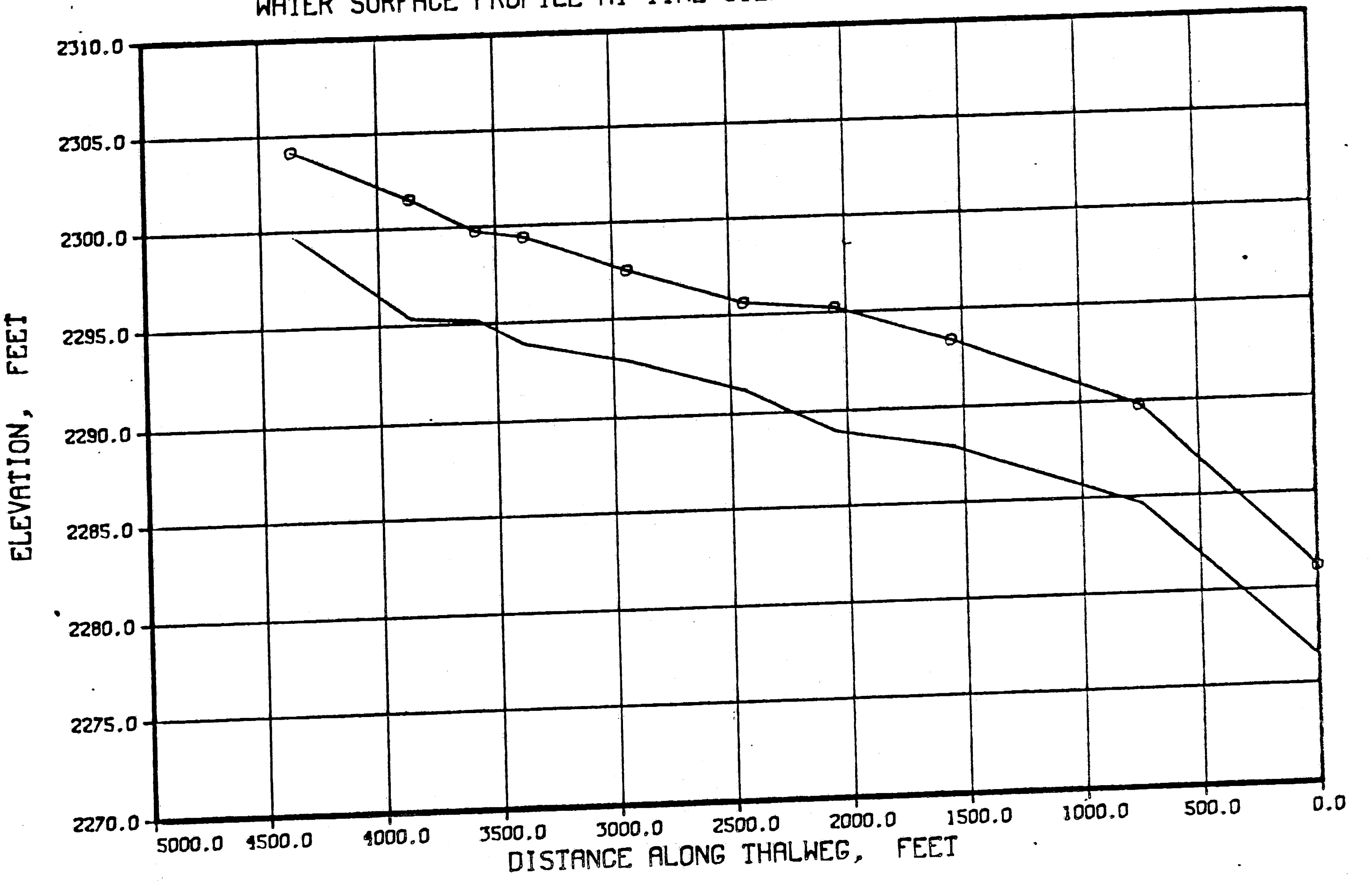
Fig. A-8


PLOT 7 16.28.32 WED 31 DEC. 1986 JOB-FOD6439 , UCC DISSPLA 9.0
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 7. DISCH- 5300 CFS
ELEVATION, FEET
2310.0
2305.0
2300.0
2295.0
2290.0
2285.0
2280.0
2275.0
2270.0
5000.0
4500.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
DISTANCE ALONG THALWEG, FEET

PLOT 8 16.28.43 WED 31 DEC. 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-9

EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 8. DISCH- 4150 CFS



PLOT 9 16.28.50 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-10

EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 9. DISCH- 3350 CFS

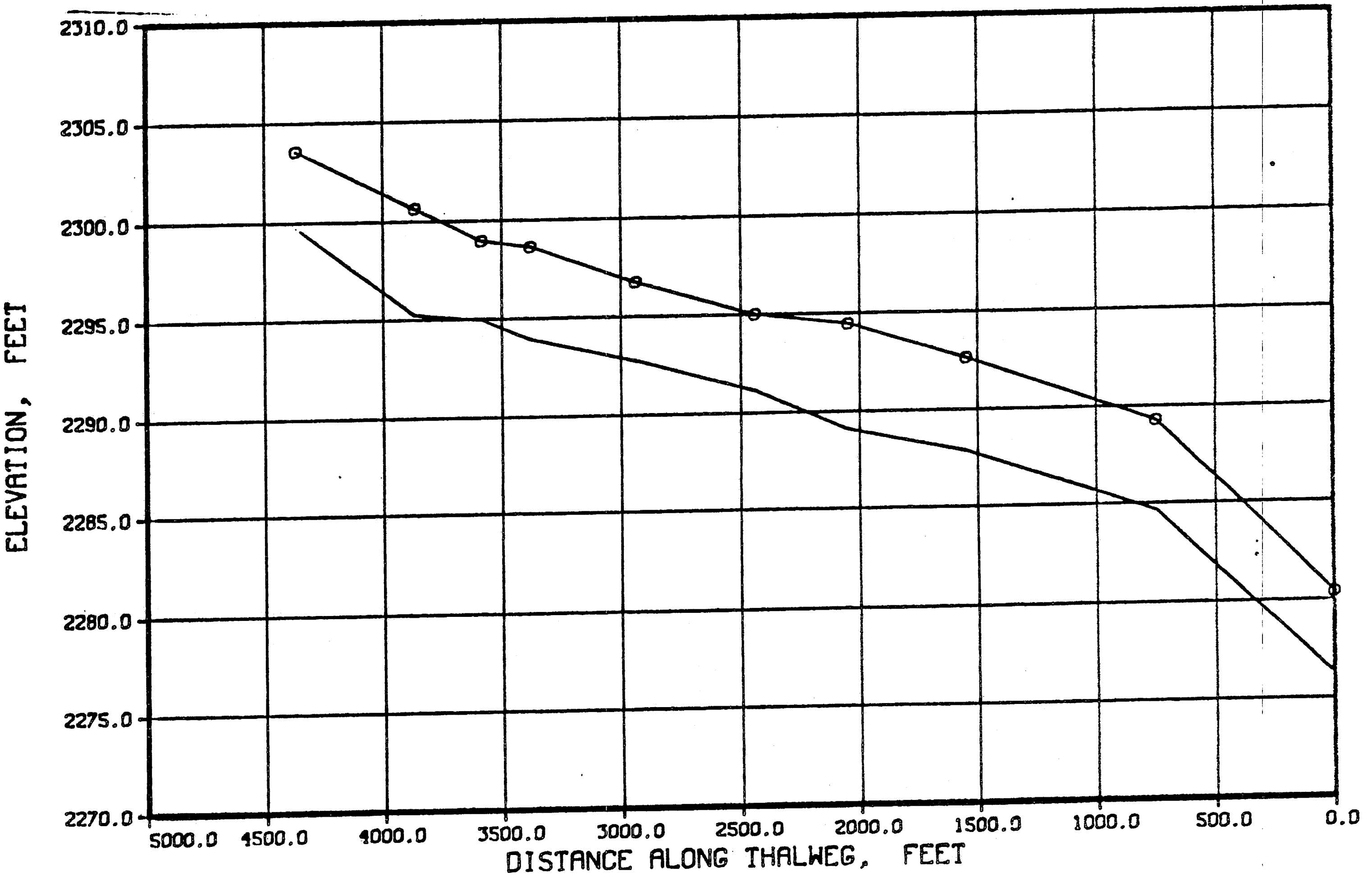
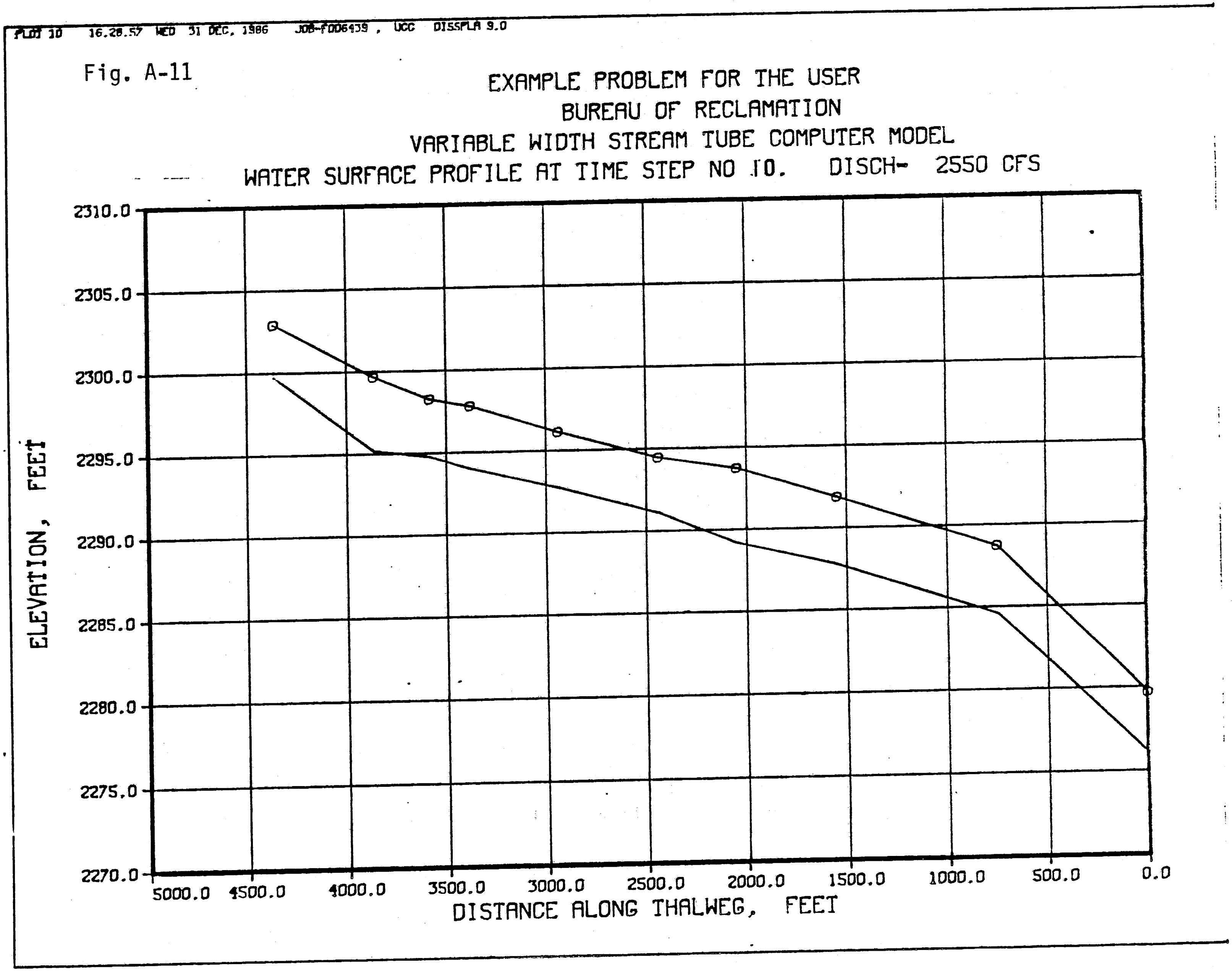
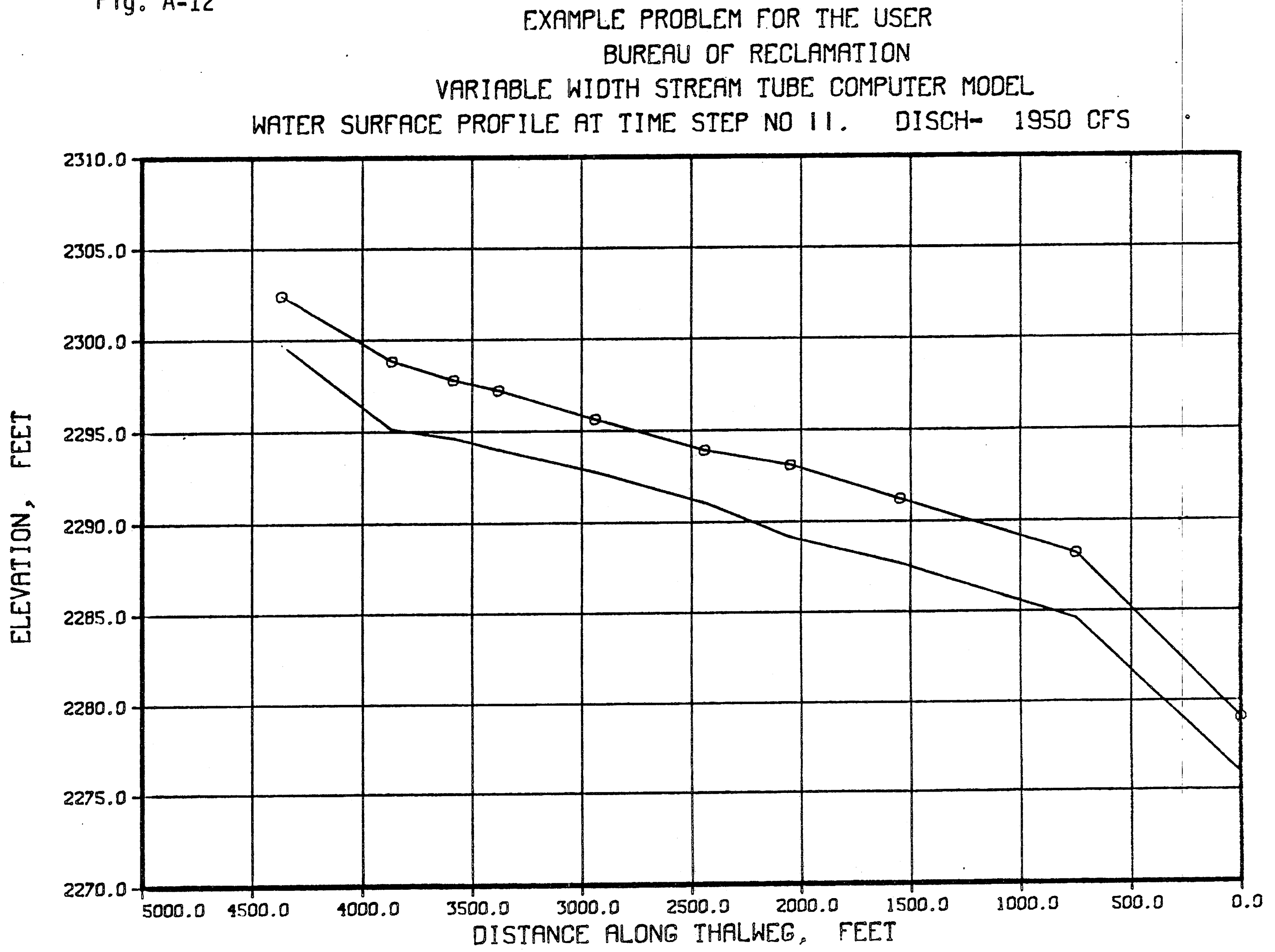


Fig. A-11


PLOT 10 16.28.57 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 10. DISCH- 2550 CFS
ELEVATION, FEET
2310.0
2305.0
2300.0
2295.0
2290.0
2285.0
2280.0
2275.0
2270.0
5000.0
4500.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
DISTANCE ALONG THALWEG, FEET

PLOT 11 16.29.03 WED 31 DEC. 1986 JOB-FOD6439 , UCC DISSPLA 9.0

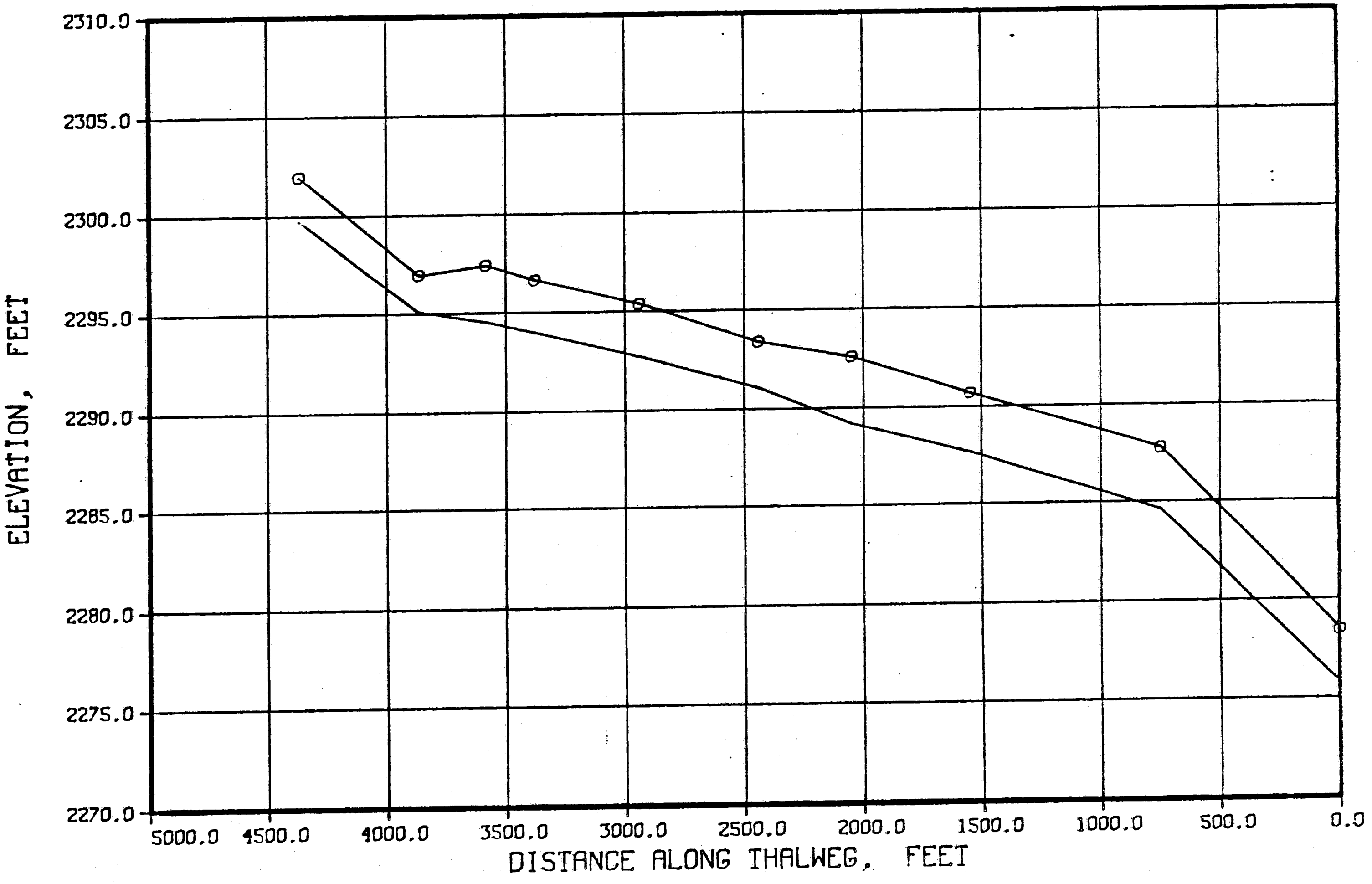
Fig. A-12


EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 11. DISCH- 1950 CFS

PLOT 12 16.29.10 WED 31 DEC. 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-13

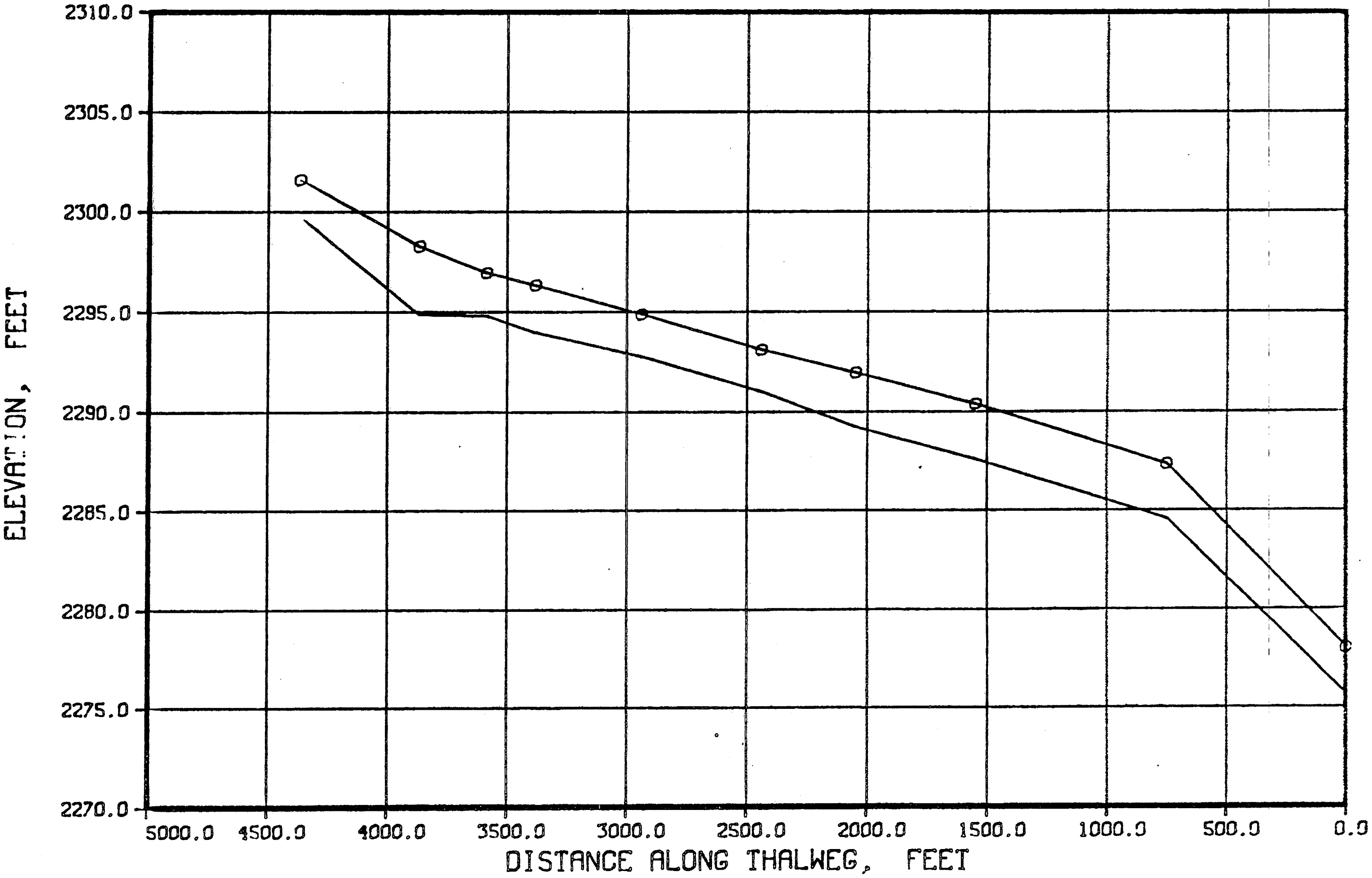
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 12. DISCH- 1500 CFS



PLOT 13 16.29.17 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-14

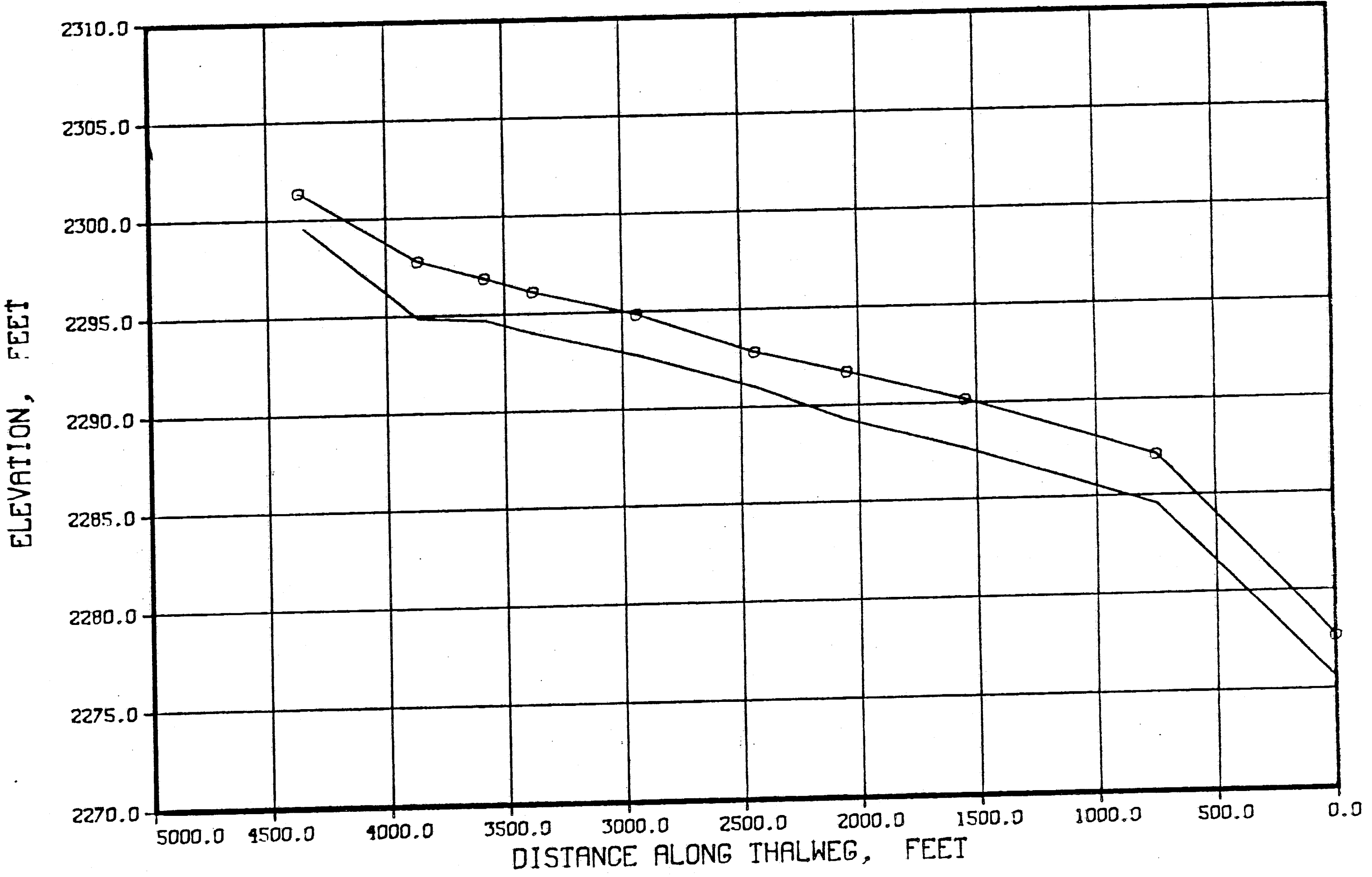
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 13. DISCH- 1150 CFS



PLOT 14 16.29.24 WED 31 DEC, 1980 JOB-FOD6439 , UCC DISSPLA 9.0

Fig. A-15

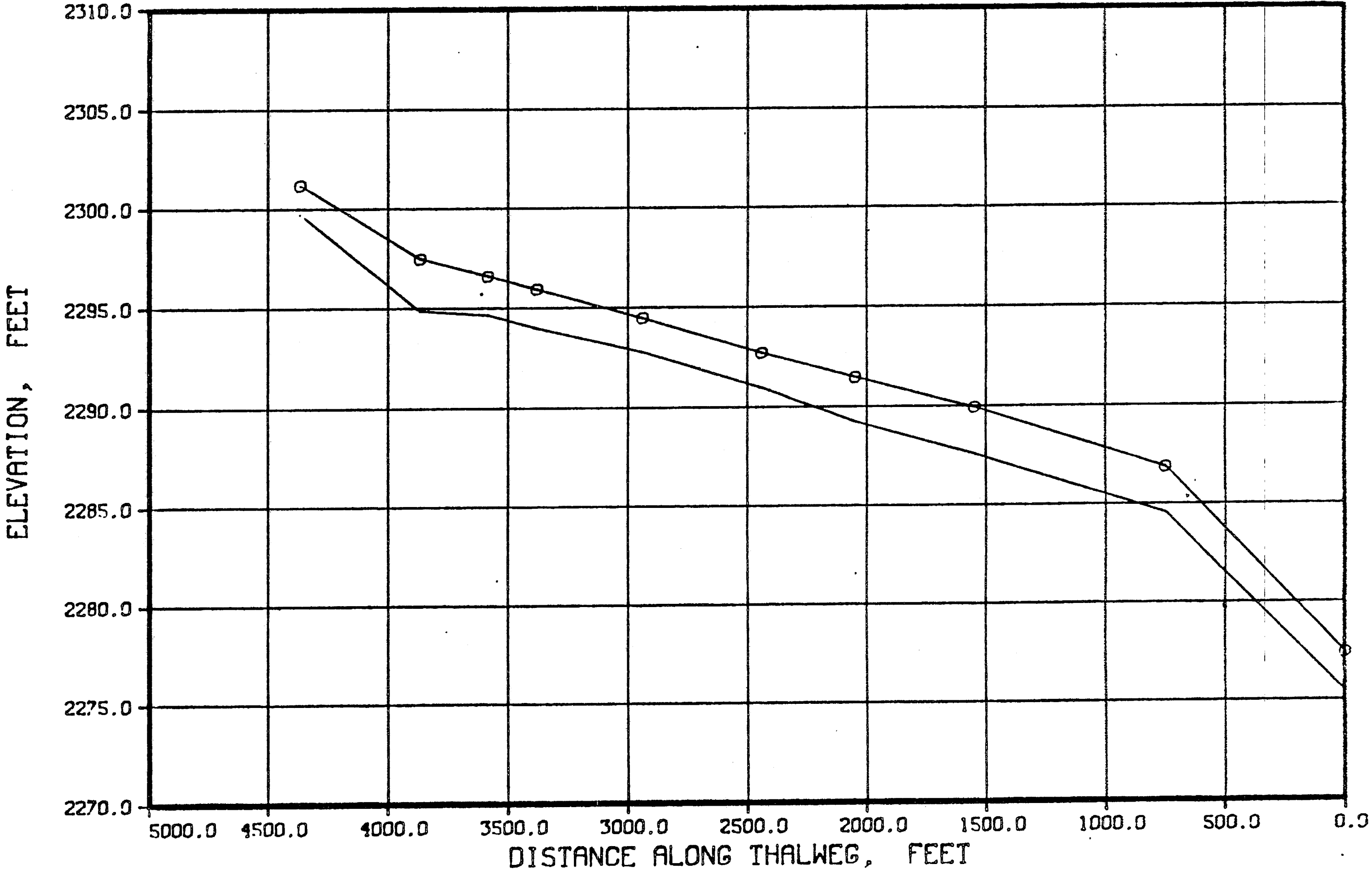
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 14. DISCH- 950 CFS



PLOT 15  16.29.35 WED 31 DEC, 1986  JOB-F006439 , UCC  DISSPLA 9.0

Fig. A-16

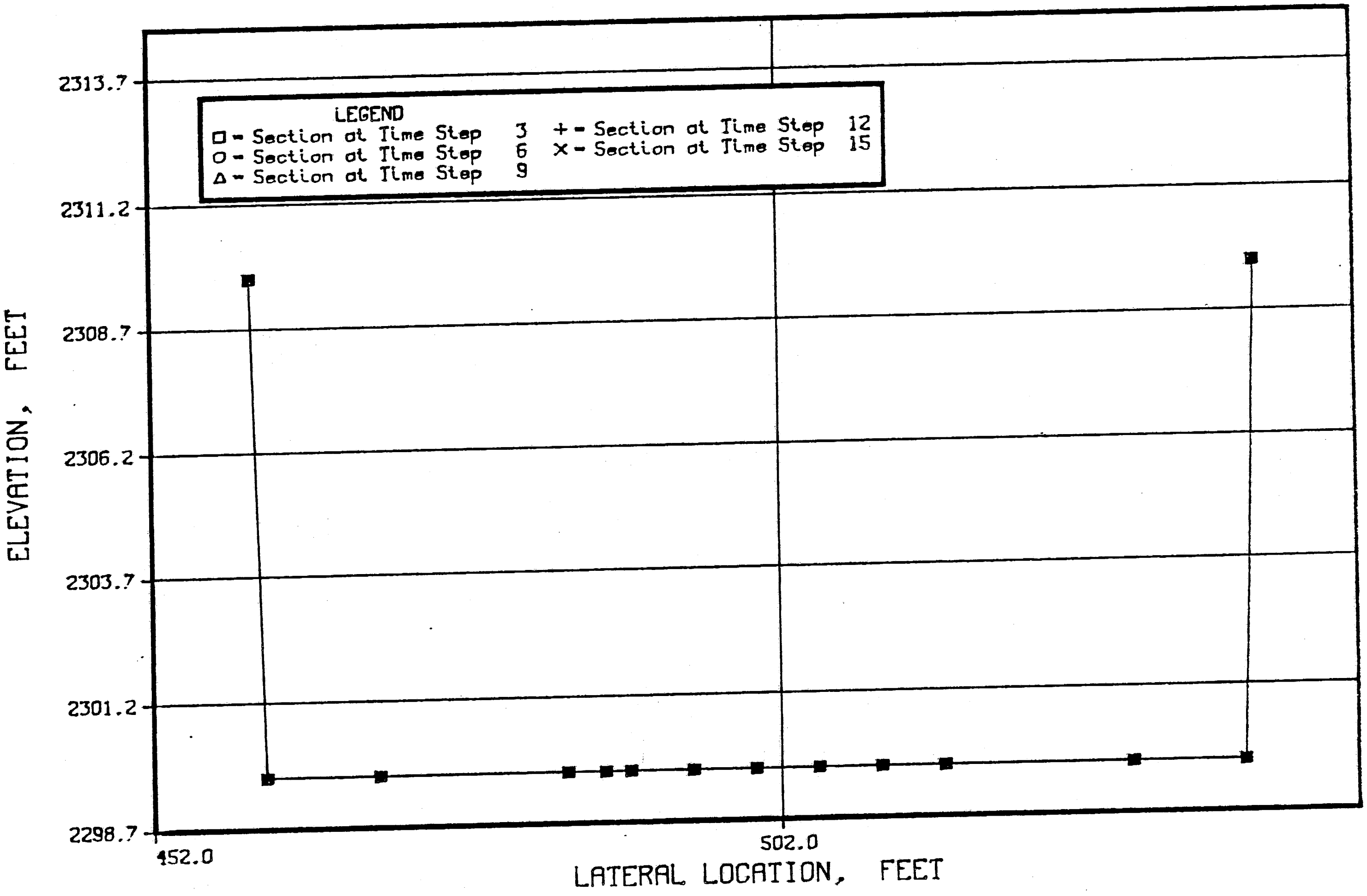
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
WATER SURFACE PROFILE AT TIME STEP NO 15. DISCH- 800 CFS



PLOT 1 20.04.31 WED 31 DEC, 1986 JOB-FOD643S , UCC DISSPLA 9.0

Fig. A-17

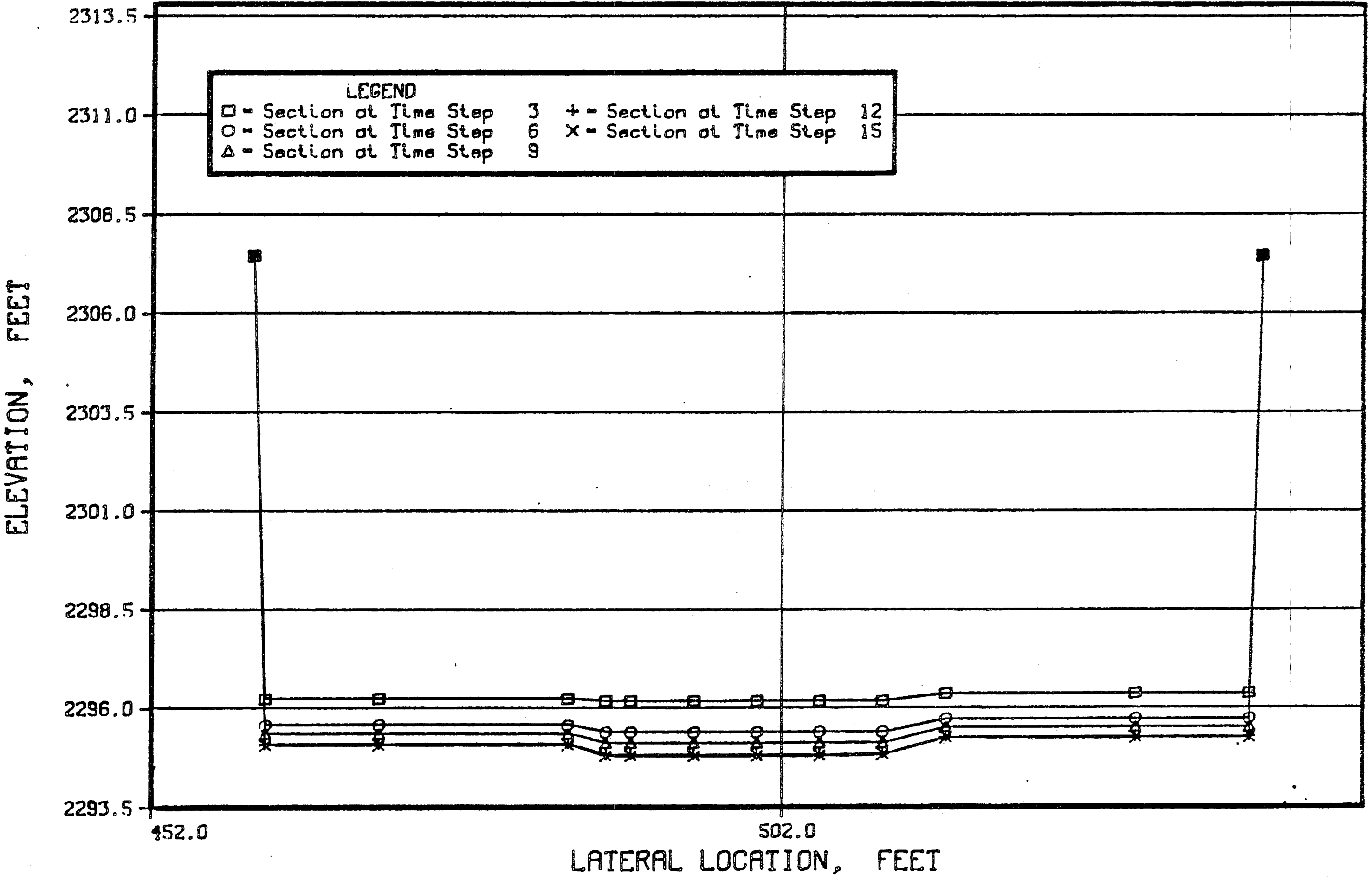
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 4365. FT.



PLOT 2 20.04.34 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-18

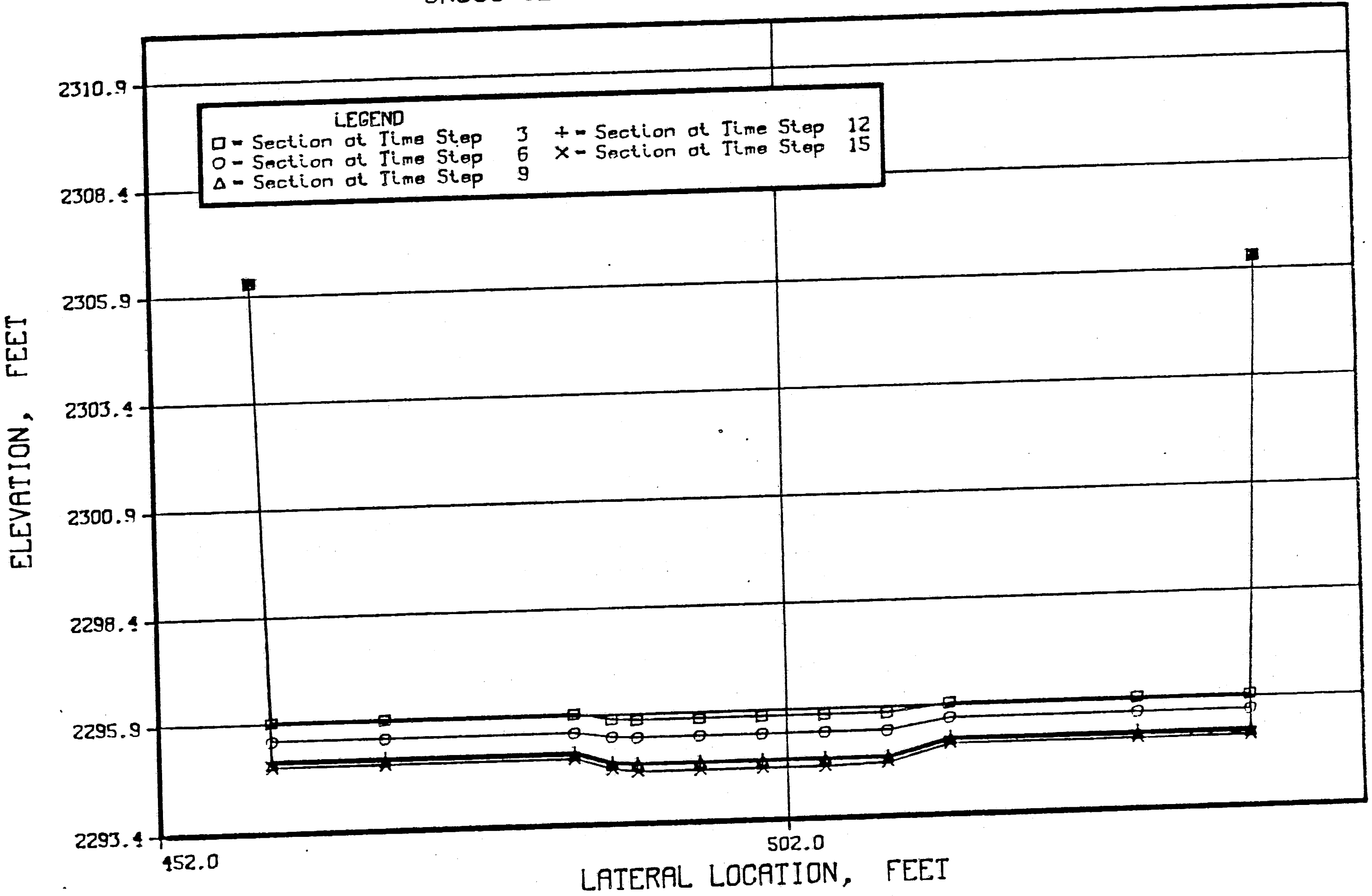
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3865. FT.



PLOT 3 20.04.38 WED 31 DEC. 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-19

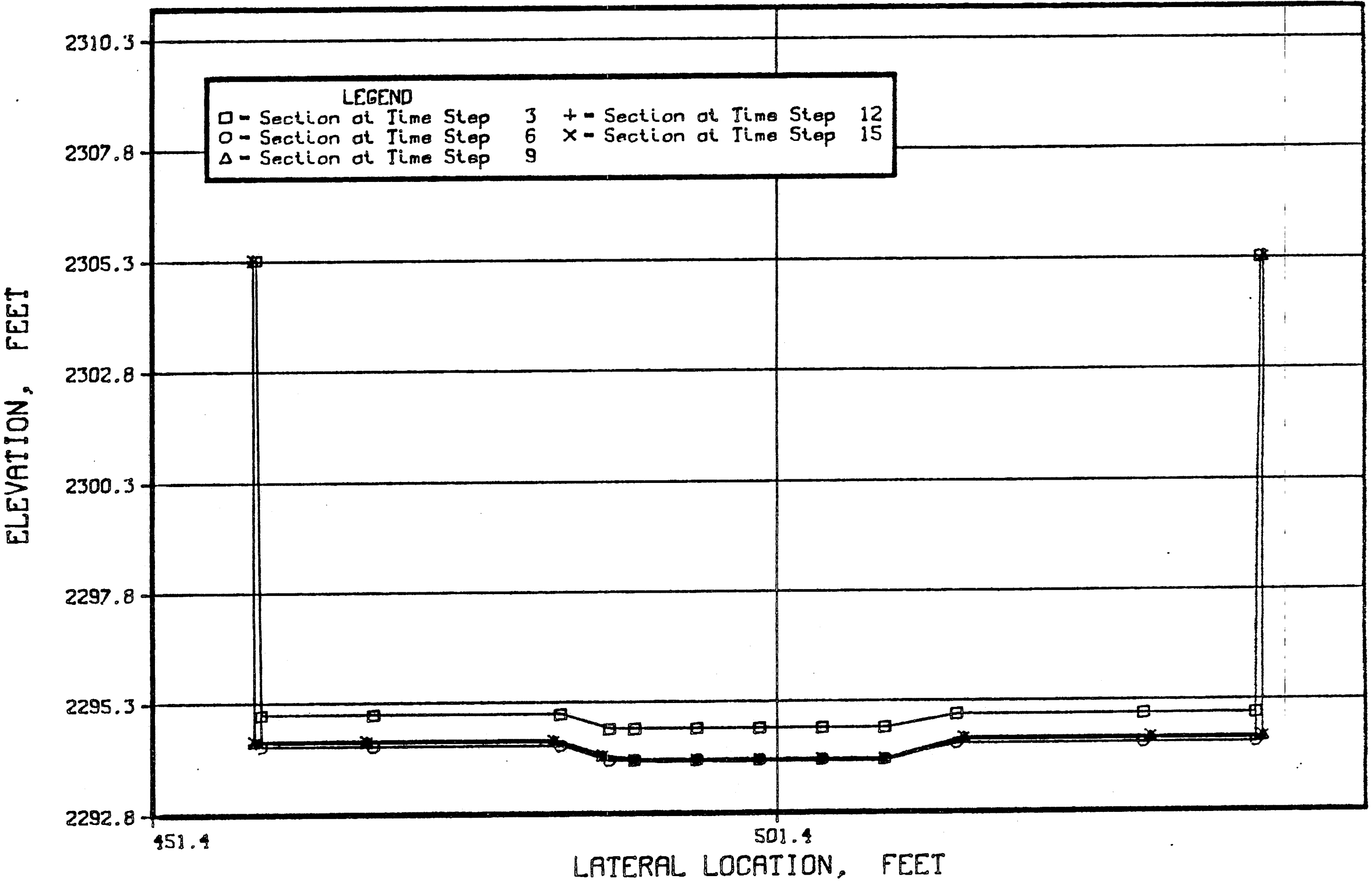
# EXAMPLE PROBLEM FOR THE USER
# BUREAU OF RECLAMATION
# VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
# CROSS SECTION PROFILES AT STA. 3585. FT.



PLOT 9 20.04.41 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-20

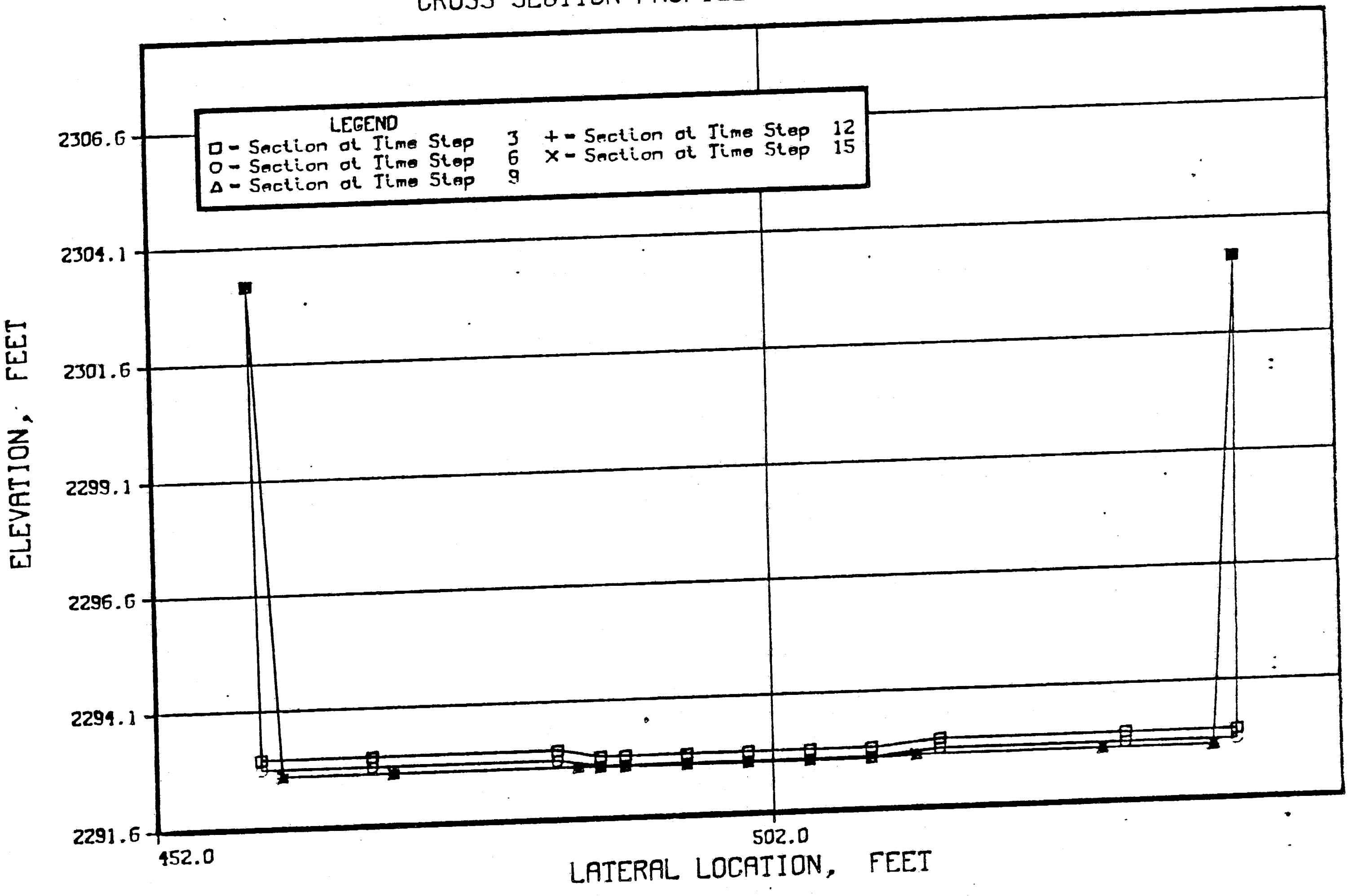
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 3380. FT.



PLOT 5    20.04.45 WED 31 DEC, 1986    JOB-FOD6439 , UCC    DISSPLA 9.0

Fig. A-21

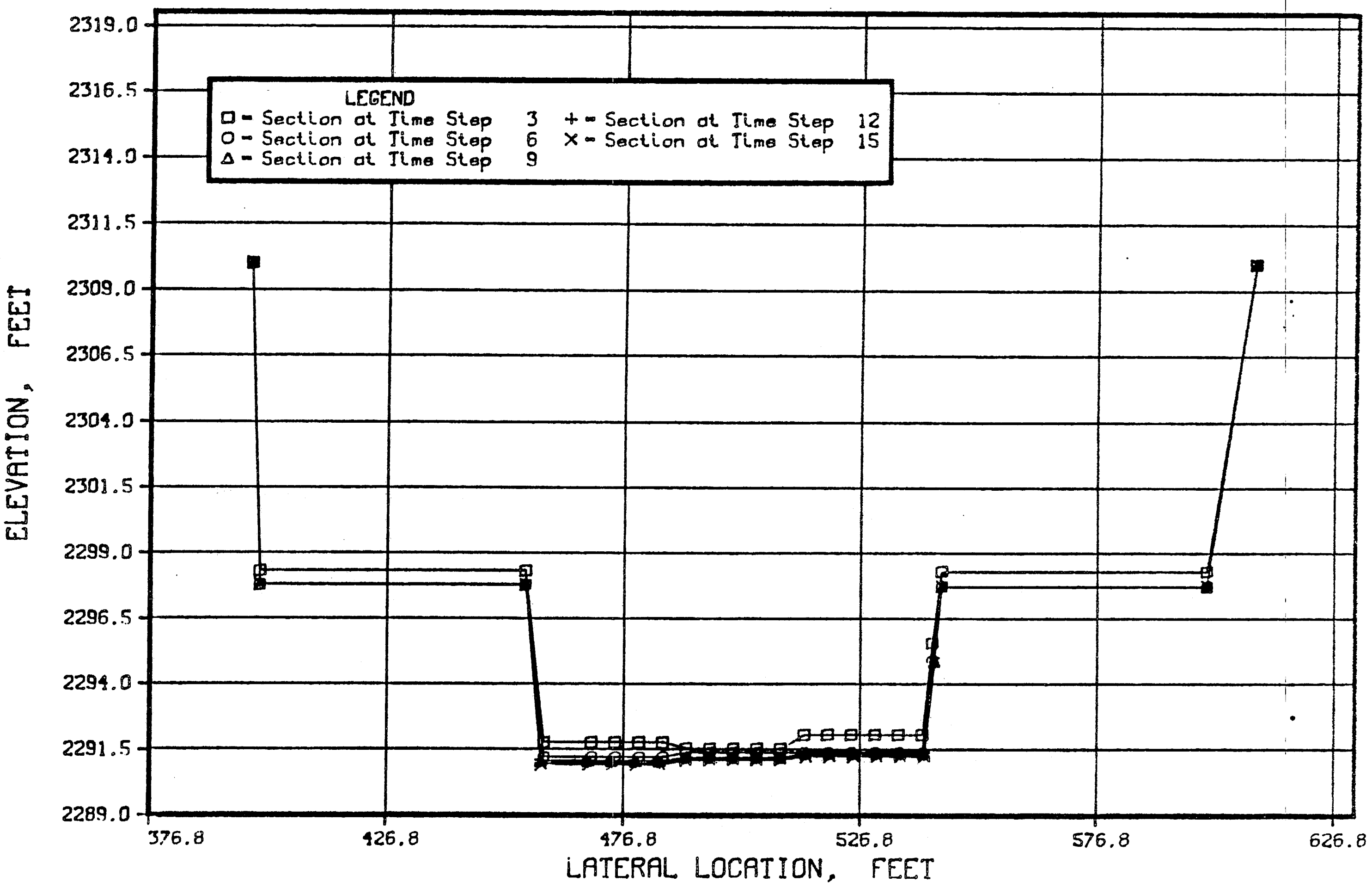
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2940. FT.



PLOT 6 20.04.48 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-22

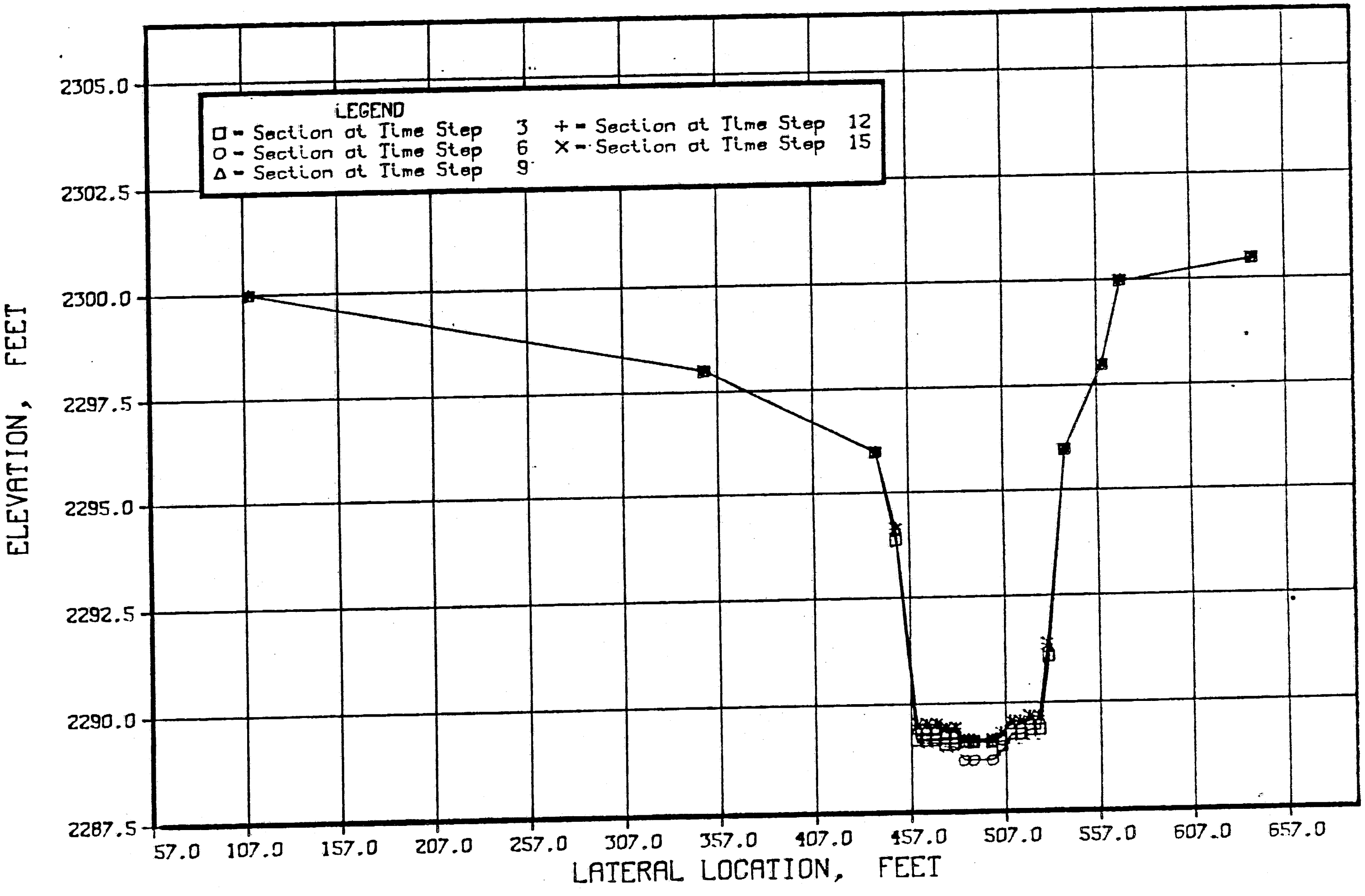
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2440. FT.



PLOT 7 20.04.52 WED 31 DEC, 1986 JOB-F006939 , UCC DISSPLA 9.0

Fig. A-23

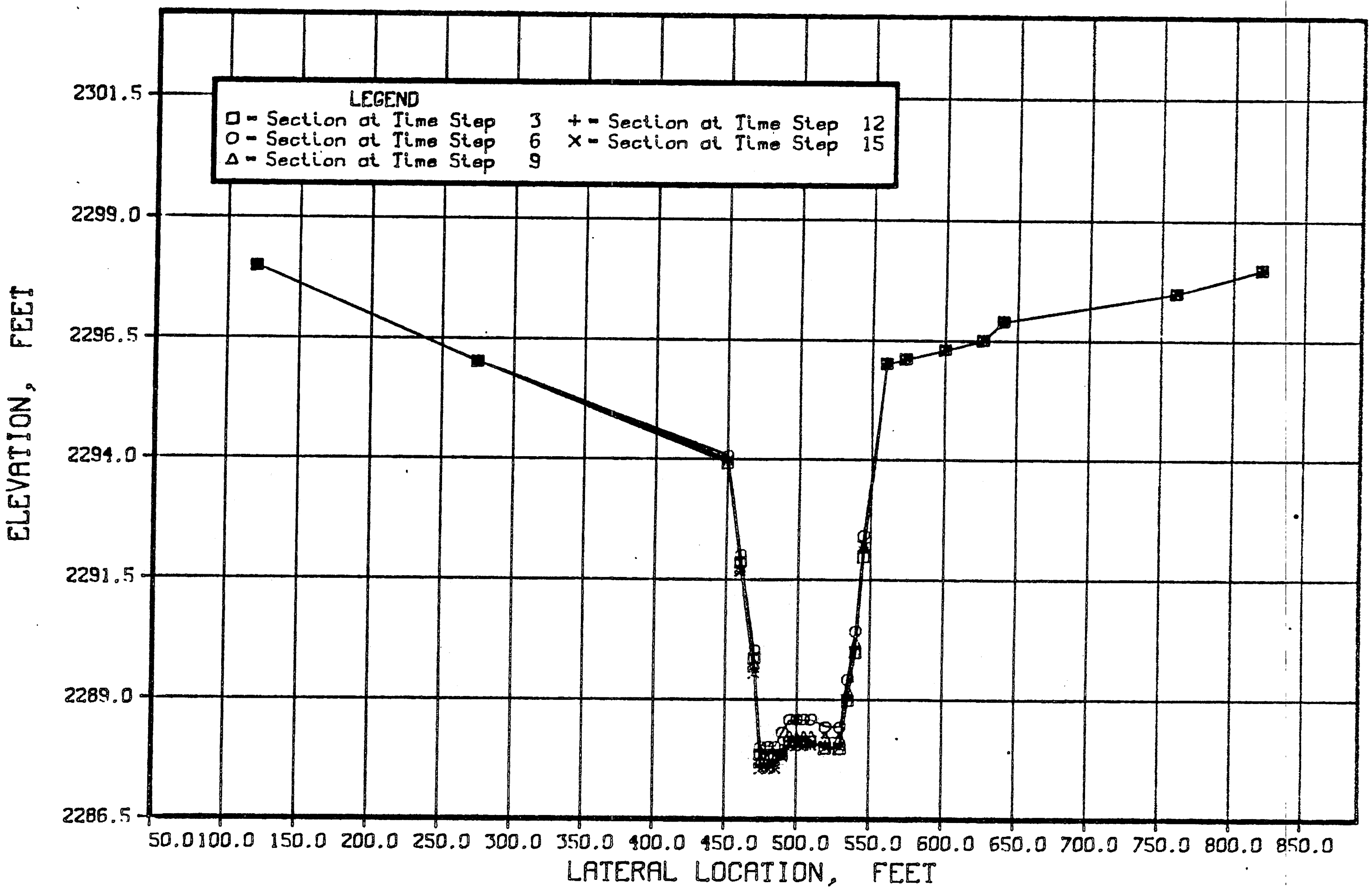
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 2050. FT.



PLOT 8 20.05.00 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-24

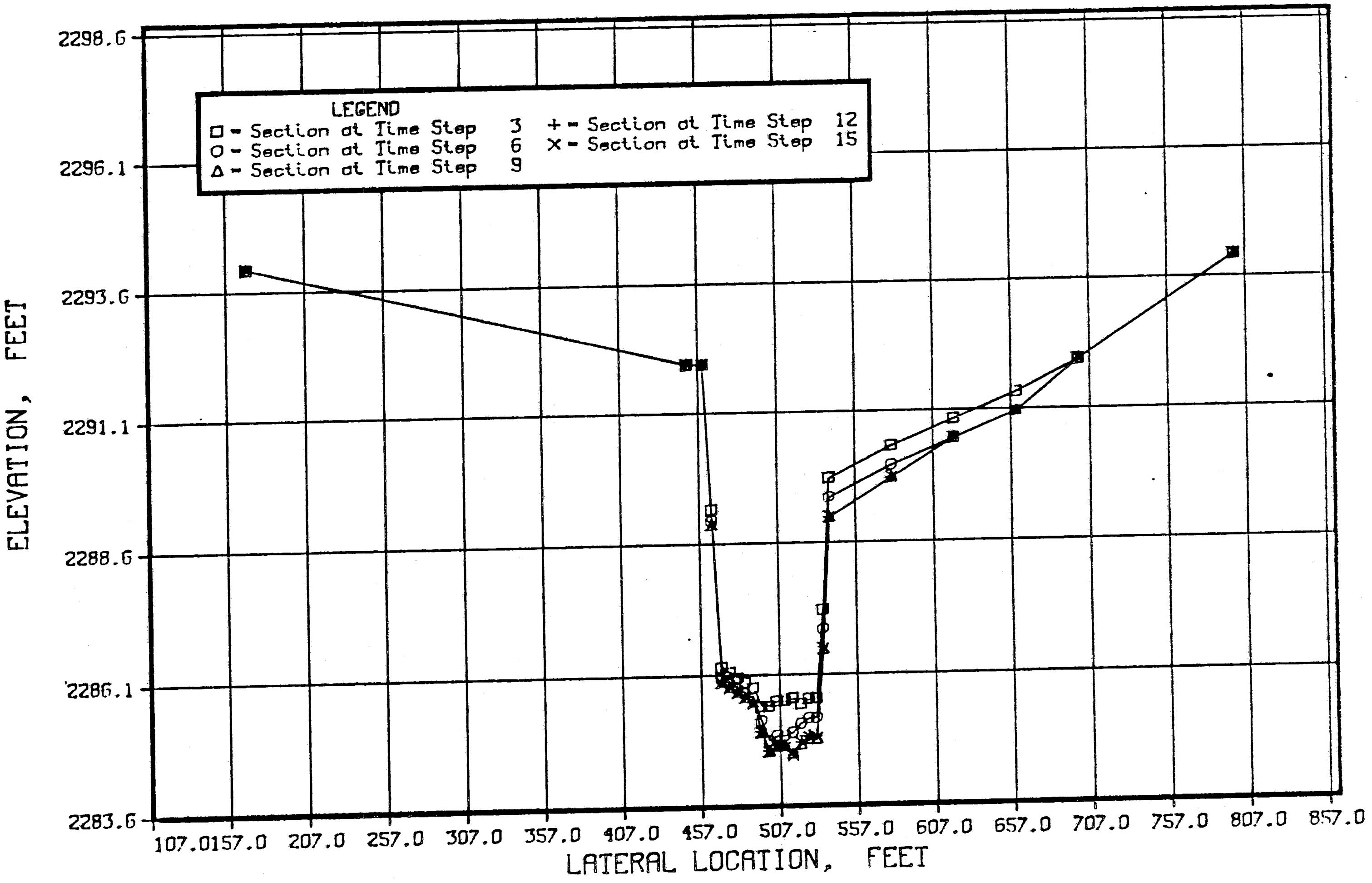
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 1550. FT.



PLOT 9 20.05.09 WED 31 DEC, 1986 JOB-F006439 , UCC DISSPLA 9.0

Fig. A-25

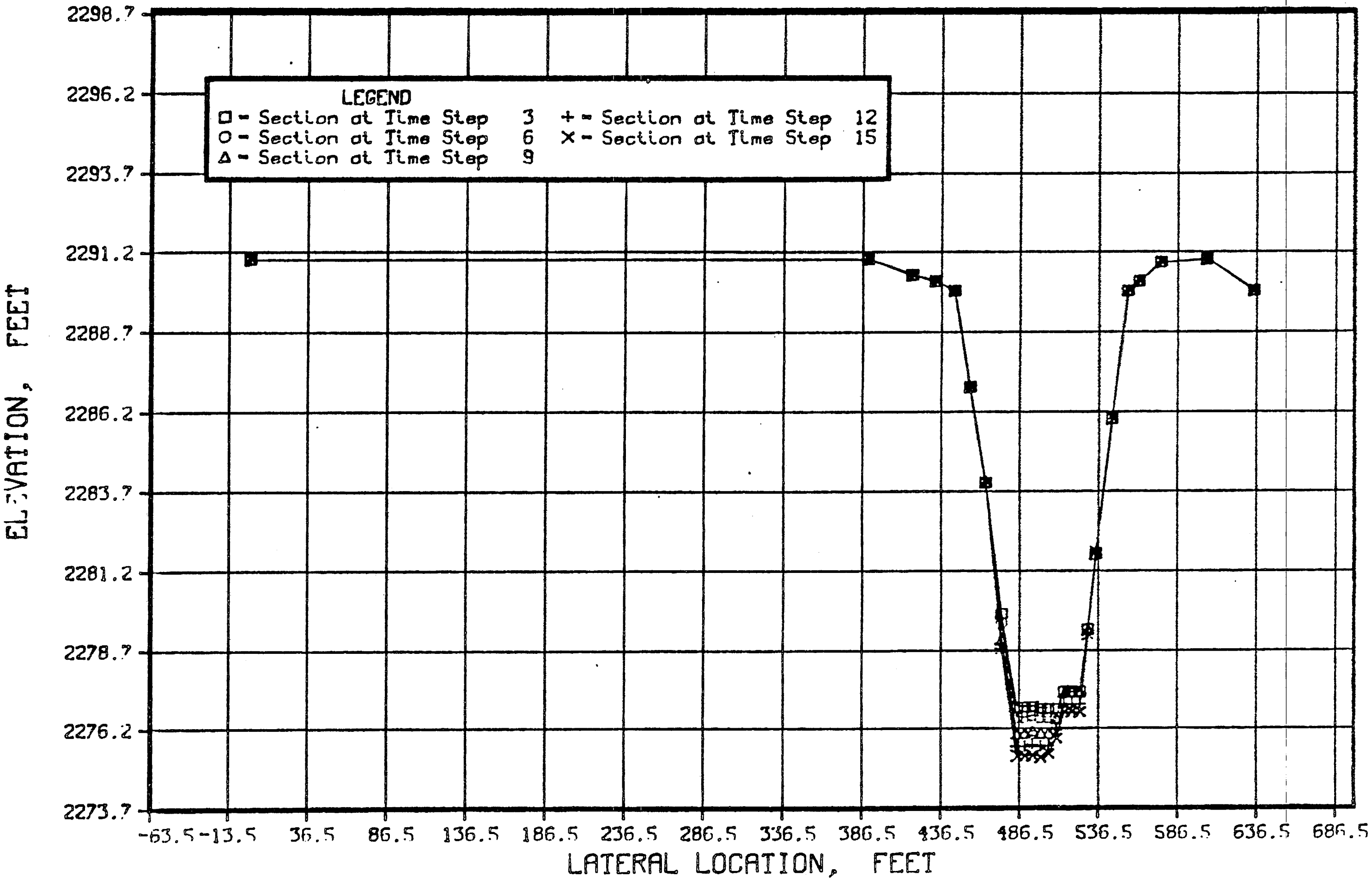
EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 750. FT.



PLOT 10 20.05.13 WED 31 DEC, 1986 JOB-FOD6439 , UCC DISSPLA 9.0

Fig. A-26

EXAMPLE PROBLEM FOR THE USER
BUREAU OF RECLAMATION
VARIABLE WIDTH STREAM TUBE COMPUTER MODEL
CROSS SECTION PROFILES AT STA. 0. FT.



# APPENDIX F

## List of GSTARS Program

```
      PROGRAM GSTARS(INPUT,OUTPUT,A11,A12,A14,A17,
     +TAPE8,TAPE9,TAPE5=INPUT,TAPE6=OUTPUT,TAPE2=A11,
     +TAPE7=A17,TAPE1=A12,TAPE4=A14)
      INTEGER ANSWER(2),SEDIMNT,SEDOPT
      COMMON/BLKO/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK10/COEF1(30),COEF2(30),COEF3(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK50/VEL,HYDEPTH,WIDTH,AREA,SFR
      COMMON/BLK52/AA(10),RR(10),CONV(10),DISCHAR(10)
      COMMON/BLK53/BACKWAT
      COMMON/BLK54/CONVY(30)
      COMMON/BLK56/XSAREA(30),HYDRAD(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK72/AREAST(30,5),HYDRAST(30,5),SFAVEST(30,5),VELST(30,
     +5)
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLK76/CONVST(30,5)
      COMMON/BLK81/TEMP,D50,SIGMA,VIS,D35,D65
      COMMON/BLK82/NSIZE,D(10),X(10),FB(10),FS(10),FV(10)
      COMMON/BLK89/TEMPI(500),QI(500),QSI(500),WSEI(500)
      COMMON/BLK90/P(30,10),PN(30,10),P1(30,10),TKA(30,10),TKI(30,10)
     +      ,QBN(30,10)
      COMMON/BLK93/BE(30),DBE(10),QBT(30)
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      DATA ANSWER(1),ANSWER(2)/10HYES       ,10HNO        /
      IR=7
      IPRLVL=0
      BE(1)=0.0
      CALL READER(SEDIMNT,DTIME,ITIMAX,NITRQS,IOPTQ,IOPTSTQ,ITABLE,
     +IPR,INTPR,INTPL1,INTPL2)
      TIME=0.
      DO 777 I=1,NSTA
      DO 777 J=1,NSTUBE
      ISWDEP(I,J)=0
      ISWSCR(I,J)=0
  777 CONTINUE
      DO 2000 ITSTEP=1,ITIMAX
      IPRCHK=(ITSTEP/INTPR)*INTPR
      IF(IPRCHK.NE.ITSTEP) IPRLVL=-2
      IF(IPRCHK.EQ.ITSTEP) IPRLVL=IPR
      IR=7
      REWIND IR
      TIME=TIME+ITSTEP*DTIME*NITRQS
      Q=QI(ITSTEP)
      WRITE(6,44) ITSTEP,Q
      IF(IOPTSTQ.NE.10HRATING CUR) GOTO 347
      DO 2002 I=1,NSTA
      WSE(I)=0.
      IF(COEF1(I).EQ.0.) GOTO 2002
      WSE(I)=COEF1(I)*Q**COEF2(I)+COEF3(I)
 2002 CONTINUE
      GOTO 348
  347 CONTINUE
      DO 346 J=1,NSTA
  346 WSE(J)=0.
      WSE(ITABLE)=WSEI(ITSTEP)
  348 CONTINUE
      IF(SEDIMNT.EQ.ANSWER(2)) GOTO 349
      TEMP=TEMPI(ITSTEP)
      CALL FALLVEL(NSIZE)
```

```
      DO 2003 K=1,NSIZE
      QBN(1,K)=12.0896*QSI(ITSTEP)*P(1,K)
 2003 CONTINUE
      QBT(1)=QSI(ITSTEP)
  349 CONTINUE
      CALL STEPMTD
      IF(INTPL2.EQ.O) GOTO 1008
      IK=(ITSTEP/INTPL2)*INTPL2
      IF(IK.NE.ITSTEP) GOTO 1008
      WRITE(9,*) NSTA
      DO 1007 IST=1,NSTA
      SFRIC=(Q/CONVY(IST))**2
      QSPROD=Q*SFRIC
      WRITE(9,*) CROSLOC(IST,1),Z(IST),WSE(IST),XSAREA(IST),HYDRAD(IST),
     +SFRIC,QSPROD
 1007 CONTINUE
 1008 CONTINUE
      CALL STUBE
      Q=Q/NSTUBE
C
C
      IF(IPRLVL.LT.2) GOTO 17
C
      WRITE(6,15)
      WRITE(6,16) (I,(CONVST(I,J),J=1,NSTUBE),I=1,NSTA)
   17 CONTINUE
      IF(IPRLVL.LT.1) GOTO 433
      DO 432 J=1,NSTUBE
      WRITE(6,9) J
      WRITE(6,49)
      WRITE(6,48) (I,AREAST(I,J),VELST(I,J),SFAVEST(I,J),I=1,NSTA)
  432 CONTINUE
  433 CONTINUE
      IF(SEDIMNT.EQ.ANSWER(2).AND.INTPL1.EQ.O) GOTO 2000
      IF(SEDIMNT.EQ.ANSWER(1)) GOTO 2008
      IF(ITSTEP.GT.1) GOTO 2008
      WRITE(8,*) NSTA
      DO 2007 IST=1,NSTA
      NPT=BOTTOM(IST,1)
      WRITE(8,*) STA(IST),NPT
      NP=BOTTOM(IST,1)+2
      WRITE(8,*) (BOTTOM(IST,J),CROSLOC(IST,J),J=3,NP)
 2007 CONTINUE
 2008 CONTINUE
      IF(SEDIMNT.EQ.ANSWER(2)) GOTO 2000
      DO 2004 ISEDTM=1,NITRQS
      CALL TIMESTP(ITSTEP,DTIME)
      CALL UPDATE(7,ITSTEP,INTPL1)
      DO 3002 I=1,NSTA
      DO 3002 JJ=1,NSTUBE
      ISWCN(I,JJ)=O
      ISWCW(I,JJ)=O
 3002 CONTINUE
      IF(ISWMN.EQ.O) GOTO 2004
      AMN=ITERMN
      ITS=((ITSTEP-1)/ITERMN)*AMN
      IF(ITS.EQ.(ITSTEP-1).AND.ISEDTM.EQ.1) GOTO 1997
      GOTO 2004
 1997 CONTINUE
      QTEMP=Q
      Q=QI(ITSTEP)
      CALL MNCHCK(ITSTEP,INTPL1)
      Q=QTEMP
 2004 CONTINUE
 2000 CONTINUE
C
```

```
C     FORMAT STATEMENTS
C
    9 FORMAT(//,15X,*STREAM TUBE NO. =*,I3,/)
   15 FORMAT(10X,*CONVEYANCE TABLE FOR INDIVIDUAL STREAM TUBES*,/,
     +5X,*STA.   STRM TUBE-1   STRM TUBE-2   STRM TUBE-3*,//)
   16 FORMAT(5X,I4,3E14.7)
   44 FORMAT(//,5X,*TIME STEP NO.*,I2,/,5X,*DISCHARGE=*,E12.6,//)
   48 FORMAT(3X,I5,2X,F10.2,5X,F6.2,9X,F7.5)
   49 FORMAT(4X,*STA NO    AREA      VELOCITY      FRICT. SLOPE*,/)
 3344 STOP
      END
      SUBROUTINE READER(ISEDMNT,DTIME,ITIMAX,NITRQS,IOPTQ,IOPTSTQ,ITABLE
     +,IPRLVL,INTPR,INTPL1,INTPL2)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ THE HYDRAULIC,HYDROLOGIC AND SEDIMENT C
C     DATA FORM TAPE1. DIFFERENT SUBROUTINES ARE CALLED FOR EACH       C
C     CATEGORY OF DATA.                                                C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER SEDOPT,ANSWER(2)
      DIMENSION IOPTPL1(3),IOPTPL2(3),IOPTPL(3)
      DATA ANSWER(1),ANSWER(2)/10HYES         ,10HNO          /
      CALL INPUT1
      CALL PREPDAT(1)
      CALL QTABLE(DTIME,ITIMAX,NITRQS,1,IOPTQ,IOPTSTQ,ITABLE)
      CALL QSTABLE(ITIMAX,1,SEDOPT)
      ISEDMNT=10HYES
      IF(SEDOPT.EQ.10HNO SEDIMEN) ISEDMNT=10HNO
      IF(SEDOPT.EQ.10HNO SEDIMEN) GOTO 341
      CALL SEDDAT(1,ITIMAX)
  341 CONTINUE
C
C     CHECK THE PLOTTING REQUIREMENTS. IF YES,CREATE THE FILES
C     TAPE8 AND TAPE9.
C
      READ(1,*) IPRLVL,INTPR
      READ(1,10) (IOPTPL(K),K=1,3)
      INTPL1=0
      INTPL2=0
      IF(IOPTPL(1).EQ.10HNO PLOTTIN) RETURN
      READ(1,10) (IOPTPL1(I),I=1,3),INTPL1
      READ(1,10) (IOPTPL2(I),I=1,3),INTPL2
      WRITE(6,10) (IOPTPL1(I),I=1,3),INTPL1
      WRITE(6,10) (IOPTPL2(I),I=1,3),INTPL2
   10 FORMAT(3A10,I3)
      CALL READMN(1)
      RETURN
      END
      SUBROUTINE INPUT1
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      DIMENSION CR(60),BO(60),R(60),C(30),EQ(2),IOPTQ(4),ISTQ(4)
      DIMENSION Q(500),ISD(4),IPL(4),IPL1(4),IPL2(4),DL(30),ZB(30)
      DIMENSION NPT(30),STGE(500),DU(30),CLOC(30),PP(10)
      DIMENSION ITITLE(3,7)
      DO 1 ICRD=1,3
      READ(2,140) ID,(ITITLE(ICRD,J),J=1,7)
    1 CONTINUE
  140 FORMAT(A2,A6,6A8)
      READ(2,10) ID,XSTA
   10 FORMAT(A2,F6.0,9F8.0)
      NSTA=XSTA
      PRINT *, NSTA
      DO 100 I=1,NSTA
      READ(2,10) ID,STA,PNTS,TYP,SWITCH,EF,WF
      NPT(I)=PNTS
```

```
      NPTS=PNTS
      ITYP=TYP
      ISWITCH=SWITCH
      PRINT *,STA,NPTS,ITYP,ISWITCH
      READ(2,10) ID,DIVI,(CLOC(J),J=1,9)
      NDIVI=DIVI
      PRINT *, NDIVI,(CLOC(J),J=1,NDIVI)
      AN=(NPTS/5.)+0.99
      JEND=AN
      DO 300 J=1,JEND
      J1=(J-1)*5+1
      J2=J*5
      IF(J.EQ.JEND) J2=NPTS
      READ(2,10) ID,(BO(JJ),CR(JJ),JJ=J1,J2)
  300 CONTINUE
      DO 200 J=1,NPTS
      CR(J)=CR(J)*WF
      BO(J)=BO(J)+EF
  200 CONTINUE
      PRINT *, (BO(J),CR(J),J=1,NPTS)
  100 CONTINUE
      READ(2,12) ID,EQ(1),EQ(2)
   12 FORMAT(A2,6X,2A8)
      WRITE(6,11)  EQ(1),EQ(2)
   11 FORMAT(2A8)
      DO 400 I=1,NSTA
      NPTS=NPT(I)
      AN=(NPTS/10.)+0.99
      JEND=AN
      DO 500 J=1,JEND
      J1=(J-1)*10+1
      J2=J*10
      IF(J.EQ.JEND) J2=NPTS
      READ(2,89) ID,(R(JJ),JJ=J1,J2)
   89 FORMAT(A2,F6.3,9F8.3)
  500 CONTINUE
      PRINT *, (R(J),J=1,NPTS)
  400 CONTINUE
      AN=(NSTA/10.)+0.99
      JEND=AN
      DO 600 J=1,JEND
      J1=(J-1)*10+1
      J2=J*10
      IF(J.EQ.JEND) J2=NSTA
      READ(2,10) ID,(C(JJ),JJ=J1,J2)
  600 CONTINUE
      PRINT *, (C(I),I=1,NSTA)
      READ(2,12) ID,IOPTZ
      WRITE(6,11)IOPTZ
      IF(IOPTZ.NE.8HREAD    ) GOTO 601
      DO 602 J=1,JEND
      J1=(J-1)*10+1
      J2=J*10
      IF(J.EQ.JEND) J2=NSTA
      READ(2,10) ID,(ZB(JJ),JJ=J1,J2)
  602 CONTINUE
      PRINT *, (ZB(I),I=1,NSTA)
  601 CONTINUE
      READ(2,10) ID,STUBE
      NSTUBE=STUBE
      PRINT *, NSTUBE
      READ(2,10) ID,TIMAX,QSITRS,DAYS
      NITRQS=QSITRS
      DTIME=DAYS
      ITIMAX=TIMAX
      PRINT *, ITIMAX,NITRQS,DTIME
```

```
      READ(2,43) ID,(IOPTQ(J),J=1,4)
   43 FORMAT(A2,6X,4A8)
      WRITE(6,42) (IOPTQ(J),J=1,4)
   42 FORMAT(4A8)
      READ(2,43) ID,(ISTQ(J),J=1,4)
      WRITE(6,42) (ISTQ(J),J=1,4)
      IF(ISTQ(1).EQ.8HRATING C .AND. IOPTQ(1).EQ.8HTABLE OF) GOTO 900
      IF(ISTQ(1).EQ.8HRATING C .AND. IOPTQ(1).EQ.8HDISCRETI) GOTO 901
C      IF(ISTQ(1).EQ.8HSTAGE DI .AND. IOPTQ(1).EQ.8HTABLE OF) GOTO 902
      READ(2,10) ID,TABLE
      ITABLE=TABLE
      PRINT *, ITABLE
      DO 910 J=1,ITIMAX
      READ(2,10) ID,Q(J),STGE(J)
      PRINT *, Q(J),STGE(J)
C   14 FORMAT(2E15.7)
  910 CONTINUE
      GOTO 904
  900 CONTINUE
      AN=(ITIMAX/10.)+0.99
      JEND=AN
      DO 905 J=1,JEND
      J1=(J-1)*10+1
      J2=10*J
      IF(J.EQ.JEND) J2=ITIMAX
      READ(2,10) ID,(Q(JJ),JJ=J1,J2)
  905 CONTINUE
      PRINT *, (Q(J),J=1,ITIMAX)
      GOTO 906
  901 CONTINUE
      NSUM=0
  907 READ(2,10) ID,DAY,QQ
      NDAY=DAY
      NSUM=NSUM+NDAY
      PRINT *, NDAY,QQ
C   27 FORMAT(I5,F10.0)
      IF(NSUM.LT.ITIMAX) GOTO 907
  906 CONTINUE
      READ(2,10) ID,CURVES
      NCURVES=CURVES
      PRINT *, NCURVES
      DO 916 N=1,NCURVES
      READ(2,10) ID,TABLE,C1,C2,C3
      ITABLE=TABLE
      PRINT *, ITABLE,C1,C2,C3
C   56 FORMAT(I5,3F10.3)
  916 CONTINUE
  904 CONTINUE
      READ(2,15) ID,(ISD(JJ),JJ=1,4)
   15 FORMAT(A2,6X,4A8)
      WRITE(6,44) (ISD(JJ),JJ=1,4)
   44 FORMAT(4A8)
      IF(ISD(1).EQ.8HNO SEDIM) GOTO 701
      NSUM=0
  899 READ(2,10) ID,DAYS,QSS
      NDAYS=DAYS
      NSUM=NSUM+NDAYS
      PRINT *, NDAYS,QSS
      IF(NSUM.LT.ITIMAX) GOTO 899
      READ(2,10) ID,SE
      ISED=SE
      PRINT *, ISED
      NSUM=0
  917 READ(2,10) ID,DAYS,TEMPI
      NDAYS=DAYS
      NSUM=NSUM+NDAYS
```

```
      PRINT *, NDAYS,TEMPI
C  18 FORMAT(I5,F5.0)
      IF(NSUM.LT.ITIMAX) GOTO 917
      READ(2,10) ID,F
      NF=F
      PRINT *, NF
C  21 FORMAT(I2)
      DO 52 I=1,NF
      READ(2,10) ID,DL(I),DU(I)
      PRINT *, DL(I),DU(I)
C  22 FORMAT(2F10.5)
   52 CONTINUE
      DO 51 I=1,NSTA
      READ(2,10) ID,(PP(J),J=1,NF)
      PRINT *, (PP(J),J=1,NF)
C  23 FORMAT(10F8.4)
   51 CONTINUE
  701 CONTINUE
      READ(2,10) ID,PRL,ANT
      IPRL=PRL
      INT=ANT
      READ(2,43) ID,(IPL(JJ),JJ=1,4)
      WRITE(6,42) (IPL(JJ),JJ=1,4)
      IF(IPL(1).EQ.8HNO PLOTT) GOTO 702
      READ(2,17) ID,(IPL1(JJ),JJ=1,3),APL1
   17 FORMAT(A2,6X,3A10,2X,F8.0)
      NPL1=APL1
      WRITE(6,16) (IPL1(JJ),JJ=1,3),NPL1
   16 FORMAT(3A10,I3)
      READ(2,17) ID,(IPL2(JJ),JJ=1,3),APL2
      NPL2=APL2
      WRITE(6,16) (IPL2(JJ),JJ=1,3),NPL2
  702 CONTINUE
C
C.....WRITE THE TITLE OF STUDY TO TAPE8,TAPE9,OUTPUT.
C
      IF(NPL1.EQ.0) GOTO 2
      DO 3 I=1,3
    3 WRITE(9,142) (ITITLE(I,J),J=1,7)
      WRITE(9,*) NPL1
    2 CONTINUE
      IF(NPL2.EQ.0) GOTO4
      DO 5 I=1,3
    5 WRITE(8,142) (ITITLE(I,J),J=1,7)
      WRITE(8,*) NPL2
    4 CONTINUE
      WRITE(6,144)
      DO 6 I=1,3
    6 WRITE(6,143) (ITITLE(I,J),J=1,7)
      WRITE(6,144)
  142 FORMAT(A6,6A8)
  143 FORMAT(15X,A6,6A8)
  144 FORMAT(15X,
     +60H************************************************************ )
      READ(2,45) ID,(IOPTMN(I),I=1,3)
   45 FORMAT(A2,6X,3A10)
      WRITE(6,46) (IOPTMN(I),I=1,3)
   46 FORMAT(3A10)
      IF(IOPTMN(1).EQ.10HNO MINIMIZ) RETURN
      ISWMN=1
      READ(2,47) ID,AMN
      ITERMN=AMN
      PRINT *,ITERMN
      DO 122 I=1,NSTA
      READ(2,47) ID,XLTI(I),XRGHTI(I),CBLI(I),CBHI(I)
   47 FORMAT(A2,F6.0,9F8.0)
```

```
      PRINT *, XLTI(I),XRGHTI(I),CBLI(I),CBHI(I)
  122 CONTINUE
      RETURN
      END
      SUBROUTINE READMN(IOR)
      COMMON/BLKO/IR,NSTA
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      COMMON/BLK70/NSTUBE,NSTRM
      ISWMN=0
      READ(IOR,10) (IOPTMN(I),I=1,3)
   10 FORMAT(3A10)
      IF(IOPTMN(1).EQ.10HNO MINIMIZ) RETURN
      READ(IOR,*) ITERMN
      ISWMN=1
      DO 200 I=1,NSTA
      READ(IOR,*) XLTI(I),XRGHTI(I),CBLI(I),CBHI(I)
  200 CONTINUE
      RETURN
      END
      SUBROUTINE MNCHCK(ITSTEP,INTPL1)
      COMMON/BLKO/IR,NSTA
      COMMON/BLK46/IPRLVL
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLK93/BE(30),DBE(10),QBT(30)
      COMMON/BLK95/TAL
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      IRR=IR
      IR=4
      DO 1999 I=2,NSTA
      CALL READDAT
      IF(QBT(I).LT.QBT(I-1)) GOTO 1998
C.....SCOURING
      DELWI=ITERMN*TAL
      SUM=0.
      CALL WIDEN(I,1,SAR1,DELWI)
      SUM=SUM+SAR1
      CALL WIDEN(I,NSTUBE,SAR2,DELWI)
      SUM=SUM+SAR2
      IF(SUM.EQ.0.) GOTO 1999
      CALL UPDATE(4,ITSTEP,INTPL1)
      IPP=IPRLVL
      IPRLVL=-1
      CALL STEPMTD
      IPRLVL=IPP
      CALL TOTALQS(QST)
      STRMPW=QST
      DELWI=SUM/(YLOC(I,NSTRM)-YLOC(I,1))
      SUM=0.
      CALL READDAT
      DO 1995 J=1,NSTUBE
      CALL DEEPEN(I,J,SAR11,DELWI)
      SUM=SUM+SAR11
 1995 CONTINUE
      CALL UPDATE(4,ITSTEP,INTPL1)
      IPP=IPRLVL
      IPRLVL=-1
      CALL STEPMTD
      IPRLVL=IPP
      CALL TOTALQS(QST1)
      STRMPD=QST1
      IF(STRMPW.GT.STRMPD) GOTO 1999
```

```
      DO 1994 J=1,NSTUBE
      ISWCW(I,J)=0
      IF(J.EQ.1.OR.J.EQ.NSTUBE) ISWCW(I,J)=1
 1994 CONTINUE
      GOTO 1999
 1998 CONTINUE
C.....DEPOSITION
      DELWI=ITERMN*TAL
      SUM=0.
      CALL READDAT
      CALL NARROW(I,1,SAR1,DELWI)
      SUM=SUM+SAR1
      CALL NARROW(I,NSTUBE,SAR2,DELWI)
      SUM=SUM+SAR2
      IF(SUM.EQ.0.) GOTO 1999
      CALL UPDATE(4,ITSTEP,INTPL1)
      IPP=IPRLVL
      IPRLVL=-1
      CALL STEPMTD
      IPRLVL=IPP
      CALL TOTALQS(QST)
      STRMPN=QST
      DELWI=SUM/(YLOC(I,NSTRM)-YLOC(I,1))
      SUM=0.
      CALL READDAT
      DO 1993 J=1,NSTUBE
      CALL RAISE(I,J,SAR11,DELWI)
      SUM=SUM+SAR11
 1993 CONTINUE
      CALL UPDATE(4,ITSTEP,INTPL1)
      IPP=IPRLVL
      IPRLVL=-1
      CALL STEPMTD
      IPRLVL=IPP
      CALL TOTALQS(QST1)
      STRMPR=QST1
      IF(STRMPN.GT.STRMPR) GOTO 1999
      DO 1997 J=1,NSTUBE
      ISWCN(I,J)=0
      IF(J.EQ.1.OR.J.EQ.NSTUBE) ISWCN(I,J)=1
 1997 CONTINUE
C
 1999 CONTINUE
      DO 1900 J=1,NSTUBE
      ISWCN(1,J)=ISWCN(2,J)
      ISWCW(1,J)=ISWCW(2,J)
 1900 CONTINUE
      IR=IRR
      RETURN
      END
      SUBROUTINE WIDEN(ISTA,J,SAR,DELWI)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      I=ISTA
      NPOINTS=BOTTOM(I,1)+2
      SAR=0.
      IF(J.NE.1) GOTO 200
      I9=0
      CRN=0.
      CRO=0.
      IF((YLOC(I,1)-DELWI).LT.XLTI(I)) GOTO 200
      DO 100 K=3,NPOINTS
```

```
      IF(CROSLOC(I,K).LT.(YLOC(I,1)-DELWI)) GOTO 100
      IF(CROSLOC(I,K).GT.YLOC(I,2)) GOTO 100
      I9=I9+1
      CRN=CROSLOC(I,K)
      CROSLOC(I,K)=CROSLOC(I,K)-DELWI
      IF(CROSLOC(I,K).LT.(YLOC(I,1)-DELWI)) CROSLOC(I,K)=YLOC(I,1)-DELWI
     +    +0.1*I9
      IF(CROSLOC(I,K).LE.YLOC(I,2).AND.CROSLOC(I,K+1).GT.YLOC(I,2))
     + GOTO 99
      GOTO 98
   99 CONTINUE
      IF(I9.LT.2) SAR=SAR+(BOTTOM(I,K-1)-BOTTOM(I,K))*DELWI*0.5
      IF(I9.GE.2) SAR=SAR+(BOTTOM(I,K-1)-BOTTOM(I,K))*DELWI
      SAR=SAR+(BOTTOM(I,K)-BOTTOM(I,K+1))*DELWI*0.5
      IF(K.LE. NPOINTS+1) GOTO 100
   98 CONTINUE
      IF(I9.LT.2) CRO=CRN
      IF(I9.LT.2) GOTO 100
      DEL=0.5*ABS(CROSLOC(I,K)+CROSLOC(I,K-1)-CRN-CRO)
      SAR=SAR+(BOTTOM(I,K-1)-BOTTOM(I,K))*DEL
      CRO=CRN
  100 CONTINUE
      IF(SAR.LT.0.) SAR=0.
  200 CONTINUE
      IF(J.NE.NSTUBE) GOTO 400
      I9=0
      CRO=0.
      CRN=0.
      IF((YLOC(I,NSTRM)+DELWI).GT.XRGHTI(I)) GOTO 400
      DO 300 K=3,NPOINTS
      IF(CROSLOC(I,K).GT.(YLOC(I,NSTRM)+DELWI)) GOTO 300
      IF(CROSLOC(I,K).LT.YLOC(I,NSTRM-1)) GOTO 300
      I9=I9+1
      CRN=CROSLOC(I,K)
      CROSLOC(I,K)=CROSLOC(I,K)+DELWI
      IF(CROSLOC(I,K).GT.(YLOC(I,NSTRM)+DELWI))
     +   CROSLOC(I,K)=YLOC(I,NSTRM)+DELWI-0.001*(10-I9)
      IF(CROSLOC(I,K-1).LE.YLOC(I,NSTRM-1).AND.CROSLOC(I,K).GT.YLOC(I,
     +   NSTRM-1)) GOTO 199
      GOTO 198
  199 CONTINUE
      SAR=SAR+(BOTTOM(I,K)-BOTTOM(I,K-1))*DELWI*0.5
      CRO=CRN
      GOTO 300
  198 CONTINUE
      IF(I9.LT.2) CRO=CRN
      IF(I9.LT.2) GOTO 300
      DEL=0.5*ABS(CROSLOC(I,K)+CROSLOC(I,K-1)-CRN-CRO)
      SAR=SAR+(BOTTOM(I,K)-BOTTOM(I,K-1))*DEL
      CRO=CRN
  300 CONTINUE
      IF(SAR.LE.0.) SAR=0.
  400 CONTINUE
      RETURN
      END
      SUBROUTINE DEEPEN(ISTA,ITUBE,SAR,DELZ)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      I9=0
      SAR=0.
      K=ITUBE
      I=ISTA
      NPOINTS=BOTTOM(I,1)+2
```

```
      DO 100 J=3,NPOINTS
      IF(CROSLOC(I,J).LT.YLOC(I,1).OR.CROSLOC(I,J).GT.YLOC(I,NSTRM))
     +    GOTO 100
      IF(CROSLOC(I,J).GE.YLOC(I,K).AND.CROSLOC(I,J).LE.YLOC(I,K+1))
     +   GOTO 32
      GOTO 100
   32 CONTINUE
      CRN=BOTTOM(I,J)
      I9=I9+1
      BOTTOM(I,J)=BOTTOM(I,J)-DELZ
      IF(CROSLOC(I,J).GT.YLOC(I,NSTRM)) BOTTOM(I,J)=CRN
      IF(BOTTOM(I,J).LE.CBLI(I)) BOTTOM(I,J)=CBLI(I)
      IF(I9.EQ.1.AND.K.EQ.1) SAR=SAR+(CROSLOC(I,J)-CROSLOC(I,J-1))*
     + (CRN-BOTTOM(I,J))*0.5
      IF(I9.EQ.1.AND.K.GT.1) SAR=SAR+(CROSLOC(I,J)-YLOC(I,K))*
     +(CRN-BOTTOM(I,J))
      IF(I9.GT.1) SAR=SAR+(CROSLOC(I,J)-CROSLOC(I,J-1))*
     +(CRN+CRO-BOTTOM(I,J)-BOTTOM(I,J-1))*0.5
      IF(CROSLOC(I,J).LT.YLOC(I,K+1).AND.CROSLOC(I,J+1).GT.
     +YLOC(I,K+1)) SAR=SAR+(CRN-BOTTOM(I,J))*(YLOC(I,K+1)-CROSLOC(I,J))
      CRO=CRN
  100 CONTINUE
      IF(SAR.LT.0.) SAR=0.
      RETURN
      END
      SUBROUTINE NARROW(ISTA,J,SAR,DELWI)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      I=ISTA
      NPOINTS=BOTTOM(I,1)+2
      SAR=0.
      IF(J.NE.1) GOTO 200
      I9=0
      DO 100 K=3,NPOINTS
      IF(CROSLOC(I,K).LT.YLOC(I,1).OR.CROSLOC(I,K).GT.YLOC(I,2))
     +    GOTO 100
      I9=I9+1
      CRN=CROSLOC(I,K)
C     CRO=CRN
      CROSLOC(I,K)=CROSLOC(I,K)+DELWI
      IF(CROSLOC(I,K).GT.YLOC(I,2)) CROSLOC(I,K)=YLOC(I,2)+.0001*I9
      IF(CROSLOC(I,K-1).LT.YLOC(I,1).AND.CROSLOC(I,K).GT.YLOC(I,1))
     +    GOTO 99
      IF(I9.EQ.1) GOTO 99
      GOTO 98
   99 CONTINUE
      SAR=SAR+0.5*(CROSLOC(I,K)-CRN)*(BOTTOM(I,K-1)-BOTTOM(I,K))
      CRO=CRN
      GOTO 100
   98 CONTINUE
C     CROSLOC(I,0)=0.
      SAR=SAR+(BOTTOM(I,K)-BOTTOM(I,K-1))*
     +(CROSLOC(I,K)+CROSLOC(I,K-1)-CRN-CRO)*0.5
      CRO=CRN
  100 CONTINUE
      IF(SAR.LT.0.) SAR=0.
  200 CONTINUE
      IF(J.NE.NSTUBE) GOTO 400
      I9=0
      DO 300 K=3,NPOINTS
      CRO=  CROSLOC(I,K)
      IF(CROSLOC(I,K).GT.YLOC(I,NSTRM).AND.
     +   CROSLOC(I,K-1).LT.YLOC(I,NSTRM)) CRN=CROSLOC(I,K)
      IF(CROSLOC(I,K).GT.YLOC(I,NSTRM).AND.
```

```
     +   CROSLOC(I,K-1).LT.YLOC(I,NSTRM)) GOTO 198
      IF(CROSLOC(I,K).LT.YLOC(I,NSTRM-1).OR.
     +   CROSLOC(I,K).GT.YLOC(I,NSTRM)) GOTO 300
      I9=I9+1
      CRN=CROSLOC(I,K)
      CROSLOC(I,K)=CROSLOC(I,K)-DELWI
      IF(CROSLOC(I,K).LT.YLOC(I,NSTRM-1)) CROSLOC(I,K)=YLOC(I,NSTRM-1)+
     +    0.0001*I9
      IF(CROSLOC(I,K-1).LE.YLOC(I,NSTRM-1).AND.CROSLOC(I,K).GT.
     +   YLOC(I,NSTRM-1)) GOTO 199
      IF(I9.EQ.1) GOTO 199
      GOTO 198
  199 CONTINUE
      SAR=SAR+0.5*(CRN-CROSLOC(I,K))*(BOTTOM(I,K)-BOTTOM(I,K-1))
      CRO=CRN
      GOTO 300
  198 CONTINUE
      SAR=SAR+(BOTTOM(I,K)-BOTTOM(I,K-1))*
     +(CRN+CRO-CROSLOC(I,K)-CROSLOC(I,K-1))*0.5
      CRO=CRN
  300 CONTINUE
      IF(SAR.LE.0.) SAR=0.
  400 CONTINUE
      RETURN
      END
      SUBROUTINE RAISE(ISTA,ITUBE,SAR,DELZ)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      I9=0
      K=ITUBE
      SAR=0.
      I=ISTA
      NPOINTS=BOTTOM(I,1)+2
      DO 100  J=3,NPOINTS
      IF(CROSLOC(I,J).LT.YLOC(I,1).OR.CROSLOC(I,J).GT.YLOC(I,NSTRM))
     +    GOTO 100
      IF(CROSLOC(I,J).GE.YLOC(I,K).AND.CROSLOC(I,J).LE.YLOC(I,K+1))
     + GOTO 32
      GOTO 100
   32 CONTINUE
      I9=I9+1
      CRN=BOTTOM(I,J)
      BOTTOM(I,J)=BOTTOM(I,J)+DELZ
      IF(BOTTOM(I,J).GT.WSE(I)) BOTTOM(I,J)=CRN
      IF(BOTTOM(I,J).GT.CBHI(I)) BOTTOM(I,J)=CBHI(I)
C
      IF(I9.EQ.1.AND.K.EQ.1) SAR=SAR+(CROSLOC(I,J)-CROSLOC(I,J-1))*
     +(BOTTOM(I,J)-CRN)*0.5
      IF(I9.EQ.1.AND.K.GT.1) SAR=SAR+(CROSLOC(I,J)-YLOC(I,K))*
     +(BOTTOM(I,J)-CRN)
      IF(I9.GT.1) SAR=SAR+(CROSLOC(I,J)-CROSLOC(I,J-1))*
     +(BOTTOM(I,J)+BOTTOM(I,J-1)-CRN-CRO)*0.5
      IF(CROSLOC(I,J).LT.YLOC(I,K+1).AND.CROSLOC(I,J+1).GT.YLOC(I,K+1))
     +SAR=SAR+(BOTTOM(I,J)-CRN)*(YLOC(I,K+1)-CROSLOC(I,J))
      IF(CROSLOC(I,J).LT.YLOC(I,NSTRM).AND.CROSLOC(I,J+1).GT.
     +YLOC(I,NSTRM)) SAR=SAR+(BOTTOM(I,J)-CRN)*0.5*(CROSLOC(I,J+1)-
     +CROSLOC(I,J))
      CRO=CRN
  100 CONTINUE
      IF(SAR.LT.0.) SAR=0.
      RETURN
      END
```

```
      SUBROUTINE TOTALQS(QSTOT)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK54/CONVY(30)
      SUMQS=0.
      HGQ2=0.5*62.4*Q*Q*Q
      DO 100 I=2,NSTA
      QSI=HGQ2*(1./CONVY(I)**2+1./CONVY(I-1)**2)*ABS(STA(I)-STA(I-1))
      SUMQS=SUMQS+QSI
  100 CONTINUE
      QSTOT=SUMQS
      RETURN
      END
      SUBROUTINE QTABLE(DTIME,ITIMAX,NITRQS,IQ,IOPTQ,IOPTSTQ,ITABLE)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ THE INPUT WATER DISCHARGE ARRAY AND C
C     THE COEFFICIENTS FOR THE STAGE-DISCHARGE CURVES AT DIFFERENT   C
C     STATIONS.                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK10/COEF1(30),COEF2(30),COEF3(30)
      COMMON/BLK89/TEMPI(500),QI(500),QSI(500),WSEI(500)
      READ(IQ,*) ITIMAX,NITRQS,DTIME
      DTIME=DTIME/NITRQS
      READ(IQ,4) IOPTQ
    4 FORMAT(A10)
      READ(IQ,4)IOPTSTQ
      IF(IOPTQ.EQ.10HTABLE OF D.AND.IOPTSTQ.EQ.10HRATING CUR) GOTO600
      IF(IOPTQ.EQ.10HTABLE OF D.AND.IOPTSTQ.EQ.10HSTAGE DISC) GOTO 200
      IB=0
  100 IF(IB.GE.ITIMAX) GOTO 200
      READ(IQ,*) NDAY,QQ
      IE=IB+NDAY
      IB=IB+1
      DO 300 I=IB,IE
      QI(I)=QQ
  300 CONTINUE
      IB=IE
      GOTO 100
  600 CONTINUE
      READ(IQ,*) (QI(I),I=1,ITIMAX)
  200 CONTINUE
      IF(IOPTSTQ.EQ.10HSTAGE DISC) GOTO 700
      DO 400 I=1,NSTA
      COEF1(I)=0.
      COEF2(I)=0.
      COEF3(I)=0.
  400 CONTINUE
      READ(IQ,*) NCURVES
      DO 500 J=1,NCURVES
      READ(IQ,*) ISTA,COEF1(ISTA),COEF2(ISTA),COEF3(ISTA)
  500 CONTINUE
      RETURN
  700 CONTINUE
      READ(IQ,*) ITABLE
      READ(IQ,*) (QI(I),WSEI(I),I=1,ITIMAX)
      RETURN
      END
      SUBROUTINE QSTABLE(ITIMAX,IQ,SEDOPT)
      INTEGER SEDOPT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ THE INPUT SEDIMENT DISCHARGE HYDRO-   C
C     GRAPH AT THE UPSTREAM BOUNDARY STATION.                          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
```

```
      COMMON/BLKO/IR,NSTA
      COMMON/BLK89/TEMPI(500),QI(500),QSI(500),WSEI(500)
      READ(IQ,2) SEDOPT
    2 FORMAT(A10)
      IF(SEDOPT.EQ.10HNO SEDIMEN) RETURN
      IB=0
  100 IF(IB.GE.ITIMAX) GOTO 200
      READ(IQ,*) NDAYS,QS
C     1 FORMAT(I5,F10.0)
      IE=IB+NDAYS
      IB=IB+1
      DO 300 I=IB,IE
      QSI(I)=QS
  300 CONTINUE
      IB=IE
      GOTO 100
  200 CONTINUE
      RETURN
      END
      SUBROUTINE PREPDAT(IOR)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE READS THE ORIGINAL DATA FILE AND MODIFIES IT     C
C     TO INCORPORATE THE INTERPOLATED CROSS-SECTIONS. THE NUMBER OF    C
C     INTERPOLATED CROSS-SECTIONS AND THEIR LOCATION IS READ IN BY     C
C     SUBROUTINE INTCRS. THIS SUBROUTINE ALSO GENERATES THE DESIRED    C
C     CROSS SECTIONS AND TRANSFERS THE INFORMATION TO SUBROUTINE       C
C     PREPDAT.                                                         C
C     IOR IS THE ORIGINAL DATA FILE AND IR IS THE MODIFIED FILE        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLKO/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK9/OBL,CHANNEL,OBR
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK47/RNTYP(3),EQROUGH
      COMMON/BLK48/OPTION(3),IOPTZ
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK55/CLOSS(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK79/WSMN(30),WSMX(30)
C
      IRR=IR
      IR=IOR
      REWIND IR
C
C     THE THE ORIGINAL DATA FILE
C
      CALL CROSSEC
      CALL ROUGHNS
      CALL COEFLOS
      CALL WSELIMT(NSTA)
      CALL BOTSLOP
C
C     INITIALIZE WATER SURFACE ELEVATIONS.
C
      DO 300 I=1,NSTA
      WSE(I)=0.0
      WSMN(I)=WSEMIN(I)
      WSMX(I)=WSEMAX(I)
  300 CONTINUE
C
```

```
C     READ THE NUMBER OF STREAM TUBES
      READ(IOR,*) NSTUBE
      NSTRM=NSTUBE+1
C
C     UPDATE THE INPUT DATA FILE
C
      IR=IRR
      REWIND IR
      DO 400 I=1,NSTA
      NDIVI=NDIV(I)
      NPOINTS=BOTTOM(I,1)
      NPOINTS=NPOINTS+2
  400 CONTINUE
      DO 500 I=1,NSTA
      NPOINTS=BOTTOM(I,1)+2
  500 CONTINUE
      IOPT=10HREAD
      IF(IOPTZ.NE.IOPT) GOTO 600
  600 CONTINUE
   10 FORMAT(A10)
      RETURN
      END
      SUBROUTINE READDAT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ THE DATA FILE IR. THE ORIGIANAL       C
C     DATA IS STORED IN TAPE3. SUBROUTINE READDAT READS THIS DATA      C
C     AT THE BEGINNING OF EACH SUBCHANNEL COMPUTATION TO INITIATE      C
C     THE COMPUTATIONS WITH ORIGINAL WATER SURFACE ELEVATIONS AND      C
C     CONTROL SECTIONS.                                                C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK55/CLOSS(30)
C
      IRR=IR
      IR=7
      REWIND IR
      CALL CROSSEC
      CALL ROUGHNS
      CALL COEFLOS
      READ(IR,10) IOPTZ
   10 FORMAT(A10)
      IOPT=10HREAD
      IF(IOPTZ.NE.IOPT) GOTO 100
      READ(IR,*) (Z(I),I=1,NSTA)
  100 CONTINUE
      IR=IRR
      RETURN
      END
      SUBROUTINE STUBE
      COMMON/BLK0/IR,NSTA
      DIMENSION DLL(30)
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK40/CM,G
      COMMON/BLK41/IOPTFR,IOPTFS
```

```
      COMMON/BLK46/IPRLVL
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK52/AA(10),RR(10),CONV(10),DISCHAR(10)
      COMMON/BLK53/BACKWAT
      COMMON/BLK54/CONVY(30)
      COMMON/BLK56/XSAREA(30),HYDRAD(30)
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK72/AREAST(30,5),HYDRAST(30,5),SFAVEST(30,5),
     +VELST(30,5)
      COMMON/BLK76/CONVST(30,5)
      COMMON/BLK74/END(30),BEGIN(30)
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      DO 100 I=1,NSTA
      AREAT=XSAREA(I)
      CONVT=CONVY(I)
      RT=HYDRAD(I)
      SFT=(Q/CONVT)**2
      NPTS=BOTTOM(I,1)
      IF(END(I).EQ.O.) END(I)=CROSLOC(I,NPTS+2)
      IF(BEGIN(I).EQ.O.) BEGIN(I)=CROSLOC(I,3)
      XR=END(I)
      XL=BEGIN(I)
      WSELEV=WSE(I)
      WIDTH=ABS(XL-XR)
      DELW=WIDTH/10.
      DO 200 J=1,10
      DLL(J)=DL(I,J)
      DL(I,J)=XL+J*(WIDTH/10.)
  200 CONTINUE
      WIDTH=ABS(XL-XR)
      BACKWAT=1.
      NDIV(I)=10
      CALL GEOMTRY(I,A,R,D,AK,WSELEV)
      NSTRM1=NSTRM-1
      YLOC(I,1)=XL
      XLOC(I,1)=CROSLOC(I,1)
      YLOC(I,NSTRM)=END(I)
      XLOC(I,NSTRM)=CROSLOC(I,1)
      IF(NSTRM1.LE.1) GOTO 301
      DO 300 KK=1,NSTRM1
      FK=KK
      DISCHRG=FK*(Q/NSTRM1)
      QI=O.
      M=O
  500 CONTINUE
      M=M+1
      IF(M.GT.10) GOTO 300
      DELQI=DISCHAR(M)
      QI=QI+DELQI
      IF(QI.LT.DISCHRG) GOTO 500
      DELQ=DISCHRG-(QI-DELQI)
      IF(M.EQ.1) XLEFT=XL
      IF(M.NE.1) XLEFT=DL(I,M-1)
      YLOC(I,KK+1)=DELW*(DELQ/DELQI)+XLEFT
      XLOC(I,KK+1)=CROSLOC(I,1)
  300 CONTINUE
      GOTO 302
  301 CONTINUE
      AREAST(I,1)=AREAT
      CONVST(I,1)=CONVT
      HYDRAST(I,1)=RT
      SFAVEST(I,1)=SFT
      VELST(I,1)=Q/AREAT
      GOTO 100
  302 CONTINUE
C.....AUG 1985 CHANGES
```

```
      NDIV(I)=NSTUBE
      DO 1 J=2,NSTRM
      J1=J-1
      DL(I,J1)=YLOC(I,J)
    1 CONTINUE
      CALL GEOMTRY(I,A,R,D,AK,WSELEV)
      DO 2 J=1,NSTUBE
      IF(AA(J).LE.0.) WRITE(6,55) I,J
      IF(AA(J).LE.0. .OR. CONV(J).LE.0.) RR(J)=RT
   55 FORMAT(5X,*ERR. IN STRM TUBE LOCS. AT STA.*,I3,* TUBE*,I2)
      IF(AA(J).LE.0.) AA(J)=AREAT/NSTUBE
      IF(CONV(J).LE.0.) WRITE(6,55) I,J
      IF(CONV(J).LE.0.) CONV(J)=CONVT/NSTUBE
      VELST(I,J)=Q/(NSTUBE*AA(J))
      AREAST(I,J)=AA(J)
      HYDRAST(I,J)=RR(J)
      CONVST(I,J)=CONV(J)
      SFAVEST(I,J)=(Q/(CONV(J)*NSTUBE))**2
    2 CONTINUE
      DO 400 J=1,10
      DL(I,J)=DLL(J)
  400 CONTINUE
C
  100 CONTINUE
      BACKWAT=0.
      RETURN
      END
      SUBROUTINE STEPMTD
      INTEGER COMPDIR,DIRECTN,ANSWER(2)
      INTEGER HYDJUMP,SEARCH,CONTROL,CONTYP
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),S0(30)
      COMMON/BLK3/ DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/ FROUDEN(30),STA(30)
      COMMON/BLK5/ ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK7/DX
      COMMON/BLK8/DIRECTN(2),FLOW(10)
      COMMON/BLK10/COEF1(30),COEF2(30),COEF3(30)
      COMMON/BLK40/CM,G
      COMMON/BLK41/IOPTFR,IOPTFS
      COMMON/BLK42/A1,A2,R1,R2,AK1,AK2
      COMMON/BLK43/HOR(30),VER(30)
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK45/SEQNT(30),SEQELEV(30),YBAR(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK47/RNTYP(3),EQROUGH
      COMMON/BLK48/OPTION(3),IOPTZ
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK52/AA(10),RR(10),CONV(10),DISCHAR(10)
      COMMON/BLK53/BACKWAT
      COMMON/BLK54/CONVY(30)
      COMMON/BLK55/CLOSS(30)
      COMMON/BLK56/XSAREA(30),HYDRAD(30)
      COMMON/BLK73/NTRPXS(30)
      COMMON/BLK74/END(30),BEGIN(30)
      DIMENSION EGL(30)
      DATA CM,G/1.486,32.2/
      DATA EPS/0.01/
      DATA KM,EPS1/20,0.01/
      DATA IOPTFR,IOPTFS/1,1/
      DATA ANSWER(1),ANSWER(2)/10HYES       ,10HNO        /
      DATA DIRECTN/10HDOWNSTREAM,10HUPSTREAM  /
      DATA CONTYP/10HNATURAL   ,10HLAKE      
     +           ,10HWEIR      ,10HGATE      /
```

```
C
C     READ IN THE HYDRAULIC DATA
C
      CALL CROSSEC
      CALL ROUGHNS
      CALL COEFLOS
      CALL WSELIMT(NSTA)
      CALL BOTSLOP
      CALL CRITCLD(EPS1,NSTA)
      CALL NORMALD(EPS1,NSTA)
C    FROUDEN(22)=FROUDEN(21)
      FROUDEN(NSTA+1)= FROUDEN(NSTA)
      IF(FROUDEN(1).GT.1.  .AND.ISWITCH(1).EQ.1) GOTO 330
      IF(FROUDEN(1).GT.1.) ISWITCH(1)=1
      IF(FROUDEN(1).GT.1.) ITYP(1)=1
      IF(FROUDEN(1).GT.1.) WSE(1)=WSEDC(1)
      IF(FROUDEN(1).GT.1.) FROUDEN(1)=1.
  330 CONTINUE
      IF(IPRLVL.LT.1) GOTO 30
      WRITE(6,27)
   27 FORMAT(//,*  ISWITCH  STA.         Z       WSE      ITYP*,/)
      WRITE(6,28) (ISWITCH(J),STA(J),Z(J),WSE(J),ITYP(J),J=1,NSTA)
   28 FORMAT(5X,I2,3F10.3,I5)
   30 CONTINUE
C

      NCONTRL=0
      HYDJUMP=ANSWER(2)
      SEARCH=ANSWER(2)
C
C

      IF(IPRLVL.LT.0) GOTO 1235
      WRITE(6,1234)
 1234 FORMAT(///,10X,*      STEP METHOD COMPUTATIONS*,///)
 1235 CONTINUE
      DO 100 I=1,NSTA
      IF(IPRLVL.LT.0) GOTO 517
      WRITE(6,500) I
  500 FORMAT(5X,*I=*,10I5)
  517 CONTINUE
      IF(SEARCH.EQ.ANSWER(1)) GOTO 200
      IF(I.EQ.1.AND.ISWITCH(I).NE.1) GOTO 201
      IF(I.NE.1) GOTO 123
      WSEI=WSE(I)
      CALL GEOMTRY(I,AI,RI,DI,AKI,WSEI)
      NCONTRL=NCONTRL+1
      KN=ITYP(1)
      K(1)=1
      CONTROL(1)=CONTYP(KN)
      Y(I)=WSE(I)-Z(I)
      IF(IPRLVL.LT.0) GOTO 201
      WRITE(6,84) I,CONTROL(I),Y(I),WSE(I)
      GOTO 201
  123 CONTINUE
      IF(HYDJUMP.EQ.ANSWER(1)) GOTO 200
      IF(FROUDEN(I-1).GE.1) GOTO 200
      IF(ISWITCH(I).EQ.1) GOTO 102
      IF(I.EQ.NSTA) GOTO 100
      IF(FROUDEN(I+1).LT. 0.99) GOTO 100
      WSE(I)=WSEDC(I)
      Y(I)=DC(I)
      FROUDEN(I)=1.0
      ISWITCH(I)=1
      NCONTRL=NCONTRL+1
      K(NCONTRL)= I
```

```
      CONTROL(NCONTRL)=CONTYP(1)
      IF(IPRLVL.LT.0) GOTO 305
      WRITE(6,84) I,CONTROL(NCONTRL),Y(I),WSE(I)
  305 CONTINUE
      WSEI=WSE(I)
      CALL GEOMTRY(I,AI,RI,DI,AKI,WSEI)
      GOTO 101
  102 CONTINUE
      Y(I)=WSE(I)-Z(I)
      NCONTRL=NCONTRL+1
      K(NCONTRL)=I
      KN=ITYP(I)
      CONTROL(NCONTRL)=CONTYP(KN)
      IF(IPRLVL.LT.0) GOTO 306
      WRITE(6,84) I,CONTROL(NCONTRL),Y(I),WSE(I)
  306 CONTINUE
      WSEI=WSE(I)
      CALL GEOMTRY(I,AI,RI,DI,AKI,WSEI)
  101 CONTINUE
      J=0
  120 CONTINUE
      I1=I-J-1
      I2=I-J
      IF(I1.LE.0) GOTO 204
      DX=ABS(STA(I1)-STA(I2))
      KM=20
      EPS1=0.01
      COMPDIR=DIRECTN(2)
      CALL BACKWTR(COMPDIR,I1,I2,DX,KM,EPS1)
C     IF(ISWITCH(I1).EQ.1  .OR.  Y(I1).NE.0.) GOTO 204
      IF(ISWITCH(I1).EQ.1) GOTO 204
      IF((SEQELEV(I1)-WSE(I1)).GE.0.1) HYDJUMP=ANSWER(2)
      IF((SEQELEV(I1)-WSE(I1)).GE.0.1) SEARCH=ANSWER(2)
      IF((SEQELEV(I1)-WSE(I1)).GE.0.1) GOTO 204
      J=J+1
      IMJ=I-J
      IF(IMJ.LE.0) GOTO 204
      GOTO 120
  204 CONTINUE
      IF(FROUDEN(I).LT. 0.99) GOTO 100
      IF(I.EQ.NSTA) GOTO 100
      IF(FROUDEN(I+1).LT. 0.99) GOTO 100
      IF(ISWITCH(I+1).EQ.1) WSECN=WSE(I+1)
      IF(ISWITCH(I+1).EQ.1) YCN=WSECN-Z(I+1)
      HYDJUMP=ANSWER(2)
      SEARCH=ANSWER(2)
      I1=I+1
      I2=I
      DX=ABS(STA(I1)-STA(I2))
      COMPDIR=DIRECTN(1)
      CALL BACKWTR(COMPDIR,I1,I2,DX,KM,EPS1)
      WSE1=WSE(I1)
      WSE2=WSE(I2)
      CALL SEQUENT(I1,I2,EPS)
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSE1)
      CALL GEOMTRY(I2,A2,R2,D2,AK2,WSE2)
      GOTO 100
  200 CONTINUE
      IF(ISWITCH(I).NE.1) GOTO 201
      IF(SEARCH.EQ.ANSWER(1).AND.WSE(I).NE.WSEDC(I)) WSECN=WSE(I)
      IF(SEARCH.EQ.ANSWER(1).AND.WSE(I).NE.WSEDC(I)) YCN=WSECN-Z(I)
      SEARCH=ANSWER(2)
      NCONTRL=NCONTRL+1
      K(NCONTRL)=I
      NN=ITYP(I)
      CONTROL(NCONTRL)=CONTYP(NN)
```

```
      IF(IPRLVL.LT.0) GOTO 307
      WRITE(6,84) I,CONTROL(NCONTRL),YCN,WSECN
  307 CONTINUE
      Y(I)=YCN
      WSE(I)=WSECN
      CALL GEOMTRY(I,ACN,RCN,DCN,AKCN,WSECN)
      FRCN=Q/(ACN*SQRT(G*DCN/ALPHA(I)))
      FROUDEN(I)=FRCN
      IF(FROUDEN(I).GT.1.01) GOTO 100
  208 CONTINUE
      ILOW=1
      IHIGH=K(NCONTRL)
      I2=IHIGH
      I1=I2-1
      NCONT=NCONTRL
   29 CONTINUE
      DX=ABS(STA(I1)-STA(I2))
      WSEUPS=WSE(I1)
      YUPSTRM=Y(I1)
      UPRWSE=WSEDC(I1)+0.005
      COMPDIR=DIRECTN(2)
      CALL BACKWTR(COMPDIR,I1,I2,DX,KM,EPS1)
      IF( ABS(WSE(I1)-UPRWSE).LE.0.005) GOTO 99
      IF(ABS(WSE(I1)-SEQELEV(I1)).LE.0.005) WSE(I1)=SEQELEV(I1)
      IF(ABS(WSE(I1)-SEQELEV(I1)).LE.0.005) HYDJUMP=ANSWER(2)
      IF(ABS(WSE(I1)-SEQELEV(I1)).LE.0.005) SEARCH=ANSWER(2)
      IF(ABS(WSE(I1)-SEQELEV(I1)).LE.0.005) GOTO 204
      IF(WSE(I1).LT.SEQELEV(I1)) GOTO 99
      I2=I2-1
      I1=I2-1
      IF(I1.GE.ILOW) GOTO 29
      IF(I1.LT.1) GOTO 129
      GOTO 29
  129 CONTINUE
      HYDJUMP=ANSWER(2)
      SEARCH=ANSWER(2)
      GOTO 204
  201 CONTINUE
      IF(SEARCH.EQ.ANSWER(1)) GOTO 68
      IF(I.EQ.1.AND.FROUDEN(I).LT. 0.99) GOTO 100

      IF(FROUDEN(I).LT. 0.99) HYDJUMP=ANSWER(1)
      IF(I.EQ.NSTA) GOTO 100
      IF(FROUDEN(I+1).LT. 0.99) HYDJUMP=ANSWER(1)
      IF(ISWITCH(I+1).EQ.1) Y(I+1)=WSE(I+1)-Z(I+1)
      IF(ISWITCH(I+1).EQ.1) WSECN=WSE(I+1)
      IF(ISWITCH(I+1).EQ.1) YCN=Y(I+1)
      I1=I+1
      IF(ISWITCH(I1).EQ.1) CALL GEOMTRY(I1,AI,RI,DI,AKI,WSECN)
      I2=I
      IF(I1.GT.NSTA) GOTO 100
      DX=ABS(STA(I1)-STA(I2))
      COMPDIR=DIRECTN(1)
      CALL BACKWTR(COMPDIR,I1,I2,DX,KM,EPS1)
      WSE1=WSE(I1)
      WSE2=WSE(I2)
      CALL SEQUENT(I1,I2,EPS)
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSE1)
      CALL GEOMTRY(I2,A2,R2,D2,AK2,WSE2)
      DSEQ=SEQELEV(I1)-WSEDC(I1)
      IF(WSEDN(I1).LE.WSEDC(I1)) GOTO 100
      IF(ABS(DSEQ).GT.0.05) GOTO 100
      SEARCH=ANSWER(1)
      GOTO 100
   99 CONTINUE
      WSE(I1)=WSEUPS
```

```
      Y(I1)=YUPSTRM
      HYDJUMP=ANSWER(2)
      SEARCH=ANSWER(2)
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSEUPS)
      FROUDEN(I1)=Q/(A1*SQRT(G*D1/ALPHA(I1)))
      GOTO 204
   68 CONTINUE
      WSE(I)=WSEDC(I)
      Y(I)=WSEDC(I)-Z(I)
      FROUDEN(I)=1.
      WSECN=WSE(I)
      CALL GEOMTRY(I,AI,RI,DI,AKI,WSECN)
      SEQELEV(I)=WSEDC(I)
      SEQNT(I)=Y(I)
      IF(FROUDEN(I-1).LT.0.99) GOTO 168
      IF( I.EQ. NSTA) GOTO 100
      IF(FROUDEN(I+1).LT.0.99) GOTO 100
      IF(ISWITCH(I+1).EQ.1) GOTO 100
      GOTO 170
  168 CONTINUE
      IF (I.EQ. NSTA) GOTO 100
      IF(FROUDEN(I+1).LT. 1.01) GOTO 100
  170 CONTINUE
      WSE(I)=WSEDC(I)
      Y(I)=WSEDC(I)-Z(I)
      FROUDEN(I)=1.
      WSECN=WSE(I)
      YCN=Y(I)
      CALL GEOMTRY(I,AI,RI,DI,AKI,WSECN)
      NCONTRL=NCONTRL+1
      K(NCONTRL)=I
      CONTROL(NCONTRL)=CONTYP(1)
      ISWITCH(I)=1
      IF(IPRLVL.LT.0) GOTO 208
      WRITE(6,84) I,CONTROL(NCONTRL),YCN,WSECN
      GOTO 208
  100 CONTINUE
      DO 1010 I=1,NSTA
      WS=WSE(I)
      CALL GEOMTRY(I,AAA,RRR,DD,AK,WS)
      HYDRAD(I)=RRR
      XSAREA(I)=AAA
      CONVY(I)=AK
      V=Q/AAA
      EGL(I)=WSE(I)+ALPHA(I)*V**2/(2.*G)
 1010 CONTINUE
   84 FORMAT(5X,*CONTROL AT SECTION*,I5,/,
     +        5X,*CONTROL TYPE =   *,A10,/,
     +        5X,*CONTROL DEPTH= *,F10.4,/,
     +        5X,*CONTROL ELEV.=*,F10.4,/)
C
      IF(IPRLVL.LT.0) GOTO 32
      IF(IPRLVL.GT.0) WRITE(6,281)
  281 FORMAT(1H1,//)
      WRITE(6,497) Q
  497 FORMAT(//,20X,43H*******************************************,/,20X,
     +1H*,41H    RESULTS OF BACKWATER COMPUTATIONS    ,1H*,/,20X,
     +1H*,17H      DISCHARGE =,F10.2,*  C.F.S.      *,1H*,/,20X,
     +43H*******************************************,//)
      WRITE(6,34)
      WRITE(6,5) (I,STA(I),WSE(I),XSAREA(I),EGL(I),FROUDEN(I),
     +I=1,NSTA)
   34 FORMAT(6X,*STA NO.     STATION     W.S. ELV     AREA      E.G.*,
     +*ELV   FROUDE NO.*,/,5X,
     +74H***************************************************************
     +**************,//)
```

```
    5 FORMAT(5X,I5,8X,F7.1,4X,F7.2,4X,E11.5,1X,E11.5,1X,F7.2)
   32 CONTINUE
      RETURN
      END
      SUBROUTINE BACKWTR(COMPDIR,I1,I2,DX,KMAX,EPS)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     SUBROUTINE BACKWTR IS TO PERFORM STANDARD STEP METHOD OF         C
C     BACKWATER COMPUTATIONS BETWEEN STATIONS I1 AND I2 .              C
C     COMPDIR       VARIABLE TO DENOTE THE DIRECTION OF COMPUTATIONS. C
C                   FOR SUBCRITICAL FLOWS IT IS SET TO (UPSTREAM);    C
C                   FOR SUPERCRITICAL FLOWS IT IS SET TO (DOWNSTREAM) C
C     DX            VARIABLE DENOTING THE DISTANCE BETWEEN STA. I1$I2 C
C     KMAX          VARIBLE CONTROLLING THE NUMBER OF ITERATIONS.     C
C     EPS           VARIABLE CONTROLLING THE ACCURACY OF RESULTS. FOR C
C                   THE EXISTING PROGRAM IT IS SET EQUAL TO 0.001     C
C     HBEND         HEAD LOSS DUE TO CHANNEL BENDS.                   C
C     HF            HEAD LOSS DUE TO CHANNEL FRICTION.                C
C     THE DETAILS OF THE METHOD ARE GIVEN IN THE BOOK ENTITLED         C
C     OPEN CHANNEL FLOW , BY HENDERSON .                               C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     STANDARD STEP METHOD OF BACKWATER COMPUTATIONS.
      INTEGER COMPDIR,DIRECTN
      INTEGER FLOW
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK8/DIRECTN(2),FLOW(10)
      COMMON/BLK40/CM,G
      COMMON/BLK41/IOPTFR,IOPTFS
      COMMON/BLK42/A1,A2,R1,R2,AK1,AK2
      COMMON/BLK45/SEQNT(30),SEQELEV(30),YBAR(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK52/AA(10),RR(10),CONV(10),DISCHAR(10)
      COMMON/BLK53/BACKWAT
      COMMON/BLK55/CLOSS(30)
      DATA DY/0.05/
      DATA FLOW/5HM3A3  ,5HS1     ,5HS2S3  ,5HS2     ,5HS3      ,
     +          5HM1M2  ,5HA2     ,5HC1C3  ,5HC1     ,5HC3     /
      DATA DIRECTN/10HDOWNSTREAM,10HUPSTREAM   /
      TWOTRD=2./3.
      II=I1
      IF(COMPDIR.EQ.DIRECTN(1)) II=I2
      WSE2=WSE(I2)
      Y(I2)=WSE(I2)-Z(I2)
      Y2=Y(I2)
      BACKWAT=0.
      CALL GEOMTRY(I2,A2,R2,D2,AK2,WSE2)
      V2=Q/A2
      BACKWAT=0.
      H2=WSE2+ALPHA(I2)*Q**2/(2.*G*A2**2)
C
C      COMPUTE THE BEND LOSSES.
C
      HBEND=CLOSS(I2)*Q**2/(2.*G*A2**2)
C
C
C     DEFINE GRADUALLY VARIED FLOW PROFILES
C
      IFLOW=5H
      IF(COMPDIR.EQ.DIRECTN(1).AND.WSEDN(I1).GT.WSEDC(I1)) IFLOW=5HM3A3
      IF(COMPDIR.EQ.DIRECTN(2).AND.WSEDN(I2).LT.WSEDC(I2)) IFLOW=5HS1
      IF(COMPDIR.EQ.DIRECTN(1).AND.WSEDN(I1).LT.WSEDC(I1)) IFLOW=5HS2S3
```

```
      IF(IFLOW.EQ.FLOW(3).AND.WSE(I2).EQ.WSEDC(I2)) IFLOW=5HS2
      IF(IFLOW.EQ.FLOW(3).AND.WSE(I2).GE.WSEDN(I2))  IFLOW=5HS2
      IF(IFLOW.EQ.FLOW(3).AND.WSE(I2).LT.WSEDN(I2))  IFLOW=5HS3
      IF(COMPDIR.EQ.DIRECTN(2).AND.WSEDN(I2).GT.WSEDC(I2)) IFLOW=5HM1M2
      IF(COMPDIR.EQ.DIRECTN(2).AND.   DN(I2).EQ. 999.9   ) IFLOW=5HA2
      IF(ABS(WSEDN(I1)-WSEDC(I1)).LE. 0.10 )               IFLOW=5HC1C3
      IF(IFLOW.EQ.FLOW(8) .AND. COMPDIR.EQ.DIRECTN(2) )    IFLOW=5HC1
      IF(IFLOW.EQ.FLOW(8) .AND. COMPDIR.EQ.DIRECTN(1) )    IFLOW=5HC3
C
C     ASSUME A WATER SURFACE ELEVATION TO START COMPUTATIONS
C
      IF(IFLOW.EQ.FLOW(1)) WSEASS=WSEDC(I1)-0.5*(WSEDC(I1)-Z(I1))
      IF(IFLOW.EQ.FLOW(2)) WSEASS=WSEDC(I1)+ 1.0
      IF(IFLOW.EQ.FLOW(3)) WSEASS=WSEDN(I1)
      IF(IFLOW.EQ.FLOW(4)) WSEASS=WSEDN(I1)+ DY
      IF(IFLOW.EQ.FLOW(5)) WSEASS=WSEDN(I1)- DY
      IF(IFLOW.EQ.FLOW(6)) WSEASS=WSEDN(I1)+DY
      IF(IFLOW.EQ.FLOW(6).AND.WSEDN(I1).EQ.99999.) WSEASS=WSE(I2)+10.
      IF(IFLOW.EQ.FLOW(6).AND.WSEDN(I1).LT.WSEDC(I1))
     + WSEASS=WSEDC(I1)+1.
      IF(IFLOW.EQ.FLOW(7)) WSEASS=WSE(I2) + 10.
      IF(IFLOW.EQ.FLOW(9)) WSEASS=WSEDC(I1)+ DY
      IF(IFLOW.EQ.FLOW(10)) WSEASS=WSEDC(I1)-DY
C
      KOUNT=0
      KOUNT2=0
   81 CONTINUE
      IF(IFLOW.EQ.FLOW(1).AND.WSEASS.GT.WSEDC(I1)) GOTO 84
      IF(IFLOW.EQ.FLOW(2).AND.WSEASS.LT.WSEDC(I1)-0.05) GOTO 85
      IF(IFLOW.EQ.FLOW(3).AND.WSEASS.GT.WSEDC(I1)) GOTO 87
      IF(IFLOW.NE.FLOW(4).AND.IFLOW.NE.FLOW(5))    GOTO 86
C
C     SUPERCRITICAL FLOW PROFILE LIMITATIONS...
C     IF S2 PROFILE,WSEASS IS NOT ALLOWED TO BE GREATER THAN WSEDC(I1)
C                   AND LESS THAN WSEDN(I1) ;
C     IF S3 PROFILE,WSEASS IS NOT ALLOWED TO BE GREATER THAN WSEDC(I1)
C                   OR WSEDN(I1) .
C
      IF(IFLOW.EQ.FLOW(4)) GOTO 88
      IF(WSEASS.GT.WSEDC(I1)) GOTO 87
      IF(WSEASS.LT.Z(I1)) GOTO 87
      GOTO 86
   88 CONTINUE
      IF(WSEASS.GT.WSEDC(I1)) GOTO 87
      IF(WSEASS.LT.Z(I1)) GOTO 87
      GOTO 86
   87 CONTINUE
      KOUNT2=KOUNT2+1
      IF(KOUNT2.LT.3) GOTO 89
      GOTO 78
   89 CONTINUE
      IF(IFLOW.EQ.FLOW(1)) WSEASS=WSEDC(I1)-(KOUNT2+1)*DY
      IF(IFLOW.EQ.FLOW(1)) GOTO 86
      IF(IFLOW.EQ.FLOW(4)) WSEASS=WSEDN(I1)+(KOUNT2+1)*DY
      IF(IFLOW.EQ.FLOW(4)) GOTO 86
      WSEASS=WSEDN(I1)-(KOUNT2+1)*DY
      IF(WSEASS.LT.Z(I1)) GOTO 74
   86 CONTINUE
      IF(IFLOW.EQ.FLOW(6).AND.WSEASS.LT.WSEDC(I1))
     +WSEASS=WSEDC(I1)+0.1+0.1*KOUNT
      IF(IFLOW.EQ.FLOW(7).AND.WSEASS.LT.WSEDC(I1)) WSEASS=WSEASS+10.
      IF(IFLOW.EQ.FLOW(9).AND. WSEASS.LT.WSEDC(I1)) GOTO 85
      IF(IFLOW.EQ.FLOW(10).AND.WSEASS.GT.WSEDC(I1)) GOTO 85
      IF(WSEASS.GT.Z(I1)) GOTO 11
      WSEASS=WSEASS+10.
      GOTO 86
```

```
   11 CONTINUE
      KOUNT=KOUNT+1
      IF(KOUNT.GT.KMAX) GOTO 78
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSEASS)
      HASS=WSEASS+ALPHA(I1)*Q*Q/(2.*G*A1*A1)
      V1=Q/A1
      RASS=R1
      FRASS=Q/(A1*SQRT(G*D1/ALPHA(I1)))
      SFASS=(Q/AK1)**2
      CALL FRLOSS(HF)
C     HLOSS SHOULD BE ALLOWED TO INCLUDE LOCAL LOSSES.
      CLOCAL=0.
      IF(COMPDIR.EQ.DIRECTN(1).AND.V1.GT.V2) CLOCAL=0.1
      IF(COMPDIR.EQ.DIRECTN(1).AND.V1.LT.V2) CLOCAL=0.3
      IF(COMPDIR.EQ.DIRECTN(2).AND.V1.GT.V2) CLOCAL=0.3
      IF(COMPDIR.EQ.DIRECTN(2).AND.V1.LT.V2) CLOCAL=0.1
      Q2G=(Q*Q)/(2.*G)
      HLOCAL=CLOCAL*ABS(Q2G/(A1*A1)-Q2G/(A2*A2))
      HLOSS=HF+HBEND+HLOCAL
      HCOMP=H2+HLOSS
      IF(COMPDIR.EQ.DIRECTN(1)) HCOMP=H2-HLOSS
      DHEAD=HASS-HCOMP
      IF(ABS(DHEAD).LE.EPS) GOTO 74
      SIGN=1.

      IF(COMPDIR.EQ.DIRECTN(1)) SIGN=-1.
      CC=1.-FRASS**2*(1.-0.5*SIGN*CLOSS(I1))+1.5*SIGN*DX*SFASS/RASS
      WSEASS=WSEASS-DHEAD/CC
      GOTO 81
   78 CONTINUE
      IF(IPRLVL.GE.1)
     +PRINT 79,KOUNT
   79 FORMAT(5X,*NO CONVERGENCE AFTER*,I4,*   ITERATIONS*)
      IF(IPRLVL.GE.1)
     +PRINT 80,I1,HCOMP,HASS,COMPDIR
   80 FORMAT(5X,*AT STATION*,I3,* HCOMP,HASS :*,2E15.7,A10)
      WS1=WSEASS
      IF(IFLOW.EQ.FLOW(1)) WSEASS=WSEDC(I1)
      IF(IFLOW.EQ.FLOW(2).AND.WSEASS.LT.WSE(I2)) WSEASS=WSE(I2)+.01
      IF(IFLOW.EQ.FLOW(4)) WSEASS=WSEDN(I1)
      IF(IFLOW.EQ.FLOW(5).AND.WSEASS.GT.WSEDN(I1)) WSEASS=WSEDN(I1)
      IF(IFLOW.EQ.FLOW(5).AND.WSEASS.LT.Z(I1)) WSEASS=WSEDN(I1)
      IF(IFLOW.EQ.FLOW(6).AND.WSEASS.LT.WSEDC(I1)) WSEASS=WSEDN(I1)
      IF(IFLOW.EQ.FLOW(6).AND.WSEASS.LT.WSE(I2)) WSEASS=WSE(I2)+.01
      IF(IFLOW.EQ.FLOW(7).AND.WSEASS.LT.WSE(I2)) WSEASS=WSE(I2)+.01
      IF(IFLOW.EQ.FLOW(5)) WSEASS=WSEDN(I1)
      IF(WSEASS.EQ.WS1) GOTO 887
      IF(IPRLVL.GE.0)
     +WRITE(6,888) WS1,WSEASS,IFLOW
  888 FORMAT(10X,* WSE BEFORE AND AFTER ADJUSTING*,2E15.7,A10)
  887 CONTINUE
   74 CONTINUE
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSEASS)
      H1=WSEASS+ALPHA(I1)*(Q/A1)**2/(2.*G)
      IF(COMPDIR.EQ.DIRECTN(1).AND.H1.GT.H2+EPS) GOTO 84
      IF(COMPDIR.EQ.DIRECTN(2).AND.H1.LT.H2+EPS) WSEASS=WSE(I2)+0.1
      WSE(I1)=WSEASS
      Y(I1)=WSEASS-Z(I1)
      FROUDEN(I1)=Q/(A1*SQRT(G*D1/ALPHA(I1)))
      RETURN
   84 CONTINUE
      WS1=WSEASS
      WSEASS=WSEDC(I1)
      IF(IPRLVL.LT.1) GOTO 740
      WRITE(6,888) WS1,WSEASS
  740 CONTINUE
```

```
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSEASS)
      WSE(I1)=WSEDC(I1)
      Y(I1)=WSE(I1)-Z(I1)
      FROUDEN(I1)=1.0
      RETURN
   85 CONTINUE
      WSEASS=WSEDC(I1)
      WSE(I1)=WSEASS
      Y(I1)=WSE(I1)-Z(I1)
      CALL GEOMTRY(I1,A1,R1,D1,AK1,WSEASS)
      FROUDEN(I1)=1.0
      RETURN
C
      END
      SUBROUTINE CROSSEC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE READS IN THE CHANNEL CROSS SECTION DATA.        C
C      THE VECTOR CROSLOC(J) CONTAINS THE STATION IDENTIFICATIONS     C
C      AND THE LATERAL LOCATION OF THE DATA POINTS. THE ARRAY         C
C      BOTTOM(I,J) CONTAINS THE CHANNEL BOTTOM ELEVATIONS.            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK9/OBL,CHANNEL,OBR
      COMMON/BLK46/IPRLVL
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK55/CLOSS(30)
      REWIND IR
      READ(IR,*) NSTA
      DO 1001 ISTA=1,NSTA
      READ(IR,*) STA(ISTA),NPOINTS,ISWITCH(ISTA),ITYP(ISTA)
      READ(IR,*)NDIVI,(DL(ISTA,J),J=1,NDIVI)
      NDIV(ISTA)=NDIVI
C
C     THE FIRST VALUE OF THE CROSLOC VECTOR CONTAINS THE RIVER MILES
C     THE FIRST COLUMN OF BOTTOM(I,J) ARRAY CONTAINS THE NO. OF DATA
C      POINTS FOR THAT SECTION.
      CROSLOC(ISTA,1)=STA(ISTA)
      BOTTOM(ISTA,1)=NPOINTS
      NPOINTS=NPOINTS+2
      JM=NPOINTS+1
      READ(IR,*) (BOTTOM(ISTA,N),CROSLOC(ISTA,N) ,N=3,NPOINTS)
      BOTTOM(ISTA,2)=99999.
      BOTTOM(ISTA,JM)=99999.
      CROSLOC(ISTA,2)=CROSLOC(ISTA,3)
C.....SEP 85 CHANGES
      CROSLOC(ISTA,JM)=CROSLOC(ISTA,NPOINTS)+1.
      IF(DL(ISTA,NDIVI).GE.CROSLOC(ISTA,NPOINTS))
     +DL(ISTA,NDIVI)=CROSLOC(ISTA,JM)
      IF(IPRLVL.NE.2) GOTO 563
      NP=BOTTOM(ISTA,1)
      WRITE(6,564) STA(ISTA),ISTA,NP,WSE(ISTA)
      DO 560 N=3,NPOINTS
      NN=N-2
      IL=6*(N/6)+1
      ILOW=IL+2
      IHIGH=ILOW+5
      IF(IL.NE.NN) GOTO 560
      IF(IHIGH.GT.NPOINTS) IHIGH=NPOINTS
      WRITE(6,561) ( CROSLOC(ISTA,IP),IP=ILOW,IHIGH)
      WRITE(6,562) (BOTTOM(ISTA,IP),IP=ILOW,IHIGH)
  560 CONTINUE
C
```

```
  561 FORMAT(11X,*X-COORDINATE*,6F9.2)
  562 FORMAT(11X,*Y-COORDINATE*,6F9.2,//)
  564 FORMAT(//,10X,*STATION *,F10.2,/,
     +11X,*STATION NUMBER   =*,I4,/,
     +11X,*NUMBER OF POINTS =*,I4,/,
     +11X,*WATER SURFACE EL.=*,F10.4,//)
C
  563 CONTINUE
C
C
 1001 CONTINUE
      RETURN
      END
      SUBROUTINE COEFLOS
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       THIS SUBROUTINE IS TO READ IN THE COEFFICIENTS OF     C
C       LOSSES DUE TO BENDS,CONSTRICTIONS,EXPANSIONS AND      C
C       OTHER LOCAL DISTURBANCES.                             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK55/CLOSS(30)
C
      READ(IR,*) (CLOSS(ISTA),ISTA=1,NSTA)
      IF(IPRLVL.LT.2) RETURN
      WRITE(6,10)
   10 FORMAT(10X,*COEFFICIENTS OF LOSSES AT DIFFERENT STATIONS*,/)
      WRITE(6,20)
   20 FORMAT(10X,*STA.   CLOSS   STA.   CLOSS   STA.   CLOSS   STA.   C
     +LOSS*,//)
      WRITE(6,30) (I,CLOSS(I),I=1,NSTA)
   30 FORMAT(10X,I4,F8.3,3X,I4,F8.3,3X,I4,F8.3,3X,I4,F8.3,3X)
      RETURN
      END
      SUBROUTINE ROUGHNS
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE READS THE CHANNEL ROUGHNESS DATA AT DIFFERENT  C
C     STATIONS IN THE DOWNSTREAM DIRECTION                           C
C     FOR EACH DATA POINT ACROSS THE CHANNEL A ROUGHNESS VALUE       C
C     SHOULD BE PROVIDED.                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK41/IOPTFR,IOPTFS
      COMMON/BLK47/RNTYP(3),EQROUGH
      DATA (RNTYP(I),I=1,3)/10HMANNING    ,10HCHEZY      ,10HDARCY      /
      READ(IR,10) EQROUGH
      DO 2001 ISTA=1,NSTA
      NPOINTS=BOTTOM(ISTA,1)+2
      JM=NPOINTS+1
      READ(IR,*) (RN(ISTA,N),N=3,NPOINTS)
      RN(ISTA,1)=RN(ISTA,3)
      RN(ISTA,2)=RN(ISTA,3)
      RN(ISTA,JM)=RN(ISTA,NPOINTS)
 2001 CONTINUE
   10 FORMAT(A10)
C    11 FORMAT(8F10.4)
      IF(EQROUGH.EQ.RNTYP(1)) IOPTFS=1
      IF(EQROUGH.EQ.RNTYP(2)) IOPTFS=2
      IF(EQROUGH.EQ.RNTYP(3)) IOPTFS=3
      RETURN
      END
      SUBROUTINE WSELIMT(NSTA)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
```

```
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK46/IPRLVL
      DO 300 ISTA=1,NSTA
      NPOINTS=BOTTOM(ISTA,1)
      WSEMIN(ISTA)=BOTTOM(ISTA,3)
      WSEMAX(ISTA)=BOTTOM(ISTA,3)
      NPOINTS=NPOINTS+2
      DO 3001 N=4,NPOINTS
      IF(BOTTOM(ISTA,N).LT.WSEMIN(ISTA)) WSEMIN(ISTA)=BOTTOM(ISTA,N)
      IF(BOTTOM(ISTA,N).GT.WSEMAX(ISTA)) WSEMAX(ISTA)=BOTTOM(ISTA,N)
 3001 CONTINUE
  300 CONTINUE
      RETURN
      END
      SUBROUTINE BOTSLOP
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ/COMPUTE BOTTOM SLOPES ALONG THE     C
C     STUDY REACH. THE AVAILABLE OPTIONS ARE: READ,COMPUTE,THALWEG. C
C     FOR THE COMPUTE OPTION LINEAR REGRESSION EQUATIONS THROUGH     C
C     SPECIFIED REACHES BOUNDED BY USER DEFINED STATION NUMBERS ARE C
C     COMPUTED. FOR THALWEG OPTION THALWEG ELEVATIONS ARE USED TO    C
C     COMPUTE BOTTOM SLOPES . FOR READ OPTION BOTTOM ELEVATIONS ARE C
C     READ IN MANUALLY .                                             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DIMENSION X(30),Y(30)
      INTEGER OPTION
      COMMON/BLKO/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK48/OPTION(3),IOPTZ
      DATA OPTION/10HREAD      ,10HCOMPUTE   ,
     +10HTHALWEG   /
      READ(IR,1) IOPTZ
      WRITE (6,199) IOPTZ
  199    FORMAT (1X,A10)
      IF(IPRLVL.LT.2) GOTO 21
      WRITE(6,101) IOPTZ
  101 FORMAT(10X,*BOTTOM ELEVATIONS DETERMINED USING OPTION:*,A10)
    1 FORMAT(A10)
   21 CONTINUE
      IF(IOPTZ.EQ.OPTION(3)) GOTO 3
      READ(IR,*) (ZREAD(ISTA),ISTA=1,NSTA)
      DO 60 I=1,NSTA
      Z(I)=ZREAD(I)
   60 CONTINUE
      GOTO 4
    3 CONTINUE
      DO 6 K=1,NSTA
      Z(K)=WSEMIN(K)
    6 CONTINUE
    4 CONTINUE
      DO 5 I=2,NSTA
      DX=ABS(STA(I)-STA(I-1))
      SO(I)=(Z(I-1)-Z(I))/DX
    5 CONTINUE
      SO(1)=SO(2)
      DO 7 M=1,NSTA
      Z(M)=WSEMIN(M)
    7 CONTINUE
      RETURN
      END
      SUBROUTINE CRITCLD(EPS,NSTA)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE CRITICAL DEPTHS IN NATURAL         C
```

```
C     CHANNELS.THE REQUIRED CONDITION FOR CRITICAL DEPTH IS            C
C     MINIMUM SPECIFIC ENERGY FOR A GIVEN DISCHARGE.                   C
C                                                                      C
C     ALPHA*(Q**2*TOP)/(G*AREA**3) = 1
C                                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK40/CM,G
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK45/SEQNT(30),SEQELEV(30),YBAR(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK53/BACKWAT
      COMMON/BLK79/WSMN(30),WSMX(30)
      DATA KMAX/20/
      BACKWAT=0.
      IF(IPRLVL.LT.1) GOTO 109
      WRITE(6,108)
  108 FORMAT(//,25X,*CRITICAL      CRITICAL       *,/,
     +25X,           * DEPTH       W.S. ELV*,/,
     +25X,23H***********************,/)
  109 CONTINUE
      DO 100 J=1,NSTA
      KOUNT=0
      KOUNT2=0
      WSE2=WSEMIN(J)+0.05
  106 CONTINUE
      WSE1=WSMX(J)+20.
      IF(WSE1.LE.WSEMIN(J)) WSE1=WSMX(J)+20.
      WSEAV=0.5*(WSE1+WSE2)
      CALL GEOMTRY(J,AMIN,RMIN,DMIN,AKMIN,WSE2)
      ALPHA2=ALPHA(J)
      CALL GEOMTRY(J,AMAX,RMAX,DMAX,AKMAX,WSE1)
      ALPHA1=ALPHA(J)
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
      ALPHAAV=ALPHA(J)
      TOPMIN=AMIN/DMIN
      TOPMAX=AMAX/DMAX
      TOPAV=AAV/DAV
C
      F1=1.- ALPHA1*(Q**2*TOPMAX)/(G*AMAX**3)
      F2=1. -ALPHA2*(Q**2*TOPMIN)/(G*AMIN**3)
  102 CONTINUE
      FAV=1.-ALPHAAV*(Q**2*TOPAV)/(G*AAV**3)
C
      IF(ABS(FAV).LE.EPS) GOTO 99
      IF(ABS(WSE1-WSE2).LE.EPS) WSEAV=0.5*(WSE1+WSE2)
      IF(ABS(WSE1-WSE2).LE.EPS) GOTO 99
      IF(F1*F2.GT.0.) GOTO 101
      IF(F1*FAV.GT.0.) WSE1=WSEAV
      IF(F1*FAV.GT.0.) F1=FAV
      IF(F1*FAV.LT.0.) WSE2=WSEAV
      IF(F1*FAV.LT.0.) F2=FAV
      KOUNT=KOUNT+1
      IF(KOUNT.GT.KMAX) GOTO 103
      WSEAV=0.5*(WSE1+WSE2)
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
      ALPHAAV=ALPHA(J)
      TOPAV=AAV/DAV
      GOTO 102
  101 CONTINUE
      IF(IPRLVL.LT.2) GOTO 299
      PRINT 10,J
   10 FORMAT(5X,*TRIAL WATER SURFACE ELEVATIONS FOR CRITICAL DEPTH*,/,5X,
     +*ARE NOT GOOD AT SECTION *,I5,/,
```

```
     +5X,*NEW MAXIMUM WATER SURFACE ELEVATION IS ASSUMED.*)
  299 CONTINUE
      KOUNT2=KOUNT2+1
      IF(KOUNT2.GT.3) GOTO 99
      WSMX(J)=WSMX(J)+20.
       GOTO 106
  103 CONTINUE
      IF(IPRLVL.LT.0) GOTO 99
      PRINT 20,J
   20 FORMAT(5X,*NO CONVERGENCE IN CRITICAL DEPTH COMPUTATIONS AT*,/,
     +*   SECTION*,I5,*AFTER 15 ITERATIONS*)
   99 CONTINUE
      WSEDC(J)=WSEAV
      DC(J)=WSEDC(J)-Z(J)
      SEQNT(J)=DC(J)
      SEQELEV(J)=WSEDC(J)
      IF(IPRLVL.LT.1) GOTO 100
      WRITE(6,104) DC(J),WSEDC(J)
  104 FORMAT(23X,F10.4,5X,F10.4)
  100 CONTINUE
      RETURN
      END
      SUBROUTINE NORMALD(EPS,NSTA)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE NORMAL DEPTHS FOR NATURAL CHANNELS C
C      FOR NORMAL DEPTHS THE FRICTION SLOPE IS EQUAL TO BOTTOM SLOPE  C
C      SO=SF                                                          C
C      THEREFORE                                                      C
C      Q=CONVEYANCE* SQRT(SO)                                         C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK40/CM,G
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK53/BACKWAT
      COMMON/BLK79/WSMN(30),WSMX(30)
      DATA KMAX/20/
      BACKWAT=0.
      IF(IPRLVL.LT.1) GOTO 205
      WRITE(6,91)
   91 FORMAT(//,18X,37H*************************************,/,18X,1H*,
     +*   NORMAL DEPTH PROPERTIES TABLE   *,1H*,/,18X,
     +37H*************************************,//)
      WRITE(6,32)
   32 FORMAT(//5X,*STA.   BOTTOM  BOTTOM     FLOW     NORM FLOW  FR.*,4X,
     +*NORMAL      NORMAL*)
      WRITE(6,33)
   33 FORMAT(5X,* ID     ELEV   SLOPE      AREA     VELOCITY   NO.*,4X,
     +*DEPTH      W.S. ELV.*,/,5X,
     +74H****************************************************************
     +**************,//)
  205 CONTINUE
      DO 200 J=1,NSTA
      KOUNT=0
      KOUNT2=0
      WSE1=WSEMIN(J)+0.05
  206 CONTINUE
      WSE2=WSMX(J)+20.
      IF(WSE2.LE.WSEMIN(J)) WSE2=WSMX(J)+20.
      IF(SO(J).GT.0.) GOTO 207
      WSEDN(J)=99999.
      DN(J)=999.9
```

```
      ALPHA(J)=1.0
      FROUDEN(J)=0.001
      AAV=99999.
      VEL=0.001
      GOTO 208
  207 CONTINUE
      WSEAV=0.5*(WSE1+WSE2)
      CALL GEOMTRY(J,AMIN,RMIN,DMIN,AKMIN,WSE1)
      CALL GEOMTRY(J,AMAX,RMAX,DMAX,AKMAX,WSE2)
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
      G1=Q-AKMAX*SQRT(SO(J))
      G2=Q-AKMIN*SQRT(SO(J))
  202 CONTINUE
      GAV=Q-AKAV*SQRT(SO(J))
      IF(ABS(GAV).LE.EPS) GOTO 199
      IF(G1*G2.GT.0.) GOTO 201
      IF(ABS(WSE1-WSE2).LE.EPS) WSEAV=0.5*(WSE1+WSE2)
      IF(ABS(WSE1-WSE2).LE.EPS) GOTO 199
      IF(G1*GAV.GT.0.) WSE2=WSEAV
      IF(G1*GAV.GT.0.) G1=GAV
      IF(G1*GAV.LT.0.) WSE1=WSEAV
      IF(G1*GAV.LT.0.) G2=GAV
      KOUNT=KOUNT+1
      IF(KOUNT.GT.KMAX) GOTO 203
      WSEAV=0.5*(WSE1+WSE2)
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
      GOTO 202
  201 CONTINUE
      IF(IPRLVL.LT.2) GOTO 399
      PRINT 30,J
   30 FORMAT(5X,*INITIAL CHOICE OF WATER SURFACE ELEVS. FOR *,/,
     +*   NORMAL DEPTH COMPUTATIONS ARE NOT PROPER AT SECT*,I5,/,
     +*   NEW MAXIMUM WATER SURFACE ELEVATION IS ASSIGNED.*)
  399 CONTINUE
      KOUNT2=KOUNT2+1
      IF(KOUNT2.GT.3) GOTO 199
      WSMX(J)=WSMX(J)+20.
      GOTO 206
  203 CONTINUE
      IF(IPRLVL.LT.0) GOTO 199
      PRINT 40,J
   40 FORMAT(5X,*NO CONVERGENCE FOR NORMAL DEPTH COMPUTATIONS*,/,
     +*   AT SECTION*,I5,*   AFTER 15 ITERATIONS*)
  199 CONTINUE
      WSEDN(J)=WSEAV
      DN(J)=WSEDN(J)-Z(J)
      ALPHAAV=ALPHA(J)
      FROUDEN(J)=Q/(AAV*SQRT(G*DAV/ALPHAAV))
      VEL=Q/AAV
  208 CONTINUE
      ISTA=STA(J)
      IF(IPRLVL.LT.1) GOTO 200
      WRITE(6,31) ISTA,Z(J),SO(J),AAV,VEL,FROUDEN(J),DN(J),WSEDN(J)
   31 FORMAT(5X,I5,F8.2,E10.3,E12.5,F8.2,F6.3,2E12.5)
  200 CONTINUE
      DO 204 J=1,NSTA
      IF(ISWITCH(J).NE.1) GOTO 204
      WSEAV=WSE(J)
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
      ALP=ALPHA(J)
      FROUDEN(J)=Q/(AAV*SQRT(G*DAV/ALP))
      IF(J.EQ.1.AND.FROUDEN(J).GE.1.) GOTO 204
      IF(J.EQ.NSTA.AND.FROUDEN(J).LE.1.) GOTO 204
      WSE(J)=WSEDC(J)+0.001
      FROUDEN(J)=1.0
      WSEAV=WSEDC(J)
```

```
      CALL GEOMTRY(J,AAV,RAV,DAV,AKAV,WSEAV)
  204 CONTINUE
      RETURN
      END
      SUBROUTINE SEQUENT(I1,I2,EPSO)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS  SUBROUTINE COMPUTES THE SEQUENT DEPTHS FOR NATURAL       C
C     CHANNELS FOR HYDRAULIC JUMP COMPUTATIONS.THE EQUATION FOR THE  C
C     HYDRAULIC JUMP IS ASSUMED TO BE                                C
C     Q**2/(AREA1*G)+ AREA1*YBAR1 = Q**2/(AREA2*G)+ AREA2*YBAR2      C
C     WHERE                                                          C
C     YBAR1,YBAR2     CENTROIDS OF THE NATURAL CHANNEL AT THE        C
C                      DOWNSTREAM END OF THE JUMP AT SEQUENT DEPTHS. C
C     AREA1,AREA2      THE FLOW AREAS AT THE  DOWNSTREAM END OF THE  C
C                      HYDRAULIC JUMP AT SEQUENT DEPTHS.             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),KO(30),CONTYP(4),ITYP(30)
      COMMON/BLK40/CM,G
      COMMON/BLK42/A1,A2,R1,R2,AK1,AK2
      COMMON/BLK44/WSEMIN(30),WSEMAX(30)
      COMMON/BLK45/SEQNT(30),SEQELEV(30),YBAR(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK79/WSMN(30),WSMX(30)
      DATA KMAX/20/
      DATA EPS/0.1/
      SUPRMOM=Q**2/(A1*G) + A1*YBAR(I1)
      K2=0
      SEQEL1=WSEDC(I1)+1.0E-04
      SEQEL2=WSMX(I1)+40.
      D1=ABS(WSE(I1)-WSEDC(I1))
      IF(D1.LE.EPS) SEQNT(I1)=DC(I1)
      IF(D1.LE.EPS) SEQELEV(I1)=WSEDC(I1)
      IF(D1.LE.EPS) RETURN
      IF(ISWITCH(I2).EQ.1) SEQEL2=WSMX(I1)-0.1
      IF(ISWITCH(I2).EQ.1) GOTO 700
      IF(ISWITCH(I2).NE.1.AND.WSE(I1).GE.WSE(I2)) GOTO 600
      D2=ABS(WSE(I1)-WSE(I2))
      IF(D2.LE.EPS) SEQNT(I1)=SEQNT(I2)
      IF(D2.LE.EPS)SEQELEV(I1)=SEQELEV(I2)
      IF(D2.LE.EPS) RETURN
      GOTO 700
  600 CONTINUE
  700 CONTINUE
      K2=K2+1
      CALL GEOMTRY(I1,A11,R11,D11,AK11,SEQEL1)
      YBAR11=YBAR(I1)
      CALL GEOMTRY(I1,A12,R12,D12,AK12,SEQEL2)
      YBAR12=YBAR(I1)
      SUBMOM1=Q**2/(A11*G)+A11*YBAR11
      SUBMOM2=Q**2/(A12*G)+A12*YBAR12
      DMOM1=SUPRMOM-SUBMOM1
      DMOM2=SUPRMOM-SUBMOM2
      K=0
      IF(ABS(DMOM1*DMOM2) .LE. EPS) GOTO 100
      IF(DMOM1*DMOM2 .LT. 0.) GOTO 200
      SIGN=+1.
      K1=0
  702 CONTINUE
      K1=K1+1
      SEQELN=SEQEL1-SIGN*K1*0.1
      CALL GEOMTRY(I1,A11,R11,D11,AK11,SEQELN)
      SUBMOMN=Q**2/(G*A11)+A11*YBAR(I1)
```

```
      IF(K2.GT.2) GOTO 703
      IF(SIGN.EQ.1. .AND. SUBMOMN.GT.SUBMOM1) GOTO 700
      IF(SIGN.EQ.-1. .AND. SUBMOMN.LT.SUBMOM1) GOTO 700
      SEQEL1=SEQELN
      SUBMOM1=SUBMOMN
      IF(K1.LT.20) GOTO 702
      IF(SIGN.EQ.-1.) GOTO 703
      SIGN=-1.
      SEQEL1=WSEDC(I1)
      GOTO 702
  703 CONTINUE
      IF(IPRLVL.LT.1) GOTO 704
      PRINT 10,STA(I1),WSE(I1),WSEDC(I1)
   10 FORMAT(10X,*AT STATION*,F10.2,*SEQ ELV TO*,F10.2,* IS ABOVE*,/,10X
     +,*THE MAXIMUM CHANNEL BOTTOM ELEVATION.IT WILL BE SET EQUAL TO*,/
     +,10X,*CRITICAL WATER SURFACE ELEVATION*,F10.2)
  704 CONTINUE
      SEQELEV(I1)=WSEDC(I1)
      SEQNT(I1)=SEQELEV(I1)-Z(I1)
      RETURN
  200 CONTINUE
      K=K+1
      SEQAV=0.5*(SEQEL1+SEQEL2)
      CALL GEOMTRY(I1,AA,RA,DA,AKA,SEQAV)
      YBARA=YBAR(I1)
      SUBMOMA=Q**2/(AA*G)+AA*YBARA
      DMOMA=SUPRMOM-SUBMOMA
      IF(ABS(DMOMA).LE.EPS) GOTO 100
      IF(ABS(SEQAV-SEQEL1).LE.EPS) GOTO 100
      IF(SUBMOMA.GT.SUPRMOM) SEQEL2=SEQAV
      IF(SUBMOMA.LE.SUPRMOM) SEQEL1=SEQAV
      IF(K.LT.KMAX) GOTO 200
      IF(IPRLVL.LT.1) GOTO 100
      PRINT 20,KMAX
   20 FORMAT(5X,*NO CONVERGENCE IN SEQUENT DEPTH COMPUTATIONS AFTER*,
     +I5,*ITERATIONS. SEQUENT ELEV. IS SET EQUAL TO CRITICAL ELV.*)
      SEQELEV(I1)=WSEDC(I1)
      SEQNT(I1)=SEQELEV(I1)-Z(I1)
      RETURN
  100 CONTINUE
      SEQELEV(I1)=0.5*(SEQEL1+SEQEL2)
      SEQNT(I1)=SEQELEV(I1)-Z(I1)
      RETURN
      END
      SUBROUTINE FRLOSS(HF)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE FRICTION LOSS HF, BY VARIOUS      C
C     METHODS. USER CAN SELECT THE DESIRED FRICTION LOSS EQUATION    C
C     BY SPECIFYING THE VARIABLE IOPTFR.                             C
C                                                                    C
C     IOPTFR=1     HF= 0.5*DL*(SF1+SF2)  --BY DEFAULT--              C
C     IOPTFR=2     HF= DL*SQRT(SF1*SF2)                              C
C     IOPTFR=3     HF= DL*(Q*N/(0.5*CM*(A1+A2)*(R1+R2)**0.667))     C
C     IOPTFR=4     HF= DL*(2.*Q/(AK1+AK2))**2                        C
C     THE NUMBERS  1 AND 2  AT THE END OF VARIABLES REFER TO THE     C
C     DOWNSTREAM AND UPSTREAM CROSS SECTIONS.                        C
C                                                                    C
C     LIST OF VARIABLES                                              C
C     HF           HEAD LOSS DUE TO FRICTION.                        C
C     SF           FRICTION SLOPE                                    C
C     DL           DISTANCE BETWEEN SECTIONS (REACH LENGTH) .        C
C     NREACH       REACH NUMBER                                      C
C     R            HYDRAULIC RADIUS.                                 C
C     A            CROSS SECTIONAL AREA.                             C
C     CM           COEFFICIENT OF CONVERSION USED IN MANNINGS EQ.    C
C                  CM=CM FOR ENGLISH UNITS,AND CM=1 FOR METRIC UNTS
```

```
C     RN(I,J)         ARRAY CONTAINING MANNINGS N VALUES FOR DIFFERENT  C
C                     REACHES.                                          C
C     AK              CONVEYANCE. AK=(CM/RN)*A*R**TWOTRD                C
C     I1,I2           UPSTREAM AND DOWNSTREAM CROSS SECTION NOS.        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C     LIST OF SUBROUTINES USED BY FRLOSS                                C
C     GEOMTRY         SUBROUTINE TO COMPUTE THE GEOMETRIC ELEMENTS.     C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK7/DL
      COMMON/BLK40/CM,G
      COMMON/BLK41/IOPTFR,IOPTFS
      COMMON/BLK42/A1,A2,R1,R2,AK1,AK2
      DATA AVRGN/0.025/
      TWOTRD=2./3.
      GO TO(1,2,3,4) IOPTFR
    1 CONTINUE
C...  IOPTFR=1
      SF1=(Q/AK1)**2
      SF2=(Q/AK2)**2
C
      HF= 0.5*DL*(SF1+SF2)
C
      RETURN
    2 CONTINUE
C...  IOPTFR=2
C
      SF1=(Q/AK1)**2
      SF2=(Q/AK2)**2
C
      HF=DL*SQRT(SF1*SF2)
C
      RETURN
    3 CONTINUE
C...  IOPTFR=3
C
      A=0.5*(A1+A2)
      R23=(R1+R2)**TWOTRD
      QN=Q*AVRGN
      CMAR23=CM*A*R23
C
      HF=DL*(QN/CMAR23)**2
C
      RETURN
    4 CONTINUE
C...  IOPTFR=4
C
C
      HF=DL*(2.*Q/(AK1+AK2))**2
      RETURN
      END
      SUBROUTINE GEOMTRY(ISTA,AREA,R,HYDEPTH,CONVEY,WSELEV)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE GEOMETRIC AND HYDRAULIC PROPERTIES   C
C     OF A NATURAL CHANNEL. FOR A GIVEN WATER SURFACE ELEVATION ,THE    C
C     HYDRAULIC RADIUS,HYDRAULIC DEPTH,AREA,CONVEYANCE AND THE CENTER   C
C     OF GRAVITY OF THE AREA AREA COMPUTED. THE CENTROID OF THE CROSS   C
C     IS DETERMINED FOR SEQUENT DEPTH COMPUTATIONS.                     C
C     LIST OF VARIABLES                                                 C
C     ISTA            STATION NUMBER                                    C
C     AREA            FLOW AREA                                         C
C     R               HYDRAULIC RADIUS                                  C
C     TOP,T(ISTA)     TOP WIDTH AT STATION ISTA.                       C
C     HYDEPTH         HYDRAULIC DEPTH                                   C
C     WSELEV          WATER SURFACE ELEVATION                           C
```

```
C      NPOINTS        NUMBER OF POINTS USED FOR DEFINING THE CHANNEL      C
C      BOTTOM(I,J)    ARRAY CONTAINING THE BOTTOM ELEVATIONS              C
C      CROSLOC(I,J)   ARRAY CONTAINING THE LATERAL LOCATION OF DATA PTS.  C
C      PER            WETTED PERIMETER                                    C
C      RN(I,J)        ARRAY CONTAINING CHANNEL ROUGHNESS VALUES IN THE    C
C                     LATERAL DIECTION AT STATION I.                      C
C      ALPHA(I)       VECTOR CONTAINING THE ENERGY COEFFICIENTS FOR       C
C                     DIFFERENT STATIONS.                                 C
C      YBAR(I)        CENTER OF GRAVITY OF THE SECTION.                   C
C                     YBAR= SUM(AREA(I)*YBAR(I)) / SUM(A(I))  I=1,2,...   C
C      DELX,DELY      LENGTH INCREMENTS IN THE LATERAL AND VERTICAL       C
C                     DIRECTIONS, RESPECTIVELY.                           C
C      DAREA          AREA OF A SUBSECTION                                C
C      DR             HYDRAULIC RADIUS OF A SUBSECTION                    C
C      DPER           WETTED PERIMETER OF A SUBSECTION                    C
C      BGNCHAN        BEGINNING OF THE CHANNEL FOR A GIVEN WATER SURFACE C
C                     ELEVATION.                                          C
C      BEGIN          BEGINNING OF THE CHANNEL. IN THE CASE OF MULTIPLE   C
C                     CHANNELS,IT NDICATES THE BEGINNING OF THE FIRST     C
C                     SUBCHANNEL FOR A GIVEN WATER SURFACE ELEVATION.     C
C      NSUBCHN        NO. OF SUBCHANNELS.                                 C
C      BACKWAT        CONTROL VARIABLE TO PERFORM CONVEYANCE COMPUTATIONSC
C      ENDCHAN        END OF THE CHANNEL FOR A GIVEN WATER SURF. ELEV.    C
C      CONVEY         CONVEYANCE OF THE CHANNEL. USER CAN SELECT THE      C
C                     CONVEYANCE EQUATION BY SPECIFYING IOPTFS            C
C                     IOPTFS=1  ... CONVEY=(CM*A*R**2/3)/RN  -MANNING-    C
C                     IOPTFS=2  ... CONVEY=AREA*SQRT(R)*RN   -CHEZY-      C
C                     IOPTFS=3  ... CONVEY=AREA*SQRT(8*G*R/RN) -DARCY-    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK40/CM,G
      COMMON/BLK41/IOPTFR,IOPTFS
      COMMON/BLK45/SEQNT(30),SEQELEV(30),YBAR(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK49/YY(65)
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK52/AA(10),RR(10),CONV(10),DISCHAR(10)
      COMMON/BLK53/BACKWAT
      COMMON/BLK54/CONVY(30)
      COMMON/BLK56/XSAREA(30),HYDRAD(30)
      COMMON/BLK74/END(30),BEGIN(30)
C
C     INITIALIZE
C
      DO 199 I=1,10
      AA(I)=0.
      RR(I)=0.
      CONV(I)=0.
      DISCHAR(I)=0.
  199 CONTINUE
      NN=NDIV(ISTA)
      SUMP=0.
      SUMA=0.
      KM=0
      ENDCHAN=0.
      BGNCHAN=0.
      BEGIN(ISTA)=0.
      END(ISTA)=0.
      NSUBCHN=0
      SUMPER=0.
      SUMAREA=0.
      SUMCONV=0.
      SUMAYBR=0.
```

```
      SUMAK=0.
      TOP=0.
      TWOTRD=2./3.
      NPOINTS=BOTTOM(ISTA,1)+3
      IJ=0
      DO 2001 IK=2,NPOINTS
      IF(WSELEV.LT.BOTTOM(ISTA,IK)) GOTO 203
      IF(WSELEV.GT.BOTTOM(ISTA,IK)) GOTO 202
      IF(WSELEV.EQ.BOTTOM(ISTA,IK).AND.WSELEV.GT.BOTTOM(ISTA,IK-1))
     + GOTO 203
      IF(WSELEV.EQ.BOTTOM(ISTA,IK).AND.WSELEV.LE.BOTTOM(ISTA,IK-1))
     + GOTO 202
  205 CONTINUE
      DELX=ABS(CROSLOC(ISTA,IK)-CROSLOC(ISTA,IK-1))
      DELY=ABS(BOTTOM(ISTA,IK)-BOTTOM(ISTA,IK-1))
      DPER=SQRT(DELX**2+DELY**2)
      DAREA=(YY(IJ)+YY(IJ-1))*DELX/2.
      SUMPER=SUMPER+DPER
      IF(DAREA.LE.0.) GOTO 201
      SUMAREA=SUMAREA+DAREA
      SUMAYBR=SUMAYBR+DAREA*(YY(IJ)+YY(IJ-1))/4.
      DR=DAREA/DPER
      IF(IOPTFS.EQ.1) DCONVEY=CM*DAREA*DR**TWOTRD/RN(ISTA,IK)
      IF(IOPTFS.EQ.2) DCONVEY=DAREA*SQRT(DR)*RN(ISTA,IK)
      IF(IOPTFS.EQ.3) DCONVEY=DAREA*SQRT(8.*G*DR/RN(ISTA,IK))
      SUMCONV=SUMCONV+DCONVEY
      SUMAK=SUMAK+DCONVEY*(DCONVEY/DAREA)**2
      IF(BACKWAT.NE.1.) GOTO 201
      DO 210 N=1,NN
      IF(CROSLOC(ISTA,IK-1).LT.DL(ISTA,N) .AND.
     +   CROSLOC(ISTA,IK).GE.DL(ISTA,N) ) GOTO 211
      GOTO210
  211 CONTINUE
      IF(CROSLOC(ISTA,IK).NE.DL(ISTA,N)) GOTO 212
      DA=0.
      DP=0.
      GOTO 213
  212 CONTINUE
      DX=ABS(DL(ISTA,N)-CROSLOC(ISTA,IK))
      DY=(DELX-DX)*(YY(IJ)-YY(IJ-1))/DELX
      DA=(YY(IJ)+YY(IJ-1)+DY)*DX/2.
      DY=ABS(DY)
      DP=SQRT(DX**2+(DELY-DY)**2)
  213 CONTINUE
      DPERIM=SUMPER-SUMP-DP
      AA(N)=SUMAREA-SUMA-DA
      RR(N)=AA(N)/DPERIM
      SUMA=SUMA+AA(N)
      SUMP=SUMP+DPERIM
      AVRN=(RN(ISTA,IK)+RN(ISTA,IK-1))/2.
C     WRITE(6,451)AA(N),RR(N),AVRN,DX,DY,DELX,DELY,N
C     WRITE(6,451) CROSLOC(ISTA,IK),CROSLOC(ISTA,IK-1),DL(ISTA,N),
C    +BOTTOM(ISTA,IK),BOTTOM(ISTA,IK-1),YY(IJ),YY(IJ-1),NDIV(ISTA)
C 451 FORMAT(5X,7F10.3,I5)
      IF(IOPTFS.EQ.1) CONV(N)=CM*AA(N)*RR(N)**TWOTRD/AVRN
      IF(IOPTFS.EQ.2) CONV(N)=AA(N)*SQRT(RR(N))*AVRN
      IF(IOPTFS.EQ.3) CONV(N)=AA(N)*SQRT(8.*G*RR(N)/AVRN)
  210 CONTINUE

      GOTO 201
  202 CONTINUE
      IJ=IJ+1
      YY(IJ)=ABS(WSELEV-BOTTOM(ISTA,IK))
      IF(WSELEV.GT.BOTTOM(ISTA,IK-1)) GOTO 205

      DELYY=ABS(BOTTOM(ISTA,IK)-BOTTOM(ISTA,IK-1))
```

```
      IF(DELYY.LE.O.) BGNCHAN=CROSLOC(ISTA,IK)
      IF(NSUBCHN.EQ.1.AND.DELYY.LE.O.) BEGIN(ISTA)=BGNCHAN                  JUL 82
      IF(DELYY.LE.O.)  NSUBCHN=NSUBCHN+1                                    JUL 82
      IF(DELYY.LE.O.) GOTO 201
      DELXX=ABS(CROSLOC(ISTA,IK)-CROSLOC(ISTA,IK-1))
      DELY=ABS(BOTTOM(ISTA,IK)-WSELEV)
      DELX=DELY*DELXX/DELYY
      BGNCHAN=CROSLOC(ISTA,IK)-DELY*DELXX/DELYY
      DPER=SQRT(DELX**2+DELY**2)
      IF(IK.EQ.2) DPER=O.                                                   JUL 82
      SUMPER=SUMPER+DPER
      DAREA=O.5*(DELX*DELY)
      IF(DAREA.LE.O.) NSUBCHN=NSUBCHN+1                                     JUL 82
      IF(NSUBCHN.EQ.1.AND.DAREA.LE.O.) BEGIN(ISTA)=BGNCHAN                  JUL 82
      IF(DAREA.LE.O.) GOTO 201
      SUMAREA=SUMAREA+DAREA
      SUMAYBR=SUMAYBR+TWOTRD*DELY*DAREA
      DR=DAREA/DPER
      IF(IOPTFS.EQ.1) DCONVEY=CM*DAREA*DR**TWOTRD/RN(ISTA,IK)
      IF(IOPTFS.EQ.2) DCONVEY=DAREA*SQRT(DR)*RN(ISTA,IK)
      IF(IOPTFS.EQ.3) DCONVEY=DAREA*SQRT(8.*G*DR/RN(ISTA,IK))
      SUMCONV=SUMCONV+DCONVEY
      SUMAK=SUMAK+DCONVEY*(DCONVEY/DAREA)**2
      NSUBCHN=NSUBCHN+1
      IF(NSUBCHN.NE.1) GOTO190
      BEGIN(ISTA)=BGNCHAN
  190 CONTINUE
      IF(BACKWAT.NE.1.) GOTO 201
      DO 200 M=1,NN
      IF(CROSLOC(ISTA,IK-1).LT.DL(ISTA,M) .AND.
     +   CROSLOC(ISTA,IK) .GE. DL(ISTA,M) ) GOTO 230
      GOTO 200
  230 CONTINUE
      IF(CROSLOC(ISTA,IK).NE.DL(ISTA,M)) GOTO 231
      DX=O.
      DY=DELY
      DA=O.
      DP=O.
      GOTO 232
  231 CONTINUE
      DX=ABS(CROSLOC(ISTA,IK)-DL(ISTA,M))
      IF((DELX-DX).GT.O.) GOTO 229                                          JUL 82
      DA=DAREA                                                              JUL 82
      DP=DPER                                                               JUL 82
      GOTO 232                                                              JUL 82
  229 CONTINUE                                                              JUL 82
      DY=(DELX-DX)*DELY/DELX
      DA=(DELY+DY)*DX/2.
      DP=SQRT(DX**2+(DELY-DY)**2)
  232 CONTINUE
      AA(M)=SUMAREA-SUMA-DA
      DPERIM=SUMPER-SUMP-DP
      IF(DPERIM.LE.O. .OR. AA(M).LE.O.) RR(M)=O.                            JUL 82
      IF(DPERIM.LE.O. .OR. AA(M).LE.O.) CONV(M)=O.                          JUL 82
      IF(DPERIM.LE.O. .OR. AA(M).LE.O.) GOTO 200                            JUL 82
      RR(M)=AA(M)/DPERIM
      SUMP=SUMP+DPERIM
      SUMA=SUMA+AA(M)
      AVRN=(RN(ISTA,IK)+RN(ISTA,IK-1))/2.
      IF(IOPTFS.EQ.1) CONV(M)=CM*AA(M)*RR(M)**TWOTRD/AVRN
      IF(IOPTFS.EQ.2) CONV(M)=AA(M)*SQRT(RR(M))*AVRN
      IF(IOPTFS.EQ.3) CONV(M)=AA(M)*SQRT(8.*G*RR(M)/AVRN)
  200 CONTINUE
      GOTO 201
  203 CONTINUE
      IF(IK.GT.3.AND.BOTTOM(ISTA,IK-1).LE.WSELEV) GOTO 204
```

```
      IF(IJ.EQ.0) GOTO 201                                              JUL 82
      MM=0                                                              JUL 82
      GOTO 250                                                          JUL 82
  204 CONTINUE
C      END OF THE CHANNEL
      DELXX=ABS(CROSLOC(ISTA,IK)-CROSLOC(ISTA,IK-1))
      DELYY=ABS(BOTTOM(ISTA,IK)-BOTTOM(ISTA,IK-1))
      DELY=ABS(WSELEV-BOTTOM(ISTA,IK-1))
      IF(DELYY.EQ.0.) DELX=0.
      IF(DELYY.NE.0.) DELX=DELY*DELXX/DELYY
      ENDCHAN=CROSLOC(ISTA,IK-1)+DELX
      TOP=TOP+ABS(BGNCHAN-ENDCHAN)
      DPER=SQRT(DELX**2+DELY**2)
      IF(IK.EQ.NPOINTS) DPER=0.                                         JUL 82
      SUMPER=SUMPER+DPER
      DAREA=DELX*DELY/2.
      IF(DAREA.LE.0.) GOTO 201
      IF(DPER.LE.0.) GOTO 201
      SUMAREA=SUMAREA+DAREA
      SUMAYBR=SUMAYBR+TWOTRD*DAREA*DELY
      DR=DAREA/DPER
      IF(IOPTFS.EQ.1) DCONVEY=CM*DAREA*DR**TWOTRD/RN(ISTA,IK)
      IF(IOPTFS.EQ.2) DCONVEY=DAREA*SQRT(DR)*RN(ISTA,IK)
      IF(IOPTFS.EQ.3) DCONVEY=DAREA*SQRT(8.*G*DR/RN(ISTA,IK))
      SUMCONV=SUMCONV+DCONVEY
      SUMAK=SUMAK+DCONVEY*(DCONVEY/DAREA)**2
      IF(BACKWAT.NE.1.) GOTO 201
      MM=0
  250 MM=MM+1
      IF(MM.GT.NN) GOTO 201
      IF(CROSLOC(ISTA,IK-1).LT.DL(ISTA,MM) .AND.
     +   CROSLOC(ISTA,IK).GE.DL(ISTA,MM)) GOTO 240
      GOTO 250
  240 CONTINUE
      IF(DL(ISTA,MM).GE.ENDCHAN) GOTO 241
      IF(DL(ISTA,MM).NE.CROSLOC(ISTA,IK)) GOTO 260
  241 CONTINUE
      DA=0.
      DP=0.
      DX=0.
      DY=DELY
      GOTO 261
  260 CONTINUE
      DX=ENDCHAN-DL(ISTA,MM)
      DY=DX*DELY/DELX
      DA=0.5*DX*DY
      DP=SQRT(DX**2+DY**2)
  261 CONTINUE
      AA(MM)=SUMAREA-DA-SUMA
      DPERIM=SUMPER-SUMP-DP
      IF(DPERIM.LE.0. .OR. AA(MM).LE.0.) RR(MM)=0.
      IF(DPERIM.LE.0. .OR. AA(MM).LE.0.) CONV(MM)=0.
      IF(DPERIM.LE.0. .OR. AA(MM).LE.0.) GOTO 250
      RR(MM)=AA(MM)/DPERIM
      AVRN=(RN(ISTA,IK)+RN(ISTA,IK-1))/2.
      SUMA=SUMA+AA(MM)
      SUMP=SUMP+DPERIM
      IF(IOPTFS.EQ.1) CONV(MM)=CM*AA(MM)*RR(MM)**TWOTRD/AVRN
      IF(IOPTFS.EQ.2) CONV(MM)=AA(MM)*SQRT(RR(MM))*AVRN
      IF(IOPTFS.EQ.3) CONV(MM)=AA(MM)*SQRT(8.*G*RR(MM)/AVRN)
      GOTO 250
  201 CONTINUE
 2001 CONTINUE
      IF(BGNCHAN.EQ.0.) BEGIN(ISTA)=CROSLOC(ISTA,3)
      IF(ENDCHAN.EQ.0.) ENDCHAN=CROSLOC(ISTA,NPOINTS-1)
      END(ISTA)=ENDCHAN
```

```
      IF(BACKWAT.NE.1.) GOTO 2002
      SUMC=0.
      DO 403 LI=1,NN
      SUMC=SUMC+CONV(LI)
  403 CONTINUE
      DO 404 LL=1,NN
      DISCHAR(LL)=Q*CONV(LL)/SUMC
      IF(DISCHAR(LL).LE.0.) VELOCIT=0.
      IF(DISCHAR(LL).NE. 0.)
     +VELOCIT=DISCHAR(LL)/AA(LL)
  404 CONTINUE
 2002 CONTINUE
      T(ISTA)=TOP
C       IF(T(ISTA).EQ.0.) T(ISTA)=ABS(END(ISTA)-BEGIN(ISTA))
      AREA=SUMAREA
      PER=SUMPER
      R=AREA/PER
      HYDEPTH=AREA/TOP
      CONVEY=SUMCONV
      HYDRAD(ISTA)=R
      XSAREA(ISTA)=AREA
      CONVY(ISTA)=CONVEY
      YBAR(ISTA)=SUMAYBR/AREA
      AKAKA2=CONVEY*(CONVEY/AREA)**2
      ALPHA(ISTA)=SUMAK/AKAKA2
      RETURN
      END
      SUBROUTINE TIMESTP(ITSTEP,DTIME)
      COMMON/BLK0/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),S0(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK72/AREAST(30,5),HYDRAST(30,5),SFAVEST(30,5),VELST(30,
     +5)
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)
      COMMON/BLK90/P(30,10),PN(30,10),P1(30,10),TKA(30,10),TKI(30,10)
     +      ,QBN(30,10)
      COMMON/BLK91/PNN(30,30,10),TKAN(30,30,10),TKIN(30,30,10)
      COMMON/BLK92/NSIZE
      COMMON/BLK95/TAL
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE PERFORMS SEDIMENT ROUTING FOR A SINGLE TIME    C
C     STEP FOR EACH STREAM TUBE AND FOR EACH SIZE FRACTION.          C
C     THE STREAM TUBE LOCATIONS AND THE INITIAL SEDIMENT CONDITIONS  C
C     FOR THE TIME STEP ARE ASSUMED TO BE KNOWN. HYDRAULIC VARIABLES C
C     ARE GIVEN.                                                     C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      CALL READDAT
      NSIZE=NF
      DO 60 J=1,NSTUBE
      IF(ITSTEP.GT.1) GOTO 10
      TAL=50.*D(NSIZE)
      NSTAM1=NSTA-1
      TOTALQS=0.
      DO 20 I=1,NSTA
      TP=0.
      NPOINTS=BOTTOM(I,1)+2
      DO 30 K=1,NSIZE
   30 TP=TP+P(I,K)
      NPTS=BOTTOM(I,1)+2
      DO 40 K=1,NSIZE
      PN(I,K)=P(I,K)/TP
      TKA(I,K)=TAL*PN(I,K)
```

```
      TKI(I,K)=0.
      P(I,K)=PN(I,K)
      DO 44 L=1,NPTS
      PNN(I,L,K)=PN(I,K)
      TKAN(I,L,K)=TKA(I,K)
      TKIN(I,L,K)=TKI(I,K)
   44 CONTINUE
   40 CONTINUE.
   20 CONTINUE
   10 CONTINUE
      DO 50 I=2,NSTA
      DO 50 K=1,NSIZE
      QBN(I,K)=0.
   50 CONTINUE
      IF(ITSTEP.EQ.1) GOTO 120
C
      DO 70 I=2,NSTA
      DO 80 M=1,NSIZE
       TKA(I,M)=0.
       TKI(I,M)=0.
       PN(I,M)=0.
   80 CONTINUE
      AREA=AREAST(I,J)
      HYDEPTH=HYDRAST(I,J)
      PERIM=AREA/HYDEPTH
      NPOINTS=BOTTOM(I,1)+2
      DXIT=0.
      DO 90 K=3,NPOINTS
      F=1.0E-03
      H=1.0E-03
      IF(CROSLOC(I,K-1).EQ.CROSLOC(I,K)) CROSLOC(I,K-1)=CROSLOC(I,K-1)-F
      IF(CROSLOC(I,K).EQ.CROSLOC(I,K+1)) CROSLOC(I,K)=CROSLOC(I,K)-H
      IF(BOTTOM(I,K-1).EQ.BOTTOM(I,K)) BOTTOM(I,K-1)=BOTTOM(I,K-1)-F
      IF(BOTTOM(I,K).EQ.BOTTOM(I,K+1)) BOTTOM(I,K)=BOTTOM(I,K)-H
      IF(J.EQ.1.AND.CROSLOC(I,K).LT.YLOC(I,1) ) GOTO 90
      IF(CROSLOC(I,K).GE.YLOC(I,J).AND.
     +    CROSLOC(I,K).LE.YLOC(I,J+1)) GOTO 92
      IF(J.EQ.NSTUBE.AND.CROSLOC(I,K).GT.YLOC(I,NSTRM)) GOTO 90
      GOTO 90
   92 CONTINUE
      IF(K.EQ.NPOINTS) DXIP=0.
      IF(K.EQ.NPOINTS) GOTO 93
      IF(BOTTOM(I,K).GE.WSE(I)) DXIP=0.
      IF(BOTTOM(I,K).GE.WSE(I)) GOTO 93
      IF(CROSLOC(I,K+1).LT.YLOC(I,J+1)) GOTO 98
      DELX=ABS(CROSLOC(I,K+1)-CROSLOC(I,K))
      DELY=ABS(BOTTOM(I,K+1)-BOTTOM(I,K))
      DX=YLOC(I,J+1)-CROSLOC(I,K)
      DY=DELY*DX/DELX
      D1=SQRT(DX*DX+DY*DY)
      DXIP=D1
      GOTO 93
   98 CONTINUE
      IF(BOTTOM(I,K).LT.WSE(I).AND.BOTTOM(I,K+1).LT.WSE(I)) GOTO 95
      DXXX=ABS(CROSLOC(I,K+1)-CROSLOC(I,K))
      DYYY=ABS(BOTTOM(I,K+1)-BOTTOM(I,K))
      DELY=WSE(I)-BOTTOM(I,K)
      DELX=DELY*DXXX/DYYY
      DXIP=SQRT(DELX**2+DELY**2)
      GOTO 93
   95 CONTINUE
      DXIP=SQRT((CROSLOC(I,K+1)-CROSLOC(I,K))**2+(BOTTOM(I,K+1)-BOTTOM(I
     +,K))**2)*0.5
   93 CONTINUE
      IF(K.EQ.3) DXIM=0.
      IF(K.EQ.3) GOTO 94
```

```
      IF(BOTTOM(I,K).GE.WSE(I)) DXIM=0.
      IF(BOTTOM(I,K).GE.WSE(I)) GOTO 94
      IF(CROSLOC(I,K-1).GT.YLOC(I,J)) GOTO 97
      DELX=ABS(CROSLOC(I,K)-CROSLOC(I,K-1))
      DELY=ABS(BOTTOM(I,K)-BOTTOM(I,K-1))
      DX=CROSLOC(I,K)-YLOC(I,J)
      DY=DX*DELY/DELX
      D1=SQRT(DX*DX+DY*DY)
      DXIM=D1
      GOTO 94
   97 CONTINUE
      IF(BOTTOM(I,K).LT.WSE(I).AND.BOTTOM(I,K-1).LT.WSE(I)) GOTO 96
      DXXX=ABS(CROSLOC(I,K)-CROSLOC(I,K-1))
      DYYY=ABS(BOTTOM(I,K-1)-BOTTOM(I,K))
      DELY=WSE(I)-BOTTOM(I,K)
      DELX=DELY*DXXX/DYYY
      DXIM=SQRT(DELX*DELX+DELY*DELY)
      GOTO 94
   96 CONTINUE
      DXIM=SQRT((CROSLOC(I,K)-CROSLOC(I,K-1))**2+(BOTTOM(I,K)-BOTTOM(I,K
     +-1))**2)*0.5
   94 DXI=DXIP+DXIM
      DXIT=DXIT+DXI
      DO 100 M=1,NSIZE
      TKA(I,M)=TKA(I,M)+TKAN(I,K,M)*DXI
      TKI(I,M)=TKI(I,M)+TKIN(I,K,M)*DXI
      PN(I,M)=PN(I,M)+PNN(I,K,M)*DXI
  100 CONTINUE
   90 CONTINUE
      DELXXX=PERIM-DXIT
C      IF(IPRLVL.LT.1) GOTO 4008
C 4008 CONTINUE
      IF(DXIT.NE.0.) GOTO 4009
      WRITE(6,4010) I,J
 4010 FORMAT(5X,*AT STA NO.*,I3,* FOR STREAM TUBE*,I3,* POINTS ARE SPA*,
     +*CED TOO FAR APART FOR SEDIMENT COMPUTATIONS. ADD MORE PTS.*)
      DO 4011 KI=1,NSIZE
      TKA(I,KI)=TAL*P(I,KI)
      TKI(I,KI)=0.
      PN(I,KI)=P(I,KI)
 4011 CONTINUE
      GOTO 70
 4009 CONTINUE
      TOTAL=0.
      DO 110 M=1,NSIZE
      TKA(I,M)=TKA(I,M)/DXIT
      TOTAL=TOTAL+TKA(I,M)
      TKI(I,M)=TKI(I,M)/DXIT
      PN(I,M)=PN(I,M)/DXIT
  110 CONTINUE
      DO 131 M=1,NSIZE
      TKA(I,M)=TKA(I,M)*TAL/TOTAL
      PN(I,M)=TKA(I,M)/TAL
  131 CONTINUE
   70 CONTINUE
  120 CONTINUE
      CALL TUBELOD(ITSTEP,DTIME,J)
   60 CONTINUE
      RETURN
      END
      SUBROUTINE TUBELOD(ITSTEP,DTIME,J)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE PERFORMS SEDIMENT ROUTING AT A GIVEN TIME STEP C
C     IN EACH STREAM TUBE.                                           C
C     IN EACH STREAM TUBE SEDIMENT LOADS ARE COMPUTED , ACTIVE AND   C
C     INACTIVE SEDIMENT LAYER THICKNESSES ARE COMPUTED.              C
```

```
C     INFORMATION IS CONVERTED INTO POINT VALUES ACROSS THE CHANNEL   C
C     AT EACH STATION                                                 C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLKO/IR,NSTA
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK70/NSTUBE,NSTRM
      COMMON/BLK72/AREAST(30,5),HYDRAST(30,5),SFAVEST(30,5),VELST(30,5)
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLK90/P(30,10),PN(30,10),P1(30,10),TKA(30,10),TKI(30,10)
     +      ,QBN(30,10)
      COMMON/BLK91/PNN(30,30,10),TKAN(30,30,10),TKIN(30,30,10)
      COMMON/BLK92/NSIZE
      COMMON/BLK93/BE(30),DBE(10),QBT(30)
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      COMMON/BLKMN4/ICHANGE(30)
      ITUBE=J
      DO 5005 I=1,NSTA
      ICHANGE(I)=5HDEPTH
      IF(ITSTEP.EQ.1.OR.ISWMN.EQ.O) GOTO 5005
      IF(ISWCW(I,J).EQ.1.OR.ISWCN(I,J).EQ.1) ICHANGE(I)=5HWIDTH
 5005 CONTINUE
      CALL SEDLOD(ITSTEP,ITUBE,DTIME)
      IF(ITSTEP.EQ.1.OR.ISWMN.EQ.O) GOTO 25
      DO 20 I=2,NSTA
      DELWI=BE(I)
      IF(BE(I).GE.O.) GOTO 33
      DELWI=-BE(I)
      IF(ISWCW(I,J).NE.1) GOTO 34
      CALL WIDEN(I,J,SAR,DELWI)
      IF(SAR.GT.O.) GOTO 20
C.........CHANGED IN OCT. 1986
      IF(J .EQ. 1) DELWI=HYDRAST(I,J)*DELWI/(YLOC(I,2)-YLOC(I,1))
      IF(J .EQ. NSTUBE) DELWI=HYDRAST(I,J)*DELWI/(YLOC(I,NSTUBE+1)-
     +YLOC(I,NSTUBE))
   34 CONTINUE
      CALL DEEPEN(I,J,SAR,DELWI)
      GOTO 20
   33 CONTINUE
      IF(ISWCN(I,J).NE.1) GOTO 36
      CALL NARROW(I,J,SAR,DELWI)
      IF(SAR.GT.O.) GOTO 20
C........CHANGED IN OCT. 1986
      IF(J .EQ.1) DELWI=HYDRAST(I,J)*DELWI/(YLOC(I,2)-YLOC(I,1))
      IF(J .EQ. NSTUBE) DELWI=HYDRAST(I,J)*DELWI/(YLOC(I,NSTUBE+1)-
     +YLOC(I,NSTUBE))
   36 CALL RAISE(I,J,SAR,DELWI)
   20 CONTINUE
   25 CONTINUE
C
      DO 22 I=2,NSTA
      NPOINTS=BOTTOM(I,1)+2
      DO 30 K=3,NPOINTS
      IF(J.EQ.1.AND.CROSLOC(I,K).LT.YLOC(I,1)) GOTO 30
      IF(CROSLOC(I,K).GE.YLOC(I,J).AND.CROSLOC(I,K).LE.YLOC(I,J+1))
     + GOTO 32
      IF(J.EQ.NSTUBE.AND.CROSLOC(I,K).GT.YLOC(I,NSTRM)) GOTO 30
      GOTO 30
   32 CONTINUE
      IF(BOTTOM(I,K).GT.WSE(I)) GOTO 30
      IF(ISWMN.EQ.O .OR.ITSTEP.EQ.1)
     +BOTTOM(I,K)=BOTTOM(I,K)+BE(I)
      DO 40 L=1,NSIZE
      PNN(I,K,L)=PN(I,L)
```

```
      TKAN(I,K,L)=TKA(I,L)
      TKIN(I,K,L)=TKI(I,L)
   40 CONTINUE
   30 CONTINUE
   22 CONTINUE
      RETURN
      END
      SUBROUTINE SEDLOD(ITSTEP,ITUBE,DTIME)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE PERFORMS SEDIMENT ROUTING FOR A SINGLE STREAM  C
C     TUBE, ITUBE , AT A GIVEN TIME FOR DIFFERENT SEDIMENT SIZES     C
C     DIFFERENT SEDIMENT TRANSPORT FORMULAS ARE PROVIDED FOR         C
C     SEDIMENT LOAD COMPUTATIONS.                                    C
C     THIS SUBROUTINE WAS ADAPTED FROM USGS SEDIMENT ROUTING PROGRAM C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLKO/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK50/VEL,HYDEPTH,WIDTH,AREA,SFR
      COMMON/BLK72/AREAST(30,5),HYDRAST(30,5),SFAVEST(30,5),VELST(30,
     +5)
      COMMON/BLK75/XLOC(30,5),YLOC(30,5)
      COMMON/BLK80/ISED,JIN,JOUT
      COMMON/BLK81/TEMP,D50,SIGMA,RMU,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),VF(10)
C
      COMMON/BLK84/QBI(10),QSI(10),QTI(10)
      COMMON/BLK90/P(30,10),PN(30,10),P1(30,10),TKA(30,10),TKI(30,10)
     +      ,QBN(30,10)
      COMMON/BLK91/PNN(30,30,10),TKAN(30,30,10),TKIN(30,30,10)
      COMMON/BLK92/NSIZE
      COMMON/BLK93/BE(30),DBE(10),QBT(30)
      COMMON/BLK94/PS(30,5),CONCI(30),QSMI(30),DNI(30),DSI(30)
      COMMON/BLK95/TAL
      COMMON/BLKMN1/IOPTMN(3),ISWMN,ITERMN
      COMMON/BLKMN2/XLTI(30),XRGHTI(30),CBLI(30),CBHI(30)
      COMMON/BLKMN3/ISWCW(30,5),ISWCN(30,5),ISWDEP(30,5),ISWSCR(30,5)
      COMMON/BLKMN4/ICHANGE(30)
      DATA EPS/0.01/
      J=ITUBE
      IPR=IPRLVL
      DO 10 I=2,NSTA
      BE(I)=0.
      QBT(I)=0.
      TTI=0.
      DO 20 K=1,NSIZE
      TTI=TTI+TKI(I,K)
      FB(K)=PN(I,K)
   20 CONTINUE
      HYDEPTH=HYDRAST(I,J)
      SFR=SFAVEST(I,J)
      VEL=VELST(I,J)
      AREA=AREAST(I,J)
      WIDTH=AREA/HYDEPTH
      IF(ISED.EQ.1) CALL YANG
      IF(ISED.EQ.2) CALL ACKERS
      IF(ISED.EQ.3) CALL ENGHANS
      QBT(I)=0.
      DO 30 K=1,NSIZE
      QBN(I,K)=QTI(K)*12.0896*DTIME
      QBT(I)=QBT(I)+QBN(I,K)
 30   CONTINUE
      QBT(I)=QBT(I)/12.0896
```

```
      IF(ISWMN.EQ.O.OR.ITSTEP.EQ.1) GOTO 36
C
      IF(QBT(I).LT.QBT(I-1).AND.ISWDEP(I,J).EQ.1) GOTO 35
      IF(QBT(I).GT.QBT(I-1).AND.ISWSCR(I,J).EQ.1) GOTO 35
      GOTO 36
   35 CONTINUE
      DO 37 K=1,NSIZE
      QBN(I,K)=QBN(I-1,K)
   37 CONTINUE
   36 CONTINUE
      IF(ISWCN(I,J).EQ.1.AND.QBT(I).GT.QBT(I-1)) GOTO 194
      IF(ISWCW(I,J).EQ.1.AND.QBT(I).LT.QBT(I-1)) GOTO 194
      IF(ISWCN(I,J).EQ.1.OR.ISWCW(I,J).EQ.1) GOTO 191
  194 CONTINUE
      QBT(I)=0.
      DO 40 K=1,NSIZE
      DQ=QBN(I-1,K)-QBN(I,K)
      IF(I.EQ.NSTA) DXI=ABS(STA(I)-STA(I-1))
      IF(I.LT.NSTA) DXI=ABS(STA(I+1)-STA(I))
      DXIM=ABS(STA(I)-STA(I-1))
      PERI=AREAST(I,J)/HYDRAST(I,J)
      IF(I.EQ.NSTA) PERIP=PERI
      IF(I.LT.NSTA)
     +PERIP=AREAST(I+1,J)/HYDRAST(I+1,J)
      PERIM=AREAST(I-1,J)/HYDRAST(I-1,J)
      DENOM=0.075*(DXI+DXIM)*(2.*PERI+PERIM+PERIP)
      DBE(K)=DQ/DENOM
      IF(DBE(K).GE.0.) GOTO 55
      IF(-DBE(K).LE.TKA(I,K)) GOTO 60
      DBE(K)=-TKA(I,K)
      DVOLUME=DBE(K)*0.075*(DXI+DXIM)*(2.*PERI+PERIM+PERIP)
      QBN(I,K)=QBN(I-1,K)-DVOLUME
      IF(QBN(I,K).LT.0.) QBN(I,K)=0.0
C
C     ACCOUNTING FOR THE BED COMPOSITION
C
C     SCOURING
C
   60 CONTINUE
      IF(TTI.GT.0.0) GOTO 70
      DO 80 KK=1,NSIZE
      TKA(I,KK)=-DBE(K)*P(I,KK)+TKA(I,KK)
      IF(KK.EQ.K) TKA(I,K)=TKA(I,K)+DBE(K)
      PN(I,KK)=TKA(I,KK)/TAL
   80 CONTINUE
      GOTO 50
   70 CONTINUE
      IF(-DBE(K).GT.TTI) GOTO 65
      DO 85 KK=1,NSIZE
      P1(I,KK)=TKI(I,KK)/TTI
      TKA(I,KK)=-DBE(K)*P1(I,KK)+TKA(I,KK)
      IF(KK.EQ.K) TKA(I,KK)=TKA(I,KK)+DBE(K)
      TKI(I,KK)=TKI(I,KK)+DBE(K)*P1(I,KK)
      PN(I,KK)=TKA(I,KK)/TAL
   85 CONTINUE
      TTI=TTI+DBE(K)
      GOTO 50
   65 CONTINUE
      DO 75 KK=1,NSIZE
      P1(I,KK)=TKI(I,KK)/TTI
      TKA(I,KK)=(-DBE(K)-TTI)*P(I,KK)+TTI*P1(I,KK)+TKA(I,KK)
      IF(KK.EQ.K) TKA(I,KK)=TKA(I,KK)+DBE(K)
      TKI(I,KK)=0.0
      PN(I,KK)=TKA(I,KK)/TAL
   75 CONTINUE
      TTI=0.0
```

```
      GOTO 50
C
C     AGGRADATION
C
   55 CONTINUE
      TTI=TTI+DBE(K)
      IF(DBE(K).GE.TAL) GOTO 66
      DO 95 KK=1,NSIZE
      TKA(I,KK)=TKA(I,KK)-DBE(K)*PN(I,KK)
      IF(KK.EQ.K) TKA(I,KK)=TKA(I,KK)+DBE(K)
      TKI(I,KK)=TKI(I,KK)+DBE(K)*PN(I,KK)
      PN(I,KK)=TKA(I,KK)/TAL
   95 CONTINUE
      GOTO 50
   66 CONTINUE
      DO 67 KK=1,NSIZE
      TKI(I,KK)=TKA(I,KK)+TKI(I,KK)
      IF(KK.EQ.K) TKI(I,KK)=TKI(I,KK)+DBE(K)-TAL
      TKA(I,KK)=0.0
      IF(KK.EQ.K) TKA(I,KK)=TAL
      PN(I,KK)=TKA(I,KK)/TAL
   67 CONTINUE
C
C     TOTAL BED CHANGE AND TOTAL BED LOAD COMPUTATION
C     AT STATION I
C
   50 CONTINUE
      BE(I)=BE(I)+DBE(K)
      QBT(I)=QBT(I)+QBN(I,K)
   40 CONTINUE
      QBT(I)=QBT(I)/12.0896
      GOTO 192
  191 CONTINUE
C........ CHANGED IN AUG. 1985....
      IF (ISWCN(I,J) .EQ.1 ) GOTO 400
      NPOINTS=BOTTOM(I,1)+2
      IF( J .NE. 1) GOTO 260
      DO 210 N=3,NPOINTS
      IF (CROSLOC(I,N) .LE. YLOC(I,J) .AND. CROSLOC(I,N+1) .GE.
     +YLOC(I,J)) GOTO 220
  210 CONTINUE
  220 CR1=CROSLOC(I,N+1)
      BO1=BOTTOM(I,N+1)
      SLOPE=(BOTTOM(I,3)-BO1)/(CR1-CROSLOC(I,3))
      CR2=XLTI(I)
      BE(I)=0.
      DO 193 K=1,NSIZE
      KOUNT=0
      KOUNT1=0
      DQ=QBN(I-1,K)-QBN(I,K)
      IF(I .EQ. NSTA) DXI=ABS(STA(I)-STA(I-1))
      IF(I .LT. NSTA) DXI=ABS(STA(I+1)-STA(I))
      DXIM=ABS(STA(I)-STA(I-1))
      DDX=(DXI+DXIM)/2.0
      HH1=HYDRAST(I,J)
      PERI=AREAST(I,J)/HH1
      IF(I.EQ.NSTA) HH2=HH1
      IF(I.EQ.NSTA) PERIP=PERI
      IF(I.LT.NSTA) HH2=HYDRAST(I+1,J)
      IF(I.LT.NSTA) PERIP=AREAST(I+1,J)/HH2
      HH3=HYDRAST(I-1,J)
      PERIM=AREAST(I-1,J)/HH3
      HH=(2.0*HH1+HH2+HH3)/4.0
      BW1=CR1-CR2
      BW2=0.
  230 BWEAV=0.5*(BW1+BW2)
```

```
      F1=ABS(DQ/DDX)-BW1*HH-BW1*SLOPE*(BW1-(CR1-CROSLOC(I,3)))
     +-0.5*BW1*SLOPE*(CR1-CROSLOC(I,3))
      F2=ABS(DQ/DDX)
  235 CONTINUE
      IF(BWEAV.LT.(CR1-CROSLOC(I,3)))
     +FAV=ABS(DQ/DDX)-BWEAV*(HH+0.5*BWEAV*SLOPE)
      IF(BWEAV.GE.(CR1-CROSLOC(I,3)))
     +FAV=ABS(DQ/DDX)-BWEAV*HH-BWEAV*SLOPE*(BWEAV-(CR1-CROSLOC(I,3)))
     +-0.5*BWEAV*SLOPE*(CR1-CROSLOC(I,3))
      IF(ABS(FAV).LE.EPS) GOTO 245
      IF(ABS(BW1-BW2).LE.EPS) BWEAV=0.5*(BW1+BW2)
      IF(ABS(BW1-BW2).LE.EPS) GOTO 245
      IF(F1*F2.GT.0.) GOTO 240
      IF(F1*FAV.GT.0.) BW1=BWEAV
      IF(F1*FAV.GT.0.) F1=FAV
      IF(F1*FAV.LT.0.) BW2=BWEAV
      IF(F1*FAV.LT.0.) F2=FAV
      KOUNT= KOUNT+1
      BWEAV=0.5*(BW1+BW2)
      GOTO 235
  240 CONTINUE
      IF(IPRLVL.LT.2) GOTO 241
      PRINT *,'TRIAL WIDENING COMPUTATION IS BAD'
  241 CONTINUE
      KOUNT1= KOUNT1+1
      IF(KOUNT1.GT.2) BWEAV=0.
      IF(KOUNT1.GT.2) GOTO 245
      BW1=BW1+500.
      GOTO 230
  245 DBE(K)=BWEAV
      IF(ABS(DBE(K)).GT.(CR1-CR2)) DBE(K)=CR1-CR2
      IF(DBE(K).LE.ITERMN*TAL) GOTO 250
      DBE(K)=-ITERMN*TAL
      DVOLUME=DBE(K)*0.075*(DXI+DXIM)*(2.0*PERI+PERIM+PERIP)
      QBN(I,K)=QBN(I-1,K)-DVOLUME
      IF(QBN(I,K).LT.0.) QBN(I,K)=0.
  250 BE(I)=BE(I)-ABS(DBE(K))
  193 CONTINUE
      GOTO 192
  260 CONTINUE
      DO 270 N=3,NPOINTS
      IF(CROSLOC(I,N) .LE. YLOC(I,J+1) .AND. CROSLOC(I,N+1) .GE.
     +YLOC(I,J+1)) GOTO 280
  270 CONTINUE
  280 CR3=CROSLOC(I,N)
      BO3=BOTTOM(I,N)
      SLOPE=(BOTTOM(I,NPOINTS)-BO3)/(CROSLOC(I,NPOINTS)-CR3)
      CR4=XRGHTI(I)
      BE(I)=0.
      DO 290 K=1,NSIZE
      KOUNT=0
      KOUNT1=0
      DQ=QBN(I-1,K)-QBN(I,K)
      IF(I.EQ.NSTA) DXI=ABS(STA(I)-STA(I-1))
      IF(I.LT.NSTA) DXI=ABS(STA(I+1)-STA(I))
      DXIM=ABS(STA(I)-STA(I-1))
      DDX=(DXI+DXIM)/2.0
      HH1=HYDRAST(I,J)
      PERI=AREAST(I,J)/HH1
      IF(I.EQ. NSTA) HH2=HH1
      IF(I.EQ.NSTA) PERIP=PERI
      IF(I.LT. NSTA) HH2=HYDRAST(I+1,J)
      IF(I.LT.NSTA) PERIP=AREAST(I+1,J)/HH2
      HH3=HYDRAST(I-1,J)
      PERIM=AREAST(I-1,J)/HH3
      HH=(2.0*HH1+HH2+HH3)/4.0
```

```
      BW3=CR4-CR3
      BW4=0.
  300 BWEAV=0.5*(BW3+BW4)
      F1=ABS(DQ/DDX)-BW3*HH-BW3*SLOPE*(BW3-(CROSLOC(I,NPOINTS)-CR3))
     +-0.5*BW3*SLOPE*(CROSLOC(I,NPOINTS)-CR3)
      F2=ABS(DQ/DDX)
  310 CONTINUE
      IF(BWEAV.LT.(CROSLOC(I,NPOINTS)-CR3))
     +FAV=ABS(DQ/DDX)-BWEAV*(HH+0.5*BWEAV*SLOPE)
      IF(BWEAV.GE.(CROSLOC(I,NPOINTS)-CR3))
     +FAV=ABS(DQ/DDX)-BWEAV*HH-BWEAV*SLOPE*(BWEAV-(CROSLOC(I,NPOINTS)
     +-CR3))-0.5*BWEAV*SLOPE*(CROSLOC(I,NPOINTS)-CR3)
      IF(ABS(FAV).LE.0.) GOTO 330
      IF(ABS(BW3-BW4).LE.EPS) BWEAV=0.5*(BW3+BW4)
      IF(ABS(BW3-BW4).LE.EPS) GOTO 330
      IF(F1*F2.GT.0.) GOTO 320
      IF(F1*FAV.GT.0.) BW3=BWEAV
      IF(F1*FAV.GT.0.) F1=FAV
      IF(F1*FAV.LT.0.) BW4=BWEAV
      IF(F1*FAV.LT.0.) F2=FAV
      KOUNT= KOUNT+1
      BWEAV=0.5*(BW3+BW4)
      GOTO 310
  320 CONTINUE
      IF(IPRLVL.LT.2) GOTO 321
      PRINT *,'TRIAL WIDENING COMPUTATION IS BAD'
  321 CONTINUE
      KOUNT1= KOUNT1+1
      IF(KOUNT1.GT.2) BWEAV=0.
      IF(KOUNT1.GT.2) GOTO 330
      BW3=BW3+500.
      GOTO 300
  330 DBE(K)=BWEAV
      IF(ABS(DBE(K)).GT.(CR4-CR3)) DBE(K)=CR4-CR3
      IF(DBE(K).LE.ITERMN*TAL) GOTO 335
      DBE(K)=-ITERMN*TAL
      DVOLUME=DBE(K)*0.075*(DXI+DXIM)*(2.0*PERI+PERIM+PERIP)
      QBN(I,K)=QBN(I-1,K)-DVOLUME
      IF(QBN(I,K).LT.0.) QBN(I,K)=0.
  335 BE(I)=BE(I)-ABS(DBE(K))
  290 CONTINUE
      GOTO 192
  400 CONTINUE
      BE(I)=0.
      DO 410 K=1,NSIZE
      DQ=QBN(I-1,K)-QBN(I,K)
      IF(I.EQ.NSTA) DXI=ABS(STA(I)-STA(I-1))
      IF(I.LT.NSTA) DXI=ABS(STA(I+1)-STA(I))
      DXIM=ABS(STA(I)-STA(I-1))
      PERI=HYDRAST(I,J)
      IF(I.EQ.NSTA) PERIP=PERI
      IF(I.LT.NSTA) PERIP=HYDRAST(I+1,J)
      PERIM=HYDRAST(I-1,J)
      DENOM=0.075*(DXI+DXIM)*(2.*PERI+PERIM+PERIP)
      DBE(K)=DQ/DENOM
      BE(I)=BE(I)+DBE(K)
  410 CONTINUE
  192 CONTINUE
   10 CONTINUE
      IPRLVL=IPR
      IF(IPRLVL.LT.0) RETURN
      WRITE(6,3111)
 3111 FORMAT(16X,49H*************************************************,
     +6H******)
      WRITE (6,3112) J
 3112     FORMAT(16X,1H*,*    SEDIMENT ROUTING RESULTS FOR STREAM*,
```

```
     +* TUBE NO.*,I3,*  *,1H*)
      WRITE (6,3113)
 3113 FORMAT(16X,49H*************************************************,
     +6H******)
      WRITE(6,31)
      WRITE(6,33) (KI,KI=1,NSIZE)
      WRITE(6,339)
      DO 3032 I=1,NSTA
      WRITE(6,32) I,QBT(I),BE(I),ICHANGE(I),(QBN(I,J),J=1,NSIZE)
 3032 CONTINUE
   31 FORMAT(5X,*  STA  TOTAL LOAD  CHANGE  DIRECTN   SEDIMENT LOAD FOR
     +DIFFERENT SIZE FRACTIONS (CU.FT)*)
   33 FORMAT(5X,*  NO.    (T/DAY)      FT.  OF CHANGE*,10I9)
  339 FORMAT(5X,84H*****************************************************
     +*******************************,//)
   32 FORMAT(5X,I5,F10.1,F9.1,5X,A5,10F9.0)
      RETURN
      END
      SUBROUTINE UPDATE(ITAPE,ITSTEP,INTPL1)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      THIS SUBROUTINE IS TO UPDATE THE CHANNEL CROSS-SECTION DATA     C
C      AT THE END OF EACH TIME STEP.                                   C
C      STARTING WITH THE DATA FILE CONTAINING INTERPOLATED CROSS       C
C      SECTIONS, TAPE7 ,COMPUTED NEW BED ELEVATIONS ARE USED TO        C
C      TO UPDATE THIS FILE.                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLKO/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK2/CROSLOC(30,30),BOTTOM(30,30),Z(30),ZREAD(30),SO(30)
      COMMON/BLK3/DN(30),DC(30),Y(30),WSE(30),WSEDC(30),WSEDN(30)
      COMMON/BLK4/FROUDEN(30),STA(30)
      COMMON/BLK5/ISWITCH(30),CONTROL(30),K(30),CONTYP(4),ITYP(30)
      COMMON/BLK6/RN(30,30)
      COMMON/BLK9/OBL,CHANNEL,OBR
      COMMON/BLK47/RNTYP(3),EQROUGH
      COMMON/BLK48/OPTION(3),IOPTZ
      COMMON/BLK51/NDIV(30),DL(30,10)
      COMMON/BLK55/CLOSS(30)
      COMMON/BLK78/ZZ(30)
      REWIND ITAPE
      WRITE(ITAPE,*) NSTA
      IF(INTPL1.EQ.0) GOTO 100
      IF(ITAPE.NE.7) GOTO 100
      IJ=(ITSTEP/INTPL1)*INTPL1
      IF(IJ.NE.ITSTEP) GOTO 100
      WRITE(8,*)  NSTA
  100 CONTINUE
      DO 400 I=1,NSTA
      NDIVI=NDIV(I)
      NPOINTS=BOTTOM(I,1)
      WRITE(ITAPE,*) STA(I),NPOINTS,ISWITCH(I),ITYP(I)
      IF(INTPL1.EQ.0) GOTO 200
      IF(ITAPE.NE.7) GOTO 200
      IF(IJ.NE.ITSTEP) GOTO 200
      WRITE(8,*) STA(I),NPOINTS
  200 CONTINUE
      WRITE(ITAPE,*) NDIVI,(DL(I,J),J=1,NDIVI)
      NPOINTS=NPOINTS+2
      WRITE(ITAPE,*) (BOTTOM(I,J),CROSLOC(I,J),J=3,NPOINTS)
      IF(INTPL1.EQ.0) GOTO 300
      IF(ITAPE.NE.7) GOTO 300
      IF(IJ.NE.ITSTEP) GOTO 300
      WRITE(8,*) (BOTTOM(I,J),CROSLOC(I,J),J=3,NPOINTS)
  300 CONTINUE
  400 CONTINUE
      WRITE(ITAPE,10) EQROUGH
```

```
C
   10 FORMAT(A10)
      DO 500 I=1,NSTA
      NPOINTS=BOTTOM(I,1)+2
      WRITE(ITAPE,*) (RN(I,J),J=3,NPOINTS)
  500 CONTINUE
      WRITE(ITAPE,*) (CLOSS(IST),IST=1,NSTA)
      WRITE(ITAPE,10) IOPTZ
      IOPT=10HREAD
      IF(IOPTZ.NE.IOPT) GOTO 600
      WRITE(ITAPE,*) (ZZ(I),I=1,NSTA)
  600 CONTINUE
      RETURN
      END
      SUBROUTINE SEDDAT(IS,ITIMAX)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE IS TO READ THE SEDIMENT INPUT DATA TO BE USED  C
C     BY VARIOUS SEDIMENT TRANSPORT FORMULAS.                        C
C     DESCRIPTION OF VARIABLES...
C     JIN            OPTION FOR SELECTING SEDIMENT SIZE DISTRIBUTION   C
C                    JIN=1 ...LOG-NORMAL SIZE DISTRIBUTION WITH USER   C
C                             SUPPLIED D50 AND SIGMA VALUE IS COMPUTED C
C                    JIN=2 ...SIZE DISTRIBUTION OF BED MATERIALS IS    C
C                             USER SUPPLIED.                           C
C                    JIN=3 ...BED LOAD AND SUSPENDED LOAD FRACTIONS FORC
C                             EACH SIZE CATEGORY IS SUPPLIED BY USER.  C
C                             (JIN=3 OPTION IS FOR MODIFIED EIN. METHD)C
C   JOUT             VARIABLE CONTROLLING THE AMOUNT OF PRINTOUT.      C
C     FB(I)          ARRAY CONTAINING THE BED LOAD SIZE FRACTIONS      C
C     FS(I)          ARRAY CONTAINING SUSPENDED LOAD SIZE FRACTIONS    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK80/ISED,JIN,JOUT
      COMMON/BLK81/TEMP,D50,SIGMA,RMU,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),VF(10)
      COMMON/BLK83/CONC,QSM,DN,DS,DRL(10),DRU(10)
      COMMON/BLK89/TEMPI(500),QI(500),QSI(500),WSEI(500)
      COMMON/BLK90/P(30,10),PN(30,10),P1(30,10),TKA(30,10),TKI(30,10)
     +     ,QBN(30,10)
      COMMON/BLK94/PS(30,5),CONCI(30),QSMI(30),DNI(30),DSI(30)
      IF(IPRLVL.LE.0) JOUT=3
      IF(IPRLVL.EQ.1) JOUT=2
      IF(IPRLVL.GE.2) JOUT=1
      READ(IS,*) ISED
      IB=0
  100 IF(IB.EQ.ITIMAX) GOTO 200
      READ(IS,*) NDAYS,TEMPER
      IE=IB+NDAYS
      IB=IB+1
      DO 300 I=IB,IE
      TEMPI(I)=TEMPER
  300 CONTINUE
      IB=IE
      GOTO 100
  200 CONTINUE
C
      C=1./304.8
C
C     SEDIMENT SIZE FRACTIONS ARE READ IN FROM FINE TO COARSE SIZES.
C
      READ(IS,*) NF
      READ(IS,*) (DRL(I),DRU(I),I=1,NF)
      DO 40 J=1,NF
      X(J)=SQRT(DRL(J)*DRU(J))
```

```
      D(J)=C*X(J)
   40 CONTINUE
      READ(IS,*) ((P(I,K),K=1,NF),I=1,NSTA)
C
C     FORMAT STATEMENTS
C
C     1 FORMAT(I1)
C     2 FORMAT(4F10.0)
C     3 FORMAT(2F10.0)
C     4 FORMAT(I2)
C     5 FORMAT(2F10.0)
C     6 FORMAT(5F10.0)
C     7 FORMAT(5F8.2)
C     8 FORMAT(I5,F5.0)
      RETURN
      END
      SUBROUTINE ACKERS
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE TOTAL BED MATERIAL LOAD USING    C
C     THE SEDIMENT TRANSPORT FUNCTION BY ACKERS AND WHITE           C
C     THE METHOD HAS BEEN MODIFIED TO COMPUTE THE SEDIMENT LOAD BY  C
C     SIZE FRACTIONS.  (UP TO 10 SIZE FRACTIONS CAN BE SPECIFIED)   C
C                                                                   C
C     LIST OF INPUT,OUTPUT VARIABLES...                             C
C                                                                   C
C     Q            WATER DISCHARGE.   (CU. FT/SEC)                  C
C     TR           TEMPERATURE     (DEG. FAHRENHEIT)                C
C     VIS          KINEMATIC VISCOSITY.   (SQ. FT/SEC)              C
C     SG           SPECIFIC GRAVITY OF SEDIMENT.                    C
C     G            GRAVITATIONAL ACCELARATION. (FT/SQ. SEC.)        C
C     DW           HYDRAULIC DEPTH   (FT)                           C
C     V            VELOCITY   (FT/SEC)                              C
C     S            FRICTION SLOPE                                   C
C     NF           NUMBER OF SIZE FRACTIONS (UP TO 10)              C
C     D(I)         GEOMETRIC MEAN DIAMETER OF SEDIMENT FALLING IN   C
C                  SIZE GROUP I.    (FT)                            C
C     FB(I)        FRACTION OF BED MATERIALS FALLING IN SIZE GROUP-I:C
C     QTI(I)       TRANSPORT OF BED MATERIALS FOR THE SIZE GROUP I  C
C     QT           TOTAL BED MATERIAL LOAD TRANSPORT  (TONS/DAY)    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK50/V,DW,W,AREA,S
      COMMON/BLK81/TR,D50,SIGMA,RMU,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)
      COMMON/BLK83/CONC,QSM,DN,DS,DRL(10),DRU(10)
      COMMON/BLK84/QBI(10),QSI(10),QTI(10)
      COMMON/BLK85/QBT,QST,QT
      GAMMAW=62.4
      G=32.175
      SG=2.65
      VSTAR=SQRT(G*DW*S)
C     IN CASE THE TEMP. USED IN THE ROUTINE IS IN DEG. FAHR.,USE
C     TR=(TR-32.)/1.8
      IF(TR.LE.10.) VIS=1.93E-05*EXP(-0.03*TR)
      IF(TR.GT.10. .AND. TR.LE.25.) VIS=1.41E-05*EXP(0.02666*(10.-TR))
      IF(TR.GT.25. .AND. TR.LE.40.) VIS=9.60E-06*EXP(0.02070*(25.-TR))
      QT=0.
      DO 100 I=1,NF
      DGEO=D(I)
      ALP=10.
      DGR=DGEO*((G*(SG-1.)/(VIS**2))**(1./3.))
      IF(DGR.LT.1.) DGR=1.
      IF(DGR.GT.60.) GOTO 15
      DG=ALOG10(DGR)
```

```
      AN=1.-(0.56*DG)
      AA=0.23/SQRT(DGR)+0.14
      AM=9.66/DGR+1.34
      TTK=2.86*DG-DG**2-3.53
      C=10.**TTK
      GOTO 16
   15 CONTINUE
      AN=0.
      AA=0.17
      AM=1.50
      C=0.025
   16 CONTINUE
      F1=((VSTAR**AN)/SQRT(G*DGEO*(SG-1.)))
      F2=(V/(SQRT(G)*ALOG10(ALP*DW/DGEO)))**(1.-AN)
      FGR=F1*F2
      GGR=0.
      CTI=0.
      QTI(I)=0.
      IF(DGEO.LT.0.0005) GOTO 29
      IF((FGR/AA-1.).LE.0.) GOTO 29
      GGR=C*((FGR/AA)-1.)**AM
      CS=(GGR*SG*DGEO/DW)*((V/VSTAR)**AN)
      QTI(I)=CS*Q*GAMMAW*43.2*FB(I)
   29 CONTINUE
      QT=QT+QTI(I)
  100 CONTINUE
      IF(IPRLVL.LT.2) RETURN
      WRITE(6,3)
      WRITE(6,2)(I,DRL(I),DRU(I),D(I),FB(I),QTI(I),I=1,NF)
      WRITE(6,1) QT
    1 FORMAT(5X,34HACKERS AND WHITE SEDIMENT LOAD =   ,E20.8,8HTONS/DAY)
    2 FORMAT(I5,3F12.7,F12.3,F12.2)
    3 FORMAT(7X,70HI     DRL(I)      DRU(I)       D(I)      FRACTION
     +BED MAT LOAD                           ,//)
      RETURN
      END
      SUBROUTINE ENGHANS
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES THE TOTAL BED MATERIAL LOAD USING       C
C     ENGELUND AND HANSENS FORMULA.                                    C
C     THE METHOD HAS BEEN MODIFIED TO COMPUTE BED MATERIAL LOAD BY     C
C     SIZE FRACTIONS. (UP TO 10 SIZE FRACTIONS CAN BE USED)            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK0/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK50/V,DW,W,AREA,S
      COMMON/BLK81/TR,D50,SIGMA,RMU,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)
      COMMON/BLK83/CONC,QSM,DN,DS,DRL(10),DRU(10)
      COMMON/BLK84/QBI(10),QSI(10),QTI(10)
      COMMON/BLK85/QBT,QST,QT
      X1=22.93*DW*S*(V**2)
      X2=(DW**2)*(S**2)
      QT=0.
      DO 100 I=1,NF
      DGEO=D(I)
      X3=2.72*DGEO**2
      X4=(X2/X3)+0.15
      QSED=X1*SQRT(X4)/SQRT(DGEO)
      QQQ=QSED/(V*DW*0.0027)
      QTI(I)=QQQ*Q*62.4*43.2*FB(I)*1.0E-06
      QT=QT+QTI(I)
  100 CONTINUE
      IF(IPRLVL.LT.2) RETURN
      WRITE(6,3)
```

```
      WRITE(6,2) (I,DRL(I),DRU(I),D(I),FB(I),QTI(I),I=1,NF)
      WRITE(6,1) QT
    1 FORMAT(5X,44HENGELUND AND HANSENS TOTAL BED MAT LOAD =     ,E20.8,
     +8HTONS/DAY,//)
    2 FORMAT(I5,3F12.7,F12.3,F12.2)
    3 FORMAT(7X,70HI      DRL(I)      DRU(I)       D(I)      FRACTION
     +BED MAT LOAD                           ,//)
      RETURN
      END
      SUBROUTINE YANG
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES TOTAL SEDIMENT DISCHARGE BY C.T. YANG    C
C     METHOD.                                                          C
C     THE ORIGINAL METHOD HAS BEEN MODIFIED TO INCLUDE SEDIMENT        C
C     TRANSPORT BY SIZE FRACTIONS.                                     C
C                                                                      C
C     INPUT REQUIREMENTS                                               C
C                                                                      C
C     THE VARIABLES USED AS INPUT DATA ARE Q,V,W,DW,TR,S,NF,FB(I),D(I)
C     Q             DISCHARGE       (C.F.S.)                           C
C     V             AVERAGE VELOCITY     (FT/SEC)                      C
C     S             FRICTION SLOPE   (FT/FT)                           C
C     NF            NUMBER OF SIZE FRACTIONS FOR THE BED MATERIALS.    C
C     D(I)          GEOMETRIC MEAN OF SIZE FRACTION I.    (FT)         C
C     FB(I)         FRACTION OF BED MATERIALS FALLING WITHIN THE       C
C                   SIZE GROUP I.(E.G. 0.10-10 PERCENT)                C
C     TR            TEMPERATURE     (DEGREES CENTIGRADE)               C
C     W             WIDTH OF CHANNEL.       (FT)                       C
C     DW            DEPTH OF FLOW).     (FT)                           C
C    IPRLVL        VARIABLE CONTRALLING THE AMOUNT OF PRINTOUT          C
C                                                                      C
C     THESE VARIABLES SHOULD BE DEFINED IN THE CALLING PROGRAM AND     C
C     TRANSFERRED TO THIS SUBROUTINE BY THE COMMON STATEMENTS          C
C     COMMON/BLKO/IR,NSTA                                              C
C     COMMON/BLK46/IPRLVL                                              C
C     COMMON/BLK50/V,D50,SIGMA,RMU,D35,D65                             C
C     COMMON/BLK81/TR,D50,SIGMA,RMU,D35,D65                            C
C     COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)                 C
C                                                                      C
C     OUTPUT VARIABLES                                                 C
C                                                                      C
C     QTI(I)        SEDIMENT TRANSPORT OF SIZE GROUP I.    (TONS/DAY)  C
C     QT            TOTAL BED MATERIAL TRANSPORT.      (TONS/DAY)      C
C                                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
      DIMENSION ARRAY(6,13),Z(2)
      COMMON/BLKO/IR,NSTA
      COMMON/BLK1/ALPHA(30),Q,T(30)
      COMMON/BLK46/IPRLVL
      COMMON/BLK50/V,DW,W,AREA,S
      COMMON/BLK81/TR,D50,SIGMA,RMU,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)
      COMMON/BLK83/CONC,QSM,DN,DS,DRL(10),DRU(10)
      COMMON/BLK84/QBI(10),QSI(10),QTI(10)
      COMMON/BLK85/QB,QS,QT
      DATA ((ARRAY(I,J),I=1,6),J=1,13)/0.00001,.001,.001,.001,.001,.001,
     +0.06,0.24,0.32,0.40,0.49,0.57,0.10,0.60,0.76,0.92,1.10,1.26,
     +0.20,1.80,2.20,2.50,2.85,3.20,0.40,4.6,5.30,5.80,6.30,6.70,
     +0.80,9.50,10.5,11.0,11.6,12.0,1.5,16.1,16.9,17.5,17.9,18.1,
     +2.0,19.9,20.3,20.7,21.1,21.5,3.0,25.3,25.6,25.9,26.2,26.5,
     +7.0,39.5,39.5,39.5,39.5,39.5,8.0,41.5,41.5,41.5,41.5,41.5,
     +9.0,43.5,43.5,43.5,43.5,43.5,10.,45.0,45.0,45.0,45.0,45.0/

C
C     TR=(TR-32.)/1.8
      IF(TR.LE.10.) VIS=1.93E-05*EXP(-0.03*TR)
```

```
      IF(TR.GT.10..AND.TR.LE.25.) VIS=1.41E-05*EXP(0.02666*(10.-TR))
      IF(TR.GT.25..AND.TR.LE.40.) VIS=9.60E-06*EXP(0.02070*(25.-TR))
      DO 10 I=1,NF
      DGEO=X(I)
      IF(DGEO.LT.0.06.OR.DGEO.GT.100.) GOTO 11
      FFV=FVEL(DGEO,TR,ARRAY)
      FV(I)=FFV/30.48
   10 CONTINUE
   11 CONTINUE
      G=32.175
      SG=2.65
      VSTAR=SQRT(G*DW*S)
      VS=V*S
      QQ=Q/W
      QT=0.
      DO 100 I=1,NF
      DGEO=X(I)
      IF(DGEO.LT.0.06.OR.DGEO.GT.100.) QTI(I)=0.
      IF(DGEO.LT.0.06.OR.DGEO.GT.100.) GOTO 60
      RE=VSTAR*DGEO/(VIS*304.8)
      IF(RE.GT.70.) GOTO 20
      VCRFV=2.5/(ALOG10(RE)-0.06)+0.66
C
      GOTO 30
   20 VCRFV=2.05
   30 REF=ALOG10(FV(I)*DGEO/(VIS*304.8))
      VSTARV=ALOG10(VSTAR/FV(I))
      IF(DGEO.LT.2.0) GOTO 31
      B1=4.988-0.114*REF
      B2=1.374-0.019*REF
      C1=-3.608
      C2=0.605
      GOTO 32
   31 CONTINUE
      B1=5.435-0.286*REF
      B2=1.799-0.409*REF
      C1=-0.457
      C2=0.314
   32 CONTINUE
      AYN=(VS/FV(I)-(VCRFV*S))
      IF(AYN) 40,40,50
   40 QTI(I)=0.
      GOTO 60
   50 CONTINUE
      CY=B1+C1*VSTARV+(B2-(C2*VSTARV))*ALOG10(AYN)
      QQQ=10.**CY
      QTI(I)=QQQ*Q*0.0027*FB(I)
   60 CONTINUE
      QT=QT+QTI(I)
  100 CONTINUE
      IF(IPRLVL.LT.2) RETURN
      WRITE(6,3)
      WRITE(6,2)(I,DRL(I),DRU(I),D(I),FB(I),QTI(I),I=1,NF)
      WRITE(6,1) QT
    1 FORMAT(5X,34HYANGS TOTAL BED MATERIAL LOAD =     ,E20.8,8HTONS/DAY)
    2 FORMAT(I8,3F12.7,F12.3,F12.2)
    3 FORMAT(7X,70HI     DRL(I)      DRU(I)       D(I)      FRACTION
     +BED MAT LOAD                           ,//)
C     4 FORMAT(5X,37HFALL VELOCITY FOR GEOMETRIC MEAN SIZE,F10.6,/,5X,
C      +27HIS OUT OF THE SAND RANGE.     )
      RETURN
      END
      FUNCTION FVEL(D,T,A)
      DIMENSION A(6,13),Z(2)
      S=T/10.
      KT=S+1.
```

```
      PT=S-KT+1.
      DL=ALOG10(D)
      I=0
   10 I=I+1
      IF(I.GE.13) GOTO 20
      IF(D.LE.A(1,I)) GOTO 20
      GOTO 10
   20 CONTINUE
      I=I-1
      C=ALOG10(A(1,I))
      E=ALOG10(A(1,I+1))
      PD=(DL-C)/(E-C)
      DO 50 L=1,2
      K=L+KT
      Z(L)=(1.-PD)*ALOG10(A(K,I))+PD*ALOG10(A(K,I+1))
   50 CONTINUE
      R=(1.-PT)*Z(1)+PT*Z(2)
      FVEL=10.**R
      RETURN
      END
      SUBROUTINE FALLVEL(NSIZE)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SUBROUTINE COMPUTES FALL VELOCITIES FOR DIFFERENT          C
C     SEDIMENT SIZE GROUPS FOR A GIVEN TEMPERATURE.                   C
C     FIRST, THE KINEMATIC VISCOSITY CORRESPONDING TO THE GIVEN       C
C     TEMPERATURE IS DETERMINED AND THEN THE FALL VELOCITY IS         C
C     COMPUTED.                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      COMMON/BLK81/TR,D50,SIGMA,VIS,D35,D65
      COMMON/BLK82/NF,D(10),X(10),FB(10),FS(10),FV(10)
      TR=(TR-32)/1.8
      IF(TR.LT.10.) VIS=1.93E-05*EXP(-0.03*TR)
      IF(TR.GT.10.AND.TR.LE.25.) VIS=1.41E-05*EXP(0.02666*(10.-TR))
      IF(TR.GT.25.AND.TR.LE.40.) VIS=9.6E-06* EXP(0.02070*(25.-TR))
      DO 10 K=1,NSIZE
      FV(K)=((2./3.*32.17*1.65*D(K)**3+36.*VIS**2)**0.5
     +    -6.*VIS)/D(K)
   10 CONTINUE
      RETURN
      END
```

# APPENDIX G

## List of XSPLOT Program

```
      PROGRAM XSPLOT(INPUT,OUTPUT,TAPE8,TAPE5=INPUT,TAPE6=OUTPUT)
      COMMON/BLK2/CROSLOC(20,30,10),BOTTOM(20,30,10),Z(20),SO(20)
      COMMON/BLK43/HOR(30),VER(30)
      COMMON/BLK44/WSEMIN(20),WSEMAX(20),CRMIN(20),CRMAX(20),NP(20),
     +STA(20)
      COMMON/BLKPL/KOUNTR,INTPL1,NTIMES
      COMMON/BLKPL2/ITITLE(3,6),IHEADIN(30)
      CALL ID(23HGSTARS PLOTTING PROGRAM  ,23)
      CALL COMPRS
C
C.......READ THE TITLE OF THE STUDY
C
C
      DO 101 I=1,3
      READ (8,10) (ITITLE(I,J),J=1,6)
      IF(EOF(8).NE.0.) GOTO 1000
   10 FORMAT(6A10)
  101 CONTINUE
C
C.......READ PLOTTING INCREMENT
C.......PLOTS ARE GENERATED EVERY INTPL1 TIME STEPS.
C
      READ(8,*) INTPL1
      CALL ID(23HGRTARS PLOTTING PROGRAM   ,23)
      CALL COMPRS
      NTIMES=0
    1 CONTINUE
      M=0
      NTIMES=NTIMES+1
C
C.......READ THE CROSS-SECTION DATA
C.......EVERY 10 PLOT STEPS,NEW GRAPHS ARE GENERATED.
    2 READ(8,*) NSTA
      IF(EOF(8).NE.0) IEND=1
      IF(IEND.EQ.1) GOTO 400
      M=M+1
      DO 100 I=1,NSTA
      READ(8,*) STA(I),NP(I)
      NPOINTS=NP(I)
      READ(8,*) (BOTTOM(I,J,M),CROSLOC(I,J,M),J=1,NPOINTS)
  100 CONTINUE
      IF(M.EQ.10) GOTO 400
      GOTO 2
  400 CONTINUE
      KOUNTR=0
      NCRV=M
      DO 300 I=1,NSTA
      KOUNTR=KOUNTR+1
      NPOINTS=NP(I)
      CRMIN(I)=CROSLOC(I,1,1)
      CRMAX(I)=CROSLOC(I,1,1)
      WSEMIN(I)=BOTTOM(I,1,1)
      WSEMAX(I)=BOTTOM(I,1,1)
      DO 200 N=1,NCRV
      DO 200 J=1,NPOINTS
      IF(CROSLOC(I,J,N).LT.CRMIN(I)) CRMIN(I)=CROSLOC(I,J,N)
      IF(CROSLOC(I,J,N).GT.CRMAX(I)) CRMAX(I)=CROSLOC(I,J,N)
      IF(BOTTOM(I,J,N).LT.WSEMIN(I)) WSEMIN(I)=BOTTOM(I,J,N)
      IF(BOTTOM(I,J,N).GT.WSEMAX(I)) WSEMAX(I)=BOTTOM(I,J,N)
  200 CONTINUE
      CALL PLOT3(NSTA,NCRV)
  300 CONTINUE
      IF(IEND.EQ.1) GOTO 500
      GOTO 1
  500 CONTINUE
      CALL DONEPL
```

```
 1000   CONTINUE
        STOP
        END
C
C
C
        SUBROUTINE PLOT3(NSTA,NCRV)
        DIMENSION IPAK(500),LEG(30),ILEG(10,3)
        DIMENSION LTITLE(4)
        COMMON/BLK2/CROSLOC(20,30,10),BOTTOM(20,30,10),Z(20),SO(20)
        COMMON/BLK44/WSEMIN(20),WSEMAX(20),CRMIN(20),CRMAX(20),NP(20),
     +  STA(20)
        COMMON/BLK43/HOR(30),VERT(30)
        COMMON/BLKPL/KOUNTR,INTPL1,NTIMES
        COMMON/BLKPL2/ITITLE(3,6),IHEADIN(30)
        INCR=INTPL1
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       THIS SUBRUTINE PLOTS THE CROSS SECTION PROFILES AT     C
C       DIFFERENT STATIONS ALONG THE STUDY REACH.              C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        LTITLE(1)=10HCROSS SECT
        LTITLE(2)=10HION PROFIL
        LTITLE(3)=10HES AT STA.
C
C.......LEGENDS
C
        DO 60 J=1,10
        ILEG(J,1)=10H(X)-(S)EC
        ILEG(J,2)=10HAT (T)IME
  60    CONTINUE
        DO 61 J=1,10
        ITIME=J*INCR+(NTIMES-1)*10*INCR
        ENCODE(10,62,ILEG(J,3)) ITIME
  62    FORMAT(6H(S)TEP,I3,1H$)
  61    CONTINUE
        DO 63 J=1,10
        JJ=(J-1)*3+1
        ENCODE(30,64,LEG(JJ)) ILEG(J,1),ILEG(J,2),ILEG(J,3)
  64    FORMAT(3A10)
  63    CONTINUE
        I=KOUNTR
        NPOINTS=NP(I)
C.......FIND THE MINIMUM AND MAXIMUM X-COORDINATE
        HORMIN=CRMIN(I)-(CRMAX(I)-CRMIN(I))*0.1
        HORMAX=CRMAX(I)+(CRMAX(I)-CRMIN(I))*0.1
C.......FIND THE MANIMUM AND MAXIMUM Y-COORDINATE
        VERMIN=WSEMIN(I)-(WSEMAX(I)-WSEMIN(I))*0.1
        VERMAX=WSEMAX(I)+(WSEMAX(I)-WSEMIN(I))*0.5
C
        DX=10HSCALE
        DY=10HSCALE
        ENCODE(10,48,LTITLE(4)) STA(I)
  48    FORMAT(F6.0,4H FT.)
        CALL BASALF(5HSTAND)
        CALL TITLE(1H ,-1,
     +23HLATERAL LOCATION,  FEET,23,16HELEVATION,  FEET,16,9.,6.)
        DO 50 N=1,3
        NN=(N-1)*6+1
        ENCODE(60,49,IHEADIN(NN)) ITITLE(N,1),ITITLE(N,2),ITITLE(N,3),
     +  ITITLE(N,4),ITITLE(N,5),ITITLE(N,6)
  49    FORMAT(5A10,A9,1H$)
  50    CONTINUE
        ENCODE(40,51,IHEADIN(19)) LTITLE(1),LTITLE(2),LTITLE(3),LTITLE(4)
  51    FORMAT(4A10)
        CALL HEADIN(IHEADIN(1),100,1.,4)
        CALL HEADIN(IHEADIN(7),100,1.,4)
```

```
      CALL HEADIN(IHEADIN(13),100,1.,4)
      CALL HEADIN(IHEADIN(19),40,1.,4)
      CALL BASALF(6HL/CSTD)
      CALL MIXALF(5HSTAND)
      CALL HEIGHT(0.10)
      NL=LINEST(IPAK,500,30)
      DO 91 N=1,NCRV
      NN=(N-1)*3+1
      CALL LINES(LEG(NN),IPAK,N)
   91 CONTINUE
      CN=(NCRV/2.)+0.99
      NLINES=CN
      XW=XLEGND(IPAK,NCRV)
      YW=YLEGND(IPAK,NCRV)
      IF(NCRV.GT.3) GOTO 92
      CALL HEIGHT(0.14)
      GOTO 93
   92 CONTINUE
      XW=XLEGND(IPAK,NLINES)
      YW=YLEGND(IPAK,NLINES)
      XW=2.*XW+0.2
   93 YL=6.-YW-0.7
      CALL BLREC(0.4,YL,XW+0.2,YW+0.2,0.03)
      CALL BLKEY(1)
      CALL HEIGHT(0.14)
      CALL BASALF(5HSTAND)
      CALL YAXANG(0.)
      CALL GRAF(HORMIN,DX,HORMAX,VERMIN,DY,VERMAX)
      CALL FRAME
      CALL GRID(1,1)
      DO 4006 K=1,NCRV
      DO 4005 J=1,NPOINTS
      HOR(J)=CROSLOC(I,J,K)
      VERT(J)=BOTTOM(I,J,K)
 4005 CONTINUE
      CALL CURVE(HOR,VERT,NPOINTS,1)
 4006 CONTINUE
      CALL BLOFF(1)
      CALL HEIGHT(0.10)
      CALL BASALF(6HL/CSTD)
      CALL MIXALF(5HSTAND)
      IF(NCRV.GT.3) GOTO 94
      CALL HEIGHT(0.14)
      CALL LEGEND(IPAK,NCRV,0.5,YL+0.1)
      GOTO 95
   94 CONTINUE
      CALL LEGEND(IPAK,NLINES,0.5,YL+0.1)
      XW=XLEGND(IPAK,NLINES)
      DO 96 NN=1,NLINES
      CALL DELLEG(NN)
   96 CONTINUE
      NJ=(NCRV/2)*2
      IF(NJ.NE.NCRV) YL=YL+0.15
      CALL MYLEGN(1H ,1)
      CALL LEGEND(IPAK,NCRV,0.7+XW,YL+0.1)
   95 CONTINUE
      CALL RESET(3HALL)
      CALL ENDPL(I)
      RETURN
      END
```

# Appendix H

## List of WSPLOT Program

```
        PROGRAM WSPLOT(INPUT,OUTPUT,TAPE9,TAPE5=INPUT,TAPE6=OUTPUT)
        COMMON/BLK2/STA(20),BOTTOM(20,100),WSELV(20,100)
        COMMON/BLK43/HOR(100),VER(100)
        COMMON/BLK44/WSEMIN(20),WSEMAX(20),CRMIN(20),CRMAX(20)
        COMMON/BLKPL/KOUNTR,INCR
        COMMON/BLKPL2/ITITLE(3,6),IHEADIN(100),DISCH(100)
C
C.......READ THE TITLE OF THE STUDY
C
        DO 101 I=1,3
        READ(9,10) (ITITLE(I,J),J=1,6)
    10  FORMAT(6A10)
   101  CONTINUE
        READ(9,*) INTPL2
        INCR=INTPL2
        M=0
   390  CONTINUE
C
C.......READ THE CROSS-SECTION DATA
C
        READ(9,*) NSTA
        IF(EOF(9).NE.0.) GOTO 400
        M=M+1
        DO 100 I=1,NSTA
        READ(9,*) STA(I),BOTTOM(I,M),WSELV(I,M),WID,DPTH,SLP,QSI
        QQ=QSI/SLP
   100  CONTINUE
        DISCH(M)=QQ
        IF(M.EQ.100) GOTO 400
        GOTO 390
   400  CONTINUE
        KOUNTR=0
        NPLOT=M
        DO 300 N=1,NPLOT
        KOUNTR=KOUNTR+1
        CRMIN(N)=STA(1)
        CRMAX(N)=STA(NSTA)
        WSEMIN(N)=BOTTOM(1,N)
        WSEMAX(N)=WSELV(1,N)
        DO 200 I=1,NSTA
        IF(BOTTOM(I,N).LT.WSEMIN(N)) WSEMIN(N)=BOTTOM(I,N)
        IF(WSELV(I,N).GT.WSEMAX(N)) WSEMAX(N)=WSELV(I,N)
   200  CONTINUE
        CALL PLOT1(NSTA,NPLOT)
   300  CONTINUE
        STOP
        END
        SUBROUTINE PLOT1(NSTA,NPLOT)
        DIMENSION LTITLE(6)
        COMMON/BLK2/STA(20),BOTTOM(20,100),WSELV(20,100)
        COMMON/BLK44/WSEMIN(20),WSEMAX(20),CRMIN(20),CRMAX(20)
        COMMON/BLK43/HOR(100),VERT(100)
        COMMON/BLKPL/KOUNTR,INCR
        COMMON/BLKPL2/ITITLE(3,6),IHEADIN(100),DISCH(100)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       THIS SUBROUTINE PLOTS THE WATER SURFACE PROFILES AT       C
C       DIFFERENT STATIONS ALNG THE STUDY REACH                   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        LTITLE(1)=10HWATER SURF
        LTITLE(2)=10HACE PROFIL
        LTITLE(3)=10HE AT TIME
        I=KOUNTR
C.......FIND THE MINIMUM AND MAXIMUM X-COORDINATE
        HORMIN=CRMIN(I)-(CRMAX(I)-CRMIN(I))*0.1
        HORMAX=CRMAX(I)
```

```
C.......FINE THE MINIMUM AND MAXIMUM Y-COORDINATE
        VERMIN=WSEMIN(I)-(WSEMAX(I)-WSEMIN(I))*0.1
        VERMAX=WSEMAX(I)
        IF(KOUNTR.NE.1) GOTO 3005
        CALL ID(23GSTARS PLOTTING PROGRAM  ,23)
        CALL COMPRS
 3005   CONTINUE
        DX=10HSCALE
        DY=10HSCALE
        KK=KOUNTR*INCR
        ENCODE(10,48,LTITLE(4)) KK
   48   FORMAT(7HSTEP NO,I3)
        CALL TITLE(1H ,-1,
     +30HDISTANCE ALONG THALWEG,  FEET ,30,16HELEVATION,  FEET,16,9.,6.)
        DO 50 N=1,3
        NN=(N-1)*6+1
        ENCODE(60,49,IHEADIN(NN)) ITITLE(N,1),ITITLE(N,2),ITITLE(N,3),
     +  ITITLE(N,4),ITITLE(N,5),ITITLE(N,6)
   49   FORMAT(5A10,A9,1H$)
   50   CONTINUE
        LTITLE(5)=10H.   DISCH=
        IDISCH=DISCH(I)+0.5
        ENCODE(10,51,LTITLE(6)) IDISCH
   51   FORMAT(I6,4H CFS)
        ENCODE(60,99,IHEADIN(19)) LTITLE(1),LTITLE(2),LTITLE(3),LTITLE(4),
     +  LTITLE(5),LTITLE(6)
   99   FORMAT(6A10)
        CALL HEADIN(IHEADIN(1),100,1.,4)
        CALL HEADIN(IHEADIN(7),100,1.,4)
        CALL HEADIN(IHEADIN(13),100,1.,4)
        CALL HEADIN(IHEADIN(19),60,1.,4)
        CALL YAXANG(0.)
        CALL GRAF(HORMIN,DX,HORMAX,VERMIN,DY,VERMAX)
        CALL FRAME
        CALL GRID(1,1)
        DO 4005 J=1,NSTA
        HOR(J)=STA(J)
        VERT(J)=BOTTOM(J,KOUNTR)
 4005   CONTINUE
        CALL CURVE(HOR,VERT,NSTA,0)
        DO 4006 J=1,NSTA
        HOR(J)=STA(J)
        VERT(J)=WSELV(J,KOUNTR)
 4006   CONTINUE
        CALL CURVE(HOR,VERT,NSTA,1)
        CALL ENDPL(I)
        IF(I.NE.NPOLT) GOTO 1005
        CALL DONEPL
 1005   CONTINUE
        RETURN
        END
```