



# HEC-6

# Scour and Deposition in Rivers and Reservoirs

User's Manual

August 1993

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# **August 1993**

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CPD-6

# **Table of Contents**

Chapter	P	age
	Foreword	xiii
1	Introduction	1 1
	1.2 Applications of HEC-6         1.3 Overview of Manual	2 2
	1.4 Summary of HEC-6 Capabilities         1.4.1 Geometry         1.4.2 Hydraulics	3 3 3
	1.4.2 Hydraulics         1.4.3 Sediment         1.4.4 General	3 4
	1.5 Theoretical Assumptions and Limitations1.6 Single Event Analysis	5 5
2	Theoretical Basis for Movable Boundary Calculations	7
	2.1 Overview of Approach and Capabilities         2.1.1 General         2.1.2 General	7 7 7
	2.1.2 Geometry2.1.3 Hydraulics and Hydrology2.1.4 Sediment Transport	7 7 8
	2.2 Theoretical Basis for Hydraulic Calculations	8 8 8
	2.2.2 Hydraulic Losses         2.2.2.1 Friction Losses	9 9
	2.2.2.2 Other Losses         2.2.3 Computation of Hydraulic Elements	9 10
	2.2.3.1Subsection Area2.2.3.2Wetted Perimeter2.2.3.3Hydraulic Radius	10 11 11
	2.2.3.4       Conveyance         2.2.3.5       Velocity Distribution Factor, Alpha	11
-	2.2.3.6 Effective Depth and Width2.2.3.7 Critical Depth Calculations	12 12
	2.2.3.8 Supercritical Flow2.2.3.9 Convergence Equations2.2.4 Representative Hydraulic Parameters Used in	13 13
	Sediment Calculations	14 15

# Chapter

# Page

2.3	Theoretical Basis for Sediment Calculations	15
	2.3.1 Equation for Continuity of Sediment Material	15
	2.3.1.1 Control Volume	15
	2.3.1.2 Concepts of the Control Volume	16
	2.3.1.3 Exner Equation	17
	2.3.1.4 Bed Gradation Recomputations	18
	2.3.2 Determination of the Active and Inactive Layers	19
	2.3.2.1 Equilibrium Depth	19
	2.3.3 Hydraulic Sorting of the Bed Material - Method 1	20
	2.3.3.1 Impact of the Active Layer on Depth of Erosion	22
	2.3.3.2 Composition of the Active Layer	23
	2.3.3.3 Rate of Replenishing the Active Layer	23
	2.3.3.4 Influence of Armoring on Transport Capacity	24
	2.3.3.5 Some Limitations of Method 1	25
	2.3.4 Hydraulic Sorting of the Bed Material - Method 2	25
	2.3.4.1 Sub-Surface Layer	27
	2.3.4.2 Characteristic Rate of Entrainment	28
	2.3.4.3 Characteristic Rate for Deposition	28
	2.3.4.4 Some Limitations of Method 2	28
	2.3.5 Bed Elevation Change	29
	2.3.5.1 Hard Bottom Channel	29
	2.3.6 Unit Weight of Deposits	30
	2.3.6.1 Initial Unit Weight	30
	2.3.6.2 Composite Unit Weight	30
	2.3.6.3 Consolidated Unit Weight	30
	2.3.7 Sediment Particle Properties	31
	2.3.8 Silt and Clay Transport	31
	2.3.8.1 Cohesive Sediment Deposition	31
	2.3.8.2 Cohesive Sediment Scour	32
	2.3.8.3 Influence of Clay on the Active Layer	32
	2.3.8.4 Mudflow Constraint on Transport Potential	33
~		25
	neral Input Requirements	35
	General Description of Data Input	35 35
5.2	Geometric Data	35 35
	3.2.1 Cross Sections (X1, X3, GR)	36
	3.2.2 Manning's <i>n</i> Values (NC, NV, \$KL, \$KI)	36
	3.2.3 Movable Bed (H, HD)	37
	3.2.4 Dredging (H, HD, \$DREDGE, \$NODREDGE)	37 37
	3.2.5 Bridges	
	3.2.6 Ineffective Flow Area (X3)	37
	3.2.7 Conveyance Limits (XL)	38

3

# Page

	3.3	Sediment Data3.3.1 Inflowing Sediment Load (LQ, LT, LF)3.3.2 Sediment Material in the Stream Bed (PF)3.3.3 Sediment Properties (I1, I2, I3, I4)3.3.4 Sediment Transport	39 40 40 41 41
		3.3.4.1 Clay and Silt Transport (I2, I3)	41 41
	3.4	Hydrologic Data	42
		3.4.1 Flow Duration (W)	43
		3.4.2 Boundary Conditions	43
		3.4.2.1 Upstream Boundary Conditions	43
		3.4.2.2 Downstream Boundary Conditions (\$RATING, RC, R, S)	44
		3.4.2.3 Internal Boundary Conditions (QT, X5, R)	44
		3.4.2.4 Transmissive Boundary Condition (\$B)	45
	<u> э</u> г	3.4.3 Example Hydrology Input	45 46
		Special Command Records (EJ, \$TRIB, \$LOCAL, \$HYD, \$\$END)         Network Model	40 46
	5.0	3.6.1 Numbering	46
		3.6.2 Cross Section Data Sets of Main Stem and Tributaries	48
		3.6.3 Sediment Data	49
		3.6.4 Hydrologic Data	50
		3.6.5 Summary of Data Input Sequence	50
		3.6.6 Calculation Sequence of Network Systems	51
		3.6.6.1 Hydraulic Computations for Network Systems	51
		3.6.6.2 Sediment Computations	51
	3.7	Input Requirements for Other Options	51
		3.7.1 Fixed Bed Calculations	51
		3.7.2 Multiple Fixed Bed Calculations	51
		3.7.3 Cross Section Shape Due to Deposition (\$GR)	52
		3.7.4 Cumulative Volume Computations (\$VOL)	52
4	Out	put Control	53
		Output Levels	53
	4.2	Geometric Data, Initial Conditions (T1)	53
		Sediment Data, Initial Conditions (T4)	53
		Hydraulic Calculations (Q)	55
		Sediment Transport Calculations (Q, \$PRT, CP, PN, END)	55
		Accumulated Sediment Volumes (\$VOL, VJ, VR)	55
	4.7	Summary of Output Controls	55
5	Мо	deling Guidelines	57
		General	57
	5.2	Establishing Geometry	57

Chapter		F	Page
	5.3	Sediment Data	57
		5.3.1 Sediment Particle Characteristics	57
		5.3.2 Inflowing Sediment Load Synthesis	58
	5.4	Hydrologic Data	58
6	Exa	mple Problems	59
		Example Problem 1 - Fixed Bed Application	60
		6.1.1 Input Data	60
		6.1.2 Output	62
	6.2	Example Problem 2 - Hydraulic and Geometric Options	66
		6.2.1 Manning's <i>n</i> Vs. Elevation	66
		6.2.2 Internal Boundary Conditions	66
		6.2.3 Ineffective Flow Area	67
		6.2.4 Conveyance Limits	69
		6.2.5 Downstream Boundary Water Surface Elevation	69
		6.2.6 A-Level Hydraulic Output	70
		6.2.7 B-Level Hydraulic Output	70
	6.3	Example Problem 3 - Movable Bed	77
		6.3.1 Movable Bed Limits	77
		6.3.2 Sediment Title Records	77
		6.3.3 Sediment Transport Control Parameters	77
		6.3.4 Inflowing Sediment Loads	78
		6.3.5 Bed Material Gradation	81
		6.3.6 Flow Data	81
		6.3.7 Output	81
		6.3.8 Output of Hydraulic and Sediment Transport Computations	82
		6.3.9 Detailed Sediment Output	83
	6.4	Example Problem 4 - Some Sediment Options	96
		6.4.1 Dredging	96
		6.4.2 Transmissive Boundary Condition	100
		6.4.3 Limerinos' Bed Form Roughness Function	100
		6.4.4 Flow Duration Option	100
		6.4.5 Modifying the Sediment Load Tables	100
		6.4.6 Downstream Rating Curve	100
		6.4.7 Accumulated Sediment Transported	101
	6.5	Example Problem 5 - Reservoirs	109
		6.5.1 Reservoir Data	109
		6.5.2 Elevation-Surface Area and Elevation-Storage Tables	112
		6.5.3 Trap Efficiency	
	6.6	Example Problem 6 - River Network System	119
		6.6.1 Network Layout and Numbering	119
		6.6.2 Geometric Data Structure	119
		6.6.3 Sediment Data Structure	120

Chapter	Pag	е
	6.6.4 Flow Data Structure126.6.5 Network Output12	
	6.7 Example Problem 7 - Cohesive Sediment       14         6.7.1 Cohesive Sediment Data       14	
	6.7.2 Output 14	9
7	References	;1

# Appendices

# Page

Α	Input Description A-i
	A1 Geometry and Channel Properties A-1
	A2 Sediment Properties and Transport Functions A-21
	A3 Hydrologic Data A-49
	A4 Special Commands and Output Controls A-63
В	Glossary B-1

# Figures

No.	Title	Page
2-1	Energy Equation Terms	8
2-2	Typical Representation of a Cross Section	10
2-3	Incremental Areas in Channel Subsection	10
2-4	Incremental Area	10
2-5	Examples of Subcritical, Critical, and Supercritical Flow Simulations in HEC-6	13
2-6	Convergence of Assumed and Computed Water Surface Elevations	13
2-7	Control Volume for Bed Material	16
2-8	Sediment Material in the Streambed	17
2-9	Computation Grid	17
2-10	A Column of Bed Material Having Surface Area (SA)	20
2-11	Gradation of Bed Material for Equilibrium Depth Computation	21
2-12	Equilibrium Depth Conditions	22
2-13	Probability of Grain Stability	23
2-14	Bed Layers at Beginning of Time Step	26
2-15	Bed Layers at Intermediate Exchange Increment.	26
2-16	Bed Layers at End of Time Step.	
2-17	Bed Layers Change When Cover Layer is Depleted.	
2-18	Cross Section Shape Due to Deposition	29
2-19	Cross Section Shape Due to Erosion	29
3-1	Cross Section Subsections	35
3-2	Sediment Material in the Stream Bed	36
3-3	Examples of Ineffective Area, Method 1	37
3-4	Examples of Ineffective Area, Method 2	38
3-5	Examples of Ineffective Area, Method 3	38
3-6	Ineffective Areas Due to Natural Levee Formation	38
3-7	Water-Sediment Inflow Relationship	40
3-8	Bed Sediment Control Volume	41
3-9	A Computational Hydrograph	
3-10	Example of Stream Network Numbering System	47
3-11	Locating Cross Sections for Stream Networks	
3-12	Uniform Deposition	52
3-13	Nonuniform Deposition	52
6-1	Schematic of Example River System	60
6-2	Manning's n vs. Elevation, Section No. 15	67
6-3	Cross Section 15.0 with encroachments	68
6-4	Cross Section 35.0, Example Problem 4	97
6-5	Schematic of a Network System	120
6-6	Flows of a Network System	
6-7	Erosion Rate Characteristics	148

# Tables

No.	Title	Page
2-1	Representative Hydraulic Parameter Weighting Factors	15
3-1	Grain Size Classification of Sediment Material	
3-2	Example of Hydrologic Input for HEC-6	
3-3	Sequence of Geometry Data for a River Network	48
3-4	Sequence of Sediment Data for a River Network	49
3-5	Hydrologic Data Input for Stream Networks	50
3-6	Example of Hydrologic Data Set for Multiple "Fixed Bed" Calculations	51
4-1	Summary of Initial Conditions Output Options	54
4-2	Summary of Continuous Simulation Output Levels	
6-1a	Example Problem 1 - Input Fixed Bed	62
6-1b	Example Problem 1 - Output Fixed Bed	64
6-2a	Example Problem 2 - Input Hydraulic Options	
6-2b	Example Problem 2 Hydraulic Output	71
6-3a	Example Problem 3 - Input Movable Bed	79
6-3b	Example Problem 3 - Output Movable Bed	85
6-4a	Example Problem 4 - Input Sediment Options	97
6-4b	Example Problem 4 - Output Sediment Options	102
6-5a	Example Problem 5 - Input Reservoir Model	109
6-5b	Example Problem 5 - Output Reservoir Model	114
6-6a	Example Problem 6 - Input Network System	121
6-6b	Example Problem 6 - Output Network System	127
6-7a	Example Problem 7 - Input Cohesive Sediment	149
6-7b	Example Problem 7 - Output Cohesive Sediment	151

#### CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	<u> </u>	To Obtain
cubic feet	0.02831685	cubic meters
cubic yards	0.7645549	cubic meters
degrees Fahrenheit	5/9*	degrees Celsius or Kelvin
feet	0.3048	meters
inches	2.54	centimeters
miles (US statute)	1.609347	kilometers
tons (2,000 pounds, mass)	907.1847	kilograms

To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C=(5/9)(F-32). To obtain Kelvin (K) readings, use: K=(5/9)(F-32)+273.15.

# Foreword

HEC-6 development was initiated by William A. (Tony) Thomas at the Little Rock District of the Corps of Engineers. That program evolved into Version 2.7 in 1976 while Mr. Thomas was at the Hydrologic Engineering Center (HEC). Since then, program development by Mr. Thomas and his staff has continued at the Waterways Experiment Station (WES). Version 3.2 was released by HEC in 1986. That version was ported to MS-DOS by HEC, and was the HEC "Library Version" of HEC-6 until replaced by Version 4.0 in 1991.

Version 4.0 was developed at HEC from the 1988 "Network Version" of HEC-6 (sometimes called TABS-1) developed at WES. Mr. Thomas had added stream network capability, as well as additional transport functions and a more complete computation of cohesive sediment resuspension, and modified the movable bed width computation (see Section 2.2.4). Ms. Joan Tinios, working at HEC under the direction of Dr. Michael Gee upgraded the source code to FORTRAN 77 Standard. Miscellaneous changes to program output and minor error corrections were also performed at that time. Because of these changes, some computed results may differ from earlier versions.

In 1993, further modifications were made to Version 4.0. Version 4.1 will compute sediment transport of grain sizes up to 2048 mm. While several new records have been added to facilitate data input, we have tried to maintain the capability to use input data from earlier program versions. HEC-6 output has also been improved.

Current information regarding availability of this and other programs is available from HEC. While the U.S. Government is not responsible for the results obtained from this program, identified errors will be eliminated to the extent that time and funds are available. HEC-6 users are encouraged to notify HEC of any suspected errors.

This manual documents Version 4.1 of the HEC-6 computer program, "Scour and Deposition in Rivers and Reservoirs." The first draft was written in 1989 by Mr. David Williams, under contract with HEC. HEC staff edited and revised the draft and added the Input Description (Appendix A), the Glossary (Appendix B), and an index. The manual was released with Version 4.0 of HEC-6 in June of 1991. Since then, minor errors and discrepancies have been corrected and those corrections have been incorporated into this update of the manual and program.

**Revision History** 

August 1993 September 1994 Original Edition Correction of minor typographic errors

# **Chapter 1**

# Introduction

## 1.1 Model Purpose and Philosophy

HEC-6 is a one-dimensional movable boundary open channel flow numerical model designed to simulate and predict changes in river profiles resulting from scour and/or deposition over moderate time periods (typically years, although applications to single flood events are possible). A continuous flow record is partitioned into a series of steady flows of variable discharges and durations. For each flow a water surface profile is calculated thereby providing energy slope, velocity, depth, etc. at each cross section. Potential sediment transport rates are then computed at each section. These rates, combined with the duration of the flow, permit a volumetric accounting of sediment within each reach. The amount of scour or deposition at each section is then computed and the cross section adjusted accordingly. The computations then proceed to the next flow in the sequence and the cycle is repeated beginning with the updated geometry. The sediment calculations are performed by grain size fraction thereby allowing the simulation of hydraulic sorting and armoring. Features of HEC-6 include: capability to analyze networks of streams, channel dredging, various levee and encroachment alternatives, and to use several methods for computation of sediment transport rates.

Separation of sediment deposition from the hydraulics of flow is valid in some circumstances; for example, deposition in deep reservoirs can usually be characterized as a progressive reduction in storage capacity if the material is rarely entrained once it is deposited. Prediction of sediment behavior in shallow reservoirs and most rivers, however, requires that the interactions between the flow hydraulics, sediment transport, channel roughness and related changes in boundary geometry be considered. HEC-6 is designed to incorporate these interactions into the simulation.

HEC-6 simulates the capability of a stream to transport sediment, given the yield from upstream sources. This computation of transport includes both bed and suspended load as described by Einstein's Bed-Load Function (1950)<sup>1</sup>. A reach of river with a bed composed of the same type of sediment material as that moving in the stream is termed an "alluvial" reach (Einstein 1950). Einstein recognized that an alluvial reach provides a record of the sediment that the stream has, and does, transport. That record is reflected in the materials that form the stream boundaries. Using the hydraulic properties of the flow and the characteristics of the sediment material (which can be determined by analyzing samples of the riverbed sediment particles), one can compute the rate of sediment transport. HEC-6 implements similar concepts to compute the movement of sediment materials for a temporal sequence of flows and, through volume conservation of bed material, changes in channel dimensions. The transport, deposition, and erosion of silts and clays may also be calculated. Effects of the creation and removal of an armor layer are also simulated.

<sup>&</sup>lt;sup>1</sup> Although Einstein's Bed-Load Function is not included in this version of HEC-6, his concepts of particle movement and interchange have guided development of the algorithms used in HEC-6 to describe the dynamic interactions between bed material composition and bed material transport.

## 1.2 Applications of HEC-6

A dynamic balance exists between the sediment moving in a natural stream, the size and gradation of sediment material in the stream's boundaries and the flow hydraulics. When a reservoir is constructed, flood damage reduction measures are implemented, or a minimum depth of flow is maintained for navigation, that balance may be changed. HEC-6 can be used to predict the impact of making one or more of those changes on the river hydraulics, sediment transport rates, and channel geometry.

HEC-6 is designed to simulate long-term trends of scour and/or deposition in a stream channel that might result from modifying the frequency and duration of the water discharge and/or stage, or from modifying the channel geometry (e.g., encroaching on the floodplains). HEC-6 can be used to evaluate deposition in reservoirs (both the volume and location of deposits), design channel contractions required to maintain navigation depths or decrease the volume of maintenance dredging, predict the influence that dredging has on the rate of deposition, estimate possible maximum scour during large flood events, and evaluate sedimentation in fixed channels. Some early applications of HEC-6 were described by Thomas and Prasuhn (1977) and more recent application advice is provided by HEC (1992). Guidelines for performing sedimentation studies is given in USACE (1989) and river hydraulics studies in USACE (1993).

## 1.3 Overview of Manual

This manual describes the fundamental concepts, numerical model limitations and capabilities, computational procedures, input requirements and output of HEC-6. A brief description of model capabilities and the organization of this manual is presented below.

#### **Theoretical Basis For Movable Boundary Calculations (Chapter 2)**

This chapter describes the theoretical basis for hydraulic and sediment computations used in the computer program HEC-6. It presents the general capabilities of the program and describes how the computations are performed.

#### **General Input Requirements (Chapter 3)**

This chapter describes the general data requirements of HEC-6. It describes the input data required for implementation of specific HEC-6 capabilities.

#### Program Output (Chapter 4)

This chapter provides information on the various output levels available for displaying the geometric, sediment, and hydrologic data; and for listing the initial and boundary conditions. It also describes how to save desired information at selected times during a simulation.

#### **Modeling Guidelines (Chapter 5)**

General modeling guidelines and additional information on how HEC-6 performs its computations are presented in this chapter.

#### **Example Problems (Chapter 6)**

This chapter gives example applications of HEC-6. It covers single river and network situations and some commonly used features of the program.

## **1.4 Summary of HEC-6 Capabilities**

### 1.4.1 Geometry

A river system consisting of a main stem, tributaries and local inflow/outflow points can be simulated. Such a system in which tributary sediment transport is calculated is referred to in this document as a **network model**. Sediment transport is calculated by HEC-6 in primary rivers and tributaries. There will be upper limits on the number of network branches, number of cross sections, etc., due to computer memory limitations. As these may change among HEC-6 implementations on various computer systems, the user should check the header on the output file to determine the limits of the particular version being used.

## 1.4.2 Hydraulics

The one-dimensional energy equation (USACE 1959) is used by HEC-6 for water surface profile computations. Manning's equation and n values for overbank and channel areas may be specified by discharge or elevation. Manning's n for the channel can also be varied by Limerinos' (1970) method using the bed gradation of each cross section. Expansion and contraction losses are included in the determination of energy losses. The energy loss coefficients may be changed at any cross section.

For each discharge in a hydrograph, the downstream water surface elevation can be determined by either a user-specified rating curve or a time dependent water surface elevation. Internal boundary conditions can be imposed on the solution. The downstream rating curve can be changed at any time. Internal boundary conditions can also be changed at any time.

Flow conveyance limits, containment of the flow by levees, ineffective flow areas, and overtopping of levees are simulated in a manner similar to HEC-2. Split flow computations are not done and no special capability for computing energy losses through bridges is available. Supercritical flow, should it occur, is approximated by normal depth; therefore, sediment transport phenomena occurring in supercritical reaches are simplified in HEC-6.

HEC-6 can be executed in "fixed bed" mode, which is similar to an HEC-2 application, in that only water surface profiles are computed. Sediment information such as inflowing sediment load and bed gradations are not needed to run HEC-6 in fixed-bed mode.

## 1.4.3 Sediment

Sediment transport rates are calculated for grain sizes up to 2048 mm. Sediment sizes larger than 2048 mm, that may exist in the bed, are used for sorting computations but are not transported. For deposition and erosion of clay and silt sizes up to 0.0625 mm, Krone's (1962) method is used for deposition and Ariathurai and Krone's (1976) adaptation of Parthenaides' (1965) method is used for scour. The default procedure for clay and silt computations allows only deposition using a method based on settling velocity.

The sediment transport function for bed material load is selected by the user. Transport functions available in the program are the following:

- a. Toffaleti's (1966) transport function
- b. Madden's (1963) modification of Laursen's (1958) relationship
- c. Yang's (1973) stream power for sands
- d. DuBoys' transport function (Vanoni 1975)
- e. Ackers-White (1973) transport function
- f. Colby (1964) transport function
- g. Toffaleti (1966) and Schoklitsch (1930) combination
- h. Meyer-Peter and Müller (1948)
- i. Toffaleti and Meyer-Peter and Müller combination
- j. Madden's (1985, unpublished) modification of Laursen's (1958) relationship
- k. Modification by Ariathurai and Krone (1976) of Parthenaides' (1965) method for scour and Krone's (1962) method for deposition of cohesive sediments
- 1. Copeland's (1990) modification of Laursen's relationship (Copeland and Thomas 1989)
- m. User specification of transport coefficients based upon observed data

The above methods (except for method a.), utilize the Colby (1964) method for adjusting the sediment transport potential when the wash load concentration is high. Armoring and destruction of the armor layer are simulated based upon Gessler's (1970) approach. Deposition or scour is modeled by moving each cross section point within the movable bed (i.e., the area which is shifted vertically each time step due to sediment movement).

The movable bed limits **may extend beyond the channel bank "limits"**. Deposition is allowed to occur in all wetted areas, even if the wetted areas are beyond the conveyance or movable bed limits. Scour occurs only within the movable bed limits. Sediment transport potential is based upon the hydraulic and sediment characteristics of the channel alone. Simulation of geological controls such as bedrock or a clay layer may be done by specifying a minimum elevation for the movable bed at any particular cross section.

The sediment boundary conditions (inflowing sediment load as a function of water discharge) for the main river channel, its tributaries and local inflow/outflow points can be changed with time. HEC-6 has the capability to simulate the diversion of water and sediment by grain size. A transmissive boundary condition is available at each downstream boundary; this boundary condition forces all sediment entering that section to pass it, resulting in no scour or deposition at that section.

#### 1.4.4 General

Computed information includes the total sediment discharge passing each cross section and the volume of deposits (or scour) accumulated at each cross section from the beginning of the simulation. HEC-6 also has the ability to simulate the effects of dredging activities. Dredging can be initiated when a depth of deposition is exceeded or can occur on a periodic basis. Dredging can also be based upon a required minimum depth for navigation.

Should a river network of a main stem and tributaries be simulated, HEC-6 uses the same data that previous versions had used if each river and tributary segment were being analyzed independently. Control point data must be supplied to link the geometric segments together into a complete stream network. Data sets from earlier versions of HEC-6 that include local inflows can be used if all **\$TRIB** records are replaced by **\$LOCAL** records and a water temperature is entered for each local inflow point.

## 1.5 Theoretical Assumptions and Limitations

HEC-6 is a one-dimensional continuous simulation model that uses a sequence of steady flows to represent discharge hydrographs. There is no provision for simulating the development of meanders or specifying a lateral distribution of sediment load across a cross section. The cross section is subdivided into two parts with input data; that part which has a movable bed, and that which does not. The movable bed is constrained within the limits of the wetted perimeter and other limitations that are explained later. The entire wetted part of the cross section is normally moved uniformly up or down; an option is available, however, which causes the bed elevation to be adjusted in horizontal layers when deposition occurs. Bed forms are not simulated; however, *n* values can be input as functions of discharge, which indirectly permits consideration of the effects of bed forms if the user can determine those effects from measured data. Limerinos' (1970) method is available as an option for computation of bed roughness. Density and secondary currents are not simulated.

There are three restrictions on the description of a network system within which sediment transport can be calculated with HEC-6:

- a. Sediment transport in distributaries is not possible.
- b. Flow around islands; i.e., closed loops, cannot be directly accommodated.
- c. Only one junction or local inflow point is allowed between any two cross sections.

## 1.6 Single Event Analysis

HEC-6 is designed to analyze long-term scour and/or deposition. Single flood event analyses must be performed with **caution**. HEC-6 bed material transport algorithms assume that equilibrium conditions are reached within each time step (with certain restrictions that will be explained later); however, the prototype is often influenced by unsteady non-equilibrium conditions during flood events. Equilibrium may not occur under these conditions because of the continuously changing hydraulic and sediment dynamics. If such situations predominate, single event analyses should be performed only on a qualitative basis. For gradually changing sediment and hydraulic conditions, such as for large rivers with slow rising and falling hydrographs, single event analyses may be performed with confidence.

# **Chapter 2**

# **Theoretical Basis for Movable Boundary Calculations**

## 2.1 Overview of Approach and Capabilities

This chapter presents the theories and concepts embodied in HEC-6. Information regarding implementation of these theories and concepts in HEC-6 is presented in Chapter 3.

### 2.1.1 General

HEC-6 processes a discharge hydrograph as a sequence of steady flows of variable durations. Using continuity of sediment, changes are calculated with respect to time and distance along the study reach for the following: total sediment load, volume and gradation of sediment that is scoured or deposited, armoring of the bed surface, and the cross section elevations. In addition, sediment outflow at the downstream end of the study reach is calculated. The location and amount of material to be dredged can be obtained if desired.

## 2.1.2 Geometry

Geometry of the river system is represented by cross sections which are specified by coordinate points (stations and elevations) and the distances between cross sections. HEC-6 raises or lowers cross section elevations to reflect deposition and scour. The horizontal locations of the channel banks are considered fixed and the floodplains on each side of the channel are considered as having fixed ground locations; however, they will be moved vertically if they are within the movable bed limits specified by the user.

## 2.1.3 Hydraulics and Hydrology

The water discharge hydrograph is approximated by a sequence of steady flow discharges, each of which continues for a specified period of time. Water surface profiles are calculated for each flow using the standard-step method to solve the energy and continuity equations. Friction loss is calculated by Manning's equation and expansion and contraction losses are calculated if the loss coefficients are specified. Hydraulic roughness is described by Manning's *n* values and can vary from cross section to cross section. At each cross section *n* values may vary vertically or with discharge.

The downstream water surface elevation must be specified for subcritical water surface profile calculations. In the case of a reservoir the operating rule may be utilized, but if open river conditions exist, a stage-discharge rating curve is usually specified as the downstream boundary condition. A boundary condition or operating rule may be used at any location along the main stem or tributaries.

### 2.1.4 Sediment Transport

Inflowing sediment loads are related to water discharge by sediment-discharge curves for the upstream boundaries of the main stem, tributaries and local inflow points. For realistic computation of stream behavior, particularly scour and stable conditions, the gradation of the material forming the stream bed must be measured. HEC-6 allows a different gradation at each cross section. If only deposition is expected, the gradation of material in the bed is less important.

Sediment gradations are classified by grain size using the American Geophysical Union scale. HEC-6 will compute transport potential for clay (particles less than 0.004 mm diameter), four classes of silt (0.004-0.0625 mm), five classes of sand (from very fine sand, 0.0625 mm, to very coarse sand, 2.0 mm), five classes of gravel (from very fine gravel, 2.0 mm, to very coarse gravel, 64 mm), two class of cobbles (from small, 64mm, to large cobbles, 256mm) and three classes of boulders (from small, 256mm, to large boulders, 2048mm).

Transport potential is calculated at each cross section using hydraulic information from the water surface profile calculation (e.g., width, depth, energy slope, and flow velocity) and the gradation of bed material. Sediment is routed downstream after the backwater computations are made for each successive discharge (time step).

### 2.2 Theoretical Basis for Hydraulic Calculations

The basis for water surface profile calculations is essentially Method II, which is described in "Backwater Curves in River Channels," EM 1110-2-1409 (USACE 1959). Conveyance is calculated from average areas and average hydraulic radii for adjacent cross sections.

### 2.2.1 Equations for Water Surface Profile Calculations

The hydraulic parameters needed to calculate sediment transport potential are velocity, depth, width and energy slope - all of which are obtained from water surface profile calculations. The one-dimensional energy equation (Equation 2-1) is solved using the standard step method and the hydraulic parameters are calculated at each cross section for each successive discharge. Figure 2-1 shows a representation of the terms in the energy equation.

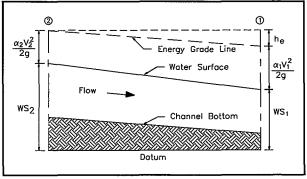


Figure 2-1 Energy Equation Terms

WS<sub>2</sub> + 
$$\frac{\alpha_2 V_2^2}{2g}$$
 = WS<sub>1</sub> +  $\frac{\alpha_1 V_1^2}{2g}$  + h<sub>e</sub> (2-1)

where:

a

h

= acceleration of gravity

- = energy loss
- V<sub>2</sub> = average velocities (total discharge ÷ total flow area) at ends of reach
- $WS_1, WS_2$  = water surface elevations at ends of reach
- $\alpha_1, \alpha_2$  = velocity distribution coefficients for flow at ends of reach.

## 2.2.2 Hydraulic Losses

#### 2.2.2.1 Friction Losses

River geometry is specified by cross sections and reach lengths; friction losses are calculated by Method II (USACE 1959). The energy loss term,  $\mathbf{h}_{e}$ , in Equation 2-1 is composed of friction loss,  $\mathbf{h}_{f}$ , and form losses,  $\mathbf{h}_{o}$ , as shown in Equation 2-2. Only contraction and expansion losses are considered in the geometric form loss term.

$$h_{e} = h_{f} + h_{o}$$
 (2-2)

To approximate the transverse distribution of flow, the river is divided into strips having similar hydraulic properties in the direction of flow. Each cross section is subdivided into portions that are referred to as subsections. Friction,  $h_f$ , loss is calculated as shown below:

$$\mathbf{h}_{f} = \left[\frac{\mathbf{Q}}{\mathbf{K}_{t}'}\right]^{2}$$
(2-3)

in which:

$$K_{t}' = \sum_{j=1}^{NSS} \left[ \frac{1.49}{n_{j}} \right] \frac{\frac{(A_{2} + A_{1})_{j}}{2} \left[ \frac{R_{2} + R_{1}}{2} \right]_{j}^{2/3}}{L_{j}^{1/2}}$$
(2-4)

where: <b>A</b> <sub>1</sub> , <b>A</b> <sub>2</sub>	=	downstream and upstream area, respectively, of the flow normal to the cross sections
NSS	=	total number of subsections across each cross section
K′ <sub>t</sub>		length-weighted subsection conveyance
L <sub>j</sub>		length of the j <sup>th</sup> strip between subsections
n		Manning's roughness coefficient
Q		water discharge
R <sub>1</sub> , R <sub>2</sub>	=	downstream and upstream hydraulic radius, respectively.

#### 2.2.2.2 Other Losses

Energy losses due to contractions and expansions are computed by the following equation:

$$h_{o} = C_{L} \left| \frac{\alpha_{2} V_{2}^{2}}{2g} - \frac{\alpha_{1} V_{1}^{2}}{2g} \right|$$
(2-5)

where:  $C_L$  = loss coefficient for expansion or contraction

If the quantity within the absolute value notation is negative, flow is contracting and  $C_L$  is the coefficient of contraction; if it is positive, flow is expanding and  $C_L$  is the coefficient of expansion.

## 2.2.3 Computation of Hydraulic Elements

Each cross section is defined by coordinates (X,Y) as shown in Figure 2-2. For convenience of assigning *n* values, reach lengths, etc., each cross section is divided into subsections, usually consisting of a main channel, with left and right overbanks.

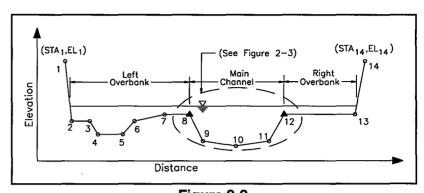
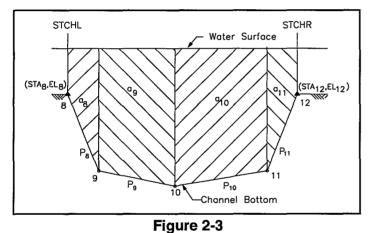


Figure 2-2 Typical Representation of a Cross Section



# 2.2.3.1 Subsection Area

computed by summing incremental areas below the water surface between consecutive coordinates of the cross section. Figure 2-3 illustrates the technique with a subsection of Figure 2-2 where STCHL and STCHR are the lateral boundaries of the subsection.

The area of each subsection is

The area of the channel subsection is:

$$A_j = a_8 + a_9 + a_{10} + a_{11}$$
 (2-6)

where:  $\mathbf{a}_i = \text{incremental area.}$ 

Incremental Areas in Channel Subsection

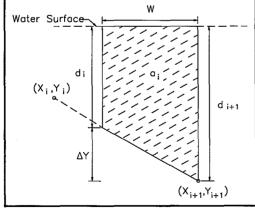


Figure 2-4 Incremental Area

The equation for an incremental area,  $\mathbf{a}_{i}$ , is:.

$$a_i = \frac{(d_i + d_{i+1}) W}{2}$$
 (2-7)

where: **d**<sub>i</sub>, **d**<sub>i+1</sub> = the left and right depth of each incremental area, respectively (see Figure 2-4)

width of an incremental area.

Normally,  $\mathbf{d}_{i}$ ,  $\mathbf{d}_{i+1}$  and  $\mathbf{W}$  are defined by two consecutive cross section coordinate points, as shown in Figure 2-4. However at the first and last increments in each subsection, a subsection station defines one side of the incremental area. If the subsection station does not coincide with an X coordinate, straight line interpolation is used to compute the length of either,  $\mathbf{d}_{i}$ ,  $\mathbf{d}_{i+1}$ , or both.

#### 2.2.3.2 Wetted Perimeter

The wetted perimeter, P, is computed as the length of the cross section below the water surface. In the case of Figure 2-3, this is:

$$P = P_8 + P_9 + P_{10} + P_{11}$$
 (2-8)

where:  $P_i$  = incremental wetted perimeter.

The equation for the wetted perimeter of the incremental area in Figure 2-4 is:

$$P_{i} = (\Delta Y^{2} + W^{2})^{1/2}$$
 (2-9)

where:  $\Delta Y$  and W are as shown in Figure 2-4.

Note that only the distance between coordinate points is considered in  $\mathbf{p}_{i}$ , not the depths  $\mathbf{d}_{i}$  and  $d_{i+1}$ . In other words, friction due to shear forces between subsections is not considered.

#### 2.2.3.3 Hydraulic Radius

The hydraulic radius, R, is calculated for each subsection, j, by:

$$R_{j} = \frac{A_{j}}{P_{j}}$$
(2-10)

where:  $A_j$  = area of subsection  $P_j$  = wetted perimeter of subsection  $R_j$  = hydraulic radius of subsection.

#### 2.2.3.4 Conveyance

The conveyance, K<sub>i</sub>, is computed for each subsection, i, by:

$$K_{j} = \frac{1.49}{n_{j}} A_{j}R_{j}^{2/3}$$
 (2-11)

The total conveyance, K<sub>t</sub>, in the cross section is:

$$K_{t} = \sum_{j=1}^{NSS} K_{j}$$
 (2-12)

where: NSS = total number of subsections.

#### 2.2.3.5 Velocity Distribution Factor, Alpha

Alpha is an energy correction factor to account for the transverse distribution of velocity across the floodplains and channel. Large values of alpha (>2) will occur if the depth of flow on the overbanks is shallow, the conveyance is small, and the area is large. Alpha is computed as follows:

> $\alpha = \frac{\sum_{j=1}^{N_{22}} \left| \frac{r_{j}}{A_{j}^{2}} \right|}{\left| \frac{K_{t}^{3}}{2} \right|}$ (2-13)

### 2.2.3.6 Effective Depth and Width

The sediment transport capacity for non-rectangular sections is calculated using a weighted depth, EFD, called the effective depth. The corresponding effective width, EFW, is calculated from the effective depth to preserve  $A(D^{2/3})$  for the cross section.

$$EFD = \frac{\sum_{i=1}^{i_{t}} D_{avg} \cdot a_{i} \cdot D_{avg}^{2/3}}{\sum_{i=1}^{i_{t}} a_{i} \cdot D_{avg}^{2/3}}$$
(2-14)  

$$EFW = \frac{\sum_{i=1}^{i_{t}} a_{i} \cdot D_{avg}^{2/3}}{EFD^{5/3}}$$
(2-15)  
re:  $a_{i} = flow area of each trapezoidal element$   
 $D_{avg} = corrace water donth of each trapezoidal element$ 

where:  $a_i = flow area of each trapezoidal element$   $D_{avg} = average water depth of each trapezoidal element$  $i_t = the total number of trapezoidal elements in a subsection$ 

The sediment transport computation is based upon hydraulics of the main channel only; therefore, the hydraulic elements are from the geometry within the channel limits only.

## 2.2.3.7 Critical Depth Calculations

To assess if the backwater profiles remain above critical depth, the critical section factor, **CRT**, is computed using Equation 2-16, and compared with the computed section factor at each cross section.

$$CRT = \frac{Q}{\left(\frac{g}{\alpha}\right)^{1/2}}$$
(2-16)

A computed section factor, ZSQ, is calculated for comparison to CRT.

$$ZSQ = A_t \left(\frac{A_t}{W_t}\right)^{1/2}$$
(2-17)

where:  $A_t$  = total area of cross section  $W_t$  = total water surface width

If **CRT** is less than **ZSQ**, subcritical flow exists and computations continue. Otherwise, critical depth is calculated by tracing the specific energy curve to the elevation of minimum total energy and the resulting water surface elevation is compared with the water surface elevation calculated by Equation 2-1 to decide if flow is supercritical. If supercritical flow is indicated, flow depth is determined as described in the following section.

## 2.2.3.8 Supercritical Flow

In the standard step method for water surface profile computations, calculations proceed from downstream to upstream based upon the reach's starting water surface elevation. At each cross section, HEC-6 examines the appropriate hydraulic parameters to determine if the reach is a subcritical or supercritical flow reach. If flow is subcritical, computations proceed upstream in the manner described in Section 2.2.1. If it is supercritical, HEC-6 approximates the channel geometry using the effective depth and width as described in Section 2.2.3.6 and determines the water surface elevation based upon the supercritical normal depth.

If a subcritical reach is eventually encountered, the downstream cross section of the reach is assumed to be at critical depth and backwater computations proceed upstream for assumed subcritical flow conditions. Note that for subcritical flow, M1 and M2 curves are possible in HEC-6 but under supercritical flow, S1 and S2 curves are not computed because only supercritical normal flow depths are calculated. An example of such a series of profiles is shown in Figure 2-5.

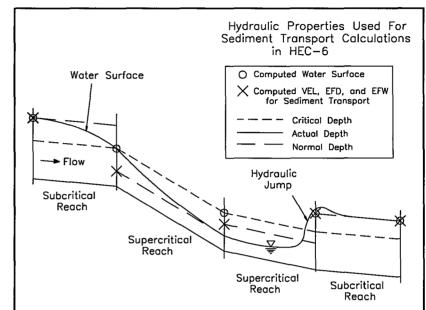


Figure 2-5 Examples of Subcritical, Critical, and Supercritical Flow Simulations in HEC-6

# 2.2.3.9 Convergence Equations

Three major steps are used to converge computational trials in computing the upstream cross section water surface elevation. Figure 2-6 demonstrates the sequence of successive trials to converge the standard step method.

**Computational Procedure:** 

- Trial 1: Based on the previous water surface elevation.
- Trial 2: Assumed change is ninety percent of  $\Delta Y_1$

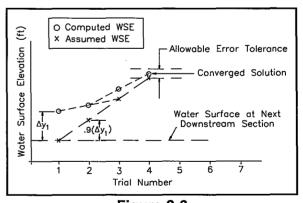


Figure 2-6 Convergence of Assumed and Computed Water Surface Elevations

Trial 3: Trial 1 and 2 elevations assumed are connected with a straight line and the computed Trial 1 and 2 solutions are also connected with a straight line. The intersection of these lines becomes Trial 3's assumed value. Trial 4, etc.: This process continues until the assumed and computed values of water surface elevation are within the allowable error tolerance. If they are, the computed water surface elevation becomes the converged solution.

Oscillation between positive and negative "error" is permitted. A note is printed in the event a solution is "forced" (after 20 trials) even though the "error" is greater than the allowable error. In this case, the last computed water surface elevation is used.

### 2.2.4 Representative Hydraulic Parameters Used in Sediment Calculations

Hydraulic parameters are converted into representative (weighted) values for each reach prior to calculating transport capacity. General equations are shown below. These weighting factors can be modified with input data.

#### **Interior Point (section)**

$VEL = XID \cdot VEL(K-1) + XIN \cdot VEL(K) + XIU \cdot VEL(K+1)$	(2-18)
EFD = XID · EFD(K-1) + XIN · EFD(K) + XIU · EFD(K+1)	(2-19)
EFW = XID · EFW(K-1) + XIN · EFW(K) + XIU · EFW(K+1)	(2-20)
SLO = $0.5 \cdot [SLO(K) + SLO(K+1)]$	(2-21)

#### **Upstream Point (section)**

VEL = UBN · VEL(K) + UBI · VEL(K-1)	(2-22)
$EFD = UBN \cdot EFD(K) + UBI \cdot EFD(K-1)$	(2-23)
$EFW = UBN \cdot EFW(K) + UBI \cdot EFW(K-1)$	(2-24)
SLO = SLO(K)	(2-25)

#### **Downstream Point (section)**

VEL = DBN · VEL(K) + DBI · VEL(K+1)	(2-26)
$EFD = DBN \cdot EFD(K) + DBI \cdot EFD(K+1)$	(2-27)
EFW = DBN · EFW(K) + DBI · EFW(K+1)	(2-28)
SLO = SLO(K)	(2-29)

		coefficients for downstream reach boundary downstream, midpoint, and upstream locations, respectively, of a reach
UBN, UBI VEL	=	friction slope coefficients for upstream reach boundary weighted velocity of the reach downstream, interior, and upstream coefficients, respectively, for interior points.

Several different weighting factors were investigated during the formulation of the computation scheme. Table 2-1 shows the set of factors which appeared to give the most stable calculation and thereby permits the longest time steps (Scheme 1) and the set which is the most sensitive to changes in bed elevation but requires shorter time steps to be stable (Scheme 2). Scheme 1 is often the best choice because the computed energy slope may vary drastically from section-to-section whereas the actual river's behavior may be dependent upon reach properties. HEC-6 defaults to Scheme 2 but this can be changed by entering other values for the weighting factors on the **I5** record.

	rehiese	Fillative	ilyula	uncia	amete	i iicigi	iung i e	
	DBI	DBN	XID	XIN	XIU	UBI	UBN	
Scheme 1	0.5	0.5	0.25	0.5	0.25	0.0	1.0	Most Stable
Scheme 2	0.0	1.0	0.0	1.0	0.0	0.0	1.0	Most Sensitive

Table 2-1.
Representative Hydraulic Parameter Weighting Factors

# 2.2.5 Hydraulic Roughness

Boundary roughness of an alluvial stream is closely tied to sediment transport and the movement of bed material. Energy losses for water surface profile calculations must include the effects of all losses: grain roughness of the movable bed, drag losses from bed forms such as ripples and dunes, bank irregularities, vegetation, contraction/expansion losses, bend losses, and junction losses. All these losses except the contraction/expansion losses are embodied in a single roughness parameter, Manning's *n*.

# 2.3 Theoretical Basis for Sediment Calculations

Sediment transport rates are calculated for each flow in the hydrograph for each grain size. The transport potential is calculated for each grain size class in the bed as though that size comprised 100% of the bed material. Transport **potential** is then multiplied by the fraction of each size class present in the bed at that time to yield the transport **capacity** for that size class. These fractions often change significantly during a time step, therefore an iteration technique is used to permit these changes to effect the transport capacity. The basis for adjusting bed elevations for scour or deposition is the Exner equation (see Section 2.3.1.3).

# 2.3.1 Equation for Continuity of Sediment Material

# 2.3.1.1 Control Volume

Each cross section represents a control volume. The control volume width is usually equal to the movable bed width and its depth extends from the water surface to the top of bedrock or other geological control beneath the bed surface. In areas where no bedrock exists, an arbitrary limit (called the "model bottom") is assigned (see Figure 2-7).

The control volume for cross section 2 is represented by the heavy dashed lines. The control volumes for cross sections 1 and 3 join that for cross section 2, etc.

The sediment continuity equation is written for this control volume; however, the energy equation is written between cross sections. Because descriptions of both sediment continuity and conservation of energy should enclose the same space; and because the averaging of two cross sections tends to smooth numerical results, the shape of the control volume is conceptually deformed.

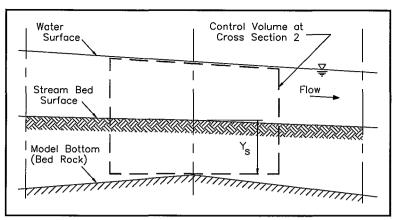


Figure 2-7 Control Volume for Bed Material

The amount of sediment in the stream bed, using an average end area approximation, is:

$$V_{sed} = B_o \cdot Y_s \cdot \frac{L_u + L_d}{2}$$
(2-30)

where:  $B_o =$  width of the movable bed

 $L_u$ ,  $L_d$  = length of the upstream and downstream reach, respectively, used in control volume computation

V<sub>sed</sub> = volume of sediment in control volume

 $f_s = depth of sediment in control volume.$ 

For a water depth, D, the volume of fluid in the water column is:

$$V_{f} = B_{o} \cdot D \cdot \frac{L_{u} + L_{d}}{2}$$
 (2-31)

 $B_o$  and D are hydraulic parameters, width and depth, which are calculated by averaging over the same space used in solving the energy equation as described in Sections 2.2.1 and 2.2.4.

The solution of the continuity of sediment equation assumes that the initial concentration of suspended bed material is negligible. That is, all bed material is contained in the sediment reservoir at the start of the computation interval and is returned to the sediment reservoir at the end of the computation interval. Therefore, no initial concentration of bed material load need be specified in the control volume.

The hydraulic parameters, bed material gradation and calculated transport capacity are assumed to be uniform throughout the control volume. The inflowing sediment load is assumed to be mixed uniformly with sediment existing in the control volume. HEC-6 assumes instantaneous diffusion of all grain size classes on a control volume basis.

### 2.3.1.2 Concepts of the Control Volume

The control volume concept employed in HEC-6 represents the alluvium of a natural river. Over time, the river will exchange sediment with its boundaries both vertically and laterally, changing its shape by forming channels, natural levees, meanders, islands, and other plan forms. HEC-6, however, only models vertical sediment exchange with the bed; the width and depth of which are user defined. Correct reproduction of the natural river system depends on modeling the proper exchange of sediment between the flow field and the bed sediment. The physics of that exchange process are not well understood. HEC-6 accounts for two sediment sources; the sediment in the inflowing water and the bed sediment. The inflowing sediment load is a boundary condition and is prescribed with input data. The bed sediment control volume provides the source-sink component and is also prescribed with input data.

Transport theory for sand and larger sizes relates the transport rate to the gradation of sediment particles on the bed surface and the flow hydraulics. Armor calculations require the gradation of material beneath the bed

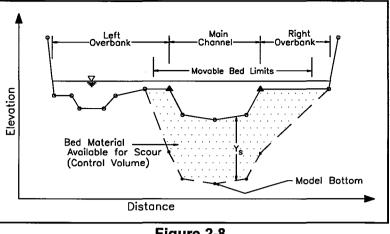


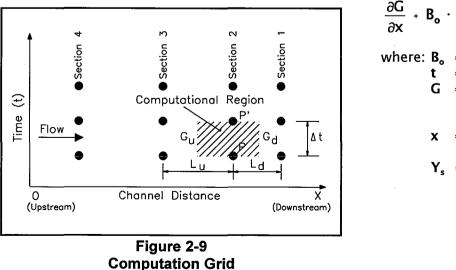
Figure 2-8 Sediment Material in the Streambed

surface. The depth to bedrock or some other material that might prevent degradation should also be identified to limit the scour process. These requirements are addressed in HEC-6 by separately computing the bed surface gradation and the sub-surface gradation.

The coordinates connected by the solid line in Figure 2-8 define the initial cross section shape at the beginning of a simulation. For scour conditions, the difference between the inflowing sediment load and the reach's transport capacity is converted to a scour volume. After each time step, the coordinates within the "movable bed" are lowered by an amount which, when multiplied by the movable bed width and the representative reach length, equals the required scour volume. If a model bottom elevation is not specified in the initial conditions, a default value of 10 ft is used, which then becomes the maximum depth of bed material available for scour.

# 2.3.1.3 Exner Equation

The above description of the processes of scour and deposition must be converted into numerical algorithms for computer simulation. The basis for simulating vertical movement of the bed is the continuity equation for sediment material (the Exner equation):



$$\frac{\partial G}{\partial x} + B_{o} \cdot \frac{\partial Y_{s}}{\partial t} = 0 \qquad (2-32)$$

where:  $B_o =$  width of movable bed t = time

- G = average sedimentdischarge (ft<sup>3</sup>/sec) rate during time step  $\Delta t$
- x = distance along the channel
- $Y_s$  = depth of sediment in control volume.

Equations 2-33 and 2-34 represents the Exner Equation expressed in finite difference form for point P using the terms shown in Figure 2-9.

$$\frac{G_{d} - G_{u}}{0.5 (L_{d} + L_{u})} + \frac{B_{sp}(Y'_{sp} - Y_{sp})}{\Delta t} = 0$$
(2-33)

$$Y'_{sp} = Y_{sp} - \frac{\Delta t}{(0.5)B_{sp}} \cdot \frac{G_d - G_u}{L_d + L_u}$$
 (2-34)

where: **B**<sub>sp</sub>

 $B_{sp}$  = width of movable bed at point P  $G_{ur} G_d$  = sediment loads at the upstream and downstream cross sections, respectively

 $L_u, L_d =$  upstream and downstream reach lengths, respectively, between cross sections

 $Y_{sp}$ ,  $Y'_{sp}$  = depth of sediment before and after time step, respectively, at point P

0.5 = the "volume shape factor" which weights the upstream and downstream reach lengths

 $\Delta t$  = computational time step

The initial depth of bed material at point P defines the initial value of  $Y_{sp}$ . The sediment load,  $G_u$ , is the amount of sediment, by grain size, entering the control volume from the upstream control volume. For the upstream-most reach, this is the inflowing load boundary condition provided by the user. The sediment leaving the control volume,  $G_d$ , becomes the  $G_u$  for the next downstream control volume.

The sediment load,  $G_d$ , is calculated by considering the transport capacity at point P, the sediment inflow, availability of material in the bed, and armoring. The difference between  $G_d$  and  $G_u$  is the amount of material deposited or scoured in the reach labelled as "computational region" on Figure 2-9, and is converted to a change in bed elevation using Equation 2-34.

The transport **potential** of each grain size is calculated for the hydraulic conditions at the **beginning** of the time interval and is not recalculated during that interval. Therefore, it is important that each time interval be short enough so that changes in bed elevation due to scour or deposition during that time interval do not significantly influence the transport potential by the end of the time interval. Fractions of a day are typical time steps for large water discharges and several days or even months may be satisfactory for low flows. The amount of change in bed elevation that is acceptable in one time step is a matter of judgment. Good results have been achieved by using either 1 ft or 10% of the water depth, whichever is less, as the allowable bed change in a computational time interval. The gradation of the bed material, however, **is** recalculated during the time interval because the amount of material transported is very sensitive to the gradation of bed material.

#### 2.3.1.4 Bed Gradation Recomputations

HEC-6 solves the Exner equation for continuity of sediment. If transport capacity is greater than the load entering the control volume, available sediment is removed from the bed to satisfy continuity. Since transport capacity for a given size depends upon the fraction of that size on the bed, it is necessary to frequently recalculate fractions present as sediment is exchanged with the bed. The number of exchange increments, **SPI**, during a time step is theoretically related to the time step length,  $\Delta t$ , velocity, and reach length in each reach by:

NO. OF EXCHANGE INCREMENTS = 
$$\frac{\Delta t \cdot VELOCITY}{REACH LENGTH}$$
 (2-35)

Usually the number of exchange increments can be less than this without generating significant numerical problems. Specify SPI in field 2 of the 11 record. Initially, SPI should be set to zero (which invokes Equation 2-35) and an extreme hydrologic event simulated. This should be the most stable (and computationally intensive) case. Then, starting from SPI=50 or more, one should decrease it in increments of 10 until the results become significantly different from the results with SPI=0. Use the smallest SPI that gives a solution close to that obtained with SPI=0.

#### 2.3.2 Determination of the Active and Inactive Layers

HEC-6 implements the concept of an active and an inactive bed layer. The active layer is assumed to be continually mixed by the flow, but it can have a surface of slow moving particles that shield the finer particles from being entrained in the flow. Two different processes are simulated: (1) Mixing that occurs between the bed sediment particles and the fluid-sediment mixture due to the energy in the moving fluid and, (2) Mixing that occurs between the active layer and the inactive layer due to the movement of the bed surface. The mixing mechanisms are attributed to large scale turbulence and bed shear stress from the moving water. The mixing depth (termed "equilibrium depth") is expressed as a function of flow intensity (unit discharge), energy slope, and particle size.

#### 2.3.2.1 Equilibrium Depth

The minimum energy hydraulic condition at which a particular grain size will just be stationary on the bed surface can be calculated by combining Manning's, Strickler's, and Einstein's equations, respectively:

$$V = \frac{1.49}{n} R^{2/3} S_f^{1/2}$$
(2-36)

$$n = \frac{d^{1/6}}{29.3}$$
(2-37)

$$\Psi = \frac{\rho_{\rm s} - \rho_{\rm f}}{\rho_{\rm f}} \cdot \frac{\rm d}{\rm DS_{\rm f}}$$
(2-38)

where: d = grain diameter

**D** = water depth

- V = water velocity
- $\rho_s =$  density of sand grains
- $\rho_{\rm f}$  = density of water
- $\psi$  = transport intensity from Einstein's bed load function, related to the inverse of Shield's parameter
- $S_f$  = friction slope

For negligible transport,  $\psi$  equals 30 or greater. Solving Equation 2-38 in terms of **S**<sub>f</sub> for a specific gravity of sand of 2.65 and with  $\psi$  set at 30 yields:

$$S_{f} = \frac{d}{18.18D}$$
 (2-39)

Combining this with the Manning and Strickler equations, in which **R** has been replaced with **D**, and multiplying velocity by depth to get unit discharge yields:

$$q = \frac{(1.49)(29.3)D^{5/3}}{d^{1/6}} \left[ \frac{d}{18.18D} \right]^{1/2}$$

$$= 10.21 \cdot D^{7/6} \cdot d^{1/3}$$
(2-40)

where:  $\mathbf{q}$  = water discharge per unit width of flow

The equilibrium depth for a given grain size and unit discharge is therefore:

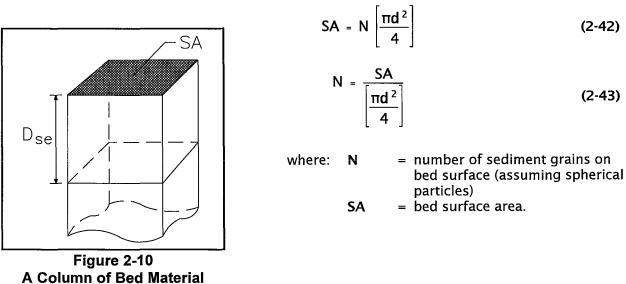
$$D_{e} = D = \left[\frac{q}{10.21d^{1/3}}\right]^{6/7}$$
(2-41)

where:  $D_e$  = the minimum water depth for negligible sediment transport (i.e., equilibrium depth) for grain size **d** 

#### 2.3.3 Hydraulic Sorting of the Bed Material - Method 1

Two methods are available in HEC-6 for computing the changes in composition (gradation) of the bed material with time. These methods are presented below. Note that, because of the limitations of each, neither method will be appropriate for all conditions.

The primary restrictions on rate of scour are the thickness of the active bed layer and amount of surface area armored. The active bed is the layer of material between the bed surface and a hypothetical depth at which no transport occurs for the given gradation of bed material and flow conditions. The thickness of the active bed is calculated at the beginning of each interval. The amount of surface area armored is proportional to the amount of active bed removed by scour. The basis for stability of the armor layer is the work by Gessler (1970). It is assumed that the transport capacity can be satisfied, if the sediment is available, within each time step within each control volume. The depth of scour required to accumulate a sufficient amount of coarse surface material to armor the bed is calculated as follows: The number of grains times the surface area shielded by each grain equals the total surface area, **SA**, of a vertical column, as illustrated by Figure 2-10 and shown in Equations 2-42 and 2-43:



Having Surface Area (SA)

The surface area of the column may be partially shielded by a rock outcrop or an armor layer such that the potential scour area is less than the total surface area of the column. This reduces the number of grains, **N**, exposed to scour as follows:

$$N = \frac{SA \cdot SAE}{\left[\frac{\pi d^2}{4}\right]}$$
(2-44)

where: SAE = ratio of surface area of potential scour to total surface area

Assuming a mixture of grain sizes, the depth of scour required to produce the volume of a particular grain size that is sufficient to completely cover the bed to a thickness of one grain diameter is:

$$V_{se} = PC \cdot SA \cdot D_{se} = N \frac{\pi d_a^3}{6}$$
(2-45)

where:

d,

smallest stable grain size in armor layer
 depth of bed material which must be removed to reach equilibrium in a time step

- **PC** = fraction of bed material coarser than size  $d_a$
- $V_{se}$  = volume of bed material which must be removed to reach equilibrium in a time step

Combining the surface area and volume equations and solving for the required depth of scour to fully develop the armor layer gives:

$$D_{se} = \left[\frac{SA \cdot SAE}{(\pi d^{2}/4)}\right] \cdot \left[\frac{(\pi d^{3}/6)}{PC \cdot SA}\right]$$

$$= \left(\frac{2}{3}\right) \left[\frac{SAE \cdot d}{PC}\right]$$
(2-46)

This equation is used with Equation 2-41 to calculate an equilibrium depth for a mixture of grain sizes. In order to determine the PC to use in Equation 2-46. the proper segment on the bed gradation curve is found by approximating the functional relationship between d and PC with a sequence of straight line segments as shown in Figure 2-11. The first step in locating the proper segment on the gradation curve is to calculate the equilibrium depths,  $D1_{eq}$  and  $D2_{eq}$  for the grain sizes at points 1 and 2 (Figure 2-12) using Equation 2-41. If the actual water depth,  $\dot{D}_{w}$ , is less than  $D2_{eq}$ , the straight line segment from 1 to 2 in Figure 2-11 defines the required functional relationship and the final equilibrium depth is calculated. If  $D_w$  is greater than

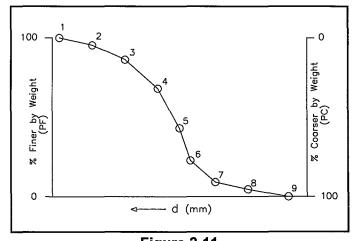


Figure 2-11 Gradation of Bed Material for Equilibrium Depth Computation

the equilibrium depth for grain size at point 2, computations move down the gradation curve to points 2 to 3, 3 to 4, etc., until either the proper segment is located or the smallest grain size is sufficient to armor the bed in which case scour will not occur.

HEC-6 designates the zone of material between the bed surface and equilibrium depth as the active layer and the zone from equilibrium depth to the model bottom as the inactive layer. The active layer provides the source of material forming the bed surface. The inactive layer initially has the same gradation as the parent bed. That gradation changes as material is deposited on the active layer and is exchanged with the inactive layer. Material is moved from one laver to the other layer as the active layer thickness changes with water depth, velocity and slope. Only the material in the active layer is subject to scour. HEC-6 allows sorting by grain size during the solution of the Exner equation which requires continuous accounting of the percent of sediment in each size class within each time step. When all material is removed from the active layer, the bed is completely armored for that hydraulic condition.

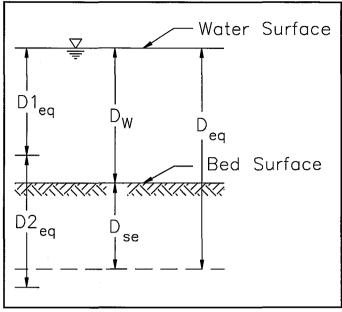


Figure 2-12 Equilibrium Depth Conditions

Assuming that the bed material is well mixed the rate of armoring is proportional to the volume of material removed, and the surface area exposed, SAE, for scour is:

$$SAE = \frac{VOL_{A}}{VOL_{SE}}$$
(2-47)

where:  $VOL_A$  = volume remaining in active layer  $VOL_{SE}$  = total volume in active layer

Leaching of the smaller particles from beneath the bed surface is prevented by adjusting the SAE. If a grain of bed sediment is smaller than the armor size, transport capacity is linearly decreased to zero as SAE decreases to 40% of the total bed surface (Harrison 1950). Thereafter, only the inflowing load of that grain size and smaller is transported through the reach. Particle sizes equal to and larger than the armor size are not constrained by this procedure.

#### 2.3.3.1 Impact of the Active Layer on Depth of Erosion

After the depth of the active layer has been calculated, Method 1 completes the bed change calculation for that cross section. At each exchange increment (SPI), Method 1 checks the volume of sediment in the active layer. However, if all material has been removed before the last exchange increment of the time step, HEC-6 does not give a warning message. When this happens, the calculated erosion rates and depths will be too small.

To avoid such a condition, the duration of each computation time step must be tested and reduced until further reductions do not change the results. This procedure is similar to the calibration method described in HEC (1992).

### 2.3.3.2 Composition of the Active Layer

When computations begin, the gradation of the active layer defaults to the inactive layer gradation. At the beginning of each new time step, a new active layer gradation is calculated as follows. When the new depth of the active layer is greater than the existing depth, sediment is added to the active layer from the inactive layer. When the new depth of the active layer is less than the existing depth, sediment is removed from the active layer and added to the inactive layer. In either case, a new gradation is calculated for the new mixture in each layer.

#### 2.3.3.3 Rate of Replenishing the Active Layer

A streambed having a gravel or cobble surface underlain by finer material is said to be armored. This condition does not reduce the stream's potential to transport sediment but rather limits the supply of sediment material so that transport theory cannot be used for grain sizes finer than those in the armor layer because their rate of movement is constrained by their availability, not the flow hydraulics. The armor layer forms when fines are transported away more rapidly than they are replaced by the inflowing load, allowing the coarser grain sizes to dominate the bed surface gradation and prevent further degradation.

The stability of the armor layer is based on a normal probability distribution function in which the ratio of critical to actual tractive force is the independent variable. Equations used for the two tractive forces are:

$$T_c = 0.047(\gamma_s - \gamma)d_m$$
 (2-48)

and

$$T_{b} = \gamma \cdot EFD \cdot S_{f}$$
 (2-49)

where: **d**<sub>m</sub> = median grain diameter of the grain size class being tested for stability EFD = effective depth

EFD = effective deptr

 $S_f = friction slope$ 

0.047 = Y-intercept of empirical data, from Shields (Vanoni 1975)

γ = unit weight of water
 γ<sub>s</sub> = unit weight of sediment particles

 $s_{\rm r}$  = bed shear stress

 $T_b$  = bed shear stress  $T_c$  = critical bed shear

stress, after Meyer-Peter and Müller (1948)

According to Gessler (1970), the stability of sediment particles on the bed surface is a probability relationship as shown on Figure 2-13. Shields' deterministic curve for movement of sediment particles corresponds to a tractive force ratio ( $T_c/T_b$ ) of 1.0 in Figure 2-13 and indicates a stability probability of 0.5. As the actual tractive force increases, the tractive force ratio decreases to reflect a lower probability that the grains will remain stationary. This does not guarantee particle movement, nor do tractive force ratios

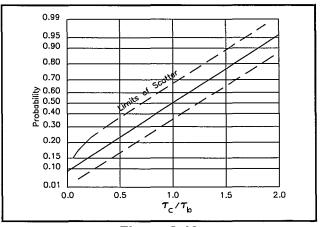


Figure 2-13 Probability of Grain Stability

greater than one guarantee that sediment particles will remain stationary in the bed. This relationship is used to calculate a bed stability coefficient, **BSF**, which includes the particle size distribution of the active layer as follows:

$$BSF = \frac{\sum_{i=1}^{NGS} PROB \cdot PROB \cdot PI_i \cdot d_{mi}}{\sum_{i=1}^{NGS} PROB \cdot PI_i \cdot d_{mi}}$$
(2-50)
where:  $d_{mi}$  = median grain diameter for grain size class i
i = grain size class analyzed
NGS = number of grain sizes present
PI = fraction of bed composed of a grain size class
PROB = probability that grains will stay in the bed

Gessler (1970) proposed that a stability factor equal to or greater than 0.65 indicates a stable armor layer. If a partially armored bed is stable for a given hydraulic condition, material is taken from the active layer until enough stable grains are left to cover the bed to the depth of one stable grain size. If the armored bed is not stable, the layer is destroyed and a completely new active bed is calculated.

The probability function could be used to determine the amount of armor layer destroyed; however, a simple linear relationship is used instead. The amount of armor layer destroyed is related to the magnitude of the bed stability coefficient, **BSF**, as:

$$SAE_{i+1} = 1.0 - \frac{BSF}{0.65}(1.0 - SAE_i)$$
 (2-51)

where subscripts i and i+1 represent beginning and ending of an exchange increment (see Section 2.3.1.4). Material from the active layer is removed until the remaining stable grains are sufficient to cover the bed at the ending **SAE**.

#### 2.3.3.4 Influence of Armoring on Transport Capacity

All grain sizes are analyzed in each exchange increment. Before the next increment, the surface area exposed for scour is calculated. In Einstein's relationship, the hiding factor adjusts transport capacity to account for armoring. In some other transport relationships, the transport capacity is corrected for armoring by a parabolic relationship which attempts to account for extra scour due to the presence of large individual sediment particles. The relationship used in HEC-6 is:

FSAE = transport capacity correction due to armoring

The value of **CSAE** is the fraction of transport capacity just sufficient to pass the inflowing sediment discharge with no deposition. HEC-6 assigns the value of 0.5 for **BSAE** unless input data specifies otherwise. **FSAE** varies between 0.5 and 1.0 and applies equally to all grain sizes.

#### 2.3.3.5 Some Limitations of Method 1

This method for computing hydraulic sorting and armoring has exhibited the following shortcomings:

- (1) In rivers with large gradation coefficients it appeared that there was too much leaching of sands; i.e., insufficient "armoring".
- (2) The active layer was too thick in many large sand bed rivers which dampened hydraulic sorting.
- (3) A sediment continuity problem was observed when consolidated silts and clays were exchanged between the active and inactive layers.

### 2.3.4 Hydraulic Sorting of the Bed Material - Method 2

A second method of computing hydraulic sorting was developed to alleviate some of the limitations of Method 1. This algorithm is based on the concept that exchange of sediment particles occurs within a thin "cover layer" of bed material at the bed surface which is continually mixed by the flow. It is presumed that, as the bed progresses toward an equilibrium condition in which deposition and resuspension of each size class is balanced, the slow moving thin cover layer becomes coarser and serves as a shield, regulating the entrainment of finer particles below. If the cover layer is replenished by deposition from the water column, it will remain as a shield constraining the entrainment of finer material from below. Harrison (1950) observed that this shielding began to occur when as little as 40% of the bed surface was covered. If conditions change such that more material is scoured from, than deposited on, the cover layer; then the cover layer begins to disintegrate and more fine material can be removed from below. Eventually, the cover layer may be completely removed and the bed surface takes on the composition of the material below. This conceptual process replaces the concepts of "surface-area exposed," SAE, and "bed-stability factor," BSF, used in Method 1.

In Method 2 there are two components of the active layer; a cover layer that is retained from the previous time step and a sub-surface layer that is created at the beginning of the time step from the inactive layer. The sub-surface layer material is returned to the inactive layer at the end of the time step. The cover layer from the previous time step is limited to an arbitrary maximum thickness 2 ft. If the previous cover layer thickness is 2 ft or greater, the new cover layer is assigned a thickness of 0.2 ft (This is approximately equal to the sampling depth of a standard US BM-54 Bed Material Sampler). The residual material is mixed with the inactive layer. The initial thickness of the sub-surface layer is calculated using the equilibrium depth concept presented in Section 2.3.2.1. The maximum thickness, however, is constrained by an estimated maximum scour that could occur during the exchange increment. The estimated maximum scour is calculated from the hydraulics, inactive bed gradation, and selected transport function. This constraint will almost always override the thickness calculated using equilibrium depth. A minimum thickness of two times the largest grain size in transport is also imposed. The computation of bed layer adjustments during a time step using Method 2 is depicted on Figures 2-14 through 2-16.

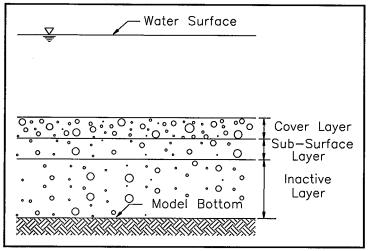


Figure 2-14 Bed Layers at Beginning of Time Step.

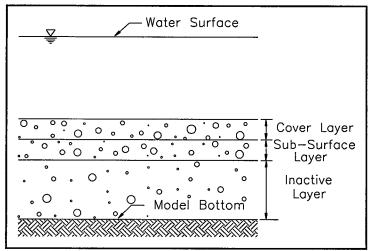
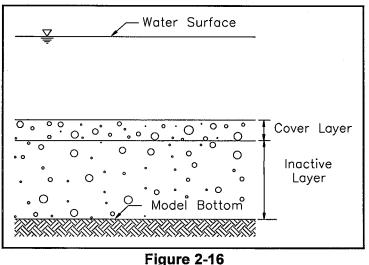


Figure 2-15 Bed Layers at Intermediate Exchange Increment.



Bed Layers at End of Time Step.

- cover layer composition and thickness are left over from the previous computational time step (maximum 2 ft).
- Sub-surface layer is created from the inactive layer with identical composition. Thickness is based on equilibrium depth and an estimate of maximum possible erosion during the time step (minimum  $2 \cdot D_{max}$ ).
- Cover layer composition coarsens with erosion, gets finer with deposition.
- Sub-surface composition coarsens with erosion because it has supplied finer materials to cover layer and to flow. It is unchanged with deposition or if armored.
- Inactive layer is unchanged.

- Cover layer saved and carried over to next time step.
- Sub-surface and inactive layers combined and completely mixed.

At the beginning of each exchange increment (subdivision of a time step in which the active layer gradation is re-computed, see Section 2.3.1.4) the volume of the cover layer is checked to make sure that there is sufficient material available to cover the bed surface to at least one grain diameter. If not, the cover layer and sub-surface layer are combined to form a new cover layer. This represents a condition where the cover layer is effectively destroyed by the flow energy. A new sub-surface layer is then created from the inactive layer with a thickness and composition identical to the subsurface layer established during the first exchange increment (Figure 2-17).

Bed material size fractions used to calculate sediment transport <u>capacity</u> are based on the composition of the <u>active layer</u>; i.e., the combined volume of both the cover and sub-surface layers.

The sediment continuity equation is then solved for the exchange increment, adding or removing material of the various size classes into or out of the active layer. Deposited material is placed in the cover layer. Eroded material is removed from the cover layer first. The cover layer is intended to act as a moving pavement or armor layer, reducing the sediment transport capacity of finer materials. If there is insufficient volume of a size class present in the cover layer. However, material from a size class cannot be withdrawn from the sub-surface layer. However, material from a size classes in the cover layer to cover the bed to a thickness of one grain diameter. When there is not a sufficient volume of coarser material in the cover layer to cover 40% of the bed to a thickness of one grain diameter, then supply from the sub-layer is not constrained by the cover layer. A linear supply constraint function is applied to cases when the bed cover is between 40% and 100%.

- New cover layer is mixture of old cover and sub-surface layers.
- New sub-surface layer taken from inactive layer has same thickness and composition as at beginning of time step.

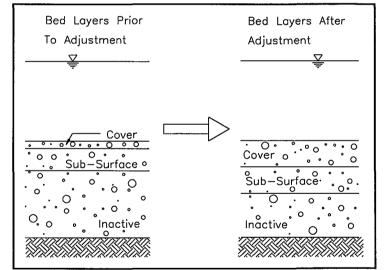


Figure 2-17 Bed Layers Change When Cover Layer is Depleted.

# 2.3.4.1 Sub-Surface Layer

The sub-surface layer is composed of well mixed sediments brought up from the inactive layer plus residual sediment left when the cover layer is destroyed. During erosion it may supply bed sediment as required to meet sediment transport capacity. However, supply of a specific size class from the sub-layer is constrained by coarser material in the cover layer. Availability of material is a constraint. Thickness of the active layer is considered to be very important and is calculated as described earlier.

#### 2.3.4.2 Characteristic Rate of Entrainment

The characteristic rate of entrainment is associated with flow turbulence. Turbulence simulation, however, is beyond the scope of HEC-6. Since sediment entrainment is not instantaneous, a characteristic "flow-distance" was created to approximate a finite rate of entrainment. Using the distance one would need to sample equilibrium concentrations in a flume as a guide, the characteristic distance for entrainment was set at 30 times the flow depth. The entrainment ratio, **ENTRLR**, associated with the rate at which a flow approaches its equilibrium load, is calculated by dividing the reach length by the characteristic distance for entrainment as follows:

$$ENTRLR = \frac{REACH LENGTH}{30 \cdot DEPTH}$$
(2-53)

The entrainment coefficient, ETCON, is then defined by:

$$ETCON = 1.368 - e^{-ENTRLR}$$
 (2-54)

**ETCON** is used to determine what percentage of the equilibrium concentration (for each grain size) is achieved in the reach, and has a maximum of 1.0. Research is needed to substantiate this entrainment hypothesis as well as the appropriate equation and coefficients.

#### 2.3.4.3 Characteristic Rate for Deposition

Deposition occurs when the inflowing sediment discharge is greater than the transport capacity. Not all size classes in a mixture will deposit; therefore, this process is calculated by size class. The rate at which sediment deposits from the flow field is controlled by particle settling velocity as follows:

$$DECAY(i) = \frac{V_s(i) \cdot \Delta t}{D_s(i)}$$
(2-55)

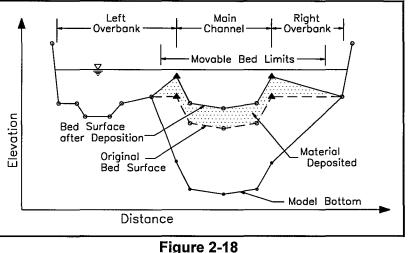
where:  $D_s(i) = effective depth occupied by sediment size i$  $<math>\Delta t = duration of time step$  $V_s(i) = settling velocity for particle size i$ 

#### 2.3.4.4 Some Limitations of Method 2

In low flow deposition zones, the cover layer becomes the depository for fine materials. In a natural river it is not mixed with sub-surface material; therefore, it retains its fine composition and can be easily removed at high flows. In HEC-6, however, transport capacity is calculated based on the composition of the entire active layer. This probably results in under-prediction of transport capacities for the finest size classes. This may depress the transport of fines, resulting in increased deposition and/or decreased scour. Modifications to the technique of computing **PI**<sub>i</sub> for Method 2 may be considered in the future if this becomes a problem. The arbitrary maximum cover layer thickness of 2 ft may hinder deposition during low energy conditions. Mixing of fine material will probably result in underestimation of scour during high flows. Erosion of fine material may be too severely constrained by the Harrison (1950) observation (see Section 2.3.3) which also limits withdrawal from the sub-surface layer.

#### 2.3.5 Bed Elevation Change

When scour or deposition occurs during a time step, HEC-6 adjusts cross section elevations within the movable bed portion of the cross section. For deposition, the streambed portion is moved vertically only if it is within the movable bed specified by the H or HD record and is below the water surface (i.e., wetted). Deposition is allowed outside of the conveyance limits defined by the **XL** record. Scour occurs only if it is within the movable bed, within the conveyance limits, within the effective flow limits defined by the X3 record, and below the



Cross Section Shape Due to Deposition

water surface. Once the scour or deposition limits are determined, the volume of scour or deposition is divided by the effective width and length of the control volume to obtain the bed elevation change. The vertical components of the cross section coordinates within these

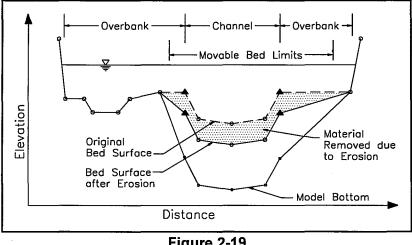


Figure 2-19 Cross Section Shape Due to Erosion

scour/deposition limits are then adjusted as shown in Figures 2-18 and 2-19. An option for adjusting the geometry in a different manner for deposition is described in Section 3.7.3.

#### 2.3.5.1 Hard Bottom Channel

The special condition of a hard channel bottom (as with a concrete channel) can be approximated by specifying zero sediment depth in the bed sediment reservoir. This is accomplished by specifying the model bottom, **EMB**, equal to the initial thalweg elevation, less a small amount. No sediment is contributed to the flow of sediment at that cross section. **EMB** is entered in field 2 of the H record.

#### 2.3.6 Unit Weight of Deposits

#### 2.3.6.1 Initial Unit Weight

Unit weight is the weight per unit volume of a deposit expressed as dry weight.

$$\gamma_{s} = (1 - P_{d}) \cdot SG \cdot \gamma$$
(2-56)

Standard field tests are recommended when major decisions depend on the unit weight. Otherwise, use tables on pages 39-41 of "Sedimentation Engineering" (Vanoni 1975) when field data is lacking at your project site.

#### 2.3.6.2 Composite Unit Weight

When dealing with mixtures of particle sizes, the composite unit weight,  $\gamma_{sc}$ , of the mixture is computed using Colby's equation (Vanoni 1975):

$$Y_{SC} = \frac{I}{\left[\frac{F_{SA}}{Y_{SA}} + \frac{F_{SL}}{Y_{SL}} + \frac{F_{CL}}{Y_{CL}}\right]}$$
(2-57)

where:  $\gamma_{SA}$ ,  $\gamma_{SL}$ ,  $\gamma_{CL}$  = unit weight of sand, silt, and clay, respectively  $F_{SA}$ ,  $F_{SL}$ ,  $F_{CL}$  = fraction of sand, silt, and clay, respectively, in the deposit

#### 2.3.6.3 Consolidated Unit Weight

Compaction of deposited sediments is caused by the grains reorienting and squeezing out the water trapped in the pores. The equation for consolidation (Vanoni 1975) is:

$$\gamma = \gamma_1 + B \cdot \log_{10} T \tag{2-58}$$

where:  $\mathbf{B}$  = coefficient of consolidation for silts or clay

**T** = accumulated time in years

 $\gamma_1$  = initial unit weight of the sediment deposit, usually after one year of consolidation

Suggested values of  $\gamma_1$  and **B** are given on page 43 of Vanoni (1975).

The average consolidated unit weight over a time period T requires integration over time. This is computed using the following relationship developed by Miller (1953).

$$Y_{ave} = Y_1 + B \cdot \left[\frac{T}{T-1}\right] \cdot \log_{10} T = 0.434 B$$
 (2-59)

These unit weights are used to convert sediment weight to volume for computation of the bed elevation change.

#### 2.3.7 **Sediment Particle Properties**

Four basic sediment properties are important in sediment transport prediction: size, shape factor, specific gravity, and fall velocity. Grain size classes are fixed in HEC-6 and described in Section 3.3. The particle shape factor. SF. is defined by:

SF = 
$$\frac{c}{(a \cdot b)^{1/2}}$$
 (2-60)

where: **a**, **b**, c = the lengths of the longest, intermediate, and shortest. respectively. mutually perpendicular axes of a sediment particle

The particle shape factor is 1.0 for a perfect sphere and can be as low as 0.1 for very irregularly shaped particles. HEC-6 uses a shape factor default of 0.667 but it can be user specified. If a "sedimentation diameter" is used, which is determined by the particle's fall velocity characteristics, the particle shape factor of 1.0 should be used. If the actual sieve diameter is used, the actual shape factor should be used.

Specific gravity of a particle is governed by its mineral makeup. In natural river systems the bed material is dominated by guartz which has a specific gravity of 2.65. HEC-6 uses 2.65 as a default; however, values of specific gravities for sand, silt, and clay may be input.

Two techniques for calculating particle fall velocity are available in HEC-6. The first is based upon the fall velocities determined by Toffaleti (1966) and is similar to Rubey's method (Vanoni 1975). This method assumes 0.9 as the shape factor. The second, which takes into consideration the particle shape factor, utilizes the procedure described in ICWR (1957), and is described in detail by Williams (1980). The second method is the default.

#### 2.3.8 Silt and Clay Transport

#### **Cohesive Sediment Deposition** 2.3.8.1

The equation for silt and clay deposition (Krone 1962) in a recirculating flume at slow aggregation rates and suspended sediment load concentrations less than 300 mg/ $\ell$  is:

$$\ln \frac{C}{C_{o}} = -k't$$
 (2-61)

or

$$\frac{C}{C_o} = e^{(-k't)}$$

(2-62)

where: C =concentration at end of time period

- $C_{o}$  = concentration at beginning of time period
- **D** = water depth

$$\mathbf{k}' = \frac{\mathbf{V}_{s}\mathbf{P}_{r}}{2.3D}$$

- $P_r$  = probability that a floc will stick to bed  $(1 T_b/T_d)$
- **t** = time = reach length/flow velocity
- $V_s$  = settling velocity of sediment particles
- $T_{b} = bed shear stress$
- $T_d$  = critical bed shear stress for deposition.

This ratio is multiplied by the inflowing clay or silt concentration to obtain the transport potential. The concentration is converted to volume and deposited on the bed.

#### 2.3.8.2 **Cohesive Sediment Scour**

Erosion is based upon work by Parthenaides (1965) and adapted by Ariathurai and Krone (1976). Particle erosion is determined by:

$$C = \frac{M_1 \cdot S_a}{Q \cdot \gamma} \cdot \left[\frac{T_b}{T_s} - 1\right] + C_o$$
(2-63)

where:  $\mathbf{C}$  = concentration at end of time period

 $C_{o}$  = concentration at beginning of time period

- $M_1$  = erosion rate for particle scour
- $\mathbf{Q}$  = water discharge
- $S_a$  = surface area exposed to scour
- $T_{\rm h}$  = bed shear stress
- $T_s$  = critical bed shear for particle scour
- v = unit weight of water

As the bed shear stress increases, particle erosion gives way to mass erosion and the erosion rate increases. Because the mass erosion rate can theoretically be infinite, Ariathurai and Krone (1976) recommended that a "characteristic time", Te, be used. With a computation interval of  $\Delta t$ , the mass erosion equation becomes:

$$C = \frac{M_2 \cdot S_a}{Q \cdot \gamma} \cdot \frac{T_e}{\Delta t} + C_o$$
(2-64)

where:  $\Delta t$  = duration of time step

 $M_2$  = erosion rate for mass erosion

 $T_{a}$  = characteristic time of erosion

Ariathurai and Krone (1976) give guidance on how to obtain or estimate T<sub>e</sub>, M<sub>1</sub>, and M<sub>2</sub>. Because erosion thresholds and rates for cohesive sediments are dependent on specific sediment particle and ambient water conditions such as mineralogy, sodium adsorption ratio, cation exchange capacity, pH, salinity, and depositional history, in situ and/or laboratory testing are the recommended methods to determine the erosion characteristics of cohesive sediments. A good discussion of cohesive material transport is found in USACE (1991).

#### 2.3.8.3 Influence of Clay on the Active Layer

The presence of clay in the streambed can cause the bed's strength to be greater than the shear stress required to move individual particles. This results in limiting the entrainment rate under erosion conditions. HEC-6 attempts to emulate this process by first checking the percentage of clay in the bed. If more than 10% of the bed is composed of clay, the entrainment rate of silts, sands and gravels is limited to the entrainment rate of the clay. This also prevents the erosion of silts, sands and gravels before the erosion of clay even if the bed shear is sufficient to erode those particles but not enough to erode the cohesive clay.

### 2.3.8.4 Mudflow Constraint on Transport Potential

Because Einstein's concept of the "equilibrium concentration" is utilized for the noncohesive load, no additional constraints are required to limit the concentrations of sands and gravels. However, when cohesive sediments are included there is no equilibrium concentration. HEC-6 assumes that erosion and entrainment of fines is limited by a "maximum mudflow concentration". The maximum mudflow concentration used by HEC-6, based on two measurements at Mt. St. Helens, is 800,000 ppm. If the concentration of fines (i.e., silt and clay) at any cross section exceeds 50,000 ppm, a counter is incremented and a message will be printed stating the total number of times high concentrations were detected. When the concentration exceeds 800,000 ppm, each grain size concentration is proportionally reduced so that the total concentration is 800,000 ppm.

# **Chapter 3**

# **General Input Requirements**

# 3.1 General Description of Data Input

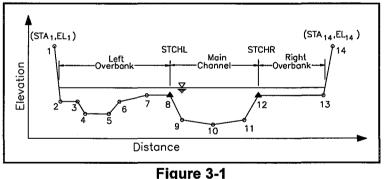
Input data are grouped into the categories of geometry, sediment, hydrology, and special commands. A description of input records is contained in Appendix A. The alphanumerics in parentheses after each section heading in this chapter refer to the input records that control the discussed data.

# 3.2 Geometric Data

Geometric data includes cross sections, reach lengths and n values. In addition, the movable bed portion of each cross section and the depth of sediment material in the bed are defined. The **NC** to **H** records are used to define the model geometry. The format used for geometric data is similar to that of HEC-2.

# 3.2.1 Cross Sections (X1, X3, GR)

Cross sections are specified for the initial conditions. Calculations are made directly from coordinate points (stations, elevations), not from tables or curves of hydraulic elements. **GR** records are used to input elevation-station coordinates to provide a description of the shape of a cross section. Elevations may be positive, zero or negative. Cross section identification numbers, entered in field 1 of the X1 record for each cross section,



Cross Section Subsections

should be positive and increase in the upstream direction. Corrections for skew  $(X1.8)^2$  and changes in elevation (X1.9) can be made without re-entering coordinate points. If the water surface elevation exceeds the end elevations of a section, calculations continue by extending the end points vertically, neglecting the additional wetted perimeter.

Each cross section may be subdivided into three parts called subsections - the left overbank, main channel and right overbank as shown in Figure 3-1. Each subsection must have a reach length. It extends from the previous (downstream) section to the present cross section. This enables the simulation of channel curves where the outer part of the bend, which is represented by an overbank area, has a reach length larger than the channel or the inside overbank area. For meandering rivers, the channel length is generally greater than the overbank reach lengths.

<sup>&</sup>lt;sup>2</sup> The reference (X1.8) means that the variable being discussed, in this case, skew, can be entered in field 8 of the X1 record).

# 3.2.2 Manning's *n* Values (NC, NV, \$KL, \$KI)

A Manning's n value is required for each subsection of a cross section. It is not possible to automatically change n values with respect to time. Static or fixed n values are entered using the **NC** record. The n values may vary with either discharge or elevation in the main channel and overbank areas by using **NV** records. When n varies with discharge, the first n on the **NV** record should be a negative value. An **NC** record must precede the first cross section even if an **NV** record immediately follows and overrides it.

Limerinos' (1970) relationship is available for the determination of Manning's n based upon bed gradation. This relationship is:

$$n = \frac{0.0926R^{1/6}}{1.16 + 2.0 \log_{10} \left(\frac{R}{d_{84}}\right)}$$
(3-1)

where: **d**<sub>84</sub> = particle size in the stream bed of which 84 percent of the bed is finer, in feet **R** = hydraulic radius, in feet

To compute n values utilizing Limerinos' relationship, the **\$KL** record is placed in the hydrologic data. To return to the input n values, a **\$KI** record must be input.

The calculation of friction loss through the reach between cross sections is made by averaging the end areas of a subsection, averaging the end hydraulic radii and applying the subsection n value and reach length to get a length-weighted subsection conveyance. Subsection conveyances are summed to get a total value for the cross section reach which is used to calculate friction loss.

#### 3.2.3 Movable Bed (H, HD)

Each cross section is divided into movable and fixed-bed portions. The H (or HD) record is used to define the movable bed limits, XSM and XFM, which can extend beyond the channel bank station. Scour and deposition will cause the movable bed to fall or rise by changing the cross section elevations within the movable bed at the end of each time step.

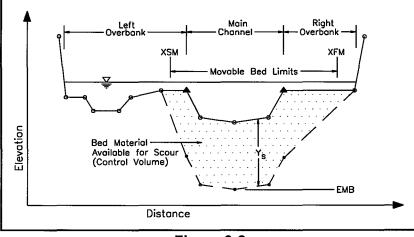


Figure 3-2 Sediment Material in the Stream Bed

The elevation of the model bottom is specified in field 2 of the H record. After determining the minimum channel elevation of each cross section, HEC-6 uses the model bottom elevation to compute the depth of sediment material available for scour. Optionally, the depth of sediment material,  $Y_s$ , can be specified directly by using an HD record instead of an H record for each cross section.

# 3.2.4 Dredging (H, HD, \$DREDGE, \$NODREDGE)

The H (or HD) record is also used to specify the bottom elevation and lateral limits of the dredged channel, as well as the depth of advanced maintenance dredging. The dredged channel limits must be within the movable bed. Dredging is initiated by the **\$DREDGE** record in the hydrologic data and is assumed to be active for all discharges until a **\$NODREDGE** record is encountered. These "on" and "off" records can be placed anywhere in the hydrologic data. Dredging can be activated any number of times during a simulation by placing pairs of **\$DREDGE**, **\$NODREDGE** records in the hydrologic data.

The elevation of the channel bottom is calculated at the end of each computation interval. When the dredging option is used, if the minimum channel elevation is higher than the specified dredging elevation, the dredged channel is lowered to the specified dredging or overdredge depth, whichever is lower. Outside of the dredged channel, the points are not changed. Sediment material is assumed to be removed from the channel and from the system. An option is available to initiate dredging if the channel bottom elevation is higher than a specified minimum draft depth (**\$DREDGE** record). When this occurs, the channel is dredged to an elevation such that the minimum draft is achieved.

# 3.2.5 Bridges

HEC-6 has no provision for calculating flow at bridges other than by normal backwater calculations. Piers can be simulated by adjustment of **GR** points to reflect net flow area change if general scour information is of interest at a bridge. Be sure that the top elevations of the **GR** points used for piers are above the highest anticipated water surface elevation. This is to assure that deposition does not occur on the piers. In most situations the user should ignore bridges and match water surface profiles by adjusting n values to avoid the short time intervals required for analyzing general scour at bridges with closely spaced cross sections. All bridge routine records in an HEC-2 data file must be removed before use of the file in HEC-6.

# 3.2.6 Ineffective Flow Area (X3)

When high ground or some other obstruction such as a levee prevents water from flowing into a subsection, the area up to that point is ineffective for conveying flow and is not used for hydraulic computations until the water surface exceeds the top elevation of the obstruction. The barrier can be a natural levee, constructed levee or some other structure. End area, wetted perimeter, *n* value and conveyance computations are not made in the ineffective area portions of a cross section. This is similar to the ineffective flow option in HEC-2. Sediment computations will not be made for ineffective areas.

Three methods for describing ineffective flow area are available. Method 1 confines the water within the channel limits unless the water surface elevation is higher than the elevation of

either channel limit. If either (or both) channel limit elevation(s) is exceeded, that overbank area is used for hydraulic conveyance calculations (see Figure 3-3).

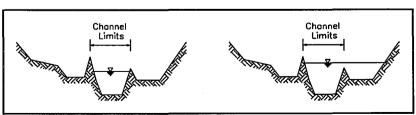
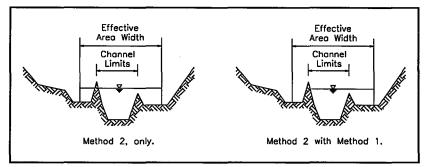


Figure 3-3 Examples of Ineffective Area, Method 1



Method 2 is used to specify an effective area width of which the left and right limits are equidistant from the centerline of the channel. This is similar to Method 2 of the encroachment option in HEC-2. Method 2 may be used in conjunction with Method 1 as shown in Figure 3-4.

Figure 3-4 Examples of Ineffective Area, Method 2

Method 3 uses the exact locations (STENCL and STENCR for left and right overbanks) and elevations (ELENCL and ELENCR for left and right overbanks) of ineffective areas for each overbank area. This method is similar to Method 1 of the encroachment option in HEC-2 as demonstrated by Figure 3-5. Method 3 cannot be used together with Method 1 or 2.

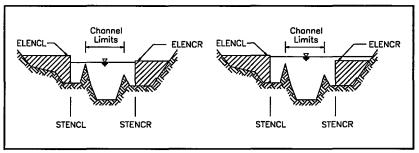


Figure 3-5 Examples of Ineffective Area, Method 3

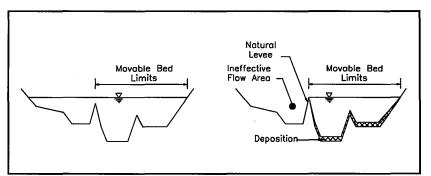


Figure 3-6 Ineffective Areas Due to Natural Levee Formation

HEC-6 automatically tests the first and last points in the movable bed to ascertain if natural levees are forming during the computations. If this occurs, HEC-6 overrides the ineffective area methods specified by input data. In fact, natural levees formed by the movable bed are always considered to establish ineffective area even if that option was not selected by input data, as illustrated in Figure 3-6.

# 3.2.7 Conveyance Limits (XL)

Sometimes water inundates areas that do not contribute to the water conveyance. Conveyance limits are specified by either entering a conveyance width to be centered between the channel limits or by input of two station locations that define the conveyance limits. Deposition is allowed to occur outside the conveyance limits (but within the movable bed); however, scour can occur only within the conveyance limits even if the movable bed limits are beyond the conveyance limits.

# 3.3 Sediment Data

Sediment data is specified on records I through PF. This data includes fluid and sediment properties, the inflowing sediment load data, and the gradation of material in the stream bed. The transport capacity relationship(s) and unit weights of deposited material are also input in this section.

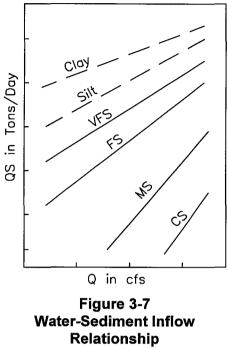
The grain sizes of sediment particles commonly transported by rivers may range over several orders of magnitude. Small sizes behave much differently from large sizes. Therefore, it is necessary to classify sediment material into groups for application of different transport theories. The three basic classes considered by HEC-6 are clay, silt, and sands-boulders. The groups are identified and subdivided based on the American Geophysical Union (AGU) classification scale (Table 2-1, Vanoni 1975) as shown in Table 3-1. HEC-6 accounts for 20 different sizes of material including one size for clay, four silt sizes, five sand sizes, five gravel, two cobble sizes, and three boulder sizes. The representative size of each class is the geometric mean size, which is the square root of the class ranges multiplied together. For example, the geometric mean size for medium silt is  $(0.016 \cdot 0.032)^{1/2}$  or 0.023 mm.

Grain Size Classification of Seument Material				
Class Size Number Used in HEC-6	Sediment Material	Grain Diameter (mm)		
A DE TRA	Clay			
11	Clay	0.002 - 0.004		
1 2 3 4	Very Fine Silt Fine Silt Medium Silt Coarse Silt	0.004 - 0.008 0.008 - 0.016 0.016 - 0.032 0.032 - 0.0625		
	Sands - Boulders			
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Very Fine Sand (VFS) Fine Sand (FS) Medium Sand (MS) Coarse Sand (CS) Very Coarse Sand (VCS) Very Fine Gravel (VFG) Fine Gravel (FG) Medium Gravel (MG) Coarse Gravel (CG) Very Coarse Gravel (VCG) Small Cobbles (SC) Large Cobbles (LC) Small Boulders (SB) Medium Boulders (MB) Large Boulders (LB)	$\begin{array}{c} 0.0625 - 0.125 \\ 0.125 - 0.250 \\ 0.25 - 0.50 \\ 0.5 - 1.0 \\ 1 - 2 \\ 2 - 4 \\ 4 - 8 \\ 8 - 16 \\ 16 - 32 \\ 32 - 64 \\ 64 - 128 \\ 128 - 256 \\ 256 - 512 \\ 512 - 1024 \\ 1024 - 2048 \end{array}$		

 Table 3-1

 Grain Size Classification of Sediment Material

# 3.3.1 Inflowing Sediment Load (LQ, LT, LF)



The aggradation or degradation of a stream bed profile depends upon the amount and size of sediment inflow relative to the transport capacity of the stream (see Section 2.3.1). The inflowing sediment supplies entering the upstream boundaries of the geometric model and at local inflow points are called inflowing sediment loads and are expressed in tons/day. The sediment load should include both bed and suspended load (total load) and is expressed as a log-log function of water discharge in cfs vs. sediment load in tons/day as depicted in Figure 3-7.

Data is entered on the LT and LF records as a table of sediment load by grain size class for a range of water discharges. The discharges entered on the LQ record should encompass the full range found in the computational hydrograph. A complete sediment load table is required for every inflow into the network. This includes the inflow to each stream segment as well as all local inflows.

In most projects, the sediment load table, once set,

exists to modify or replace a sediment load table at any time during the simulation. This option is provide by the **\$SED** option. See Appendix A for a description of this option.

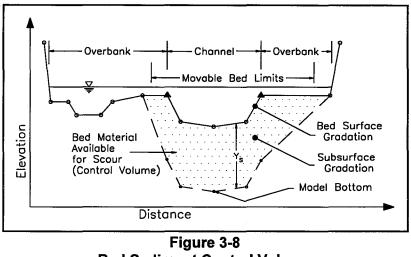
If the inflowing sediment load is essentially of one grain size, that size should be located in Table 3-1, identified by its classification, and assigned the number of its grain size class. For instance, if the representative size is 0.035 mm, its classification is medium sand and its sand size number is 3. This number is then input for variables IGS and LGS on the I4 record. But if the inflowing load is composed of a range of grain sizes, it is desirable to further subdivide sand and perhaps silts and clays into the classifications shown in Table 3-1. Use as many of these classifications as needed to describe the situation. It is not necessary to start with the smallest size nor is it necessary to go to the coarsest size, but once a range of sizes is selected, all grain sizes within that range must be included. The AGU classifications in Table 3-1 are stored internally in HEC-6 and cannot be modified.

# 3.3.2 Sediment Material in the Stream Bed (PF)

Transport theory for sand relates the total moving sand and coarser load to the gradation of sediment particles on the bed surface. Armor calculations require the gradation of material beneath the bed surface and knowledge about the depth to bedrock or some other material that might prevent degradation.

The gradation of sediment material in the stream bed (the subsurface gradation) is specified as a function of percent finer vs. grain size on the **PF** records. Cross section numbers are used in field 2 of the **PF** records to identify the subsurface gradation location within the geometric data set. Subsurface gradations are linearly interpolated for those cross sections for which **PF** records have not been specified.

The gradation of sediment particles on the stream bed (the bed surface gradation) and the distribution of sizes in the inflowing load are intimately related. One must complement the other in sediment transport theory. The significant depth for sediment transport calculations is two grain diameters and is difficult to sample. Therefore, in using HEC-6, it is customary to specify inflowing sediment load and the subsurface gradation and let HEC-6 calculate the bed surface gradation.



**Bed Sediment Control Volume** 

# 3.3.3 Sediment Properties (I1, I2, I3, I4)

Five basic properties are considered: grain size, specific gravity, grain shape factor, unit weight of deposits and fall velocity. The grain size classifications shown in Table 3-1 are predefined in HEC-6. The specific gravity of bed material has a default value of 2.65 and the grain shape factor has a default value of 0.667. These values can be altered by providing the new values on the **I2-I4** records. The fall velocity method is input on the **I1** record.

# 3.3.4 Sediment Transport

# 3.3.4.1 Clay and Silt Transport (I2, I3)

Two methods for clay and silt transport are available in HEC-6. They are only applicable for flows with suspended sediment concentrations less than 300 mg/ $\ell$  (Krone 1962). The first method (MTCL and MTSL = 1 in I2 and I3 records, respectively) allows the deposition of clays and silts but does not allow scour. The second method (MTCL and MTSL = 2) allows for both deposition and scour as described in Section 2.3.8. When this method is used, two additional I2 records are required to provide information regarding critical shear stress thresholds for deposition and shear stress thresholds and erosion rates for both particle and mass erosion. Further details concerning these additional I2 records are given in the **Special I2** record description in Appendix A.

# 3.3.4.2 Sand and Gravel Transport (I1, J, K)

There are several sand and gravel transport relationships available in HEC-6. The **I4** record is used to specify which of the following to use.

- a. Toffaleti's (1966) transport function
- b. Madden's (1963) modification of Laursen's (1958) relationship
- c. Yang's (1973 and 1984) stream power for sands and gravels
- d. DuBoys' transport function (Vanoni 1975)

- e. Ackers-White (1973) transport function
- f. Colby (1964) transport function
- g. Toffaleti (1966) and Schoklitsch (1930) combination
- h. Meyer-Peter and Müller (1948)
- i. Toffaleti and Meyer-Peter and Müller combination
- j. Madden's (1985, unpublished) modification of Laursen's (1958) relationship
- k. Copeland's (1990) modification of Laursen's relationship (Copeland and Thomas 1989)
- I. User specification of transport coefficients based upon observed data

For the options involving two sediment transport relationships, the transport potential for each sediment size is computed using both methods and the largest transport potential is utilized.

If there is enough field data to develop a functional relationship between hydraulic parameters and sediment transport by grain size, the user-developed relationship using the J and K records should be considered. The functional relationship for each size class, i, is:

$$GP_{i} = \left[\frac{EFD \cdot SLO - C_{i}}{A_{i}}\right]^{B_{i}} \cdot EFW \cdot STO$$
(3-2)

where:	EFD	= effective depth
	EFW	= effective width
	SLO	= energy slope
	STO	= roughness correction factor, see Equation 3-3
	A, B, C	= sediment transport coefficients developed using data
	GP	= sediment transport potential

Often the transport potential is affected by variations in flow resistance. To account for this, the K record is used to define a factor, STO, which is multiplied by GP to determine the sediment transport potential. STO is defined by:

$$STO = 10^{-6} \cdot D \cdot n^{E}$$
(3-3)

where:	D,E n	<ul> <li>sediment transport coefficients developed using data</li> <li>Manning's roughness coefficient</li> </ul>
	STO	= multiplying factor of GP

#### 3.4 Hydrologic Data

Hydrologic data is specified on records Q through W. The hydrologic data includes water discharges, temperatures, downstream water surface elevations and flow duration.

Having specified the initial geometry (size, shape, and slope of the channel) and the sediment relationships for the stream, the final step in sediment calculations is to simulate the response of these data to hydrologic inputs and, perhaps, reservoir operation rules. A continuous simulation is needed for a water discharge hydrograph since both sediment transport and hydraulics of flow are nonlinear functions of water discharge. The lack of coincidence between main stem and tributary flood hydrographs makes it essential to enter flow from tributaries at their correct locations along the main stem.

# 3.4.1 Flow Duration (W)

HEC-6 treats a continuous hydrograph as a sequence of discrete steady flows, each having a specified duration,  $\Delta T$ , as illustrated in Figure 3-9. This is done to reduce the number of time steps used to simulate a given time period, and thus reduce execution time. A discharge hydrograph blocked out in this manner is referred to as a "computational hydrograph". One  $\Delta T$  value is entered on each W record (each set of Q through W records in the hydrologic data represents a time step or increment of the computational hydrograph.)

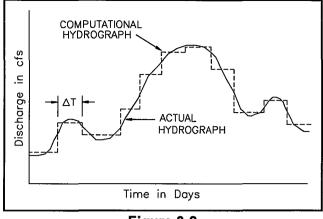


Figure 3-9 A Computational Hydrograph

# 3.4.2 Boundary Conditions

In a river system there are three types of boundaries: upstream, downstream, and internal. The upstream and downstream boundaries are at the cross sections that are most upstream and most downstream, respectively, on a stream segment. There are three types of internal boundaries: a local inflow point, a tributary junction point, and an hydraulic control point.

There are also three boundary conditions that can be prescribed by HEC-6: water discharge, sediment discharge, and water surface elevation (stage). The water and sediment discharges must be defined at each upstream boundary and at each local inflow point. Stage must be prescribed at the downstream boundary of the primary stream segment; and it can be prescribed at hydraulic control points.

# 3.4.2.1 Upstream Boundary Conditions

# Water Discharge (Q, T)

The water discharge entering the river network at the upstream end of each stream segment is entered on the Q record. Each value on the Q record represents a discrete steady flow from the computational hydrograph for the each stream segment or local inflow.

The temperature of the inflowing water is set by inserting a T record in the Q, Q, and W data. A water temperature (T) record is **required** for the first time step. The temperature is assumed to be the same for subsequent discharges until another T record is encountered. The water temperature of a stream segment downstream of a junction point is determined by discharge weighting of the tributary/local inflow and main stem temperatures. The water temperature is essential for the calculation of particle fall velocities. New fall velocities are calculated each time a new T record is read.

# **Sediment Discharge**

The sediment discharge data is entered as a sediment load table vs. discharge on LQ, LT and LF records. This is outlined in Section 3.3.1.

#### 3.4.2.2 Downstream Boundary Conditions (\$RATING, RC, R, S)

A water surface elevation must be specified at the downstream boundary of the model for every time step. HEC-6 provides three options for prescribing this downstream boundary condition: (1) a rating curve, (2) **R** records, or (3) a combination of a rating curve and **R** records.

The first option involves the use of a rating curve which can be specified using a **\$RATING** record followed by a set of **RC** records containing the water surface elevation data as a function of discharge (See Table 3-2). The rating curve need only be specified once at the start of the hydrologic data and a water surface elevation will be determined by interpolation using the discharge given on the **Q** record for each time step. The rating curve may be temporarily modified using the **S** record or replaced by entering a new set of **\$RATING** and **RC** records before any Q record in the hydrologic data.

In the second option, **R** records can be used **instead** of a rating curve to define the water surface elevation. This option is often used with reservoirs where the water surface elevations are a function of time and not flow. To use this method, an **R** record is required for the first time step. The elevation entered in Field 1 of this record will be used for each succeeding time step until another **R** record is found with a non-zero value in Field 1 to change it. In this way, you only insert **R** records to change the water surface to a new value.

Option 3 is a combination of the first two options. This option makes it possible to use the rating curve most of the time to determine the downstream water surface elevation while still allowing the user to specify the elevation exactly at given time steps. In this option, the **R** record's non-zero Field 1 value for the downstream water surface elevation will override the rating curve for that time step. On the next time step, HEC-6 will go back to using the rating curve unless another **R** record is found with a non-zero value in Field 1.

#### 3.4.2.3 Internal Boundary Conditions (QT, X5, R)

The **QT** record defines the location of a local inflow or tributary junction. The methods for prescribing the inflowing water and sediment discharge data are discussed in Section 3.4.2.1 (these are upstream boundary conditions). The water surface elevation of the downstream boundary of a tributary cannot be prescribed by the user; HEC-6 assigns the water surface of the cross section downstream of the junction to the downstream boundary of the tributary (this is a downstream boundary).

An X5 record in the geometry data creates an internal boundary (or hydraulic control point) at which the water surface may be specified. The specified water surface at this internal boundary is called an internal boundary condition. Two options are available to specify the water surface at this internal boundary. A rule-curve type of option can be specified to establish a constant operating elevation of a navigation pool within the geometric data. This is accomplished by specifying a water surface elevation and a head loss on the X5 record. When the tailwater elevation plus the head loss term is higher than the specified water surface elevations which usually had constant head losses for all discharges. The second option allows users to specify a rating curve at an internal boundary by using a combination of X5 and R records. This is helpful in modeling weirs and drop structures.

### 3.4.2.4 Transmissive Boundary Condition (\$B)

If a **\$B** record is encountered in the hydrologic data, a transmissive boundary condition is defined at every downstream boundary in the system. This transmissive boundary condition will allow sediment reaching that boundary to pass without changing that cross section. This is useful for situations where the conditions at the downstream boundary are anomalous (such as at a bridge, weir, drop structure, etc.) and may cause upstream computations to be in error if incorporated into the sediment transport/bed change computations.

# 3.4.3 Example Hydrology Input

An example set of hydrologic data for several time steps is shown in Table 3-2. The **\$HYD** record indicates that the hydrologic data follows. The **\$RATING** and **RC** records are used to input a discharge-elevation relationship. Every time step must have **\***, **Q** and **W** (or **X**) records. The **\*** records contain user comments and also control the output level for each time step. The A in Column 5 and the B in Column 6 of the **\*** record for event number 1 will produce A-level output of the water surface profile computations and B-level output of the sediment transport computations.

The Q record contains the water discharge and its duration, in days, is on the W record. Because long time steps may cause computational oscillations, it may be desirable to divide long time steps into smaller increments. In time step 3, an X record is used to divide a long 10 day time step into 20 half day increments.

A water temperature (T) record is **always** required for the first time step. In this example, no T record is given in time step 2; therefore, the second time step will use the same temperature as time step 1 (60°F). The T record in time step number 3 changes the temperature (70°F).

Table 3-2 Example of Hydrologic Input for HEC-6 \$HYD field1|field 2|field 3|field 4|field 5|field 6|field 7|.. **\$RATING** RC 3 100 0 520 525 528 Ω AB Time Step 1, A/B Level Output \* 100 Q T 60 W 1 Time Step 2 - No Output \* Q 200 W \* А Time Step 3 - 10 days at 20 increments Q 200 R 527 T 70 . 5 10 Х field1|field 2|field 3|field 4|field 5|field 6|field 7|. **\$RATING** RC 3 100 0 525 528 520 BB TIME STEP NO. \* 200 Q 1 \$\$END

The water surface elevation in Field 1 on the **R** record in time step number 3 sets the stage for the downstream boundary to 527 ft. This value overrides the Stage-Discharge Rating curve entered before time step 1. The rating curve (**\$RATING** and **RC** records) just before event number 4 is used to determine the starting water surface for time step number 4 and overrides elevation 527 from the **R** record in time step 3.

A \$\$END record marks the end the hydrologic data as well as the entire HEC-6 input file.

# 3.5 Special Command Records (EJ, \$TRIB, \$LOCAL, \$HYD, \$\$END)

A command record structure was developed to enhance the flexibility of HEC-6. The EJ, \$HYD, and \$\$END records are used to delineate the geometric, sediment and hydrologic data. These commands are **required** for all data sets. The EJ record identifies the end of geometric input. The \$HYD record identifies the beginning of the hydrologic data. The \$\$END record identifies the end of the input. If tributaries or local inflow/outflow points are being modeled, \$TRIB and \$LOCAL records, respectively, are required. The \$TRIB and \$LOCAL records are used to distinguish tributary and local data from data for the primary stream segment in the geometric and sediment data sets.

# 3.6 Network Model

A network system in which sediment transport in tributaries is calculated can be simulated with HEC-6. This section describes the required data sequence.

The network option is designed so that individual segments of the stream network can be analyzed independently to calibrate and confirm the model. With only minor changes, the user will be able to link the data sets together and perform the final analysis on the entire stream network.

Correct methodology for labeling model segments is essential. HEC-6 saves information from the first title record in each geometric model as a label and prints it out as an identifier of the segment. Therefore, the stream's name and data model/test/run number code should be included on the T1 record. The date of the data set is also useful information.

The following are presented to define the terms used in this section.

Control Point:	The downstream boundary of the main stem and the junction point of each tributary.
Local Inflow/Outflow Point:	Points along any river segment at which water and sediment enters or exits that segment.
River Segment:	A part of a river system which has an upstream water and sediment inflow point and has a downstream termination at a control point. Sediment transport is calculated along a segment.
Tributary:	A river segment other than the main stem in which sediment transport is calculated.
Main Stem:	The primary river segment with its outflow at the downstream end of the model.

# 3.6.1 Numbering Stream Segments

Stream segments and control points should not be numbered arbitrarily. To illustrate the numbering procedure, Figure 3-10 is used as an example and depicts a stream network. Each river segment's upstream-most inflow point is designated by  $I_k$  where k is the segment number. Local inflow/outflow points are marked with large arrows and labelled by  $L_{i,j}$  where j is the sequence number (going upstream) of local inflow/outflow points along segment i. Control points are designated by a circled number. The numbering of segments, inflow/outflow points, and control points should follow these steps:

- Step 1 Sketch out the stream network system.
- Step 2 Number the control points 1, 2, and 3 along the main stem at the junctions with tributaries. With the main stem as segment 1, number segments 2 and 3. Number the main stem's upstream inflow point with  $I_1$  and for segment 2,  $I_2$  and for segment 3,  $I_3$ . Label the main stem's local inflow/outflow points,  $L_{1,1}$  and  $L_{1,2}$ .
- Step 3 Starting from the downstream-most tributary (at control point 2) of the main stem, continue numbering control points 4 and 5. Number segments 4 and 5 coming off the control points and place inflow points  $I_4$  and  $I_5$ . Label  $L_{4,1}$  for the local inflow entering segment 4.

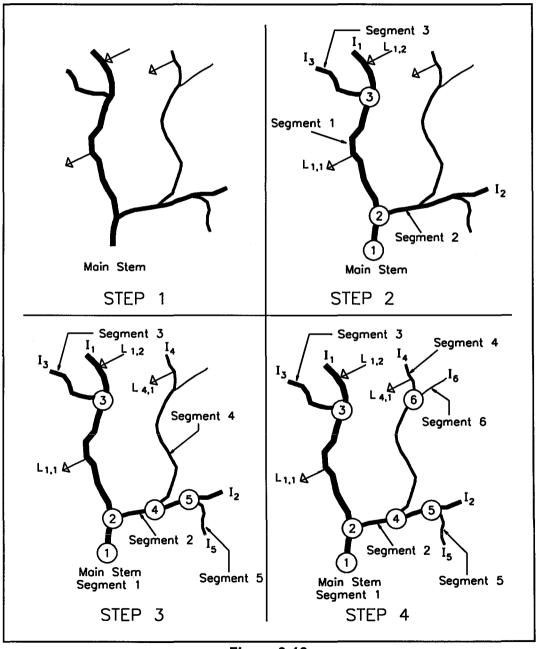


Figure 3-10 Example of Stream Network Numbering System

- Step 4 Starting from the downstream-most tributary of segment 2 (at control point 4), continue along segment 4, numbering control point 6, segment 6 and inflow point I<sub>6</sub>. Since there are no tributaries on segment 6, check for tributaries on segment 5 (next upstream tributary of segment 4). Since there are no tributaries on segment 5 and all tributaries from control point 2 are accounted for, go to step 5.
- Step 5 Check the next upstream segment off the main stem, segment 3, for tributaries.
   If there were tributaries, the procedure would have continued as in steps 3 and 4 with the next control point being 7. Since there are no more tributaries, the numbering is complete.

# 3.6.2 Cross Section Data Sets of Main Stem and Tributaries

HEC-6 identifies segments by the order in which cross section sets are assembled in forming the geometric model. When HEC-6 reads the main stem geometry and, eventually, reaches the first EJ record in the geometric data set, it will read one more record. If that record is a **\$TRIB** record, HEC-6 will begin reading data for a segment in a stream network. This process is repeated until all geometric data sets representing river segments are read. The CP record following the **\$TRIB** record identifies the control point number associated with the geometry information for each tributary segment data set. Table 3-3 illustrates these requirements for the network shown in Figure 3-10.

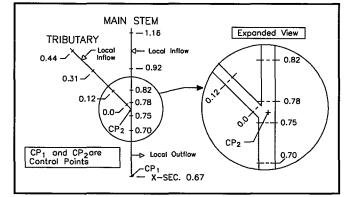
Record	Comments
T1 T2 T3 EJ \$TRIB CP 2 T1 T2 T3 EJ \$TRIB CP 3	SEGMENT 2 - THE FIRST TRIBUTARY UPSTREAM OF CONTROL POINT 1. AMERICAN RIVER SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA Geometry of Segment 2, contains QT records for segment 4 and 5. End of Segment 2. Indicates that data for additional tributary segments follow. This stream segment enters the network at control point 3.
T1 T2 T3 EJ \$TRIB CP 4 T1 T2 T3 EJ T4	SEGMENT 3 - SECOND TRIBUTARY - UPSTREAM ON SACRAMENTO RIVER DRY CREAK SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA Geometry of Segment 3. End of Segment 3. Indicates that data for additional tributary segments follow. This stream segment enters the network at control point 4. SEGMENT 4 - FIRST TRIBUTARY ON SEGMENT 2 ARDEN CREEK SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA AND ENDS AT <b>I4</b> . Geometry of Segment 4, contains <b>QT</b> records for Segment 6 and L <sub>4,1</sub> . End of Segment 4. Sediment data follows.

Table 3-3Sequence of Geometry Data for a River Network

Figure 3-11 shows how to position cross sections at a control point. The location of the junction (control) point is specified by inserting a **QT** record just prior to the **X1** record for the

next cross section upstream from the control point location (e.g., 0.78 in Figure 3-11). The control point number must be coded on that **QT** record. It is not necessary to treat the control point reach any differently than other reaches. HEC-6 will mix flow, temperature and sediment concentrations as though this were a normal river reach. There is no accounting of momentum losses due to impinging flows.

### 3.6.3 Sediment Data



The main stem sediment data follows the geometric data in the data file. The main

Figure 3-11 Locating Cross Sections for Stream Networks

stem data specifies the fluid and sediment properties, number of grain size classes and unit weight of deposits for the **entire** network. If sediment properties in 11 through 15 records are present in the tributary data sets, they will be skipped by HEC-6. Information for local inflows and/or diversions on a segment are input as a part of that segment's sediment data. These are identified with a **\$LOCAL** record followed by inflow/outflow sediment discharge tables.

After the main stem sediment data set is entered, it is followed by a **\$TRIB** record and then the first tributary sediment data set. It is not necessary to enter a control point number since the sediment data must be in the same sequence as the geometric sets described earlier. This is illustrated in Table 3-4 which is for the network shown in Figure 3-10.

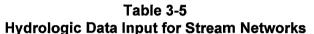
Record	Comments
 T4-T8	Previous geometric records. T4-T8 records are used for comments on main stem.
	Rest of sediment data of main stem are entered.
\$LOCAL	Indicates information on local inflow points follows.
LQL	Provide sediment load data for local inflow on LQL, LTL and LFL records.
LTL	Since there are two local inflow/diversion points in
LFL	segment 1 $(L_{1,1} \text{ and } L_{1,2})$ , two complete sets of these records are
LQL	required; enter the data for $L_{1,1}$ first followed by that for $L_{1,2}$ .
LFL	
\$TRIB	Sediment data for segment 2 begins here.
T4-T8	T4-T8 records are used for comments on segment 2.
	Enter the LQ-LF and PF records for segment 2 here.
\$TRIB	Sediment data for segment 3 begins here.
T4-T8	T4-T8 records are used for comments on segment 3.
	Enter the LQ-LF and PF records for segment 3 here.
STRIB	Sediment data for segment 4 begins here.
T4-T8	T4-T8 records are used for comments on segment 4. Enter the LQ-LF and PF records for segment 4 here.
\$LOCAL	Indicates information on local inflow/diversion points follows.
LQL	indicates information of focal information points formed
LTL	These records are for the local inflow/diversion point L <sub>4.1</sub> .
LFL	
\$TRIB	Sediment data for segment 5 begins here.
	Enter sediment data for the remaining segments in similar fashion.
\$HYD	Start of hydrology.

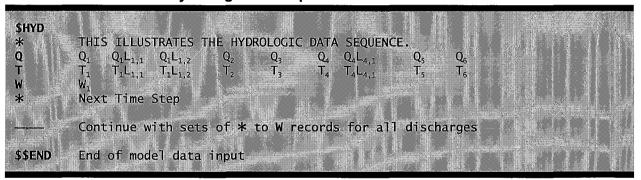
Table 3-4Sequence of Sediment Data for a River Network

#### 3.6.4 Hydrologic Data

The Hydrologic data set depicted in Table 3-5 is for the stream network shown in Figure 3-10. In general the water discharge and temperatures (**Q** and **T** records) are entered in the order of the control point numbers. If the control point's segment contains local inflow/outflow points, their discharges and temperatures are entered in the fields after the control point information. The information for the next control point is then entered. An example of this procedure follows.

The information in field 1 of the  $\mathbf{Q}$  (Q<sub>1</sub>) and  $\mathbf{T}$  (T<sub>1</sub>) records refers to segment 1 (see Figure 3-10). Information on these records is for the water exiting segment 1 at control point 1. An example is given in Table 3-5. Information in fields 2 (Q<sub>1</sub>L<sub>1,1</sub> and T<sub>1</sub>L<sub>1,1</sub>) and 3 (Q<sub>1</sub>L<sub>1,2</sub> and T<sub>1</sub> L<sub>1,2</sub>) are for the local inflow points L<sub>1,1</sub> and L<sub>1,2</sub>, respectively, which are on segment 1. Field 4 (Q<sub>2</sub> and T<sub>2</sub>) contains the information on the water entering control point 2 from segment 2. Segment 3 information is entered in field 5 (Q<sub>3</sub> and T<sub>3</sub>) and is for water entering control point 3 from segment 3. This procedure is continued for each control point and segment. The flow duration (**W** record) data remains constant for the entire stream network computation for that time step. Since HEC-6 does not "route" the water, it is necessary to process the hydrologic data for each segment and produce a single duration which best simulates the hydraulic and sediment processes of the whole system.





# 3.6.5 Summary of Data Input Sequence

The first data set in the data input is the geometric data. The main stem geometry is followed by a **\$TRIB** command record, a **CP** record and then the geometric model for the first tributary, i.e., the stream segment joining the main stem at control point number 2. If more than one junction (control) point is present, each tributary data set must follow sequentially with a **\$TRIB** command record followed by a **CP** record.

After all geometric data have been read, HEC-6 reads sediment data. Sediment data, one set for each stream segment, must be arranged in the sequence of the control point numbers. A **\$TRIB** command record precedes the sediment data for each tributary.

Hydrologic data follows the sediment data, but a different concept is utilized for entering hydrologic data than was used in the geometric and sediment data sets. No **\$TRIB** command records are required. Instead, the main stem flow, local inflows and tributary junction flows are all entered on the same **Q** record. The starting water surface elevation is read or calculated for the downstream boundary (control point 1), water temperatures are read for each water discharge, and the flow duration is read.

# 3.6.6 Calculation Sequence of Network Systems

### 3.6.6.1 Hydraulic Computations for Network Systems

Water surface profiles are calculated for the main stem first and the elevation at each control point is saved. Each time the water discharge changes, the water discharges are mixed and new water temperatures are calculated for the main stem and tributaries. Upon reaching the upstream end of stream segment number 1, computations return to control point number 2, its starting water surface elevation is retrieved from storage, and the hydraulic computations are made for stream segment number 2. Like the main stem, a tributary can have local inflows/diversions and tributary junctions. These are handled like the main stem, as presented above. Hydraulic computations are continued for segment 3 in a similar fashion until all stream segments have been analyzed; then sediment movement computations begin.

# 3.6.6.2 Sediment Computations

Although data input and hydraulic computations proceed through network segments in the same order in which the data was read, sediment computations are made in the reverse order. It is necessary for HEC-6 to process the most remote tributary first (highest segment number) to determine its sediment contribution to the next stream segment. After all sediment computations for the tributary are completed and results are printed, computations proceed to the next lower numbered segment. After the main stem calculations, HEC-6 cycles back to read the next discharge. The process is repeated until all water discharges have been analyzed.

# 3.7 Input Requirements for Other Options

#### 3.7.1 Fixed-Bed Calculations

HEC-6 is capable of being executed as a "fixed bed" model similar to HEC-2. The minimum records required are: T1-T3, NC, X1, GR, H, EJ, \$HYD, \*, Q, R, T, W and \$\$END. The H record can be left blank. Optional records are NV, X3, X5, \$RATING and RC. Note that T4 through PF records are not required; if these records are present, a fixed-bed run is achieved by moving the \$HYD through \$\$END records to just after the EJ record of the geometry data set. Fixed-bed runs are used to identify and correct any errors in the geometric data and analyze the hydraulic behavior of the model for a full range of flows. Calibration and confirmation of the hydraulics are performed similar to procedures used for HEC-2 (HEC 1990).

# 3.7.2 Multiple Fixed-Bed Calculations

If there are no tributaries or local inflow/outflow points, up to ten profiles may be computed in one run. Table 3-6 contains an example of a time step using five discharges from 100 to 10,000 cfs with starting water surface elevations ranging from 510 to 518 ft. Multiple profile runs are preferred over single

Table 3-6
Example of Hydrologic Data Set for Multiple
Fixed-Bed Calculations

*	A 5	DISCHAR	GES FRO	M LOW T	O HIGH	
Q	100.	500.	1000.	5000.	10000.	
R	510.	512.	513.	516.	518.	
Г	70.	70.	70.	70.	70.	
W	1.	1.	1.	1.	1.	

runs because the printout is more compact for the same number of discharges making it easier to make comparisons. If a **\$RATING** record set has been entered, the **R** record is not needed.

# 3.7.3 Cross Section Shape Due to Deposition (\$GR)

By default, HEC-6 adjusts the elevation of each cross section coordinate within the wet portion of the movable bed a constant amount for deposition or erosion as illustrated in Figure 3-12. A nonuniform deposition option is provided by the use of a **\$GR** record in the hydrologic data. This nonuniform deposition is a function of water depth which, over time, will ultimately result in a horizontal deposition surface. Bed elevation adjustments for erosion remain uniform.

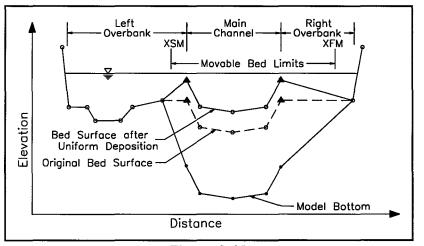


Figure 3-12 Uniform Deposition

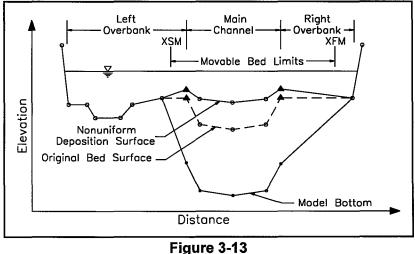


Figure 3-13 Nonuniform Deposition

# 3.7.4 Cumulative Volume Computations (\$VOL)

An option is available in HEC-6 to compute the cumulative volume of sediment material passing each cross section. This option is initiated with the **\$VOL** record. HEC-6 will also calculate the storage volume for a table of elevations for each cross section. The **VR** and **VR** records are use to define the table of elevations.

# Chapter 4

# **Output Control**

## 4.1 Output Levels

The user must determine what information is needed and request a level of output that provides it. By default, HEC-6 produces a minimum level of information so that the user will know that the data file has been processed and computations have completed; however, this output will not be sufficient for analyzing model performance.

Each major data group (geometry, sediment and hydrology) has a "normal" output level with one or more additional levels available to provide more detailed information. These output levels are summarized in Tables 4-1 and 4-2, described in the following paragraphs, and illustrated in the example problems in Chapter 6.

Summary of Initial Conditions Output Options			
Record	Level	Description	
TI	-	Title records are echoed. Each cross section is identified by it's ID number. Each special option used is noted.	
	В	Initial geometry, all geometry records are echoed.	
	С	Trace output. Warning messages may be generated by inconsistent data.	
		Initial condition of inflowing sediment loads and cross-sectional bed gradations. Also, secondary parameters computed from input information defining the initial conditions.	
	В	Echo of input records. Trace Output.	

Table 4-1 Summary of Initial Conditions Output Options

# 4.2 Geometric Data, Initial Conditions (T1)

B-level geometric data output, available on the T1 record, is helpful in debugging the input records. After the geometry data is deemed correct, this option is usually turned off. For production simulations, it is suggested that this option be used to document geometric input.

# 4.3 Sediment Data, Initial Conditions (T4)

The default output produced during processing of the sediment data is usually sufficient for most needs. However, the B-level output option on the **T4** record will provide echo of the input records as well as some trace information through the input routines. This output may allow the user to find some less common errors in the input data than is normally apparent. This option should be removed after the data have been checked for accuracy.

Record	Level	Description
* Column 5	-	No output from hydraulics computations.
Columnity	A	Discharge, starting water surface elevation, water temperature, flow duration. General hydraulic parameters for each cross section.
	В	Initial geometry, distribution of hydraulic parameters across subsections.
	D	Trace information.
	Ë	Detailed trace information. Hydraulic data for each incremental area, each trial elevation in backwater computations at each cross section.
* Column 6	-	No output from sediment computations.
column o	А	Volume of sediment entering and exiting model, trap efficiency.
	В	Bed elevation changes, water surface elevations, thalweg elevation, sediment load exiting model.
	С	Detailed output; including transport potential, load, and bed gradation per grain size.
	D	Detailed trace information
<b>\$DREDGE</b> Column 8	A - E	Levels A - E provide output from the dredging routines. The magnitude of this output ranges from simple data echo (level A) to detailed trace information (level E).
\$PRT	N	Turn off output at all cross sections.
Column 8	А	Provide output for all cross sections at <b>*</b> record output level.
СР	F	The stream segment number where needed cross sections are located. Used with <b>\$PRT</b> option.
PS	-	Cross sections where output is requested. Used with <b>\$PRT</b> option.
END	-	End of <b>\$PRT</b> records.
<b>\$VOL</b> Column 7	-	Cumulative bed and volume change.
Column 7	х	Table of volume versus elevation.
<b>\$VOL</b> Column 8		

Input parameters for elevation-volume table; used with **\$VOL** record.

Table 4-2Summary of Continuous Simulation Output Levels

VJ, VR

-

# 4.4 Hydraulic Calculations (\*)

The water surface profile is calculated before the sediment calculations begin, therefore, an A-level hydraulic output for the first discharge calculations is useful for diagnosing immediate data problems. B-, D- and E-levels are increasingly detailed and may be useful for unusual situations. Subsequently, the user should request output using the A-level only when interested in velocity and flow distribution information. Output from the hydraulic calculations is not particularly useful once geometric problems are resolved and the *n* values are calibrated.

# 4.5 Sediment Transport Calculations (\*, \$PRT, CP, PN, END)

Interpretation of HEC-6 performance requires careful selection and analysis of computed information. The availability of this information in the output file is governed by the user. The most useful sediment output options are on the \* record. Since this record is in the hydrology section, output can be turned on or off at any time in the simulation. The B-level sediment output is the most commonly used and provides all the essential sediment information for calibration, confirmation and production runs. C-level output is recommended only for the first discharge and then only if unusual results are encountered. D- and E-levels should be used only for analysis of suspected software errors. By default, output for every cross section is produced by the \* record output options.

Often it is desirable to receive output only at selected points in time and only for those cross sections of interest. This is accomplished by providing **\$PRT**, **CP**, **PS** and **END** records in the hydrologic data. The **\$PRT** record tells HEC-6 that instructions for selective printout follow. The **CP** record indicates the stream segment where the cross sections listed on the following **PS** records are to be found and the **END** record completes the input for this option.

Caution must be exercised when interpreting the calculated "bed change". This change is related to the movement of the thalweg after scour and deposition and may not reflect the average bed elevation or sediment volume change of the cross section. To obtain this type of information, the **\$VOL** option described in Section 4.6 should be utilized.

# 4.6 Accumulated Sediment Volumes (\$VOL, VJ, VR)

The **\$VOL** record in the hydrologic data causes HEC-6 to compute the cumulative bed elevation and volume change of each cross section and the sediment load that has passed each cross section. The sediment load information is provided for each grain size class. The **\$VOL** record initiates the computation of an elevation-cumulative sediment volume table which is helpful for reservoir analysis. The elevation table displays the accumulated sediment volume between each parallel elevation plane specified by an elevation table which is defined by the **VJ** and **VR** records. In reservoir studies, these planes are usually horizontal but HEC-6 has the capability to determine the table based upon a user specified slope of the elevation planes.

# 4.7 Summary of Output Controls

Table 4-1 summarized the output controls for initial conditions. These controls affect the output level associated with input data, such as geometry, inflowing sediment loads, bed gradations, and sediment characteristics. Table 4-2 summarized the output controls for the simulation. These include volume of sediment entering and exiting the reach, sediment trap efficiency, bed elevation changes, subsectional water velocities, water surface elevations, and other hydraulic and sediment information.

# Chapter 5

## **Modeling Guidelines**

#### 5.1 General

Training Document No. 13, entitled "Guidelines for the Calibration and Application of Computer Program HEC-6," (HEC 1992) describes methods and procedures for calibrating and applying computer program HEC-6. Other useful documents for sediment transport modeling are Thomas (1977), Gee (1984), Vanoni (1975), USACE (1989), and USACE (1993). Data requirements for river geometry, sediment characteristics and hydrology are discussed in these documents. Sensitivity of computed water surface profiles to data uncertainties is presented by HEC (1986).

#### 5.2 Establishing Geometry

With the study reach located on a topographic map, mark the upstream boundary, the downstream boundary, the lateral limits and the location of each cross section. Assign an identification number to each cross section; river miles are recommended. Subdivide the floodplain into channel and overbank portions. These can be considered as subsections having similar hydraulic properties in the direction of flow. Within a subsection, flow conditions (depth, velocity, roughness) should be similar and, therefore, representative *n* values and reach lengths can be selected.

Plot each cross section as it appears at the starting time of the simulation (time zero) and divide each into two parts; the movable bed part in the main channel and the fixed part. Mark the elevations of geologic controls such as bedrock and clay layers on each cross section. If none are present, the program will arbitrarily assign ten feet below channel bottom to provide some finite depth of sediment material in the model. If more than ten feet of scour is expected, assign a lower bottom elevation.

It is necessary to locate the downstream end of the reach where there is a stable rating curve or known water surface elevation. For analysis of potential degradation this may be many miles downstream from the dam at a rock outcrop or concrete weir. For studies of reservoirs, the operating policy will define the reservoir level for the water surface profile computations and the program will adjust the bed according to calculated results.

#### 5.3 Sediment Data

#### 5.3.1 Sediment Particle Characteristics

Only inorganic sediments are addressed by the HEC-6 transport functions. Therefore, the amount of organic sediments in samples should be measured, expressed as a percentage, and removed before testing for the inorganic properties presented below. If a significant quantity of organic particles is present, such as on the Big Sandy River where coal amounted to 40% of the sample by weight, a suitable procedure for correcting the calculations must be developed. In the Big Sandy River case, the coal was represented by an equivalent sand size and treated as inorganic sediment having a specific gravity of 2.65.

#### 5.3.2 Inflowing Sediment Load Synthesis

If the inflowing sediment load is not available, HEC-6 can calculate it from gradation curves for the bed material. This procedure is less desirable than obtaining measured inflowing sediment load data because of the difficulty of obtaining representative sediment samples for the entire bed. However, simulating conditions along a segment of the river permits the use of indicators such as aggradation, degradation and fluctuation in sediment discharge from one cross section to another. Use of these indicators helps to make a better estimate of the noncohesive sediment load than can be made by applying transport theory at only one point on the river.

#### 5.4 Hydrologic Data

It is important that the water discharges in the computational hydrograph reproduce the long term flow-duration curve (for long term simulations). If a period of record flow sequence is not available, an annual pattern hydrograph can be determined from knowledge of the duration curve and the annual pattern of flows. It is important to include a wet and dry year in addition to an average year.

It is desirable to repeat discharges at selected time intervals throughout the hydrologic data set to provide a common basis for comparing rates of change. For example, the ending of each year with the same discharge (of short duration) will permit the comparison of water surface and bed profiles at fixed time intervals as time progresses.

Representation of the discharge hydrograph as a series of steady flows requires the preservation of total annual water and sediment volume while maintaining the shape and peak discharges of flood events. The duration of each discharge in the computational hydrograph should be at least long enough to permit the flow to pass through the longest reach. For instance, if the average water velocity is 10 ft/sec and the longest reach is 10,000 ft, the minimum flow duration for that flow is 10,000  $\div$  10 or 1,000 seconds (0.278 days). Longer durations may be used; however, since this is an explicit formulation of the basic equations, care must be taken to insure that time steps are not so long that oscillations are introduced into the sediment bed and water surface profiles. Limiting bed oscillations may require time steps on the order of the flow-through time for the shortest reach. See HEC (1992) for further information.

For moderate to large rivers, it is usually acceptable to approximate an **annual** hydrograph with 15 to 25 discharge segments. In general, the larger the discharge, the shorter its duration must be, because the larger discharges carry greater amounts of sediment and result in larger bed movements, increasing the possibility of numerical oscillations. A large discharge can be entered as several successive constant discharges to satisfy the requirement for shorter durations.

## Chapter 6

## **Example Problems**

This section presents several example problems that illustrate the contents of input data and computed results files for several typical applications of HEC-6. Detailed descriptions of the input data records can be found in the Input Description (Appendix A), and are not duplicated here. These example problems are **not** meant to provide engineering application guidance for use of HEC-6; such guidance can be found in Gee (1984), USACE (1989) and HEC (1992). These examples are provided **only** to illustrate the type and sequence of data needed to model various situations. They encompass a range of situations from fixed-bed backwater computation to simulation of the movement of sediment in a dendritic network of streams.

Although derived from an actual engineering application, the example problems have been altered for illustration purposes. Therefore, the values of the parameters used in these problems are not based on field data and **should not necessarily be used** in an actual project.

Figure 6-1 shows a schematic of the river system that was the basis for these example problems. Each example builds upon the previous examples, therefore, only the additional or changed data is described for each successive problem.

Several options are available that allow some data to be defined in more than one way. For example, the depth of the bed sediment control volume can be defined explicitly on the HD record or expressed in terms of the elevation of the model bottom on the H record; since only one H or HD record is required for each cross section, either record can be used at a given cross section. Each analyst should select the appropriate options for their particular application. The selection should be based on the physical circumstances, study objectives, data availability and ease of use of the selected option.

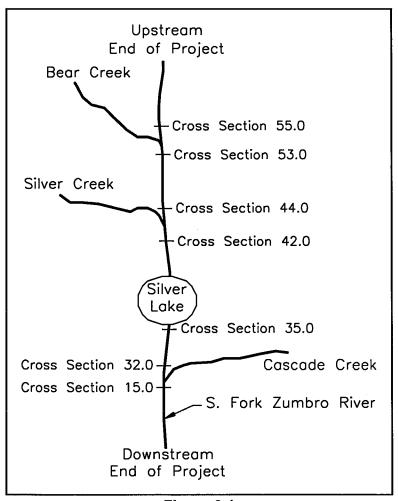


Figure 6-1 Schematic of Example River System

#### 6.1 Example Problem 1 - Fixed-Bed Application

When initially preparing geometric data and calibrating energy loss coefficients, it is often worthwhile to use HEC-6 as a fixed-bed (backwater) model.

#### 6.1.1 Input Data

The data for Example Problem 1, shown in Table 6-1a, is designed to operate HEC-6 as a fixed-bed model. Note that this data is quite similar to HEC-2 data, although some data records (such as QT and X5) have different parameters for HEC-6. These differences are noted in the Input Description (Appendix A). HEC-6 data begins with three title records, T1, T2, and T3. These are followed by bed roughness data (NC) and the geometry for each cross section, beginning with the X1 record. GR records define the cross section's geometry as a series of elevation and station points. The HD records delineate the movable portion of the bed of each cross section; though irrelevant for fixed bed operation of HEC-6, an HD record must follow the GR data for every cross section in the data file.

In general, HEC-6 data records are position dependent. The cross sections are entered from **downstream** to **upstream**. The **QT** records locate inflow/outflow points and tributary junctions. **NC** records note changes in bed roughness. Comment records, however, are not position dependent; they can be placed anywhere in the data. Comment records are indicated by a blank ID in field 0 (i.e., the first two characters or columns of the record are blank). Comment records can be used throughout a data file to document unusual attributes or conditions in the model.

Duplicate or repeat cross sections are often used to provide extra computational nodes for improving the accuracy of integration of the energy loss equation (HEC, 1986). As indicated by the comment records, Section No. 33.3 is a *duplicate* of Section No. 33.0. This was accomplished by *copying* the data records for Section No. 33.0 and changing the section ID number and reach lengths. In this case, Section No. 33.3 also differs from Section No. 33.0 by width and elevation adjustments. Width and elevation modifications can be made to any cross section in a manner similar to the HEC-2 procedure. A *repeat* section 53.1 in Example Problem 5); this is an indicator to HEC-6 that the geometry of the previous section should be re-used for this section. The repeat section option was instituted early in HEC-6's development due to the limitations of file editors and keypunch machines, however, with today's more sophisticated file editors (like COED), it is recommended that duplicated sections be used instead. Care must be taken to assure that duplicate or repeat cross sections have sediment transport characteristics that embody the theory of "reach representative" cross sections (Thomas, 1982).

The distinguishing characteristic of an HEC-6 fixed boundary simulation data file is that **there are no sediment data**. The geometric data is followed by the flow data which begins with a **\$HYD** record. The flow data for this example contains a rating curve (**\$RATING** and **RC** records), and flow information (**\***, **Q**, **T**, and **W** records). The temperature (**T**) and duration (**W**) data, while necessary in the data file, play no role in fixed-bed computations. Example Problem 1 thus is a "multiple profile" run with two flow profiles being computed through a single project reach.

#### Table 6-1a Example Problem 1 - Input Fixed Bed

EXAMPLE PROBLEM NO 1. FIXED-BED APPLICATION. BASIC GEOMETRY. 3 LOCAL INFLOWS WITH A RATING CURVE AT THE DOWNSTREAM BOUNDARY. SOUTH FORK, ZUMBRO RIVER \*\* Example Problem 1 \*\* Τ1 T2 T3 .04 10077. 978.4 .1 NC 1 . 3 31 X1 1.0 Ô n n 9915. 10092. 10243. 959.2 944.7 959.8 966.0 GR 1004. 10002. 956.0 10060. 10077. 10081. 959.3 10138. 10275. 10700. 10225. 10325. 11060. GR 950.0 GR 956.2 948.48 10108. 946.6 10158. 955.2 959.9 958.9 957.4 10250. 10400. 959.8 970.0 10300. 10960. GR 958.8 10350. 970.0 GR 968.0 GR 962.0 11085. 968.0 11240. 12400. 970.0 11365. 970.0 11500. 970.0 11615 11665. 962.0 976.0 12550. 980.0 12670. 982.0 12730 ĞR 984.0 12735. HD 1.0 15.0 **X**1 10665. 10850 3560. 3030 3280. 27 GR 992.0 9570. 982.0 10110. 976.0 10490. 10300. 976.0 966.0 10610. GR 964.7 10665. 10703. 956.0 10673. 953.0 10693. 954.0 955.6 10723. GR 958.6 10750. 959.3 10800. 957.0 10822. 957.3 10825. 961.5 10850. GR 962.0 10852. 964.0 10970. 966.0 11015. 961.0 11090. 962.0 11150. GR 970.0 11190. 972.0 11310. 980.0 11410. 984.0 11570. 990.0 11770. GR 990.0 11865. 1000.0 12150. 15.0 HD Model Cascade Creek as a local inflow. οτ X1 32.0 29 10057. 10271. 3630. 3060. 4240. GR 998.0 9080. 982.0 9250. 9510. 982.0 980.0 9600. 980.01 9925. GR979.48 10000. 978.5 10057. 968.6 10075. 959.82 10087. 956.5 10097. GR 956.8 957.8 10117. 10137. 959.4 10157. 959.6 10177. 959.82 10196. GR 966.5 10225. 971.2 10250. 978.5 10271. 978.5 10300. 978.6 10350. GR978.91 10370. 978.96 10387 980.0 10610 982.0 10745 982.0 11145 GR 984.0 11150. 992.0 11240. 1000.0 11330. 1008. 11425. HD 32.0 **X**1 33.0 21 1850 2150 3130 3320. 3250 GR1000.0 980. 990.0 1060. 980.0 1150. 982.0 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. 3170. GR 1000. HD 33.0 NOTE: Section 33.3 is a duplicate of Section 33.0. Section 33.0 is a good representative cross section 55.0. duplicate is used here to break up the long reach into two smaller reaches. 33.3 21 1850. 2150. 1550. 1750. 1750. .95 1.49 X1 GR 1000. GR 980.0 GR 982.0 990.0 982.0 982.0 980. 1060. 980.0 1150. 982.0 1180. 982.0 1215. 1260. 1730. 1350. 1850. 980.0 979.1 1300. 1830. 982.0 984.4 1420. 1851. 980.0 961.0 1540. 1900.8 GR 961.0 GR 1000. HD 33.3 976.0 982.0 990.0 2099.2 2149. 984.5 2150. 2800. 3100. 3170. HD X1 35.0 22 9894. 10245. 1050. 1050. 1050. 9035. 9135. 9745. GR 984.0 980.0 9070. 978.0 980.0 9185. 9270. 982.0 GR 980.0 963.4 967.6 9465. 981.7 9595. 983.7 984.7 9894. 9894.1 9954. GR 963.3 967.1 9974. 967.4 10004. 968.2 10054. 10044. 10115. GR 973.4 977.4 10120. 983.7 10155 984.0 10245 982.0 10695. GR 982.0 10895. 1004.0 11085. HD 35.0 Silver .06 42.0 Lake occupies this reach .06 .045 32 9880. 10130. NC 5370. X1 5000. 5210. 7130. GR 996.0 998.0 7310. 998.0 7930. 992.0 8205. 990.0 8495. 8780. 9707. 989.44 985.8 GR 988.0 986.0 8990 985.7 9570. 986.45 9857. GR 990.0 9880. 969.8 969.8 9941. 9941. 9881. 985.8 9943. GR 10001. 969.8 9943. 969.8 986.7 10001. 986.7 10003. 969.8 10003. GR 969.8 10067. 985.8 10067. 985.8 10069. 969.8 10069. 969.8 10129. GR 989.9 10130. 989.5 10180. 988.6 10230. 987.6 10280. 985.2 10430. GR 986.8 11720. 989.9 12310. HD 42.0 Model Silver Creek as a local inflow. ОТ 28 X1 44.0 9845 10127. 3200. 3800. 3500. GR 1002. 8035. 992.0 8150. 990.0 8305. 990.0 8735. 988.0 8835. 996.0 9285. 1017.6 9425. 990.0 9505. 986.0 9650. 9788. GR 984.1 9845. 970.5 GR 980.6 970.9 9868. 972.2 9898. 9968. 967.5 9998 GR 968.9 10028. 967.4 10058. 967.1 10078. 971.9 10118. 976.8 10127. GR 977.8 10150. 976.9 10193. 982.0 10206. 981.2 10300. 979.2 10325. GR 983.1 10400. 999.8 10450. 1002.4 10464. HD 44.0

X1	53.0	22	10000.	10136.	3366.	2832.	2942.				
	1004.		1000.0	7760.	998.0	8440.	996.0	8640.	996.0	8780.	
	994.0		986.0	9245.	986.3	9555.	986.3	9825.	983.8	9900.	
	982.8		978.2	10011.	974.0	10041.	972.2	10071.	972.6	10101.	
	978.2		988.7	10136.	989.3	10154.	999.2	10200.	1000.1	10320.	
	1002.		1004.0	10700.				102000			
HD	53.0		100110	20,001							
		Bear Cre	ek as a	local in	flow						
QT		Dear ere	ch ub u	iocui in							
X1	55.0	18	9931.	10062.	2275.	3430.	2770.				
	1004.		1000.0	7947.	996.0	8627.	990.0	9052.	986.0	9337.	
	984.3		984.7	9837.	985.5	9910.	987.2	9931.	978.1	9955.	
	974.8		974.2	10005.	972.9	10035.	973.2	10045.	983.8	10062.	
	985.8		986.0	10307.	990.0	10497.	515.2	10010.	20210	10001.	
HD	55.0		200.0	100071	220.0	101971					
X1	58.0		9912.	10015.	1098.	1012.	1462.				
	1006.	8542.	1004.0	8952.	1000.0	9702.	997.2	9812.	996.3	9912.	
	976.2		975.4	9974.	978.2	9991.	990.4	10015.	988.3	10062.	
	988.8		988.3	10065.	989.3	10169.	990.0	10172.	992.0	10242.	
	992.0		988.0	10642.	986.7	10852.	988.0	11022.	986.0	11097.	
	986.0		988.0	11192.	200.7	10052.	200.0	TTOPP:	200.0	110071	
HD	58.0		200.0	11192.							
EJ	50.0										
ŜĤ	YD										
	ATING										
RC		40	2000	0	0	950.0	955.1	958.0	960.0	962.0	
RC		963.6	965.1	966.2	967.0	967.7	968.3	968.9	969.4	969.8	
RC		970.2	970.6	971.0	971.4	971.8	972.1	972.4	972.7	972.9	
RC		973.1	973.3	973.5	973.7	973.8	973.9	974.0	974.1	974.2	
RC		974.3	974.4	974.5	974.6	974.7	974.8	974.9	975.0	5/1.2	
*	A	PROFILE 1					574.0	571.5	5.5.0		
Q	1250.	150.	78.	340.		LIGE					
Ť	12001	1507		5707							
ŵ	1.										
*		PROFILE 2	- BANK	FULL FLC	w						
ĝ	2500.	300.	150.	650.	••						
w	1.		200.								
	END										
ιψΨ											

#### 6.1.2 Output

The output from Example Problem 1 is shown in Table 6-1b. Various levels of output detail are available to the user. These are controlled by several input data items (see Chapter 4); the output produced by these options will be described as encountered in the problems. The terminology for output is; default, A-level, B-level, etc., each succeeding level providing increasing detail. The default HEC-6 output provides the minimum level of information.

HEC-6 first gives information regarding program version and date, and the date and time of the run. The input and output file names are placed in the output file for the user's future reference. Information regarding the geometric data follows.

In Example Problem 1, the default (minimum) geometric output is presented. Additional information can be obtained via switches on the T1 record (see Appendix A). Each cross section is labelled by its identification number from the X1 record. We suggest that river mile be used to identify cross sections. The "DEPTH of the Bed..." is based on information from the HD record. Information regarding cross section adjustment is echoed as well as the locations of local inflow points and changes to the energy loss coefficients.

Following the geometric data output, profiles (or time steps) 1 and 2 produced A-level output for the hydraulic, or backwater, computations. This output is triggered by an A in column 5 of the \* record which causes the discharge, water surface elevation, energy grade line elevation, velocity head, alpha, top width, average bed elevation, and average velocity in each subsection for each cross section to be written to the output file. The discharge value represents the subtraction of local inflows as the backwater computation proceeds upstream. Local flow data should be checked to assure that the main river discharge never becomes

negative. The average bed elevation (AVG BED) is the water surface elevation minus the effective depth (see Section 2.2.3.6). Subsection 1 is the left overbank, 2 the channel, and 3 the right overbank. This hydraulic information is very useful when first assembling geometric data; once the data are verified and the loss coefficients are calibrated, the A-level hydraulic output may be suppressed.

Table 6-1b
Example Problem 1 - Output
Fixed Bed
**************************************
* Version: 4.1.00 - AUGUST 1993 * * HYDROLOGIC ENGINEERING CENTER * * INPUT FILE: EXAMPLEI.DAT * * 609 SECOND STREET *
* OUTPUT FILE: EXAMPLE1.OUT * * DAVIS, CALIFORNIA 95616-4687 * * RUN DATE: 30 AUG 93 RUN TIME: 10:27:58 * * (916) 756-1104 *
***************************************
X X XXXXXX XXXXX XXXXX X X X X X X X X
X X X X X X XXXXXXX XXXX X XXXXX XXXXXX
X X X X X X X X X X X X X X X X X X X
X X XXXXXXX XXXXX XXXXX
* MAXIMUM LIMITS FOR THIS VERSION ARE: *
* 150 Cross Sections *
* 20 Grain Sizes *
* 10 Control Points * ***********************************
T1 EXAMPLE PROBLEM NO 1. FIXED-BED APPLICATION. BASIC GEOMETRY. T2 3 LOCAL INFLOWS WITH A RATING CURVE AT THE DOWNSTREAM BOUNDARY. T3 SOUTH FORK, ZUMBRO RIVER ** Example Problem 1 **
N values Left Channel Right Contraction Expansion 0.1000 0.0400 0.1000 1.1000 0.7000
SECTION NO. 1.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 15.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
LOCAL INFLOW POINT 1 occurs upstream from Section No. 15.000
SECTION NO. 32.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 33.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 33.300 Adjust Section WIDTH to 95.00% of original.
Adjust Section ELEVATIONS by 1.490 ft. DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 35.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
N values Left Channel Right Contraction Expansion 0.0600 0.0450 0.0600 1.1000 0.7000
SECTION NO. 42.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
LOCAL INFLOW POINT 2 occurs upstream from Section No. 42.000
SECTION NO. 44.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 53.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
LOCAL INFLOW POINT 3 occurs upstream from Section No. 53.000
SECTION NO. 55.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 58.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.

NO. OF CROSS SECTIONS IN STREAM SEGMENT= 11 NO. OF INPUT DATA MESSAGES = 0

TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = 11 TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK = 1 END OF GEOMETRIC DATA

#### 

## \$HYD FIXED-BED MODEL

\$RATING

\$RATING							
Downstream Bou Elevation	Stage	t <b>ion - Ratin</b> g Discharge	Elevation	n Stage	Discharge		
950.000 955.100	950.000 955.100	0.000 2000.000	972.40 972.70	972.400 972.700	40000.000 42000.000		
958.000	958.000	4000.000	972.90		44000.000		
960.000	960.000	6000.000	973.10		46000.000		
962.000	962.000	8000.000	973.30		48000.000		
963.600 965.100	963.600 965.100	10000.000 12000.000	973.50 973.70		50000.000 52000.000		
966.200	966.200	14000.000	973.80		54000.000		
967.000	967.000	16000.000	973.90		56000.000		
967.700	967.700	18000.000	974.00		58000.000		
968.300	968.300	20000.000	974.10		60000.000		
968.900	968.900	22000.000	974.20		62000.000		
969.400	969.400	24000.000	974.30	974.300	64000.000		
969.800	969.800	26000.000	974.40	974.400	66000.000		
970.200	970.200	28000.000	974.50		68000.000		
970.600	970.600	30000.000	974.60		70000.000		
971.000	971.000	32000.000	974.70		72000.000		
971.400	971.400	34000.000	974.80		74000.000		
971.800	971.800 972.100	36000.000	974.90		76000.000		
972.100	972.100	38000.000	975.00	975.000	78000.000		
TIME STEP #	1 E 1 = AVERAG						-
EXAMPLE PROBLE ACCUMULATED TI				ASIC GEOMETRY.			
Downstream	Boundary Co	ndition Data	for STREAD	SEGMENT NO	1 at Contro	l Point # 1	_
Downberoum	Doundary co	DISCHARGE		JRE WATER SUR		1 101110 # 1	
		(cfs)	(deg F				
		1250.000			188		
**** DISCHARG (CFS)	E WATER SURFACE	ENERGY VI LINE	ELOCITY A HEAD	LPHA TOP WIDTH	AVG BED	AVG VEL (by s 1 2	ubsection) 3
SECTION NO.	SURFACE 1.000	LINE	HEAD	LPHA TOP WIDTH	AVG BED		
SECTION NO.	SURFACE 1.000		HEAD 0.063 1	lpha top	<b>AVG</b> <b>BED</b> 948.191	AVG VEL (by so 1 2 2 0.000 2.019 0.000 100.000	ubsection) 3 0.000 0.000
SECTION NO. **** 1250.00	SURFACE 1.000 0 953.188 15.000	LINE	HEAD 0.063 1 1.135 1	L <b>PHA TOP</b> WIDTH	AVG BED 948.191 ION (%) = 954.971	0.000 2.019	0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 0 957.150	<b>LINE</b> 953.251 958.285	HEAD 0.063 1 1.135 1	LPHA TOP WIDTH .000 123.928 FLOW DISTRIBUT .000 67.126 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO.	SURFACE 1.000 953.188 15.000 0 957.150	<b>LINE</b> 953.251 958.285 1 is upstrea	HEAD 0.063 1 1.135 1 am of Sectio	LPHA TOP WIDTH .000 123.928 FLOW DISTRIBUT .000 67.126 FLOW DISTRIBUT on No. 15	AVG BED 948.191 ION (%) = 954.971	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 0 957.150	JINE 953.251 958.285 1 is upstree DISCHARGE	HEAD 0.063 1 1.135 1 am of Secti TEMPERAT	LPHA TOP WIDTH .000 123.928 PLOW DISTRIBUT .000 67.126 PLOW DISTRIBUT On No. 15 JRE	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 957.150 OW POINT #	JINE 953.251 958.285 1 is upstrea DISCHARGE (cfs)	HEAD 0.063 1 1.135 1 am of Secti TEMPERAT (deg F	LPHA TOP WIDTH 2000 123.928 FLOW DISTRIBUT 2000 67.126 FLOW DISTRIBUT 2000 No. 15 JRE	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 957.150 OW FOINT # cal Inflow:	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.0.	LPHA TOP WIDTH .000 123.928 7LOW DISTRIBUT .000 67.126 7LOW DISTRIBUT on No. 15 TRE .00	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 957.150 OW POINT #	JINE 953.251 958.285 1 is upstrea DISCHARGE (cfs)	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.0.	LPHA TOP WIDTH .000 123.928 7LOW DISTRIBUT .000 67.126 7LOW DISTRIBUT on No. 15 TRE .00	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00	SURFACE 1.000 953.188 15.000 957.150 OW FOINT # cal Inflow:	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.0.	LPHA TOP WIDTH .000 123.928 7LOW DISTRIBUT .000 67.126 7LOW DISTRIBUT on No. 15 TRE .00	AVG BED 948.191 ION (%) = 954.971 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
CCFSU SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo	SURFACE 1.000 953.188 15.000 957.150 OW POINT # cal Inflow: Total: 32.000	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000	HEAD 0.063 1 1.135 1 	LPHA TOP WIDTH .000 123.928 7LOW DISTRIBUT .000 67.126 7LOW DISTRIBUT on No. 15 TRE .00	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000	0.000 2.019 0.000 100.000 0.000 8.546	0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 0 957.150 OW POINT # Cal Inflow: Total: 32.000 0 963.529	253.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000 1100.000	HEAD 0.063 1 1.135 1 	LPHA TOP WIDTH 2000 123.928 FLOW DISTRIBUT 2000 67.126 FLOW DISTRIBUT 200 No. 15 JRE 200 200	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000	0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 0 963.529 33.000	253.251 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580	HEAD 0.063 1 1.135 1 am of Section TEMPERATT (deg F 0.0 0.051 1	LPHA TOP WIDTH 2000 123.928 FLOW DISTRIBUT 2000 67.126 FLOW DISTRIBUT 200 057.126 200 15TRIBUT 200 057.126 200 15TRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000	0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 0 963.529 33.000	253.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000 1100.000	HEAD 0.063 1 1.135 1 am of Secti. TEMPERAT (deg F 0.0 0.051 1 0.034 1	LPHA TOP WIDTH .000 123.928 FLOW DISTRIBUT .000 67.126 FLOW DISTRIBUT on No. 15 JRE .00 .000 130.197 FLOW DISTRIBUT .000 219.876	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484	0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LO SECTION NO. **** 1100.00 SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 0 957.150 OW POINT # cal Inflow: Total: 32.000 0 963.529 33.000 0 964.565	253.251 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580	HEAD 0.063 1 1.135 1 am of Secti. TEMPERAT (deg F 0.0 0.051 1 0.034 1	LPHA TOP WIDTH 2000 123.928 FLOW DISTRIBUT 2000 67.126 FLOW DISTRIBUT 200 057.126 200 15TRIBUT 200 057.126 200 15TRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000	0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 963.529 33.000 964.565 33.300	LINE 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580 964.599	HEAD 0.063 1 1.135 1 am of Section TEMPERATT (deg F 0.051 1 0.051 1 0.034 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 15TRIBUT 000 000 000 000 130.197 FLOW DISTRIBUT 0000 219.876 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LO SECTION NO. **** 1100.00 SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 963.529 33.000 964.565 33.300	253.251 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580	HEAD 0.063 1 1.135 1 am of Secti- TEMPERAT (deg F 0.0 0.051 1 0.034 1 0.057 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 219.876 FLOW DISTRIBUT 000 219.876	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LOCAL INFL SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 0 957.150 OW FOINT # cal Inflow: Total: 32.000 963.529 33.000 0 964.565 33.300 0 965.348	LINE 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580 964.599	HEAD 0.063 1 1.135 1 am of Secti- TEMPERAT (deg F 0.0 0.051 1 0.034 1 0.057 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 15TRIBUT 000 000 000 000 130.197 FLOW DISTRIBUT 0000 219.876 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 963.529 33.000 964.565 33.300 0 965.348 35.000	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000 1100.000 963.580 964.599 965.405	HEAD 0.063 1 1.135 1 am of Secti. TEMPERAT (deg F 0.0 0.051 1 0.034 1 0.057 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 219.876 FLOW DISTRIBUT 000 205.246 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 957.150 OW POINT # Cal Inflow: Total: 32.000 963.529 33.000 964.565 33.300 0 965.348 35.000	LINE 953.251 958.285 1 is upstrea (cfs) 150.000 1100.000 963.580 964.599	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.051 1 0.051 1 0.034 1 0.057 1 0.373 1	LPHA TOP WIDTH .000 123.928 FLOW DISTRIBUT .000 67.126 FLOW DISTRIBUT .000 130.197 FLOW DISTRIBUT .000 219.876 FLOW DISTRIBUT .000 205.246 FLOW DISTRIBUT .000 77.367	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000 0.000 4.898	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LOCAL INFL SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 957.150 OW POINT # cal Inflow: Total: 32.000 963.529 33.000 964.565 33.300 965.348 35.000 966.613	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000 1100.000 963.580 964.599 965.405	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.051 1 0.051 1 0.034 1 0.057 1 0.373 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 219.876 FLOW DISTRIBUT 000 205.246 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL Lo. SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 0 957.150 OW FOINT # Cal Inflow: Total: 32.000 0 963.529 0 33.000 0 964.565 33.300 965.348 0 35.000 966.613 42.000	LINE 953.251 958.285 1 is upstrea DISCHARGE (cfs) 150.000 1100.000 963.580 964.599 965.405	HEAD 0.063 1 1.135 1 am of Section TEMPERATT (deg F 0.051 1 0.051 1 0.057 1 0.373 1	LPHA TOP WIDTH .000 123.928 FLOW DISTRIBUT .000 67.126 FLOW DISTRIBUT .000 130.197 FLOW DISTRIBUT .000 219.876 FLOW DISTRIBUT .000 205.246 FLOW DISTRIBUT .000 77.367	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000 0.000 4.898	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LOCAL INFL LOCAL INFL SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 0 957.150 OW FOINT # Cal Inflow: Total: 32.000 0 963.529 0 33.000 0 964.565 33.300 965.348 0 35.000 966.613 42.000	LINE 953.251 958.285 1 is upstree (cfs) 150.000 1100.000 963.580 964.599 965.405 966.986	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.051 1 0.051 1 0.057 1 0.373 1 0.032 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 67.126 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 219.876 FLOW DISTRIBUT 000 205.246 FLOW DISTRIBUT 000 77.367 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711 ION (%) = 969.815	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000 0.000 4.898 0.000 100.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LOCAL INFL LOCAL INFL LOCAL INFL SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00	SURFACE 1.000 953.188 15.000 0 957.150 OW POINT # Cal Inflow: Total: 32.000 0 963.529 0 33.000 0 964.565 0 33.300 0 965.348 0 965.613 0 42.000 0 972.961	LINE 953.251 958.285 1 is upstree (cfs) 150.000 1100.000 963.580 964.599 965.405 966.986 972.994	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.051 1 0.051 1 0.057 1 0.373 1 0.032 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 000 130.197 FLOW DISTRIBUT 000 219.876 FLOW DISTRIBUT 0000 205.246 FLOW DISTRIBUT 0000 77.367 FLOW DISTRIBUT 0000 242.312 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711 ION (%) = 963.815 ION (%) =	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000 0.000 4.898 0.000 100.000 0.000 1.443	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
SECTION NO. **** 1250.00 SECTION NO. **** 1250.00 LOCAL INFL LOCAL INFL LOCAL INFL SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO. **** 1100.00 SECTION NO.	SURFACE 1.000 953.188 15.000 0 957.150 OW POINT # Cal Inflow: Total: 32.000 0 963.529 0 33.000 0 964.565 0 33.300 0 965.348 0 965.613 0 42.000 0 972.961	LINE 953.251 958.285 1 is upstree (cfs) 150.000 1100.000 963.580 964.599 965.405 966.986	HEAD 0.063 1 1.135 1 am of Section TEMPERAT (deg F 0.051 1 0.051 1 0.057 1 0.373 1 0.032 1	LPHA TOP WIDTH 0000 123.928 FLOW DISTRIBUT 0000 67.126 FLOW DISTRIBUT 0000 130.197 FLOW DISTRIBUT 0000 219.876 FLOW DISTRIBUT 0000 205.246 FLOW DISTRIBUT 0000 77.367 FLOW DISTRIBUT 0000 77.367 FLOW DISTRIBUT 0000 242.312 FLOW DISTRIBUT	AVG BED 948.191 ION (%) = 954.971 ION (%) = .000 958.863 ION (%) = 961.193 ION (%) = 962.559 ION (%) = 963.711 ION (%) = 969.815	0.000 2.019 0.000 100.000 0.000 8.546 0.000 100.000 0.000 1.811 0.000 100.000 0.000 1.484 0.000 100.000 0.000 1.922 0.000 100.000 0.000 4.898 0.000 100.000 0.000 1.443	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

(cfs) 78.000 1022.000 (deg F) 0.00 0.00 Local Inflow: Total: SECTION NO. 44.000 \*\*\*\* 1022.000 973.803 1.000 969.857 973.819 0.015 260.206 0.000 0.995 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 53.000 \*\*\*\* 1022.000 975.218 0.000 6.141 0.000 100.000 975.804 0.586 L.000 78.162 973.089 FLOW DISTRIBUTION (%) = 1.000 0.000 0.000

64

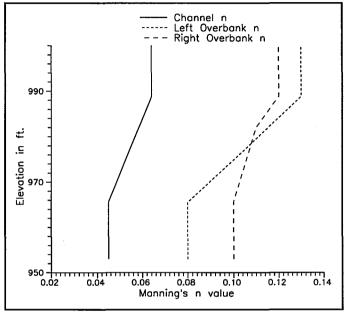
--- LOCAL INFLOW POINT # 3 is upstream of Section No. 53.000 ---DISCHARGE TEMPERATURE (cfs) (deg F) 340.000 Local Inflow: 0.00 682.000 0.00 Total: SECTION NO. 55.000 \*\*\*\* 682.000 978.823 978.863 0.040 1.000 101.072 974.641 0.000 1.614 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO ON NO. 58.000 682.000 979.887 980.091 0.204 3.625 1.000 56.154 976.536 0.000 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 TIME STEP # **\* A** PROF 2 A PROFILE 2 = BANK FULL FLOW EXAMPLE PROBLEM NO 1. FIXED-BED APPLICATION. BASIC GEOMETRY. ACCUMULATED TIME (yrs)..... 0.003 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 1 at Control Point # 1 ---DISCHARGE TEMPERATURE WATER SURFACE (deg F) (cfs) (ft) 2500.000 0.00 955.825 ENERGY VELOCITY \*\*\*\* DISCHARGE WATER ALPHA тор AVG VEL (by subsection) AVG SURFACE WIDTH RED (CFS) LINE HEAD 2 SECTION NO. 1.000 \*\*\*\* 2500.000 955.825 955.927 0.102 1.000 1.000 151.140 949.377 FLOW DISTRIBUTION (%) = 0.000 2.565 0.000 0.000 100.000 0.000 SECTION NO. 15.000 1.000 169.528 957.119 FLOW DISTRIBUTION (%) = 2500.000 959.673 960.191 0.518 1.000 0.000 5.774 0.000 \*\*\*\* 0.000 100.000 0.000 --- LOCAL INFLOW POINT # 1 is upstream of Section No. 15.000 ---DISCHARGE TEMPERATURE (cfs) (deg F) Local Inflow: 300.000 0.00 Total. 2200 000 0 00 N NO. 32.000 2200.000 965.362 SECTION NO. 965.465 0.103 1.000 140.643 0.000 2.572 959.281 0.000 0.000 100.000 FLOW DISTRIBUTION (%) = 0.000 N NO. 33.000 2200.000 966.551 SECTION NO. 966.604 0.053 1.000 232.014 961.404 0.000 1,842 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 N NO. 33.300 2200.000 967.192 SECTION NO. 967.273 0.082 1,000 215.861 962.746 0.000 2.292 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 35.000 \*\*\*\* 2200.000 968.416 0.000 968.811 0.395 1.000 168.513 965.827 0.000 5.043 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 2200.000 974 SECTION NO. 974.977 975.025 0.048 1.000 242.514 969.809 0.000 1.755 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 --- LOCAL INFLOW POINT # 2 is upstream of Section No. DISCHARGE TEMPERATURE 42.000 ---(cfs) 150.000 (deg F) Local Inflow: 0.00 2050.000 0.00 Total: SECTION NO. ON NO. 44.000 2050.000 975.775 975.802 0.027 1.000 268.762 969.954 0.000 1.310 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 NNO. 53.000 2050.000 977.052 SECTION NO. 1.000 977.665 0.613 97.657 973.710 0.000 6.281 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 --- LOCAL INFLOW POINT # 3 is upstream of Section No. 53.000 ---DISCHARGE TEMPERATURE (cfs) 650.000 (deg F) 0.00 Local Inflow: Total: 1400.000 0.00 SECTION NO. 55.000 \*\*\*\* 1400.000 980.715 980.794 0.080 1.000 108.982 975.039 0.000 2.264 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 58.000 63.384 977.053 0.000 4.522 \*\*\*\* 1400.000 981.937 982.255 0.318 1.000 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 ŚŚEND 0 DATA ERRORS DETECTED. TOTAL NO. OF TIME STEPS READ = TOTAL NO. OF WS PROFILES = ITERATIONS IN EXNER EQ = 2 2 0 COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES & 0.00 SECONDS

#### 6.2 Example Problem 2 - Hydraulic and Geometric Options

This problem builds on Example Problem 1; it is also a fixed-bed run and illustrates some of the more frequently used options for describing certain geometric and hydraulic conditions. The input file for Example Problem 2 is shown in Table 6-2a. Input items that differ from Example Problem 1 are discussed in Sections 6.2.1 through 6.2.5. Output is described in Sections 6.2.6 through 6.2.7.

#### 6.2.1 Manning's *n* Vs. Elevation

Some situations are better modeled by varving *n* values vertically rather than horizontally; this is done in Example Problem 2 at Section No. 15.0 by using NV records (see Appendix A for details). The n vs. elevation functions derived for Section No. 15.0 are shown graphically in Figure 6-2. These functions will be used at all subsequent (upstream) cross sections until another NV or NC record is found. Elevations on NV records are constant for all subsequent cross sections, therefore, as the computation proceeds upstream they may become too low. In this example, the NC record at Section No. 32.0 returns the computations to an *n* vs. subsection function. The NV record can also be used to vary *n* with discharge.



# 6.2.2 Internal Boundary Conditions

Figure 6-2 Manning's *n* vs. Elevation, Section No. 15

Study reaches will occasionally contain hydraulic controls, such as weirs and gated structures, where the step backwater solution is not appropriate. The effects of such structures can be simulated using X5 and R data to define an Internal Boundary Condition (IBC). In Example Problem 2, Section No. 33.0 is immediately upstream of a gated spillway that can arbitrarily control the upstream water surface elevation. Also, Section No. 35.0 is at the upstream face of an erosion control weir which maintains a fixed water surface elevation of 974 ft at that section during low flow conditions.

An internal boundary condition breaks the project reach into two smaller subreaches, creating a new upstream boundary and a new downstream boundary at that break point. The new upstream boundary is the cross section downstream of the internal boundary condition; the new downstream boundary is the cross section containing the X5 record defining the internal boundary condition.

Some modifications to the reach geometry are needed when an internal boundary condition is added to the model. Because Section No. 32.0 is representative of the reach downstream of the spillway at Section No. 33.0, Section No. 32.1, a duplicate of Section No. 32.0, was added at the downstream face of the spillway. This new cross section was assigned downstream reach lengths equal to those originally defined for Section No. 33.0 and the reach lengths of Section No. 33.0 were set to 0.0. The "2" in Field 4 of the X5 record for Section No. 33.0 causes the water surface elevation for that cross section to be read from Field 2 of the **R** record in the flow data. Thus, for this example, the specified water surface elevation at Section No. 33.0 will be 966 ft for the first discharge and 978 ft for the second. The larger of this water surface elevation or that computed by the step backwater is used.

Similarly, Section No. 33.9, a duplicate of Section No. 33.3, was added downstream of Section No. 35.0; its reach lengths are those originally set for Section No. 35.0 and the reach lengths for Section No. 35.0 were also set to 0.0. The X5 record entered with this cross section indicates that the minimum water surface elevation and head loss at this point are 974 ft and 0.5 ft, respectively.

#### 6.2.3 Ineffective Flow Area

A portion of Section No. 15.0 is deemed to be ineffective; that is, it carries no flow. This is described with the X3 record. which allows easy modification of existing cross section data to reflect encroachments. In this case, the left encroachment starts at the intersection of the left bank at elevation 961 ft and extends at that elevation to station 10,700 ft. The right encroachment starts at station 11,000 ft and extends at elevation 970 ft to the right bank. This is implemented in HEC-6 by raising the **GR** points within an encroachment to the encroachment elevation.

Another commonly used Ineffective Flow option is available to restrain flow within the channel

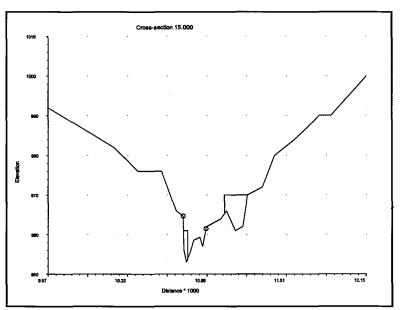


Figure 6-3 Cross Section 15.0 with encroachments

until the water surface is above the bank elevation. This option is used in Section No. 33.9 and 35.0 to model the natural levees in that reach.

#### Table 6-2a Example Problem 2 - Input Hydraulic Options

```
Τ1
        EXAMPLE PROBLEM NO 2. HYDRAULIC AND GEOMETRIC OPTIONS.
т2
        3 LOCAL INFLOWS, USE OF R RECORDS.
Т3
        SOUTH FORK, ZUMBRO RIVER
                                       ** Example Problem 2 **
NC
               .1
                      .04
                                        .3
      .1
                               .1
                                                ٥.
X1
     1.0
              31
                   10077
                           10275.
                                        Ο.
                                                         0.
GR 1004.
           9915.
                    978.4
                           10002.
                                    956.0
                                           10060.
                                                     959.2
                                                            10077.
                                                                      959.3
                                                                             10081.
GR 950.0
                                           10138.
                                                                      955.2
                                                                             10225.
          10092.
                   948.48
                           10108.
                                                     944.7
                                                             10158.
                                    946.6
GR 956.2
          10243.
                    958.9
                           10250.
                                            10275.
                                                     959.8
                                                                      959.9
                                                                              10325.
                                    959.8
                                                             10300.
GR 958.8
          10350.
                    957.4
                           10400.
                                    970.0
                                           10700.
                                                     966.0
                                                             10960.
                                                                      970.0
                                                                             11060.
GR 968.0
          11085.
                    968.0
                           11240.
                                    970.0
                                           11365.
                                                     970.0
                                                            11500.
                                                                      970.0
                                                                             11615.
GR 962.0
          11665.
                    962.0
                           12400.
                                     976.0
                                           12550.
                                                     980.0
                                                            12670.
                                                                      982.0
                                                                              12730.
GR 984.0
          12735.
HD
     1.0
             .045
                                     988.8
NV
      22
                    965.6
                             .064
NV
      12
             .08
                    965.6
                              .13
                                     988.8
```

982.0 988.8 NV 965.6 .12 33 . 1 .11 15.0 X1 X3 10850 3030. 3280. 970.0 27 10665. 3560. 10700. 961.0 11000. GR 992.0 9570. 982.0 10110. 976.0 10300. 976.0 10490. 966.0 10610. 10703. 955.6 GR 964.7 10665. 956.0 10673. 953.0 10693. 954.0 10723. 10822. 10825. GR 958.6 10750. 959.3 10800. 957.0 957.3 961.5 10850. GR 962.0 10852. 964.0 10970. 966.0 11015. 961.0 11090. 962.0 11150. GR 970.0 11190. 972.0 11310. 980.0 11410. 984.0 11570. 990.0 11770. GR 990.0 11865. 1000.0 12150. HD 15.0 Model Cascade Creek as a local inflow. ot ÑĈ .1 .1 .05 32.0 10057. 10271. X1 29 3630. 3060. 4240. GR 998.0 9080. 982.0 9250. 982.0 9510. 980.0 9600. 980.01 9925. GR979.48 978.5 10057. 10075. 956.5 10097. 10000. 968.6 959.82 10087. GR 956.8 10137. 10157. 959.6 10177. 959.82 10196. 10117. 957.8 959.4 978.6 10350. GR 966.5 978.5 978.5 10225. 971.2 10250. 10271. 10300. GR978.91 10370. 978.96 10387. 980.0 10610. 982.0 10745. 982.0 11145. GR 984.0 992.0 1000.0 1008. 11150. 11240. 11330. 11425. HD 32.0 Section 32.1 is a duplicate of Sec 32.0 which is representative of the reach downstream of the spillway at Sec 33.0. Sec 32.1 is a new upstream boundary. 32.1 29 10057. 10271. 3130. 3250. 3320. X1 32.1 Х3 10 GR 998.0 980.01 9925. 9080. 982.0 9250. 982.0 9510. 980.0 9600. GR979.48 10000. 978.5 10057. 968.6 10075. 959.82 10087. 956.5 10097. GR 956.8 957.8 10137. 10157. 959.6 10177. 959.82 10196. 10117. 959.4 GR 966.5 971.2 978.5 10271. 978.5 10300. 978.6 10350. 10225. 10250. GR978.91 10370. 978.96 10387. 980.0 10610. 982.0 10745. 982.0 11145. GR 984.0 992.0 11240. 1000.0 11330. 1008. 11150. 11425 HD 32.1 A spillway is located here X1 2150. 33.0 21 1850. 0 0 0 X5 ХL 250. GR 1000. 980. 990.0 1060. 980.0 1150. 982.0 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.0 NOTE : Section 33.3 is a duplicate of Section 33.0. Section 33.0 is a good representative cross section for a long reach. A duplicate is used here to break up the long reach into two smaller reaches. 33.3 21 1850. 2150. 1550. 1750. 1750. .95 1.49 X1 XT. 250. GR 1000. 982.0 980. 990.0 1060. 980.0 1150. 982.0 1180. 1215. 1540. 982.0 980.0 980.0 GR 980.0 1260. 982.0 1300. 1350. 1420. 979.19 984.41 1850. 961.0 1900.8 GR 982.0 1730. 982.0 1830. 1851. GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.3 Section 33.9 is a duplicate of Section 33.3. It is placed at the downstream face of the weir being defined at Section 35.0 and is a new upstream boundary. X1 33.9 21 1850. 2150. 1050. 1050. 1050. .95 1.65 X3 10 X3 10 GR 1000. 990.0 1060. 982.0 982.0 980. 980.0 1150. 1180. 1215. GR 980.0 982.0 980.0 1420. 980.0 1540. 1300. 982.0 1350. 1260. GR 982.0 1730. 979.19 1851. 961.0 1900.8 982.0 1830. 984.41 1850. GR 961.0 982.0 990.0 3100. 2099.2 976.0 2149. 984.5 2150. 2800. GR 1000. 3170. HD 33.9 is located here. 22 9894. A weir X1 35.0 10245. 0 0 0 10 Х3 X5 974. 0.5 GR 984.0 9035. 980.0 9070. 978.0 980.0 9185. 982.0 9270. 9135. GR 980.0 9465. 981.7 9595. 983.7 9745. 984.7 9894. 963.4 9894.1 GR 963.3 9954. 967.1 9974. 10004. 968.2 10044. 967.6 10054. 967.4 984.0 GR 973.4 10115. 977.4 10120. 983.7 10155. 10245. 982.0 10695. GR 982.0 10895. 1004.0 11085. 35.0 HD NC .06 .06 .045 42.0 9880. 32 10130. 5370. 5000. 5210. X1 GR 996.0 7930. 7130. 998.0 7310. 998.0 992.0 8205. 990.0 8495. 986.0 9707. 989.44 9857. GR 988.0 8780. 8990. 985.7 9570. 986.45 9941. GR 990.0 9941. 985.8 9943. 9880. 969.8 9881. 969.8 985.8 969.8 GR 969.8 969.8 10001. 9943. 10001. 986.7 986.7 10003. 10003. 985.8 10067. GR 969.8 10067. 985.8 10069. 969.8 10069. 969.8 10129. GR 989.9 10130. 989.5 10180. 988.6 10230. 987.6 10280. 985.2 10430. GR 986.8 11720. 989.9 12310. 42.0 HD

```
Model Silver Creek as a local inflow.
QT
                             10127.
λī
XL
    44.0
                28
                     9845.
                                        3200.
                                                 3800.
                                                          3500.
                                       10200.
                               9850.
                                                 8305.
                                                                   8735.
                                                                            988 0
GR 1002.
            8035.
                     992.Ò
                               8150.
                                       990.0
                                                          990.0
                                                                                     8835
GR 996.0
            9285.
                    1017.6
                               9425.
                                        990.0
                                                 9505.
                                                          986.0
                                                                   9650.
                                                                            984.1
                                                                                     9788.
                                                9898.
                                                                   9968.
GR 980.6
            9845.
                     970.9
                               9868.
                                       972.2
                                                          970.5
                                                                            967.5
                                                                                     9998.
                                                10078.
GR 968.9
           10028.
                     967.4
                             10058.
                                        967.1
                                                          971.9
                                                                  10118.
                                                                            976.8
                                                                                    10127.
GR 977.8
           10150.
                     976.9
                             10193.
                                        982.0
                                                10206.
                                                          981.2
                                                                  10300.
                                                                            979.2
                                                                                    10325.
GR 983.1
           10400.
                     999.8
                             10450.
                                       1002.4
                                               10464.
HD
   44.0
X1
    53.0
               22
                    10000.
                             10136.
                                       3366.
                                                 2832.
                                                          2942.
            7550.
                                                                            996.0
                                                                                     8780.
GR 1004.
                                                          996.0
                                                                   8640
                    1000.0
                               7760.
                                        998.0
                                                 8440.
                                                                            983.8
                               9245.
                                                                                     9900.
GR 994.0
            8940.
                     986.0
                                        986.3
                                                 9555.
                                                          986.3
                                                                   9825.
GR 982.8
                                                                            972.6
                     978.2
                             10011.
                                               10041.
                                                          972.2
                                                                  10071.
           10000.
                                        974.0
                                                                                    10101.
GR 978.2
                             10136.
           10121.
                     988.7
                                        989.3
                                               10154.
                                                          999.2
                                                                  10200.
                                                                           1000.1
                                                                                    10320.
GR 1002.
           10470.
                    1004.0
                             10700.
HD
    53.0
   model Bear Creek as a local inflow.
QT
ñ1
    55.0
                18
                     9931.
                             10062.
                                        2275.
                                                 3430.
                                                          2770.
   1004.
            7592.
                    1000.0
                                                          990.0
                                                                   9052.
                                                                            986.0
                                                                                     9337.
GR
                               7947.
                                        996.0
                                                 8627.
   984.3
            9737.
                     984.7
                               9837.
                                        985.5
                                                 9910.
                                                          987.2
                                                                   9931.
                                                                            978.1
                                                                                     9955.
GR
   974.8
            9975.
                     974.2
                             10005.
                                        972.9
                                                10035.
                                                          973.2
                                                                  10045.
                                                                            983.8
                                                                                    10062.
GR
GR 985.8
           10187.
                     986.0
                             10307.
                                        990.0
                                                10497.
HD
    55.0
    58.0
X1
                22
                    9912.0 10015.0
                                        1098.
                                                 1012.
                                                          1462.
GR 1006.
                                                          997.2
                                                                            996.3
            8542.
                    1004.0
                               8952.
                                       1000.0
                                                 9702.
                                                                   9812.
                                                                                     9912.
   976.2
                     975.4
                               9974.
                                                          990.4
                                                                            988.3
                                                                                    10062.
GR
            9944.
                                        978.2
                                                 9991.
                                                                  10015.
GR 988.8
           10065.
                     988.3
                             10065.
                                        989.3
                                                10169.
                                                          990.0
                                                                  10172.
                                                                            992.0
                                                                                    10242.
GR 992.0
           10492.
                     988.0
                             10642.
                                        986.7
                                               10852.
                                                          988.0
                                                                  11022.
                                                                            986.0
                                                                                    11097.
GR 986.0
           11137.
                     988.0
                             11192.
HD
    58.0
EJ
$HYD
*
         PROFILE 1 = AVERAGE ANNUAL DISCHARGE
    А
Q
R
   1250.
             150.
                        78.
                                340.
    960.
             966.
т
     60.
               60.
                        60.
                                 60.
w
*
      5.
    в
         PROFILE 2 = FLOOD EVENT
                                      (0.5% CHANCE FLOOD)
0
R
  10000.
            1200.
                       600.
                               2600.
    973.
             978.
W
      1.
$$END
```

#### 6.2.4 Conveyance Limits

Ineffective flow areas can also be specified with XL data. In Example Problem 2, Section No. 33.0 has non-conveying areas centered about the channel on both sides, leaving a conveyance width of 250 ft. Since Section No. 33.3 is a duplicate of Section No. 33.0, the conveyance limit is duplicated at this section. At Section No. 44.0, conveyance limits have been specified at stations 9,850 and 10,200, leaving a conveyance width of 350 ft (not centered about the channel). The difference between the ineffective flow area option and the conveyance limits option is that deposition may occur in wetted areas outside the conveyance limits, but not in ineffective flow areas. Although both methods may yield the same hydraulic conditions, sediment deposition may differ. Refer to Sections 3.2.7 for more details.

#### 6.2.5 Downstream Boundary Water Surface Elevation

In Example Problem 1, the downstream boundary water surface elevation was computed for each flow by interpolation within a rating curve provided by the user. Alternately, when the downstream water surface elevation is independent of discharge, as with a reservoir pool elevation, the boundary condition can be specified as a time series of water surface elevations (i.e. a stage hydrograph). This is illustrated by the **R** records in the input data for Example Problem 2. For this problem the starting water surface elevation at the downstream boundary is 960 ft for the first discharge and 973 ft for the second.

#### 6.2.6 A-Level Hydraulic Output

A-level hydraulic output was produced for the first flow profile (time step) of Example Problem 2. This output, shown in Table 6-2b, is quite similar to that of Example Problem 1. Note that the water surface elevation at Section No. 33.0 of 966 ft reflects the elevation specified on the **R** record.

A-level hydraulic output is a subset of B-level hydraulic output. It can, therefore, be seen that at time step 2, the 974 ft minimum pool elevation for Section No. 35.0 (as specified on the X5 record) was submerged by tailwater and, therefore, a head loss of 0.5 ft was added to the tailwater elevation of 978.675 ft resulting in a computed water surface elevation of 979.175 ft.

The large discharge for time step 2 produced a sufficiently high water surface profile that the flow at Sections 33.0 and 44.0 is bounded by the conveyance limits. This can be seen in the column labeled "TOP WIDTH" where the values are 250 ft and 350 ft respectively for these cross sections.

#### 6.2.7 B-Level Hydraulic Output

B-level hydraulic output was produced for the second flow profile of Example Problem 2. This output is more detailed than the A-level output produced by the first profile. It may be used to check the effective geometry of each cross section as well as the computed value of most of the hydraulic parameters used in the backwater calculations. For example, to check the operation of the *n* vs. elevation function at Section No. 15.0, refer to the table "REACH PROPERTIES BY STRIP". The *n* values used for the left overbank, channel, and right overbank are 0.0963, 0.0512, and 0.1046, respectively. These are interpolated from the input **NV** table for a computed water surface elevation of 973.158 ft. Also, note that the **GR** data shown for Section No. 15.0 reflect the **X3** encroachment. Elevations on the left side are kept above 961 ft to station 10,700. The same is seen on the right side as elevations are kept at 970 ft after station 11,000 until the original ground line is encountered.

## Table 6-2b Example Problem 2 Hydraulic Output

<pre>* SCOUR AND DEPOSITION IN RIVERS AND RESERVOIRS * * U.S. ARMY CORPS OF ENGINEERS * * Version: 4.1.00 - AUGUST 1993 * * HUDROLOGIC ENGINEERING CENTER * * INPUT FILE: EXAMPLE2.DAT * 609 SECOND STREET * * OUTPUT FILE: EXAMPLE2.OUT * DAVIS, CALIFORNIA 95616-4687 * RUN DATE: 30 AUG 93 RUN TIME: 10:28:02 * * (916) 756-1104 ** **********************************</pre>	******	* * * * * * * * * * * * * * * * * * * *	*****	*****
<pre>* Version: 4.1.00 - AUGUST 1993 * * HYDROLOGIC ENGINEERING CENTER * * INPUT FILE: EXAMPLE2.DAT * 609 SECOND STREET * OUTPUT FILE: EXAMPLE2.OUT * DAVIS, CALIFORNIA 95616-4687 * * RUN DATE: 30 AUG 93 RUN TIME: 10:28:02 * (916) 756-1104 * ***********************************</pre>	* SCOUR AND DEPOSITI	ION IN RIVERS AND RE	ESERVOTRS *	* ILS ARMY CORPS OF ENGINEERS *
<pre>* INPUT FILE: EXAMPLE2.DAT * * 609 SECOND STREET * * OUTPUT FILE: EXAMPLE2.OUT * DAVIS, CALIFORNIA 95616-4687 * * CNU DATE: 30 AUG 93 RUN TIME: 10:28:02 * * (916) 756-1104 ***********************************</pre>				
<pre>* OUTPUT FILE: EXAMPLE2.OUT * * DAVIS, CALIFORNIA 95616-4687 * * RUN DATE: 30 AUG 93 RUN TIME: 10:28:02 * * (916) 756-1104 * ***********************************</pre>			*	
* RUN DATE: 30 AUG 93 RUN TIME: 10:28:02 * * (916) 756-1104 * X X XXXXXX XXXX XXXX XXXXX X X X X			*	
<pre>X X XXXXXX XXXXX XXXXX X X X X X X X X X X X X X X X X XXXXXX</pre>			28.02 *	
X X X X X X X X X X X X X X X X XXXXXX X X X				
X X X X X X X X X X X X X X X X XXXXXX X X X				
X X X X X X XXXX X XXXXXXX XXXX X XXXXX X X X X X		x x xxxxxxx	XXXXX	XXXXX
XXXXXX XXXX X XXXX XXXXXX X X X X X X X		х хх	х х	х х
X XXXXXX		х хх	х	х
X X X X X X X X X X X XXXXXX XXXX XXXX		XXXXXXX XXXX	x xxxxx	XXXXXX
X X XXXXXX XXXX XXXX ******************		х хх	х	х х
<pre>* MAXIMUM LIMITS FOR THIS VERSION ARE: * 10 Stream Segments (Main Stem + Tributaries) * * 150 Cross Sections * * 100 Elevation/Station Points per Cross Section * * 20 Grain Sizes * * 10 Control Points * * 10 Control Points *</pre>		х хх	х х	X X
<ul> <li>MAXIMUM LIMITS FOR THIS VERSION ARE:</li> <li>10 Stream Segments (Main Stem + Tributaries)</li> <li>150 Cross Sections</li> <li>100 Elevation/Station Points per Cross Section</li> <li>20 Grain Sizes</li> <li>10 Control Points</li> <li>*</li> </ul>		x x xxxxxxx	XXXXX	XXXXX
<ul> <li>MAXIMUM LIMITS FOR THIS VERSION ARE:</li> <li>10 Stream Segments (Main Stem + Tributaries)</li> <li>150 Cross Sections</li> <li>100 Elevation/Station Points per Cross Section</li> <li>20 Grain Sizes</li> <li>10 Control Points</li> <li>*</li> </ul>				
*       10       Stream Segments (Main Stem + Tributaries)       *         *       150       Cross Sections       *         *       100       Elevation/Station Points per Cross Section       *         *       20       Grain Sizes       *         *       10       Control Points       *	********	*****	* * * * * * * * * * * * * * * * *	******
<ul> <li>* 150 Cross Sections</li> <li>* 100 Elevation/Station Points per Cross Section</li> <li>* 20 Grain Sizes</li> <li>* 10 Control Points</li> <li>* *</li> </ul>	* MAXIMUM I	JIMITS FOR THIS VERS	SION ARE:	*
<ul> <li>* 100 Elevation/Station Points per Cross Section</li> <li>* 20 Grain Sizes</li> <li>* 10 Control Points</li> <li>* ***********************************</li></ul>	* 10	Stream Segments (Ma	ain Stem + Tribu	taries) *
* 20 Grain Sizes * * 10 Control Points * ***********************************	* 150	Cross Sections		*
* 10 Control Points * ***********************************	* 100	Elevation/Station P	Points per Cross	Section *
****************	* 20	Grain Sizes		*
	* 10	Control Points		*
	*********	*****	******	******
T1 EXAMPLE PROBLEM NO 2. HYDRAULIC AND GEOMETRIC OPTIONS.	T1 EXAMPLE PROBL	LEM NO 2. HYDRAULIC	C AND GEOMETRIC	OPTIONS.
T2 3 LOCAL INFLOWS, USE OF R RECORDS.		WS, USE OF R RECORD		

#### Chapter 6

.. Left Channel Right 0.1000 0.0400 0.1000 N values... Contraction Expansion 1.1000 0.7000 SECTION NO. 1.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. N-Values vs. Elevation Table Channel 0.0450 966. 0.0640 989. 0.0000 0. Left Overbank Right Overbank 0.1000 966 0.0800 966. 966. 0.1300 989. 0.1100 982 n 989 SECTION NO. SECTION NO. 15.000 ...Left Encroachment defined at station 10700.000 at elevation 961.000 ...Right Encroachment defined at station 11000.000 at elevation 970.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. LOCAL INFLOW POINT 1 occurs upstream from Section No. 15 000 Expansion N values... Left Channel Right 0.1000 0.0500 0.1000 Contraction 0.7000 1.1000 32.000 SECTION NO ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO 32 100 ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 10057.000 10271.000 Ineffective Elevation 978.500 978.500 ...DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 33.000 SECTION NO. 33.000 ...Internal Boundary Condition Water Surface Elevation will be read from R-RECORD, Field 2 Head Loss = 0.000 ...Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 33.300 ...Adjust Section WIDTH to 95.00% of original. ...Adjust Section ELEVATIONS by 1.490 ft. ...Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. ...DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 33,900 SECTION NO. 33.900 ...Adjust Section WIDTH to 95.00% of original. ...Adjust Section ELEVATIONS by 1.650 ft. ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 1757.500 2042.500 Ineffective Elevation 986.060 986.150 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 35,000 SECTION NO. 35.000 ...Internal Boundary Condition Water Surface Elevation = 974.000 Head Loss = \_\_\_0.500 Head Loss = 0.500 ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 9894.000 10245.000 0.00 ft. Ineffective Elevation 984.700 ... DEPTH of the Bed Sediment Control Volume = N values... Left Channel Right 0.0600 0.0450 0.0600 Contraction Expansion 0.7000 1.1000 SECTION NO. 42.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. LOCAL INFLOW POINT 2 occurs upstream from Section No. 42.000 SECTION NO. 44.000 ...Limit CONVEYANCE between stations 9850.000 and 10200.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 53.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. LOCAL INFLOW POINT 3 occurs upstream from Section No. 53.000 SECTION NO. 55.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 58.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 13 NO. OF INPUT DATA MESSAGES = 0 TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = 13 TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK= 1 END OF GEOMETRIC DATA  \$HYD FIXED-BED MODEL

XAMPLE PROBLEM 1 ACCUMULATED TIME			GEOMETRI 0.000	C OPTION	s.			
Downstream Bo	oundary Con	ndition Da DISCHARG (cfs) 1250.0	E TEMPEI (deg		MENT NO. 1 WATER SURFA (ft) 960.00	CE	ol Point # 1	-
**** DISCHARGE (CFS)	WATER SURFACE	ENERGY LINE	VELOCITY HEAD	ALPHA	TOP WIDTH	AVG BED	AVG VEL (by su 1 2	ubsectio 3
SECTION NO. **** 1250.000	1.000 960.000	960.008	0.008	1.266 FLOW	412.262 DISTRIBUTIO	951.520 N (%) =	0.120 0.731 0.589 98.210	0.075 1.201
ECTION NO. 2 *** 1250.000	960.343	960.518	0.174	1.000 FLOW	143.121 DISTRIBUTIO	957.736 N (%) =	0.000 3.350 0.000 100.000	0.000
LOCAL INFLOW	POINT # 1 Inflow: Total:	l is upstr DISCHARG (cfs) 150.0 1100.0	E TEMPE (deg	ction Nc RATURE g F) 60.00 60.00	o. 15.0	00		
ECTION NO. 3	32.000 964.111	964.151	0.041	1.000	133.277	959.020	0.000 1.621	0.000
ECTION NO. 3	32.100 965.009	965.038	0.029	1.000	DISTRIBUTIO	959.202	0.000 100.000	0.000
ECTION NO	33.000 <b>dary Condi</b> t	tion - Wat	er Surface Head Los:	e = 9	DISTRIBUTIO 066.000 0.000	N (%) =	0.000 100.000	0.000
*** 1100.000 ECTION NO. 3	<b>966.000</b>	966.016	0.016	1.000	228.689 DISTRIBUTIO	961.331 N (%) =	0.000 1.030 0.000 100.000	0.000
	966.410 33.900	966.441	0.031	1.000 FLOW	210.966 DISTRIBUTIO	962.711 N (%) =	0.000 1.410 0.000 100.000	0.000
*** 1100.000 ECTION NO. 3 Internal Bound	966.792 35.000	966.820	0.027		212.251 DISTRIBUTIO	962.893 N (%) =	0.000 1.329 0.000 100.000	0.000
*** 1100.000	974.000	974.008	Head Los: 0.008	<b>s =</b> 1.000	0.500 221.700 DISTRIBUTIO	967.056 N (%) =	0.000 0.715 0.000 100.000	0.000
ECTION NO. 4 *** 1100.000	2.000 974.356	974.371	0.016	1.000	242.451 DISTRIBUTIO	969.819	0.000 1.000 0.000 100.000	0.000
LOCAL INFLOW	POINT # 2	DISCHARG	E TEMPEI	RATURE	9. 42.0	00		
Local	Inflow: Total:	(cfs) 78.0 1022.0	00	g F) 60.00 60.00				
*** 1022.000	4.000 974.697	974.707	0.010	1.000 FLOW	264.095 DISTRIBUTIO	969.892 N (%) =	0.000 0.805 0.000 100.000	0.000
ECTION NO. 5 *** 1022.000	53.000 975.359	975.884	0.525	1.000 FLOW	79.436 DISTRIBUTIO	973.146 N (%) =	0.000 5.813 0.000 100.000	0.000
LOCAL INFLOW	POINT # 3 Inflow: Total:	3 is upstr DISCHARG (cfs) 340.0 682.0	E TEMPE (deg	ction No RATURE g F) 60.00 60.00	o. 53.0	00		
ECTION NO. 5 *** 682.000	5.000 978.831	978.872	0.042	1.000 FLOW	100.844 DISTRIBUTIO	974.694 N (%) =	0.000 1.635 0.000 100.000	0.000
ECTION NO. 5 *** 682.000	58.000 979.918	980.119	0.201	1.000	56.248 DISTRIBUTIO	976.547	0.000 3.596 0.000 100.000	0.000
IME STEP # BB PROFILE :	2		.5% CHANCE					=
XAMPLE PROBLEM 1 CCUMULATED TIME	10 2. HYDI	RAULIC ANI		-	IS.			
							ol Point # 1	

**** DISCHARGE WATER (CFS) SURFACE	ENERGY VELOCIT LINE HEAD	Y ALPHA		VG AVG ED 1	VEL (by s 2	subsection) 3	
SECTION NO. 1.000							
10092.000         950.000         102           10243.000         956.200         102           10350.000         958.800         104           11085.000         968.000         112	TA, ELEV)         002.000       978.400         108.000       948.480         250.000       958.900         400.000       957.400         240.000       968.000         400.000       962.000	10138.000 10275.000 10700.000 11365.000	946.600 959.800 970.000 970.000	10077.000 10158.000 10300.000 10960.000 11500.000 12670.000	959.200 944.700 959.800 966.000 970.000 980.000	10081.000 10225.000 10325.000 11060.000 11615.000 12730.000	959.300 955.200 959.900 970.000 970.000 982.000
**** 10000.000 973.000	973.013 0.013		501.875 95: STRIBUTION (	1.520 0.30 %) = 1.91		0.258 45.211	
REACH PROPERTIES BY ST		2	3				
INEFF FLOW U/S SECTION CONVEY		1200769.591					
HYD RA REACH Manning SQR D/S SECTION	DIUS 9.8620 'S N 0.1000 F(L) 0.0000 AREA 0.00	20.9515 0.0400 0.0000 0.00	7.8160 0.1000 0.0000 0.00				
HYD RAI SECTION NO. 15.000	DIUS 0.000	0.000	0.000				
Cross Section Geometry (S <sup>7</sup> 9570.000 992.000 10 10665.000 964.700 <b>10</b> 10703.000 954.000 10 10825.000 957.300 10 <b>11000.001 970.000 11</b>	TA,ELEV) 110.000 982.000 673.000 961.000 723.000 955.600 850.000 961.500 015.000 970.000 410.000 980.000	10693.000 10750.000 10852.000 11090.000	<b>961.000</b> 958.600 962.000 <b>970.000</b>	10490.000 <b>10699.999</b> 10800.000 10970.000 <b>11150.000</b> 11770.000	976.000 <b>961.000</b> 959.300 964.000 <b>970.000</b> 990.000	10610.000 10700.000 10822.000 11000.000 <b>11190.000</b> 11865.000	966.000 953.700 957.000 965.333 <b>970.000</b> 990.000
**** 10000.000 973.158	973.259 0.102		800.329 958 STRIBUTION (	8.554 0.79 %) = 5.85		0.700	
REACH PROPERTIES BY ST		2	3				
INEFF FLOW U/S SECTION CONVEY		454198.571	95851.669				
HYD RAI REACH Manning	DIUS 5.2173	13.9368	4.8880				
SQR	r(L) 59.6657 Area 635.95	57.2713 4252.96	55.0454 17543.21				
LOCAL INFLOW POINT # :		Section No. PERATURE deg F)	15.000				
Local Inflow: Total:	1200.000 8800.000	60.00 60.00					
SECTION NO. 32.000							
10000.000 979.480 100 10117.000 956.800 100 10225.000 966.500 100 10370.000 978.910 100	<b>FA, ELEV</b> )         250.000       982.000         057.000       978.500         137.000       957.800         250.000       971.200         387.000       978.960         240.000       992.000	10075.000 10157.000 10271.000 10610.000	968.600 959.400 978.500 980.000	9600.000 10087.000 10177.000 10300.000 10745.000 11425.000	980.000 959.820 959.600 978.500 982.000 1008.000	9925.000 10097.000 10196.000 10350.000 11145.000	980.010 956.500 959.820 978.600 982.000
**** 8800.000 974.581	974.786 0.205		195.704 963 STRIBUTION (	2.193 0.00 %) = 0.00	00 3.630 00 100.000	0.000 0.000	
REACH PROPERTIES BY ST INEFF FLOW		2 -99999.000	3 -99999.000				
U/S SECTION CONVEY		377076.318	0.000				
	DIUS 0.0000 SN 0.1000 F(L) 60.2495 AREA 736.62	11.9716 0.0500 65.1153 2701.62	0.0000 0.1000 55.3173 2342.75				
HYD RAI SECTION NO. 32.100	DIUS 5.217	13.937	4.888				
Cross Section Geometry (S 9080.000 998.000 92 10000.000 979.480 100 10117.000 956.800 100 10225.000 966.500 100 10370.000 978.910 100	TA,ELEV) 250.000 982.000 057.000 978.500 137.000 957.800 250.000 971.200 387.000 978.960 240.000 992.000	10075.000 10157.000 10271.000 10610.000	968.600 959.400 978.500 980.000	9600.000 10087.000 10177.000 10300.000 10745.000 11425.000	980.000 959.820 959.600 978.500 982.000 1008.000	9925.000 10097.000 10196.000 10350.000 11145.000	980.010 956.500 959.820 978.600 982.000
**** 8800.000 <b>976.143</b>	976.304 0.161		202.931 963 STRIBUTION (3	2.684 0.00 %) = 0.00	00 3.222 00 100.000	0.000 0.000	

REACH PROPERTIES BY STRIP 1 INEFF FLOW EL 978.500 U/S SECTION CONVEYANCE 0.000 AREA 0.00	2 -99999.000 448358.998 2731.27	3 978.500 0.000 0.00			
HYD RADIUS 0.0000 REACH Manning's N 0.1000	12.9813 0.0500	0.0000 0.1000			
SQRT(L) 55.9464 D/S SECTION AREA 0.00 HYD RADIUS 0.000	57.6194 2424.45 11.972	57.0088 0.00 0.000			
SECTION NO. 33.000 Internal Boundary Condition - Water Surfa Head Lo					
Cross Section Geometry (STA, ELEV)980.0001060.0001060.0001260.000980.0001300.000982.0001830.000982.0001900.800961.0002099.2002800.000982.0003100.000	1150.000 1350.000 1850.000 2125.000 3170.000	980.000         1180.           982.000         1420.           984.410         1851.           968.771         2149.           1000.000         1420.	000 980.000 000 979.190	1215.000 1540.000 1875.000 2150.000	982.000 980.000 970.424 984.500
**** 8800.000 <b>978.000</b> 978.074 0.074		5 <b>0.000</b> 961.887 TRIBUTION (%) =	0.000 2.185 0.000 100.000	0.000 0.000	
REACH PROPERTIES BY STRIP         1           INEFF FLOW EL         -99999.000           U/S SECTION         CONVEYANCE         0.000           AREA         0.00           HYD RADIUS         0.0000           REACH         Manning's N         0.1000           SQRT(L)         0.0000           D/S SECTION         AREA         0.000           HYD RADIUS         0.0000           BORT(L)         0.0000           D/S SECTION         AREA         0.000	2 -99999.000 758052.954 4028.19 15.9335 0.0500 0.0000 2731.27 12.981	3 -99999.000 0.000 0.000 0.0000 0.1000 0.0000 0.000			
SECTION NO. 33.300					
Cross Section Geometry (STA, ELEV)931.0001001.4901007.000991.4901197.000981.4901235.000983.4901643.500983.4901738.500983.4901805.760962.4901994.240962.4902660.000983.4902945.000991.490	1092.500 1282.500 1757.500 2018.750 3011.500	981.490         1121.           983.490         1349.           985.900         1758.           970.261         2041.           1001.490         1001.490	000 981.490 450 980.680	1154.250 1463.000 1781.250 2042.500	983.490 981.490 971.914 985.990
**** 8800.000 978.266 978.363 0.096		37.500 963.377 TRIBUTION (%) =	0.000 2.488 0.000 100.000	0.000	
REACH PROPERTIES BY STRIP         1           INEFF FLOW         -99999.000           U/S SECTION         CONVEYANCE         0.000           AREA         0.00           HYD RADIUS         0.0000           REACH         Manning's N         0.1000           SQRT(L)         39.3700           D/S SECTION         AREA         0.000           HYD RADIUS         0.000	2 -99999.000 630880.219 3536.31 14.7069 0.0500 41.8330 4028.19 15.934	3 -99999.000 0.000 0.000 0.1000 41.8330 0.00 0.000			
SECTION NO. 33.900					
Cross Section Geometry (STA, ELEV) 931.000 1001.650 1007.000 991.650 1197.000 981.650 1235.000 983.650 1643.500 983.650 1738.500 983.650 1994.240 962.650 2041.550 977.650 3011.500 1001.650	1092.500 1282.500 1757.500 2042.500	981.6501121.983.6501349.986.0601758.986.1502660.	000 981.650 450 980.840	1154.250 1463.000 1805.760 2945.000	983.650 981.650 962.650 991.650
**** 8800.000 <b>978.486</b> 978.574 0.088		77.066 965.114 FRIBUTION (%) =			
	13.0880 0.0500 32.4037 3536.31	$\begin{array}{r} 3\\ 986.150\\ 0.000\\ 0.00\\ 0.000\\ 0.1000\\ 32.4037\\ 0.00\\ 0.000\\ 0.000\\ \end{array}$			
SECTION NO. 35.000 Internal Boundary Condition - Water Surf. Head L	ace = 974.0 oss = 0.1				
Cross Section Geometry (STA, ELEV) 9035.000 984.000 9070.000 980.000 9465.000 980.000 9595.000 981.700 9954.000 963.300 9974.000 967.100 10115.000 973.400 10120.000 977.400 10895.000 982.000 11085.000 1004.000	9745.000 10004.000 10155.000	983.700 9894.	000 984.700 000 968.200	9270.000 9894.100 10054.000 10695.000	982.000 963.400 967.600 982.000
**** 8800.000 <b>978.986</b> 979.155 0.169		34.784 967.632 TRIBUTION (%) =			
	2 -99999.000 381293.994	3 984.000 0.000			

REACH D/S SECTION.	HYD RA	J'S N (T(L) AREA	$\begin{array}{c} 0.00\\ 0.0000\\ 0.1000\\ 0.0000\\ 0.000\\ 0.000\\ 0.000\end{array}$	2665.83 10.5576 0.0500 0.0000 3704.84 13.088	0.00 0.0000 0.1000 0.0000 0.000 0.000				
SECTION NO. Cross Section	42.000 Geometry (S	STA.ELEV)							
7130.000 8780.000 9880.000 9943.000 10067.000 10130.000	996.000 7 988.000 8 990.000 9 969.800 10 969.800 10 969.800 10	7310.000 8990.000 881.000 0001.000 0067.000 0180.000 2310.000	998.000 986.000 969.800 969.800 985.800 985.500 989.500	7930.000 9570.000 9941.000 10001.000 10069.000 10230.000	998.000 985.700 969.800 986.700 985.800 988.600	8205.000 9707.000 9941.000 10003.000 10069.000 10280.000	992.000 986.450 985.800 986.700 969.800 987.600	8495.000 9857.000 9943.000 10003.000 10129.000 10430.000	990.000 989.440 985.800 969.800 969.800 985.200
**** 8800.00	0 981.452	981.603	0.151		43.155 96 TRIBUTION (	9.845 0.00 %) = 0.00	0 3.118 0 100.000	0.000 0.000	
REACH PRO U/S SECTION. REACH D/S SECTION.	HYD RA Manning SQF	V EL -9 ANCE AREA ADIUS J'S N AT(L) AREA	1 99999.000 0.000 0.0000 0.0600 73.2803 0.000 0.000	2 -99999.000 385783.789 2822.24 8.4220 0.0450 72.1803 2665.83 10.558	3 -99999.000 0.000 0.0000 0.0600 70.7107 0.00 0.000				
LOCAL INFL	OW POINT #	2 is upst DISCHAR		ection No. ERATURE	42.000				
Lo	cal Inflow: Total:	(cfs) 600. 8200.	(d 000	eg F) 60.00 60.00					
SECTION NO.	44.000	0200.		00.00					
9285.000 9845.000 9998.000 10127.000	002.000 8 996.000 9 980.600 9 967.500 10 976.800 10	3150.000	992.000 1017.600 978.491 968.900 977.800 979.200	8305.000 9505.000 9868.000 10058.000 10193.000 10400.000	990.000 990.000 970.900 967.400 976.900 983.100	8735.000 9650.000 9898.000 10078.000 10200.000 10450.000	990.000 986.000 972.200 967.100 979.646 999.800	8835.000 9788.000 9968.000 10118.000 10206.000 10464.000	988.000 984.100 970.500 971.900 982.000 1002.400
**** 8200.00	0 982.491	982.571	0.079		<b>50.000</b> 97 TRIBUTION (	0.182 0.00 %) = 0.00		0.958 4.321	
0200100	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQR	STRÌP I EL -9 IANCE AREA DIUS I'S N I'S N I'S N I'L) AREA	1 99999.000 0.000 0.0000 0.0600 56.5685 0.000 0.000			<b>%) = 0.00</b>			
REACH PRO U/S SECTION. REACH	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQR 	STRÌP I EL -9 IANCE AREA DIUS I'S N I'S N I'S N I'L) AREA	1 99999.000 0.000 0.0000 0.0600 56.5685 0.00	FLOW DIS 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.00	<b>%) = 0.00</b>			
REACH PRO U/S SECTION. REACH D/S SECTION. SECTION NO. Cross Section 7550.000 1 8940.000 10000.000	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF   HYD RA 53.000 Geometry (S 004.000 7 994.000 9 982.800 10 978.200 10	STRIP J EL -9 AREA ADIUS J'S N TT(L) AREA ADIUS STA, ELEV) 760.000 2245.000 011.000 0136.000	1 99999.000 0.000 0.0000 0.0600 56.5685 0.00	FLOW DIS 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.00	<b>%) = 0.00</b>			996.000 983.800 972.600 1000.100
REACH PRO U/S SECTION. REACH D/S SECTION. SECTION NO. Cross Section 7550.000 1 8940.000 10000.000	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF  HYD RA 53.000 Geometry (S 004.000 7 994.000 9 982.800 10 978.200 10	STRIP J EL -9 AREA ADIUS J'S N TT(L) AREA ADIUS STA, ELEV) 760.000 2245.000 011.000 0136.000	1 9999.000 0.000 0.0000 56.5685 0.00 0.000 986.000 986.000 978.200 988.700 1004.000	FLOW DIS' 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24 8.422 8440.000 9555.000 10041.000 10154.000 1.037 1	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.000 998.000 998.000 986.300 974.000 989.300	<pre>%) = 0.00 8640.000 9825.000 10071.000 10200.000 5.086 0.68</pre>	0 95.679 996.000 986.300 972.200 999.200 1 7.586	4.321 8780.000 9900.000 10101.000	983.800 972.600
REACH PRO: U/S SECTION. REACH D/S SECTION. SECTION NO. Cross Section 7550.000 1 8940.000 10121.000 1 10470.000 1 **** 8200.00	PERTIES BY S INEFF FLOW HYD RA Manning SQF  53.000 Geometry (S 004.000 7 994.000 7 994.000 7 994.000 10 002.000 10 002.000 10 00978.200 10 00978.200 10 00978.200 10 00 983.479 PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF	STRIP L EL -9 AREA AREA DJUS LT(L) AREA DJUS STA, ELEV) 760.000 0245.000 011.000 0245.000 011.000 0136.000 700.000 984.372 STRIP L -9 AREA	1 9999.000 0.000 0.0000 56.5685 0.00 0.000 986.000 986.000 978.200 988.700 1004.000	FLOW DIS' 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24 8.422 8440.000 9555.000 10041.000 10154.000 1.037 1	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.00 0.000 998.000 986.300 974.000 989.300 96.098 97	<pre>8640.000 9825.000 10071.000 10200.000 5.086 0.68 %) = 0.19</pre>	0 95.679 996.000 986.300 972.200 999.200 1 7.586	4.321 8780.000 9900.000 10101.000 10320.000 0.000	983.800 972.600
REACH PRO U/S SECTION. REACH D/S SECTION. SECTION NO. Cross Section 7550.000 1 8940.000 10100.000 1012.000 10470.000 1 **** 8200.00 REACH PRO U/S SECTION. REACH PRO U/S SECTION. LOCAL INFLA	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF  53.000 Geometry (S 004.000 7 994.000 9 982.800 10 002.000 10 00 983.479 PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF  HYD RA	STRIP J EL -9 AREA AREA ADIUS J'S N T'(L) AREA ADIUS TA, ELEV) 7760.000 0245.000 0245.000 011.000 0136.000 984.372 STRIP J EL -9 AREA AREA ADIUS J'S N T(L) AREA AREA ADIUS JUS	1 99999.000 0.000 0.0000 56.5685 0.00 986.000 978.200 988.700 1004.000 274.155 22.82 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.000	FLOW DIS' 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24 8.422 8440.000 9555.000 10041.000 10154.000 10154.000 1.037 1 FLOW DIS 2 -99999.000 144394.365 1078.93 8.1588 0.0450 54.2402 3409.65 12.163	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.00 988.300 974.000 989.300 96.098 97 TRIBUTION ( -99999.000 0.0000 0.0000	<pre>8640.000 9825.000 10071.000 10200.000 5.086 0.68 %) = 0.19</pre>	0 95.679 996.000 986.300 972.200 999.200 1 7.586	4.321 8780.000 9900.000 10101.000 10320.000 0.000	983.800 972.600
REACH PRO U/S SECTION. REACH D/S SECTION. SECTION NO. Cross Section 7550.000 1 8940.000 10100.000 1012.000 10470.000 1 **** 8200.00 REACH PRO U/S SECTION. REACH PRO U/S SECTION. LOCAL INFLA	PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF  53.000 Geometry (S 004.000 7 994.000 9 982.800 10 078.200 10 078.200 10 0078.200 10 0078.200 10 00983.479 PERTIES BY S INEFF FLOW CONVEY HYD RA Manning SQF  HYD RA	STRIP L EL -9 AREA AREA DIUS LT(L) AREA DIUS STA, ELEV) 7760.000 0245.000 0245.000 0245.000 0245.000 011.000 984.372 STRIP L EL -9 STRIP L EL -9 STRIP L EL -9 AREA DIUS STRIP L EL -9 AREA DIUS 3 is upst DISCHAR (cfs) 2600	1 99999.000 0.000 0.0000 56.5685 0.00 986.000 978.200 988.700 1004.000 274.155 22.82 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.3378 0.0600 58.0172 0.000	FLOW DIS' 2 -99999.000 595477.263 3409.65 12.1625 0.0450 59.1608 2822.24 8.422 8440.000 9555.000 10041.000 10154.000 1.037 1 FLOW DIS 2 -99999.000 144394.365 1078.93 8.1588 0.0450 54.2402 3409.65 12.163 ection No. ERATURE eg F) 60.00	TRIBUTION ( 3 -99999.000 26895.576 369.93 5.0296 0.0600 61.6441 0.00 988.000 986.300 974.000 989.300 96.098 97 TRIBUTION ( -99999.000 0.000 0.000 0.0000 0.0000 0.0000 0.0000 53.2165 369.93 5.030	<pre>8640.000 9825.000 10071.000 10200.000 5.086 0.68 %) = 0.19</pre>	0 95.679 996.000 986.300 972.200 999.200 1 7.586	4.321 8780.000 9900.000 10101.000 10320.000 0.000	983.800 972.600

9975.000 974.800 10005.0 10187.000 985.800 10307.0				10045.000	973.200	10062.000	983.800
**** 5600.000 986.704 986	.858 0.155			(%) = 13.27			
REACH PROPERTIES BY STRIP INEFF FLOW EL U/S SECTION CONVEYANCE AREA HYD RADIUS	-99999.000 32889.590	-99999.000 204875.028	-99999.000				
AREA HYD RADIUS REACH Manning's N SQRT(L) D/S SECTION AREA HYD RADIUS	0.0600 47.6970 22.82 0.338	0.0450 52.6308 1078.93 8.159	0.0600 58.5662 0.00 0.000	) 1 )			
SECTION NO. 58.000							
Cross Section Geometry (STA,EI 8542.000 1006.000 8952.0 9944.000 976.200 9974.0 10065.000 988.800 10065.0 10492.000 992.000 10642.0 11137.000 986.000 11192.0	10001004.000000975.400000988.300000988.000	9991.000	978.200	10015.000	990.400	10062.000	996.300 988.300 992.000 986.000
**** 5600.000 987.850 988	.551 0.701	1.806 5 FLOW DIS	76.704 97 TRIBUTION (	(%) = 0.00	00 6.959 00 92.947	1.060 7.053	
REACH PROPERTIES BY STRIP INEFF FLOW EL U/S SECTION CONVEYANCE AREA AREA	1 -99999.000 0.000 0.00	2 -99999.000 101054.470 747.99	3 -99999.000 7668.432 372.73	) 2 3			
REACH Manning's N	0.0000	8.2752	0.0600	-			
U/S SECTION CONVEYANCE AREA HYD RADIUS REACH Manning's N SORT(L) D/S SECTION AREA HYD RADIUS							
\$\$END							
0 DATA ERRORS DETECTED	).						
TOTAL NO. OF TIME STEPS READ = TOTAL NO. OF WS PROFILES = ITERATIONS IN EXNER EQ =	2 2 0						
COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES	5 & 1.00 SECC	ONDS					

#### 6.3 Example Problem 3 - Movable Bed

The following example demonstrates how to add sediment data to the previously developed file. Existence of sediment data within the input file causes HEC-6 to compute sediment transport rates and modify the cross section geometry as described in Section 2.3. Sediment related data consists of the delineation of the movable bed, characteristics and gradation of sediment within the bed, and inflowing/outflowing sediment loads and gradations. The sediment data is inserted between the EJ record of the geometry data and the \$HYD record of the flow data. Table 6-3a shows the input data developed for Example Problem 3.

#### 6.3.1 Movable Bed Limits

Information delineating the movable bed have been added to the HD record of each cross section. For example, at Section No. 1.0, the movable bed limits have been defined at stations 10,081 and 10,250. The "fixed" GR points are those outside of the movable bed stations; that is, should a limit of the movable bed coincide with a GR point, that point is movable and the next point outward is fixed.

The vertical limit (initial depth) of the movable portion of the cross section must also be defined. Data describing the location of this bedrock is entered in Field 2 of the **HD** record for each cross section. In Example Problem 3, it was determined that the reach represented by Section No. 58.0 had bedrock 3.4 ft below the thalweg. Section No. 33.0 through Section No. 42.1 have either concrete or bedrock at the thalweg.

#### 6.3.2 Sediment Title Records

Five title records (T4-T8) are required at the beginning of the sediment data; these records are available for user documentation of the sediment data.

#### 6.3.3 Sediment Transport Control Parameters

Parameters governing the computation of sediment transport rates and selection of grain sizes are entered on the I records. For Example Problem 3, the number of times that the bed material gradation is to be re-calculated within a time step is set to 5 on the I1 record (see Section 2.3.1.4). Default values for the other parameters on this record will be used. Only sands and gravels are analyzed in Example Problem 3. Since there are no clays or silts in either the bed or the inflowing load, there are no I2 or I3 records. Ten sand and gravel sizes are being analyzed as seen by the 1 in Field 3 and 10 in Field 4 of the I4 record. The transport computation method chosen is that of Yang (4 in Field 2 of the I4 record). Default values for the other parameters were selected, by not providing data. It is important to remember that the range of grain sizes selected on the I records **must** encompass the entire range of sizes found in both the bed material and inflowing load, even though some of those sizes may be missing in either the bed or inflowing materials.

The "most stable" weighting scheme for the hydraulic parameters has been selected via the **15** record (see Section 2.2.4).

#### 6.3.4 Inflowing Sediment Loads

The inflowing sediment load at the upstream end of the main river is described with a table of sediment load vs. water discharge by grain size. This table is entered using LQ, LT, and LF records. The LQ record contains the water discharges and the LT record contains the corresponding total inflowing sediment loads. The entire range of discharges in the hydrograph being simulated must be spanned by these data. For Example Problem 3, the range of water discharges in the load table is from 1 to 90,000 cfs and the related inflowing sediment loads vary from 0.011 to 400,000 tons/day. The distribution of grain sizes is described by the LF records which contain the fraction of the total load comprised of any particular grain size. These data are entered from fine to coarse and must correspond to the size ranges selected with the I2 to I4 data.

There are three local inflows of water and sediment in this problem; their locations are defined by the QT records in the geometric data. The tables of sediment load vs. local inflow are on LQL, LTL, and LFL records, analogous to the main river inflowing load data. The local flow load tables are entered in the same sequence as the geometric data; that is, downstream to upstream.

#### Table 6-3a Example Problem 3 - Input Movable Bed

T1		KAMPLE I	PROBLEM N	оз. мо	VABLE BE	ED				
Т2 Т3			RK, ZUMBR		** I		Problem 3	**		
NC	.1	.1	.04	.1	.3	sxampre	Proprem 3	~ ~		
X1	1.0	31	10077.	.1 10275.	0.	0.	0.			
	1004.	9915.	978.4	102/3.	956.0	10060.	959.20	10077.	959.3	10081.
	950.0	10092.	948.48	10108.	946.6	10138.	944.70	10158.	955.2	10225.
	956.2	10092.	958.9	10250.	959.8	10138.	959.80	101300.	959.9	10325.
	958.8	10350.	957.4	10400.	970.0	10700.	966.00	10960.	970.0	11060.
	968.0	11085.	968.0	11240.	970.0	11365.	970.00	11500.	970.0	11615.
	962.0	11665.	962.0	12400.	976.0	12550.	980.00	12670.	982.0	12730.
	984.0	12735.	502.0	12400.	570.0	12550.	500.00	12070.	502.0	12750.
HD	1.0	10.	10081.0	10250.						
NV	22	.045	965.6	.064	988.8					
NV	12	.08	965.6	.13	988.8					
NV	33	.1	965.6	.11	982.0	.12	988.8			
X1	15.0		10665.0	10850.	3560.	3030.	3280.			
X3				10700.	961.0	11000.	970.0			
	992.0	9570.	982.0	10110.	976.0	10300.	976.00	10490.	966.0	10610.
	964.7	10665.	956.0	10673.	953.0	10693.	954.00	10703.	955.6	10723.
	958.6	10750.	959.3	10800.	957.0	10822.	957.30	10825.	961.5	10850.
	962.0	10852.	964.0	10970.	966.0	11015.		11090.	962.0	11150.
	970.0	11190.	972.0	11310.	980.0	11410.	984.00	11570.	990.0	11770.
	990.0	11865.	1000.0	12150.						
HD		10.		10852.						
			- local							
QT										
NC	.1	.1	.05							
X1	32.0	29	10057.0	10271.	3630.	3060.	4240.			
GR	998.0	9080.	982.0	9250.	982.0	9510.	980.00	9600.	980.01	9925.
GR	979.48	10000.	978.5	10057.	968.6	10075.	959.82	10087.	956.5	10097.
GR	956.8	10117.	957.8	10137.	959.4	10157.	959.60	10177.	959.82	10196.
GR	966.5	10225.	971.2	10250.	978.5	10271.	978.50	10300.	978.6	10350.
GRS	978.91	10370.	978.96	10387.	980.0	10610.	982.00	10745.	982.0	11145.
GR	984.0	11150.	992.0	11240.	1000.0	11330.	1008.0	11425.		
	32.0	10.	10075.	10275.						
5				cate of			d to mode	l IBC at	Sec 33.	0
X1		29	10057.0	10271.	3130.	3250.	3320.			
Х3	10									
	998.0	9080.	982.0	9250.	982.0	9510.	980.00	9600.	980.01	9925.
	979.48	10000.	978.5	10057.	968.6	10075.	959.82	10087.	956.5	10097.
	956.8	10117.	957.8	10137.	959.4	10157.	959.60	10177.	959.82	10196.
	966.5	10225.	971.2	10250.	978.5	10271.	978.50	10300.	978.6	10350.
	978.91	10370.	978.96	10387.	980.0	10610.	982.00	10745.	982.0	11145.
	984.0	11150.	992.0	11240.	1000.0	11330.	1008.0	11425.		
HD	32.1	10.	10075.	10275.						

A spillway is located here. X1 33.0 2150. 0 0 21 1850. 0 X5 2 250. ХL GR 1000. 980. 990.0 1060. 980.0 1150. 982.00 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.00 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 979.19 1850. 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.00 2800. 990.0 3100. GR 1000. 3170. HD 33.0 0. 1851. 2149. NOTE : Section 33.3 is a duplicate of Section 33.0. Section 33.0 is a good representative cross section for a long reach. duplicate is used here to break up the long reach into two smaller reaches. X1 33.3 21 1850. 2150. 1550. 1750. 1750 . 95 1.49 XL 250. GR 1000. 980. 990.0 1060. 980.0 1150. 982.00 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.00 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.00 2800. 990.0 3100. GR 1000. 3170. D 33.3 0. 1851. 2149. Section 33.9 is a duplicate of Sec 33.3, needed to model IBC at Sec 35.0 HD 33.3 X1 33.9 21 1850. 2150. 1050. 1050. 1050. .95 1.65 X3 10 GR 1000. 980. 990.0 1060. 980.0 1150. 982.00 1180. 982.0 1215. 1350. GR 980.0 1260. 982.0 1300. 982.0 980.00 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.00 2800. 990.0 3100. GR 1000. 3170. HD 33.9 0. 1851. 2149. A weir is located here. X1 35.0 22 9894. 10245. 0 0 0 X3 10 X5 974. 0.5 GR 984.0 980.0 9035. 9070. 978.0 9135. 980.00 9185. 982.0 9270 GR 980.0 9465. 981.7 9595. 983.7 9745. 984.70 9894. 963.4 9894.1 GR 963.3 9954. 967.1 9974. 967.4 10004. 968.20 10044. 967.6 10054. GR 973.4 10115. 977.4 10120. 983.7 10155. 984.00 10245. 982.0 10695. GR 982 0 10895. 1004.0 11085. HD 35.0 0. 9954. 10155. Silver Lake - - -NC . 06 .06 045 X1 42.0 32 9880. 10130. 5370. 5000. 5210. GR 996.0 7130. 998.0 7310. 998.0 7930. 992.00 8205. 990.0 8495 GR 988.0 8780. 986.0 8990. 985.7 9570. 986.45 9707. 989.44 9857. GR 990.0 9880. 969.8 9881. 969.8 9941. 985.80 9941. 985.8 9943. GR 969.8 9943. 969.8 10001. 986.7 10001. 986.70 10003. 969.8 10003. 10069. GR 969.8 10067. 985.8 10067. 985.8 969.80 10069. 969.8 10129. GR 989.9 10130 989 5 10180. 988.6 10230. 987.60 10280. 985.2 10430. GR 986.8 11720. 989.9 12310. HD 42.0 0. 9881. 10021. Silver Creek - local inflow QT X1 44.0 9845. 10127. 28 3200. 3800. 3500. хL 9850. 10200. GR 1002. 992.0 8035 8150. 990.0 8305. 990.00 8735 988.0 8835. GR 996.0 9285. 1017.6 990.0 9788. 9425. 9505. 986.00 9650. 984.1 GR 980.6 972.2 9845. 970.9 9868. 9898. 970.50 9968. 967.5 9998. GR 968.9 10028. 967.4 10058 967.1 10078. 971.90 10118. 976.8 10127. GR 977.8 976.9 10150. 10193. 982.0 10206. 981.20 10300. 979.2 10325. GR 983.1 999.8 10400. 10450 1002.4 10464. HD 44.0 X1 53.0 1. 9868. 10193. 22 10000. 10136. 3366. 2832. 2942. 7550. GR 1004. 1000.0 7760 998.0 8440. 996.00 8640. 996 0 8780. GR 994.0 8940. 986.0 9245. 986.3 9555. 986.30 9825. 983.8 9900. GR 982.8 978.2 10000. 10011. 974.0 10041. 972.20 10071. 972.6 10101. GR 978.2 10121. 988.7 10136. 989.3 10154. 999.20 10200. 1000.1 10320. GR 1002. 10470. 1004.0 10700. 53.0 10. 10000. 10 Bear Creek - local inflow HD 53.0 10136. от X1 55.0 18 9931. 10062. 2275. 3430. 2770. GR 1004. 7592. 1000.0 7947. 996.0 8627. 990.00 9052. 986.0 9337. GR 984.3 9737. 984.7 985.5 987.20 9955. 9837. 9910. 9931. 978.1 GR 974.8 9975. 974.2 972.9 10005. 10035. 973.20 10045. 983.8 10062. GR 985.8 10187. 986.0 10307 990.0 10497. HD 55.0 10. *9931*. 10062. 1098. X1 58.0 22 9912. 10015. 1012. 1462 GR 1006. 8542. 1004.0 1000.0 997.20 9812. 996.3 9912. 8952. 9702. GR 976.2 975.4 9944. 9974. 978.2 9991. 990.40 10015. 988.3 10062. GR 988.8 10172. 10065. 988.3 10065. 989.3 10169. 990.00 992.0 10242. GR 992.0 10492. 988.0 10642. 986.7 10852. 988.00 11097. 11022. 986.0 GR 986.0 11137. 988.0 11192. HD 58.0 3.4 *9912*. 10015.

ЕЈ **Т4** \*\* Example Problem 3 \*\* South Fork, Zumbro River - Stream Segment 1 Т5 LOAD CURVE FROM GAGE DATA. Т6 BED GRADATIONS FROM FIELD SAMPLES. Т7 Use Full Range of Sands and Gravels т8 **I1** SEDIMENT TRANSPORT BY Yang'S STREAM POWER [ref ASCE JOURNAL (YANG 1971)] 5 **T4** SAND 4 10 Î5 . 5 . 5 . 5 .25 n 1.0 .25 1 50 1000 5800 90000 TOTAL 0110 1.5 320 4500. 400000 LF VFS .119 .119 .498 .511 .582 LF FS 328 .328 .331 .306 .280 ĹF MS .553 .553 .156 .154 .110 LF CS .000 .000 .011 .016 .020 LF vcs .000 .000 .004 .008 .005 LF VFG .000 .000 .000 .004 .002 LF FG .000 .000 .000 .001 .001 **L**F MG .000 .000 .000 .000 .000 LF CG .000 .000 .000 .000 .000 LF VCG .000 .000 .000 .0 .0 PF EXAMP 1.0 1.0 16.0 95.0 4.0 91.0 32.0 96.5 8.0 PFC 2.0 85.0 1.0 37.0 73.0 .125 .5 .25 8.0 1.0 PFC.0625 0.0 PF EXAMP 32.0 1.0 64.0 32.0 99.5 16.0 99.0 8.0 98.5 PFC 4.0 96.0 2.0 93.5 1.0 83.0 .50 45.5 .250 8.0 PFC .125 1.0 .0625 0.0 PF EXAMP 58.0 32.0 1.0 64.0 97.0 16.0 94.0 8.0 94.0 PFC 4.0 90.0 2.0 79.0 1.0 56.0 4.0 .125 0.0 .50 \$LOCAL LOAD TABLE - CASCADE CREEK - A LOCAL INFLOW LQL 1 100 1000 10000 LTLTOTAL .0040 10 500 30000 VFS  $\mathbf{LFL}$ .664 .664 .015 .198  $\mathbf{LFL}$ FS.207 .207 .245 .181 LFLMS .086 .086 .605 .107  $\mathbf{LFL}$ CS .031 .031 .052 .098  $\mathbf{LFL}$ vcs .008 .008 .039 .127  $\mathbf{LFL}$ VFG .0030 .0030 .0200 .1160  $\mathbf{FG}$ .0010 .0010 .0910 LFL.0110  $\mathbf{LFL}$ MG .0000 .0000 .0530 .0110 LFLCG .0000 .0000 .0000 .0220 LFLVCG .0000 .0000 .0000 .0060 LOAD TABLE - SILVER CREEK - A LOCAL INFLOW LQL 1 100 1000 10000 LTLTOTAL .0040 10 500 30000  $\mathbf{LFL}$ VFS .664 .664 .015 .198  $\mathbf{LFL}$ FS .207 .207 .245 .181  $\mathbf{LFL}$ MS .086 .086 .605 .107 LFLCS .031 .031 .052 .098 LFL VCS .008 .008 .039 .127 LFL VFG .0030 .0030 .0200 .1160 LFL FG .0010 .0010 .0110 .0910 LFL MG .0000 .0000 .0110 .0530 LEL. CG .0000 .0000 .0000 .0220  $\mathbf{LFL}$ VCG .0000 .0000 .0000 .0060 LOAD TABLE - BEAR CREEK A LOCAL INFLOW LOL 1. 100. 500. 1000. 30000. LTLTOTAL .0020 30.0 500. 1200 22500 VES .201 LFL .201 .078 .078 .137 .175 FS LFL .342 .342 .172 .218 MS LFI. 451 .451 .454 .601 .476 LFL CS .001 .001 .197 .142 .158 VCS .000 LFL .000 .000 .003 .008 LFL VFG .0000 .0000 .0000 .0000 .0020 LFL FG .0000 .000 .0000 .0000 .0010 LFL. MG .0000 .000 .0000 .0000 .0000 CG .0000 LFL .000 .0000 .0000 .0000 LFL. VCG .0000 .000 .0000 .0000 .0000 **SHYD** \* A FLOW 1 =BASE FLOW OF 750 CFS Q R 750. 61. 29. 128. 956. 962. T W 65. 72. 70 67 2. \* В FLOW 2 = 50 DAYS AT BANK FULL DISCHARGE 2500. Q R 300. 150. 650. 965. 970. W 50. SPRT CP  $\mathbf{PS}$ 15.0 32.0 32.1 END

Chapter 6

```
*
    AC
            FLOW 3 = NEAR BANK FULL DISCHARGE
Q
  1250.
            150.
                       78.
                              340.
R
    960.
             966.
W
      1.
SPRT
       А
*
     R
            FLOW 4 = BASE FLOW OF 750 CFS
    750.
0
              61.
                      29.
                              128.
    957.
R
             963.
w
      1.
$$END
```

#### 6.3.5 Bed Material Gradation

The **initial** gradation of material in the bed sediment control volume is described with **PF** (percent finer) and **PFC** (percent finer continuation) records. In Example Problem 3, this data has only been provided at Sections 1.0, 32.0, and 58.0 as noted in Field 2 of the **PF** records. The selection of which, and how many, cross sections at which to provide this data depends on study objectives, field data, etc. For intermediate cross sections HEC-6 will linearly interpolate the bed material gradation. Note that the points in the gradation tables need not coincide with the size classes selected for computation. See Appendix A for specific details of these data records.

#### 6.3.6 Flow Data

The flow data input structure is similar to that shown in the previous examples. One of the differences, however, is the selection of A-, B- and C-level output for sediment computations on the \* records. Also, the hydrologic data are extremely important to the results of a movable bed simulation. Particular care must be taken when selecting the period of record or hypothetical event to be simulated and time step sizes to be used. Water temperature may also be important in some instances. See Gee (1984) and HEC (1992) for information regarding preparation of flow data.

#### 6.3.7 Output of Sediment Model

Table 6-3b shows the output file for Example Problem 3. The geometric data output, similar to that produced by Example Problem 2, is followed by sediment data. At this point, no hydraulic or sediment transport computations have been performed. Rather, the input data have been read and manipulated in preparation for the computations which begin when the flow data are read. The sediment title records are echoed followed by the information on the I records. Next is the inflowing sediment load table from stream segment 1; the sediment loads are in scientific notation because of the wide range of possible values. Note that a very small value is used instead of zero because log-log interpolation is used within these data tables.

The table headed "REACH GEOMETRY FOR STREAM SEGMENT 1" depicts the status of the bed sediment control volume at the beginning of the simulation, as described by the input data. Note that the movable bed widths are not necessarily the same as given in the HD data. For example, at Section No. 1.0, the movable bed limits are specified at stations 10,081 and 10,250 which coincide with existing points in the **GR** data, therefore, these points are part of the movable bed width used for computations extends halfway to the next, fixed, **GR** points (at stations 10,077 and 10,275).

Movable Bed Width =  $\frac{10275+10250}{2} - \frac{10081+10077}{2}$ = 183.5 ft The table headed "BED MATERIAL GRADATION" contains the information from the **PF** and **PFC** records. That data has been converted from percent finer values to bed fractions per grain size and computed for each cross section. This table allows for checking of the interpolation at each grain size boundary as well as at each cross section.

The next section contains the load tables for the local inflows, these are similar to the table for the main river.

The last table produced by the sediment data is titled "Bed Sediment Control Volumes." The "control volume" is the volume of bed sediment used at each cross section for the sediment transport computations. Generally, this control volume is defined as the depth of the bed times the width times the length. The length used equals one-half the sum of the channel reach lengths upstream and downstream of the cross section. However, if a cross section is an upstream or downstream boundary, then the upstream or downstream reach length, respectively, is zero. As previously noted, an X5 record creates an internal boundary condition within the model, effectively creating a downstream boundary at the X5's cross section and an upstream boundary at the preceding cross section. In locating the new boundaries at these two cross sections, the reach length between them should be zero. For this reason, care should be taken when locating cross sections at internal boundary conditions.

#### 6.3.8 Output of Hydraulic and Sediment Transport Computations

All output that follows the sediment data is produced by the hydraulic and sediment transport computations. By default, HEC-6 will produce no output from these computations unless an output flag is set for either (or both) the hydraulic or sedimentation computations. A-level sediment output was generated for the first time step of this example. This output is limited to "TABLE SA-1", which shows cumulative (since the beginning of the simulation) trap efficiency information. The "ENTRY POINT" is any cross section in the model at which something special occurs; "something special" includes upstream and downstream boundaries, local inflow and tributary junction points (QT), and internal boundary conditions (X5). Note that trap efficiency is computed at each downstream boundary. "TABLE SA-1" for the last time step shows that after 54 days, 13.29 acre-ft of sands and gravels had entered the model at Section No. 58.0; with 16.15 and 0.36 acre-ft entering at local inflows, the total inflowing sediment load to Section No. 35.0 is 29.81 acre-ft. The total load leaving Section No. 35.0 is 5.52 acre-ft, yielding a trap efficiency of 81% for that part of the model reach.

B-level sediment output was requested for the second and fourth time steps. This output begins with information regarding flow changes as the sediment computations proceed from **upstream** to **downstream**. Next is the A-level trap efficiency table. This information is followed by "TABLE SB-1", which shows the **instantaneous** ("snap shot") sediment inflows and outflows by grain size for the entire model. The "SEDIMENT INFLOW" enters the model at the upstream boundary (Section No. 58.0) and the "SEDIMENT OUTFLOW" leaves the model at the downstream boundary (Section No. 1.0). The last table produced by B-level output is "TABLE SB-2: STATUS OF THE BED..." which contains both cumulative and instantaneous information. The BED CHANGE is cumulative from time zero, while the rest of the data are for this time step, only. For example, the "REACH GEOMETRY" table produced after processing the sediment input data shows that the thalweg (minimum elevation **GR** point within the channel) at Section No. 1.0 was initially 944.70 ft. After a simulation time of 54 days, TABLE SB-2 for time step 4 shows that there was a computed bed change of 1.22 ft at Section No. 1.0, resulting in a thalweg elevation of 945.92 ft.

#### 6.3.9 Detailed Sediment Output

Additional information regarding the sedimentation computations can be obtained with C-level output. Although this output was originally designed for use by HEC-6 developers, some of the information may be of use for project applications.

The Selective Printout option (**\$PRT**) was used to limit output to Sections 15.0, 32.0 and 32.1 for time step 3. A-level hydraulics output for these cross sections begins the output for this time step. This is followed by C-level sediment output; first, the relevant flow information is listed for the Upstream boundary, then the fall velocity of each grain size is calculated based on the inflowing water temperature. Next is the detailed output for each of the selected cross sections. Because a local inflow enters the stream segment upstream of Section No. 15.0, local flow data and a new trap efficiency table precedes the detailed output for Section No. 15.0. The new fall velocity table is included because the particle fall velocities change due to the change in water temperature caused by the local inflow.

The detailed output for each cross section begins with the "HYDRAULIC PARAMETERS" table. This table contains the flow velocity (VEL), energy slope (SLO), effective depth (EFD), effective width (EFW), Manning's n (N-VALUE), average shear stress,  $\tau$  (TAU), the grain shear velocity, U\* (USTARM), and the Froude number. See Vanoni (1975) for definitions of these hydraulic variables.

At this point, it should be noted that the velocity listed in the A-level hydraulics output table may not be equal to the velocity listed in the "HYDRAULIC PARAMETERS" table in the detailed sediment output. For example, at Section No. 15.0, the velocity calculated by the hydraulics computations is 1.637 ft/sec, but due to the weighting factors entered on the **I5** record, the weighted velocity at the current cross section that is used in the sedimentation computations is calculated as follows:

Weighted VEL = XID · VEL at Downstream Section + XIN · VEL at Current Section + XIU · VEL at Upstream Section = 0.25 (1.371) + 0.5 (1.637) + 0.25 (3.048) = 1.923

Listed in the "BED SEDIMENT CONTROL VOLUME COMPUTATIONS" table is a new surface area of the bed sediment control volume. The K-PORTION is that area of the control volume bounded by the conveyance limits. The S-PORTION is the area of the control volume outside the conveyance limits; this will be greater than zero only when the movable bed limits extend beyond the conveyance limits.

The "GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS" table shows the gradation of the bed material at this cross section at this time. The first column is the contents of the bed by grain size, as fractions of the total bed. For example, at Section No. 15.0, 1% of the bed is very fine sand, 7% is fine sand, etc. These size classes were specified on the I records. The column is the same data as percent finer for each grain size; e.g., 99.1% of the bed material is smaller than coarse gravel.

At the start of the simulation, the bed sediment was 10 ft deep at Section No. 15.0 (HD data). The detailed output for this cross section shows that by the end of time step 3, 9.64 ft of sands and gravels remain in the inactive layer and 0.17 ft are in the active layer. This indicates a loss of 0.19 ft from the bed which corresponds to the 0.19 ft of erosion shown in TABLE SB-2 for this cross section.

#### Table 6-3b Example Problem 3 - Output Movable Bed

<pre>* SCOUR AND DEPOSITION IN RIVERS AND RESERVOIRS * * U.S. ARMY CORPS OF ENGINEERS * U.S. ARMY CORPS OF ENGINEERS * HYDROLOGIC ENGINEERING CENTER * INPUT FILE: EXAMPLE3.DAT * 609 SECOND STREET * OUTPUT FILE: EXAMPLE3.OUT * DAVIS, CALIFORNIA 95616-4687 * RUN DATE: 01 SEP 93 RUN TIME: 10:29:27 * (916) 756-1104 ***********************************</pre>
X X XXXXXX XXXXX XXXXX X X X X X X X X X X X X X X XXXXXX
<ul> <li>MAXIMUM LIMITS FOR THIS VERSION ARE:</li> <li>10 Stream Segments (Main Stem + Tributaries)</li> <li>150 Cross Sections</li> <li>100 Elevation/Station Points per Cross Section</li> <li>20 Grain Sizes</li> <li>10 Control Points</li> <li>*</li> </ul>
T1 EXAMPLE PROBLEM NO 3. MOVABLE BED T2 3 LOCAL INFLOWS T3 SOUTH FORK, ZUMBRO RIVER ** Example Problem 3 **
N values Left Channel Right Contraction Expansion 0.1000 0.0400 0.1000 1.1000 0.7000
SECTION NO. 1.000 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
N-Values vs. Elevation Table         Right Overbank           Channel         Left Overbank         Right Overbank           0.0450         966.         0.1000         966.           0.0640         989.         0.1100         982.           0.0000         0.         0.1200         989.
SECTION NO. 15.000 Left Encroachment defined at station 10700.000 at elevation 961.000 Right Encroachment defined at station 11000.000 at elevation 970.000 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
LOCAL INFLOW POINT 1 occurs upstream from Section No. 15.000
N values Left Channel Right Contraction Expansion 0.1000 0.0500 0.1000 1.1000 0.7000 SECTION NO. 32.000
DEPTH of the Bed Sediment Control Volume = 10.00 ft.
SECTION NO. 32.100 Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 10057.000 10271.000 Ineffective Elevation 978.500 978.500 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
<pre>SECTION NO. 33.000Internal Boundary Condition Water Surface Elevation will be read from R-RECORD, Field 2 Head Loss = 0.000Limit CONVEYANCE to 250.000 ft. centered about midpoint of channelDEPTH of the Bed Sediment Control Volume = 0.00 ft.</pre>
SECTION NO. 33.300 Adjust Section WIDTH to 95.00% of original. Adjust Section ELEVATIONS by 1.490 ft. Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 33.900 Adjust Section WIDTH to 95.00% of original. Adjust Section ELEVATIONS by 1.650 ft. Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 1757.500 2042.500 Ineffective Elevation 986.060 986.150 DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 35.000 Internal Boundary Condition Water Surface Elevation = 974.000 Head Loss = 0.500

...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 9894.000 10245.000 984.000 0.00 ft. Ineffective Elevation 984 ...DEPTH of the Bed Sediment Control Volume = 984.700 Channel Right 0.0450 0.0600 N values... Left Contraction Expansion 0.0600 1.1000 0,7000 SECTION NO. 42.000 ...DEPTH of the Bed Sediment Control Volume = 0.00 ft. LOCAL INFLOW POINT 2 occurs upstream from Section No. 42.000 SECTION NO. 44.000 ...Limit CONVEYANCE between stations 9850.0 ...DEPTH of the Bed Sediment Control Volume = 9850.000 and 10 **1ume = 1.00 ft.** 10200.000 SECTION NO. 53.000 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. LOCAL INFLOW POINT 3 occurs upstream from Section No. 53.000 SECTION NO. 55.000 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. SECTION NO. 58.000 ...DEPTH of the Bed Sediment Control Volume = 3.40 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 13 NO. OF INPUT DATA MESSAGES = 0TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = 13 TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK = 1 END OF GEOMETRIC DATA South Fork, Zumbro River - Stream Segment 1 LOAD CURVE FROM GAGE DATA. т4 \*\* Example Problem 3 \*\* Т5 Т6 BED GRADATIONS FROM FIELD SAMPLES. Т7 Т8 Use Full Range of Sands and Gravels SEDIMENT TRANSPORT BY Yang's STREAM POWER [ref ASCE JOURNAL (YANG 1971)] EXAMPLE PROBLEM NO 3. MOVABLE BED 3 LOCAL INFLOWS SOUTH FORK, ZUMBRO RIVER \*\* Example Problem 3 \*\* . . . . . . . . . . . . . . . . SEDIMENT PROPERTIES AND PARAMETERS NFALL SPI IBG MNO SPGF ACGR IBSHER 1.000 2 I1 5. 0 1 32.174 - - - - - - -- - - - - - - - - -SANDS - BOULDERS ARE PRESENT MTC IASA LASA SPGS GSF BSAE PSI UWDLB Т4 0.667 30.000 2,650 93.000 10 0.500 4 1 USING TRANSPORT CAPACITY RELATIONSHIP # 4, YANG GRAIN SIZES UTILIZED (mean diameter - mm) 
 0.088
 VERY FINE GRAVEL.
 2.828

 0.177
 FINE GRAVEL.
 5.657

 0.354
 MEDIUM GRAVEL.
 11.314

 0.707
 COARSE GRAVEL.
 22.627

 1.414
 VERY COARSE GRAVEL
 45.255
 VERY FINE SAND.... FINE SAND..... MEDIUM SAND..... COARSE SAND..... VERY COARSE SAND ... COEFFICIENTSFORCOMPUTATIONSCHEMEWERESPECIFIEDDBIDBNXIDXINXIUUBI150.5000.5000.2500.5000.2500.000 **UBN** JSL 1.000 1 SEDIMENT LOAD TABLE FOR STREAM SEGMENT # LOAD BY GRAIN SIZE CLASS (tons/day) | 1.00000 | 50.0000 | 1000.00 | 5800.00 | 90000.0 LQ - 1 -------------VFS 0.130900E-02 0.178500 159.360 FS 0.360800E-02 0.492000 105.920  $\mathbf{LF}$ 2299.50 232800. 
 VFS
 0.130900E-02
 0.178500
 159.360
 229.50
 232800.

 FS
 0.360800E-02
 0.492000
 105.920
 1377.00
 112000.

 MS
 0.608300E-02
 0.829500
 49.9200
 693.000
 44000.0

 CS
 0.100000E-19
 0.100000E-19
 3.52000
 72.0000
 8000.00

 VCS
 0.100000E-19
 0.100000E-19
 1.28000
 36.0000
 2000.00

 VFG
 0.100000E-19
 0.100000E-19
 0.100000E-19
 18.0000
 800.000

 VG
 0.100000E-19
 0.100000E-19
 0.100000E-19
 1.00000E-19
 10.0000E-19

 G
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19

 G
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19

 CG
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19

 VCG
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19
 0.100000E-19

</tabr>  $\mathbf{LF}$  $_{\rm LF}$ LF LF LF LF  $\mathbf{LF}$ LF TOTAL |0.110000E-01| 1.50000 | 320.000 | 4500.00 | 400000. 1

#### Example Problem 3

#### REACH GEOMETRY FOR STREAM SEGMENT 1

CROSS SECTION	REACH LENGTH	MOVABLE BED	INITIA LEFT SIDE		VATIONS RIGHT SIDE		CHANNEL DISTANCE DWNSTREAM
NO.	(ft)	WIDTH	(ft)	(ft)	(ft)	(ft)	(miles)
	0.000						
1.000	3280.000	183.500	959.300	944.700	958.900	0.000	0.000
15.000	3280.000	242.000	961.000	953.700	962.000	3280.000	0.621
32.000	4240.000	010 500		056 500	978.500	7520.000	1.424
32.000	3320.000	219.500	968.600	956.500	978.500	7520.000	1.424
32.100		219.500	968.600	956.500	978.500	10840.000	2.053
33.000	0.000	299.000	979.190	961.000	976.000	10840.000	2.053
22.200	1750.000				077 400	10500 000	0.004
33.300	1050.000	284.050	980.680	962.490	977.490	12590.000	2.384
33.900		284.050	980.840	962.650	977.650	13640.000	2.583
35.000	0.000	275.950	963,300	963.300	983.700	13640.000	2.583
	5210.000						-
42.000	3500.000	154.500	969.800	969.800	969.800	18850.000	3.570
44.000		337.500	970.900	967.100	976.900	22350.000	4.233
53.000	2942.000	195.000	982.800	972.200	988.700	25292.000	4.790
	2770.000						
55.000	1462.000	204.000	987.200	972.900	983.800	28062.000	5.315
58.000		176.500	996.300	975.400	990.400	29524.000	5.592

### BED MATERIAL GRADATION

SECNO	SAE	DMAX (ft)	DXPI (ft)	XPI		BED MATERIAL FRACTIONS per grain size
1.000	1.000	0.105	0.105	1.000	1.000	VF SAND         0.010         VC SAND         0.120         M GRVL         0.015           F SAND         0.070         VF GRVL         0.060         C GRVL         0.035           M SAND         0.290         F GRVL         0.040         VC GRVL         0.000           C SAND         0.360
15.000	1.000	0.151	0.151	1.000	1.000	VF SAND         0.010         VC SAND         0.113         M GRVL         0.011           F SAND         0.070         VF GRVL         0.045         C GRVL         0.022           M SAND         0.327         F GRVL         0.033         VC GRVL         0.002           C SAND         0.367
32.000	1.000	0.210	0.210	1.000	1.000	VF SAND         0.010         VC SAND         0.105         M GRVL         0.005           F SAND         0.070         VF GRVL         0.025         C GRVL         0.005           M SAND         0.375         F GRVL         0.025         VC GRVL         0.005           C SAND         0.375         F         GRVL         0.025         VC GRVL         0.005
32.100	1.000	0.210	0.210	1.000	1.000	VF SAND         0.008         VC SAND         0.124         M GRVL         0.004           F SAND         0.062         VF GRVL         0.038         C GRVL         0.009           M SAND         0.321         F GRVL         0.027         VC GRVL         0.009           C SAND         0.397
33.000	1.000	0.210	0.210	1.000	1.000	VF SAND         0.008         VC SAND         0.124         M GRVL         0.004           F SAND         0.062         VF GRVL         0.038         C GRVL         0.009           M SAND         0.321         F GRVL         0.027         VC GRVL         0.009           C SAND         0.397
33,300	1.000	0.210	0.210	1.000	1.000	VF SAND         0.008         VC SAND         0.134         M GRVL         0.004           F SAND         0.058         VF GRVL         0.045         C GRVL         0.011           M SAND         0.293         F GRVL         0.028         VC GRVL         0.011           C SAND         0.408         -
33.900	1.000	0.210	0.210	1.000	1.000	VF SAND         0.007         VC SAND         0.140         M GRVL         0.004           F SAND         0.056         VF GRVL         0.049         C GRVL         0.012           M SAND         0.276         F GRVL         0.029         VC GRVL         0.012           C SAND         0.415         -         -         -         -         -
35.000	1.000	0.210	0.210	1.000	1.000	VF SAND         0.007         VC SAND         0.140         M GRVL         0.004           F SAND         0.056         VF GRVL         0.049         C GRVL         0.012           M SAND         0.276         F GRVL         0.029         VC GRVL         0.012           C SAND         0.415         -         -         -         -         -
42.000	1.000	0.210	0.210	1.000	1.000	VF SAND         0.005         VC SAND         0.169         M GRVL         0.002           F         SAND         0.044         VF GRVL         0.069         C GRVL         0.018           M         SAND         0.192         F GRVL         0.033         VC GRVL         0.018           C         SAND         0.450
44.000	1.000	0.210	0.210	1.000		VF SAND         0.003         VC SAND         0.189         M GRVL         0.002           F SAND         0.036         VF GRVL         0.082         C GRVL         0.022           M SAND         0.136         F GRVL         0.035         VC GRVL         0.022           C SAND         0.473
53.000	1.000	0.210	0.210	1.000	1.000	VF SAND         0.002         VC SAND         0.206         M GRVL         0.001           F SAND         0.030         VF GRVL         0.094         C GRVL         0.025           M SAND         0.088         F GRVL         0.037         VC GRVL         0.025           C SAND         0.492

86

55.000 1.000 0.210 0.210 1.000 1.000 VF SAND 0.001 VC SAND 0.222 M GRVL 0.000 F SAND 0.023 VF GRVL 0.104 C GRVL 0.028 M SAND 0.044 F GRVL 0.039 VC GRVL 0.028 C SAND 0.044 F GRVL 0.039 VC GRVL 0.028
C SAND 0.510   58.000 1.000 0.210 0.210 1.000 1.000 VF SAND 0.000 VC SAND 0.230 M GRVL 0.000   F SAND 0.020 VF GRVL 0.110 C GRVL 0.030
F         SAND         0.020         VF         GRVL         0.110         C         GRVL         0.030           M         SAND         0.020         F         GRVL         0.040         VC         GRVL         0.030           C         SAND         0.520         F         GRVL         0.040         VC         GRVL         0.030
LOCAL INFLOW DATA
SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 1 AT LOCAL INFLOW POINT # 1
LOAD BY GRAIN SIZE CLASS (tons/day)
LQL   1.00000   100.000   1000.00   10000.0
LFL         VFS         0.265600E-02         6.64000         7.50000         5940.00           LFL         FS         0.828000E-03         2.07000         122.500         5430.00           LFL         MS         0.344000E-03         0.860000         302.500         3210.00           LFL         CS         0.124000E-03         0.860000         26.0000         2940.00           LFL         VCS         0.32000E-04         0.80000E-01         19.5000         3810.00           LFL         VFG         0.12000E-04         0.30000E-01         10.0000         3480.00           LFL         VFG         0.10000E-19         0.10000E-19         5.50000         2730.00           LFL         MG         0.100000E-19         5.50000         1590.00           LFL         CG         0.100000E-19         0.100000E-19         660.000           LFL         CG         0.100000E-19         0.100000E-19         660.000
LFL MS 0.344000E-03 0.860000 302.500 3210.00 LFL CS 0.124000E-03 0.310000 26.0000 2940.00
LFL VCS 0.320000E-04 0.800000E-01 19.5000 3810.00
LFL FG 0.400000E-05 0.100000E-01 5.50000 2730.00 LFL MG 0.100000E-19 0.100000E-19 5.50000 1590.00
LFL CG 0.100000E-19 0.100000E-19 0.100000E-19 660.000 LFL VCG 0.100000E-19 0.100000E-19 0.100000E-19 180.000
TOTAL  0.400000E-02  10.0000   499.000   29970.0
SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 1 AT LOCAL INFLOW POINT # 2
LOAD BY GRAIN SIZE CLASS (tons/day)
LQL   1.00000   100.000   1000.00   10000.0
LFL         VFS         0.265600E-02         6.64000         7.50000         5940.00           LFL         FS         0.828000E-03         2.07000         122.500         5430.00           LFL         MS         0.344000E-03         0.860000         302.500         3210.00           LFL         CS         0.124000E-03         0.310000         26.0000         2940.00           LFL         VCS         0.320000E-04         0.800000E-01         19.5000         3810.00           LFL         VCG         0.120000E-04         0.300000E-01         10.0000         3480.00           LFL         VFG         0.100000E-05         0.100000E-01         5.50000         2730.00           LFL         MG         0.100000E-19         5.50000         1590.00           LFL         CG         0.100000E-19         0.100000E-19         660.000           LFL         CG         0.100000E-19         0.100000E-19         660.000
LFL MS 0.344000E-03 0.860000 302.500 3210.00 LFL CS 0.124000E-03 0.310000 26.0000 2940.00
LFL VCS 0.320000E-04 0.800000E-01 19.5000 3810.00 LFL VFG 0.120000E-04 0.300000E-01 10.0000 3480.00
LFL FG 0.400000E-05 0.100000E-01 5.50000 2730.00
LFL CG 0.100000E-19 0.100000E-19 0.100000E-19 660.000 LFL VCG 0.100000E-19 0.100000E-19 0.100000E-19 180.000
TOTAL  0.400000E-02  10.0000   499.000   29970.0
SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 1
AT LOCAL INFLOW POINT # 3 LOAD BY GRAIN SIZE CLASS (tons/day)
LQL   1.00000   100.000   500.000   1000.00   30000.0
LFL         VFS         0.402000E-03         6.03000         39.0000         93.6000         3082.50           LFL         FS         0.684000E-03         10.2600         86.0000         210.000         4905.00           LFL         MS         0.902000E-03         13.5300         227.000         721.200         10710.0           LFL         CS         0.20000E-05         0.30000E-01         98.5000         170.400         3555.00           LFL         VCS         0.100000E-19         0.100000E-19         0.100000E-19         3.60000         180.000
LFL MS 0.902000E-03 13.5300 227.000 721.200 10710.0 LFL CS 0.200000E-05 0.300000E-01 98.5000 170.400 3555.00
LFL VCS 0.100000E-19 0.100000E-19 0.100000E-19 3.60000 180.000 LFL VFG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 45.0000
LFL FG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 22.5000 LFL MG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19
LFL CG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 LFL VCG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19
TOTAL  0.199000E-02  29.8500   450.500   1198.80   22500.0
BED SEDIMENT CONTROL VOLUMES
STREAM SEGMENT # 1: EXAMPLE PROBLEM NO 3. MOVABLE BED
SECTIONLENGTHWIDTHDEPTHVOLUMENUMBER(ft)(ft)(cu.ft)(cu.yd)
1.000   1640.000   203.000   10.000  0.332920E+07   123304.
15.000         3760.000         229.266         10.000         0.862040E+07         319274.           32.000         3780.000         223.706         10.000         0.845610E+07         313189.
32.100         1660.000         219.500         10.000         0.364370E+07         134952.           33.000         875.000         294.017         0.000         0.000000         0.000000
33.300         1400.000         287.165         0.000         0.000000         0.000000           33.900         525.000         284.050         0.000         0.000000         0.000000
35.000         2605.000         235.467         0.000         0.000000         0.000000           42.000         4355.000         203.228         0.000         0.000000         0.000000
44.000         3221.000         282.665         1.000         910465.         33720.9           53.000         2856.000         220.920         10.000         0.630947E+07         233684.
55.000         2116.000         198.870         10.000         0.420808E+07         155855.           58.000         731.000         185.667         3.400         461456.         17091.0
NO. OF INPUT DATA MESSAGES= $0$
END OF SEDIMENT DATA

SHYD BEGIN COMPUTATIONS.

TIME STEP # 1 * A FLOW 1 = BAS	E FLOW OF 750 CF	S		· · · · · · · · · · · · · · · · · · ·
	BLEM NO 3. MOVAN	BLE BED		
ACCUMULATED	AC-FT ENTERING		STREAM SEGMENT	
TIME ENTRY *	SAND	*		
TIME ENTRY * DAYS POINT * 2.00 58.000 * 53.000 * 42.000 * TOTAL= 35.000 *	INFLOW OUTFI	LOW TRAP EFF *		
2.00 58.000 *	0.09	*		
53.000 *	0.04	*		
42.000 *	0.00	*		
TIME ENTRY *	SAND	*		
TIME         ENTRY *           DAYS         POINT *           2.00         35.000 *           TOTAL=         33.000 *	INFLOW OUTFI	LOW TRAP EFF *		
2.00 35.000 *	0.00	*		
TOTAL= 33.000 *	0.00 0			
TTME ENTRY *	SAND	*		
DAYS POINT *	INFLOW OUTFI	LOW TRAP EFF *		
2.00 33.000 *	0.00	*		
TIME ENTRY * DAYS POINT * 2.00 33.000 * 15.000 * TOTAL= 1.000 *	0.00	*		
* TOTAL= 1.000 *	U.UU U.UV	.02 -3.36 *		
EXAMPLE PROBLEM NO 3. ACCUMULATED TIME FLOW DURATION (d	MOVABLE BED (yrs) ( ays) 5(	0.142 0.000		
UPSTREAM BOUNDARY CONDI				
	DISCHARGE	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)	
INFLOW	1400.00	529.98	62.04	
Upstream of SECTION NO. LOCAL INFLOW POINT # 3	53.000 is DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)	
MATH CTEM THELOW	1400 00			
MAIN STEM INFLOW LOCAL INFLOW	650.00	647.71	67.00	
TOTAL	2050.00	1177.69	63.61	
Upstream of SECTION NO. LOCAL INFLOW POINT # 2	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)	
MAIN STEM INFLOW LOCAL INFLOW	150.00	14.45	70.00	
	2200.00			
	1	•	1 04.05	
Upstream of SECTION NO. LOCAL INFLOW POINT # 1	DISCHARGE	SEDIMENT LOAD	TEMPERATURE	
	(cfs)	(tons/day)	(deg F)	
MATN CODM TNDI OU		1102 12	CA DE	
MAIN STEM INFLOW LOCAL INFLOW	300.00	1192.13	64.05 72.00	
		+0.00		
TOTAL	2500.00	1232.13	65.00	
TOTAL	2500.00	1232.13	65.00	
TOTAL FABLE SA-1. TRAP EFFICI	2500.00 ENCY ON STREAM SI	1232.13 EGMENT # 1	65.00	
TOTAL FABLE SA-1. TRAP EFFICI EXAMPLE PRO	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI	1232.13 EGMENT # 1 BLE BED		
TOTAL FABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING A	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 42.000 * TOTAL= 35.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 42.000 * TOTAL= 35.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED ************************************	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING J SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 ***********************************	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS LOW TRAP EFF * .51 0.81 * ***********************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED ************************************	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING J SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 ***********************************	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS LOW TRAP EFF * .51 0.81 * ***********************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 42.000 * TOTAL= 35.000 * TIME ENTRY * DAYS POINT * DAYS POINT * 52.00 35.000 * TOTAL= 33.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 SAND INFLOW OUTFI 5.51 5.51 1	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 53.000 * 42.000 * TOTAL= 35.000 * TIME ENTRY * DAYS POINT * DAYS POINT * DAYS POINT * 52.00 35.000 * TOTAL= 33.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 SAND INFLOW OUTFI 5.51 1 5.51 1	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 53.000 * 42.000 * TOTAL= 35.000 * TIME ENTRY * DAYS POINT * DAYS POINT * DAYS POINT * 52.00 35.000 * TOTAL= 33.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 SAND INFLOW OUTFI 5.51 1 5.51 1	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED MACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 42.000 * TOTAL= 35.000 * TIME ENTRY * DAYS POINT * DAYS POINT * DAYS POINT * 52.00 35.000 * TOTAL= 33.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 SAND INFLOW OUTFI 5.51 1 5.51 1	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		
TOTAL TABLE SA-1. TRAP EFFICI EXAMPLE PRO ACCUMULATED TIME ENTRY * DAYS POINT * 52.00 58.000 * 42.000 * TOTAL= 35.000 * TIME ENTRY * DAYS POINT * 52.00 35.000 * TOTAL= 33.000 *	2500.00 ENCY ON STREAM SI BLEM NO 3. MOVAI AC-FT ENTERING I SAND INFLOW OUTFI 13.17 16.03 0.36 29.56 5 SAND INFLOW OUTFI 5.51 1 5.51 1	1232.13 EGMENT # 1 BLE BED AND LEAVING THIS ************************************		

TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 1 SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE ZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) -----VERY FINE SAND.... VERY FINE GRAVEL.. 265.63 0.00 FINE SAND..... FINE GRAVEL..... 173.06 0.00 MEDIUM GRAVEL..... COARSE GRAVEL..... 82.59 6.27 2.42 82.59 0.00 COARSE SAND..... 0.00 VERY COARSE SAND.. 2.42 VERY COARSE GRAVEL 0.00 \_\_\_\_\_ TOTAL = 529.98 SEDIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) VERY FINE SAND.... 0.24 VERY FINE GRAVEL.. 0.00 FINE SAND...... 0.27 0.72 FINE GRAVEL..... MEDIUM GRAVEL..... 0.00 0.00 COARSE SAND......0.72VERY COARSE SAND...0.59VERY COARSE SAND..0.13 COARSE GRAVEL..... VERY COARSE GRAVEL 0.00 0.00 -----TOTAL = 1.94 TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 52,000 DAYS -----TRANSPORT RATE (tons/day) SECTION BED CHANGE WS ELEV THALWEG 0 NUMBER (ft) (ft) (cfs) SAND (ft) 981.86 980.67 58.000 -0.60 974.80 1400. 557. 973.00 972.60 55.000 0.10 1400. 525. 53.000 0.40 977.12 2050. 1044. 967.18 970.72 963.47 44.000 42.000 0.08 975.90 975.15 2050. 1014. 0.92 2200. 300. 35.000 0.17 974.00 223. 2200. 2200. 2200. 33.900 0.57 970.36 963.22 160 33.300 0.12 970.19 962.61 124. 33.000 0.33 970.00 2200. 59 961.33 956.31 956.37 2200. 2200. 32,100 -0.19 967.63 105 32.000 -0.13 966.55 157. 15.000 -0.19 965.13 953.51 2500. 232 1.000 1.03 965.00 945.73 2500. 2. SPRT ... Selective Printout Option - Print at the following cross sections CP 1 15.0 PS 32.0 32.1 END TIME STEP #3\*ACFLOW 3=NEAR BANK FULL DISCHARGE EXAMPLE PROBLEM NO 3. MOVABLE BED ACCUMULATED TIME (yrs)..... 0.142 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 1 at Control Point # 1 ---DISCHARGE TEMPERATURE WATER SURFACE (deg F) (cfs) (ft) 1250.000 65.00 960.000 ENERGY VELOCITY ALPHA \*\*\*\* DISCHARGE WATER тор AVG AVG VEL (by subsection) WIDTH (CFS) SURFACE LINE HEAD **BFD** ON NO. 15.000 1250.000 960.477 SECTION NO. 0.000 **3.048** 0.000 0.000 100.000 0.000 1.000 144.463 957.639 FLOW DISTRIBUTION (%) = 960.622 0.144 1.000 \*\*\*\* --- LOCAL INFLOW POINT # 1 is upstream of Section No. DISCHARGE TEMPERATURE 15.000 ---(cfs) 150.000 (deg F) Local Inflow: 72.00 Total: 1100.000 64.05 SECTION NO. 32.000 \*\*\*\* 1100.000 963.899 963.941 0.042 1.000 132.795 958.838 0.000 1.637 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 32.100 \*\*\*\* 1100.000 964.813 964.842 0.029 1.000 138,333 959 013 0.000 1.371 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 EXAMPLE PROBLEM NO 3. MOVABLE BED ACCUMULATED TIME (yrs) .... 0.145 FLOW DURATION (days)..... 1.000 UPSTREAM BOUNDARY CONDITIONS 
 Stream Segment # 1
 DISCHARGE
 SEDIMENT LOAD
 TEMPERATURE

 Section No.
 58.000
 (cfs)
 (tons/day)
 (deg F)
 INFLOW 682.00 682.00 61.89

SEDIMENT INFLO GRAIN SIZE	DW at SECTION NO. E LOAD (tons/	58.000 dav)   GR2	AIN SIZE	LOAD	(tons/dav	·)	
FINE SAND	AND 66 53 29 0 SAND 0	.32 FINE	GRAVEL	жь	0.00		
MEDIUM SAND.		.58 MEDIU	JM GRAVEL.		0.00		
COARSE SAND		.01 COARS	SE GRAVEL.		0.00		
VERY COARSE	SAND 0	.00   VERY	COARSE GR	AVEL	0.00		
			TOT	'AL =	149.81		
DI	<b>TIES - Method 2</b> LAMETER VELOCITY		NO.				
VE SAND O	000290 0 1860300	E-01 0 4558		59 21192	•		
F SAND 0	.000580 0.5765145	E-01 2.825	166	12.35143			
M SAND 0.	001160 0.1327884	13.014	137	4.656360			
C SAND 0.		54.94	943	2.089569			
VF GRVL 0.	009280 0.7191215	563.84	104	1.270145			
F GRVL 0	018559 1.039704	1630.3	395	1.215254			
M GRVL 0.	037118 1.472894	4619.4	401 61	1.211086			
VC GRVL 0	000290 0.1860300 000580 0.5765145 001160 0.1327884 002320 0.2803304 004640 0.4807405 009280 0.7191215 018559 1.039704 037118 1.472894 074237 2.082985 148474 2.945788	36955	.21	1.211086			
	*****				******	*****	* * * *
	TRACE OUTPUT FO						
HYDRAIII TC PARAMI	FTFRS ·						
VEL	ETERS: 5LO EFD 00271 6.763	EFW /	N-VALUE	TAU	USTARM	FROUDE NO.	
1.371 0.00	00271 6.763	118.634	0.0500	0.11467	0.24306	0.093	
BED SEDIMENT CON NEW SURFACE AREA	VTROL VOLUME COMPU A (SQ FT): TOT 2149	TATIONS: AL K-1 70.00 2.	PORTION 14970.00	S-PORT	TION 0.00		
CRADATION OF ACT		DEDOCTTO					
BED MATERIAL PER	RIVE PLUS INACITUS C GRAIN SIZE: B VF SAND F SAND M SAND C SAND VC SAND	ED FRACTION	PERCENT F	INER		BED FRACTION	PERCENT FINER
	VF SAND F SAND	0.012074	1.207	441	VF GRVL	0.038537	94.998190 97 778156
	M SAND	0.319568	39.373	478	M GRVL	0.004329	98.211069
	C SAND	0.394570	78.830	455	C GRVL	0.008945	<i>99.105534</i>
	VC SAND	0.123140	91.144	443	VC GRVL	0.008945	99.999998
SAND ** ARMOR LAYER * STABILITY COEFFI MIN.GRAIN DIAM	** ICIENT= 0.8199 = 0.00194 DSED = 0.2836	2 3					
INACIIVI %	E LAYER         ACTIV           DEPTH         %           0.00         0.0000           0.00         0.0000           9.76         1.0000           9.76         1.0000	E LAYER DEPTH					
CLAY 0.0000	0.00 0.0000	0.00					
SILT 0.0000	0.00 0.0000	0.00					
SAND 1.0000 TOTAL 1.0000	9.76 1.0000	0.05					
AVG. UNIT WEIGHT	r AVG WE	. UNIT IGHT					
0.046500		046500					
COMPOSITE UN	NIT WT OF ACTIVE L	AYER (t/cf)	) = C	.046500			
COMPOSITE UN	NIT WT OF INACTIVE	LAYER (t/cf)	) = C	.046500			
	RFACE LAYER (ft) JRFACE LAYER (tons	) DSI ) WTSI		0.1 833.0			
	ACTIVE LAYER (ft			0.0008			
	W ACTIVE LAYER (to	ns) WTMXA	L=	7.6			
	D ACTIVE LAYER(to HT, OLD INACTIVE			497.7 97534.4			
	A OF DEPOSIT (sq f		u- K= 0.21497				
** INACTIVE LAY	2D **						
BED MATERIAL PER		ED FRACTION	PERCENT F	INER		BED FRACTION	PERCENT FINER
	VF SAND	0.008485	0.848	488	VF GRVL	0.038120	95.056453
	F SAND M SAND	0.062410 0.321199	7.089 39.209		F GRVL M GRVL	$0.027476 \\ 0.004279$	97.804037 98.231907
	C SAND	0.396583	78.867		C GRVL	0.008840	99.115953
	VC SAND	0.123768	91.244	461	VC GRVL	0.008840	99.999998
** ACTIVE LAYER BED MATERIAL PER		ED FRACTION	PERCENT F	INER		BED FRACTION	PERCENT FINER
	VF SAND	0.715456	71.545	615	VF GRVL	0.120357	83.581306
	F SAND	0.000000	71.545		F GRVL	0.091254	92.706690
	M SAND C SAND	0.000000 0.000000	71.545 71.545		M GRVL C GRVL	0.014211 0.029361	94.127749 97.063875
	VC SAND	0.000000	71.545		VC GRVL	0.029361	100.000000
C FINES COFF (C	FML), MX POTENTIA		+00 0 1000	008+01 0	2376000.0	17	
	PORT (tons/day):		0062E+03	VF GRVL (	.100000E-	-06	
	· •	F SAND 0.19	9470E+03	F GRVL (	0.100000E-	-06	
		M SAND 0.12 C SAND 0.94			D.100000E- D.100000E-		
		VC SAND 0.76	5651E+02	VC GRVL (	0.100000E-	-06	

SEDIMENT OUTFLOW FROM SECTION NO. 32.100 GRAIN SIZE LOAD (tons GRAIN SIZE LOAD (tons/day) | LOAD (tons/day) VERY FINE SAND.... 148.98 0.00 FINE SAND..... FINE GRAVEL..... MEDIUM GRAVEL..... 9.07 0.00 MEDIUM SAND..... 23.59 0.00 COARSE SAND ..... COARSE GRAVEL..... VERY COARSE GRAVEL 21.05 0.00 VERY COARSE SAND. 5.30 0.00 TRACE OUTPUT FOR SECTION NO. 32.000 HYDRAULIC PARAMETERS: VEL SLO N-VALUE SLO EFD EFW TAU USTARM FROUDE NO. 1.923 0.000527 5.733 110.118 0.0500 0.18875 0.31184 0.142 BED SEDIMENT CONTROL VOLUME COMPUTATIONS: K-PORTION K-PORTION NEW SURFACE AREA (SQ FT): TOTAL 495163.69 S-PORTION 495163.69 0 00 GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER VF SAND 0.011063 1.106303 BED FRACTION PERCENT FINER 1.106303 VF GRVL 95.945944 0.025317 F GRVL M GRVL C GRVL F SAND 0.070203 8.126581 0.025337 98.479681 M SAND 0.374483 0.373745 45.574892 82.949358 0.005068 98,986453 c SAND 0.005068 99.493225 VC SAND 0.104649 93.414209 VC GRVL 0.005068 99.999998 SAND \*\* ARMOR LAYER \*\* STABILITY COEFFICIENT= MIN.GRAIN DIAM = 0.76487 0.003170 MIN.GRAIN DIAM = BED SURFACE EXPOSED = 1.00000 INACTIVE LAYER ACTIVE LAYER 
 %
 DEPTH

 0.0000
 0.00

 0.0000
 0.00

 1.0000
 0.03
 DEPTH ÷ 0.0000 CLAY 0.00 0.00 SILT 0.0000 SAND 1.0000 9.84 1,0000 0.03 1.0000 TOTAL 9.84 1.0000 0.03 AVG. UNIT WEIGHT AVG. UNIT WEIGHT 0.046500 0.046500 COMPOSITE UNIT WT OF ACTIVE LAYER (t/cf)= COMPOSITE UNIT WT OF INACTIVE LAYER (t/cf)= 0.046500 0.046500 DEPTH OF SURFACE LAYER (ft) WEIGHT IN SURFACE LAYER (tons) DSL= 0.1 1918.8 WTSL= DEPTH OF NEW ACTIVE LAYER (ft) DSE= 0.0042 WEIGHT IN NEW ACTIVE LAYER (tons) WEIGHT IN OLD ACTIVE LAYER(tons) WTMXAL= 97.6 WAL= WIL= 635.8 USEABLE WEIGHT, OLD INACTIVE LAYER SURFACE AREA OF DEPOSIT (sq ft) 226538.3 SABK= 0.49516369E+06 \*\* INACTIVE LAYER \*\* SIZE: BED FRACTION PERCENT FINER VF SAND 0.009994 BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER VF GRVL 0.009994 0.069961 0.999449 7.995595 95.968320 98.488119 0.025198 F SAND F GRVL 0.025198 M C SAND SAND 0.374794 0.374794 45.474949 M GRVL 0.005040 98.992078 82.954303 С 0.005040 GRVL 99.496038 VC SAND VC GRVL 99.999998 0.104942 93,448522 0.005040 \*\* ACTIVE LAYER \*\* BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER BED FRACTION PERCENT FINER VF SAND 39.181331 VF GRVL 0.391813 0.067850 87.972420 F SAND M SAND 0.156193 54.800582 F GRVL M GRVL 0.075005 95.472886 81.187410 81.187410 0.263868 0.015090 96.981924 С SAND 0.000000 С GRVL 0.015090 98.490962 VC SAND 0.000000 81.187410 VC GRVL 0.015090 100.000000 C FINES, COEF(CFFML), MX POTENTIAL= 0.000000E+00 0.100000E+01 0.237600E+07 POTENTIAL TRANSPORT (tons/day): VF SAND 0.279192E+04 VF GRVL 0.108066E+01 F SAND 0.906230E+03 F GRVL 0.100000E-06 M SAND 0.533420E+03 M GRVL 0.100000E-06 C SAND 0.403607E+03 C GRVL 0.100000E-06 VC SAND 0.382254E+03 VC GRVL 0.100000E-06 SEDIMENT OUTFLOW FROM SECTION NO. 32.000 GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/dav) ----------VERY FINE SAND.... 256.66 VERY FINE GRAVEL.. 0.04 FINE GRAVEL..... MEDIUM GRAVEL..... FINE SAND...... MEDIUM SAND..... 78.38 185.55 0.00 0.00 COARSE SAND...... VERY COARSE SAND... COARSE GRAVEL..... VERY COARSE GRAVEL 116.49 0.00 30.96 0 00 15.000 is... DISCHARGE | SEDIMENT LOAD | TEMPERATURE Upstream of SECTION NO. LOCAL INFLOW POINT # 1 | (cfs) (tons/day) | (deg F) (tons/day MAIN STEM INFLOW LOCAL INFLOW 1100.00 150.00 362.61 14.45 64.05 72.00 \_\_\_\_ ------TOTAL 1250.00 377.06 | 65.00

SEDI	MENT LOAD FR	OM LOCA	L INFLOW:						
C	GRAIN SIZE	LOA	D (tons/da	y)   G					
VEI	RY FINE SAND NE SAND DIUM SAND ARSE SAND RY COARSE SA	••••	6.7	B   VER	Y FINE GR	AVEL	0.08		
FII	NE SAND	• • • •	4.2	5 FIN	E GRAVEL.		0.03		
CO	ARSE SAND	 	0.6	B COA	RSE GRAVE	L	0.00		
VE	RY COARSE SA	ND	0.2	1 VER	Y COARSE (	GRAVEL	0.00		
				-		OTAL =			
FA	LL VELOCITIE	S - Met	hod 2						
	DIAM	ETER '	VELOCITY						
VF	SAND 0.00						-		
F	SAND 0.00	0580 0	.5916114E-	01 3.02	7072	11.72910			
M C	SAND 0.00 SAND 0.00	1160 0 2320 0	.1355164	13.8 57.9	6779 8200	4.470784			
vc	SAND 0.00	4640 0	.4824925	197.	4999	1.410740			
VF F	GRVL 0.00 GRVL 0.01	9280 0 8559 <sup>·</sup>	.7200893	589. 1703	5120 .352	1.266733			
M	GRVL 0.03	7118	1.472894	4823	.231	1.211086			
C VC	SAND         0.00           GRVL         0.00           GRVL         0.01           GRVL         0.03           GRVL         0.07           GRVL         0.14	4237 : 8474 :	2.082985	1364 3858	2.13 5.85	1.211086			
*****			UTPUT FOR				********	********	****
HYDRAII	LIC PARAMETE								
111010101	VEL SLO		EFD	EFW	N-VALUE	TAU	USTARM	FROUDE NO. 0.151	
								0.151	
BED SEL NEW SUP	<b>DIMENT CONTR</b> RFACE AREA (.	OL VOLU SQ FT):	ME COMPUTA TOTAL 543327	<b>TIONS:</b> .92	<b>-PORTION</b> 543327.92	S-PORT	FION 0.00		
CRADAT	TON OF ACTTV			EDACTTC					
BED MAT	FERIAL PER G	RAIN SI	ZE: BED	FRACTION	PERCENT	FINER	VE COVI	BED FRACTION	PERCENT FINER
		F	SAND	0.070017	8.0	63516	F GRVL	0.045645	96.460669
		м	SAND	0.325449	40.6	08371	M GRVL	0.010834	97.544118
		vc	SAND	0.113092	88.4	86534	VC GRVL	0.022338	<b>PERCENT FINER</b> 93.051050 96.460669 97.544118 99.777722 99.999998
SAND									
** ARM(	OR LAYER **								
STABILI	ITY COEFFICI	ENT=	0.78731						
BED SUP	AIN DIAM RFACE EXPOSE	= D =	0.002878						
	* D	EPTH	%	DEPTH					
CLAY	0.0000	0.00	0.0000	0.00					
SAND	INACTIVE L % D 0.0000 0.0000 <b>1.0000</b> 1.0000	9.64	1.0000	0.17					
TOTAL	1.0000	9.64	1.0000	0.17					
	AVG. UNIT		AVG.						
	AVG. UNIT WEIGHT 0.046500		WEIG 0.04						
		1700 AT			<i>e</i> \				
	MPOSITE UNIT MPOSITE UNIT				f)= f)=	0.046500			
	PTH OF SURFA				SL=	0.1			
	PTH OF NEW A				SL= SE=	$2105.4 \\ 0.0000$			
	IGHT IN NEW					0.0			
	IGHT IN OLD . EABLE WEIGHT				AL= IL=	4252.7 243631.1			
SUR	RFACE AREA O	F DEPOS	IT (sq ft)	SA	BK= 0.543	32792E+06			
	TIVE LAYER								
BED MAI	FERIAL PER G		ZE: BED SAND	FRACTION 0.010000	PERCENT 1.0	FINER 00000	VF GRVL	BED FRACTION 0.044734	PERCENT FINER 93.180849
		F	SAND	0.070000	8.0	00000	F GRVL	0.033457	96.526594
			SAND SAND	0.327074		07446 61700	M GRVL C GRVL	0.010638 0.021915	97.590423 99.781913
			SAND	0.113457		07445	VC GRVL	0.002181	99.999998
	IVE LAYER ** FERIAL PER G	RAIN ST	ZE: RED	FRACTION	PERCENT	FINER		BED FRACTION	PERCENT FINER
		VF	SAND	0.046017	4.6	01728	VF GRVL	0.097841	85.615105
			SAND SAND	0.071005		02227 32536	F GRVL M GRVL	0.070689 0.022074	92.683996 94.891357
		C	SAND	0.316834		15964	C GRVL	0.046463	99.537628
		VC	SAND	0.092150	75.8	31001	VC GRVL	0.004624	100.000000
	G, COEF (CFFM								
POTENTI	IAL TRANSPOR	r (tons,				VF GRVL ( F GRVL (			
			М	SAND 0.6	38850E+03	M GRVL (	0.100000E-	-06	
						C GRVL ( VC GRVL (			

SEDIMENT OUTFLOW FROM SECTION NO. 15.000 LOAD (tons/day) | GRAIN SIZE GRAIN SIZE LOAD (tons/day) -----------------VERY FINE SAND.... 138.47 VERY FINE GRAVEL.. 0.18 FINE SAND...... 75.72 FINE GRAVEL..... 0.00 MEDIUM GRAVEL..... 0.00 COARSE SAND..... COARSE GRAVEL .. 162.61 0.00 VERY COARSE SAND. 47.90 VERY COARSE GRAVEL 0.00 TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 1 EXAMPLE PROBLEM NO 3. MOVABLE BED ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT TIME ENTRY \* SAND POINT \* 58.000 \* 53.000 \* INFLOW OUTFLOW TRAP EFF DAYS 13.25 16.13 53.00 42.000 \* 35.000 \* \*\*\*\*\* 0.36 5.52 TOTAL= 29.74 0.81 \* \*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\* TIME ENTRY \* POINT \* SAND INFLOW OUTFLOW TRAP EFF DAYS 35.000 \* 5.52 53.00 TOTAL= 33.000 \* 5.52 1.54 0.72 \*\*\*\*\*\*\* ENTRY \* POINT \* TIME SAND INFLOW DAYS OUTFLOW TRAP EFF 33.000 \* 15.000 \* 1.54 1.00 53.00 TOTAL= 1.000 \* 2.54 0.07 0.97 \* \*\*\*\* TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 1 SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) VERY FINE SAND.... 66.90 VERY FINE GRAVEL.. 0.00 FINE SAND...... FINE GRAVEL..... MEDIUM GRAVEL..... 53.32 0.00 29.58 0.00 COARSE SAND..... 0.01 COARSE GRAVEL.... 0.00 VERY COARSE GRAVEL VERY COARSE SAND ... 0.00 0.00 . \_ \_ \_ \_ TOTAL = 149.81 SEDIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/dav) -----VERY FINE SAND.... 2.05 VERY FINE GRAVEL.. 0 00 FINE SAND..... FINE GRAVEL..... MEDIUM GRAVEL..... 1.13 0.00 MEDIUM SAND..... 2.94 0.00 COARSE SAND...... VERY COARSE SAND.. 2.79 COARSE GRAVEL. 0.00 VERY COARSE GRAVEL 1.08 0.00 TOTAL = 9.99 TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 53.000 DAYS \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ SECTION BED CHANGE WS ELEV THALWEG Q TRANSPORT RATE (tons/day) NUMBER (ft) (ft) 974.57 (cfs) (ft) SAND 979.94 979.11 -0.83 682. 682. 58,000 818. 55.000 0.04 972.94 1476. 53.000 0.25 975.42 974.82 972.45 1022. 4056. 44.000 0.19 967.29 1022. 560. 42.000 970.74 0.94 974.43 1100. 15. 35.000 0.17 974.00 963.47 1100. 6 966.96 33,900 0.48 963.13 1100. 528 33.300 0.13 966.48 962.62 1100. 442. 33.000 0.36 966.00 961.36 1100. 156 32.100 -0.20 964.81 956.30 1100. 208. 32.000 -0.1 963.90 956.35 1100. 668. -0.19 1250. 15.000 960.48 953.51 593. 1.000 1.07 960.00 945.77 1250. 10. Accumulated Water Discharge from day zero (sfd) MAIN 127750.00 \_\_\_\_\_ \$PRT A ....Selective Printout Option A - Print at all cross sections TIME STEP # 4 \* B FLOW 4 = BASE FLOW OF 750 CFS EXAMPLE PROBLEM NO 3. MOVABLE BED ACCUMULATED TIME (yrs).... 0.148 FLOW DURATION (days) ..... 1.000

UPSTREAM BOUNDARY CONDITIONS

UPSTREAM BOUNI					
	= # 1 58.000		SEDIMENT LOAD		 E
	INFLOW	532.00	93.3	0   63.44	
Upstream of SI LOCAL INFLOW I	ECTION NO. POINT # 3	53.000 is. DISCHARGE (cfs)	SEDIMENT LOA (tons/day)	D <b>TEMPERATURI</b> (deg F)	в
MAIN STE LOCAL	M INFLOW INFLOW	532.00 128.00	93.3 9 43.2	0   63.44 0   67.00	 1 0
	TOTAL	660.00	136.5	0   64.13	
Upstream of SI LOCAL INFLOW D	SCTION NO. POINT # 2	42.000 is DISCHARGE (cfs)	SEDIMENT LOA (tons/day)	D TEMPERATURI (deg F)	E
MAIN STI LOCAL	M INFLOW INFLOW	660.00 29.00	)   136.5 )   1.2	0 64.11 2 70.00	 3 0
	TOTAL	689.00	137.7	2 64.3	8
Upstream of SE LOCAL INFLOW E	CTION NO. POINT # 1	15.000 is. DISCHARGE (cfs)	SEDIMENT LOA (tons/day)	D TEMPERATURI (deg F)	E
MAIN STI LOCAL	M INFLOW INFLOW	689.00 61.00	)   137.7	2   64.3 2   72.0	B 0
	TOTAL	750.00	)   142.0	4   65.00	0
EZ	CAMPLE PROP COMULATED		VABLE BED 3 AND LEAVING TH		ENT
**************************************	**************************************	**************************************	**************************************	*	
DAYS	POINT *	INFLOW OUT	FLOW TRAP EFF	*	
54.00	58.000 *	16.15		*	
TOTAL=	42.000 * <b>35.000</b> *	0.36 <b>29.81</b>	ND IFLOW TRAP EFF 5.52 0.81	*	
DAYS	POINT *	INFLOW OUT	ND TFLOW TRAP EFF 2.04 0.63	*	
54.00	35.000 *	5.52		*	
TOTAL=	33.000 *	5.52	2.04 0.63	*	
TIME	ENTRY *	SAL	۱D	*	
DAYS	POINT *	INFLOW OUT	ND TFLOW TRAP EFF 0.08 0.97	*	
54.00	33.000 *	2.04 1.00		*	
TOTAL=	1.000 *	3.04	0.08 0.97	*	
**********	*******	*********	******	*	
TABLE SB-1: S	SEDIMENT LO	DAD PASSING THE	BOUNDARIES OF		r#1
SEDIMENT IN	LOW at the	e Upstream Bour			ns/day)
VERY FINE	SAND	38.08	VERY FINE GR	AVEL	0.00
FINE SAND.		34.16	FINE GRAVEL.	• • • • • • •	0.00 0.00
COARSE SAM	1D	0.00	COARSE GRAVE	Б Б	0.00
VERY COARS	SE SAND	0.00	FINE GRAVEL. MEDIUM GRAVE COARSE GRAVE VERY COARSE	GRAVEL	0.00
	-			OTAL =	93.30
GRAIN S			n Boundary   GRAIN SIZE	LOAD (to:	ns/day)
VERY FINE FINE SAND.		6.28	VERY FINE GR	AVEL.	0.15 0.19
MEDIUM SAN		6.67	MEDIUM GRAVE	 L	0.07
COARSE SAM		6.38	COARSE GRAVE	Б	0.00
VERY COARS	SE SAND	2.69	VERY FINE GR FINE GRAVEL. MEDIUM GRAVE COARSE GRAVE VERY COARSE	GRAVEL	0.00
			т	OTAL =	25.24
TABLE SB-2: S	STATUS OF	THE BED PROFIL	E AT TIME = 5		
					RATE (tons/day)
NUMBER	(ft)	(ft)	(ft) (cfs	) SAND	-
58.000	-0.94	979.24 9 978.47 °	/4.46 532 72.90 533	. 415. 822	
53.000	0.23	974.73 9	72.43 660	. 1274.	
44.000	0.22	974.40 96	57.32 660	. 138.	
42.000	0.94	974.18 9	70.74 689	. 1.	
35.000	0.17	974.00 96	53.47 689	. 0. . 433.	
33.300	0.11	965.05 96	52.60 689	. 433.	
33.000	0.33	963.74 90	LLWEG         Q           (ft)         (cfs           74.46         532           72.43         660           70.74         689           73.47         689           73.65         689           52.60         689           51.33         689	. 713.	

32.100	-0.10	963.74	956.40	689.	49.	
32.000	-0.18	963.13	956.32	689.	694.	
15.000	-0.24	957.66	953.46	750.	1530.	
1.000	1.22	957.00	945.92	750.	25.	
			•••••	,		
\$\$END						
0 DATA	ERRORS D					
0 DAIA	BRROKS D	BIBCIED.				
TOTAL NO. OF TI	ME STEPS	READ =	4			
TOTAL NO. OF WS			4			
ITERATIONS IN E			260			
TIBUCTIONS IN E	were en -	•	200			
COMPUTATIONS CO						
CONFOIRITONO CO	עמומעיניייי					

COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES & 2.00 SECONDS

#### 6.4 Example Problem 4 - Some Sediment Options

Several options are available in HEC-6 to control sedimentation. Among these are dredging, transmissive boundary conditions, an alternate bed roughness computation method, and the opportunity to enter a new sediment load table or rating curve at any point in the hydrograph. In any study, selection and use of any of these options must be based on sound engineering analysis. Example Problem 4 illustrates how to use these options.

The data for this example problem (shown in Table 6-4a) also shows the use of output control to select output at specified cross sections (**\$PRT** and **PN**) and request cumulative volumes of sediment passing each cross section (**\$VOL**). Table 6-4b shows the simulation output for this example; since the output produced by the geometry and sediment input data does not differ from that of Example Problem 3, it has been omitted from Table 6-4b.

#### 6.4.1 Dredging

Frequent dredging occurs in the reach bounded by Sections 35.0 and 44.0. The geometric data for the cross sections in this reach were modified via the HD record to identify the dredged

channel template. The dredging option is activated by a **\$DREDGE** record in the flow data and will be performed at the start of each time step until deactivated by a **\$NODREDGE** record.

The default output produced by the dredging option is limited to the quantity of material removed from the bed and is only given for those cross sections at which material was removed. The output for Example Problem 4 (Table 6-4b), shows that the dredging algorithm was initiated before time step 2 and terminated after time step 3. The table labelled "TONS OF SEDIMENT DREDGED FROM THIS REACH" indicates that prior to time step 3, 13568.3 tons of material was dredged from Sections 42.0 and 44.0.

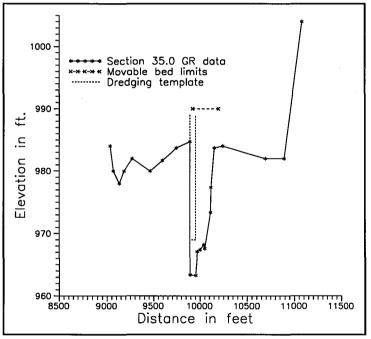


Figure 6-4 Cross Section 35.0, Example Problem 4

#### Table 6-4a Example Problem 4 - Input Sediment Options

T1	E	XAMPLE P	ROBLEM N	O 4. SOME	SEDIM	IENT OPI	TIONS.			
т2	3	LOCAL I	NFLOWS							
т3	S	SOUTH FOR	K, ZUMBR	O RIVER	** E	xample	Problem 4	**		
NC	.1	.1	.04	.1	.3					
X1	1.0	31	10077.	10275.	0.	0.	0.			
GR	1004.	9915.	978.4	10002.	956.0	10060.	959.2	10077.	959.3	10081.
GR	950.0	10092.	948.48	10108.	946.6	10138.	944.7	10158.	955.2	10225.
GR	956.2	10243.	958.9	10250.	959.8	10275.	959.8	10300.	959.9	10325.
GR	958.8	10350.	957.4	10400.	970.0	10700.	966.0	10960.	970.0	11060.

968.0 11240. 970.0 11365. 970.0 11615. GR 968.0 11085. 970.0 11500. GR 962.0 11665. 962.0 12400. 976.0 12550. 980.0 12670. 982.0 12730. 12735. GR 984.0 HD 1.0 10. 10081. 10250. NV 22 .045 965.6 .064 988.8 NV 12 .08 965.6 .13 988.8 NV 33 .1 965.6 .11 982.0 .12 988.8 15.0 27 10850. 3560. 3030. 3280. X1 10665. 10700. 961.0 11000. 970.0 X3 GR 992.0 9570. 982.0 10110. 976.0 10300. 976.0 10490. 966.0 10610. GR 964.7 10665. 956.0 10703. 10673. 953.0 10693. 954.0 955.6 10723. GR 958.6 10750. 959.3 10800. 957.0 10822. 10825. 961.5 957.3 10850. 10852. GR 962.0 964.0 10970. 966.0 11015. 11090. 961.0 962.0 11150. GR 970.0 11190. 972.0 11310. 980.0 11410. 984.0 11570. 990.0 11770. GR 990.0 11865. 1000.0 12150. HD 15.0 10. 10673. 10852. CASCADE CREEK - Local Inflow QТ NC . 1 .1 .05 X1 32.0 29 10057.0 10271.0 3630. 3060. 4240. 9080. GR 998.0 982.0 9250. 982.0 9510. 9600. 980.01 9925. 980.0 GR979.48 10000. 978.5 10057. 968.6 10075. 959.82 10087. 956.5 10097. GR 956.8 10117. 957.8 10137. 959.4 10157. 959.6 10177. 959.8 10196. 10225. 971.2 10250. 978.5 978.6 GR 966.5 10271. 978.5 10300. 10350. GR978.91 10370. 978.96 10387. 980.0 10610. 982.0 10745. 982.0 11145. 992.0 1000.0 GR 984.0 11150. 11240. 11330. 1008. 11425. 10. 10075. 10275. HD 32.0 Section 32.1 is a duplicate of Sec 32.0 - Needed to model IBC at Sec 33.0 X1 32.1 29 10057.0 10271.0 3130. 3250. 3320. х3 10 GR 998.0 9080. 982.0 9250. 982.0 9510. 980.0 9600. 980.01 9925. GR979.48 10000. 978.5 10057. 968.6 10075. 959.82 10087. 956.5 10097. GR 956.8 10117. 957.8 10137. 959.4 10157. 959.6 10177. 959.8 10196. GR 966.5 10225. 971.2 10250. 978.5 10271. 978.5 10300. 978.6 10350. GR978.91 10370. 978.96 10387. 980.0 10610. 982.0 10745. 982.0 11145. 1000.0 GR 984.0 11150. 992.0 11240. 11330. 1008. 11425. HD 32.1 10. 10075. 10275. A spillway is located here. X1 33.0 21 1850. 2150. 0 0 0 X5 2 хL 250 GR 1000. 980. 990.0 1060. 980.0 982.0 982.0 1150. 1180. 1215. GR 980.0 1260. 982.0 982.0 1300. 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 984.41 979.19 982.0 1830. 1850. 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. 1851. HD 33.0 Ο. 2149. a duplicate of Section Section 33.3 is 33.0. X1 33.3 21 1850. 2150. 1550. 1750. 1750. .95 1.49 хг 250. GR 1000. 980. 990.0 1060. 980.0 1150. 982.0 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.3 ο. 1851. 2149. Section 33.9 is a duplicate of Sec 33.3 - Needed to model IBC at Sec 35.0 X1 33.9 21 1850. 1050. 1050. 1050. .95 2150. 1.65 Х3 10 GR 1000. 980. 990.0 1060. 980.0 1150. 1180. 982.0 982.0 1215. GR 980.0 1260. 982.0 1420. 1300. 982.0 1350. 980.0 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.9 Ο. 1851. 2149. A weir is located here. X1 35.0 0 0 22 9894. 10245. 0 х3 10 0.5 974. **X**5 GR 984.0 9035. 980.0 9070. 978.0 9135. 980.0 9185. 982.0 9270. GR 980.0 9465. 9595. 9894. 9894.1 981.7 983.7 9745. 984.7 963.4 GR 963.3 9954. 967.1 9974. 10004. 10044. 967.6 10054. 967.4 968.2 GR 973.4 10115. 977.4 10120. 982.0 983.7 10155. 984.0 10245. 10695. GR 982.0 10895. 1004.0 11085. HD 35.0 Ο. 9954. 10155. 969.0 9894. 9954 1.0 SILVER LAKE -- - -- -.06 NC .06 .045 9880. X1 42.0 32 10130 5370. 5000. 5210. GR 996.0 7130. 998.0 7310. 998.0 7930. 992.0 8205. 990.0 8495. GR 988.0 8780. 986.0 8990. 985.7 9570. 986.45 9707. 989.44 9857. GR 990.0 9880. 969.8 9881. 969.8 9941. 985.8 9941. 985.8 9943. GR 969.8 9943. 969.8 10001. 986.7 10001. 986.7 10003. 969.8 10003. GR 969.8 10067. 985.8 10067. 985.8 10069. 969.8 10069. 969.8 10129. GR 989.9 10130. 989.5 988.6 10230. 987.6 10280. 985.2 10180. 10430.

GR 986.8	11720.	989.9	12310.		071 0	0001	00/1		1.0
HD 42.0 STLVER (	.0. - אפפאר	9881. Local In	10021.		<b>9</b> 71.0	9881.	9941.		1.0
OT		Docar In	IL LOW						
X1 44.0	28	9845.	10127.	3200.	3800.	3500.			
XL			9850.	10200.					
GR 1002.	8035.	992.0	8150.	990.0	8305.	990.0	8735.	988.0	8835.
GR 996.0	9285.	1017.6	9425.	990.0	9505.	986.0	9650.	984.1	9788.
GR 980.6 GR 968.9	9845. 10028.	970.9 967.4	9868. 10058.	972.2 967.1	9898. 10078.	970.5 971.9	9968. 10118.	967.5 976.8	9998. 10127.
GR 977.8	10150.	976.9	10193.	982.0	10206.	981.2	10110.	979.2	10325.
GR 983.1	10400.	999.8	10450.	1002.4	10464.	JUL.2	100000	57512	10020.
HD 44.0	1.	9868.	10193.		971.0	<i>9968</i> .	10028.		1.0
X1 53.0	22	10000.	10136.	3366.	2832.	2942.			
GR 1004.	7550.		7760.	998.0	8440.	996.0	8640.	996.0	8780.
GR 994.0	8940.	986.0	9245.	986.3	9555.	986.3	9825.	983.8	9900.
GR 982.8	10000.	978.2	10011.	974.0	10041.	972.2	10071.	972.6	10101.
GR 978.2	10121.	988.7	10136.	989.3	10154.	999.2	10200.	1000.1	10320.
GR 1002.	10470.	1004.0	10700.						
HD 53.0	10.	10000.	10136.						
	SEK - LO	ocal Infl	OW						
QT X1 55.0	18	9931.	10062.	2275.	3430.	2770.			
GR 1004.	7592.	1000.0	7947.	996.0	8627.	990.0	9052.	986.0	9337.
GR 984.3	9737.	984.7	9837.	985.5	9910.	987.2	9931.	978.1	9955.
GR 974.8	9975.	974.2	10005.	972.9	10035.	973.2		983.8	10062.
GR 985.8	10187.	986.0	10307.	990.0	10497.				
HD 55.0	10.	9931.	10062.						
X1 58.0	22	9912.	10015.	1098.	1012.	1462.			
GR 1006.	8542.		8952.	1000.0	9702.	997.2	9812.	996.3	9912.
GR 976.2	9944.	975.4	9974.	978.2	9991.	990.4	10015.	988.3	10062.
GR 988.8	10065.	988.3	10065.	989.3	10169.	990.0	10172.	992.0	10242.
GR 992.0	10492.	988.0	10642.	986.7	10852.	988.0	11022.	986.0	11097.
GR 986.0	11137.	988.0	11192.						
HD 58.0	3.4	9912.	10015.						
EJ	with Ros	ala Zumba	- Dimen	Chanan	Coment	1	** -	lo Dwohl	
		rk, Zumbr /E FROM G			Segment	T	** Examp	Die Probi	em 4 **
		ATIONS FR							
		JE OF SAN			•				
		TRANSPOR			AM POWER	[REF-AS	CE JOURN	JAL (YANG	1971)]
									,
I1	5			- 14	5				
I1 I4 SAND	5 4	1	10	- 1.	8				
		1 .5	10 .25	.5	.25	0	1.0		
I4 SAND I5 LQ	4		.25 1000	5800	90000	0	1.0		
I4 SAND I5 LQ LT TOTAL	4 .5 1 .0110	.5 50 1.5	.25 1000 320	5800 4500.	90000 400000	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS	4 .5 .0110 .119	.5 50 1.5 .119	.25 1000 320 .498	5800 4500. .511	90000 400000 .582	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS	4 .5 .0110 .119 .328	.5 50 1.5 .119 .328	.25 1000 320 .498 .331	5800 4500. .511 .306	90000 400000 .582 .280	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS	4 .5 .0110 .119 .328 .553	.5 50 1.5 .119 .328 .553	.25 1000 320 .498 .331 .156	5800 4500. .511 .306 .154	90000 400000 .582 .280 .110	0	1.0		
I4 SAND I5 LQ LF TOTAL LF VFS LF FS LF MS LF CS	4 .5 1 .0110 .119 .328 .553 .000	.5 50 1.5 .119 .328 .553 .000	.25 1000 320 .498 .331 .156 .011	5800 4500. .511 .306 .154 .016	90000 400000 .582 .280 .110 .020	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS	4 .5 1 .0110 .119 .328 .553 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000	.25 1000 320 .498 .331 .156 .011 .004	5800 4500. .511 .306 .154 .016 .008	90000 400000 .582 .280 .110 .020 .005	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VCS LF VFG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000	5800 4500. .511 .306 .154 .016 .008 .004	90000 400000 .582 .280 .110 .020 .005 .002	0	1.0		
I4 SAND I5 L7 LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VCG LF VFG LF FG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001	90000 400000 .582 .280 .110 .020 .005 .002 .001	o	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VCS LF VFG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000	90000 400000 .582 .280 .110 .020 .005 .002	o	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VCS LF VFG LF FG LF MG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000	0	1.0		
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF CS LF CS LF VCS LF VFG LF FG LF MG LF CG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000	0	1.0	4.0	91.0
I4 SAND I5 LC LT TOTAL LF VFS LF FS LF MS LF CS LF VFG LF FG LF MG LF CG FF EXAMP PFC 2.0	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000			4.0 .125	91.0 1.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VG LF FG LF KMG LF CG PF EXAMP PFC 2.0 PFC.0625	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 .000 .5	90000 40000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .37.0	8.0 .25	95.0 8.0	.125	1.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VFG LF VG LF FG LF MG LF CG LF VCG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP	4 .5 1 .01100 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 .5 .5	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0	95.0 8.0 99.0	.125 8.0	1.0 98.5
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF VCS LF VCS LF VG LF FG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC 2.0	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 32.0 73.0 64.0 93.5	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 .000 .5	90000 40000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .37.0	8.0 .25	95.0 8.0	.125	1.0
I4 SAND I5 L7 TOTAL LF VFS LF FS LF MS LF CS LF VFG LF VFG LF FG LF MG LF CG LF VCG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50	95.0 8.0 99.0 45.5	.125 8.0 .250	1.0 98.5 8.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCG LF VCG LF VCG LF VCG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 125 PF EXAMP	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 .000 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF CS LF VFG LF VG LF KG LF CG LF CG LF VCG PF EXAMP PFC 2.0 PFC 4.0	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50	95.0 8.0 99.0 45.5	.125 8.0 .250	1.0 98.5 8.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF VCS LF VCS LF VG LF FG LF CG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 SLOCAL	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 79.0	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0 32.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF VCS LF VCS LF VG LF FG LF CG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 SLOCAL	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 79.0	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0 32.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VG LF FG LF CG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 SLOCAL LOAD TAE	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF VS LF VFG LF VG LF VG LF VGG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 PFC 4.0 SLOCAL LOAD TAE LQL	4 .5 1 .0110 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 LOCAL IN 10000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VG LF CG LF CG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 PFC 4.0 PFC 4.0 SLOCAL LOAD TAE LQL LTLTOTAL LFL VFS LFL FS	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 79.0 EEK - A 1000 .015 .245	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VFG LF VFG LF VFG LF VGG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC.125 PF EXAMP PFC 4.0 PFC	4 .5 1 .01100 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 UOCAL IN 10000 30000 .198 .181 .107	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF KS LF KS LF CS LF VCS LF VCS LF VCG LF CG LF CG LG CG LF CG LG CG LF CG LG CG LF CG LG CG LF CG LG CG LF CG LG CG CG LG CG LG CG LG CG LG CG CG LG CG LG CG CG LG CG	4 .5 1 .01100 .1199 .328 .553 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .000000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 .000 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF CS LF VFG LF VFG LF VCG PF EXAMP PFC 2.0 PFC 2.0	4 .5 1 .01100 .119 .328 .553 .0000 .000 .000 .000 .000 .000 .00	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 79.0 8EEK - A 1000 .015 .245 .605 .052 .039	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 .000 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VCG LF VCG PF EXAMP PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 4.0 SLOCAL LOAD TAE LQL LTLTOTAL LFL VFS LFL VS LFL VCS LFL VCS LFL VCS	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 79.0 64.0 79.0 500 .015 .245 .605 .052 .039 .0200	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF MS LF CS LF VCS LF VG LF FG LF CG LF CG LF VCG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC 4.0 PFC 4.0 PFC 4.0 SLOCAL LOAD TAE LQL LTTOTAL LFL VFS LFL FS LFL S LFL CS LFL VCS LFL VFG LFL FG	4 .5 1 .01100 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .000 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 30000 .198 .181 .107 .098 .127 .1160 .0910	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF KS LF KS LF CS LF VCS LF VG LF VG LF CG LF CG LF CG LF CG LF CG LF CG LF CG LF CG LF CG FF EXAMP PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 2.0 PFC 4.0 SLOCAL LOAD TAF LQL LTLTOTAL LFL VFS LFL KS LFL CS LFL VCS LFL VCG LFL VCG LFL FG LFL KG	4 .5 1 .01100 .1199 .328 .553 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 1.0 8.181 .107 .098 .127 .1160 .0910 .0530	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF CS LF VFG LF VCG PF C LF VCG PF EXAMP PFC 2.0 PFC	4 .5 1 .01100 .119 .328 .553 .0000 .000 .000 .000 .000 .000 .00	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 1.0 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 2.0 .0625 1.0 0.000 .0625 1.0 0.000 .000 .000 .000 .000 .000 .00	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 79.0 84.0 79.0 84.0 79.0 85 .245 .605 .052 .039 .0200 .0110 .0110 .0000	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 .000 .000 .000	90000 400000 .582 .280 .110 .020 .005 .002 .001 .000 .000 .000 .000 .000 .000	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VCG LF VCG PF EXAMP PFC 2.0 PFC 2.0	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 79.0 24.5 .050 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000 .0000	5800 4500. .511 .306 .154 .016 .008 .001 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 3.000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VCG LF CG LF CG LF CG LF CG LF CG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 PFC .125 PF EXAMP PFC 4.0 PFC .125 PF EXAMP PFC 4.0 SLOCAL LOAD TAE LFL VFS LFL FS LFL VCS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL VCG LFL VCG LFL VCG LFL VCG LFL VCG LFL VCG	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 79.0 24.5 .050 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000 .0000	5800 4500. .511 .306 .154 .016 .008 .001 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 1.0 32.0 1.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 3.000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VCG LF VCG PF EXAMP PFC 2.0 PFC 2.0	4 .5 1 .0110 .119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 .000	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 79.0 64.0 79.0 64.0 79.0 64.0 79.0 64.0 79.0 64.0 500 500 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0110 .0110 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .015 .025 .025 .025 .025 .025 .025 .025 .02	5800 4500. .511 .306 .154 .016 .008 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 1.0 1.0 1.0 1.0 30000 .198 .127 .1160 .0910 .0220 .0060 .0060 .0060	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VCS LF VCS LF VCG LF VCG LF CG LF VCG LF VCG LF VCG LF VCG LF VCG PFC 2.0 PFC 4.0 SLOCAL LOAD TAH LQL LFL VFS LFL KS LFL VCS LFL VCS LFL VCG LFL CG LFL VCG LFL CG LFL VCG LQAD TAH LQA	4 .5 1 .01100 .1199 .328 .553 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0085 .0031 .0086 .0311 .0086 .0311 .0080 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 .000 1.0 1.0 1	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 .000 .000 .000	5800 4500. .511 .306 .154 .016 .008 .004 .000 .000 .000 16.0 .5 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 32.0 1.0 30000 .000 .000 .000 .000 .000 .0	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF VFS LF KS LF CS LF VCS LF VCG PF C3 LF CG LF CG LF CG LF VCG PF EXAMP PFC 2.0 PFC.0625 PF EXAMP PFC 4.0 SLOCAL LOAD TAE LTLTOTAL LFL VFS LFL VFS LFL KS LFL CS LFL VCS LFL CG LFL CG LF	4 .5 1 .01100 .1199 .328 .553 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0040 .0000 .0010 .0010 .0010 .00000 .00000 .00000 .000000	.5 50 1.5 .119 .328 .553 .000 .000 .000 .000 .000 .000 1.0 1.0 1	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 .000 32.0 73.0 64.0 93.5 0.0 64.0 93.5 0.0 64.0 79.0 84.0 79.0 84.0 79.0 850 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000 .0110 .0100 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .011 .005 .052 .039 .0200 .0110 .0000 .015 .052 .039 .0200 .0110 .0100 .0110 .0000 .011 .0000 .011 .00000 .00000 .00000 .00000 .00000 .00000 .000000	5800 4500. .511 .306 .154 .008 .004 .000 .000 .000 .000 .000 .00	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0
I4 SAND I5 LQ LT TOTAL LF VFS LF FS LF KS LF VFG LF VCS LF VCG LF VCG PF EXAMP PFC 2.0 PFC 2.0	4 .5 1 .01100 .1199 .328 .553 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .664 .2077 .086 .0310 .0040 .008 .0030 .008 .0030 .008 .0030 .0010 .0080 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0064 .0064 .0064	.5 50 1.5 119 .328 .553 .000 .000 .000 .000 .000 1.0 1.0 1.0 1.	.25 1000 320 .498 .331 .156 .011 .004 .000 .000 32.0 73.0 64.0 93.5 0.0 0.0 0.0 64.0 93.5 0.0 0.0 0.0 64.0 93.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0	5800 4500. .511 .306 .154 .016 .008 .004 .001 .000 .000 16.0 .5 32.0 1.0 30000 .006 .006 .006 .006 .006 .006	90000 400000 .582 .280 .110 .020 .001 .000 .000 .000 .000 .00	8.0 .25 16.0 .50 16.0	95.0 8.0 99.0 45.5 94.0	.125 8.0 .250 8.0	1.0 98.5 8.0 94.0

LFL CS LFL VCS LFL VFG	.031								
LFL VCS		.031	.052	.098					
	000	.031	.032						
LFL VFG	.008			.127					
	.0030	.0030	.0200	.1160					
LFL FG	.0010	.0010	.0110	.0910					
LFL MG	.0000	.0000	.0110	.0530					
LFL CG	.0000	.0000	.0000	.0220					
LFL VCG	.0000	.0000	.0000	.0060					
					1.7				
			- A LOCA						
LQL	1.	100.	500.	1000.	30000.				
LTLTOTAL	.0020	30.0	500.	1200	22500				
LFL VFS	.201	.201	.078	.078	.137				
LFL FS	.342	.342	.172	.175	.218				
LFL MS	.451	.451	.454	.601	.476				
LFL CS	.001	.001	.197	.142	.158				
LFL VCS	.000	.000	.000	.003	.008				
LFL VFG	.0000	.0000	.0000	.0000	.0020				
LFL FG	.0000	.000	.0000	.0000	.0010				
LFL MG	.0000	.000	.0000	.0000	.0000				
LFL CG	.0000	.000	.0000	.0000	.0000				
LFL VCG	.0000	.000	.0000	.0000	.0000				
\$HYD									
\$B	2								
\$KL									
* а	FLOW 1	= BASE	FLOW OF 7	750 CES					
	61.	29.	128.						
		29.	128.						
R 956.	962.								
г 65.	72.	70.	67.						
wi 2.									
\$DREDGE									
<b>ж в</b>	FLOW 2	= 50 D7	אאם ידע פעע	AK FILL	DISCHARGE				
				AN FORD	DI CUMRCE				
Q 2500.	300.	150.	650.						
R 965.	970.								
х	2.5	50.							
*	FLOW 3	= NEAR	BANK FULI	DISCH	ARGE				
Q 1250.	150.	78.	340.						
R 960.	966.								
	500.								
W 1.									
\$SED									
NEW LOAD	TABLE F	OR MAIN	STEM						
LPOINT	1	0							
LQ	1	50	1000	5800	90000				
LT TOTAL	.0110	1.5	320	4500.					
LF VFS	.119	.119	.498	.511	.582				
LF FS	.328	.328	.331	.306	.280				
LF MS	.553	.553	.156	.154	.110				
LF CS	.345	.345	.011	.016	.020				
LF VCS	.025	.025	.004	.008	.005				
LF VFG	.005	.005	.000	.004	.002				
LF FG	.000	.000	.000	.001	.001				
LF MG	000	.000	.000	.000	.000				
ur 110	.000	.000	.000	.000	.000				
	.000		.000	.000	.000				
LF CG	.000								
LF CG LF VCG	.000. .0	.0		4 1 4 4 4					
LF CG LF VCG <b>NEW LOAD</b>	.000 .0 <b>TABLE F</b>	.0 FOR SILV		- A LOC	CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT	.000 .0 TABLE F 1	.0 FOR SILV 2	ER CREEK		CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT	.000 .0 <b>TABLE F</b>	.0 FOR SILV		- A LOC	CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT LQL	.000 .0 TABLE F 1	.0 FOR SILV 2	ER CREEK		CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT LQL LTLTOTAL	.000 .0 <b>TABLE F</b> 1 .0040	.0 FOR SILV 2 100 10	/ER CREEK	10000 30000	CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT LQL LTLTOTAL LFL VFS	.000 .0 <b>TABLE F</b> 1 .0040 .664	.0 FOR SILV 2 100 10 .664	/ER CREEK 1000 500 .015	10000 30000 .198	CAL INFLOW				
LF CG LF VCG <b>NEW LOAD</b> LPOINT LQL LTLTOTAL LFL VFS LFL FS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207	.0 FOR SILV 100 .664 .207	<b>/ER CREEK</b> 1000 500 .015 .245	10000 30000 .198 .181	CAL INFLOW				
LF CG LF VCG <i>NEW LOAD</i> LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086	.0 FOR SILV 100 .664 .207 .086	<b>/ER CREEK</b> 1000 500 .015 .245 .605	10000 30000 .198 .181 .107	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS LFL CS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031	.0 FOR SILV 100 .664 .207 .086 .031	/ER CREEK 1000 500 .015 .245 .605 .052	10000 30000 .198 .181 .107 .098	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS LFL CS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086	.0 FOR SILV 100 .664 .207 .086	<b>/ER CREEK</b> 1000 500 .015 .245 .605	10000 30000 .198 .181 .107	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS LFL CS LFL VCS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031	.0 FOR SILV 100 .664 .207 .086 .031	/ER CREEK 1000 500 .015 .245 .605 .052	10000 30000 .198 .181 .107 .098	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL MS LFL MS LFL CS LFL VCS LFL VFG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030	.0 FOR SILV 100 .664 .207 .086 .031 .008 .0030	/ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200	10000 30000 .198 .181 .107 .098 .127 .1160	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VFG LFL FG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010	.0 <b>FOR SILU</b> 100 .664 .207 .086 .031 .008 .0030 .0010	/FR CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110	10000 30000 .198 .181 .107 .098 .127 .1160 .0910	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS LFL VCS LFL VCS LFL VGG LFL FG LFL MG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000	.0 <b>FOR SILU</b> 100 .664 .207 .086 .031 .008 .0030 .0010 .0000	/FR CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL CS LFL VCS LFL VCS LFL VFG LFL FG LFL MG LFL CG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000	.0 FOR SILV 2 100 .00 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000	/ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL VFG LFL KG LFL CG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000	.0 <b>FOR SILU</b> 100 .664 .207 .086 .031 .008 .0030 .0010 .0000	/FR CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL FG LFL CG LFL CG LFL VCG	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000	.0 FOR SILV 2 100 .00 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000	/ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL CS LFL CS LFL VCS LFL VCS LFL FG LFL FG LFL CG LFL VCG END	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000	.0 FOR SILV 2 100 .00 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000	/ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220	CAL INFLOW				
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCG LFL FG LFL CG LFL VCG END \$RATING	.000 .0 <b>TABLE F</b> 1 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0010 .0000	.0 <b>FOR SILV</b> 100 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000	/FR CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000 .0000	10000 30000 .198 .107 .098 .127 .1160 .0910 .0530 .0220 .0060			958 0	960 0	962 1
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL CS LFL VCS LFL VCG LFL VCG LFL CG LFL CCG LFL VCG END \$RATING RC	.000 .0 <b>TABLE F</b> 1 .0040 .664 .001 .008 .0030 .0010 .0000 .0000 .0000	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000	/ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0110 .0000 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060	950.0	955.1	958.0	960.0	
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL VG LFL CG LFL CG LFL CG LFL CG RC RC	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000	.0 <b>FOR SILV</b> 100 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	//ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0100 .0000 .0000 .0000 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0220 .0060 0 967.0	950.0 967.7	955.1 968.3	968.9	969.4	962 969
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL VCG END \$RATING RC RC	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000	.0 <b>FOR SILV</b> 100 .004 .207 .086 .030 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	<pre>// CREEK     1000     500     .015     .245     .605     .052     .039     .0200     .0110     .0110     .0000     .0000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     000000</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 0 967.0 971.4	950.0 967.7 971.8	955.1 968.3 972.1	968.9 972.4	969.4 972.7	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL VCG END \$RATING RC RC	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000	.0 <b>FOR SILV</b> 100 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	//ER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0100 .0000 .0000 .0000 .0000	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0220 .0060 0 967.0	950.0 967.7	955.1 968.3	968.9	969.4	969.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VCG LFL CG LFL VCG END \$RATING RC RC RC	.000 .0 <b>TABLE F</b> 1 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .00000 .0010 .00000	.0 <b>FOR SILU</b> 1000 .004 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .0000 .0000000 .00000 .00000000	<pre>// CREEK     1000     500     .015     .245     .605     .039     .0200     .0110     .0110     .00000     .00000     .0000     .0000     .0000     .00000     .0</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL VCG END \$RATING RC RC RC RC	.000 .0 <b>TABLE F</b> 1 .0040 .664 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000	.0 <b>FOR SILV</b> 100 .004 .207 .086 .030 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	<pre>// CREEK     1000     500     .015     .245     .605     .052     .039     .0200     .0110     .0110     .0000     .0000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     00000     000000</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 0 967.0 971.4	950.0 967.7 971.8	955.1 968.3 972.1	968.9 972.4	969.4 972.7	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL CS LFL VCS LFL VCG LFL VCG LFL CG LFL CG LFL CG LFL VCG END \$RATING RC RC RC \$PRT	.000 .0 <b>TABLE F</b> 1 .0040 .664 .001 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .002 .0010 .002 .0010 .002 .0010 .002 .0010 .002 .002	.0 <b>FOR SILU</b> 1000 .004 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .0000 .0000000 .00000 .00000000	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL KS LFL CS LFL VCS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL CG RC RC RC RC \$PRT CP	.000 .0 <b>TABLE F</b> 1 .0040 .664 .007 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0020 .00	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .00000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .0000 .0	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF CG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VCG LFL VCG END \$RATING RC RC RC RC CP PS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .001 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .002 .0010 .002 .0010 .002 .0010 .002 .0010 .002 .002	.0 <b>FOR SILU</b> 1000 .004 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .0000 .0000000 .00000 .00000000	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VCS LFL VCG LFL VCG END \$RATING RC RC RC RC CP PS	.000 .0 <b>TABLE F</b> 1 .0040 .664 .007 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0020 .00	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .00000 .0000 .0000 .0000000 .0000 .0000 .0000 .0000 .0000	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL VS LFL VCS LFL VCS LFL VCG LFL VCG LFL VCG END \$RATING RC RC RC RC RC PS END	.000 .0 <b>TABLE F</b> 1 .0040 .664 .007 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0020 .00	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .00000 .0000 .0000 .0000000 .0000 .0000 .0000 .0000 .0000	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .098 .127 .1160 .0910 .0530 .0220 .0060 .0060 .0967.0 967.0 971.4	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF CG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL MS LFL CS LFL VFG LFL VGG LFL VGG LFL CG LFL CG LFL CG LFL CG LFL CG RC RC RC RC RC RC PS END \$NODREDGE	.000 .0 <b>TABLE F</b> 1 .0040 .664 .001 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0000 .0010 .0010 .0000 .0000 .0000 .00000 .0000 .00000 .00000 .000	.0 FOR SILV 2 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .0	YER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0100 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0015 .245 .605 .052 .039 .0200 .0110 .0100 .015 .245 .052 .039 .0200 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .00000 .0000 .0000 .0000 .0000 .0000 .000000 .000000 .0000000 .00000000	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL CS LFL CS LFL VCS LFL VCG LFL CG LFL CG LFL CG LFL CG LFL CG CF FATING RC RC RC RC RC SPRT CP PS SNODREDGE * C	.000 .0 <b>TABLE F</b> 1 1 .0040 .664 .001 .008 .0030 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0031 .0086 .0031 .0086 .0031 .0086 .0031 .0086 .0030 .0030 .0030 .0050	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .00	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF CG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VCS LFL VG LFL GG LFL VG END \$RATING RC RC RC RC RC RC RC PS END \$NODREDGE * C Q 750.	.000 .0 <b>TABLE F</b> 1 1 .0040 .644 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0000 .0010 .0000 .0010 .0000 .0010 .0010 .0000 .0000 .0010 .0000 .0000 .00000 .0000 .0000	.0 FOR SILV 2 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .0	YER CREEK 1000 500 .015 .245 .605 .052 .039 .0200 .0110 .0100 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0015 .245 .605 .052 .039 .0200 .0110 .0100 .015 .245 .052 .039 .0200 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .0000 .0110 .00000 .0000 .0000 .0000 .0000 .0000 .000000 .000000 .0000000 .00000000	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL FS LFL CS LFL VCS LFL VCS LFL VCG LFL FG LFL VCG END <b>\$RATING</b> RC RC RC RC RC <b>\$PS</b> END <b>\$NORREDGE</b> <b>*</b> C Q 750. R 957.	.000 .0 <b>TABLE F</b> 1 1 .0040 .664 .001 .008 .0030 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0031 .0086 .0031 .0086 .0031 .0086 .0031 .0086 .0030 .0030 .0030 .0050	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .00	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF CG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL MS LFL CS LFL VCS LFL VCS LFL VCS LFL VG LFL GG LFL VG END \$RATING RC RC RC RC RC RC RC PS END \$NODREDGE * C Q 750.	.000 .0 <b>TABLE F</b> 1 1 .0040 .644 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0000 .0010 .0000 .0010 .0010 .0000 .0000 .0010 .0000 .0000 .00000 .0000 .0000	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .00	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.
LF CG LF VCG NEW LOAD LPOINT LQL LTLTOTAL LFL VFS LFL VFS LFL CS LFL VCS LFL VCS LFL VCG LFL VCG LFL VCG END \$RATING RC RC RC RC RC RC RC \$PS END \$NODREDGE * C Q 750. R 957.	.000 .0 <b>TABLE F</b> 1 1 .0040 .644 .207 .086 .031 .008 .0030 .0010 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0010 .0000 .0010 .0000 .0010 .0010 .0000 .0000 .0010 .0000 .0000 .00000 .0000 .0000	.0 <b>FOR SILV</b> 1000 .664 .207 .086 .031 .008 .0030 .0010 .00000 .0000 .0000 .0000 .0000 .000000 .0000 .0000 .0000 .00	<pre>// CREEK</pre>	10000 30000 .198 .181 .107 .0910 .0910 .0220 .0060 967.0 971.4 973.7 974.6	950.0 967.7 971.8 973.8	955.1 968.3 972.1 973.9	968.9 972.4 974.0	969.4 972.7 974.1	969. 972.

# 6.4.2 Transmissive Boundary Condition

With the addition of the **\$B** record at the beginning of the hydrologic data, HEC-6 implements a transmissive boundary condition at each downstream boundary. This option causes all inflowing sediment to pass through the affected cross section without interacting with the bed. A caution: this option applies to all downstream boundaries in the model.

As in Example Problems 2 and 3, this example has two internal boundary conditions which effectively divide the model into 3 subreaches, each with its own downstream boundary.

The effect of the transmissive boundary condition on the 3 downstream boundaries can be seen by carefully reviewing the output of Example Problem 4. For instance, looking at TABLE SB-2 for the last time step, Sections 35.0, 33.0, and 1.0 all show that no bed change has occurred after a simulation of 52 days.

#### 6.4.3 Limerinos' Bed Form Roughness Function

The Limerinos function (16) for bed form roughness is used in this example (KL record). The value of Manning's *n* resulting from this computation can be found in the "HYDRAULIC PARAMETERS" table of the C-level sediment output. For example, the *n* value calculated by the Limerinos equation for the last time step for Section No. 42.1 is 0.0153. Note, this computation overrides the roughness data (NC and NV records) in the geometric data.

#### 6.4.4 Flow Duration Option

The use of X rather than W data to select the time step is also illustrated in this problem. This option allows a long period of constant flow to be subdivided into multiple computational time steps without repeating \*, Q, W data.

In this example, time step 2 represents 20 separate (incremental or computational) time steps each having a duration of 2.5 days. At the end of the last incremental time step, output is produced depicting the state of the river system for the last 2.5 day time step (i.e., instantaneous data such as the sediment load data in TABLE SB-2 are only for the last 2.5 day time step, while cumulative data, such as trap efficiency and bed change, represent changes since the start of the simulation.) Caution, because of this dichotomy, output produced by a time step such as this can be misleading. See Example Problem 7, Section 6.7.2.

#### 6.4.5 Modifying the Sediment Load Tables

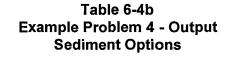
Sometimes the inflowing water vs. sediment relationship will change in time due to land use changes or even seasonal variations in vegetation. Such changes, should they be known or predicted, can be described in the flow data by using the **\$SED** option. Example Problem 4 demonstrates the use of this option by changing the inflowing load curve for the main river and one local inflowing load curve prior to the last flow in the hydrograph. Tables echoing this data are shown in the output after time step 3.

#### 6.4.6 Downstream Rating Curve

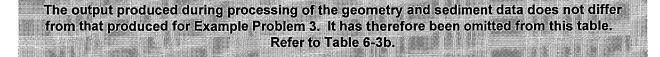
Prior to the last time step, a rating curve (**\$RATING**) was added to replace the stage hydrograph (**R** records). Although a rating curve is usually defined prior to the first time step, it can be placed (or replaced) before any time step of the simulation.

### 6.4.7 Accumulated Sediment Transported

Summary information regarding weight and volume of sediment can be requested via the Alevel output option on the **\$VOL** record. A-level output begins with the table labelled "SUMMARY TABLE: MASS AND VOLUME OF SEDIMENT". This table lists cumulative values of sediment transported through and deposited at each cross section since time zero. The difference between the sediment volume entering and leaving a cross section represents the material scoured from or deposited into the control volume associated with that cross section. This value is given under the heading "SEDIMENT DEPOSITED IN REACH IN CUBIC YARDS"; negative values represent scour. Under the heading "TOTAL SEDIMENT per grain size THROUGH EACH CROSS SECTION" are tables listing the total sediment transported through each cross section's control volume since the start of the simulation by grain size. Because the \$PRT option was invoked to limit output to Sections 1.0 and 15.0, only tables for these cross sections have been produced.



******	*****	*******	****	****	* *	****	****	******	*****	******	******
* SCOUR AND DEPOSI	TION IN RIVI	ERS AND RE	SERVO	DIRS	*	* U	.s. 1	ARMY CO	RPS OF	ENGINE	ERS *
<ul> <li>Version: 4.</li> </ul>	1.00 - AUG	JST 1993			*	* H	YDRO	LOGIC E	NGINEE	RING CE	NTER *
* INPUT FILE: exa	mple4.DAT				*	* 6	09 SI	COND S	TREET		*
* OUTPUT FILE: exa	mple4.OUT				*	* D	AVIS	, CALIF	ORNIA	95616-4	687 *
* RUN DATE: 31 AUG	93 RUN 7	CIME: 16:0	6:03		*	* (	916)	756-11	.04		*
*****	*******	*******	****	****	* *	****				******	******
	х х	XXXXXXX	XXX	XXX		XX	XXX				
	х х	х	х	х		х	х				
	х х	х	х			х					
	XXXXXXX	XXXX	х		XXXXX	XXX	XXX				
	X X	х	х			х	х				
	х х	х	х	х		х	х				
	х х	XXXXXXX	XXX	XXX		XX	XXX				
*******	*******	********	****	****	******	****	****	******	*****	**	
* MAXIMUM	LIMITS FOR	THIS VERS	SION A	ARE :						*	
* 10	Stream Seg	yments (Ma	in St	cem +	Tribut	arie	es)			*	
* 150	Cross Sect	cions								*	
* 100	Elevation	/Station H	points	s per	Cross	Sect	ion			*	
* 20	Grain Size	es								*	
* 10	Control Po	oints								*	
******	**********	*******	****	****	*****	****	****	******	*****	**	



\$HYD BEGIN COMPUTATIONS. \*B ...Transmissive Boundary Condition - ON \*KL ...USING LIMERINOS METHOD TO CALCULATE BED ROUGHNESS.

TIME STEP # 1 \* A FLOW 1 = BASE FLOW 0F 750 CFS TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 1 EXAMPLE PROBLEM NO 4. SOME SEDIMENT OPTIONS. ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT TIME ENTRY \* SAND DAYS POINT \* INFLOW OUTFLOW TRAP EFF \* 2.00 58.000 \* 0.09 53.000 \* 0.04 42.000 \* 0.00 TOTAL-35.000 \* 0.14 0.00 1.00 \*\*\*\*\*\* \*\*\*\*\*\* ENTRY \* POINT \* TIME SAND DAYS INFLOW OUTFLOW TRAP EFF 35.000 \* 2.00 0.00 33.000 \* TOTAL= 0.00 0.00 0.36 \* \*\*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\* TIME ENTRY \* SAND POINT \* OUTFLOW TRAP EFF \* INFLOW DAYS 33.000 \* 0.00 2.00 15.000 \* TOTAL= 1.000 \* 0.00 2.96 -692.13 \* \*\*\*\*\*\* \*\*\*\*\* \*\*\*\*\* **\$DREDGE** STREAM SEGMENT # 1: EXAMPLE PROBLEM NO 4. SOME SEDIMENT OPTIONS. SEC NO. 42.000 ELEVATION OF DREDGED CHANNEL INCLUDING 1.00 FEET OF OVER DREDGING= 970.00 TIME STEP # 2 \* B FLOW 2 = 50 DAYS AT BANK FULL DISCHARGE COMPUTING FROM TIME= 2.0000 DAYS TO TIME= 52.0000 DAYS IN 20 COMPUTATION STEPS - - - - -- - -EXAMPLE PROBLEM NO 4. SOME SEDIMENT OPTIONS. ACCUMULATED TIME (yrs).... 0.142 FLOW DURATION (days)..... 2.500 UPSTREAM BOUNDARY CONDITIONS -----DISCHARGE | SEDIMENT LOAD | TEMPERATURE (cfs) | (tons/day) | (deg F) Stream Segment # 1 (cfs) 58.000 Section No. -----------1400.00 INFLOW 529.98 62.04 Upstream of SECTION NO. 53.000 is... LOCAL INFLOW POINT # 3 DISCHARGE SEDIMENT LOAD | TEMPERATURE (deg F) (cfs) (tons/day) ·--------------MAIN STEM INFLOW 1400.00 529.98 62.04 LOCAL INFLOW 650.00 647.71 67 00 -----TOTAL 2050.00 1177.69 63.61 Upstream of SECTION NO. 42.000 is... DISCHARGE LOCAL INFLOW POINT # 2 SEDIMENT LOAD TEMPERATURE (cfs) (tons/day) (deg F) \_\_\_\_\_ MAIN STEM INFLOW 2050.00 1177.69 63.61 INFLOW LOCAL 150.00 14.45 70.00 -----TOTAL 2200.00 | 1192.13 64.05 Upstream of SECTION NO. 15.000 is... DISCHARGE LOCAL INFLOW POINT # 1 | SEDIMENT LOAD | TEMPERATURE (deg F) (cfs) (tons/day) ----------MAIN STEM INFLOW | 2200.00 1192.13 64.05 LOCAL INFLOW 300.00 40.00 72.00 -----2500.00 | TOTAL | 1232.13 65.00

*	EFF	TRAP	OUTFLOW	INFLOW	*	POINT	DAYS
*				13.17	*	58.000	52.00
*				16.03	*	53.000	
*				0.36	*	42.000	
*	0.93	(	2.05	29.56	*	35.000	TOTAL=
* *	****	*****	* * * * * * * * * *	*******	***	********	******
*			SAND		*	ENTRY	TIME
*	EFF	TRAP	OUTFLOW	INFLOW	*	POINT	DAYS
*				2.05	*	35.000	52.00
*	0.96	(	0.08	2.05	*	33.000	TOTAL=
	****	*****	********	*******	***	********	*******

TIME ENTRY * DAYS POINT * 52.00 33.000 * 15.000 * TOTAL= 1.000 *	SAND INFLOW OUTFLOW 0.08 0.99 1.07 3.42	* TRAP EFF * * -2.21 *			
*****	****	****			
TABLE SB-1: SEDIMENT I					
GRAIN SIZE I	ne Upstream Boundary: LOAD (tons/day)   0			-	
VERY FINE SAND	265.63 VEF 173.06 FIN 82.59 MET 6.27 COA 2.42 VEF	Y FINE GRAVEL.	0.00		
MEDIUM SAND	82.59 MEI	IUM GRAVEL	0.00		
VERY COARSE SAND	2.42   VEF	Y COARSE GRAVEL	0.00		
OPDINOVE OFFICE OF Second	n the Downstream Bound	TOTAL =	529.98		
GRAIN SIZE I	LOAD (tons/day) 0	RAIN SIZE LO	DAD (tons/day)		
VERY FINE SAND	1.42 VEF 1.61 FIN 7.44 MEE 9.01 COZ 3.68 VEF	Y FINE GRAVEL	0.03	-	
FINE SAND MEDIUM SAND	1.61 FIN 7.44 MEI	E GRAVEL	0.00		
COARSE SAND VERY COARSE SAND	9.01 COZ 3.68 VEE	RSE GRAVEL	0.00		
		•	23.18		
ייאסוב כם_ס. כייאייוכ ספ	דיי דיג עוזערפת חעם שטייי	ME - 52 000 D	AVC		
TABLE SB-2:         STATUS OF           SECTION         BED CHANGE           NUMBER         (ft)           58.000         -2.79           55.000         -1.24           53.000         -1.25           44.000         0.92           42.000         1.75           35.000 <b>0.00</b> 33.900         0.69           33.300         0.01           33.000 <b>0.00</b> 32.100         -0.52           32.000         -0.18           1.000 <b>0.00</b>	INE BED PROFILE AT II				
NUMBER (ft)	(ft) (ft)	(cfs)	SAND	.ons/day)	
58.000 -2.79 55.000 -1.24	978.33 972.61 978.30 971.66	1400. 1400.	577. 837.		
53.000 -1.55	976.02 970.65	2050.	1885.		
44.000 0.92 42.000 1.75	974.67 968.02 974.19 971.55	2050.	138.		
35.000 <b>0.00</b>	974.00 963.30 970.03 963.34	2200.	138.		
33.300 0.01	970.01 962.50	2200.	4.		
33.000 <b>0.00</b> 32.100 -0.52	970.00 961.00 965.75 955.98	2200.	4. 107.		
32.000 -0.05	965.23 956.45 964 99 953 52	2200. 2500	138.		
1.000 <b>0.00</b>	965.00 944.70	2500.	23.		
STREAM SEGMENT # 1: EX					
STREAM SEGMENT # 1: EX SEC NO. 42.000	XAMPLE PROBLEM NO 4.	SOME SEDIMENT OP	TIONS.		
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH	XAMPLE PROBLEM NO 4.	SOME SEDIMENT OP	TIONS.		
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH	XAMPLE PROBLEM NO 4. HANNEL INCLUDING 1. HANNEL INCLUDING 1.	Some Sediment op 00 feet of over 1 00 feet of over 1	TIONS. DREDGING= :	970.00	13568.
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CO SEC NO. 44.000	XAMPLE PROBLEM NO 4. HANNEL INCLUDING 1. HANNEL INCLUDING 1.	SOME SEDIMENT OP 00 FEET OF OVER 1 00 FEET OF OVER 1 13568.3 ACC	TIONS. DREDGING= :	970.00	13568. 10807.
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CO SEC NO. 44.000 ELEVATION OF DREDGED CO TONS OF SEDIMENT DREDGO	XAMPLE PROBLEM NO 4. HANNEL INCLUDING 1. HANNEL INCLUDING 1. ED FROM THIS REACH= CUBIC YARDS=	SOME SEDIMENT OP 00 FEET OF OVER 1 00 FEET OF OVER 1 13568.3 ACC 10807.1	TIONS. DREDGING= DREDGING= UMULATED FROM	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH 	XAMPLE PROBLEM NO 4. HANNEL INCLUDING 1. HANNEL INCLUDING 1. ED FROM THIS REACH= CUBIC YARDS=	SOME SEDIMENT OP 00 FEET OF OVER 1 00 FEET OF OVER 1 13568.3 ACC 10807.1	TIONS. DREDGING= DREDGING= UMULATED FROM	970.00	
STREAM SEGMENT # 1: E) SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH  STREAM SEGMENT # 1: E) \$SED LPOINT 1	XAMPLE PROBLEM NO 4. HANNEL INCLUDING 1. HANNEL INCLUDING 1. ED FROM THIS REACH= CUBIC YARDS= XAMPLE PROBLEM NO 4.	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CI SEC NO. 44.000 ELEVATION OF DREDGED CI TONS OF SEDIMENT DREDGI 	XAMPLE PROBLEM NO 4.         HANNEL INCLUDING       1.         HANNEL INCLUDING       1.         HANNEL INCLUDING       1.         ED FROM THIS REACH= CUBIC YARDS=       1.         KAMPLE PROBLEM NO 4.       1.         OR       R STREAM SEGMENT # 1.         N SIZE CLASS (tons/dag)	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1 SOME SEDIMENT OP	TIONS. DREDGING= DREDGING= UMULATED FROM	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH STREAM SEGMENT # 1: EX \$SED LPOINT 1 SEDIMENT LOAD TABLE FON LOAD BY GRAIN	KAMPLE PROBLEM NO 4.         HANNEL INCLUDING         HANNEL INCLUDING         I.         HANNEL INCLUDING         I.         ED FROM THIS REACH=         CUBIC YARDS=         KAMPLE PROBLEM NO 4.         R         STREAM SEGMENT #         N SIZE CLASS (tons/day         50.0000       1000.00	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH STREAM SEGMENT # 1: EX \$SED LPOINT 1 SEDIMENT LOAD TABLE FON LOAD BY GRAIN	XAMPLE PROBLEM NO 4.         HANNEL INCLUDING         HANNEL INCLUDING         I.         HANNEL INCLUDING         I.         ED FROM THIS REACH=         CUBIC YARDS=         CAMPLE PROBLEM NO 4.         O         R STREAM SEGMENT #         SIZE CLASS (tons/day         50.0000       1000.00	SOME SEDIMENT OF 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM TIONS.	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH STREAM SEGMENT # 1: EX \$SED LPOINT 1 SEDIMENT LOAD TABLE FON LOAD BY GRAIN	XAMPLE PROBLEM NO 4.         HANNEL INCLUDING         HANNEL INCLUDING         I.         HANNEL INCLUDING         I.         ED FROM THIS REACH=         CUBIC YARDS=         CAMPLE PROBLEM NO 4.         O         R STREAM SEGMENT #         SIZE CLASS (tons/day         50.0000       1000.00	SOME SEDIMENT OF 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM TIONS.	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH STREAM SEGMENT # 1: EX \$SED LPOINT 1 SEDIMENT LOAD TABLE FON LOAD BY GRAIN	XAMPLE PROBLEM NO 4.         HANNEL INCLUDING         HANNEL INCLUDING         I.         HANNEL INCLUDING         I.         ED FROM THIS REACH=         CUBIC YARDS=         CAMPLE PROBLEM NO 4.         O         R STREAM SEGMENT #         SIZE CLASS (tons/day         50.0000       1000.00	SOME SEDIMENT OF 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM TIONS.	970.00	
STREAM SEGMENT # 1: EX SEC NO. 42.000 ELEVATION OF DREDGED CH SEC NO. 44.000 ELEVATION OF DREDGED CH TONS OF SEDIMENT DREDGH STREAM SEGMENT # 1: EX \$SED LPOINT 1 SEDIMENT LOAD TABLE FON LOAD BY GRAIN	XAMPLE PROBLEM NO 4.         HANNEL INCLUDING         HANNEL INCLUDING         HANNEL INCLUDING         IN SIZE CLASS (tons/day         50.0000         1000.000	SOME SEDIMENT OF 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM TIONS.	970.00	
STREAM SEGMENT # 1: EX           SEC NO.         42.000           ELEVATION OF DREDGED CI           SEC NO.         44.000           ELEVATION OF DREDGED CI           TONS OF SEDIMENT DREDGI	Compute PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           OR         STREAM SEGMENT #           SIZE CLASS (tons/day)         1000.00           0.178500         159.360           0.178500         159.360           0.178500         159.360           0.517500         3.52000           0.517500         3.52000           0.750000E-01         1.28000           0.100000E-19         0.100000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1 	TIONS. DREDGING= UMULATED FROM  TIONS. 232800. 112000. 44000.0 8000.00 2000.00 800.000 400.000	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         TONS OF SEDIMENT DREDGO         STREAM SEGMENT # 1: EX         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FOU         LQ       1.00000         LF       VFS         0.130900E-02         LF       S         LF       S         0.608300E-02         LF       VS         0.79500E-02         LF       VS         LF       VS         0.360800E-02         LF       MS         0.608300E-02         LF       VS         LF       VS         0.550000E-03         LF       VFG         LF       VFG         0.550000E-04         LF       FG         LF       NG         LF       CG         LF       CG         LF       CG	CAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           R STREAM SEGMENT #         1.           S0.0000         1000.00           0.178500         159.360           0.492000         105.920           0.375000E-01         1.28000           0.375000E-02         0.100000           0.100000E-19         0.100000           0.100000E-19         0.100000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1 	TIONS. DREDGING= DREDGING= UMULATED FROM  FIONS. 232800. 112000. 44000.0 800.000 800.000 400.000 9 0.10000E-19 9 0.10000E-19	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         TONS OF SEDIMENT DREDGI	CAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         SIZE CLASS (tons/dag)           50.0000         1000.00           0.178500         159.366           0.492000         105.926           0.375000E-01         1.28000           0.375000E-02         0.100000           0.100000E-19         0.100000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 72.0000 36.0000 1377.00 693.000 72.0000 36.0000 1377.	TIONS. DREDGING= DREDGING= UMULATED FROM  TIONS. 232800. 112000. 232800. 112000. 44000.0 8000.00 2000.00 2000.00 90.10000E-19 90.10000E-19 90.10000E-19	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         TONS OF SEDIMENT DREDGO         STREAM SEGMENT # 1: EX         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FOU         LQ       1.00000         LF       FS         LQ       1.030900E-02         LF       FS         LF       VFS         0.130900E-02       LF         LF       S0.360800E-02         LF       FS         LF       VCS         LF       VCS         LF       VCS         LF       VCS         LF       VCS         LF       VCG         LF <td>XAMPLE         PROBLEM         NO         4.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           ED         FROM THIS         REACH=           CUBIC         YARDS=           XAMPLE         PROBLEM         NO           CAMPLE         PROBLEM         NO           SIZE         CLASS         (tons/da)           50.0000         1000.00         0.178500           0.178500         159.360         0.5920           0.829500         49.9200         0.59200           0.517500         3.52000         0.100000           0.750000E-01         1.28000         0.100000           0.100000E-19         0.100000         0.100000           0.100000E-19         0.100000         0.100000</td> <td>SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 0 1377.00 693.000 0 1377.00 1370.00 1370</td> <td>TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 800.000 2000.00 800.000 90.10000E-19 90.10000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.100E-19 90</td> <td>970.00</td> <td></td>	XAMPLE         PROBLEM         NO         4.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           HANNEL         INCLUDING         1.           ED         FROM THIS         REACH=           CUBIC         YARDS=           XAMPLE         PROBLEM         NO           CAMPLE         PROBLEM         NO           SIZE         CLASS         (tons/da)           50.0000         1000.00         0.178500           0.178500         159.360         0.5920           0.829500         49.9200         0.59200           0.517500         3.52000         0.100000           0.750000E-01         1.28000         0.100000           0.100000E-19         0.100000         0.100000           0.100000E-19         0.100000         0.100000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 0 1377.00 693.000 0 1377.00 1370.00 1370	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 800.000 2000.00 800.000 90.10000E-19 90.10000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.100E-19 90	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CH         SEC NO.       44.000         ELEVATION OF DREDGED CH         SEC NO.       44.000         ELEVATION OF DREDGED CH         TONS OF SEDIMENT DREDGED         STREAM SEGMENT # 1: EX         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FON         LQ       1.00000         LF       VFS         LF       0.130900E-02         LF       KS         LF       VFS         0.130900E-02         LF       KS         0.3060800E-02         LF       VFS         0.130900E-02         LF       VS         LF       0.130900E-02         LF       VCS         LF       VCS         0.379500E-03         LF       VCS	CAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         1.000.00           R STREAM SEGMENT #         1.           50.0000         1000.00           0.178500         159.366           0.492000         105.926           0.375000E-01         1.28000           0.375000E-01         1.28000           0.100000E-19         0.100000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 0 1377.00 693.000 0 1377.00 1370.00 1370	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 800.000 2000.00 800.000 90.10000E-19 90.10000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.1000E-19 90.100E-19 90	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         TONS OF SEDIMENT DREDGI	Compute PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           OR         STREAM SEGMENT #           SIZE CLASS (tons/day)         1000.00           0.178500         159.360           0.829500         49.9200           0.517500         3.52000           0.10000E-19         0.100000           0.100000E-19         0.100000           0.100000E-19         0.100000           0.100000E-19         0.100000           0.100000E-19         0.100000           2.06250         320.000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 72.0000 36.000 00 1377.00 693.000 00 1377.00 1377.00 00 1377.00 1377.00 00 1377.00 1377.00 00 1377.00 1377	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         SEC NO.       44.000         ELEVATION OF DREDGED CO         TONS OF SEDIMENT DREDGED         STREAM SEGMENT # 1: EX         \$SED         LPOINT       1         LQ       1.00000         LF VFS       0.130900E-02         LF FS       0.360800E-02         LF MS       0.608300E-02         LF VFS       0.379500E-03         LF VCS       0.275000E-03         LF VG       0.550000E-04         LF VG       0.100000E-19         LF VG       0.1	XAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CO         1.           R STREAM SEGMENT #         1.           N SIZE CLASS (tons/dag)         50.0000           0.178500         159.360           0.492000         105.920           0.375000E-01         1.28000           0.750000E-02         0.100000           0.100000E-19         0.100000           0.100000E-19         0.100000           1.000000         0.100000           2.06250         320.000	SOME SEDIMENT OP 00 FEET OF OVER I 13568.3 ACC 13568.3 ACC 10807.1 SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 072.0000 36.0000 08E-19 18.0000 08E-19 0.100000E-1 18E-19 0.100000E-1 051.0000 00000000000000000000000000000000	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         TONS OF SEDIMENT DREDGI	XAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         R STREAM SEGMENT #           SIZE CLASS (tons/day)         1000.00           0.178500         159.360           0.178500         159.360           0.178500         159.360           0.517500         3.52000           0.517500         3.52000           0.10000E-19         0.100000           0.10000E-19         0.100000           0.100000E-19         0.100000           1.00000E-19         0.100000           2.06250         320.000           2         STREAM SEGMENT #           CAL INFLOW POINT #         X           SIZE CLASS (tons/day)	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1  SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 72.0000 36.000 00 1377.00 693.000 00 1377.00 1377.00 00 1377.00 137	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	
STREAM SEGMENT # 1: E2         SEC NO.       42.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         TONS OF SEDIMENT DREDGI         STREAM SEGMENT # 1: E2         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FOI         LQ       1.00000         LF VFS       0.130900E-02         LF MS       0.608300E-02         LF MS       0.608300E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF MS       0.608300E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.100000E-19         LF VGG       0.100000E-19         LF VGG       0.100000E-19         LF VGG       0.100000E-19         LF VCG       0.265600E-02	XAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         STEE CLASS (tons/day)           50.0000         1000.00           0.178500         159.360           0.275000E-01         1.28000           0.375000E-01         1.28000           0.10000E-19         0.100000           0.10000E-19         0.100000           0.100000E-19         0.100000           2.06250         320.000           2         STREAM SEGMENT #           CAL INFLOW POINT #         X           SIZE CLASS (tons/day)         100.000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1 SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 151.00 151.00 151.00 151.00 151.00 100.00 151.00 100.	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	
STREAM SEGMENT # 1: E2         SEC NO.       42.000         ELEVATION OF DREDGED CI         SEC NO.       44.000         ELEVATION OF DREDGED CI         TONS OF SEDIMENT DREDGI         STREAM SEGMENT # 1: E2         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FOI         LQ       1.00000         LF VFS       0.130900E-02         LF MS       0.608300E-02         LF MS       0.608300E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF MS       0.608300E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.130900E-02         LF VFS       0.100000E-19         LF VGG       0.100000E-19         LF VGG       0.100000E-19         LF VGG       0.100000E-19         LF VCG       0.265600E-02	XAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         STEE CLASS (tons/day)           50.0000         1000.00           0.178500         159.360           0.275000E-01         1.28000           0.375000E-01         1.28000           0.10000E-19         0.100000           0.10000E-19         0.100000           0.100000E-19         0.100000           2.06250         320.000           2         STREAM SEGMENT #           CAL INFLOW POINT #         X           SIZE CLASS (tons/day)         100.000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1 SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 151.00 151.00 151.00 151.00 151.00 100.00 151.00 100.	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	
STREAM SEGMENT # 1: EX         SEC NO.       42.000         ELEVATION OF DREDGED CH         SEC NO.       44.000         ELEVATION OF DREDGED CH         SEC NO.       44.000         ELEVATION OF DREDGED CH         TONS OF SEDIMENT DREDGH            STREAM SEGMENT # 1: EX         \$SED         LPOINT       1         SEDIMENT LOAD TABLE FON         LQ       1.00000         LF       VFS         0.130900E-02         LF       VFS         0.130900E-02         LF       VS         0.3060800E-02         LF       VFS         0.130900E-02         LF       VS         0.3079500E-02         LF       VCS         LF       VCS         0.100000E-19         LF       VCG         LF       VCG         0.100000E-19         LF       VCG         VCG       0.151250E-01         TOTAL         LOAD BY GRATI         LQL       1.00000	XAMPLE         PROBLEM NO 4.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           HANNEL INCLUDING         1.           ED FROM THIS REACH= CUBIC YARDS=         1.           CAMPLE PROBLEM NO 4.         1.           O         STEE CLASS (tons/day)           50.0000         1000.00           0.178500         159.360           0.275000E-01         1.28000           0.375000E-01         1.28000           0.10000E-19         0.100000           0.10000E-19         0.100000           0.100000E-19         0.100000           2.06250         320.000           2         STREAM SEGMENT #           CAL INFLOW POINT #         X           SIZE CLASS (tons/day)         100.000	SOME SEDIMENT OP 00 FEET OF OVER 1 13568.3 ACC 13568.3 ACC 10807.1 SOME SEDIMENT OP 5800.00 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 2299.50 1377.00 693.000 151.00 151.00 151.00 151.00 151.00 100.00 151.00 100.	TIONS. DREDGING= DREDGING= UMULATED FROM 90000.0 232800. 112000. 44000.0 8000.00 2000.00 800.000 90.10000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19 90.100000E-19	970.00	

LFL FG 0.40 LFL MG 0.10 LFL CG 0.10	20000E-04 0.3 00000E-05 0.1 00000E-19 0.1 00000E-19 0.1 00000E-19 0.1 00000E-19 0.1	00000E-01 5 00000E-19 5 00000E-19 0.	.50000 .50000 100000E-19			
TOTAL  0.40	D0000E-02  10	.0000 4	99.000	29970.0		
\$RATING						
Downstream Bou	undary Condit	ion - Ratino	Curve			
Elevation	Stage	Discharge	Elevation	Stage	Discharge	
950.000 955.100 958.000 960.000 962.000 963.600 965.100 966.200 967.000 967.000 967.000 968.300 968.900 969.400 969.800 970.200	950.000 955.100 960.000 962.000 963.600 965.100 966.200 967.000 967.700 968.300 968.300 968.900 969.400 969.400 969.600	0.000 2000.000 4000.000 8000.000 12000.000 14000.000 14000.000 16000.000 22000.000 22000.000 24000.000 26000.000 28000.000	972.400 972.700 972.900 973.100 973.500 973.500 973.800 973.900 974.100 974.100 974.200 974.200 974.400 974.400	972.400 972.700 973.900 973.100 973.500 973.700 973.800 973.800 974.000 974.100 974.200 974.300 974.300 974.400 974.500	$\begin{array}{c} 40000.000\\ 42000.000\\ 42000.000\\ 46000.000\\ 50000.000\\ 52000.000\\ 52000.000\\ 54000.000\\ 56000.000\\ 58000.000\\ 62000.000\\ 62000.000\\ 64000.000\\ 66000.000\\ 68000\\ 68000.000\\ 68000\\ 68000\\ 68000\\ 68000\\ 68000\\ 68000\\$	
970.600 971.000	970.600 971.000	30000.000 32000.000	974.600 974.700	974.600 974.700	70000.000 72000.000	
971.400 971.800	971.400 971.800	34000.000 36000.000	974.800 974.900	974.800 974.900	74000.000 76000.000	
972.100	972.100	38000.000	975.000	975.000	78000.000	
\$PRT Selective I	Printout Optic		ations			
CP	$1.0^{1}$ 15.0	ing cross se	ccions			
END						
\$NODREDGE						
TIME STEP #						
TIME STEP #	4 OW 4 = BASE F	LOW OF 750 C	CFS			
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUI	4 OW 4 = BASE F	LOW OF 750 C  E SEDIMENT O rs)	CFS			
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUI	4 DW 4 = BASE F. M NO 4. SOMI JATED TIME (yr) JRATION (days)	LOW OF 750 C SEDIMENT O SSI	FS  PTIONS. 0.148			
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU	4 DW 4 = BASE F. SM NO 4. SOMI JATED TIME (yy) RATION (days) DARY CONDITION	LOW OF 750 C SEDIMENT O SSI	FS  PTIONS. 0.148			
TIME STEP # * C FL( EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND	4 DW 4 = BASE F M NO 4. SOMI JATED TIME (yr) JRATION (days) DARY CONDITION CARY CONDITION = # 1 58.000	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs)	PTIONS. 0.148 1.000 SEDIMENT (tons/da	LOAD TEMPER y) (deg	ATURE J F)	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No.	4 DW 4 = BASE F. SM NO 4. SOMI JATED TIME (yy) JRATION (days) DARY CONDITION 4 $58.000$	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs)	PTIONS. 0.148 1.000 SEDIMENT (tons/da	LOAD TEMPER y) (deg	cature g F)	
TIME STEP # * C FLG EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No.	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr TRATION (days) DARY CONDITION # 1 58.000 INFLOW   FLOW at SECTION	LOW OF 750 C E SEDIMENT O rs)) NS DISCHARGE (cfs) 532.00 ON NO. 5	FS PTIONS. 0.148 1.000 SEDIMENT (tons/da 9 8.000	LOAD   TEMPEH y)   (dec 6.26	ATURE 5 F) 63.44	
TIME STEP # * C FL( EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No. SEDIMENT INE GRAIN SI	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr TRATION (days) DARY CONDITION = # 1 58.000 INFLOW   FLOW at SECTION INFLOW	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs) 532.00 CN NO. 5 (tons/day)	FS 0.148 1.000 SEDIMENT (tons/da 9 8.000 GRAIN S	LOAD   TEMPER LOAD   (deg 6.26   TIZE LOAI	CATURE g F) 63.44 0 (tons/day)	
TIME STEP # * C FL( EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No. SEDIMENT INE GRAIN SI	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr TRATION (days) DARY CONDITION = # 1 58.000 INFLOW   FLOW at SECTION INFLOW	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs) 532.00 CN NO. 5 (tons/day)	FS 0.148 1.000 SEDIMENT (tons/da 9 8.000 GRAIN S	LOAD   TEMPER LOAD   (deg 6.26   TIZE LOAI	CATURE g F) 63.44 0 (tons/day)	
TIME STEP # * C FL( EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No. SEDIMENT INE GRAIN SI	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr TRATION (days) DARY CONDITION = # 1 58.000 INFLOW   FLOW at SECTION INFLOW	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs) 532.00 CN NO. 5 (tons/day)	FS 0.148 1.000 SEDIMENT (tons/da 9 8.000 GRAIN S	LOAD   TEMPER LOAD   (deg 6.26   TIZE LOAI	CATURE g F) 63.44 0 (tons/day)	
TIME STEP # * C FL( EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUND Stream Segment Section No. SEDIMENT INE GRAIN SI	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr TRATION (days) DARY CONDITION # 1 58.000 INFLOW   FLOW at SECTION E LOAD SAND D BE SAND	LOW OF 750 C E SEDIMENT O rs) NS DISCHARGE (cfs) 532.00 CN NO. 5 (tons/day)	FS 0.148 1.000 SEDIMENT (tons/da 9 8.000 GRAIN S	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL EL AVEL SE GRAVEL	CATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNI Stream Segment Section No. SEDIMENT INE GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARSE FALL VELOO	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr RATION (days) DARY CONDITION = # 1 58.000   INFLOW   FLOW at SECTION ZEE LOAD SAND D D ES SAND ES SAND	LOW OF 750 C E SEDIMENT O (rs)) NS DISCHARGE (cfs) 532.00 DN NO. 5 (tons/day) 38.08 34.16 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da 98.000 GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR	LOAD   TEMPEH y)   (deg 6.26   SIZE LOAN GRAVEL EL AVEL SE GRAVEL SE GRAVEL TOTAL =	CATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOM LATED TIME (yr RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : : INFLOW   ?LOW at SECTION : SAND : SAND	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	
TIME STEP # * C FLC EXAMPLE PROBLE ACCUMUL FLOW DU UPSTREAM BOUNL Stream Segment Section No. SEDIMENT INF GRAIN SI VERY FINE FINE SAND. MEDIUM SAN COARSE SAN VERY COARS FALL VELOO	4 DW 4 = BASE F. M NO 4. SOMI LATED TIME (yr) RATION (days) DARY CONDITION : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 : # 1 58.000 :	LOW OF 750 C E SEDIMENT O rs)) ) DISCHARGE (cfs) 532.00 ON NO. 5 (tons/day) 38.08 34.6 21.06 2.35 0.61	PTIONS. 0.148 1.000 SEDIMENT (tons/da GRAIN S GRAIN S GRAIN S FINE GRAV MEDIUM GR COARSE GR VERY COAR REY. NO.	LOAD   TEMPEH Y)   (deg 6.26   IZE LOAN GRAVEL AVEL AVEL SE GRAVEL TOTAL = CD	RATURE g F) 63.44 0 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 96.26	

Upstream of SECTION NO. LOCAL INFLOW POINT # 1	(cfs)	(tons/day)	(deg	F)		
MAIN STEM INFLOW LOCAL INFLOW						
		0   145.0				
SEDIMENT LOAD FROM LC GRAIN SIZE I	OCAL INFLOW: NAD (tons/day)	GRAIN SIZ	e load	(tons/day)		
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	2.87 0.89 0.37 0.13 0.03	VERY FINE GI FINE GRAVEL MEDIUM GRAVI COARSE GRAVI VERY COARSE	RAVEL EL EL GRAVEL GRAVEL	0.01 0.00 0.00 0.00 0.00		
FALL VELOCITIES - M DIAMETER	lethod 2 VELOCITY	REY. NO.				
VF SAND 0.000290 F SAND 0.000580 M SAND 0.001160 C SAND 0.002320 VC SAND 0.004640 VF GRVL 0.009280 F GRVL 0.018559 M GRVL 0.037118 C GRVL 0.074237 VC GRVL 0.148474	0.1931441E-01 0.5916114E-01 0.2833008 0.4824925 0.7200893 1.040325 1.472894 2.082985 2.945788	0.4941259 3.027072 13.86779 57.98200 197.4999 589.5120 1703.352 4823.231 13642.13 38585.85	55.02308 11.72910 4.470784 2.045980 1.410740 1.266733 1.213806 1.211086 1.211086 1.211086			
	OUTPUT FOR SEC	CTION NO. 1	5.000			* * * *
HYDRAULIC PARAMETERS: VEL SLO 4.382 0.000558	EFD 1 4.555 72	EFW <b>N-VALUE</b> 2.960 <b>0.0167</b>	TAU 0.15863	USTARM 0.28588	FROUDE NO. 0.362	
BED SEDIMENT CONTROL VC NEW SURFACE AREA (SQ FT	HUME COMPUTATIO	JNS:				
GRADATION OF ACTIVE PLU BED MATERIAL PER GRAIN	S INACTIVE DEPC SIZE: BED FI VF SAND 0. F SAND 0. M SAND 0. C SAND 0. VC SAND 0.	DSITS           RACTION         PERCENT           .010519         1.4           .068551         7.3           .324948         40.4           .367062         77.3           .113979         88.3	F FINER 051939 907044 401812 107991 505902	F GRVL F GRVL M GRVL C GRVL VC GRVL	BED FRACTION 0.045573 0.034049 0.010808 0.022292 0.002220	PERCENT FINER 93.063185 96.468071 97.548838 99.777989 99.999998
SAND ** ARMOR LAYER ** STABILITY COEFFICIENT= MIN.GRAIN DIAM = BED SURFACE EXPOSED =	0.80177 0.030569 0.00000					
INACTIVE         LAYER           %         DEPTH           CLAY         0.0000         0.00           SILT         0.0000         0.00           SAND         1.0000         9.25           TOTAL         1.0000         9.25	* DE 0.0000 ( 0.0000 ( 1.0000 (					
AVG. UNIT WEIGHT 0.046500	AVG. UNI WEIGHT 0.04650					
COMPOSITE UNIT WT C COMPOSITE UNIT WT C DEPTH OF SURFACE LA WEIGHT IN SURFACE I DEPTH OF NEW ACTIVE WEIGHT IN NEW ACTIV WEIGHT IN OLD ACTIV USEABLE WEIGHT, OLD SURFACE AREA OF DEF	PF ACTIVE LAYER FF INACTIVE LAYER VER (ft) AYER (tons) : LAYER (ft) E LAYER (tons) F LAYER (tons) O INACTIVE LAYEE	(t/cf) = ER (t/cf) = DSL= WTSL= DSE= WTMXAL= WAL=	0.046500 0.046500 0.1 1305.5 0.0373 584.9 8927.8 144962.8 690125E+06			
	VFSAND0FSAND0MSAND0CSAND0	.070000 8.0 .327074 40. .366543 77.2	F FINER 000000 000000 707446 361700 707445	VF GRVL F GRVL M GRVL C GRVL VC GRVL	BED FRACTION 0.044734 0.033457 0.010638 0.021915 0.002181	PERCENT FINER 93.180849 96.526593 97.590423 99.781912 99.999998
	VF SAND 0		F FINER 895284 397700	VF GRVL F GRVL	BED FRACTION 0.059193 0.043652	PERCENT FINER 91.152666 95.517835

M SAND C SAND VC SAND	0.290415 0.375493 0.122449	35.439182 72.988468 85.233411	M GRVL C GRVL VC GRVL	0.013558 0.028407 0.002857	96.873609 99.714290 100.000000
C FINES, COEF(CFFML), MX POTEN POTENTIAL TRANSPORT (tons/day)	FIAL= 0.000000E+C : VF SAND 0.7676 F SAND 0.2222 M SAND 0.1200 C SAND 0.8790 VC SAND 0.8853	00 0.100000E+01 0 531E+04 VF GRVL 08E+04 F GRVL 096E+04 M GRVL 011E+03 C GRVL 663E+03 VC GRVL	0.162000E+07 0.540007E+02 0.856678E+02 0.924255E+02 0.343755E+01 0.100000E-06		
BED MATERIAL PER GRAIN SIZE: VF SAND F SAND M SAND C SAND VC SAND	BED FRACTION E 0.011944 0.037695 0.276179 0.387609 0.125654	PERCENT FINER 1.194380 4.963900 32.581777 71.342665 83.908024	BED VF GRVL F GRVL M GRVL C GRVL VC GRVL	FRACTION 0.064549 0.047476 0.014690 0.031077 0.003127	PERCENT FINER 90.362954 95.110553 96.579579 99.687310 100.000000
SEDIMENT OUTFLOW FROM SECTION GRAIN SIZE LOAD (to) VERY FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	ns/day)   GRAI	IN SIZE LOAI			
**************************************	FOR SECTION NO.	1.000		*******	****
HYDRAULIC PARAMETERS: VEL SLO EFD 4.011 0.000004 5.834		-VALUE TAU D.0176 0.00159	USTARM 0.02864	FROUDE NO. 0.293	
BED SEDIMENT CONTROL VOLUME CON NEW SURFACE AREA (SQ FT): 21	MPUTATIONS: FOTAL K-PC 09373.61 209	ORTION S-POP 9373.61	TION 0.00		
TRANSMISSIVE BOUNDARY CONDITION BED MATERIAL PER GRAIN SIZE: VF SAND F SAND M SAND C SAND VC SAND	BED FRACTION F 0.010000 0.070000 0.290000 0.360000 0.120000	PERCENT FINER 1.000000 8.000000 36.999999 72.999998 84.999998	BED VF GRVL F GRVL M GRVL C GRVL VC GRVL	FRACTION 0.060000 0.040000 0.015000 0.035000 0.000000	PERCENT FINER 90.999998 94.999998 96.499998 99.999998 99.999998
SEDIMENT OUTFLOW FROM SECTION GRAIN SIZE LOAD (top	N NO. 1.000 ns/day)   GRAI	IN SIZE LOAI	) (tons/day)		
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	115.42         VERY F           101.72         FINE G           348.91         MEDIUN           332.83         COARSE           108.39         VERY G	FINE GRAVEL SRAVEL 4 GRAVEL 3 GRAVEL COARSE GRAVEL	3.19 3.74 1.25 0.10 0.00		
TABLE SA-1. TRAP EFFICIENCY ON EXAMPLE PROBLEM NO ACCUMULATED AC-FT         TIME       ENTRY *         DAYS       POINT *         54.00       58.000 *         13       53.000 *         42.000 *       0         TOTAL=       35.000 *         AVS       POINT *         DAYS       POINT *         TOTAL=       35.000 *         TOTAL=       35.000 *         AVS       POINT *         INFL       54.00         54.00       35.000 *         TOTAL=       33.000 *         TIME       ENTRY *         DAYS       POINT *         TABLE       ENTRY *         DAYS       POINT *         TOTAL=       33.000 *         TIME       ENTRY *         DAYS       POINT *         TABLE       INFL         54.00       33.000 *         15.000 *       1         TOTAL=       1.000 *       2	4. SOME SEDIMEN ENTERING AND LEAN SAND OW OUTFLOW TRA 30 15 36 81 2.05 SAND OW OUTFLOW TRA 05 05 1.22 SAND OW OUTFLOW TRA 22 00 22 4.07	TT OPTIONS. /ING THIS STREAM ******** AP EFF * * 0.93 * ******** AP EFF * 0.40 * ******** * AP EFF * * -0.83 * ********			
TABLE SB-1: SEDIMENT LOAD PAS: SEDIMENT INFLOW at the Upstr GRAIN SIZE LOAD (to)	eam Boundary:				
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	38.08         VERY I           34.16         FINE (           21.06         MEDIUN           2.35         COARSI           0.61         VERY (	FINE GRAVEL GRAVEL 4 GRAVEL 3 GRAVEL COARSE GRAVEL	0.00 0.00 0.00 0.00 0.00 0.00 96.26		

CLAY

0. 0.

0. 0.

0. 0. 0. 0. 0.

0. 0.

GRAIN	SIZE 1		iy)   GI	RAIN SIZE		AD (tons/day			
VERY FI	NE SAND	115.4	2   VER	Y FINE GE	AVEL	3.19			
FINE SA	ND	115.4 101.3 348.9 332.8 108.3	2 FINE	E GRAVEL.		3.74			
MEDIUM :	SAND	348.9	MEDI	IUM GRAVE	L	1.25			
VERY CO	ARSE SAND	108.3	9 VERY	Y COARSE	GRAVEL	0.10			
			-		-				
				1	OTAL =	1015.54			
TABLE SB-2:	STATUS OF	THE BED PROP	PILE AT TIN	VIE = 5	4.000 DA	YS			
CECTION	PED CUANCE	MC FIEU				NCDODE DARE	/tong/daw		
NUMBER	(ft)	wS ELEV (ft)	(ft)	(cfs	s)	SAND	(cons/day)		
58.000	-2.93	976.06	972.47	532		195.			
55.000	-1.23	975.95	971.67	532	!.	193.			
53.000	-1.54	974.32	970.66	660	).	156.			
44.000	0.01	974.07	968.04	680	).	7.			
35.000	ŏ.ŏŏ	974.00	963.30	685	, . ) .	ö.			
33.900	0.22	964.63	962.87	689		2576.			
33.300	0.03	963.41	962.52	685		2295.			
33.000	0.00	963.00	961.00	689	).	2295.			
32.100	-0.31	961.87	956.19	685	, .	85. 241			
15.000	-0.23	957.71	953.47	750	).	1016.			
1.000	0.00	957.00	944.70	750	).	NSPORT RATE SAND 195. 193. 156. 7. 0. 0. 2576. 2295. 2295. 85. 241. 1016. 1016.			
		harge from da							
\$VOL A									
ŞVOL A									
STREAM SEGM	ENT # 1: EX	KAMPLE PROBLE	EM NO 4. S	SOME SEDI	MENT OPT	IONS.			
	SUM	MARY TABLE:	MASS AND	VOLUME OF	- SEDIMEN	π			
SECTION						MENT DEPOSIT CUMULATIVE	ED IN REACH SAND	I in cu. yds SILT	CLAY
		26932.							
58.000	34630.	34630.	0.	Ο.	-6132.	-6132. -16025.	-6132.	0.	0
55.000	47052.	47052.	0.	0.	-9894.	-16025.	-9894.	0.	0
LOCAL	32721.	32721.	0.	0.	26062.				
53.000	104248.	104248.	0.	0.	-19495.	-35520.	-19495.	0.	0
44.000	73173.	73173.	Ο.	0.	24751.	-35520. -10769.	24751.	0.	0
LOCAL	733.	733.	Ο.	0.	583.				
42.000	4159.	4159.	0.	0.	55553.	44784.	55553.	0.	0
33,900	2940	2940.	0.	0.	971.	44764.	971.	0.	0
33.300	2475.	2475.	ö.	0.	370.	46125.	370.	0.	ő
33.000	2475.	2475.	0.	0.	0.	46125.	Ο.	0.	0
32.100	5577.	5577.	<u>o</u> .	0.	-2471.	44784. 44784. 45755. 46125. 46125. 43655. 42283.	-2471.	0.	0
32.000	7299.	7299.	υ.	υ.	-13/1.	42283.	-1371.	0.	0
LOCAL	2027.	2027.	0.	0.	1615.				
15.000	8242.	8242. 8242.	0.	0.	863. 0.	43147.	863.	Ο.	0
1.000	8242.	8242.	0.	0.	0.	43147.	0.	0.	0
TOTAL SEDIM	ENT - per gi	rain size - 1	THROUGH EA	CH CROSS	SECTION	(tons)			
UPSTREAM	INFLOW 12	162 100 071	m 1		CDUT	Ο.			
VF F	SAND 13-	103. VC SAL 809. VF GRV	л. т. Л.	0. VC	GRVL	0.			
M	SAND 42	463. VC SAI 809. VF GRV 222. F GRV 316.	лц.	0.	un -	<u>0</u> .			
С	SAND	316.							
LOCAL INF	LOW								
VF	SAND 2'	765. VC SAL	1D	0. C	GRVL	Ο.			
F	SAND 6:	765. VC SAN 123. VF GRV 758. F GRV		0. VC	GRVL	0.			
	SAND 17	758. F GRV	ΛL	0.		0.			
	SAND 6								
LOCAL INF	LOW		-		ant	-			
	SAND SAND	346. VC SAN 214. VF GRV	ND :		GRVL	0. 0.			
М	SAND	214. VF GRV 122. F GRV	л.	4. VC 2.	GIVU	0.			
C	SAND	34.				-			
LOCAL INF	LOW								
VF	SAND	367. VC SAL	JD !	55. C	GRVL	Ο.			
F	SAND	732. VF GRV	/L :	24. VC	GRVL	0.			

М	SAND	709.	F	GRVL		10.			ο.		
C	SAND	129.									
SECTION	NO.	15.000									
VF	SAND	320.	VC	SAND		851.	С	GRVL	3.		
F	SAND	1079.	VF	GRVL		13.		GRVL	0.		
М	SAND	3214.	F	GRVL		14.			0.		
С	SAND	2742.									
SECTION	NO.	1.000									
VF	SAND	320.	VC	SAND		851.	С	GRVL	з.		
F	SAND	1079.	VF	GRVL		13.	vc	GRVL	0.		
М	SAND	3214.	F	GRVL		14.			0.		
С	SAND	2742.									
									 	 	 -
\$\$END											
0	DATA E	RRORS DETEC	TED	•							
		STEPS READ	=		4						
TOTAL NO.					23						
ITERATIONS	IN EXNI	R RÕ =		11	.50						
COMPLITATIO	NO COMP										

COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES & 9.00 SECONDS

# 6.5 Example Problem 5 - Reservoirs

HEC-6 simulates reservoirs by allowing the water surface elevation at the reservoir location to be a function of time, as defined by input data. The hydraulic computations are still steady state; therefore, there is no routing of the water (i.e outflow equals inflow at all times).

# 6.5.1 Reservoir Data

Example Problem 5 input is shown in Table 6-5a and illustrates the data for a problem with two reservoirs; one at the downstream boundary (Section No. 1.0) and one at Silver Lake - which begins at Section No. 35.0 and extends upstream to Section No. 53.0 (much farther upstream than is illustrated in Figure 6-1). Section No. 33.3 is at the approximate upstream extent of the pool for the downstream reservoir and Section No. 53.0 is at the upstream end of Silver Lake. The operation of the downstream reservoir is simulated by the time history of pool elevations entered in field 1 of the R records in the flow data. Similarly, the X5 record at Section No. 35.0 that defines the downstream boundary of the Silver Lake reservoir indicates that the time history of pool elevations will be in Field 2 of the R record. The X5 record at Section No. 53.1 marks the upstream limit of Silver Lake. The two X5 records divide the model into 3 subreaches; the first, which represents the downstream reservoir, is bounded by Sections 1.0 and 33.9, the second subreach, Silver Lake, is bounded by Sections 53.1 and 58.0. Thus the information produced for each subreach can be used to analyze the behavior of the two reservoirs and the contributing upstream reach.

#### Table 6-5a Example Problem 5 - Input Reservoir Model

т1	E	XAMPLE P	ROBLEM N	05. RE	SERVOIRS					
Т2	2	RESERVO	IRS, 3 L	OCAL INF	LOWS.					
т3	S	OUTH FOR	K, ZUMBR	O RIVER	** E	xample H	Problem 5	**		
NC	.1	.1	.04	.1	.3	-				
X1	1.0	31	10077.	10275.	Ο.	ο.	Ο.			
GR	1004.	9915.	978.4	10002.	956.0	10060.	959.2	10077.	959.3	10081.
GR	950.0	10092.	948.48	10108.	946.6	10138.	944.7	10158.	955.2	10225.
GR	956.2	10243.	958.9	10250.	959.8	10275.	959.8	10300.	959.9	10325.
GR	958.8	10350.	957.4	10400.	970.0	10700.	966.0	10960.	970.0	11060.
GR	968.0	11085.	968.0	11240.	970.0	11365.	970.0	11500.	970.0	11615.
GR	962.0	11665.	962.0	12400.	976.0	12550.	980.0	12670.	982.0	12730.
GR	984.0	12735.								
HD	1.0	10.	10081.	10250.						
NV	22	.045	965.6	.064	988.8					
NV	12	.08	965.6	.13	988.8					
NV	33	.1	965.6	.11	982.0	.12	988.8			
<b>X</b> 1	15.0	27	10665.	10850.	3560.	3030.	3280.			
Х3				10700.	961.0	11000.	970.0			
GR	992.0	9570.	982.0	10110.	976.0	10300.	976.0	10490.	966.0	10610.
GR	964.7	10665.	956.0	10673.	953.0	10693	954.0	10703.	955.6	10723.
GR	958.6	10750.	959.3	10800.	957.0	10822.	957.3	10825.	961.5	10850.
GR	962.0	10852.	964.0	10970.	966.0	11015.	961.0	11090.	962.0	11150.
GR	970.0	11190.	972.0	11310.	980.0	11410.	984.0	11570.	990.0	11770.
GR	990.0	11865.	1000.0	12150.						
HD	15.0	10.	10673.	10852.						
(	CASCADE	CREEK -	LOCAL I	NFLOW						
QT										
NC	.1	.1	.05							
<b>X</b> 1	32.0	29	10057.	10271.	3630.	3060.	4240.			
GR	998.0	9080.	982.0	9250.	982.0	9510.	980.0	9600.	980.01	9925.
GR	979.48	10000.	978.5	10057.	968.6	10075.	959.82	10087.	956.5	10097.
GR	956.8	10117.	957.8	10137.	959.4	10157.	959.6	10177.	959.82	10196.
GR	966.5	10225.	971.2	10250.	978.5	10271.	978.5	10300.	978.6	10350.
GR	978.91	10370.	978.96	10387.	980.0	10610.	982.0	10745.	982.0	11145.
GR	984.0	11150.	992.0	11240.	1000.0	11330.	1008.	11425.		

HD 32.0 10. 10075. 10275. 33.0 1850. 3130. 3250. 3320. X1 21 2150. хL 250. GR 1000. 980. 990.0 980.0 982.0 1180. 982.0 1060. 1150 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 2149. 984.5 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.0 ο. 1851. 2149. NOTE : Section 33.3 is a duplicate of Section 33.0. X1 33.3 21 1850.0 2150.0 1550. 1750. 1750. . 95 1.49 250. XL GR 1000. 980. 990.0 1060. 980.0 1150. 982.0 1180. 982.0 1215. GR 980.0 1260. 982.0 1300. 982.0 1350. 980.0 1420. 980.0 1540. GR 982.0 1730. 982.0 1830. 984.41 1850. 979.19 1851. 1900.8 961.0 GR 961.0 2099.2 976.0 2149. 984.5 2150. 2800. 3100. 982.0 990.0 GR 1000. 3170. HD 33.3 Ο. 1851. 2149. . 95 1.65 Section 33.9 is a duplicate of Sec 33.3, needed to model IBC at Sec 35.0 X1 33.9 21 1850.0 2150.0 1050. 1050. 1050. 10 Х3 GR 1000. 980. 990.0 980.0 982.0 1060. 1150. 982.0 1180. 1215. GR 980.0 1260. 982.0 1300. 982.0 980.0 1420. 980.0 1350. 1540. 1730. GR 982.0 982.0 1830. 984.41 1850. 979.19 1851. 961.0 1900.8 GR 961.0 2099.2 976.0 984.5 2149. 2150. 982.0 2800. 990.0 3100. GR 1000. 3170. HD 33.9 Ο. 1851. 2149. 35.0 22 0 9894. 10245. 0 0 X1 ΧЗ 10 X5 GR 984.0 9035. 980.0 9070. 978.0 9135. 980.0 9185. 982.0 9270. GR 980.0 9465. 981.7 9595. 983.7 9745. 984.7 9894. 963.4 9894.1 GR 963.3 9954. 967.1 9974. 967.4 10004. 968.2 10044. 967.6 10054. GR 973.4 10115. 977.4 10120. 983.7 10155. 982.0 10695. 984.0 10245. GR 982.0 10895. 1004.0 11085. HD 35.0 0. 9954. 10155. - - -SILVER LAKE -NC .06 .06 .045 X1 42.0 32 9880. 5370. 10130. 5000. 5210. GR 996.0 7130. 998.0 7310. 998.0 7930. 992.0 8205. 990.0 8495. GR 988.0 8780. 986.0 8990. 985.7 9570. 9707. 989.4 9857. 986.4 GR 990.0 9880. 969.8 9881. 969.8 985.8 9941. 985.8 9941. 9943. GR 969.8 9943. 969.8 10001. 986.7 10001. 986.7 10003. 969.8 10003. GR 969.8 10067. 985.8 10067. 985.8 10069. 10069. 969.8 10129. 969.8 GR 989.9 10130. 989.5 988.6 10180. 10230. 10280. 985.2 987.6 10430. GR 986.8 11720. 989.9 12310. HD 42.0 0. 9881. 10021. SILVER CREEK - LOCAL INFLOW от 44.0 28 9845. 10127. 3200. X1 3800. 3500. хL 9850.0 10200.0 GR 1002. 992.0 8035. 8150. 990.0 8305. 990.0 8735. 988.0 8835. GR 996.0 9285. 1017.6 9425. 990.0 9505. 9650. 984.1 9788. 986.0 GR 980.6 9845. 970.9 9868. 972.2 967.5 9898. 970.5 9968. 9998. GR 968.9 10028. 967.4 10058. 967.1 10078. 976.8 971.9 10118. 10127. GR 977.8 10150. 976.9 10193. 982.0 10206. 981.2 10300. 979.2 10325. GR 983.1 10400. 999.8 10450. 1002.4 10464. HD 44.0 10. 9868. 10193. 53.0 22 10000. 3366. X1 10136. 2832. 2942. GR 1004. 7550. 998.0 996.0 1000.0 7760. 8640. 8780. 8440. 996.0 GR 994.0 8940. 986.0 9245. 986.3 9825. 983.8 9555. 9900. 986.3 GR 982.8 10000. 974.0 972.6 978.2 10011. 10041. 972.2 10071. 10101. GR 978.2 10121. 988.7 10136. 989.3 10154. 999.2 10200. 1000. 10320. GR 1002. 10470. 1004.0 10700. HD 53.0 10. 10000. 10136. Section 53.1 is a REPEAT of Sec 53.0, needed to model an IBC at THIS location. NOTE: no water surface is defined at this IBC, i.e. No Hydraulic Cntrl Strctr X1 53.1 0 10000. 10136. 0 n 0 X5 53.1 HD 10. 10000. 10136. BEAR CREEK - LOCAL INFLOW OT X1 55.0 18 9931 10062. 2275 3430. 2770 GR 1004. 7592. 1000.0 7947. 996.0 8627. 990.0 9052. 986.0 9337. GR 984 3 9737 984.7 9837. 985.5 9910. 987.2 9931. 978.1 9955. GR 974.8 9975. 974.2 10005. 972.9 10035. 973.2 10045. 983.8 10062. GR 985.8 10187. 986.0 10307. 990.0 10497. 9931. HD 55.0 10. 10062. X1 58.0 22 9912. 10015. 1098. 1012. 1462. 9702. GR 1006. 8542. 1004.0 8952. 1000.0 997.2 9812. 996.3 9912. GR 976.2 9944. 975.4 9974. 978.2 9991. 990.4 10015. 988.3 10062. GR 988.8 10065. 988.3 10065. 989.3 10169. 990.0 10172. 992.0 10242. GR 992.0 10492. 988.0 10642. 986.7 10852. 988.0 11022. 986.0 11097. GR 986.0 11137. 988.0 11192.

HD 58.0 3.4 9912. 10015. ΕJ Т4 South Fork, Zumbro River - Stream Segment 1 \*\* Example Problem 5 \*\* т5 LOAD CURVE FROM GAGE DATA. т6 BED GRADATIONS FROM FIELD SAMPLES. т7 Use full range of Sands and Gravels т8 SEDIMENT TRANSPORT BY Yang'S STREAM POWER [ref ASCE JOURNAL (YANG 1971)] 11 5 SAND 14 4 10 1 15 . 5 .5 .25 .5 .25 0 1.0 50 5800 90000 ЬQ 1 1000 TOTAL  $\mathbf{LT}$ .0110 1.5 320 4500. 400000 VFS  $\mathbf{LF}$ .119 .119 .498 .511 .582  $\mathbf{LF}$ FS .328 .328 .331 .306 .280  $\mathbf{LF}$ MS .553 .553 .156 .154 .110  $\mathbf{LF}$ CS .000 .000 .016 .020 .011  $\mathbf{LF}$ vcs .000 .000 .004 .008 .005 VFG  $\mathbf{LF}$ .000 .000 .000 .004 .002  $\mathbf{LF}$ FG .000 .000 .000 .001 .001 MG  $\mathbf{LF}$ .000 .000 .000 .000 .000  $\mathbf{LF}$ CG .000 .000 .000 .000 .000  $\mathbf{LF}$ VCG .0 .0 .000 .000 .000 PF EXAMP 1.0 1.0 32.0 16.0 96.5 8.0 95.0 4.0 91.0 2.0 PFC 85.0 1.0 73.0 .5 37.0 .25 8.0 ,125 1.0 PFC.0625 0.0 8.0 PF EXAMP 32.0 99.5 99.0 32.0 1.0 64.0 16.0 98.5 PFC 4.0 96.0 2.0 93.5 1.0 83.0 45.5 .250 8.0 .50 PFC .125 1.0 .0625 0.0 94.0 PF EXAMP 58.0 1.0 64.0 32.0 97.0 16.0 8.0 94.0 PFC 4.0 90.0 2.0 79.0 1.0 56.0 .50 4.0 .125 0.0 **\$LOCAL** LOAD TABLE - CASCADE CREEK - A LOCAL INFLOW LQL 1 100 1000 10000 LTLTOTAL .0040 30000 10 500 VFS LFL.664 .664 .015 .198 FS .207 LFL .207 .245 .181 LFLMS .086 .086 .605 .107 CS LFL.031 .031 .052 .098 VCS LFL.008 .008 .039 .127 LFLVFG .0030 .0030 .0200 .1160  $\mathbf{LFL}$ FG .0010 .0010 .0110 .0910  $\mathbf{LFL}$ MG .0000 .0000 .0530 .0110 LFLCG .0000 .0000 .0000 .0220 VCG .0000 .0000 .0000 LFL .0060 LOAD TABLE - SILVER CREEK - A LOCAL INFLOW LQL 1000 1 100 10000 LTLTOTAL .0040 500 30000 10 LFL VFS .664 .664 .015 .198  $\mathbf{LFL}$ FS .207 .207 .181 .245  $\mathbf{LFL}$ MS .086 .086 .605 .107  $\mathbf{LFL}$ CS .031 .052 .098 .031 vcs  $\mathbf{LFL}$ .008 .008 .127 .039 LFLVFG .0030 .0030 .0200 .1160  $\mathbf{LFL}$ FG .0010 .0010 .0110 .0910  $\mathbf{LFL}$ MG .0000 .0000 .0110 .0530 LFL CG .0000 .0000 .0000 .0220 VCG .0000 .0000  $\mathbf{LFL}$ .0000 .0060 LOAD TABLE - BEAR CREEK A LOCAL INFLOW LQL 30000. 1. 100. 500. 1000. LTLTOTAL .0020 22500 30.0 500. 1200 VFS .137  $\mathbf{LFL}$ .201 .201 .078 .078  $\mathbf{LFL}$ FS .342 .342 .172 .175 .218  $\mathbf{LFL}$ MS .451 .451 .454 .601 .476 LFLCS .001 .001 .142 .158 .197 LFLvcs .000 .000 .000 .003 .008 VFG .0000 .0000 .0020 LFL.0000 .0000 LFL  $\mathbf{FG}$ .0000 .0000 .0000 .0010 .000 LFLMG .0000 .000 .0000 .0000 .0000 LFL CG .0000 .000 . 0000 .0000 .0000 VCG LFL .0000 .000 .0000 .0000 .0000 ŚHYD \$PRT CP 1 1.0 35.0 53.1 PSEND \$VOL X 0 νJ 16 VR 944 946 948 950 952 954 956 **9**58 960 962 VR 964 966 968 970 972 974 \$PRT А \* А FLOW 1 BASE FLOW OF 750 CFS -750 Q 61 29 128 R 960. 973.5

T W	65 10.	72	70	67						
*	A			YS AT BAN	K FULL D	ISCHARGE				
Q R	2500.0 965.	300. 975	150.	650.						
х	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	2.5	50.							
*	А	FLOW 3	= NEAR	BANK FULL	DISCHAR	GE				
Q	1250.	150.	78.	340.						
R	963.	974.5								
W	1.									
*	в	FLOW 4	= BASE	FLOW OF 7	50 CFS					
Q	750.	61	29	128						
R	960.	973								
W	1.									
\$P	RT									
CP		1								
PS		1.0	35.0	53.1						
EN										
	ÖL X									
νJ		0								
VR		946	948	<b>950</b>	<b>9</b> 52	954	956	958	960	962
VR		966	968	970	972	974	550	550	500	502
	END	500	500	570	572	5/4				

#### 6.5.2 Elevation-Surface Area and Elevation-Storage Tables

Tables of elevation *vs.* surface area and storage can be obtained by use of the **\$VOL**, **VJ**, and **VR** records in the flow data. In this example, these records were used to request that these tables be produced for a series of horizontal planes extending from elevation 944 ft (the approximate thalweg of Section No. 1.0) to elevation 974 ft (the approximate thalweg of section No. 53.0) in 2 ft increments. Care should be taken to ensure that the endpoints of each cross section are higher than these elevations; otherwise, HEC-6 will extend the ends of the sections vertically and the surface areas and volumes will be too small.

The output for Example Problem 5 is shown in Table 6-5b. Prior to time step 1 and after time step 4, tables containing the surface areas and storage volumes for Sections 1.0, 35.0, and 53.1 at each elevation specified on the VR records. (The **\$PRT** option was used to limit the **\$VOL** output to these cross sections.) For example, at Section No. 35.0, the initial storage volume at elevation 968 ft is 859.78 acre-ft; and after the last time step, the storage volume is 855.45 acre-ft. This indicates that approximately 4.3 acre-ft of sediment was deposited between Sections 35.0 and 58.0 below elevation 968 ft, reducing the storage capability of Silver Lake. One only needs to use information in the table for elevations above the thalweg of the cross section at the dam of interest. These tables can be used to construct elevation-deposition and deposition-distance relations.

#### 6.5.3 Trap Efficiency

The computation of trap efficiency and the interpretation of "TABLE SA-1" were presented in Section 6.3.8 for Example Problem 3. In this example, the X5 records were used to delineate the upstream and downstream extent of the reservoirs causing trap efficiency to be computed for each. For example, looking at TABLE SA-1 of time step 4 for the middle reach which represents Silver Lake, 42.71 acre-ft has entered the reservoir from the upstream reach, 0.37 acre-ft from Silver Creek and 3.55 acre-ft have passed through Silver Lake, giving it a trap efficiency of 91% for this simulation. The downstream reservoir has a trap efficiency of 99%. Negative trap efficiencies indicate scour.

# Table 6-5b Example Problem 5 - Output Reservoir Model

<pre>* SCOUR AND DEPOSITION IN RIVERS AND RESERVOIRS * * Version: 4.1.00 - AUGUST 1993 * HYDROLOGIC ENGINEERING CENTER * * INPUT FILE: EXAMPLE5.DAT * 609 SECOND STREET * * OUTPUT FILE: EXAMPLE5.OUT * DAVIS, CALIFORNIA 95616-4687 * * RUN DATE: 31 AUG 93 RUN TIME: 15:53:06 * (916) 756-1104 * ***********************************</pre>
$\begin{array}{cccccccccccccccccccccccccccccccccccc$
<pre>************************************</pre>
T1 EXAMPLE PROBLEM NO 5. RESERVOIRS. T2 2 RESERVOIRS, 3 LOCAL INFLOWS. T3 SOUTH FORK, ZUMBRO RIVER ** Example Problem 5 **
N values Left Channel Right Contraction Expansion 0.1000 0.0400 0.1000 1.1000 0.7000
SECTION NO. 1.000 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
N-Values vs. Elevation Table Channel Left Overbank Right Overbank 0.0450 966. 0.0800 966. 0.1000 966. 0.0640 989. 0.1300 989. 0.1100 982. 0.0000 0. 0.0000 0. 0.1200 989.
SECTION NO. 15.000 Left Encroachment defined at station 10700.000 at elevation 961.000 Right Encroachment defined at station 11000.000 at elevation 970.000 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
LOCAL INFLOW POINT 1 occurs upstream from Section No. 15.000
N values Left Channel Right Contraction Expansion 0.1000 0.0500 0.1000 1.1000 0.7000
SECTION NO. 32.000 DEPTH of the Bed Sediment Control Volume = 10.00 ft.
SECTION NO. 33.000 Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 33.300 Adjust Section WIDTH to 95.00% of original. Adjust Section ELEVATIONS by 1.490 ft. Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 33.900 Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 1850.000 2150.000 Ineffective Elevation 984.410 984.500
DEPTH of the Bed Sediment Control Volume = 0.00 ft.
SECTION NO. 35.000 Internal Boundary Condition Water Surface Elevation will be read from R-RECORD, Field 2 Head Loss = 0.000 Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 9894.000 10245.000 Ineffective Elevation 984.700 984.000
DEPTH of the Bed Sediment Control Volume = 0.00 ft.
N values Left Channel Right Contraction Expansion 0.0600 0.0450 0.0600 1.1000 0.7000
SECTION NO. 42.000 DEPTH of the Bed Sediment Control Volume = 0.00 ft.

#### **Example Problem 5**

LOCAL INFLOW POINT 2 occurs upstream from Section No. 42.000 SECTION NO. 44.000 ...Limit CONVEYANCE between stations 9850.00 ...DEPTH of the Bed Sediment Control Volume = 9850.000 and 10200.000 10.00 ft. SECTION NO. 53,000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 53,100 ...Internal Boundary Condition ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. LOCAL INFLOW POINT 3 occurs upstream from Section No. 53.100 SECTION NO. 55.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 58.000 ... DEPTH of the Bed Sediment Control Volume = 3.40 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 13 NO. OF INPUT DATA MESSAGES = 0 TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = 13 TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK = 1 END OF GEOMETRIC DATA 

# The output produced during processing of the sediment data does not differ from that produced for Example Problem 3. It has therefore, been omitted from this table. Refer to Table 6-3b.

\$HYD BEGIN CC

BEGIN COMPUTATIONS.

\$PRT ...Selective Printout Option - Print at the following cross sections CP 1 PS 1.0 35.0 53.1 END

\$VOL X

STREAM SEGMENT # 1: EXAMPLE PROBLEM NO 5. RESERVOIRS.

	SUM	MARY TABLE:	MASS ANI	O VOLUME OF	SEDIMENT					
SECTION	SEDIME TOTAL	NT THROUGH SAND	SECTION (t	tons) CLAY	SEDIM TOTAL	ENT DEPOSITED CUMULATIVE	IN REACH SAND	in cu. SILT	yds CLAY	
INFLOW	0.	0.	ο.	ο.	0.					
58.000	Ο.	Ο.	0.	0.	Ο.	0.	Ο.	ο.	ο.	
55.000	Ο.	0.	Ο.	0.	Ο.	0.	Ο.	0.	0.	
53.100	Ο.	Ο.	0.	Ο.	Ο.	0.	Ο.	Ο.	0.	
53.000	Ο.	0.	ο.	Ο.	Ο.	Ο.	Ο.	Ο.	0.	
44.000	0.	0.	0.	0.	0.	0.	Ο.	0.	0.	
42,000	Ο.	0.	0.	0.	Ο.	0.	Ο.	0.	0.	
35.000	0.	0.	Ο.	0.	ο.	0.	Ο.	ο.	0.	
33.900	0.	ο.	<b>0</b> .	Ο.	Ο.	Ο.	Ο.	0.	0.	
33.300	0.	0.	ο.	Ο.	ο.	ο.	Ο.	ο.	0.	
33.000	0.	Ο.	Ο.	0.	0.	0.	Ο.	0.	0.	
32.000	0.	Ο.	ō.	ο.	0.	ο.	Ο.	ο.	0.	
15.000	Ο.	Ο.	0.	Ο.	0.	Ο.	Ο.	Ο.	0.	
1.000	Ο.	0.	0.	0.	0.	0.	0.	Ο.	0.	
	ELEV	SURFACE AREA	VOLUME AC-FT	VOLUME CY						
SECTION NO.	1.000									
	974.00	0.00	0.00	0.0	0					
SECTION NO.	35.000		,							
	944.00	0.00	0.00	0.0	0					
	946.00	0.83	0.54		8					
	948.00	2.39	3.6							
	950.00	3.76	9.89	9 15949.3	3					
	952.00	4.33	17.9	7 28994.3	5					
	954.00	5.16	27.24	43939.7	5					
	956.00	8.11	40.39	9 65164.1	3					

	958.00 960.00	17.48 36.80	64.33 116.56		8
	962.00 964.00 966.00	83.01 102.86 114.88	210.59 399.48 616.41	644489.5	2
	<b>968.00</b> 970.00	<b>133.90</b> 174.82	<b>859.78</b> 1146.51	<b>1387110.8</b> 1849704.7	2 2
	972.00 974.00	188.44 195.16	1509.87 1893.47		
SECTION NO.	53.100 944.00	0.00	0.00	0.0	0
	946.00 948.00	0.83 2.39	0.54 3.67	867.7 5915.0	8 9
	950.00 952.00	3.76 4.33	9.89 17.97	15949.3 28994.3	5
	954.00 956.00	5.16 8.11	27.24 40.39		3
	958.00 960.00	17.48 36.80	64.33 116.56	188053.6	8
	962.00 964.00	83.01 106.66	210.59 401.88		
	966.00 968.00	119.32 147.00	627.06 883.72	1425731.2	
	970.00 972.00	219.64 242.73	1211.25 1671.97	1954147.0 2697446.6	
	974.00	254.16		3501589.0	
\$PRT A	Davis	Ontion			
	at all c	ross section			
TIME STEP #	1	ASE FLOW OF		*********	
TABLE SA-1.					
	ACCUMULAT		ERING AND I	LEAVING THI	S STREAM SEGMENT
**************************************	ENTRY	************ *	*********** SAND	**********	
DAYS 10.00	POINT 58.000		OUTFLOW	TRAP EFF	
TOTAL=	53.100 53.100	* 0.21	5.24	-6.78 *	
********	*******	*******	******		
TIME DAYS	ENTRY POINT		SAND OUTFLOW	TRAP EFF	
10.00	$53.100 \\ 42.000$			1	
TOTAL=	35.000	* 5.25	0.00	1.00	
TIME	ENTRY	*********** *	SAND	**********	
DAYS 10.00	POINT 35.000		OUTFLOW	TRAP EFF	
	15.000	* 0.02		,	
TOTAL= **********	1.000	* 0.02 ********	0.00 *********	0.98 * *********	
TIME STEP #	2				
		0 DAYS AT BA 10.0000			0000 DAYS IN 20 COMPUTATION STEPS
	EXAMPLE P	ROBLEM NO 5.	RESERVOI	RS.	
*******	*******	********	*******		S STREAM SEGMENT
TIME DAYS	ENTRY POINT	* * INFLOW	SAND OUTFLOW	TRAP EFF	
60.00	58.000	* INFLOW * 13.54			
		* 16.20 * 29.74			
	******** ENTRY	* * * * * * * * * * * * *	*********** Sand	*********	
DAYS	POINT	* INFLOW * 40.95	OUTFLOW	TRAP EFF	
60.00					
	35.000	* 0.36 * 41.31 *******	3.55		
TIME	ENTRY	*	SAND	-	
DAYS 60.00	POINT 35.000	* INFLOW * 3.55	OUTFLOW	TRAP EFF	
ጥ ጥ እ ፣	15.000	* 3.55 * 1.01 * 4.56	0.06	0 00	
***********	********	* 4.50	*********	********	

··· \_\_\_\_\_

T A FLOW 5	= NEAR	BANK FULL DISC		
TABLE SA-1. TRAP E EXAMPI	SFFICIEN LE PROBL	CY ON STREAM S EM NO 5. RESE	EGMENT # 1	STREAM SEGMENT
**************	*******	******	******	
TIME ENT DAYS POJ 61.00 58.0 53.1 TOTAL= 53.1	FRY *	SAND	* ההיה העמות או	
DAIS POI 61.00 58 0	700 ×	13.62	LOW IKAP EFF *	
53.1	L00 *	16.30	*	
TOTAL= 53.1	L00 *	29.92 41	.19 -0.38 *	
****************	*******	***********	************	
TIME END DAYS POJ 61.00 53.1 42.0 TOTAL= 35.0	I'RY *	TNELOW OUTE	.OW TRAD FFF *	
61.00 53.1	100 *	41.19	*	
42.0	* 000	0.37	*	
TOTAL= 35.0	000 *	41.56 3	.55 0.91 *	
*************************************	******** 1707 *	**************************************	*****************	
DAYS POI	INT *	INFLOW OUTF	LOW TRAP EFF *	
61.00 35.0	* 000	3.55	*	
TIME         ENT           DAYS         POI           61.00         35.0           15.0         TOTAL=	000 *	1.02	*	
TOTAL= 1.(	)00 *	4.57 0	.06 0.99 *	
ME STEP # B FLOW 4 CAMPLE PROBLEM NO ACCUMULATEI	4 = BASE  D 5. RE	FLOW OF 750 CF	s 	
FLOW DURATI		yrs) s)	1.000	
Stream Segment # 1 Section No. 58	L 3.000	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
			93.30	
pstream of SECTIC OCAL INFLOW POINT	ON NO. F#3	53.100 is DISCHARGE (cfs)	SEDIMENT LOAD   (tons/day)	TEMPERATURE (deg F)
LOCAL IN	NFLOW	128.00	93.30 43.20	67.00
			136.50	
Upstream of SECTIC LOCAL INFLOW POINT	r#2	DISCHARGE (cfs)	SEDIMENT LOAD   (tons/day)	TEMPERATURE (deg F)
MAIN STEM IN	NFLOW	660.00	136.50	64.13
LOCAL IN	NFLOW	29.00	136.50 1.22	70.00
	•			
		689 00	127 70	64 38
נ	FOTAL		137.72	64.38
ן Upstream of SECTIO	TOTAL	15.000 is DISCHARGE	137.72 SEDIMENT LOAD (tons/day)	TEMPERATURE
Destream of SECTIC	$\begin{bmatrix} rotal \\ rotal \\ r \\ m \\ r \\ m \\ m \\ m \\ m \\ m \\ m \\ m$	15.000 is DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
Destream of SECTIC	$\begin{bmatrix} rotal \\ rotal \\ r \\ m \\ r \\ m \\ m \\ m \\ m \\ m \\ m \\ m$	15.000 is DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
Jpstream of SECTIC JOCAL INFLOW POINT MAIN STEM IN LOCAL IN	FOTAL   ON NO. F # 1   NFLOW   NFLOW	15.000 is DISCHARGE (cfs) 689.00 61.00	SEDIMENT LOAD (tons/day) 137.72 4.32	TEMPERATURE (deg F) 64.38 72.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN	FOTAL   ON NO. F # 1   NFLOW   NFLOW	15.000 is DISCHARGE (cfs) 689.00 61.00	SEDIMENT LOAD   (tons/day)   137.72   4.32	TEMPERATURE (deg F) 64.38 72.00
Upstream of SECTIO LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM	TOTAL   DN NO. F # 1   NFLOW   FOTAL   EFFICIEN LE PROBL ULATED A *******	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE C-FT ENTERING	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS	TEMPERATURE (deg F) 64.38 72.00
Jpstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAPI EXAMPI ACCUMI	TOTAL   DN NO. F # 1   NFLOW   TOTAL   EFFICIEN LE PROBL JLATED A *****	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE C-FT ENTERING ************************************	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS	TEMPERATURE (deg F) 64.38 72.00 65.00
Jpstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAPI EXAMPI ACCUMI	TOTAL   DN NO. F # 1   NFLOW   TOTAL   EFFICIEN LE PROBL JLATED A *****	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE C-FT ENTERING ************************************	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS	TEMPERATURE (deg F) 64.38 72.00 65.00
Destream of SECTIC JOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUMI	TOTAL   DN NO. F # 1   NFLOW   TOTAL   EFFICIEN LE PROBL JLATED A *****	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE C-FT ENTERING ************************************	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS	TEMPERATURE (deg F) 64.38 72.00 65.00
Jpstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUMI TIME ENT DAYS POI 62.00 58.0 53.0 TOTAL= 53.0	FOTAL                     DN NO.         F         # 1                     IFLOW                   .         .           FOTAL                   .         .           FOTAL                   .         .           FOTAL                   .         .           FOTAL                   .         .           EFFICIEN         L         PROBL         .           JULATED         A         .         .           VILATED         A         .         .           NT         *         .         .           100         *         100         *	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S ICY ON STREAM S C-FT ENTERING SAND INFLOW OUTF 13.66 16.32 29.99 41	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POI 62.00 58. 53. TOTAL= 53.	<pre>FOTAL   DN NO. F # 1   FLOW   FLOW   FLOW   FOTAL   EFFICIENLE PROBL LLE PROBL LLE PROBL LLATED A ************************************</pre>	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE LC-FT ENTERING SAND INFLOW OUTF 13.66 16.32 29.99 41	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POI 62.00 58. 53. TOTAL= 53.	<pre>FOTAL   DN NO. F # 1   FLOW   FLOW   FLOW   FOTAL   EFFICIENLE PROBL LLE PROBL LLE PROBL LLATED A ************************************</pre>	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE LC-FT ENTERING SAND INFLOW OUTF 13.66 16.32 29.99 41	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POI 62.00 58. 53. TOTAL= 53.	<pre>FOTAL   DN NO. F # 1   FLOW   FLOW   FLOW   FOTAL   EFFICIENLE PROBL LLE PROBL LLE PROBL LLATED A ************************************</pre>	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE LC-FT ENTERING SAND INFLOW OUTF 13.66 16.32 29.99 41	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Jpstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN CABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POD 62.00 58. 53. TOTAL= 53.	<pre>FOTAL   DN NO. F # 1   FLOW   FLOW   FLOW   FOTAL   EFFICIENLE PROBL LLE PROBL LLE PROBL LLATED A ************************************</pre>	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE LC-FT ENTERING SAND INFLOW OUTF 13.66 16.32 29.99 41	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Jpstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUMI TIME ENT DAYS POI 62.00 58.0 TOTAL= 53.0 TOTAL= 53.0 TOTAL= 33.0 TOTAL= 35.0	FOTAL                     DN NO.         F         #           F         #                     NFLOW                               FOTAL                               FOTAL                               FOTAL                               FOTAL                               IDTAL                               IDTAL                               IDTAL                               IDTAL                               ILLATED         A                     IDT                               IDT                               IDO                               IDO                               IDT                               IDT                               IDT                               IDT                               IDT                               IDT                               IDT                               IDT                               IDT	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S LEM NO 5. RESE C-FT ENTERING ************************************	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POD 62.00 58. 53. TOTAL= 53. TIME ENT DAYS POD 62.00 53. 42.0 TOTAL= 35.	FOTAL                     DN NO.         F           F # 1                     NFLOW                     FOTAL                     FOTAL                     EFFICIEN                     LE PROBL                     JLATED A           ********           PRY *           100 *           100 *           ********           PRY *           100 *           100 *           000 *           000 *	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S EM NO 5. RESE C-FT ENTERING INFLOW OUTF 13.66 16.32 29.99 41 SAND INFLOW OUTF 41.34 0.37 41.71 3	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POD 62.00 58. 53. TOTAL= 53. TIME ENT DAYS POD 62.00 53. 42.0 TOTAL= 35.	FOTAL                     DN NO.         F           F # 1                     NFLOW                     FOTAL                     FOTAL                     EFFICIEN                     LE PROBL                     JLATED A           ********           PRY *           100 *           100 *           ********           PRY *           100 *           100 *           000 *           000 *	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S EM NO 5. RESE C-FT ENTERING INFLOW OUTF 13.66 16.32 29.99 41 SAND INFLOW OUTF 41.34 0.37 41.71 3	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POI 62.00 58. 53. TOTAL= 53. TIME ENT DAYS POI 62.00 53. 42.0 53.	FOTAL                     DN NO.         F         #         1           F         #         1                     INFLOW                   -         -           TOTAL                   -         -           FOTAL                   -         -           TOTAL                   -         -           BEFFICIEN         +         -         -           ILL PROBL         -         -         -           000 *         -         -         -           000 *         -         -         -           100 *         -         -         -           000 *         -         -         -           000 *         -         -         -	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S EM NO 5. RESE C-FT ENTERING INFLOW OUTF 13.66 16.32 29.99 41 SAND INFLOW OUTF 41.34 0.37 41.71 3	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Upstream of SECTIC LOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN TABLE SA-1. TRAP I EXAMPI ACCUM TIME ENT DAYS POD 62.00 58. 53. TOTAL= 53. TIME ENT DAYS POD 62.00 53. 42.0 TOTAL= 35.	FOTAL                     DN NO.         F         #         1           F         #         1                     INFLOW                   -         -           TOTAL                   -         -           FOTAL                   -         -           TOTAL                   -         -           BEFFICIEN         +         -         -           ILL PROBL         -         -         -           000 *         -         -         -           000 *         -         -         -           100 *         -         -         -           000 *         -         -         -           000 *         -         -         -	15.000 is DISCHARGE (cfs) 689.00 61.00 750.00 ICY ON STREAM S EM NO 5. RESE C-FT ENTERING INFLOW OUTF 13.66 16.32 29.99 41 SAND INFLOW OUTF 41.34 0.37 41.71 3	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00
Destream of SECTIC NOCAL INFLOW POINT MAIN STEM IN LOCAL IN LOCAL IN CABLE SA-1. TRAP I EXAMPI ACCUME TIME ENT DAYS POI 62.00 58.0 TOTAL= 53.0 TOTAL= 53.0 TIME ENT DAYS POI 62.00 53.0 42.0 TOTAL= 35.0	FOTAL                     DN NO.         F         #           F         #         1           JUATED         *           FOTAL                     EFFICIEN         *           LLATED         *           ILATED         *           INT         *           1000         *           000         *           000         <	15.000 is DISCHARGE (cfs) 	SEDIMENT LOAD (tons/day) 137.72 4.32 142.04 EGMENT # 1 RVOIRS. AND LEAVING THIS ************************************	TEMPERATURE (deg F) 64.38 72.00 65.00

GRAIN	SIZE	LOAD (tons/	n Boundary: (day)   G	RAIN SIZE	LOA	D (tons/day	r)			
VERY FI	NE SAND	38	3.08 VER 4.16 FIN .06 MED 0.00 COA 0.00 VER	Y FINE GR	AVEL	0.00	)			
MEDIUM	ND	34	.16 FIN	E GRAVEL. IUM GRAVE	 L	0.00	)			
COARSE	SAND		.00 COA	RSE GRAVE	Б	0.00	)			
VERY CO.	ARSE SAND		).00   VER							
GRAIN	OUTFLOW fro	m the Downs LOAD (tons/	stream Bound (day)   G	ary		93.30 D (tons/day				
FINE SA	D	C	0.05 FIN	E GRAVEL.		0.00	)			
COARSE	SAND		0.11 MED	IUM GRAVE. RSE GRAVE	Ц Т.	0.00				
VERY CO	ARSE SAND	č	0.06   VER 0.05   FIN 0.11   MED 0.08   COA 0.02   VER	Y COARSE	GRAVEL	0.00				
				Т	OTAL =	0.32	2			
LE SB-2:	STATUS OF	THE BED PR	ROFILE AT TI	ME = 63	2.000 DAY	s 				
ECTION	BED CHANGE	WS ELEV	THALWEG (ft) 973.28 971.93 970.12 970.11 969.08 963.53 961.00 962.49 961.00 955.95 953.95 945.63	Q (cfs	TRAN	SPORT RATE	(tons/day)			
58.000	-2.12	978.00	973.28	532	, <u>.</u>	196.				
55.000	-0.97	977.02	971.93	532	•	237.				
53.100	-1.18	975.27	971.02	660	•	303.				
53.000 44 000	-2.09	975.27 974 14	970.11	660	•	243.				
42.000	0.68	973.32	970.48	689	•	17.				
35.000	0.23	973.00	963.53	689	•	1.				
33.900	0.00	965.13	961.00	689	•	1.				
33.300	0.00	964.81	962.49	689	•	7.				
32 000	0.00	963.72 967 69	961.00 955 95	689 689	•	159				
15.000	0.25	960.18	953.95	750	•	175.				
1.000	0.93	960.00	945.63	750	•	0.				
- Print	1 1.0 35	1]owing crc .0 53.1			<b>-</b>					
- Print	E at the fo 1.0 35  ENT # 1: E SUM	llowing crc .0 53.1 	BLEM NO 5. MASS AND	RESERVOIR	SEDIMENT					
- Prin L X EAM SEGM	c at the fo 1 1.0 35 ENT # 1: E SUM	llowing crc .0 53.1 	BLEM NO 5. MASS AND	RESERVOIR	SEDIMENT		TED IN REACH S SAND	in cu. 3 SILT	rds CLAY	
- Prin L X EAM SEGMI SECTION INFLOW	at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675.	BLEM NO 5. MASS AND SECTION (to SILT 0.	RESERVOIR VOLUME OF ns) CLAY 0.	SEDIMENT SEDIM TOTAL 22043.	ENT DEPOSI CUMULATIVI	TED IN REACH S SAND	in cu. y SILT	rds CLAY	
- Prin L X EAM SEGMI SECTION INFLOW	at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675.	BLEM NO 5. MASS AND SECTION (to SILT 0.	RESERVOIR VOLUME OF ns) CLAY 0.	SEDIMENT SEDIM TOTAL 22043.	ENT DEPOSI CUMULATIVI	TED IN REACH S SAND	in cu. y SILT	rds CLAY	
- Prin L X EAM SEGMI SECTION INFLOW	at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675.	BLEM NO 5. MASS AND SECTION (to SILT 0.	RESERVOIR VOLUME OF ns) CLAY 0.	SEDIMENT SEDIM TOTAL 22043.	ENT DEPOSI CUMULATIVI	TED IN REACH 3 SAND -4968. -7684.	in cu. y SILT	rds CLAY	
- Prin L X EAM SEGMI SECTION INFLOW 58.000 55.000	E at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0.	RESERVOIR VOLUME OF ns) CLAY 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684.	ENT DEPOSI CUMULATIVI	TED IN REACH S SAND	in cu. y SILT	rds CLAY	
- Prin <i>L X</i> EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF CLAY 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441.	-4968. -12652. -18319. -34760.	TED IN REACH S SAND -4968. -7684. -5667. -16441.	in cu. y SILT 0. 0. 0. 0.	rds CLAY 0. 0. 0.	
- Prin L X EAM SEGM SECTION INFLOW 58.000 55.000 LOCAL 53.100	E at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF ns) CLAY 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667.	ENT DEPOSI? CUMULATIVI -4968. -12652. -18319.	TED IN REACH 3 SAND -4968. -7684. -5667.	in cu. y SILT 0. 0. 0.	vds CLAY 0. 0.	
- Prin <i>L X</i> EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF CLAY 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441.	-4968. -12652. -18319. -34760.	TED IN REACH S SAND -4968. -7684. -5667. -16441.	in cu. y SILT 0. 0. 0. 0.	rds CLAY 0. 0. 0.	
- Prin L X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000	E at the for 1 0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR volume of ns) CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408.	-4968. -12652. -18319. -34760.	TED IN REACH S SAND -4968. -7684. -5667. -16441.	in cu. y SILT 0. 0. 0. 0.	rds CLAY 0. 0. 0.	
- Print L X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 35.000	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185.	-4968. -12652. -18319. -34760. 17646. 39054. 43240.	<pre>FED IN REACH S SAND -49687684566716441. 52407. 21408. 4185.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0.	
- Prin L X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 35.000 33.900	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193.	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF 	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3.	-4968. -12652. -18319. -34760. 17646. 39054. 43240. 43243.	<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0.	
- Prin L X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 33.900 33.300	<pre>t at the for 1 .0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192.</pre>	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF Ins) CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0.	-4968. -12652. -18319. -34760. 17646. 39054. 43240. 43243. 43243.	<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3. 0.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0.	
- Prin <i>L X</i> EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 35.000 33.900	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193.	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF 	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3.	-4968. -12652. -18319. -34760. 17646. 39054. 43240. 43243.	<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0.	
- Print - Print EAM SEGMI SECTION INFLOW 58.000 5.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 35.000 33.900 33.000	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0. 5.	-4968. -12652. -18319. -34760. 17646. 39054. 43240. 43243. 43243. 43248.	<pre>FED IN REACH 3 SAND -49687684566716441. 52407. 21408. 4185. 3. 0. 5.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
- Prin 2 X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 33.900 33.300 33.000 33.000 1000 LOCAL 15.000	t at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186. 25290. 2062. 16144.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF Ins) CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0. 5. -14420. 1642. 8927.		<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3. 0. 5. -14420.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
- Print - Print EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 42.000 35.000 33.000 33.000 32.000 LOCAL	E at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186. 25290. 2062.	llowing crc .0 53.1 XAMPLE PROE MARY TABLE: NT THROUGH SAND 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186. 25290. 2062.	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0. 5. -14420. 1642.	-4968. -12652. -18319. -34760. 17646. 39054. 43240. 43243. 43243. 43248. 28828.	<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3. 0. 5. -14420.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
- Prin 2 X EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 42.000 33.000 33.000 33.000 33.000 33.000 10	t at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186. 25290. 2062. 16144. 119.	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR VOLUME OF Ins) CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0. 5. -14420. 1642. 8927.		<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3. 0. 5. -14420.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
- Print - Print EAM SEGMI SECTION INFLOW 58.000 55.000 LOCAL 53.100 53.000 44.000 LOCAL 42.000 33.900 33.900 33.000 32.000 LOCAL 15.000 1.000	<pre>t at the for 1.0 35 ENT # 1: E SUM SEDIME TOTAL 27675. 33913. 43560. 33067. 83742. 104383. 38587. 742. 12452. 7197. 7193. 7192. 7186. 25290. 2062. 16144. 119. ELEV 1.000</pre>	llowing crc .0 53.1 	BLEM NO 5. MASS AND SECTION (to SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	RESERVOIR. VOLUME OF Ins) CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	SEDIMENT SEDIM TOTAL 22043. -4968. -7684. 26338. -5667. -16441. 52407. 591. 21408. 4185. 3. 0. 5. -14420. 1642. 8927. 12764.		<pre>FED IN REACH SAND -4968. -7684. -5667. -16441. 52407. 21408. 4185. 3. 0. 5. -14420.</pre>	in cu. y SILT 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	rds CLAY 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
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	950.00	3.16	6.65	10729.40
	952.00	4.06	14.05	22667.32
	954.00	4.67	22.74	36692.89
	956.00	7.60	34.72	56007.76
	958.00	17.55	59.75	96392.34
	960.00	36.89	112.36	181277.81
	962.00	83.15	206.06	332439.56
	964.00	103.07	394.36	636234.41
	966.00	115.08	611.72	986900.29
	968.00	134.04	855.45	1380128.58
	970.00	174.87	1142.37	1843028.68
	972.00	188.44	1505.77	2429301.12
	974.00	195.16	1889.36	3048170.38
ECTION NO.	53,100			
derion no.	944.00	0.00	0.00	0.00
	946.00	0.23	0.00	68.42
	948.00	1.60	1.80	2907.75
	950.00	3.16	6.65	10729.40
	952.00	4.06	14.05	22667.32
	954.00	4.67	22.74	36692.89
	956.00	7.60	34.72	56007.76
	958.00	17.55	59.75	96392.34
	960.00	36.89	112.36	181277.81
	962.00	83.15	206.06	332439.56
	964.00	106.80	396.31	639386.72
	966.00	119.44		1003106.83
	968.00	142.01	621.76 875.94	1413188.12
	970.00			
	970.00	197.85	1186.47	1914179.58
	972.00	236.59	1632.71	2634112.44
	9/4.00	253.24	2120.94	3421777.07

#### ŞŞENL

0 DATA ERRORS DETECTED.

TOTAL NO. OF TIME STEPS READ =	4
TOTAL NO. OF WS PROFILES =	23
ITERATIONS IN EXNER EQ =	1495

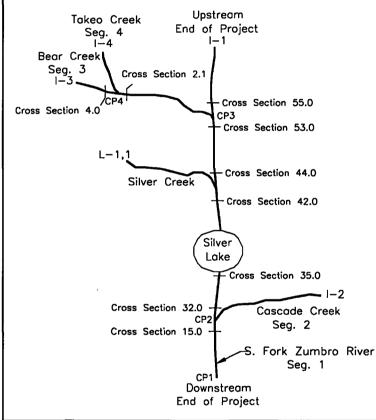
COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES & 6.00 SECONDS

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# 6.6 Example Problem 6 - River Network System

This example problem adds tributaries to the existing problem. Tributaries are described with cross section and sediment data; therefore, sediment transport and bed movement is calculated for the tributaries as well as for the main stem. See Chapter 3, Section 3.6 for a detailed description of data preparation for network systems. It is suggested that the data for each segment of the system be tested and corrected separately so that any subsequent errors are due to the construction of the network system data and not due to errors in any individual segments. A schematic of the system is shown in Figure 6-5. Silver Creek is treated as a local inflow, all other segments are tributaries.

# 6.6.1 Network Layout and Numbering



# Figure 6-5 Schematic of a Network System

# 6.6.2 Geometric Data Structure

The input data file for Example Problem 6 is shown in Table 6-6a. The data for the main river segment is first, with QT records indicating locations of the tributaries (see Section 3.6.2); an EJ record marks the end of the geometry data for each stream segment. The number in Field 1 of the QT record is the control point associated with the entering tributary; thus, the first QT record encountered is for Cascade Creek which enters the main stem at control point 2 (upstream of Section No. 15.0). A second QT record is located after Section No. 42.0; since this is a local inflow, there is no control point number on the QT record. A third QT record, entered after Section No. 53.0, marks the entrance of Bear Creak at control point 3. The geometry data

The numbering of stream segments and control points must follow the scheme presented in Section 3.6. This is shown for Example Problem 6 in Figure 6-5. The stream segments, control points (CP), and inflows are numbered from downstream to upstream. The control points are numbered first, then each tributary is given a segment number that corresponds to the control point at its confluence with another segment or the main stem. The inflow points of each segment are then numbered corresponding to the segment number, e.g. the inflow to Bear Creek is designated I-3. Silver Creek is the only local inflow, so it is designated L-1,1, with the first number being the segment into which it flows and the second being which local it is on that segment.

for each tributary is then entered in sequence by segment number. Therefore, the second set of cross section data is for Cascade Creek, the third is Bear Creek, and the fourth is Takeo Creek. Note the use of the **QT** record within the Bear Creek geometry data to locate the confluence of Takeo Creek at control point 4.

#### 6.6.3 Sediment Data Structure

The sediment data are entered in a sequence similar to the geometric data. Note, however, that the sediment load tables for local inflows on a given segment follow the sediment data for that segment. In other words, first the sediment data for the main river segment is entered, then the load tables for any local inflows on that segment; thereafter the sediment data for each tributary follows in sequence of segment number. The sediment data for each tributary begins with a **\$TRIB** record.

# 6.6.4 Flow Data Structure

The flows and temperatures for local and tributary flows must be entered in the proper sequence on the Q and T records. The flows entering this system for the last (fourth) time step are shown on Figure 6-6. The first flow on the O record is that leaving the downstream boundary of the main stem (500 cfs), the next is the local inflow (Silver Creek) to the main stem (29 cfs). Since there are no more local inflows on the main stem, Field 3 contains the flow (61 cfs) for segment 2, Cascade Creek. Bear Creek flow (128 cfs) is in Field 4 and Takeo Creek flow (90 cfs) in Field 5. Note, this sequence is the same as the order in which the sediment load tables were defined.

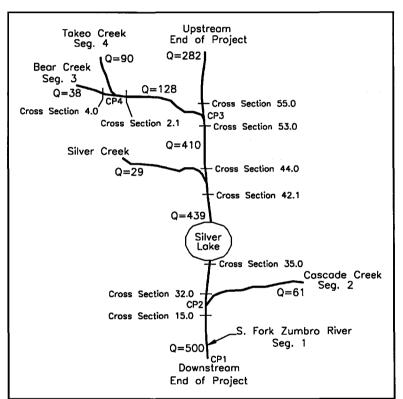


Figure 6-6 Flows of a Network System

#### Table 6-6a Example Problem 6 - Input Network System

<b>T1</b> T2 T3	c	CASCADE &	BEAR: T	RIBS OF S	ZUMBRO;	TAKEO:	TRIB OF	BEAR;	<b>Segment</b> SILVER: L roblem 6	OCAL
NC	.100	.100	.040	.1	.3					
X1	1.0	31	10077.	10275.	Ο.	0.	Ο.			
GR	1004.	9915.	978.4	10002.	956.0	10060.	959.2	10077.	959.3	10081.
GR	950.0	10092.	948.48	10108.	946.6	10138.	944.7	10158.	955.2	10225.
GR	956.2	10243.	958.9	10250.	959.8	10275.	959.8	10300.	959.9	10325.
GR	958.8	10350.	957.4	10400.	970.0	10700.	966.0	10960.	970.0	11060.
GR	968.0	11085.	968.0	11240.	970.0	11365.	970.0	11500.	970.0	11615.

GR 962.0	11665.	962.0	12400.	976.0	12550.	980.0	12670.	982.0	12730.
GR 984.0	12735.								
HD 1.0	10.	10081.	10250.						
NV 12	.08	965.6	.13	988.8					
NV 22	.045	965.6	.064	988.8					
NV 33	.1	965.6	.11	982.0	.12	988.8			
X1 15.0	27	10665.	10850.	3560.	3030.	3280.			
X3			10700.	961.0	11000.	970.0			
GR 992.0	9570.	982.0	10110.	976.0	10300.	976.0	10490.	966.0	10610.
GR 964.7	10665.	956.0	10673.	953.0	10693.	954.0	10703.	955.6	10723.
GR 958.6	10750.	959.3	10800.	957.0	10822.	957.3		961.5	10850.
GR 962.0	10852.	964.0	10970.	966.0			11090.		11150.
GR 970.0	11190.	972.0	11310.	980.0	11410.	984.0	11570.	990.0	11770.
GR 990.0	11865.	1000.0	12150.						
HD 15.0	10.	10673.	10852.						
	CREEK -	IKIBUIA	IRY						
QT 2 NC .10	.10	05							
X1 32.0	29	.05 10057.	10071	3630.	3060.	1210			
			10271.			4240.	0000	000 01	9925.
GR 998.0	9080.	982.0	9250.	982.0	9510. 10075	980.0	9600.	980.01	
GR979.48 GR 956.8	10000.	978.5	10057.	968.6	10075.	959.82	10087.	956.5 959.82	10097. 10196.
	10117.	957.8	10137.	959.4	10157.	959.6	10177.	978.6	
GR 966.5 GR978.91	10225.	971.2 978.96	10250.	978.5	10271.	978.5			10350.
	10370. 11150.	992.0	10387.	980.0	10610.	982.0		982.0	11145.
GR 984.0 HD 32.0	11150.		11240.	1000.0	11330.	1008.	11425.		
		10075.	10275.	2120	2050	2220			
X1 33.0 XL	21	1850. 250	2150.	3130.	3250.	3320.			
GR 1000.	980.	250 990.0	1060.	980.0	1150.	982.0	1180.	982.0	1215.
GR 1000. GR 980.0	980. 1260.	990.0 982.0	1300.	980.0 982.0	1350.	982.0 980.0	1420.	982.0 980.0	1540.
GR 982.0	1730.	982.0	1830.	984.41	1850.	979.19	1851.	961.0	1900.8
GR 961.0	2099.2	976.0	2149.	984.5	2150.	982.0	2800.	990.0	3100.
GR 1000.	3170.			0.0	2150.	982.0	2800.	0.0	0.
HD 33.0	0.0	0.0 1851.	0. 2149.	0.0	0.	0.0	0.	0.0	0.
				Section	33 0				
X1 33.3	21	1850.	2150.	1550.	1750.	1750.	.95	1.49	
XL 35.5	21	250	2150.	1550.	1750.	1750.		1.45	
GR 1000.	980.	990.0	1060.	980.0	1150.	982.0	1180.	982.0	1215.
GR 980.0	1260.	982.0	1300.	982.0	1350.	980.0	1420.	980.0	1540.
GR 982.0	1730.	982.0	1830.	984.41	1850.	979.19	1851.	961.0	1900.8
GR 961.0	2099.2	976.0	2149.	984.5	2150.	982.0	2800.	990.0	3100.
GR 1000.	3170.				2150.	902.0			
				0 0	0	0 0	0	0 0	
		0.0	0. 2149	0.0	0.	0.0	0.	0.0	0.
HD 33.3	0.0	1851.	2149.						
HD 33.3 Section	0.0 33.9 is	1851. a dupli	2149. cate of	Sec 33.3	, needed	to mode	l IBC at	Sec 35.	
HD 33.3 Section X1 33.9	0.0	1851.	2149.						
HD 33.3 Section X1 33.9 X3 10	0.0 33.9 is 21	1851. a dupli 1850.	2149. cate of 2150.	Sec 33.3 1050.	, needed 1050.	to mode 1050.	l IBC at .95	Sec 35. 1.65	0
HD 33.3 Section X1 33.9 X3 10 GR 1000.	0.0 33.9 is 21 980.	1851. a dupli 1850. 990.0	2149. cate of 2150. 1060.	Sec 33.3 1050. 980.0	, needed 1050. 1150.	to mode 1050. 982.0	1 IBC at .95 1180.	Sec 35. 1.65 982.0	0 1215.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0	0.0 33.9 is 21 980. 1260.	1851. a dupli 1850. 990.0 982.0	2149. cate of 2150. 1060. 1300.	Sec 33.3 1050. 980.0 982.0	, needed 1050. 1150. 1350.	to mode 1050. 982.0 980.0	l IBC at .95 1180. 1420.	Sec 35. 1.65 982.0 980.0	0 1215. 1540.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0	0.0 33.9 is 21 980. 1260. 1730.	1851. a dupli 1850. 990.0 982.0 982.0	2149. cate of 2150. 1060. 1300. 1830.	Sec 33.3 1050. 980.0 982.0 984.41	, needed 1050. 1150. 1350. 1850.	to mode 1050. 982.0 980.0 979.19	el IBC at .95 1180. 1420. 1851.	Sec 35. 1.65 982.0 980.0 961.0	0 1215. 1540. 1900.8
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2	1851. a dupli 1850. 990.0 982.0 982.0 976.0	2149. .cate of 2150. 1060. 1300. 1830. 2149.	Sec 33.3 1050. 980.0 982.0 984.41 984.5	<pre>, needed 1050. 1150. 1350. 1850. 2150.</pre>	to mode 1050. 982.0 980.0 979.19 982.0	l IBC at .95 1180. 1420. 1851. 2800.	Sec 35. 1.65 982.0 980.0 961.0 990.0	0 1215. 1540. 1900.8 3100.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000.	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0	2149. cate of 2150. 1060. 1300. 1830. 2149. 0.	Sec 33.3 1050. 980.0 982.0 984.41	, needed 1050. 1150. 1350. 1850.	to mode 1050. 982.0 980.0 979.19	el IBC at .95 1180. 1420. 1851.	Sec 35. 1.65 982.0 980.0 961.0	0 1215. 1540. 1900.8
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851.	2149. cate of 2150. 1060. 1300. 1830. 2149. 0. 2149.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0	<pre>, needed 1050. 1150. 1350. 1850. 2150. 0.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0	l IBC at .95 1180. 1420. 1851. 2800.	Sec 35. 1.65 982.0 980.0 961.0 990.0	0 1215. 1540. 1900.8 3100.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0	2149. cate of 2150. 1060. 1300. 1830. 2149. 0.	Sec 33.3 1050. 980.0 982.0 984.41 984.5	<pre>, needed 1050. 1150. 1350. 1850. 2150.</pre>	to mode 1050. 982.0 980.0 979.19 982.0	l IBC at .95 1180. 1420. 1851. 2800.	Sec 35. 1.65 982.0 980.0 961.0 990.0	0 1215. 1540. 1900.8 3100.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851.	2149. .cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0	<pre>, needed 1050. 1150. 1350. 1850. 2150. 0.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0	l IBC at .95 1180. 1420. 1851. 2800.	Sec 35. 1.65 982.0 980.0 961.0 990.0	0 1215. 1540. 1900.8 3100.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894.	2149. cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0	, needed 1050. 1150. 1350. 1850. 2150. 0. 0.	to mode 1050. 982.0 980.0 979.19 982.0 0.0	l IBC at .95 1180. 1420. 1851. 2800. 0.	Sec 35. 1.65 982.0 980.0 961.0 990.0	0 1215. 1540. 1900.8 3100. 0.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 X5 GR 984.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0	2149. .cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2 9070.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0	<pre>, needed 1050. 1150. 1350. 1850. 2150. 0. 0 9135.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 982.0	1 IBC at .95 1180. 1420. 1851. 2800. 0. 9185.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0	0 1215. 1540. 1900.8 3100. 0. 9270.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 S GR 984.0 GR 984.0 GR 980.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894.	2149. cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2 9070. 9595.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7	, needed 1050. 1150. 1350. 1850. 2150. 0. 0.	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894.	Sec 35. 1.65 982.0 980.0 961.0 990.0 0.0 982.0 982.0 963.4	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 X5 GR 984.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1	2149. .cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2 9070.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 982.0	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0	0 1215. 1540. 1900.8 3100. 0. 9270.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 X5 GR 984.0 GR 984.0 GR 980.0 GR 983.3	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465.	1851. a dupli 1850. 990.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1 977.4	2149. cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2 9070. 9595. 9974. 10120.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 X5 GR 984.0 GR 984.0 GR 984.3 GR 963.3 GR 973.4	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1	2149. cate of 2150. 1060. 1300. 1830. 2149. 02. 2149. 10245. 2 9070. 9595. 9974.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 GR 984.0 GR 984.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 954. 10115. 10895.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1 977.4 1004.0 9954.	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 11085. 10155.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 GR 984.0 GR 984.0 GR 984.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 982.0 982.0 982.0 982.0 982.0 984.0 9894. 9894. 980.0 981.7 967.1 977.4 977.4	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 11085. 10155.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 K1 35.0 X3 10 GR 984.0 GR 984.0 GR 980.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L	1851. a dupli 1850. 990.0 982.0 976.0 982.0 976.0 1851. 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 11085. 10155.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 X5 GR 984.0 GR 984.0 GR 984.0 GR 980.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0 	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L .06	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 1851. 9894. 9894. 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE	2149. cate of 2150. 1060. 1300. 1830. 2149. 02149. 10245. 2 9070. 9595. 9974. 10120. 11085. 10155.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 0 978.0 983.7 967.4 983.7	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2 984.0	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 982.0 963.4 967.6	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054.
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HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 1000. HD 33.9 X1 35.0 X3 10 GR 984.0 GR 984.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0  NC .06 X1 42.0 GR 996.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L .06 32 7130.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE .045 9880.	2149. cate of 2150. 1060. 1300. 249. 0. 2149. 10245. 2 9070. 9595. 9974. 10120. 11085. 10155. - 10130.	Sec 33.3 1050. 980.0 984.41 984.5 0.0 0 978.0 978.0 983.7 967.4 983.7 5370.	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155.</pre>	to mode 1050. 982.0 979.19 982.0 0.0 0 980.0 984.7 968.2 984.0 5210.	l IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245.	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 961.0 GR 961.0 GR 961.0 GR 960.0 GR 980.0 GR 980.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0  NC .06 X1 42.0 GR 988.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L .06 32 7130. 8780.	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1 967.1 967.1 907.4 1004.0 9954. AKE .045 9880. 988.0 988.0 986.0	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 11085. - 10130. 7310. 8990.	Sec 33.3 1050. 980.0 984.41 984.5 0.0 0 978.0 983.7 967.4 983.7 967.4 983.7	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 0 980.0 984.7 968.2 984.0 5210. 992.0 986.45	<pre>1 IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245.</pre>	Sec 35. 1.65 982.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0 982.0 982.0	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857.
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HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 HD 33.9 X1 35.0 X3 10 X5 GR 984.0 GR 984.0 GR 983.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0  NC .6 X1 42.0 GR 996.0 GR 988.0 GR 996.0 GR 988.0 GR 996.8 GR 988.9 GR 969.8 GR 988.9 JU 42.0 SILVER QT X1 44.0 XL	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 222 9035. 9465. 9954. 10115. 10895. 0 SILVER L 	1851. a dupli 1850. 990.0 982.0 982.0 976.0 0.0 1851. 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE .045 9880. 998.0 998.0 998.0 998.0 998.0 998.0 980.0 988.	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 10185. 10155. - 10130. 7310. 8990. 9881. 10067. 10180. 12310. 10221. WFLOW 10127. 9850. 8150.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.8 985.7 998.0 985.7 998.0 985.7 985.8 988.6	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 9570. 9941. 10001. 10069. 10230. 3800. 8305.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 986.0 984.7 968.2 984.0 5210. 992.0 986.45 985.8 985.8 985.8 985.8 985.8 987.6 3500. 990.0	<pre>el IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10069. 10280.</pre>	Sec 35. 1.65 982.0 980.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0 982.0 989.44 985.8 969.8 969.8 969.8 985.2 985.2	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 943. 1003. 10129. 10430.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 HD 33.9 X1 35.0 X3 10 GR 984.0 GR 984.0 GR 984.0 GR 984.0 GR 963.3 GR 973.4 GR 963.3 GR 973.4 GR 982.0 HD 35.0 C. 06 X1 42.0 GR 996.0 GR 988.0 GR 996.0 GR 988.0 GR 996.8 GR 989.9 GR 989.9 GR 986.8 HD 42.0 SILVER OT X1 44.0 XL GR 1002. GR 996.0	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L .06 32 7130. 8780. 9843. 10067. 10130. 11720 0 CREEK - 28 8035. 9285.	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 981.7 9894. 9894. 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE 045 9880. 9954. 988.0 986.0 986.0 986.0 985.8 989.5 988.5 989.5 989.5 989.5 989.5 989.5 989.5 989.5 989.5 988.5 989.5 989.5 988.5 989.5 984.5 992.0 1017.5	2149. cate of 2150. 1060. 1300. 1830. 2149. 0. 2149. 10245. 2 9070. 9595. 9974. 10120. 10185. 10155. - 10130. 7310. 8990. 9881. 10021. 10021. 10021. VFLOW 10127. 9825. 9425.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 985.8 988.6 3200. 10200 990.0 990.0	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 9570. 9570. 9570. 9541. 10001. 10069. 10230. 3800. 8305. 9505.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 986.0 984.7 968.2 984.0 984.7 968.2 984.0 5210. 992.0 986.45 985.8 985.8 985.8 985.6 3500. 990.0 986.0	<pre>el IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10280. 8735. 9650.</pre>	Sec 35. 1.65 982.0 980.0 990.0 990.0 982.0 963.4 967.6 982.0 989.44 985.8 969.8 969.8 985.2 985.2	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 9943. 1003. 10129. 10430. 8835. 9788.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 HD 33.9 X1 35.0 X3 10 GR 984.0 GR 980.0 GR 980.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0  NC .06 X1 42.0 GR 996.0 GR 988.0 GR 980.6	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L .06 32 7130. 8780. 9880. 9880. 9880. 9880. 9880. 9880. 10130. 11720 0 <b>CREEK -</b> 28 8035. 9845.	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 982.0 981.7 9894. 980.0 981.7 967.1 977.4 1004.0 9954. AKE .045 9880. 9954. AKE .045 9880. 9954. AKE .045 9880. 9954. AKE .045 9880. 985.8 989.8 989.8 989.5 989.9 9881. ICCAL IN 9845. 992.0 1017. 970.9	2149. cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 1085. 10155. - 10130. 7310. 8990. 9881. 10001. 10087. 10180. 12310. 10021. WFLOW 10127. 9850 8150. 9425. 9868.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.4 985.7 967.2 985.7 967.2 985.7 967.2 985.7 967.2 985.7 967.2 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8 985.7 985.8	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 9570. 9941. 10001. 10230. 3800. 8305. 9505. 9898.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 0 980.0 984.7 968.2 984.0 5210. 992.0 986.45 985.8 985.8 985.8 985.8 985.6 3500. 990.0 990.0 990.0	<pre>1 IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10280. 8735. 9650. 9968.</pre>	Sec 35. 1.65 982.0 980.0 990.0 990.0 982.0 963.4 967.6 982.0 989.44 985.8 969.8 969.8 985.2 988.0 984.1 967.5	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 9943. 10003. 10129. 10430. 8835. 9788. 9998.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 GR 961.0 GR 961.0 GR 961.0 GR 988.0 GR 988.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0  NC .06 X1 42.0 GR 996.0 GR 996.0 GR 969.8 GR 969.8 GR 969.8 GR 969.8 GR 969.8 GR 969.8 GR 969.8 GR 988.0 GR 998.0 GR 988.8 HD 42.0 SILVER OT X1 44.0 XL GR 1002. GR 996.6 GR 968.9	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 10115. 10895. 0 SILVER L 	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 1851. 9894. 9894. 9894. 9894. 9894. 987.4 1004.0 9954. 9977.4 1004.0 9954. 9977.4 1004.0 9954. 9954. 880. 9954. 9880. 9954. 880. 9954. 9880. 9954. 1004.0 9954. 9880. 9954. 1004.0 9954. 1004.0 9954. 1004.0 9954. 1004.0 9954. 9880. 9954. 1004.0 9958. 998.0 989.0 988.0 989.0 988.0 989.0 988.0 989.5 989.5 989.0 988.0 988.0 988.0 988.0 988.0 988.0 989.5 989.0 988.0	2149. cate of 2150. 1060. 1300. 249. 0. 2149. 10245. 2 9070. 9595. 9974. 10120. 10185. 10130. 7310. 8990. 9881. 10001. 10067. 10180. 12310. 10221. WFLOW 10127. 9850. 8150. 9868. 10058.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 983.7 983.7 5370. 998.0 983.7 5370. 998.0 985.7 998.0 985.7 998.0 985.7 998.0 985.7 985.8 988.6 3200. 10200 990.0 990.0 990.0 997.2 2967.1	<pre>, needed 1050. 1150. 1350. 1850. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 95745. 10004. 10155. 5000. 7930. 9541. 10001. 10069. 10230. 3800. 8305. 9505. 9898. 10078.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 984.7 984.0 984.0 984.0 984.0 984.0 985.8 985.8 986.7 969.8 986.7 969.8 987.6 3500. 990.0 990.0 980.0	<pre>el IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10280. 8735. 9650. 9650. 9668. 10118.</pre>	Sec 35. 1.65 982.0 980.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0 989.44 985.8 969.8 969.8 969.8 969.8 985.2 988.0 988.0 984.1 967.5 976.8	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 9943. 10003. 10129. 10430. 8835. 9788. 9998. 10127.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 GR 961.0 GR 961.0 GR 984.0 GR 986.3 GR 982.0 HD 35.0 SILVER GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 988.0 GR 986.8 HD 42.0 SILVER QT X1 44.0 XL GR 1002. GR 986.0 GR 986.0 GR 986.0 GR 986.0 GR 986.0 GR 986.0 SILVER OF 980.0 GR 980.0 SILVER OF 980.0 GR 980.0 GR 980.0 SILVER OF 980.0 GR 980.0 SILVER OF 980.0 GR 980.0 SILVER OF 980.0 SILVER OF 980.0 SILVER OF 980.0 GR 980.0 GR 977.8	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 222 9035. 9465. 9954. 10115. 10895. 0 SILVER L 06 32 7130. 8780. 9880. 9880. 9880. 9880. 10067. 10130. 11720 0 <b>CREEK -</b> 28 8035. 9285.	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 1851. 9894. 9894. 9894. 9894. 9894. 9894. 9954. AKE .045 9880. 9954. 880. 9954. 9954. 880. 9954. 998.0 997.0 907.4 970.9 907.4 976.9	2149. Cate of 2150. 1060. 1300. 1830. 2149. 10245. 2149. 10245. 29070. 9595. 9974. 10120. 10155. 10130. 7310. 8990. 9881. 10067. 10180. 12310. 10067. 10180. 12310. 10221. VFLOW 10127. 9850. 8150. 9425. 9868. 10193.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.8 985.7 985.8 988.6 3200. 10200 990.0 990.0 990.0 990.0 990.0	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 9570. 9941. 10001. 10069. 10230. 3800. 8305. 9505. 9598. 10078. 10206.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 984.7 984.0 984.0 984.0 984.0 984.0 985.8 985.8 986.7 969.8 986.7 969.8 987.6 3500. 990.0 990.0 980.0	<pre>el IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10280. 8735. 9650. 9650. 9668. 10118.</pre>	Sec 35. 1.65 982.0 980.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0 989.44 985.8 969.8 969.8 969.8 969.8 985.2 988.0 988.0 984.1 967.5 976.8	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 9943. 10003. 10129. 10430. 8835. 9788. 9998. 10127.
HD 33.3 Section X1 33.9 X3 10 GR 1000. GR 980.0 GR 982.0 GR 982.0 GR 961.0 GR 961.0 GR 961.0 GR 982.0 HD 33.9 X1 35.0 X5 GR 984.0 GR 984.0 GR 963.3 GR 973.4 GR 982.0 HD 35.0 C .06 X1 42.0 GR 996.0 GR 988.0 GR 996.8 GR 969.8 GR 968.9 GR 977.8 GR 1002. GR 968.9 GR 967.8 GR 968.1	0.0 33.9 is 21 980. 1260. 1730. 2099.2 3170. 0.0 22 9035. 9465. 9954. 1015. 1015. 10895. 0 SILVER L .06 32 7130. 8780. 9843. 10067. 10130. 11720 0 CREEK - 28 8035. 9845. 9845. 10130. 11720. 0 CREEK - 28	1851. a dupli 1850. 990.0 982.0 982.0 982.0 982.0 982.0 981.7 9894. 9894. 9894. 9894. 985.8 9880. 998.0 986.0 985.8 989.5 999.5 800.5 999.5 800.5 999.5 800.5 999.5 800.5	2149. Cate of 2150. 1060. 1300. 1830. 2149. 10245. 2 9070. 9595. 9974. 10120. 10185. 10155. - 10130. 7310. 8990. 9881. 10067. 10180. 12310. 10067. 10180. 12310. 10021. WFLOW 10127. 9850 8150. 9425. 9868. 10153. 10153. 10153. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 9850. 10127. 1021. 10127. 1021. 10127. 1021. 1021. 1022. 1022. 1022. 1022. 1022. 1022. 1022. 1022. 1022. 1023. 1023. 1025.	Sec 33.3 1050. 980.0 982.0 984.41 984.5 0.0 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.4 983.7 967.8 985.7 969.8 985.7 985.8 988.6 3200. 10200 990.0 990.0 990.0 990.0	<pre>, needed 1050. 1150. 1350. 2150. 0. 0 9135. 9745. 10004. 10155. 5000. 7930. 9570. 9941. 10001. 10069. 10230. 3800. 8305. 9505. 9598. 10078. 10206.</pre>	to mode 1050. 982.0 980.0 979.19 982.0 0.0 984.7 984.0 984.0 984.0 984.0 984.0 985.8 985.8 986.7 969.8 986.7 969.8 987.6 3500. 990.0 990.0 980.0	<pre>el IBC at .95 1180. 1420. 1851. 2800. 0. 9185. 9894. 10044. 10245. 8205. 9707. 9941. 10003. 10280. 8735. 9650. 9650. 9668. 10118.</pre>	Sec 35. 1.65 982.0 980.0 961.0 990.0 0.0 982.0 963.4 967.6 982.0 989.44 985.8 969.8 969.8 969.8 969.8 985.2 988.0 988.0 984.1 967.5 976.8	0 1215. 1540. 1900.8 3100. 0. 9270. 9894.1 10054. 10695. 8495. 9857. 9943. 10003. 10129. 10430. 8835. 9788. 9998. 10127.

GR 1004. GR 994.0 GR 982.8	7550								
	7550.	1000.0	7760.	998.0	8440.	996.0	8640.	996.0	8780.
GR 982.8	8940.	986.0	9245.	986.3	9555.	986.3	9825.	983.8	9900.
	10000.	978.2	10011.	974.0	10041.	972.2	10071.	972.6	10101.
GR 978.2	10121.		10136.	989.3	10154.			1000.1	
		988.7		969.5	10154.	999.2	10200.	1000.1	10320.
GR 1002.	10470.	1004.0	10700.						
HD 53.0	10.	10000.	10136.						
BEAR CH	REEK – TI	TBI/TARY							
QT 3									
X1 55.0	18	9931.	10062.	2275.	3430.	2770.			
GR 1004.	7592.	1000.0	7947.	996.0	8627.	990.0	9052.	986.0	9337.
GR 984.3	9737.	984.7	9837.	985.5	9910.	987.2	9931.	978.1	9955.
GR 974.8	9975.	974.2	10005.	972.9	10035.	973.2	10045.	983.8	10062.
GR 985.8	10187.	986.0	10307.	990.0	10497.				
				220.0	10407.				
HD 55.0	10.	9931.	10062.						
X1 58.0	22	9912.	10015.	1098.	1012.	1462.			
GR 1006.	8542.	1004.0	8952.	1000.0	9702.	997.2	9812.	996.3	9912.
GR 976.2	9944.	975.4	9974.	978.2	9991.	990.4	10015.	988.3	10062.
	10065.			989.3					
GR 988.8		988.3	10065.		10169.	990.0	10172.	992.0	10242.
GR 992.0	10492.	988.0	10642.	986.7	10852.	988.0	11022.	986.0	11097.
GR 986.0	11137.	988.0	11192.						
HD 58.0	3.4	9912.	10015.						
EJ	5.1	<i>JJ</i> <b>1</b> 2.	10015.						
		<i></i>							
\$TRIB		CASCA	DE GEOME	TRY, SEG	MENT 2,	CONTROL	POINT 2		
СР 2									
T1 E	EXAMPLE 6	6 Cont. Z	UMBRO RI	VER Proj	ect - CA	SCADE CR	EEK - St	ream Seq	ment 2
		IS A TRIB							
		CREEK GEO						Problem	
							-vembre	TODIE	•
NC .120	.120	.045	.1	.3					
X1 1.0	25	5000.	5100.	0.	0.	Ο.			
GR 995.0	4570.	980.0	4600.	970.0	4690.	968.0	4740.	968.0	4850.
GR965.24	4900.	964.6	4950.	964.0	4975.	963.7	5000.	961.5	5003.
GR 959.8	5014.	960.2	5025.	959.9	5038.	960.1	5068.	960.4	5073.
GR 962.5	5075.	963.1	5083.	968.9	5094.	969.6	5100.	970.3	5150.
GR 970.0	5260.	972.0	5280.	972.0	5400.	980.0	5460.	982.	5780.
H 1.0		4925.	5121.						
X1 3.0	24	4942.	5050.	460.	280.	537.			
GR 1000.	4715.	983.9	4897.	982.9	4942.	973.2	4959.	973.0	4967.
GR 970.2	5000.	964.78	5007.	964.3	5017.	965.1	5027.	965.17	5027.
GR 968.7	5042.	969.9	5050.	969.4	5067.	971.1	5092.	970.3	5103.
GR 972.7	5180.	970	5207.	972.8	5217.	971.1	5242.	970.7	5267.
								570.7	5207.
GR 975.2	5277.	976.56	5300.	980.0	5360.	982.0	5690.		
н 3.0	964.3	4942.	5103.						
X1 4.0	18	4950.	5045.	300.	280.	240.			
GR 1000.	4775.	991.3	4875.	988.1	4931.		4941.	981.7	4950.
						981.6			
GR 975.4	4961.	972.9	4975.	970.6	5004.	968.3	5015.	969.2	5025.
GR 969.4	5040.	981.2	5045.	981.2	5075.	985.7	5082.	985.9	5100.
GR 980.0	5270.	982.0	5330.	982.0	5700.				
н 4.0	968.3	4950.	5047.						
		4950.	5047.						
		<b>E 0 0 0</b>							
X1 6.2	17	5000.	5130.	405.	350.	474.			
X1 6.2 X3 10	17	5000.	5130.	405.	350.	474.			
X3 10							4940.	987.4	5000.
X3 10 GR 994.0	4700.	990.0	4720.	986.0	4750.	986.0	4940.	987.4 974 0	5000.
X3 10 GR 994.0 GR 983.1	4700. 5000.	990.0 979.0	4720. 5016.	986.0 972.0	4750. 5032.	986.0 972.0	5092.	974.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0	4700. 5000. 5109.	990.0 979.0 982.7	4720. 5016. 5126.	986.0	4750.	986.0			
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0	4700. 5000. 5109. 5830.	990.0 979.0	4720. 5016. 5126. 5900.	986.0 972.0	4750. 5032.	986.0 972.0	5092.	974.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0	4700. 5000. 5109.	990.0 979.0 982.7	4720. 5016. 5126.	986.0 972.0	4750. 5032.	986.0 972.0	5092.	974.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2	4700. 5000. 5109. 5830.	990.0 979.0 982.7 982.0	4720. 5016. 5126. 5900.	986.0 972.0	4750. 5032.	986.0 972.0	5092.	974.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ	4700. 5000. 5109. 5830.	990.0 979.0 982.7 982.0 5000.	4720. 5016. 5126. 5900. 5130.	986.0 972.0 987.5	4750. 5032. 5130.	986.0 972.0 986.0	5092. 5210.	974.0 980.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b>	4700. 5000. 5109. 5830.	990.0 979.0 982.7 982.0 5000.	4720. 5016. 5126. 5900. 5130.	986.0 972.0 987.5	4750. 5032. 5130.	986.0 972.0	5092. 5210.	974.0 980.0	5100.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ \$TRIB CP 3	4700. 5000. 5109. 5830. 972.0	990.0 979.0 982.7 982.0 5000.	4720. 5016. 5126. 5900. 5130.	986.0 972.0 987.5 <b>METRY,</b>	4750. 5032. 5130.	986.0 972.0 986.0 <b>3 CONTRO</b>	5092. 5210.	974.0 980.0 <b>3</b>	5100. 5420.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ \$TRIB CP 3 T1 E	4700. 5000. 5109. 5830. 972.0	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b>	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI	986.0 972.0 987.5 <b>METRY,</b> VER Proj	4750. 5032. 5130. SEGMENT ect - BE	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK	5092. 5210.	974.0 980.0 <b>3</b> um Segmen	5100. 5420.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ \$TRIB CP 3 T1 E	4700. 5000. 5109. 5830. 972.0	990.0 979.0 982.7 982.0 5000.	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI	986.0 972.0 987.5 <b>METRY,</b> VER Proj	4750. 5032. 5130. SEGMENT ect - BE	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM	5092. 5210. • <b>POINT</b> • Streat OF SILVE	974.0 980.0 <b>3</b> am Segmen ER CREEK	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TH	986.0 972.0 987.5 <b>METRY,</b> WER Proj E ZUMBRC	4750. 5032. 5130. SEGMENT ect - BE NIVER (	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM	5092. 5210. • <b>POINT</b> • Streat OF SILVE	974.0 980.0 <b>3</b> um Segmen	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 <b>B</b> T2 <b>B</b> T2 <b>B</b> T3 <b>B</b>	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS A BEAR CREF	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 3K GEOMET	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TH RY - STR	986.0 972.0 987.5 METRY, WER Proj E ZUMBRC EAM SEGM	4750. 5032. 5130. SEGMENT ect - BE NIVER (	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM	5092. 5210. • <b>POINT</b> • Streat OF SILVE	974.0 980.0 <b>3</b> am Segmen ER CREEK	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 976.0 H 6.2 EJ <b>\$TRIB</b> CP 3 T1 E T2 E T3 E NC .090	4700. 5000. 5109. 5830. 972.0 BEAR IS 2 BEAR IS 2 BEAR CREE .090	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 5K GEOMET .046	4720. 5016. 5126. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC EAM SEGM .5	4750. 5032. 5130. SEGMENT ect - BE RIVER U HENT 3	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa	5092. 5210. • <b>POINT</b> • Streat OF SILVE	974.0 980.0 <b>3</b> am Segmen ER CREEK	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 F T2 F T3 F NC .090 X1 1.0	4700. 5000. 5109. 5830. 972.0 BEAR IS & BEAR IS & BEAR CREH .090 19	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA SK GEOMET .046 10115.	4720. 5016. 5126. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250.	986.0 972.0 987.5 <b>METRY,</b> VER Proj LE ZUMBRC LEAM SEGM .5 0.	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U ENT 3 0.	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM ** Exa 0.	5092. 5210. DE POINT - Strea OF SILVE mple Pro	974.0 980.0 3 am Segmen SR CREEK oblem 6 *	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0	4700. 5000. 5109. 5830. 972.0 BEAR IS 2 BEAR IS 2 BEAR CREH .090 19 9020.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 6K GEOMET .046 10115. 990.0	4720. 5016. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420.	986.0 972.0 987.5 <b>DMETRY,</b> VER Proj E ZUMBRC EAM SEGM .5 0. 988.0	4750. 5032. 5130. SEGMENT ect - BE RIVER U ENT 3 0. 9550.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0	5092. 5210. DE POINT - Streat OF SILVE mple Pro 9780.	974.0 980.0 3 am Segmen SR CREEK oblem 6 * 985.3	5100. 5420. t 3 *
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 F T2 F T3 F NC .090 X1 1.0	4700. 5000. 5109. 5830. 972.0 BEAR IS & BEAR IS & BEAR CREH .090 19	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA SK GEOMET .046 10115.	4720. 5016. 5126. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250.	986.0 972.0 987.5 <b>METRY,</b> VER Proj LE ZUMBRC LEAM SEGM .5 0.	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U ENT 3 0.	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM ** Exa 0.	5092. 5210. DE POINT - Strea OF SILVE mple Pro	974.0 980.0 3 am Segmen SR CREEK oblem 6 *	5100. 5420. t 3
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0	4700. 5000. 5109. 5830. 972.0 BEAR IS 2 BEAR IS 2 BEAR CREH .090 19 9020.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 6K GEOMET .046 10115. 990.0	4720. 5016. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137.	986.0 972.0 987.5 OMETRY, VVER Proj E ZUMBRC EAM SEGM .5 0. 988.0 977.2	4750. 5032. 5130. SEGMENT ect - BE NIVER U ENT 3 0. 9550. 10147.	986.0 972.0 986.0 3 CONTRO BAR CREEK JPSTREAM ** Exa 0. 994.0 977.0	5092. 5210. <b>DE POINT</b> - Streat OF SILVE mple Pro 9780. 10157.	974.0 980.0 3 am Segmen SR CREEK oblem 6 * 985.3	5100. 5420. t 3 * 10055. 10200.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> CP 3 T1 5 T2 F T3 F NC .090 X1 1.0 GR 985.0 GR 985.0 GR 978.2	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 4 BEAR CREF .090 19 9020. 10115. 10209.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 5 GEOMET .046 10115. 990.0 978.18 981.6	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216.	986.0 972.0 987.5 <b>DMETRY,</b> UVER Proj IE ZUMBRC EAM SEGM .5 0. 988.0 977.2 982.8	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U HENT 3 0. 9550. 10147. 10225.	986.0 972.0 986.0 3 CONTRO SAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7	5092. 5210. <b>L POINT</b> - Strea oF SILVE mple Pro 9780. 10157. 10250.	974.0 980.0 3 SR CREEK Sblem 6 * 985.3 977.1	5100. 5420. t 3 *
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 978.2 GR 987.1	4700. 5000. 5109. 5830. 972.0 82AMPLE 6 BEAR IS 4 BEAR CREF .090 19 9020. 10115.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA K GEOMET .046 10115. 990.0 978.18 981.6 988.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380.	986.0 972.0 987.5 OMETRY, VVER Proj E ZUMBRC EAM SEGM .5 0. 988.0 977.2	4750. 5032. 5130. SEGMENT ect - BE NIVER U ENT 3 0. 9550. 10147.	986.0 972.0 986.0 3 CONTRO BAR CREEK JPSTREAM ** Exa 0. 994.0 977.0	5092. 5210. <b>DE POINT</b> - Streat OF SILVE mple Pro 9780. 10157.	974.0 980.0 3 SR CREEK Sblem 6 * 985.3 977.1	5100. 5420. t 3 * 10055. 10200.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 F T2 F T3 F NC .090 X1 1.0 GR 996.0 GR 985.0 GR 987.1 H 1.0	4700. 5000. 5109. 5830. 972.0 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115.	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275.	986.0 972.0 987.5 WETRY, VER Proj E ZUMBRO E ZUMBRO E ZUMBRO .5 0. 988.0 977.2 982.8 990.0	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0	5092. 5210. <b>L POINT</b> - Strea oF SILVE mple Pro 9780. 10157. 10250.	974.0 980.0 3 SR CREEK Sblem 6 * 985.3 977.1	5100. 5420. t 3 * 10055. 10200.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 978.2 GR 987.1	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 4 BEAR CREF .090 19 9020. 10115. 10209.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA K GEOMET .046 10115. 990.0 978.18 981.6 988.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380.	986.0 972.0 987.5 <b>DMETRY,</b> UVER Proj IE ZUMBRC EAM SEGM .5 0. 988.0 977.2 982.8	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U HENT 3 0. 9550. 10147. 10225.	986.0 972.0 986.0 3 CONTRO SAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7	5092. 5210. <b>L POINT</b> - Strea oF SILVE mple Pro 9780. 10157. 10250.	974.0 980.0 3 SR CREEK Sblem 6 * 985.3 977.1	5100. 5420. t 3 * 10055. 10200.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 F T2 F T3 F NC .090 X1 1.0 GR 996.0 GR 985.0 GR 987.1 H 1.0	4700. 5000. 5109. 5830. 972.0 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115.	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275.	986.0 972.0 987.5 WETRY, VER Proj E ZUMBRO E ZUMBRO E ZUMBRO .5 0. 988.0 977.2 982.8 990.0	4750. 5032. 5130. SEGMENT ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260.	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890.	974.0 980.0 3 SR CREEK Oblem 6 * 985.3 977.1	5100. 5420. t 3 * 10055. 10200.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2	4700. 5000. 5109. 5830. 972.0 82AR JS 2 82AR CREF .090 19 9020. 10115. 10209. 10300. 21 600.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA EK GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790.	986.0 972.0 987.5 <b>DMETRY,</b> VVER Proj E ZUMBRC EAM SEGM .5 0. 988.0 977.2 982.8 990.0 210. 990.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE O RIVER U ENT 3 0. 9550. 10147. 10225. 10560. 310. 970.	986.0 972.0 986.0 3 CONTRO BAR CREEK DPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0	5100. 5420. t 3 * 10055. 10200. 10275. 972.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 978.2 GR 985.0 GR 977.1 H 1.0 X1 2.1 GR 995.2 GR 989.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 1000.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 1629. 1080.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC 5 0. 988.0 977.2 988.0 977.2 982.8 990.0 210. 990.0 988.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290.	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM <b>** Exa</b> 0. 994.0 977.0 984.7 1000.0 260. 990.0	5092. 5210. <b>L POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 985.9 990.0 990.8	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 F T2 F T3 F T2 F T3 F NC .090 X1 1.0 GR 996.0 GR 985.0 GR 987.1 H 1.0 X1 2.1 GR 987.0 GR 989.0 GR 989.8	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 1493.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 986.7	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>D POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP 3</b> T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 978.2 GR 985.0 GR 977.1 H 1.0 X1 2.1 GR 995.2 GR 989.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 1000.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 1629. 1080.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC 5 0. 988.0 977.2 988.0 977.2 982.8 990.0 210. 990.0 988.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290.	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM <b>** Exa</b> 0. 994.0 977.0 984.7 1000.0 260. 990.0	5092. 5210. <b>L POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 985.9 990.0 990.8	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E T3 E T3 C 996.0 GR 985.0 GR 985.0 GR 985.0 GR 985.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.8 GR 989.8 GR 990.7	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 1493. 1650.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 986.7	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>D POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0 GR 985.0 GR 985.2 GR 987.2 GR 985.2 GR 989.2 GR 989.8 GR 990.7 GR 1002.	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 1493.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 988.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>D POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E T3 E T3 E T3 E T3 E T3 E T3 E T3	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 1493. 1650. 2580.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA K GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 986.7 988.0 1511.	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>D POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>STRIB</b> <b>CP</b> 3 T1 E T2 E T3 E T3 E T3 E T1 0 GR 995.0 GR 978.2 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.0 GR 989.8 GR 990.7 GR 989.8 GR 990.7 H 2.1	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 1493. 1650. 2580.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 988.0	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>D POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E T3 E T3 E T3 E T3 E T3 E T3 E T3	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 10493. 1650. 2580. CREEK - 7	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 988.0 1511. <b>IRIBUTARY</b>	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>DE POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>STRIB</b> <b>CP</b> 3 T1 E T2 E T3 E T3 E T3 E T1 0 GR 995.0 GR 978.2 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.0 GR 989.8 GR 990.7 GR 989.8 GR 990.7 H 2.1	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 1493. 1650. 2580.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA K GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 986.7 988.0 1511.	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629.	986.0 972.0 987.5 <b>METRY,</b> VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 988.0 977.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 984.7 1000.0 984.7	5092. 5210. <b>DE POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629.	974.0 980.0 3 mm Segmen SR CREEK bblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> CP 3 T1 F T2 F T3 F T2 F T3 C P T3 C P S CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10115. 10209. 10300. 21 600. 1090. 10300. 21 600. 1090. 1050. 2580. CREEK - 7 30	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA SK GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 10115. 1511. <b>RIBUTARY</b> 10537.	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660.	986.0 972.0 987.5 <b>WETRY,</b> VER Proj E ZUMBRC EAM SEGM 5 0. 988.0 977.2 982.8 990.0 210. 990.0 210. 990.0 988.0 977.3 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE NIVER U ENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 990.0 990.0 990.0 990.0 990.0 990.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100.	974.0 980.0 3 SR CREEK Oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.0 GR 989.8 GR 990.7 GR 1002. H 2.1 <b>TAKEO C</b> QT 4 X1 4.0 GR 998.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 21 600. 10300. 221 600. 10300. 2380. CREEK - 7 30 8370.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 986.7 988.0 1511. <b>IRIBUTARY</b> 10537. 997.0	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 988.0 977.3 992.0 1053. 998.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000. 533. 9100.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 977.3 994.0	5092. 5210. <b>L POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>STRIB</b> CP 3 T1 E T2 E T3 F T2 E T3 F NC .090 X1 1.0 GR 995.0 GR 978.2 GR 985.0 GR 978.2 GR 985.0 GR 978.2 GR 985.0 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.0 GR 985.0 GR 985.0 GR 998.0 GR 998.0 GR 998.0 GR 998.0 GR 998.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 221 600. 10300. 2380. CREEK - 7 30 8370. 9560.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 988.0 988.0 988.0 1511. <b>TRIBUTARY</b> 10537. 997.0 996.0	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860. 9640.	986.0 972.0 987.5 METRY, VER Proj E ZUMERC 5 0. 988.0 977.2 982.8 990.0 210. 990.0 210. 990.0 977.3 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000. 533. 9100. 9900.	986.0 972.0 986.0 <b>3 CONTRO</b> EAR CREEK JPSTREAM <b>** Exa</b> 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 977.3 994.0 708. 994.5 992.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350. 9980.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0 998.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480. 10400.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.0 GR 989.8 GR 990.7 GR 1002. H 2.1 <b>TAKEO C</b> QT 4 X1 4.0 GR 998.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 21 600. 10300. 221 600. 10300. 2380. CREEK - 7 30 8370.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 986.7 988.0 1511. <b>IRIBUTARY</b> 10537. 997.0	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 988.0 977.3 992.0 1053. 998.3	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000. 533. 9100.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 977.3 994.0	5092. 5210. <b>L POINT</b> - Stread OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>STRIB</b> CP 3 T1 E T2 E T3 F T2 E T3 F NC .090 X1 1.0 GR 995.0 GR 978.2 GR 985.0 GR 978.2 GR 985.0 GR 978.2 GR 985.0 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.2 GR 985.0 GR 985.0 GR 985.0 GR 985.0 GR 998.0 GR 998.0 GR 998.0 GR 998.0 GR 998.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 221 600. 10300. 2380. CREEK - 7 30 8370. 9560.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 10115. 1511. 988.0 1511. <b>TRIBUTARY</b> 10537. 995.2	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR 0420. 10137. 10216. 10380. 10275. 1629. 790. 1840. 1629. 10660. 8860. 9640. 10506.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC EAM SEGM 988.0 977.2 982.8 990.0 210. 990.0 210. 990.0 210. 990.0 210. 990.0 210. 990.0 210. 990.0 210. 998.0 977.3 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000. 533. 9100. 9900.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 997.3 994.0 777.3 994.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350. 9980.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0 998.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480. 10400.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> CP 3 T1 E T2 E T3 E T3 E T3 E T3 E T3 E S7 CP 3 T1 1 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 10300. 21 600. 10493. 1650. 2580. CREEK - 7 30 8370. 9560. 1025. 10561.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 10115. 1511. 992.0 988.0 10115. 1511. 992.0 988.0 10537. 997.0 997.0 997.0 995.2 980.9	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860. 9640. 10570.	986.0 972.0 987.5 METRY, VER Proj E ZUMERC EAM SEGM 988.0 977.2 982.8 990.0 210. 990.0 210. 990.0 210. 990.0 988.0 977.3 992.0 1053. 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1516. 2000. 533. 9100. 9900. 9900. 9900. 10523. 10585.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 990.0 990.0 994.0 777.3 994.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350. 9980. 10537. 10595.	974.0 980.0 3 sm Segmen SR CREEK Oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0 996.0 998.0 996.0 993.9 986.0 993.9	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480. 10400. 10550. 10600.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> <b>CP</b> 3 T1 E T2 E T3 E NC .090 X1 1.0 GR 996.0 GR 985.0 GR 978.2 GR 987.1 H 1.0 X1 2.1 GR 995.2 GR 989.0 GR 989.8 GR 990.7 GR 1002. H 2.1 <b>TAKEO C</b> QT 4 X1 4.0 GR 998.0 GR 998.0	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR CREF .090 19 9020. 10115. 10209. 10300. 21 600. 10300. 21 600. 10300. 221 600. 10300. 2380. 2580. 208.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. ZA A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 988.0 10115. 1511. 992.0 988.0 10115. 1511. 992.0 988.0 1511. <b>TRIBUTARY</b> 10537. 997.0 996.0 995.2 980.9 980.8	4720. 5016. 5126. 5900. 5130. <b>REEK GEO</b> UMBRO RI RY OF TR RY - STR RY - STR .3 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860. 9640. 10506. 10570. 10636.	986.0 972.0 987.5 METRY, VER Proj E ZUMBRC 5 0. 988.0 977.2 982.8 990.0 210. 988.0 977.3 992.0 210. 990.0 988.0 977.3 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U ENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1290. 1516. 2000. 533. 9100. 9900. 10523. 10523.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 977.3 994.0 708. 994.5 994.5 994.5 992.0 986.3 978.3 978.3	5092. 5210. <b>L POINT</b> - Stread OF SILVE mple Prod 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350. 9980. 10537. 10595. 10660.	974.0 980.0 3 m Segmen SR CREEK oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0 996.0 993.9 986.0 993.9 986.0 993.9 986.0	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480. 10400. 10400. 10550. 10600. 10675.
X3 10 GR 994.0 GR 983.1 GR 976.0 GR 980.0 H 6.2 EJ <b>\$TRIB</b> CP 3 T1 E T2 E T3 E T3 E T3 E T3 E T3 E S7 CP 3 T1 1 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3 CP 3	4700. 5000. 5109. 5830. 972.0 EXAMPLE 6 BEAR IS 2 BEAR CREH .090 19 9020. 10115. 10209. 10300. 21 600. 1000. 10300. 21 600. 10493. 1650. 2580. CREEK - 7 30 8370. 9560. 1025. 10561.	990.0 979.0 982.7 982.0 5000. <b>BEAR C</b> 5 Cont. Z A TRIBUTA 8K GEOMET .046 10115. 990.0 978.18 981.6 988.0 10115. 1511. 992.0 988.0 10115. 1511. 992.0 988.0 10115. 1511. 992.0 988.0 10537. 997.0 997.0 995.2 980.9	4720. 5016. 5126. 5900. 5130. <b>CREEK GEO</b> UMBRO RI RY OF TH RY - STR RY - STR 10250. 9420. 10137. 10216. 10380. 10275. 1629. 790. 1080. 1511. 1840. 1629. 10660. 8860. 9640. 10570.	986.0 972.0 987.5 METRY, VER Proj E ZUMERC EAM SEGM 988.0 977.2 982.8 990.0 210. 990.0 210. 990.0 210. 990.0 988.0 977.3 992.0 1053. 992.0	4750. 5032. 5130. <b>SEGMENT</b> ect - BE 0 RIVER U IENT 3 0. 9550. 10147. 10225. 10560. 310. 970. 1516. 2000. 533. 9100. 9900. 9900. 9900. 10523. 10585.	986.0 972.0 986.0 3 CONTRO EAR CREEK JPSTREAM ** Exa 0. 994.0 977.0 984.7 1000.0 260. 990.0 990.0 990.0 990.0 994.0 777.3 994.0	5092. 5210. <b>L POINT</b> - Strea OF SILVE mple Pro 9780. 10157. 10250. 10890. 971. 1450. 1629. 2100. 9350. 9980. 10537. 10595.	974.0 980.0 3 sm Segmen SR CREEK Oblem 6 * 985.3 977.1 985.9 990.0 990.8 986.7 998.0 996.0 998.0 996.0 993.9 986.0 993.9	5100. 5420. t 3 * 10055. 10200. 10275. 972. 1490. 1629. 2450. 9480. 10400. 10550. 10600.

н 4.0 978.3 10537. 10660. 6.0 10100. 330. 570 29 10222. 665. X1 х3 10 GR 998.0 8500. 997.1 1000.0 8900. 1002.0 9110. 1001.0 8650. 9400. GR 999.8 9525. 1002.0 9610. 1002.0 9730. 995.16 10000. 1000.0 9840. GR 995.6 10100. 994.2 10109. 990.8 10125. 987.3 10140. 985.8 10150. GR 986.2 10161. 985.24 10162. 983.3 10172. 983.3 10182. 982.8 10202. GR985.24 10210. 992.0 10222. 992.2 10250. 993.5 10300. 994.2 10325. GR 1000. 997.8 10770. 10470. 10640. 998.0 1004.6 10910. 6.0 982.7 10100.0 10325.0 н ЕJ TAKEO CREEK GEOMETRY, SEGMENT 4, CONTROL POINT 4 **\$TRIB** ĊP 4 T1 . EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 TAKEO CREEK IS A TRIBUTARY OF BEAR CREEK UPSTREAM OF SECTION 2.1 т2 TAKEO CREEK GEOMETRY - STREAM SEGMENT 4 т3 \*\* Example Problem 6 \*\* .090 NC .090 .046 .3 .5 10115. 10250. Ο. X1 1.0 19 Ο. 0 GR 996.0 9020. 990.0 988.0 9550. 994.0 9780. 985.3 10055. 9420. GR 985.0 10115. 977.2 10157. 978.18 10137. 10147. 977.0 977.1 10200. GR 978.2 10209. 981.6 10216. 982.8 10225. 984.7 10250. 985.9 10275. GR 987.1 10300. 988.0 10380. 990.0 10560. 1000.0 10890. н 1.0 10115. 10275. 2.1 21 210. X1 1511. 1629. 310. 260. 2. GR 995.2 600. 992.0 790. 990.0 970. 990.0 971. 990.0 972. GR 989.0 1000. 988.0 1080. 988.0 1290. 990.0 1450. 990.8 1490. GR 989.8 977.3 1493. 986.7 1511. 1516. 977.3 1629. 986.7 1629. GR 990.7 1650. 988.0 1840. 992.0 2000. 994.0 2100. 998.0 2450. GR1002.0 2580. н 2.1 1511.0 1629.0 4.0 **X**1 30 10537. 10660. 1053. 533. 708. 2. GR 998.0 8370. 997.0 8860. 998.3 9100. 994.5 9350. 996.0 9480. GR 999.0 9560. 996.0 9640. 994.0 9900. 992.0 9980. 993.9 10400. GR 994.0 10425. 995.2 10506. 993.1 10523. 10537. 10550. 986.3 986.0 GR 985.8 10561. 980. 10570. 978.7 10585. 978.3 10595. 978.4 10600. GR 980.5 10625. 980.8 10636. 991.77 10657. 992.3 10660. 991.3 10675. GR 991.4 10700. 998.0 10970. 998.0 11120. 1000.0 11290. 1006.0 11400.0 4.0 10537. 10660. н 978.3 6.0 29 10100. 10222. 330. 570. 665. 2. X1 Х3 10 GR 998.0 8500. 997.1 8650. 1000.0 8900. 1002.0 9110. 1001.0 9400. GR 999.8 9525. 1002.0 9610. 1002.0 9730. 1000.0 9840. 995.16 10000. GR 995.6 10100. 994.2 990.8 10109. 10125. 987.3 10140. 985.8 10150. GR 986.2 10161. 985.24 10162. 983.3 10172. 983.3 10182. 982.8 10202. GR985.24 10210. 992.0 10222. 992.2 993.5 10250. 10300. 994.2 10325. GR 1000. 10470. 997.8 998.0 10770. 10640. 1004.6 10910. 6.0 982.7 10100. 10325. н ЕJ **T4** T5 South Fork, Zumbro River - Stream Segment 1 LOAD CURVE FROM GAGE DATA. \*\* Example Problem 6 \*\* т6 BED GRADATIONS FROM FIELD SAMPLES. т7 Use full range of sands and gravels т8 SEDIMENT TRANSPORT BY Yang's STREAM POWER [ref ASCE JOURNAL (YANG 1971)] Ι1 5 **I4** SAND 4 10 1 15 .5 .25 1.0 .5 .25 .5 0 5800 90000 гo 1 50 1000 LT TOTAL .0110 1.5 4500. 400000 320  $\mathbf{LF}$ VFS .119 .119 .498 .511 .582  $\mathbf{LF}$ FS .280 .328 .328 .331 .306  $\mathbf{LF}$ MS .553 .154 .553 .156 .110 LFCS .000 .000 .011 .016 .020 vcs  $\mathbf{LF}$ .000 .000 .004 .008 .005 VFG .000  $\mathbf{LF}$ .000 .000 .004 .002 LF FG .000 .000 .000 .001 .001 MG .000 .000 .000 LF .000 .000 CG .000 .000 LF .000 .000 .000 VCG .000 LF . 0 .0 .000 .000 PF EXAMP 1.0 1.0 95.0 4.0 32.0 16.0 96.5 8.0 91.0 PFC 2.0 85.0 1.0 73.0 .5 37.0 .25 8.0 .125 1.0 PFC.0625 0.0 PF EXAMP 32.0 1.0 64.0 32.0 99.5 16.0 99.0 8.0 98.5 PFC 4.0 96.0 2.0 93.5 1.0 83.0 .50 45.5 .250 8.0 PFC .125 1.0 .0625 0.0 PF EXAMP 32.0 97 0 94.0 8.0 94.0 58.0 1.0 64.0 16.0 PFC 4.0 90.0 2.0 79.0 1.0 56.0 .50 4.0 .125 0.0 \$LOCAL 100 1000 10000 LO 1 LT TOTAL .0040 30000 10 500 VFS :664  $\mathbf{LF}$ .664 .015 .198 FS  $\mathbf{LF}$ .207 .207 .245 .181  $\mathbf{LF}$ MS .086 .086 .605 .107 cs  $\mathbf{LF}$ .031 .031 .052 .098

	1700				100					
LF	VCS	.008	.008	.039	.127					
LF	VFG		.0030	.0200	.1160					
LF	FG	.0010	.0010	.0110	.0910					
LF	MG	.0000	.0000	.0110	.0530					
$\mathbf{LF}$	CG	.0000	.0000	.0000	.0220					
$\mathbf{LF}$	VCG	.0000	.0000	.0000	.0060					
\$TR:	TB									
T4	C	ASCADE CH	REEK ~ S	TREAM SE	GMENT 2	** Ex	(ample Pr	oblem 6	**	
Т5	F	IRST TRIE	3 ON Zuml	oro Rive	r.		•			
Т6	L	OAD CURVE	FROM G	AGE DATA	. BED G	RADATIONS	FROM FIE	LD SAMPI	JES.	
Т7	U	se full r	ange of	sands a	nd grave	ls - Yang'	s Stream	Power.		
т8		umbro Riv			-	-				
LQL		1	100	1000	10000					
LTL	TOTAL	.0040	10	500	30000					
LFL	VFS	.664	.664	.015	.198					
LFL	FS	.207	.207	.245	.181					
LFL	MS	.086	.086	.605	.107					
LFL	CS	.031	.031	.052	.098					
LFL	vcs	.008	.008	.039	.127					
LFL	VFG	.0030	.0030	.0200	.1160					
LFL	FG									
		.0010	.0010	.0110	.0910					
LFL	MG	.0000	.0000	.0110	.0530					
LFL	CG	.0000	.0000	.0000	.0220					
LFL	VCG	.0000	.0000	.0000	.0060					
PF	CASC	1.0	1.0	64.	32.	94.	16.	85.	8.	70.
PFC	4.	50.	2.	32.	1.	18.	.5	9.	.25	5.
PFC	.125	2.5	.0625	Ο.						
\$TR	τB									
T4	B	EAR CREEK	( - Stre	am Segme	nt 3	** Examp	ole Probl	em 6 **		
<b>T</b> 5	SI	ECOND UPS	TREAM TI	RIB ON Z	umbro Ri	ver.				
Т6	$\Gamma$	DAD CURVE	FROM G	AGE DATA	. BED G	RADATIONS	FROM FIE	LD SAMPI	LES	
T7	U	se full r	ange of	sands a	nd grave	ls. Yang'	s Stream	Power.		
т8	Zı	umbro Riv	er Proje	ect						
LQL		1	100	500	1000	30000				
LTLI	TAL	.0020	30.0	500.	1200	22500				
LFL	VFS	.201	.201	.078	.078	.137				
LFL	FS	.342	.342	.172	.175	.218				
LFL	MS	.451	.451	.454	.601	.476				
LFL	CS	.001	.001	.197	.142	.158				
LFL	vcs	.000	.000	.000		.008				
					.003					
LFL	VFG	.0000	.0000	.0000	.0000	.0020				
LFL	FG	.0000	.000	.0000	.0000	.0010				
LFL	MG	.0000	.000	.0000	.0000	.0000				
LFL	CG	.0000	.000	.0000	.0000	.0000				
LFL	VCG	.0000	.000	.0000	.0000	.0000				
PF	BEAR	1.	1.	4.	2.	99.5	1.	99.	.5	93.
PFC	.25	27	.125	3.	.0625	0.				
PF	BEAR	6.	1.	4.	2.	99.5	1.	99.	.5	89.5
PFC	.25	22.5	.125	2.5	.0625	0.				
\$TR	CB									
Ť4	T/	AKEO CREE	K - Str	eam Seam	ent 4	** Exan	nple Prob	]em 6 *	*	
T5		IRST TRIB								
Т6	L	DAD CURVE	IS FROM	GAGE D	ATA. BED	GRADATION	IS FROM F	IELD SAN	APLES.	
<b>T7</b>	U	se full r	ange of	sands a	nd grave	ls. Yang'	s Stream	n Power.		
тв		umbro Riv	-		5					
LQL		1	100	500	1000	30000				
	TOTAL	.0020	30.0	500.	1200	22500				
LFL		.201	.201	.078	.078	.137				
LFL	FS	.342	.342	.172	.175	.218				
LFL	MS	.342	.342	.172	.601	.218				
LFL	CS	.451	.451		.142	.476				
	vcs			.197						
LFL		.000	.000	.000	.003	.008				
LFL	VFG	.0000	.0000	.0000	.0000	.0020				
LFL	FG	.0000	.000	.0000	.0000	.0010				
LFL	MG	.0000	.000	.0000	.0000	.0000				
LFL	CG	.0000	.000	.0000	.0000	.0000				
LFL		.0000	.000	.0000	.0000	.0000	_		_	
	TAKEO	1.	1.	4.	2.	99.5	1.	99.	.5	93.
PFC	.25	27.	.125	3.	.0625	0.				
	PAKEO	6.	1.	4.	2.	99.5	1.	99.	.5	89.5
PFC	.25	22.5	.125	2.5	.0625	0.				
ŞHYI	2									
*	AB	FLOW 1	= BASE	FLOW OF	750 CFS					
Q	750	29	61	128	90					
Ř	956.	970.								
т	65	70	72	67	73					
ŵ	2			• ·						
\$PR7										
		River, Se	ctions	35.1 and	55.0					
CP		1		unu						
PS	35.1	55.0								

```
Takeo Creek, Section 6.0
CP
                4
PS
     6.0
END
*
    AC
            FLOW 2 = 50 DAYS AT BANK FULL DISCHARGE
             150
Q 2500.0
                      300
                               650
                                       450
             978.
R
    965.
х
*
                5
                       50
            FLOW 3 = NEAR BANK FULL DISCHARGE
     Α
Q
   1250.
               78
                      150
                              340.
                                       250
R
W
    960.
             975.
      1.
            FLOW 4 = BASE FLOW OF 500 CFS
*
     в
Q
R
     500
               29
                       61
                               128
                                        90
             973.
    955.
w
       2
$$END
```

### 6.6.5 Network Output

The output produced for a network system is very similar to that of a single stream problem. The output for Example Problem 6 is shown in Table 6-6b. The geometric data is output (as entered) in increasing segment order. Sediment data are then given for the main stem, the local inflow (Silver Creek), and the tributaries. The user is advised to take advantage of the title (and comment) records to annotate the output file. The information from the T1 records is used throughout the output so they should contain the name of each stream segment.

The A-level hydrologic data are output in the sequence in which the backwater computation is performed. Segment 1 is calculated first, from downstream to upstream and the water surface elevation at each control point is printed. When segment 1 is complete, the backwater computations start at the downstream boundary of segment 2 using the water surface computed at control point 2 as the starting water surface. This process continues though the remainder of the tributaries in order.

The temperature in each stream segment changes as differing water temperatures enter from the tributaries and local inflows. For example, in time step 1, the inflow from Cascade Creek is 61 cfs at 72°F and the flow in the main stem below that confluence is 750 cfs at 65°F. Therefore, the flow in the main stem above the confluence is 689 cfs at 64.38°F (689  $\cdot$  64.38 + 61  $\cdot$  72 = 750  $\cdot$  65).

In previous examples it was noted that the sedimentation computations proceed from upstream to downstream, in reverse order from the hydraulic computations. In this example network system, this means that the sedimentation computations begin at the upstream boundary of segment 4, work downstream to the confluence with segment 3, then proceed to the upstream boundary of segment 3 and so on. Sediment output contains the same information previously discussed; identified primarily by cross section and segment.

Output can be limited to specified cross sections on any stream segment. As seen in the previous example problems, this is done via the **\$PRT**, **CP**, and **PN** records. The output level is governed by the output options on the \* record. For example, prior to time step 2, the **\$PRT** option was used to limit output to Sections 35.1 and 55.0 on the main river segment and Section No. 6.0 on segment 4, Takeo Creek; A-level hydraulic and C-level sediment output was requested for time step 2 on the \* record.

#### Table 6-6b Example Problem 6 - Output Network System

\*\*\*\*\*\* SCOUR AND DEPOSITION IN RIVERS AND RESERVOIRS \* Version: 4.1.00 - AUGUST 1993 \* INPUT FILE: example6.DAT \* OUTPUT FILE: example6.OUT \* RUN DATE: 31 AUG 93 RUN TIME: 18:54:00 \* \* U.S. ARMY CORPS OF ENGINEERS \* HYDROLOGIC ENGINEERING CENTER \* 609 SECOND STREET \* DAVIS, CALIFORNIA 95616-4687 \* (916) 756-1104 \*\*\*\*\*\*\*\*\*\* х х XXXXXXXX XXXXX XXXXX x x x х х х х х x x x х XXXXXXX XXXXX XXXXXX XXXX х x х х х x х x х х x x x x X XXXXXXX XXXXX XXXXX х \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* MAXIMUM LIMITS FOR THIS VERSION ARE: 10 Stream Segments (Main Stem + Tributaries) 150 Cross Sections 100 Elevation/Station Points per Cross Section 20 Grain Sizes 10 Control Points \*\*\*\*\*\* EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1 CASCADE & BEAR: TRIBS OF ZUMBRO; TAKEO: TRIB OF BEAR; SILVER: LOCAL ZUMBRO RIVER PROJECT - Dendritic System \*\* Example Problem 6 \*\* Τ1 т2 т3 . Left Channel Right 0.1000 0.0400 0.1000 N values... Contraction Expansion 1.1000 0.7000 SECTION NO. 1.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. N-Values vs. Elevation Table Left Overbank Channel 0.0450 Right Overbank 966. 0.0800 0.1000 0.1100 966. 966. 0.0640 0.1300 989. 989. 982. 0.0000 ο. 0.0000 0.1200 0. 989. SECTION NO. 15.000 ...Left Encroachment defined at station 10700.000 at elevation 961.000 ...Right Encroachment defined at station 11000.000 at elevation 970.000 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. TRIBUTARY ENTRY POINT 1 occurs upstream from Section No. 15.000 at Control Point # 2 Channel Right 0.0500 0.1000 N values... Left Contraction Expansion 0.1000 1,1000 0.7000 32.000 SECTION NO. ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 33.000 ...Limit CONVEXANCE to 250.000 ft. centered about midpoint of channel. ...DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 33.300 ...Adjust Section WIDTH to 95.00% of original. ...Adjust Section ELEVATIONS by 1.490 ft. ...Limit CONVEYANCE to 250.000 ft. centered about midpoint of channel. ...DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 33.900 ...Adjust Section WIDTH to 95.00% of original. Section No. ...Adjust Section WIDTH to 95.00% or original. ...Adjust Section ELEVATIONS by 1.650 ft. ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 1757.500 2042.500 Treffective Elevation 986.060 986.150 ... DEPTH of the Bed Sediment Control Volume = SECTION NO SECTION NO. 35.000 ...Internal Boundary Condition Water Surface Elevation will be read from R-RECORD, Field 2 Water Survect License and Head Loss = 0.000 ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 9894.000 10245.000 Ineffective Elevation 984.700 984.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. N values... Left Channel Right 0.0600 0.0450 0.0600 Contraction Expansion 1.1000 0.7000 SECTION NO. 42.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft.

LOCAL INFLOW POINT 1 occurs upstream from Section No. 42.000 SECTION NO. 44.000 ...Limit CONVEYANCE between stations 9850.000 and 100 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. 9850.000 and 10200.000 SECTION NO. 53.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. TRIBUTARY ENTRY POINT 2 occurs upstream from Section No. 53.000 at Control Point # 3 SECTION NO. 55.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 58.000 ... DEPTH of the Bed Sediment Control Volume = 3 40 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 12 NO. OF INPUT DATA MESSAGES = 0 Τ1 EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 CASCADE IS A TRIBUTARY OF THE ZUMBRO RIVER DOWNSTREAM OF SILVER LAKE CASCADE CREEK GEOMETRY - STREAM SEGMENT 2 \*\* Example Problem 6 \*\* т2 Т3 Expansion N values... Left Channel Right 0.1200 0.0450 0.1200 Contraction 0.7000 1.1000 SECTION NO. 1.000 ... ELEVATION of Model Bottom = 949.800 ft. SECTION NO. 3.000 ...ELEVATION of Model Bottom = 964.300 ft. SECTION NO. 4.000 ...ELEVATION of Model Bottom = 968.300 ft. SECTION NO. 6.200 ... Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 5000.000 5130.000 Ineffective Elevation 987.400 987.500 ... ELEVATION of Model Bottom = 972.000 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 4 NO. OF INPUT DATA MESSAGES = 0 \_\_\_\_\_ EXAMPLE 6 Cont. ZUMBRO RIVER Project - BEAR CREEK - Stream Segment 3 T1 BEAR IS A TRIBUTARY OF THE ZUMBRO RIVER UPSTREAM OF SILVER CREEK BEAR CREEK GEOMETRY - STREAM SEGMENT 3 \*\* Example Problem 6 \* T2т3 Contraction N values... Left Channel Right 0.0900 0.0460 0.0900 Expansion 1.3000 0.5000 SECTION NO. 1.000 ...ELEVATION of Model Bottom = 967.000 ft. SECTION NO. 2.100 ...ELEVATION of Model Bottom = 967.300 ft. TRIBUTARY ENTRY POINT 1 occurs upstream from Section No. 2.100 at Control Point # 4 SECTION NO. 4.000 ...ELEVATION of Model Bottom = 978.300 ft. SECTION NO. 6.000 ...Ineffective Flow Area - Method 1 - Left Overbank Right Overbank Natural Levees at Station 10100.000 10222.000 Ineffective Elevation 995.600 992.000 ...ELEVATION of Model Bottom = 982.700 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 4 NO. OF INPUT DATA MESSAGES = 0 \_\_\_\_\_ EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 T1 TAKEO CREEK IS A TRIBUTARY OF BEAR CREEK UPSTREAM OF SECTION 2.1 TAKEO CREEK GEOMETRY - STREAM SEGMENT 4 \*\* Example Problem 6 т2 \*\* Example Problem 6 \*\* тз Contraction N values... Left Channel Right 0.0900 0.0460 0.0900 Expansion 1.3000 0.5000 SECTION NO. 1.000 ... Adjust Section ELEVATIONS by 2.000 ft. ...ELEVATION of Model Bottom = 969.000 ft. SECTION NO. 2.100 ... Adjust Section ELEVATIONS by 2.000 ft. ...ELEVATION of Model Bottom = 969.300 ft. SECTION NO. 4.000

... Adjust Section ELEVATIONS by 2.000 ft. ... ELEVATION of Model Bottom = 980.300 ft. SECTION NO. 6.000 Ineffective Elevation 997.600 994.000 ... ELEVATION of Model Bottom = 984.700 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT= 4 NO. OF INPUT DATA MESSAGES = 0 TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK= 24 END OF GEOMETRIC DATA Τ4 South Fork, Zumbro River - Stream Segment 1 \*\* Example Problem 6 \*\* т5 LOAD CURVE FROM GAGE DATA. BED GRADATIONS FROM FIELD SAMPLES. Use full range of sands and gravels T6 T7 T8 SEDIMENT TRANSPORT BY Yang's STREAM POWER [ref ASCE JOURNAL (YANG 1971)] EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1 CASCADE & BEAR: TRIBS OF ZUMBRO; TAKEO: TRIB OF BEAR; SILVER: LOCAL ZUMBRO RIVER PROJECT - Dendritic System \*\* Example Problem 6 \*\* SEDIMENT PROPERTIES AND PARAMETERS SPI IBG MNO SPGF ACGR NFALL 2 IBSHER 1.000 Τ1 5. 0 1 32.174 1 - - - - - -- - - -SANDS - BOULDERS ARE PRESENT MTC IASA LASA SPĠS UWDLB GSF BSAE PSI 14 2.650 0.667 0.500 30.000 93.000 4 1 10 USING TRANSPORT CAPACITY RELATIONSHIP # 4, YANG GRAIN SIZES UTILIZED (mean diameter - mm) ----------------VERY FINE SAND.... 0.088 VERY FINE GRAVEL.. 2.828 FINE SAND..... MEDIUM SAND..... COARSE SAND..... FINE GRAVEL..... 0.177 5.657 MEDIUM GRAVEL..... COARSE GRAVEL..... 0.354 0.707 11.314 22.627 VERY COARSE GRAVEL 45.255 VERY COARSE SAND.. 1.414 \_\_\_\_\_ ----- - -COEFFICIENTS FOR COMPUTATION SCHEME WERE SPECIFIED XIN ALC 500 0.250 DBI DBN 500 0.500 DBN XID IIBT UBN JSL 0.250 0.500 0.500 0.000 15 1.000 1 \_ \_ \_ \_ \_ - - - -- -- - - - - - -SEDIMENT LOAD TABLE FOR STREAM SEGMENT # LOAD BY GRAIN SIZE CLASS (tons/day) 50.0000 1000.00 90000.0 LO 1.00000 | 5800.00 ---- 
 VFS
 0.130900E-02
 0.178500
 159.360

 FS
 0.360800E-02
 0.492000
 105.920

 MS
 0.608300E-02
 0.829500
 49.9200

 CS
 0.100000E-19
 0.100000E-19
 3.52000

 VCS
 0.100000E-19
 0.100000E-19
 1.28000

 VFG
 0.100000E-19
 0.100000E-19
 1.20000E-19
 232800.  $\mathbf{LF}$ 2299.50 1377.00 112000. LF 693.000 LF 44000.0  $\mathbf{LF}$ 72.0000 8000.00  $\mathbf{LF}$ 36.0000 2000.00  $\mathbf{LF}$ 18.0000 800.000 0.100000E-19 0.100000E-19 0.100000E-19 4.50000 400.000 0.100000E-19  $\mathbf{LF}$  $\mathbf{FG}$  $\mathbf{LF}$ MG  $\mathbf{LF}$ CG  $\mathbf{LF}$ VCG 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 TOTAL |0.110000E-01| 1.50000 320.000 4500.00 400000. REACH GEOMETRY FOR STREAM SEGMENT 1 ACCUMULATED CHANNEL DISTANCE CROSS REACH MOVABLE INITIAL BED-ELEVATIONS SECTION LENGTH BED LEFT SIDE THALWEG RIGHT SIDE FROM DOWNSTREAM NO. (ft) WIDTH (ft) (ft) (ft) (ft) (miles) --------0.000 1.000 183.500 959.300 944.700 958.900 0.000 0.000 3280.000 15.000 242.000 953.700 962.000 3280.000 0.621 961.000 4240.000 32.000 219,500 968,600 956.500 978.500 7520.000 1.424 3320.000 33.000 299.000 979.190 961.000 976.000 10840.000 2.053 1750.000 33.300 284.050 980.680 962.490 977.490 12590.000 2.384 1050.000 33.900 284.050 980.840 977.650 13640.000 2.583 962.650

35.000

42.000

0.000

5210.000

275.950

154.500

963.300

969.800

963.300

969.800

983.700

969.800

13640.000

18850.000

2.583

3.570

44.000	3500.		227 600	070 0	00 00	7 1 0 0		22350.00	0	4.233	
53.000	2942.	000	337.500 195.000	970.9			76.900 38.700	25292.00		4.233	
	2770.	000		982.8							
55.000	1462.	000	204.000	987.2			33.800	28062.00	0	5.315	
58.000			176.500	996.3	00 97	5.400 99	0.400	29524.00	0	5.592	
BED MATERIA											
SECNO	SAE	DMAX (ft)				BED		n size	S		
1.000	1.000	0.105				VF SAND F SAND	0.010 0.070 0.290	VC SAND VF GRVL F GRVL	0.120	M GRVL C GRVL	0.015 0.035
15.000	1.000	0.151	0.151	1.000	1.000	VF SAND F SAND M SAND C SAND	0.010 0.070 0.327 0.367	VC SAND VF GRVL F GRVL	0.045	M GRVL C GRVL VC GRVL	0.011 0.022 0.002
32.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.010 0.070 0.375 0.375	VC SAND VF GRVL F GRVL		M GRVL C GRVL VC GRVL	0.005 0.005 0.005
33.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.008 0.062 0.321 0.397	VC SAND VF GRVL F GRVL	0.124 0.038 0.027	M GRVL C GRVL VC GRVL	0.004 0.009 0.009
33.300	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.008 0.058 0.293 0.408	VC SAND VF GRVL F GRVL	0.045	M GRVL C GRVL VC GRVL	0.004 0.011 0.011
33.900	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.007 0.056 0.276 0.415	VC SAND VF GRVL F GRVL	0.140 0.049 0.029	M GRVL C GRVL VC GRVL	0.004 0.012 0.012
35.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.007 0.056 0.276 0.415	VC SAND VF GRVL F GRVL	0.049	M GRVL C GRVL VC GRVL	0.004 0.012 0.012
42.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.005 0.044 0.192 0.450	VC SAND VF GRVL F GRVL	0.069	M GRVL C GRVL VC GRVL	0.002 0.018 0.018
44.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.003 0.036 0.136 0.473	VC SAND VF GRVL F GRVL	0.189 0.082 0.035	C GRVL	0.002 0.022 0.022
53.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.002 0.030 0.088 0.492	VC SAND VF GRVL F GRVL		C GRVL	0.001 0.025 0.025
55.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.001 0.023 0.044 0.510	VC SAND VF GRVL F GRVL	0.222 0.104 0.039	M GRVL C GRVL VC GRVL	0.000 0.028 0.028
58.000	1.000	0.210	0.210	1.000	1.000	VF SAND F SAND M SAND C SAND	0.000 0.020 0.020 0.520	VC SAND VF GRVL F GRVL	0.230 0.110 0.040	M GRVL C GRVL VC GRVL	0.000 0.030 0.030

\_\_\_\_\_

	LOCAL INFLOW DATA SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 1 AT LOCAL INFLOW POINT # 1 LOAD BY GRAIN SIZE CLASS (tons/day)											
LQ		1.00000	100.000	1000.00	10000.0							
LF LF LF LF LF LF LF LF	VFS FS CS VCS VFG FG CG VCG	0.400000E-05 0.100000E-19 0.100000E-19	2.07000 0.860000 0.310000	10.0000 5.50000 5.50000 0.100000E-19	5940.00 5430.00 3210.00 2940.00 3810.00 3480.00 2730.00 1590.00 660.000 180.000							
	TOTAL	0.400000E-02	10.0000	499.000	29970.0							

\*\* Example Problem 6 \*\*

\_\_\_\_\_

CASCADE CREEK - STREAM SEGMENT 2 **T4** т5

LOAD CURVE FROM GAGE DATA. BED GRADATIONS FROM FIELD SAMPLES. т6

Use full range of sands and gravels - Yang's Stream Power.

Т7 Т8 Zumbro River Project

> EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 CASCADE IS A TRIBUTARY OF THE ZUMBRO RIVER DOWNSTREAM OF SILVER LAKE CASCADE CREEK GEOMETRY - STREAM SEGMENT 2 \*\* Example Problem 6 \*\*

#### SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 2 LOAD BY GRAIN SIZE CLASS (tons/day)

LQL		1.00000	100.000	1000.00	10000.0	1
						-
$\mathbf{LFL}$	VFS	0.265600E-02	6.64000	7.50000	5940.00	
LFL	FS	0.828000E-03	2.07000	122.500	5430.00	
LFL	MS	0.344000E-03	0.860000	302.500	3210.00	
LFL	CS	0.124000E-03	0.310000	26.0000	2940.00	
$\mathbf{LFL}$	VCS	0.320000E-04	0.800000E-01	19.5000	3810.00	
$\mathbf{LFL}$	VFG	0.120000E-04	0.300000E-01	10.0000	3480.00	
$\mathbf{LFL}$	FG	0.400000E-05	0.100000E-01	5.50000	2730.00	
LFL	MG	0.100000E-19	0.100000E-19	5.50000	1590.00	
LFL	CG	0.100000E-19	0.100000E-19	0.100000E-19	660.000	
LFL	VCG	0.100000E-19	0.100000E-19	0.100000E-19	180.000	
						-
Т	OTAL	0.400000E-02	10.0000	499.000	29970.0	1

REACH GEOMETRY FOR STREAM SEGMENT 2

CROSS SECTION NO.	REACH LENGTH (ft)	MOVABLE BED WIDTH	INITIA LEFT SIDE (ft)	L BED-ELE THALWEG (ft)	VATIONS RIGHT SIDE (ft)		CHANNEL DISTANCE OWNSTREAM (miles)
	0.000						
1.000		200.000	964.600	959.800	969.600	0.000	0.000
3.000	537.000 240.000	222.000	982.900	964.300	970.300	537.000	0.102
4.000		114.500	981.700	968.300	981.200	777.000	0.147
6.200	474.000	200.000	987.400	972.000	987.500	1251.000	0.237

BED MATERIAL GRADATION

XPI TOTAL BED MATERIAL FRACTIONS SECNO SAE DMAX DXPI (ft) (ft) BED per grain size -----VF SAND 0.025 VC SAND 0.140 | M GRVL 0.150 VF GRVL 0.180 | C GRVL 0.090 1.000 1.000 0.210 0.210 1.000 1.000 F SAND 0.025 VC GRVL 0.060 м SAND 0.040 F GRVL 0.200 С SAND 0.090 M GRVL 0.150 C GRVL 0.090 VC GRVL 0.060 3.000 1.000 0.210 0.210 1.000 1.000 VF SAND 0.025 VC SAND 0.140 SAND 0.025 VF GRVL 0.180 F М SAND 0.040 F GRVL 0.200 С SAND 0.090 4.000 1.000 0.210 0.210 1.000 1.000 VF SAND 0.025 VC SAND 0.140 M GRVL 0.150 
 VF GRVL
 0.180
 C
 GRVL
 0.150

 F
 GRVL
 0.200
 VC
 GRVL
 0.060
 F SAND 0.025 0.040 М SAND С 0.090 SAND 
 VC
 SAND
 0.140
 M
 GRVL
 0.150

 VF
 GRVL
 0.180
 C
 GRVL
 0.090

 F
 GRVL
 0.200
 VC
 GRVL
 0.060
 VF SAND 0.025 6.200 1.000 0.210 0.210 1.000 1.000 F SAND 0.025 М SAND 0.040 С SAND 0.090

#### Т4 BEAR CREEK - Stream Segment 3 \*\* Example Problem 6 \*\*

Т5 Т6 SECOND UPSTREAM TRIB ON Zumbro River. LOAD CURVE FROM GAGE DATA. BED GRADATIONS FROM FIELD SAMPLES Use full range of sands and gravels. Yang's Stream Power.

т7

TЯ Zumbro River Project

EXAMPLE 6 Cont. ZUMBRO RIVER Project - BEAR CREEK - Stream Segment 3 BEAR IS A TRIBUTARY OF THE ZUMBRO RIVER UPSTREAM OF SILVER CREEK BEAR CREEK GEOMETRY - STREAM SEGMENT 3 \*\* Example Problem 6 \*\*

#### SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 3 LOAD BY GRAIN SIZE CLASS (tons/day)

гõг		1.00000	100.000	500.000	1000.00	30000.0	1
LFL LFL LFL LFL LFL	FS MS CS	0.402000E-03 0.684000E-03 0.902000E-03 0.200000E-05 0.100000E-19	10.2600 13.5300 0.300000E-01		93.6000 210.000 721.200 170.400 3.60000	3082.50 4905.00 10710.0 3555.00 180.000	
1111	ves	10.100000E-13	0.1000008-19	0.1000008-19	3.60000	1 180.000	

LFL	VFG	0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19  45.0000	
LFL		0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 22.5000	
LFL		0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19	
LFL	CG	0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19	
$\mathbf{LFL}$	VCG	0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19 0.100000E-19	
Т	OTAL	0.199000E-02 29.8500 450.500 1198.80 22500.0	
		***************************************	

#### REACH GEOMETRY FOR STREAM SEGMENT 3

CROSS	REACH	MOVABLE		L BED-ELE	ACCUMULATED CHANNEL DISTANCE			
SECTION NO.	LENGTH (ft)	BED WIDTH	LEFT SIDE (ft)	THALWEG (ft)	RIGHT SIDE (ft)	FROM DO (ft)	OWNSTREAM (miles)	
	0.000							
1.000		202.500	985.000	977.000	985.900	0.000	0.000	
	260.000							
2.100		137.500	986.700	977.300	986.700	260,000	0.049	
	708.000							
4.000	CCE 000	137.500	986.300	978.300	992.300	968.000	0.183	
6.000	665.000	347.500	995.600	982.800	994.200	1633.000	0.309	

BED MATERIAL GRADATION

SECNO	SAE	DMAX (ft)	DXPI (ft)	XPI	TOTAL BED	BED MATERIAL FRACTIONS per grain size
1.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.030         VC SAND         0.005         M GRVL         0.000           F SAND         0.240         VF GRVL         0.005         C GRVL         0.000           M SAND         0.660         F GRVL         0.000         VC GRVL         0.000           C SAND         0.060         F GRVL         0.000         VC GRVL         0.000
2.100	1.000	0.013	0.013	1.000	1.000	VF SAND         0.029         VC SAND         0.005         M GRVL         0.000         F           F SAND         0.234         VF GRVL         0.005         C GRVL         0.000         M         SAND         0.662         F GRVL         0.000         VC GRVL         0.000         C SAND         0.066         C         SAND         0.066         C         SAND         0.066         C         SAND         0.066         C         SAND         0.066         C         SAND         C
4.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.027         VC SAND         0.005         M GRVL         0.000           F SAND         0.216         VF GRVL         0.005         C GRVL         0.000           M SAND         0.666         F GRVL         0.000         VC GRVL         0.000           C SAND         0.081
6.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.025         VC SAND         0.005         M GRVL         0.000         F           F SAND         0.200         VF GRVL         0.005         C GRVL         0.000         M           M SAND         0.670         F GRVL         0.000         VC GRVL         0.000         C           C SAND         0.095

# **T4** T5 T6 T7 T8

\_\_\_\_\_

TAKEO CREEK - Stream Segment 4\*\* Example Problem 6 \*\*FIRST TRIBUTARY ON Bear Creek.LOAD CURVE IS FROM GAGE DATA. BED GRADATIONS FROM FIELD SAMPLES.Use full range of sands and gravels.Yang's Stream Power.Zumbro River Project

EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 TAKEO CREEK IS A TRIBUTARY OF BEAR CREEK UPSTREAM OF SECTION 2.1 TAKEO CREEK GEOMETRY - STREAM SEGMENT 4 \*\* Example Problem 6 \*\* - - - - -- - - - - -

## SEDIMENT LOAD TABLE FOR STREAM SEGMENT # 4

		LOAD BY GRAIN SIZE CLA	ASS (tons/day)		
LQL		1.00000   100.000	500.000	1000.00	30000.0
LFL LFL LFL LFL LFL LFL LFL	VFS FS MS CS VCS VFG FG	0.402000E-03 6.03000 0.684000E-03 10.2600 0.902000E-03 13.5300 0.20000E-05 0.300000 0.100000E-19 0.1000000 0.100000E-19 0.1000000	E-19 0.100000E-19 E-19 0.100000E-19	93.6000 210.000 721.200 170.400 3.60000 0.100000E-19 0.100000E-19	3082.50 4905.00 10710.0 3555.00 180.000 45.0000 22.5000
$_{ m LFL}$	MG CG	0.100000E-19 0.100000 0.100000E-19 0.100000	E-19 0.100000E-19		0.100000E-19 0.100000E-19
LFL T	VCG OTAL	0.100000E-19 0.100000 0.199000E-02  29.8500	3-19 0.100000E-19   450.500	0.100000E-19	0.100000E-19 22500.0

#### REACH GEOMETRY FOR STREAM SEGMENT 4

CROSS SECTION NO.	REACH LENGTH (ft)	MOVABLE BED WIDTH	INITIA LEFT SIDE (ft)	L BED-ELE THALWEG (ft)	VATIONS RIGHT SIDE (ft)		CHANNEL DISTANCE OWNSTREAM (miles)
	0.000						
1.000	260,000	202.500	987.000	979.000	987.900	0.000	0.000
2.100	708.000	137.500	988.700	979.300	988.700	260.000	0.049
4.000		137.500	988.300	980.300	994.300	968.000	0.183
6.000	665.000	347.500	997.600	984.800	996.200	1633.000	0.309

BED MATERIAL GRADATION

SECNO	SAE	DMAX (ft)	DXPI (ft)	XPI	TOTAL BED	BED MATERIAL FRACTIONS per grain size
1.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.030         VC SAND         0.005         M GRVL         0.000           F SAND         0.240         VF GRVL         0.005         C GRVL         0.000           M SAND         0.660         F GRVL         0.000         VC GRVL         0.000           C SAND         0.060         F         GRVL         0.000         VC GRVL         0.000
2.100	1.000	0.013	0.013	1.000	1.000	VF SAND         0.029         VC SAND         0.005         M GRVL         0.000           F SAND         0.234         VF GRVL         0.005         C GRVL         0.000           M SAND         0.662         F GRVL         0.000         VC GRVL         0.000           C SAND         0.066
4.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.027         VC SAND         0.005         M GRVL         0.000           F SAND         0.216         VF GRVL         0.005         C GRVL         0.000           M SAND         0.666         F GRVL         0.000         VC GRVL         0.000           C SAND         0.081
6.000	1.000	0.013	0.013	1.000	1.000	VF SAND         0.025         VC SAND         0.005         M GRVL         0.000           F SAND         0.200         VF GRVL         0.005         C GRVL         0.000           M SAND         0.670         F GRVL         0.000         VC GRVL         0.000           C SAND         0.095

#### BED SEDIMENT CONTROL VOLUMES

STREAM SEGMENT # 1: EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1

SECTION	LENGTH	WIDTH	DEPTH	VOL	UME
NUMBER	(ft)	(ft)	(ft)	(cu.ft)	(cu.yd)
$\begin{array}{c} 1.000\\ 15.000\\ 32.000\\ 33.000\\ 33.900\\ 35.000\\ 42.000\\ 44.000\\ 53.000\\ 53.000\\ 55.000\\ 58.000\end{array}$	1640.000 3760.000 3780.000 2535.000 1400.000 525.000 2605.000 4355.000 3221.000 2856.000 2116.000 731.000	203.000 229.266 235.344 279.927 287.165 284.050 235.467 203.228 282.665 220.920 198.870 185.667	$\begin{array}{c} 10.000\\ 10.000\\ 10.000\\ 0.000\\ 0.000\\ 0.000\\ 0.000\\ 0.000\\ 10.000\\ 10.000\\ 10.000\\ 10.000\\ 3.400\end{array}$	0.332920E+07 0.862040E+07 0.889600E+07 0.000000 0.000000 0.000000 0.000000 0.910465E+07 0.420808E+07 461456.	

#### BED SEDIMENT CONTROL VOLUMES

STREAM SEGMENT # 2: EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2

SECTION NUMBER	LENGTH (ft)	WIDTH (ft)	DEPTH (ft)	VOL (cu.ft)	UME   (cu.yd)	
1.000 3.000 4.000 6.200	268.500 388.500 357.000 237.000	207.333 205.864 145.465 171.500	10.000 0.000 0.000 0.000	556690. 0.000000 0.000000 0.000000 0.000000	20618.1 0.000000 0.000000 0.000000 0.000000	

#### BED SEDIMENT CONTROL VOLUMES

STREAM SEGME	NT # 3: EXAMI   LENGTH	PLE 6 Cont. Z	UMBRO RIVER		I <b>R CREEK - Strea</b> , име	am Segment 3
NUMBER	(ft)	(ft)	(ft)	(cu.ft)	(cu.yd)	
1.000 2.100 4.000 6.000	130.000 484.000 686.500 332.500	180.833 143.320 171.404 277.500	10.000 10.000 0.000 0.100	235083. 693667. 0.000000 9226.87	8706.79 25691.4 0.000000 341.736	

#### BED SEDIMENT CONTROL VOLUMES

STREAM SEGMENT # 4: EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4

	NUMBER	(ft)	(ft)	(ft)	(cu.ft)	LUME   (cu.yd)	
-	1.000 2.100 4.000 6.000	130.000 484.000 686.500 332.500	180.833 143.320 171.404 277.500	10.000 10.000 0.000 0.100	235083. 693667. 0.000000 9226.87	8706.79 25691.4 0.000000 341.736	

NO. OF INPUT DATA MESSAGES= END OF SEDIMENT DATA

\$HYD

#### BEGIN COMPUTATIONS.

TIME STEP # 1 \* AB FLOW 1 = BASE FLOW 0F 750 CFS

0

--- Downstream Boundary Condition Data for STREAM SEGMENT NO. 1 at Control Point # 1 ---DISCHARGE TEMPERATURE WATER SURFACE (deg F) (cfs) (ft) 750.000 65.00 956.000 \*\*\*\* DISCHARGE WATER ENERGY VELOCITY ALPHA TOP AVG AVG VEL (by subsection) (CFS) SURFACE LINE HEAD WIDTH BED SECTION NO. 1.000 750.000 956.000 956.009 0.009 1.000 154.497 0.000 0.749 \* \* \* \* 949.519 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 CRITICAL \*\* Using Critical Water Surface + NO. 15.000 TIME = 2.000 DAYS. TRIAL COMPUTED CONTRACT SECTION NO. \*\* SUPERCRITICAL \*\* SECTION NO. TRIAL NO. WS 957.779 WS ws 956.256 0. 957.873 956.309 957.823 1. 957.873 958.688 0.815 \*\*\*\* 1.000 58.210 956.094 FLOW DISTRIBUTION (%) = 750.000 1.000 0.000 7.243 0 000 0.000 100.000 0.000 --- TRIBUTARY JUNCTION - CONTROL POINT # 2 is upstream of Section No. DISCHARGE TEMPERATURE 15 000 ---(cfs) 61.000 689.000 (deg F) 72.00 Tributary Inflow: 64.38 Total: NO. 32.000 689.000 963.275 SECTION NO 963.297 1.000 0.000 0.022 128.771 0.000 958.809 1.198 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 33.000 689.000 964.126 964.144 0.018 1.000 217,196 0.000 1.069 0.000 961.158 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO 33.300 689.000 964.929 964.962 0.032 1.000 202.548 962 570 0.000 0.000 1.442 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO 33.900 689.000 965.528 965.551 0.023 1.000 205.131 0.000 1.210 0.000 962.752 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 35 000 ... Internal Boundary Condition - Water Surface = 970.000 = 0.000 1.000 1^-Head Loss = 689.000 970.000 \*\*\*\* 970.014 0.014 185.172 966.132 0.000 0.962 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 NO. 42.000 689.000 971. SECTION NO. 1.000 971.707 971.743 0.036 242.186 969.833 0.000 1.517 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 --- LOCAL INFLOW POINT # 1 is upstream of Section No. DISCHARGE TEMPERATURE 42.000 ---(deg F) 70.00 (cfs) 29.000 Local Inflow: Total: 64.13 SECTION NO. 44.000 660.000 972.831 972.842 0.011 1.000 256.448 969.726 0.000 0.829 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. NO. 53.000 660.000 974.325 975.010 0.685 1.000 972 871 6.641 0.000 68.355 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 --- TRIBUTARY JUNCTION - CONTROL POINT # 3 is upstream of Section No. 53.000 ---DISCHARGE TEMPERATURE (cfs) (deg F) 128.000 Tributary Inflow: 67.00 63.44 Total: 532.000 55.000 SECTION NO. 978.436 532.000 978.466 \*\*\*\* 0.030 1.000 99.479 974.567 0.000 1.382 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 532.000 970 SECTION NO. 979.363 54.345 979.535 0.172 1.000 976.417 0.000 3.323 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 2 at Control Point # 2 ---DISCHARGE TEMPERATURE WATER SURFACE (cfs) (deg F) (ft) 61.000 72.00 957.873 \*\*\*\* DISCHARGE WATER ENERGY VELOCITY ALPHA TOP AVG AVG VEL (by subsection) SURFACE LINE HEAD WIDTH (CFS) BED 3 SECTION NO. 1.000 \*\* CRITICAL WATER SURFACE USED AT SECTION NO. 1.000 AT TIME = 2 1.000 60.932 960.070 FLOW DISTRIBUTION (%) = 2.000 DAYS.\*\* \*\*ELOEQ\*\* 61.000 960.360 960.545 1.000 0.186 0.000 3.457 0.000 0.000 100.000 0.000 SECTION NO. 3.000 1.000 24.774 964.785 FLOW DISTRIBUTION (%) = \*\*\*\* 61.000 965.937 966.008 0.071 1.000 0.000 2.137 0.000 0.000 100.000 0.000 SECTION NO. 4.000 \*\* SUPERCRITICAL \*\* Using Critical Water Surface + SECTION NO. 4.000 TIME = 2.000 DAYS. SECTION NO. SECTION NO.

TRIAL COMPUTED TRIAL CRITICAL WS 968.272 967.882 WS NO. WS 969.500 969.594 Ο. 969 544 1. 969.594 969.797 0.203 1.000 31.272 969.055 بد بد بد 61.000 0.000 3.616 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 6.200 64.729 972.019 61.000 972.744 972.771 0.026 1.000 0.000 1.300 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 EXAMPLE 6 Cont. ZUMBRO RIVER Project - BEAR CREEK - Stream Segment 3 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 3 at Control Point # 3 ---DISCHARGE TEMPERATURE WATER SURFACE (cfs) (deg F) 67.00 (ft) 128.000 974.325 ENERGY VELOCITY ALPHA AVG VEL (by subsection) \*\*\*\* DISCHARGE TOP WATER AVG SURFACE LINE HEAD WIDTH BED (CFS) SECTION NO 1.000 1.000 AT TIME = 2 1.000 60.598 977.140 FLOW DISTRIBUTION (%) = CRITICAL WATER SURFACE USED AT SECTION NO. 2.000 DAYS.\*\* \*\*ELOEQ\*\* 128.000 977.612 977.924 0.312 1.000 0.000 4.478 0.000 100.000 0.000 0.000 2.100 SECTION NO. 113.709 977.267 128.000 978.595 978.607 0.011 1.000 0.000 0.847 0.000 \*\*\*\* FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 --- TRIBUTARY JUNCTION - CONTROL POINT # 4 is upstream of Section No. DISCHARGE TEMPERATURE 2.100 ---(deg F) 73.00 (cfs) 90.000 Tributary Inflow: Total: 38.000 52.79 \*\* SUPERCRITICAL \*\* US SECTION NO CAL \*\* Using Critical Water Surface + 4.000 TIME = 2.000 DAYS. COMPUTED TRIAL TRIAL CRITICAL NO. WS WS WS 978.649 978.920 2. 978.687 978.964 979.014 979.198 0.184 з. 979.014 \* \* \* \* 1.000 24.453 978.563 0.000 38.000 3.441 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 6.000 38.000 983.945 983.973 0.028 1.000 37.207 0.000 \*\*\*\* 983.189 0.000 1.351 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 4 at Control Point # 4 ---DISCHARGE TEMPERATURE WATER SURFACE (cfs) (deg F) (ft) 90.000 73.00 978.595 \*\*\*\* DISCHARGE ENERGY VELOCITY AVG WATER ALPHA TOP AVG VEL (by subsection) (CFS) SURFACE LINE HEAD WIDTH BED 3 SECTION NO. 1.000 \*\* CRITICAL WATER SURFACE USED AT SECTION NO. \*\*\*\* 90.000 979.501 979.688 0.188 1.000 AT TIME = 2 00 59.777 979.067 2.000 DAYS.\*\* 7 0.000 3.475 \*\*ELOEO\*\* 1.000 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. NO. 2.100 90.000 980.319 980.328 1.000 113.557 979.275 0.000 0.759 \* \* \* \* 0.009 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 4.000 90.000 981.486 981.662 1.000 37.369 0.000 \*\*\*\* 0.176 980.771 3.369 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 SECTION NO. 6.000 90.000 986.358 1.000 40 719 985 269 0.000 2.029 986,422 0.064 0.000 FLOW DISTRIBUTION (%) = 0.000 100.000 0.000 EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 ACCUMULATED TIME (yrs).... FLOW DURATION (days)..... 0.005 2.000 UPSTREAM BOUNDARY CONDITIONS -----Stream Segment # 4 SEDIMENT LOAD TEMPERATURE (tons/day) (deg F) DISCHARGE \_\_\_\_ARGE (cfs) 6.000 Section No. INFLOW | 23.96 73.00 90.00 

 TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 4

 EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4

 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT

 TTME ENTRY \* SAND POINT \* INFLOW OUTFLOW TRAP EFF \* DAYS 0.02 6.000 \* 2.00 1.000 \* TOTAL 0.02 0.93 -38.26 \* \*\*\*\*

	LOAD PASSING THE		
SEDIMENT INFLOW at t GRAIN SIZE	he Upstream Bound	lary:	
	(cemp/aaj/		LOAD (tons/day)
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	4.84	VERY FINE GRAVE	L 0.00
MEDIUM SAND	10.86	MEDIUM GRAVEL	0.00
COARSE SAND	0.02	COARSE GRAVEL	0.00
VERY COARSE SAND.	0.00	VERY COARSE GRA	VEL 0.00
SEDIMENT OUTFLOW fro	om the Downstream	Boundary	
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	31.85	VERY FINE GRAVE	L 1.42
FINE SAND	231.57	FINE GRAVEL	0.00
COARSE SAND	55.40	COARSE GRAVEL	0.00
VERY COARSE SAND.	4.42	VERY COARSE GRA	VEL 0.00
			L = 940.52
LE SB-2: STATUS OF			
ECTION BED CHANGE	WS ELEV THAI	weg Q	TRANSPORT RATE (tons/day) SAND 53. 42. 250. 941.
UMBER (ft)	(ft) (f	t) (cfs)	SAND
6.000 -0.10	986.36 984	.70 90.	53.
2.100 -0.20	. 961.49 980 ) 980.32 979	0.31 90. 0.10 90	42. 250.
1.000 -2.85	5 979.50 976	.15 90.	941.
AMPLE 6 Cont. ZUMBRO ACCUMULATED TIN FLOW DURATION STREAM BOUNDARY CONI	1E (yrs) (days)	0.005 2.000	аш эеутепт з
ream Segment # 3 ction No. 6.000	) DISCHARGE (cfs)	(tons/day)	(deg F)
TNPT 01	1	3.96	52 79
tream of SECTION NO	). 2.100 is	•	
BUTART JUNCTION # ·	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
BUTART JUNCTION # ·	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
MAIN STEM INFLOW	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F) 52.79 73.00
MAIN STEM INFLOW TRIBUTARY INFLOW	38.00 90.00	3.96 940.52	52.79 73.00
MAIN STEM INFLOW TRIBUTARY INFLOW	38.00 90.00	SEDIMENT LOAD (tons/day) 3.96 940.52 944.48	52.79 73.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI BLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE	38.00         90.00           1         128.00           1         128.00           CIENCY ON STREAM S         2000           Cont. ZUMBRO RIVE         2000           DAC-FT ENTERING         2000	3.96 940.52 944.48 944.48 5EGMENT # 3 5E Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI BLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULAT	38.00         90.00           128.00         128.00           CIENCY ON STREAM S         2000000000000000000000000000000000000	3.96 940.52 944.48 5EGMENT # 3 5R Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI	38.00         90.00           128.00         128.00           CIENCY ON STREAM S         2000000000000000000000000000000000000	3.96 940.52 944.48 5EGMENT # 3 5R Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI SLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATI	38.00         90.00           128.00         128.00           CIENCY ON STREAM S         2000000000000000000000000000000000000	3.96 940.52 944.48 5EGMENT # 3 5R Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE	38.00         90.00           128.00         128.00           CIENCY ON STREAM S         2000000000000000000000000000000000000	3.96 940.52 944.48 5EGMENT # 3 5R Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE	38.00         90.00           128.00         128.00           CIENCY ON STREAM S         2000000000000000000000000000000000000	3.96 940.52 944.48 5EGMENT # 3 5R Project - BEAR AND LEAVING THIS	52.79 73.00 67.00 CREEK - Stream Segment 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI CLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULAT TIME ENTRY DAYS POINT 2.00 6.000 2.100 TOTAL= 1.000	N         38.00           90.00         90.00           128.00         128.00           CIENCY ON STREAM S         SAND           Cont. ZUMBRO RIVE         SAND           AC-FT ENTERING         SAND           INFLOW OUTF         0.00           0.93         0.93           0.93         1	3.96 940.52 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT
MAIN STEM INFLOU TRIBUTARY INFLOU TOTAL CALL SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE TIME ENTRY 2.00 6.000 2.100 * TOTAL= 1.000 COLOR	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       ED AC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       1.93       DAC-FT ENTERING	3.96 940.52 944.48 556MENT # 3 57 Project - BEAR AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI CLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE ACCUMULATE DAYS POINT 2.00 6.000 4 2.100 4 TOTAL= 1.000 4 COTAL= 1.0000 4 COTAL= 1.000 4	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 944.48 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day)
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI CLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATH TIME ENTRY 2.00 6.000 2.100 * TOTAL= 1.000 * COTAL= 1.000 * COTAL= 1.000 * COTAL= 1.000 * COTAL= 1.000 * COTAL= 1.000 * CLE SB-1: SEDIMENT EDIMENT INFLOW at t GRAIN SIZE	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 944.48 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day)
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL ELE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE ACCUMULATE DAYS POINT 2 2.00 6.000 4 2.100 4 70TAL= 1.000 4 **********************************	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 944.48 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day)
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATT TIME ENTRY 1 DAYS POINT 2 2.00 6.000 3 2.100 3 TOTAL= 1.000 3 **********************************	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 944.48 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day)
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE DAYS POINT 4 2.00 6.000 4 2.100 4 COTAL= 1.000 4 COTAL= 1.0000 4 COTAL= 1.0	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 944.48 944.48 <b>EEGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day)
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI E SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE TIME ENTRY 2.00 6.000 2.100 * 2000 2.100 * COTAL= 1.000 * COTAL= 0.000 * COTAL= 0.0000 * COTAL= 0.0000 * COTAL= 0.0000 * COTAL= 0.000 *	N     38.00       90.00       128.00       CIENCY ON STREAM S       Cont. ZUMBRO RIVE       DAC-FT ENTERING       SANI       INFLOW OUTE       0.00       0.93       0.93       0.93       0.93       CODE       DACASENCE THE	3.96 940.52 940.52 944.48 966MENT # 3 FR Project - BEAR AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT TREAM SEGMENT # 3 LOAD (tons/day) CL 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE DAYS POINT * 2.00 6.000 * 2.100 * COTAL= 1.000 * COARSE SAND	M       38.00         90.00       90.00         128.00       128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE       20.00         DAC-FT ENTERING       SANI         INFLOW OUTF       0.00         0.93       0.93         LOAD PASSING THE       Cont. ZUMBRO RIVE         LOAD (tons/day)       0.80         1.36       1.79         0.00       0.00         m the Downstream	3.96 940.52 944.48 <b>EGMENT # 3</b> <b>ER Project - BEAR</b> AND LEAVING THIS ************************************	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT # 3 LOAD (tons/day) LOAD (tons/day) L 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATT DAYS POINT * 2.00 6.000 * 2.100 * 2.100 * TOTAL= 1.000 * *********************************	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         COAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULAT DAYS POINT 2.00 6.000 2.100 TOTAL= 1.000 TOTAL= 1.000 COTAL= 1.000 COTAL= 1.000 COTAL= 1.000 COTAL= 1.000 COTAL= 1.000 CORSE SAND FINE SAND VERY FINE SAND VERY COARSE SAND VERY COARSE SAND	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         COAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE DAYS POINT 4 2.00 6.000 4 2.100 4 2.100 4 TOTAL= 1.000 4 **********************************	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         COAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATH TIME ENTRY 2.00 6.000 2.100 2.100 TOTAL= 1.000 TOTAL= 1.000 EDIMENT INFLOW at t GRAIN SIZE VERY FINE SAND VERY FINE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         LOAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL TOTAL E SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATE TIME ENTRY 2.00 6.000 2.100 COTAL= 1.000 COTAL= 1.0000 COTAL= 1.00000 COTAL= 1.00000 COTAL= 1.00000 COTAL= 1.00000 COTAL= 1.00000 COTAL= 1.00000 COTAL= 1.000000 COTAL= 1.0000000 COTAL= 1.000000000000000000000000000000000000	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         LOAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATH TIME ENTRY 2.00 6.000 2.100 * 2.00 2.100 * TOTAL= 1.000 * COTAL= 1.000 * EDIMENT INFLOW at t GRAIN SIZE VERY FINE SAND FINE SAND VERY COARSE SAND VERY COARSE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND FINE SAND	M       38.00         90.00         128.00         CIENCY ON STREAM S         Cont. ZUMBRO RIVE         DAC-FT ENTERING         SANI         INFLOW OUTF         0.93         0.93         0.93         0.93         LOAD PASSING THE         LOAD (tons/day)         0.80         1.36         1.79         0.00	3.96 940.52 944.48 944.48 944.48 3 5 5 5 5 7 5 7 7 7 7 7 7 7 7 7 7 7 7 7	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT 3 TREAM SEGMENT 3 LOAD (tons/day) L 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATH TIME ENTRY 4 2.00 6.000 4 2.100 7 TOTAL= 1.000 7 TOTAL= 1.000 7 TOTAL= 1.000 7 TOTAL= 1.000 7 COTAL= 1.0000 7 COTAL= 1.00000 7 COTAL= 1.0000 7 COTAL= 1.000	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           DAC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.80           1.36           1.79           0.00           0.00           0.00           0.136           1.79<	3.96 940.52 944.48 944.48 944.48 3 5 5 5 5 7 5 7 7 7 7 7 7 7 7 7 7 7 7 7	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT LOAD (tons/day) LOAD (tons/day) LOAD (tons/day) L. 0.00
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL 3LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATT DAYS POINT 2 2.00 6.000 2 2.100 2 2.100 2 TOTAL 1.000 2 3 COTAL 1.000 2 3 COTAL 1.000 2 COTAL 2.00 2 COTAL 2.00 2 COARSE SAND VERY FINE SAND VERY FINE SAND VERY COARSE SAND FINE SAND VERY FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           ED AC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.93           0.93           0.93           COAD PASSING THE           LOAD PASSING THE           Che Upstream Bound           LOAD (tons/day)           0.80           1.36           1.79           0.00           0.51.95           363.17           838.78           69.59           5.54           THE BED PROFILE	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT 3 TREAM SEGMENT 3 LOAD (tons/day) EL 0.00 0.
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL CONCUMULATY DAYS POINT 2.00 6.000 2.100 TOTAL= 1.000 TOTAL= 1.000 COARSE SAND FINE SAND FINE SAND VERY FINE SAND VERY FINE SAND VERY COARSE SAND FINE SAND VERY FINE SAND FINE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           ED AC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.93           0.93           0.93           COAD PASSING THE           LOAD PASSING THE           Che Upstream Bound           LOAD (tons/day)           0.80           1.36           1.79           0.00           0.51.95           363.17           838.78           69.59           5.54           THE BED PROFILE	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT 3 TREAM SEGMENT 3 LOAD (tons/day) EL 0.00 0.
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL CLE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATT DAYS POINT 2 2.00 6.000 2 2.100 2 TOTAL 1.000 2 2.100 2 TOTAL 1.000 2 2.100 2 TOTAL 1.000 2 2 COTAL 1.000 2 COTAL 1.000 2 COTAL 2.000 2 COTAL 2.000 2 COASE SAND VERY FINE SAND VERY FINE SAND VERY COARSE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND FINE SAND VERY FINE SAND VERY FINE SAND VERY FINE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           ED AC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.93           0.93           0.93           COAD PASSING THE           LOAD PASSING THE           Che Upstream Bound           LOAD (tons/day)           0.80           1.36           1.79           0.00           0.51.95           363.17           838.78           69.59           5.54           THE BED PROFILE	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT 3 TREAM SEGMENT 3 LOAD (tons/day) EL 0.00 0.
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAL CONCUMULATY DAYS POINT 2.00 6.000 2.100 TOTAL= 1.000 TOTAL= 1.000 COARSE SAND FINE SAND FINE SAND VERY FINE SAND VERY FINE SAND VERY COARSE SAND FINE SAND VERY FINE SAND FINE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND VERY COARSE SAND	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           ED AC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.93           0.93           0.93           COAD PASSING THE           LOAD PASSING THE           Che Upstream Bound           LOAD (tons/day)           0.80           1.36           1.79           0.00           0.51.95           363.17           838.78           69.59           5.54           THE BED PROFILE	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT 3 TREAM SEGMENT 3 LOAD (tons/day) EL 0.00 0.
MAIN STEM INFLOW TRIBUTARY INFLOW TOTAI LE SA-1. TRAP EFFIC EXAMPLE 6 ACCUMULATT DAYS POINT 4 2.00 6.000 4 2.100 4 2.000 5 2.100 4 TOTAL= 1.000 4 TOTAL= 1.0000 4 TOTAL= 1.0000 4 TOTAL= 1.0000 4 TOTAL= 1.0000 4 TOTAL=	38.00           90.00           128.00           CIENCY ON STREAM S           Cont. ZUMBRO RIVE           ED AC-FT ENTERING           SANI           INFLOW OUTF           0.93           0.93           0.93           0.93           COAD PASSING THE           LOAD PASSING THE           Che Upstream Bound           LOAD (tons/day)           0.80           1.36           1.79           0.00           0.51.95           363.17           838.78           69.59           5.54           THE BED PROFILE	3.96 940.52 944.48 944.48 944.48 944.48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52.79 73.00 67.00 CREEK - Stream Segment 3 STREAM SEGMENT # 3 LOAD (tons/day) L 0.00 

UPSTREAM BOUNDARY CONDITIONS

EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 ACCUMULATED TIME (yrs).... 0.005 FLOW DURATION (days)..... 2.000 

 UPSTREAM BOUNDARY CONDITIONS

 Stream Segment # 2
 DISCHARGE
 SEDIMENT LOAD
 TEMPERATURE

 Section No.
 6.200
 (cfs)
 (tons/day)
 (deg F)

 INFLOW 61.00 4.32 72.00 TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 2 EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT

- - - - - - -

TIME	ENTRY	*		SAND	*
DAYS	POINT	*	INFLOW	OUTFLOW	TRAP EFF *
2.00	6.200	*	0.00		*
TOTAL=	1.000	*	0.00	0.02	-3.99 *
********	******	****	*******	*******	******

#### TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 2

SEDIMENT INFLOW at the Upstream Boundary: 

 EDIMENT INFLOW at the Upstream Boundary:
 GRAIN SIZE
 LOAD (tons/day)
 GRAIN SIZE
 LOAD (tons/day)

 VERY FINE SAND....
 2.87
 VERY FINE GRAVEL.
 0.0

 FINE SAND....
 0.89
 FINE GRAVEL....
 0.0

 MEDIUM SAND.....
 0.37
 MEDIUM GRAVEL.....
 0.0

 COARSE SAND....
 0.13
 COARSE GRAVEL....
 0.0

 VERY COARSE SAND...
 0.03
 VERY COARSE GRAVEL
 0.0

 LOAD (tons/day) 0.01 0.00 0.37 MEDIUM GRAVEL.... 0.13 COARSE GRAVEL.... 0.03 VERY COARSE GRAVEL 0.00 0.00 VERY COARSE SAND ... 0.00 0 TOTAL = -----4.32 SEDIMENT OUTFLOW from the Downstream Boundary IIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) 
 VERY FINE SAND....
 2.57

 FINE SAND.....
 1.56

 MEDIUM SAND.....
 1.96

 COARSE SAND......
 4.05

 VERY COARSE SAND.......
 6.21
 VERY FINE GRAVEL.. 3.14 FINE GRAVEL..... MEDIUM GRAVEL..... COARSE GRAVEL..... 2.08 0.00 COARSE GRAVEL..... 0.00 VERY COARSE GRAVEL 0.00 -----TOTAL = 21.57 TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 2.000 DAYS \_\_\_\_\_ SECTION BED CHANGE WS ELEV THALWEG 0 TRANSPORT RATE (tons/day) (ft) 0.00 (cfs) NUMBER (ft) SAND (ft) 61. 61. 6.200 972.74 972.00 з. 3. 4.000 0.00 969.59 968.30 3.000 965.94 964.30 2. 61.

959.74

61.

22.

## EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1 ACCUMULATED TIME (yrs).... 0.005 FLOW DURATION (days)..... 2.000

960.36

UPSTREAM BOUNDARY CONDITIONS

-0.06

1.000

OFSIREAM BOOMDART CONDI-	TIONS		
Stream Segment # 1 Section No. 58.000	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
INFLOW	532.00	93.30	63.44
Upstream of SECTION NO. TRIBUTARY JUNCTION # 3	<b>53.000 is</b> DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
MAIN STEM INFLOW TRIBUTARY INFLOW	532.00 128.00	93.30 1330.97	63.44 67.00
TOTAL	660.00	1424.27	64.13
Upstream of SECTION NO. LOCAL INFLOW POINT # 1	<b>42.000 is</b> DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
MAIN STEM INFLOW LOCAL INFLOW	660.00 29.00	1424.27 1.22	64.13 70.00
TOTAL	689.00	1425.49	64.38
Upstream of SECTION NO. TRIBUTARY JUNCTION # 2	15.000 is DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPERATURE (deg F)
MAIN STEM INFLOW TRIBUTARY INFLOW	689.00 61.00	1425.49 21.57	64.38 72.00
TOTAL	750.00	1447.06	65.00

Chapter 6

		ON STREAM SEC	<b>GMENT # 1</b> Fork, ZUMBRO RI	WER - Stroom	m Sogmont	1	
			D LEAVING THIS			1	
************	*********	*************	*****				
TIME EN DAYS PO	TRY *	SAND	W TRAP EFF *				
2.00 58.	000 * 101	0.09 0.09	W IRAP EFF *				
53.	000 *	1.31	*				
2.00 58. 53. 42. TOTAL= 35.	000 *	0.00	*				
TIME EN DAYS PO 2.00 35. 15. TOTAL= 1.	TRY *	SAND	*				
DAYS PO	INT * IN	FLOW OUTFLO	W TRAP EFF *				
2.00 35.	000 *	0.03	*				
15.	000 * 0	0.02	*				
***************	*******	*************	*****				
TABLE SB-1: SEDI					T#1		
SEDIMENT INFLOW							
			GRAIN SIZE	LOAD (to	ns/day)		
VERY FINE SAN	D	38.08	VERY FINE GRAVE	L	0.00		
FINE SAND	• • • • •	34.16	FINE GRAVEL		0.00		
COARSE SAND.		0.00	COARSE GRAVEL.		0.00		
VERY COARSE S.	AND	0.00	VERY FINE GRAVE FINE GRAVEL MEDIUM GRAVEL COARSE GRAVEL VERY COARSE GRA	VEL	0.00		
		'					
	W from the	Downet room		AL =	93.30		
SEDIMENT OUTFLO GRAIN SIZE	IOAD (	tons/dav)	GRAIN SIZE	LOAD (to	ns/dav)		
VERY FINE SAN	D	0.99	VERY FINE GRAVE FINE GRAVEL MEDIUM GRAVEL COARSE GRAVEL VERY COARSE GRA	L	0.60		
FINE SAND		2.37	FINE GRAVEL	•••	0.72		
COARGE SAND	• • • • •	5.74	COAPSE CRAVEL.	•••	0.25		
VERY COARSE S.	AND	2.49	VERY COARSE GRA	VEL	0.00		
			TOTA	L =	18.86		
TABLE SB-2: STAT	US OF THE B	ED PROFILE AT	TTME = 2.0	00 DAYS			
SECTION BED C	HANGE WS 1	ELEV THALWE	SG Q	TRANSPORT	RATE (ton	s/day)	
NUMBER (f	t) (:	ft) (ft)	(cfs)	SAND			
58.000	-0.13 97	9.36 975.2	27 532.	284.			
53.000	0.07 97	5.44 972.0 4.32 972.0	53 532. 27 660	1413			
44.000	0.07 97	2.83 967.1	L7 660.	326.			
42.000	0.01 97	1.71 969.8	31 689.	56.			
35.000	0.00 97	0.00 963.3	689.	28.			
33.900	0.00 96	5.53 962.6	5 689.	22.			
33.000	0.00 96	4.13 961 (	10 689	13			
32.000	-0.05 96	3.28 956.4	689.	602.			
15.000	-0.14 95	7.87 953.5	56 750.	1724.			
SECTION BED C NUMBER (f 56.000 55.000 44.000 42.000 35.000 33.900 33.900 33.300 33.000 32.000 15.000 1.000	0.37 950	5.00 945.0	750.	19.			
\$PRT							
Selective Prin			•				
- Print at t CP 1	ne tollowing	g cross sect	ions				
PS 35.1 55.0							
CP 4							
PS 6.0							
PS 6.0							
PS 6.0 END							
PS 6.0 END	2	***********					
PS 6.0 END TIME STEP #	2	AT BANK FULL	DISCHARGE				
PS 6.0 END TIME STEP # * AC FLOW 2	2 = 50 DAYS	AT BANK FULL	DISCHARGE TIME= 52.00	000 DAYS IN	10 COMP	UTATION STEPS	
PS 6.0 END TIME STEP # * AC FLOW 2	2 = 50 DAYS	AT BANK FULL		000 DAYS IN	10 COMP	UTATION STEPS	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TI	2 = 50 DAYS ME= 2.0	AT BANK FULL 0000 DAYS TO	TIME= 52.00		10 COMP	UTATION STEPS	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N	2 = 50 DAYS ME= 2.0 0 6. South	AT BANK FULL 0000 DAYS TO Fork, ZUMBRO	TIME= 52.00 DRIVER - Stream		10 COMP	UTATION STEPS	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIJ EXAMPLE PROBLEM N ACCUMULATED TIME	2 = 50 DAYS ME= 2.0 0 6. South (yrs)	AT BANK FULL 0000 DAYS TO Fork, ZUMBR( 0.0	TIME= 52.00 <b>D RIVER - Stream</b> 005	n Segment 1			
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIJ EXAMPLE PROBLEM N ACCUMULATED TIME	2 = 50 DAYS ME= 2.0 0 6. South (yrs) undary Cond	AT BANK FULL 0000 DAYS TO Fork, ZUMBRO 0.0	TIME= 52.00 DRIVER - Stream DOS DRIVER - STREAM SEGMEN	Segment 1 NT NO. 1 at			
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIJ EXAMPLE PROBLEM N ACCUMULATED TIME	2 = 50 DAYS ME= 2.0 0 6. South (yrs) undary Cond	AT BANK FULL 0000 DAYS TO Fork, ZUMBRO 0.0 ition Data for DISCHARGE 1	TIME= 52.00 <b>DRIVER - Stream</b> 005 <b>DRIVER - Stream</b> <b>DRIVER - Stream</b> <b>DRIVER - Stream</b>	<b>Segment 1</b> NT NO. 1 at TER SURFACE			
PS 6.0 END TIME STEP # k AC FLOW 2 COMPUTING FROM TI EXAMPLE PROBLEM N ACCUMULATED TIME	2 = 50 DAYS ME= 2.0 0 6. South (yrs) undary Cond	AT BANK FULL 0000 DAYS TO Fork, ZUMBRO 0.0	TIME= 52.00 DRIVER - Stream DOS DRIVER - STREAM SEGMEN	<b>Segment 1</b> N <b>T NO. 1 at</b> TER SURFACE (ft)			
PS 6.0 END TIME STEP # k AC FLOW 2 COMPUTING FROM TIM EXAMPLE PROBLEM N ACCUMULATED TIME	2 = 50 DAYS ME= 2.0 0 6. South (yrs) undary Cond	AT BANK FULL 0000 DAYS TO Fork, ZUMBRO 0.0 ition Data for DISCHARGE 1 (cfs)	TIME= 52.00 <b>DRIVER - Stream</b> 005 <b>DRIVER - Stream</b> 005 <b>DRIVER - Stream</b> 005 <b>DRIVER - Stream</b> 005	<b>Segment 1</b> NT NO. 1 at TER SURFACE			
PS 6.0 END TIME STEP # K AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME COMPUTING TIME TIME TIME TIME TIME TIME TIME TIME	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond 1 WATER	AT BANK FULL O000 DAYS TO Fork, ZUMBRO ition Data fo DISCHARGE 1 (cfs) 2500.000 ENERGY VELOO	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> <b>D</b> DO5 <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b>	<b>Segment 1</b> <b>NT NO. 1 at</b> TER SURFACE (ft) 965.000 TOP A	Control P	<b>'oint # 1</b> VG VEL (by sub	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo	2 = 50 DAYS ME= 2.0 0 6. South (yrs) undary Cond	AT BANK FULL 0000 DAYS TO Fork, ZUMBR( 0.( ition Data for DISCHARGE 1 (cfs) 2500.000	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> <b>D</b> DO5 <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b>	<b>Segment 1</b> <b>NT NO. 1 at</b> TER SURFACE (ft) 965.000 TOP A	Control P		section) 3
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIM EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond 1 WATER	AT BANK FULL O000 DAYS TO Fork, ZUMBRO ition Data fo DISCHARGE 1 (cfs) 2500.000 ENERGY VELOO	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> <b>D</b> DO5 <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b>	<b>Segment 1</b> <b>NT NO. 1 at</b> TER SURFACE (ft) 965.000 TOP A	Control P	<b>'oint # 1</b> VG VEL (by sub	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond 1 WATER SURFACE	AT BANK FULL AT BANK FULL Fork, ZUMBR( 0.0 ition Data for DISCHARG 1 (cfs) 2500.000 ENERGY VELOO LINE HE? TROL POINT #	TIME= 52.00 <b>DRIVER - Stream</b> DOS <b>DRIVER - Stream</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b>	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> VG VEL (by sub	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo	2 = 50 DAYS ME= 2.4 O 6. South (yrs) undary Cond J WATER J SURFACE CTION - CONT	AT BANK FULL 0000 DAYS TO Fork, ZUMBR( 0.0 ition Data fo DISCHARGE 1 (cfs) 2500.000 ENERGY VELOO LINE HE2 TROL POINT # DISCHARGE 1	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> <b>OF STREAM SEGMEN</b> (deg F) 65.00 CITY ALPHA AD 3 is upstream CEMPERATURE	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> WG VEL (by sub 1 2	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream BO ***** DISCHARGE (CFS)	2 = 50 DAYS . ME= 2.4 0 6. South (yrs) undary Cond WATER 1 SURFACE CTION - CON	AT BANK FULL 0000 DAYS TO Fork, ZUMBR( 0 fition Data f( DISCHARGE 1 (cfs) 2500.000 ENERGY VELOC LINE HE2 TROL POINT # DISCHARGE 1 (cfs)	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> (deg F) 65.00 CITY ALPHA AD 3 is upstream TEMPERATURE (deg F)	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> WG VEL (by sub 1 2	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond SURFACE CTION - CONT Inflow:	AT BANK FULL AT BANK FULL Fork, ZUMBR 0.0 ition Data for (cfs) 2500.000 ENERGY VELOO LINE HEZ TROL POINT # DISCHARGE T (cfs) 650.000	TIME= 52.00 <b>DRIVER - Stream</b> DOS <b>DRIVER - Stream</b> DOS <b>DRIVER - Stream</b> TEMPERATURE WAT (deg F) 65.00 CITY ALPHA AD 3 is upstream TEMPERATURE (deg F) 67.00	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> WG VEL (by sub 1 2	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TH EXAMPLE PROBLEM N ACCUMULATED TIME Downstream BO ***** DISCHARGE (CFS) TRIBUTARY JUN	2 = 50 DAYS . ME= 2.4 0 6. South (yrs) undary Cond WATER 1 SURFACE CTION - CON	AT BANK FULL 0000 DAYS TO Fork, ZUMBR( 0 fition Data f( DISCHARGE 1 (cfs) 2500.000 ENERGY VELOC LINE HE2 TROL POINT # DISCHARGE 1 (cfs)	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> (deg F) 65.00 CITY ALPHA AD 3 is upstream TEMPERATURE (deg F)	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> WG VEL (by sub 1 2	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIJ EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo **** DISCHARGE (CFS) TRIBUTARY JUN Tributary SECTION NO. 5	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond 1 WATER 1 SURFACE CTION - CONT 1 Inflow: Total: 5.000	AT BANK FULL AT BANK FULL Fork, ZUMBR( 0.0 ition Data for (cfs) 2500.000 ENERGY VELOO LINE HE2 TROL POINT # DISCHARGE T (cfs) 650.000 1400.000	TIME= 52.00 <b>DRIVER - Stream</b> DOS <b>DRIVER - Stream</b> DOS <b>DRIVER - Stream</b> <b>STREAM SEGMEN</b> <b>TEMPERATURE WAT</b> (deg F) 65.00 CITY ALPHA AD 3 is upstream <b>TEMPERATURE</b> (deg F) 67.00 62.04	<b>NT NO. 1 at</b> VER SURFACE (ft) 965.000 TOP A WIDTH B	Control P VG A ED	<b>'oint # 1</b> WG VEL (by sub 1 2	
PS 6.0 END TIME STEP # * AC FLOW 2 COMPUTING FROM TIJ EXAMPLE PROBLEM N ACCUMULATED TIME Downstream Bo **** DISCHARGE (CFS) TRIBUTARY JUN Tributary SECTION NO. 5	2 = 50 DAYS ME= 2.4 0 6. South (yrs) undary Cond 1 WATER 1 SURFACE CTION - CONT 1 Inflow: Total: 5.000	AT BANK FULL AT BANK FULL Fork, ZUMBR 0.0 ition Data for (cfs) 2500.000 ENERGY VELOO LINE HEZ TROL POINT # DISCHARGE T (cfs) 650.000	TIME= 52.00 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> DO5 <b>DRIVER - Stream</b> <b>DRIVER - Stream</b> <b>TEMPERATURE</b> (deg F) 67.00 62.04 D74 1.000 1	<b>Segment 1</b> <b>WT NO. 1 at</b> TER SURFACE (ft) 965.000 TOP A WIDTH B of Section	 Control F VG A ED No. 5 4.980 0.	<b>Coint # 1</b> <b>NG VEL (by sub</b> 1 2 3.000 000 2.182	

EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4

EXAMPLE 6 Cont. ZUMBR	80 RIVER Project	- TAKEO CREEK - St	tream Segment 4		
Downstream Bounda	DISCHARGE	a for STREAM SEGME TEMPERATURE WA (deg F) 0 73.00	TER SURFACE	rol Point # 4	
**** DISCHARGE WA (CFS) SUR				AVG VEL (by 1 2	subsection) 3
SECTION NO. 6.00 **** 450.000 988	0 .475 988.626	0.151 1.000 FLOW DI	67.244 986.328 STRIBUTION (%) =	0.000 3.11 0.000 100.00	.7 0.000 00 0.000
EXAMPLE 6 Cont. ZUMBR ACCUMULATED TI FLOW DURATION		- TAKEO CREEK - St			-
UPSTREAM BOUNDARY CON	DITIONS				
Stream Segment # 4 Section No. 6.00					
INFLC	W 450.00	356.05	73.00		
SEDIMENT INFLOW at	SECTION NO.	6.000	LOAD (tons/da	(z)	
FINE SAND MEDIUM SAND	. 74.83	FINE GRAVEL MEDIUM GRAVEL.	0.0	0	
COARSE SAND VERY COARSE SAND.	. 57.98 . 0.00	COARSE GRAVEL. VERY COARSE GR	7EL.         0.0            0.0            0.0            0.0            0.0            0.0            0.0            0.0	0 0	
			AL = 356.0	-	
FALL VELOCITIES - DIAMETE		REY. NO.	CD		
F SAND 0.00058 M SAND 0.00116	0 0.6288557E-01 0 0.1423402	3.579113 16.20246	10.38092 4.052398		
C SAND 0.00232 VC SAND 0.00464	0 0.2905100 0.4865262	66.13704 221.5240	1.945695 1.387444		
VF GRVL 0.00928	0 0.7223283	657.7777 1897 368	1.258893		
M GRVL 0.03711	8 1.472894	5365.081	1.211086		
VF SAND 0.00029 F SAND 0.0018 M SAND 0.00116 C SAND 0.00232 VC SAND 0.00444 VF GRVL 0.00928 F GRVL 0.01855 M GRVL 0.03711 C GRVL 0.07423 VC GRVL 0.14847	7 2.082985 4 2.945788	15174.71 42920.64	1.211086 1.211086		
**************************************	CE OUTPUT FOR SE		**************************************	***********	***
HYDRAULIC PARAMETERS:					
3.117 0.008268	2.838 50	D.874 0.0460	TAU USTARM 1.46520 0.86883	0.326	
BED SEDIMENT CONTROL NEW SURFACE AREA (SQ	VOLUME COMPUTATION FT): TOTAL 22942.50	ONS: K-PORTION 0 22942.50	S-PORTION 0.00		
GRADATION OF ACTIVE F				DED EDIGETON	DED CENTRE DELIER
BED MATERIAL PER GRAI		RACTION PERCENT E .080074 8.007		BED FRACTION 0.000000	PERCENT FINER 99.999999
		.214080 29.415 .539976 83.413		0.000000 0.000000	99.999999 99.9999999
	C SAND 0	.165870 99.999	9999 C GRVL	0.000000	99.9999999 99.9999999
	= 0.013194				
BED SURFACE EXPOSED					
INACTIVE LAYE	H & DE	PTH			
CLAY 0.0000 0.0 SILT 0.0000 0.0		0.00 0.00			
SAND 1.0000 0.0 TOTAL 1.0000 0.0	0 1.0000	0.36			
AVG. UNIT	AVG. UN				
WEIGHT 0.046500	WEIGHT 0.0465				
		2.00 DAYS.			
ACTIVE LAYER THICKNES			JOIR.		

...LOWER THE MODEL BOTTOM BY MORE THAN 1.35 FT.

$\begin{array}{llllllllllllllllllllllllllllllllllll$	0 0 1 9 8 8 8 8 8 0 5
** INACTIVE LAYER ** BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER VF SAND 0.000000 0.000000 F SAND 0.000000 0.000000 M SAND 0.000000 0.000000 C SAND 0.000000 0.000000 VC SAND 0.000000 0.000000	BED FRACTION         PERCENT FINER           VF GRVL         0.000000         0.000000           F GRVL         0.000000         0.000000           M GRVL         0.000000         0.000000           C GRVL         0.000000         0.000000           C GRVL         0.000000         0.000000           VC GRVL         0.000000         0.000000
** ACTIVE LAYER ** BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER VF SAND 0.080074 8.007434 F SAND 0.214080 29.415438 M SAND 0.539976 83.413004 C SAND 0.165870 100.000000 VC SAND 0.000000 100.000000	BED         FRACTION         PERCENT FINER           VF         GRVL         0.000000         100.000000           F         GRVL         0.000000         100.000000           M         GRVL         0.000000         100.000000           C         GRVL         0.000000         100.000000           VC         GRVL         0.000000         100.000000
C FINES, COEF(CFFML), MX POTENTIAL= 0.000000E+00 0.100000E+01 POTENTIAL TRANSPORT (tons/day): VF SAND 0.897832E+05 VF GRVI F SAND 0.221666E+05 F GRVI M SAND 0.964949E+04 M GRVI C SAND 0.957199E+04 C GRVI VC SAND 0.432242E+04 VC GRVI	L 0.204164E+02 L 0.182502E+02 L 0.846757E+00 L 0.100000E-06
SEDIMENT OUTFLOW FROM SECTION NO. 6.000 GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LOA	AD (tons/day)
VERY FINE SAND40.64VERY FINE GRAVELFINE SAND91.22FINE GRAVELMEDIUM SAND230.08MEDIUM GRAVELCOARSE SAND70.67COARSE GRAVELVERY COARSE SAND0.00VERY COARSE GRAVEL	
TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 4         EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREE         ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM         TIME ENTRY * SAND *         DAYS POINT * INFLOW OUTFLOW TRAP EFF *         52.00 6.000 * 8.81         TOTAL= 1.000 * 8.81	
TABLE SE-1: SEDIMENT LOAD PASSING THE BOUNDARTES OF STREAM	SEGMENT # 4
SEDIMENT INFLOW at the Upstream Boundary:         GRAIN SIZE         LOAD (tons/day)         GRAIN SIZE         LOAD	AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LO.	AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LO.	AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LO.	AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary:         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO.         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE SAND         MEDIUM SAND       188.73       MEDIUM GRAVEL       COARSE GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         TOTAL =       SEDIMENT OUTFLOW from the Downstream Boundary	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 356.05
SEDIMENT INFLOW at the Upstream Boundary:         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LOAD         VERY FINE SAND       34.51       VERY FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL         COARSE SAND       57.98       COARSE GRAVEL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 356.05 AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary:         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LOAD         VERY FINE SAND       34.51       VERY FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL         COARSE SAND       57.98       COARSE GRAVEL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 356.05 AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary:         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LOAD         VERY FINE SAND       34.51       VERY FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL         COARSE SAND       57.98       COARSE GRAVEL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary         GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 356.05 AD (tons/day)
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO.         VERY FINE SAND       34.51       VERY FINE GRAVEL.       FINE GRAVEL.         FINE SAND       74.83       FINE GRAVEL.       FINE GRAVEL.         MEDIUM SAND       188.73       MEDIUM GRAVEL.       MEDIUM GRAVEL.         COARSE SAND       57.98       COARSE GRAVEL.       TOTAL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.75       VERY FINE GRAVEL.       FINE GRAVEL.       FINE GRAVEL.       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL.       FINE GRAVEL.       MEDIUM GRAVEL.         VERY COARSE SAND       68.94       COARSE GRAVEL.       COARSE GRAVEL.       WERY COARSE GRAVEL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL       MEDIUM GRAVEL       MEDIUM GRAVEL	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 356.05 AD (tons/day) 0.01 0.00 0.00 0.00 0.00 0.00 0.00
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL       MEDIUM GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LO         VERY FINE SAND       34.75       VERY FINE GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL         MEDIUM SAND       261.12       MEDIUM GRAVEL         MEDIUM SAND       68.94       COARSE GRAVEL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL       MEDIUM GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       68.94       COARSE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL       TOTAL =         TOTAL =       TOTAL =       TOTAL =       TOTAL =	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL       MEDIUM GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       90.86 <td>AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0</td>	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL       MEDIUM GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       90.86 <td>AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0</td>	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL       FINE GRAVEL         FINE SAND       74.83       FINE GRAVEL       MEDIUM GRAVEL         MEDIUM SAND       188.73       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       57.98       COARSE GRAVEL       TOTAL =         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL       MEDIUM GRAVEL         VERY COARSE SAND       90.86 <td>AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0</td>	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL.       FINE GRAVEL.       FINE GRAVEL.         FINE SAND       74.83       FINE GRAVEL.       FINE GRAVEL.         MEDIUM SAND       188.73       MEDIUM GRAVEL         COARSE SAND       57.98       COARSE GRAVEL.         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         VERY COARSE SAND       0.00       VERY COARSE GRAVEL         VERY FINE SAND       90.06       FINE GRAVEL         VERY FINE SAND       90.86       FINE GRAVEL         MEDIUM SAND       261.12       MEDIUM GRAVEL         COARSE SAND       68.94       COARSE GRAVEL.         VERY COARSE SAND       0.35       VERY COARSE GRAVEL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL         TOTAL =       TOTAL =       TOTAL =	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZEGRAIN SIZELOAD (tons/day)GRAIN SIZELOADVERY FINE SAND34.51VERY FINE GRAVELFINE SAND74.83FINE GRAVELMEDIUM SAND188.73MEDIUM GRAVELCOARSE SAND57.98COARSE GRAVELVERY COARSE SAND0.00VERY COARSE GRAVELVERY COARSE SAND0.01VERY COARSE GRAVELGRAIN SIZELOAD (tons/day)GRAIN SIZELOVERY FINE SAND90.86FINE GRAVELFINE SAND90.86FINE GRAVELMEDIUM SAND261.12MEDIUM GRAVELCOARSE SAND68.94COARSE GRAVELCOARSE SAND0.35VERY COARSE GRAVELVERY COARSE SAND0.35VERY COARSE GRAVELTOTAL =TABLE SB-2: STATUS OF THE BED PROFILE AT TIME =52.000 DASECTION BED CHANGE WS ELEV THALWEG Q TRANUMBER(ft)(ft)(ft)(ft)(cfs)6.000-0.10988.47984.70450.2.100-5.56979.39973.74450.1.000-2.93979.22976.07450.ACCUMULATED TIME (yrs)0.142FLOW DURATION (days)5.000	AD (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.0
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       34.51       VERY FINE GRAVEL.       FINE GRAVEL.         FINE SAND       74.83       FINE GRAVEL.       FINE GRAVEL.         MEDIUM SAND       188.73       MEDIUM GRAVEL       FOR GRAVEL.         COARSE SAND       57.98       COARSE GRAVEL.       TOTAL         SEDIMENT OUTFLOW from the Downstream Boundary       GRAIN SIZE       LOAD (tons/day)       GRAIN SIZE       LO         VERY FINE SAND       90.86       FINE GRAVEL.       TOTAL       FINE GRAVEL.         VERY FINE SAND       90.86       FINE GRAVEL.       MEDIUM GRAVEL.       TOTAL         VERY FINE SAND       90.86       FINE GRAVEL.       MEDIUM GRAVEL.       TOTAL         VERY COARSE SAND       90.86       FINE GRAVEL.       TOTAL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL       TOTAL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL       TOTAL         VERY COARSE SAND       0.35       VERY COARSE GRAVEL       TOTAL         TOTAL       TOTAL       TOTAL       TOTAL       TOTAL         TABLE SB-2:	AD (tons/day) 0.00 0.33 428 461. 456.

TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 3 EXAMPLE 6 Cont. ZUMBRO RIVER Project - BEAR CREEK - Stream Segment 3 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT TIME ENTRY \* SAND POINT \* OUTFLOW TRAP EFF \* INFLOW DAYS 6.000 \* 2.12 52.00 2.100 \* 15.35 18.72 -0. 1.000 \* TOTAL 0 \* 17.46 -0 07 \* -TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 3 SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/dav) VERY FINE GRAVEL.. 0.0 VERY FINE SAND.... 13.47 0.00 FINE SAND..... FINE GRAVEL..... 25.63 0.00 
 25.63
 FINE GRAVEL.....

 45.58
 MEDIUM GRAVEL.....

 0.98
 COARSE GRAVEL.....

 0.00
 VERY COARSE GRAVEL
 45.58 0.98 MEDIUM SAND..... COARSE SAND..... 0.00 0.00 VERY COARSE SAND ... 0.00 -----TOTAL = 85.67 SEDIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) 
 VERY FINE SAND....
 37.77

 FINE SAND......
 62.53

 MEDIUM SAND......
 97.21

 COARSE SAND......
 19.34

 VERY COARSE SAND......
 0.13
 VERY FINE GRAVEL.. 0.00 FINE GRAVEL..... 0.00 0.00 COARSE GRAVEL..... 0.00 VERY COARSE GRAVEL 0.00 TOTAL = 216.98 TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 52.000 DAYS -----\_\_\_\_\_ SECTION BED CHANGE WS ELEV THALWEG 0 TRANSPORT RATE (tons/day) SAND (ft) 0.05 0.02 -2.39 NUMBER (cfs) (ft) (ft) 6.000 982.85 985.16 200. 69. 73. 979.89 979.22 978.32 974.91 4.000 200. 2.100 650. 589. 1.000 4.42 979.11 972.82 650. 217. EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 ACCUMULATED TIME (yrs).... 0.142 FLOW DURATION (days)..... 5.000 UPSTREAM BOUNDARY CONDITIONS Stream Segment # 2 # 2<br/>6.200DISCHARGE<br/>(cfs)SEDIMENT LOAD<br/>(tons/day)TEMPERATURE<br/>(deg F)INFLOW300.0040.0072.00 Section No. ------TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 2 EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT TIME ENTRY \* DAYS POINT \* SAND INFLOW OUTFLOW TRAP EFF \* 6.200 \* 0.99 52.00 1.000 \* 0.99 0.76 0.23 \* TOTAL= TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 2 . SEDIMENT INFLOW at the Upstream Boundary: 
 GRAIN SIZE
 LOAD (tons/day) |
 GRAIN SIZE
 LOAD (tons/day)

 ERY FINE SAND....
 7.04
 VERY FINE GRAVEL..
 0.4
 LOAD (tons/day) \_\_\_\_\_ VERY FINE SAND.... 0.48 FINE SAND..... FINE GRAVEL..... 14.50 0.20 14.10 2.57 1.10 MEDIUM GRAVEL.... COARSE GRAVEL.... MEDIUM SAND..... 0.00 0.00 COARSE SAND..... VERY COARSE GRAVEL VERY COARSE SAND ... 1.10 0.00 -----TOTAL = 40.00 SEDIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) VERY FINE SAND.... 5.88 VERY FINE GRAVEL.. 0.65 
 VERY FINE SAND.....
 5.00

 FINE SAND.....
 13.30

 MEDIUM SAND.....
 11.37

 COARSE SAND.....
 2.01

 VERY COARSE SAND....
 0.99
 FINE GRAVEL..... MEDIUM GRAVEL..... 1.02 0.57 0.00 COARSE GRAVEL.... VERY COARSE GRAVEL -----

TOTAL = 35.77

TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 52.000 DAYS	
SECTION         BED CHANGE         WS ELEV         THALWEG         Q         TRANSPORT RATE (tons/day)           NUMBER         (ft)         (ft)         (cfs)         SAND           6.200         0.06         973.80         972.06         300.         32.           4.000         0.03         970.92         968.33         300.         26.           3.000         0.02         966.52         964.32         300.         22.           1.000         0.21         965.15         960.01         300.         36.	
6.200         0.06         973.80         972.06         300.         32.           4.000         0.03         970.92         968.33         300.         26.	
3.000 0.02 966.52 964.32 300. 22. 1.000 0.21 965.15 960.01 300. 36.	
EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1	
ACCUMULATED TIME (yrs) 0.142 FLOW DURATION (days) 5.000	
UPSTREAM BOUNDARY CONDITIONS	
Stream Segment # 1 DISCHARGE   SEDIMENT LOAD   TEMPERATURE	
Stream Segment # 1     DISCHARGE     SEDIMENT LOAD     TEMPERATURE       Section No.     58.000     (cfs)     (tons/day)     (deg F)	
INFLOW   1400.00   529.98   62.04	
SEDIMENT INFLOW at SECTION NO. 58.000 GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LOAD (tons/day)	
VERY FINE SAND 265.63 VERY FINE GRAVEL 0.00	
FINE SAND         173.06         FINE GRAVEL         0.00           MEDIUM SAND         82.59         MEDIUM GRAVEL         0.00	
VERY FINE SAND         265.63         VERY FINE GRAVEL         0.00           FINE SAND         173.06         FINE GRAVEL         0.00           MEDIUM SAND         82.59         MEDIUM GRAVEL         0.00           COARSE SAND         6.27         COARSE GRAVEL         0.00           VERY COARSE SAND         2.42         VERY COARSE GRAVEL         0.00	
TOTAL = 529.98	
FALL VELOCITIES - Method 2	
DIAMETER VELOCITY REY. NO. CD	
VF SAND       0.000290       0.1863592E-01       0.4575463       59.10251         F       SAND       0.000580       0.5772227E-01       2.834376       12.32115         M       SAND       0.001160       0.1329160       13.05331       4.647428         C       SAND       0.002320       0.2804704       55.08844       2.087483         VC SAND       0.004640       0.4808243       188.8821       1.420545         VF GRVL       0.009280       0.7191678       565.0209       1.269982         F       GRVL       0.018559       1.039734       1633.750       1.215185         M       GRVL       0.037118       1.472894       4628.774       1.211086         C       GRVL       0.074237       2.082985       13092.12       1.211086         VC GRVL       0.148474       2.945788       37030.19       1.211086	
M SAND 0.001160 0.1329160 13.05331 4.647428 C SAND 0.002320 0.2804704 55.08844 2.087483	
VC SAND 0.004640 0.4808243 188.8821 1.420545 VF GRVL 0.009280 0.7191678 565.0209 1.269982	
F GRVL 0.018559 1.039734 1633.750 1.215185 M GRVL 0.037118 1.472894 4628.774 1.211086	
C GRVL 0.074237 2.082985 13092.12 1.211086	
VC GRVL 0.148474 2.945788 37030.19 1.211086	
***************************************	
TRACE OUTPUT FOR SECTION NO. 55.000	
TRACE OUTPUT FOR SECTION NO. 55.000	
TRACE OUTPUT FOR SECTION NO.       55.000         HYDRAULIC PARAMETERS:	
TRACE OUTPUT FOR SECTION NO.       55.000         HYDRAULIC PARAMETERS:	
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:       NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         30938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS	
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.003404       0.340403       VF GRVL       0.106364       90.22	
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:       NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00       36726       0.208         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.003404       0.340403       VF GRVL       0.106364       90.22         M SAND       0.023017       2.642100       F GRVL       0.39881       94.22	27344 50950
TRACE OUTPUT FOR SECTION NO. 55.000INTRACE OUTPUT FOR SECTION NO. 55.000HYDRAULIC PARAMETERS: VEL SLO EFD EFW N-VALUE TAU USTARM FROUDE NO. 2.978 0.000661 6.346 86.708 0.0450 0.26180 0.36726 0.208BED SEDIMENT CONTROL VOLUME COMPUTATIONS: NEW SURFACE AREA (SQ FT): TOTAL K-PORTION S-PORTION 230938.67 230938.67 0.00GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER VF SAND 0.003404 0.340403 VF GRVL 0.106364 90.21 F SAND 0.023017 2.642100 F GRVL 0.039881 94.21 M SAND 0.043820 7.024101 M GRVL 0.000336 94.21 C SAND 0.028706 97.11	27344
TRACE OUTPUT FOR SECTION NO. 55.000         INTRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.003404       0.340403       VF GRVL       0.106364       90.22         M SAND       0.043802       7.024101       M GRVL       0.0039881       94.22         M SAND       0.043802       7.024101       M GRVL       0.0028706       97.11         VC SAND       0.219762       79.602775       VC GRVL       0.028685       99.95	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:       NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00       340403       VF GRVL       0.106364       90.22         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT FINER       BED FRACTION PERCENT       F SAND       0.023017       2.642100       F GRVL       0.106364       90.22         M SAND       0.023017       2.642100       F GRVL       0.106364       90.22         M SAND       0.023017       2.642100       F GRVL       0.039881       94.22         M SAND       0.023017       2.642100       F GRVL       0.00336       94.22         M SAND       0.023017       2.642100       F GRVL       0.028706       97.11         VC SAND       0.219762       79.602775       VC GRVL       0.028685       99.91         SAND       ** ARMOR LAYER ***	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.023017       2.642100       F       GRVL       0.039881       94.22         M SAND       0.043820       7.024101       M       GRVL       0.0028706       97.11         VC SAND       0.219762       79.602775       VC GRVL       0.028685       99.91	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA       (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00       GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.003404       0.340403       VF GRVL       0.106364       90.22         M SAND       0.0034017       2.642100       F GRVL       0.0039881       94.22         M SAND       0.043820       7.024101       M GRVL       0.0028766       97.91         VC SAND       0.219762       79.602775       VC GRVL       0.028685       99.99         SAND         * ARMOR LAYER **         SAND       0.003556         BED SURFACE EXPOSED = 1.00000 <t< td=""><td>27344 50950 31515</td></t<>	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         INTRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION       PERCENT         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.003404       0.340403       VF GRVL       0.106364       90.22         M SAND       0.023017       2.642100       F GRVL       0.003366       94.22         M SAND       0.043820       7.02401       M GRVL       0.000336       94.22         M SAND       0.219762       79.602775       VC GRVL       0.028685       99.99         SAND         ** ARMOR LAYER **         STABILITY COEFFICIENT=       0.84259	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00       0.00         SRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT       FECENT         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         YF SAND       0.003404       0.340403       YF GRVL       0.106364       90.22         M SAND       0.043820       7.024101       M GRVL       0.00386       94.22         C SAND       0.219762       79.602775       VC GRVL       0.028685       99.93         SAND       ** ARMOR LAYER ***       **       STABILITY COEFFICIENT=       0.84259         MIN.GRAIN DIAM       =       0.003556       BED SURFACE EXPOSED =       1.00000         INACTIVE LAYE	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         SADATION OF ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         YF SAND       0.003017       2.642100       F       GRVL       0.0039881       94.22         M< SAND	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00       0.00         SRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT       FECENT         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT         YF SAND       0.003404       0.340403       YF GRVL       0.106364       90.22         M SAND       0.043820       7.024101       M GRVL       0.00386       94.22         C SAND       0.219762       79.602775       VC GRVL       0.028685       99.93         SAND       ** ARMOR LAYER ***       **       STABILITY COEFFICIENT=       0.84259         MIN.GRAIN DIAM       =       0.003556       BED SURFACE EXPOSED =       1.00000         INACTIVE LAYE	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BEED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       0.00         RADATION OF ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER       BED FRACTION PERCENT         VF SAND       0.023017       2.642100       F GRVL       0.033681       94.22         C SAND       0.506025       57.626611       C GRVL       0.028706       97.11         VC SAND       0.219762       79.602775       VC GRVL       0.028685       99.91         SAND         INACTIVE LAYER         * ARMOR LAYER **         SAND         INACTIVE LAYER         * DEPTH         CLAY 0.0000	27344 50950 31515
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         TRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.978       0.000661       6.346       86.708       0.450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         GRADATION OF ACTIVE PLUS INACTIVE DEPOSITS       BED FRACTION PERCENT       F SAND       0.0033017       2.642100       F GRVL       0.106364       90.21         M SAND       0.043820       7.024101       M GRVL       0.003364       94.22         C SAND       0.219762       79.602775       VC GRVL       0.028685       99.91         SAND         INACTIVE LAYER         *         VF SAND       0.003556         BED FRACTIVE LAYER         *         VC SAND       0.000       0.06         INACTIVE LAYER       C CAN       0.0000 <t< td=""><td>27344 50950 31515</td></t<>	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         INTRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.979 0.000661       6.346       86.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE ARBA (SQ FT):       TOTAL       K-PORTION       S-PORTION         230938.67       230938.67       0.00         SRADATION OF ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE:       BED FRACTION PERCENT FINER       BED FRACTION PERCENT VF SAND         VF SAND       0.03404       0.340403       VF GRVL       0.000381       94.22         VC SAND       0.203027       7.22401       M GRVL       0.028685       99.91         SAND         NO         ***********************************	27344 50950 31515
TRACE OUTPUT FOR SECTION NO. 55.000         INTRACE OUTPUT FOR SECTION NO. 55.000         HYDRAULIC PARAMETERS:         VEL       SLO       EFD       EFW       N-VALUE       TAU       USTARM       FROUDE NO.         2.979       0.000661       6.346       B6.708       0.0450       0.26180       0.36726       0.208         BED SEDIMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K.PORTION       S-PORTION         SAND CONTROL VOLUME COMPUTATIONS:         BED SUBLEMENT CONTROL VOLUME COMPUTATIONS:         NEW SURFACE AREA (SQ FT):       TOTAL       K.PORTION       S-PORTION         SAND ACTIVE PLUS INACTIVE DEPOSITS         BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER       BED FRACTION PERCENT         YE SAND 0.023017       2.642100       YE GRVL       0.106364       90.22         M SAND 0.034820       7.0240101       M GRVL 0.008356       97.12         VC SAND 0.219762       79.602775       VC GRVL 0.028685       99.91         WE SAND         NOTON         INACTIVE LAYER         Y SOUTON	27344 50950 31515

** INACTIVE LAYER ** BED MATERIAL PER GRAIN	SIZE: BED FRA VF SAND 0.0 F SAND 0.0 M SAND 0.0 C SAND 0.5 VC SAND 0.2	CTION         PERCENT         FIN           00671         0.06708         23154         2.38243           43769         6.75937         609027         57.66204           21065         79.76856         76.76856	IER BEI 19 VF GRVL 19 F GRVL 18 M GRVL 17 C GRVL 16 VC GRVL	<pre>&gt; FRACTION 0.105367 0.039383 0.000335 0.028615 0.028615</pre>	PERCENT FINER 90.305284 94.243549 94.277093 97.138545 99.999998
** ACTIVE LAYER ** BED MATERIAL PER GRAIN : 	SIZE:         BED         FRA           VF         SAND         0.4           F         SAND         0.0           M         SAND         0.0           C         SAND         0.0           VC         SAND         0.0	ACTION         PERCENT FIN           64173         46.41728           00000         46.41728           52353         51.65259           000000         51.65259           000000         51.65259	NER BEI 36 VF GRVL 36 F GRVL 37 M GRVL 37 C GRVL 37 VC GRVL	<pre>&gt; FRACTION 0.274462 0.123966 0.000440 0.044068 0.040538</pre>	PERCENT FINER 79.098798 91.495417 91.539461 95.946230 100.000000
C FINES, COEF(CFFML), M POTENTIAL TRANSPORT (to)	ns/day): VF SAN F SAN M SAN C SAN VC SAN	D 0.101876E+05 VF D 0.305709E+04 F D 0.170276E+04 M D 0.126234E+04 C D 0.124827E+04 VC	DE+01 0.302400E+07 GRVL 0.133530E+02 GRVL 0.122091E+02 GRVL 0.100000E-06 GRVL 0.100000E-06 C GRVL 0.100000E-06		
SEDIMENT OUTFLOW FROM GRAIN SIZE L	OAD (tons/day)	GRAIN SIZE	LOAD (tons/day)		
FINE SAND	175.65	FINE GRAVEL	0.96		
MEDIUM SAND	69.90 30.28	MEDIUM GRAVEL COARSE GRAVEL	0.00		
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	13.04	VERY COARSE GRAV	7EL 0.00		
TABLE SA-1. TRAP EFFICI EXAMPLE PRO	ENCY ON STREAM S BLEM NO 6. Sout	SEGMENT # 1	/ER - Stream Segmen	t 1	
******	*****	******	JINDEN DEGREMI		
TIME ENTRY * DAYS POINT * 52.00 58.000 * 53.000 * 42.000 * TOTAL= 35.000 *	SANI INFLOW OUTE	) * LOW TRAP EFF *			
52.00 58.000 *	13.17	*			
42.000 *	0.36	*			
TIME ENTRY *	SANI	***************************************			
DAYS POINT *	INFLOW OUTH	LOW TRAP EFF *			
TIME ENTRY * DAYS POINT * 52.00 35.000 * 15.000 *	0.34	*			
TOTAL= 1.000 *	1.10 (	0.07 0.93 *			
TABLE SB-1: SEDIMENT L					
SEDIMENT INFLOW at the GRAIN SIZE Le	OAD (tons/day)	GRAIN SIZE	LOAD (tons/day)		
VERY FINE SAND FINE SAND MEDIUM SAND COARSE SAND VERY COARSE SAND	265.63	VERY FINE GRAVEL	L 0.00		
MEDIUM SAND	82.59	MEDIUM GRAVEL	0.00		
COARSE SAND VERY COARSE SAND	6.27 2.42	COARSE GRAVEL VERY COARSE GRAV	0.00 /EI, 0.00		
· · · · · · · · · · · · · · · · · · ·					
SEDIMENT OUTFLOW from	the Downstream		L = 529.98		
	OAD (tons/day)	GRAIN SIZE	LOAD (tons/day)		
VERY FINE SAND	0.24	VERY FINE GRAVE	0.00	-	
FINE SAND	0.32	FINE GRAVEL	0.00		
MEDIUM SAND COARSE SAND	0.96	COARSE GRAVEL	0.00 0.00		
VERY COARSE SAND	0.19	VERY FINE GRAVEI FINE GRAVEL MEDIUM GRAVEL COARSE GRAVEL VERY COARSE GRAV	/EL 0.00		
		TOTAI			
TABLE SB-2: STATUS OF '	THE BED PROFILE	AT TIME = 52.00	NO DAYS		
		AT TIME - 52.00			
SECTION BED CHANGE	WS ELEV THAI	JWEG Q	TRANSPORT RATE (to	ons/day)	
SECTION         BED         CHANGE           NUMBER         (ft)           58.000         -1.11           55.000         -0.13           53.000         -0.04           44.000         1.50           42.000         0.26           35.000         0.02           33.900         0.00           33.300         0.00           32.000         -0.51           15.000         0.00           1.000         1.01	981.78 974	.29 1400.	559.		
55.000 -0.13 53.000 -0.04	980.83 972 979.11 973	2.77 1400. 2.16 2050	586. 1005.		
44.000 1.50	978.55 968	3.60 2050.	274.		
42.000 0.26 35.000 0.02	978.28 970 978.00 965	1.06 2200. 3.32 2200	31. 16.		
33.900 0.00	968.54 962	2.65 2200.	13.		
33.300 0.00 33.000 0.00	968.08 962 967.49 961	2200. 00 2200.	10. 8.		
32.000 -0.51	966.51 955	2200.	285.		
15.000 0.00 1.000 1.01	965.15 953 965.00 944	5.70 2500. 5.71 2500	232.		
		. (. (. )			
Accumulated Water Disch MAIN	argo trom days go	wo (atd)			
PLATIN	arge from day ze	(514)			
1500.00					

TIME STEP # 3 \* A FLOW 3 = NEAR BANK FULL DISCHARGE TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 4 EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT ENTRY \* TIME SAND POINT \* DAYS INFLOW OUTFLOW TRAP EFF \* 6.000 \* 8.87 53.00 -0.79 \* 1.000 \* TOTAL= 8.87 15.87 \*\*\*\*\*\*\*\*\*\*\* TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 3 EXAMPLE 6 Cont. ZUMBRO RIVER Project - BEAR CREEK - Stream Segment 3 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT ENTRY \* TIME SAND POINT \* INFLOW OUTFLOW TRAP EFF DAYS 2.13 15.87 6.000 \* 53.00 2.100 \* 1.000 \* TOTAL= 1.000 \* 18.00 20.27 -0 -0.13 \* TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 2 EXAMPLE 6 Cont. ZUMBRO RIVER Project - CASCADE CREEK - Stream Segment 2 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT \*\*\*\*\* TIME ENTRY \* SAND POINT \* DAYS INFLOW OUTFLOW TRAP EFF \* 6.200 \* 1.00 53.00 TOTAL= 1.000 \* 0.97 0.03 \* \*\*\*\*\* TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 1 EXAMPLE PROBLEM NO 6. South Fork, ZUMBRO RIVER - Stream Segment 1 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT \*\*\*\*\*\* ENTRY \* SAND TIME POINT \* DAYS INFLOW OUTFLOW TRAP EFF 58.000 \* 53.000 \* 53.00 13.25 20.27 42.000 \* 0.36 TOTAL= 35.000 \* 33.88 0.34 0.99 ENTRY \* POINT \* TIME SAND DAYS INFLOW OUTFLOW TRAP EFF 35.000 \* 15.000 \* 53.00 0.34 0.97 1.000 \* TOTAL= 1.31 0.08 0.94 \* \*\*\*\*\* TIME STEP # 4 FLOW 4 = BASE FLOW OF 500 CFS в \_ \_ \_ \_ \_ - - - - - - - - -EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 ACCUMULATED TIME (yrs).... 0.151 FLOW DURATION (days)..... 2.000 UPSTREAM BOUNDARY CONDITIONS \_\_\_\_\_ ----DISCHARGE | SEDIMENT LOAD | TEMPERATURE (cfs) | (tons/day) | (deg F) Stream Segment # 4 Section No. 6.000 (cfs) \_\_\_\_\_ INFLOW 90.00 23.96 73.00 TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 4 EXAMPLE 6 Cont. ZUMBRO RIVER Project - TAKEO CREEK - Stream Segment 4 ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT ENTRY \* TIME SAND POINT \* 6.000 \* DAYS INFLOW OUTFLOW TRAP EFF \* 55.00 8.90 1.000 \* TOTAL= 8.90 16.24 -0.83 \* \*\*\*\*\*\*\*\*\*\* TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 4 SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day) GRAIN SIZE LOAD (tons/dav) -----------VERY FINE SAND.... VERY FINE GRAVEL.. 4 84 0 00 FINE SAND..... FINE GRAVEL..... 8.23 0.00 MEDIUM SAND..... 10.86 MEDIUM GRAVEL.... 0.00 COARSE SAND...... VERY COARSE SAND.. 0.02 COARSE GRAVEL..... VERY COARSE GRAVEL 0.00 0.00 0.00 TOTAL = 23.96 SEDIMENT OUTFLOW from the Downstream Boundary LOAD (tons/day) GRAIN SIZE LOAD (tons/day) | GRAIN GRAIN SIZE GRAIN SIZE VERY FINE SAND.... VERY FINE GRAVEL.. 15.35 0.09 FINE GRAVEL..... FINE SAND..... 91.96 0.00

MEDIUM & COARSE & VERY COA	SAND SAND ARSE SAND	244.08 22.05 1.39	MEDIUM GRAVEL. COARSE GRAVEL. VERY COARSE GR	  AVEL	0.00 0.00 0.00	
			TOT.	AL = 37	4.91	
			AT TIME = 55.			
SECTION NUMBER	BED CHANGE (ft)	WS ELEV THAL (ft) (f	WEG         Q           (t)         (cfs)           .70         90.           .30         90.           .02         90.           .01         90.	TRANSPORT R SAND	ATE (tons/day)	
6.000	-0.10	986.44 984	.70 90.	34.		
4.000	0.00	981.30 980	.30 90.	35.		
1.000	-2.99	976.52 976	.01 90.	375.		
EXAMPLE 6 CO ACCU FLOW	ont. ZUMBRO 1 MULATED TIME DURATION (da	RIVER Project - (yrs) ays)	BEAR CREEK - Str 0.151 2.000	eam Segment 3		
	JNDARY CONDI				-	
Stream Segme Section No.	ent # 3 6.000	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	(deg F)		
	INFLOW	38.00	3.96	52.79	-	
*****	TRAP EFFICI EXAMPLE 6 Co ACCUMULATED	ENCY ON STREAM S ont. ZUMBRO RIVE AC-FT ENTERING	EGMENT # 3 R Project - BEAR AND LEAVING THIS		m Segment 3 T	
DAYS	ENTRY *	TNFLOW OF	TOW TRAP EFF *			
55.00	6.000 *	SAND INFLOW OUTF 2.13 16.24 18.37 20	*			
	2.100 *	16.24	*			
TOTAL= *********	* 1.000 *	18.37 20	**************************************			
TABLE SB-1:	SEDIMENT L	DAD PASSING THE	BOUNDARIES OF S	TREAM SEGMENT	# 3	
GRAIN	SIZE LO	e Upstream Bound DAD (tons/day)	GRAIN SIZE	LOAD (tons	/day)	
	NE SAND	0 80 I	VERV ETNE CRAV	 FT.	0.00	
	vD	1.36	FINE GRAVEL		0.00	
	SAND	1.79	MEDIUM GRAVEL.	• • • •	0.00	
	SAND	0.00	VERY FINE GRAV FINE GRAVEL MEDIUM GRAVEL. COARSE GRAVEL. VERY COARSE GR	•••••	0.00	
VERT CO2		0.00				
SEDIMENT ( GRAIN	OUTFLOW from SIZE LO	the Downstream DAD (tons/day)	TOT Boundary GRAIN SIZE		3.96 ;/day)	
					0 01	
FINE SAL	ND	9.72 15.97	FINE GRAVEL	БЦ 	0.00	
MEDIUM S	SAND	26.14	MEDIUM GRAVEL.		0.00	
COARSE S	SAND	2.18	VERY FINE GRAV FINE GRAVEL MEDIUM GRAVEL. COARSE GRAVEL. VERY COARSE GR		0.00	
VERY COM	ARSE SAND	0.09	VERY COARSE GR	AVEL	0.00	
			TOT	AL = 5	4.11	
			AT TIME = 55.			
OT OTT ON	DED GUANCE	NO 11 DI	weg Q		ATE (tons/day)	
NUMBER	(ft)	(ft) (f	t) (cfs)	SAND	-	
6.000	-0.10	983.91 982	30 38.	3.		
2.100	-2.90	975.20 974	.40 128.	718.		
1.000	4.08	974.82 972	.48 128.	54.		
SECTION       BED CHARGE       WS ELEV       THALMEG       Q       TRANSPORT RATE (tons/day)         NUMBER       (ft)       (ft)       (cfs)       SAND         6.000       -0.10       983.91       982.70       38.       3.         4.000       0.00       978.95       978.30       38.       9.         2.100       -2.90       975.20       974.40       128.       718.         1.000       4.08       972.48       128.       54.         EXAMPLE 6 Cont. ZUMERO RIVER Project - CASCADE CREEK - Stream Segment 2       ACCUMULATED TIME (yrs)       0.151         FLOW DURATION (days)       2.000       128.       10.00						
	JNDARY CONDI				-	
Stream Segme Section No.	ent # 2 6.200	DISCHARGE (cfs)	SEDIMENT LOAD   (tons/day)	TEMPERATURE (deg F)		
			4.32			
	2111 101	1 01.00	1 1.52	1 /2:00		
	EXAMPLE 6 Co ACCUMULATED	AC-FT ENTERING	R Project - CASC AND LEAVING THIS	ADE CREEK - St STREAM SEGMEN	ream Segment 2 T	
**********	***********	********************************	*****			
TIME	ENTRY * POINT *	SANE INFLOW OUTUR	* LOW TRAP EFF * * 0.98 0.02 *			
55.00	6.200 *	1.00	*			
TOTAL=	1.000 *	1.00 0	.98 0.02 *			
			*****			

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SEDIMENT I	NFLOW at the	e Upstream	Bounda	ary:				
GRAIN	SIZE LO	DAD (tons/d	ay)	GRAI	N SIZE	LOAD	(tons/day)	_
VERY FIN	NE SAND ID SAND SAND ARSE SAND	2.	87	VERY I	INE GRAVE	L	0.01	
FINE SAN	10	0.	89	FINE C	RAVEL		0.00	
MEDIUM S	SAND	0.	37	MEDIUN	I GRAVEL	• • •	0.00	
VERY COA	AND	U. 0.	03	VERY (	OARSE GRA	VEL	0.00	
				12111	0111010 010			
	OUTFLOW from SIZE LO				TOTA	L =	4.32	
SEDIMENT C	OUTFLOW from	the Downst	ream H	Boundary	N 9775	1.030	(tone/day)	
GRAIN	IE SAND IE SAND ID							-
VERY FIN	E SAND	1.	47	VERY I	INE GRAVE	ъ	3.51	
FINE SAN	ID	0.	46	FINE C	RAVEL	• • •	1.94	
COARSE S		0.	19	COARGI	I GRAVEL CRAVEL	•••	0.00	
VERY COA	ARSE SAND	o.	02	VERY (	OARSE GRA	VEL	0.00	
	-		'					
					TOTA	ц =	7.65	
BLE SB-2:	STATUS OF 1	THE BED PRO	FILE A	AT TIME	= 55.0	00 DAYS		
SECTION	BED CHANGE	WS ELEV	THAL	VEG	Q	TRANS	PORT RATE (t	ons/day)
NOMBER	(10)	(LT) 972 81	(It 972	-/	(CIS) 61	SA	3.	
4.000	0.00	969.50	968	.30	61.		3.	
3.000	0.00	965.80	964	.30	61.		2.	
1.000	BED CHANGE (ft) 0.00 0.00 0.00 -0.30	960.06	959.	.50	61.		8.	
ACCUM FLOW STREAM BOU	BLEM NO 6. S MULATED TIME DURATION (da INDARY CONDIT	(yrs) ays) TIONS	2	0.151 2.000				
ream Segme	ent # 1 58.000	DISCHAR (cfs)	GE	SEDIMI (tons	ENT LOAD s/day)	TEMPER (deg	ATURE F)	
	TNFLOW	28	2.00		28.81		62.06	
*******	ACCUMULATED	AC-FT ENTE	RING A	AND LEAN	ZUMBRO RJ		tream Segmer SEGMENT	it 1
********	ACCUMULATED	AC-FT ENTE	RING A	n Fork, AND LEAN	ZUMBRO RJ			ıt 1
TIME DAYS 55.00 TOTAL=	ACCUMULATED ************************************	AC-FT ENTE ***********************************	RING 2 ***** SAND OUTFI	n Fork, AND LEAN ******* LOW TRA	ZUMBRO RJ VING THIS ******** AP EFF * * * 0.99 *			ıt 1
TIME DAYS 55.00 TOTAL=	ACCUMULATED ************************************	AC-FT ENTE ***********************************	RING A SAND OUTFI	n Fork, AND LEAN ******** LOW TRA	ZUMBRO RJ VING THIS ******** AP EFF * * * 0.99 *			it 1
TIME DAYS 55.00 TOTAL=	ACCUMULATED ************************************	AC-FT ENTE ***********************************	RING A SAND OUTFI	n Fork, AND LEAN ******** LOW TRA	ZUMBRO RJ VING THIS ******** AP EFF * * * 0.99 *			it 1
TIME DAYS 55.00 TOTAL=	ACCUMULATED ************************************	AC-FT ENTE ***********************************	RING A SAND OUTFI	n Fork, AND LEAN ******** LOW TRA	ZUMBRO RJ VING THIS ******** AP EFF * * * 0.99 *			it 1
TIME DAYS 55.00 TOTAL=	ACCUMULATED ************************************	AC-FT ENTE ***********************************	RING A SAND OUTFI	n Fork, AND LEAN ******** LOW TRA	ZUMBRO RJ VING THIS ******** AP EFF * * * 0.99 *			it 1
TIME DAYS 55.00 TOTAL= ******** TIME DAYS 55.00 TOTAL=	ACCUMULATED ************* ENTRY * POINT * 58.000 * 42.000 * 35.000 * ENTRY * POINT * 35.000 * 1.000 *	AC-FT ENTE *********** INFLOW 13.28 20.32 0.36 33.96 ********** INFLOW 0.34 0.98 1.32	RING A SAND OUTFI 0 SAND SAND OUTFI	n Fork, AND LEAN 	ZUMBRO R] /ING THIS ******** AP EFF * * 0.99 * ******** AP EFF * * * 0.93 *			it 1
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TIME DAYS 55.00 TOTAL= ********* TIME DAYS 55.00 TOTAL= ************************************	ACCUMULATED ********** ENTRY * POINT * 58.000 * 42.000 * 355.000 * 42.000 * 355.000 * 15.000 * 15.000 * 15.000 * 15.000 * 15.000 * SEDIMENT LC NFLOW at the SIZE LC IE SAND WITFLOW from SIZE LC IE SAND UTFLOW from SIZE LC IE SAND	AC-FT ENTE ************************************	RING 2 ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI 0. ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI **** *** SAND OUTFI ***** SAND OUTFI ***** SAND OUTFI **** SAND OUTFI **** SAND OUTFI **** SAND OUTFI **** SAND OUTFI SAND OUTFI **** SAND OUTFI SAND OUTFI SAND SAND SAND SAND SAND SAND SAND SAND	1 Fork, NND LEAN NND	ZUMBRO RJ ZUMBRO RJ JING THIS ******** * 0.99 * ******** 0.99 * **********************************	TREAM SE LOAD L   LOAD L = LOAD	GMENT # 1 (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	
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TIME DAYS 55.00 TOTAL= ************************************	ACCUMULATED ********** ENTRY * POINT * 58.000 * 42.000 * 35.000 * 42.000 * 35.000 * 12.000 * *********************************	AC-FT ENTE ************************************	RING 2 ***** SAND OUTFI  0 ***** SAND OUTFI  0 ***** SAND OUTFI  0 ***** THE Bounda ay)  7 THE 80unda ay)  84 00 0 ream I ay)  82 76 38 89 61	1 Fork, NND LEAN NND	ZUMBRO RJ ZUMBRO RJ JING THIS ******* AP EFF * * 0.99 * ******** AP EFF * * 0.93 * ******** RIES OF SJ EN SIZE FINE GRAVEL COARSE GRAVEL SRAVEL TOTA / IN SIZE ********* *************************	TREAM SE LOAD L   LOAD L = LOAD	GMENT # 1 (tons/day) (tons/day) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	
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TIME DAYS 55.00 TOTAL= *********** DAYS 55.00 TOTAL= ************************************	ACCUMULATED ********* ENTRY * POINT * 53.000 * 42.000 * 35.000 * 42.000 * 35.000 * 42.000 * 35.000 * 1	AC-FT ENTE ************************************	RING 2 ***** SAND OUTFI  0 ***** SAND OUTFI  0 ***** THE 0 ***** THE 0 0 ***** THE 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 Fork, NND LEAN NND	ZUMBRO RJ ZUMBRO RJ JING THIS ******** * 0.99 * ******** 0.99 * **********************************	TREAM SE LOAD LOAD LL = LOAD LOAD LOAD	GMENT # 1 (tons/day) (	
TIME DAYS 55.00 TOTAL= ************************************	ACCUMULATED ********* ENTRY * POINT * 53.000 * 42.000 * 35.000 * 42.000 * 35.000 * 42.000 * 35.000 * 1	AC-FT ENTE ************************************	RING 2 ***** SAND OUTFI  0 ***** SAND OUTFI  0 ***** THE 0 ***** THE 0 0 ***** THE 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 Fork, NND LEAN NND	ZUMBRO RJ ZUMBRO RJ JING THIS ******** * 0.99 * ******** 0.99 * **********************************	TREAM SE LOAD LOAD LL = LOAD LOAD LOAD	GMENT # 1 (tons/day) (	
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33.900	0.00	964.90	962.65	439.	Ο.	
33.300	0.00	964.25	962.49	439.	0.	
33,000	0.00	962.87	961.00	439.	0.	
32.000	-0.54	961.80	955.96	439.	211.	
15.000	-0.12	957.22	953.58	500.	1054.	
1.000	1.37	955.00	946.07	500.	14.	
\$\$END						
0 DAT	A ERRORS D	ETECTED.				
TOTAL NO. OF T	IME STEPS	READ =	4			
TOTAL NO. OF W	S PROFILES	=	13			
ITERATIONS IN 1	EXNER EQ =		1560			

COMPUTATIONS COMPLETED RUN TIME = 0 HOURS, 0 MINUTES & 9.00 SECONDS

## 6.7 Example Problem 7 - Cohesive Sediment

Example Problem 7 illustrates the deposition of clays and silts in an impoundment at the downstream end of a single stream segment. Subsequent lowering of the pool level in that impoundment causes erosion of the cohesive deposits. Table 6-7a shows the input data for this example and Table 6-7b shows the output.

## 6.7.1 Cohesive Sediment Data

This example uses Method 2 (see Sections 2.3.8, 3.3.4.1 and the I2 record in Appendix A) to compute the deposition and erosion rates for clay and silts. This method requires the addition of two **Special I2** records to provide the data; one for the active layer and one for the inactive layer. The data for the active layer is described below and is illustrated (along with the data for the inactive layer) in Figure 6-7.

The shear stress threshold above which clays and silts will not deposit is  $0.02 \text{ lb/ft}^2$ . The shear stress at which deposited cohesive material will scour is  $0.05 \text{ lb/ft}^2$ . The shear stress above which mass erosion occurs is  $0.10 \text{ lb/ft}^2$ . The erosion rate at that shear stress is  $1.5 \text{ lb/ft}^2/\text{hr}$ . The slope of the mass erosion rate curve is 60/hr. These values are depicted in Figure 30 for both the active and inactive layers. Note that the shear strength of the inactive layer is larger than that of the active layer and it erodes more slowly. This represents, perhaps, the effect of consolidation.

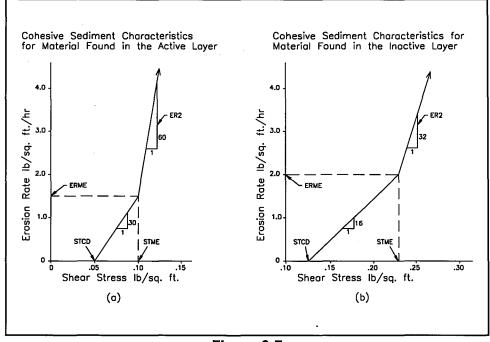


Figure 6-7 Erosion Rate Characteristics

**Caution**, the cohesive sediment values given in Example Problem 7 are not factual and **should not be used** under any circumstances without field verification. To determine these values, laboratory tests must be performed on the sediments to be simulated. These tests must be done under the same physical and chemical conditions as in the prototype (see Section 2.3.8).

## Table 6-7a Example Problem 7 - Input **Cohesive Sediment**

Tl	EXAMPLE I			HESIVE S	EDIMENT				
T2	A LAKE IS								
T3	SOUTH FOR	•			xample	Problem 7	**		
NC .:		.04	.1	.3					
X1 1.4 GR 1004		10077. 978.4	10275. 10002.	0. 956.0	0.		10077.	050 2	10091
GR 950.0		948.48	10108.	946.6	10060. 10138.		10158.	959.3 955.2	10081. 10225.
GR 956.2		958.9	10108.	959.8	10138.		10300.	959.9	10325.
GR 958.		957.4	10400.	970.0	10700.		10960.	970.0	11060.
GR 968.0		968.0	11240.	970.0	11365.		11500.	970.0	11615.
GR 962.0		962.0	12400.	976.0	12550.		12670.	982.0	12730.
GR 984.0						,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	120.00		
HD 1.0		10081.	10250.						
NV 22	.045	965.6	.064	988.8					
NV 12	2.08	965.6	.13	988.8					
NV 33	3.1	965.6	.11	982.0	.12	988.8			
X1 15.0	) 27	10665.	10850.	3560.	3030.	3280.			
Х3			10700.	961.0	11000.	970.0			
GR 992.0	9570.	982.0	10110.	976.0	10300.	976.0	10490.	966.0	10610.
GR 964.'	7 10665.	956.0	10673.	953.0	10693.	954.0	10703.	955.6	10723.
GR 958.0	5 10750.	959.3	10800.	957.0	10822.	957.3	10825.	961.5	10850.
GR 962.0	10852.	964.0	10970.	966.0	11015.	961.0	11090.	962.0	11150.
GR 970.0	) 11190.	972.0	11310.	980.0	11410.	984.0	11570.	990.0	11770.
GR 990.0	) 11865.	1000.0	12150.						
HD 15.0	) 10.	10673.	10852.						
NC .:		.05							
	ADE CREEK								
X1 32.0		10057.	10271.	3630.	3060.	4240.			
GR 998.0		982.0	9250.	982.0	9510.		9600.	980.01	9925.
GR979.48		978.5	10057.	968.6	10075.		10087.	956.5	10097.
GR 956.8		957.8	10137.	959.4	10157.		10177.	959.82	10196.
GR 966.5		971.2	10250.	978.5	10271.		10300.	978.6	10350.
GR978.91		978.96	10387.	980.0	10610.		10745.	982.0	11145.
GR 984.0		992.0	11240.	1000.0	11330.	1008.	11425.		
HD 32.0		10075.	10275.						
NC .00		.045							
X1 42.0		9880.	10130.	8500.	8250.				
GR 996.0		998.0	7310.	998.0	7930.		8205.	990.0	8495.
GR 988.0		986.0	8990.	985.7	9570.		9707.	989.44	9857.
GR 990.0		969.8	9881.	969.8	9941.		9941.	985.8	9943.
GR 969.8		969.8	10001.	986.7	10001.		10003.	969.8	10003.
GR 969.8		985.8	10067.	985.8	10069.		10069.	969.8	10129.
GR 989.9 GR 986.8		989.5 989.9	10180.	988.6	10230.	987.6	10280.	985.2	10430.
HD 42.0		989.9 9881.	12310. 10021.						
	CREEK	<b>3001</b> .	10021.						
X1 44.0		9845.	10127.	3200.	3800.	3500.			
XL 44.0	, 20	J04J.	9850.	10200.	3000.	3500.			
GR 1002	8035.	992.0	8150.	990.0	8305.	990.0	8735.	988.0	8835.
GR 996.0		1017.6	9425.	990.0	9505.		9650.	984.1	9788.
GR 980.6		970.9	9868.	972.2	9898.		9968.	967.5	9998.
GR 968.9		967.4	10058.	967.1	10078.		10118.	976.8	10127.
GR 977.8		976.9	10193.	982.0	10206.		10300.	979.2	10325.
GR 983.1		999.8	10450.	1002.4	10464.				
HD 44.0	) 10.	9868.	10193.						
X1 53.0		10000.	10136.	3366.	2832.	2942.			
GR 1004		1000.0	7760.	998.0	8440.		8640.	996.0	8780.
GR 994.0	8940.	986.0	9245.	986.3	9555.	986.3	9825.	983.8	9900.
GR 982.8	3 10000.	978.2	10011.		10041.		10071.	972.6	10101.
GR 978.2	10121.	988.7	10136.	989.3	10154.	999.2	10200.	1000.1	10320.
GR 1002.		1004.0	10700.						
HD 53.0	) 10.	10000.	10136.						
BEAR (									
X1 55.0		9931.	10062.	2275.	3430.				
GR 1004			7947.	996.0	8627.		9052.	986.0	9337.
GR 984.3		984.7	9837.	985.5	9910.		9931.	978.1	9955.
GR 974.8		974.2	10005.	972.9	10035.		10045.	983.8	10062.
GR 985.8		986.0	10307.	990.0	10497.				
HD 55.0		9931.	10062.						
X1 58.0		9912.	10015.	1098.	1012.				
GR 1006		1004.0	8952.	1000.0	9702.		9812.	996.3	9912.
GR 976.2		975.4	9974.	978.2	9991.			988.3	10062.
GR 988.8		988.3	10065.	989.3				992.0	10242.
GR 992.0		988.0	10642.	986.7	10852.	988.0	11022.	986.0	11097.
GR 986.0		988.0	11192.						
HD 58.0 EJ	) 3.4	9912.	10015.						
20									

T4South Fork, Zumbro River \*\* Example Problem 7 \*\* т5 LOAD CURVE FROM GAGE DATA Т6 BED GRADATIONS FROM FIELD SAMPLES. Т7 CLAY and SILT added to full range of Sands and Gravels. т8 SEDIMENT TRANSPORT BY Yang's STREAM POWER [ref ASCE JOURNAL (YANG 1971)] 11 ٥ I2 CLAY 2 12 12 13 60. 32. CLAY CLAY 02 05 1.5 2.0 1 2 .1 .23 . 02 . 125 SILT 2 1 4 14 SAND 4 1 10 15 .5 . 5 .25 .5 .25 0 1.0 5800 LQ 1 50 1000 90000 LT TOTAL .0220 3.0 640 9000. 800000 LF CLAY LF SILT1 .22 .22 .15 . 13 .10 .25 .25 . 15 . 104 .07 LF SILT2 . 18 . 18 . 13 . 12 .05 .17 .185 LF SILT3 . 13 . 13 . 145 .08 LF SILT4 LF VFS . 10 . 06 . 150 .10 .06 .170 .105 .156 .230  $\mathbf{LF}$ FS .04 .04 .066 .090 .160  $\mathbf{LF}$ MS .02 .02 .027 .060 .115  $\mathbf{LF}$ CS 0 0 .016 .014 .030 vcs  $\mathbf{LF}$ 0 0 .005 .003 .010  $\mathbf{LF}$ VFG 0 .002 0 .004 0  $\mathbf{LF}$ .001 FG 0 0 0 .001  $\mathbf{LF}$ MG 0 0 0 0 0  $\mathbf{LF}$ CG 0 0 0 0 0 VCG  $\mathbf{LF}$ 0 0 0 0 0 PF EXAMP 1.0 1.0 32.0 16.0 96.5 8.0 95.0 4.0 91.0 PFC 2.0 85.0 1.0 1.0 73.0 37.0 .25 8.0 .125 .5 PFC.0625 0.0 PF EXAMP 32.0 1.0 32.0 99.5 99.0 8.0 98.5 64.0 16.0 PFC 4.0 2.0 96.0 93.5 83.0 45.5 .250 8.0 1.0 .50 PFC .125 .0625 0.0 1.0 PF EXAMP 58.0 1.0 32.0 97.0 94.0 8.0 94.0 64.0 16.0 PFC 4.0 90.0 2.0 79.0 1.0 56.0 .50 4.0 .125 0.0 \$HYD \* в FLOW 1 = WARM-UP BASE FLOW OF 750 CFS, LAKE IMPOUNDED. Q 750 R 985 т 65 W 1 \$PRT CP 1 PS 32.0 END \* AB FLOW 2 = 100 DAYS AT BANK FULL Q, LAKE IMPOUNDED. 1250. Q R 985 х 10 100 **\$RATING** 962.0 RC 40 2000 0 0 950.0 955.1 958.0 960.0 963.6 966.2 967.0 RC 965.1 967.7 968.3 968.9 969.4 969.8 RC 970.2 970.6 971.4 972.1 972.4 972.7 972.9 971.0 971.8 RC 973.1 973.3 973.5 973.7 973.8 973.9 974.0 974.1 974.2 RC 974.4 974.6 974.3 974.5 974.7 974.8 974.9 975.0 \* AC FLOW 3 = NEAR BANK FULL Q, LAKE LOWERED. Q 1250 W 2 \$prt **\*** Α в FLOW 4 = NEAR BANK FULL Q, LAKE LOWERED. Q X 1250. 1 20. \* FLOW 5 = LAST FLOW, BASE FLOW OF 750 CFS, LAKE IS LOWERED. в Q 750. x 2 20. \$\$END

## 6.7.2 Output

The geometric and sediment output provide the same information as in previous examples. When the sediment data is read, HEC-6 produces tables of cohesive sediment properties under the headings "CLAY IS PRESENT" and "SILT IS PRESENT". The remainder of the input sediment data is output as before. The first time step has a flow of 750 cfs, a duration of 1 day and a downstream water surface (or pool elevation) of 985 ft. The "TRAP EFFICIENCY..." table, TABLE SA-1, shows that only 7% of the inflowing clay load was deposited in the reservoir since the beginning of the simulation, while 73% of the inflowing silts and 100% of the inflowing sands and gravels were deposited. TABLE SB-2, the "STATUS OF THE BED PROFILE...", shows the outflowing load at each cross section for this time step and the cumulative bed change since the start of the simulation. Only Section No. 58.0 shows a significant bed change, but because there are no local inflows, diversions, or tributaries affecting the load at any cross section, the progressive decrease in the outflowing load at each cross section indicates deposition.

In this example, time step 2 represents 10 separate (incremental) time steps each having a duration of 10 days with a starting water surface of 985 ft and a flow of 1250 cfs. At the end of the last incremental time step, output is produced depicting the state of the reservoir for the last 10 day time step (i.e., instantaneous values such as the sediment load data in TABLE SB-2 are only for the last 10 days, while cumulative data, such as trap efficiency and bed change, represent changes since the start of the simulation - 101 days.) Because of this, output produced by this time step can be misleading. For example, the trap efficiency of clay has decreased since time step 1 indicating that erosion has occurred during the 100 days of this time step. However, the outflowing clay load compared to the inflowing clay load (as shown in TABLE SB-1) indicates that deposition is occurring which reflects the difference between instantaneous and cumulative values.

A rating curve representing channel control at the downstream-most section precedes the data for time step 3. Although the flow for time step 3 and 4 remains at 1250 cfs, the starting water surface obtained from the rating curve is much lower, significantly altering the hydraulic parameters. C-level output was requested for time step 3 and limited to Sections 32.0 and 42.0. The increased velocity at Section No. 32.0 results in a bed shear stress of 0.2980 lb/sq ft, which, from Figure 6-7, results in mass erosion of both layers. The computed potential erosion rates for both clay and silt are 141,700 and 44,214 tons/day for the active and inactive layers respectively. The actual erosion rates will be limited by the availability of these materials.

## Table 6-7b Example Problem 7 - Output Cohesive Sediment

<pre>* SCOUR AND DEPOSITION IN RIVERS AND RESERVOIRS * * Version: 4.1.00 - AUGUST 1993 * INPUT FILE: EXAMPLE7.DAT * * OUTPUT FILE: EXAMPLE7.OUT * RUN DATE: 31 AUG 93 RUN TIME: 08:21:08 * ***********************************</pre>	<pre>* U.S. ARMY CORPS OF ENGINEERS *    HYDROLOGIC ENGINEERING CENTER *    609 SECOND STREET *    DAVIS, CALIFORNIA 95616-4687 *    (916) 756-1104 * ***********************************</pre>
X X XXXXXX XXXXX X X X X X X X X X X X	* tibutaries) * * * * * * * * * * * * * * * * * * *
T1 EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. T2 A LAKE IS CREATED. T3 SOUTH FORK, ZUMBRO RIVER ** Example Prob N values Left Channel Right Contraction 0.1000 0.0400 0.1000 1.1000	

SECTION NO. 1.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. N-Values vs. Elevation Table Right Overbank Channel 0.0450 966. Left Overbank 0.0800 966. 0.1300 989. 966. 966. 989. 982. 0.0640 989. 0.1100 0.0000 0. 0.0000 Ο. 0.1200 989. SECTION NO. 15.000 ...Left Encroachment defined at station 10700.000 at elevation 961.000 ...Right Encroachment defined at station 11000.000 at elevation 970.000 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. . Left Channel Right 0.1000 0.0500 0.1000 Right Contraction N values... Expansion 1.1000 0.7000 SECTION NO. 32.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. . Left Channel Right 0.0600 0.0450 0.0600 Contraction N values... Expansion 1.1000 0.7000 SECTION NO. 42.000 ... DEPTH of the Bed Sediment Control Volume = 0.00 ft. SECTION NO. 44.000 ...Limit CONVEYANCE between stations 9850.000 and 10 ...DEPTH of the Bed Sediment Control Volume = 10.00 ft. 9850.000 and 10200.000 SECTION NO. 53.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 55.000 ... DEPTH of the Bed Sediment Control Volume = 10.00 ft. SECTION NO. 58.000 ... DEPTH of the Bed Sediment Control Volume = 3.40 ft. NO. OF CROSS SECTIONS IN STREAM SEGMENT=  $\ 8$  NO. OF INPUT DATA MESSAGES =  $\ 0$ TOTAL NO. OF CROSS SECTIONS IN THE NETWORK = TOTAL NO. OF STREAM SEGMENTS IN THE NETWORK= 8 1 END OF GEOMETRIC DATA South Fork, Zumbro River LOAD CURVE FROM GAGE DATA. T4\*\* Example Problem 7 \*\* Т5 BED GRADATIONS FROM FIELD SAMPLES. т6 CLAY and SILT added to full range of Sands and Gravels. SEDIMENT TRANSPORT BY Yang'S STREAM POWER [ref ASCE JOURNAL (YANG 1971)] т7 т8 EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. A LAKE IS CREATED. SOUTH FORK, ZUMBRO RIVER \*\* Example Problem 7 \*\* ------SEDIMENT PROPERTIES AND PARAMETERS ACGR NFALL 32.174 CGR NFALL IBSHER 174 2 1 IBG MNQ SPGF SPI 1.000 I1 5. 0 1 1 - - -CLAY IS PRESENT. SPGC PHCD MTCL UWCL. CCCD Τ2 2.650 78.000 30.000 16.000 2 DEPOSITION COEFFICIENTS BY LAYER DEPOSITION THRESHOLD SHEAR LAYER STRESS NO. lb/sq.ft ACTIVE LAYER 1 0.0200 INACTIVE LAYER 2 0.0200 EROSION COEFFICIENTS BY LAYER PARTICLE MASS MASS SLOPE OF SLOPE OF EROSION EROSION EROSION PARTICLE MASS SHEAR SHEAR RATE EROSION EROSION STRESS LAYER STRESS LINE=ER1 LINE=ER2 lb/sq.ft lb/sq.ft. lb/sf/hr NO 1/hr 1/hr 1.5000 0.0500 0.1000 ACTIVE LAYER 1 INACTIVE LAYER 2 30.0000 60.0000 0.1250 0.2300 2.00 2.0000 19.0476 32.0000 - -\_ \_ \_ \_ \_ \_ \_ SILT IS PRESENT MTCL IASL LASL SGSL PUSDLB UWSDLB CCSDLB 13 2 1 4 2.650 82.000 65.000 5.700

-

DEPOSITION COEFFI	DEPOSITION THRESHOLD SHEAR				
ACTIVE LAYER 1 INACTIVE LAYER 2					
EROSION COEFFICI	ENTS BY LAYER PARTICLE MAS EROSION ERO SHEAR SHE STRESS STR lb/sq.ft lb/	S MASS SION EROSIC AR RATE ESS sg.ft. lb/sf/	SLOPE OF PARTICLE EROSION LINE=ER1 'hr 1/hr	SLOPE OF MASS EROSION LINE=ER2 1/hr	
ACTIVE LAYER 1 INACTIVE LAYER 2					
SANDS - BOULDERS A	ARE PRESENT				
MTC IASA I4 4 1	A LASA SPG 10 2.65	S GSF 0 0.667	BSAE 0.500 30	PSI UWDL 0.000 93.00	B 0
USING TRANSPORT CAN GRAIN SIZES UTILIZH	ACITY RELATIONSH	IP # 4, YANG - mm)			
CLAY VERY FINE SILT. MEDIUM SILT COARSE SILT VERY FINE SAND MEDIUM SAND	0.003 0.006 0.011 0.022 0.044 0.088 0.177 0.354	COARSE SAND. VERY COARSE S VERY FINE GRJ FINE GRAVEL. MEDIUM GRAVEI COARSE GRAVEI VERY COARSE G	0.70           SAND         1.41           AVEL         2.82            5.65            11.31           SAVEL         22.62           GRAVEL         45.25	07 -4 -8 57 -4 -2 55	
COEFFICIENTS FOR CO DBI DE IS 0.500 0.50	OMPUTATION SCHEMEBNXID000.2500.2500.250	WERE SPECIFII XIN XIU 500 0.250	3D UBI 0.000 1.	UBN JSL .000 1	
SEDIMENT LOAD TABLE					
LOAD BY (		(tons/day)			
LQ 1.00000	50.0000	1000.00	5800.00	90000.0	
LF CLAY 0.4840001 LF SILT1 0.5500001 LF SILT2 0.396000 LF SILT3 0.2860001 LF SILT4 0.2200001 LF VFS 0.1320001 LF VFS 0.1320001 LF CS 0.1000001 LF VCS 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001 LF CG 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001 LF VCG 0.1000001	2-02 0.660000 2-02 0.750000 3-02 0.540000 3-02 0.390000 2-02 0.300000 3-03 0.120000 3-03 0.60000E-01 3-19 0.100000E-19 3-19 0.10000E-19 3-19 0.10000E-19 0.10000E-19 3-19 0.10000E-19 0.10000E-19 3-19 0.10000E-19 0.10000E-19 3-19 0.10000E-19 0.10000E-19 0.1000E-19 0.10000E-19 0.10000E-19 0.1000E-19 0.	96.0000 96.0000 83.2000 108.800 118.400 67.2000 42.2400 17.2800 8.96000 1.92000 0.10000E-19 0.10000E-19 0.10000E-19	1170.00 936.000 1080.00 1305.00 1404.00 810.000 540.000 144.000 45.0000 18.0000 0.100000E-19 0.100000E-19	80000.0 56000.0 40000.0 64000.1 120000. 128000. 92000.0 24000.0 8000.00 3200.00 800.000 0.100000E-19 0.100000E-19	
TOTAL  0.2200001	3-01 3.00000	640.000	8991.00	800000.	

REACH GEOMETRY FOR STREAM SEGMENT 1

CROSS SECTION	REACH LENGTH	MOVABLE BED	INITIA LEFT SIDE	L BED-ELE THALWEG	VATIONS RIGHT SIDE		O CHANNEL DISTANCE
NO.	(ft)	WIDTH	(ft)	(ft)	(ft)	(ft)	(miles)
	0.000						
1.000	3280.000	183.500	959.300	944.700	958.900	0.000	0.000
15.000		242.000	961.000	953.700	962.000	3280.000	0.621
32.000	4240.000	219.500	968.600	956.500	978.500	7520.000	1.424
42,000	8530.000	154.500	969.800	969.800	969.800	16050.000	3.040
44.000	3500.000	337.500	970.900	967.100	976.900	19550.000	3.703
	2942.000						
53.000	2770.000	195.000	982.800	972.200	988.700	22492.000	4.260
55.000	1462.000	204.000	987.200	972.900	983.800	25262.000	4.784
58.000	1402.000	176.500	996.300	975.400	990.400	26724.000	5.061

#### Chapter 6

BED MATERIAL GRADATION

SECNO	SAE	DMAX (ft)	DXPI (ft)	XPI	TOTAL BED	BED MATERIAL FRACTIONS per grain size
1.000	1.000	0.105	0.105	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.360         M         GRVL         0.015           VF         SILT         0.000         VF         SAND         0.010         VC         SAND         0.120         C         GRVL         0.035           F         SILT         0.000         F         SAND         0.070         VF         GRVL         0.060         VC         GRVL         0.000           M         SILT         0.000         M         SAND         0.290         F         GRVL         0.040         VC
15.000	1.000	0.151	0.151	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.367         M         GRVL         0.011           VF         SILT         0.000         VF         SAND         0.010         VC         SAND         0.113         C         GRVL         0.022           F         SILT         0.000         F         SAND         0.070         VF         GRVL         0.045         VC         GRVL         0.002           M         SILT         0.000         M         SAND         0.327         F         GRVL         0.033         VC         GRVL         0.002         VC
32.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.375         M         GRVL         0.005           VF         SILT         0.000         VF         SAND         0.010         VC         SAND         0.105         C         GRVL         0.005           F         SILT         0.000         F         SAND         0.070         VF         GRVL         0.025         VC         GRVL         0.005           M         SILT         0.000         M         SAND         0.375         F         GRVL         0.025         VC         GRVL         0.005
42.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.439         M         GRVL         0.003           VF         SILT         0.000         VF         SAND         0.006         VC         SAND         0.161         C         GRVL         0.016           F         SILT         0.000         F         SAND         0.048         VF         GRVL         0.063         VC         GRVL         0.016           M         SILT         0.000         M         SAND         0.217         F         GRVL         0.032         VC         GRVL         0.016
44.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.466         M         GRVL         0.002           VF         SILT         0.000         VF         SAND         0.004         VC         SAND         0.183         C         GRVL         0.021           F         SILT         0.000         F         SAND         0.039         VF         GRVL         0.078         VC         GRVL         0.021           M         SILT         0.000         M         SAND         0.153         F         GRVL         0.034
53.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.488         M         GRVL         0.001           VF         SILT         0.000         VF         SAND         0.002         VC         SAND         0.202         C         GRVL         0.024           F         SILT         0.000         F         SAND         0.031         VF         GRVL         0.024         VC         GRVL         0.024           M         SILT         0.000         M         SAND         0.098         F         GRVL         0.037
55.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.509         M         GRVL         0.000           VF         SILT         0.000         VF         SAND         0.001         VC         SAND         0.220         C         GRVL         0.028           F         SILT         0.000         F         SAND         0.024         VF         GRVL         0.104         VC         GRVL         0.028           M         SILT         0.000         M         SAND         0.047         F         GRVL         0.039
58.000	1.000	0.210	0.210	1.000	1.000	CLAY         0.000         C         SILT         0.000         C         SAND         0.520         M         GRVL         0.000           VF         SILT         0.000         VF         SAND         0.000         VC         SAND         0.230         C         GRVL         0.030           F         SILT         0.000         F         SAND         0.020         VF         GRVL         0.110         VC         GRVL         0.030           M         SILT         0.000         M         SAND         0.020         F         GRVL         0.040

BED SEDIMENT CONTROL VOLUMES

STREAM SEGMENT # 1: EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT.

SECTION NUMBER	LENGTH (ft)	WIDTH (ft)	DEPTH (ft)	VOL (cu.ft)	UME   (cu.yd)	
$\begin{array}{c} 1.000\\ 15.000\\ 32.000\\ 42.000\\ 44.000\\ 53.000\\ 55.000\\ 58.000\end{array}$	1640.000 3760.000 6385.000 6015.000 3221.000 2856.000 2116.000 731.000	203.000 229.266 207.517 187.610 282.665 220.920 198.870 185.667	$ \begin{array}{c} 10.000\\ 10.000\\ 0.000\\ 10.000\\ 10.000\\ 10.000\\ 10.000\\ 3.400 \end{array} $	0.332920E+07 0.862040E+07 0.132500E+08 0.00000 0.910465E+07 0.630947E+07 0.420808E+07 461456.	123304. 319274. 490740. 0.000000 337209. 233684. 155855. 17091.0	

NO. OF INPUT DATA MESSAGES= END OF SEDIMENT DATA 0

#### \$HYD

BEGIN COMPUTATIONS.

TIME STEP # 1 \* B FLOW 1 = WARM-UP BASE FLOW OF 750 CFS, LAKE IMPOUNDED.

EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. ACCUMULATED TIME (yrs).... 0.003 FLOW DURATION (days)..... 1.000

UPSTREAM BOUNDARY CONDITIONS

Stream Segment	# 1	DISCHARGE	SEDIMENT LOAD	TEMPERATURE
Section No.	58.000	(cfs)	(tons/day)	(deg F)
	INFLOW	750.00	373.33	65.00

TABLE SA-1.	TRAP EFFICIENCY	ON STREAM SEGMENT # 1	
	EXAMPLE PROBLEM	NO 7. COHESIVE SEDIMENT.	

	ACCUMULA	TED AC-FT	ENTERING	AND LEAVIN	3 THI	S STREAM	I SEGMEN	г					
*********	*******	********	*******	*******	*****	*******	******	- ******	****	*******	*******	*****	*****
TIME	ENTRY *		CLAY				TLT				SAND		· .
TIME	ENTRI *		CLAT		×	-	)TT1		*		SAND		*
DAYS	POINT *	INFLOW	OUTFLOW	TRAP EFF	* IN	FLOW C	UTFLOW	TRAP E	FF *	INFLOW	OUTFLOW	TRAP	EFF *
1.00	58.000 *	0.09			*	0.17			*	0.04			*
TOTAL=	1.000 *	0.09	0.09	0.07	*	0.17	0.05	0.	73 ×	0.04	0.00	3	1.00 *
*********	*******	* * * * * * * * *	*******	*******	* * * * *	******	******	* * * * * * *	****	*******	*******	*****	*****

TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 1 ------SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) CLAY.... 59.51 COARSE SAND..... 0.09 . . . . . . VERY COARSE SAND.. VERY FINE GRAVEL.. VERY FINE SILT.... 60.24 0.02 FINE SILT...... MEDIUM SILT..... 51.29 0.00 63.35 FINE GRAVEL..... 0.00 COARSE SILT..... VERY FINE SAND.... MEDIUM GRAVEL.... COARSE GRAVEL.... 66.69 0.00 38.05 0.00 FINE SAND..... 24.05 VERY COARSE GRAVEL 0.00 10.03 MEDIUM SAND..... TOTAL = 373.33 SEDIMENT OUTFLOW from the Downstream Boundary GRAIN SIZE LOAD (tons/day) | GRAIN SIZE LOAD (tons/day) CLAY..... VERY FINE SILT.... COARSE SAND..... VERY COARSE SAND.. VERY FINE GRAVEL.. 55.63 0.00 45.88 0.00 FINE SILT..... 17.36 0.00 MEDIUM SILT..... COARSE SILT..... FINE GRAVEL..... MEDIUM GRAVEL..... 0.88 0.00 0.00 0.00 VERY FINE SAND.... COARSE GRAVEL.... 0.00 0.00 FINE SAND....... MEDIUM SAND..... VERY COARSE GRAVEL 0.00 0.00 0.00 -----TOTAL = 119.76 TABLE SB-2: STATUS OF THE BED PROFILE AT TIME = 1.000 DAYS ----- 
 TRANSPORT RATE (tons/day)

 CLAY
 SILT

 60.
 242.

 60.
 242.

 59.
 196.

 59.
 144.

 58.
 100.

 57.
 79.

 56.
 69.

 56.
 64.
 \_\_\_\_\_ SECTION BED CHANGE WS ELEV THALWEG 0 (ft) 0.02 (ft) 985.12 985.06 (ft) 975.42 972.90 NUMBER (cfs) SAND 58.000 750. 750. 5 55.000 0.00 ō. 53.000 0.00 985.01 972.20 750. 0 44.000 0.00 985.01 985.01 967.10 750. Ο. 750. 42.000 969.80 Ο. 32.000 0.00 985.00 956.50 750. Ο. 15,000 0.00 985.00 953.70 750. Ο. 1.000 0.00 985.00 944.70 750. Ο. \_\_\_\_\_ \$PRT ... Selective Printout Option - Print at the following cross sections 1 CP PS 32.0 END TIME STEP # 2 \* AB FLOW 2 = 100 DAYS AT BANK FULL Q, LAKE IMPOUNDED. COMPUTING FROM TIME= 1.0000 DAYS TO TIME= 101.0000 DAYS IN 10 COMPUTATION STEPS 0.003 --- Downstream Boundary Condition Data for STREAM SEGMENT NO. 1 at Control Point # 1 ---DISCHARGE TEMPERATURE WATER SURFACE (cfs) (deg F) (ft) (deg F) (cfs) (ft) 1250.000 65.00 985.000 WATER ENERGY VELOCITY ALPHA SURFACE LINE אדאר \*\*\*\* DISCHARGE TOP AVG AVG VEL (by subsection) (CFS) WIDTH BED 2 1 3 NN NO. 32.000 1250.000 985.002 985.002 0.001 SECTION NO. 3.255 1943.167 963.558 0.037 0.214 0.037 FLOW DISTRIBUTION (%) = 10.548 78.455 10.997 \*\*\*\* EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. ACCUMULATED TIME (yrs).... 0.277 FLOW DURATION (days)..... 10.000 UPSTREAM BOUNDARY CONDITIONS Stream Segment # 1 | DISCHARGE | SEDIMENT LOAD DISCHARGE SEDIMENT LOAD TEMPERATURE (cfs) (tons/day) (deg F) Section No. 58.000 INFLOW 1250.00 890.88 65.00 TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT \*\*\*\*\*\*\* 
 TIME
 ENTRY \*
 CLAY
 \*
 SILT
 \*

 DAYS
 POINT \*
 INFLOW
 OUTFLOW
 TRAP
 EFF \*
 IO.04
 TOTAL
 IO.04
 \*
 IO.04
 \*
 IO.04
 \*
 IO.04
 \*
 IO.04
 IO.04
 \*
 IO.04
 IO.04
 IO.04
 IO.04
 IO.04
 IO.04
 I SAND OUTFLOW TRAP EFF \* 101.00 0.00 TOTAL= 1.00 \* \*\*\*\*\*\* \*\*\*\*\*\* \*\*\*\*\*\*

	SIZE LO	e Upstream Bou DAD (tons/day)	GRAIN S	IZE LOA	D (tons/day)		
CLAY	· · · · · · · · · · · · · · ·	131.86	COARSE SAL	 ND	12.75		
VERY FI	NE SILT	128.18	VERY COAR	SE SAND	2.87		
FINE SII	GT	115.20	VERY FINE	GRAVEL	0.00 0.00		
COARSE S	SILT	163.84	MEDIUM GR	AVEL	0.00		
VERY FIN	NE SAND	98.84	COARSE GR	AVEL	0.00		
FINE SAM	ND	131.86 128.18 115.20 149.14 163.84 98.84 61.46 26.75	VERY COAR	SE GRAVEL	0.00		
		the Downstrea					
GRAIN	SIZE LO	DAD (tons/day)	GRAIN S	IZE LOA	D (tons/day)		
CLAY		127.12	COARSE SAL	ND	0.00		
VERY FIL	NE SILT	110.63	VERY COAR	SE SAND	0.00		
FINE SI	JT	64.14	VERY FINE	GRAVEL	0.00		
COARSE 9	5161 2117	14.76	FINE GRAV.	EL	0.00		
VERY FT	VE SAND	0.02	COARSE GR	AVEL	0.00		
FINE SAL	۱D	0.00	VERY COAR	SE GRAVEL	0.00		
MEDIUM S	SAND	$127.12 \\ 110.63 \\ 64.14 \\ 14.76 \\ 0.02 \\ 0.00 \\ 0$	1				
					316.67		
		THE BED PROFIL					
ECTION UMBER	BED CHANGE	WS ELEV TH (ft)	ALWEG (ft) /-	Q TRAN	LAY	cons/day) ILT	SAND
58.000	-0.25	985.38 9	75.15 1	250.	132.	556.	216.
55.000	1.18	985.20 9	74.08 1	250.	132.	556.	79.
53.000	0.24	985.04 9	72.44 1	250.	132.	556.	3.
44.000	0.43	985.03 9	67.53 1	250.	131.	430.	0.
42.000	0.35	985.01 9	70.15 1	250.	130.	292.	0. 0.
15.000	0.10	985.00	53.80 1	250.	128.	202.	0.
1.000	0.12	WS ELEV TF (ft) 985.38 9 985.20 9 985.04 9 985.03 9 985.01 9 985.00 9 985.00 9 985.00 9	44.82 1	250.	127.	190.	0.
TTNG							
nstream I	Boundary Con	dition - Ratin Discharge	g Curve	<b>C</b> h	<b>D</b> <sup>2</sup> <b>b</b>		
			Elevation	Stage	Discharge	-	
950.000	950.000	0.000 2000.000 4000.000 6000.000 8000.000	972.400	972.400	40000.000		
955.100	955.100	2000.000	972.700	972.700	42000.000		
958.000	958.000	4000.000	972.900	972.900	44000.000		
960.000	960.000	6000.000	973.100	973.100	46000.000		
962.000	962.000	8000.000	973.300	973.300	48000.000		
	965.100	12000.000	973.700	973.700	52000.000		
965 100	066 200	14000.000	973.800	973.800	54000.000		
965.100 966.200	300.200	16000.000	973.900	973.900	56000.000		
965.100 966.200 967.000	967.000		974.000	974.000	58000.000		
965.100 966.200 967.000 967.700	968.200 967.000 967.700	18000.000		974 100	60000.000		
965.100 966.200 967.000 967.700 968.300	968.200 967.000 967.700 968.300	18000.000 20000.000	974.100	571.100			
965.100 966.200 967.000 967.700 968.300 968.900	966.200 967.000 967.700 968.300 968.900	18000.000 20000.000 22000.000	974.100 974.200	974.200	62000.000		
965.100 966.200 967.000 967.700 968.300 968.900 969.400 969.800	966.200 967.000 967.700 968.300 968.900 969.400 969.400	18000.000 20000.000 22000.000 24000.000 26000.000	974.100 974.200 974.300 974.400	974.200 974.300 974 400	62000.000 64000.000 66000.000		
965.100 966.200 967.000 967.700 968.300 968.900 969.400 969.800 970.200	968.300 968.900 969.400 969.800	$18000.000 \\ 20000.000 \\ 22000.000 \\ 24000.000 \\ 26000.000 \\ 28000.0000 \\ 28000.0000 \\ 28000.000 \\ 28000.0000 \\ 28000.0000 \\ 280000000 \\ $	974.100 974.200 974.300 974.400 974.500	974.200 974.300 974.400 974.500	62000.000 64000.000 66000.000 68000.000		
965.100 966.200 967.000 967.700 968.300 968.900 969.400 969.800 970.200 970.600	968.200 967.000 968.300 968.900 969.400 969.800 970.200 970.600	20000.000	$\begin{array}{c} 972.400\\ 972.700\\ 972.900\\ 973.100\\ 973.500\\ 973.500\\ 973.800\\ 973.800\\ 973.800\\ 973.900\\ 974.000\\ 974.000\\ 974.200\\ 974.200\\ 974.200\\ 974.200\\ 974.500\\ 974.500\\ 974.600\\ \end{array}$	974.200 974.300 974.400 974.500 974.600			
970.600 971.000	970.600 971.000	30000.000	974.600 974.700	974.600 974.700	70000.000 72000.000		
970.600 971.000 971.400	970.600 971.000	30000.000	974.600 974.700	974.600 974.700	70000.000 72000.000		
970.600 971.000	970.600 971.000	30000.000 32000.000 34000.000 36000.000	974.600 974.700 974.800 974.900	974.600	70000.000 72000.000 74000.000 76000.000		
970.600 971.000 971.400 971.800 972.100	970.600 971.000 971.400 971.800 972.100	20000.000 32000.000 34000.000 36000.000 38000.000	974.600 974.700 974.800 974.900 975.000	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 ========	970.600 971.000 971.400 971.800 972.100	30000.000 32000.000 34000.000 36000.000 38000.000	974.600 974.700 974.800 974.900 975.000	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 ========	970.600 971.000 971.400 971.800 972.100	20000.000 32000.000 34000.000 36000.000 38000.000	974.600 974.700 974.800 974.900 975.000	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.400 971.800 972.100 E STEP # AC	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA	20000.000 32000.000 34000.000 36000.000 38000.000 R BANK FULL Q	974.600 974.700 974.800 974.900 975.000	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 ===================================	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA SLEM NO 7.	20000.000 32000.000 34000.000 36000.000 38000.000 R BANK FULL Q	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 E STEP # AC MPLE PRODUMULATED	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA	20000.000 32000.000 34000.000 38000.000 R BANK FULL Q COHESIVE SEDIN	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED	974.600 974.700 974.800 974.900 975.000	70000.000 72000.000 74000.000 76000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 E STEP # AC	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA	20000.000 32000.000 34000.000 38000.000 R BANK FULL Q	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED LAKE LOWERED	974.600 974.700 974.800 974.900 975.000	7000.000 7200.000 7400.000 7600.000 78000.000 78000.000		
970.600 971.000 971.400 971.800 972.100 E STEP # AC	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA	20000.000 32000.000 34000.000 38000.000 R BANK FULL Q COHESIVE SEDIN	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED 	974.600 974.700 974.800 974.900 975.000  SEGMENT NO. E WATER SUF (ft)	7000.000 7200.000 74000.000 7600.000 78000.000 78000.000		
* DISCH	970.600 971.000 971.400 971.800 972.100 FLOW 3 = NEA JEEM NO 7. TIME (yrs). Sam Boundary	20000.000 32000.000 34000.000 38000.000 R BANK FULL Q COHESIVE SEDIN CONDITION DAT DISCHARGE (cfs) 1250.00 R ENERGY N	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED	974.600 974.700 974.800 975.000 ==================================	7000.000 7200.000 74000.000 76000.000 78000.000 1800.000	 1 Point # AVG VEL	1 (by subsect
970.600         971.000         971.400         971.400         971.800         972.100         E STEP #         AC         PAC         MPLE PRODUMULATED         Downstreet         * DISCHI         (CFS)         TION NO.	970.600 971.600 971.400 971.800 972.100 FLOW 3 = NEA JEEM NO 7. TIME (yrs). Sam Boundary ARGE WATE S) SURFA	20000.000 32000.000 34000.000 38000.000 R BANK FULL 0 COHESIVE SEDIN CONDITION DAT DISCHARGE (cfs) 1250.00 R ENERGY V CE LINE	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED	974.600 974.700 974.800 975.000 ==================================	7000.000 7200.000 74000.000 76000.000 78000.000 	 1 Point # AVG VEL 1	1 (by subsect 2 3
970.600           971.000           971.400           971.400           971.400           972.100           E STEP #           AC           MPLE PRODUMULATED           Downstreet           * DISCHI           (CFS)           TION NO.	970.600 971.600 971.400 971.800 972.100 FLOW 3 = NEA JEEM NO 7. TIME (yrs). Sam Boundary ARGE WATE S) SURFA	20000.000 32000.000 34000.000 38000.000 R BANK FULL Q COHESIVE SEDIN CONDITION DAT DISCHARGE (cfs) 1250.00 R ENERGY N	974.600 974.700 974.800 974.900 975.000 LAKE LOWERED LAKE LOWERED LOCITY HEAD 0.037 1.0	974.600 974.700 974.800 975.000 ==================================	7000.000 7200.000 74000.000 76000.000 78000.000  1 at Contro FFACE .188 AVG BED	 Point # AVG VEL 1 0.000 1	1 (by subsect 2 3 .543 0.00

UPSTREAM BOUNDARY CONDI						
Stream Segment # 1 Section No. 58.000	DISCHARGE (cfs)	SEDIMENT LOAD (tons/day)	TEMPER	ATURE F)		
INFLOW	1250.00	890.88		65.00		
SEDIMENT INFLOW at SE GRAIN SIZE L	OAD (tons/day)	GRAIN SIZE	LOAD	(tons/day)	)	
CLAY. VERY FINE SILT FINE SILT MEDIUM SILT COARSE SILT VERY FINE SAND FINE SAND MEDIUM SAND	131.86 128.18 115.20 149.14 163.84	COARSE SAND VERY COARSE SA VERY FINE GRAV FINE GRAVEL MEDIUM GRAVEL.	 ND EL 	12.75 2.87 0.00 0.00 0.00		
FINE SAND FINE SAND MEDIUM SAND	98.84 61.46 26.75	VERY COARSE GRAVEL.	AVEL	0.00		
				890.88		
	VELOCITY	REY. NO.		-		
CLAY 0.00009 VF SILT 0.000018 F SILT 0.000036 M SILT 0.000072 C SILT 0.000144 VF SAND 0.000290 F SAND 0.000290 C SAND 0.001160 C SAND 0.002320 VC SAND 0.004640 VF GRVL 0.009280 F GRVL 0.018559 M GRVL 0.018559 M GRVL 0.037118 C GRVL 0.074237 VC GRVL 0.148474	0.2105298E-04 0.8390687E-04 0.3337332E-03 0.1318051E-02	0.1671599E-04 0.1332435E-03 0.1059932E-02 0.8372224E-02	1437286. 180969.4 22878.70 2933.566			
	OUTPUT FOR SECT	TION NO. 32.0	00		**********	* * * *
UVDDAILTC DADAMETEDC.						
VEL SLO 3.347 0.001024	EFD EI 4.661 132	W N-VALUE	TAU 0.29798	USTARM 0.39182	FROUDE NO. 0.273	
BED SEDIMENT CONTROL VC NEW SURFACE AREA (SQ FT	LUME COMPUTATION ): TOTAL 882419.52	NS: K-PORTION 882419.52	S-POR	TION 0.00		
GRADATION OF ACTIVE PLU BED MATERIAL PER GRAIN	S INACTIVE DEPOS SIZE: BED FRJ CLAY 0.( VF SILT 0.( M SILT 0.( C SILT 0.( VF SAND 0.( F SAND 0.(		TINER 790 6649 9994 894 934 245 419		BED FRACTION 0.371366 0.103983 0.024758 0.024758 0.004952 0.004952 0.004952	PERCENT FINER 83.164717 93.562979 96.038755 98.514532 99.009687 99.504842 99.999998
CLAY TRANSPORT CAPACITY BED SHEAR STRESS, 1b/sq. FINE GRAIN SEDIMENT TY LAYER TY DEPOSITION THRESHOLD #/ MASS EROSION THRESHOLD,	$\begin{array}{rcl} ft &=& 0.2980 \\ PE &=& 1 \\ PE &=& 1 \\ sq.ft &=& 0.0200 \end{array}$	2 0.0200 <b>0.2300</b>				
-	DN RATE (tons/da INACTIV LAYER 44213.70					
SILT TRANSPORT CAPACITY BED SHEAR STRESS, 1b/sq. FINE GRAIN SEDIMENT TY LAYER TY DEPOSITION THRESHOLD #/ EROSION THRESHOLD, #/sq.	ft = 0.2980 PE = 1 PE = 1 sf = 0.0200	2 0.0200 0.2300				
SIZE EROSIC CLASS ACTIVE LAYER	N RATE (tons/da INACTIV LAYER					
2 141669.82 3 141669.82 4 141669.82 5 141669.82	44213.70 44213.70 44213.70 44213.70					

SAND ** ARMOR LAYER ** STABILITY COEFFICIENT= 0.71485 MIN.GRAIN DIAM = 0.000290 BED SURFACE EXPOSED = 1.00000
INACTIVE         LAYER         ACTIVE         LAYER           %         DEPTH         %         DEPTH           CLAY         0.0000         0.0121         0.01           SILT         0.0000         0.00         0.5279         0.14           SAND         1.0000         9.92         0.4600         0.08           TOTAL         1.0000         9.92         1.0000         0.23
AVG. UNIT         AVG. UNIT           WEIGHT         WEIGHT           0.046500         0.037114
COMPOSITE UNIT WT OF ACTIVE LAYER $(t/cf) = 0.037114$ COMPOSITE UNIT WT OF INACTIVE LAYER $(t/cf) = 0.046500$ DEPTH OF SURFACE LAYER $(ft)$ DSL=0.1WEIGHT IN SURFACE LAYER $(tons)$ WTSL=3419.4DEPTH OF NEW ACTIVE LAYER $(ft)$ DSE=0.0032WEIGHT IN NEW ACTIVE LAYER $(tons)$ WAL=7434.0USEABLE WEIGHT, OLD INACTIVE LAYERWIL=406905.7SURFACE AREA OF DEPOSIT $(sq ft)$ SABK=0.88241952E+06
** INACTIVE LAYER ** BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER CLAY 0.000000 0.000000 C SAND 0.375000 82.999998 VF SILT 0.000000 0.000000 VC SAND 0.105000 93.499998 M SILT 0.000000 0.000000 VF GRVL 0.025000 95.999998 M SILT 0.000000 0.000000 F GRVL 0.025000 98.499998 C SILT 0.000000 0.000000 M GRVL 0.025000 98.499998 C SILT 0.000000 0.000000 M GRVL 0.005000 98.999998 VF SAND 0.010000 1.00000 C GRVL 0.005000 99.4999988 F SAND 0.070000 8.000000 VC GRVL 0.005000 99.4999988 M SAND 0.375000 45.49999
** ACTIVE LAYER ** BED MATERIAL PER GRAIN SIZE: BED FRACTION PERCENT FINER CLAY 0.012145 1.214493 C SAND 0.172485 92.180679 VF SILT 0.045067 5.721205 VC SAND 0.048296 97.010260 F SILT 0.130056 18.726806 VF GRVL 0.011499 98.160160 M SILT 0.290883 47.815126 F GRVL 0.011499 99.310060 C SILT 0.061889 54.003994 M GRVL 0.002300 99.540040 VF SAND 0.004600 54.463954 C GRVL 0.002300 99.770020 F SAND 0.032197 57.683674 VC GRVL 0.002300 100.000000 M SAND 0.172485 74.932177
C FINES, COEF(CFFML), MX POTENTIAL= 0.329756E+05 0.208796E+01 0.258871E+07 POTENTIAL TRANSPORT (tons/day): CLAY 0.142505E+06 C SAND 0.443530E+04 VF SILT 0.142493E+06 VC SAND 0.420230E+04 F SILT 0.150708E+06 VF GRVL 0.2230E+02 M SILT 0.176257E+06 F GRVL 0.831880E+02 C SILT 0.205679E+06 M GRVL 0.212266E+02 VF SAND 0.420247E+05 C GRVL 0.208796E-06 F SAND 0.43022E+04
SEDIMENT OUTFLOW FROM SECTION NO. 32.000 GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LOAD (tons/day)
CLAY       1286.69       COARSE SAND       1543.60         VERY FINE SILT       4498.13       VERY COARSE SAND       411.34         FINE SILT       13872.54       VERY FINE GRAVEL
TABLE SA-1. TRAP EFFICIENCY ON STREAM SEGMENT # 1 EXAMPLE PROBLEM NO 7. COHESIVE SEDIMENT. ACCUMULATED AC-FT ENTERING AND LEAVING THIS STREAM SEGMENT
TIME         ENTRY *         CLAY         *         SILT         *         SAND         *           DAYS         POINT *         INFLOW         OUTFLOW         TRAP EFF *         INFLOW         INFLOW<
TABLE SB-1: SEDIMENT LOAD PASSING THE BOUNDARIES OF STREAM SEGMENT # 1
SEDIMENT INFLOW at the Upstream Boundary: GRAIN SIZE LOAD (tons/day)   GRAIN SIZE LOAD (tons/day)
CLAY       131.86       COARSE SAND       12.75         VERY FINE SILT       128.18       VERY COARSE SAND
TOTAL = 890.88

CLAY VERY FINE FINE SILT MEDIUM SI COARSE SI VERY FINE FINE SANI MEDIUM SI				IN SIZE	LOAD (t	ons/day) 		
VERY FINE		1653.4	7 COARS	SE SAND	•	688.85		
	3 SILT	5805.0	4 VERY	COARSE SAND.	•	226.85		
MEDIUM SI	LT	49534.8	4 FINE	GRAVEL	•	8.66		
COARSE SI	LT	66420.6	3 MEDIU	M GRAVEL	•	3.69		
FINE SAN	. SAND	369.7	8 VERY	COARSE GRAVE	L	0.00		
MEDIUM SA	4ND	859.2	5					
			-	TOTAL	= 14	3092.25		
		THE BED PROF						
SECTION F	SED CHANGE	WS ELEV	THALWEG	0	TRANSPOR	T RATE (to)		
NUMBER	(ft)	(ft)	(ft)	(cfs)	CLAY	SIL	r SAND	
58.000	-0.39	982.31	975.01	1250.	132.	55	6. 2349. 	
53.000	0.23	976.09	972.43	1250.	132.	694	4. 13246.	
44.000	0.07	974.32	967.17	1250.	304.	4997	5. 1816.	
42.000	0.00	971.56	969.80	1250.	835.	11045	7. 1550.	
15.000	-0.02	959.04	953.63	1250.	1512.	13600	6. 11706.	
1.000	0.23	953.19	944.93	1250.	1653.	13889	ns/day) F SAND 6. 2349. 6. 12521. 4. 13246. 5. 1816. 7. 1550. 9. 5534. 6. 11706. 1. 2548.	
Accumulated W MAIN 1000.00	Water Disch	narge from da	y zero (sfo	1)				
SPRT A		Option						
A - Print	at all cro	oss sections						
============================= TIME STEP # * B F1	4							-
					DAYS IN	20 COM	PUTATION STEPS	3
EXAMPLE PROBL		COHESTVE SED						
ACCUM	JLATED TIME	E (yrs)	0.332					
FLOW I	JURATION (C	lays)	1.000					
UPSTREAM BOUN								
Stream Segmen	1t # 1	DISCHARG	E   SEDIN	IENT LOAD   T	EMPERATU	RE		
Section No.	58.000	DISCHARG	(tor	ns/day)	(deg F)			
	INFLOW	1250	.00	890.88	65.	00		
TABLE SA-1 7	PRAD FFFT("	IENCY ON STRE	AM GEGMENT	# 1				
E	EXAMPLE PRO	DBLEM NO 7. D AC-FT ENTER	COHESIVE SE	EDIMENT.		MUNIC		
********	*********	********	*********	*********	******	********	*****	*****
TIME	ENTRY *	CLAY		*	SILT		*	SAND
DAYS	POINT * 1	INFLOW OUTF	LOW TRAP I	EFF * INFLOW	OUTFL	OW TRAP E	FF * INFLOW	OUTFLOW TRAP
TOTAL=	1.000 *	24.35 24 *****	.08 0. *******	.01 * 47.41	40.	90 0.	14 * 12.06	23.31 -(
***********				*********	*******	*******	************	
***********	SEDIMENT I	LOAD PASSING	THE BOUNDA				**********	
**************************************				ARIES OF STRE	AM SEGME	NT # 1		
TABLE SB-1: SEDIMENT IN GRAIN S	NFLOW at th SIZE I	he Upstream B LOAD (tons/da	oundary: y)   GRA	ARIES OF STRE	AM SEGME	NT # 1 		
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**************************************	VFLOW at th SIZE I SILT C LLT S SAND ND	he Upstream B LOAD (tons/da 131.8 128.1 115.2 149.1 163.8 98.8 61.4 26.7	Goundary: y)   GRJ 6   COARS 8   VERY 0   VERY 4   FINE 4   MEDIL 4   COARS 6   VERY 5   -	ARIES OF STRE AIN SIZE BE SAND COARSE SAND. FINE GRAVEL. GRAVEL COARSE GRAVE COARSE GRAVE TOTAL	AM SEGME	NT # 1 		
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TABLE SB-1: SEDIMENT IN GRAIN S CLAY VERY FINE FINE SILI MEDIUM SI COARSE SI VERY FINE FINE SANI MEDIUM SI SEDIMENT OU GRAIN S	NFLOW at th SIZE I SIZE I SIZE I SAND SAND JTFLOW from SIZE I	he Upstream B LOAD (tons/da 131.8 128.1 115.2 149.1 163.8 98.8 61.4 26.7 	coundary: y)   GRJ 6   COARS 8   VERY 0   VERY 4   FINE 4   MEDII 4   COARS 6   VERY 5   - - - - - - - - - - - - - - - - - - -	ARIES OF STRE AIN SIZE BE SAND COARSE SAND. FINE GRAVEL M GRAVEL COARSE GRAVEL COARSE GRAVE TOTAL Y AIN SIZE	AM SEGME	NT # 1 		
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• EFF

				IME = 121.200				
SECTION BE	D CHANGE (ft)	WS ELEV (ft)	THALWEG (ft)	Q (cfs)	TRANSPORT R CLAY	ATE (tons/da SILT	y) SAND	
58.000	-1.32	980.72	974.08	1250.	132.	556.	225.	
55.000	-0.89	979.73 975.71	972.01	1250.	132.	556.	888.	
44.000	0.10	973.98	967.20	1250.	132.	556.	1078.	
42.000	0.06	971.56 964 05	969.86 956 27	1250.	132.	556. 556	1029. 1091.	
15.000	-0.96	959.43	952.74	1250.	132.	556.	2278.	
1.000	1.63	953.19	946.33	Q (cfs) 1250. 1250. 1250. 1250. 1250. 1250. 1250. 1250.	132.	556.	2265.	
IME STEP # B FLC	5 W 5 = LAS	T FLOW, BAS	SE FLOW OF	750 CFS, LAKE ME= 141.2000	IS LOWERED.			
KAMPLE PROBLE ACCUMUL	M NO 7. ATED TIME	COHESIVE SE (yrs) ays)	DIMENT. 0.38	7				
PSTREAM BOUND						_		
tream Segment ection No.	# 1 58.000	DISCHAR (cfs)	RGE SE	DIMENT LOAD   T tons/day)	EMPERATURE (deg F)	_		
				373.33				
	AMPLE PRO	BLEM NO 7.	COHESIVE	SEDIMENT.				
*****	*******	*******	*******	LEAVING THIS ST	*********	******	******	****
TIME E	NTRY * OTNTF * T	NELOW OUT	AY PELOW TRA	* PEFF * INFLOW	SILT	* TRAP EFF *	TNFLOW	SAND OUTFLOW TRAP EFF
141.20 58	.000 *	26.17		* 50.82		*	12.78	OUTFLOW TRAP EFF 32.67 -1.56
TOTAL= 1	.000 * ******	26.17 2 *******	25.90 ********	0.01 * 50.82	44.32 *****	0.13 * *********	12.78	32.67 -1.56
BLE SB-1: S	EDIMENT L	OAD PASSING	G THE BOU	NDARIES OF STRE	AM SEGMENT	# 1		
SEDIMENT INF GRAIN SI	LOW at th ZE L	e Upstream OAD (tons/d	Boundary: lay)	GRAIN SIZE	LOAD (tons	/day)		
CLAY		59.	.51   CC	ARSE SAND	•	0.09		
VERY FINE	SILT	60. 51	.24   VE 29   VE	RY COARSE SAND. BY FINE GRAVEL	•	0.02		
MEDIUM SIL	т	63	.35 FI	NE GRAVEL	•	0.00		
COARSE SIL	T	66.	.69 ME	DIUM GRAVEL	•	0.00		
FINE SAND.		24.	.05 VE	RY COARSE GRAVE	EL	0.00		
MEDIUM SAN	D	10.	.03	ARSE SAND RY COARSE SAND. RY FINE GRAVEL. NE GRAVEL JUM GRAVEL ARSE GRAVEL RY COARSE GRAVE				
SEDIMENT OUT	FLOW from	the Downst	ream Boun	darv	- 57	5.55		
GRAIN SI	2E L	OAD (EONS/C	iay)	GRAIN SIZE	LOAD (LORS			
CLAY	SILT	59. 60	.51 CC	ARSE SAND RY COARSE SAND. RY FINE GRAVEL. NE GRAVEL DIUM GRAVEL ARSE GRAVEL RY COARSE GRAVE	. 33	4.69		
FINE SILT.		51.	.29 VE	RY FINE GRAVEL.		0.21		
MEDIUM SIL	Τ	63.	.35 FI	NE GRAVEL	•	0.10		
VERY FINE	SAND	40	.39 CC	ARSE GRAVEL	• •	0.00		
FINE SAND.		51.	.68 VE	RY COARSE GRAVE	8L	0.00		
MEDIUM SAN	D		.84					
BLE SB-2. S	TATUS OF	THE BED PR	יי ידע אודער	TOTAL IME = 141.200	= 100	5.51		
						ATE (tone/de	av)	
NUMBER	(ft)	(ft)	(ft)	(cfs)	CLAY	SILT	SAND	
58.000	-1.76	978.97	973.64	750.	60.	242.	168.	
53.000	-1.15	978.10 974.57	971.75	750.	60.	242. 242.	∠54. 507.	
44.000	0.12	973.19	967.22	750.	60.	242.	437.	
42.000	0.03	970.80 962 77	969.83 956 27	750. 750	60. 60	242. 242	532. 558	
15.000	-1.13	958.12	952.57	750.	60.	242.	582.	
1.000	1.09	951.91	945.79	Q (cfs) 750. 750. 750. 750. 750. 750. 750. 750.	60.	242.	704.	
	A ERRORS	DETECTED.						
	S PROFILE	READ =  S = =	5 42 1680					

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# Appendix A

## **Input Description**

A-i

#### Introduction

HEC-6 processes data from a single input data file. This introduction provides some basic information about an HEC-6 input data file and its records.

#### The HEC-6 Input Data Record

This appendix contains a detailed description of the data input requirement for each variable on each input record. In general, the descriptions of records are ordered as the records would appear in a data file. Many of the records described can be omitted if the options to which they apply are not needed.

HEC-6 input records follow the basic HEC-2 input record format. Each record is divided into ten fields of eight columns each, except Field 1. A variable in Field 1 may only occupy columns 3 through 8 since columns 1 and 2 (called Field 0) are reserved for record identification.

The location of the variables for each input record is shown by field number. The values a variable may assume and the conditions for each are described. Where the value of a variable is to be zero, unless otherwise noted, the field may be left blank since a blank field is read as zero. Any number without a decimal point must be right justified in its field. Any number without a sign is considered positive.

The location of variables on records is often referred to by an abbreviated designation; for example, X1.5 refers to the fifth field of the X1 record.

Comment records may be used to annotate the input file. HEC-6 identifies any record with Field 0 blank as a comment record. These records are ignored by HEC-6 and will not be repeated in the output.

HEC-6 recognizes only the records described in this appendix. Any unrecognized or misplaced records will, in most cases, cause HEC-6 to terminate execution.

#### **The HEC-6 Input File**

A typical HEC-6 input file consists of 3 basic parts. The first part is the river system geometry; the second part is the sediment properties; and the third is the hydrology.

The records described in Section A1 are used to define the geometry of the river system being modeled. Title records (T1-T3) are required at the beginning of each stream segment. Each set of X1 through H (or HD) records are used to describe the geometry and special features of a cross section along a stream segment. The QT, \$TRIB, and CP records are used to combine single stream segments into a river network.

The initial sediment properties and quantities for the model are defined using the records in Section A2. Each stream segment in the river network must be described with a separate set of **T4-PF** records. The information entered on the **I1** through **I5** records pertain to the whole network system. Therefore, they need only be entered with the mainstem sediment data records. If these records are entered with the sediment data for any other stream segment, they will be ignored. Local inflow data (**\$LOCAL** and **LQL-LFL** records) are entered after the complete set of sediment records has been entered for the stream segment in which they are located and before the records for the next stream segment.

The records that make up the hydrology data are described in Section A3. The **\$HYD** record is used only once to indicate the beginning of the hydrologic data section in the input file. The **\***, **Q**, and **W** records are entered as a set for each time step (discharge) to be modeled in the hydrologic data. The **T** record is required with the first time step (discharge) and is optional thereafter. All other records are optional and are to be added to the appropriate time step(s). The **\$\$END** record should be entered as the last record of the input file and can also occur only once.

Section A4 describes records that can be entered to trigger one or more special options. These commands are inserted into the HYDROLOGIC data after the **\$HYD** record and immediately before any \* record. They are entered one after another, inserted singularly, or used as many times as desired. Some require additional data as explained in the detailed instructions that follow.

Section

Page

#### **Table of Contents**

A1		try and Channel Properties
	A1.1	Title Records (T1 - T3) A-3
	A1.2	NC Record - Manning's <i>n</i> values (required for first cross section) A-4
	A1.3	NV Record - Vary <i>n</i> Values by Elevation or Discharge (optional) A-
	A1.4	QT Record - Tributary or Local Inflow/Outflow Location (optional) A-7
	A1.5	X1 Record - Cross Section Location (required for each cross section) . A-8
	A1.6	X3 Record - Encroachments (optional) A-10
	A1.7	X5 Record - Internal Boundary Condition (optional)
	A1.8	XL Record - Conveyance Limits (optional)
	A1.9	GR Record - Cross Section Coordinates (required) A-1
	A1.10	H Record - Movable Bed Limits (required if not using HD Record) A-16
	A1.11	EJ Record (required) - End of Geometric Data A-18
	A1.12	\$TRIB Record - Tributary Inflow Point (optional)       A-19
	A1.13	CP Record - Control Point Identification (optional) A-19
A2	Sedime	nt Properties and Transport Functions
	A2.1	Title Records - Comments (five required - T4 - T8) A-23
	A2.2	11 Record - Sediment Properties (required) A-24
	A2.3	12 Record - Parameters Required for Clay Transport (optional) A-26
	A2.4	Special 12 Records - Cohesive Sediment Transport Method 2 -
		Supplemental Parameters (optional)
	A2.5	13 Record - Parameters Required for Silt Transport (optional) A-29
	A2.6	14 Record - Parameters Required for Sand Transport (optional) A-3
	A2.7	15 Record - Weighting Factors for Numerical Integration Method
		(optional)
	A2.8	J Record - User Specified Transport Function (optional) A-3
	A2.9	K Record - User Specified Transport Function (optional) A-30
	A2.10	LQ Record - Water Discharge for the Water Discharge-Sediment
		Load Relationship (required)
	A2.11	LT Record - Total Sediment Load for the Water Discharge-Sediment
		Load Relationship (required)
	A2.12	LF Record - Fraction of Load for the Water Discharge-Sediment
	,	Load Relationship (required)
	A2.13	PF Record - Bed Material Gradation - Percent Finer
	A2.14	\$LOCAL Record - Local Inflow (optional)
	A2.15	LQL Record - Water Discharge for Local Inflows/Diversions
	712.15	Specification (optional)
	A2.16	LTL Record - Total Sediment Load for Local Inflows/Diversions
		Specification (optional)
	A2.17	LFL Record - Sediment Grain Size Distribution for Local
	/	Inflows/Diversions (optional)

#### A - v

#### Section

#### Page

A3	Hydrologic Data					
	A3.1	\$HYD Record - Hydrologic Data (required) A-51				
	A3.2	* Record - Comment and Output Control (required) A-52				
	A3.3	Q Record - Water Discharges in cfs (required) A-54				
	A3.4	R Record - Downstream Water Surface Elevation Boundary Condition				
		(required)				
	A3.5	S Record - Rating Shift (optional)				
	A3.6	T Record - Water Temperature (optional) A-58				
	A3.7	W Record - Duration (required) A-59				
	A3.8	X Record - Alternate Format for Duration Data (optional)				
	A3.9	\$\$END Record - Required				
A4	Special	Commands and Output Control A-63				
	A4.1	\$B Record - Transmissive Boundary Condition (optional) A-65				
	A4.2	\$DREDGE Record - Dredging Option (optional)				
	A4.3	\$NODREDGE Record - Dredging Option (optional) A-66				
	A4.4	\$EX Record - Exner Options (optional) A-67				
	A4.5	\$GR Record - Cross Section Shape Option (optional) A-68				
	A4.6	\$KL - \$KI Records - Channel n Values by Relative Roughness				
		(optional)				
	A4.7	\$PRT Record - Selective Output Option (optional)				
	A4.8	CP Record - Selective Output (see \$PRT record - optional) A-71				
	A4.9	PS Record - Selective Output (see \$PRT Record - optional) A-71				
	A4.10	END Record - Selective Output (see \$PRT Record; optional) A-71				
	A4.11	\$RATING Record - Tailwater Rating (optional)				
	A4.12	RC Record - Tailwater Rating A-72				
	A4.13	\$SED Record - Water Discharge-Sediment Load Table (optional) A-73				
	A4.14	LPOINT Record -Inflow Point Identification for the Water Discharge-				
		Sediment Load Table (optional)				
	A4.15	LRATIO Record -Ratio for the Water Discharge-Sediment Load Table				
		(optional)				
	A4.16	END Record - Termination Record for the \$SED Option A-74				
	A4.17	\$VOL Record - Compute Cumulative Volume and Deposits at all				
		Sections (optional)				
	A4.18	VJ Record - Elevation Table for Cumulative Volume Computations				
		(optional; see \$VOL Record) A-76				
	A4.19	VR Record - Elevation Table for Cumulative Volume Computations				
		(optional; see \$VOL Record)A-76				

## Figures

Page
A-4
A-6
A-8
. A-10
<b>A-11</b>
. A-15

### Tables

#### Number

A1-1	Relationship of <i>n</i> values to Elevations or Flows	A-6
A2-1	Grain Size Classes; Silts	A-29
A2-2	Grain Size Classes; Sands	A-32
A4-1	\$B - Transmissive Boundary	A-65
A4-2	Example - \$ Dredge Record	A-66
A4-3	\$EX - Alternate Exner Equation	A-67
A4-4	\$GR - Nonuniform Deposition Option	A-68
A4-5	\$KL - Limerinos' Relative Roughness Option	A-69
A4-6	\$PTR - Selective Output Option	A-70
A4-7	\$SED - Replace Sediment Load Table	A-73

#### 

Page

## **Section A1**

## **Geometry and Channel Properties**

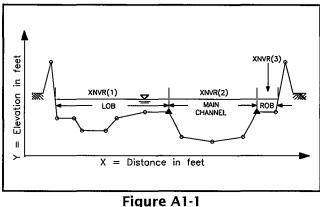
#### A1.1 Title Records (T1 - T3)

Three title records are required at the beginning of the geometric data for each stream segment. Additional output of geometric data can be requested by specifying a B or C in Column 3 on the **T1** record.

Field	Variable	Value	Description
0	ID	ΤI	Record identification in Columns 1 and 2. Enter <b>T1</b> , <b>T2</b> and <b>T3</b> for the first, second and third title records, respectively.
Column 3 of T1, record only	OPTION	Blank (zero not allowed)	Normal output-lists data from title records and the NC record. Only the cross section identification number is listed for records X1 through EJ.
		В	This option outputs the initial geometry of the model and causes the input records to be echoed in the output enabling the user to verify the initial geometry of the model. B-level output is normally not recommended, but it may provide useful additional information when initially developing a data set.
		С	This option activates trace level output. Use of this print option is not recommended. C-level trace output is intended only for error checking purposes.
2-10		Comments	Fields 2 through 10 (Columns 9-80) may be used for identification purposes such as labeling the data set, noting the date of the run, or other relevant information.

#### A1.2 NC Record - Manning's *n* values (required for first cross section)

The NC record specifies Manning's n values and the expansion and contraction coefficients for transition losses. An NC is required prior to the first cross section definition (the first X1 record). When changing previously specified values additional NC records are required at those cross sections where *n* values change. The NC record values are constant with depth and will be used until changed by the next NC record. NC records may be inserted before any X1 record. The *n* values apply over the reach, and will be used starting in the reach in which the record appears in the data set. Expansion and/or contraction coefficients apply to the next upstream reach.



Channel and Overbank *n* values

**Note:** HEC-6 applies *n* values to the upstream reach whereas HEC-2 applies them halfway to the cross section on either side of the one for which they appear in the data set. However, results using either method are usually in close agreement without changing the *n* values.

Field	Variable	Value	Description
0	ID	NC	Record identification.
1	XNVR(1)	+	Manning's n value for the left overbank.
		0	No change from previous <i>n</i> value for the left overbank.
2	XNVR(3)	+	Manning's <i>n</i> value for the right overbank.
		0	No change from previous <i>n</i> value for the right overbank.
3	XNVR(2)	+	Manning's <i>n</i> value for the channel.
		0	No change from previous <i>n</i> value for the <b>channel.</b>
4	СС	+	<b>Contraction coefficient</b> used in computing transition losses.
		0	No change in contraction coefficient.
5	CE	+	Expansion coefficient used in computing transition losses.
		0	No change in expansion coefficient.
6-10			Leave blank.

#### A1.3 NV Record<sup>1</sup> - Vary *n* Values by Elevation or Discharge (optional)

A table of Manning's *n* values vs. either elevations or discharges can be entered on the **NV** record. The left overbank, the channel, and the right overbank are the three subsections. A separate **NV** record must be entered for each subsection. Code values in order of **increasing elevation** or **discharge**. The values on this record will be used for all succeeding cross sections until changed by the next **NC** or **NV** record.

HEC-6 linearly interpolates when elevations or discharges are between values specified in the table. When elevations or discharges are outside the range of values specified in the table the extreme values are used; i.e., no extrapolation occurs.

Field	Variable	Value	Description
0	ID	NV	Record identification.
1	NPAR, NCH	++	Enter subsection number in Column 7 and number of <i>n</i> values in Column 8. Subsection numbers are:
			1 = left overbank 2 = channel 3 = right overbank
			A maximum of five <i>n</i> values are permitted per subsection. (For example, 13 denotes that three <i>n</i> values are coded for subsection number 1, the left overbank.)
2	VALN(1)	+	<b>Manning's <i>n</i> value</b> for lowest elevation in the table. A positive (+) <i>n</i> value denotes that a " <i>n</i> vs. elevation" table is being defined.
		-	Manning's <i>n</i> value for smallest discharge in the table. A negative (-) <i>n</i> value denotes that a " <i>n</i> vs. discharge" table is being defined.
			<b>Note:</b> Do not mix discharge tables and elevation tables at the same cross section.
3	ELQ(1)	-, 0, +	The elevation for positive VALN(1) or the discharge for negative VALN(1).
4	VALN(2)	+	Enter the next <i>n</i> value in the table. This can be blank if there is only one <i>n</i> value for this subsection.
5	ELQ(2)	-, 0, +	Enter the elevation or discharge for VALN(2).
6-10			Continue entering table values across the record. Code the fifth elevation or discharge value in Field 1 of a second <b>NV</b> record if five points are desired.
			<b>Note:</b> A maximum of five points may be entered per subsection.

<sup>&</sup>lt;sup>1</sup> This record is different from HEC-2's **NV** record.

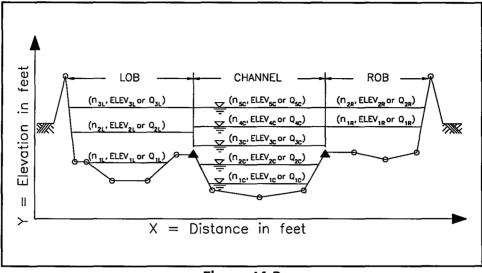


Figure A1-2 An Illustration of VALN and ELQ

Table A1-1           Relationship of <i>n</i> values to Elevations or Flows							
<i>n</i> vs. Ele	<i>n</i> vs. Elevation <i>n</i> vs. Discharge						
VALN(i)	ELQ(i)		VALN(i)	ELQ(i)			
+n,	ELEV <sub>1</sub>		-n <sub>1</sub>	Q <sub>1</sub>			
n <sub>2</sub>	ELEV <sub>2</sub>	OR	n <sub>2</sub>	Q <sub>2</sub>			
n <sub>3</sub>	ELEV <sub>3</sub>		n <sub>3</sub>	Q₃			
n <sub>4</sub>	ELEV₄		n <sub>4</sub>	Q₄			
<u>ns</u>	ELEV,		<u>n,</u>	Q <sub>5</sub>			

#### A1.4 QT Record - Tributary or Local Inflow/Outflow Location (optional)

This record identifies the location of a tributary or a diversion point. It should be placed immediately before the X1 record for the first cross section upstream from the tributary or local inflow/outflow location. See Section 3.6.2.

Field	Variable	Value	Description
0	ID	QT	Record identification.
1	KQCH		Control point number.
			A local inflow/diversion point. When defining a local inflow/outflow point, leave Field 1 blank.
		2-10	A tributary junction (control) point. When defining a tributary junction point, a value must be entered in Field 1. This value should be within the range 2 through 10.
2-10			Leave blank.

#### A1.5 X1 Record - Cross Section Location (required for each cross section)

This record is used to identify the cross section and define its location relative to its downstream neighbor. Figure A1-3 illustrates the basic cross section information entered on this record.

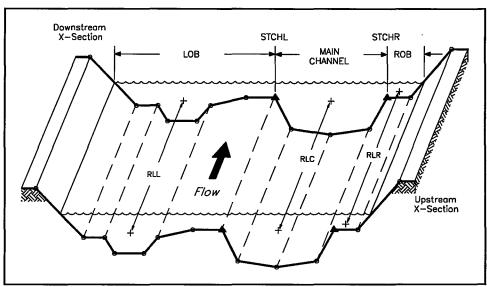


Figure A1-3 Example Illustrating the Main Channel and Right and Left Overbank Reach Lengths Between Consecutive Cross Sections

Field	Variable	Value	Description
0	ID	X1	Record identification.
1	SECID	-, 0, +	<b>Cross section identification number.</b> It is recommended that SECID be positive and increase in the upstream direction.
2	NXY	+	Total <b>number of coordinate points</b> used to describe the cross section's geometry on the <b>GR</b> records which follow $(5 \le NXY \le 100)$ .
		0	<b>Repeat Cross Section Option.</b> The geometry of the previous (downstream) cross section ( <b>GR</b> records) will be repeated for the present cross section. Therefore, no <b>GR</b> records will be entered for this section. Do not enter zero for the first cross section.
3	STCHL	-, +	<b>Station</b> of the <b>left</b> bank of the channel. Use top-bank when the bank roughness is included in channel <i>n</i> values. Toe of bank is recommended when channel bank roughness is included in overbank <i>n</i> values. STCHL need not equal one of the station values entered on the <b>GR</b> records for this cross section.
		0	For a repeat cross section, enter zero (or blank); i.e., when NXY is zero. The bank stations from the previous section will be used.

Field	Variable	Value	Description
4	STCHR	-, 0, +	<b>Station</b> of the <b>right</b> bank of the channel. Same rules as for STCHL above.
5	RLL	+	<b>Reach length</b> of the <b>left</b> overbank between current cross section and the (previous) downstream cross section.
		0	Enter zero (or blank) for the first cross section or when there is no left overbank subsection.
6	RLR	0, +	<b>Reach length</b> of the <b>right</b> overbank. Same rules apply as for RLL above.
7	RLC	0, +	<b>Channel Reach Length</b> . The same rules apply as for overbank reach lengths (RLL and RLR) above.
8	RX		<b>Cross Section Width Adjustment Factor</b> . Each station value defined in the <b>GR</b> data for this cross section will be <b>multiplied</b> by RX. For a repeat cross section, station values from the previous cross section will be changed before they are reused. For example, an RX value of 1.1 would increase each station by 10% and thereby, effectively widen the entire cross section by 10%.
			Note: The left and right channel stations, conveyance limits, ineffective area limits, movable bed limits, and limits of the dredged channel will all be adjusted by RX.
		+	Use a value for RX between 0.0 and 1.0 to narrow the cross section. Use a value greater than 1.0 to widen the cross section.
		0	No change to cross section stations.
9	DH		<b>Cross Section Elevation Adjustment Factor.</b> The constant DH will be <b>added</b> to each elevation value defined in the <b>GR</b> data for the cross section. For a repeat cross section, elevation values from the previous cross section will be changed before they are reused. For example, to describe a 4,000 ft long flume having a 1 ft/thousand slope, just enter the <b>GR</b> data for the first cross section and insert four repeat cross sections spaced 1,000 ft apart with DH=1.
			Note: If NV records are present, <b>elevations</b> will be changed, but the dredging template elevation, <b>EDC</b> , ( <b>H</b> .6 or <b>HD</b> .6), is not changed.
		+	Constant that will be added to all elevations.
		-	Constant that will be subtracted from all elevations.
		0	No change to cross section elevations.

#### A1.6 X3 Record<sup>2</sup> - Encroachments (optional)

The X3 record provides three methods for defining encroachments to a cross section. These methods are: (1) ineffective flow area, defined using Field 1; (2) encroachment width, defined using Field 3; and (3) encroachment stations, defined using Fields 4-7. See Section 3.2.6 for a complete description of these three methods.

Field	Variable	Value	Description
0	ID	Х3	Record identification.
1	MEID		Method 1. Ineffective flow area option.
		10	All water is confined to the channel, as defined by variables STCHL and STCHR on the X1 record, until the calculated water surface elevation exceeds the channel bank elevation (the elevations corresponding to STCHL and STCHR on the X1 record). The rest of this record may be left blank. See Figure A1-4.
		0	No ineffective flow area. Total area of the cross section described on <b>GR</b> records below the water surface elevation is used in the computations.
2			Leave blank.
3	ENCFP		<b>Method 2.</b> Encroachment width for all flow. This option computes the STENCL and STENCR (encroachment stations) from a specified width, ENCFP, centered about the channel. These station points are added to the GR data but no points outside these stations are adjusted in elevation. Rather, the cross section limits are reset to the computed values of STENCL and STENCR.
		+	HEC-6 confines all flow to the width specified by ENCFP. It will be centered between the left and right bank stations of the channel (STCHL and STCHR on X1 record). Side boundaries will be vertical and frictionless. Method 2 may be used in conjunction with Method 1.
		0	The width option is not being used or is not changed from previous value.
		<b>▲</b>	

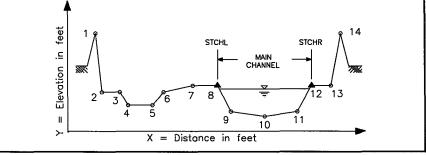


Figure A1-4 Example of Method 1 Encroachment to Keep Flow in the Main Channel up to the Designated Bank Elevations

<sup>&</sup>lt;sup>2</sup> The HEC-6 X3 record is different from the HEC-2 X3 record.

Field	Variable	Value	Description
4	STENCL		Method 3. Encroachment station left. Method 3 may not be used in conjunction with Methods 1 and/or 2.
		-, +	STENCL sets a limit for flow on the <b>left</b> side of the channel. The side will be vertical and frictionless unless ELENCL is also used (see Field 5 below). See also Figure A1-5.
			Note: Do not enter a station value of zero since it will be treated as if no value was entered. Enter a small positive number like 0.01 instead.
5	ELENCL		Method 3. Encroachment elevation left.
		-, +	Enter the elevation at the top of the <b>left</b> encroachment. All cross section elevations for stations to the left of STENCL are raised to this elevation.
		0	When a value of zero is entered for the encroachment elevation ELENCL, the left cross section limit is reset to STENCL.
6	STENCR		Method 3. Encroachment station right.
		-, +	Same rules and purpose as STENCL but for use on the <b>right</b> side of the channel.
7	ELENCR		Method 3. Encroachment elevation right.
		-, 0, +	Same rules and purpose as ELENCL but for use on the <b>right</b> side of the channel.

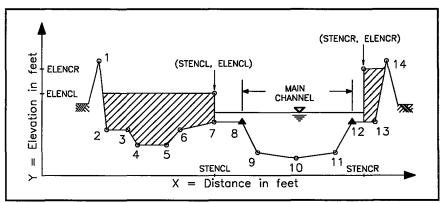


Figure A1-5 Example of Method 3 Encroachment Using Prescribed Stations and Elevations (STENCL, ELENCL)

#### A1.7 X5<sup>3</sup> Record - Internal Boundary Condition (optional)

The X5 record creates an internal boundary (or hydraulic control point) within a project reach. If a minimum water surface elevation is specified at this internal boundary, it is called an internal boundary condition.

An internal boundary effectively divides the reach into two subreaches; the cross section where the X5 is placed becomes the downstream boundary for the reach upstream and the cross section immediately downstream becomes an upstream boundary for the downstream reach. Therefore, X5 records cannot be placed at successive cross sections, nor can they be placed at the cross section immediately upstream of an existing downstream boundary. It is important to note that the reach immediately downstream from the cross section at which an X5 record is placed is "transmissive"; i.e., no sediment interaction with the bed is computed in this reach. Therefore, the length of the reach downstream from the X5 location should be quite short or zero. Because this reach is transmissive, its length can be short (or zero) without impacting upon the time step selection. Use of repeat cross sections facilitates use of the X5 option.

An internal boundary can be used for two functions: (1) it provides two methods for setting an internal boundary condition as discussed below, and (2) it separates the reach into smaller subreaches for the purposes of sediment volume accounting and trap efficiency calculations. Example Problems 2 through 5 show how to use both methods of feature (1) and Example Problem 7 has an example using feature (2).

Method 1 is used to establish a minimum water surface elevation at dams, weirs, bridges, etc. This method allows the user to define a minimum water surface elevation as the internal boundary condition at an internal cross section. If the computed water surface at the next downstream cross section plus a specified head loss (field 3) is less than the minimum water surface elevation, then the specified elevation is assigned to the internal cross section and the step backwater computations proceed upstream.

Method 2 enables the user to prescribe the minimum water surface elevation at an internal cross section at each time step during the hydraulic computations. This is accomplished by specifying (in field 4 of the X5 record) the field on the **R** record where the minimum water surface elevation for this cross section can be found. Fields 2 through 10 are available on the **R** record for this purpose, therefore the user may not specify a value less than two nor greater than ten in Field 4 of the X5 record. The effect of this **R** record field specification occurs each time an **R** record is encountered in the hydrologic data set with a new value in the specified field. When this occurs, the new minimum water surface elevation is compared to the computed water surface of the downstream cross section plus the specified head loss (field 3). As in Method 1, the greater water value is assigned to the internal cross section as the computed water surface elevation.

By separating the project reach into smaller subreaches, the X5 record provides a mechanism for obtaining trap efficiency and sediment volume accounting for each subreach. This feature is invoked simply by the existence of the X5 record in the cross section definition. If it is not desired to specify the water surface elevation (internal boundary condition), but trap efficiency values are of interest, simply enter an X5 record with Fields 1-10 blank.

<sup>&</sup>lt;sup>3</sup> The HEC-6 X5 record is different from the HEC-2 X5 record.

Field	Variable	Value	Description
0	ID	X5	Record Identification
1			Leave blank.
2	UPE	-, +	Method 1 - Minimum Water Surface Elevation. The water surface elevation at this cross section will be UPE unless the water surface at the downstream section plus HLOS exceeds UPE. (HLOS is coded in Field 3.)
		0	Zero indicates that Method 1 is not used. If the desired minimum water surface elevation <b>is</b> zero, enter a small positive value (e.g., 0.001).
3	HLOS	0, +	<b>Head loss</b> between this section and the cross section immediately downstream. The specified water surface elevation is overridden when the tailwater elevation plus HLOS is higher.
4	ICSH	2-10	Method 2 - R Record Field. This method allows the user to specify the minimum water surface elevation for this cross section on each R record in the hydrologic data set. The value entered here is the number of the field of each R record where HEC-6 will look for the minimum water surface elevation for this cross section (see R record description in Section A3.4).
			Note: Do not use ICSH=1. Field 1 is reserved for specifying the water surface elevation at the downstream boundary control point.
		0	Zero indicates that Method 2 is not used. When using Method 2, allowable values are in the range from 2 to 10.

#### A1.8 XL Record - Conveyance Limits (optional)

Two methods are available for specifying conveyance limits. In Method 1, only a width is specified which is centered between the left and right bank stations specified on the X1 record. Use Field 3 to specify this width and leave Fields 4 and 5 blank. In Method 2 both a left and right station must be specified to define the conveyance portion of the channel. Enter the left and right stations for the conveyance limits in Fields 4 and 5 and enter a zero in Field 3 or simply leave it blank.

Field	Variable	Value	Description
0	ID	XL	Record identification.
1-2			Leave blank.
3	CLC	+	<b>Method 1.</b> Enter the width of the conveyance channel. It will be centered between left and right bank stations (STCHL and STCHR on <b>X1</b> record).
		0	Use Method 2.
4	CLL	-, +	Method 2. Enter the cross section station for the left side of the conveyance channel. It does not have to coincide with a GR station point. It can be any place in the cross section, but it must be less than CLR.
			Note: Do not enter a value of zero since it will be interpreted as though no value was entered. Enter a small positive value (e.g., 0.001) when a value of zero is desired.
5	CLR	-, +	<b>Method 2.</b> Enter the cross section station on the right side of the conveyance channel. It does not have to coincide with a coordinate point. It can be any place in the cross section, but it must be greater than CLL.
			Note: Do not enter a value of zero since it will be interpreted as though no value was entered. Enter a small positive value (e.g., 0.001) when a value of zero is desired.
6-10			Leave blank.

.

#### A1.9 GR Record - Cross Section Coordinates (required)

Cross section geometry is defined as a series of elevation and station coordinates entered on **GR** record. This record specifies the elevation and station of each coordinate used to describe the geometry of a cross section as illustrated in Figure A1-6. A set of **GR** records is required for each cross section unless NXY (X1.2) is zero indicating a repeat cross section. Stations must be entered in increasing order. Enter up to five coordinates per **GR** record. A maximum of 100 points (or twenty **GR** records) per cross section is permitted.

Field	Variable	Value	Description
0	ID	GR	Record identification.
1	EL(1)	-, 0, +	Elevation of first ground point.
2	STA(1)	-, 0, +	Station of first ground point.
3	EL(2)	-, 0, +	Elevation of second ground point.
4	STA(2)	-, 0, +	Station of second ground point.
5-10			Etc., continue elevation and station values for up to 100 ground point pairs. Each continuation record is identified with <b>GR</b> in Field 0, and the format is identical for all

records.

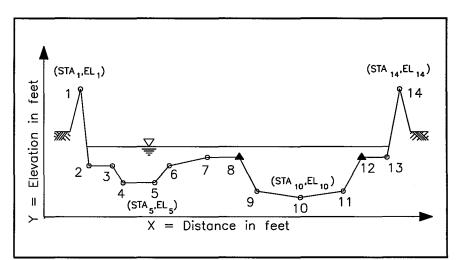


Figure A1-6 Example of GR Station and Elevation Pairs Defining a Channel Cross Section

#### A1.10 H Record - Movable Bed Limits (required if not using HD Record)

This record prescribes the width and depth of the bed sediment control volume and the dredging template at a cross section. HEC-6 computes the depth of sediment in the bed from the elevation of the model bottom, **EMB**, defined in Field 2 of this record. The **HD** record allows the user to directly prescribe the depth of the bed sediment control volume in Field 2. Other data on this record is the same as the **HD** record and either record is acceptable. Note that if a movable bed limit coincides with a GR point, that point is movable.

Field	Variable	Value	Description
0	ID	H or HD	Record identification.
1	SECID	-, +	<b>Cross Section Identification Number.</b> Use the same value as previously entered in X1.1 for this cross section.
For H Re	ecord		
2	ЕМВ	-, +	<b>Elevation of Model Bottom</b> (EMB). Enter the desired elevation. HEC-6 will not scour the bed below this elevation. <b>Beware</b> , a large depth of sediment can cause calculated volumes to be too large for computer word lengths, resulting in program failure.
		0	HEC-6 sets EMB to 10 ft below the minimum channel elevation of this cross section.
For HD I	Record		
2	DSM	0, +	<b>Depth of the Bed Sediment Control Volume</b> at this cross section. Negative values are not permitted. There is no default. (See warning for EMB above.)
3	XSM	-, +	<b>Movable Bed Boundary, Left.</b> Cross section station at change from fixed bed to movable bed; counterpart to XFM (H.4). Cross section coordinates between and including XSM and XFM will be adjusted vertically for scour and deposition. This station need not coincide with an existing <b>GR</b> point.
		0	HEC-6 will automatically set the movable bed limits according to the location of the water surface.
4	XFM	-, +	Movable Bed Boundary, Right. Cross section station at change from movable bed to fixed, counterpart to XSM (H.3). See XSM.
	,	0	HEC-6 will automatically set the movable bed limits according to the location of the water surface.
5			Leave blank.

Field	Variable	Value	Description
6	EDC	-, +	<b>Elevation of Bottom of Dredged Channel.</b> Do not include overdredging here (see H.10). This value should always be above the model bottom. (EMB in field H.2.)
		0	Dredging is not desired at this cross section. If the desired elevation of the dredged bottom channel is zero, enter a small positive value.
7	XSD	-, +	<b>Dredged Channel Boundary, Left.</b> Enter the station of the cross section coordinate point on the left side of the dredged channel, so that the elevation of coordinate points within the dredged channel (from XSD to XFD (H.8)) can be corrected for dredging. XSD <b>should always be</b> <b>greater than or equal to</b> XSM.
		0	XSD is set equal to XSM (H.3).
8	XFD	+	<b>Dredged Channel Boundary, Right</b> . Enter the station of the cross section point at the right of the dredged channel, beyond which no dredging is performed, counterpart to XSD. XFD <b>should always be less than or equal</b> to XFM.
		0	XFD is set equal to XFM (H.4).
9	XDM	+	Cross section <b>station of highest elevation</b> inside the dredge template. HEC-6 tests the elevation of that point against the elevation of dredged channel to determine whether or not dredging is required. Enter the station value of the coordinate having the highest elevation within the portion of channel to be dredged.
		0	HEC-6 uses the first (left-most) station within the dredged channel portion of the cross section.
10	DOD	+	Depth of Overdredging. Used to establish some extra depth below the required bottom elevation. Enter the amount of overdredging desired at this cross section. Do not allow overdepth dredging below the bottom of the bed sediment control volume.
		0, b	Leave blank if overdredging is not required.

#### A1.11 EJ Record (required) - End of Geometric Data

End of geometric model data is established by an EJ record. This record must be the last geometry record entered for each stream segment described in the geometry section.

Field	Variable	Value	Description
0	ID	EJ	Record identification.
1-10			Leave blank.

#### A1.12 \$TRIB Record - Tributary Inflow Point (optional)

This is the HEC-6 record which identifies the beginning of the geometry or sediment data set for each tributary in the stream network. The difference between a tributary and a local inflow is that the tributary is a branch in the network geometry data set whereas a local inflow point has no geometry. Refer to Section 3.6 for instructions on assembling data for tributary systems.

Place a **\$TRIB** command in front of each tributary geometric data set and in front of each tributary sediment data set.

# Important Note:A \$TRIB record for this version of HEC-6 has a different meaning than<br/>a \$TRIB record for versions released prior to June 1991. A \$TRIB<br/>record from an old (pre 1991) data file should be changed to a \$LOCAL<br/>record in order to run the data using Version 4.0 or later of HEC-6.

Field	Variable	Value	Description
0	ID	\$TRIB	Record identification (Columns 1 - 5).
2-10			Leave blank.

#### A1.13 CP Record - Control Point Identification (optional)

The **CP** record is used to associate each tributary data set with the cross section where it enters the network. The value entered in Field 1 should equal that given on the **QT** record associated with the tributary.

A **CP** record must follow each **\$TRIB** record used in the geometry data set. The appropriate records (described previously in this section) needed to detail the geometry of the tributary should follow the **CP** record.

Field	Variable	Value	Description
0	ID	СР	Record identification.
1	JPNUM	+	Junction (control) point number.
2-10			Leave blank.

# **Section A2**

## **Sediment Properties**

and

**Transport Functions** 

#### A2.1 Title Records - Comments (five required, T4 - T8)

**Five Title Records are required** to precede the sediment data **for each segment** in a network. They each have a T in Column 1 and the sequence number in Column 2. The number four is suggested for the first sequence number. A Data Echo print option is available; see below for details.

Field	Variable	Value	Description
0	ID	Τ4	Record identification in Columns 1 and 2. <b>T4, T5, T6, T7,</b> and <b>T8</b> for the fourth through eighth title records, respectively.
Column 4 of T4 record only	OPTION	В	<b>Data Echo.</b> Each input record is echoed to the output file as it is read. This is available to help the user verify the initial conditions and is not recommended for normal use. To exercise this option, enter B in Column 4 of the first title record ( <b>T4</b> ) of this group. Otherwise leave blank.
2-10 <sup>4</sup>			Fields 2 through 10 (Columns 9-80) may be used for identifying the stream segment, project date, or any other relevant information.

<sup>&</sup>lt;sup>4</sup> Column 4 of the first title record (T4) is reserved for requesting an output option that echoes the input and should be left blank if a data echo is not required.

#### A2.2 I1 Record - Sediment Properties (required)

Field	Variable	Value	Description
0	ID	11	Record identification.
1			Leave Blank.
2	SPI		Iterations of the Exner computations.
		+	Specify the number of exchange increments used during each time step to recalculate the composition of material in the bed.
			<b>Note:</b> More than any other input variable, SPI affects computation time. If too small of a value is used, calculations may display oscillations in the amount of sediment being transported and in the bed profile. The value can be increased to 20 or more, until the computed results are essentially the same as those calculated with SPI left blank or zero.
		0	HEC-6 calculates a value for SPI.
			Note: The value of SPI computed by HEC-6 (if the user does not specify a value) can be very large for some problems. We suggest that users avoid using values greater than SPI = 50. A message will appear in your output if the computed SPI value is greater than 50. If the user chooses to use the larger values, the desired SPI must be entered in Field 2 (I1.2) and HEC-6 re-executed. Refer to Section 2.3.4.1 and Training Document No. 13, "Guidelines for the Calibration and Application of Computer Program HEC-6" (HEC 1992), for further discussion.
3	IBG		<b>Gradation Calculation Method</b> . Instructs HEC-6 to calculate gradation in surface layer based upon transport capacity required to just transport the inflowing load with no scour or deposition if possible. Use this option <u>only</u> if bed material gradations are not available.
		0	HEC-6 uses gradation on <b>PF</b> records to calculate transport capacity.
		+	HEC-6 calculates gradation of surface layer based on inflowing load and sediment transport theory. Iterative process performed in IBG iterations.
4			Leave Blank.

The I1 record contains sediment properties.

Field	Variable	Value	Description
5	SPGF	+	<b>Specific Gravity of Fluid.</b> It is used with density and acceleration of gravity to calculate unit weight.
		0	HEC-6 uses SPGF=1.0000 (fresh water at 39.2 degrees F).
6	ACGR	+	Acceleration Due to Gravity.
		0	HEC-6 uses G=32.174 ft/sec² (standard at 45 degrees latitude, sea level).
7	NFALL		<b>Fall Velocity Computation Method.</b> Refer to Section 2.3.7, for a discussion of the available methods.
		0	HEC-6 defaults to Method 2.
		1	Original Toffaleti (1966) method for computing fall velocities.
		2	Federal Interagency Sedimentation Project (ICWR 1957 & Williams 1980) method for computing fall velocities.
8	IBSHER		Bed Shear Stress Computation Method.
		0, 1	HEC-6 calculates bed shear stress as yDS for clay/silt erosion and deposition.
		2	HEC-6 uses U* from smooth wall law to calculate bed shear stress for clay/silt erosion and deposition.

#### A2.3 I2 Record - Parameters Required for Clay Transport (optional)

The presence of an **I2** record instructs HEC-6 to calculate transport of clay. The data included on this record provides parameters and guidelines with which to structure the computations for clay transport.

**Note:** The clay transport relationships were derived from experiments where the suspended sediment concentrations were less than 300 mg/ℓ (Krone 1962). Applications to field situations where suspended sediment concentrations are greater than 300 mg/ℓ may exceed the intended range of applicability of the relationships. Also note, that the relationships for clay deposition were derived from one-dimensional channels where the velocity and sediment concentration profiles are reasonably uniform. Users may experience difficulty simulating clay deposition rates in deep reservoirs.

If the I2 record is used by itself, HEC-6 will only compute **deposition** of clay. However, if two **Special I2** records are used in addition to the first I2, both deposition and erosion of cohesive sediment (clay and silt) will be computed.

Field	Variable	Value	Description
0	ID	12	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTCL		Clay Transport Method.
		0, 1	<b>Deposition</b> of clay using settling velocity is computed <b>only. No clay erosion</b> is computed.
		2	<b>Deposition and erosion of cohesive sediments</b> are computed. Deposition is computed by the Krone (1962) equation and erosion by the Ariathurai (1976) method. Note that this method requires the addition of two <b>Special I2</b> records.
3	ICS	b, 1	Initial size class interval for clay - there is only one clay size available, so enter 1 or leave blank.
4	LCS	b, 1	Last size class interval for clay - there is only one clay size available, so enter 1 or leave blank.
5	SPGC	+	Specific gravity of clay particles.
		0	The default is 2.65.
6	DTCL	+	The shear threshold for clay deposition. This is the average bed shear stress in lbs/sq ft above which clay will not be deposited. This value is ignored when the <b>Special</b> I2 records are used.
		0	The default is 0.02 lb/sq ft.
7			Leave blank.

Field	Variable	Value	Description
8	PUCD	+	The unit of weight for fully compacted clay deposits, lb/cu ft.
		0	The default is 78 lb/cu ft.
9	UWCL	+	The initial (before compaction) unit weight for clay deposits, lb/cu ft.
		0	The default is 30 lb/cu ft.
10	CCCD	+	Compaction coefficient for clay deposits for the equation:
			$\gamma_{clay}$ =UWCL + [CCCD · log <sub>10</sub> (Time)]
			where Time is in years. See Section 2.3.6.3.
		0	The default is 16 lb/cu ft.

#### A2.4 Special I2 Records - Cohesive Sediment Transport Method 2 -Supplemental Parameters (optional)

The **Special I2** records are used to prescribe the depositional and erosional shear stress thresholds for fine grained cohesive sediment (clay and silt) to be used by clay and silt transport Method 2 (MTCL - I2.2, MTSL - I3.2). Refer to Section 2.3.9. If used, two **Special I2** records must be employed (in addition to the first I2 record described on the preceding pages): one to describe the active layer and one to describe the inactive layer.

**Note:** The clay transport algorithms were derived from experiments where the suspended sediment concentrations were less than 300 mg/ $\ell$  (see Krone, 1962). Applications to field situations where suspended sediment concentrations may be greater than 300 mg/ $\ell$  may exceed the intended range of applicability of the relationships. Also note, that the relationships for clay deposition were derived from one-dimensional channels where the velocity and sediment concentration profiles are reasonably uniform. Users may experience difficulty simulating clay deposition rates in deep reservoirs.

The erosion parameters defined on the **Special I2** records apply to silt as well as clay sediments. If erosion of silt sizes is desired, then an **I3** record must follow the **Special I2** record.

Field	Variable	Value	Description
0	ID	12	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	J	1	Data on this record applies to the active layer (the first <b>Special 12</b> record).
		2	Data on this record applies to the inactive layer (the second <b>Special I2</b> record).
3	DTCL	+	The shear threshold for clay and silt deposition. This is the average bed shear stress in lbs/sq ft above which clay and silt will not be deposited.
		0	The default is 0.02 lb/sq ft.
4	STCD	+	Shear stress threshold for erosion of clay and silt particles, lb/sq ft. This is the shear stress above which clay and silt material will be scoured from the bed <sup>5</sup> .
5	STME	+	Shear stress threshold for mass erosion, lb/sq ft. <sup>5</sup>
6	ERME	+	<b>Erosion rate of clay and silt</b> at STME, lb/sq ft/hr. <sup>5</sup>
7	ER2	+	Slope of the erosion rate curve for mass erosion, 1/hr. <sup>5</sup>

<sup>&</sup>lt;sup>5</sup> There is no default, user must enter a value.

### A2.5 I3 Record - Parameters Required for Silt Transport (optional)

The presence of an **I3** record instructs HEC-6 that the mixture of sediment to be analyzed contains silt size particles. The data included on this record provides parameters and guidelines within which to structure the computations for silt transport. Do not attempt to include silt particles without also including clay. If no clay is present in the system, enter zero for clay on the **LF** and **PF** records.

When modeling erosion of silts, you must provide an I2 and two **Special I2** records to define erosion parameters of silt grains.

Field	Variable	Value	Description
0	ID	13	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTSL		Silt Transport Method
		1	Settling velocity method for calculating deposition of silt.
		2	Method for computing scour and deposition of silt.
			<b>Note:</b> This method requires the use of an I2 record and two <b>Special I2</b> records, as described on the preceding pages.
3	IASL	+	ID number of the <b>smallest grain size classification</b> of silt to be transported (see Table A2-1). IASL must always be less than LASL.
		0	Default IASL=1.
4	LASL	+	ID number of the <b>largest grain size classification</b> of silt to be transported (see Table A2-1).
		0	Default LASL=4.

#### Table A2-1 Grain Size Classes; Silts

ID Number	Classification	Grain Size (mm)	Geometric Mean (mm)
1	Very fine silt	.0040080	.005
2	Fine	.0080160	.011
3	Medium	.0160310	.022
4	Coarse	.0310625	.044

The data in Table A-2 is predefined in HEC-6; IASL and LASL must be selected from this table. HEC-6 automatically includes all sizes between IASL and LASL if the **I3** record is present in the input. If transport of clay is to be computed as well as silts, IASL should equal one to provide a continuous representation of grain size classes from clay to silts. If transport of sands is to be computed as well as silts, LASL should equal four for the same reason. Grain sizes which are not found in the bed may be so noted (with zero values) in the bed material gradation specified on the **PF** records.

Field	Variable	Value	Description
5	SGSL	+	Specific gravity of silt particles.
		0	Default = 2.65
6	DTSL		Deposition threshold for silt.
		+	The average bed shear stress in lb/sq ft above which silt material will not be deposited. This value is ignored if <b>Special 12</b> records are used.
		0	Default = 0.02 lb/sq ft (for lack of better data).
7			Leave blank.
8	PUSD	+	<b>Unit weight</b> of fully consolidated silt deposits in lb/cu ft.
		0	Default = 82 lb/cu ft.
9	UWSL	+	<b>Unit weight</b> of silt material at the moment it is deposited on the stream bed.
		0	Default = 65 lb/cu ft.
10	CCSD	+	Compaction coefficient for silt deposits for the equation
			$\gamma_{silt} = UWSL + [CCSD \cdot (log_{10}(Time)]$
			where Time is the accumulated simulation time expressed in years.
		0	Default = 5.7 lb/cu ft/yr.

13

## A2.6 I4 Record - Parameters Required for Sand Transport (optional)

The presence of an I4 record indicates that sand sizes are present in the mixture of sediment to be analyzed. The data on this record provides parameters and guidelines within which to perform the computations for sand transport.

Field	Variable	Value	Description
0	lD	14	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	MTC		<b>Transport capacity relationship</b> <sup>6</sup> to be used by HEC-6 to compute sediment load for a given water discharge.
		0, 1	Toffaleti's (1966) transport function.
		2	<b>User Specified Transport Function</b> . User specification of transport coefficients based upon observed data. User must supply his own transport relationship in the form of DS vs. transport coefficients (on records J and K), where DS is depth times slope. See instructions for the J and K records for a more complete description.
		3	Madden's (1963) modification of Laursen's (1958) relationship
		4	Yang's (1973) stream power for sands
		5	DuBoys' transport function (Vanoni 1975)
		6	Not used
		7	Ackers-White (1973) transport function
		8	Colby (1964) transport function
		9	Toffaleti (1966) and Schoklitsch (1930) combination
		10	Meyer-Peter and Müller (1948)
		11	Not used
		12	Toffaleti and Meyer-Peter and Müller combination
		13	Madden's (1985, unpublished) modification of Laursen's (1958) relationship
		14	Copeland's (1990) modification of Laursen's relationship (Copeland and Thomas 1989)

<sup>&</sup>lt;sup>6</sup> Users should refer to Chapter 2 of Vanoni's Sedimentation Engineering (1975), for information regarding the best transport function to use for specific types of rivers and bed material types.

Field	Variable	Value	Description
3	IASA	+	ID number of the <b>smallest grain size classification</b> of sand to be transported in the calculations (see Table A-3). IASA must always be less than LASA.
		0	Default IASA = 1.
4	LASA	+	ID number of the <b>largest grain size classification</b> of sand to be transported in the calculations (see Table A-3).
		0	Default LASA = 10.

The following table of grain sizes is predefined in HEC-6. IASA and LASA must be selected from this table. All sizes between, and including, IASA and LASA will be transported. If transport of silts is to be computed as well as sands, IASA should equal one to provide a continuous representation of grain size classes from silts to sands even if the very fine sand sizes are not found in the bed. Grain sizes which are not found in the bed may be so noted in the bed material gradation specified on the **PF** record.

ID Number	Classification	Grain Size (mm)	Geometric Mean (mm)
1	Very Fine Sand	.062125	.088
2	Fine Sand	.125250	.177
3	Medium Sand	.2550	.354
4	Coarse Sand	.50 - 1.0	.707
5	Very Coarse Sand	1 - 2	1.414
6	Very Fine Gravel	2 - 4	2.828
7	Fine Gravel	4 - 8	5.657
8	Medium Gravel	8 - 16	11.31
9	Coarse Gravel	16 - 32	22.63
10	Very Coarse Gravel	32 - 64	45.26
11	Small Cobbles (SC)	64 - 128	90.51
12	Large Cobbles (LC)	128 - 256	181.0
13	Small Boulders (SB)	256 - 512	362.0
14	Medium Boulders (MB)	512 - 1024	724.1
15	Large Boulders (LB)	1024 - 2048	1446.2

Table A2-2Grain Size Classes; Sands

Field	Variable	Value	Description
5	SPGS	+	<b>Specific gravity of sand particles.</b> (Not the unit weight of deposited material.)
		0	Default = 2.65.
6	GSF	+	Grain shape factor.
		0	Default = 0.667.
7	BSAE	+	<b>Coefficient in surface area exposed function.</b> Equation is as follows:
			$FSAE = ASAE(SAE^{BSAE}) + CSAE$
		0	Default = 0.5.
8	PSI	+	The parameter $\psi$ from Einstein's (1950) method is used to approximate $\psi^*$ for calculating equilibrium bed elevation. See Section 2.3.2.1.
		0	Default = 30.
9	UWD	+	Unit weight of deposited sediment. Specify in lb/cu ft.
		0	Default UWD = 93 lb/cu ft, a reasonable value for sand. HEC-6 does not change this value with time.

# A2.7 I5 Record - Weighting Factors for Numerical Integration Method (optional)

Use this record to enter hydraulic parameter weighting factors. Section 2.2.4 presents two sets or schemes of weighting factors for the numerical integration method used by HEC-6. If the I5 record is omitted, HEC-6 defaults to the Scheme 2 weighting factors. All values must be supplied.

Field	Variable	Value	Description
0	ID	15	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	DBI	+	Weight assigned to hydraulic properties at second cross section when calculating at downstream boundary.
3	DBN	+	Weight assigned to hydraulic properties at downstream boundary for downstream boundary calculations.
			Note: DBI + DBN must equal 1.0.
4	XID	+	Weight assigned to hydraulic properties at the downstream cross section - interior point calculations.
5	XIN	+	Weight assigned to hydraulic properties at cross section of interest - interior point calculations.
6	XIU	+	Weight assigned to hydraulic properties at the upstream cross section - interior point calculations.
			Note: XID + XIN + XIU must equal 1.0.
7	UBI	+	Weight assigned to hydraulic properties at next to last cross section for calculation at upstream boundary.
8	UBN	+	Weight assigned to hydraulic properties at upstream boundary.
			Note: UBI + UBN must equal 1.0.

#### A2.8 J Record<sup>7</sup> - User Specified Transport Function (optional)

Use the J record to define the coefficients of the User Specified Transport Function. This function is expressed by the equation:

 $GP_{I} = (((EFD \cdot SLO) - C_{I})/A_{I})^{B_{I}}) \cdot EFW \cdot STO$ 

where:  $A_i$ ,  $B_i$ ,  $C_i$  = coefficients entered on the J records in units of tons/day/foot of width for each grain size

STO = correction factor computed from the coefficients on the K record

EFD = effective depth

EFW = effective width

SLO = energy slope

GP = potential transport per grain size

A separate J record is required for each grain size fraction being evaluated. Enter data from fine to coarse. The data contained on the J and K records is relevant to HEC-6 only if the selected transport capacity relationship, MTC (14.2), equals two. If MTC does not equal two, HEC-6 will simply ignore the data contained on these records. Section 3.3.4.1 contains a complete description of the user specified transport function option.

Field	Variable	Value	Description
0	ID	J	Record identification (Column 1).
1		Comment	Comment information such as the name of the grain size classification to which the data on this record relates.
2	A <sub>i</sub>	+	Coefficient corresponding to A in above equation for grain size i.
3	B <sub>i</sub>	+	Coefficient corresponding to B in above equation for grain size i.
4	C <sub>i</sub>	+	Coefficient corresponding to C in above equation for grain size i.

<sup>&</sup>lt;sup>7</sup> If the user decides to use the special transport function option, then **both** a set of **J** records and **K** record must be provided in order to specify the required information and coefficients to use this option.

### A2.9 K Record - User Specified Transport Function (optional)

Use the K record to define the coefficients of the function which is used to correct the User Specified Transport Function for variation in n value. This correcting function is expressed by the equation:

$$STO = 10^{-6} \cdot D \cdot n^{E}$$

The data contained on the J and K records is relevant to HEC-6 only if the selected transport capacity relationship, MTC (I4.2), equals two. If MTC does not equal two, HEC-6 will simply ignore the data contained on these records. Section 3.3.4.1 provides a complete description of this transport function option.

Field	Variable	Value	Description
0	ID	К	Record identification (Column 1).
1		Comment	Comment information.
2	CNCO(1)		Coefficient corresponding to D in the above equation.
3	CNCO(2)		Coefficient corresponding to E in the above equation.

Κ

# A2.10 LQ Record - Water Discharge for the Water Discharge-Sediment Load Relationship (required)

The inflowing sediment load is related to water discharge by prescribing the discharge in cfs on the LQ record, total sediment load in tons per day on the LT record and the fraction of the sediment load in each grain size class on LF records. Each LF record will describe one grain size fraction and they should be entered from fine to coarse. Enter the water discharge in cfs on the LQ record as follows.

Field	Variable	Value	Description
0	ID	LQ	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	QWATER	+	<b>Water discharge</b> in cfs. Enter the first discharge value <sup>8</sup> for the water discharge vs. sediment load table. If the range of water discharges in the inflow hydrograph is beyond that specified in this table, the extreme values of sediment load from the table will be used (i.e., HEC-6 will not extrapolate beyond the ends of the table).
3	QWATER	+	The second water discharge for the water discharge vs. sediment load table. Each consecutive water discharge must be greater than the previous one.
4-10	QWATER	+	Continue to enter increasing water discharge values in Fields 4 through 10. A maximum of nine water discharge values is permitted.

<sup>&</sup>lt;sup>8</sup> QWATER cannot be zero or negative.

### A2.11 LT Record - Total Sediment Load for the Water Discharge-Sediment Load Relationship (required)

The inflowing sediment load is related to water discharge by prescribing the discharge in cfs on the LQ record, total sediment load in tons per day on the LT record and the fraction of the sediment load in each grain size class on LF records. Each LF record describes one grain size fraction; they should be entered from fine to coarse. Enter the total sediment load in tons per day on the LT record as follows.

Field	Variable	Value	Description
0	ID	LT	Record identification.
1		Comment	Any alphanumeric characters or comments.
2	QSED	+, 0	<b>Total sediment load</b> in tons per day. This value corresponds to the water discharge entered in Field 2 of the LQ record.
3	QSED	+, 0	Total sediment load in tons per day. This value corresponds to the water discharge entered in Field 3 of the LQ record.
4-10	QSED	+, 0	Continue to enter the total sediment load values for each subsequent water discharge entered on the LQ record. A maximum of nine values is permitted.

#### A2.12 LF Record - Fraction of Load for the Water Discharge-Sediment Load Relationship (required)

The inflowing sediment load is related to water discharge by prescribing the discharge in cfs on the LQ record, total sediment load in tons per day on the LT record and the fraction of the sediment load in each grain size class on LF records.

Each LF record describes the sediment load of one grain size fraction. There must be one LF record for each grain size classification selected on records I2 through I4 even if the fraction of the load for any grain size is zero. LF records should be entered from fine to coarse.

Field	Variable	Value	Description
0	ID	LF	Record identification.
1		Comment	Any alphanumeric characters or comments. (It is recommended that the name of the grain size class to which the data on this record relates be used in this field; i.e., CLAY, SILT1, SILT2, VFS, FS, VCG.)
2	QSF	+, 0	The fraction for this grain size of the total sediment load corresponding to the water discharge in Field 2 of the LQ record.
3	QSF	+, 0	The fraction for this grain size of the total sediment load corresponding to the water discharge in Field 3 of the LQ record.
4-10	QSF	+, 0	Continue to enter the fraction of the total sediment load corresponding to each subsequent water discharge entered on the <b>LQ</b> record. A maximum of nine values is permitted.

## A2.13 PF Record - Bed Material Gradation - Percent Finer

The **PF** record defines the gradation of the bed sediment control volume (in percent finer) at each cross section as a grain size distribution curve. The sediment computations require gradation information for each cross section; however, it is not necessary to enter **PF** records for every cross section. Specific rules are:

- a. There must be at least one **PF** record for each stream segment in the network. If only one **PF** record is present, that gradation is used for all cross sections on that stream segment.
- b. The cross section ID number is entered in Field 2 to tell HEC-6 where the **PF** data applies. The cross section ID number on each **PF** record must correspond to one used previously on an **X1** record. If more than one **PF** record is present, but not one for each cross section on the stream segment, a linear interpolation is made to fill in the missing data.
- c. If the cross section ID number is omitted from a **PF** record, it will be assigned to the last cross section (i.e., the one most upstream), and values to the previous **PF** record will be interpolated.

d. The gradation for any cross sections after the final PF record will be assigned the	values
on that record.	

Field	Variable	Value	Description
0	ID	PF	Record identification.
		PFC	Record identification, continuation records.
1		Comment	Comment on PF record; data on PFC records.
2	SECID	-, 0, +	Cross section ID number. There is no default. Do not leave this field blank.
3	SAE	b, 0	The fraction of the bed surface that is exposed to erosion. That is, a portion of the bed may be armored or partially covered with bedrock. Usually SAE is left blank in which case, HEC-6 will use a default value of 1.0.
		.001-1.0	The normal range.
4	DMAX	+	The diameter of the maximum particle size in millimeters. Always enter a value. HEC-6 assigns a percent finer (PFXIS(1)=100) to correspond with DMAX. Although not required for execution, it is best if DMAX corresponds to a class interval boundary. DMAX is also known as DAXIS(1).

Field	Variable	Value	Description
5	DAXIS(2)	+	<b>The grain size diameter</b> in millimeters at the first coordinate point down the percent finer curve from DMAX. If DAXIS (1) or (2) particle size is larger than 2048 mm, choose a point that will approximate the PF-Curve with two straight line segments from DMAX to 2048 mm.
			Note: It is not necessary that this or any PF- coordinate correspond to a grain size class interval boundary - although they can. Semi-log interpolation is used to calculate the percent finer at each class interval boundary and these are subtracted to calculate the fraction of sediment in each size class.
6	PFAXIS(2)	0, +	The percent finer corresponding to DAXIS(2). Code as a percent (e.g., enter 10 for 10%, 20 for 20%, etc.).
7-10	DAXIS-PFAXIS	0, +	Continue to code points from the percent finer curve in (grain size diameter, percent finer) pairs. Use up to 3 continuation <b>PFC</b> records to code a maximum of 16 points. Begin coding data in Field 1 of continuation records.

#### A2.14 \$LOCAL Record - Local Inflow (optional)

This record indicates that a water-sediment discharge table for a local inflow or diversion follows. It is used to separate inflow/diversion data from other data in the data stream.

Place the **\$LOCAL** record after the **PF** records in the sediment data to separate the sediment data for the current stream segment from the water-sediment discharge table information needed for the local inflow(s) on the same stream segment. Use only one **\$LOCAL** record per branch of the network even though several sediment inflow/diversion data sets may be present on that stream segment.

A separate set of LQL, LTL and LFL records is required to specify **each** local inflow and/or diversion. Enter each set of LQL, LTL and LFL records in the same order as the local inflow points appear in the stream segment's geometry (downstream to upstream). The range of water discharges are specified on the LQL records, with corresponding sediment loads (for each water discharge) on the LTL records. Each LFL record specifies the sediment load fraction associated with each grain size defined by the I2 - I4 records.

**Note:** The **\$LOCAL** record replaces the **\$TRIB** record in old data sets.

Field	Variable	Value	Description
0	ID		Record identification (Columns 1 through 6).

### A2.15 LQL Record - Water Discharge for Local Inflows/Diversions Specification (optional)

A set of LQL, LTL, and LFL records are used to specify the water discharge and sediment load associated with a local inflow or diversion. The LQL record specifies the water discharge portion of the load curve associated with local inflows and diversions. If only local inflow occurs, the data values on the LQL record are all positive and have the same format as specified on the LQ record. If a diversion is to be modeled, two negative values must be entered that **bracket** the maximum and minimum diversion values in the hydrograph. These values are entered as negative numbers in Fields 2 and 3. Fields 4 through 10 are left blank. If the flow direction at the local inflow point varies from one time step to another, then specify the range of the diversion flows with negative QWATER values in Fields 2 and 3 and enter positive QWATER values in Fields 4 through 10 to specify the flow curve for the positive inflows.

**Note:** No continuation record is permitted. If a flow value in the hydrograph is above the extreme discharges on the LQL record, HEC-6 will use the sediment load value associated with the extreme discharge. If diversions are entered, they must fall between LQL.2 and LQL.3.

Field	Variable	Value	Description
0	ID	LQL	Record identification (Columns 1 through 3).
1		Comment	Any alphanumeric character comment.
Inflows			
2	QWATER	+	<b>Water Discharge</b> - Enter a positive discharge whose value is less than the smallest inflow value in the local hydrograph.
3-10	QWATER	+	Water Discharge - Enter increasing water discharges for the local inflow curve.
Diversions			
2	QWATER	-	<b>Water Discharge</b> - Enter a number slightly larger in absolute value than the maximum diversion value here. For example, if the maximum diversion value was 10.0, then one might enter -10.1.
			<b>Note:</b> The values entered in Fields 2 and 3 <b>must be negative</b> to denote diversions.
3	QWATER	-	Enter a number slightly smaller in absolute value than the minimum diversion value. For example, if the minimum diversion value was 1.0, a user might enter -0.9.
4-10			Leave blank.

Field	Variable	Value	Description
Combined	d Diversions a	nd Inflows	
2, 3	QWATER	-	Enter negative values that lie on either side of the maximum and minimum diversion discharges.
4	QWATER	+	<b>Water Discharge</b> - Enter a positive discharge whose value is less than the smallest inflow value in the local hydrograph (as in Inflows, above.)
5-10	QWATER	+	Water Discharge - Continue entering increasing water discharges for the local inflow curve.
			Note: A maximum of seven values may be entered.

#### A2.16 LTL Record - Total Sediment Load for Local Inflows/Diversions Specification (optional)

A set of LQL, LTL, and LFL records are used to specify the water discharge and sediment load associated with a local inflow or diversion. The total sediment load corresponding to the discharges entered on the LQL record is entered on the LTL record in units of tons/day.

Field	Variable	Value	Description	
0	ID	LTL	Record identification (Columns 1 through 3).	
1		Comment	Any alphanumeric characters or comments.	
Inflows				
2-10	QSED	+	<b>Total sediment load</b> (tons/day) corresponding to each water discharge given on the <b>LQL</b> record, for the local flow-sediment load table. A maximum of nine values is permitted.	
Diversions				
2, 3	QSED	1.0	If only diversions make up the local hydrograph, enter 1.0 in Fields 2 and 3 and leave Fields 4 through 10 blank.	
4-10			Leave blank.	
Combined Diversions and Inflows				
2, 3	QSED	1.0	If diversions are included in the local hydrograph, enter 1.0 in Fields 2 and 3.	
4-10	QSED	+	Total sediment load (tons/day) corresponding to each water discharge given on the LQL record, for the local flow-sediment load table. A maximum of seven values is permitted.	

#### A2.17 LFL Record - Sediment Grain Size Distribution for Local Inflows/Diversions (optional)

A set of LQL, LTL, and LFL records are used to specify the water discharge and sediment load associated with a local inflow or diversion. The LFL records specify the fraction of the total local sediment load per size class.

The LFL records should be entered from fine to coarse with one LFL record for **each** of the sediment size classes specified on the I2 - I4 records. If only inflows occur as this local point, then the LFL records have the same format and rules as the LF records. Diversion points and combination inflow-diversion points require a slight variation from the upstream inflowing sediment load table. All diversions are prescribed by a ratio of the concentration of sediment in diverted water to that in the main channel just upstream from the diversion point.

Field	Variable	Value	Description
0	ID	LFL	Record identification (Columns 1 through 3).
1		Comment	Any alphanumeric character comment. (It is recommended that the grain size class be entered in the comment field, i.e. CLAY, SILT1, SILT2, VFS, FS, VCG).
Inflows			
2-10	QSF	+, 0	Enter the <b>fraction of the total sediment load</b> for this sediment size class corresponding to each water discharge specified on the <b>LQL</b> record.
Diversions			
2, 3	QSF		Enter the <b>diversion coefficient</b> (ratio of diverted sediment concentration to the ambient channel concentration) for the corresponding diversion (negative) discharge specified on the LQL record.
		+	When field data is available, calculate the ratio of $C_{\text{Diverted}}/C_{\text{Ambient}}$ and use that value. Otherwise, a value of 1.0 may be appropriate for suspended load and possibly, >1.0 for bed load.
4-10			Leave blank.

Field	Variable	Value	Description
Combined	l Diversions a	nd Inflows	3
2, 3	QSF		Enter the <b>diversion coefficient</b> (ratio of diverted sediment concentration to the ambient channel concentration) for the corresponding diversion (negative) discharge specified on the <b>LQL</b> record.
		+	When field data is available, calculate the ratio of D <sub>Diverted</sub> /C <sub>Ambient</sub> and use that value. Otherwise, a value of 1.0 may be appropriate for suspended load and possibly, >1.0 for bed load.
4-10	QSF	+, 0	Enter the <b>fraction of the total sediment load</b> or this sediment size class corresponding to each water discharge specified on the <b>LQL</b> record.

# **Section A3**

Hydrologic Data

# A3.1 \$HYD Record - Hydrologic Data (required)

The **\$HYD** record marks the beginning of the hydrologic data. This record is required and precedes discharge data described on the following pages.

Field	Variable	Value	Description
0	ID	\$HYD	Record identification.

## A3.2 \* Record - Comment and Output Control (required)

One comment record is required for each **Q** record in the hydrologic data. This record provides title information for each time step. It also allows the user to select various output options.

Field	Variable	Value	Description
0	ID	*	Record identification (Column 1).
Output Co	ntrol for Hy	draulic Info	rmation
Column 5	OPTION		Optional output from <b>the hydraulic computations</b> (water surface profiles) is obtained by specifying one of the following codes in Column 5 on the <b>*</b> record.
		blank	Discharge, starting water surface elevation, water temperature and flow duration in days is output. For this option, leave Column 5 blank, not zero. This is the standard hydraulic output option.
		A	Water surface and energy line elevations, velocity head, alpha, top width, average bed elevation, and velocity in each subsection are output for each discharge at each cross section.
		В	Cross section coordinates at the current time and distribution of hydrologic data across the section for the final calculated water surface are output.
		D	Trace information. (Not recommended for most users.)
		E	Detailed Trace Information. All of the above information plus coordinates, area and wetted perimeter for each trapezoidal area in each cross section and for each trial elevation at each cross section. (Not recommended for most users.)
Note:	Output le	evels D and I	E produce very large quantities of output from the hydraulic

**Note:** Output levels D and E produce very large quantities of output from the hydraulic computations. This output was designed for software error checking. Execution time will increase and output files will become very large if either of these options are used.

\*

Field Variable Value Description

#### **Output Control for Sediment Transport Information**

Column 6	OPTION		Optional output from sediment transport computations.
		blank	No output except summary at end of job. For this option leave Column 6 blank, not zero.
		A	A table showing the volume of sediment entering and leaving each segment and the computed trap efficiency for each segment.
		В	In addition to A, the cumulative bed change, the water surface and thalweg elevations, and the sediment load passing in tons/day for clay, silt and sand for each cross section. This and all higher output levels cause a supplemental output file to be written at this time step for post-processing purposes.
		С	In addition to the above, values of the detailed distribution by grain size fraction for the bed surface material at each cross section before the values are corrected by percentage present in the bed. (Not recommended for most users.)
		D, E	Detailed Trace Information. (Not recommended for most users.)

**Note:** Output levels C, D and E produce very large quantities of output from the sedimentation computations. This trace output was designed primarily for software error checking. Execution time will increase and output files will become very large if any of these options are used.

#### **Time Step Title Information**

2-10 Comment	Comment data for discharge-elevation-duration data that follows. Use the remainder of this record to provide
	title/comment information for this time step. This data
	will appear in the output file.

# A3.3 Q Record - Water Discharges in cfs (required)

A **Q** record is required for each time step defined in the hydrologic data. The **Q** record provides HEC-6 with the outflow at the downstream boundary as well as flow conditions at each of the control points in a stream network. See Sections 3.4.1, 3.6, and Sections 6.1 through 6.3 for a complete description of how to enter data on the **Q** record for a stream network.

Field	Variable	Value	Description
0	ID	Q	Record identification (Column 1).
1	Q(1)	+	Outflow from downstream boundary of geometric model for this time step.
			aries, Local Inflows or Diversions Present in the Geometric Data
2	Q(2)	0, +	Tributary discharge of first local inflow (diversion) point on main stem. If no local flows, enter discharge from stream segment at control point 2.
		-	Diversion flows are identified by a negative discharge. Otherwise, diversions and tributaries are subject to the same coding rules. They may be mixed but they both may not occur at the same time at the same cross section.
3-10	Q(3)-Q(10)	0, +, -	The discharge, inflow or outflow, of the next control/junction point defined in the network (see Section 3.6 and Sections 6.1 through 6.4 for details).
			aries, Local Inflows, and Divisions <u>t</u> Present in the Geometric Data
2-10	Q(2)-Q(10)	+	Up to MNQ (11.4) parallel discharges may be entered across the <b>Q</b> record.

# A3.4 R Record - Downstream Water Surface Elevation Boundary Condition (required<sup>9</sup>)

A water surface elevation must be specified at the downstream boundary of the model for every time step to begin the backwater computations. HEC-6 provides three methods for prescribing this downstream boundary condition: (1) a rating curve, (2) stage vs. time (**R** records), or (3) a combination of a rating curve and **R** records.

Method 1 involves the use of a rating curve which is specified using a **\$RATING** record followed by a set of **RC** records containing the water surface elevation data as a function of discharge. The rating curve need only be specified once at the start of the hydrologic data (immediately following the **\$HYD** record) and a water surface elevation will be determined by interpolation using the discharge given on the **Q** record for each time step. The rating curve may be temporarily modified using the **S** record or replaced by entering a new set of **\$RATING** and **RC** records before any **\*** record in the hydrologic data.

In Method 2, **R** records are used **instead** of a rating curve to define the water surface elevation. To use this method, an **R** record is required for the first time step. The elevation entered in Field 1 of this record will be used for each succeeding time step until another **R** record is found with a non-zero value in Field 1. In this way, you need only insert **R** records to change the downstream water surface elevation to a new value.

Method 3 is a combination of the first two methods. This method makes it possible to use the rating curve most of the time to determine the downstream water surface elevation while still allowing the user to specify the elevation exactly at given time steps. In this method, the **R** record's non-zero Field 1 value for the downstream water surface elevation will override the rating curve for that time step. On the next time step, HEC-6 will obtain the downstream water surface from to the rating curve unless another **R** record is found with a non-zero value in Field 1.

#### **Water Surface Elevation at Internal Boundaries**

**R** records have a secondary purpose. They may also be used to define the water surface elevation at certain internal boundaries in the geometry. The location of an internal boundary is defined by an **X5** record. **R** records are then necessary to define the water surface at those internal boundaries where an **R** record field has been specified in field 4 of the **X5** record. The water surface elevation (UPE) for that time step will be read from the **R** record at the field prescribed on the **X5** record (**X5**.4). See the **X5** record description (Section A1.7) for further details.

<sup>&</sup>lt;sup>9</sup> An R record is required only if a rating table is not used, and then it is only required for the first time step.

Field	Variable	Value	Description
0	ID	R	Record identification (Column 1).
1	WS(1)	+	Enter the value for the prescribed <b>water surface</b> <b>elevation</b> that corresponds to the outflow entered on the <b>Q</b> record in Field 1.
		0	When no internal boundaries are present, then a zero in Field 1 <b>should not be used.</b> To define a water surface elevation at zero, input a small positive value (e.g., 0.001)
2-10			Leave blank.

#### If Internal Boundaries are <u>not</u> Present in the Geometry

# If Internal Boundaries <u>are</u> Present in the Geometry

Field	Variable	Value	Description
0	ID	R	Record identification (Column 1).
1	WS(1)	+	Enter the value for the prescribed <b>water surface</b> elevation that corresponds to the outflow entered on the Q record in Field 1.
		0	When internal boundaries are present (defined on X5 records) and a rating curve exists, the water surface will be determined from the rating curve ( <b>\$RATING</b> and <b>RC</b> records). If a rating curve does not exist, the water surface from the previous time step will be reused.
2-10	WS(n)	+	Enter the water surface elevation for the internal boundary for which ICSH (X5.4)=n, where n equals the current field.
		0	Use the water surface value from the previous time step. To define a water surface elevation of zero, enter a small positive value (e.g., 0.001).

### A3.5 S Record - Rating Shift (optional)

This record allows the user to alter the starting water surface elevation at the downstream boundary by a constant value. This alteration will remain in effect for succeeding time steps until another S record is read with a new shift value. The shift value is not cumulative.

Field	Variable	Value	Description
0	ID	S	Record identification (Column 1).
1	SHIFT	+, -	Enter the shift for starting water surface elevations in Field 1. All starting elevations will be shifted by this amount for this and subsequent Q's until a new shift value is read from an <b>S</b> record. To return to zero shift, enter an <b>S</b> record with Field 1 blank or zero.
		b, 0	Use original water surface elevation. No alteration.
2-10			Leave blank.

## A3.6 T Record - Water Temperature (optional)

The T record provides water temperature data (refer to Section 3.4.2.1). This record is required only in the first time step. Include subsequent T records only if the water temperature changes. The water temperature(s) entered on this record will remain in effect until another T record is entered to change it. Water temperature is important for computing sediment settling velocity (especially for fine materials).

Field	Variable	Value	Description
0	ID	т	Record identification (Column 1).
1-10	WT(1)WT(10)	+	Water temperature, in degrees Fahrenheit, corresponding to each Q that exists on the Q record. T.1 corresponds to Q.1, etc. Enter new values only if the water temperature changes from the values entered on the previous T record.

#### A3.7 W Record - Duration (required)

The W record defines the duration of the flow for the present time step. A W record is required for each time step in the hydrologic data set (refer to Section 3.4.1 and Figure 3.9).

Field	Variable	Value	Description
0	ID	W	Record identification (Column 1).
1	DD	+	<b>The flow duration</b> of this time step in days or fractions of days.
2			Leave Blank.

### A3.8 X Record - Alternate Format for Duration Data (optional)

The X record may be used in place of the W record to define the flow duration. The purpose, however, is to subdivide the time step prescribed by the W record into shorter time steps. This need arises when unstable computation steps are not detected until after the hydrologic data has been assembled using the traditional W record approach. The X record allows the computation time interval to be shortened without requiring additional time step data sets (**\***, **Q**, **W** record sets) to be inserted into the hydrologic data. To use this capability, replace the W record of the unstable time step with an X record. Two options for coding the X record are allowed. Option 1 is recommended.

Field	Variable	Value	Description
0	ID	х	Record identification (Column 1).
1			Leave blank.
2	DT	+	<b>Time Increment</b> in days. Must be less than the total duration of the original time step (from <b>W</b> record).
3	DD	+	The Total Duration of the original time step. This is the value previously coded in the W record:
			$NINC = DD \div DT$
			Where NINC is the number of computational time steps that will be executed using the flow, temperature and starting water surface data of this timestep.
4-10			Leave blank.

#### Coding Option #1

X

Coding	Option	#2
--------	--------	----

Field	Variable	Value	Description
0	ID	х	Record identification (Column 1).
1	ТСН	+	The Total Accumulated Time in days to be reached at the completion of this composite time step. This value must be accurate and can be obtained from the output of the original data set using the <b>W</b> records.
			The total duration of this flow equals TCH minus the accumulated time at the end of the previous time step.
2	DT	+	<b>Time Increment</b> in days. Must be less than the total duration of the original time step.
			Total duration divided by DT equals the number of computational time steps that will be used.
3-10			Leave blank.

# A3.9 \$\$END Record - Required

Last record in the data file.

Field	Variable	Value	Description
0	ID	\$\$END	Record identification (Columns 1 through 5).

# **Section A4**

# **Special Commands**

# and

**Output Control** 

\$\$END

# A4.1 \$B Record - Transmissive Boundary Condition (optional)

The **\$B** record is used to suspend the sedimentation computations at each downstream boundary. The sediment discharge for each downstream boundary is set to the rate of sediment leaving the next upstream cross section. Use this option when sediment deposits at the downstream boundary and there is no physical explanation for it (e.g., as in a supercritical flow reach when the sediment concentration is very high). See Section 3.4.2.4 for a brief discussion of this option.

Field	Variable	Value	Description
0	ID	\$B	Record identification.
2	ISBT	2	Approaching sediment discharge is transmitted past the outflow boundary section without change. This turns the option on.
		0, 1	Sediment discharge is calculated at the outflow boundary. This returns the computation to the default conditions; i.e., it turns this option off.
		\$B	Table A4-1 - Transmissive Boundary
	\$HYD \$B \$RATING	2	
	* AB Q 100 T 60 W 1	Time Step :	0 0 520 525 528 ield 3 field 4 field 5 field 6 field 7  1, A level hydraulics, B level sediment 2 - No Output
	W 2		

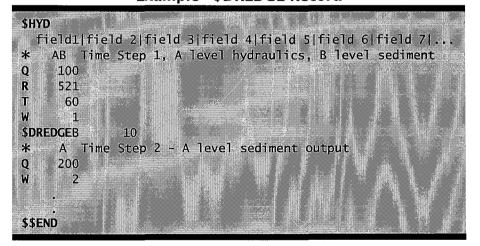
# A4.2 \$DREDGE Record - Dredging Option (optional)

The **\$DREDGE** record initiates dredging calculations to be performed at all cross sections where dredging parameters have been specified (H.6 - H.10). When the depth of water required for navigation (draft depth) specified in Field 2 is not available, HEC-6 will determine dredging elevations and compute the volume of dredged material removed during dredging. The dredging option is initiated at the beginning of the next time step following the **\$DREDGE** record. It continues to operate until turned off by a **\$NODREDGE** record later in the hydrologic data. The first **\$DREDGE** record must not precede the records which define the first time step. See Section 3.2.4 and Section 6.4.1 for further discussion of this option.

Field	Variable	Value		Description		
0	ID	\$DREDGE	Record id	Record identification.		
2	DFT	+	Depth of water required for navigation.			
			Note:	Detailed dredging output can be obtained by entering a print level flag in column 8 of the <b>\$DREDGE</b> record. Print levels range from Level A, which provides a small level of output to Level E which produces a detailed trace output through the dredging routines. For example, the <b>\$DREDGE</b> record in Table A4-2 the following record will turn on the dredging option, specify a draft depth of 10 ft and obtain		

Table A4-2 Example - \$DREDGE Record

a B level trace output.



# A4.3 \$NODREDGE Record - Dredging Option (optional)

The presence of a **\$NODREDGE** record stops the dredging option triggered previously by the **\$DREDGE** record.

Field	Variable	Value	Description
0	ID		Record identification

# A4.4 \$EX Record - Exner Options (optional)

HEC-6 has two different methods for solving the Exner equation. Method 1 (also known as EXNER1) is the original method used by HEC-6 prior to Version 4.0. Method 1 is described in detail in Section 2.3.3. Method 2 (a.k.a. EXNER5) is currently the default method used in HEC-6. A detailed discussion of this method can be found in Section 2.3.4.

The purpose of the **\$EX** record is to provide the user access to Method 1. To exercise this option, place a **\$EX** record with a 1 in field 1 immediately after the **\$HYD** record. Otherwise, HEC-6 will default to Method 2.

Field	Variable	Value	Description
0	ID	\$EX	Record identification.
1	OPTION	1	Method 1 for hydraulic sorting will be used (see Section 2.3.3).
		2	Method 2 for hydraulic sorting will be used (see Section 2.3.4). Default.

Table A4-3 \$EX - Alternate Exner Equation

\$HYD
SEX 1
field1 field 2 field 3 field 4 field 5 field 6 field 7
<pre>* AB Time Step 1, A/B Level Output</pre>
Q 100
Г 60
1
R 521
K Time Step 2 - No Output
<b>2</b> 200
2
\$\$END

# A4.5 \$GR Record - Cross Section Shape Option (optional)

By default, HEC-6 retains the original cross section shape by adjusting the elevation of each cross section point below the water surface and within the movable bed by a constant amount for deposition and erosion after each time step. The **\$GR** option 2 causes HEC-6 to vary the depth of deposit at each point of a cross section in proportion to the depth of flow at that point. Thus, deeper portions of a cross section will receive more deposited material than more shallow areas. The elevation of each point in the wet portion of the movable bed is still adjusted, but the amount of deposition at each point depends on the depth of flow at that point in the cross section. Erosion remains uniform. Figures 3-12 and 3-13 in Section 3.7.3 illustrate this operation.

Field	Variable	Value	Description
0	ID	\$GR	Record identification.
1	OPTION	2	Vary the amount of deposition depending on depth. (A "2" in field 1 turns the <b>\$GR</b> option on.)
		0	Move Y-coordinates by a constant amount after each time step. (A "0" in field 1 turns the <b>\$GR</b> option off; i.e., this returns the method of deposition back to the default.)

Table A4-4 \$GR - Nonuniform Deposition Option

	2 Tield1 field	2 field 3 fie	1d 4 fie1d 5 f	ield 61fi	ield 71
	TING	zji ielu sji ie	ia spricia spr		
RC	3 10	0 0	0 520	525	528
*	AB Time St	ep 1, A/B Lev	el Output		
Q	100				
Т	60				
W	1				
*	Time St	ep 2 - No Out	put		
Q	200				
W	2				
\$\$E	END				

# A4.6 **\$KL - \$KI Records - Channel** *n* **Values by Relative Roughness (optional)**

When a **\$KL** record is encountered, HEC-6 ignores the Manning's *n* values for the channel given on the **NC** and/or **NV** records and calculates bed roughness as a function of the bed material gradation via Limerinos' (1970) relative roughness method. A detailed description of this option is given in Section 3.2.2.

Field	Variable	Value	Description
0	ID	\$KL	Record identification. Use Limerinos' Roughness Method.

\$KI Use Manning's *n* values. Default Method.

Table A4-5 \$KL - Limerinos' Relative Roughness Option

\$HY	D						
\$KL							
f	ield1 fi	eld 2 fie	2]d 3 fi€	ald 4 fi	eld 5 fi	eld 6 fi	ield 7]
\$RA	TING						
RC	3	100	0	0	520	525	528
*	AB Tim	e Step 1	, A/B Lev	vel Outp	but		
Q	100						
Т	60						
W	1						
*	Tim	ie Step 2	- No Ou	tput			
Q	200						
W	2						
	•						
\$\$E	ND .						

# A4.7 \$PRT Record - Selective Output Option (optional)

The **\$PRT** record is used alone to turn output on or off for all cross sections. It is also used preceding **CP** and **PS** records to generate output at specified cross sections. An **END** record is required at the end of the **CP-PS** record set to mark the end of the selective output request. See Example Problem 6 in Chapter 6 for an example of this option.

Field	Variable	Value	Description
0	ID	\$PRT	Record identification.
Column 8	OPTION	N	Turn output <b>off</b> at all sections.
		Α	Turn output <b>on</b> at all sections.
		blank	Directs HEC-6 to look for <b>CP</b> and <b>PS</b> records to determine selected cross sections for output.

Table A4-6 \$PTR - Selective Output Option

3PTK - Selective Output Option
SHYD
Turn output OFF for ALL cross section
SPRT N
field1 field 2 field 3 field 4 field 5 field 6 field 7
\$RATING
RC   3   100   0   520   525   528
* AB Time Step 1, A level hydraulics, B level sediment Q 100
T 60
Turn output ON for ALL cross section
\$PRT A
* Time Step 2 - B level sediment output
Q 200
<b>W</b> 2
<pre>* Time Step 3 - B level sediment</pre>
Q 200
W 2
Turn output on at cross sections 15.0 and 33.2 ONLY <pre>\$PRT</pre>
CP 1
PN 15.0 33.2
field1 field 2 field 3 field 4 field 5 field 6 field 7
\$RATING
RC 3 120 0 0 530 536 540
* Time Step 4 - C level sediment
Q 200
W 2
\$\$END

# A4.8 CP Record - Selective Output (see \$PRT record - optional)

The **CP** record defines the stream segment for which the cross sections given on the **PS** record(s) apply. Each **CP** record must be followed by one or more **PS** records.

Field	Variable	Value	Description
0	ID	СР	Record identification.
2	NGDS	+	Stream segment number.

# A4.9 PS Record - Selective Output (see \$PRT Record - optional)

Use the **PS** record to specify the cross sections where output is desired. Each set of **PS** records applies to the stream segment defined on the **CP** record immediately preceding it. Additional **PS** records may be used if more than ten cross sections per stream segment are requested. When specifying the desired cross section for printing, use its identification number, as entered on the **X1** record.

Field	Variable	Value	Description
0	ID .	PS	Record identification.
1-10	SECNO	+	Enter the identification number of the desired cross section as given in Field 1 of the X1 record. HEC-6 generates output for each SECID on the current stream segment defined by the preceding <b>CP</b> record.

# A4.10 END Record - Selective Output (see \$PRT Record; optional)

An END record is used to indicate the end of the **\$PRT** data. This record should be placed after the last **PS** record. If output for cross sections on more than one stream segment is desired, sets of **CP** and **PS** records may be stacked one after another. The END record is inserted only after the last set.

Field	Variable	Value	Description
0	ID	END	Record identification.

# A4.11 \$RATING Record - Tailwater Rating (optional)

A starting water surface elevation must be specified at the downstream boundary for every time step. HEC-6 provides several methods for prescribing this downstream boundary condition. Specification of a tailwater rating curve is one of these methods.

The rating curve is specified using a **\$RATING** record followed by a set of **RC** records. The **\$RATING** record indicates that a set of **RC** records follows containing rating curve information. The rating curve can be input immediately after the **\$HYD** record or before any **\*** record in the hydrologic data. Once a rating curve has been input it can be changed by inputting a new rating curve (a new set of **\$RATING** and **RC** records) before any **\*** record later in the hydrologic data. Table A4-6 illustrates the use of the **\$RATING** option.

Field	Variable	Value	Description
0	ID	\$RATING	Record identification.

#### A4.12 RC Record - Tailwater Rating

The **RC** (rating curve) records prescribe the tailwater elevation as a rating curve.

Field	Variable	Value	Description
0	ID	RC	Record identification.
1			Leave blank.
2	MNI	+	The number of water surface values that will be read. (May not exceed 40).
3	TINT	+	The <b>discharge interval</b> between water surface values in cfs. Use as small an interval as desired, but it must be a constant for the full range of water surface elevations that follow.
4	QBASE	+	If the <b>first discharge</b> in the table is not zero enter its value here in cfs.
5	GZRO	+	If the rating table is a stage-discharge curve rather than elevation-discharge, enter <b>gage zero</b> here.
6	RAT(1)	+	Lowest water surface elevation or stage goes here.
7-10	RAT(2) RAT(MNI)		Continue entering <b>water surface elevation or stage</b> <b>values</b> defining the rating curve using Fields 7-10 on this record and Fields 2-10 on continuation <b>RC</b> records. A maximum of 40 points can be entered to define the curve.

#### A4.13 **\$SED Record - Water Discharge-Sediment Load Table (optional)**

This HEC-6 command option allows the user to change a sediment load table during a simulation. A change to a sediment load table can be made by either entering a new sediment load table definition on LPOINT, LQ, LT and LF records or by altering the existing table with a ratio defined on an LRATIO record.

A \$SED command precedes a LPOINT, LQ, LT, LF record combination that defines the discharge-sediment load rating curve. It should also precede an LRATIO record. The LPOINT record is used to specify the location where the new sediment load table applies. It is required with the LQ, LT and LF records. An END record completes the \$SED data records.

If the sediment load table for the main stem or a tributary is to be replaced, see the input descriptions for the LQ, LT and LF records given in Sections A2.10 to A2.12. However, if the sediment load table for a local inflow or outflow is to be replaced, refer to the input description for the LQL, LTL, and LFL records given in Sections A2.15 to A2.17 instead (i.e. LQ, LT, LF records are used for the main channel and tributaries. The LQL, LTL and LFL records are used for local inflows and outflows).

Field	Variable	Value	Description
0	ID	\$SED	Record identification.
			Table A4-7

\$SED - Replace Sediment Loa	d Table
<pre>\$HYD field1 field 2 field 3 field 4 field 5 1 \$RATING</pre>	field 6 field 7
RC         3         100         0         0         520           *         AB         Time         Step 1, A/B         Level         Output           Q         100         7         60         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1         9         1 <th1< th=""> <th1< th=""> <th1< th=""> <th1< th=""><th>525 528</th></th1<></th1<></th1<></th1<>	525 528
LPOINT 1 1 LQ LT LF CLAY	
LF VCS END * Time Step 2 - No Output Q 200 W 2 \$SED	
LRATIO -3 0 1.1	
* AB Time Step n, A/B Level Output Q 100 W 1 \$\$END	

**\$SED** 

# A4.14 LPOINT Record - Inflow Point Identification for the Water Discharge-Sediment Load Table (optional)

The LPOINT record defines the stream segment and/or inflow point whose sediment load table will be modified by the succeeding set of LQ, LT, and LF records. The LPOINT record is only used with the \$\$ED option and should not be used with the L records in the sediment data.

Field	Variable	Value	Description
0	ID	LPOINT	Record identification.
2	NGDS	+	Stream segment number
3	NLOC	+	Local inflow/outflow point number.

# A4.15 LRATIO Record - Ratio for the Water Discharge-Sediment Load Table (optional)

When changing the sediment discharge with the **\$SED** option, the existing sedimentdischarge load table can be modified by entering an **LRATIO** record with a constant multiplier, rather than by entering a whole new table.

Field	Variable	Value	Description
0	ID	LRATIO	Record identification.
2	NGDS	+	Stream segment number.
3	NLOC	+	Local inflow/outflow point number.
4	RATIO	+	Existing sediment-discharge rating curve will be multiplied by RATIO.

#### A4.16 END Record - Termination Record for the \$SED Option

An END record is used to indicate the end of the changes made to the sediment load table(s). This record should be inserted after the last LRATIO or LF record. If changes are to be made to more than one sediment load table, LRATIO records and/or sets of LPOINT, LQ, LT, LF records may be stacked one after another. Insert the END record only after the last set of change records.

Field	Variable	Value	Description
0	ID	END	Record identification

The **\$VOL** command causes HEC-6 to calculate the cumulative bed change and load passing each cross section.

Field	Variable	Value	Description
0	ID	\$VOL	Record identification
Column 7	OPTION	Х	Causes HEC-6 to look for a VJ record immediately after the <b>\$VOL</b> command and compute the storage volume for a table of elevations specified on succeeding VR records.
Column 8	TRACE	Α	Additional output showing cumulative weight of sediment passing each cross section by size class.
		В	A-level output plus extra trace information from the PRTVOL and STOVOL routines. (Not recommend for normal applications.)

# A4.18 VJ Record - Elevation Table for Cumulative Volume Computations (optional; see \$VOL Record)

Field	Variable	Value	Description
0	ID	VJ	Record identification.
1	JM	1-30	The number of elevation values which are listed on the following <b>VR</b> records. Limited to thirty values.
2	AVGSLO	0	Compute volumes based on planes with no slope.
		+	Compute volumes based on planes having slope AVGSLO.

# A4.19 VR Record - Elevation Table for Cumulative Volume Computations (optional; see \$VOL Record)

Field	Variable	Value	Description
0	ID	VR	Record identification.
1	ELSTO(1)	-, 0, +	Enter up to thirty elevations in Fields 1 through 10 on this and succeeding <b>VR</b> records.

# **Appendix B**

# Glossary

ACCURACY Degree of conformity of a measure to a standard or true value.

- ACTIVE BED The active bed is the layer of material between the bed surface and a hypothetical depth at which no transport will occur for the given gradation of bed material and flow conditions. See also, ACTIVE LAYER.
- ACTIVE LAYER The depth of material from bed surface to equilibrium depth continually mixed by the flow, but it can have a surface of slow moving particles that shield the finer particles from being entrained by the flow. See Figure B-1.

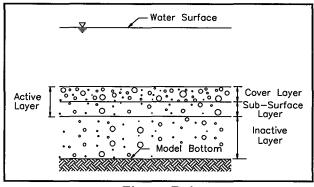


Figure B-1 Composition of the Active Layer

- **AGGRADATION** The geologic process by which stream beds, floodplains, and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.
- ALGORITHM A procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation. A step by step procedure for solving a problem or accomplishing an end. A set of numerical steps or routines to obtain a numerical output from a numerical input.
- ALLUVIAL Pertains to alluvium deposited by a stream or flowing water.
- ALLUVIAL DEPOSIT Clay, silt, sand, gravel, or other sediment deposited by the action of running or receding water.
- ALLUVIAL REACH A reach of river with a sediment bed composed of the same type of sediment material as that moving in the stream.
- ALLUVIAL STREAM A stream whose channel boundary is composed of appreciable quantities of the sediments transported by the flow, and which generally changes its bed forms as the rate of flow changes.
- ALLUVIUM A general term for all detrital deposits resulting directly or indirectly from the sediment transported by (modern) streams, thus including the sediments laid down in riverbeds, floodplains, lakes, fans, and estuaries.

#### ARMOR LAYER See ARMORING.

- **ARMORING** The process of progressive coarsening of the bed layer by removal of fine particles until it becomes resistant to scour. The coarse layer that remains on the surface is termed the "armor layer". Armoring is a temporary condition; higher flows may destroy an armor layer and it may re-form as flows decrease. Or simply, the formation of a resistant layer of relatively large particles resulting from removal of finer particles by erosion.
- **AVERAGE END CONCEPT** The averaging of the two end cross sections of a reach in order to smooth the numerical results.
- **BACKWATER PROFILE** Longitudinal profile of the water surface in a stream where the water surface is raised above its normal level by a natural or artificial obstruction.

- **BANK SEDIMENT RESERVOIR** The portion of the alluvium on the sides of a channel. See Figure B-2. (Note: HEC-6 only uses the BED SEDIMENT RESERVOIR as the source-sink of material.)
- **BED FORMS** Irregularities found on the bottom (bed) of a stream that are related to flow characteristics. They are given names such as "dunes", "ripples", and "antidunes". They are related to the transport of sediment and interact with the flow because they change the roughness of the stream bed. An analog to stream bed forms are desert sand dunes (although the physical mechanisms for their creation and movement may be different).
- **BED LAYER** An arbitrary term used in various procedures for computation of sediment transport. From observation of slow motion movies of laboratory flume experiments, H. Einstein defined the "bed layer" as: "A flow layer, 2 grain diameters thick, immediately above the bed. The thickness of the bed layer varies with the particle size."
- **BED LOAD** Material moving on or near the stream bed by rolling, sliding, and sometimes making brief excursions into the flow a few diameters above the bed, i.e. jumping. The term "saltation" is sometimes used in place of "jumping". Bed load is bed material that moves in continuous contact with the bed; contrast with SUSPENDED LOAD.
- **BED LOAD DISCHARGE** The quantity of bed load passing a cross section in a unit of time, i.e. the rate. Usually presented in units of tons per day. May be measured or computed. See BED LOAD.
- **BED MATERIAL** The sediment mixture of which the moving bed is composed. In alluvial streams, bed material particles are likely to be moved at any moment or during some future flow condition. Bed material consists of both bed load and suspended load. Contrast with WASH LOAD.
- **BED MATERIAL DISCHARGE** The total rate (tons/day) at which bed material (see BED MATERIAL) is transported by a given flow at a given location on a stream.
- **BED MATERIAL LOAD** The total rate (tons/day) at which bed material is transported by a given location on a stream. It consists of bed material moving both as bed load and suspended load. Contrast with WASH LOAD.
- **BEDROCK** A general term for the rock, usually solid, that underlies soil or other unconsolidated, bed material.
- **BED SEDIMENT CONTROL VOLUME** The source-sink component of sediment sources in a river system (the other

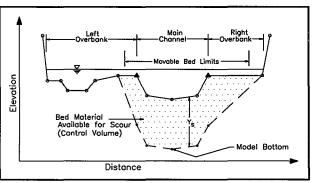


Figure B-2 Sediment Material in the Streambed

component is the suspended sedment in the inflowing discharge). Its user-defined dimensions are the movable bed width and depth, and the average reach length.

**BOUNDARY CONDITIONS** Definition or statement of conditions or phenomena at the boundaries. Water surface elevations, flows, sediment concentrations, etc., that are specified at the boundaries of the area being modeled. The downstream water surface elevation and the incoming upstream water and sediment discharges are the standard HEC-6 boundary conditions.

**BOUNDARY ROUGHNESS** The roughness of the bed and banks of a stream or river. The greater the roughness, the greater the frictional resistance to flows; and, hence, the greater the water surface elevation for any given discharge.

- **BRAIDED CHANNEL** A stream that is characterized by random interconnected channels divided by islands or bars. Bars which divide the stream into separate channels at low flows are often submerged at high flow.
- **CHANNEL** A natural or artificial waterway which periodically or continuously contains moving water.
- **CHANNEL INVERT** The lowest point in the channel.
- **CHANNEL STABILIZATION** A stable channel is neither progressively aggrading nor degrading, or changing its cross-sectional area through time. It could aggrade or degrade slightly, but over the period of a year, the channel would remain similar in shape and dimensions and position to previous times. Unstable channels are depositing or eroding in response to some exterior conditions. Stabilization techniques consist of bank protection and other measures that work to transform an unstable channel into a stable one.
- CLAY See Table B-1.

**COBBLES** See Table B-1.

Class Name	Millimeters	Feet	PHI Value
Boulders	> 256		< -8
Cobbles	256 - 64		-8 to -6
Very Coarse Gravel	64 - 32	.148596	-6 to -5
Coarse Gravel	32 - 16	.074216	-5 to -4
Medium Gravel	16 - 8	.037120	-4 to -3
Fine Gravel	8 - 4	.018560	-3 to -2
Very Fine Gravel	4 - 2	.009279	-2 to -1
Very Coarse Sand	2.0 - 1.0	.004639	-1 to 0
Coarse Sand	1.0 - 0.50	.002319	0 to +1
Medium Sand	0.50 - 0.25	.001160	+1 to +2
Fine Sand	0.25 - 0.125	.000580	+2 to +3
Very Fine Sand	0.125 - 0.0625	.000288	+3 to +4
Coarse Silt	0.0625 - 0.031	.000144	+4 to +5
Medium Silt	0.031 - 0.016	.000072	+5 to +6
Fine Silt	0.016 - 0.008	.000036	+6 to +7
Very Fine Silt	0.008 - 0.004	.000018	+7 to +8
Coarse Clay	0.004 - 0.0020	.000009	+8 to +9
Medium Clay	0.0020 - 0.0010		+9 to +10
Fine Clay	0.0010 - 0.0005		+10 to +11
Very Fine Clay	0.005 - 0.00024		+11 to +12
Colloids	<0.00024		> +12

 Table B-1<sup>1</sup>

 Scale for Size Classification of Sediment Particles

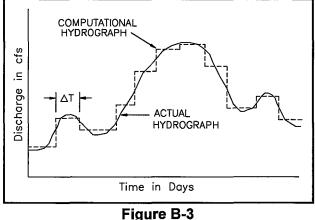
<sup>&</sup>lt;sup>1</sup> Portions of Table B-1 are taken from EM 1110-2-4000, March 1988.

**COHESIVE SEDIMENTS** Sediments whose resistance to initial movement or erosion is affected mostly by cohesive bonds between particles.

### COMPUTATIONAL HYDROGRAPH A

sequence of discrete steady flows, each having a specified duration in days, is used to represent the continuous discharge hydrograph. This is done to minimize the number of time steps needed to simulate a given time period, and, thus minimize computer time. See Figure B-3.

**CONCENTRATION OF SEDIMENT** The dry weight of sediment per unit volume of water-sediment mixture, i.e. mg/l. (Note: In earlier writings, concentration was calculated as the ratio of the dry weight of sediment in a water-sediment mixture to the total weight of the mixture multiplied



Computational Hydrograph

by 1,000,000. It was expressed as parts per million, i.e. ppm. Either method gives the same result, within one percent, for concentrations up to 16,000 mg/ $\ell$ . A correction is needed for concentrations in excess of that value.) The conversion to mg/ $\ell$  (miligrams per liter) from ppm (parts per million) is as follows:

$$mg/\ell = K \cdot (ppm) = K \cdot \frac{weight of sediment \cdot 1,000,000}{weight of water - sediment mixture}$$

where: K = correction factor

- **CONCEPTUAL MODEL** A simplification of prototype behavior used to demonstrate concepts.
- **CONSOLIDATION** The compaction of deposited sediments caused by grain reorientation and by the squeezing out of water trapped in the pores.
- **CONTROL POINT** The downstream boundary of the main river segment and the junction point of each tributary. In Figure B-4, each control point is designated by a circled number.
- **CONVERGENCE** The state of tending to a unique solution. A given scheme is convergent if an increasingly finer computational grid leads to a more accurate solution.
- **CONVEYANCE** A measure of the carrying capacity of the channel section. Flow is directly proportional to conveyance for steady flow. From Manning's equation, the proportionality factor is the square root of the energy slope.

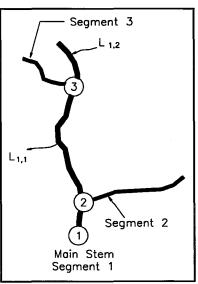


Figure B-4 Control Point Numbering

**COVER LAYER** One of the two sublayers of the active layer. It lies above the sub-surface layer (the second sublayer in the active layer). See Figure B-1.

**CRITICAL BED SHEAR STRESS** See CRITICAL TRACTIVE FORCE.

- **CRITICAL DEPTH** If discharge is held constant and the water depth allowed to decrease, as in the case of water approaching a free overfall, velocity head will increase, pressure head will decrease, and total energy will decrease toward a minimum value where the rate of decrease in the pressure head is just counter-balanced by the rate of increase in velocity head. This is the critical depth. More generally, the critical depth is the depth of flow that would produce the minimum total energy head.
- **CRITICAL FLOW** The state of flow where the water depth is at the critical depth and when the inertial and gravitational forces are equal.
- **CRITICAL TRACTIVE FORCE** The critical tractive force is the maximum unit tractive force that will not cause serious erosion of the material forming the channel bed on a level surface.
- **CROSS SECTION** Depicts the shape of the channel in which a stream flows. Measured by surveying the stream bed elevation across the stream on a line perpendicular to the flow. Necessary data for the computation of hydraulic and sediment transport information.
- **CROSS-SECTIONAL AREA** The area of a cross section between the stream bed and the water surface.
- **DEGRADATION** The geologic process by which stream beds, floodplains, and the bottoms of other water bodies are lowered in elevation by the removal of material from the boundary. It is the opposite of aggradation.
- **DEPOSITION** The mechanical or chemical processes through which sediments accumulate in a (temporary) resting place. The raising of the stream bed by settlement of moving sediment that may be due to local changes in the flow, or during a single flood event.
- **DEPTH OF FLOW** The depth of flow is the vertical distance from the bed of a stream to the water surface.
- **DISCHARGE** The discharge (Q) is the volume of a fluid or solid passing a cross section of a stream per unit time.
- **DISTRIBUTARIES** Diverging streams which do not return to the main stream, but discharge into another stream or the ocean.
- **DOMINANT DISCHARGE** A particular magnitude of flow which is sometimes referred to as the "channel forming" discharge. Empirical relations have been developed between "equilibrium" stream width, depth, and slope and dominant discharge. It has been variously defined as the bank full flow, mean annual discharge, etc.
- **DRAFT DEPTH** The depth measured perpendicularly from the water surface to the bottom of a boat, ship, etc. (i.e., a "clearance" depth).
- **DROP** A structure in an open conduit or canal installed for the purpose of dropping the water to a lower level and dissipating its energy. It may be vertical or inclined; in the latter case it is usually called a chute.
- **EFFECTIVE (GRAIN) SIZE** The diameter of the particles in an assumed rock or soil that would transmit water at the same rate as the rock or soil under consideration, and that is composed of spherical particles of equal size and arranged in a specific manner. The effective grain size is that single particle diameter that best depicts the bed material properties. The D50 grain size is often used as the effective grain size.

**EQUILIBRIUM DEPTH** The minimum water depth for the condition of no sediment transport.

- **ENTRAINMENT** The carrying away of bed material produced by erosive action of moving water.
- **EQUILIBRIUM LOAD** The amount of sediment that a system can carry for a given discharge without an overall accumulation (deposit) or scour (degradation).
- **EROSION** The wearing away of the land surface by detachment and movement of soil and rock fragments through the action of moving water and other geological agents.
- FALL VELOCITY The falling or settling rate of a particle in a given medium.
- FIXED BED MODEL Model in which the bed and side materials are nonerodible. Deposition does not occur as well.
- **FLOW DURATION CURVE** A measure of the range and variability of a stream's flow. The flow duration curve represents the percent of time during which specified flow rates are exceeded at a given location. This is usually presented as a graph of flow rate (discharge) versus percent of time that flows are greater than, or equal to, that flow.
- **FREQUENCY** The number of repetitions of a periodic process in a certain time period.
- **GEOLOGIC CONTROL** A local rock formation or clay layer that limits (within the engineering time frame) the vertical and/or lateral movement of a stream at a particular point. Note that man-made controls such as drop structures also exist.
- **GRADATION** The proportion of material of each particle size, or the frequency distribution of various sizes, constituting a particulate materialsuch as a soil, sediment, or sedimentary rock. The limits of each size are chosen arbitrarily. Four different gradations are significant: the gradation of the suspended load, the gradation of the bed load, the gradation of the material comprising the bed surface, and the gradation of material beneath the bed surface.
- **GRADATION CURVE** Sediment samples usually contain a range of grain sizes, and it is customary to break this range into classes of percentages of the total sample weight contained in each class. After the individual percentages are

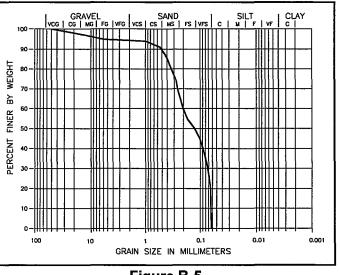


Figure B-5 Sample Gradation Curve

accumulated, a graph, the "gradation curve", shows the grain size versus the accumulated percent of material that is finer than that grain size. These curves are used by movable boundary models to depict the bed sediment material properties (e.g., grain size distribution of the bed material). See Figure B-5.

**GRAIN SHAPE FACTOR** See PARTICLE SHAPE FACTOR.

**GRAIN SIZE** See PARTICLE SIZE.

**GRAIN SIZE DISTRIBUTION (GRADATION)** A measure of the variation in grain (particle) sizes within a mixture. Usually presented as a graph of grain diameter versus percent of the mixture that is finer than that diameter. See Figure B-5.

**GRAVEL** See Table B-1.

- **HISTORIC FLOWS** The collection of recorded flow data for a stream during the period of time in which steam gages were in operation.
- HYDRAULIC MODEL A physical scale model of a river used for engineering studies.
- **HYDRAULICS** The study and computation of the characteristics, e.g. depth (water surface elevation), velocity and slope, of water flowing in a stream or river.
- **HYDROGRAPH** A graph showing, for a given point on a stream or conduit, the discharge,water surface elevation, stage, velocity, available power, or other property of water with respect to time.
- **HYDROLOGY** The study of the properties, distribution, and circulation of water on the surface of the land, in the soil, and in the atmosphere.
- **INACTIVE LAYER** The depth of material beneath the active layer. See Figure B-1.
- **INCIPIENT MOTION** The flow condition at which a given size bed particle just begins to move. Usually related to a "threshold" shear stress.
- **INEFFECTIVE FLOW** When high ground or some other obstruction such as a levee prevents water from flowing into a subsection, the area up to that point is ineffective for conveying flow and is not used for hydraulic computations until the water surface exceeds the top elevation of the obstruction. The barrier can be a natural levee, man-made levee or some other structure.

**INFLOWING LOAD CURVE** See SEDIMENT RATING CURVE.

**INITIAL CONDITIONS** The value of water levels, velocities, concentrations, etc., that are specified everywhere in the mesh at the beginning of a model run. For an iterative solution, the initial conditions represent the first estimate of the variables the model is trying to solve.

**IN SITU** In (its original) place.

LEFT OVERBANK See OVERBANK.

**LOCAL INFLOW/OUTFLOW POINT** Points along any river segment at which water and sediment enter or exit that segment as a local flow. Each local inflow/outflow point is designated by an arrow and  $L_{n,m}$  where *n* is the segment number and m is the sequence number (going upstream) of the local inflow/outflow points located along segment n, as shown in Figure B-6.

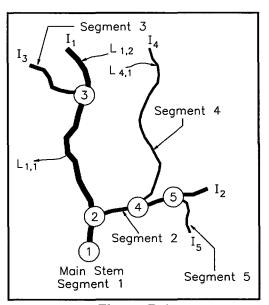


Figure B-6 Local Inflow/Outflow Points

- **LOCAL SCOUR** Erosion caused by an abrupt change in flow direction or velocity. Examples include erosion around bridge piers, downstream of stilling basins, at the ends of dikes, and near snags.
- M1 AND M2 CURVES M1 and M2 curves represent mild sloping water surface profiles.
- MAIN STEM The primary river segment with its outflow at the downstream end of the model.
- **MANNING'S EQUATION** The empirical Manning's equation commonly applied in water surface profile calculations defines the relationship between surface roughness, discharge, flow geometry, and rate of friction loss for a given stream location.
- **MANNING'S** *n* VALUE *n* is the coefficient of roughness with the dimensions of  $T \cdot L^{-1/3}$ . *n* accounts for energy loss due to the friction between the bed and the water. In fluvial hydraulics (movable boundary hydraulics), the Manning's *n* value includes the effects of all losses, such as grain roughness of the movable bed, form roughness of the movable bed, bank irregularities, vegetation, bend losses, and junction losses. Contraction and expansion losses are not included in Manning's *n*, but are typically accounted for separately.
- **MATHEMATICAL MODEL** A model that uses mathematical expressions (i.e., a set of equations, usually based upon fundamental physical principles) to represent a physical process.
- **MEANDERING STREAM** An alluvial stream characterized in planform by a series of pronounced alternating bends. The shape and existence of the bends in a meandering stream are a result of alluvial processes and not determined by the nature of the terrain (geology) through which the stream flows.
- **MODEL** A representation of a physical process or thing that can be used to predict the process's or thing's behavior or state.

Examples: A conceptual model: If I throw a rock harder, it will go faster. A mathematical model:  $F = m \cdot a$ A hydraulic model: Columbia River physical model.

- **MOVABLE BED** That portion of a river channel cross section that is considered to be subject to erosion or deposition.
- **MOVABLE BED LIMITS** The lateral limits of the movable bed that define where scour or deposition occur. See Figure B-2.
- **MOVABLE BED MODEL** Model in which the bed and/or side material is erodible and transported in a manner similar to the prototype.
- **NETWORK MODEL** A network model is a network of main stem, tributary, and local inflow/outflow points that can be simulated simultaneously and in which tributary sediment transport can be calculated.
- **NORMAL DEPTH** The depth that would exist if the flow were uniform is called normal depth.
- **NUMERICAL EXPERIMENTS** Varying the input data, or internal parameters, of a numerical model to ascertain the impact on the output.

**NUMERICAL MODEL** A numerical model is the representation of a mathematical model as a sequence of instructions (program) for a computer. Given approximate data, the execution of this sequence of instructions yields an approximate solution to the set of equations that comprise the mathematical model.

**ONE-DIMENSIONAL ENERGY EQUATION** This equation has the same form as the Bernoulli Equation and the same terms are present. In addition, an  $\alpha$  term has been added to correct for velocity distribution.

**OPERATING POLICY** See OPERATING RULE.

- **OPERATING RULE** The rule that specifies how water is managed throughout a water resource system. Often they are defined to include target system states, such as storage, above which one course of action is implemented and below which another course is taken.
- OVERBANK In a river reach, the surface area between the bank on the main channel and the limits of the floodplain. See Figure B-7.
- **OVERDREDGING** The additional depth dredged beyond the minimum dredging depth used to provide sufficient

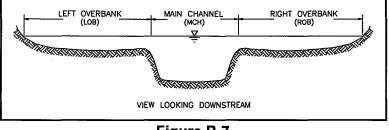


Figure B-7 Examples of Overbanks

navigational depth, to minimize

redredging, and to help compensate for the sloughing off and resettling of sediment after dredging occurs

- **PARAMETER** Any set of physical properties whose values determine the characteristics or behavior of something.
- **PARTICLE SHAPE FACTOR** The particle shape factor of a perfect sphere is 1.0 and can be as low as 0.1 for very irregular shapes. It is defined by:

$$SF = \frac{c}{(\mathbf{a} \cdot \mathbf{b})^{1/2}}$$

where: a,b,c = the lengths of the longest, intermediate, and shortest, respectively, mutually perpendicular axes on a sediment particle.

- **PARTICLE SIZE** A linear dimension, usually designated as "diameter", used to characterize the size of a particle. The dimension may be determined by any of several different techniques, including sedimentation sieving, micrometric measurement, or direct measurement.
- **PERMEABILITY** The property of a soil that permits the passage of water under a gradient of force.
- **PLANFORM** The shape and size of channel and overbank features as viewed from directly above.
- **PRIMARY TRIBUTARY** A tributary that is directly connected to or that joins with the main river segment.

**PROTOTYPE** The full-sized structure, system process, or phenomenon being modeled.

**QUALITATIVE** Relating to or involving quality or kind.

**RATING CURVE** See STAGE-DISCHARGE CURVE.

**REACH** (1) The length of a channel, uniform with respect to discharge, depth, area, and slope, e.g., "study reach", "typical channel reach" or "degrading reach", etc. (2) The length of a stream between two specified gaging stations.

**RIGHT OVERBANK** See OVERBANK.

**RIPPLES** Small triangular-shaped bed forms, similar to dunes but have much smaller heights and are 0.3m or less in length. They develop when the Froude number is less than 0.3.

**RIVER SEGMENT** See STREAM SEGMENT.

**S1 AND S2 CURVES** S1 and S2 curves represent steep sloping water surface profiles.

SAND See Table B-1.

- **SATURATION** The degree to which voids in soil are filled with water.
- **SCOUR** The enlargement of a flow section by the removal of bed material through the action of moving water.
- **SECONDARY CURRENTS (OR FLOW)** The movement of water particles on a cross section normal to the longitudinal direction of the channel.
- **SEDIMENT** (1) Particles derived from rocks or biological materials that have been transported by a fluid. (2) Solid material (sludges) suspended in or settled from water. A collective term meaning an accumulation of soil, rock and mineral particles transported or deposited by flowing water.
- **SEDIMENTATION** A broad term that pertains to the five fundamental process responsible for the formation of sedimentary rocks: (1) weathering, (2) detachment, (3) transportation, (4) deposition (sedimentation), and (5) diagenesis; and to the gravitational settling of suspended particles that are heavier than water.
- **SEDIMENTATION DIAMETER** The diameter of a sphere of the same specific weight and the same terminal settling velocity as the given particle in the same fluid.
- **SEDIMENT DISCHARGE** The mass or volume of sediment (usually mass) passing a stream cross section in a unit of time. The term may be qualified, for example; as suspended-sediment discharge, bed load discharge, or total-sediment discharge. See SEDIMENT LOAD.
- **SEDIMENT-DISCHARGE RELATIONSHIP** Tables which relate inflowing sediment loads to water discharge for the upstream ends of the main stem, tributaries, and local inflows.
- **SEDIMENT LOAD** A general term that refers to material in suspension and/or in transport. It is not synonymous with either discharge or concentration. It may also refer to a particular type of load; e.g. total, suspended, wash, bed, or material.
- **SEDIMENT PARTICLE** Fragments of mineral or organic material in either a singular or aggregate state.

SEDIMENT TRANSPORT (RATE) See SEDIMENT DISCHARGE.

- **SEDIMENT TRANSPORT FUNCTION** A formula or algorithm for calculating the sediment transport rate given the hydraulics and bed material at a cross section. Most sediment transport functions compute the bed material load capacity. The actual transport may be less than the computed capacity due to armoring, geologic controls, etc.
- **SEDIMENT TRANSPORT ROUTING** The computation of sediment movement for a selected length of stream (reach) for a period of time with varying flows. Application of sediment continuity relations allow the computation of aggradation and deposition as functions of time.

**SEDIMENT TRAP EFFICIENCY** See TRAP EFFICIENCY.

**SETTLING VELOCITY** See FALL VELOCITY.

**SHAPE FACTOR** See PARTICLE SHAPE FACTOR.

- **SHEAR INTENSITY** A dimensionless number that is taken from Einstein's bed load function. It is the inverse of Shield's parameter.
- **SHEAR STRESS** Frictional force per unit of bed area exerted on the bed by the flowing water. An important factor in the movement of bed material.
- **SHIELD'S DETERMINISTIC CURVE** A curve of the dimensionless tractive force plotted against the grain Reynolds number (i.e.,  $U_{\Omega} \cdot D_s / v$  where,  $U_{\Omega}$  = turbulent shear velocity,  $D_s$  = characteristic or effective size of the grains or roughness elements, v = kinematic viscosity) and which is used to help determine the CRITICAL TRACTIVE FORCE.
- **SHIELD'S PARAMETER** A dimensionless number referred to as a dimensionless shear stress. The beginning of motion of bed material is a function of this dimensionless number.

$$\frac{T_c}{(\gamma_s - \gamma) D_s}$$

where:  $T_c$  = critical tractive force

 $\gamma_s$  = specific weight of the particle

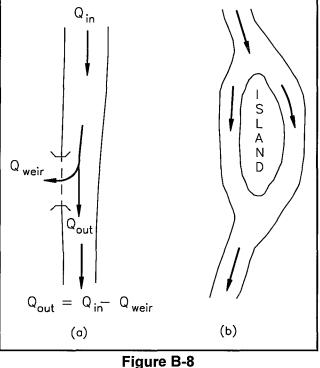
 $\gamma$  = specific weight of water

- $D_s$  = characteristic or effective size of the grains or roughness elements
- **SIEVE DIAMETER** The smallest standard sieve opening size through which a given particle of sediment will pass.
- **SILT** See Table B-1.
- **SILTATION** An unacceptable term. Use sediment deposition, sediment discharge, or sediment yield as appropriate.
- **SIMULATE** To express a physical system in mathematical terms.
- **SINUOSITY** A measure of meander "intensity". Computed as the ratio of the length of a stream measured along its thalweg (or centerline) to the length of the valley through which the stream flows.

- **SORTING** The dynamic process by which sedimentary particles having some particular characteristic (such as similarity of size, shape, or specific gravity) are naturally selected and separated from associated but dissimilar particles by the agents of transportation. Also, see GRADATION.
- **SPLIT FLOW** Flow that leaves the main river flow and takes a completely different path from the main river [Case (a)]. Split flow can also occur in the case of flow bifurcation around an island [Case (b)]. See Figure B-8.
- **STABLE CHANNEL** A stream channel that does not change in planform or bed profile during a particular period of time. For purposes of this glossary the time period is years to tens of years.

#### **STAGE-DISCHARGE (RATING)**

**CURVE** Defines a relationship between discharge and water surface elevation at a given location.



Split Flow

- **STANDARD STEP METHOD** Method where the total distance is divided into reaches by cross sections at fixed locations along the channel and, starting from one control, profile calculations proceed in steps from cross section to cross section to the next control.
- **STEADY STATE MODEL** Model in which the variables being investigated do not change with time.
- **STREAM GAGE** A device that measures and records flow characteristics such as water discharge and water surface elevation at a specific location on a stream. Sediment transport measurements are usually made at stream gage sites.
- **STREAM POWER** The product of bed shear stress and mean cross-sectional velocity at a cross section for a given flow.
- **STREAM PROFILE** A plot of the elevation of a stream bed versus distance along the stream.
- **STREAM SEGMENT** A stream segment is a specified portion of a river with an upstream inflow point and with a downstream termination at a control point. Primary Inflow points are designated by  $I_n$ , where *n* is the segment number. Primary inflow points are always at the upstream most end of a tributary or main stem segment. See Figure 3-7.
- **SUBCRITICAL FLOW** The state of flow where the water depth is above the critical depth. Here, the influence of gravity forces dominate the influences of inertial forces, and flow, having a low velocity, is often described as tranquil.
- **SUB-SURFACE LAYER** The sub-surface layer is composed of well mixed sediments brought up from the inactive layer plus sediment which has deposited from the water column. It will replenish the cover layer and thereby supply bed sediment as required to meet sediment transport capacity. When the weight in the sub-surface layer becomes less than the weight required to cover 100% of the bed surface to a depth of two times the size of the largest

particle in transport, a new sub-surface layer is brought up from the inactive layer. See Figure B-1.

- **SUPERCRITICAL FLOW** The state of flow where the water depth is below the critical depth, inertial forces dominate the gravitational forces, and the flow is described as rapid or shooting.
- **SUSPENDED BED MATERIAL LOAD** That portion of the suspended load that is composed of particle sizes found in the bed material.
- **SUSPENDED LOAD** Includes both suspended bed material load and wash load. Sediment that moves in suspension is continuously supported in the water column by fluid turbulence. Contrast with BED LOAD.
- **SUSPENDED-SEDIMENT DISCHARGE** The quantity of suspended sediment passing a cross section in a unit of time usually given in tons/day. See SUSPENDED LOAD.
- **TAIL WATER** The water surface elevation downstream from a structure, such as below a dam, weir or drop structure.
- **THALWEG** The line following the lowest part of a valley, whether under water or not. Usually the line following the deepest part or middle of the bed or channel of a river.
- **TOTAL SEDIMENT DISCHARGE** The total rate at which sediment passes a given point on the stream (tons/day). See TOTAL SEDIMENT LOAD.
- **TOTAL-SEDIMENT LOAD (TOTAL LOAD)** Includes bed load, suspended bed material load, and wash load. In general, total sediment load cannot be calculated or directly measured.
- **TRACTIVE FORCE** When water flows in a channel, a force is developed that acts in the direction of flow on the channel bed. This force, which is simply the pull of water on the wetted area, is known as the tractive force. In a uniform flow, the equation for the unit tractive force (i.e., the average value to the tractive force per unit wetted area) is:

 $T_0 = \gamma RS$ 

where:  $\tau_{o}$  = unit tractive force

- $\gamma$  = unit weight of water
- R = the hydraulic radius
- S = the slope of the channel
- **TRANSMISSIVE BOUNDARY** A boundary (cross section) that will allow sediment that reaches it to pass without changing that cross section.
- **TRANSPORTATION (SEDIMENT)** The complex processes of moving sediment particles from place to place. The principal transporting agents are flowing water and wind.
- **TRANSPORT CAPACITY** The ability of the stream to transport a given volume or weight of sediment material of a specific size per time for a given flow condition. The units of transport capacity are usually given in Tons per day of sediment transported passed a given cross section for a given flow. Transport capacity for each sediment grain size is the transport potential for that size material multiplied by the actual fraction of each size class present in the bed and bank material.
- **TRANSPORT POTENTIAL** Transport potential is the rate at which a stream could transport sediment of a given grain size for given hydraulic conditions if the bed and banks were composed entirely of material of that size.

- **TRAP EFFICIENCY** Proportion of sediment inflow to a stream reach (or reservoir) that is retained within that reach (or reservoir). Computed as inflowing sediment volume minus outflowing sediment volume divided by inflowing sediment volume. Positive values indicate aggradation; negative values, degradation.
- **TRIBUTARY** A river segment other than the main stem in which sediment transport is calculated. More generally, a stream or other body of water, surface or underground, that contributes its water to another and larger stream or body of water.
- **TURBULENCE** In general terms, the irregular motion of a flowing fluid.
- **WASH LOAD** That part of the suspended load that is finer than the bed material. Wash load is limited by supply rather than hydraulics. What grain sizes constitute wash load varies with flow and location in a stream. Sampling procedures that measure suspended load will include both wash load and suspended bed material load. Normally, that is of sediment particles smaller than 0.062 mm.
- **WATER COLUMN** An imaginary vertical column of water used as a control volume for computational purposes. Usually the size of a unit area and as deep as the depth of water at that location in the river.

WATER DISCHARGE See STREAM DISCHARGE.

- **WATERSHED** A topographically defined area drained by a river/stream or system of connecting rivers/streams such that all outflow is discharged through a single outlet. Also called a drainage area.
- **WEIR** A small dam in a stream, designed to raise the water level or to divert its flow through a desired channel. A diversion dam.
- **WETTED PERIMETER** The wetted perimeter is the length of the wetted contact between a stream of flowing water and its containing channel, measured in a direction normal to the flow.

# Index

#### Α

A-level 45, 55, 62, 63, 70, 82, 83, 101, 125. A-75 Accumulated Sediment Volumes 55 Ackers-White 4, 42, A-31 Active Layer 19, 22-25, 27, 28, 32, 83, 90-92, 105, 138, 139, 141, 142, 147, 151, 152, 157, A-28, B-3, B-6, B-9 Aggradation 40, 58, B-7, B-12, B-15 Alluvial 1, 15, B-3, B-4, B-10 Alluvial Stream 15, B-10 American Geophysical Union (AGU) 39 Ariathurai 3, 4, 32, A-26 Armor Calculations 17, 40 Armor Layer 1, 4, 20, 21, 23, 24, 27, 90-92, 105, 138, 141, 157, B-3 Armoring 1, 4, 7, 18, 22, 24, 25, B-3, B-12

#### В

B-Level 45, 53, 55, 62, 70, 82, A-3 Backwater Computations 8, 13, 54, 125, A-12, A-55 Bank Roughness A-8 Bed Elevation 5, 15, 18, 29, 30, 52, 54, 55 Bed Elevation 62, 63, A-33, A-52, B-7 Bed Elevation Change 29, 30 Bed Forms 5, 15, B-3, B-4, B-11 Bed Gradation 3, 18, 21, 25, 36, 54 Bed Gradation Curve 21 Bed Gradation Recomputations 18 Bed Layer 19, 20, 25, B-3, B-4 Bed Load 19, A-46, A-47, B-4, B-8, B-12, B-13, B-14, B-15 Bed Material 1, 3, 5, 8, 15-18, 20-22, 25, 27, 31, 41, 58, 77, 81-83, 86. 90-92, 105, 106, 129-132, 138, 139, 141, 142, 153, 156, 157, A-24, A-30, A-31, A-32, A-40, A-69, B-3, B-4, B-7, B-8, B-12, B-13, B-14, B-15 Bed Material Load B-12, B-14, B-15 Bed Sediment Reservoir 29, A-40, B-4 Bed Shear Stress 19, 23, 31, 32, 150, 156, A-25, A-26, A-28, A-30, B-14 Bend Losses 15, B-10 Boundary Conditions 2-4, 43, 44, 66, 82, 88, 89, 94, 96, 100, 102, 104, 116, 134-136, 138-141, 143-145, 153, 154, 156, 158, 159. B-4 Boundary Roughness 15

Bridges 3, 37, A-12

# С

C-Level 55, 81, 83, 100, 125, 150, A-3 Channel 1-4, 7, 10-13, 17, 29, 35-38, 42, 57, 63, 67, 69-71, 82, 84-86, 96, 102, 103, 113, 126-128, 130, 131, 150-152, A-1, A-4, A-5, A-8, A-9, A-10, A-11, A-14, A-15, A-16, A-17, A-46, A-47, A-69, A-73, B-3, B-4. B-5. B-6. B-7. B-10. B-11. B-12, B-13, B-15, B-16 Channel Bank Elevation A-10 Channel Contractions 2 Channel Stabilization B-5 Characteristic Rate for Deposition 28 Characteristic Rate of Entrainment 28 Characteristic Time 32 Clay 3, 4, 8, 30-33, 39, 41, 57, 90-92, 105, 107, 114, 117, 138, 141, 147, 149-159, B-5, B-8 Cobble 23, 39 **Cohesive Sediment Deposition 31** Cohesive Sediment Scour 32 Cohesive Sediments 4, 32, 33, A-26 Colby 4, 30, 42, A-31 **Composite Unit Weight 30** Computation Grid 17 Computational Hydrograph 40, 43, 58, B-6 Computational Oscillations 45 Computational Time Interval 18 Concrete Channel 29 Consolidation 30, 147 Continuity of Sediment 7, 15, 16, 18 Contraction Coefficient A-4 Contraction Losses 3, 7 Control Point 4, 43, 44, 46-51, 64, 65, 72, 89, 119, 120, 122, 123, 125-127, 133, 134, 137, 138, 154, 155, A-7, A-12, A-13, A-19, A-54, B-6, B-14 Control Volume 15-18, 20, 29, 41, 59, 63, 71, 81-85, 90-92, 101, 105, 106, 113, 114, 126, 127, 138, 141, 151, 156, A-16, A-17, B-16 Convergence 13 Conveyance 3, 4, 8, 9, 11, 29, 36-38, A-9, A-14, B-6 Cover Layer 25-28, B-14 Critical Depth 12, 13, B-6, B-7, B-14 Critical Shear Stress 41 Cross Section 1, 3-5, 7-13, 15, 17, 22, 29, 33, 35-37, 40, 44, 45, 48, 49, 52-55, 57, 58, 59-63, 66-68, 70,

73-77, 79, 82-84, 96, 100, 101, 107, 112, 113, 119, 120, 125, 126, 150, A-3, A-4, A-5, A-7, A-8, A-9, A-10, A-11, A-12, A-13, A-14, A-15, A-16, A-17, A-19, A-34, A-40, A-52, A-53, A-54, A-65, A-68, A-70, A-71, A-75, B-4, B-7, B-10, B-12, B-13, B-14, B-15 Cross Section Definition A-4, A-12 **Cross Section Elevation Adjustment** Factor A-9 Cross Section Shape Due To Deposition 29.52 **Cross Section Width Adjustment Factor** A-9

# D

Dams A-12 Degradation 17, 23, 40, 57, 58, B-3, B-8, B-15 Deposition 1-5, 7, 8, 15, 17, 18, 25, 26, 28, 29, 31, 36-38, 41, 52, 55, 63, 69, 70, 84, 101, 112, 113, 126, 147, 150-152, 156, A-16, A-24, A-25, A-26, A-28, A-29, A-30, A-68, B-3, B-8, B-10, B-12, B-13 **Discharge Calculations 55** Discharge Hydrograph 7, 42, 43, 58, B-6 Diversion 4, 49, A-7, A-42, A-43, A-44, A-45, A-46, A-47, A-54, B-16 Downstream Boundary 4, 7, 43-46, 50, 57, 61, 63-66, 69, 72, 82, 89, 93, 94, 100, 103, 104, 107, 109, 117, 120, 125, 133, 134-140, 142-145, 154, 155, 158, 159, A-12, A-13, A-34, A-54, A-55, A-57, A-65, A-72, B-6 Draft Depth 37, A-66 Dredged Channel 37, 96, 102, 103, A-9, A-17 Dredging Template A-9, A-16 Dry Weight 30, B-6 DuBoys 4, 41, A-31

# Ε

Effective Depth 12, 13, 23, 28, 42, 63, 83, A-35 Effective Width 12, 29, 42, 83, A-10, A-35 Einstein 1, 19, 24, 33, A-33, B-4, B-13 Einstein's Bed Load Function 19, B-13 Elevation of Model Bottom (EMB) A-16 Encroachment 1, 38, 67, 70, 71, 84, 113, 126, 151, A-10, A-11 Energy Equation 3, 8, 16 Energy Losses 3, 9, 15 Entrainment 25, 28, 32, 33 Equilibrium Concentration 28, 33 Equilibrium Conditions 5 Equilibrium Depth 19-22, 25, 26, B-3 Equilibrium Load 28 Erosion 1, 3, 22, 26-29, 32, 33, 41, 52, 66, 83, 147, 150-152, 156, A-25, A-26, A-28, A-29, A-40, A-68, B-3, B-5, B-7, B-9, B-10 Exner Equation 15, 17, 18, 22, A-67 Expansion Coefficient A-4

# F

Fall Velocity 31, 41, 83, A-25, B-12 Flow-duration Curve 58 Frequency 2, B-8 Friction Loss 7, 9, 36, B-10

# G

Geometric Data 35, 40, 44, 48-51, 53 Geometric Data 60, 62-64, 71, 78, 81, 85, 96, 100, 114, 119, 120, 125, 128, 151, A-3, A-18, A-19, A-54 Gessler 4, 20, 23, 24 Gradation Curve 21, B-8 Grain Roughness 15, B-10 Grain Shape Factor 41, A-33 Grain Size Distribution A-40, A-46, B-8 Gravel 8, 23, 39, 41, 77, 83, 85, 89-94, 103-107, 117, 128, 135-145, 152, 154-159, A-32, B-3, B-5

# Η

Hard Bottom Channel 29 Harrison 22, 25, 28 Head Loss 44, 67, 70-72, 74, 84, 113, 126, 133, A-12, A-13 Hydraulic Computations 37, 51, 109, 125, A-12, A-52, B-9 Hydraulic Control 43, 44, A-12 Hydraulic Losses 9 Hydraulic Parameters 8, 13, 14, 16, 42, 54, 70, 77, 83, 90-92, 100, 105, 106, 138, 141, 150, 156 Hydraulic Radius 9, 11, 36, B-15 Hydraulic Roughness 7, 15 Hydrologic Data 2, 36, 37, 42-46, 50-52, 55, 58, 81, 100, 125, A-12, A-13, A-49, A-51, A-52, A-54, A-55, A-59, A-60, A-66, A-72 Hypothetical Depth 20, B-3

#### I

ICWR 31, A-25 Inactive Layer 19, 22, 23, 25-27, 83, 90-92, 105, 138, 139, 141, 142, 147, 151, 152, 157, A-28, B-14 Ineffective Area 37, 38, A-9 Inflowing Sediment Load 3, 4, 16, 17, 39-41, 58, 78, 81, 82, A-37, A-38, A-39, A-46 Inorganic Sediments 57 Interior Points 14 Internal Boundary Condition 44, 66, 71, 72, 74, 82, 84, 113, 114, 126, 133, A-12 Islands 5, 16, B-5

# J

Junction 5, 15, 43, 44, 46, 48, 50, 82, 133-137, A-7, A-19, A-54, B-6, B-10

#### Κ

Krone 3, 4, 31, 32, 41, A-26, A-28

# L

Lateral Boundaries 10 Lateral Distribution 5 Laursen 4, 41, 42, A-31 Limerinos 3, 5, 36, 100, 101, A-69

#### Μ

Madden 4, 41, 42, A-31 Manning's Equation 3, 7, B-6, B-9 Manning's N 3, 7, 15, 36, 66, 73-76, 83, 100, A-4, A-5, A-69, B-10 Meanders 5, 16 Meyer-Peter and Muller 4, 23, 42, A-31 Miller 30 Movable Bed Limits 4, 7, 36, 38, 77, 81, 83, A-9, A-16 Mudflow 33

#### Ν

n value 36, 37, 100, A-4, A-5, A-36, B-10 Natural Levee Formation 38 Navigation 2, 4, 44, A-66 Network 2-5, 40, 43, 46-51, 59, 64, 71, 85, 114, 119, 120, 125, 126, 128, 151, B-10 Network Situations 2 Noncohesive Sediment Load 58 Normal Depth 3, 13, B-10

# 0

One-dimensional Energy Equation 3, 8 Overbank Reach Lengths 35, A-8, A-9 Overbank Subsection A-9 Overdredging A-17

#### Ρ

Parthenaides 3, 4, 32 Particle Shape Factor 31, B-8, B-11, B-12 Particle Size 19, 24, 28, 36, A-40, A-41, B-4, B-8 Post-processing A-53 Probability of Grain Stability 23 Profile 1, 3, 7, 8, 13, 15, 40, 45, 51, 55, 57, 60, 62, 64, 65, 69, 70, 72, 89, 93, 94, 103, 107, 117, 135-137, 139-142, 144, 145, 150, 154, 155, 158, 159, A-24, B-3, B-9, B-13

# R

Rating Curve 3, 7, 44, 45, 57, 60, 61, 63, 64, 69, 96, 100, 104, 150, 155, A-55, A-56, A-72, A-73, A-74 Rating Curve B-9 Reach Length 17, 18, 28, 31, 35, 36, 82, A-9, B-4 River Network 4, 43, 48, 49, 119 River Segment 46, 119, 120, 125, B-6, B-9, B-11, B-15 River System 3, 7, 16, 43, 46, 59, 100 B-4 Roughness 1, 5, 7, 9, 15, 42, 57, 60, 96, 100, 101, A-8, A-69, B-4, B-9, B-10, B-13 Rubey's Method 31

#### S

Sand 8, 17, 19, 25, 30, 31, 39-41, 57, 77, 80, 83, 85-94, 98, 102-108, 111, 114-117, 123, 128-132, 134-145, 149, 152-159, A-31, A-32, A-33, A-53, B-3, B-4, B-5 Schoklitsch 4, 42, A-31 Scour 1-5, 7, 8, 15, 17, 18, 20-22, 24, 25, 28, 29, 32, 36-38, 41, 55, 57, 63, 70, 84, 101, 112, 113, 126, 147, 150, A-16, A-24, A-29, B-3, B-8, B-10 Secondary Currents 5, B-12 Sediment Computations 2, 37, 51, 54, 81, 82, A-40 Sediment Data 39, 46, 48-50, 53, 57, 60, 77, 81, 82, 87, 101, 114, 119, 120, 125, 132, 147, 149, 153, A-19, A-23, A-42, A-74 Sediment Discharge 4, 17, 24, 25, 28, 43, 44, 49, 58, A-42, A-65, A-74, B-12, B-13 Sediment Load 3-5, 7, 16-18, 31, 39-41, 43, 49, 54, 55, 58, 78, 81, 82, 85, 87-89, 91-94, 96, 100, 102-106, 116, 117, 120, 128-131, 134-145, 150, 152-159, A-31, A-37, A-38, A-39, A-42, A-43, A-45, A-46, A-47, A-53, A-73, A-74, B-12, B-15 Sediment Mixture 19, B-4, B-6 Sediment Properties 31, 39, 41, 49, 85, 128, 149, 151, A-22, A-24 Sediment Reservoir 16, 29, 138, A-40, B-4 Sediment Transport 1-5, 8, 12, 15, 20, 27, 31, 41, 42, 45, 46, 55, 57, 60, 77, 80-82, 85, 98, 111, 119, 123, 128, 149, 151, A-24, A-28, A-53, B-4, B-7, B-10, B-12, B-14, B-15 Sediment Transport Capacity 12, 27, B-14 Sediment Transport Function 3 Sediment Transport Potential 4, 8, 42 Sediment Trap Efficiency 55 Sediment Volume Table 55 Sedimentation Diameter 31 Settling Velocity 3, 28, 31, A-26, A-29, A-58, B-12 Shape Factor 18, 31, 41, A-33, B-8, B-11, B-12

Shear Stress 19, 23, 31, 32, 41, 83, 147, 150, 156, A-25, A-26, A-28, A-30, B-9, B-13, B-14 Shield's Parameter 19, B-13 Sieve Diameter 31 Silt 3, 8, 30-33, 39, 41, 90-92, 105, 107, 114, 117, 138, 141, 149-159, A-25, A-26, A-28, A-29, A-30, A-53, B-3, B-5 Single Event Analysis 5 Sodium Adsorption 32 Sorting 1, 3, 20, 22, 25, A-67 Split Flow 3, B-14, B-13 Stage-discharge Rating Curve 7, 45 Standard Step Method 8, 13 Stream Power 4, 41, 80, 85, 98, 111, 123, 124, 128, 130, 131, 149, 151, A-31 Stream Segment 40, 43, 46, 48, 50, 51, 54, 55, 63-65, 71, 72, 80, 81, 83, 85-89, 93, 94, 98, 102-104, 106, 107, 111, 114-117, 119, 120, 122-145, 147, 151-159, A-3, A-18, A-23, A-40, A-42, A-54, A-71, A-74, B-11, B-14 Sub-Surface Layer 25-28, B-6, B-14 Subcritical Flow 12, 13 Subsections 9-11, 35, 54, 57, A-5 Supercritical Flow 3, 12, 13, A-65 Suspended Load 1, 40, A-46, A-47, B-4, B-8, B-14, B-15

# Т

Tailwater 44, 70, A-13, A-72 Temperature 4, 43, 45, 49, 54, 60, 64, 65, 72, 73, 75, 81, 83, 88, 89, 91, 94, 102, 104, 105, 116, 125, 133-141, 143, 144, 145, 153-156, 158, 159 Temperature A-52, A-58, A-60 Thalweg 29, 54, 55, 77, 82, 86, 89, 93, 94, 103, 107, 112, 117, 128, 130, 131, 135-137, 139-142. 144, 145, 152, 154, 155, 158, 159, A-53, B-13 Time Step 4, 5, 8, 15, 17, 18, 20-23, 25-29, 32, 36, 43-45, 50, 51, 64, 65, 70, 72, 77, 81-83, 88, 89, 93, 96, 100, 102, 104, 112, 115, 116, 120, 125, 132, 137, 143, 150, 153-155, 158, 159, A-12, A-24, A-52, A-53, A-54, A-55, A-56, A-58, A-59, A-60, A-65, A-66, A-67, A-68, A-69, A-70, A-72, A-73

Toffaleti 4, 31, 41, 42, A-25, A-31 Tractive Force 23, B-6, B-7, B-13, B-15 Transition Losses A-4 Transmissive Boundary 4, 45, 96, 100, 101.106.A-65 Transport Capacity 12, 14-18, 20, 22, 24, 25, 27, 28, 39, 40, 85, 128, 152, 156, A-24, A-31, A-35, A-36, B-14, B-15 Transport Potential 4, 8, 15, 18, 33, 42, 54, B-15 Trap Efficiency 54, 55, 82, 83, 88, 93, 94, 100, 102, 106, 112, 115, 116, 134-137, 139, 140, 142-145, 150, 153, 154, 157-159, A-12, A-53, B-12 Tributaries 3, 4, 7, 8, 42, 46-48, 51, 63, 70, 84, 101, 113, 119, 125, 126, 150, A-54, A-73, B-12 **Tributary Inflow Point A-19** Tributary Junction 43, 44, 50, 82, 133-137, A-7 Tributary Sediment Data 49, A-19 Tributary Sediment Transport 3, B-10 **Tributary Systems A-19** Turbulence 19, 28, B-14

### U

Unit Weight 23, 30, 32, 41, 49, A-25, A-27, A-30, A-33, B-15 Upstream Boundary 43, 44, 57, 66, 68, 82, 83, 88, 89, 93, 94, 102-104, 106, 116, 117, 125, 134-145, 153, 154, 155-159, A-12, A-34

#### V

Velocity Distribution Factor 11 Volume of Deposits 4

#### W

Wash Load 4, B-4, B-14, B-15 Water Discharge 2, 4, 7-9, 20, 32, 40, 42, 43, 45, 50, 51, 78, 93, 107, 142, 158, A-31, A-37, A-38, A-39, A-42, A-43, A-44, A-45, A-46, A-47, A-73, A-74, B-12, B-14 Water Surface Elevation 3, 7, 12-14, 35, 37, 43-45, 50, 51, 54, 57, 62, 63, 66, 67, 69-71, 84, 109, 113, 125, 126, A-10, A-12, A-13, A-52, A-55, A-56, A-57, A-72, B-4, B-9, B-13, B-14 Water Surface Profile 1, 3, 7, 8, 13, 15, 45, 55, 57, 70, B-9 Water Surface Width 12 Water Temperature 4, 43, 45, 54, 81, 83, A-52, A-58 Water-Sediment Inflow Relationship 40 Weighting Factors 14, 15, 83, A-34 Weir 45, 57, 66, 68, 79, 97, B-14

#### Y

Yang 4, 41, 77, 80, 85, 98, 111, 123, 124, 128, 130, 131, 149, 151, 152, A-31